Appendix A – Existing and Future Needs and Opportunities Analysis

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Technical Memorandum

December 15, 2023 Project# 28673

To: Garrett Sabourin and Carrie Theus, City of Bend

From: Katie Popp, Jacki Smith, PE and Matt Kittelson, PE, Kittelson and Associates, Inc.

RE: Aune Street (East) Extension Study – Existing and Future Needs and Opportunities Technical Memorandum (Task 3.5)

INTRODUCTION

This memorandum documents the identification of existing and future needs and opportunities in support of the Aune Street (East) Extension Study. Needs and opportunities are identified based on an existing and future conditions assessment, which includes an analysis of traffic operations, bicycle facilities, pedestrian facilities, transit facilities, crash and speed data, and other key characteristics for 12 intersections and roadway facilities in the Aune Street (East) Extension Study Area.

The following sections describe the existing and future conditions assessment in more detail. The identified needs and opportunities will inform development and support the evaluation of conceptual alternatives.

Project Background

The Aune Street (East) Extension Study was identified through several City of Bend Planning efforts including the Central Westside Plan (2015) and the Bend Transportation System Plan (2020). The project was included in the voter approved 2020 Transportation General Obligation Bond (GO Bond) with funding allocated for planning, design and construction.

The purpose of the study is to identify and evaluate conceptual alternatives for the Aune Street extension and intersection improvements along 3rd Street between Clay Ave and Wilson Ave[1]. These infrastructure improvements will enhance the east-west connectivity in a core area of Bend, improving connectivity for all transportation users.

[1] The Aune Street extension is planned to extend west to Bond Street. The western portion of the extension (from Bond Street to the US 97 undercrossing) is being advanced by private development and is not included in this evaluation.

Plans and Policies Review

Kittelson reviewed existing City, County, and Statewide plans, policies, laws, and ordinances applicable to the Aune Street (East) Extension Study. The review summarizes guidelines, standards, goals, and key issues within the project influence area.

2040 Bend MPO Metropolitan Transportation Plan (2019)

The Bend Metropolitan Transportation Plan (MTP), adopted in 2019, is a regional document that serves as a multi-modal transportation plan designed to meet the anticipated 20-year transportation needs within the BMPO planning area boundary, including the area within the Bend UGB and portions of unincorporated Deschutes County outside of the Bend UGB.

Project Relevance: The recommended project alternatives in the Aune Street (East) Extension Study should align with goals and objectives outlined in the MTP.

Bend Transportation System Plan (TSP) (2020)

The Bend Transportation System Plan (TSP) provides a policy and plan framework that guides the City's transportation investments for the next 20 years.

Project Relevance: The Aune Street (East) Extension Study will be addressing several locations identified in the Bend TSP for transportation improvements, including the extension of Aune Road from Bond Street to 3rd Street (C-5), pedestrian/ bicycle crossing improvement at Clay Avenue/ 3rd Street (M-7), intersection improvements at 3rd Street/ Miller Ave (S-5 and S-6), and pedestrian/ biking crossing improvements along Key Walking and Biking Route 7 (R7-A, R7-B, and R7-C).

Bend Area Transportation Safety Action Plan (TSAP) (2019)

The Bend Area Transportation Safety Action Plan (TSAP) provides an approach that supports policy, programs, and project recommendations to achieve a vision of zero transportation fatalities or serious injuries on roads within the City of Bend.

Project Relevance: The 3rd Street area near Miller Avenue was identified in the TSAP for location-specific applications of safety treatments based on a screening of the Bend roadway network. Within the TSAP study period, there were 14 total crashes at 3rd Street and Miller Avenue. Of those crashes, 71% were turning movement crashes, with 80% of those turning movement crashes involving eastbound to northbound left-turning movements. Two of the 14 crashes resulted in a fatality or incapacitating injury.

City of Bend Core Area Project (CAP) Report (2020)

The Bend Core Area Project (CAP) outlines a common vision and action plan to support implementation of short- and long-term strategic investments in the Bend Core Area.

Project Relevance: The Aune Street (East) Extension Study area overlaps parts of the Greater Korpine, Wilson, and Bend Central District sub-areas defined by the Core Area Project. Therefore, the intended outcomes of the Aune Street (East) Extension Study will consider outcomes of the Core Area Plan and support implementation of the Report's key recommendations.

Central Westside Plan (CWP) (2016)

The objective of the Central Westside Plan is to create a strategy for land use and transportation system that supports a vibrant and livable community in the Central Westside area.

***Project Relevance*:** The Aune Street (East) Extension Study will consider key findings and outcomes of the Central Westside Study when developing recommended project alternatives that enhance east-west connectivity in Bend.

Bend Parkway Plan (BPP) (2020)

The Bend Parkway Plan (BPP) outlines a multi-phase approach to improve safety, mobility, active transportation, and transit use on US97 in Bend.

Project Relevance: Recommended improvements by the BPP at the Colorado Avenue interchange will be considered in the development of project alternatives in the Aune Street (East) Extension Study.

2040 Cascades East Transit (CET) Master Plan and Bend Mobility Hub Feasibility Study (2022)

The 2040 CET Master Plan is a long-range planning document that outlines transit service in Central Oregon through 2040. The need for a Mobility Hub Feasibility Study was identified through the 2040 Master Plan and conducted in 2022.

Project Relevance: The alternatives development process of the Aune Street (East) Extension Study will consider CET's long-range plans within the study area, including a possible mobility hub within the vicinity of the Old Mill District.

Deschutes County Intelligent Transportation (ITS) System Plan (2020)

The Deschutes County ITS Plan identifies provides a strategic approach for implementing ITS technologies in Deschutes County to improve safety and management of the transportation system.

Project Relevance: The Aune Street (East) Extension Study will consider ITS needs and opportunities outlined in the ITS Plan when developing recommended project alternatives.

Central Oregon Rail Plan (2009)

The Central Oregon Rail Plan develops a regional strategy for Crook, Jefferson, and Deschutes counties to address various safety and congestion issues associated with roadway/railway at-grade crossings and to enhance freight mobility.

Project Relevance: The Aune Street (East) Extension Study will consider safety and congestion issues at at-grade crossings within the study area in the development of recommended project alternatives.

Urban Growth Boundary Expansion Remand (2016)

The Urban Growth Boundary Expansion Remand project provides land needs to plan for Bend's projected housing and employment growth and identifies nine opportunity areas in Bend for development.

Project Relevance: The Aune Street (East) Extension Study is in the KorPine Opportunity Area identified by the UGB Expansion Remand.

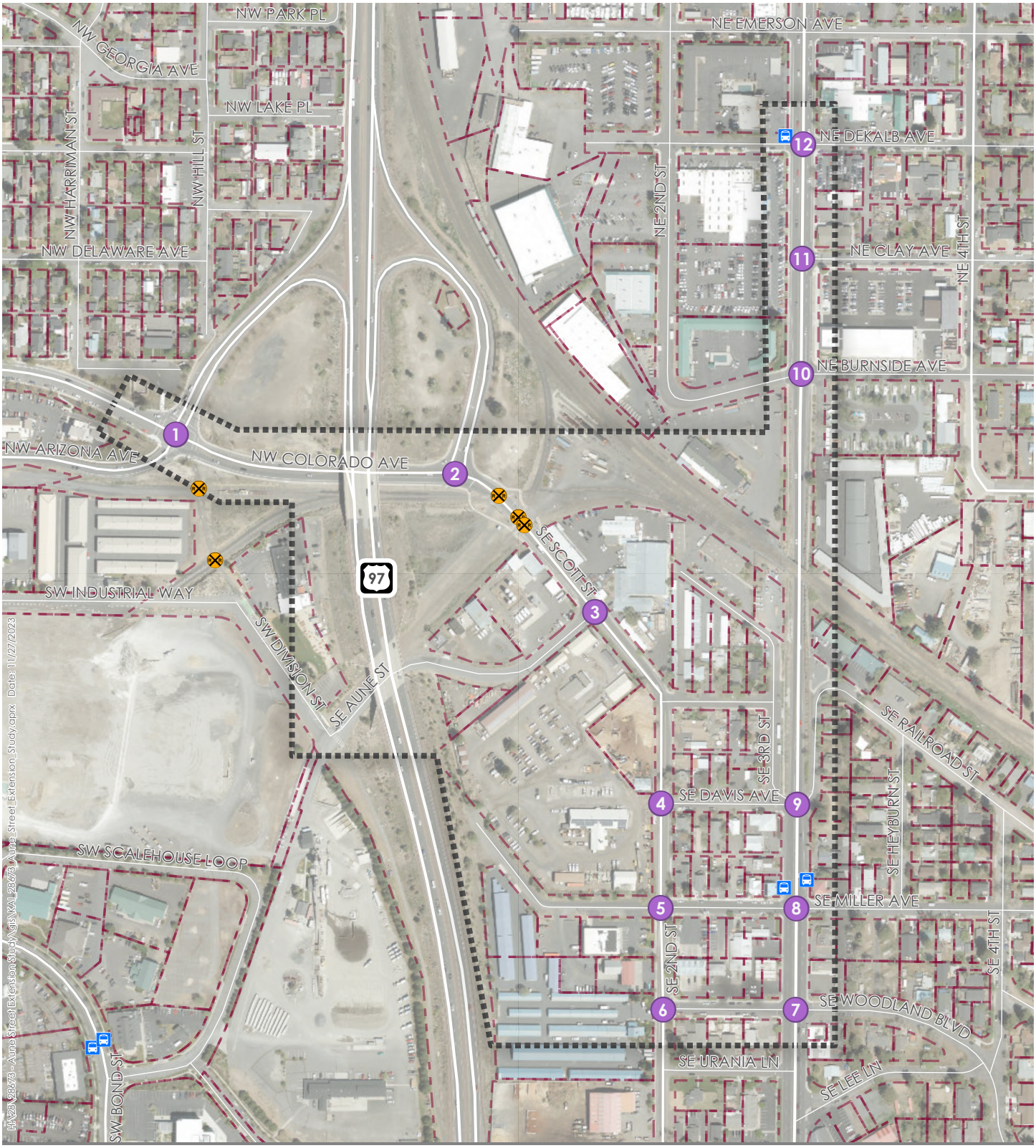
EXISTING CONDITIONS ASSESSMENT

Study Area

The study area is bounded by Dekalb Ave to the north, SE 3rd Street to the east, SE Woodland Boulevard to the south, and generally US97 to the west (including the southbound US97/Colorado Avenue ramp intersection). The existing and future conditions assessments includes the 12 study intersections provided below:

1. Colorado Avenue/US97 SB Ramp
2. Colorado Avenue/US97 NB Ramp
3. Scott Street/Aune Street
4. 2nd/Davis Avenue
5. 2nd Street/Miller Avenue
6. 2nd Street/Woodland Boulevard
7. 3rd Street/Woodland Boulevard
8. 3rd Street/Miller Avenue
9. 3rd Street/Davis Avenue
10. 3rd Street/Burnside Avenue
11. 3rd Street/Clay Avenue
12. 3rd Street/Dekalb Avenue

The study area and study intersections are shown in Figure 1.



Study Intersections

At-Grade Railroad Crossing

Cascades East Transit (CET) Stops

Parcels

Study Area

0 0.1 Miles

Figure 1

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Study Area

Transportation Disadvantaged Populations

Analyzing population demographics in the study area supports the development and evaluation of project alternatives that enhance connectivity and mobility for all users. The following seven population demographics are commonly used indicators of disadvantaged populations with respect to transportation:

- Population living below the Federal Poverty Line (FPL)
- Population living below 200% of the FPL
- Population with disabilities (by census tract)
- Population aged 65+ years old
- Population with Limited English Proficiency (LEP)
- Zero Car Households
- Households with children (0-18)

The City of Bend provided demographic data for the indicators above from the Bend MPO Equity Demographic Viewer. This data is sourced from the American Community Survey (ACS) 2021 5-year estimate data. A summary of key takeaways is shown in Table 1. Maps of the study area vicinity displaying each of the indicators by census block groups are provided in Attachment A.[2]

Table 1. Summary of Equity Demographics in the Study Area

Equity Demographic	Percentage of Population within Demographic*
Population Living Below the FPL	34.3% west of 2nd Street in the study area
Population Living Below 200% FPL	66% west of 2nd Street in the study area
Population with Disabilities	19% east of 2nd Street in the study area
Youth Population (Ages 0-18)	51% east of 2nd Street in the study area
Senior Population (Ages 65+)	5% to 10% through study area (less than Bend MPO average of 16%)
Non-White and Hispanic Population	17% east of 2nd Street in the study area
Zero Car Households	11% to 14% through study area
Population with Limited English Proficiency	12% west of 2nd Street in the study area

*Note: Percentage is higher than Bend MPO average unless stated.

Transportation disadvantaged populations are expected to benefit from the Aune Street Extension. The project alternatives should consider how to provide meaningful connections for these identified populations.

[2] Maps were developed by Kittelson & Associates using data provided by the City of Bend.

Key Activity Centers and Destinations

Figure 2 displays key activity centers and destinations near the study area. As shown, the existing Aune Street alignment is located between several major activity areas in Bend, including the Old Mill District/ Mill Quarter to the west, the 3rd Street business corridor to the east, and Downtown Bend to the northwest. These areas are hubs for numerous businesses offering dining, retail, hospitality services and future residential housing units. The Old Mill District also offers popular recreational activities, including tourist attractions and access to the Deschutes River Trail. Today, Aune Street provides the only access to Crux Fermentation Project, a popular brewpub/ food truck pod located on Division Street. Additionally, Bend Senior High is located northeast of the study area. Jaycee Park is located just east of the study area along Miller Ave/ Centennial Street.

Several multi-use developments along Industrial Way and Arizona Avenue are near construction or under construction at the time of the study (*see Future Land Uses section*), including Timber Yards and Jackstraw.

Land Use

The areas within the study area are primarily industrial (Industrial Light - IL) east of 2nd Street and commercial uses along Colorado Avenue (Commercial General – CG) and west of 2nd Street (Commercial Light - CL). Figure 3 displays zoning within the vicinity of the study area based on the Bend Comprehensive Plan.

Near the study area the zoning is Mixed Urban (MU) to the west, Commercial General (CG) to the north, and Commercial Limited (CL) along the 3rd Street corridor to the east. Beyond the direct vicinity of the study area, there are residential areas to the north and east and Mixed Riverfront (MR) to the west.

A summary of key parcels in the study area is displayed with blue shading in Figure 4. Details about each parcel are provided in Attachment B.

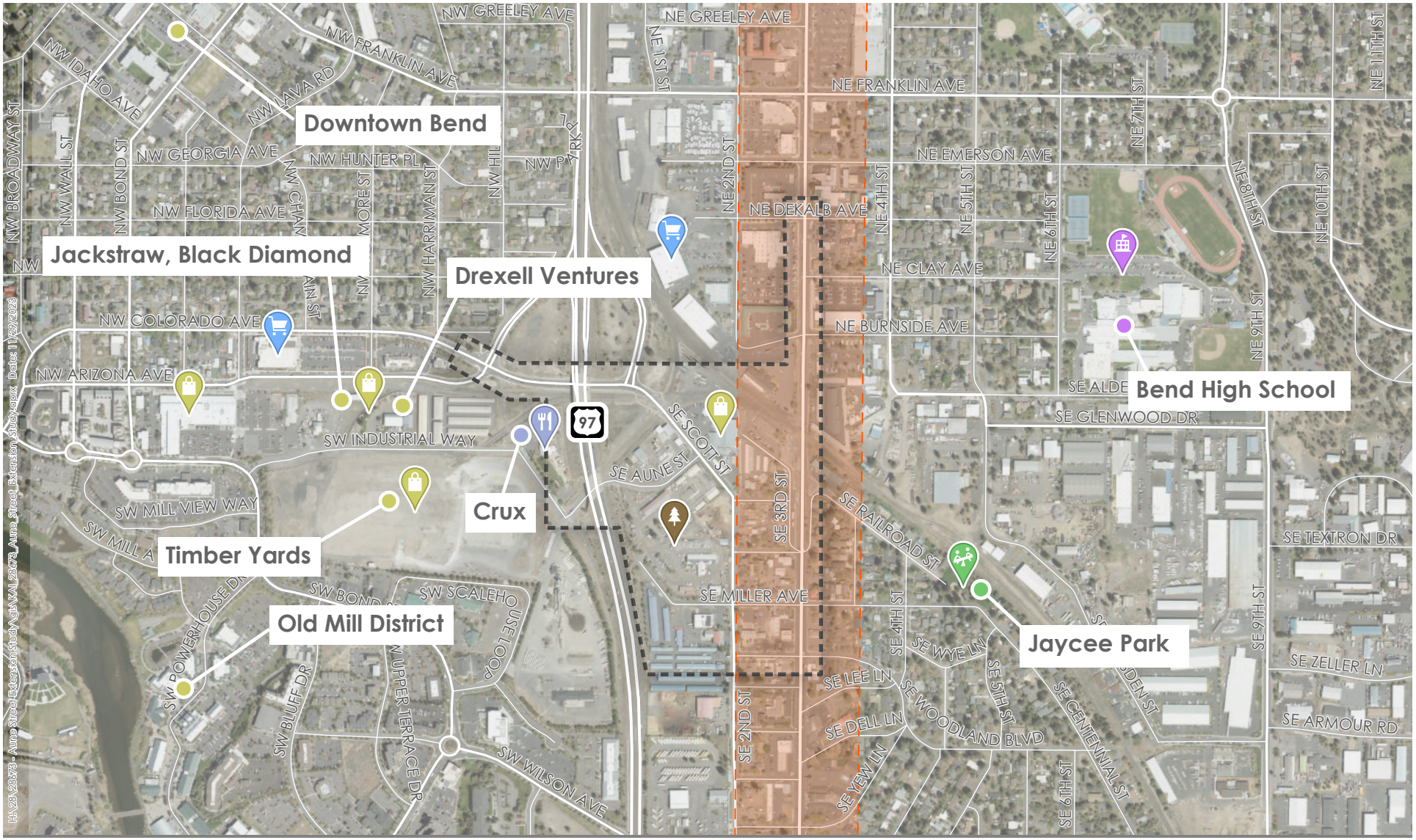

Figure 2

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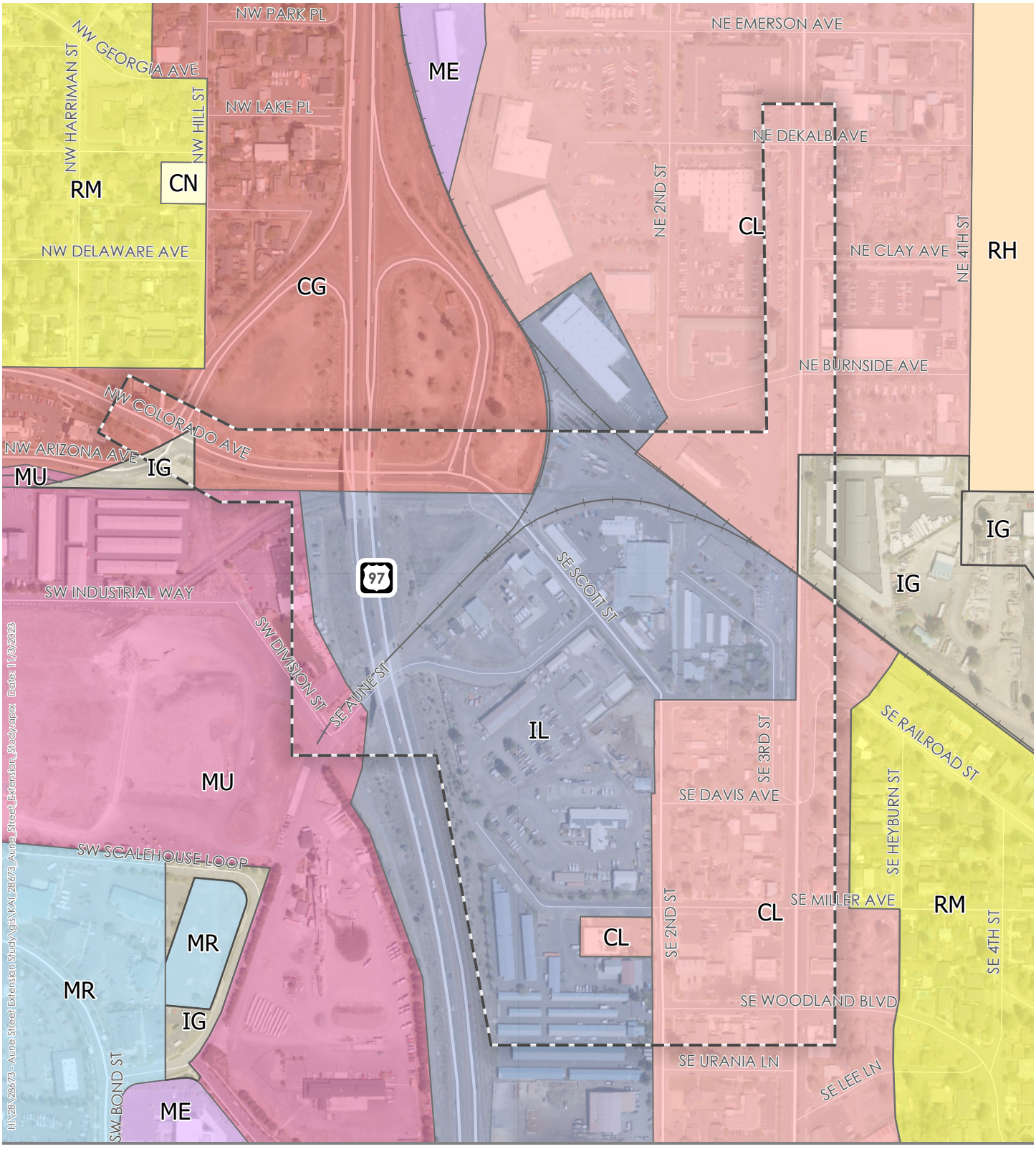
Key Activity Centers and Destinations



Zoning

- CG - Commercial General
- CL - Commercial Limited
- CN - Neighborhood Commercial
- IG - Industrial General
- IL - Industrial Light
- ME - Mixed Employment
- MR - Mixed Riverfront
- MU - Mixed Urban
- RH - Residential Urban High Density
- RM - Residential Urban Medium Density
- Study Area

0 0.1 Miles

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Figure 3

Zoning

Source: City of Bend

Figure 4

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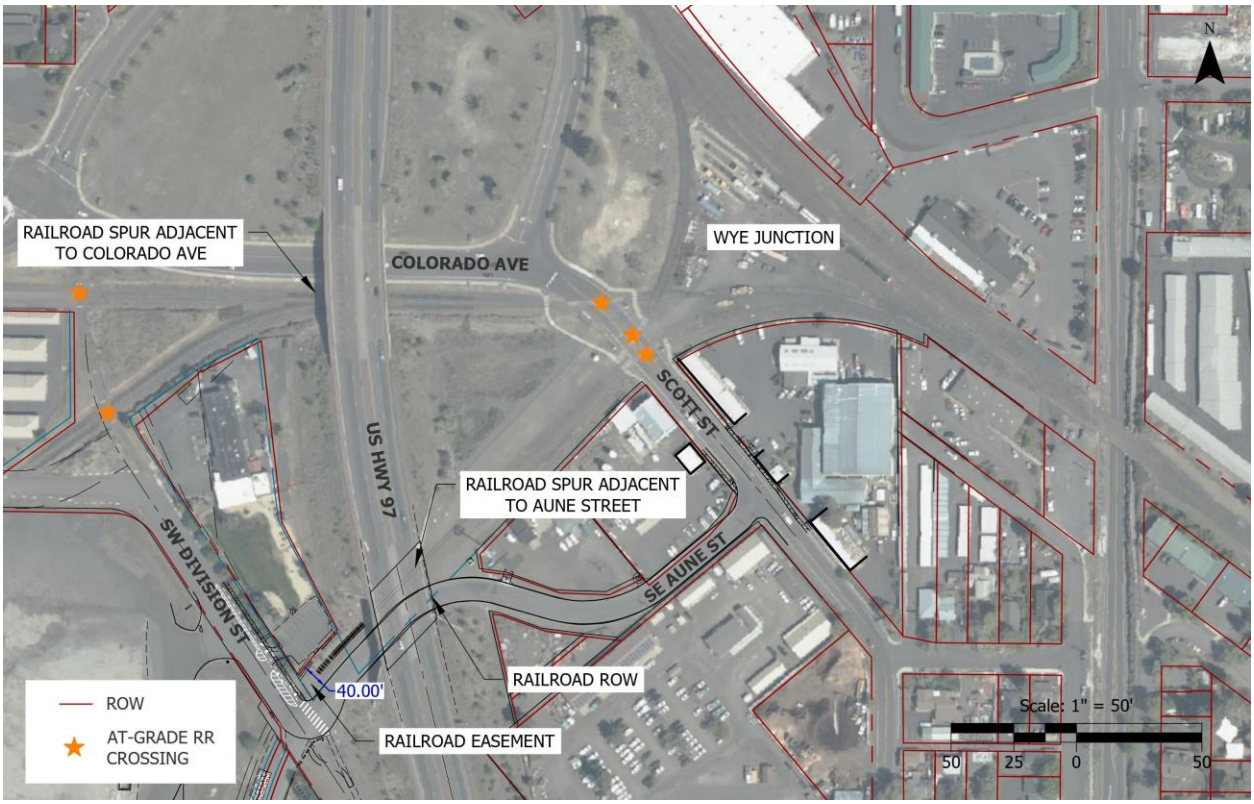
Key Parcels

Property/ Right-of-Way/ Encumbrance Mapping

ODOT's right-of-way includes the area within the vicinity of US97 and the Colorado Avenue interchange. BNSF owns the right-of-way parallel to the rail mainline, including the railroad wye junction[3] and two rail spurs. As shown in Figure 5, the railroad right-of-way extends along the south side of Colorado Avenue and the north side of Aune Street from the undercrossing to Division Street. A portion of Aune Street is within BNSF Railroad right-of-way. Crux Fermentation Project has a 40-foot railroad easement for apportion of the railroad tracks west of the undercrossing.

Figure 5. BNSF Railroad Right-of-Way



Operational Analysis

Kittelson evaluated the study intersections to determine current and future traffic volumes and movements. Traffic counts were collected on May 2nd, 2023, and

[3] The wye junction provides the ability for BNSF to turn railcars the opposite direction (i.e., turning a northbound car to be southbound). This function is important to BNSF operations within Central Oregon and the broader Oregon region.

seasonally adjusted to reflect 30th highest hour conditions. Traffic count data are provided in Attachment C. An overview of the methodology and operational standards used for conducting the existing and future conditions analyses is discussed in Technical Memo #1 (Methodology Memo), provided in Attachment D.

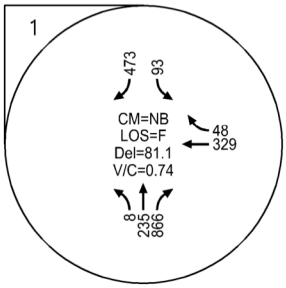
Volume, level-of-service (LOS), critical movement, volume-to-capacity (v/c) ratio, and delay are summarized in Figure 6. Circles outlined in red indicate the intersection does not meet the operational standards defined by ODOT or the City of Bend. A summary of queue lengths and detailed operational analysis sheets at each intersection is provided in Attachment E.

Key observations include:

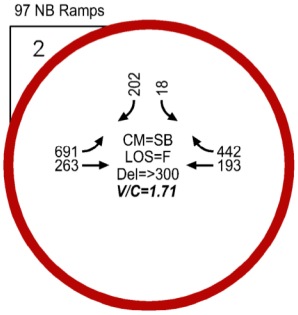
- The intersection of NW Colorado Avenue/ Scott Street/ US 97 northbound (NB) ramps is the only intersection observed to not meet operational standards today.
    - The critical movement is the southbound left turning movement (US 97 northbound exiting traffic) with a v/c ratio of 1.71, LOS F, and high delay per vehicle.
    - For eastbound traffic, operational results showed that the queue length for the left turning movement does not exceed available left-turn lane storage. However, observations in the field demonstrate that during the weekday peak hour period the left-turn lane storage may extend back to the Arizona Avenue intersection.
- The NW Colorado Ave/ Arizona Ave/ US97 southbound (SB) Ramp intersection meets City operational standards with an intersection v/c of 0.74. The intersection delay is approximately 81 seconds per vehicle and the intersection operates at LOS F.
    - The critical movement is the northbound movement from Arizona Avenue with a v/c of 1.04 for the right turn lane and an LOS E for the entire approach.
    - The queue length for the southbound right-turning movements is approximately 525 feet, exceeding the 200-foot right-turn lane storage.
- The intersection v/c ratios at intersections along Scott/ 2nd Street and 3rd Street range from 0.03 to 0.36 and the delay ranges from 11.7 to 34.3 seconds per vehicle. The critical movements for these 10 intersections are side street left turns[4].

[4] Eastbound left turn for Scott St/ Aune St, Miller Ave/ 2nd St, Miller Ave/ 3rd St, Davis Ave/ 3rd St, Woodland Ave/ 3rd St, Burnside Ave/ 3rd St, and Dekalb Ave/ 3rd St. Westbound left turn for Davis Ave/ 2nd Street, Woodland Ave/ 3rd St, and Clay Ave/ 3rd St.

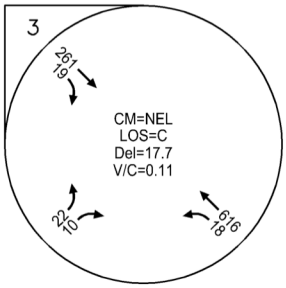
NW Colorado Ave/ Arizona Ave/ US 97 SB Ramps*



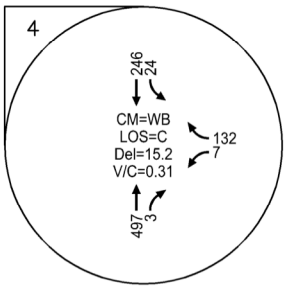
NW Colorado Ave/ Scott St/ US 97 NB Ramps



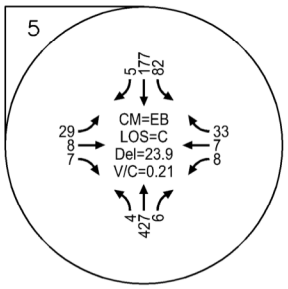
Scott St/ 2nd St/ Aune St



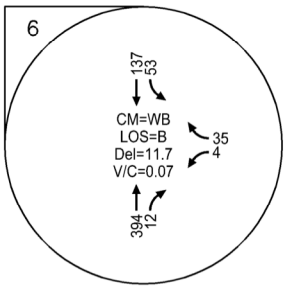
Davis Ave/ 2nd St



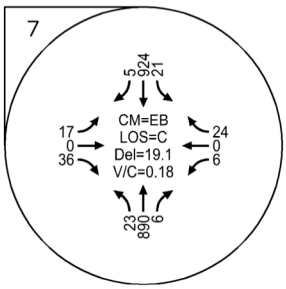
Miller Ave/ 2nd St



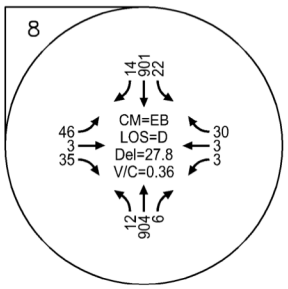
Woodland Blvd/ 2nd St



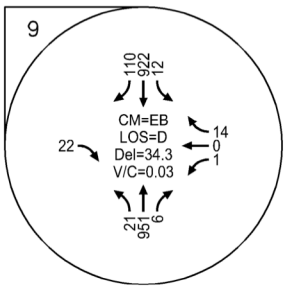
Woodland Blvd/ 3rd St



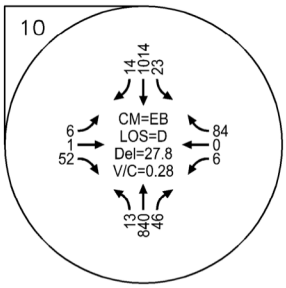
Miller Ave/ 3rd St



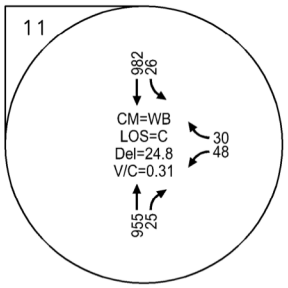
Davis Ave/ 3rd St



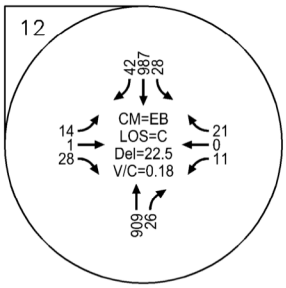
Burnside Ave/ 3rd St



Clay Ave/ 3rd St



Dekalb Ave/ 3rd St



*For signalized intersections, the overall intersection LOS, delay, and v/c are shown.

Existing (2023) PM Peak Hour Traffic Operations
Aune Street (East) Extension Study (Bend, OR)

Figure 6

Roadway and Intersection Characteristics

Study intersection and roadway characteristics are summarized in Table 2.

Table 2. Intersection and Roadway Characteristics

Study Intersection			Major Approach		Minor Approach	
Major/ Minor Approach	**Traffic Control**	**Legs**	**Functional Classification**	**Posted Speed**	**Functional Classification**	**Posted Speed**
Colorado Ave/ US97 SB Ramp	Signalized	4	Minor Arterial	25 mph	Highway Ramp	45 mph
Colorado Ave/ US97 NB Ramp	Side Street Stop Control	3	Minor Arterial	25 mph	Highway Ramp	45 mph
Scott Street/ Aune Street	Side Street Stop Control	3	Minor Arterial	30 mph	Proposed Collector	25 mph
2nd Street/ Davis Avenue	Side Street Stop Control	3	Minor Arterial	30 mph	Local	25 mph
2nd Street/ Miller Avenue	Side Street Stop Control	4	Minor Arterial	30 mph	Minor Arterial[1]	25 mph
2nd Street/ Woodland Blvd	Side Street Stop Control	3	Collector	30 mph	Local	25 mph
3rd Street/ Dekalb Avenue	Side Street Stop Control	4	Principal Arterial	35 mph	Local	25 mph
3rd Street/ Clay Avenue	Side Street Stop Control	3	Principal Arterial	35 mph	Local	25 mph
3rd Street/ Burnside Avenue	Side Street Stop Control	4	Principal Arterial	35 mph	Local	25 mph
3rd Street/ Miller Avenue	Side Street Stop Control	4	Principal Arterial	35 mph	Minor Arterial[2]	25 mph
3rd Street/ Woodland Blvd	Side Street Stop Control	4	Principal Arterial	35 mph	Local	25 mph

[1]2nd Street is a Minor Arterial north of Miller Avenue and a Collector south of Miller Avenue. [2]Miller Ave is classified as a minor arterial between 2nd and 3rd Street and a local road east of 3rd St.

Observed Speeds

Speed data was collected on 2nd Street and 3rd Street south of Davis Avenue on May 2, 2023, during the PM peak hour. A summary of observed 85th percentile speed and posted speed is provided in Table 3. As shown, the observed 85th percentile speeds on 2nd Street are higher than the posted speed limit on the south leg and 3rd Street shows higher 85th percentile speeds than the posted speed limit for both directions.

Table 3. Roadway Speed Data

Intersection	Posted Speed	Northbound	South Leg
2nd Street south of Davis Ave	30 mph	29 mph	33 mph
3rd Street south of Davis Ave	35 mph	39 mph	37 mph

Multimodal Facilities

Key Walking and Biking Routes

The City of Bend has identified "Key Walking and Biking Routes" (Key Routes) within the Bend TSP. Key Routes are designed to be "low stress"[5] for pedestrians and bicyclists, provide safe and appealing connections to schools, parks, and other destinations, as well as providing cross-city travel. Three of the identified Key Routes are in the study area:

- Key Route 7 – east-west route from Aune Street to Bend High School via 2nd Street, Miller Avenue, and 3rd Street
- Key Route 9 – north-south from Scott Street/ Miller Ave to China Hat Road
- Key Route 10 – north-south from Old Bend Redmond Highway to China Hat Road that utilizes the shared path west of US97 in the study area

The Key Routes Projects are supported by the GO Bond and will be discussed with the Bicycle and Pedestrian sections below.

Bicycle Facilities

Existing bicycle facilities and future Key Routes within the study area vicinity are displayed in Figure 7. As shown, there are on-street bicycle facilities on Scott Street/ 2nd Street and on 3rd Street north of Burnside Avenue. Aune Street is a designated neighborhood greenway – a walking and bicycling route that may be more comfortable than nearby busier streets. There is a shared use path on the east side of US97 south of Aune Street between Division Street and Wilson Avenue.

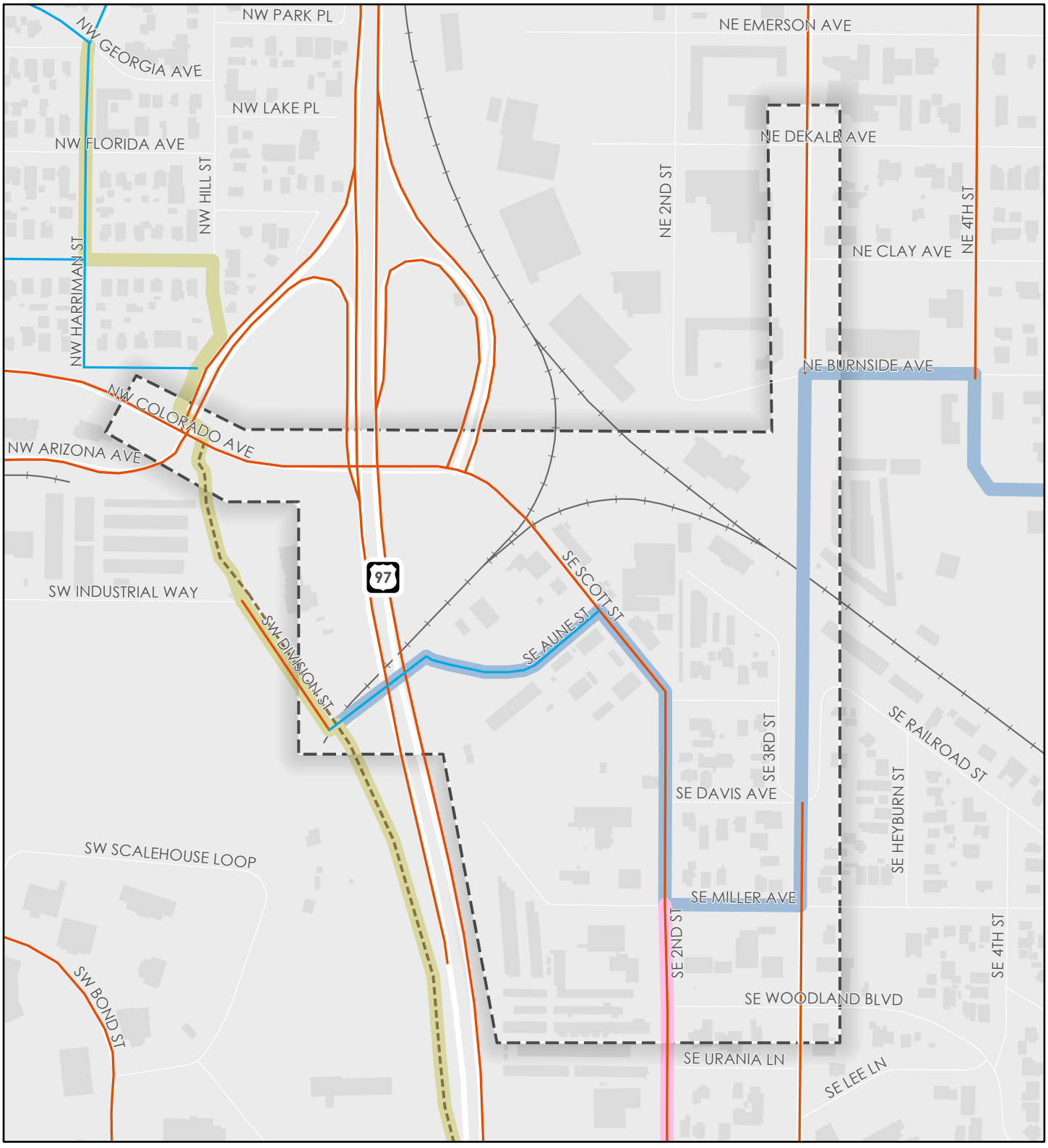
There are no bicycle facilities on the local city roadways within the study area such as Davis Avenue, Miller Avenue, Woodland Boulevard, Burnside Avenue, Clay Avenue, and Dekalb Avenue. There is a gap in bicycle facilities on 3rd Street between the BNSF railroad undercrossing between Burnside Avenue and Davis Avenue. The cross section on 3rd Street is reduced under the BNSF bridge where the on-street bicycle lanes are eliminated and cyclists must either take the travel lane or dismount and use the sidewalks that parallel the roadway. The section of roadway and bicycle facilities is not included in the scope of this project as part of the concept evaluation process.

The Bend TSP identified a system of low-stress bicycle routes that are required to be built or reconstructed to provide Level of Traffic Stress 1 or 2. This low-stress network (LSN) is mapped in Figure 8 along with LTS in the study area. LTS data on the LSN was provided by City of Bend. Kittelson analyzed LTS using guidance from the ODOT Analysis

[5] Low-stress is defined as routes with Level of Traffic Stress (LTS) 1 or 2

Procedures Manual for segments that aren't on the LSN. This analysis is provided in Attachment F.

As shown, the bicycle low stress network (BLSN) generally overlaps with the Key Routes with some additional segments that provide additional bicycle connectivity. The gap in the bicycle network on 3rd Street is shown as LTS 4 (highest stress) and the roadway segments surrounding the Burnside Avenue and Miller Avenue intersections are shown as LTS 3.



Bicycle Greenway
On-Street Bicycle Facility
Paths and Trails
Study Area

Key Routes
Route 7
Route 9
Route 10

0 0.1 Miles

Figure 7

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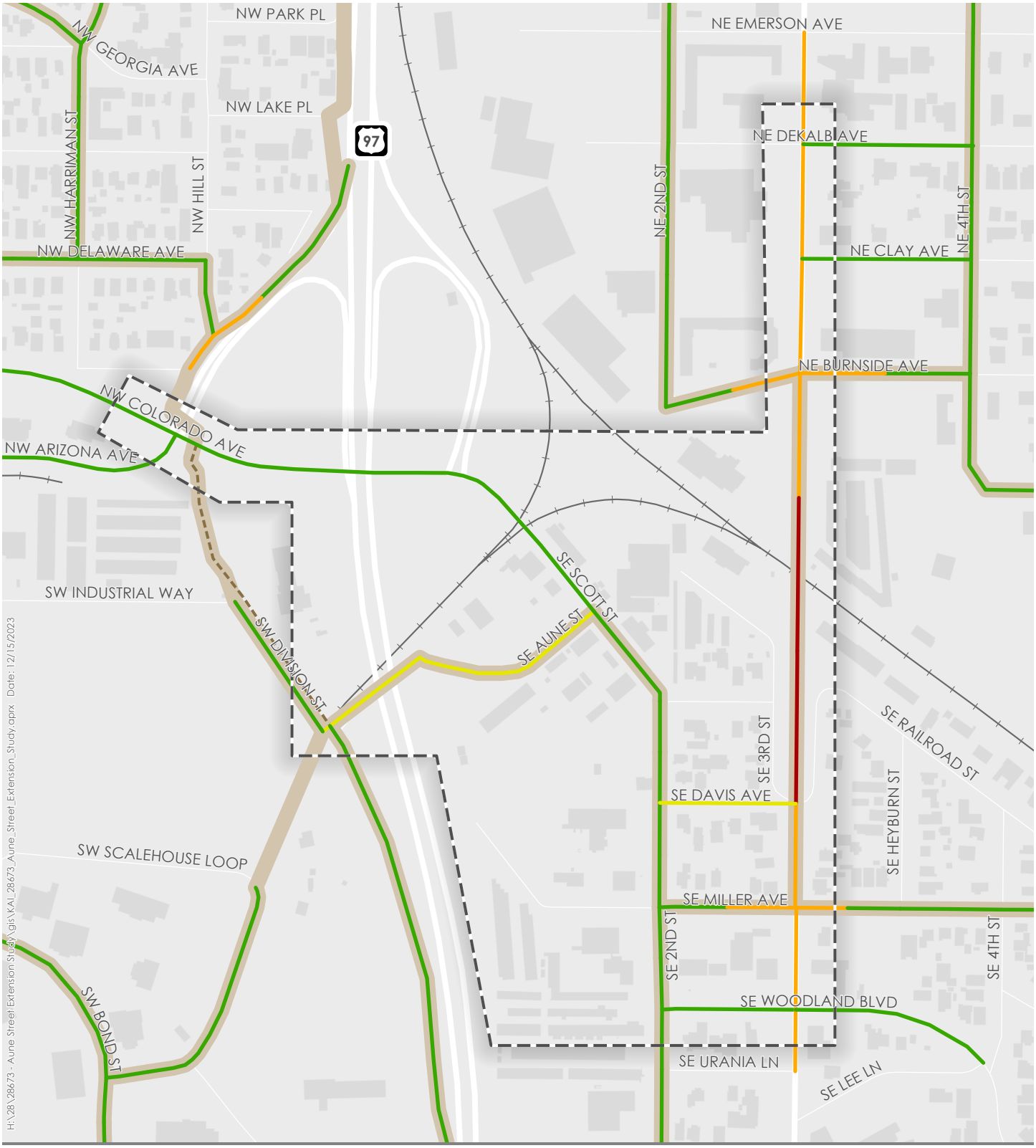
Existing Conditions
Bicycle Facilities, Key Routes
Source: City of Bend



Bicycle Level of Traffic Stress (LTS)

- 4
- 3
- 2
- 1

Bicycle Low Stress Network (LSN)

Paths and Trails

Study Area

0 0.1 Miles

Figure 8

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Level of Traffic Stress (LTS) and City of Bend Low Stress Network (LSN)

Source: City of Bend and KAI

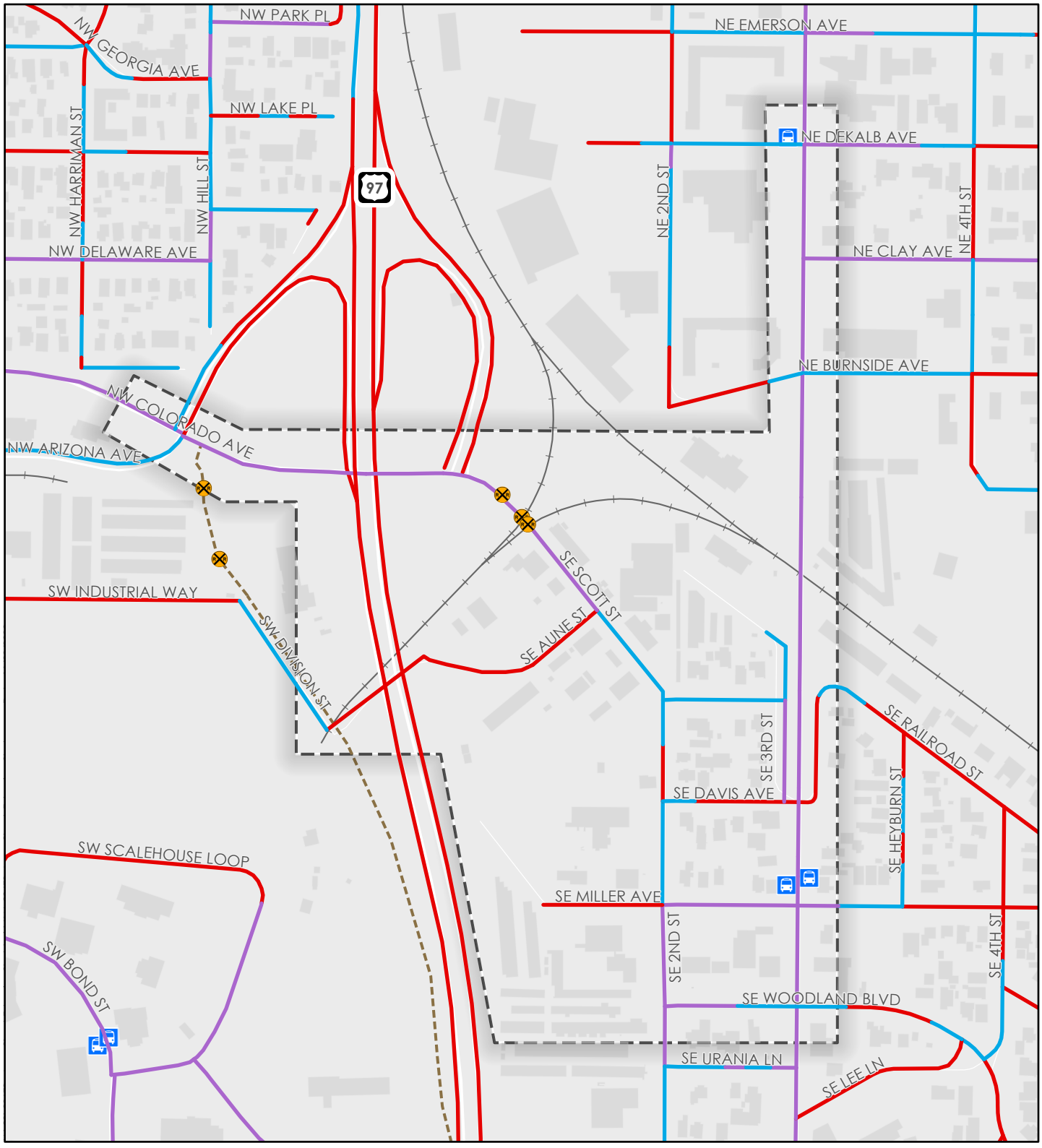
Pedestrian Facilities

Pedestrian facilities within the study area vicinity are displayed in Figure 9. As shown, there is generally a sidewalk on at least one side of the road along most of the non-local roadways.

Colorado Ave/ Scott Street/ 2nd Street has sidewalks on both sides of the roadway north of Aune Street and south of Miller Avenue. There are sidewalk facilities on one side of Scott Street/ 2nd Street between Aune and Miller, with a gap of no sidewalk just north of Davis Ave. On 3rd Street, there are sidewalks on both sides of the roadway except for a segment south of Woodland Boulevard on the east side.

There are generally sidewalks on both sides of Dekalb Avenue, Clay Avenue, Miller Avenue, and Woodland Avenue (west of 3rd Street). Burnside Avenue east of 3rd Street has sidewalks on the north side and Woodland Avenue east of 3rd Street does not have sidewalks.

Kittelson analyzed pedestrian LTS based on guidance from the ODOT Analysis Procedures Manual. Pedestrian LTS is shown in Figure 10 and the detailed analysis is provided in Attachment F. As shown, LTS is 4 where there are no sidewalks on Aune Street, 2nd Street, and 3rd Street between the undercrossing and Miller Avenue on the east side.



No Sidewalk
Sidewalk on One Side
Sidewalk on Both Sides
<all other values>

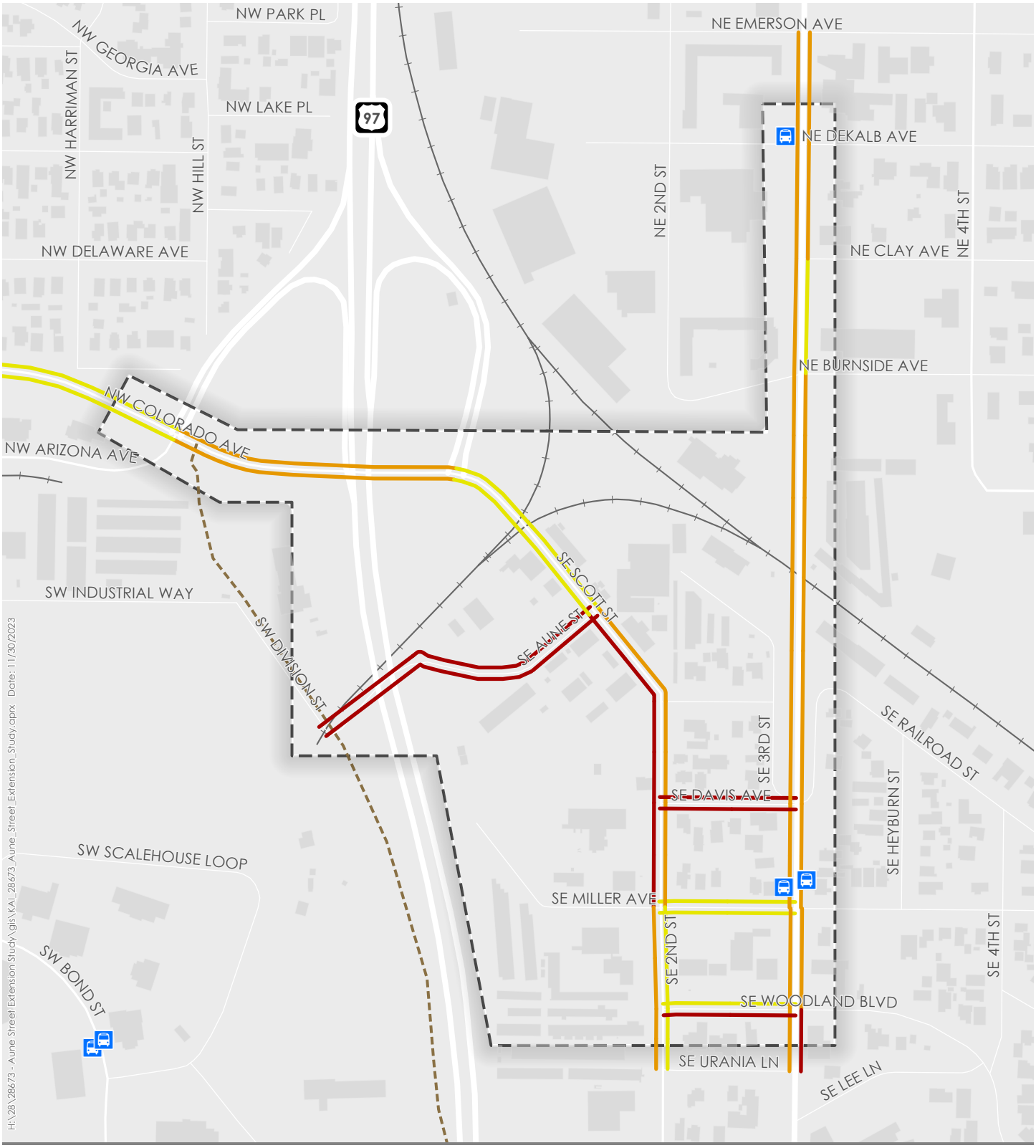
At-Grade Railroad Crossing
Cascades East Transit (CET)
Paths and Trails
Study Area

0 0.1 Miles

Figure 9

KITTELSON & ASSOCIATES

Existing Conditions
Pedestrian Facilities



Pedestrian Level of Traffic Stress (LTS)

- 2
- 3
- 4

Cascades East Transit (CET)

Paths and Trails

Study Area

0 0.1 Miles

Figure 10

KITTELSON & ASSOCIATES

Pedestrian Level of Traffic Stress (LTS)

Transit

Cascades East Transit (CET) operates their fixed route along 3rd Street within the study area (Route 1 – South 3rd Street). There are northbound and southbound stops at 3rd Street/ Miller Avenue and a southbound stop at Dekalb Avenue.

The 2040 CET Master Plan (2020) and Bend Mobility Hub Feasibility Study (2022) identified a possible mobility hub within the vicinity of the Old Mill District and the study area.

Railroad

Burlington Northern Sante Fe (BNSF) owns and operates rail track within the study area. The rail track north of the study area runs parallel to US97 north of Colorado Avenue and then curves east at a wye, or triangular junction, towards the industrial zone of Bend along 9th Street. The wye is used for turning railway equipment and rail car storage. There are two railroad spurs within the study area that are part of the wye junction, including one that runs adjacent to Aune Street and terminates at Division Street and another that runs adjacent to Colorado Avenue and terminates at Industrial Way. The railroad uses the wye and storage on a limited basis; however, the wye is a critical facility for maneuvering rail cars and is the only such junction in the Central Oregon region.

There are three at-grade railroad crossings on Scott Street east of the US97 northbound ramps and two crossings on the shared use path between Colorado Avenue and Aune Street.

The project team is coordinating with BNSF throughout the alternative development process to ensure the identified alternatives align with BNSF's long-term planning activities.

Crash Evaluation

ODOT provided the most recent 5 years of crash data between January 1, 2017, and December 31, 2021. Within the 5-year study period, there were no reportable intersection crashes at Scott Street/ Aune Street, 2nd Street/ Davis Avenue, or 2nd Street/ Woodland Avenue. Additionally, there were no fatal or suspected serious injury (Injury A) crashes reported on 2nd Street between US97 SB ramps and Woodland Blvd and on 3rd Street between Dekalb Avenue and Woodland Boulevard.

Intersection crash data is summarized by collision and critical crash rate in Table 4. Values shown in ***bold*** indicate that the observed intersection crash rate exceeds the critical crash rate by volume or by intersection type.

Key observations include:

- **3rd Street/ Burnside Avenue**: Of the 10 total crashes within the 5-year period, 4 were angle crashes. The observed crash rate does not exceed the critical crash rate by intersection type or volume but is close to the 0.33 threshold at 0.26. Of these crashes, there was 1 angle crash that resulted in a fatality.
- **3rd Street/ Miller Avenue**: Of the 15 total crashes within the 5-year period, 12 were angle crashes. The 12 angle crashes included 7 crashes involving vehicles turning left from the west leg of Miller Avenue to travel northbound on 3rd Street. The observed crash rate (0.42) exceeds the critical crash rate by intersection type. Of these crashes, there was 1 fatality. Of these crashes, there was 1 pedestrian crash that resulted in a fatality.
- Most of the crashes at 3rd Street intersections at Burnside Avenue, Clay Avenue, Dekalb avenue, and Miller Avenue were angle crashes.

The 3rd Street/ Miller Avenue intersection was identified by the Bend TSAP for an intersection improvement based on the crash history, including a fatality. The intersection was also identified by ODOT as a 2021 Safety Priority Index System (SPIS) since it scored in the top 15% of off-state locations.

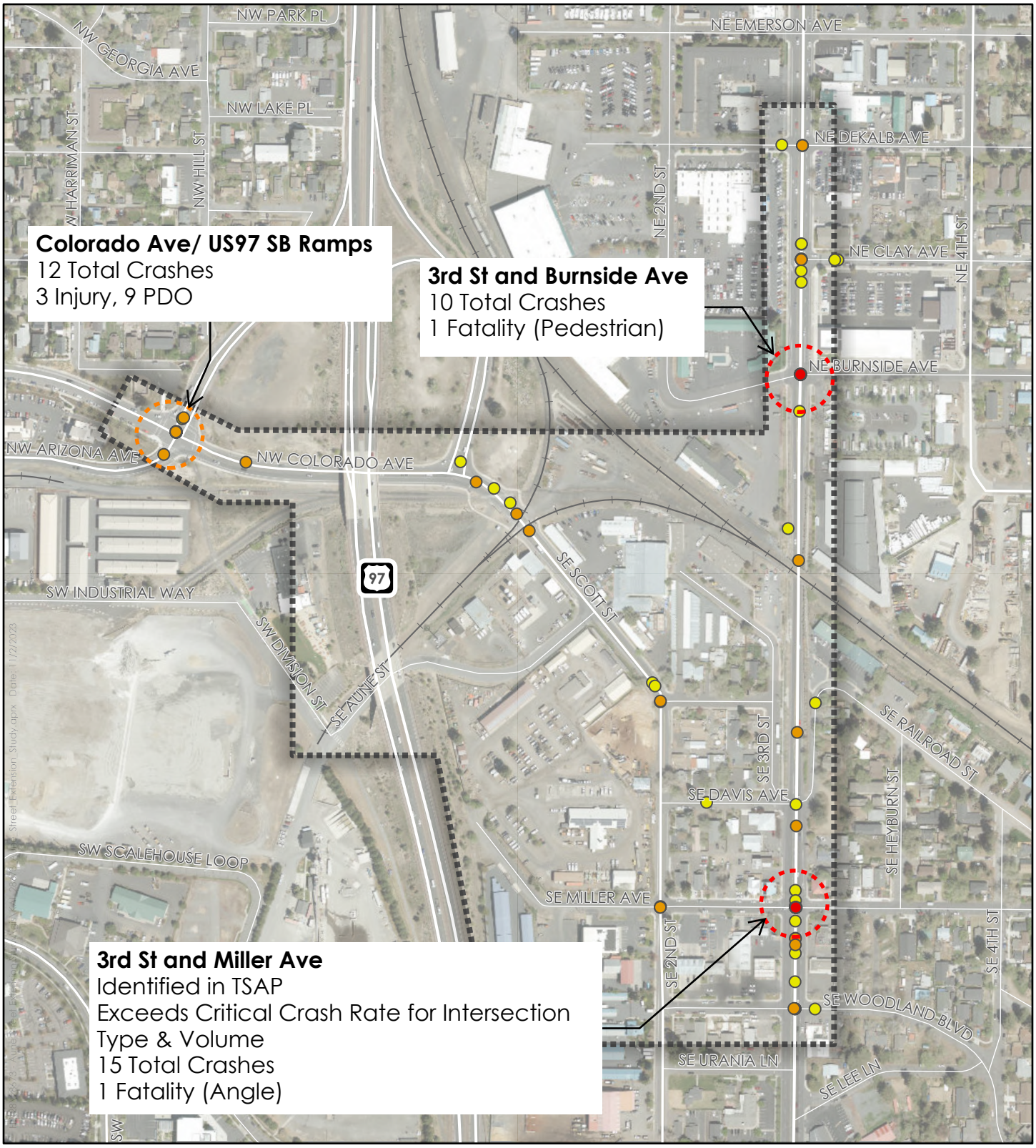
Table 4. Study Intersection Crashes by Collision Type and Critical Crash Rate

#	Location	Collision Type						Total	Critical Crash Rate by Intersection Type	Critical Crash Rate by Volume	Observed Crash Rate
		Rear-end	Turning	Angle	Fixed	Ped	Side-Swipe				
1	Colorado Ave/ US97 SB Ramps	5	0	7	0	0	0	12	0.43	0.44	0.32
2	Colorado Ave/ US97 NB Ramps	0	1	0	0	0	0	1	0.25	0.45	0.03
5	2nd St/ Miller Ave	0	2	2	0	0	0	4	0.45	0.36	0.34
7	3rd St/ Woodland Blvd	0	1	4	0	0	0	5	0.33	0.44	0.14
8	3rd St/ Miller Ave	2	1	12	0	0	0	15	0.33	0.44	***0.42***
9	3rd St/ Davis Ave	0	1	0	0	0	0	1	0.33	0.44	0.03
10	3rd St/ Burnside Ave	2	2	4	1	1	0	10	0.33	0.43	0.26
11	3rd St/ Clay Ave	1	0	3	0	0	0	4	0.24	0.44	0.11
12	3rd At/ Dekalb Ave	2	0	2	0	0	0	4	0.33	0.44	0.11

Table 5. Study Intersection Crashes by Severity

#	Location	Severity						Total Crashes
		Fatal	PDO[1]	Total Injury	Injury A	Injury B	Injury C	
1	**Colorado Ave/ US97 SB Ramps**	0	9	3	0	1	2	12
2	**Colorado Ave/ US97 NB Ramps**	0	1	1	0	0	1	2
5	**2nd St/ Miller Ave**	0	3	1	0	0	1	4
7	**3rd St/ Woodland Blvd**	0	3	2	0	1	1	5
8	**3rd St/ Miller Ave**	1	6	8	0	1	7	15
9	**3rd St/ Davis Ave**	0	1	0	0	0	0	1
10	**3rd St/ Burnside Ave**	1	5	4	0	1	3	10
11	**3rd St/ Clay Ave**	0	1	3	0	2	1	4
12	**3rd St/ Dekalb Ave**	0	1	3	0	1	2	4
	[1]Property Damage Only (PDO)							

Figure 11 displays all intersection and segment crashes within the 5-year study period located in the study area.



Crash Severity

- Fatality
- Injury
- Property Damange Only (PDO)

0 0.1 Miles

Figure 11

KITTELSON & ASSOCIATES

ODOT Crash Data (2017-2021)

FUTURE CONDITIONS ASSESSMENT

The future conditions assessment includes a review of future land uses to conduct an analysis of future year 2045 operations. This scenario provides a baseline to assess future alternatives with. Key findings from this assessment will serve as the basis for identifying future needs and opportunities associated with anticipated development and growth in the study area.

Future Land Uses

The planned land uses established by the adopted City of Bend Comprehensive Plan are consistent with current zoning districts within the study area. These planned land uses align with strategies outlined in the Comprehensive Plan for the Bend Central Core area to reduce vehicle miles traveled (VMT) per capita by increasing mixed-use districts and encouraging dense land uses.

There are multiple mixed-use developments planned in the area west of Aune Street that will influence traffic within the study area. Key future developments near the study area include:

Timber Yards

The Timber Yards development is planned on two tax lots that will be combined to form an approximately 30-acre parcel bounded by Industrial Way to the north, Scalehouse Loop to the south, Bond Street to the West, and Division Street/ US97 to the east. The mixed-use development is planning approximately 1,600 multi-unit and senior residential units, a 180-room hotel with 20,000 square feet of retail and civic space, 120,000 square feet of office space, and 57,000 square feet of retail. According to the Transportation Impact Analysis (TIA) for the proposed development, the development will generate 8,217 daily trips and 413 PM peak hour trips.

Jackstraw

The Jackstraw development is planned on two tax lots that will be combined to form a 4.88-acre parcel north of Industrial Way, east of Lava Road, and west of the planned Sisemore Street collector. The mixed-use development will consist of 311 apartments and 16,000 square feet of retail. According to the transportation report in the land use application, the development will generate 1,782 vehicles daily trips and 186 weekday PM peak hour trips.

Black Diamond

A land use application (PLLD20220311) is currently being processed by the City to subdivide the tax lot adjacent to the north side of the proposed Jackstraw development into five units of land with dedicated right-of-way for the Sisemore Street extension. There are two proposed mixed-use developments on this tax lot, referred to in this memo as Black Diamond and Drexell Ventures. The proposed Black Diamond development is located south of Arizona Avenue adjacent to the north side of the planned Jackstraw development and west of the planned Sisemore Street extension. The development is mixed-use and will include three buildings with 12,640 square feet of commercial space, 16 housing units, and 2 food carts. The development is anticipated to generate 410 new weekday daily trips and 46 weekday PM peak hour trips.

Drexell Ventures

The proposed development is located on the east side of the planned Sisemore Street extension, adjacent to the north side of the planned Jackstraw development. The development is mixed-use and will include a three-story development with 5,158 square feet of retail and 13 residential units. The development is anticipated to generate 210 new weekday daily trips and 25 weekday PM peak hour trips.

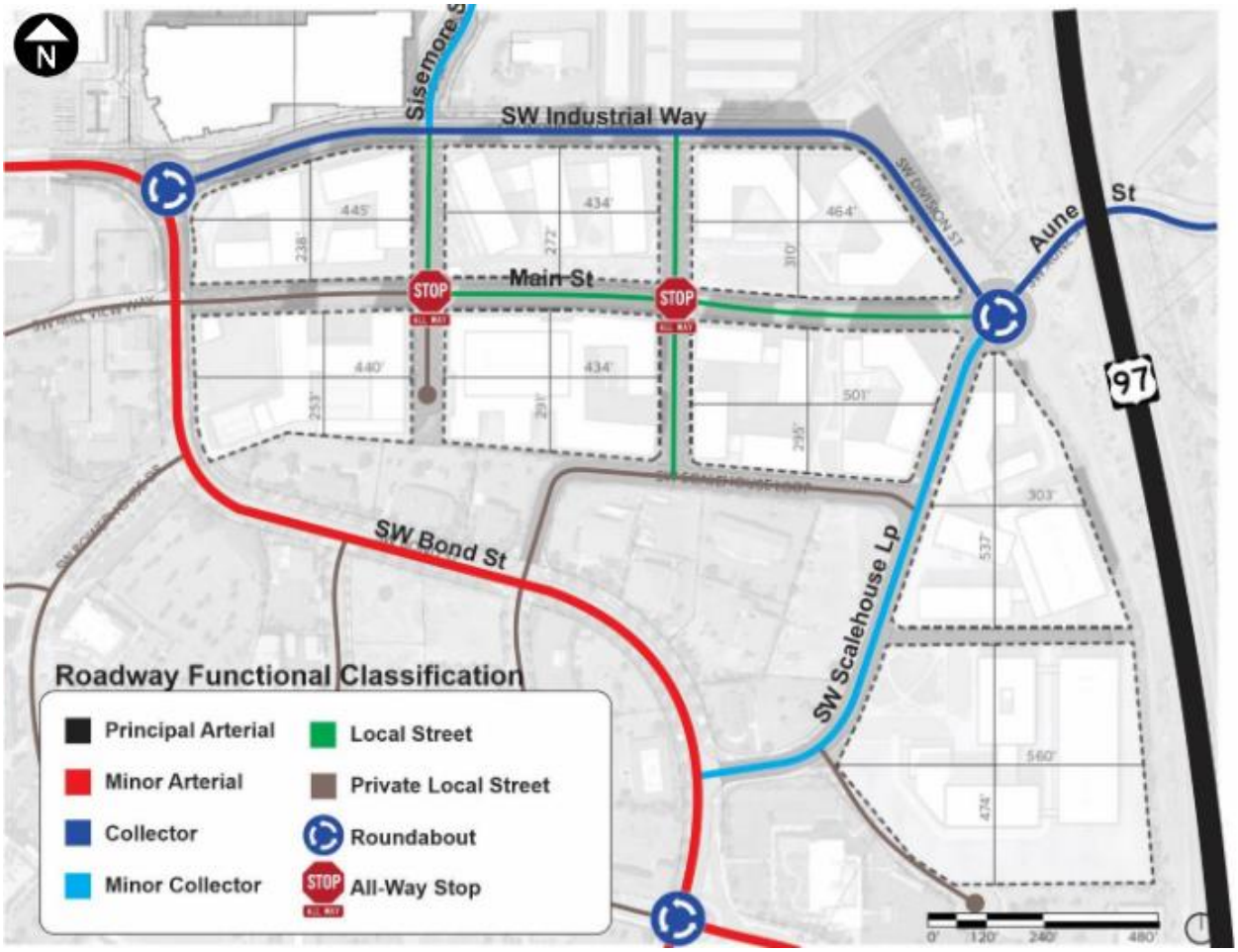
Planned/ Funded Projects

The proposed Timber Yards Master Plan documents the recommended transportation infrastructure for the KorPine Opportunity Area. The recommended infrastructure addresses internal traffic flow through the proposed site as well as improvements on the fringe of the property that will address traffic impacts from the planned high-density, mixed-use development.

The recommended transportation infrastructure is displayed in Figure 12. Planned functional classifications from the City of Bend Transportation System Plan are incorporated in the proposed infrastructure, including the extension of Sisemore Street south to Industrial Way. Industrial Way and Aune Street will be classified as collectors, Bond Street will be classified as a minor arterial, and Scalehouse Loop and the new Sisemore Street extension will be classified as a minor collector, consistent with the planned functional classifications for those streets identified in the City of Bend Transportation System Plan.

Traffic control recommendations on the fringe of the proposed development include a proposed roundabouts at Industrial Way and Bond Street and at Industrial Way and Aune Street. Kittelson and the City of Bend have been coordinating with the Timber Yards project team on the most updated concepts for the Industrial Way and Aune Street roundabout.

Figure 12. Recommended Vehicular System Classification and Traffic Control (Source: Timber Yards Master Plan)



Future Traffic Forecast

Kittelson developed future 2045 scenario intersection turning movement volumes using the Bend-Redmond Regional Travel Demand Model tool and methodology from the *National Cooperative Highway Research Program (NCHRP) Report 765 Highway Traffic Data for Urbanized Area Project Planning and Design*. This methodology is described in more detail in the Methodology Memo (Attachment D).

The following changes were made to the base Travel Demand Model to reflect future network and development assumptions:

- Aune Street and the Aune Street extension from the existing Aune alignment to Miller Avenue were included in the 2040 base scenario, but not the 2019 base. The Aune Street (East) Extension from Aune Street to Miller Avenue was removed from the 2040 scenario.

- The model was modified to include the Sisemore Street extension from Colorado Avenue to Industrial Avenue as a 2-lane collector with a posted speed of 25 mph.
- The model was modified to include housing, employment, and population assumptions that reflect the current site plans for the Jackstraw and Timber Yard developments.

Future year (2045) turning movement demand at the study intersections was forecast using the methodology from the NCHRP 765 report. Growth rates from the 2040 model were applied to the existing turning movements to forecast 2045 volumes. Attachment G contains the NCHRP 765 methodology worksheet and resulting growth rates.

Operational Analysis

Future year (2045) traffic volumes and operational analysis results are shown in Figure 13. Forecasted turning movement volumes are provided in Attachment H. A summary of queue lengths and detailed operational analysis sheets at each intersection is provided in Attachment I. As shown, the following intersections **are forecast to exceed** ODOT or City of Bend operational standards in 2045:

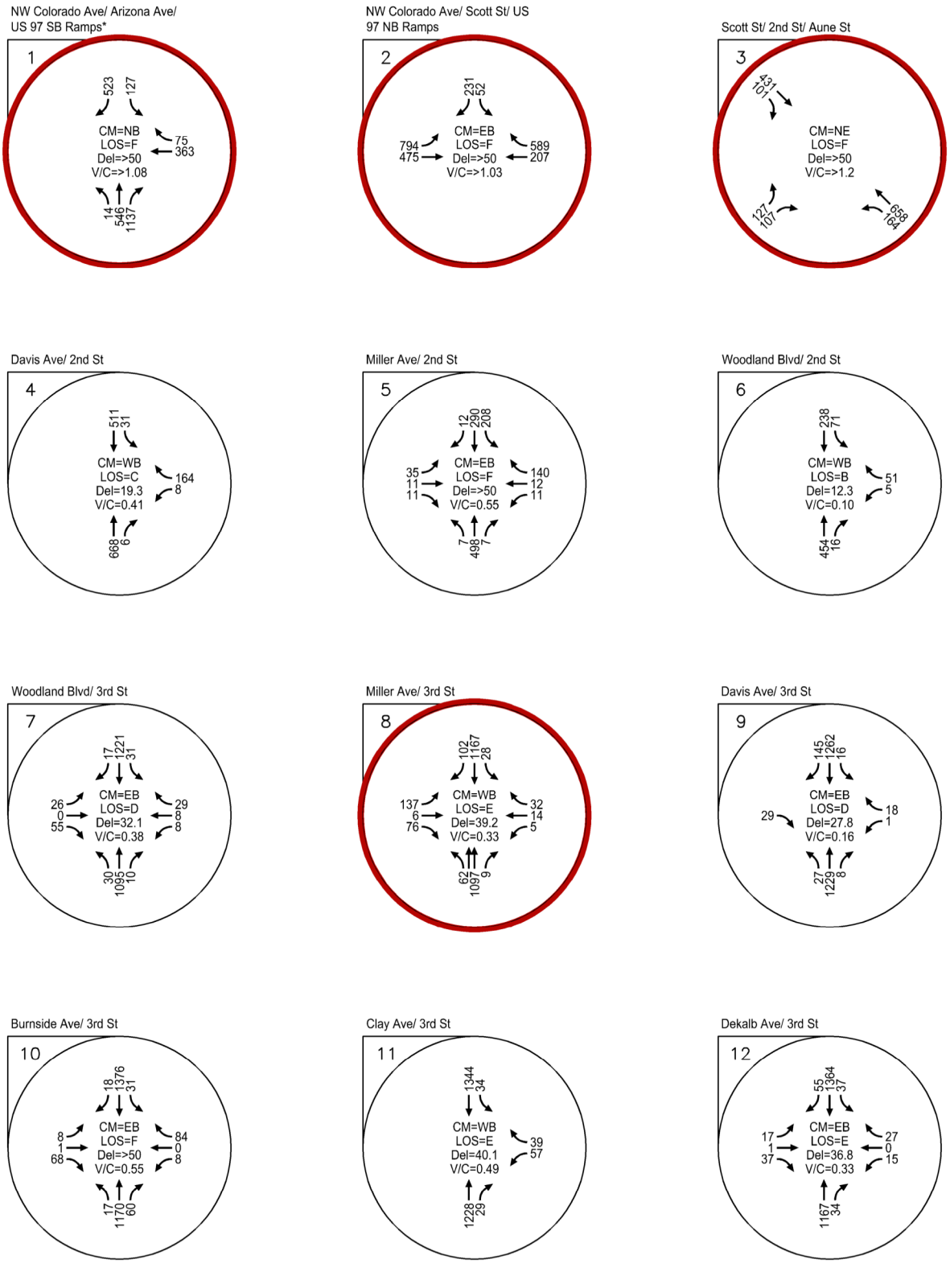
- Colorado Avenue/ Arizona Avenue/ US97 Southbound (SB) Ramps
- Colorado Avenue/ Scott Street/ US97 Northbound (NB) Ramps
- Scott Street/ 2nd Street/ Aune Street
- Miller Avenue/ 3rd Street

Based on the future year scenario, the Colorado Avenue interchange is projected to have delays in excess of 60 seconds per vehicle and queuing of more than 475 feet at both intersections influenced by the high northbound right demand at Colorado Avenue/US97 SB Ramp and the eastbound left demand at Colorado Avenue/ US97 NB Ramp. At the Colorado Avenue/ Arizona Avenue/ US97 SB ramps, the northbound right-turn is the critical movement with delay expected to exceed 200 seconds per vehicle and a right-turning queue over 2,000 feet to Wall Street. At the Colorado Avenue/ Scott Street/ US97 Northbound ramps intersection, the eastbound left turn is the critical movement with a v/c of 1.02, delay of approximately 60 seconds per vehicle, and a left-turning queue of approximately 475 feet, exceeding the available 200 feet of storage in the dedicated left-turn lane. To fully address the operational deficiencies at the Colorado Avenue interchange, an Interchange Area Management Plan (IAMP) will be needed, consistent with IAMP guidelines established by the ODOT Transportation Development Division.

Trips generated from the mixed-use developments are expected to use Scott Street/ 2nd Street/ Aune Street as a route to access the Colorado Avenue intersection. As a result, the northeast-bound left turning movement from Aune Street to Scott Street does not meet City operational standards with stop-controlled delay over 200 seconds and a v/c ratio exceeding 1.0.

According to the model, vehicles accessing development on Aune Street are anticipated to use Miller Avenue to/from 3rd Street. The higher eastbound demand on Miller Avenue at 3rd Street results in the intersection exceeding the operational standards for side-street stop-controlled intersections.

Consistent with the exiting conditions traffic assessment, side street left-turn movements onto 3rd Street continue have the highest delay. However, side-street volumes are less than 100 weekday peak hour vehicles at Dekalb Avenue, Clay Avenue, Burnside Avenue, Davis Avenue, and Woodland Boulevard and therefore do not exceed City of Bend operational standards.



*For signalized intersections, the overall intersection LOS, delay, and v/c are shown.

Future (2045) PM Peak Hour Traffic Operations
Aune Street (East) Extension Study (Bend, OR)

Figure 13

NEEDS AND OPPORTUNITIES

System needs and opportunities identified in this assessment are summarized below:

- **Transportation Disadvantaged Populations** – The study area has a higher percentage of zero-vehicle households compared to the Bend MPO average. The area west of 2nd Street has a higher percentage of people below the federal poverty line and with low English proficiency and the area east of 2nd Street has a higher population of people with disabilities, youth, and non-white and Hispanic-identifying people than the Bend MPO average.
- **Property/ Right-of-Way** – ODOT owns right-of-way within the vicinity of US97 and the Colorado Avenue interchange. A portion of Aune Street along the US97 undercrossing is within BNSF right-of-way.
- **Existing Conditions Operational Analysis** – The intersection of NW Colorado Avenue/ Scott St/ US 97 northbound (NB) ramps is currently not meeting ODOT operational standards in the PM peak hour. All other study intersections meet applicable standards.
- **Bicycle Connectivity** – There are on-street bicycle facilities on Colorado Avenue, Scott Street, 2nd Street, and 3rd Street north of Burnside Avenue. Aune Street is a designated neighborhood greenway. The proposed low-stress network (LSN) and Key Routes identified by the TSP are located on 3rd Street, 2nd Street, Miller Avenue, Burnside Avenue, and Aune Street. There are several segments on the proposed LSN that don't have on-street bicycle facilities, including Burnside Avenue, Miller Avenue, and Aune Street.
- **Bicycle LTS** – The majority of streets within the study area operate with low to moderate stress (LTS1-2), including 2nd Street, Scott Street, Aune Street, and Colorado Avenue.
  Areas with the highest stress include 3rd Street along the undercrossing (LTS 4), 3rd street south of Miller Avenue (LTS 4), and 3rd Street north of Burnside (LTS 3).
- **Pedestrian Connectivity** – There are no pedestrian facilities on Aune Street, Davis Avenue, a segment of 2nd Street between Scott Street and Davis Avenue, and 3rd Street just north and south of the intersection with Davis Avenue. Except for these gaps, the following pedestrian facilities are in the study area:
  - 3rd Street has sidewalks on both sides north of the undercrossing and south of Miller Avenue
  - 2nd Street has sidewalks on both sides between Miller Avenue and Woodland Boulevard
  - 2nd Street has sidewalks on one side between Scott Street and Miller Avenue, except for the short gap of no sidewalks north of Davis Avenue
- **Pedestrian LTS** – The majority of streets operate with moderate to high pedestrian LTS (LTS 3-4). Areas without any sidewalks are the areas with the highest PLTS, including Aune Street, 2nd Street between Scott Street and Miller Avenue, and 3rd Street between the undercrossing and Miller Avenue.

- **Safety Analysis** – A crash analysis of study intersections found that the observed crash rate 3rd Street/ Miller Avenue exceeds critical crash rate by intersection type. This intersection was identified by the Bend TSAP for an intersection improvement based on crash history, including a fatality. The intersection was also identified by ODOT as a 2021 Safety Priority Index System (SPIS) since it scored in the top 15% of off-state locations.
    - The intersection of 3rd Street and Burnside Avenue also had a pedestrian crash resulting in a fatality within the 5-year study period.
    - The US97 Southbound Ramp intersection with Colorado Avenue had 12 crashes. Of these crashes, 7 were angle crashes and 5 were rear-end crashes.
- **Future Conditions Operational Analysis** – the following intersections **are forecast to exceed** applicable operational standards in 2045:
    - Colorado Interchange – Expected to have significant delays and queuing at both intersections. Operations at these intersections are influenced by the high northbound demand at Colorado Avenue/US97 SB Ramp and the eastbound left demand at Colorado Avenue/ US97 NB Ramp. An ODOT IAMP will be needed to fully understand and address the operational deficiencies at the Colorado Avenue interchange.
    - Scott Street/ 2nd Street/ Aune Street and Miller Avenue/ 3rd Street – According to the Bend Regional Model, vehicles accessing mixed-use developments on Aune Street are anticipated to increase the northeast-bound left-turns at Scott Street/ 2nd Street/ Aune Street and the southbound right turns at Miller Avenue/ 3rd Street.

NEXT STEPS

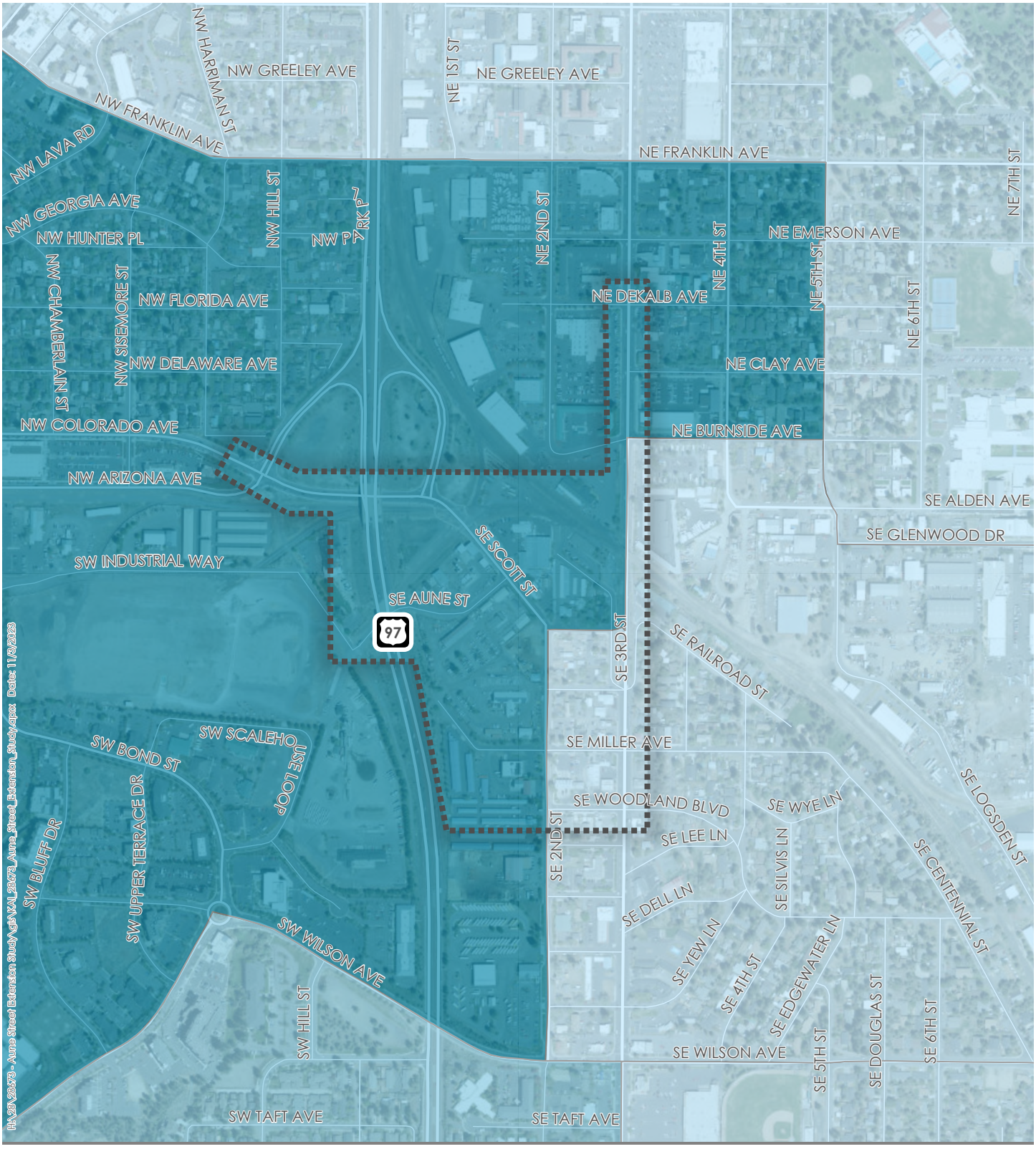
The project team will use the information and data collected in the existing conditions and future needs assessments to conduct the feasibility study and alternatives analysis.

ATTACHMENTS

A. Population Equity Demographics
B. Tax Lots
C. Seasonally Adjusted Traffic Volumes (2023)
D. Methodology Memorandum
E. Existing (2023) Operational Analysis and Queue Lengths
F. Level of Traffic Stress Analysis
G. NCHRP 765 Growth Rates
H. Forecasted (2045) Traffic Volumes
I. Future (2045) Operational Analysis and Queue Lengths

ATTACHMENT A: POPULATION EQUITY DEMOGRAPHICS

Figures A.1 to A.8 show population equity demographics by Census block group within the vicinity of the Aune Street (East) Extension Study Area. Data was provided by the City of Bend from the Bend MPO Equity Demographic Viewer.



Below Bend MPO Average (10.1%)

10.2% - 20%

20% - 30%

Over 30%

Study Area

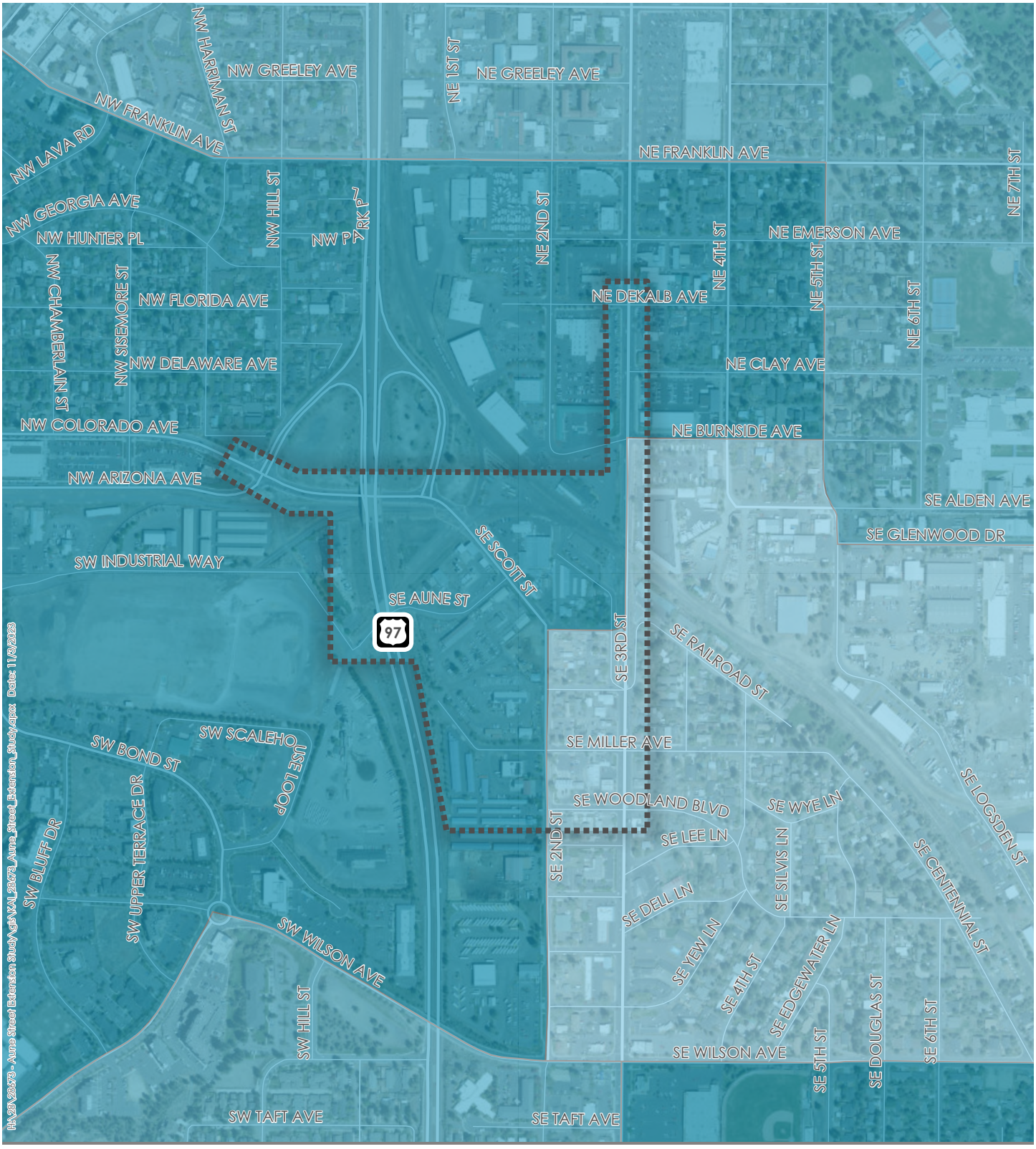
0 0.25 Miles

Figure A.1

KITTELSON & ASSOCIATES

Population Living Below Federal Poverty Line (FPL)

Source: City of Bend and KAI



Less than Bend MPO Average (24.6%)

24.7% - 35%

35.1% - 45%

Over 45%

Study Area

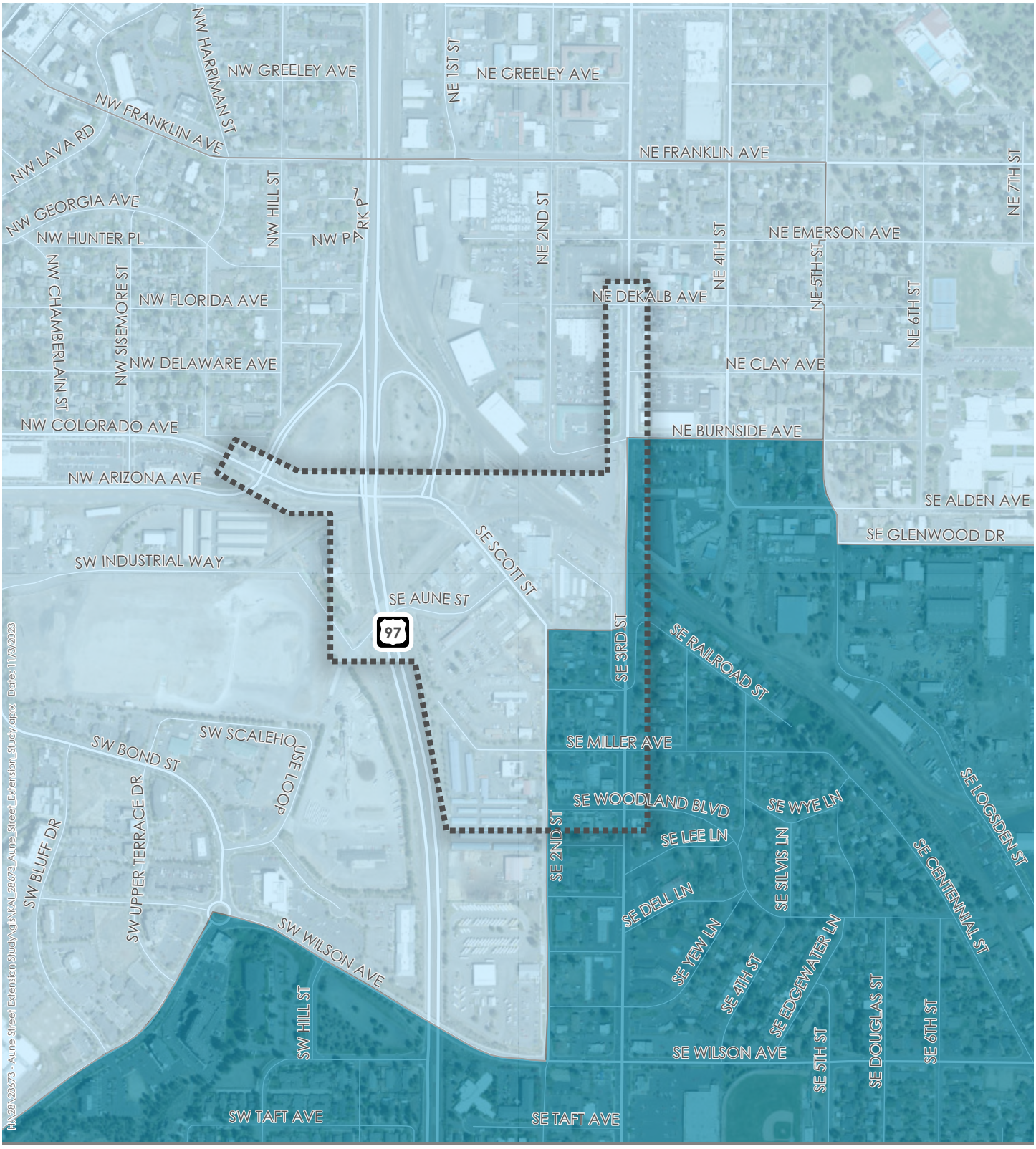
0 0.25 Miles

Figure A.2

KITTELSON & ASSOCIATES

Population Living Below 200% Federal Poverty Line (FPL)

Source: City of Bend and KAI



Below Bend MPO Average (9.8%)

9.9% - 15%

Over 15%

Study Area

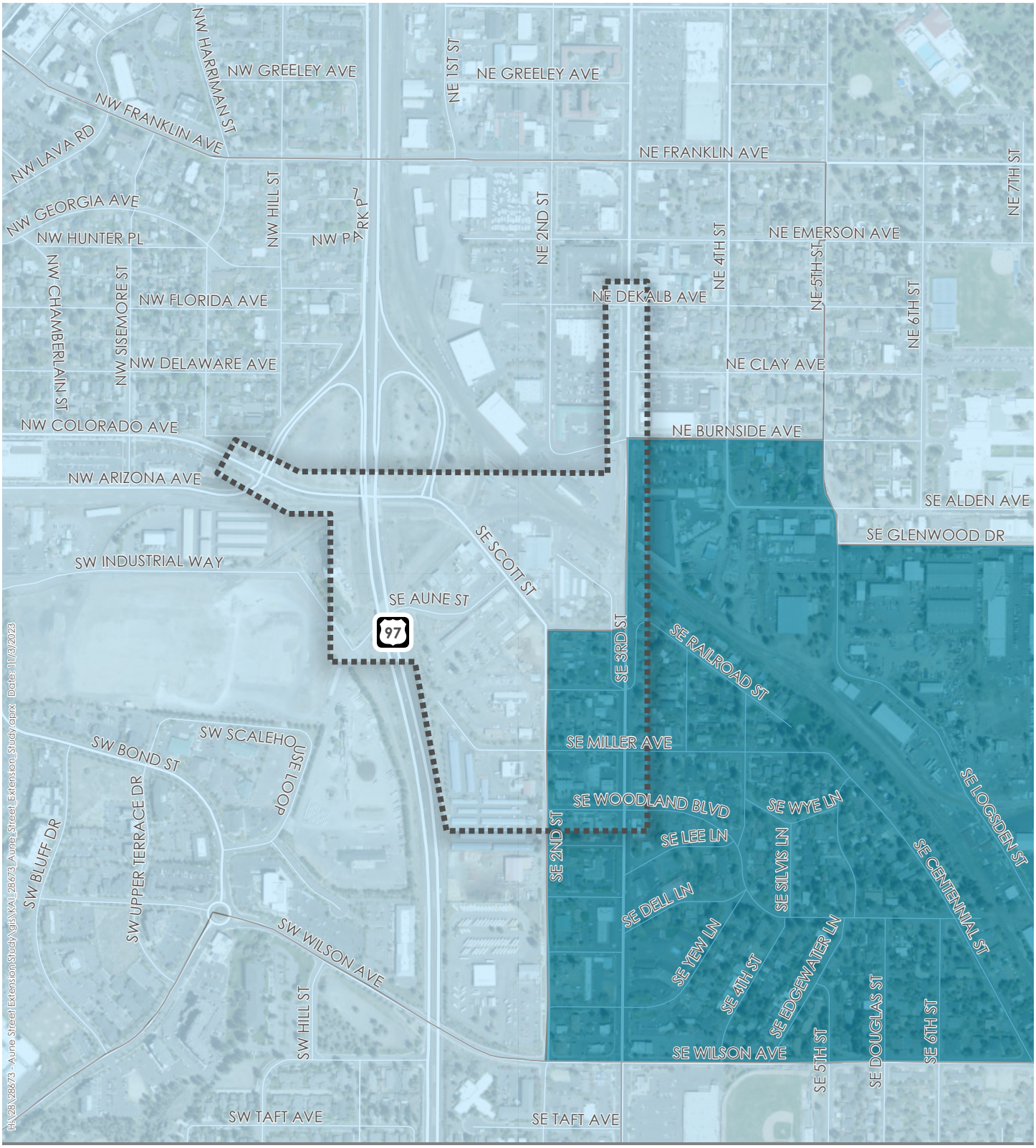
0 0.25 Miles

Figure A.3

KITTELSON & ASSOCIATES

Population with Disabilities (by Census Tract)

Source: City of Bend and KAI



Below Bend MPO Average (30.4%)

30.1% - 40%

40.1% - 50%

Over 50%

Study Area

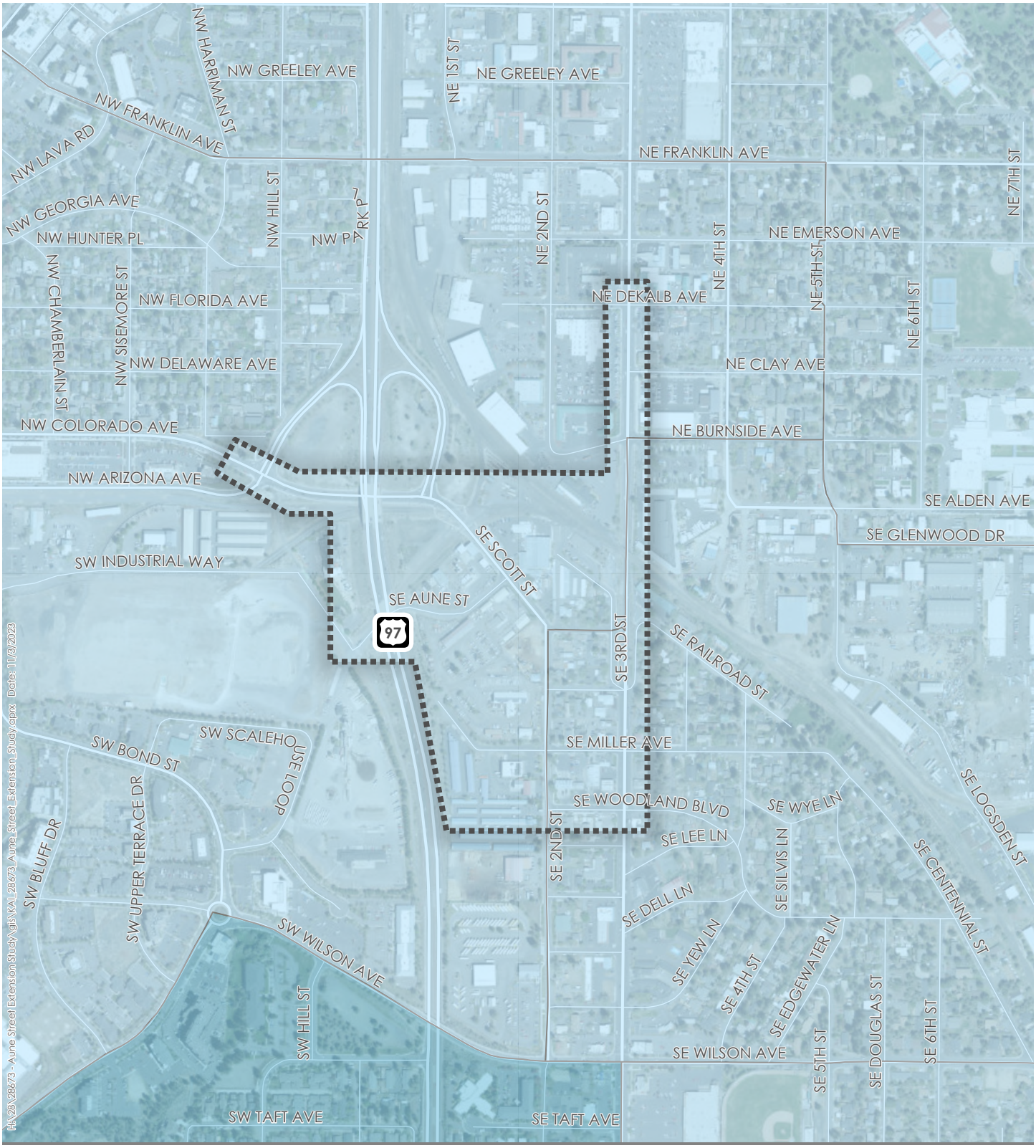
0 0.25 Miles

Figure A.4

KITTELSON & ASSOCIATES

Households with Children (0-18)

Source: City of Bend and KAI



Less than Bend MPO Average (16%)

16.1% - 28%

28.1% - 40%

Over 40%

Study Area

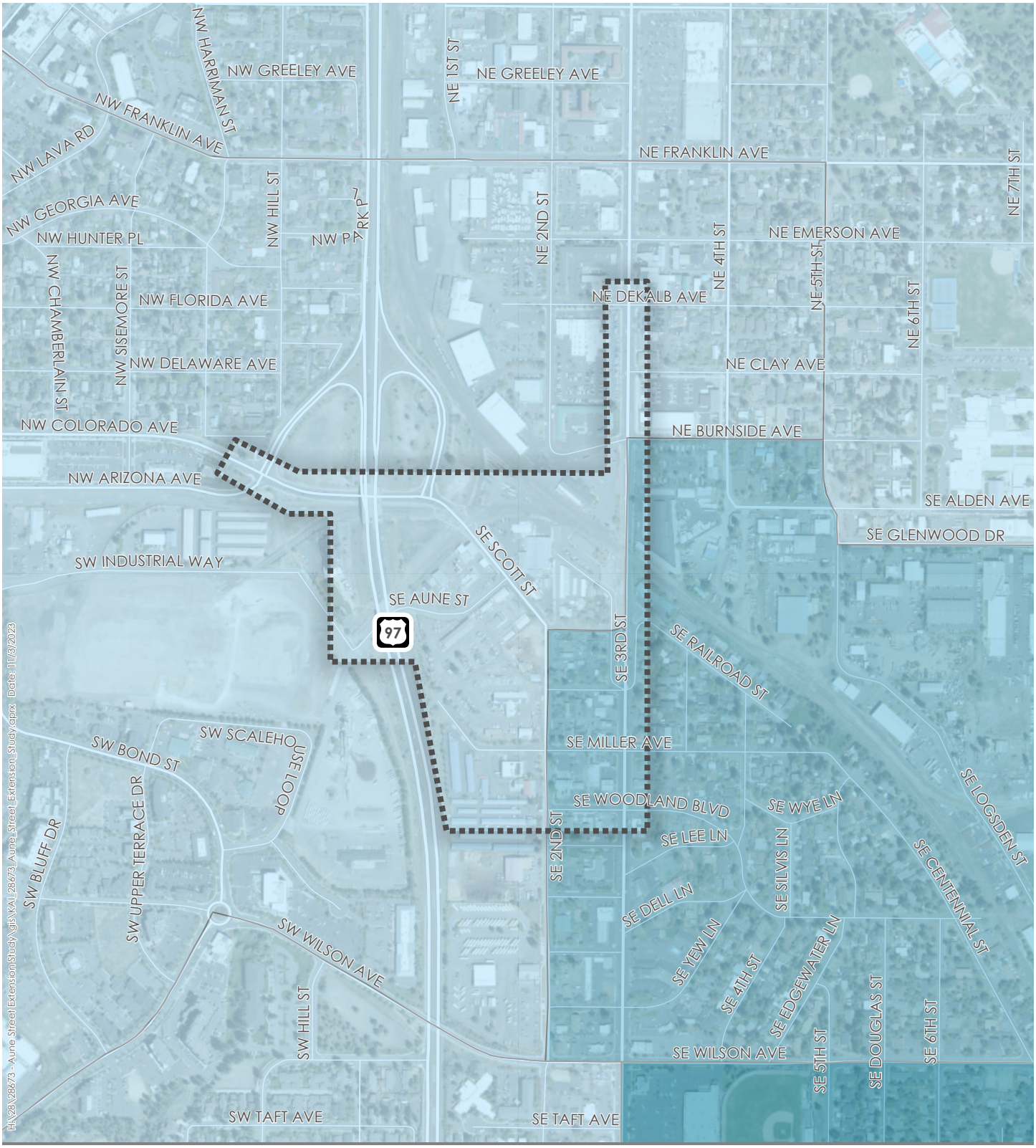
0 0.25 Miles

Figure A.5

KITTELSON & ASSOCIATES

Population Over 65

Source: City of Bend and KAI



Below Bend MPO Average (15.5%)

15.6% - 20%

20.1% - 30%

Over 30%

Study Area

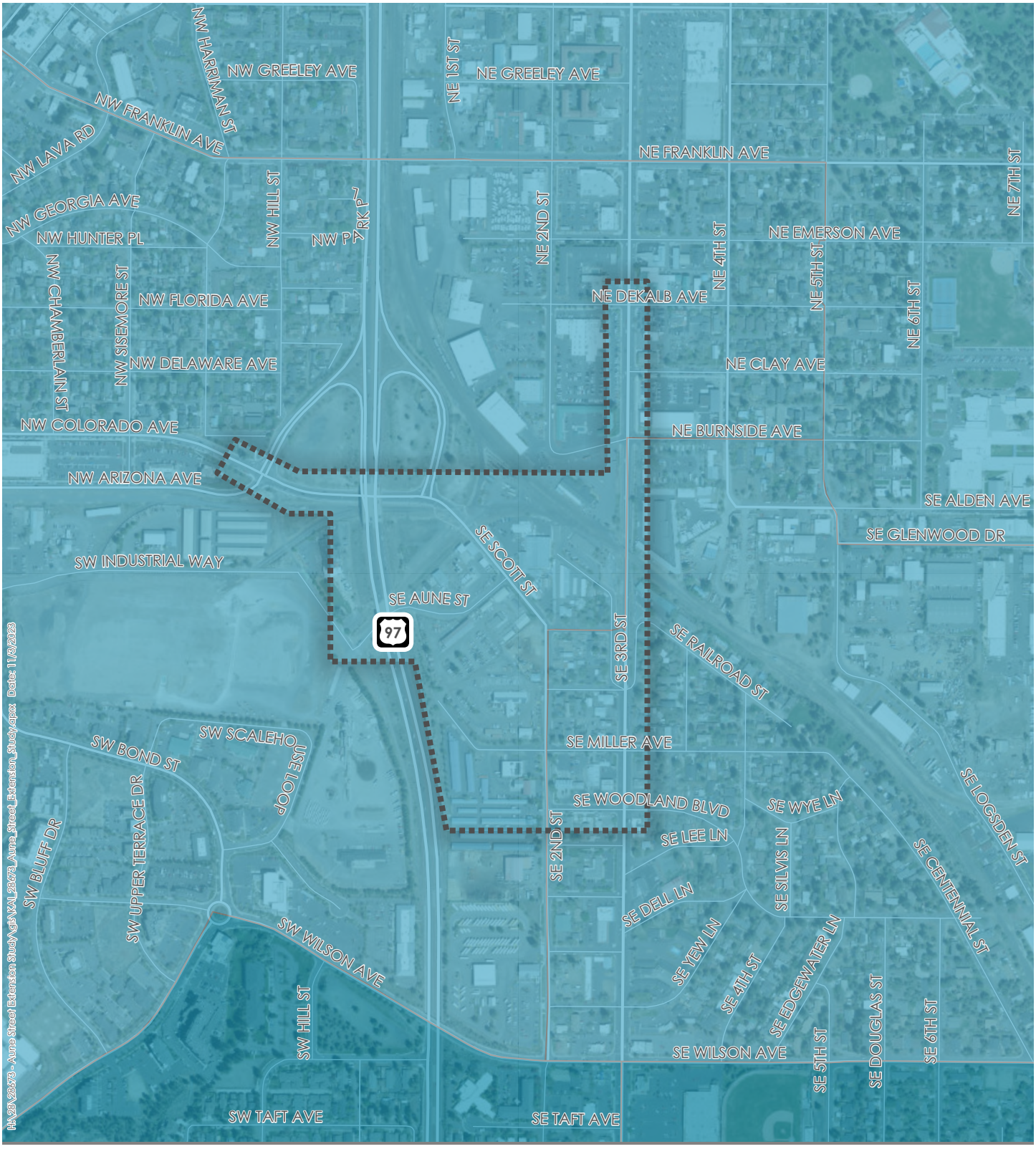
0 0.25 Miles

Figure A.6

KITTELSON & ASSOCIATES

Non-White and Hispanic Population

Source: City of Bend and KAI



Less than Bend MPO Average (5%)

5.1% - 10%

10.1% - 15%

Over 15%

Study Area

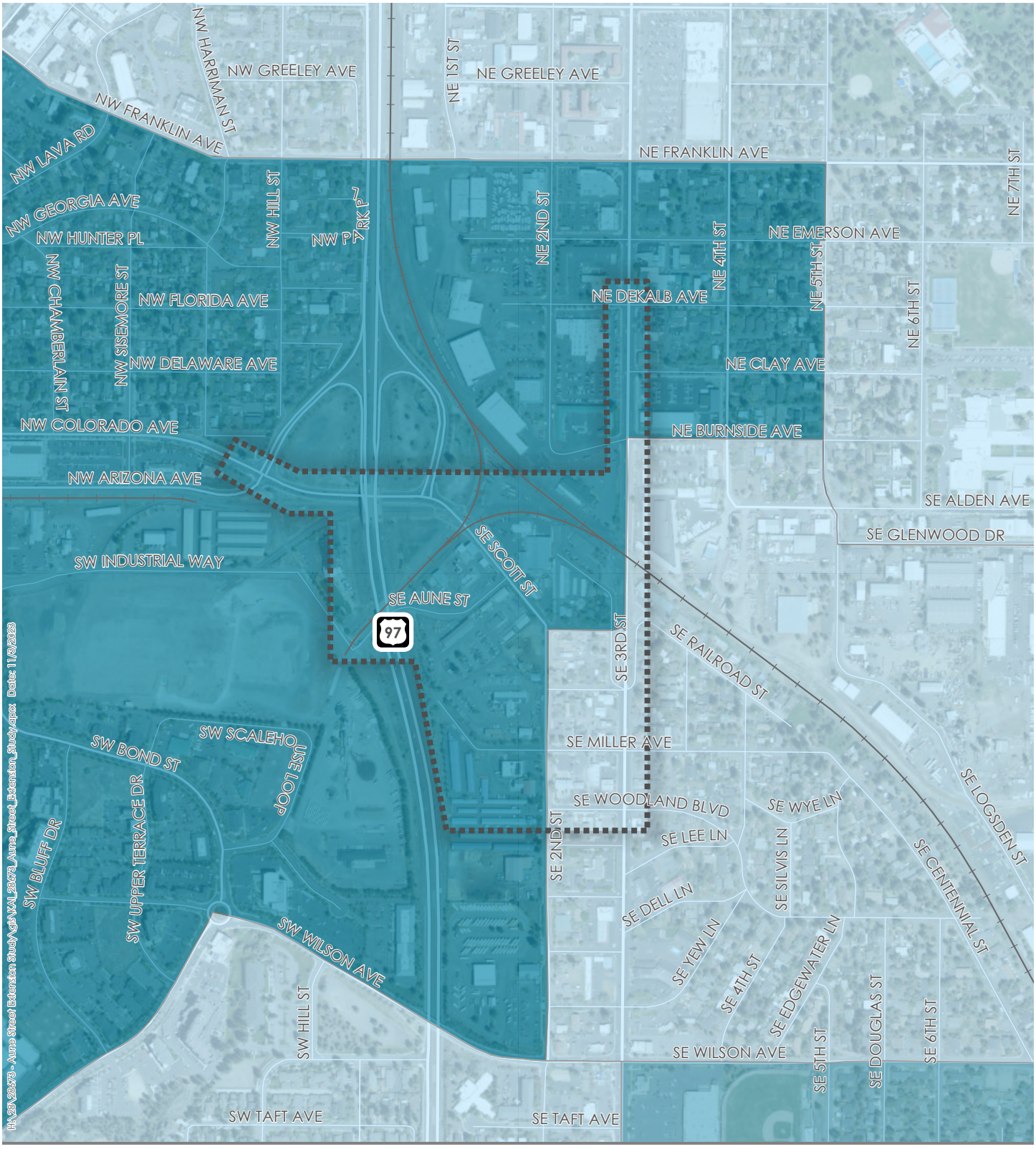
0 0.25 Miles

Figure A.7

KITTELSON & ASSOCIATES

Zero-Vehicle Households

Source: City of Bend and KAI



Less than Bend MPO Average (1.9%)

2% - 7%

Over 7%

Study Area

0 0.25 Miles

Figure A.8

KITTELSON & ASSOCIATES

Households with Limited English Proficiency (LEP)

Source: City of Bend and KAI

ATTACHMENT B: TAX LOTS

Information from Deschutes County Dial for key parcels in the study area is summarized in Table B.1.

Table B.1. Key Parcels in the Study Area

Parcel #	Taxlot	Use	Owner	Parcel Size (Acres)
00100	181205AA00100	Industrial	Exchange Properties Inc	2.2
00100	181205AD00100	Industrial	Larsen Rentals LLC	0.36
00100	181205A000100	Commercial	NSA Property Holdings LLC	2.57
00200	181205AD00200	Industrial	Larsen Rentals LLC	0.23
00200	181205A000200	Industrial	WILLIAM SMITH PROPERTIES INC	1.77
00300	181205AD00300	Industrial	Alliance Storage LLC	2.88
00300	181205A000300	Commercial	Industrial Way QOZB LLC	2.15
00400	181205A000400	Commercial	Industrial Way QOZB LLC	2.73
00500	181205A000500	Industrial	KW KELTON-BEND OWNER LLC	21.41
00501	181205AD00501	Industrial	2Nd St Properties LLC	2.5
00601	181205AD00601	Municipal or Other Exempt	Administrative School District No 1	0.18
00700	181205AD00700	Municipal or Other Exempt (School District)	School District #1	6.26
00701	181205AA00701	Commercial (Crux)	50 SW Division LLC	1.57
00701	181205AD00701	Municipal or Other Exempt	Administrative School District No 1	0.04
00900	181205AA00900	Municipal or Other Exempt	USA	0.21
00901	181205AA00901	Industrial	Wolf Holdings LLC	0.62
01000	181205AA01000	Industrial	G3 Land Company LLC	1.1
01100	181205AA01100	Municipal or Other Exempt (USFS)	USA	6.04
01200	181205AA01200	Industrial	Myrmo & Sons Inc	0.82
01300	181205AA01300	Industrial	Alliance Storage LLC	0.66
01400	181205AA01400	Industrial	Larsen Rentals LLC	0.3
01401	181205AA01401	Commercial	201 SE 2nd Street LLC	0.5
01500	181205AA01500	Municipal or Other Exempt	USA	0.17

ATTACHMENT C: SEASONALLY ADJUSTED (2023) TRAFFIC VOLUMES

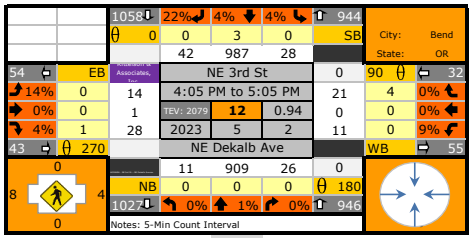
SEASONAL TREND TABLE (Updated: 11/10/2022)																									Seasonal Trend Peak Period Factor
TREND	1-Jan	15-Jan	1-Feb	15-Feb	1-Mar	15-Mar	1-Apr	15-Apr	1-May	15-May	1-Jun	15-Jun	1-Jul	15-Jul	1-Aug	15-Aug	1-Sep	15-Sep	1-Oct	15-Oct	1-Nov	15-Nov	1-Dec	15-Dec	
INTERSTATE URBANIZED	1.0937	1.1592	1.1547	1.1502	1.0841	1.0180	0.9963	0.9746	0.9815	0.9885	0.9625	0.9366	0.9211	0.9056	0.9175	0.9295	0.9470	0.9645	0.9721	0.9796	0.9885	0.9973	1.0384	1.0794	0.9056
INTERSTATE NONURBANIZED	1.2128	1.3303	1.3475	1.3647	1.2141	1.0634	1.0236	0.9838	0.9687	0.9536	0.9130	0.8724	0.8404	0.8084	0.8293	0.8501	0.8889	0.9276	0.9583	0.9889	1.0037	1.0185	1.1007	1.1830	0.8084
COMMUTER	1.1005	1.1479	1.1341	1.1204	1.0651	1.0099	0.9836	0.9574	0.9663	0.9752	0.9544	0.9336	0.9338	0.9341	0.9453	0.9566	0.9608	0.9649	0.9693	0.9736	0.9935	1.0134	1.0465	1.0796	0.9336
COASTAL DESTINATION	1.1584	1.2243	1.2052	1.1862	1.1005	1.0149	0.9887	0.9625	0.9672	0.9720	0.9181	0.8642	0.8386	0.8130	0.8299	0.8468	0.8926	0.9384	0.9940	1.0496	1.0999	1.1502	1.1960	1.2419	0.8130
COASTAL DESTINATION ROUTE	1.2909	1.3694	1.3728	1.3763	1.2315	1.0867	1.0419	0.9972	0.9581	0.9191	0.8590	0.7989	0.7607	0.7225	0.7389	0.7554	0.8235	0.8916	0.9820	1.0724	1.1507	1.2291	1.3629	1.4967	0.7225
AGRICULTURE	1.4312	1.4915	1.4980	1.5046	1.3605	1.2164	1.1152	1.0141	0.9356	0.8572	0.8266	0.7960	0.8137	0.8315	0.8448	0.8581	0.8336	0.8092	0.8496	0.8901	0.9684	1.0467	1.2566	1.4666	0.7960
RECREATIONAL SUMMER	1.4118	1.5326	1.6112	1.6898	1.4761	1.2623	1.1772	1.0921	0.9752	0.8582	0.7947	0.7311	0.7197	0.7082	0.7395	0.7708	0.8006	0.8304	0.8977	0.9651	1.0781	1.1910	1.4205	1.6501	0.7082
RECREATIONAL SUMMER WINTER	0.7518	0.8394	0.9654	1.0914	1.0422	0.9930	1.0357	1.0785	1.0310	0.9834	0.9358	0.8882	0.7824	0.6767	0.7712	0.8658	0.9973	1.1289	1.2850	1.4412	1.5833	1.7254	1.3952	1.0650	0.6767
RECREATIONAL WINTER	0.5086	0.5112	0.5988	0.6864	0.7354	0.7845	0.9435	1.1025	1.2219	1.3414	1.2723	1.2032	1.0545	0.9058	1.0033	1.1007	1.2108	1.3209	1.4791	1.6373	2.0741	2.5110	1.7317	0.9524	0.5086
SUMMER	1.2166	1.2914	1.2738	1.2563	1.1530	1.0496	1.0061	0.9625	0.9423	0.9220	0.8906	0.8591	0.8435	0.8279	0.8550	0.8821	0.9088	0.9355	0.9732	1.0109	1.0420	1.0731	1.1534	1.2337	0.8279
SUMMER < 2500	1.2683	1.3194	1.3010	1.2826	1.1889	1.0952	1.0262	0.9573	0.9119	0.8664	0.8549	0.8434	0.8442	0.8451	0.8727	0.9003	0.9080	0.9157	0.9406	0.9654	1.0279	1.0903	1.1996	1.3089	0.8434

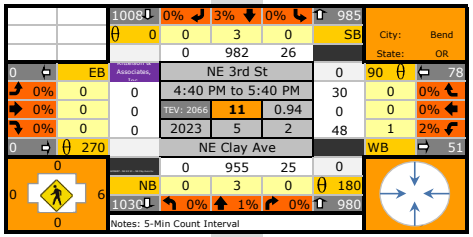
*** Seasonal Trend Table factors are based on previous year ATR data. The table is updated yearly.**
*** Grey shading indicates months were seasonal factor is greater than or less than 30%**

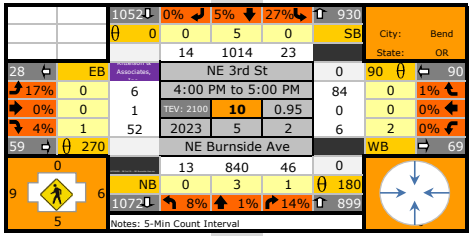
Seasonal Adjustment Factor 1.04

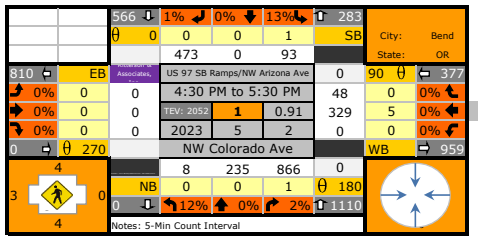
Seasonally Adjusted PM Peak Hour Volumes

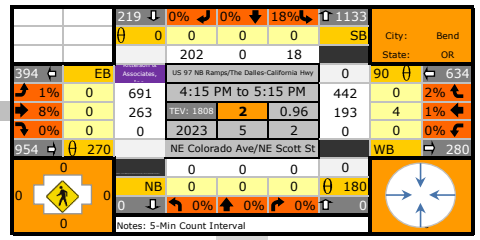
Seasonal Adjustment Factor 1.04

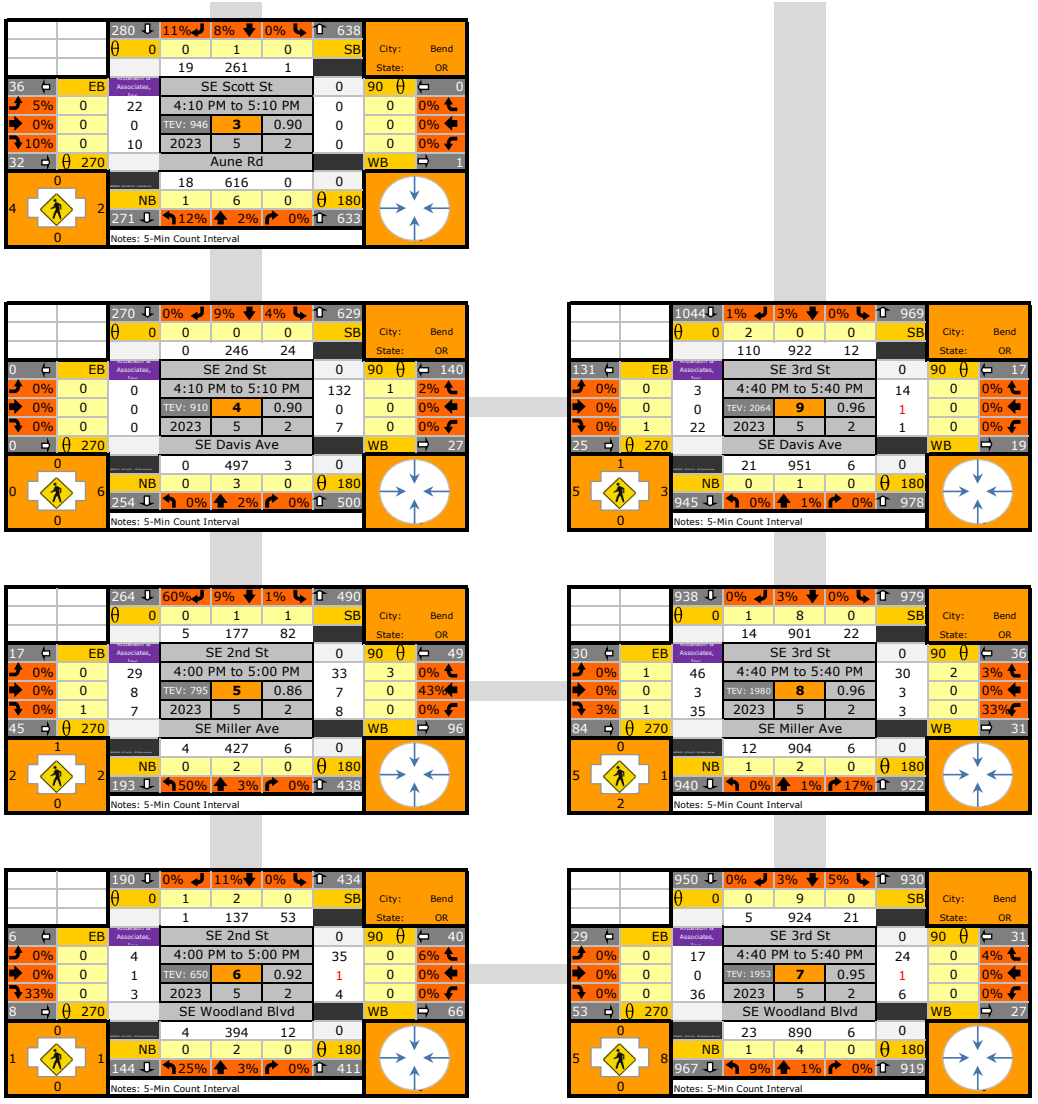











City: Bend
State: OR
SE Scott St
4:10 PM to 5:10 PM
Aune Rd
Notes: 5-Min Count Interval
SE 2nd St
4:10 PM to 5:10 PM
SE Davis Ave
Notes: 5-Min Count Interval
SE 3rd St
4:40 PM to 5:40 PM
SE Davis Ave
Notes: 5-Min Count Interval
SE 2nd St
4:00 PM to 5:00 PM
SE Miller Ave
Notes: 5-Min Count Interval
SE 3rd St
4:40 PM to 5:40 PM
SE Miller Ave
Notes: 5-Min Count Interval
SE 2nd St
4:00 PM to 5:00 PM
SE Woodland Blvd
Notes: 5-Min Count Interval
SE 3rd St
4:40 PM to 5:40 PM
SE Woodland Blvd
Notes: 5-Min Count Interval

ATTACHMENT D: METHODOLOGY MEMORANDUM

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Bend, OR 97702
P 541.312.8300

Technical Memorandum

July 20, 2023 Project# 28673

To: Garrett Sabourin and Carrie Theus

From: Katie Popp, Jacki Smith, PE & Matt Kittelson, PE

CC: ODOT Region 4, ODOT Transportation Planning Analysis Unit (TPAU)

RE: Aune Street Extension Study – Methodology Memorandum

METHODOLOGY MEMORANDUM

This memorandum documents the methodology and assumptions to perform technical analyses for the Aune Street Extension Study located in the City of Bend.

The methodology and assumptions include:

- Operational analysis
  - Data collection and volume development
  - Existing year and planning horizon (year 2045) traffic conditions
- Future growth methods and scenarios
- Safety analysis
- Multimodal analysis
- Crossing analysis

The following sections discuss each of these in more detail. These assessments establish the framework for evaluating conceptual alternatives and solutions for the Aune Street Extension Study.

Project Background

The Aune Street Extension Study was identified through several City of Bend Planning efforts including the Central Westside Plan (2015) and the Bend Transportation System Plan (2020). The project was included in the voter approved 2020 Transportation General Obligation Bond (GO Bond) with funding allocated for this study and future design and construction.

This study provides the framework for identifying near- and long-term infrastructure on Aune Street east of US97 to provide an enhanced connection from the Parkway undercrossing to 3rd Street, providing improved system connectivity for all users. The Aune Street extension west of US 97 to Bond Street will be built by private developers as adjacent land is developed.

Study Area

The study area is bounded by Franklin Avenue to the north, SE 3rd Street to the east, Wilson Avenue to the south, and generally US97 to the west (including the southbound US97/Colorado Avenue ramp intersection). The existing and future conditions assessments will focus on the 12 study intersections provided below:

1. Colorado Avenue/US97 SB Ramp
2. Colorado Avenue/US97 NB Ramp
3. Scott Street/Aune Street
4. 2nd/Davis Avenue
5. 2nd Street/Miller Avenue
6. 2nd Street/Woodland Boulevard
7. 3rd Street/Woodland Boulevard
8. 3rd Street/Miller Avenue
9. 3rd Street/Davis Avenue
10. 3rd Street/Burnside Avenue
11. 3rd Street/Clay Avenue
12. 3rd Street/Dekalb Avenue

The study area and study intersections are shown in Figure 1.

Figure 1. Study Area

Operational Analysis

The following section describes how traffic volumes were collected within the study area and how they will be used to evaluate existing and future traffic conditions at each study intersection. Operational analysis of the study intersections is based on Chapter 4.7 of the Bend Development Code (BDC). Analysis of intersections on an ODOT facility will be evaluated based on ODOT mobility targets provided in the Oregon Department of Transportation (ODOT) Oregon Highway Plan (OHP) and Highway Design Manual (HDM), as applicable. The following analysis periods will be evaluated:

- 2023 Existing Conditions
- 2045 Future Conditions

Traffic Counts

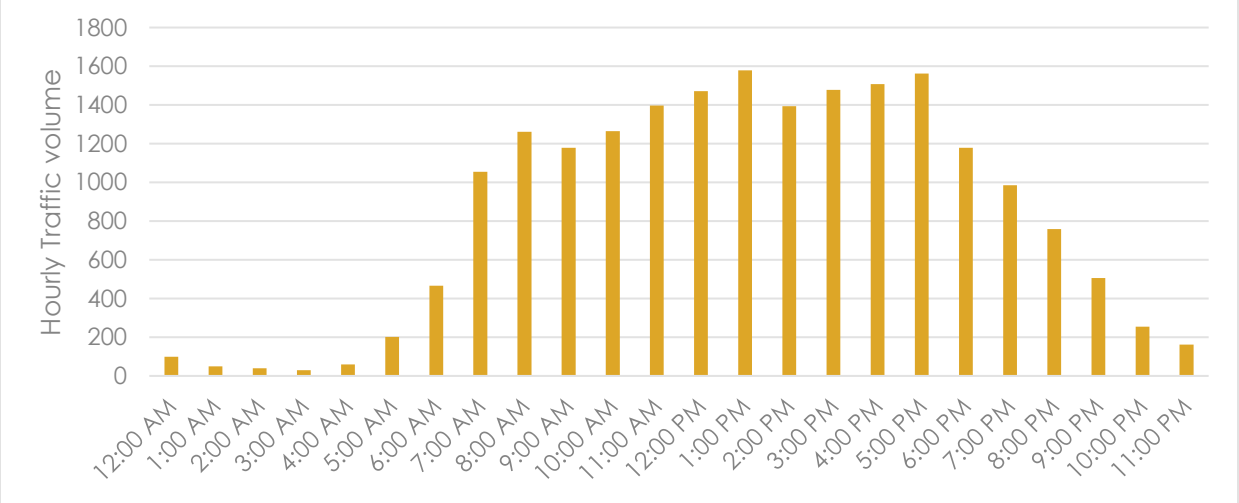
Turning movement counts and 24-hour tube counts on 2nd Street and 3rd Street were collected on May 2, 2023. All counts include the total number of pedestrians, bicyclists,

motor vehicles, and percentage of heavy vehicles that entered the intersections in 5-minutes intervals. The PM peak hour (4pm-6pm) data was reduced and summarized. 24-hour video data was collected at all the study intersections.

Peak Hour Selection

Based on review of 24-hour traffic count data, 4pm-5pm is representative of the system peak hour to be used in existing and future conditions assessments. As shown in Exhibit 1, hourly volumes on 3rd Street are relatively uniform between 8am-5pm. While the hourly bi-directional peak shows the highest traffic volumes from 1-2pm, the volumes remain consistent throughout typical daytime hours. Therefore, because the volumes have minimal fluctuation and the travel demand model output reflects the pm peak hour, intersections will be evaluated using the system peak hour of 4pm-5pm.

Exhibit 1. Bidirectional Hourly Volumes - 3rd Street



Seasonal Adjustment Methods

The traffic count data will be seasonally adjusted using the *ODOT Analysis Procedure Manual (APM) Chapter 5 ATR Seasonal Trend Table Method* for a commuter corridor to reflect 30th highest hour conditions. For count data collected in early May, the seasonal adjustment factor that will be applied to all turning movement counts is 1.04.

Intersection Mobility Targets

State Facilities

The US97/Colorado Avenue intersections are owned and maintained by ODOT. Therefore, the northbound and southbound ramp intersections are subject to ODOT mobility targets. Table 6 of the OHP provides the mobility targets for facilities outside the

Portland Metro area. US97 in the study area is within an MPO and identified as a Statewide Highway with Expressway designation. Therefore, the volume-to-capacity mobility target for the US97 ramp approaches is 0.85. The OHP also states that non-state highway unsignalized intersection approaches should adhere to the volume to capacity ratio for District/Local Interest Roads. Therefore, the mobility target for the Colorado Avenue approaches within the study area is a v/c ratio less than 0.95.

Table 1200-1 of the 2023 ODOT HDM provides v/c ratios used to assist in identifying future system deficiencies and evaluating future alternatives on state highways. The ODOT HDM states that a statewide NHS freight route inside an urban growth boundary and inside an MPO should be designed for a mobility target v/c ratio less than 0.75 for a new roadway. Additionally, the HDM states that local interest roads should be designed for a mobility target v/c of 0.85. Depending on the operational efficiencies of various identified alternative improvements and coordination with ODOT on future plans for the interchange, an alternative mobility standard may be presented within the alternative development.

City Facilities

All other roadways in the study area are owned and operated by the City of Bend. Applicable operating standards for each intersection are based on Bend Development Code (BDC) 4.7.500.B.6.d:

- Two-Way Stop Control. Average delay for the critical lane group for any major intersection with greater than 100 peak hour trips is greater than or equal to 50 seconds during the peak hour.
- All-Way Stop Control. Average delay for any major intersection as a whole is greater than or equal to 80 seconds during the peak hour.
- For signalized intersections, the volume-to-capacity ratio for the intersection as a whole is greater than or equal to 1.0 during the peak hour.
- For roundabout intersections, the volume-to-capacity ratio for the critical movement is greater than or equal to 1.0 during the peak hour.

Traffic operations at the study intersections will be evaluated as outlined above. Project alternatives will consider applicable operating standards as part of the alternative development.

Operational Analysis Modeling Software and Parameters

The following data sources and methodologies are proposed for conducting traffic analysis.

- Intersection/Road Geometry (e.g., number of lanes, lane configurations, cross-section elements, etc.) will be collected through aerial photography and site visits. Available as-built data may also be used to verify existing roadway geometry. The

analysis models will be constructed on scaled roadway line work from GIS or aerial photography.

- Operational Data (e.g., posted speeds, intersection control, rail crossings, etc.) will be collected through aerial photography and confirmed through site visits.
- Peak Hour Factors (PHF) will be 1.0, per City of Bend analysis standards.
- Traffic Volume Development is described in previous sections.
- Traffic Operations
  - The methodologies identified in the Highway Capacity Manual 7th Edition (HCM – Reference 5) will be used to analyze traffic operations at the study intersections.
  - The team will utilize Vistro or Synchro, both software tools designed to assist with operations analyses in accordance with HCM 7th Edition methodologies; therefore, these software packages will be used to conduct the traffic operations analyses. Level-of-service (LOS), delay, v/c ratios (critical movement for unsignalized intersections) and 95th percentile queue lengths (note where queues would impact adjacent intersections or access points).
  - Roundabout operational analysis will be conducted consistent with roundabout calibration factors developed for Bend and document in the Bend Roundabout Evaluation and Design Guidelines.
  - Current signal timing data will be requested from ODOT for analysis of all existing traffic signals.

Table 1 summarizes the software and input assumptions for the traffic analysis.

Table 1: Traffic Analysis Assumptions

Intersection Parameters	Existing Conditions Assumptions
Peak Hour Factor	From traffic counts
Conflicting Bikes and Pedestrians per Hour	From traffic counts (as available)
Area Type	Based on local conditions
Ideal Saturation Flow Rate (All Movements)	1,750 passenger cars per hour per lane
Lane Width	12 feet (unless field observations suggest otherwise)
Percent Heavy Vehicles (All Movements)	From traffic counts (as available)
Percent Grade	Estimated based on field observations
95th-Percentile & Average Vehicle Queues	Traffic analysis summary output

Future Growth Methods and Scenarios

The Bend Redmond Regional Travel Demand Model (BRM) tool will be used to estimate year 2045 turning movement volumes at all study intersections. The BRM tool links land use, demographics, travel demand management strategies (such as parking pricing),

and the transportation network to forecast/predict how much people will travel, by which mode, and by which route, including sensitivity to system operational factors such as travel time due to congestion.

The assumptions included in the 2045 model are consistent with the Bend Transportation System Plan (TSP) land uses, which includes over 50 percent growth in housing and employment in Bend. This growth is spread throughout vacant lands, specific opportunity areas, and expansion areas identified through the 2016 Urban Growth Boundary update. This includes strategies identified through integrated transportation and land use planning to reduce vehicle miles travelled (VMT) per capita, such as increase in mixed-use, dense land uses, consistent with the land use designations shown in the adopted Bend Comprehensive Plan. The model run will include all local and reginal planned projects and developments including the Timberyards development west of the project area.

Raw link level volumes from the BRM will be post-processed using methods consistent with the ODOT APM V2 to develop intersection turn-movement volumes. This approach is derived from methodologies outlined in the National Cooperative Highway Research Program (NCHRP) Report 765 Highway Traffic Data for Urbanized Area Project Planning and Design. If needed for certain locations, network refinements be made in the travel model to help evaluate local-street level circulation patterns that are not represented in the regional model framework.

The project team will coordinate with the Bend MPO and ODOT Transportation Planning and Analysis Unit (TPAU) to ensure that the future year scenario is reflective of the higher housing densities being contemplated for the Timberyard Opportunity Area to the west.

Safety Analysis

The crash analysis will review the most recent five years of reported crash data at the study intersections, obtained from ODOT's Crash Analysis & Reporting Unit as well as document any fatal or severe injury crashes on roadway segments in the study area. Possible crash patterns that may include location, type, characteristics, and/or severity will be identified. Intersection crash rates will be developed and compared with statewide crash rates (ODOT Analysis Procedures Manual [APM] Exhibit 4-1). Specific emphasis will be given to crashes involving people walking, biking, or rolling.

The recently completed Bend Transportation Safety Action Plan (TSAP) and City of Bend All Roads Transportation Safety (ARTS) project list will be reviewed for each study intersection.

Multimodal Analysis

The multimodal analysis will review the following elements of the active transportation network to identify potential facility and service alternatives for people walking, rolling, biking, and taking transit within the study area:

- Availability of facilities and services (including transit) within the study area.
- Level of Traffic Stress (LTS) ratings for pedestrian and bicycle facilities with the study area. This analysis will rely on recently completed City of Bend LTS evaluations as available.
- Review of facilities included in the Bend Transportation System Plan with particular emphasis on the Low Street Bicycle Network and Key Walking and Biking Routes.

The LTS analyses will be performed in accordance with the methodologies identified in Chapter 14 of the APM. Pedestrian and Bicycle LTS have unique criteria that are used to determine a facility's LTS score (e.g., number of travel lanes, bike lane widths, adjacent parking, roadway functional classification, daily volume, posted speed limits, sidewalk conditions and widths, illumination presence, etc.). LTS scores range from little traffic stress (LTS 1) to high traffic stress (LTS 4) and are based on the perceived safety issue of being in close proximity to vehicles.

The LTS evaluation will be an essential component of identifying a preferred alignment for Key Walking and Biking Route 7, including 3rd Street crossing locations[1]. This route is planned to utilize the Aune Street extension.

Crossing Analysis

A crossing analysis will be conducted to evaluate recommended crosswalk treatments at intersections where the key walking/biking route crosses an arterial or collector. The analysis will use Table 11 of the Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines (FHWA Publication Number HRT-04-100, September, 2005). The use of this table is consistent with existing City of Bend practices in Section 4.7.500 of the Bend Development Code.

[1] This project addresses LTS from US97 to 3rd Street and the intersection crossing locations stated. Barriers along 3rd Street from Franklin Ave to Wilson Ave will not be addressed as part of this study.

ATTACHMENT E: EXISTING (2023) OPERATIONAL ANALYSIS AND QUEUE LENGTHS

Table E.1 summarizes 95th percentile queue lengths for each study intersection in the PM peak hour with existing (2023) traffic volumes. Values in bold and italicized indicate that the queue length exceeds available storage. As shown, the queue length for southbound right-turning vehicles at the Colorado Avenue/ US97 southbound ramp exceeds the 200-foot right-turn lane storage. At the Colorado Avenue northbound ramps intersection, Operational results showed that the queue length for the eastbound left turning movement does not exceed available left-turn lane storage. However, observations in the field demonstrate that during the weekday peak hour period the left-turn lane storage may extend back to the Arizona Avenue intersection.

Table E.1. Existing Conditions Operational Analysis Summary (PM Peak Hour)

Intersection	Direction	95th Percentile Queue Length (ft) (Movements)
Colorado Ave/ US97 SB Ramp	NB	225 ft/ 950 ft (TR/R)
	SB	75/ ***525*** (L/***R***)
	EB	-
	WB	350 ft (R)
Colorado Ave/ US97 NB Ramp	NB	-
	SB	100 ft/ 50 ft (L/ R)
	EB	200 ft (L)
	WB	0 ft
Scott Street/ Aune Street[2]	NWB	0 ft
	SEB	0 ft
	NEB	25 ft (L)
	SWB	-
2nd/ Davis Avenue	NB	0 ft
	SB	25 ft (L)
	WB	50 ft (L)
2nd Street/ Miller Avenue	NB	0 ft
	SB	25 ft (L)
	EB	25 ft (L)
	WB	25 ft (L)
2nd Street/ Woodland Blvd	NB	25 ft (L)
	SB	25 ft (L)
	WB	25 ft (L)
3rd Street/ Dekalb Avenue	NB	25 ft (L)
	SB	25 ft (L)
	EB	25 ft (L)
	WB	25 ft (L)
3rd Street/ Clay Avenue	NB	0 ft
	SB	25 ft (L)
	WB	50 ft (L)
3rd Street/ Burnside Avenue	NB	25 ft (L)
	SB	25 ft (L)
	EB	50 ft (L)
	WB	50 ft (L)
3rd Street/ Davis Avenue	NB	25 ft (L)

Intersection	Direction	95th Percentile Queue Length (ft) (Movements)
	SB	25 ft (L)
	EB	25 ft (L)
	WB	25 ft (L)
3rd Street/ Miller Avenue	NB	25 ft (L)
	SB	25 ft (L)
	EB	50 ft (L)
	WB	50 ft (L)
3rd Street/ Woodland Blvd	NB	25 ft (L)
	SB	25 ft (L)
	EB	25 ft (L)
	WB	25 ft (L)

Aune Street (East) Extension Study

Vistro File: H:\...\28763_Colorado97_Existing.vistro
Report File: H:\...\Existing_PMPeak_11_03_23.pdf

Scenario 1 Existing (2023) PM Peak Hour
11/3/2023

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Colorado Ave/ US97 SB Ramps	Signalized	HCM 6th Edition	NB Right	0.740	81.1	F

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Colorado Ave/ US97 SB Ramps

Control Type:	Signalized	Delay (sec / veh):	81.1
Analysis Method:	HCM 6th Edition	Level Of Service:	F
Analysis Period:	15 minutes	Volume to Capacity (v/c):	0.740

Intersection Setup

Name	Arizona Ave			US97 Ramp SB						Colorado Ave/ Scott St		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Entry Pocket	0	0	1	0	0	1	0	0	0	0	0	0
Entry Pocket Length [ft]	100.00	100.00	1000.00	100.00	100.00	200.00	100.00	100.00	100.00	100.00	100.00	100.00
No. of Lanes in Exit Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Exit Pocket Length [ft]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Speed [mph]	25.00			25.00			30.00			25.00		
Grade [%]	0.00			0.00			0.00			0.00		
Curb Present	No			No						No		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name	Arizona Ave			US97 Ramp SB						Colorado Ave/ Scott St		
Base Volume Input [veh/h]	8	235	866	93	0	473	0	0	0	0	329	48
Base Volume Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Heavy Vehicles Percentage [%]	12.00	0.00	1.00	13.00	2.00	1.00	2.00	2.00	2.00	2.00	0.00	0.00
Growth Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	8	235	866	93	0	473	0	0	0	0	329	48
Peak Hour Factor	0.9100	0.9100	0.9100	0.9100	1.0000	0.9100	1.0000	1.0000	1.0000	1.0000	0.9100	0.9100
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	2	65	238	26	0	130	0	0	0	0	90	13
Total Analysis Volume [veh/h]	9	258	952	102	0	520	0	0	0	0	362	53
Presence of On-Street Parking	No		No	No		No				No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
v_do, Outbound Pedestrian Volume crossing	0			0			0			0		
v_di, Inbound Pedestrian Volume crossing m	0			0			0			0		
v_co, Outbound Pedestrian Volume crossing	0			0			0			0		
v_ci, Inbound Pedestrian Volume crossing mi	0			0			0			0		
v_ab, Corner Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Lane Group Calculations

Lane Group	C	R	L	R		C
C, Cycle Length [s]	89	89	89	89		89
L, Total Lost Time per Cycle [s]	5.00	5.00	4.00	4.00		5.00
l1_p, Permitted Start-Up Lost Time [s]	0.00	0.00	0.00	0.00		0.00
l2, Clearance Lost Time [s]	3.00	0.00	2.00	2.00		3.00
g_i, Effective Green Time [s]	20	50	30	30		25
g / C, Green / Cycle	0.22	0.56	0.34	0.34		0.28
(v / s)_i Volume / Saturation Flow Rate	0.16	0.66	0.07	0.36		0.25
s, saturation flow rate [veh/h]	1707	1442	1461	1442		1672
c, Capacity [veh/h]	384	810	493	486		470
d1, Uniform Delay [s]	31.71	19.50	21.02	29.50		30.61
k, delay calibration	0.14	0.50	0.08	0.50		0.32
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00		1.00
d2, Incremental Delay [s]	2.88	91.63	0.15	60.75		14.65
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00		0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00		1.00
PF, progression factor	1.00	1.00	1.00	1.00		1.00

Lane Group Results

X, volume / capacity	0.70	1.18	0.21	1.07		0.88
d, Delay for Lane Group [s/veh]	34.59	111.13	21.18	90.25		45.26
Lane Group LOS	C	F	C	F		D
Critical Lane Group	No	Yes	No	Yes		No
50th-Percentile Queue Length [veh/ln]	5.53	35.73	1.53	18.27		10.26
50th-Percentile Queue Length [ft/ln]	138.30	893.35	38.16	456.77		256.43
95th-Percentile Queue Length [veh/ln]	9.39	51.44	2.75	26.40		15.51
95th-Percentile Queue Length [ft/ln]	234.73	1285.89	68.69	660.10		387.75

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	34.59	34.59	111.13	21.18	0.00	90.25	0.00	0.00	0.00	0.00	45.26	45.26
Movement LOS	C	C	F	C		F					D	D
d_A, Approach Delay [s/veh]	94.37			78.93			0.00			45.26		
Approach LOS	F			E			A			D		
d_I, Intersection Delay [s/veh]	81.07											
Intersection LOS	F											
Intersection V/C	0.740											

Other Modes

g_Walk,mi, Effective Walk Time [s]	11.0	11.0	9.0	11.0
M_corner, Corner Circulation Area [ft²/ped]	0.00	0.00	0.00	0.00
M_CW, Crosswalk Circulation Area [ft²/ped]	0.00	0.00	0.00	0.00
d_p, Pedestrian Delay [s]	34.18	34.18	35.96	34.18
l_p,int, Pedestrian LOS Score for Intersection	2.269	2.192	2.293	2.311
Crosswalk LOS	B	B	B	B
s_b, Saturation Flow Rate of the bicycle lane	2000	2000	2000	2000
c_b, Capacity of the bicycle lane [bicycles/h]	449	674	0	562
d_b, Bicycle Delay [s]	26.75	19.56	44.50	23.01
l_b,int, Bicycle LOS Score for Intersection	3.571	1.560	4.132	2.244
Bicycle LOS	D	A	D	B

Sequence

Ring 1	-	4	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection	
Int Delay, s/veh	19.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	691	263	193	442	18	202
Future Vol, veh/h	691	263	193	442	18	202
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	96	96	96	96	96	96
Heavy Vehicles, %	1	8	1	2	18	0
Mvmt Flow	720	274	201	460	19	210

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	661	0	-	0	2145	431
Stage 1	-	-	-	-	431	-
Stage 2	-	-	-	-	1714	-
Critical Hdwy	4.11	-	-	-	6.58	6.2
Critical Hdwy Stg 1	-	-	-	-	5.58	-
Critical Hdwy Stg 2	-	-	-	-	5.58	-
Follow-up Hdwy	2.209	-	-	-	3.662	3.3
Pot Cap-1 Maneuver	932	-	-	-	48	629
Stage 1	-	-	-	-	623	-
Stage 2	-	-	-	-	146	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	932	-	-	-	~ 11	629
Mov Cap-2 Maneuver	-	-	-	-	~ 11	-
Stage 1	-	-	-	-	141	-
Stage 2	-	-	-	-	146	-

Approach	EB	WB	SB
HCM Control Delay, s	14.9	0	95.6
HCM LOS			F

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	932	-	-	-	11	629
HCM Lane V/C Ratio	0.772	-	-	-	1.705	0.335
HCM Control Delay (s)	20.6	-	-	-	$ 1016.3	13.6
HCM Lane LOS	C	-	-	-	F	B
HCM 95th %tile Q(veh)	7.9	-	-	-	3.2	1.5

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	0.7

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations						
Traffic Vol, veh/h	261	19	18	616	22	10
Future Vol, veh/h	261	19	18	616	22	10
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	100	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	261	19	18	616	22	10

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	280	0	923	271
Stage 1	-	-	-	-	271	-
Stage 2	-	-	-	-	652	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1283	-	299	768
Stage 1	-	-	-	-	775	-
Stage 2	-	-	-	-	518	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1283	-	293	768
Mov Cap-2 Maneuver	-	-	-	-	293	-
Stage 1	-	-	-	-	775	-
Stage 2	-	-	-	-	507	-

Approach	SE	NW	NE
HCM Control Delay, s	0	0.2	15.6
HCM LOS			C

Minor Lane/Major Mvmt	NELn1	NELn2	NWL	NWT	SET	SER
Capacity (veh/h)	293	768	1283	-	-	-
HCM Lane V/C Ratio	0.075	0.013	0.014	-	-	-
HCM Control Delay (s)	18.3	9.7	7.8	0	-	-
HCM Lane LOS	C	A	A	A	-	-
HCM 95th %tile Q(veh)	0.2	0	0	-	-	-

Intersection	
Int Delay, s/veh	2.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	7	132	497	3	24	246
Future Vol, veh/h	7	132	497	3	24	246
Conflicting Peds, #/hr	0	0	0	6	6	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	0	2	2	0	4	9
Mvmt Flow	7	132	497	3	24	246

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	799	505	0	0	506	0
Stage 1	505	-	-	-	-	-
Stage 2	294	-	-	-	-	-
Critical Hdwy	6.4	6.22	-	-	4.14	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.318	-	-	2.236	-
Pot Cap-1 Maneuver	357	567	-	-	1049	-
Stage 1	610	-	-	-	-	-
Stage 2	761	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	345	564	-	-	1043	-
Mov Cap-2 Maneuver	345	-	-	-	-	-
Stage 1	606	-	-	-	-	-
Stage 2	740	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.8	0	0.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	547	1043	-
HCM Lane V/C Ratio	-	-	0.254	0.023	-
HCM Control Delay (s)	-	-	13.8	8.5	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	1	0.1	-

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		⇕			⇕			⇕			⇕	
Traffic Vol, veh/h	29	8	7	8	7	33	4	427	6	82	177	5
Future Vol, veh/h	29	8	7	8	7	33	4	427	6	82	177	5
Conflicting Peds, #/hr	1	0	0	0	0	1	2	0	2	2	0	2
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	0	0	43	0	50	3	0	1	9	60
Mvmt Flow	29	8	7	8	7	33	4	427	6	82	177	5

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	805	789	182	791	788	433	184	0	0	435	0	0
Stage 1	346	346	-	440	440	-	-	-	-	-	-	-
Stage 2	459	443	-	351	348	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.93	6.2	4.6	-	-	4.11	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.93	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.93	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4.387	3.3	2.65	-	-	2.209	-	-
Pot Cap-1 Maneuver	303	325	866	310	280	627	1148	-	-	1130	-	-
Stage 1	674	639	-	600	514	-	-	-	-	-	-	-
Stage 2	586	579	-	670	568	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	262	296	864	281	255	625	1146	-	-	1128	-	-
Mov Cap-2 Maneuver	262	296	-	281	255	-	-	-	-	-	-	-
Stage 1	669	586	-	596	510	-	-	-	-	-	-	-
Stage 2	544	575	-	602	521	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	18.9	14.2	0.1	2.6
HCM LOS	C	B		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1146	-	-	302	441	1128	-	-
HCM Lane V/C Ratio	0.003	-	-	0.146	0.109	0.073	-	-
HCM Control Delay (s)	8.2	0	-	18.9	14.2	8.4	0	-
HCM Lane LOS	A	A	-	C	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0.5	0.4	0.2	-	-

Intersection	
Int Delay, s/veh	1.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	4	35	394	12	53	137
Future Vol, veh/h	4	35	394	12	53	137
Conflicting Peds, #/hr	0	0	0	1	1	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	0	6	3	0	0	11
Mvmt Flow	4	35	394	12	53	137

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	644	401	0	0	407	0
Stage 1	401	-	-	-	-	-
Stage 2	243	-	-	-	-	-
Critical Hdwy	6.4	6.26	-	-	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.354	-	-	2.2	-
Pot Cap-1 Maneuver	440	640	-	-	1163	-
Stage 1	681	-	-	-	-	-
Stage 2	802	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	418	639	-	-	1162	-
Mov Cap-2 Maneuver	418	-	-	-	-	-
Stage 1	680	-	-	-	-	-
Stage 2	763	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.3	0	2.3
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	606	1162	-
HCM Lane V/C Ratio	-	-	0.064	0.046	-
HCM Control Delay (s)	-	-	11.3	8.2	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.2	0.1	-

Intersection	
Int Delay, s/veh	1.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	17	0	36	6	0	24	23	890	6	21	924	5
Future Vol, veh/h	17	0	36	6	0	24	23	890	6	21	924	5
Conflicting Peds, #/hr	0	0	0	0	0	0	5	0	8	8	0	5
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	0	0	0	4	9	1	0	5	3	0
Mvmt Flow	17	0	36	6	0	24	23	890	6	21	924	5

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1465	1924	470	1451	1923	456	934	0	0	904	0	0
Stage 1	974	974	-	947	947	-	-	-	-	-	-	-
Stage 2	491	950	-	504	976	-	-	-	-	-	-	-
Critical Hdwy	7.5	6.5	6.9	7.5	6.5	6.98	4.28	-	-	4.2	-	-
Critical Hdwy Stg 1	6.5	5.5	-	6.5	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.5	5.5	-	6.5	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.34	2.29	-	-	2.25	-	-
Pot Cap-1 Maneuver	91	68	545	93	68	546	687	-	-	729	-	-
Stage 1	274	333	-	285	342	-	-	-	-	-	-	-
Stage 2	533	341	-	524	332	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	78	59	542	78	59	542	684	-	-	723	-	-
Mov Cap-2 Maneuver	181	165	-	183	164	-	-	-	-	-	-	-
Stage 1	255	311	-	264	317	-	-	-	-	-	-	-
Stage 2	475	316	-	460	310	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	17.9	15	0.6	0.5
HCM LOS	C	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	684	-	-	331	389	723	-	-
HCM Lane V/C Ratio	0.034	-	-	0.16	0.077	0.029	-	-
HCM Control Delay (s)	10.4	0.3	-	17.9	15	10.1	0.3	-
HCM Lane LOS	B	A	-	C	C	B	A	-
HCM 95th %tile Q(veh)	0.1	-	-	0.6	0.2	0.1	-	-

Intersection	
Int Delay, s/veh	1.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↔			↔			↑↑↔			↑↑↔	
Traffic Vol, veh/h	46	3	35	3	3	30	12	904	6	22	901	14
Future Vol, veh/h	46	3	35	3	3	30	12	904	6	22	901	14
Conflicting Peds, #/hr	0	0	2	2	0	0	5	0	1	1	0	5
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	3	33	0	3	0	1	17	0	3	0
Mvmt Flow	46	3	35	3	3	30	12	904	6	22	901	14

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1435	1892	465	1430	1896	456	920	0	0	911	0	0
Stage 1	957	957	-	932	932	-	-	-	-	-	-	-
Stage 2	478	935	-	498	964	-	-	-	-	-	-	-
Critical Hdwy	7.5	6.5	6.96	8.16	6.5	6.96	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.5	5.5	-	7.16	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.5	5.5	-	7.16	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.33	3.83	4	3.33	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	96	71	541	72	70	549	750	-	-	756	-	-
Stage 1	281	339	-	232	348	-	-	-	-	-	-	-
Stage 2	543	347	-	450	336	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	83	64	537	62	63	548	746	-	-	755	-	-
Mov Cap-2 Maneuver	191	173	-	154	174	-	-	-	-	-	-	-
Stage 1	270	317	-	224	336	-	-	-	-	-	-	-
Stage 2	492	335	-	391	314	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	25.3	15.1	0.1	0.2
HCM LOS	D	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	746	-	-	260	394	755	-	-
HCM Lane V/C Ratio	0.016	-	-	0.323	0.091	0.029	-	-
HCM Control Delay (s)	9.9	-	-	25.3	15.1	9.9	-	-
HCM Lane LOS	A	-	-	D	C	A	-	-
HCM 95th %tile Q(veh)	0	-	-	1.3	0.3	0.1	-	-

Intersection	
Int Delay, s/veh	0.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	3	0	22	1	0	14	21	951	6	12	922	110
Future Vol, veh/h	3	0	22	1	0	14	21	951	6	12	922	110
Conflicting Peds, #/hr	1	0	0	0	0	1	5	0	3	3	0	5
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-	0	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	0	0	0	0	0	1	0	0	3	1
Mvmt Flow	3	0	22	1	0	14	21	951	6	12	922	110

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	2010	-	982	2011	2060	958	1037	0	0	960	0	0
Stage 1	1006	-	-	999	999	-	-	-	-	-	-	-
Stage 2	1004	-	-	1012	1061	-	-	-	-	-	-	-
Critical Hdwy	7.1	-	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.1	-	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	-	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	-	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	44	0	305	44	56	315	678	-	-	725	-	-
Stage 1	293	0	-	296	324	-	-	-	-	-	-	-
Stage 2	294	0	-	291	303	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	39	-	304	38	51	314	675	-	-	723	-	-
Mov Cap-2 Maneuver	137	-	-	135	154	-	-	-	-	-	-	-
Stage 1	272	-	-	275	301	-	-	-	-	-	-	-
Stage 2	262	-	-	265	296	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	17.8	18.2	0.2	0.1
HCM LOS	C	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	675	-	-	304	288	723	-	-
HCM Lane V/C Ratio	0.031	-	-	0.072	0.052	0.017	-	-
HCM Control Delay (s)	10.5	0	-	17.8	18.2	10.1	-	-
HCM Lane LOS	B	A	-	C	C	B	-	-
HCM 95th %tile Q(veh)	0.1	-	-	0.2	0.2	0.1	-	-

Intersection	
Int Delay, s/veh	1.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	6	1	52	6	0	84	13	840	46	23	1014	14
Future Vol, veh/h	6	1	52	6	0	84	13	840	46	23	1014	14
Conflicting Peds, #/hr	0	0	5	5	0	0	9	0	6	6	0	9
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	0	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	17	0	4	0	0	1	8	1	14	27	5	0
Mvmt Flow	6	1	52	6	0	84	13	840	46	23	1014	14

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	2007	1994	1035	1994	1978	869	1037	0	0	892	0	0
Stage 1	1076	1076	-	895	895	-	-	-	-	-	-	-
Stage 2	931	918	-	1099	1083	-	-	-	-	-	-	-
Critical Hdwy	7.27	6.5	6.24	7.1	6.5	6.21	4.18	-	-	4.37	-	-
Critical Hdwy Stg 1	6.27	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.27	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.653	4	3.336	3.5	4	3.309	2.272	-	-	2.443	-	-
Pot Cap-1 Maneuver	40	61	279	46	63	353	648	-	-	665	-	-
Stage 1	249	298	-	338	362	-	-	-	-	-	-	-
Stage 2	301	353	-	260	296	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	28	54	275	34	56	351	642	-	-	661	-	-
Mov Cap-2 Maneuver	113	159	-	120	161	-	-	-	-	-	-	-
Stage 1	242	271	-	329	353	-	-	-	-	-	-	-
Stage 2	224	344	-	192	270	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	25.2	21.2	0.2	0.2
HCM LOS	D	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	642	-	-	237	311	661	-	-
HCM Lane V/C Ratio	0.02	-	-	0.249	0.289	0.035	-	-
HCM Control Delay (s)	10.7	-	-	25.2	21.2	10.6	0	-
HCM Lane LOS	B	-	-	D	C	B	A	-
HCM 95th %tile Q(veh)	0.1	-	-	1	1.2	0.1	-	-

Intersection	
Int Delay, s/veh	1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	48	30	955	25	26	982
Future Vol, veh/h	48	30	955	25	26	982
Conflicting Peds, #/hr	0	0	0	6	6	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	1	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	2	0	1	0	0	3
Mvmt Flow	48	30	955	25	26	982

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1517	496	0	0	986	0
Stage 1	974	-	-	-	-	-
Stage 2	543	-	-	-	-	-
Critical Hdwy	6.84	6.9	-	-	4.1	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	110	525	-	-	709	-
Stage 1	327	-	-	-	-	-
Stage 2	546	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	100	522	-	-	705	-
Mov Cap-2 Maneuver	223	-	-	-	-	-
Stage 1	325	-	-	-	-	-
Stage 2	502	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	22.2	0	0.3
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	286	705	-
HCM Lane V/C Ratio	-	-	0.273	0.037	-
HCM Control Delay (s)	-	-	22.2	10.3	-
HCM Lane LOS	-	-	C	B	-
HCM 95th %tile Q(veh)	-	-	1.1	0.1	-

Intersection	
Int Delay, s/veh	0.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	14	1	28	11	0	21	11	909	26	28	987	42
Future Vol, veh/h	14	1	28	11	0	21	11	909	26	28	987	42
Conflicting Peds, #/hr	0	0	0	0	0	0	8	0	4	4	0	8
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	14	0	4	9	0	0	0	1	0	4	4	22
Mvmt Flow	14	1	28	11	0	21	11	909	26	28	987	42

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1549	2033	523	1498	2041	472	1037	0	0	939	0	0
Stage 1	1072	1072	-	948	948	-	-	-	-	-	-	-
Stage 2	477	961	-	550	1093	-	-	-	-	-	-	-
Critical Hdwy	7.78	6.5	6.98	7.68	6.5	6.9	4.1	-	-	4.18	-	-
Critical Hdwy Stg 1	6.78	5.5	-	6.68	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.78	5.5	-	6.68	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.64	4	3.34	3.59	4	3.3	2.2	-	-	2.24	-	-
Pot Cap-1 Maneuver	69	58	493	79	57	544	678	-	-	713	-	-
Stage 1	215	299	-	267	342	-	-	-	-	-	-	-
Stage 2	508	337	-	470	293	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	60	50	489	67	49	542	673	-	-	710	-	-
Mov Cap-2 Maneuver	151	151	-	170	152	-	-	-	-	-	-	-
Stage 1	206	269	-	257	329	-	-	-	-	-	-	-
Stage 2	472	324	-	400	264	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	20.5	18	0.1	0.3
HCM LOS	C	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	673	-	-	275	309	710	-	-
HCM Lane V/C Ratio	0.016	-	-	0.156	0.104	0.039	-	-
HCM Control Delay (s)	10.4	-	-	20.5	18	10.3	-	-
HCM Lane LOS	B	-	-	C	C	B	-	-
HCM 95th %tile Q(veh)	0.1	-	-	0.5	0.3	0.1	-	-

ATTACHMENT F: LEVEL OF TRAFFIC STRESS ANALYSIS

Bicycle Level of Traffic Stress (BLTS) Analysis

Analysis methodology from ODOT Analysis Procedures Manual (APM) Chapter 14, Tables 14-21 to 14-24

Street	From	To	Side	Facility Type	Bicycle LTS Criteria									
					Speed (MPH)	Prevailing Speed (From Data)	Lanes per Direction	Bike Lane Width (feet)	Parking	Frequent Blockage	ADT (vph)	Functional Class	Exhibit Used	BLTS
Principal Arterial (State Highway)														
3rd St	Davis	Woodland Blvd	West	Bike Lane	35	40	2	5.5	No	Yes	>8000	Principal Arterial	14-6	3
	Davis	Woodland Blvd	East	Bike Lane	35	40	2	5.5	No	Yes	>8000	Principal Arterial	14-6	3
Collector/Local Streets														
Colorado Ave/ Scott St	US97 SB Ramps	US 97 NB Ramps	North	Bike Lane	25	30	1	6	No	Yes	>3000	Minor Arterial	14-4	1
	US97 SB Ramps	US 97 NB Ramps	South	Bike Lane	25	30	1	5	No	Yes	>3000	Minor Arterial	14-4	2
	US97 NB Ramps	Aune Street	North	Bike Lane	30	30	1	6	No	Yes	>3000	Minor Arterial	14-4	1
	US97 NB Ramps	Aune Street	South	Bike Lane	30	30	1	5	No	Yes	>3000	Minor Arterial	14-4	2
Davis Ave	2nd St	3rd St	West	No Bike Lane	25		1	None	Yes	Yes	1500-3000	Local	14-5	2
	2nd St	3rd St	East	No Bike Lane	25		1	None	Yes	Yes	1500-3000	Local	14-5	2
Miller Ave	2nd St	3rd St	North	No Bike Lane	25		1	None	Yes	Yes	750-1500	Collector	14-5	1
	2nd St	3rd St	South	No Bike Lane	25		1	None	Yes	Yes	750-1500	Collector	14-5	1
Woodland Blvd	2nd St	3rd St	North	No Bike Lane	25		1	None	Yes	Yes	750-1500	Local	14-5	1
	2nd St	3rd St	South	No Bike Lane	25		1	None	Yes	Yes	750-1500	Local	14-5	1
Dekalb Ave	3rd St	5th St	North	No Bike Lane	25		1	None	Yes	Yes	750-1500	Local	14-5	1
	3rd St	5th St	South	No Bike Lane	25		1	None	Yes	Yes	750-1500	Local	14-5	1
Clay Ave	3rd St	5th St	North	No Bike Lane	25		1	None	Yes	Yes	750-1500	Local	14-5	1
	3rd St	5th St	South	No Bike Lane	25		1	None	Yes	Yes	750-1500	Local	14-5	1
Burnside Ave	3rd St	5th St	North	No Bike Lane	25		1	None	Yes	Yes	1500-3000	Local	14-5	2
	3rd St	5th St	South	No Bike Lane	25		1	None	Yes	Yes	1500-3000	Local	14-5	2
Aune Street	Scott Street	Division Street	North	No Bike Lane	25		1	None	No	No	1500-3000	Local/ Collector	14-5	2
	Scott Street	Division Street	South	No Bike Lane	25		1	None	No	No	1500-3000	Local/ Collector	14-5	2

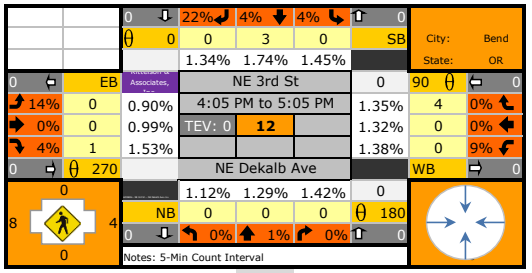
Pedestrian Level of Traffic Stress (PLTS) Analysis

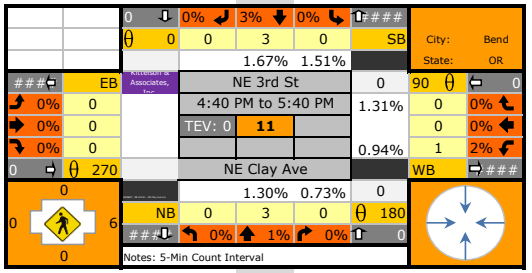
Analysis methodology from ODOT Analysis Procedures Manual (APM) Chapter 14, Tables 14-21 to 14-24

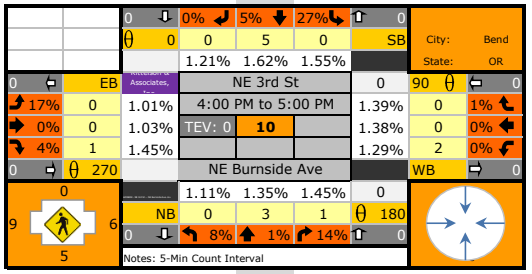
Street	From	To	Side	Pedestrian LTS Criteria																
				Speed (MPH)	Lanes per Direction	Bike Lane (feet)	Parking	Sidewalk Condition	Sidewalk Width (feet) [1]	PLTS Ranking Ex. 14-21	Buffer	PLTS Ranking Ex. 14-22	Buffer Width	PLTS Ranking Ex. 14-23	Illumination		Land Use	PLTS Ranking Ex. 14-24	PLTS with Land Use ranking	PLTS
Principal Arterial (State Highway)																				
3rd St	Emerson Ave	Dekalb Ave	West	35	2	5	No	Good	>=6	1	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Emerson Ave	Dekalb Ave	East	35	2	5	No	Good	>=6	1	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Dekalb Ave	Clay Ave	West	35	2	5	No	Good	>=6	1	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Dekalb Ave	Clay Ave	East	35	2	5	No	Fair	>=5	2	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Clay Ave	Burnside Ave	West	35	2	5	No	Good	>=5	2	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Clay Ave	Burnside Ave	East	35	2	5	No	Good	>=6	2	Landscaped with trees	1	8'	2	No	+1	Commercial Corridor	3	3	2
	Burnside Ave	250' South of Burnside	West	35	1	0	No	Poor	>=5	3	Landscaped/ Vertical	2	8'	2	No	+1	Commercial Corridor	3	3	3
	Burnside Ave	250' South of Burnside	East	35	1	0	No	Poor	>=5	3	Landscaped/ Vertical	2	8'	2	No	+1	Commercial Corridor	3	3	3
	250' South of Burnside (Undercrossing)	250' North of Davis (Undercrossing)	West	35	1	0	No	Poor	>=5	3	Landscaped/ Vertical	1	8'	2	No	+1	Commercial Corridor	3	3	3
	250' South of Burnside (Undercrossing)	250' North of Davis (Undercrossing)	East	35	1	0	No	Poor	>=5	3	Landscaped/ Vertical	1	8'	2	No	+1	Commercial Corridor	3	3	3
	250' North of Davis	Davis Ave	West	35	1	0	No	Fair	>=5	2	Landscaped/ Vertical	2	15-25'	2	No	+1	Commercial Corridor	3	3	3
	250' North of Davis	Davis Ave	East	35	1	0	No	No Sidewalk	N/A	4	N/A	N/A	N/A	N/A	No	+1	Commercial Corridor	3	3	4
	Davis Ave	Miller Ave	West	35	2	5	No	Very Poor	>=5	4	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	4
	Davis Ave	Miller Ave	East	35	2	5	No	No Sidewalk	N/A	4	N/A	N/A	N/A	N/A	No	+1	Commercial Corridor	3	3	4
	Miller Ave	Woodland Blvd	West	35	2	0	No	Fair	>=5	2	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Miller Ave	Woodland Blvd	East	35	2	0	No	Fair	>=5	2	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Woodland	Urania	West	35	2	0	No	Good	>=5	2	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	3
	Woodland	Urania	East	35	2	0	No	Fair	<=4	4	No Buffer	3	None	4	No	+1	Commercial Corridor	3	3	4
Minor Arterial/ Collector/Local Streets																				
Colorado Ave/ Scott St	Sisemore	US97 SB Ramps	North	25	1	6	No	Good	>=6	1	No Buffer	2	None	2	No	+1	Commercial Corridor	3	3	2
	Sisemore	US97 SB Ramps	South	25	1	0	Yes	Good	>=6	1	No Buffer	2	None	2	No	+1	Commercial Corridor	3	3	2
	US97 SB Ramps	US 97 NB Ramps	North	25	1	6	No	Good	>=5	2	No Buffer	2	None	3	No	+1	Commercial Corridor	3	3	3
	US97 SB Ramps	US 97 NB Ramps	South	25	1	6	No	Good	>=5	2	No Buffer	2	None	3	No	+1	Commercial Corridor	3	3	3
	US97 NB Ramps	Aune Street	North	30	1	6	No	Good	>=5	2	No Buffer	3	None	2	Yes	0	Commercial Corridor	3	3	2
	US97 NB Ramps	Aune Street	South	30	1	6	No	Good	>=5	2	Landscaped	2	5	2	Yes	0	Commercial Corridor	3	3	2
Scott St/ 2nd St	Aune Street	Davis Ave	West	30	1	6	No	N/A	N/A	4	N/A	4	N/A	4	No	+1	Commercial Corridor	3	4	4
	Aune Street	Davis Ave	East	30	1	6	No	Fair	>=5	2	No Buffer	3	None	2	No	+1	Commercial Corridor	3	3	3
	Davis Ave	Miller Ave	West	30	1	6	No	N/A	N/A	4	N/A	4	N/A	4	No	+1	Commercial Corridor	3	4	4
	Davis Ave	Miller Ave	East	30	1	6	No	Poor	>=5	3	No Buffer	3	None	2	No	+1	Commercial Corridor	3	3	3
	Miller Ave	Woodland Blvd	West	30	1	6	No	Fair	>=5	2	No Buffer	3	None	2	No	+1	Commercial Corridor	3	3	3
	Miller Ave	Woodland Blvd	East	30	1	6	No	Good	>=5	2	Landscape	2	5	2	No	+1	Commercial Corridor	3	2	3
	Woodland	Urania	West	30	1	6	No	Good	>=5	2	No Buffer	2	5	2	No	+1	Commercial Corridor	3	3	3
	Woodland	Urania	East	30	1	6	No	Good	>=5	2	Landscape	2	5	2	No	+1	Commercial Corridor	3	2	3
Davis Ave	2nd St	3rd St	West	25	1	None	Yes	N/A	N/A	4	N/A	2	N/A	2	N/A		Commercial Corridor	3	2	3
	2nd St	3rd St	East	25	1	None	Yes	N/A	N/A	4	N/A	2	N/A	2	N/A		Commercial Corridor	3	2	3
Miller Ave	2nd St	3rd St	North	25	1	None	Yes	Good	>=6	1	No Buffer	2	None	2	No	+1	Low density development	2	2	2
	2nd St	3rd St	South	25	1	None	Yes	Fair	>=6	1	No Buffer	2	None	2	No	+1	Low density development	2	2	2
Woodland Blvd	2nd St	3rd St	North	25	1	None	Yes	Good	>=6	1	No Buffer	2	None	2	No	+1	Low density development	2	2	2
	2nd St	3rd St	South	25	1	None	Yes	Good	>=6	4	No Buffer	4	None	4			Low density development	2	2	4
Aune Street	Division Street	2nd Street	North	25	1	None	No	N/A	N/A	4	N/A	2	None	2	No	+1	Commercial Corridor	4	4	4
	Division Street	2nd Street	South	25	1	None	No	N/A	N/A	4	N/A	2	None	2	No	+1	Commercial Corridor	4	4	4

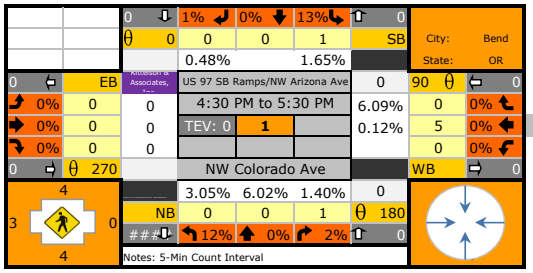
ATTACHMENT G: NCHRP 765 GROWTH RATES

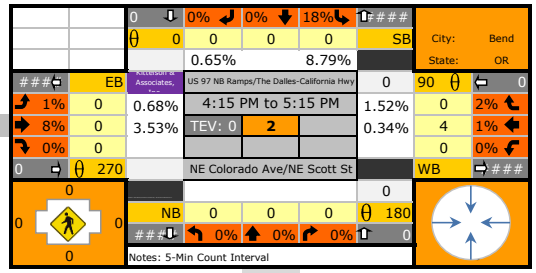
Growth Rates - NCHRP 765 Methodology

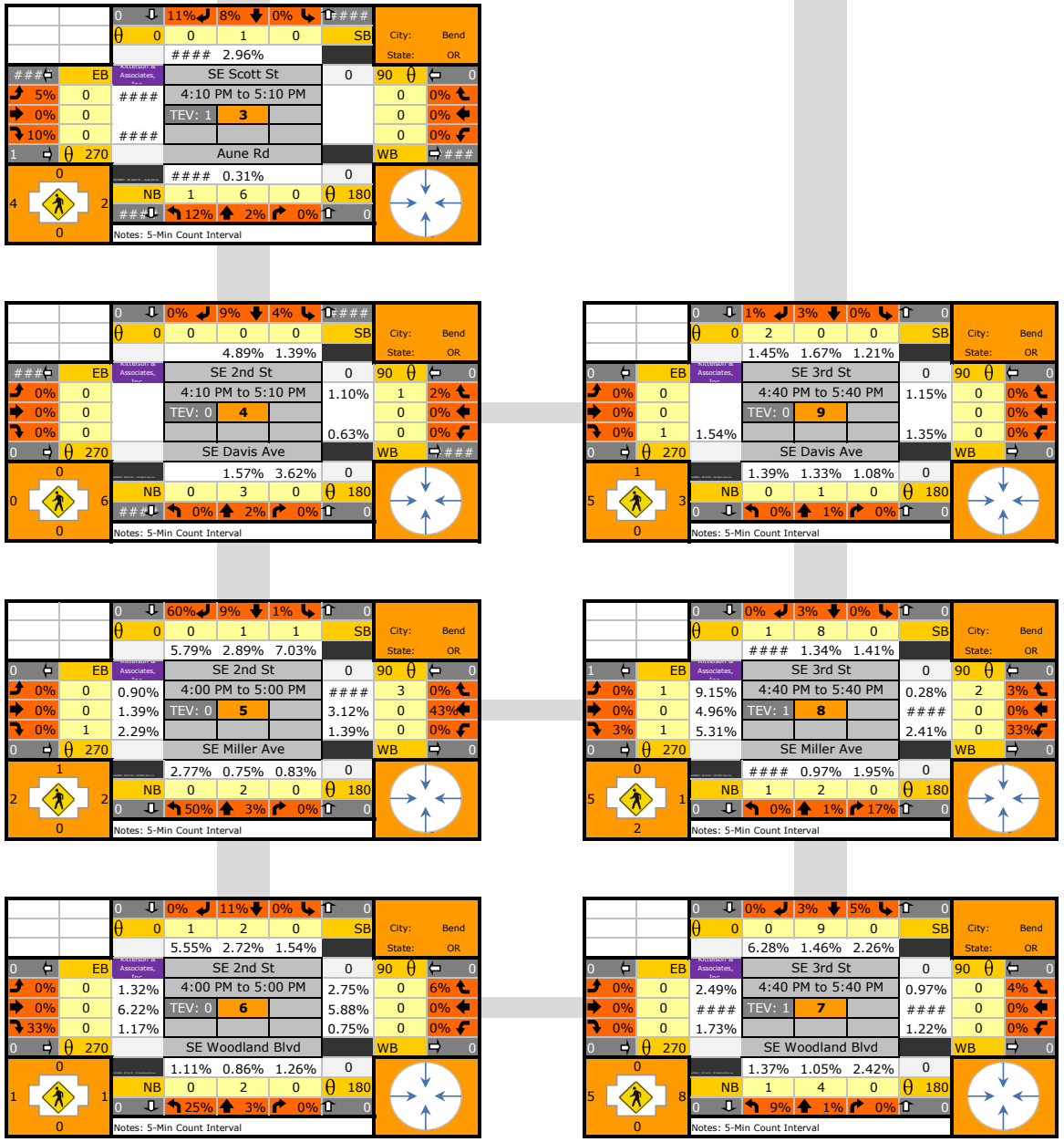






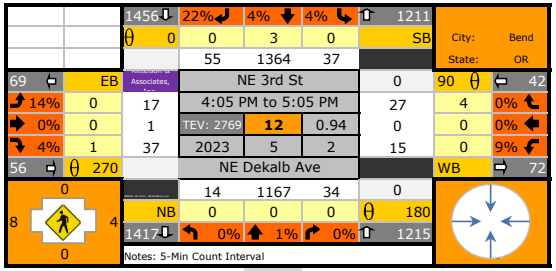


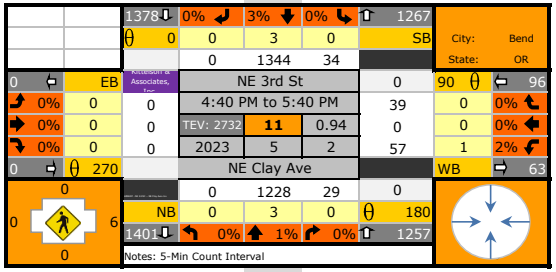


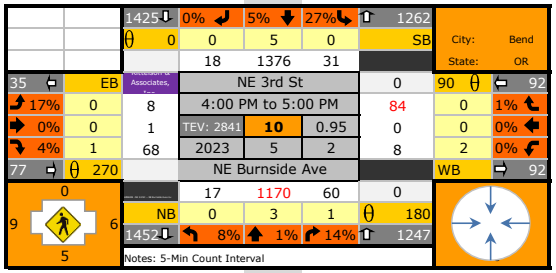

SE Scott St
4:10 PM to 5:10 PM
Aune Rd
SE 2nd St
4:10 PM to 5:10 PM
SE Davis Ave
SE 3rd St
4:40 PM to 5:40 PM
SE Davis Ave
SE 2nd St
4:00 PM to 5:00 PM
SE Miller Ave
SE 3rd St
4:40 PM to 5:40 PM
SE Miller Ave
SE 2nd St
4:00 PM to 5:00 PM
SE Woodland Blvd
SE 3rd St
4:40 PM to 5:40 PM
SE Woodland Blvd
City: Bend
State: OR
Notes: 5-Min Count Interval

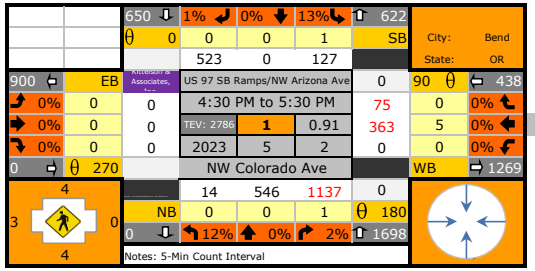
ATTACHMENT H: FORECASTED (2045) TRAFFIC VOLUMES

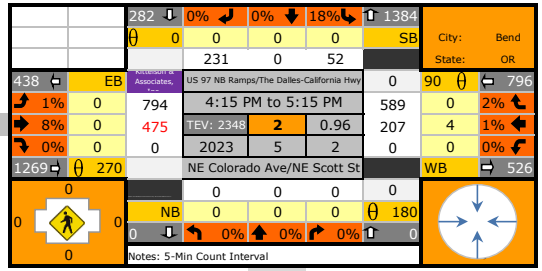
Future (2045) PM Peak Hour Volumes












City: Bend
State: OR
SE Scott St
4:10 PM to 5:10 PM
Aune Rd
Notes: 5-Min Count Interval
SE 2nd St
4:10 PM to 5:10 PM
SE Davis Ave
Notes: 5-Min Count Interval
SE 3rd St
4:40 PM to 5:40 PM
SE Davis Ave
Notes: 5-Min Count Interval
SE 2nd St
4:00 PM to 5:00 PM
SE Miller Ave
Notes: 5-Min Count Interval
SE 3rd St
4:40 PM to 5:40 PM
SE Miller Ave
Notes: 5-Min Count Interval
SE 2nd St
4:00 PM to 5:00 PM
SE Woodland Blvd
Notes: 5-Min Count Interval
SE 3rd St
4:40 PM to 5:40 PM
SE Woodland Blvd
Notes: 5-Min Count Interval

ATTACHMENT I: FUTURE (2045) OPERATIONAL ANALYSIS AND QUEUE LENGTHS

Table I.1 summarizes 95th percentile queue lengths for each study intersection in the PM peak hour with projected future (2045) traffic volumes. Values in ***bold and italicized*** indicate that the queue length exceeds available storage. As shown, the queue length for southbound right-turning vehicles at the Colorado Avenue/ US97 southbound ramp exceeds the 200-foot right-turn lane storage. At the Colorado Avenue northbound ramps intersection, operational results showed that the queue length for the eastbound left turning movement exceeds available left-turn lane storage and extends to the Arizona Avenue intersection. Additionally, outside northbound right-turning lane on Arizona Avenue queue length extends 1725 feet to approximately Bond Street. The analysis shows the eastbound left queue length on Miller Avenue extends past the length of the Miller segment between 2nd Street and 3rd Street.

Table I.1 Existing Conditions Operational Analysis Summary (PM Peak Hour)

Intersection	Direction	95th Percentile Queue Length (ft) (Movements)
Colorado Ave/ US97 SB Ramp	NB	1025 ft/ 1725 ft (TR/R)
	SB	100 ft/ ***525 ft (L***/R)
	EB	-
	WB	475 ft (R)
Colorado Ave/ US97 NB Ramp	NB	-
	SB	***>300 ft***/ 75 **(L**/R)
	EB	475 (L)
	WB	0 ft
Scott Street/ Aune Street[2]	NWB	25 ft (L)
	SEB	0 ft
	NEB	225 ft/ 25 ft (L/ R)
	SWB	-
2nd/ Davis Avenue	NB	0 ft
	SB	50 ft (L)
	WB	25 ft (L)
2nd Street/ Miller Avenue	NB	0 ft
	SB	25 ft (L)
	EB	75 ft (L)
	WB	75 ft (L)
2nd Street/ Woodland Blvd	NB	0 ft
	SB	25 ft (L)
	WB	25 ft (L)
3rd Street/ Dekalb Avenue	NB	25 ft (L)
	SB	0 ft
	EB	50 ft (L)
	WB	25 ft (L)
3rd Street/ Clay Avenue	NB	0 ft
	SB	25 ft (L)
	WB	75 ft (L)
3rd Street/ Burnside Avenue	NB	25 ft (L)
	SB	0 ft
	EB	75 ft (L)

Intersection	Direction	95th Percentile Queue Length (ft) (Movements)
	WB	100 ft (L)
3rd Street/ Davis Avenue	NB	25 ft (L)
	SB	25 ft (L)
	EB	25 ft (L)
	WB	25 ft (L)
3rd Street/ Miller Avenue	NB	25 ft (L)
	SB	25 ft (L)
	EB	***450 ft (L)***
	WB	50 ft (L)
3rd Street/ Woodland Blvd	NB	25 ft (L)
	SB	25 ft (L)
	EB	50 ft (L)
	WB	25 ft (L)

Aune Street (East) Extension Study

Vistro File: H:\...\28763_Colorado97_Existing.vistro
Report File: H:\...\Future_PMPeak_11_03_23.pdf

Scenario 2 Future (2045) PM Peak Hour
11/3/2023

Intersection Analysis Summary

ID	Intersection Name	Control Type	Method	Worst Mvmt	V/C	Delay (s/veh)	LOS
1	Colorado Ave/ US97 SB Ramps	Signalized	HCM 6th Edition	NB Thru	1.079	126.6	F

V/C, Delay, LOS: For two-way stop, these values are taken from the movement with the worst (highest) delay value. For all other control types, they are taken for the whole intersection.

Intersection Level Of Service Report
Intersection 1: Colorado Ave/ US97 SB Ramps

Control Type:	Signalized	Delay (sec / veh):	126.6
Analysis Method:	HCM 6th Edition	Level Of Service:	F
Analysis Period:	15 minutes	Volume to Capacity (v/c):	1.079

Intersection Setup

Name	Arizona Ave			US97 Ramp SB						Colorado Ave/ Scott St		
Approach	Northbound			Southbound			Eastbound			Westbound		
Lane Configuration												
Turning Movement	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right
Lane Width [ft]	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
No. of Lanes in Entry Pocket	0	0	1	0	0	1	0	0	0	0	0	0
Entry Pocket Length [ft]	100.00	100.00	1000.00	100.00	100.00	200.00	100.00	100.00	100.00	100.00	100.00	100.00
No. of Lanes in Exit Pocket	0	0	0	0	0	0	0	0	0	0	0	0
Exit Pocket Length [ft]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Speed [mph]	25.00			25.00			30.00			25.00		
Grade [%]	0.00			0.00			0.00			0.00		
Curb Present	No			No						No		
Crosswalk	Yes			Yes			Yes			Yes		

Volumes

Name	Arizona Ave			US97 Ramp SB						Colorado Ave/ Scott St		
Base Volume Input [veh/h]	14	546	1137	127	0	523	0	0	0	0	363	75
Base Volume Adjustment Factor	0.9100	0.9100	0.9100	0.9100	1.0000	0.9100	1.0000	1.0000	1.0000	1.0000	0.9100	0.9100
Heavy Vehicles Percentage [%]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Growth Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
In-Process Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Site-Generated Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Diverted Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Pass-by Trips [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Existing Site Adjustment Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Other Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Right Turn on Red Volume [veh/h]	0	0	0	0	0	0	0	0	0	0	0	0
Total Hourly Volume [veh/h]	13	497	1035	116	0	476	0	0	0	0	330	68
Peak Hour Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Other Adjustment Factor	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Total 15-Minute Volume [veh/h]	3	124	259	29	0	119	0	0	0	0	83	17
Total Analysis Volume [veh/h]	13	497	1035	116	0	476	0	0	0	0	330	68
Presence of On-Street Parking	No		No	No		No				No		No
On-Street Parking Maneuver Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
Local Bus Stopping Rate [/h]	0	0	0	0	0	0	0	0	0	0	0	0
v_do, Outbound Pedestrian Volume crossing	0			0			0			0		
v_di, Inbound Pedestrian Volume crossing m	0			0			0			0		
v_co, Outbound Pedestrian Volume crossing	0			0			0			0		
v_ci, Inbound Pedestrian Volume crossing mi	0			0			0			0		
v_ab, Corner Pedestrian Volume [ped/h]	0			0			0			0		
Bicycle Volume [bicycles/h]	0			0			0			0		

Lane Group Calculations

Lane Group	C	R	L	R		C
C, Cycle Length [s]	89	89	89	89		89
L, Total Lost Time per Cycle [s]	5.00	5.00	4.00	4.00		5.00
l1_p, Permitted Start-Up Lost Time [s]	0.00	0.00	0.00	0.00		0.00
l2, Clearance Lost Time [s]	3.00	0.00	2.00	2.00		3.00
g_i, Effective Green Time [s]	20	50	30	30		25
g / C, Green / Cycle	0.22	0.56	0.34	0.34		0.28
(v / s)_i Volume / Saturation Flow Rate	0.30	0.72	0.07	0.33		0.24
s, saturation flow rate [veh/h]	1681	1431	1603	1431		1634
c, Capacity [veh/h]	378	804	540	482		459
d1, Uniform Delay [s]	34.50	19.50	21.08	29.31		30.42
k, delay calibration	0.50	0.50	0.08	0.44		0.31
I, Upstream Filtering Factor	1.00	1.00	1.00	1.00		1.00
d2, Incremental Delay [s]	174.22	138.87	0.15	35.30		13.06
d3, Initial Queue Delay [s]	0.00	0.00	0.00	0.00		0.00
Rp, platoon ratio	1.00	1.00	1.00	1.00		1.00
PF, progression factor	1.00	1.00	1.00	1.00		1.00

Lane Group Results

X, volume / capacity	1.35	1.29	0.21	0.99		0.87
d, Delay for Lane Group [s/veh]	208.72	158.37	21.23	64.61		43.48
Lane Group LOS	F	F	C	E		D
Critical Lane Group	Yes	Yes	No	Yes		No
50th-Percentile Queue Length [veh/ln]	26.32	46.00	1.74	14.52		9.62
50th-Percentile Queue Length [ft/ln]	658.05	1149.90	43.47	363.09		240.52
95th-Percentile Queue Length [veh/ln]	40.21	68.36	3.13	20.77		14.71
95th-Percentile Queue Length [ft/ln]	1005.22	1709.08	78.25	519.34		367.69

Movement, Approach, & Intersection Results

d_M, Delay for Movement [s/veh]	208.72	208.72	158.37	21.23	0.00	64.61	0.00	0.00	0.00	0.00	43.48	43.48
Movement LOS	F	F	F	C		E					D	D
d_A, Approach Delay [s/veh]	174.99			56.11			0.00			43.48		
Approach LOS	F			E			A			D		
d_I, Intersection Delay [s/veh]	126.58											
Intersection LOS	F											
Intersection V/C	1.079											

Other Modes

g_Walk,mi, Effective Walk Time [s]	11.0	11.0	9.0	11.0
M_corner, Corner Circulation Area [ft²/ped]	0.00	0.00	0.00	0.00
M_CW, Crosswalk Circulation Area [ft²/ped]	0.00	0.00	0.00	0.00
d_p, Pedestrian Delay [s]	34.18	34.18	35.96	34.18
l_p,int, Pedestrian LOS Score for Intersection	2.358	2.252	2.223	2.343
Crosswalk LOS	B	B	B	B
s_b, Saturation Flow Rate of the bicycle lane	2000	2000	2000	2000
c_b, Capacity of the bicycle lane [bicycles/h]	449	674	0	562
d_b, Bicycle Delay [s]	26.75	19.56	44.50	23.01
l_b,int, Bicycle LOS Score for Intersection	4.109	1.560	4.132	2.216
Bicycle LOS	D	A	D	B

Sequence

Ring 1	-	4	8	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 2	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ring 4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Intersection	
Int Delay, s/veh	20.7

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	794	475	207	589	52	231
Future Vol, veh/h	794	475	207	589	52	231
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	0	0
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	96	96	96	96	96	96
Heavy Vehicles, %	1	8	1	2	18	0
Mvmt Flow	827	495	216	614	54	241

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	830	0	-	0	2672	523
Stage 1	-	-	-	-	523	-
Stage 2	-	-	-	-	2149	-
Critical Hdwy	4.11	-	-	-	6.58	6.2
Critical Hdwy Stg 1	-	-	-	-	5.58	-
Critical Hdwy Stg 2	-	-	-	-	5.58	-
Follow-up Hdwy	2.209	-	-	-	3.662	3.3
Pot Cap-1 Maneuver	~ 806	-	-	-	~ 22	558
Stage 1	-	-	-	-	564	-
Stage 2	-	-	-	-	87	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	~ 806	-	-	-	0	558
Mov Cap-2 Maneuver	-	-	-	-	0	-
Stage 1	-	-	-	-	0	-
Stage 2	-	-	-	-	87	-

Approach	EB	WB	SB
HCM Control Delay, s	38.3	0	
HCM LOS			-

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	~ 806	-	-	-	-	558
HCM Lane V/C Ratio	1.026	-	-	-	-	0.431
HCM Control Delay (s)	61.1	-	-	-	-	16.3
HCM Lane LOS	F	-	-	-	-	C
HCM 95th %tile Q(veh)	19	-	-	-	-	2.2

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	19.9

Movement	SET	SER	NWL	NWT	NEL	NER
Lane Configurations						
Traffic Vol, veh/h	431	101	164	658	127	107
Future Vol, veh/h	431	101	164	658	127	107
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	100	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	431	101	164	658	127	107

Major/Minor	Major1		Major2		Minor1	
Conflicting Flow All	0	0	532	0	1468	482
Stage 1	-	-	-	-	482	-
Stage 2	-	-	-	-	986	-
Critical Hdwy	-	-	4.12	-	6.42	6.22
Critical Hdwy Stg 1	-	-	-	-	5.42	-
Critical Hdwy Stg 2	-	-	-	-	5.42	-
Follow-up Hdwy	-	-	2.218	-	3.518	3.318
Pot Cap-1 Maneuver	-	-	1036	-	141	584
Stage 1	-	-	-	-	621	-
Stage 2	-	-	-	-	361	-
Platoon blocked, %	-	-		-		
Mov Cap-1 Maneuver	-	-	1036	-	~ 106	584
Mov Cap-2 Maneuver	-	-	-	-	~ 106	-
Stage 1	-	-	-	-	621	-
Stage 2	-	-	-	-	271	-

Approach	SE	NW	NE
HCM Control Delay, s	0	1.8	128.4
HCM LOS			F

Minor Lane/Major Mvmt	NELn1	NELn2	NWL	NWT	SET	SER
Capacity (veh/h)	106	584	1036	-	-	-
HCM Lane V/C Ratio	1.198	0.183	0.158	-	-	-
HCM Control Delay (s)	226	12.5	9.1	0	-	-
HCM Lane LOS	F	B	A	A	-	-
HCM 95th %tile Q(veh)	8.3	0.7	0.6	-	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	2.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	8	164	668	6	31	511
Future Vol, veh/h	8	164	668	6	31	511
Conflicting Peds, #/hr	0	0	0	6	6	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	0	2	2	0	4	9
Mvmt Flow	8	164	668	6	31	511

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1250	677	0	0	680	0
Stage 1	677	-	-	-	-	-
Stage 2	573	-	-	-	-	-
Critical Hdwy	6.4	6.22	-	-	4.14	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.318	-	-	2.236	-
Pot Cap-1 Maneuver	193	453	-	-	903	-
Stage 1	509	-	-	-	-	-
Stage 2	568	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	183	450	-	-	898	-
Mov Cap-2 Maneuver	183	-	-	-	-	-
Stage 1	506	-	-	-	-	-
Stage 2	541	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	19.3	0	0.5
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	421	898	-
HCM Lane V/C Ratio	-	-	0.409	0.035	-
HCM Control Delay (s)	-	-	19.3	9.2	0
HCM Lane LOS	-	-	C	A	A
HCM 95th %tile Q(veh)	-	-	1.9	0.1	-

Intersection	
Int Delay, s/veh	8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↕			↕			↕			↕	
Traffic Vol, veh/h	35	11	11	11	12	140	7	498	7	208	290	12
Future Vol, veh/h	35	11	11	11	12	140	7	498	7	208	290	12
Conflicting Peds, #/hr	1	0	0	0	0	1	2	0	2	2	0	2
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	0	0	43	0	50	3	0	1	9	60
Mvmt Flow	35	11	11	11	12	140	7	498	7	208	290	12

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1307	1235	298	1241	1238	505	304	0	0	507	0	0
Stage 1	714	714	-	518	518	-	-	-	-	-	-	-
Stage 2	593	521	-	723	720	-	-	-	-	-	-	-
Critical Hdwy	7.1	6.5	6.2	7.1	6.93	6.2	4.6	-	-	4.11	-	-
Critical Hdwy Stg 1	6.1	5.5	-	6.1	5.93	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.1	5.5	-	6.1	5.93	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4.387	3.3	2.65	-	-	2.209	-	-
Pot Cap-1 Maneuver	138	178	746	153	147	571	1028	-	-	1063	-	-
Stage 1	425	438	-	544	471	-	-	-	-	-	-	-
Stage 2	496	535	-	421	376	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	78	134	745	115	111	569	1026	-	-	1061	-	-
Mov Cap-2 Maneuver	78	134	-	115	111	-	-	-	-	-	-	-
Stage 1	420	334	-	538	466	-	-	-	-	-	-	-
Stage 2	361	529	-	306	287	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	75.3	22.8	0.1	3.8
HCM LOS	F	C		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1026	-	-	104	362	1061	-	-
HCM Lane V/C Ratio	0.007	-	-	0.548	0.45	0.196	-	-
HCM Control Delay (s)	8.5	0	-	75.3	22.8	9.2	0	-
HCM Lane LOS	A	A	-	F	C	A	A	-
HCM 95th %tile Q(veh)	0	-	-	2.5	2.3	0.7	-	-

Intersection	
Int Delay, s/veh	1.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	5	51	454	16	71	238
Future Vol, veh/h	5	51	454	16	71	238
Conflicting Peds, #/hr	0	0	0	1	1	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	0	6	3	0	0	11
Mvmt Flow	5	51	454	16	71	238

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	843	463	0	0	471	0
Stage 1	463	-	-	-	-	-
Stage 2	380	-	-	-	-	-
Critical Hdwy	6.4	6.26	-	-	4.1	-
Critical Hdwy Stg 1	5.4	-	-	-	-	-
Critical Hdwy Stg 2	5.4	-	-	-	-	-
Follow-up Hdwy	3.5	3.354	-	-	2.2	-
Pot Cap-1 Maneuver	337	591	-	-	1101	-
Stage 1	638	-	-	-	-	-
Stage 2	696	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	312	590	-	-	1100	-
Mov Cap-2 Maneuver	312	-	-	-	-	-
Stage 1	637	-	-	-	-	-
Stage 2	644	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	12.3	0	2
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	547	1100	-
HCM Lane V/C Ratio	-	-	0.102	0.065	-
HCM Control Delay (s)	-	-	12.3	8.5	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0.3	0.2	-

Intersection	
Int Delay, s/veh	2.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	26	0	55	8	8	29	30	1095	10	31	1221	17
Future Vol, veh/h	26	0	55	8	8	29	30	1095	10	31	1221	17
Conflicting Peds, #/hr	0	0	0	0	0	0	5	0	8	8	0	5
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	0	0	0	4	9	1	0	5	3	0
Mvmt Flow	26	0	55	8	8	29	30	1095	10	31	1221	17

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1909	2470	624	1841	2473	561	1243	0	0	1113	0	0
Stage 1	1297	1297	-	1168	1168	-	-	-	-	-	-	-
Stage 2	612	1173	-	673	1305	-	-	-	-	-	-	-
Critical Hdwy	7.5	6.5	6.9	7.5	6.5	6.98	4.28	-	-	4.2	-	-
Critical Hdwy Stg 1	6.5	5.5	-	6.5	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.5	5.5	-	6.5	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.3	3.5	4	3.34	2.29	-	-	2.25	-	-
Pot Cap-1 Maneuver	42	31	433	48	30	466	519	-	-	606	-	-
Stage 1	174	234	-	209	270	-	-	-	-	-	-	-
Stage 2	452	268	-	416	232	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	28	22	431	32	21	462	517	-	-	601	-	-
Mov Cap-2 Maneuver	102	99	-	111	96	-	-	-	-	-	-	-
Stage 1	147	194	-	176	227	-	-	-	-	-	-	-
Stage 2	347	226	-	303	193	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	32.1	27.3	1.2	1.1
HCM LOS	D	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	517	-	-	212	206	601	-	-
HCM Lane V/C Ratio	0.058	-	-	0.382	0.218	0.052	-	-
HCM Control Delay (s)	12.4	0.9	-	32.1	27.3	11.3	0.9	-
HCM Lane LOS	B	A	-	D	D	B	A	-
HCM 95th %tile Q(veh)	0.2	-	-	1.7	0.8	0.2	-	-

Intersection	
Int Delay, s/veh	41.9

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	137	6	76	5	14	32	62	1097	9	28	1167	102
Future Vol, veh/h	137	6	76	5	14	32	62	1097	9	28	1167	102
Conflicting Peds, #/hr	0	0	2	2	0	0	5	0	1	1	0	5
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	3	33	0	3	0	1	17	0	3	0
Mvmt Flow	137	6	76	5	14	32	62	1097	9	28	1167	102

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	1959	2510	642	1872	2557	554	1274	0	0	1107	0	0
Stage 1	1279	1279	-	1227	1227	-	-	-	-	-	-	-
Stage 2	680	1231	-	645	1330	-	-	-	-	-	-	-
Critical Hdwy	7.5	6.5	6.96	8.16	6.5	6.96	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	6.5	5.5	-	7.16	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.5	5.5	-	7.16	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.5	4	3.33	3.83	4	3.33	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	~ 39	29	414	31	27	473	552	-	-	638	-	-
Stage 1	179	239	-	147	253	-	-	-	-	-	-	-
Stage 2	412	252	-	360	226	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	~ 21	17	411	16	16	473	549	-	-	637	-	-
Mov Cap-2 Maneuver	~ 82	86	-	67	75	-	-	-	-	-	-	-
Stage 1	~ 126	201	-	104	178	-	-	-	-	-	-	-
Stage 2	250	178	-	240	190	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	$ 508.9	39.2	0.7	0.2
HCM LOS	F	E		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	549	-	-	114	155	637	-	-
HCM Lane V/C Ratio	0.113	-	-	1.921	0.329	0.044	-	-
HCM Control Delay (s)	12.4	-	-	$ 508.9	39.2	10.9	-	-
HCM Lane LOS	B	-	-	F	E	B	-	-
HCM 95th %tile Q(veh)	0.4	-	-	17.8	1.3	0.1	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	0.7

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	0	0	29	1	1	18	27	1229	8	16	1262	145
Future Vol, veh/h	0	0	29	1	1	18	27	1229	8	16	1262	145
Conflicting Peds, #/hr	1	0	0	0	0	1	5	0	3	3	0	5
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-	0	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	0	0	0	0	0	0	0	1	0	0	3	1
Mvmt Flow	0	0	29	1	1	18	27	1229	8	16	1262	145

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	-	-	1340	2671	2734	1237	1412	0	0	1240	0	0
Stage 1	-	-	-	1290	1290	-	-	-	-	-	-	-
Stage 2	-	-	-	1381	1444	-	-	-	-	-	-	-
Critical Hdwy	-	-	6.2	7.1	6.5	6.2	4.1	-	-	4.1	-	-
Critical Hdwy Stg 1	-	-	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	-	-	3.3	3.5	4	3.3	2.2	-	-	2.2	-	-
Pot Cap-1 Maneuver	0	0	188	15	21	217	489	-	-	569	-	-
Stage 1	0	0	-	203	236	-	-	-	-	-	-	-
Stage 2	0	0	-	180	199	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	-	-	187	11	17	216	487	-	-	567	-	-
Mov Cap-2 Maneuver	-	-	-	69	89	-	-	-	-	-	-	-
Stage 1	-	-	-	166	194	-	-	-	-	-	-	-
Stage 2	-	-	-	148	192	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	27.8	27.1	0.3	0.1
HCM LOS	D	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	487	-	-	187	183	567	-	-
HCM Lane V/C Ratio	0.055	-	-	0.155	0.109	0.028	-	-
HCM Control Delay (s)	12.8	0	-	27.8	27.1	11.5	-	-
HCM Lane LOS	B	A	-	D	D	B	-	-
HCM 95th %tile Q(veh)	0.2	-	-	0.5	0.4	0.1	-	-

Intersection	
Int Delay, s/veh	3.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	8	1	68	8	0	84	17	1170	60	31	1376	18
Future Vol, veh/h	8	1	68	8	0	84	17	1170	60	31	1376	18
Conflicting Peds, #/hr	0	0	5	5	0	0	9	0	6	6	0	9
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	0	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	17	0	4	0	0	1	8	1	14	27	5	0
Mvmt Flow	8	1	68	8	0	84	17	1170	60	31	1376	18

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	2732	2726	1399	2727	2705	1206	1403	0	0	1236	0	0
Stage 1	1456	1456	-	1240	1240	-	-	-	-	-	-	-
Stage 2	1276	1270	-	1487	1465	-	-	-	-	-	-	-
Critical Hdwy	7.27	6.5	6.24	7.1	6.5	6.21	4.18	-	-	4.37	-	-
Critical Hdwy Stg 1	6.27	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.27	5.5	-	6.1	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.653	4	3.336	3.5	4	3.309	2.272	-	-	2.443	-	-
Pot Cap-1 Maneuver	12	21	170	14	22	225	468	-	-	486	-	-
Stage 1	149	196	-	217	249	-	-	-	-	-	-	-
Stage 2	190	241	-	157	194	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	~ 6	14	168	~ 6	15	224	464	-	-	483	-	-
Mov Cap-2 Maneuver	50	81	-	38	79	-	-	-	-	-	-	-
Stage 1	142	139	-	208	238	-	-	-	-	-	-	-
Stage 2	114	231	-	66	137	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	63.9	56.1	0.2	0.3
HCM LOS	F	F		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	464	-	-	133	157	483	-	-
HCM Lane V/C Ratio	0.037	-	-	0.579	0.586	0.064	-	-
HCM Control Delay (s)	13.1	-	-	63.9	56.1	13	0	-
HCM Lane LOS	B	-	-	F	F	B	A	-
HCM 95th %tile Q(veh)	0.1	-	-	2.9	3.1	0.2	-	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	1.6

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Traffic Vol, veh/h	57	39	1228	29	34	1344
Future Vol, veh/h	57	39	1228	29	34	1344
Conflicting Peds, #/hr	0	0	0	6	6	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	1	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	100	100	100	100	100	100
Heavy Vehicles, %	2	0	1	0	0	3
Mvmt Flow	57	39	1228	29	34	1344

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1989	635	0	0	1263	0
Stage 1	1249	-	-	-	-	-
Stage 2	740	-	-	-	-	-
Critical Hdwy	6.84	6.9	-	-	4.1	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.3	-	-	2.2	-
Pot Cap-1 Maneuver	~ 53	426	-	-	557	-
Stage 1	234	-	-	-	-	-
Stage 2	433	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	~ 40	424	-	-	554	-
Mov Cap-2 Maneuver	142	-	-	-	-	-
Stage 1	233	-	-	-	-	-
Stage 2	328	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	40.1	0	0.3
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	195	554	-
HCM Lane V/C Ratio	-	-	0.492	0.061	-
HCM Control Delay (s)	-	-	40.1	11.9	-
HCM Lane LOS	-	-	E	B	-
HCM 95th %tile Q(veh)	-	-	2.4	0.2	-

Notes			
~: Volume exceeds capacity	$: Delay exceeds 300s	+: Computation Not Defined	*: All major volume in platoon

Intersection	
Int Delay, s/veh	1.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Vol, veh/h	17	1	37	15	0	27	14	1167	34	37	1364	55
Future Vol, veh/h	17	1	37	15	0	27	14	1167	34	37	1364	55
Conflicting Peds, #/hr	0	0	0	0	0	0	8	0	4	4	0	8
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	1	-	-	1	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-	-	0	-
Peak Hour Factor	100	100	100	100	100	100	100	100	100	100	100	100
Heavy Vehicles, %	14	0	4	9	0	0	0	1	0	4	4	22
Mvmt Flow	17	1	37	15	0	27	14	1167	34	37	1364	55

Major/Minor	Minor2			Minor1			Major1			Major2		
Conflicting Flow All	2086	2707	718	1973	2717	605	1427	0	0	1205	0	0
Stage 1	1474	1474	-	1216	1216	-	-	-	-	-	-	-
Stage 2	612	1233	-	757	1501	-	-	-	-	-	-	-
Critical Hdwy	7.78	6.5	6.98	7.68	6.5	6.9	4.1	-	-	4.18	-	-
Critical Hdwy Stg 1	6.78	5.5	-	6.68	5.5	-	-	-	-	-	-	-
Critical Hdwy Stg 2	6.78	5.5	-	6.68	5.5	-	-	-	-	-	-	-
Follow-up Hdwy	3.64	4	3.34	3.59	4	3.3	2.2	-	-	2.24	-	-
Pot Cap-1 Maneuver	26	21	367	34	21	446	483	-	-	564	-	-
Stage 1	119	192	-	181	256	-	-	-	-	-	-	-
Stage 2	419	251	-	351	187	-	-	-	-	-	-	-
Platoon blocked, %								-	-		-	-
Mov Cap-1 Maneuver	17	13	364	21	13	444	479	-	-	562	-	-
Mov Cap-2 Maneuver	79	76	-	92	74	-	-	-	-	-	-	-
Stage 1	108	130	-	164	232	-	-	-	-	-	-	-
Stage 2	358	228	-	213	126	-	-	-	-	-	-	-

Approach	EB	WB	NB	SB
HCM Control Delay, s	36.8	29.6	0.1	0.3
HCM LOS	E	D		

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	479	-	-	167	188	562	-	-
HCM Lane V/C Ratio	0.029	-	-	0.329	0.223	0.066	-	-
HCM Control Delay (s)	12.7	-	-	36.8	29.6	11.9	-	-
HCM Lane LOS	B	-	-	E	D	B	-	-
HCM 95th %tile Q(veh)	0.1	-	-	1.3	0.8	0.2	-	-

Appendix B– Identify Intended Outcomes and Evaluation Methodology

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Technical Memorandum

October 19, 2023 Project# 28673

To: Garrett Sabourin and Carrie Theus

From: Katie Popp, Jacki Smith, PE & Matt Kittelson, PE

RE: Aune Street Extension Study – Intended Outcomes & Evaluation Methodology

INTENDED OUTCOMES & EVALUATION METHODOLOGY

This memorandum documents the intended outcomes and evaluation methodology for the Aune Street Extension Study. Information presented within this document outlines key outcomes that the completed project should achieve as informed by City of Bend planning documents, the 2020 Transportation General Obligation Bond (GO Bond), and the project team. The evaluation methodology includes specific evaluation metrics that will be used throughout the alternative development process to assess a particular alternative's ability to achieve the intended outcomes. This memorandum provides a framework for the alternatives development process and will guide final recommendations by the project team.

Project Purpose and Project Background

The City of Bend identified the need for the Aune Street Extension Study through several planning efforts, including the Central Westside Plan (2015), the Bend Transportation System Plan (TSP) (2020), and the Core Area Project (2020), among others. These plans emphasize the need for multi-modal east-west connectivity through the city's Core Area, including a connection between the Old Mill District to areas east of 3rd Street along the existing Aune Street alignment. The project was included in the 2020 Transportation General Obligation Bond (GO Bond) with funding allocated for planning, design, and construction.

The purpose of the study is to identify and evaluate conceptual alternatives for the Aune Street extension. The study will consider future alignment options for Aune Street and connectivity between US97 and 3rd Street, including GO Bond Key Routes identified in the TSP, enhanced crossing locations/ treatments along 3rd Street, and intersection improvements along 3rd Street. These options will also be evaluated for consistency with the portion of the Aune Street alignment being built by developers to the west.

An improved connection between US97 and 3rd Street will:

1. Provide alternative east-west routes to supplement Colorado Avenue, Wilson Avenue, and Reed Market Road
2. Enhance access to US97 from 3rd Street
3. Streamline bicycle and pedestrian access to Bend's low-stress network and key walking and biking routes
4. Identify and reduce potential for crashes to improve system safety and user connectivity
5. Identify near- and long-term options for Aune Street alignment that will be compatible with City right-of-way and future development and transportation system needs.

Problem Statement

The Bend Core Area lacks critical east-west connections between the Old Mill District and areas east of the US97 Parkway. As the City continues to invest in economic opportunities in the surrounding area within the Bend Core Area, travel demand will increase. Increased demand in this area necessitates near-term improvements that enhance connections between US97 and 3rd Street and increase safe and accessible transportation options, especially for pedestrians, cyclists and people that use transit.

Intended Outcomes

The project team has identified six intended outcomes for the Aune Street Extension Study. The outcomes consist of several objectives that will establish the specific evaluation criteria. These intended outcomes are based on goals, principles, and community values outlined in the Bend Transportation System Plan (TSP).

The outcomes include:

1. **System Connectivity and Operations: Provide a safe and efficient transportation system for all modes of travel that meets existing and future mobility needs within the study area.**
    a. Objectives
        1.a Address the existing and future year 2045 traffic operational needs and deficiencies within the study area.
        1.b Provide a connected multi-modal east-west connection between the Old Mill District and the area east of 3rd Street.
        1.c Increase transportation choices in the Bend Core Area by adding or improving bicycle and pedestrian routes, crossings, and connections to transit, including a potential location for a CET mobility hub.

1.d Support the development of low-stress pedestrian and bicycle routes where the Aune Extension overlaps Key Routes identified in the TSP.

1.e Where possible, develop local connections that enhance traffic circulation to and from US97 access points including Colorado Avenue, Wilson Avenue, and Reed Market Road.

2. **Near-Term Feasibility: Evaluate alternatives that can be implemented within near-term constraints.**
    a. Objectives
        2.a Provide alternatives that are compatible with City right-of-way, near-term development, and anticipated transportation system needs based on 2045 volumes.
3. **Long-term Compatibility: Support the City's adopted plans, development opportunities, and long-term infrastructure investment.**
    a. Objectives
        3.a Provide transportation infrastructure that supports future opportunities of identified properties, railroad infrastructure, and/ or ODOT connections.
        3.b Establish a transportation system that aligns with guiding principles identified in the Bend Core Area Project and Bend Transportation System Plan.
4. **Safety for All Users: Provide a safe, comfortable, efficient, and accessible transportation system for all users within the study area.**
    a. Objectives
        4.a Address the identified safety gaps and deficiencies within the study area by reducing conflict points.
        4.b Establish a low-stress bicycle and pedestrian network consistent with the routes identified in the TSP. Provide safe bicycle and pedestrian crossings.
        4.c Provide safe pedestrian and bicycle crossings that enhance connectivity of low stress routes.
        4.d Consider concepts that reduce conflicts at at-grade railroad crossings and along rail tracks.
5. **Equity: Improve connections for transportation disadvantaged populations to key destinations within the community by providing a safe, efficient, and comfortable transportation system.**
    a. Objectives
        5.a Document how proposed infrastructure enhances mobility for transportation disadvantaged populations within study area and the surrounding community.
6. **Cost: Invest in an efficient transportation system that fits within the City's allocated budget and meets the existing and future needs of the Core Area.**
    a. Objectives

6.a Address existing and future needs through 2045 while meeting the budget allocated by the GO Bond for the Aune Street Extension (East) project.

Evaluation Methodology

Kittelson developed an evaluation methodology that will be used to compare and select preferred recommendations for the Aune Street Extension Study. At this level of alternatives screening and assessment, projects will be evaluated based on a qualitative assessment of each evaluation criterion. The evaluation will be captured with the following circle system:

- **Solid circle** (●)**:** The alternative addresses the criterion and/ or makes substantial improvements in the criteria category.
- **Half-filled circle** (◒)**:** The project addresses the criterion and/ or has neutral or marginal improvements in the criteria category.
- **Empty circle** (○)**:** The alternative does not address criterion and/ or negatively impacts the criteria category.

Proposed Evaluation Criteria

Table 1 summarizes the evaluation criteria that will be used to qualitatively evaluate potential alternatives developed through the Study. These criteria will be used to inform discussions about the benefits and tradeoffs of each alternative.

Table 1. Summary of Intended Outcomes, Objectives, and Evaluation Criteria for the Aune Street Extension Study

Intended Outcome	Objective	Evaluation Criteria
System Connectivity and Operations	1.a Address the existing and future year 2045 traffic operational needs and deficiencies within the study area. 1.b Provide a connected multi-modal east-west connection between the Old Mill District and the area east of 3rd Street. 1.c Increase transportation choices in the Bend Core Area by adding or improving bicycle and pedestrian routes, crossings, and connections to transit, including a potential location for a CET mobility hub. 1.d Support the development of low-stress pedestrian and bicycle routes within the City of Bend. 1.e Develop local connections that enhance traffic circulation to and from US97 access points including Colorado Avenue, Wilson Avenue, and Reed Market Road.	• Does the alternative improve traffic operations within the study area in future year 2045? • Does the alternative increase transportation choices for users within the study area by adding/ improving pedestrian and bicycle routes, crossings, and connections to transit? • Does the alternative promote a low-stress network for key walking and biking routes?
Near-Term Feasibility	2.a Provide alternatives that are compatible with near-term development, and anticipated transportation system needs.	• Does the alternative address transportation system needs of near-term developments in the KorPine area? • Does the alternative align with plans, policies, and laws adopted by the City? • Does the alternative align with plans, policies, and laws adopted by ODOT? • Does the alternative align with plans, policies, and laws adopted by BNSF? • Is the alternative consistent with the alignment of Aune Street (to the west) being built by developers?

Long-Term Compatibility	3.a Provide transportation infrastructure that aligns with the long-term vision of the Bend Core Area and the surrounding community. 3.b Establish a transportation system that aligns with future development and encourages continued investment in the economic growth of the Bend Core Area.	• Does the alternative support the City's adopted plans? • Does the alternative support development opportunities at identified properties? • Does the alternative support infrastructure investment on US97 consistent with ODOT's long-term vision with the parkway? • Does the alternative support BNSF's adopted plans and long-term strategy for railroad infrastructure investment in the study area?
Safety for All Users	4.a Address the identified safety gaps and deficiencies within the study area by reducing conflict points. 4.b Establish low-stress bicycle and pedestrian connections using traffic calming strategies that promote driver compliance with posted speeds. 4.c Increase safety at pedestrian and bicycle crossings. 4.d Evaluate potential alternatives to reduce conflicts at at-grade railroad crossings and along rail tracks, including alternatives where the at-grade crossing is removed.	• Does the alternative meet TSP level of stress goals (LTS 1 or 2)? • Does the alternative reduce the potential for crash trends at identified high-crash locations? • Does the alternative maintain or improve potential safety conflicts between railway operations and drivers, pedestrians, and cyclists?
Equity	5.a Increase transportation options that connect users to key destinations. 5.b Provide links that enhance mobility for transportation disadvantaged populations within study area and the surrounding community.	• Does the alternative improve pedestrian and/ or bicycle access to key destinations within the study area? • Does the alternative serve transportation disadvantaged populations?
Cost	6.a Address existing and future needs through 2045 while meeting the budget allocated by the GO Bond for the Aune Street Extension (East) project.	• Is the alternative feasible within the allocated budget?

Appendix C – Methodology Memorandum

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Technical Memorandum

July 20, 2023 Project# 28673

To: Garrett Sabourin and Carrie Theus

From: Katie Popp, Jacki Smith, PE & Matt Kittelson, PE

CC: ODOT Region 4, ODOT Transportation Planning Analysis Unit (TPAU)

RE: Aune Street Extension Study – Methodology Memorandum

METHODOLOGY MEMORANDUM

This memorandum documents the methodology and assumptions to perform technical analyses for the Aune Street Extension Study located in the City of Bend.

The methodology and assumptions include:

- Operational analysis
  - Data collection and volume development
  - Existing year and planning horizon (year 2045) traffic conditions
- Future growth methods and scenarios
- Safety analysis
- Multimodal analysis
- Crossing analysis

The following sections discuss each of these in more detail. These assessments establish the framework for evaluating conceptual alternatives and solutions for the Aune Street Extension Study.

Project Background

The Aune Street Extension Study was identified through several City of Bend Planning efforts including the Central Westside Plan (2015) and the Bend Transportation System Plan (2020). The project was included in the voter approved 2020 Transportation General Obligation Bond (GO Bond) with funding allocated for this study and future design and construction.

This study provides the framework for identifying near- and long-term infrastructure on Aune Street east of US97 to provide an enhanced connection from the Parkway undercrossing to 3rd Street, providing improved system connectivity for all users. The Aune Street extension west of US 97 to Bond Street will be built by private developers as adjacent land is developed.

Study Area

The study area is bounded by Franklin Avenue to the north, SE 3rd Street to the east, Wilson Avenue to the south, and generally US97 to the west (including the southbound US97/Colorado Avenue ramp intersection). The existing and future conditions assessments will focus on the 12 study intersections provided below:

1. Colorado Avenue/US97 SB Ramp
2. Colorado Avenue/US97 NB Ramp
3. Scott Street/Aune Street
4. 2nd/Davis Avenue
5. 2nd Street/Miller Avenue
6. 2nd Street/Woodland Boulevard
7. 3rd Street/Woodland Boulevard
8. 3rd Street/Miller Avenue
9. 3rd Street/Davis Avenue
10. 3rd Street/Burnside Avenue
11. 3rd Street/Clay Avenue
12. 3rd Street/Dekalb Avenue

The study area and study intersections are shown in Figure 1.

Figure 1. Study Area

Operational Analysis

The following section describes how traffic volumes were collected within the study area and how they will be used to evaluate existing and future traffic conditions at each study intersection. Operational analysis of the study intersections is based on Chapter 4.7 of the Bend Development Code (BDC). Analysis of intersections on an ODOT facility will be evaluated based on ODOT mobility targets provided in the Oregon Department of Transportation (ODOT) Oregon Highway Plan (OHP) and Highway Design Manual (HDM), as applicable. The following analysis periods will be evaluated:

- 2023 Existing Conditions
- 2045 Future Conditions

Traffic Counts

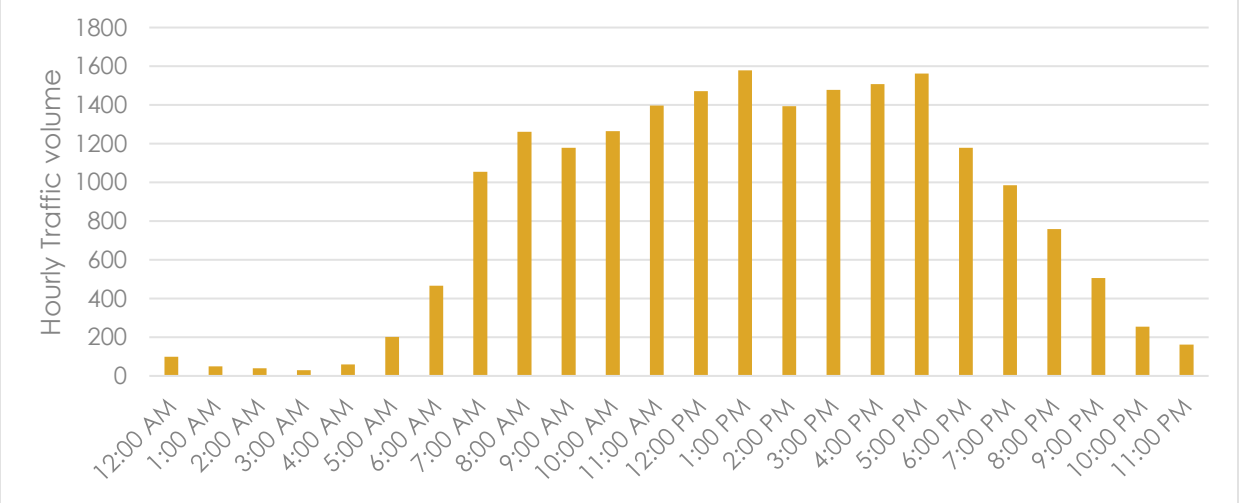
Turning movement counts and 24-hour tube counts on 2nd Street and 3rd Street were collected on May 2, 2023. All counts include the total number of pedestrians, bicyclists,

motor vehicles, and percentage of heavy vehicles that entered the intersections in 5-minutes intervals. The PM peak hour (4pm-6pm) data was reduced and summarized. 24-hour video data was collected at all the study intersections.

Peak Hour Selection

Based on review of 24-hour traffic count data, 4pm-5pm is representative of the system peak hour to be used in existing and future conditions assessments. As shown in Exhibit 1, hourly volumes on 3rd Street are relatively uniform between 8am-5pm. While the hourly bi-directional peak shows the highest traffic volumes from 1-2pm, the volumes remain consistent throughout typical daytime hours. Therefore, because the volumes have minimal fluctuation and the travel demand model output reflects the pm peak hour, intersections will be evaluated using the system peak hour of 4pm-5pm.

Exhibit 1. Bidirectional Hourly Volumes - 3rd Street



Seasonal Adjustment Methods

The traffic count data will be seasonally adjusted using the *ODOT Analysis Procedure Manual (APM) Chapter 5 ATR Seasonal Trend Table Method* for a commuter corridor to reflect 30th highest hour conditions. For count data collected in early May, the seasonal adjustment factor that will be applied to all turning movement counts is 1.04.

Intersection Mobility Targets

State Facilities

The US97/Colorado Avenue intersections are owned and maintained by ODOT. Therefore, the northbound and southbound ramp intersections are subject to ODOT mobility targets. Table 6 of the OHP provides the mobility targets for facilities outside the

Portland Metro area. US97 in the study area is within an MPO and identified as a Statewide Highway with Expressway designation. Therefore, the volume-to-capacity mobility target for the US97 ramp approaches is 0.85. The OHP also states that non-state highway unsignalized intersection approaches should adhere to the volume to capacity ratio for District/Local Interest Roads. Therefore, the mobility target for the Colorado Avenue approaches within the study area is a v/c ratio less than 0.95.

Table 1200-1 of the 2023 ODOT HDM provides v/c ratios used to assist in identifying future system deficiencies and evaluating future alternatives on state highways. The ODOT HDM states that a statewide NHS freight route inside an urban growth boundary and inside an MPO should be designed for a mobility target v/c ratio less than 0.75 for a new roadway. Additionally, the HDM states that local interest roads should be designed for a mobility target v/c of 0.85. Depending on the operational efficiencies of various identified alternative improvements and coordination with ODOT on future plans for the interchange, an alternative mobility standard may be presented within the alternative development.

City Facilities

All other roadways in the study area are owned and operated by the City of Bend. Applicable operating standards for each intersection are based on Bend Development Code (BDC) 4.7.500.B.6.d:

- Two-Way Stop Control. Average delay for the critical lane group for any major intersection with greater than 100 peak hour trips is greater than or equal to 50 seconds during the peak hour.
- All-Way Stop Control. Average delay for any major intersection as a whole is greater than or equal to 80 seconds during the peak hour.
- For signalized intersections, the volume-to-capacity ratio for the intersection as a whole is greater than or equal to 1.0 during the peak hour.
- For roundabout intersections, the volume-to-capacity ratio for the critical movement is greater than or equal to 1.0 during the peak hour.

Traffic operations at the study intersections will be evaluated as outlined above. Project alternatives will consider applicable operating standards as part of the alternative development.

Operational Analysis Modeling Software and Parameters

The following data sources and methodologies are proposed for conducting traffic analysis.

- Intersection/Road Geometry (e.g., number of lanes, lane configurations, cross-section elements, etc.) will be collected through aerial photography and site visits. Available as-built data may also be used to verify existing roadway geometry. The

analysis models will be constructed on scaled roadway line work from GIS or aerial photography.

- Operational Data (e.g., posted speeds, intersection control, rail crossings, etc.) will be collected through aerial photography and confirmed through site visits.
- Peak Hour Factors (PHF) will be 1.0, per City of Bend analysis standards.
- Traffic Volume Development is described in previous sections.
- Traffic Operations
  - The methodologies identified in the Highway Capacity Manual 7th Edition (HCM – Reference 5) will be used to analyze traffic operations at the study intersections.
  - The team will utilize Vistro or Synchro, both software tools designed to assist with operations analyses in accordance with HCM 7th Edition methodologies; therefore, these software packages will be used to conduct the traffic operations analyses. Level-of-service (LOS), delay, v/c ratios (critical movement for unsignalized intersections) and 95th percentile queue lengths (note where queues would impact adjacent intersections or access points).
  - Roundabout operational analysis will be conducted consistent with roundabout calibration factors developed for Bend and document in the Bend Roundabout Evaluation and Design Guidelines.
  - Current signal timing data will be requested from ODOT for analysis of all existing traffic signals.

Table 1 summarizes the software and input assumptions for the traffic analysis.

Table 1: Traffic Analysis Assumptions

Intersection Parameters	Existing Conditions Assumptions
Peak Hour Factor	From traffic counts
Conflicting Bikes and Pedestrians per Hour	From traffic counts (as available)
Area Type	Based on local conditions
Ideal Saturation Flow Rate (All Movements)	1,750 passenger cars per hour per lane
Lane Width	12 feet (unless field observations suggest otherwise)
Percent Heavy Vehicles (All Movements)	From traffic counts (as available)
Percent Grade	Estimated based on field observations
95th-Percentile & Average Vehicle Queues	Traffic analysis summary output

Future Growth Methods and Scenarios

The Bend Redmond Regional Travel Demand Model (BRM) tool will be used to estimate year 2045 turning movement volumes at all study intersections. The BRM tool links land use, demographics, travel demand management strategies (such as parking pricing),

and the transportation network to forecast/predict how much people will travel, by which mode, and by which route, including sensitivity to system operational factors such as travel time due to congestion.

The assumptions included in the 2045 model are consistent with the Bend Transportation System Plan (TSP) land uses, which includes over 50 percent growth in housing and employment in Bend. This growth is spread throughout vacant lands, specific opportunity areas, and expansion areas identified through the 2016 Urban Growth Boundary update. This includes strategies identified through integrated transportation and land use planning to reduce vehicle miles travelled (VMT) per capita, such as increase in mixed-use, dense land uses, consistent with the land use designations shown in the adopted Bend Comprehensive Plan. The model run will include all local and reginal planned projects and developments including the Timberyards development west of the project area.

Raw link level volumes from the BRM will be post-processed using methods consistent with the ODOT APM V2 to develop intersection turn-movement volumes. This approach is derived from methodologies outlined in the National Cooperative Highway Research Program (NCHRP) Report 765 Highway Traffic Data for Urbanized Area Project Planning and Design. If needed for certain locations, network refinements be made in the travel model to help evaluate local-street level circulation patterns that are not represented in the regional model framework.

The project team will coordinate with the Bend MPO and ODOT Transportation Planning and Analysis Unit (TPAU) to ensure that the future year scenario is reflective of the higher housing densities being contemplated for the Timberyard Opportunity Area to the west.

Safety Analysis

The crash analysis will review the most recent five years of reported crash data at the study intersections, obtained from ODOT's Crash Analysis & Reporting Unit as well as document any fatal or severe injury crashes on roadway segments in the study area. Possible crash patterns that may include location, type, characteristics, and/or severity will be identified. Intersection crash rates will be developed and compared with statewide crash rates (ODOT Analysis Procedures Manual [APM] Exhibit 4-1). Specific emphasis will be given to crashes involving people walking, biking, or rolling.

The recently completed Bend Transportation Safety Action Plan (TSAP) and City of Bend All Roads Transportation Safety (ARTS) project list will be reviewed for each study intersection.

Multimodal Analysis

The multimodal analysis will review the following elements of the active transportation network to identify potential facility and service alternatives for people walking, rolling, biking, and taking transit within the study area:

- Availability of facilities and services (including transit) within the study area.
- Level of Traffic Stress (LTS) ratings for pedestrian and bicycle facilities with the study area. This analysis will rely on recently completed City of Bend LTS evaluations as available.
- Review of facilities included in the Bend Transportation System Plan with particular emphasis on the Low Street Bicycle Network and Key Walking and Biking Routes.

The LTS analyses will be performed in accordance with the methodologies identified in Chapter 14 of the APM. Pedestrian and Bicycle LTS have unique criteria that are used to determine a facility's LTS score (e.g., number of travel lanes, bike lane widths, adjacent parking, roadway functional classification, daily volume, posted speed limits, sidewalk conditions and widths, illumination presence, etc.). LTS scores range from little traffic stress (LTS 1) to high traffic stress (LTS 4) and are based on the perceived safety issue of being in close proximity to vehicles.

The LTS evaluation will be an essential component of identifying a preferred alignment for Key Walking and Biking Route 7, including 3rd Street crossing locations[1]. This route is planned to utilize the Aune Street extension.

Crossing Analysis

A crossing analysis will be conducted to evaluate recommended crosswalk treatments at intersections where the key walking/biking route crosses an arterial or collector. The analysis will use Table 11 of the Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations Final Report and Recommended Guidelines (FHWA Publication Number HRT-04-100, September, 2005). The use of this table is consistent with existing City of Bend practices in Section 4.7.500 of the Bend Development Code.

[1] This project addresses LTS from US97 to 3rd Street and the intersection crossing locations stated. Barriers along 3rd Street from Franklin Ave to Wilson Ave will not be addressed as part of this study.

Appendix D – Initial Alternative Development Memorandum

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Technical Memorandum

January 25, 2024 Project# 28673

To: Garrett Sabourin and Carrie Theus, City of Bend

From: Katie Popp, Jacki Smith, PE and Matt Kittelson, PE, Kittelson and Associates, Inc.

RE: Aune Street (East) Extension Study – Initial Alternatives Development Technical Memorandum (Task 4.2)

INTRODUCTION

This memorandum documents the development of and presents the initial alternatives for the Aune Street (East) Extension Study. These alternatives were developed based on the needs and opportunities identified through the *Existing and Future Conditions Assessment Technical Memorandum* and discussions with the City and key stakeholders. The alternatives include a range of potential infrastructure improvements intended to improve mobility for all transportation users within the area by enhancing east-west connectivity, safety, and multimodal options.

The following sections describe a series of infrastructure improvements within key sub-areas throughout the project study area. These areas include:

- **Sub-Area A**: 3rd Street influence area between the BNSF railroad undercrossing and Clay Avenue
- **Sub-Area B**: 3rd Street influence area between the BNSF railroad undercrossing and Woodland Boulevard. Includes 2nd Street from Scott Street to Woodland Boulevard.
- **Sub-Area C**: Aune Street influence area and Scott Street north of Scott Street/Scott Street intersection to the Colorado Interchange

The sub-areas are illustrated in Figure 1.

This memorandum provides initial concepts and documentation of key considerations associated with each alternative, including options for implementing Key Walking and Biking Routes ("Key Routes") identified in the Bend Transportation System Plan (TSP). The project team and City staff will meet to discuss these alternatives at a work session as part of the next stage of the alternatives assessment process. The outcomes of this work session will be integrated in the next stage of the alternatives development process, which includes an in-depth evaluation of each alternative based on evaluation criteria developed in the *Intended Outcomes and Evaluation Criteria* memorandum. Final recommendations for the Aune Street (East) Extension Study will be presented as part of the evaluation criteria assessment.

Figure 1. Aune Street (East) Extension Study Sub-Areas

The alternatives presented in this memorandum are intended to address the following outcomes identified and described in the *Intended Outcomes and Evaluation Methodology Technical Memorandum*:

1. System Connectivity and Operations: Provide a safe and efficient transportation system for all modes of travel that meets existing and future mobility needs within the study area.
2. Near-Term Feasibility
3. Long-Term Compatibility
4. Safety for All Users
5. Equity
6. Cost

BNSF Coordination

City staff and the project team have had ongoing conversations with BNSF staff to discuss options and opportunities to improve safety and functionality for both BNSF and public interest as the land uses surrounding Aune Avenue and the study area become more densely urbanized. These discussions have been incorporated in the development of initial near-term alternatives and long-term options discussed in this memorandum.

Key takeaways from discussions with BNSF include:

- The southern wye adjacent to Aune Street is a critical junction for BNSF in Oregon. BNSF assumes and expects that this southern spur will remain in place for the foreseeable future.
- BNSF is receptive to working with the City of Bend to relocate the northern spur adjacent to Colorado Avenue (approximately 2,000 feet of track) to the small railroad yard between Murphy Road and Reed Market Road. No formal agreement has been reached between the City and BNSF; however, the removal of the northern spur could expand transportation alternatives under the Colorado Avenue undercrossing. Allocation of future right-of-way that could be acquired by the City as a result of the spur removal would need to be further evaluated to identify the use with the most public benefit.
- BNSF is open to allowing the City to utilize a maximum of 6 additional feet north of the existing curb on Aune Street under the Parkway Undercrossing to provide a sidewalk on the north side of the street – enhancing the safety and connectivity for people walking and biking. However, BNSF will not allow a fence between the sidewalk and the tracks as maintenance vehicles occasionally pull up on the curb to access the wye.

INITIAL ALTERNATIVES

This section describes initial alternatives for the three sub-areas.

Sub-Area A: 3rd Street – North of Undercrossing

The initial alternatives for Sub-Area A consist of two options for enhanced pedestrian crossings: Clay Avenue (Alternative A.1) and Burnside Avenue (Alternative A.2). These alternatives provide options for implementing Key Route 7, providing an east-west connection from the Bend Senior High School area across 3rd Street.

In the TSP, Key Route 7 is proposed to connect with 3rd Street at Burnside Avenue. As the Route continues south, it turns to Miller Avenue to connect to 2nd Street, then travels

north along 2nd Street to connect to Aune Street – eventually terminating at Division Street. The route requires a crossing along 3rd Street between Burnside Avenue and Miller Avenue to connect with 2nd Street.

The bicycle Low Stress Network (LSN), as defined in the TSP, extends west of Burnside Avenue to 2nd Street north of the undercrossing. There are no marked or enhanced crossings between Franklin Avenue and Wilson Avenue. An east-west crossing north of the railroad undercrossing can enhance the safety and efficiency of low-stress connections within the vicinity of 3rd Street. Alternatives A.1 and A.2 describe two options for a proposed crossing north of the railroad undercrossing that support the implementation of Key Route 7 and the crossing to the Low Stress Bicycle Network.

The TSP also identifies a long-term project to widen 3rd Street to four lanes under the railroad with complete street design from Emerson Avenue to Miller Avenue (C-54). Both options for Sub-Area A are compatible with the assumptions of the 3rd Street widening.

The two concepts are described below:

Alternative A.1: Crossing at Clay Avenue

Alternative A.1 consists of an enhanced crossing such as a rectangular rapid flashing beacon (RRFB) on the south side of the Clay Avenue/3rd Street intersection, as shown in Figure 2. The crossing includes continental crosswalk bars and a median placed in the existing two-way-left-turn area to provide a median refuge for pedestrians. "Stop Here for Pedestrians" signs would be installed ahead of the north and south approaches of the intersection along with a painted stop bar to indicate where vehicles must stop. Other considerations for this alternative include:

- The Clay/3rd Street intersection is a T-intersection resulting in fewer vehicle conflict points compared to a 4-leg intersection. Fewer intersection approaches reduce conflict points between vehicles and pedestrians.
- Placing the median on the south side of the intersection eliminates the mainline southbound left turn conflict between vehicles and pedestrians. The median does not restrict existing vehicle turning movements from the mainline or side street.
- At Clay Avenue the southbound lane merges from two lanes to one through the intersection influence area. Drivers may be positioning themselves with other vehicles through the merge area near a potential crossing instead of focusing on someone using the crosswalk.
- Shifting the crossing from Burnside Avenue to Clay Avenue would increase out-of-direction travel for Key Route 7 and the extension of the low stress network to 2nd Street north of the undercrossing.

Figure 2. Alternative A.1 Crossing at Clay Avenue

Alternative A.2: Crossing at Burnside

Alternative A.2 includes an enhanced crossing on the south side of the Burnside Avenue/3rd Street, as shown in Figure 3. The crossing includes striped crossing markings and a median placed in the existing northbound left-turn lane, which provides pedestrian refuge area. Other considerations for this alternative include:

- Burnside Avenue is a four-leg intersection located immediately south of the 3rd Street transition area from a five-lane cross-section to a three-lane cross-section.
- The proposed enhanced crossing is located on the south leg of the intersection where 3rd Street is a three-lane cross section with a northbound left-turn lane. A crossing on Burnside Avenue instead of Clay Avenue reduces the total number of lanes a pedestrian must cross at a time and has an overall shorter crossing distance compared to the alternative at Clay Avenue (approximately 45 feet).
- The location of the median refuge island on the south side of the intersection would restrict northbound left turns requiring those vehicles to use Dekalb Avenue to circulate to 2nd Street.

- A crossing at Burnside Avenue facilitates the continuation of the low stress network to 2nd Street north of the undercrossing

Figure 3. Alternative A.2 Crossing at Burnside Avenue

If Burnside is selected as the preferred crossing location north of the 3rd Street undercrossing, additional alternatives such as a crossing on the north side will be considered as part of the conceptual design phase.

Table 1 provides a comparison of how each alternative addresses the criteria presented in the scope of work (Section 4.2):

Table 1. North of 3rd Street Key Considerations

Considerations	Alternative A.1: Clay Avenue Undercrossing	Alternative A.2: Burnside Avenue Undercrossing
Environmental Resources	No anticipated conflicts with environmental resources	No anticipated conflicts with environmental resources
Conflicts or Coordination with BNSF	No coordination needed	No coordination needed
Business Access	No changes to existing accesses	No changes to existing accesses
Cost Estimate[1]	$500,000 (Assumes RRFB and 500ft of sidewalk enhancements on westside of 3rd St)[2]	$500,000 (Assumes RRFB and 500ft of sidewalk enhancements on westside of 3rd St)[1]
Key Routes	Key Route 7 is changed from Burnside Avenue to Clay Avenue	Consistent with TSP
Impacts or Benefits to Transportation Disadvantaged Populations (TDPs)	Enhances safety and efficiency of multimodal east-west crossings in areas with populations of TDPs	Enhances safety and efficiency of multimodal east-west crossings in areas with populations of TDPs
Traffic Operations	No impacts	Northbound left-turn lane replaced with a pedestrian refuge area. Northbound lefts must continue north and turn at Dekalb Ave
Bicycle and Pedestrian Connectivity	Maintains connectivity but requires more out-of-direction travel for the low stress network connection to 2nd Street north of the undercrossing. Requires crossing of 2 lanes at a time. Fewer conflict points compared to Alternative A.2 as a three-leg intersection.	Facilitates continuation of low stress network across Burnside Avenue to 2nd Street north of the undercrossing. Requires crossing of only 1 lane at a time. More conflict points compared to Alternative A.1 as a four-leg intersection.

[1] See Appendix G for Cost Estimates.
[2] Both alternatives assume an RRFB, consistent with existing enhanced crossings with pedestrian refuge islands on 3rd Street both upstream and downstream of Clay Avenue and Burnside Avenue (e.g., Hawthorne Avenue and the canal crossing). Treatment will be further evaluated through design.

Sub-Area B: 3rd Street – South of Undercrossing

Findings from the *Existing and Future Conditions Assessment Technical Memorandum* indicate an increase in travel demand on Miller Avenue due to anticipated baseline growth as well as increased traffic from the Korpine and Jackstraw area. Therefore, the initial alternatives for Sub-Area B include three traffic control and lane configuration options that are intended to address traffic challenges associated with anticipated growth. There are three alternatives proposed for this Sub-Area:

- **Alternative B.1**: Traffic Signal at 3rd Street/ Miller Avenue
- **Alternative B.2**: Traffic Signal at 3rd Street/ Woodland Boulevard and one-way couplet on Miller Avenue and Woodland Boulevard
- **Alternative B.3**: Traffic Signal with Continuous Green Northbound Through (NBT) at 3rd Street/ Miller Avenue

Alternative B.1: Traffic Signal at 3rd Street/ Miller Avenue

Alternative B.1 consists of a traffic signal at 3rd Street/Miller Avenue and installation of a median between Davis Avenue and Miller Avenue, shown in Figure 4. The median restricts left turns (right-in/ right-out (RI/ RO)) at Davis Avenue (existing RIRO) and East Railroad Street and restricts the southbound left turn at 3rd Street/Miller Avenue. The signal has been analyzed as having protected/permissive phasing for the northbound left-turn movement and permissive phasing on Miller Avenue. Traffic calming on the west side of Miller Avenue would be implemented to discourage the Miller Avenue to Centennial Street cut-through to Wilson Avenue.

Opportunities

- Adding a median in the southbound left-turn lane allows for the inclusion of a pedestrian refuge island and increases the northbound effective green time for the traffic signal by approximately 2 seconds.
- The traffic signal provides a signalized eastbound left-turning movement to address the increased eastbound demand on Miller Avenue.
- Restriping and using the southbound left turn lane as a median provide an opportunity to extend the two northbound lanes north of Miller Avenue to allow for more room for driver decision-making ahead of the merge.
- Restricting the southbound left turning movement restricts cut through traffic from Miller Avenue to Centennial Street to Wilson Avenue that a permitted signalized southbound left turning movement may facilitate.
- This Alternative is expected to meet City operational standards in 2045 (analysis worksheets provided in Attachment A).
  - The traffic signal analysis estimates a 0.82 v/c ratio, which is less than the City's operational threshold of 1.0.

  - Queues are estimated to be approximately 575 feet for the northbound through (extends past Lee Lane), 425[3] feet for the southbound through, 150 feet for the eastbound approach, and 50 feet for the westbound approach.
  - The location of the start of the merging zone just north of the Miller Avenue intersection indicates that northbound lane utilization should be adjusted to account for vehicles moving to the inside lane south of Miller Avenue to prepare for the merge. Therefore, the project team assumed lane utilization for the northbound lanes to be 80% in the inside northbound lane in 20% in the southbound left turn lane for this analysis.
- This option is expected to have minimal impacts to right-of-way.
- Introduces a traffic control device to address crash history as identified in the Bend TSAP and in the 2021 ODOT State Priority Index System (SPIS).
- The low-stress network connection will be facilitated on Miller Avenue, consistent with the TSP. The conceptual design could include a protected intersection for bicycle crossings.

Challenges

- Restricting left turning movements north of Miller Avenue shifts traffic to neighborhood network and requires may increase out-of-direction travel.
- Drivers would likely use the Woodland Boulevard intersection to make the southbound left turning movement with the restriction of the southbound left at Miller Avenue. This could increase circulation in the local street network in the residential area east of 3rd Street, especially along 4th Street.
- Business access north of Miller Avenue would be restricted to right-in/ right-out.
- Providing a full access signalized approach on for the east leg of Miller Avenue could attract cut through traffic from Wilson Avenue and Centennial Street. Traffic calming treatments such as speed humps/speed tables, traffic circles, or bulb outs may reduce the likelihood of cut through traffic and attractiveness of the route choice for regional trips.

[3] Estimated queue likely extends farther than the 475 feet because of the reduction in lanes north of Davis Avenue. Davis Avenue is approximately 275 feet north of Miller Avenue.

Figure 4. Alternative B.1 Traffic Signal at 3rd Street/ Miller Avenue

Alternative B.2: Traffic Signal at 3rd Street/ Woodland Boulevard and One-Way Conversion

Alternative B.2 consists of a traffic signal at 3rd Street and Woodland Boulevard, shown in Figure 5. Miller Avenue west of 3rd Street and Woodland Boulevard east/west of 3rd Street would be converted to one-way movements: Miller Avenue westbound only and Woodland Boulevard eastbound only. Northbound and southbound left turn movements would be restricted at Woodland Boulevard, and the traffic signal would operate as a two-phase signal. Curb extensions would be implemented at the Miller Avenue/ 2nd Street intersection one-way. This option assumes one-way bicycle facilities on Woodland Boulevard and Miller Avenue. Traffic calming on the west side of Woodland Boulevard would be implemented to discourage the Miller Avenue to Centennial Street cut-through to Wilson Avenue.

Opportunities

- The traffic signal provides a signalized eastbound left-turning movement to address the increased eastbound demand on Miller Avenue.
- A two-phase signal maximizes green time for through movements on 3rd Street.
- Provides a signalized crossing and pedestrian refuge islands for crossing 3rd Street.
- A traffic signal at Woodland Boulevard, which would be necessary to meet City mobility standards through the horizon year (standards would not be met if the intersection was side-street stop-controlled), increases the distance between the traffic signal and the merge south of the railroad undercrossing.
- This option is expected to have minimal impacts to right-of-way.
- Eliminates the uncontrolled eastbound turn movements at 3rd Street/Miller Avenue reducing the crash conflict points which was identified in the Bend TSAP and in the 2021 ODOT State Priority Index System (SPIS) based on recent crash history.
- The one-way configurations on Woodland Boulevard and Miller Avenue increase opportunities for maximizing parking and pedestrian and bicycle facilities within the right-of-way. Crossing distances can be decreased on the side streets with curb extensions.
- Woodland Boulevard is expected to meet City operational standards in 2045 (analysis worksheets provided in Attachment B).
    - The traffic signal analysis estimates a 0.72 v/c ratio, which is less than the City's operational threshold of 1.0.
    - Queues are estimated to be approximately 250 feet for the northbound through, 325 feet for the southbound through, 150 feet for the eastbound approach, and 25 feet for the westbound approach.
- The reduction in conflict points from the one-way conversion reduces bicyclist conflicts on the LSN.

Challenges

- Restricting northbound and southbound left-turning movements at Woodland Boulevard introduces wayfinding challenges for vehicles typically accessing Woodland Boulevard with a left-turning movement.
- Drivers could use the Miller Avenue intersection to make left-turning movements. However, this could increase circulation in the local street network in the residential area east of 3rd Street.
- Transitioning traffic on Miller Avenue and Woodland Boulevard from two-way to one-way has impacts on business circulation on Miller Avenue and Woodland Boulevard.
- The LSN connection on Miller Avenue requires bicyclists to cross in free-flow traffic on 3rd Street.
- An intersection improvement at the Lee Lane/ Woodland Boulevard/ 4th Street/ Dell Lane intersection such as a mini roundabout or curb extensions may be required to clarify travel path and direction.

- Restricting left turns at a traffic signal on Miller Avenue reduces opportunities for controlled access with left turns on this segment on 3rd Street.

Figure 5. Alternative B.2 Traffic Signal at 3rd Street/ Woodland Boulevard

Alternative B.3: Traffic Signal with Continuous Green Northbound Through at 3rd Street/ Miller Avenue

Alternative B.3 is a two-phase signalized concept at 3rd Street/Miller Avenue where the southbound and eastbound movements are signalized and the northbound movement is free flow without a signal head, shown in Figure 6. Left-turning vehicles from Miller Avenue merge with northbound traffic north of the intersection. South of Miller Avenue the inside northbound lane merges to one lane. This single lane continues north past Miller Avenue and is joined by the signalized eastbound left turning movements. These two lanes would then merge north of Miller Avenue before the undercrossing. The east leg of Miller Avenue would be restricted to right-in, right-out.

An example of an existing signalized continuous green movement is located on Biddle Road immediately east of I-5 in Medford. Exhibit 1 shows a Google Streetview example

of one of the four signals on Biddle Road with a continuous through movement. For this alternative at 3rd Street/Miller Avenue the northbound left movement is restricted, therefore no signal mast arm would be required for the northbound through.

Exhibit 1. Example of Continuous Through Movement at Signal on Biddle Road in Medford, OR

Opportunities

- The traffic signal provides a signalized eastbound left-turning movement to address the increased eastbound demand on Miller Avenue.
- Opportunities for mid-block crossings on 3rd Street between Miller Avenue and Woodland Boulevard. The proposed median provides a pedestrian refuge space to reduce the distance pedestrians need to cross at a single time.
- Northbound 3rd Street traffic is continuous flow.
- Reduces crash conflict points at 3rd Street and Miller Avenue intersection, which was identified in the Bend TSAP and the 2021 ODOT Safety Priority Index System (SPIS) based on recent crash history.
- Expected to meet City operational standards in 2045 (analysis worksheets provided in Attachment C).
  - A two-phase signal maximizes green time for the eastbound approach.

- The traffic signal analysis estimates a 0.65 v/c ratio, which is less than the City's operational threshold of 1.0.
- Queues are estimated to be approximately 225 feet for the southbound through and 100 feet for the eastbound approach.

Challenges

- Limited space north of Miller Avenue and south of the railroad undercrossing to facilitate eastbound left-turn merge with northbound through volumes. Requires additional design criteria review to determine if the merge can be facilitated without a design exception.
- Business access on 3rd Street from Woodland Boulevard to the undercrossing is restricted to right-in/ right-out.
- Westbound left-turns on Miller Avenue are not permitted. Therefore, traffic is expected to circulate in the local street network to the east of 3rd Street at Woodland Boulevard, Lee Lane, Dell Lane, or Yew Lane to access southbound 3rd Street.
- There are no east-west crossing opportunities at 3rd Street/Miller Avenue with the continuous northbound design. The nearest crossing would be at a proposed midblock crossing between Miller Avenue and Woodland Boulevard.
- The LSN connection is facilitated at the mid-block crossing south of Miller Avenue. This would require more out-of-direction travel for bicyclists crossing 3rd Street.

Figure 6. Alternative B.3 Continuous Northbound Green at Miller Avenue

Key considerations for each Alternative are summarized in Table 2.

Table 2. South of 3rd Street Key Considerations

Considerations	Alternative B.1 Traffic Signal at Miller Avenue	Alternative B.2 Traffic Signal at Woodland Boulevard	Alternative B.3 Continuous NBT
Environmental Resources	No anticipated conflicts	No anticipated conflicts	No anticipated conflicts
Conflicts or Coordination with BNSF	No coordination needed	No coordination needed	No coordination needed
Business Access	Business access north of Miller Avenue is restricted to Right-In/ Right-Out	Couplet on Miller Avenue and Woodland Boulevard	Business access between undercrossing and Woodland

		may result in circulation challenges	Boulevard is restricted to Right-In/ Right-Out
Cost Estimate[4]	$4.7M (traffic signal and medians)	$4.4M (traffic signal)	$4.1M (traffic signal and medians)
Key Routes	See "Key Routes" section	See "Key Routes" section	See "Key Routes" section
Impacts or Benefits to Transportation Disadvantaged Populations (TDPs)	Provides signalized crossing and pedestrian refuge area on the northside. Restricting southbound left-turning movements reduces conflict points at the intersection. Restricts left turns to business access north of Miller Avenue.	Provides signalized crossing and pedestrian refuge area on 3rd Street. Restricting northbound and southbound left-turning movements reduces conflict points at the intersection. Does not restrict business access north of Miller Avenue.	Provides enhanced crossing on 3rd Street between Miller Avenue and Woodland Boulevard with pedestrian refuge area.
Traffic Operations	Operates with a volume-to-capacity (v/c) ratio of 0.82 in 2045. Northbound and southbound queues may block side streets (Davis Avenue, Woodland Boulevard, and Lee Lane) in the p.m. peak hour.	Operates with a v/c ratio of 0.72 in 2045. Northbound queues may block Lee Lane in the p.m. peak hour.	Operates with a v/c ratio of 0.65 in 2045.

Cross-Sections

The project team developed cross-section alternatives for 2nd Street, Miller Avenue, and East Scott Street that include enhanced bicycle and pedestrian facilities in support of the Key Routes identified in the Bend TSP. This section provides an overview of the existing cross-sections and alternatives for each segment.

2nd Street

The City of Bend TSP identifies 2nd Street as a route for low-stress multimodal facilities, with Key Route 7 proposed on 2nd street between Miller Avenue and Aune Street and Key Route 9 proposed on 2nd Street to Wilson Avenue. As part of this study, the project team is considering options for the cross-section of 2nd Street along this segment to

[4] See Appendix G for Cost Estimates.

facilitate the implementation of low-stress Key Routes that enhance the comfort and safety of active transportation users.

The project team developed two options that enhance the comfort and safety of multimodal facilities along 2nd Street. Existing right-of-way varies on 2nd Street. The majority of available right-of-way on 2nd Street in the study area is 60 feet, however, the segment between East Scott Street and Davis Avenue is 50 feet. The cross sections in Figure 7 illustrate options for both the 50 feet and 60 feet cross-sections.

Existing Cross-Section

The existing cross-section of 2nd Street along this segment consists of two 12-foot travel lanes, a 6-foot bike lane on each side, and a 6-foot sidewalk on the eastside of the roadway and sidewalk gaps on the westside. The City will be implementing a grant project in 2024 to restripe 2nd Street to have 11-foot lanes, and five-foot bike lanes/ two foot buffers on both sides with pilot delineators in select locations.

Option 1

Option 1 consists of two 11-foot travel lanes, 6-foot bike lanes on each side of the roadway with 2-foot buffers, and 6-foot sidewalks on both sides. This option provides separated facilities for bicyclists and pedestrians. Pedestrian facilities on both sides of 2nd Street tie into the existing facilities north of Aune Street and south of Miller Avenue. Where right-of-way is available, landscape buffers could be included to provide separation between the curb and the sidewalk.

Option 2

Option 2 consists of two 11-foot travel lanes, 6.5-foot bike lanes on each side of the roadway with 2.5-foot buffers, and a 10-foot sidewalk on the east side of 2nd Street. This option provides separate facilities for bicyclists and pedestrians, including wider buffer and bike lane widths compared to Option 2. Where right-of-way is available, a sidewalk could be accommodated on the west side of the roadway, however, marked crossings would be required to provide options for pedestrians to cross where right-of-way is not available.

Option 3

Options 3-5 assume 60 feet of right-of-way consistent with the majority of the 2nd Street corridor. This option is similar to Option 2 but has a shared use path on both sides.

Option 4

Similar to Option 1 but has a landscape buffer between the bike lane and the sidewalk.

Option 5

Option 5 minimizes the pavement width and only includes 11-foot travel lanes within the curb. Bicycles and pedestrians are both on 12-foot shared-use paths on both sides of the roadway. A 6-foot landscape strip provides separation between vehicles and non-motorists.

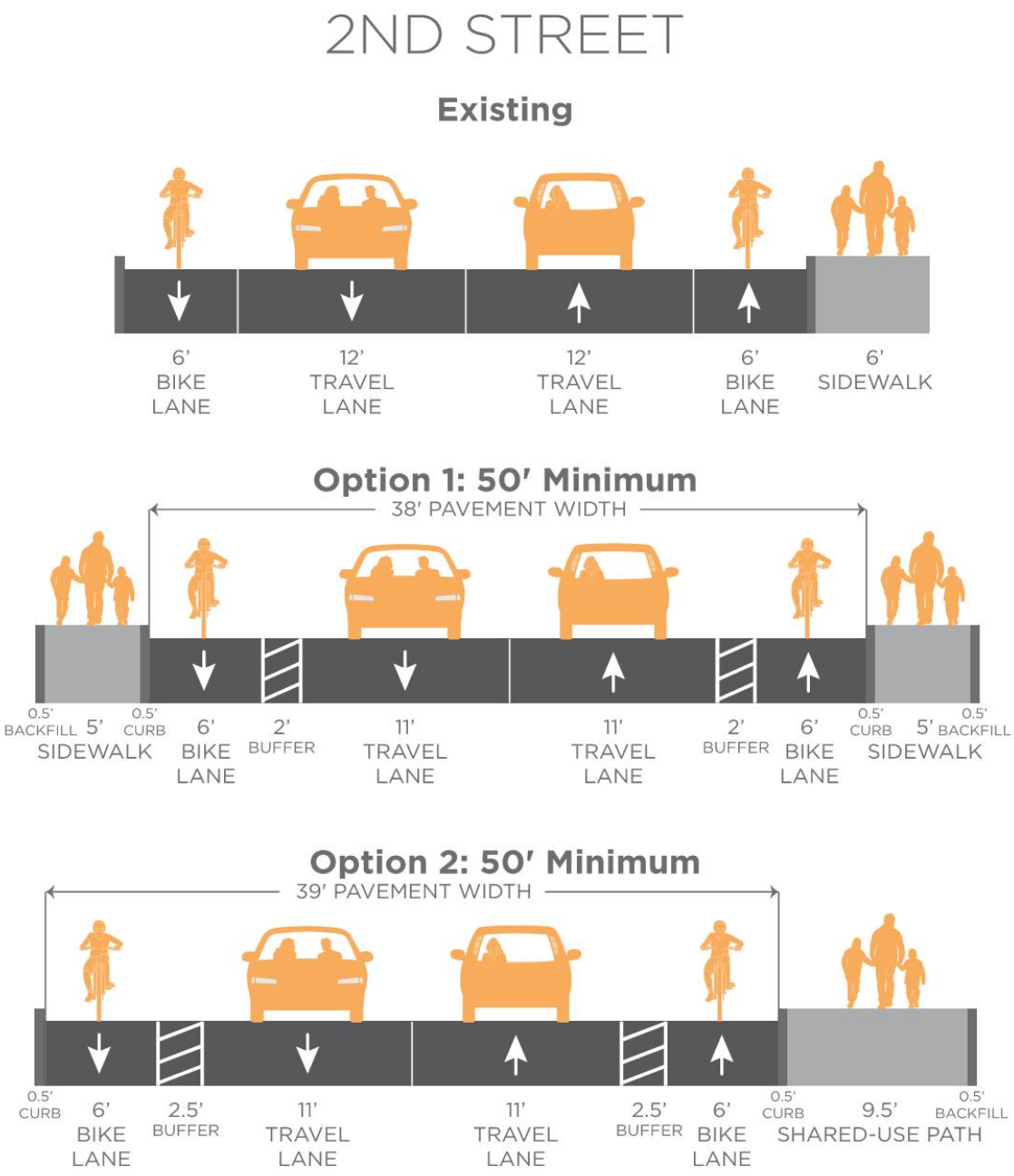
Option 6

Option 6 includes 11-foot travel lanes and an 8-foot on street parking lane on one side of the road. This option does not have bike lanes but accommodates bicycles and pedestrians via shared-use paths on both sides of the roadway.

Option 7

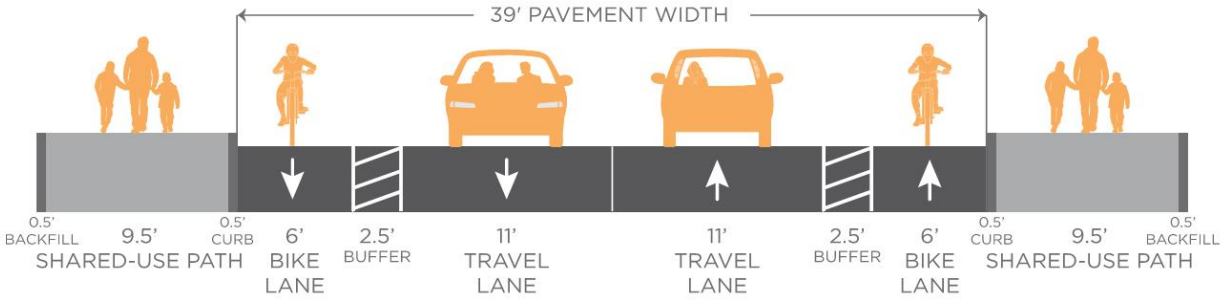
Option 7 minimizes the pavement width and only includes 11-foot travel lanes within the curb. A landscape buffer is provided between the travel lane and the 6-foot bike lane. A low profile curb is provided between the bike lane and the 7-foot sidewalk for people with no- or low-vision to differentiate between the sidewalk and the bike lane.

Figure 7. 2nd Street Cross-Section Alternatives (Facing North)

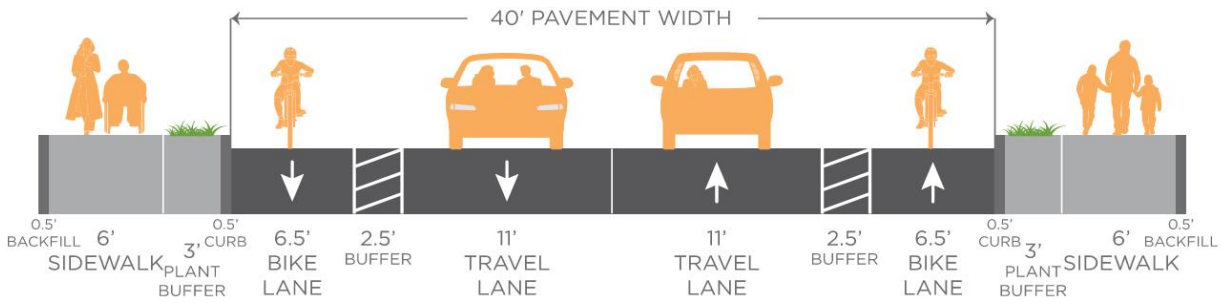


2ND STREET

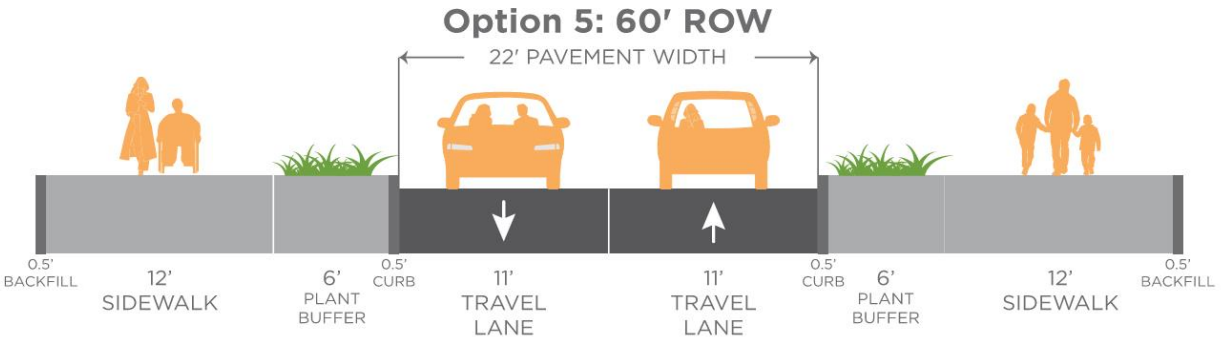
Option 3: 60′ ROW

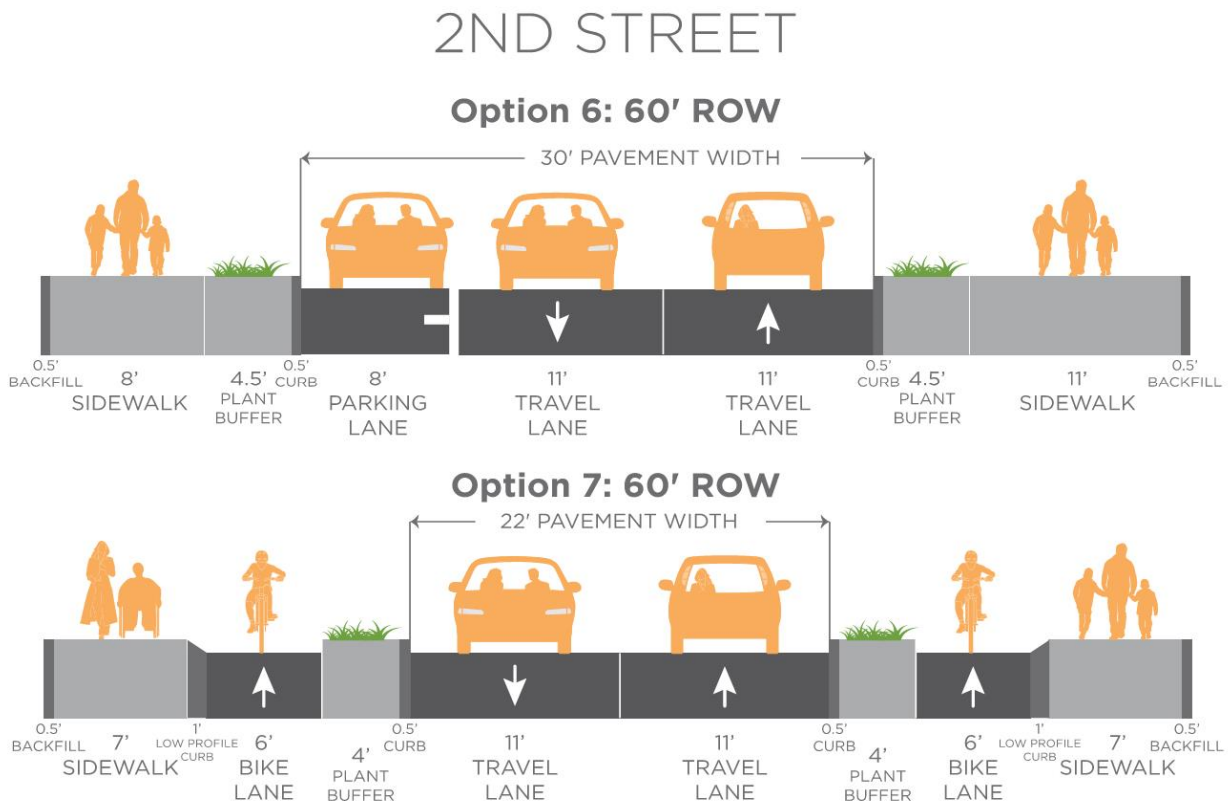


Option 4: 60′ ROW



Option 5: 60′ ROW





Miller Avenue

Miller Avenue is identified in the Bend TSP as the east-west connection between 3rd Street and 2nd Street for Key Route 7. The project team developed two alternatives for the Miller Avenue cross-section that enhance bicycle and pedestrian comfort and safety along the segment between 3rd Street and 2nd Street to support implementation of the Key Routes, shown in Figure 8.

Existing Cross-Section

Miller Avenue consists of two 11-foot travels lane and 7 feet of on-street parking. Lanes and parking are not stripped. Five-foot sidewalks are provided on both sides. Available right-of-way is assumed to be approximately 60 feet. The available right-of-way should be confirmed by survey data in future design.

Option 1

This option includes 11-foot travel lanes, buffered bicycle lanes, on street parking on one side, and 6-foot curb tight sidewalk.

Option 2

This option eliminates on street parking and includes 11-foot travel lanes, buffered bicycle lanes, 6-foot sidewalks, and a landscape buffer.

Option 3

Option 3 includes a 70-foot right-of-way. This would require right-of-way acquisition on both sides of the roadway. This option similar to Option 1 but includes a wider buffer between the travel lane and the bike lane and includes a landscape buffer on both sides.

Option 4

Option 4 includes a 70-foot right-of-way. This would require right-of-way acquisition on both sides of the roadway. This option has on-street parking on both sides and no bike lanes. People walking and biking would use the share-use paths on both sides of the roadway.

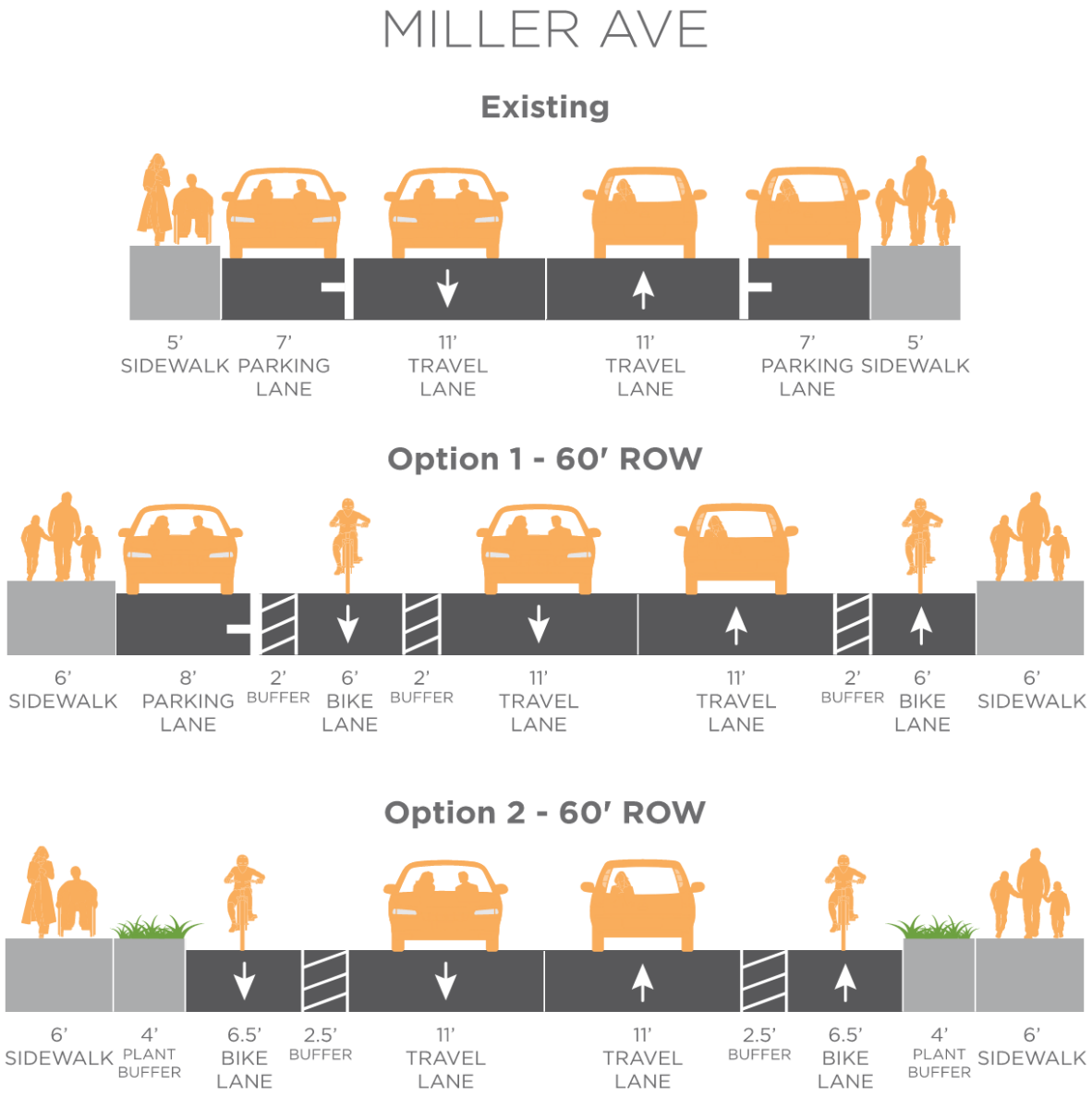
Option 5

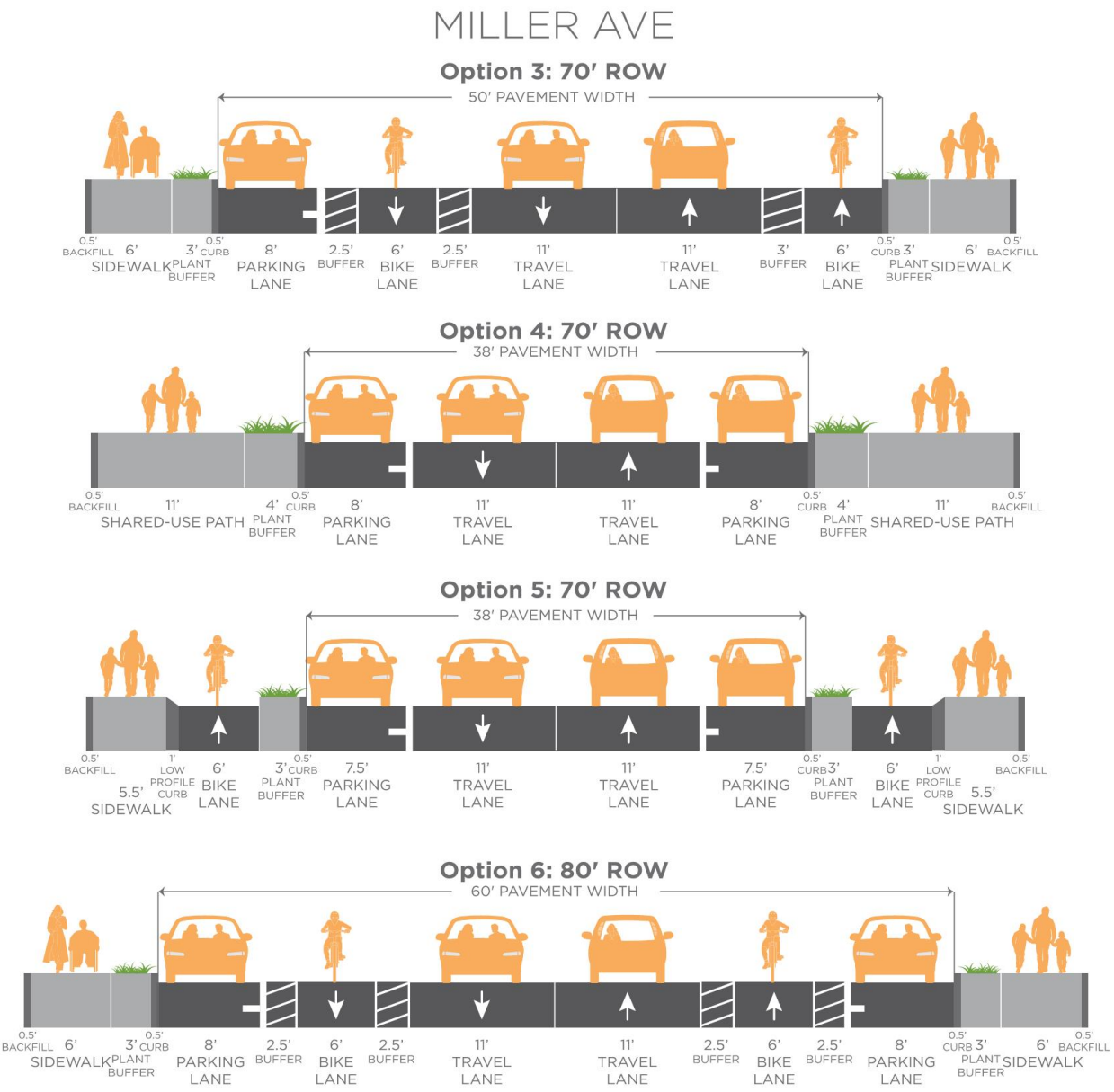
Option 5 includes a 70-foot right-of-way. This would require right-of-way acquisition on both sides of the roadway. This option has on-street parking on both sides of the roadway. A landscape buffer is provided between the travel lane and the 6-foot bike lane. A low-profile curb is provided between the bike lane and the 5.5-foot sidewalk for people with no- or low-vision to differentiate between the sidewalk and the bike lane.

Option 6

Option 6 includes an 80-foot right-of-way. This would require right-of-way acquisition on both sides of the roadway. This option includes on-street parking and buffered bike lanes on both sides of the roadway with a 3-foot landscape buffer and 6-foot sidewalks.

Figure 8. 2nd Street Cross-Section Alternatives





Scott Street (East)

East Scott Street is being considered as another option for the east-west connection of Key Route 7 between 2nd Street and 3rd Street (see *Key Route Alternative 4*). Compared to Miller Avenue, East Scott Street is expected to have lower vehicular volumes in 2045 and requires less out-of-direction travel for bicyclists or pedestrians traveling from 3rd Street to Aune Street or Colorado Avenue using the path on the westside of the undercrossing. Compared to Miller Avenue, East Scott Street has narrower driveways, reducing the pedestrian exposure to vehicles moving in and out of businesses and

residences. The project team developed two alternatives for Scott Street (East), shown in Figure 9.

Existing Cross-Section

The existing Scott Street cross-section includes 28 feet of a 6-foot sidewalk on the south side, and gravel/ shoulder parking on the north side. The north side does not have curb and gutter. Available right-of-way is assumed to be approximately 50 feet. The available right-of-way should be confirmed by survey data in future design.

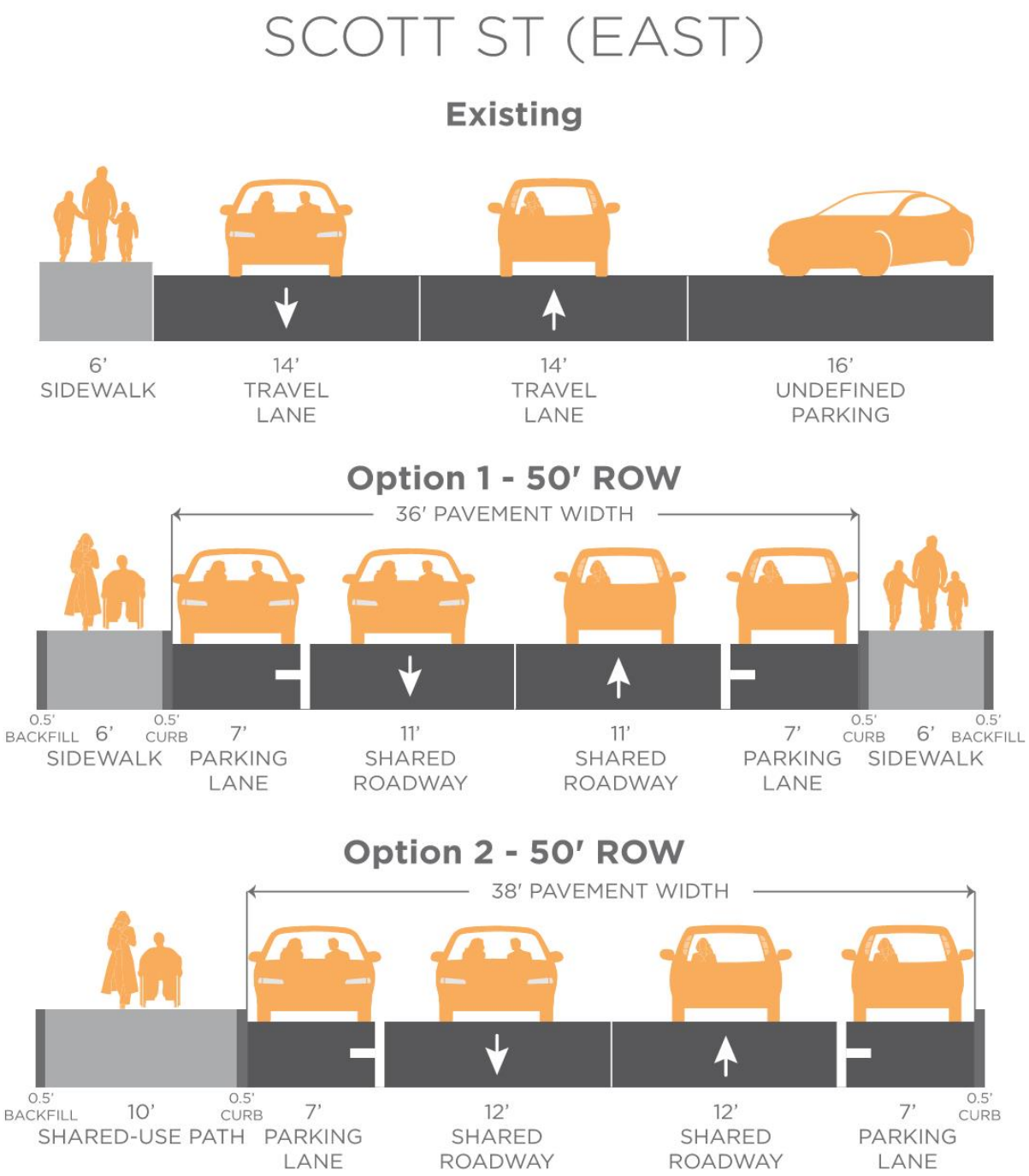
Option 1

This option includes two 11-foot shared travel lanes, 8-foot parking, and 6-foot sidewalks on both sides of the roadway. This option provides pedestrian facilities on both sides, providing access to businesses and residences adjacent to the north and south sides of Scott Street.

Option 2

This option includes two 12-foot shared travel lanes, 8-foot parking, and a 10-foot sidewalk on the south side of Scott Street. Compared to Option 1, this option provides wider shared facilities for bicyclists to travel with vehicles. However, pedestrian facilities are only provided on the south side of East Scott Street, limiting access to businesses and residences on the north side.

Figure 9. Scott Street (East) Cross-Section Alternatives (Facing West) between 2nd Street and 3rd Street



Davis Avenue

Like Scott Street, Davis is a low volume roadway that could be an alternative Key Route. Davis Avenue has driveways along the roadway and sidewalk gaps. Parking is

permitted on both sides of the road. Davis Avenue is moderately out of direction compared to Scott Street but provides an opportunity for bicycle and pedestrian mobility on a low stress facility.

SUB-AREA C: AUNE STREET ALIGNMENT

The initial alternatives for Sub-Area C include three options for the intersection of Aune Street and 2nd Street/ Scott Street and cross-sections for the Aune Street alignment. The options include:

- **Alternative C.1**: Side Street Stop Control
- **Alternative C.2**: Roundabout
- **Alternative C.3**: Traffic Signal

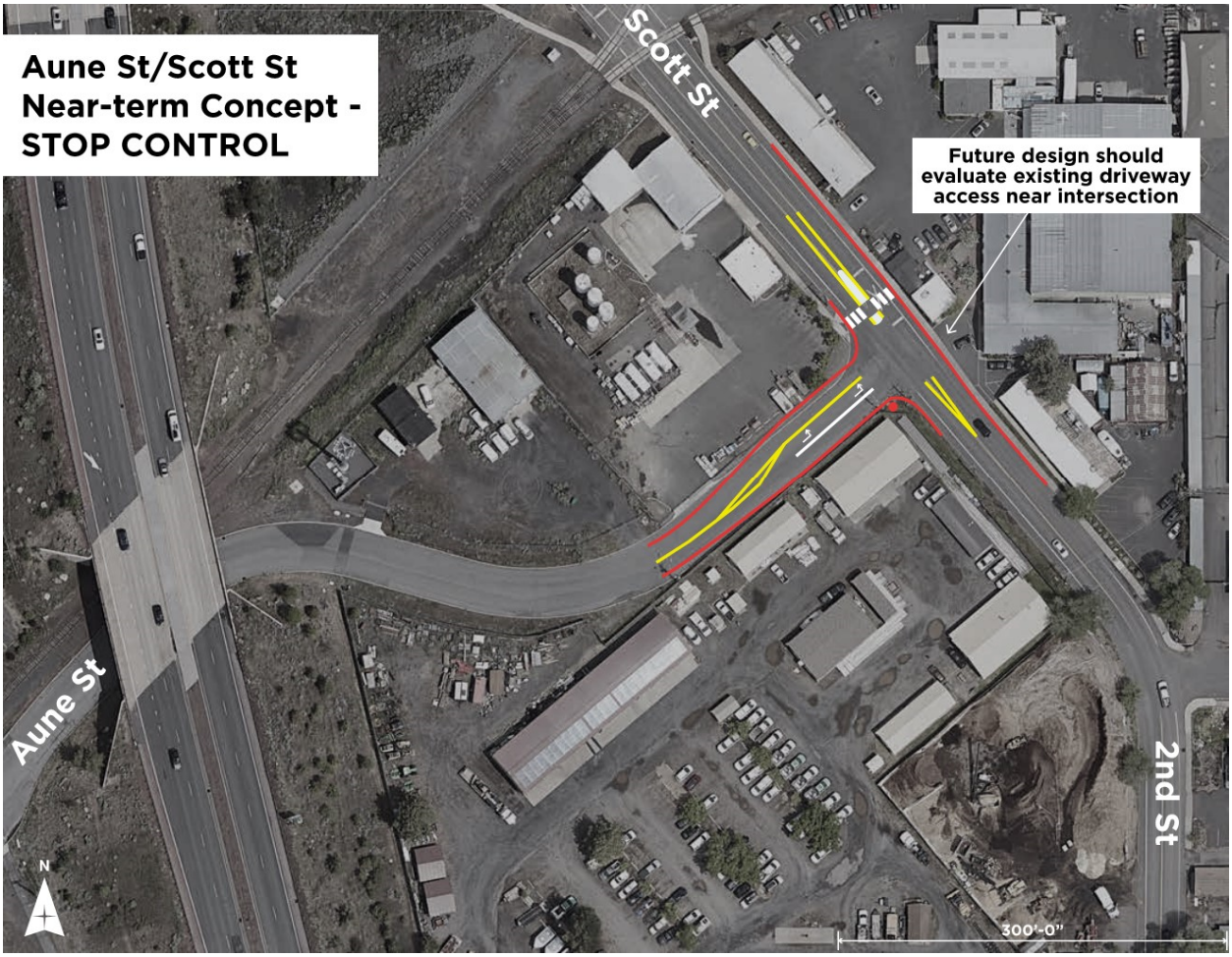
New mixed-use developments including Timber Yards and Jackstraw are expected to generate additional volume on Aune Street for drivers traveling to and from the area west of US97. As a result, volume is expected to exceed capacity on the Aune Street approach at the Scott Street/ 2nd Street intersection by 2037 with the existing traffic control and lane configuration.

A near-term concept was developed to maximize the use of the current Aune Street alignment and side street stop control configuration before an enhanced intersection treatment is necessary. Mid-term concepts include two options for addressing traffic operations beyond year 2037. Each concept is described in further detail below.

Alternative C.1: Side Street Stop Control (Near-Term)

Alternative C.1 includes side-street stop control on Aune Street with a dedicated left-turn lane and an enhanced crossing on the north leg of Scott Street, shown in Figure 10. This concept maintains the current Aune Street alignment with minor right-of-way required from the northern property frontage for the development of the turn lane. Further design consideration would be required for the consideration of the small parking area serving Café des Chutes and the businesses adjacent to Aune Street north of Scott Street.

Figure 10. Alternative C.1 Side Street Stop Control



Opportunities

- Less right-of-way impact until more robust traffic control is necessary.
- Enhanced pedestrian crossing on Scott Street with pedestrian refuge area to support Key Route 7.
- Maintains 250' between intersection and at-grade railroad crossing.
- Dedicated left-turn lane for vehicles on Aune Street.

Challenges

- Does not meet the City's operational standards past year 2036. After 2036, the Aune Street delay surpasses the operational standard threshold of 50 seconds (analysis worksheets are provided in Attachment D).
- Business driveway access near the intersection should be evaluated in future design.
- Will require right-of-way from the northwest property to fit pedestrian facilities that connect to the enhanced crossing.

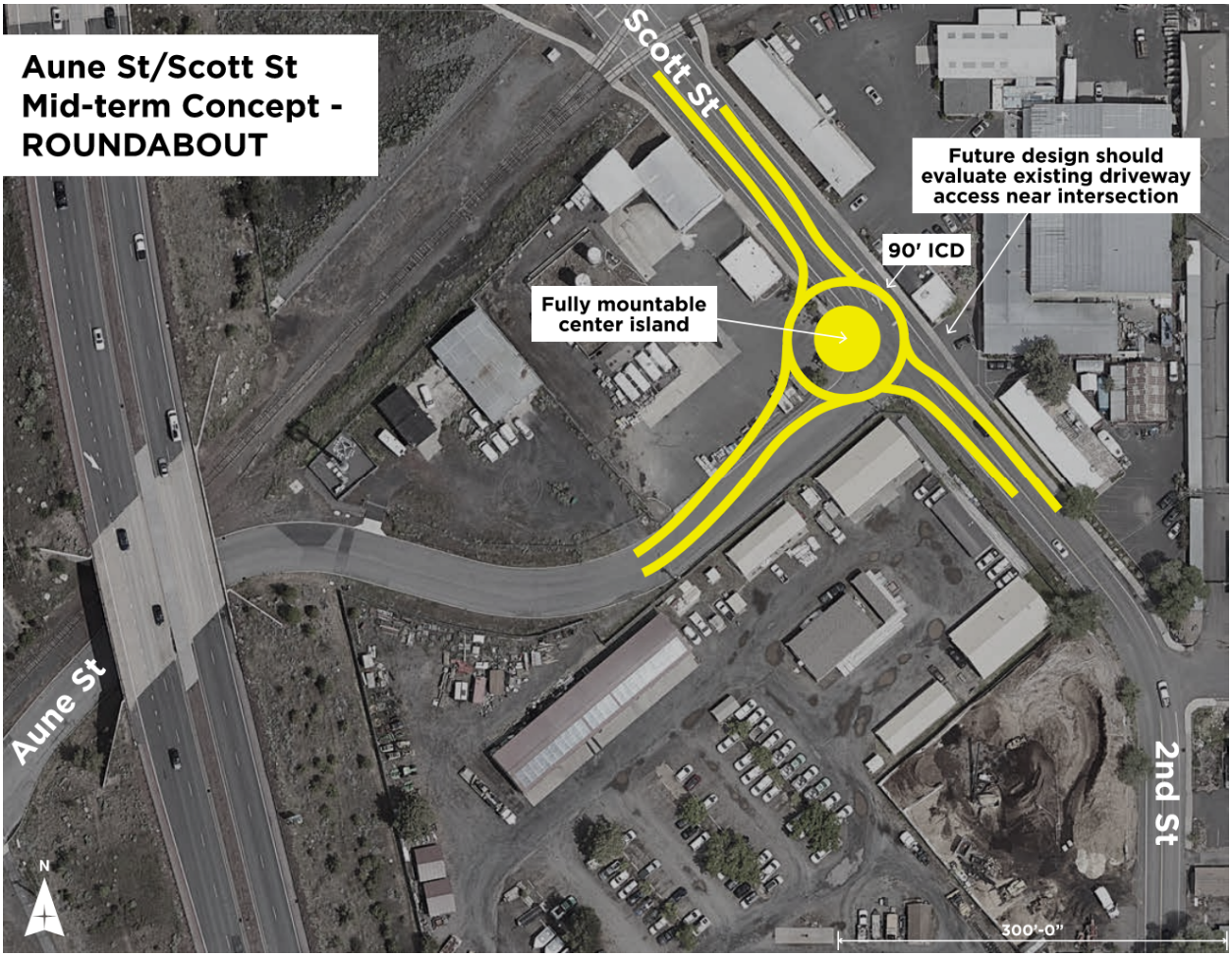
Alternative C.2: Single-Lane Roundabout (Mid-Term)

Alternative C.2 includes a three-leg roundabout at the intersection of Aune Street, Scott Street, and 2nd Street, shown in Figure 11. The center island will be fully mountable to accommodate turning movements for design vehicles. The roundabout is constrained by the USFS building on the southwest corner, buildings and a parking lot to the northeast, and a building adjacent to Scott Street on the northwest corner. An inscribed circle diameter is proposed to be 90 feet to minimize right-of-way impacts to adjacent properties. Land from the northwest property is required to fit the footprint of the roundabout.

While roundabout analysis procedures and methodologies are included in the Highway Capacity Manual (HCM), fully mountable, or mini, roundabouts have a more complex methodology and are not fully developed as an industry standard. While typically operating like a single lane roundabout, when large vehicles need to use the mountable island the other approaches of the roundabout must wait for the turning maneuver to conclude before entering the roundabout. Therefore, a fully mountable roundabout is likely to operationally behave better than an all way stop but not as efficiently as a single lane roundabout.

In 2045, the intersection delay for an all-way stop controlled intersection at Aune Street and Scott Street (93.6s) slightly exceeds the City's operational threshold for delay (80s), whereas a single-lane roundabout has a critical approach delay of approximately 22.6 seconds and meets the City's operational standards. While large vehicle activity will occur at the intersection, it is not anticipated that the volume of large vehicles would consistently stop vehicles on the approaches for turning movements. Therefore, we believe the mini roundabout would operate more like the single lane roundabout than all way stop, meeting the City's operational standards.

Figure 11. Alternative C.2 Roundabout



Opportunities

- Expected to meet City operational standards in 2045 (analysis worksheets are provided in Attachment E).
  - The single-lane roundabout analysis estimates a 0.83 v/c, which is less than the City's operational threshold of 1.0.
  - Queues are estimated to be approximately 250 feet for the northbound approach, 100 feet for the southbound approach[5], and 50 feet for the eastbound approach.
- Enhances intersection safety by reducing conflict points. Roundabouts have fewer conflict points than side-street stop-controlled intersections and traffic signals.
- Center island is fully mountable to accommodate larger vehicle traffic traveling to/ from the US97 ramps and the USFS property and existing concrete facility.

[5] Distance from existing Aune Street/ 2nd Street/ Scott Street intersection to the at-grade railroad crossing is approximately 250'.

- Roundabout median islands provide pedestrian refuge space that reduces overall crossing distance.
- Roundabout location/ proximity to the railroad is feasible with railroad preemption.

Limitations

- Intersection likely needs to be shifted northwest to minimize impacts to businesses east of 2nd Street/ Scott Street. Therefore, acquisition of the building adjacent to Scott Street on the northwest property is likely.
- Access to businesses on the east side will likely need to be modified or restricted.
- Shifting the intersection northwest will put it closer to the at-grade railroad crossing. Railroad preemption would likely have to be integrated into the design of the roundabout.

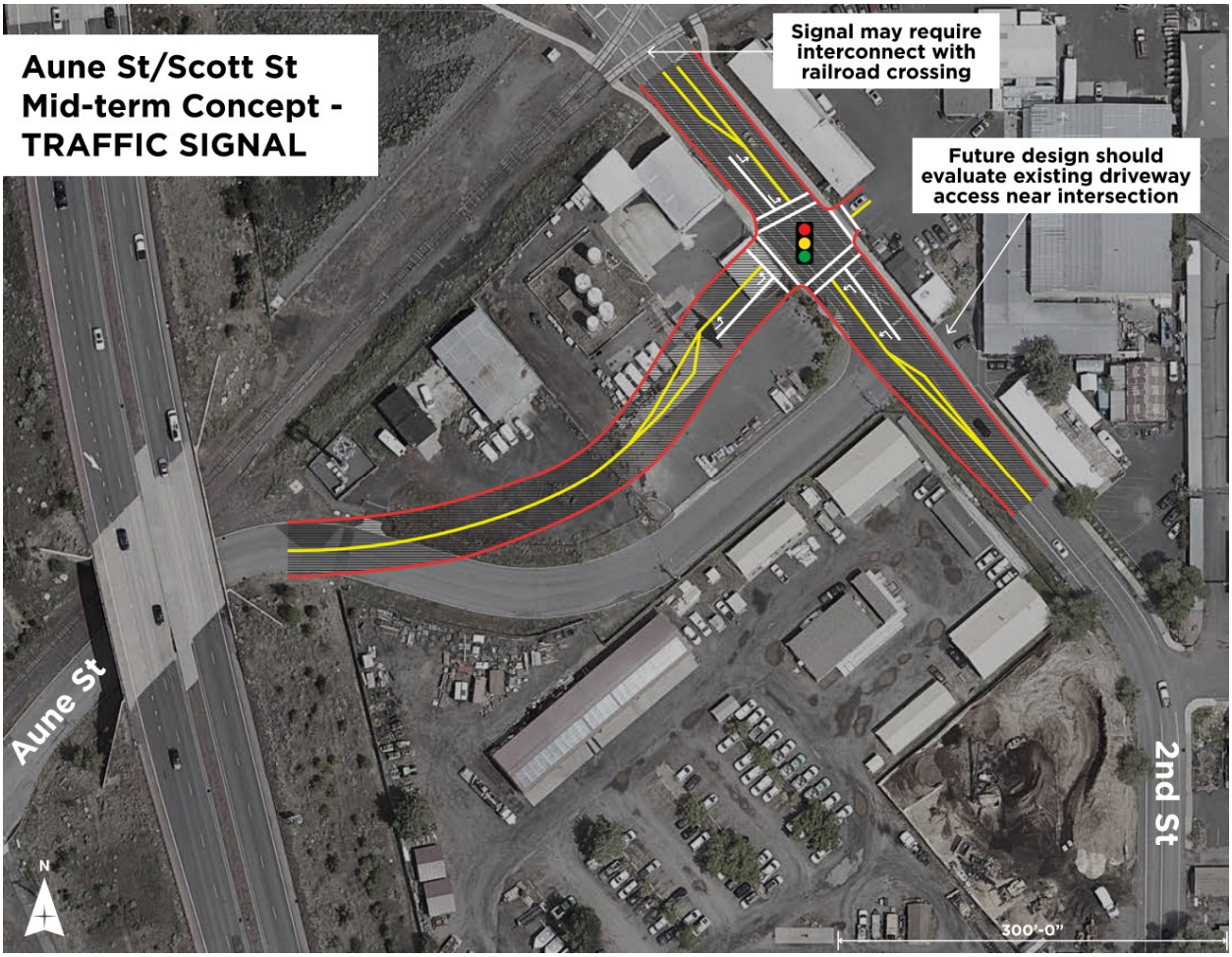
Alternative C.3 Traffic Signal (Mid-Term)

Alternative C.3 includes realigning Aune Street and installing a signal at the intersection of Aune Street and 2nd Street, shown in Figure 12. The traffic signal is shifted further north on 2nd Street/ Scott Street, reducing the horizontal curvature on Aune Street, and providing opportunities for maintaining access to businesses to the east.

The alignment of both alternative C.2 and C.3 are dependent on right-of-way impacts to nearby properties. Placing the traffic signal at the existing intersection location would reduce impacts to the northern property but would require right-of-way from the USFS and the businesses east of the intersection. Impacts to surrounding properties are a critical decision point for the City when considering the alignment of Aune Street and the placement of the intersection control.

Opportunities and Challenges below reflect the alignment shown in Figure 12.

Figure 12. Alternative C.3 Traffic Signal



Opportunities

- Expected to meet City operational standards in 2045 (analysis worksheets are provided in Attachment F).
  - Intersection volume-to-capacity ratio is 0.57, less than the City's 1.0 threshold.
  - Queues are estimated to be approximately 200 feet for the northbound through approach, 75 feet for the northbound left turn lane, 175 feet for the southbound through approach, 75 feet for the eastbound left turn lane, and 50 feet for the eastbound right turn lane.
- Provides signalized crossing for pedestrians on all legs of the intersection.
- Reduces horizontal curvature on Aune Street.
- Access to businesses to the east can likely be maintained. *Future design should evaluate driveway access near the intersection*.
- Limited or no property acquisition from USFS on the southeast corner.

Challenges

- Railroad preemption is likely required based on ODOT Traffic Signal Policy and Design Guidelines[6]
- Property to the northwest is required for the proposed Aune Street alignment. Multiple buildings on the property will need to be demolished.
- Utility relocation likely required to develop new Aune Street alignment.
- Parking at businesses east of Scott Street/ 2nd Street will likely be impacted to construct the northeast leg of the traffic signal.

Key considerations for each Alternative are summarized in Table 3.

Table 3. Aune Street (East) Alignment Key Considerations

Considerations	Alternative C.1 Side Street Stop Control (Near-Term)	Alternative C.2 Roundabout (Mid-Term)	Alternative C.3 Traffic Signal (Mid-Term)
Environmental Resources	No anticipated conflicts	No anticipated conflicts	Environmental reconnaissance for new Aune Alignment
Conflicts or Coordination with BNSF	No coordination need	Coordination is likely necessary for railroad preemption.	Coordination and signal preemption is likely necessary.
Business Access	Maintains access to businesses east of Scott Street/ 2nd Street.	Modifications to business access are likely.	Modifications to business access are likely. Parking may be impacted to install signal and reconfigure approach for a signal.
Cost Estimate[7]	$4.6 million (upgrade Aune Street and 2nd Street to complete streets, intersection upgrades at Aune St/Scott St)	$4.7 million (roundabout)[2]	$3.7 million (traffic signal and reconstructed Aune St alignment)[1]
Key Routes	See "Key Routes" section	See "Key Routes" section	See "Key Routes" section
Impacts or Benefits to	Provides enhanced crossing at Scott	Provides enhanced crossing at Scott Street/	Provides signalized crossing at Scott Street/

[6] Oregon Department of Transportation. (2023). *Traffic Signal Policy and* Guidelines. < https://www.oregon.gov/odot/Engineering/Documents_TrafficStandards/Traffic-Signal-Policy-Guidelines.pdf>

[7] See Appendix G for Cost Estimates.

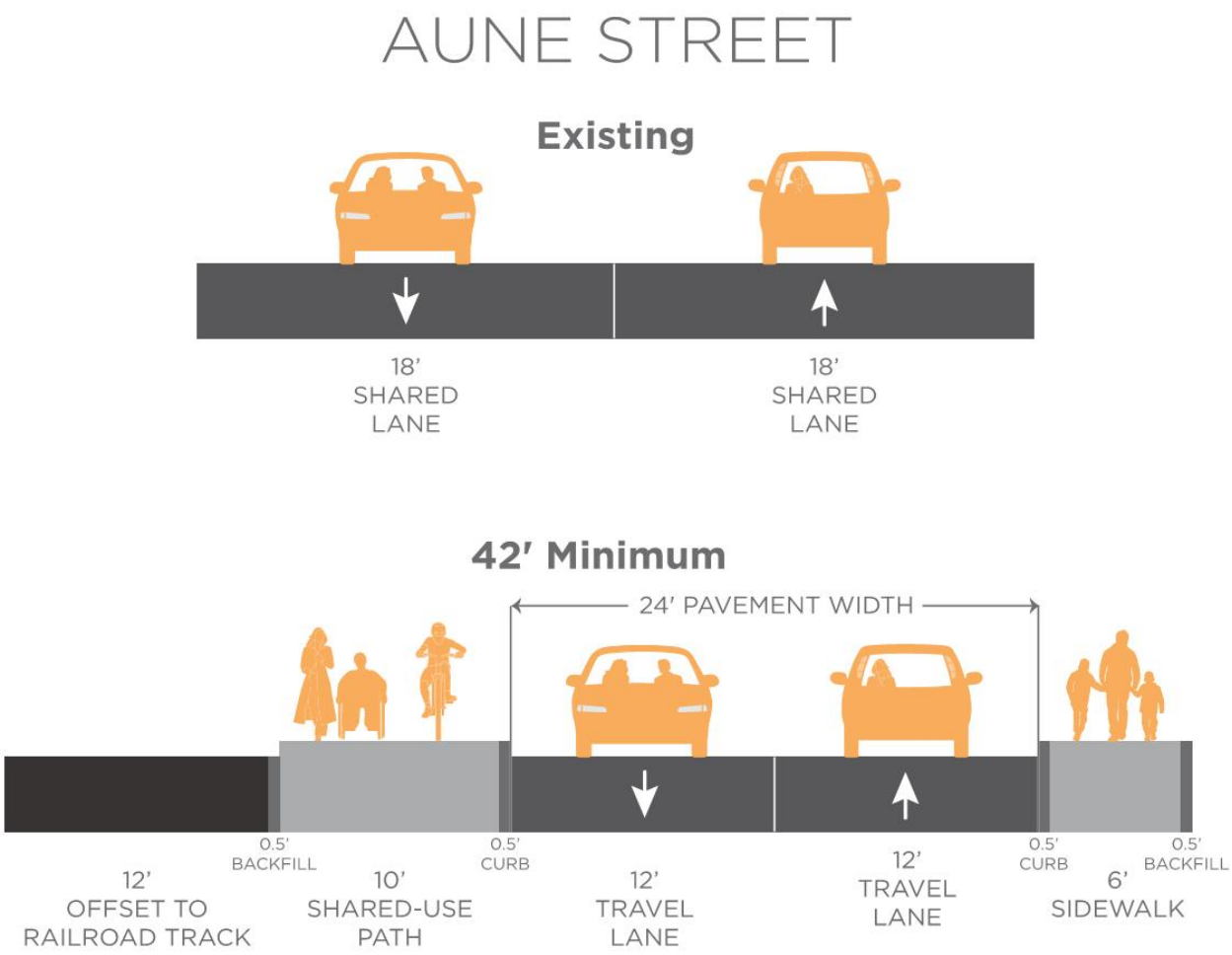
Transportation Disadvantaged Populations (TDPs)	Street/ 2nd Street and Aune Street intersection.	2nd Street and Aune Street intersection and reduces conflict points between vehicles and pedestrians.	2nd Street and Aune Street intersection. Longest crossing distances compared to the other C alternatives.
Traffic Operations	Meets City standards until 2037. After 2037, delay exceeds the 50 second threshold defined by the City for two-way stop-controlled intersections.	Meets City standards in 2045.	Meets City standards in 2045.

[1]Cost estimates for alternatives B.2 and B.3 do not include cost of complete streets upgrades on Aune Street and 2nd Street. These upgrades are assumed to be constructed as part of the implementation of Alternative B.1 as a near-term improvement.

Aune Street Cross-Section

An initial alternative for the Aune Street cross-section is illustrated in Figure 13. The cross-section has been seen and evaluated by both City Staff and BNSF staff and includes two 12-foot travel lanes, a 6-foot sidewalk on the east side, and a 10-foot shared-use path on the west side. The option maintains a 12-foot offset to the BNSF railroad spur. The minimum right-of-way is assumed to be 42 feet under the undercrossing.

Figure 13. Aune Street Cross-Section (Facing East)



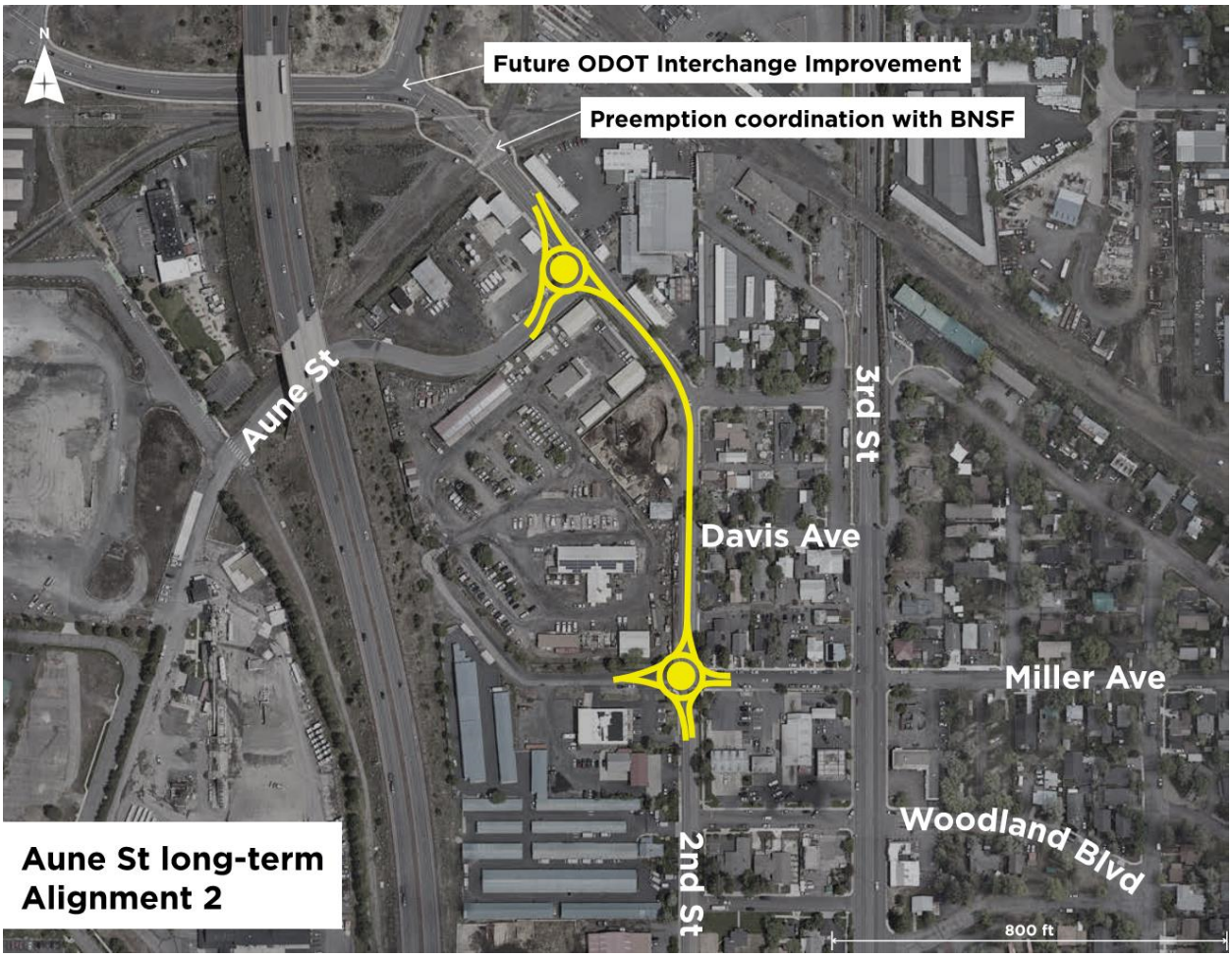
LONG-TERM ALIGNMENT

Kittelson developed two long-term alignment alternatives for the Aune Street (East) Extension that address two right-of-way scenarios. Alignment 1 describes a proposed long-term alignment with minimal right-of-way needs from the properties to the north and south of the existing Aune Street and Alternative 2 describes an alignment that assumes properties to the north and south of Aune Street are acquired by the City. Both options include intersection improvements to increase traffic capacity and provide east-west multimodal connections.

Long-Term Alignment Alternative 1

Alternative 1 assumes the existing 2nd Street/ Scott Street alignment is the primary connection between 3rd Street and the Colorado Avenue interchange. The Alternative includes intersection improvements at 2nd Street/ Miller Avenue and 2nd Street/ Scott Street/ Aune Street to address capacity and safety needs.

Figure 14. Long-Term Aune Street Alignment Alternative 1



Long-Term Alignment Alternative 2

The long-term Aune Street (East) Extension alignment assumes that the properties to the north and south of Aune Street west of Scott Street/ 2nd Street are acquired by the City. In this alignment, a new two-lane collector between Miller Avenue and the US97 Northbound ramps at Colorado Avenue is proposed. This north-south connection provides a direct route along Miller Avenue connecting 3rd Street to the US97

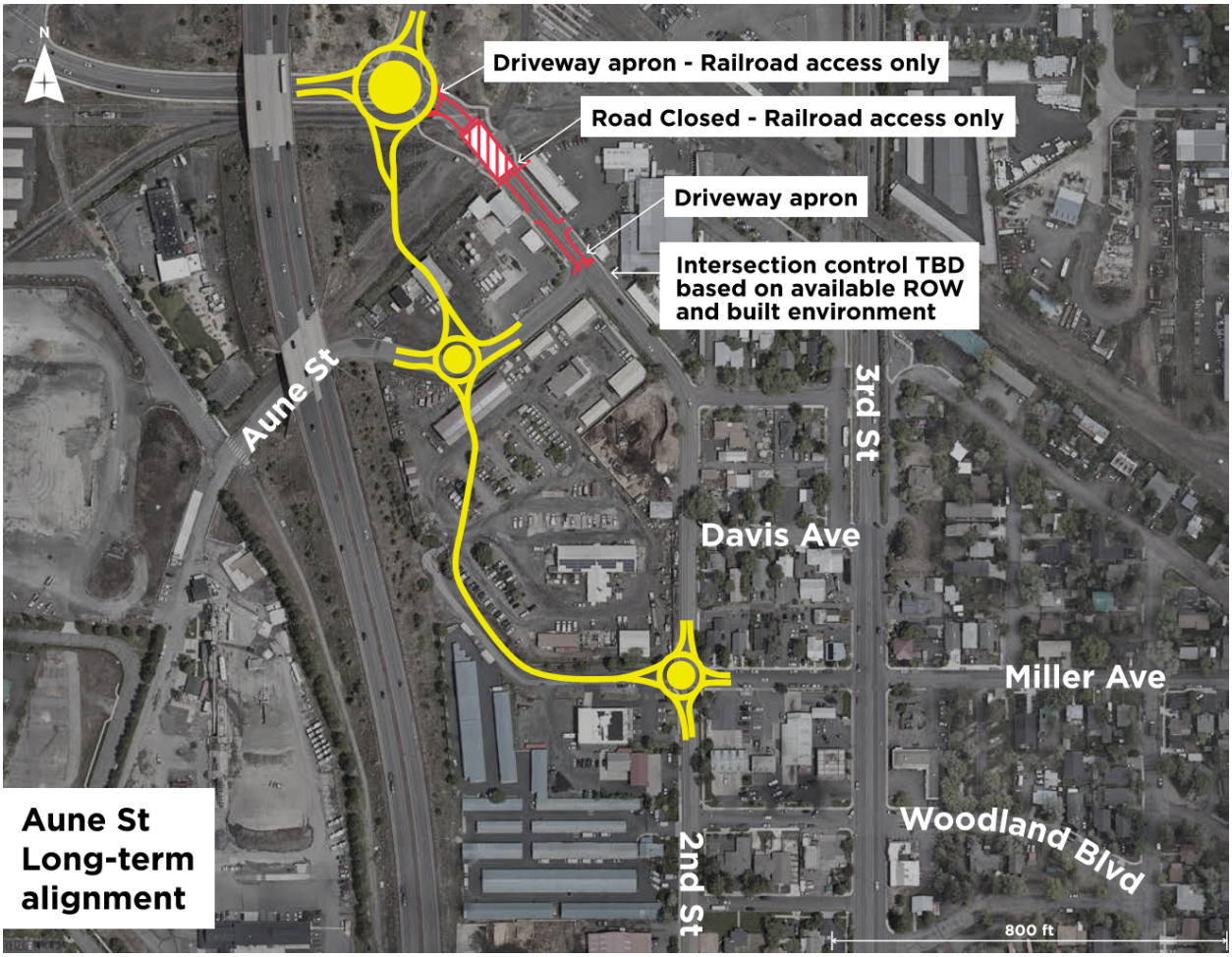
interchange at Colorado Avenue. This connection improves traffic circulation along 3rd Street, 2nd Street, and the developing area west of US97. This long-term concept assumes that the northern spur adjacent to Colorado Avenue is acquired by the City, which reduces the number of at-grade crossings from three crossings to one crossing along the new Aune Street alignment.

The initial long-term alignment is shown in Figure 15. The alignment includes:

- New collector roadway from Miller Avenue to Colorado Avenue at the US97 ramps. The new alignment is to be developed through the existing USFS property and the property bordering Aune Street to the north.
- Roundabouts at Miller Avenue and 2nd Street, Aune Street East and Aune Street, and at the Colorado Avenue/ Scott Street and US97 northbound ramps.
  - Intersection control at the US97 ramps will require ODOT coordination and is dependent on the findings of an Interchange Area Management Plan (IAMP).
- Closure of Scott Street between Colorado Avenue and Aune Street except for railroad access.
- Shared-use path to the west of the USFS property, providing a more direct connection from Miller Avenue to Aune Street and Colorado Avenue.
- Intersection control to be determined at Aune Street and Scott Street/ Aune Street based on available right-of-way and the built environment.

The feasibility of the long-term alignment demonstrates an option for traffic circulation along Aune Street and the areas directly east and west of US97. However, the implementation is dependent on property availability, coordination with ODOT, and coordination with BNSF. Therefore, intersection alternatives such as Alternative C.2 or C.3 or the outcomes of a future IAMP at the Colorado Avenue interchange may identify more feasible long-term options to ensure that the transportation network can serve the transportation needs of Aune Street, Scott Street, and 2nd Street.

Figure 15. Long-Term Aune Street Alternative Alignment 1



KEY ROUTES

The TSP identifies a system of Key Routes designed to be low stress for pedestrians and bicyclists. In the area near Aune Street, there are three proposed Key Routes:

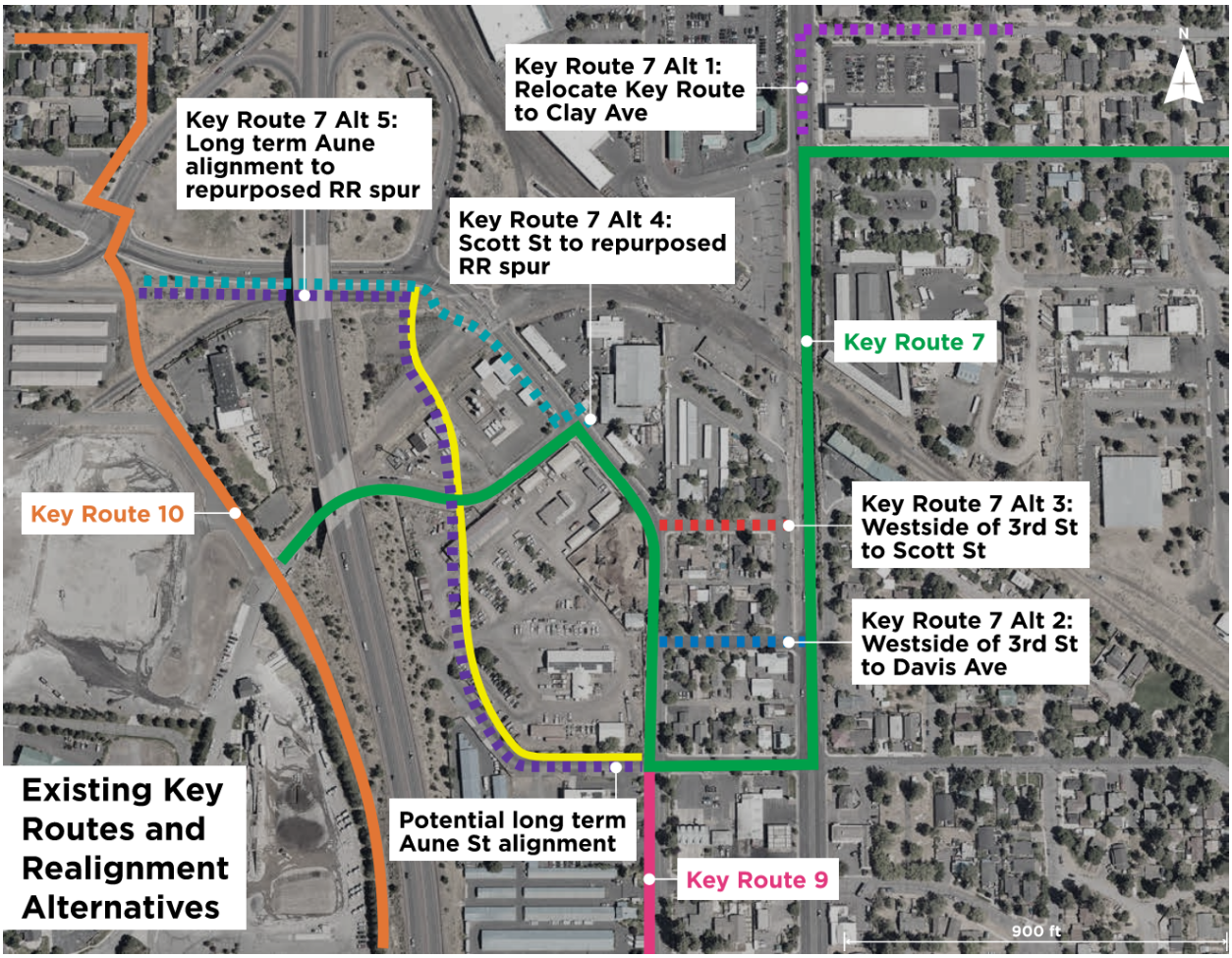
- **Key Route 7**: Connects Bend Senior High School to Division Street on a separated path via Burnside Avenue, 3rd Street, Miller Avenue, 2nd Street, and Aune Street. Provides an important connection or surrounding areas with limited connectivity due to US97 and the railroad.
- **Key Route 9**: North-south route connecting to Key Route 7 at 2nd Street.
- **Key Route 10**: North-South route connecting to Key Route 7 at the intersection of Division Street and Aune Street.

Key Route 7 is currently proposed along Aune Street. However, the railroad spur operated by BNSF adjacent to Aune Street limits the right-of-way available for separated pedestrian or bicycle facilities, especially at the US97 underpass. As part of the Aune Street (East) Extension Study, alternatives for the identified Key Routes in the

City of Bend Transportation System Plan (TSP) will be considered based on the initial alternatives for Aune Street, 2nd Street, 3rd Street.

As shown in Figure 16, there are several options for alternatives to Key Route 7 depending on the selected treatments for 3rd Street, 2nd Street, and Aune Street. The green line shows Key Route 7 based on the TSP. Dashed lines show potential options for changing the Key Route to align with enhanced crossings and low-stress facilities.

Figure 16. Long-Term Options for Key Routes



There are three scenarios that may impact the selected path for Key Route 7 based on the implementation of the long-term alignment:

- **Scenario 1, Aune Street**: If the long-term Aune Street alignment is not implemented and the northern spur cannot be repurposed, Key Route 7 is likely to remain on Aune Street.
- **Scenario 2, Northern Spur**: If the City acquires the northern spur along Colorado Avenue from BNSF, Key Route 7 may be moved to a separated path constructed along the south side of Colorado Avenue. The Key Route will not travel along Aune Street and will instead continue north on Scott Street/ 2nd Street.

- **Scenario 3, New Aune Street Alignment and Northern Spur**: If the BNSF property, USFS property, and adjacent to Aune Street to the north are acquired by the City, Key Route 7 may be moved to the new alignment and connect to Key Route 10 near Colorado Avenue/ Arizona Avenue along the northern railroad spur.

There are seven potential alternatives for Key Route 7 that the project team developed alongside the intersection and cross-section alternatives in Sub-Areas A, B, and C.

Key Route Alternative 1

As discussed in Sub-Area A, there may be safety benefits to shifting Key Route 7 north to Clay Avenue from the proposed Burnside Avenue. The Key Route would then continue south on the westside of 3rd Street starting north of the railroad undercrossing. However, shifting to Clay Avenue would require more out-of-direction travel for Key Route 7.

For both the existing Key Route and Alternative 1, it is recommended that the Key Route be located on the west side of 3rd Street. The existing sidewalk infrastructure on the east side of 3rd Street is in poor condition and will require significant maintenance support and upgrades. Additionally, the walking network south of the undercrossing is incomplete where the sidewalk intersects Railroad Street. Pedestrians currently have to use the side of the roadway on a steep grade to get to 3rd Street where there are no sidewalk facilities north of Miller Avenue. Facilitating the Key Route on the west side aligns with the low stress network on 2nd Street across from Burnside. It also opens opportunities for Key Routes to be located on lower-volume streets south of the undercrossing such as Scott Street or Davis. Additionally, the City has plans to reconstruct the retaining wall on the west side of 3rd Street, which could incorporate a wider sidewalk facility along this segment of 3rd Street.

The feasibility of the Key Route on the west side should also be considered with the location of the stormwater pump infrastructure, which may be a pinch point for enhanced pedestrian facilities along the west side of 3rd Street. The constructability of this option will be discussed in the next memorandum.

Key Route Alternatives 2

As traffic volumes increase due to new development west of US97, the comfort of pedestrian and bicyclists on Miller Avenue may be impacted. Key Route Alternative includes an option for connecting the Key Route between 2nd and 3rd Street on Davis Avenue. Davis Avenue is classified as a local road in the City of Bend TSP. this option would reduce out-of-direction travel for bicyclists or pedestrians traveling between the east and west side of US97. Additionally, Davis Avenue is expected to have lower traffic volumes and have fewer business driveways compared to Miller Avenue, resulting in

fewer potential conflicts between vehicles and bicyclists or pedestrians. Davis Street would require a marginal amount of out of direction travel for people on the Key Route.

Key Route Alternative 3

Like Key Route Alternative 2, Scott Street (East) between 2nd Street and 3rd Street provides a connection with lower traffic stress and reduces out-of-direction travel for Key Route 7. East Scott Street has an existing curb ramp to the sidewalk coming from down the grade from the 3rd Street undercrossing that provides direct access to 2nd Street. Compared to Alternative 2, the connection along Scott Street (East) would allow for a connection to the east side across from 3rd Street.

Key Route Alternative 4

If BNSF removes the northern railroad spur along Colorado Avenue from service, Key Route 7 could continue north on 2nd Street/ Scott Street and connect to a new separated path along the northern spur alignment. This option includes an enhanced crossing at Aune Street and 2nd Street/ Scott Street. Utilizing the railroad spur alignment would allow for a wider facility with greater separation from roadway traffic compared to the Aune Street option, especially at the pinch point under US97.

Key Route Alternative 5

Key Route Alternative 5 shows the alignment for the Key Route if the long-term alignment for Aune Street is implemented. The proposed Key Route would operate alongside the proposed Aune Street alignment that connects Miller Avenue to Colorado Avenue/ US97 Northbound Ramps, then continue along the northern railroad spur to terminate at Key Route 10.

NEXT STEPS

. The findings of this memorandum and the discussions at the workshop will be used to assess each alternative based on the Evaluation Criteria presented in the *Intended Outcomes and Evaluation Methodology* memorandum.

ATTACHMENTS

A. Alternative B.1 Traffic Operations – 2045 P.M. Peak Hour
B. Alternative B.2 Traffic Operations – 2045 P.M. Peak Hour
C. Alternative B.3 Traffic Operations – 2045 P.M. Peak Hour
D. Alternative C.1 Traffic Operations – 2045 P.M. Peak Hour
E. Alternative C.2 Traffic Operations – 2045 P.M. Peak Hour
F. Alternative C.3 Traffic Operations – 2045 P.M. Peak Hour
G. Cost Estimate Opinion

TECHNICAL MEMORANDUM

TO:	Jacki Smith
FROM:	Scott Little, Jim Albin, Justin Mason
DATE:	March 26, 2024
PROJECT:	Final Constructability Review

Below are constructability comments for the Alternatives Analysis:

Sub-Area A: 3rd Street – North of Undercrossing

Alternative A.1: Crossing at Clay Avenue

- Will illumination be required? Right of way and ADA on the west side may be tight.
- Will the double white striping between the northbound lanes tie into the existing solid wide stripe between the lane between Burnside and Clay? If so, will this impact the access to Les Schwab?

Alternative A.2: Crossing at Burnside

- Likely not an issue, but Burnside will have a steeper cross slope than Clay. What is the existing cross slope at Burnside? If it's greater than 5% and regrading is required, this may rule out Burnside.
- Approximately 45 ft, curb-to-curb should allow for design of median to meet standards, but allow for traffic during construction to be unabated. 14 ft travel with bikes in roadway each direction will allow for an approximate 17 ft work zone width.

Sub-Area B: 3rd Street – South of Undercrossing

Alternative B.1: Traffic Signal at 3rd Street/Miller Avenue

- Emergency vehicles could get stuck in single lane with median (north of Davis Ave)
- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Miller Avenue.
- Potential right of way acquisitions on the corners.
    1. It appears Red Carpet has potential encroachments.
- The north end of the median at Davis Avenue may introduce issues with the 20 ft clear curb-to-curb for EMS. If outside curb needs to move, there is grade in the area to be addressed.
- The north end of the median at Davis Avenue may require special sequencing and staging during construction to maintain southbound traffic.

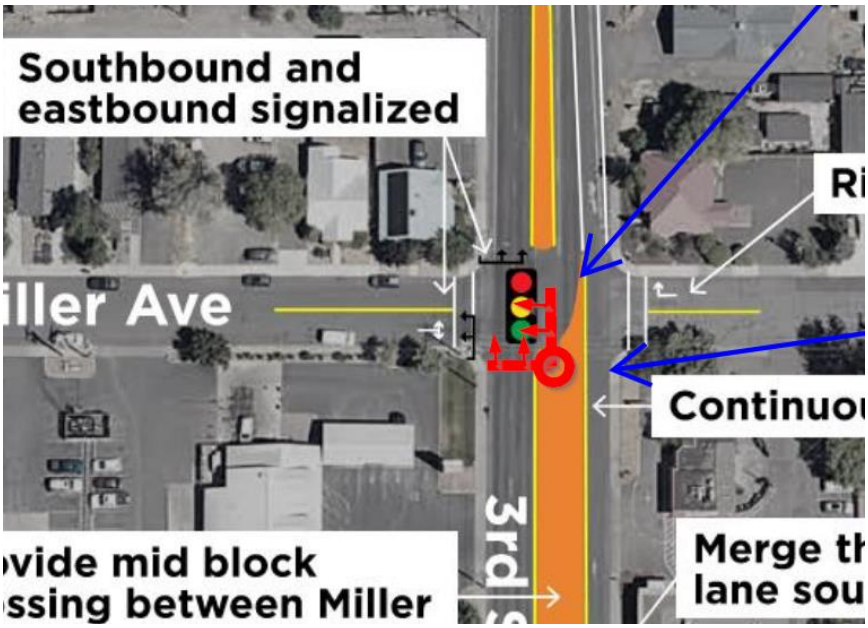
Alternative B.2: Traffic Signal at 3rd Street/Woodland Boulevard and One-Way Conversion

- Would SB 3rd St queues at the Woodland signal make the NB 3rd to WB Miller a difficult movement?

- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Woodland Boulevard.
- Potential right of way acquisitions on the corners on the west side of 3rd Street, but curb bulbouts could help. SE Woodland Boulevard appears to have substantial right of way on the east side of 3rd Street.
- Apparent parking lot encroachments on the southeast corner. Not a constructability issue, but for note.
- Adequate width on 3rd Street appears to be available for maintaining one lane of traffic in each of the north-south directions.

Alternative B.3: Traffic Signal with Continuous Green Northbound Through at 3rd Street/Miller Avenue

- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Miller Avenue.
- Potential right of way acquisitions on the corners on the west side of 3rd Street, but curb bulbouts could help. SE Woodland Boulevard appears to have substantial right of way on the east side of 3rd Street.
- Potential right of way acquisitions on the corners.
  1. It appears Red Carpet has potential encroachments.
- The north end of the median at Davis Avenue may introduce issues with the 20 ft clear curb-to-curb for EMS. If outside curb needs to move, there is grade in the area to be addressed.
- The north end of the median at Davis Avenue may require special sequencing and staging during construction to maintain southbound traffic.
- Grade issues will be introduced with any widening needed to maintain 20 ft curb-to-curb and lane drop lengths north of Davis Avenue. Construction in the undercrossing limits would likely require full closure during construction.
- Verify undercrossing stormwater pump station designs and capacities can handle additional hard surfaces, if needed.
- Is there a physical barrier here (i.e., raised median)? Potential maintenance, snowplow, and EMS issue.
- No bike lane northbound south of Miller Avenue
- If ADA crossing is only on the south side of Miller Avenue, can the center median north of Miller Avenue be narrowed (if turning movements work) to help gain more room?
- Access management – driveways and streets will be right in-right out as well for the limits of the center median. Will u-turns be allowed at the traffic signals at either end?
- Can the signal poles, southbound and eastbound be moved into the medians to alleviate the overhead utility conflicts?

1. 

Alternative B.4: 3rd Street/Miller Avenue Roundabout (Added)

- Significant ROW acquisition
- Franchise relocations

Alternative B.5: 3rd Street/Davis Avenue Roundabout (Added)

- Significant ROW acquisition
- Franchise relocations
- Impacts to frontage road
- Potential wall construction

2nd Street Typical Sections

- Option 1: 50’ Minimum
    1. Show sidewalk at 7' width to account for 6” curb and 6” bench between back of walk and ROW. This will require losing 12” in the section.
    2. Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.
- Option 2: 50’ Minimum
    1. If the goal is to have a 10’ sidewalk, recommend planning for 11 feet to account for curb and bench at back of sidewalk. This would require losing 12” in the section elsewhere.

Miller Avenue Typical Sections

- Option 1: 60’ ROW
    1. Show sidewalk at 7' width to account for 6” curb and 6” bench between back of walk and ROW. This will require losing 12” in the section.

2. Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.

- Option 2: 60’ ROW
  1. Will require a design exception; planter strips can't be less than 5' per Design Standard 3.4.2.1.

Scott Street Typical Sections

- Option 1: 50’ Minimum
  1. Show sidewalk at 7' width to account for 6” curb and 6” bench between back of walk and ROW. This will require losing 12” in the section.
  2. Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.
- Option 2: 50’ Minimum
  1. If the goal is to have a 10’ sidewalk, recommend planning for 11 feet to account for curb and bench at back of sidewalk. This would require losing 12” in the section elsewhere.

Sub-Area C: Aune Street Alignment

Alternative C.1: Side Street Stop Control

- Coordinate with BNSF early on the protected ADA crossing as shown. It appears the intersection is outside the SSD for the rail crossing.
- Verify intersection sight distance with the introduction of the median.
- No bike or ped facilities shown.
- Utility coordination with the overhead and underground utilities on the west side of Scott Street. The north corner appears to be adequate, but the south corner will be constrained.
- Potential right of way impacts on the southwest corner.
- Approximately 42 ft, curb-to-curb should allow for design of median to meet standards but allow for traffic during construction to be unabated. 14 ft travel with bikes in roadway each direction will allow for an approximate 15 ft work zone width.

Alternative C.2: Roundabout

- There appear to be fuel tanks on property that would be acquired, potential environmental costs for remediation.
- Relocation of the existing power pole and services on the northwest side of the intersection will need to be relocated.
- Franchise utility relocations
- Significant ROW acquisition
- Business access at existing driveway (Sparrow Bakery)
- BNSF and ODOT rail coordination due to proximity of the rail crossing. While the intersection is outside the SSD, BNSF and ODOT rail will be brought in due to the potential traffic impacts, similar to Wilson Avenue.

Alternative C.3: Traffic Signal (Mid-Term)

- There appear to be fuel tanks on property that would be acquired, potential environmental costs for remediation.
- Significant ROW acquisition
- Franchise utility coordination for overhead utilities in potential conflict with the new signal.
- BNSF and ODOT rail coordination due to proximity of the rail crossing.
- The majority of this could be built with a closure of Scott Street from Aune to the ODOT ramps.
- Table 3. Aune Street (East) Alignment Key Considerations
    1. Cost Estimate
        i. Alternative C.2 Roundabout (Mid-Term)
            I. Consider adding ROW acquisition cost to estimate
        ii. Alternative C.3 Traffic Signal (Mid-Term)
            I. Significant ROW acquisition cost to estimate

Aune Street Typical Sections

- 42’ Minimum - Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk

Appendix E – Alternative Evaluation & Refinement Memorandum

KITTELSON & ASSOCIATES
1001 SW Emkay Drive, Suite 140
Bend, OR 97702
P 541.312.8300

Technical Memorandum

February 2, 2024 Project# 28673

To: Garrett Sabourin and Carrie Theus

From: Katie Popp, Jacki Smith, PE & Matt Kittelson, PE

CC: Robin Lewis, City of Bend
Janet Hruby, City of Bend

RE: Aune Street Extension Study – Alternative Evaluation & Refinement

ALTERNATIVE EVALUATION & REFINEMENT

This memorandum documents outcomes of the alternatives workshop, constructability review, and alternatives evaluation for the Aune Street Extension Study. The findings of this memorandum will inform discussions with the City and other partner agencies to refine the alternatives presented in the Initial Alternatives Memorandum and identify a final recommendation.

The information presented in this document summarizes the results of the constructability review and alternatives evaluation for the Aune Street Extension Study. These assessments are intended to ensure consistency with the vision to increase safe and accessible east-west connections in the study area, especially for people walking, biking, and using transit.

CONSTRUCTIBILITY REVIEW

A constructability review and fatal flaw analysis was conducted to support the evaluation of each alternative. A constructability review is a critical element in conceptual design phases and ensures that the proposed concepts incorporate construction expertise to achieve the goals established for the project. The fatal flaw analysis will determine if there are any primary concerns that may determine the project is not viable and should be removed from consideration as a final recommendation.

The constructability review considers construction staging and temporary traffic control impacts, utility conflicts, right-of-way (ROW), excavation and grading challenges, access management, permanent utility installation challenges and more. Attachment A includes the constructability review provided by DOWL. Table 1 summarizes the review for each alternative.

Table 1. Constructability Review

Alternative	Constructability Comments
Sub-Area A – 3rd Street North of Undercrossing	
Alternative A.1 Crossing at Clay Avenue	▪ Installing illumination may require small ROW acquisition
Alternative A.2 Crossing at Burnside Avenue	▪ Cross slopes will need to be evaluated to meet ADA requirements, ▪ Will need to further evaluate construction staging to minimize full closures on 3rd Street.
Sub-Area B – 3rd Street South of Undercrossing	
Alternative B.1 Traffic Signal at 3rd Street/ Miller Avenue	▪ ROW acquisition for signal equipment ▪ Special construction staging to minimize impact of constructing medians under traffic ▪ Maintaining 20-feet of lateral clearance for emergency vehicles near Davis Ave
Alternative B.2 Traffic Signal at 3rd Street/ Woodland Boulevard	▪ Possible ROW acquisition ▪ Challenges with circulation and access
Alternative B.3 Traffic Signal with Continuous Green at 3rd Street/ Miller Avenue	▪ Overhead utility coordination ▪ Verification of stormwater pump capacity with additional hard surfaces ▪ Special construction staging to minimize impact of constructing medians under traffic ▪ Maintaining 20-feet of lateral clearance for emergency vehicles near Davis Ave
Sub-Area C – Aune Street Alignment	
Alternative C.1 Side Street Stop Control	▪ Coordination with BNSF ▪ Utility coordination ▪ Construction staging of median under traffic ▪ ROW acquisition
Alternative C.2 Roundabout	▪ Coordination with BNSF for railroad preemption ▪ Utility relocation ▪ Construction staging of roundabout under traffic ▪ Business access

Alternative C.3 Traffic Signal	▪ Environmental remediation and evaluation may be required on northwest property because of existing fuel tanks ▪ Utility relocation for new alignment ▪ Coordination with BNSF for railroad preemption ▪ Requires full ROW acquisition of northwest property

ALTERNATIVES WORKSHOP SUMMARY

City staff and the Consultant team met on January 17, 2024, to discuss the initial alternatives concepts using the evaluation criteria as a comparative basis for discussion. Key takeaways from the workshop are as follows:

- To support the next phase of the Aune project that includes a public process and design, selected alternatives should include multiple options and considerations for implementation (i.e. if Burnside Avenue is selected as a preferred location to provide an enhanced crossing then the recommendation should also note that the future design should consider various design variations such as providing a crossing on the southside of the intersection, crossings on both the north and southside, modal filters, right-in, right-out from the side streets, etc.).
- As the concepts are refined the City would like to see further detail for how key routes could be provided through intersections.
- Regardless of which roads are utilized to implement Key Route 7 between Burnside Avenue and Aune Street , pedestrian and bicycle improvements are still necessary on Miller Avenue to extend the low stress network from the eastside of Miller Avenue at 3rd Street to key route 9 and 7 on 2nd Street.
- Future redevelopment and, thus, future right-of-way that could be available to provide enhanced transportation facilities within the study area remains uncertain. As such, a stop-controlled improvement at Aune Street/Scott Street would serve expected demand through 2030 and provide future flexibility for the City to partner with development to refine a long-term alignment of roads south of Aune Street and west of Scott Street/2nd Street to improve overall network circulation. Given this context, a more modest improvement at the Aune Street/Scott Street intersection is likely prudent as part of this project.
- With the exception of the tree services business between Scott Street and Davis Avenue, 2nd Street has 60-feet of right-of-way. The project team will consider improvements to the 2nd Street that assume a 60-foot cross section with a 50-foot pinch point in this location.
- The City of Bend is programmed to install buffered bicycle lanes on 2nd Street with vertical protection in the buffer strip (i.e., tubular markers) in 2025. The City will

coordinate with the design team in the next phase of the project to provide consistent bicycle facilities from Wilson Avenue to Aune Street.

ALTERNATIVE EVALUATION

The evaluation framework provides a methodology for screening, comparing, and selecting preferred recommendations for the Aune Street Extension Study. The framework applies project goals and objectives identified in the *Intended Outcomes and Evaluation Methodology Technical Memorandum* (Attachment B) to the initial alternatives and is used to screen out the lowest-ranking alternatives. The evaluation matrix provides a comparative methodology for evaluating the initial alternatives documented in the *Initial Alternatives Development Technical Memorandum* (Attachment C).

The evaluation is captured with the following circle system:

- **Solid circle** (●)**:** The alternative addresses the criterion and/ or makes substantial improvements in the criteria category.
- **Half-filled circle** (◒)**:** The project addresses the criterion and/ or has neutral or marginal improvements in the criteria category.
- **Empty circle** (○)**:** The alternative does not address criterion and/ or negatively impacts the criteria category.

Tables 2-4 summarize the alternatives evaluation for each Sub-Area using the evaluation criteria to compare the alternatives against one another. The tables are organized as follows:

- Table 1: Sub-Area A Alternatives
- Table 2: Sub-Area B Alternatives
- Table 3: Sub-Area C Alternatives

Table 2. Evaluation Criteria – Sub-Area A: North of Undercrossing

Intended Outcome	Evaluation Criteria	Alternative			
		A.1: Crossing at Clay Avenue		A.2: Crossing at Burnside Avenue	
		Score	Notes	Score	Notes
System Connectivity and Operations	Does the alternative improve traffic operations within the study area in future year 2045?	○	N/A	○	Could require rerouted traffic if turning movements are restricted
	Does the alternative increase transportation choices for users within the study area by adding/ improving pedestrian and bicycle routes, crossings, and connections to transit?	●	Yes, provides improved crossing	●	Yes, provides improved crossing
	Does the alternative promote a low-stress network for key walking and biking routes?	◒	Yes, provides improved crossing. However, not currently on the LSN or Key Route	●	Yes, provides improved crossing
Near-Term Feasibility	What are the right-of-way impacts of the alternative?	●	Possible minor ROW required for illumination	●	Possible minor ROW required for illumination
	Does the alternative address transportation system needs of near-term developments in the Korpine area?	○	Outside of Korpine area	○	Outside of Korpine area
	Does the alternative align with plans, policies, and laws adopted by the City, ODOT, and BNSF?	◒	Enhances multimodal connections but requires TSP amendment (changing key route)	●	Aligns with TSP
Long-Term Compatibility	Does the alternative support the City's adopted plans, development opportunities, and infrastructure investment?	●	Supports transportation system	●	Supports transportation system
Safety for All Users	Does the alternative reduce the level of stress experienced by pedestrians and/ or cyclists?	●	Yes, provides improved crossing	●	Yes, provides improved crossing
	Does the alternative reduce the potential for crash trends at identified high-crash locations?	◒	Provides median refuge and marked/signed crossing location. No pedestrian/bicycle crashes in last 5 years.	●	Provides median refuge and marked/signed crossing location. Fatal pedestrian crash at Burnside/3rd in 2017.
	Does the alternative maintain or improve potential safety conflicts between railway operations and drivers, pedestrians, and cyclists?	○	Not at at-grade rail crossing	○	Not at at-grade rail crossing
Equity	Does the alternative improve pedestrian and/ or bicycle access to key destinations within the study area?	●	Improves east-west connectivity	●	Improves east-west connectivity
	Does the alternative serve transportation disadvantaged populations?	●	Enhances east-west multimodal connections	●	Enhances east-west multimodal connections
Cost	Is the alternative feasible within the allocated budget?	●	Meets TSP estimate	●	Meets TSP estimate

Table 3. Evaluation Criteria – Sub-Area B: South of Undercrossing

Intended Outcome	Evaluation Criteria	Alternative					
		B.1 Traffic Signal at 3rd / Miller		B.2 Traffic Signal at 3rd/Woodland		B.3 Continuous Green 3rd/Miller	
		Score	Notes	Score	Notes	Score	Notes
System Connectivity and Operations	Does the alternative improve traffic operations within the study area in future year 2045?	◒	Meets City standards but anticipated to have long queues blocking Davis, Woodland, and Lee	◒	Meets City standards; queues to Miller Avenue and Lee Lane	●	Meets city standards. Northbound is free flow.
	Does the alternative increase transportation choices for users within the study area by adding/ improving pedestrian and bicycle routes, crossings, and connections to transit?	●	Signalized crossing at Miller Avenue with crossings	●	Signalized crossing at Woodland Boulevard; refuge areas on north and south legs of Woodland	◒	Adds a mid-block crossing between Miller Avenue and Woodland Boulevard. Removes crossings at Davis and Miller Avenue.
	Does the alternative promote a low-stress network for key walking and biking routes?	●	Signalized crossing at Miller Avenue; ped refuge on the north side	●	Enhanced crossing at Woodland Boulevard; restricted movements reduce conflict points at Woodland Boulevard; curb extensions at Woodland Boulevard to reduce crossing distance	●	Adds mid-block crossing and reduces number of lanes on 3rd Street that need to be crossed (in the northbound direction)
Near-Term Feasibility	What are the right-of-way impacts of the alternative?	●	Signal installation	●	Signal installation	●	Signal installation
	Does the alternative address transportation system needs of near-term developments in the Korpine area?	●	Meets City standards; provides signalized EBL movement	●	Meets City standards; provides signalized EBL movement	●	Meets City standards; provides signalized EBL movement
	Does the alternative align with plans, policies, and laws adopted by the City, ODOT, and BNSF?	●	Aligns with TSP and TSAP	○	May require relocating low stress network route on eastside of Miller Ave	○	Will likely require design exception from City for northbound merge
Long-Term Compatibility	Does the alternative support the City's adopted plans, development opportunities, and infrastructure investment?	◒	Restricts business access north of Miller Avenue; restricts southbound left turns at Miller avenue	◒	Does not restrict business access north of Miller but creates business circulation challenges on Miller and Woodland	◒	Restricts business access north of Miller Avenue; restricts southbound left turns at Miller avenue
Safety for All Users	Does the alternative reduce the level of stress experienced by pedestrians and/ or cyclists?	●	Enhanced crossing at Miller Avenue; reduces conflict points at Miller Ave by removing SBL	◒	Enhanced crossing at Woodland Boulevard; requires relocating low stress route on eastside of Miller Ave	◒	Adds mid-block crossing and reduces number of lanes on 3rd Street that need to be crossed (in the northbound direction); longer distance to reach crossing opportunity
	Does the alternative reduce the potential for crash trends at identified high-crash locations?	◒	Will likely decrease angle crashes (the highest number of crashes shown in crash data) but increase rear end crashes	◒	Marginally improves safety at Miller Avenue by restricting eastbound movement. Signal at Woodland will likely reduce	◒	Will likely decrease angle crashes (the highest number of crashes shown in crash data) but increase rear end crashes and sideswipe crashes from merge

					angle crashes but increase rear end crashes		
	Does the alternative maintain or improve potential safety conflicts between railway operations and drivers, pedestrians, and cyclists?	○	N/A	○	N/A	○	N/A
Equity	Does the alternative improve pedestrian and/ or bicycle access to key destinations within the study area?	●	Signalized crossing at Miller Avenue; ped refuge on the north side	◒	Signalized crossing at Woodland Boulevard; refuge areas on north and south legs of Woodland; longer distance to reach crossing opportunity	◒	Adds mid-block crossing and reduces number of lanes on 3rd Street that need to be crossed (in the northbound direction); longer distance to reach crossing opportunity
	Does the alternative serve transportation disadvantaged populations?	◒	Signalized crossing at Miller Avenue; ped refuge on the north side. Restricts business access north of Miller Avenue. Traffic may be circulated to surrounding neighborhoods to access businesses.	●	Signalized crossing at Woodland Blvd; ped refuge on the north and south side. Does not restrict business access, but some traffic may be circulated to surrounding neighborhoods.	◒	Restricts business access north of Miller Avenue. Traffic may be circulated to surrounding neighborhoods to access businesses.
Cost	Is the alternative feasible within the allocated budget?	◒	More than TSP estimate to include medians	●	Roughly same as TSP estimate	●	Roughly same as TSP estimate

Table 4. Evaluation Criteria – Sub-Area C: Aune Street Alignment

Intended Outcome	Evaluation Criteria	Alternatives					
		C.1 Side Street Stop Control		C.2 Roundabout		C.3 Traffic Signal	
		Score	Notes	Score	Notes	Score	Notes
System Connectivity and Operations	Does the alternative improve traffic operations within the study area in future year 2045?	○	Exceeds standards in 2036	●	Meets City standards	●	Meets City standards
	Does the alternative increase transportation choices for users within the study area by adding/ improving pedestrian and bicycle routes, crossings, and connections to transit?	◒	Adds crossing on NW leg	●	Provides crossings with median refuges	●	Provides signalized crossing
	Does the alternative promote a low-stress network for key walking and biking routes?	◒	Adds enhanced crossing on NW leg	●	Provides crossings with median refuges	◒	Provides signalized crossing; longest crossing distances compared to other C alternatives
Near-Term Feasibility	What are the right-of-way impacts of the alternative?	◒	Requires minimal ROW on NW property	○	Requires ROW on NW property	○	Requires ROW on NW property
	Does the alternative address transportation system needs of near-term developments in the Korpine area?	◒	Exceeds standards in 2036; improves route to Korpine area	●	Improves route to Korpine area	●	Improves route to Korpine area
	Does the alternative align with plans, policies, and laws adopted by the City, ODOT, and BNSF?	●	Intersection improvement at Aune Street	◒	Will require coordination with BNSF for possible preemption	◒	Will require coordination with BNSF for possible preemption
Long-Term Compatibility	Does the alternative support the City's adopted plans, development opportunities, and infrastructure investment?	◒	Until 2036	◒	May not be required if long term alignment is implemented	◒	May not be required if long term alignment is implemented
Safety for All Users	Does the alternative reduce the level of stress experienced by pedestrians and/ or cyclists?	●	Infrastructure improvements on Aune and 2nd	●	Provides crossings with median refuges	●	Provides signalized crossing
	Does the alternative reduce the potential for crash trends at identified high-crash locations?	◒	Adds marked pedestrian crossing with median refuge; median refuge on one quadrant of intersection only	●	Reduces conflict points; slows vehicles down	◒	Signal will likely reduce angle crashes but increase rear end crashes
	Does the alternative maintain or improve potential safety conflicts between railway operations and drivers, pedestrians, and cyclists?	○	Maintains existing	○	Maintains existing	○	Maintains existing

Equity	Does the alternative improve pedestrian and/ or bicycle access to key destinations within the study area?	◒	Adds marked pedestrian crossing with median refuge; median refuge on one quadrant of intersection only	●	Reduces crossing distance; provides median refuge; slows vehicles down	●	Signalized crossings
	Does the alternative serve transportation disadvantaged populations?	◒	Improved crossing at Aune/Scott; sidewalk infill on Aune and 2nd	●	Reduces crossing distance; provides median refuge; slows vehicles down	●	Signalized crossings
Cost	Is the alternative feasible within the allocated budget?	●	Roughly same as TSP estimate	◒	More than TSP estimate	◒	More than TSP estimate

KEY ROUTE EVALUATION

A separate evaluation is presented below to compare the key route alternatives to current Key Route 7. Table 5 includes criteria to support the selection of the preferred key route through the study area. This route should promote safety, useability, and comfort for people walking and biking.

Table 5. Key Route Comparison Summary

Evaluation Criteria	Key Route Alternative			
	Existing Route 7- Miller	Alternative 2 - Davis	Alternative 3 – Scott	Alternative 4 – Northern RR Spur
Does the alternative provide a direct route to other key routes within the area?	○	◒	●	◒
What is the comparative level of pedestrian and bicycle stress between the alternatives?	○	●	●	●
Does the alternative require additional coordination with the City, ODOT, BNSF, or property owners?	●	●	●	◒
Is the route intuitive to people walking and biking?	○	◒	●	●

The existing key route 9 requires southbound users to travel to Miller Avenue and then back north on 2nd Street to traverse west of the railroad tracks. While Miller Avenue is the existing Key Route, the future traffic volume estimate and frequent turning movement conflicts with business driveways on Miller Avenue would increase the level of stress for pedestrians and cyclists. However, in addition to Key Route 7, Miller Avenue is also identified as part of the low stress bikeway network which extends east-west along Miller Avenue and Centennial Street from 2nd Street to Wilson Avenue.

Providing the Key Route along Davis Avenue would benefit from the existing low volume, local roadway context which is similar to other greenways throughout the City. However, the route is moderately out of direction for southbound users compared to the Scott Street alternative, which has similar roadway characteristics. In addition, Scott Street provides direct access to the 3rd Stret undercrossing tunnel and requires the least out of direction travel to connect to Aune Street.

Providing the Key Route where the northern BNSF railroad spur, assuming this spur is relocated, would provide a separate facility for people walking and biking. It does, however, require continued coordination with BNSF to acquire the property where the path would go and could be less direct than other alternatives depending on the final route alignment.

NEXT STEPS

City staff will review the evaluation of the alternatives presented in this memorandum and provide comments and/or recommendations for adjustments to scoring. The updated scoring and outcomes will be incorporated in a final memorandum and used inform the recommendation for the preferred concept and preferred key route. The preferred concept and key route will be documented in the Aune East Extension Study Report.

ATTACHMENTS

Attachment A: Constructability Review

Attachment B: Intended Outcomes and Evaluation Criteria Methodology Memo

Attachment C: Initial Alternatives Memo

TECHNICAL MEMORANDUM

TO:	Jacki Smith
FROM:	Scott Little, Jim Albin, Justin Mason
DATE:	March 26, 2024
PROJECT:	Final Constructability Review

Below are constructability comments for the Alternatives Analysis:

Sub-Area A: 3rd Street – North of Undercrossing

Alternative A.1: Crossing at Clay Avenue

- Will illumination be required? Right of way and ADA on the west side may be tight.
- Will the double white striping between the northbound lanes tie into the existing solid wide stripe between the lane between Burnside and Clay? If so, will this impact the access to Les Schwab?

Alternative A.2: Crossing at Burnside

- Likely not an issue, but Burnside will have a steeper cross slope than Clay. What is the existing cross slope at Burnside? If it's greater than 5% and regrading is required, this may rule out Burnside.
- Approximately 45 ft, curb-to-curb should allow for design of median to meet standards, but allow for traffic during construction to be unabated. 14 ft travel with bikes in roadway each direction will allow for an approximate 17 ft work zone width.

Sub-Area B: 3rd Street – South of Undercrossing

Alternative B.1: Traffic Signal at 3rd Street/Miller Avenue

- Emergency vehicles could get stuck in single lane with median (north of Davis Ave)
- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Miller Avenue.
- Potential right of way acquisitions on the corners.
    1. It appears Red Carpet has potential encroachments.
- The north end of the median at Davis Avenue may introduce issues with the 20 ft clear curb-to-curb for EMS. If outside curb needs to move, there is grade in the area to be addressed.
- The north end of the median at Davis Avenue may require special sequencing and staging during construction to maintain southbound traffic.

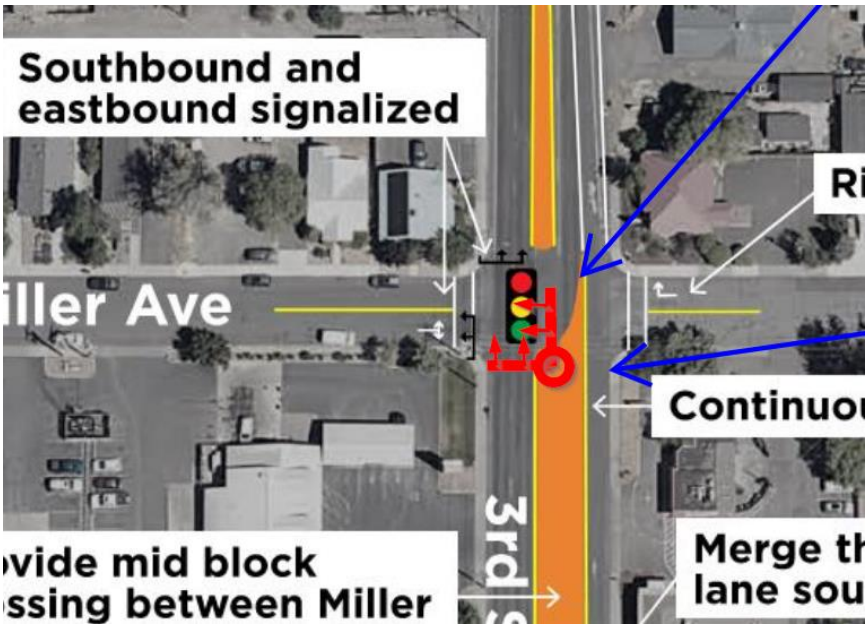
Alternative B.2: Traffic Signal at 3rd Street/Woodland Boulevard and One-Way Conversion

- Would SB 3rd St queues at the Woodland signal make the NB 3rd to WB Miller a difficult movement?

- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Woodland Boulevard.
- Potential right of way acquisitions on the corners on the west side of 3rd Street, but curb bulbouts could help. SE Woodland Boulevard appears to have substantial right of way on the east side of 3rd Street.
- Apparent parking lot encroachments on the southeast corner. Not a constructability issue, but for note.
- Adequate width on 3rd Street appears to be available for maintaining one lane of traffic in each of the north-south directions.

Alternative B.3: Traffic Signal with Continuous Green Northbound Through at 3rd Street/Miller Avenue

- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Miller Avenue.
- Potential right of way acquisitions on the corners on the west side of 3rd Street, but curb bulbouts could help. SE Woodland Boulevard appears to have substantial right of way on the east side of 3rd Street.
- Potential right of way acquisitions on the corners.
  1. It appears Red Carpet has potential encroachments.
- The north end of the median at Davis Avenue may introduce issues with the 20 ft clear curb-to-curb for EMS. If outside curb needs to move, there is grade in the area to be addressed.
- The north end of the median at Davis Avenue may require special sequencing and staging during construction to maintain southbound traffic.
- Grade issues will be introduced with any widening needed to maintain 20 ft curb-to-curb and lane drop lengths north of Davis Avenue. Construction in the undercrossing limits would likely require full closure during construction.
- Verify undercrossing stormwater pump station designs and capacities can handle additional hard surfaces, if needed.
- Is there a physical barrier here (i.e., raised median)? Potential maintenance, snowplow, and EMS issue.
- No bike lane northbound south of Miller Avenue
- If ADA crossing is only on the south side of Miller Avenue, can the center median north of Miller Avenue be narrowed (if turning movements work) to help gain more room?
- Access management – driveways and streets will be right in-right out as well for the limits of the center median. Will u-turns be allowed at the traffic signals at either end?
- Can the signal poles, southbound and eastbound be moved into the medians to alleviate the overhead utility conflicts?

1. 

Alternative B.4: 3rd Street/Miller Avenue Roundabout (Added)

- Significant ROW acquisition
- Franchise relocations

Alternative B.5: 3rd Street/Davis Avenue Roundabout (Added)

- Significant ROW acquisition
- Franchise relocations
- Impacts to frontage road
- Potential wall construction

2nd Street Typical Sections

- Option 1: 50’ Minimum
    1. Show sidewalk at 7' width to account for 6” curb and 6” bench between back of walk and ROW. This will require losing 12” in the section.
    2. Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.
- Option 2: 50’ Minimum
    1. If the goal is to have a 10’ sidewalk, recommend planning for 11 feet to account for curb and bench at back of sidewalk. This would require losing 12” in the section elsewhere.

Miller Avenue Typical Sections

- Option 1: 60’ ROW
    1. Show sidewalk at 7' width to account for 6” curb and 6” bench between back of walk and ROW. This will require losing 12” in the section.

2. Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.

- Option 2: 60’ ROW
  1. Will require a design exception; planter strips can't be less than 5' per Design Standard 3.4.2.1.

Scott Street Typical Sections

- Option 1: 50’ Minimum
  1. Show sidewalk at 7' width to account for 6” curb and 6” bench between back of walk and ROW. This will require losing 12” in the section.
  2. Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.
- Option 2: 50’ Minimum
  1. If the goal is to have a 10’ sidewalk, recommend planning for 11 feet to account for curb and bench at back of sidewalk. This would require losing 12” in the section elsewhere.

Sub-Area C: Aune Street Alignment

Alternative C.1: Side Street Stop Control

- Coordinate with BNSF early on the protected ADA crossing as shown. It appears the intersection is outside the SSD for the rail crossing.
- Verify intersection sight distance with the introduction of the median.
- No bike or ped facilities shown.
- Utility coordination with the overhead and underground utilities on the west side of Scott Street. The north corner appears to be adequate, but the south corner will be constrained.
- Potential right of way impacts on the southwest corner.
- Approximately 42 ft, curb-to-curb should allow for design of median to meet standards but allow for traffic during construction to be unabated. 14 ft travel with bikes in roadway each direction will allow for an approximate 15 ft work zone width.

Alternative C.2: Roundabout

- There appear to be fuel tanks on property that would be acquired, potential environmental costs for remediation.
- Relocation of the existing power pole and services on the northwest side of the intersection will need to be relocated.
- Franchise utility relocations
- Significant ROW acquisition
- Business access at existing driveway (Sparrow Bakery)
- BNSF and ODOT rail coordination due to proximity of the rail crossing. While the intersection is outside the SSD, BNSF and ODOT rail will be brought in due to the potential traffic impacts, similar to Wilson Avenue.

Alternative C.3: Traffic Signal (Mid-Term)

- There appear to be fuel tanks on property that would be acquired, potential environmental costs for remediation.
- Significant ROW acquisition
- Franchise utility coordination for overhead utilities in potential conflict with the new signal.
- BNSF and ODOT rail coordination due to proximity of the rail crossing.
- The majority of this could be built with a closure of Scott Street from Aune to the ODOT ramps.
- Table 3. Aune Street (East) Alignment Key Considerations
    1. Cost Estimate
        i. Alternative C.2 Roundabout (Mid-Term)
            I. Consider adding ROW acquisition cost to estimate
        ii. Alternative C.3 Traffic Signal (Mid-Term)
            I. Significant ROW acquisition cost to estimate

Aune Street Typical Sections

- 42’ Minimum - Hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk

Appendix F – Evaluation Criteria

Table F.1 Evaluation Criteria – 3rd Street/ Burnside Avenue

Intended Outcome	Evaluation Criteria	Alternatives					
		A.1 Crossing on South Side		A.2 Crossing on North Side		A.3 Modal Filters	
		Score	Notes	Score	Notes	Score	Notes
System Connectivity and Operations	Does the alternative improve traffic operations within the study area in future year 2045?	◒	Requires rerouted traffic for single movement.	◒	Requires rerouted traffic for single movement.	○	Requires rerouted traffic to and from side streets.
	Does the alternative increase transportation choices for users within the study area by adding/ improving pedestrian and bicycle routes, crossings, and connections to transit?	●	Yes, provides improved crossing on Key Route 7 and the LSN.	●	Yes, provides improved crossing on Key Route 7 and the LSN.	●	Yes, provides improved crossing on Key Route 7 and the LSN.
	Does the alternative promote a low-stress network for key walking and biking routes?	◒	Yes, provides improved crossing on Key Route 7 and the LSN.	◒	Yes, provides improved crossing on Key Route 7 and the LSN.	●	Yes, provides improved crossing on Key Route 7 and the LSN. Restricting the intersection to RI/ RO reduces the most conflicts compared to A.1 and A.2.
Near-Term Feasibility	What are the right-of-way impacts of the alternative?	●	Possible minor ROW required for illumination.	●	Possible minor ROW required for illumination.	●	Possible minor ROW required for illumination.
	Does the alternative address transportation system needs of near-term developments in the Korpine area?	○	Outside of Korpine area.	○	Outside of Korpine area.	○	Outside of Korpine area.
	Does the alternative align with plans, policies, and laws adopted by the City, ODOT, and BNSF?	●	Aligns with TSP.	●	Aligns with TSP.	●	Aligns with TSP.
Long-Term Compatibility	Does the alternative support the City's adopted plans, development opportunities, and infrastructure investment?	●	Supports transportation system.	●	Supports transportation system.	●	Supports transportation system.
Safety for All Users	Does the alternative reduce the level of stress experienced by pedestrians and/ or cyclists?	◒	Yes, provides improved crossing on Key Route 7 and the LSN.	◒	Yes, provides improved crossing on Key Route 7 and the LSN.	●	Yes, provides improved crossing on Key Route 7 and the LSN. Reduces conflict points creates staging area for cyclists to actuate the RRFB and cross.
	Does the alternative reduce the potential for crash trends at identified high-crash locations? (*Fatal pedestrian crash at 3rd St/ Burnside Ave in 2017*)	◒	Provides median refuge and marked/signed crossing location. Reduces conflicts by restricting left turns in on direction.	◒	Provides median refuge and marked/signed crossing location. Reduces conflicts by restricting left turns in on direction.	●	Provides median refuge and marked/signed crossing on both sides of the intersection. Reduces conflicts by restricting left turns in all directions and the east-west through movement.
	Does the alternative maintain or improve potential safety conflicts between railway operations and drivers, pedestrians, and cyclists?	○	Not at at-grade rail crossing	○	Not at at-grade rail crossing	○	Not at at-grade rail crossing

Equity	Does the alternative improve pedestrian and/ or bicycle access to key destinations within the study area?	●	Improves east-west connectivity.	●	Improves east-west connectivity.	●	Improves east-west connectivity.
	Does the alternative serve transportation disadvantaged populations?	●	Enhances east-west multimodal connections.	●	Enhances east-west multimodal connections.	●	Enhances east-west multimodal connections.
Cost	Is the alternative feasible within the allocated budget?	●	Meets TSP estimate.	●	Meets TSP estimate.	◒	Higher cost than TSP estimate. Require constructing more median and RRFB infrastructure.

Table F.2 Evaluation Criteria – Sub-Area B: 3rd Street/ Miller Avenue

Intended Outcome	Evaluation Criteria	Alternative			
		B.1 : Restrict Southbound Left		B.2: Single Northbound Through Lane	
		Score	Notes	Score	Notes
System Connectivity and Operations	Does the alternative improve traffic operations within the study area in future year 2045?	●	Meets City standards. Drivers must use surrounding network (south of Miller Avenue) to make left turns.	◒	Meets City standards. Longer northbound and eastbound queues. Maintains turning movements.
	Does the alternative increase transportation choices for users within the study area by adding/ improving pedestrian and bicycle routes, crossings, and connections to transit?	●	Signalized crossing at Miller Avenue with crossings and a ped refuge.	●	Signalized crossing at Miller Avenue with crossings and curb extensions on the east and south legs.
	Does the alternative promote a low-stress network for key walking and biking routes?	●	Signalized crossing at Miller Avenue; ped refuge on the north side.	●	Signalized crossing at Miller Avenue; curb extensions reduce crossing distance on the west and south legs.
Near-Term Feasibility	What are the right-of-way impacts of the alternative?	●	Signal installation. Minor ROW impact.	●	Signal installation. Minor ROW impact.
	Does the alternative address transportation system needs of near-term developments in the Korpine area?	●	Meets City standards; provides signalized EBL movement.	●	Meets City standards; provides signalized EBL movement.
	Does the alternative align with plans, policies, and laws adopted by the City, ODOT, and BNSF?	●	Aligns with TSP and TSAP.	●	Aligns with TSP and TSAP.
Long-Term Compatibility	Does the alternative support the City's adopted plans, development opportunities, and infrastructure investment?	◒	Restricts business access north of Miller Avenue; restricts southbound left turns at Miller Avenue.	◒	Restricts business access north of Miller Avenue. Possible access control necessary on eastside of 3rd Street south of Miller Avenue.
Safety for All Users	Does the alternative reduce the level of stress experienced by pedestrians and/ or cyclists?	●	Enhanced crossing at Miller Avenue; reduces conflict points at Miller Ave by removing SBL	●	Enhanced crossing at Miller Avenue; reduces crossing distance on the east and south legs.
	Does the alternative reduce the potential for crash trends at identified high-crash locations?	◒	Will likely decrease angle crashes (the highest number of crashes shown in crash data) but increase rear end crashes	◒	Will likely decrease angle crashes (the highest number of crashes shown in crash data) but increase rear end crashes
	Does the alternative maintain or improve potential safety conflicts between railway operations and drivers, pedestrians, and cyclists?	○	N/A	○	N/A
Equity	Does the alternative improve pedestrian and/ or bicycle access to key destinations within the study area?	●	Signalized crossing at Miller Avenue; ped refuge on the north side.	●	Signalized crossing at Miller Avenue; curb extensions on the east and south legs.
	Does the alternative serve transportation disadvantaged populations?	◒	Signalized crossing at Miller Avenue; ped refuge on the north side. Restricts	◒	Signalized crossing at Miller Avenue; curb extensions on the east and south

			business access north of Miller Avenue. Traffic may be circulated to surrounding neighborhoods to access businesses.		sides. Restricts business access north of Miller Avenue. Traffic may be circulated to surrounding neighborhoods to access businesses.
Cost	Is the alternative feasible within the allocated budget?	◒	More than TSP estimate to include medians	◒	More than TSP estimate to include medians

Table F.3 Evaluation Criteria – Sub-Area C: Aune Street/ 2nd Street/ Scott Street Bicycle and Pedestrian Crossings

Intended Outcome	Evaluation Criteria	Alternatives					
		C.1a Bicycle J-Turn		C.1b Shared Use Crossing		C.1c Raised Intersection	
		Score	Notes	Score	Notes	Score	Notes
System Connectivity and Operations	Does the alternative improve traffic operations within the study area in future year 2045?	○	Exceeds standards in 2036.	○	Exceeds standards in 2036.	○	Exceeds standards in 2036.
	Does the alternative increase transportation choices for users within the study area by adding/ improving pedestrian and bicycle routes, crossings, and connections to transit?	●	Adds marked crossings for pedestrians and bicyclists. Pedestrians have a median refuge. Bicyclists must make angled crossing.	◒	Adds marked crossing for all users with a refuge area. Northbound bicyclists must merge with traffic or use shared use path.	◒	Adds marked crossing for pedestrians. Bicyclists share the roadway.
	Does the alternative promote a low-stress network for key walking and biking routes?	●	Marked crossings for pedestrians and bicyclists. Bicycle refuge area to improve sight distance.	●	Marked crossing for all users.	◒	Marked crossing for pedestrians.
Near-Term Feasibility	What are the right-of-way impacts of the alternative?	○	ROW required from northwest property. Impacts to parking at nearby businesses.	○	ROW required from northwest property. Impacts to parking at nearby businesses.	○	ROW required from northwest property. Impacts to parking at nearby businesses.
	Does the alternative address transportation system needs of near-term developments in the Korpine area?	◒	Meets mobility standards until 2036. Improves ped/bike connections.	◒	Meets mobility standards until 2036. Improves ped/bike connections.	◒	Meets mobility standards until 20236. Improves ped/bike connections.
	Does the alternative align with plans, policies, and laws adopted by the City, ODOT, and BNSF?	◒	Distance to BNSF at grade crossing may require additional coordination effort with BNSF.	◒	Distance to BNSF at grade crossing may require additional coordination effort with BNSF.	◒	Distance to BNSF at grade crossing may require additional coordination effort with BNSF.
Long-Term Compatibility	Does the alternative support the City's adopted plans, development opportunities, and infrastructure investment?	◒	Meets city standards until 2036. Restricts business access on the east side of the intersection.	◒	Meets city standards until 2036. Restricts business access on the east side of the intersection.	◒	Meets city standards until 2036. Restricts business access on the east side of the intersection.
Safety for All Users	Does the alternative reduce the level of stress experienced by pedestrians and/ or cyclists?	◒	Adds marked pedestrian crossing with median refuge. Adds bicycle refuge to facilitate left turn.	◒	Adds marked crossing with refuge area for pedestrians and bicyclists.	○	Adds marked crossings and traffic calming infrastructure. Bicyclists share the roadway with motor vehicles.
	Does the alternative reduce the potential for crash trends at identified high-crash locations?	●	Pedestrian refuge provided for crossing. Northbound left bicyclists reoriented to cross intersection.	●	Refuge island provided for crossing pedestrians and bicyclists.	◒	Raised intersection reduces vehicle speeds. Marked crossings. Bicyclists share the roadway
	Does the alternative maintain or improve potential safety conflicts between railway operations and drivers, pedestrians, and cyclists?	○	Maintains existing	○	Maintains existing	○	Maintains existing
Equity	Does the alternative improve pedestrian and/ or bicycle access to key destinations within the study area?	◒	Adds marked pedestrian crossing with median refuge. Adds bicycle refuge to facilitate left turn.	◒	Adds marked crossing with refuge area for pedestrians and bicyclists.	○	Adds marked crossings and traffic calming infrastructure. Bicyclists share the roadway with motor vehicles.

	Does the alternative serve transportation disadvantaged populations?	◒	Improved crossing at Aune/Scott; sidewalk infill on Aune and 2nd	◒	Improved crossing at Aune/Scott; sidewalk infill on Aune and 2nd	◒	Improved crossing at Aune/Scott; sidewalk infill on Aune and 2nd
Cost	Is the alternative feasible within the allocated budget?	◒	More than TSP estimate	◒	More than TSP estimate	◒	More than TSP estimate

Appendix G – Cost Opinions

Pre-Class 5 Cost Estimates for Planning Projects

UPDATED COST ITEMS

ITEM	Construction (Ver 2d)	Construction (esclated from 2019 to 2026 at 4% per year)	Project Management 5% of Construction	Planning 5% of Construction	Design 20% of Construction	Contingency 30% of Construction	ROW 10% of Construction	TOTAL (Ver 2d)	UNIT	2019 Total (Ver 2d, for reference)
New 2 lane Collector/Arterial*	$ 878	$ 1,155	$ 58	$ 58	$ 231	$ 347	$ 116	$ 1,964	Per linear foot	$ 1,492
New 3 lane Collector/Arterial*	$ 940	$ 1,237	$ 62	$ 62	$ 247	$ 371	$ 124	$ 2,102	Per linear foot	$ 1,597
New 5 lane Arterial*	$ 1,595	$ 2,099	$ 105	$ 105	$ 420	$ 630	$ 210	$ 3,568	Per linear foot	$ 2,712
New Frontage Road (2 lane)	$ 550	$ 724	$ 36	$ 36	$ 145	$ 217	$ 72	$ 1,230	Per linear foot	$ 935
Upgrade 2 lane Collector/Arterial to 3 lane Collector/Arterial/Complete Street*	$ 1,070	$ 1,408	$ 70	$ 70	$ 282	$ 422	$ 141	$ 2,393	Per linear foot	$ 1,819
Upgrade 2 lane Arterial to 5 lane Arterial*	$ 1,450.00	$ 1,908	$ 95	$ 95	$ 382	$ 572	$ 191	$ 3,244	Per linear foot	$ 2,465
Upgrade 3 lane Arterial to 5 lane Arterial*	$ 1,160.00	$ 1,526	$ 76	$ 76	$ 305	$ 458	$ 153	$ 2,595	Per linear foot	$ 1,972
Sidewalk Infill and ADA Ramps (no Curb, no bike lane)	$ 228	$ 300	$ 15	$ 15	$ 60	$ 90	$ 30	$ 511	Per linear foot	$ 388
Bike Lane Infill (Buffered Lane by Restriping)	$ 0.31	$ 0	$ 0	$ -	$ -	$ -	$ -	$ 0	Per linear foot	$ 0
Bike Lane (Parking Protected by Restriping)	$ 9.28	$ 12	$ 1	$ -	$ -	$ -	$ -	$ 13	Per linear foot	$ 9
Shared Use Path Adjacent to Roadway	$ 183.16	$ 241	$ 12	$ 12	$ 48	$ 72	$ 24	$ 410	Per linear foot	$ 311
Neighborhood Greenway	$ 56.82	$ 75	$ 4	$ 4	$ 15	$ 22	$ -	$ 120	Per linear foot	$ 91
			$ -	$ -	$ -	#REF!	$ -	#REF!		
Road Bridge New Road Bridge (over RR, Hwy, River or canal)	$ 6,119,958	$ 8,053,448	$ 402,672	$ 402,672	$ 1,610,690	$ 2,416,034	$ 805,345	$ 13,690,861	EACH	$ 10,403,929
Footbridge (add bike-ped to existing canal bridge)	$ 568,890	$ 748,621	$ 37,431	$ 37,431	$ 149,724	$ 224,586	$ 74,862	$ 1,272,655	EACH	$ 967,113
Footbridge New Bridge (over Deschutes River)	$ 1,500,000	$ 1,973,898	$ 98,695	$ 98,695	$ 394,780	$ 592,169	$ 197,390	$ 3,355,626	EACH	$ 2,550,000
Footbridge New Bridge (over RR/Hwy)	$ 5,000,000	$ 6,579,659	$ 328,983	$ 328,983	$ 1,315,932	$ 1,973,898	$ 657,966	$ 11,185,420	EACH	$ 8,500,000
New Single Lane Roundabout	$ 2,150,260	$ 2,829,595	$ 141,480	$ 141,480	$ 565,919	$ 848,878	$ 282,959	$ 4,810,311	EACH	$ 3,655,441
New Multilane Roundabout	$ 2,286,173	$ 3,008,448	$ 150,422	$ 150,422	$ 601,690	$ 902,534	$ 300,845	$ 5,114,362	EACH	$ 3,886,495
Single Lane Roundabout Reconstruct	$ 695,814	$ 915,644	$ 45,782	$ 45,782	$ 183,129	$ 274,693	$ 91,564	$ 1,556,595	EACH	$ 1,182,884
Signal Modernization (poles, mast arms, controller, illumination, ADA ramps)	$ 1,236,270	$ 1,626,847	$ 81,342	$ 81,342	$ 325,369	$ 488,054	$ 162,685	$ 2,765,640	EACH	$ 2,101,659
New Signal 5 x 3 lane with New Intersection	$ 2,218,114	$ 2,918,887	$ 145,944	$ 145,944	$ 583,777	$ 875,666	$ 291,889	$ 4,962,108	EACH	$ 3,770,795
New Signal 3 x 3 lane with New Intersection	$ 1,330,869	$ 1,751,332	$ 87,567	$ 87,567	$ 350,266	$ 525,400	$ 175,133	$ 2,977,265	EACH	$ 2,262,477
ADA Ramps	$ 5,714	$ 7,519	$ 376	$ 376	$ 1,504	$ 2,256	$ 752	$ 12,783	EACH	$ 9,714
RRFB	$ 125,000	$ 164,491	$ 8,225	$ 8,225	$ 32,898	$ 49,347	$ 16,449	$ 279,636	EACH	$ 212,500

*Includes curbs, sidewalks and bike lanes both directions

Escalation Since 2019	
7	years
0.04	% increase
1.315931779	Factor increase

Alternative A.1 - Crossing southside of Burnside	LINEAR FT	Total Cost	Notes
New 2 lane Collector/Arterial*		$ -	
New 3 lane Collector/Arterial*		$ -	
New 5 lane Arterial*		$ -	
New Frontage Road (2 lane)		$ -	
Upgrade 2 lane Collector/Arterial to 3 lane Collector/Arterial/Complete Street*		$ -	
Upgrade 2 lane Arterial to 5 lane Arterial*		$ -	
Upgrade 3 lane Arterial to 5 lane Arterial*		$ -	
Sidewalk Infill and ADA Ramps (no Curb, no bike lane)	600	$ **306,351.60**	Includes estimate for sidewalk infill on westside of 3rd to undercrossing & median
Bike Lane Infill (Buffered Lane by Restriping)		$ -	
Bike Lane (Parking Protected by Restriping)		$ -	
Shared Use Path Adjacent to Roadway		$ -	
Neighborhood Greenway		$ -	
	EACH		
Road Bridge New Road Bridge (over RR, Hwy, River or canal)		$ -	
Footbridge (add bike-ped to existing canal bridge)		$ -	
Footbridge New Bridge (over Deschutes River)		$ -	
Footbridge New Bridge (over RR/Hwy)		$ -	
New Single Lane Roundabout		$ -	
New Multilane Roundabout		$ -	
Single Lane Roundabout Reconstruct		$ -	
Signal Modernization (poles, mast arms, controller, illumination, ADA ramps)		$ -	
New Signal 5 x 3 lane with New Intersection		$ -	
New Signal 3 x 3 lane with New Intersection		$ -	
ADA Ramps	2	$ **25,565.40**	additional ramps on eastside of 3rd
RRFB	1	$ **279,635.50**	
	TOTAL	$ **611,552.50**	

GENERAL: Cost estimates used are from recent *2023 GO Bond Project Estimates prepared for City*
Costs escalated to year 2026

Alternative A.2 - Crossing northside of Burnside	LINEAR FT	Total Cost	Notes
New 2 lane Collector/Arterial*		$ -	
New 3 lane Collector/Arterial*		$ -	
New 5 lane Arterial*		$ -	
New Frontage Road (2 lane)		$ -	
Upgrade 2 lane Collector/Arterial to 3 lane Collector/Arterial/Complete Street*		$ -	
Upgrade 2 lane Arterial to 5 lane Arterial*		$ -	
Upgrade 3 lane Arterial to 5 lane Arterial*		$ -	
Sidewalk Infill and ADA Ramps (no Curb, no bike lane)	700	$ 357,410.20	Includes estimate for sidewalk infill on westside of 3rd to undercrossing, additional sidewalk north of Burnside & median
Bike Lane Infill (Buffered Lane by Restriping)		$ -	
Bike Lane (Parking Protected by Restriping)		$ -	
Shared Use Path Adjacent to Roadway		$ -	
Neighborhood Greenway		$ -	
	EACH		
Road Bridge New Road Bridge (over RR, Hwy, River or canal)		$ -	
Footbridge (add bike-ped to existing canal bridge)		$ -	
Footbridge New Bridge (over Deschutes River)		$ -	
Footbridge New Bridge (over RR/Hwy)		$ -	
New Single Lane Roundabout		$ -	
New Multilane Roundabout		$ -	
Single Lane Roundabout Reconstruct		$ -	
Signal Modernization (poles, mast arms, controller, illumination, ADA ramps)		$ -	
New Signal 5 x 3 lane with New Intersection		$ -	
New Signal 3 x 3 lane with New Intersection		$ -	
ADA Ramps	2	$ 25,565.40	additional ramps on eastside of 3rd
RRFB	1	$ 279,635.50	
	TOTAL	$ 662,611.10	

GENERAL: Cost estimates used are from recent *2023 GO Bond Project Estimates prepared for City*
Costs escalated to year 2026

Alternative A.3 - Modal filter at 3rd/Burnside	LINEAR FT	Total Cost	Notes
New 2 lane Collector/Arterial*		$ -	
New 3 lane Collector/Arterial*		$ -	
New 5 lane Arterial*		$ -	
New Frontage Road (2 lane)		$ -	
Upgrade 2 lane Collector/Arterial to 3 lane Collector/Arterial/Complete Street*		$ -	
Upgrade 2 lane Arterial to 5 lane Arterial*		$ -	
Upgrade 3 lane Arterial to 5 lane Arterial*		$ -	
Sidewalk Infill and ADA Ramps (no Curb, no bike lane)	1000	$ **510,586.00**	Includes estimate for sidewalk infill on westside of 3rd to undercrossing, additional sidewalk north of Burnside & median
Bike Lane Infill (Buffered Lane by Restriping)		$ -	
Bike Lane (Parking Protected by Restriping)		$ -	
Shared Use Path Adjacent to Roadway		$ -	
Neighborhood Greenway		$ -	
	EACH		
Road Bridge New Road Bridge (over RR, Hwy, River or canal)		$ -	
Footbridge (add bike-ped to existing canal bridge)		$ -	
Footbridge New Bridge (over Deschutes River)		$ -	
Footbridge New Bridge (over RR/Hwy)		$ -	
New Single Lane Roundabout		$ -	
New Multilane Roundabout		$ -	
Single Lane Roundabout Reconstruct		$ -	
Signal Modernization (poles, mast arms, controller, illumination, ADA ramps)		$ -	
New Signal 5 x 3 lane with New Intersection		$ -	
New Signal 3 x 3 lane with New Intersection		$ -	
ADA Ramps	2	$ **25,565.40**	additional ramps on northside & eastside
RRFB	1	$ **279,635.50**	
	TOTAL	$ **815,786.90**	

GENERAL: Cost estimates used are from recent *2023 GO Bond Project Estimates prepared for City*
Costs escalated to year 2026

Alternative B.1&B.2 - Traffic Signal at Miller/3rd	LINEAR FT	Total Cost	Notes
New 2 lane Collector/Arterial*		$ -	
New 3 lane Collector/Arterial*		$ -	
New 5 lane Arterial*		$ -	
New Frontage Road (2 lane)		$ -	
Upgrade 2 lane Collector/Arterial to 3 lane Collector/Arterial/Complete Street*		$ -	
Upgrade 2 lane Arterial to 5 lane Arterial*	200	$ **648,754.37**	Cost to include additional medians and updates north of miller
Upgrade 3 lane Arterial to 5 lane Arterial*		$ -	
Sidewalk Infill and ADA Ramps (no Curb, no bike lane)		$ -	
Bike Lane Infill (Buffered Lane by Restriping)		$ -	
Bike Lane (Parking Protected by Restriping)		$ -	
Shared Use Path Adjacent to Roadway		$ -	
Neighborhood Greenway		$ -	
	EACH		
Road Bridge New Road Bridge (over RR, Hwy, River or canal)		$ -	
Footbridge (add bike-ped to existing canal bridge)		$ -	
Footbridge New Bridge (over Deschutes River)		$ -	
Footbridge New Bridge (over RR/Hwy)		$ -	
New Single Lane Roundabout		$ -	
New Multilane Roundabout		$ -	
Single Lane Roundabout Reconstruct		$ -	
Signal Modernization (poles, mast arms, controller, illumination, ADA ramps)		$ -	
New Signal 5 x 3 lane with New Intersection	1	$ **4,962,108.32**	
New Signal 3 x 3 lane with New Intersection		$ -	
ADA Ramps		$ -	
RRFB		$ -	
	TOTAL	$ **5,610,862.68**	

GENERAL: Cost estimates used are from recent *2023 GO Bond Project Estimates prepared for City*
Costs escalated to year 2026

Alternative C.1&2 - Side Street Stop Control	LINEAR FT	Total Cost	Notes
New 2 lane Collector/Arterial*		$ -	
New 3 lane Collector/Arterial*		$ -	
New 5 lane Arterial*		$ -	
New Frontage Road (2 lane)		$ -	
Upgrade 2 lane Collector/Arterial to 3 lane Collector/Arterial/Complete Street	2100	$ **5,026,097.35**	aune from division 3rd/miller as provided in GO bond estimate
Upgrade 2 lane Arterial to 5 lane Arterial*		$ -	
Upgrade 3 lane Arterial to 5 lane Arterial*		$ -	
Sidewalk Infill and ADA Ramps (no Curb, no bike lane)	150	$ **76,587.90**	Captures cost for median on northside of Scott St
Bike Lane Infill (Buffered Lane by Restriping)		$ -	
Bike Lane (Parking Protected by Restriping)		$ -	
Shared Use Path Adjacent to Roadway		$ -	
Neighborhood Greenway		$ -	
	EACH		
Road Bridge New Road Bridge (over RR, Hwy, River or canal)		$ -	
Footbridge (add bike-ped to existing canal bridge)		$ -	
Footbridge New Bridge (over Deschutes River)		$ -	
Footbridge New Bridge (over RR/Hwy)		$ -	
New Single Lane Roundabout		$ -	
New Multilane Roundabout		$ -	
Single Lane Roundabout Reconstruct		$ -	
Signal Modernization (poles, mast arms, controller, illumination, ADA ramps)		$ -	
New Signal 5 x 3 lane with New Intersection		$ -	
New Signal 3 x 3 lane with New Intersection		$ -	
ADA Ramps		$ -	
RRFB		$ -	
	TOTAL	$ **5,102,685.25**	

GENERAL: Cost estimates used are from recent *2023 GO Bond Project Estimates prepared for City*
Costs escalated to year 2026

Appendix H – Constructability Review

TECHNICAL MEMORANDUM

TO:	Jacki Smith
FROM:	Scott Little, Jim Albin, Justin Mason
DATE:	May 3, 2024
PROJECT:	Aune Street Extension Study Alternatives Constructability Review

Below are constructability comments for the Study Alternatives:

Sub-Area A: 3rd Street – North of Undercrossing

Alternative A.1: Crossing South of Burnside

- Likely not an issue, but, has the existing cross slope south of Burnside been measured? If it's greater than 5% regrading is required, this may rule out a crossing south of Burnside.
- Approximately 45 ft, curb-to-curb should allow for design of median to meet standards while maintaining traffic during construction. 14 ft travel with bikes in roadway each direction will allow for an approximate 17 ft work zone width.
- Intersection appears to have mostly unobstructed sunlight; good for solar RRFB installation. Vertical clearance will need to be verified between RRFB and overhead communications lines behind the west sidewalk.
- Advance RRFB for northbound traffic will be difficult to place; limited space between back of curb and exposed rock face coming out of undercrossing.

Alternative A.2: Crossing North of Burnside

- Approximately 60 ft, curb-to-curb should allow for design of median to meet standards while maintaining traffic during construction. 14 ft travel with bikes in roadway each direction will allow for an approximate 32 ft work zone width.
- Intersection appears to have mostly unobstructed sunlight; good for solar RRFB installation. Vertical clearance will need to be verified between RRFB and overhead communications lines behind the west sidewalk.
- Advance RRFB for northbound traffic will be difficult to place; limited space between back of curb and exposed rock face coming out of undercrossing.
- Curb bulb out in northwest corner will require removal and decommissioning of existing drill hole, or new catch basin and reuse of existing drill hole in new manhole. New storm infrastructure will be required in the northwest and northeast corners.

Alternative A.3: Modal Filters

- Likely not an issue, but, has the existing cross slope south of Burnside been measured? If it's greater than 5% regrading is required, this may rule out a crossing south of Burnside.
- Approximately 45 ft, curb-to-curb should allow for design of median to meet standards while maintaining traffic during construction. 14 ft travel with bikes in roadway each direction will allow for an approximate 17 ft work zone width.
- Intersection appears to have mostly unobstructed sunlight; good for solar RRFB installation. Vertical clearance will need to be verified between RRFB and overhead communications lines behind the west sidewalk.

- Advance RRFB for northbound traffic will be difficult to place; limited space between back of curb and exposed rock face coming out of undercrossing.
- Curb bulb out in northwest corner will require removal and decommissioning of existing drill hole, or new catch basin and reuse of existing drill hole in new manhole. New storm infrastructure will be required in the northwest, northeast, and southwest corners.
- Existing sewer manhole in the intersection of Burnside and 3rd Street will need to be located outside of curb lines and adjusted.

Sub-Area B: 3rd Street – South of Undercrossing

Alternative B.1: Traffic Signal at 3rd Street/Miller Avenue w/ Restricted Left Turn

- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Miller Avenue.
- Potential right of way acquisitions on the corners.

  1. It appears Red Carpet has potential encroachments.

- Existing bus stop in the northwest and northeast corners will require coordination and/or relocation during construction.
- Water meter relocations along Miller Avenue will either need to be in the sidewalk or behind in a PUE.
- Power/utility poles on Miller Avenue will need to be relocated and placed in the sidewalk or behind in a PUE.
- Fire hydrant relocations on Miller Avenue (2nd Street and 3rd Street) will need to be in the sidewalk or behind in a PUE.
- Grade constraints on the south side of Miller Avenue likely requiring retaining walls on the south side. Driveway grades could be a struggle.
- The north end of the median at Davis Avenue may introduce issues with the 20 ft clear curb-to-curb for EMS. If outside curb needs to move, there is grade in the area to be addressed.
- The north end of the median at Davis Avenue may require special sequencing and staging during construction to maintain southbound traffic.

Alternative B.2: Traffic Signal at 3rd Street/Miller Avenue with Single Northbound Through Lane

- Utility coordination required with OH power and comm running north-south on the west side of 3rd Street (similar to Wilson Avenue) and east-west on the south side of Miller Avenue.
- Potential right of way acquisitions on the east corners of 3rd Street and Miller Avenue.

  1. It appears Red Carpet has potential encroachments.

- Existing bus stop in the northwest and northeast corners will require coordination and/or relocation during construction.
- Potential utility service pole relocation on the SE corner of 3rd Street and Davis Avenue
- Water meter relocations along Miller Avenue will either need to be in the sidewalk or behind in a PUE.

- There is an existing drillhole on the NE corner of 3rd Street and Miller Avenue that may require abandonment based upon final walk alignment.
- Power/utility poles on Miller Avenue will need to be relocated and placed in the sidewalk or behind in a PUE.
- Fire hydrant relocations on Miller Avenue (2nd Street and 3rd Street) will need to be in the sidewalk or behind in a PUE.
- Grade constraints on the south side of Miller Avenue likely requiring retaining walls on the south side. Driveway grades could be a struggle.
- The north end of the median at Davis Avenue may introduce issues with the 20 ft clear curb-to-curb for EMS. If outside curb needs to move, there is grade in the area to be addressed.
- The north end of the median at Davis Avenue may require special sequencing and staging during construction to maintain southbound traffic.

Sub-Area C: Aune Street Alignment

Alternative C.1

- Significant ROW acquisition along Aune St
- Removes business parking east of Scott St (Sparrow Bakery)
- Coordinate with BNSF early on the protected ADA crossing as shown. It appears the intersection is outside the SSD for the rail crossing.
- Verify intersection sight distance with the introduction of the median.
- Utility coordination with the overhead and underground utilities on the west side of Scott Street. This concept appears to minimize or miss utility impacts but should be confirmed through final designs.
- Approximately 42 ft, curb-to-curb should allow for design of median to meet standards but allow for traffic during construction to be unabated. 14 ft travel with bikes in roadway each direction will allow for an approximate 14 ft work zone width.
- On Scott Street, hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.
- Pedestrian and ADA access to the building adjacent right of way at 50 S Scott Street will be difficult to maintain.
- Tubular markers in bike buffer create challenge for snow removal in bike lane and are likely to be damaged when plows clearing the travel lane push snow into the tubular markers.

Alternative C.2:

- Significant ROW acquisition along Aune St
- Removes business parking east of Scott St (Sparrow Bakery)
- Coordinate with BNSF early on the protected ADA crossing as shown. It appears the intersection is outside the SSD for the rail crossing.
- Verify intersection sight distance with the introduction of the median.

- Utility coordination with the overhead and underground utilities on the west side of Scott Street. This concept appears to minimize or miss utility impacts but should be confirmed through final designs.
- Construction of the median will require lane closures with 18 ft curb to curb on the southbound lane and 15 ft curb to curb on the northbound lane. Verify with EMS.
- On Scott Street, hydrants, utility vaults/pedestals/poles, storm structures, and mailboxes will all end up in the sidewalk. This can be accommodated but needs to be understood and agreed upon.
- Pedestrian and ADA access to the building adjacent right of way at 50 S Scott Street will be difficult to maintain.
- Tubular markers in bike buffer create challenge for snow removal in bike lane and are likely to be damaged when plows clearing the travel lane push snow into the tubular markers.

Appendix I – Alternative B.1 Existing and Future Operational Analysis

Lane Group	EBT	WBT	NBL	NBT	SBT
Lane Group Flow (vph)	219	51	62	1106	1298
v/c Ratio	0.69	0.14	0.18	0.80	0.76
Control Delay	32.0	12.5	6.9	15.7	20.1
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	32.0	12.5	6.9	15.7	20.1
Queue Length 50th (ft)	76	7	8	225	253
Queue Length 95th (ft)	145	31	27	#582	#475
Internal Link Dist (ft)	289	315		194	226
Turn Bay Length (ft)			100		
Base Capacity (vph)	496	568	345	1623	1712
Starvation Cap Reductn	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0
Reduced v/c Ratio	0.44	0.09	0.18	0.68	0.76

Intersection Summary

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	137	6	76	5	14	32	62	1097	9	0	1196	102
Future Volume (veh/h)	137	6	76	5	14	32	62	1097	9	0	1196	102
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		0.98	1.00		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1750	1750	1709	1300	1750	1709	1750	1736	1518	0	1709	1750
Adj Flow Rate, veh/h	137	6	76	5	14	32	62	1097	9	0	1196	102
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Percent Heavy Veh, %	0	0	3	33	0	3	0	1	17	0	3	0
Cap, veh/h	259	22	97	76	108	198	355	1849	15	0	1453	124
Arrive On Green	0.20	0.20	0.20	0.20	0.20	0.20	0.11	0.66	0.66	0.00	0.48	0.48
Sat Flow, veh/h	794	111	481	50	532	980	1667	2785	23	0	3105	257
Grp Volume(v), veh/h	219	0	0	51	0	0	62	424	682	0	642	656
Grp Sat Flow(s),veh/h/ln	1387	0	0	1562	0	0	1667	1077	1732	0	1624	1653
Q Serve(g_s), s	7.2	0.0	0.0	0.0	0.0	0.0	0.9	13.1	13.1	0.0	20.3	20.4
Cycle Q Clear(g_c), s	8.8	0.0	0.0	1.6	0.0	0.0	0.9	13.1	13.1	0.0	20.3	20.4
Prop In Lane	0.63		0.35	0.10		0.63	1.00		0.01	0.00		0.16
Lane Grp Cap(c), veh/h	378	0	0	382	0	0	355	715	1150	0	782	796
V/C Ratio(X)	0.58	0.00	0.00	0.13	0.00	0.00	0.17	0.59	0.59	0.00	0.82	0.82
Avail Cap(c_a), veh/h	645	0	0	682	0	0	457	863	1388	0	906	922
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	0.00	1.00	1.00
Uniform Delay (d), s/veh	22.4	0.0	0.0	19.7	0.0	0.0	9.4	5.6	5.6	0.0	13.3	13.4
Incr Delay (d2), s/veh	1.4	0.0	0.0	0.2	0.0	0.0	0.2	0.8	0.5	0.0	5.4	5.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.8	0.0	0.0	0.6	0.0	0.0	0.3	2.1	3.2	0.0	7.3	7.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	23.8	0.0	0.0	19.8	0.0	0.0	9.6	6.4	6.1	0.0	18.7	18.8
LnGrp LOS	C	A	A	B	A	A	A	A	A	A	B	B
Approach Vol, veh/h		219			51			1168			1298	
Approach Delay, s/veh		23.8			19.8			6.4			18.8	
Approach LOS		C			B			A			B	

Timer - Assigned Phs		2		4	5	6		8				
Phs Duration (G+Y+Rc), s		43.8		16.1	10.9	32.8		16.1				
Change Period (Y+Rc), s		4.0		4.0	4.5	4.0		4.0				
Max Green Setting (Gmax), s		48.0		24.0	10.1	33.4		24.0				
Max Q Clear Time (g_c+I1), s		15.1		10.8	2.9	22.4		3.6				
Green Ext Time (p_c), s		9.1		1.0	0.1	6.4		0.2				

Intersection Summary												
HCM 6th Ctrl Delay			13.9									
HCM 6th LOS			B									

Appendix J – Alternative B.2 Existing and Future Operational Analysis

Lane Group	EBT	WBT	NBL	NBT	SBL	SBT
Lane Group Flow (vph)	219	51	62	1106	28	1302
v/c Ratio	0.86	0.17	0.20	0.94	0.13	0.62
Control Delay	74.9	22.8	6.3	35.5	5.9	14.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	74.9	22.8	6.3	35.5	5.9	14.9
Queue Length 50th (ft)	163	13	13	~988	6	338
Queue Length 95th (ft)	#292	50	25	#1252	14	411
Internal Link Dist (ft)	289	315		194		226
Turn Bay Length (ft)			100		100	
Base Capacity (vph)	294	343	305	1182	223	2183
Starvation Cap Reductn	0	0	0	0	0	0
Spillback Cap Reductn	0	0	0	0	0	0
Storage Cap Reductn	0	0	0	0	0	0
Reduced v/c Ratio	0.74	0.15	0.20	0.94	0.13	0.60

Intersection Summary

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	137	6	76	5	14	32	62	1097	9	28	1200	102
Future Volume (veh/h)	137	6	76	5	14	32	62	1097	9	28	1200	102
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.99	1.00		0.98	1.00		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1750	1750	1709	1300	1750	1709	1750	1736	1518	1750	1709	1750
Adj Flow Rate, veh/h	137	6	76	5	14	32	62	1097	9	28	1200	102
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Percent Heavy Veh, %	0	0	3	33	0	3	0	1	17	0	3	0
Cap, veh/h	203	9	86	46	94	178	345	1142	9	181	1936	164
Arrive On Green	0.18	0.18	0.18	0.18	0.18	0.18	0.07	0.66	0.66	0.05	0.64	0.64
Sat Flow, veh/h	859	53	485	67	528	1002	1667	1719	14	1667	3021	256
Grp Volume(v), veh/h	219	0	0	51	0	0	62	0	1106	28	644	658
Grp Sat Flow(s),veh/h/ln	1397	0	0	1597	0	0	1667	0	1733	1667	1624	1654
Q Serve(g_s), s	14.4	0.0	0.0	0.0	0.0	0.0	1.3	0.0	68.9	0.6	27.5	27.6
Cycle Q Clear(g_c), s	17.7	0.0	0.0	3.2	0.0	0.0	1.3	0.0	68.9	0.6	27.5	27.6
Prop In Lane	0.63		0.35	0.10		0.63	1.00		0.01	1.00		0.15
Lane Grp Cap(c), veh/h	298	0	0	317	0	0	345	0	1151	181	1041	1060
V/C Ratio(X)	0.73	0.00	0.00	0.16	0.00	0.00	0.18	0.00	0.96	0.15	0.62	0.62
Avail Cap(c_a), veh/h	360	0	0	387	0	0	366	0	1212	241	1135	1157
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	46.3	0.0	0.0	40.7	0.0	0.0	8.8	0.0	18.1	25.6	12.4	12.5
Incr Delay (d2), s/veh	6.2	0.0	0.0	0.2	0.0	0.0	0.2	0.0	16.9	0.4	0.9	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.7	0.0	0.0	1.3	0.0	0.0	0.4	0.0	29.8	0.5	9.6	9.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	52.5	0.0	0.0	40.9	0.0	0.0	9.0	0.0	35.0	26.0	13.3	13.4
LnGrp LOS	D	A	A	D	A	A	A	A	D	C	B	B
Approach Vol, veh/h		219			51			1168			1330	
Approach Delay, s/veh		52.5			40.9			33.7			13.6	
Approach LOS		D			D			C			B	

Timer - Assigned Phs	1	2		4	5	6		8				
Phs Duration (G+Y+Rc), s	10.5	81.3		24.6	13.2	78.6		24.6				
Change Period (Y+Rc), s	4.5	4.0		4.0	4.5	4.0		4.0				
Max Green Setting (Gmax), s	10.1	81.4		26.0	10.1	81.4		26.0				
Max Q Clear Time (g_c+I1), s	2.6	70.9		19.7	3.3	29.6		5.2				
Green Ext Time (p_c), s	0.0	6.4		0.6	0.1	13.0		0.2				

Intersection Summary			
HCM 6th Ctrl Delay		25.7	
HCM 6th LOS		C	