APPENDIX E

FUTURE CONDITIONS AND DEFICIENCIES
Introduction

The future traffic analysis for the Murphy Road Corridor Project was conducted to identify expected future traffic conditions and congested-related deficiencies within the project study area. The purpose of this task is to determine how improvements to Murphy Road, including a westerly extension to Brookwood Boulevard and an easterly extension to 15th Street, affect future travel patterns and future traffic operations within the study area and southeast Bend.

Findings from the analysis indicate that traffic volumes along Murphy Road increase under all future scenarios. Traffic increases are higher under scenarios where improvements are made to Murphy Road, although the net difference observed from widening to a five-lane cross section was not significant. Furthermore, the addition of signals at Parrell Road, Country Club Road, and 15th Street\(^1\), and left turn pockets along Murphy Road at each intersection between 3rd Street and 15th Street bring traffic operations along Murphy Road into compliance with relevant City of Bend and Oregon Department of Transportation (ODOT) mobility standards. The analysis also shows that an extension of Murphy Road east to 27th Street shifts a low to moderate amount of traffic onto Murphy Road from 15th Street and Knott Road.

Methodology and Assumptions

Future travel patterns and volumes were obtained through the Bend Metropolitan Planning Organization (MPO) EMME/2 travel demand model. Model runs were conducted by ODOT’s Transportation Planning and Analysis Unit (TPAU). Future land use assumptions were developed by the Bend MPO and used in all models developed by TPAU. The year 2030 was set as the future forecast target year.

\(^1\) Traffic signals were analyzed at Parrell Road, Country Club Drive and 15th Street. Though it is anticipated that roundabouts would work at these locations as well, further operations analysis at these locations would be required prior to final recommendation.
Two groups of future conditions scenarios were analyzed as part of the Murphy Road Project:

1. 2030 No Build (future traffic volumes with no major changes to transportation network)
2. 2030 Build – Improvements to Murphy Corridor Only
   a. Three-Lane Murphy Road between 3rd and Brosterhous, westerly extension of Murphy Road to Brookswood and easterly extension to 15th Street
   b. Similar to (a) above, except widening Murphy Road to a five-lane cross section between 3rd and Brosterhous
   c. Similar to (a) above, except continue extension of Murphy Road to 27th Street to the east.

A description of each scenario is presented in the sections below. Improvements for all 2030 scenarios are shown in Figure 1.

**2030 No Build**

The 2030 No Build scenario includes future land use assumptions, future background projects that are part of the City of Bend’s Capital Improvement Program (CIP) and the State of Oregon’s State Transportation Improvement Program (STIP), and privately funded projects that are funded and expected to be built in the near term. In the 2030 No Build scenario, Murphy Road is a 2-lane section that terminates at 3rd Street to the west and Brosterhous Road to the east.

**2030 Build – Improvements to Murphy Road Only**

**2030 Build - Murphy Crossing and Extension Only**

The 2030 Build - Murphy Crossing and Extension Only scenario includes widening Murphy Road to a three-lane section along its existing alignment and extending the corridor to 15th Street to the east as a three lane roadway. This scenario includes all background projects that are included within the 2030 No Build scenario. The 2030 Build - Murphy Crossing and Extension Only scenario also includes the Murphy Road Crossing project from 3rd Street to Brookswood Boulevard to the west.

Along the Murphy Road corridor between 3rd Street and 15th Street, left turn pockets were added at each east and west approach at Parrell Road, Country Club Road, Brosterhous Road, and 15th Street. Signals were added at the intersections of Murphy Road/Parrell Road, Murphy Road/Country Club Road, and Murphy Road/Brosterhous Road. Roundabouts could also be considered at these locations. Based on the 2001/2002 Bend City Council Transportation Implementation Plan, the city has a policy of considering roundabouts as the preferred option of intersection control.
Murphy Road Project Improvements:

2030 Build - Murphy Crossing:
- Add Left Turn Pockets on E/W Approaches
- Extension of Murphy to 15th Street
- Improve to 3-Lane Section
- Signalize Parrell, Country Club, & Brosterhous
- Signalize 3rd Street/Pinebrook in “Build” Scenarios

2030 Build - Murphy Crossing, Modification A
- Includes 2030 Murphy Crossing Project Improvements
- Improve Murphy to 5-Lane section between 3rd Street and Brosterhous Road

2030 Build - Murphy Crossing, Modification B
- Includes 2030 Murphy Crossing Project Improvements
- Included extension of Murphy Road to 27th Street

Planned Future Improvement:
- Extend Murphy Road to Brookswood Blvd.
- Construct Murphy Road as 3-Lane Roadway
- Included in All “Build” Scenarios

Murphy Road/ Parrell Road* Geometry in “Build” Scenarios:

Murphy Road/ Brosterhous Rd.* Geometry in “Build” Scenarios:

Murphy Road/ 15th Street Geometry in “Build” Scenarios:

Murphy Extension, Modification B Only
- Extend Murphy Road to 27th Street
- Construct Murphy Road as 3-Lane Roadway

*Roundabouts may be considered at Parrell Road, Country Club Road, and Brosterhous along Murphy Road. Further analysis would be required to determine if acceptable operations will occur with the inclusion of roundabouts.

Figure 1. Murphy Crossing and Extension Project Improvements
This page left blank intentionally.
2030 Build - Modification A
The 2030 Build Modification A is based off of the 2030 Build - Murphy Crossing and Extension Only scenario, but expands Murphy Road to a five-lane cross-section between 3rd Street and Brosterhous Road. This requires an additional lane of capacity in each direction on this section of road. Future background committed projects and the portion of Murphy Road between Brosterhous Road and SE 15th Street remain the same as the 2030 No Build and 2030 Build - Murphy Crossing and Extension Only scenarios.

2030 Build - Modification B
The 2030 Build - Modification B scenario, extends Murphy Road to 27th Street as a three-lane roadway. The connection of Murphy Road at 27th Street will be near the 27th Street/Rickard Road intersection. Future background committed projects and the portion of Murphy Road between Brookwood Boulevard and 15th Street remain the same as the 2030 No Build and 2030 Build - Murphy Crossing and Extension Only scenarios.

Model Forecast Results
PM peak future roadway volumes were estimated by TPAU through the Bend MPO EMME/2 travel demand model for each of the scenarios. Volume difference plots were created to determine the level and types of impacts that occurred due to each scenario. Green bars represent areas where the first scenario is larger than the second scenario and red bars represent roadway where the second scenario is larger than the first scenario. Raw EMME/2 travel demand model volumes were used to develop the volume difference plots for the scenarios described below.

2030 No Build
In relationship to existing conditions, the 2030 No Build scenario showed traffic growth occurring on all roadways. As illustrated in Figure 2 below, roadways with the largest amount of growth included Brosterhous Road, Bend Parkway, and 15th Street.

Figure 2 shows the traffic volume difference plot for the [2030 No Build (–) Existing] scenarios.
2030 Build – Murphy Crossing and Extension Only

In comparison to the 2030 No Build scenario, the 2030 Build - Murphy Crossing and Extension Only scenario shows growth of traffic volumes occurring along Murphy Road between Brookswood Boulevard and 15th Street, along 15th Street between Reed Market Road and Murphy Road, and to a lesser extent, along Ferguson Road and 27th Street north of Ferguson Road. The 2030 Build - Murphy Crossing and Extension Only scenario also shows a reduction in traffic volumes along Country Club Road, the Bend Parkway, 27th Street/Knott Road between 15th Street and Ferguson Road, and along 15th Street south of Murphy Road. The reduction of traffic volumes at these locations is attributed to the fact that the extension of Murphy Road to 15th Street causes Murphy Road to become more attractive for trips traveling east-west and thus draws trips from other available routes that may not be as desirable. Figure 3 shows the traffic volume difference plot for the [2030 Build – Murphy Crossing and Extension Only] (-) [2030 No Build] scenarios.
2030 Build – Modification A

The 2030 Build - Modification A scenario results in virtually the same travel patterns and volumes as the 2030 Build - Murphy Crossing and Extension Only scenario. There is no significant difference between the roadway volumes of these two scenarios. A potential reason for their similarity is because both scenarios include the Murphy Road extension between Brosterhous Road and 15th Street and both scenarios have the same capacity at this location. If the 2030 Build - Modification A scenario were to extend the five-lane cross-section of Murphy to 15th Street, it could potentially draw more trips to the Murphy corridor. Further analysis would need to be conducted to make this assessment. Current analysis shows that Murphy Road would operate at an acceptable level as a three-lane cross section.

Figure 4 shows the traffic volume difference plot for the [2030 Build –Modification A] (-) [2030 No Build] scenarios. Figure 5 shows the traffic volume difference plot for the [2030 Build – Modification A] (-) [2030 Build – Murphy Crossing and Extension Only] scenarios.
2030 Build – Modification B

The 2030 Build - Modification B scenario results in a similar increase in roadway volumes as the 2030 Build – Murphy Crossing and Extension Only scenario for all roadways except 15th Street south of Murphy Road and 27th Street/Knott Road between 15th Street and Ferguson
Road, where volumes are decreased due to the extension of Murphy Road to 27th Street. By extending Murphy Road to 27th Street, the extension becomes a more desirable route for vehicles trying to travel east-west due to its direct connection to 27th Street. This in turn causes 27th Street and Knott Road between 15th Street and Ferguson Road to become less desirable and reduces traffic volumes along these roadways. The 2030 Build – Modification B scenario shows approximately 400 vehicles/hour using the new portion of Murphy Road between 15th Street and 27th Street. These volumes are substantially lower than what is observed on the existing section of Murphy Road (approximately 1,000 vehicles/hour immediately east of the Parrell Road intersection). Although extending Murphy Road to 27th Street provides moderate relief to Knott Road, other effects of this extension are not substantial.

Figure 6 shows the traffic volume difference plot for the [2030 Build – Modification B] (-) [2030 No Build] scenarios. Figure 7 shows the traffic volume difference plot for the [2030 Build – Modification B] (-) [2030 Build – Murphy Crossing and Extension Only] scenarios.
Traffic Operations

A PM peak hour operational and queuing analysis was conducted for all 14 study area intersections for the 2030 No Build and 2030 Build - Murphy Crossing and Extension Only scenarios using the Synchro (version 6) traffic analysis software package. Future turning movement volumes were obtained by post-processing raw turning movement volumes from the Bend MPO EMME/2 travel demand model according to standards described in National Cooperative Highway Research Program (NCHRP) Report 255. The software program WTURNNS, which utilizes NCHRP 255 standards, was used to post-process the raw EMME/2 turning movement volumes.

Operational Analysis Results

The intersection operational analysis showed that two intersections operate at levels greater than the mobility standard in the 2030 No Build scenario, and three intersections will be operating at higher than acceptable levels in the 2030 Build - Murphy Crossing and Extension Only scenario. The 2030 No Build analysis is illustrated as Figure 8, and the 2030 Build – Murphy Crossing and Extension Only analysis is illustrated as Figure 9. The intersections of Knott Road/15th Street and 3rd Street/Pinebrook Boulevard are not expected to meet City of Bend traffic operations requirements in both scenarios. In addition, the intersection of Murphy Road/Brosterhous Road is not expected to meet traffic operations requirements in the 2030 No Build scenario. The unacceptable operations at Murphy Road/Brosterhous Road will be resolved with the improvements to Murphy Road as part of the project. The unacceptable operation at Knott Road/15th Street is not attributable to the Murphy Crossing project since they are expected to fail in the 2030 No Build scenario.
This page left blank intentionally.
Intersection Delay: 30.7 V/C: 0.72

Intersection Delay: 30.8 V/C: 0.38

Intersection Delay: 12.3 V/C: 0.42

Intersection Delay: 50.9 V/C: 0.30

Intersection Delay: 23.0 V/C: 0.53

Intersection Delay: 35.2 V/C: 0.56

Intersection Delay: 14.5 V/C: 0.25

Intersection Delay: 10.4 V/C: 0.53

Intersection Delay: 28.7 V/C: 0.67

Intersection Delay: 11.8 V/C: 0.59

Intersection Delay: 16.5 V/C: 0.79

Intersection Delay: 44.6 V/C: 0.88

Intersection Delay: 160.0 V/C: 0.48

Intersection Delay: 355.0 V/C: 0.48

Intersection Delay: >150.0 V/C: 0.50

**FIGURE 9**

**Legend**

- Intersection Number
- Does Not Meet Bend's Traffic Operational Requirements
- Does Not Meet Bend's Traffic Operational Requirements
- Existing Channelization
- Signalized Intersection
- HV% = Percent Heavy Vehicles (by approach)

*NOTE: For TWSC or AWSC, delay is reported for the highest minor street lane group delay*
This page left blank intentionally.
The 2030 Build – Murphy Crossing and Extension Only scenario assumes that signals are constructed at 3rd Street/Pinebrook Road, Murphy Road/Parrell Road, Murphy Road/Country Club Road, and Murphy Road/Brosterhous Road as part of the project. Without signals at these intersections, it is expected that they will have unacceptable operations in the 2030 Build scenario. Further analysis of these intersections is required to determine if roundabouts at these locations will achieve acceptable operations in the 2030 Build scenario and whether signal warrants will be met at these locations. The city has a policy of considering roundabouts as the preferred option of intersection control.

With the expected improvements made to Murphy Road intersections as part of the project, all of the study intersections along Murphy Road between 3rd Street and 15th Street are expected to meet the city’s traffic operations requirements.

### Table 1

<table>
<thead>
<tr>
<th>Intersection</th>
<th>2030 No Build</th>
<th>2030 Build - Murphy Crossing and Extension Only</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control Type</td>
<td>V/C Ratio</td>
</tr>
<tr>
<td>Powers Road at Bend Pkwy (SB Ramps)</td>
<td>TWSC</td>
<td>0.55</td>
</tr>
<tr>
<td>Powers Road at Bend Pkwy (NB Ramps)</td>
<td>TWSC</td>
<td>0.57</td>
</tr>
<tr>
<td>Parrell Road at Powers Rd.</td>
<td>TWSC</td>
<td>0.25</td>
</tr>
<tr>
<td>SE 15th Street at Ferguson Rd.</td>
<td>TWSC</td>
<td>0.18</td>
</tr>
<tr>
<td>US 97 at Ponderosa Dr./China Hat Rd.</td>
<td>TWSC</td>
<td>0.53</td>
</tr>
<tr>
<td>Knott Road at SE 15th St/Tekampe Rd.</td>
<td>TWSC</td>
<td>&gt;1.50</td>
</tr>
<tr>
<td>Brookwood Blvd at Pinebrook Blvd.</td>
<td>TWSC</td>
<td>0.51</td>
</tr>
<tr>
<td>SE 3rd Street at Pinebrook Blvd.</td>
<td>TWSC</td>
<td>&gt;1.50</td>
</tr>
<tr>
<td>SE 3rd Street at Murphy Rd.</td>
<td>Signal</td>
<td>0.70</td>
</tr>
<tr>
<td>Murphy Road at Parrell Rd.</td>
<td>TWSC</td>
<td>0.52</td>
</tr>
<tr>
<td>Murphy Road at Country Club Rd.</td>
<td>TWSC</td>
<td>0.42</td>
</tr>
<tr>
<td>Murphy Road at Brosterhous Rd.</td>
<td>TWSC</td>
<td>0.98</td>
</tr>
<tr>
<td>Murphy Road at 15th St.</td>
<td>Does Not Exist in No Build Scenario</td>
<td>TWSC</td>
</tr>
<tr>
<td>Ferguson Road at 27th St.</td>
<td>TWSC</td>
<td>0.64</td>
</tr>
</tbody>
</table>

**Notes:**
1 – The maximum individual lane group volume-to-capacity ratio (V/C ratio) from the intersection analysis.
2 – For TWSC or AWSC intersections, reported delay is for the highest minor street lane group delay.
* Information reported in **bold** font indicates higher than acceptable levels of congestion.

Queuing Results

An analysis of the 95th percentile queue length during the PM peak hour for the 2030 No Build and 2030 Build – Murphy Crossing and Extension Only scenario is reported for all stop
controlled approaches at unsignalized intersections and for all approaches at the signalized SE 3rd Street at Murphy Road intersection. The Synchro software package was used to provide the queue lengths for all study area intersections.

The intersections of Knott Road/15th Street, Pinebrook Blvd./3rd Street, and Murphy Road/3rd Street all have at least one lane group that has a 95th percentile queue that exceeds 200 feet in the 2030 No Build scenario. The intersections of Knott Road/15th Street, Pinebrook Blvd./3rd Street, Murphy Road/3rd Street, Murphy Road/Parrell Road, Murphy Road/Country Club Road, Murphy Road/Brosterhous Road, Ferguson Rd./27th Street, and Powers Road/Bend Parkway SB Ramps all have at least one lane group where the 95th percentile queue exceeds 200 feet in the 2030 Build- Murphy Crossing and Extension Only scenario. A potential area of concern for approaches where the 95th percentile queue exceeds 200 feet is with safety issues associated with the long queue or spillback of the queue to the previous intersection.

Summary of Key Findings

The 2030 model forecast results show that extending Murphy Road to Brookswood Boulevard on the west and 15th Street on the east as a three-lane roadway (2030 Build - Murphy Crossing and Extension Only) will increase traffic volumes along Murphy Road and 15th Street to the north of Murphy Road, and decrease traffic volumes along Brosterhous Road, Knott Road, 27th Street, and the Bend Parkway. The model forecasts show essentially the same traffic volume results with both the three-lane (2030 Build - Murphy Crossing and Extension Only) and five-lane (2030 Build, Modification A) Murphy Road cross-section.

Results from the travel demand model show that the majority of trips destined to eastbound Murphy Road originate from west of Bend Parkway, with a smaller amount originating from 3rd Street to the north and south of Murphy Road. The majority of trips destined to westbound Murphy Road originate from east of 27th Street and then utilize SB 15th street, with a smaller amount utilizing SB Brosterhous Road.

Extending Murphy Road to 27th Street (2030 Build - Modification B) generally adds traffic volumes along Murphy Road and 15th Street north of Murphy Road, and decreases traffic along 15th Street south of Murphy and along Knott Road and 27th Street. The extension of Murphy Road to 27th Street shifts a slight to moderate amount of traffic traveling along Knott Road and 27th Street to utilize the more direct connection of the Murphy Road extension.

In the 2030 Build - Murphy Crossing and Extension Only scenario, all intersections along Murphy Road between 3rd Street and 15th Street are expected to operate at an acceptable level-of-service when left turn pockets are added on the east and west approaches and signals are added at Murphy Road/Brosterhous Road, Murphy Road/Country Club Road, and Murphy Road/Parrell Road. Roundabouts could also be considered at these locations.

It is expected that two intersections outside of the Murphy Road corridor (Knott Road/15th Street and Pinebrook Blvd./3rd Street), will not meet the City of Bend’s traffic operations standards in the 2030 No Build scenario. In the 2030 Build - Murphy Crossing and Extension Only scenario, two intersections, Ferguson Road/15th Street and Ferguson Road/27th Street, are expected to not meet the city’s traffic operations standards.