
Design Acceptance Package

US 97/Murphy Road: Brookswood-Parrell (Bend)

**The Dalles-California Highway
Deschutes County, Oregon
ODOT Region 4
ODOT Key # 14215**

Prepared for
City of Bend
Oregon Department of Transportation

May 2011

Prepared by
CH2MHILL®

This report has been prepared under the direction of a registered engineer.

Executive Summary

This Design Acceptance Package (DAP) has been prepared to document the US 97: Brookwood-Parrell (Bend) project. The purpose of the project is to improve safety and connectivity by constructing an east-west arterial on the southern end of Bend and eliminating the traffic signals at the intersections of U.S. Highway 97 (US 97) at Pinebrook Boulevard and US 97 at 3rd Street.

The project consists of an extension and realignment of Murphy Road from Parrell Road across US 97 to Brookwood Boulevard. The road and bridge improvements include the following:

- A realignment of Murphy Road from 3rd Street (Business US 97) east to Parrell Road
- An extension of Murphy Road from 3rd Street (Business US 97) west to Brookwood Boulevard
- A new bridge on Murphy Road that crosses over US 97 (Bend Parkway)
- A new southbound flyover bridge from 3rd Street to US 97. The new structure enables the traffic signal at the intersection of US 97 and 3rd Street to be removed which will resolve the existing safety issues at the intersection
- Modification of accesses at 3rd Street/Murphy Road and US 97 and Pinebrook Boulevard
- A realignment of the existing northbound exit from US 97 to 3rd Street
- Construction of a roundabout at the intersection of the new Murphy Road and 3rd Street
- Construction of a roundabout at the intersection of Murphy Road and Brookwood Boulevard
- Construction of a roundabout at the intersection of Murphy Road and Parrell Road

Funding is provided through Oregon House Bill 2001, known as the Jobs in Transportation Act, which was passed by the Oregon Legislature in 2009. The project budget is \$25.2 million.

The final design and the purchase of right-of-way will begin in 2011. Construction will begin in late 2012 or early 2013. Design Plans are located in Appendix A.

The estimated construction cost for the project is \$17,574,000. The cost estimate includes a contingency and escalation to 2014. Final project costs will vary from those presented in this document and will depend on actual labor and material costs, competitive market conditions, and final project scope, among other variables.

A Design Acceptance Workshop was conducted on March 10, 2011. Comments on the Draft DAP document have been reviewed and responses provided in Appendix L.

Contents

Section	Page
1	Introduction.....1-1
1.1	Purpose and Need and Project Description.....1-1
1.2	Project Funding.....1-2
1.3	Summary of Existing Conditions1-2
1.3.1	Existing Conditions1-2
1.3.2	ADT Calculations1-3
1.4	Outline of Project Constraints.....1-3
1.5	Report Organization1-4
2	Design Approach.....2-1
2.1	Design Development.....2-1
2.1.1	Changes to the Adopted Design Concept.....2-1
2.1.2	Community and Stakeholder Acceptance2-5
2.2	Design Criteria for Selected Alternative2-5
2.2.1	Roadway Classifications.....2-5
3	Proposed Design.....3-1
3.1	Design Exception Request Proposed List3-1
3.1.1	Interchange Spacing - 3rd Street to Powers Road.....3-1
3.1.2	Shoulder Width - US 97 Inside and Outside Shoulders3-1
3.1.3	Shy Distance - 3rd Street Right Side Shoulder Barrier3-2
3.2	Horizontal Alignments.....3-2
3.2.1	3rd Street.....3-2
3.2.2	Southbound On-Ramp.....3-3
3.2.3	Northbound Off-Ramp.....3-3
3.2.4	Brookwood Boulevard3-3
3.2.5	Murphy Road.....3-4
3.2.6	Parrell Road.....3-4
3.2.7	Bike and Pedestrian Path.....3-4
3.2.8	Roundabout Approaches3-4
3.2.9	Typical Roadway Sections3-5
3.3	Vertical Alignment3-5
3.3.1	3rd Street.....3-5
3.3.2	Southbound On-Ramp.....3-6
3.3.3	Northbound Off-Ramp.....3-6
3.3.4	Brookwood Boulevard3-6
3.3.5	Murphy Road.....3-6
3.3.6	Parrell Road.....3-6
3.3.7	Bike and Pedestrian Path.....3-6
3.4	Intersection Forms3-6

3.4.1	Murphy Road/3rd Street Intersection	3-7
3.5	Access Modifications	3-7
3.5.1	Murphy Road and 3rd Street.....	3-7
3.5.2	US 97 and Pinebrook Boulevard.....	3-8
3.5.3	US 97 and Romaine Village Way	3-8
3.5.4	Northbound Off-Ramp to Les Schwab Tire Center and Central Lakes Marina Driveways	3-8
3.6	Geotechnical.....	3-9
3.7	Structures	3-9
3.7.1	Murphy Road Bridge.....	3-10
3.7.2	3rd Street Bridge	3-10
3.8	Pavement Design and Pavement Typical Sections	3-11
3.9	Right-of-Way	3-12
3.10	Traffic.....	3-13
3.10.1	Traffic Operations	3-13
3.10.2	Construction Staging and Temporary Protection	3-14
3.11	Stormwater.....	3-16
3.12	Utility Conflict Analysis.....	3-16
3.13	Environmental Impacts and Mitigation Measures.....	3-23
3.14	Construction Cost Estimate Summary.....	3-27
3.15	Project Schedule	3-27
4	References	4-1

Appendixes

A	Design Plans
B	Roadside Inventories
C	Design Exception Requests
D	Roundabout Figures
E1	Geotechnical Foundation Report
E2	Geotechnical Data Report
F	Bridge Type, Size, and Location Report
G	Pavement Design Report
H	Traffic Analysis Report
I	Stormwater Management Plan
J	Cost Estimate Detail Spreadsheet
K	Construction Schedule
L	Design Acceptance Workshop Comments and Responses

Figures

1- 1	Project Study Area
2-1	Location and Vicinity Maps

Tables

1-1	Key Roadway Characteristics
2-1	Proposed Design Standards
3-1	Preliminary Pavement Sections by Project Segment
3-2	Future Build Traffic Analysis Results
3-3	Utility Company Contact Information
3-4	Features of Potential Environmental Concern
3-5	Anticipated Permits
3-6	Summary of Mitigation Measures and Environmental Commitments

Introduction

1.1 Purpose and Need and Project Description

The purpose of the project is to improve safety and connectivity by constructing an east-west arterial on the southern end of Bend and eliminating the traffic signals at the intersections of U.S. Highway 97 (US 97) at Pinebrook Boulevard and US 97 at 3rd Street. The project would enhance safety and mobility for the overall Bend transportation system. US 97 is a statewide priority expressway and designated as a primary freight and travel route through central Oregon. Murphy Road is an arterial/collector road and a strategic corridor for the City of Bend's overall transportation system. The elimination of the signalized intersections at 3rd Street and Pinebrook Boulevard on US 97 would alleviate congestion, increase mobility in the corridor, and improve safety. The US 97/Pinebrook Boulevard intersection was a top 5 percent Safety Priority Index System (SPIS) site from 2007 to 2009 and the US 97/3rd Street intersection was a top 10 percent site for 2005.

The US 97/Murphy Road project is a high priority for the City of Bend, Bend Metropolitan Planning Organization, Oregon Department of Transportation (ODOT) Region 4, and the Central Oregon Area Commission on Transportation. This project has been identified in the South Parkway Refinement Plan, Murphy Crossing Refinement Plan, and the US 97: South Parkway/Murphy Interchange Area Management Plan.

The project consists of an extension and realignment of Murphy Road from Parrell Road across US 97 to Brookswood Boulevard. The road and bridge improvements include the following:

- A realignment of Murphy Road from 3rd Street (Business US 97) east to Parrell Road
- An extension of Murphy Road from 3rd Street (Business US 97) west to Brookswood Boulevard
- A new bridge on Murphy Road that crosses over US 97 (Bend Parkway)
- A new southbound flyover bridge from 3rd Street to US 97. The new structure enables the traffic signal at the intersection of US 97 and 3rd Street to be removed which will resolve the existing safety issues at the intersection
- Modification of accesses at 3rd Street/Murphy Road and US 97 and Pinebrook Boulevard
- A realignment of the existing northbound exit from US 97 to 3rd Street
- Construction of a roundabout at the intersection of the new Murphy Road and 3rd Street
- Construction of a roundabout at the intersection of Murphy Road and Brookswood Boulevard

- Construction of a roundabout at the intersection of Murphy Road and Parrell Road

The final design and the purchase of right-of-way will begin in 2011. Construction will begin in late 2012 or early 2013. Design Plans are located in Appendix A.

1.2 Project Funding

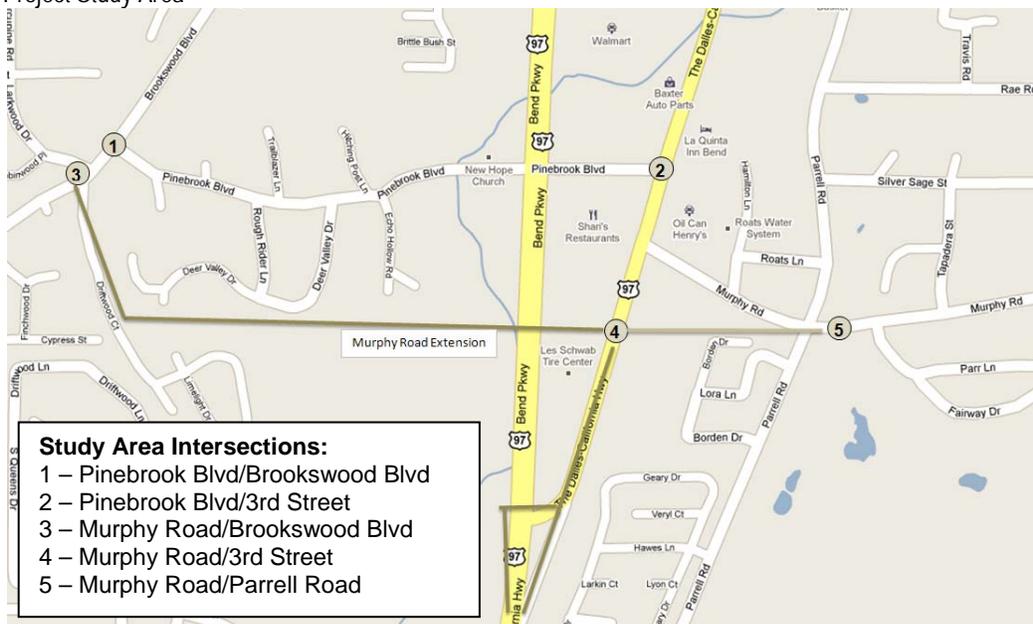
Funding is provided through Oregon House Bill 2001, known as the Jobs in Transportation Act, which was passed by the Oregon Legislature in 2009. The project budget is \$25.2 million.

1.3 Summary of Existing Conditions

1.3.1 Existing Conditions

The US 97 Murphy Road - Brookswood Boulevard to Parrell Road project study area is shown on Figure 1-1.

FIGURE 1-1
Project Study Area



Key characteristics for each of the roadways within the study area are listed in Table 1-1.

TABLE 1-1
 Key Roadway Characteristics

Roadway	Highway Classification	Number of Lanes	Posted Speed (miles per hour)
Major Roadways			
US 97	Urban Expressway	4	45 to 55
3rd Street	Principal Arterial	5	45
Secondary Roadways			
Murphy Road	Urban Collector	2	35
Brookwood Boulevard	Minor Arterial	2	35
Parrell Road	Urban Collector	2	40
Pinebrook Boulevard	Local Road	2	25

An existing ODOT Roadside Inventory was completed for US 97 and 3rd Street as it approaches US 97. This inventory is provided in Appendix B.

1.3.2 ADT Calculations

Existing year average daily traffic (ADT) values can be retrieved from ODOT ATR 09-003, which is located 0.17 miles south of China Hat Road on US 97. These values have been adjusted to just north of China Hat Road by accounting for turning movements that occur at China Hat Road from the 2006 Murphy Corridor Study volumes. The 2009 calculated ADT value is 23,380 vehicles.

In support of the Design Acceptance Package (DAP) work, a Design Year 2030 ADT value was calculated for US 97 just north of China Hat Road. This was done using existing and future no-build Bend MPO Model link plot volumes. These were compared to ADT values at ATR 09-003 (Lava Butte ATR, located 0.17 miles south of China Hat Road) using National Cooperative Highway Research Program (NCHRP) 255 Post Processing Difference Method. This process resulted in a Design Year ADT of 31,450 vehicles.

Truck percentages are also based on data from ATR 09-003, which provides truck percents of ADT based on the Federal Highway Administration (FHWA) 13-class vehicle break down. Assuming classes 4 through 13 are included in the definition of trucks, the truck percentage in this area of US 97 is 9.90 percent.

1.4 Outline of Project Constraints

The project corridor contains several project constraints that shaped the project scope and design. These constraints include topography, environmental, right-of-way, and cost.

The topography of the project area would generally be described as rolling terrain. The most challenging topography is found along the alignment of the Murphy Road extension from 3rd Street west over US 97. The Murphy Road alignment travels over US 97 and then intersects 3rd Street at grade. The close proximity of US 97 to 3rd Street creates a topographic as well as a design constraint. Providing adequate clearance for Murphy Road over US 97 while still touching down at 3rd Street requires the use of a two span bridge with

a shallow structure depth, a maximum road slope of 6 percent and positioning the Murphy Road/3rd Street intersection as far north as possible to provide adequate horizontal distance for the road to drop down to the intersection with 3rd Street.

Environmental constraints include both the natural and built environment, although the natural environment constraints are limited. The proposed roadway alignments strive to minimize the impacts to the built environment. The alignment of Murphy Road traverses both residential and commercial land uses. Environmental impacts are addressed in the Right-of-Way (Section 3.9) and Environmental (Section 3.13) sections.

The project budget is fixed at \$25.2 million in state funds. Current project cost estimates exceed the project budget. The primary cost elements consist of the capital cost of construction and right-of-way acquisition. Both contain uncertainty, with the economic climate and the potential for market changes over the next 18-24 months before this project goes to bid. As the right-of-way acquisition process advances, this will bring more certainty to that portion of the project cost. If necessary, the project scope can be reduced to fit within the budget if additional state or local funding is not secured.

1.5 Report Organization

This report is organized as follows:

- **Executive Summary:** Proposed design for approval.
- **Section 1 - Introduction:** Introduces the reader to the project location, purpose and need, funding sources, existing conditions, project constraints, and DAP organization.
- **Section 2 - Design Approach:** Describes the approach used to evaluate and select a preferred alternative; discusses public involvement, area management, and proposed project design criteria.
- **Section 3 - Proposed Design:** Provides a detailed description of the proposed project design.
- **Section 4 - References**
- **Appendix A - Design Plans**
- **Appendix B - Roadside Inventories**
- **Appendix C - Design Exception Requests**
- **Appendix D - Roundabout Figures**
- **Appendix E1 - Geotechnical Foundation Report**
- **Appendix E2 - Geotechnical Data Report**
- **Appendix F - Bridge Type, Size, and Location Report**
- **Appendix G - Pavement Design Report**

- **Appendix H - Traffic Analysis Report**
- **Appendix I - Stormwater Management Plan**
- **Appendix J - Cost Estimate Detail Spreadsheet**
- **Appendix K- Construction Schedule**
- **Appendix L - Design Acceptance Workshop Comments and Responses**

Design Approach

2.1 Design Development

2.1.1 Changes to the Adopted Design Concept

Preliminary design for the US 97/Murphy Road project commenced with the design concept developed during the South Parkway and Murphy Crossing Refinement Plans, and further documented in the Draft *US 97: South Parkway/Murphy Crossing Interchange Area Management Plan*. This design included the following project elements:

Murphy Road: A new alignment for Murphy Road from Brookwood Boulevard to Parrell Road, with a new bridge over US 97 and roundabout intersections at Murphy/Brookwood Roads and Murphy/Parrell Roads and a traffic signal at the new Murphy Road/3rd Street intersection.

US 97 Ramp Connections: This included a northbound US 97 off-ramp to 3rd Street similar to the existing ramp with refined geometry and a southbound 3rd Street to southbound flyover bridge to US 97 on-ramp. A future phase would include a southbound 3rd Street to northbound US 97 loop on-ramp and a southbound US 97 off-ramp to a future unnamed City north-south collector street.

The project location is shown in Figure 2-1.

As this design was refined, there were some project impacts to local businesses along 3rd Street that became more apparent. Constructing the southbound flyover ramp would require limiting and/or removing some driveways to businesses on 3rd south of Murphy Road. While reviewing the design with the Steering Committee on August 19, 2010, the project team was asked to evaluate changes to the flyover ramp design, including evaluating use of a lower design speed and altering the functional design, to reduce access impacts and enhance safety.

The project team developed concept sketches that addressed revisions to the US 97 flyover ramp designs to reduce the access impacts. The team also developed a sketch for a new interchange concept that could be phased to create a full diamond interchange with ramp connections serving all movements to and from US 97 and 3rd Street. These concepts were reviewed at a September 7, 2010 Project Management Team (PMT) meeting and direction was given to develop a CAD-based drawing of the full diamond interchange sketch. The diamond interchange concept was found to warrant further review as it provided several improvements over the original design including:

- Business access along 3rd Street can be maintained.
- A future phase to construct the northbound on-ramp from 3rd Street to US 97 would limit impacts to businesses on 3rd Street.

- The design creates a connection between US 97 and 3rd Street that would be more consistent with FHWA policy for locating exits and entrances near one another, resulting in a design that is more intuitive to drivers

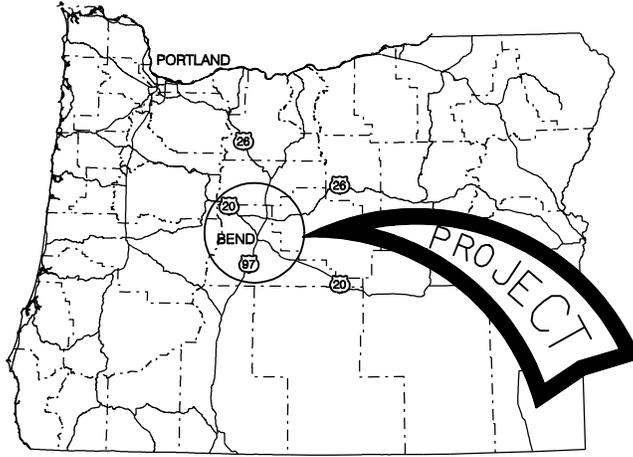
For the scope of this JTA-funded project, the partial diamond interchange concept was found to be very similar in footprint to the original design, with similar ramp connection points to US 97. These ramp connections include a northbound off-ramp and a southbound on-ramp. The study area for the environmental work would not need to be altered with this change. It should be noted that construction of a full diamond interchange is beyond the scope of the JTA-funded project, and from a policy standpoint is inconsistent with current adopted plans and policies. Further discussions between the City and ODOT will be necessary, and planning methodologies outlined and implemented before action could be taken to implement a full diamond interchange.

During the same period, the City conducted a high level review of safety, access, and connectivity along 3rd Street between the new Murphy Road intersection and Badger Street. Anticipating the need to limit driveway access to 3rd Street to improve safety, both with this project and with future improvements along 3rd Street, City staff recommended that a roundabout be evaluated as an intersection form for the new Murphy Road/3rd Street intersection. Consistent with the City Design Guidelines, a roundabout should be evaluated for intersections where a traffic signal is being considered. Roundabouts are the intersection form of choice for the City, and based on the high level review of this corridor, roundabouts will be considered in the future at the 3rd Street/Pinebrook and 3rd Street/Badger intersections.

The traffic signal at the existing intersection of Murphy Road/3rd Street is planned to be removed regardless of the intersection form chosen at the new Murphy Road/3rd Street intersection. The location of the new Murphy/3rd intersection will require access changes to several private driveways along 3rd Street near the new intersection as part of the project. A median limiting access to right-in/right-out will be installed. These changes will also impact the old intersection, which will revert to function as a limited access local drive.

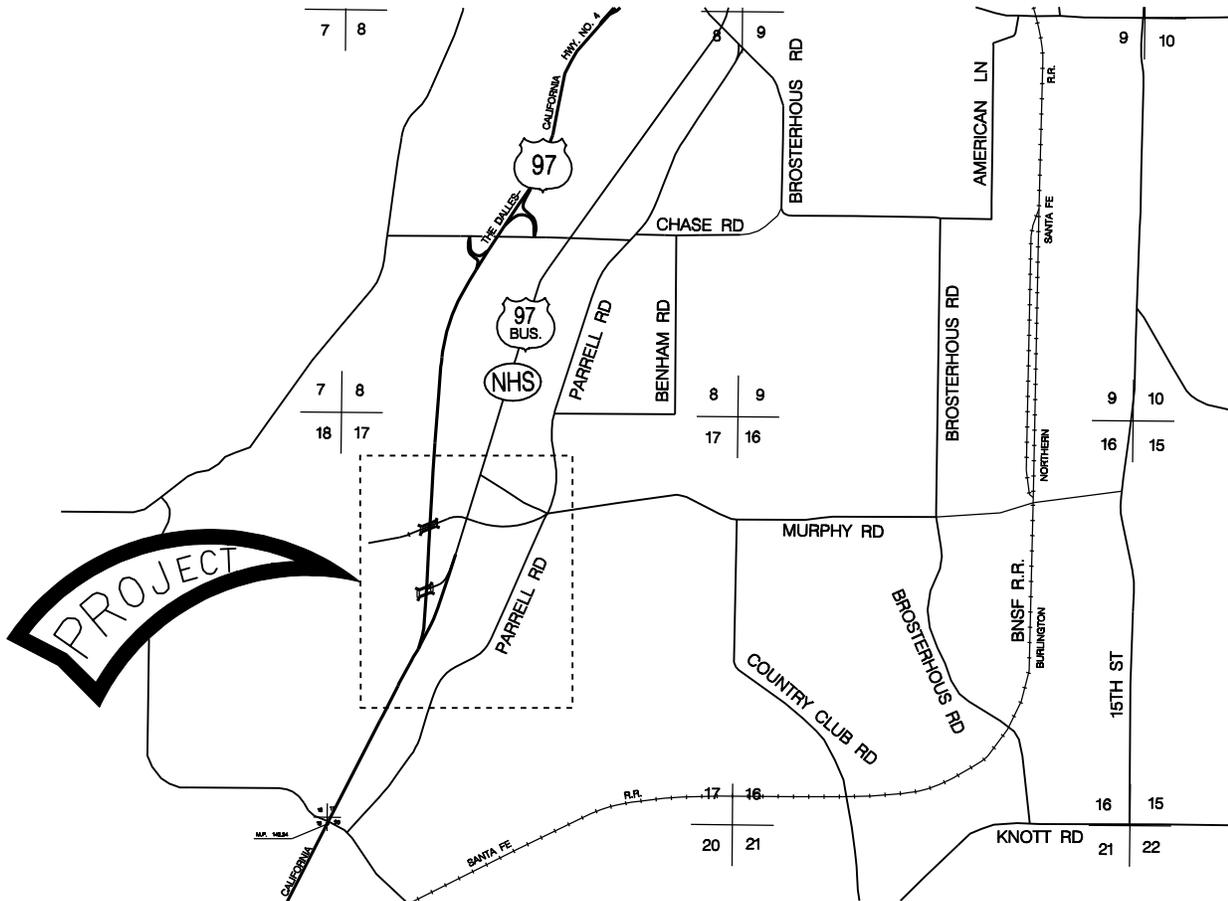
The concept of using a roundabout at the new Murphy Road/3rd Street intersection was also presented at the September 7th PMT. A double lane roundabout is anticipated to accommodate 2030 traffic demands. The roundabout design characteristics better address “U-turn” type movements that result from limiting access to nearby driveways. Furthermore, the multi-lane roundabout will reduce crashes, allow greater access options, and reduce long term maintenance. The congestion associated with the roundabout is also anticipated to be less than a traffic signal, thereby decreasing the influence area of the intersection, as determined by the vehicle queues back from the intersection.

Another advantage of the new diamond interchange and the Murphy Road/3rd Street intersection roundabout design is that it creates a gateway and transition from the high speed US 97 to 3rd Street. The new lower speed interchange design geometry requires drivers to reduce their speed as they leave US 97 and, in combination with the roundabout, provides some redundancy in calming the traffic and creating a sense of arrival at this urban environment.



VICINITY MAP

No Scale



LOCATION MAP

No Scale

FIGURE 2-1
LOCATION AND VICINITY MAPS

US HWY 97 AT MURPHY RD PROJECT
CITY OF BEND AND OREGON DEPT. OF TRANSPORTATION



The diamond interchange and Murphy Road/3rd Street intersection roundabout designs were presented at the September 21, 2010 PMT. The PMT agreed to move forward to incorporate the partial diamond interchange and Murphy Road/3rd Street roundabout intersection into the scope of the JTA-funded project. This decision was reviewed with the Steering Committee members individually and informally endorsed during this same time period. The design concepts and scope of the project were formally reviewed and endorsed at a January 11, 2011 Steering Committee Meeting.

2.1.2 Community and Stakeholder Acceptance

A public process accompanied the South Parkway and Murphy Crossing Refinement Plans, where this project emerged following consideration of alternatives. To provide updates and gather feedback during this project development phase, a series of meetings with community members have been held within the past 9 months. Separate meetings with the Old Farm, SE Bend and SW Bend Neighborhood associations and the Pinebrook and Romaine Village Homeowner associations were held in October 2010. Meetings have also been held with most of the business owners along 3rd Street. In general, there is support for the project, but several concerns have been raised, including:

- The removal of the Pinebrook Boulevard and 3rd Street traffic signals and the Romaine Village Parkway access will necessitate out-of-direction travel for vehicles, pedestrians, and bicyclists.
- The new alignment for Murphy Road will create several impacts to residential and commercial properties both in terms of physical impacts and changes in access.
- Operational concerns with the new roundabouts, particularly the complexity of the double lane roundabout at the Murphy Road/3rd Street intersection.

Future outreach plans include individual meetings and mailings to the residents and businesses along the corridor. A City-hosted website is also being used to provide project information.

A meeting with the Bicycle and Pedestrian Advisory Committee was held on January 6, 2011, and a meeting with Bend Area Transit representatives was held on January 13, 2011. A meeting is also planned with Emergency Services providers. These meetings have resulted in refinements to the design, and ongoing communication during the design process with these stakeholders is anticipated.

2.2 Design Criteria for Selected Alternative

This project is categorized as ODOT 4-R/New Construction. It consists of new roadway construction, roadway and ramp realignments, interchange construction, new bridge construction, roundabout construction, and new wall construction. Project design criteria are specified in this section.

2.2.1 Roadway Classifications

The *City of Bend Design Standards, June 2006* lists the functional classification of Brookwood Boulevard as a minor arterial, Parrell Road as a major collector, and 3rd Street as a principal arterial. The functional classification of Murphy Road is major collector east of

3rd Street and minor arterial west of 3rd Street. The 1999 *Oregon Highway Plan, Appendix D* classifies existing US 97 as Urban Expressway and the *ODOT Highway Design Manual (HDM)* (2003) classifies the new interchange ramps as Non-Freeway Ramps.

The *City of Bend Design Standards, June 2006* references horizontal curvature standards for urban streets from the American Association of State Highway and Transportation Officials (AASHTO), *A Policy on Geometric Design of Highways and Streets, 1990*. Low-speed urban standards are slightly more conservative (larger radii for comparable super elevation) in the most recent publication of AASHTO, *A Policy on Geometric Design of Highways and Streets* released in 2004. Because of the more conservative values, the proposed horizontal alignments for Murphy Road, Brookswood Boulevard, Parrell Road, and 3rd Street are designed using the low-speed urban table in AASHTO, *A Policy on Geometric Design of Highways and Streets, 2004*. Other design criteria (stopping sight distance, minimum vertical design K values, and maximum super elevation) for the aforementioned roads are taken from *City of Bend Design Standards, June 2006*. The interchange ramps and median modifications to US 97 are designed to the ODOT HDM, 2003.

Table 2-1 lists the project design features and the respective standards to be applied, the sources of the standards, and any design exceptions. Not all design standards listed for these classifications will be addressed in the actual design, for reasons of excessive cost and physical limitations. Design exceptions are discussed in Section 3, Proposed Design, and included in Appendix C.

TABLE 2-1
 Proposed Design Standards

Design Feature	Standard	Design	Source	Exception ^a
Classification				
Murphy Road	Major Collector (East of 3rd Street)		City of Bend, Section IIA1	--
	Minor Arterial (West of 3rd Street)		City of Bend, Section IIA1	--
Brookwood Blvd	Minor Arterial		City of Bend, Section IIA1	--
Parrell Road	Major Collector		City of Bend, Section IIA1	--
3rd Street	Principal Arterial		City of Bend, Section IIA1	--
Existing US 97 (The Dalles-California Highway)	Urban Expressway		Oregon Highway Plan, Appendix D	--
Design Speed				
Murphy Road	V=35 mph (East of 3rd Street)		AASHTO (page 151) ^b	--
	V=30 mph (West of 3rd Street)		AASHTO (page 151) ^b	--
Brookwood Blvd	V=35 mph		AASHTO (page 151) ^b	--
Parrell Road	V=30 mph		AASHTO (page 151) ^b	--
3rd Street	V=25 mph		AASHTO (page 151) ^b	--
NB US 97 Off-Ramp	V=50 mph		HDM, Table 9-3	--
SB US 97 On-Ramp	V=60 mph		HDM, Table 9-3	--
Existing US 97 (The Dalles-California Highway)	V=55 mph (North of 3rd Street)		HDM, Table 8-1	--
	V=65 mph (South of 3rd Street)		HDM, Table 8-1	--
Separated Bike and Pedestrian Path	V=20 mph (Grades < 4%)		AASHTO GDBF (page 36)	--
Maximum Degree of Curvature / Minimum Horizontal Radius				
Murphy Road	R _{min} =510 feet at NC (East of 3rd Street)	R=600 feet	AASHTO (page 151) ^b	--
	R _{min} =250 feet at 4% Super (West of 3rd Street)	R=250 feet	AASHTO (page 151) ^b	--
Brookwood Blvd	R _{min} =510 feet at NC	R=510 feet	AASHTO (page 151) ^b	--
Parrell Road	R _{min} =333 feet at NC	R=333 feet	AASHTO (page 151) ^b	--

Design Feature	Standard	Design	Source	Exception ^a
3rd Street	R _{min} =167 feet at 2% RC	R=191 feet	AASHTO (page 151) ^b	--
NB US 97 Off-Ramp	8°15'	8°00'	HDM, Table 9-5	--
SB US 97 On-Ramp	5°00'	5°00'	HDM, Table 9-5	--
Existing US 97 (The Dalles-California Highway)	5°15'	N/A	HDM, Table 8-1	--
Separated Bike and Pedestrian Path	R _{min} =100 feet at NC	R= 44 feet	AASHTO GDBF (page 38)	--
Stopping Sight Distance				
Murphy Road	250 feet (East of 3rd Street)	267 feet	City of Bend, Section IIA5	--
	200 feet (West of 3rd Street)	266 feet	City of Bend, Section IIA5	--
Brookwood Blvd	250 feet	262 feet	City of Bend, Section IIA5	--
Parrell Road	200 feet	272 feet	City of Bend, Section IIA5	--
3rd Street	155 feet	262 feet	City of Bend, Section IIA5	--
NB US 97 Off-Ramp	425 feet	549 feet	HDM, Table 9-5	--
SB US 97 On-Ramp	570 feet	1600 feet	HDM, Table 9-5	--
Existing US 97 (The Dalles-California Highway)	495 feet	N/A	HDM, Table 5-2	--
Separated Bike and Pedestrian Path	140 feet	N/A	AASHTO GDBF (page 42)	--
Maximum Grade				
Murphy Road	8% (East of 3rd Street)	5%	City of Bend, Section IIA1	--
	6% (West of 3rd Street)	6%	City of Bend, Section IIA1	--
Brookwood Blvd	6%	5.73%	City of Bend, Section IIA1	--
Parrell Road	8%	3.00%	City of Bend, Section IIA1	--
3rd Street	6%	5.97%	City of Bend, Section IIA1	--
NB US 97 Off-Ramp	6%	2%	HDM, Table 9-6	--
SB US 97 On-Ramp	6%	2.51%	HDM, Table 9-6	--
Existing US 97 (The Dalles-California Highway)	5%	N/A	HDM, Table 8-1	--
Separated Bike and Pedestrian Path	5%	5%	AASHTO GDBF (page 39)	--

Design Feature	Standard	Design	Source	Exception ^a
Minimum K (Sag)				
Murphy Road	K=49 (East of 3rd Street)	K=52	City of Bend, Section IIA6	--
	K=37 (West of 3rd Street)	K=50	City of Bend, Section IIA6	--
Brookswood Blvd	K=49	K=52	City of Bend, Section IIA6	--
Parrell Road	K=37	K=53	City of Bend, Section IIA6	--
3rd Street	K=26	K=50	City of Bend, Section IIA6	--
NB US 97 Off-Ramp	K=96	K=96	HDM, Figure 5-2	--
SB US 97 On-Ramp	K=136	K=139	HDM, Figure 5-2	--
Existing US 97 (The Dalles-California Highway)	K=115	N/A	HDM, Figure 5-2	--
Separated Bike and Pedestrian Path	N/A	N/A		--
Minimum K (Crest)				
Murphy Road	K=29 (East of 3rd Street)	K=50	City of Bend, Section IIA6	--
	K=19 (West of 3rd Street)	K=31	City of Bend, Section IIA6	--
Brookswood Blvd	K=29	K=43	City of Bend, Section IIA6	--
Parrell Road	K=19	K=40	City of Bend, Section IIA6	--
3rd Street	K=12	K=48	City of Bend, Section IIA6	--
NB US 97 Off-Ramp	K=136	K=142	HDM, Figure 5-1	--
SB US 97 On-Ramp	K=245	K=248	HDM, Figure 5-1	--
Existing US 97 (The Dalles-California Highway)	K=185	N/A	HDM, Figure 5-1	--
Separated Bike and Pedestrian Path	N/A	N/A		--
Maximum Superelevation				
Murphy Road	e _{max} =6%	e=4%	City of Bend, Section IIA3	--
Brookswood Blvd	e _{max} =6%	e=NC	City of Bend, Section IIA3	--
Parrell Road	e _{max} =6%	e=NC	City of Bend, Section IIA3	--
3rd Street	e _{max} =6%	e=2%	City of Bend, Section IIA3	--
NB US 97 Off-Ramp	e _{max} =10.5%	e=10.5%	HDM, Table 9-23	--
SB US 97 On-Ramp	e _{max} =9.5%	e=9.5%	HDM, Table 9-22	--
Existing US 97 (The Dalles-California Highway)	e _{max} =6%	N/A	HDM, Table 8-1	--

Design Feature	Standard	Design	Source	Exception ^a
Separated Bike and Pedestrian Path	$e_{max}=3\%$	N/A	AASHTO GDBF (page 38)	--
Spiral Length				
Murphy Road	N/A	N/A		--
Brookwood Blvd	N/A	N/A		--
Parrell Road	N/A	N/A		--
3rd Street	N/A	N/A		--
NB US 97 Off-Ramp	$L_s=250$ feet	$L_s=250$ feet	HDM, Table 9-23	--
SB US 97 On-Ramp	$L_s=250$ feet	$L_s=250$ feet	HDM, Table 9-22	--
Existing US 97 (The Dalles-California Highway)	$L_s=500$ feet	N/A	HDM, Table 5-5	--
Separated Bike and Pedestrian Path	N/A	N/A		--
Vertical Clearance	17 feet 7 inches		ODOT	--
Guardrail				
	Used where: - Slopes are greater than 1:3 - Clear zone cannot be achieved - Bridge ends		HDM, § 5.8 AASHTO (Roadside Design Guide, Figure 5.1b)	--
	ODOT facilities require 2 feet of shy distance (E) for right side shoulders	E=2 feet	HDM, § 5.4	Yes ^{c,d}
Clear Zone				
Murphy Road	18 feet	18 feet	HDM, Figure 5-9	--
Brookwood Blvd	18 feet	18 feet	HDM, Figure 5-9	--
Parrell Road	18 feet	18 feet	HDM, Figure 5-9	--
3rd Street	18 feet	18 feet	HDM, Figure 5-9	--
NB US 97 Off-Ramp	26 feet	26 feet	HDM, Figure 5-9	--
SB US 97 On-Ramp	40 feet	40 feet	HDM, Figure 5-9	--
Existing US 97 (The Dalles-California Highway)	22 feet	22 feet	HDM, Figure 5-9	--
Ramp Minimum Acceleration Length				
SB US 97 On-Ramp	540 feet (minimum) 750 feet (desirable)	750 feet	HDM, Figure 9-22	--
Ramp Acceleration "T" Distance				
SB US 97 On-Ramp	366.81 feet	424 feet	HDM, Figure 9-22	--

Design Feature	Standard	Design	Source	Exception ^a
Ramp Minimum Deceleration Length				
NB US 97 Off-Ramp	280 feet	335 feet	HDM, Figure 9-23	--
Cross-Section Width				
Murphy Road				
Travel Lanes	12 feet (East of 3rd Street)	12 feet	City of Bend, Section IIA1	--
	11 feet (West of 3rd Street)	11 feet	City of Bend, Section IIA1	--
Striped Median	16 feet	12 feet ^c	City of Bend, Section IIA1	--
Bike Lane	6 feet	6 feet	City of Bend, Section IIA1	--
Planter Strip	8 feet	8 feet	City of Bend, Section IIA1	--
Sidewalk	5 feet	5 feet	City of Bend, Section IIA1	--
Brookwood Blvd/ Parrell Road				
Travel Lanes	12 feet	12 feet	City of Bend, Section IIA1	--
Bike Lane	6 feet	6 feet	City of Bend, Section IIA1	--
Planter Strip	8 feet	8 feet	City of Bend, Section IIA1	--
Sidewalk	5 feet	5 feet	City of Bend, Std. Drg. 2-1	--
3rd Street				
Travel Lanes	12 feet	12 feet	City of Bend, Section IIA1	--
Shoulders	6 feet	6 feet	City of Bend, Section IIA1	--
Planter Strip	5 feet	6 feet ^c	City of Bend, Section IIA1	--
Sidewalk	6 feet	6 feet ^c	City of Bend, Section IIA1	--
Ramps				
Travel lanes	14 feet	14 feet	HDM, Figure 9-27	--
Shoulders	2 feet inside	2 feet inside	HDM, Figure 9-27	--
	6 feet outside	6 feet outside	HDM, Figure 9-27	--
Existing US 97 (The Dalles-California Highway)				
Travel lanes	12 feet	12 feet	HDM, Figure 9-27	--
Shoulders	4 feet inside	2 feet inside	HDM, Figure 8-1	Yes ^d
	8 feet outside	6 feet outside	HDM, Figure 8-1	Yes ^d

Design Feature	Standard	Design	Source	Exception ^a
Separated Bike and Pedestrian Path				
Path Width	10 feet	12 feet	AASHTO GDBF (page 35)	--
Interchange Spacing				
3rd Street to Powers Road	1.9 miles	1.02 miles	HDM, Table 9-2	Yes ^d
Ramp Skew				
NB US 97 Off-Ramp	60°-120°	62.84°	HDM, Figure 9-25	--
SB US 97 On-Ramp	60°-120°	67.33°	HDM, Figure 9-25	--
Roundabout Criteria				
Brookwood Boulevard and Murphy Road				
Parrell Road and Murphy Road				
Classification	Urban Single Lane	Urban Single Lane	FHWA (page 13)	--
Design Year/Traffic	2030	2030		--
Design Vehicle	WB-50	WB-50	RDCG (page 5)	--
Approach Design Speed	V=25 mph ^e	25 mph ^e	RDCG (page 4)	--
Circulation Design Speed	V=20 mph ^e	20 mph ^e	RDCG (page 4)	--
Incribed Circle Diameter	100 feet min.	130 feet	FHWA (page 13)	--
Entry/Exit Lane Widths	20 feet/18 feet 20 feet (face curb to face curb)	20 feet/18 feet	RDCG (page 11)	--
Circulating Roadway Width	20 feet	20 feet	RDCG (page 5)	--
Truck Apron Width	3-13 feet	10 feet	RDCG (page 11)	--
Planter Strip	5 feet	5.5 feet	FHWA (page 169)	--
Sidewalks	10 feet min. w/bike	10 feet	RDCG (page 7)	--
3rd Street and Murphy Road				
Classification	Urban Multi-Lane	Urban Multi-Lane	FHWA (page 13)	--
Design Year/Traffic	2030	2030		--
Design Vehicle	WB-67	WB-67	RDCG (page 5)	--
Approach Design Speed	V=30 mph ^e	30 mph ^e	RDCG (page 4)	--
Circulation Design Speed	V=20 mph ^e	20 mph ^e	RDCG (page 4)	--
Incribed Circle Diameter	150 feet min.	180 feet	FHWA (page 13)	--
Entry/Exit Lane Widths	15 feet 20 feet min. (face curb to face curb)	15 feet	RDCG (page 11)	--
Circulating Roadway Width	30 feet (2 lanes)	30 feet	RDCG (page 5)	--
Truck Apron Width	3-13 feet	10 feet	RDCG (page 11)	--
Planter Strip	5 feet	varies	FHWA (page 169)	--

Design Feature	Standard	Design	Source	Exception ^a
Sidewalks	10 feet min. w/bike	10 feet	RDCG (page 7)	--

Notes

^a ODOT. *Highway Design Manual*, 2003, Table 13-2

^b AASHTO. *A Policy on Geometric Design of Highways and Streets*, 2004.

^c Only in locations as specified in plans.

^d Included in list of design exceptions in Appendix C.

^e Approximate, See Appendix D.

AASHTO = American Association of State Highway and Transportation Officials

AASHTO GDBF = Guide for the Development of Bicycle Facilities, 1999

ADA = Americans with Disabilities Act

City of Bend, Section xxx = Refers to City of Bend Design Standards, June 2006

FHWA = Federal Highway Administration: *Roundabouts: An Informational Guide*, 2000

e_{max} = maximum superelevation

HDM = *Highway Design Manual* (ODOT, 2003)

L_s = length of spiral

mph = miles per hour

N/A = not applicable

NB = northbound

NC = normal crown

ODOT = Oregon Department of Transportation

R_{min} = minimum horizontal radius

RC = reverse crown

RDCG = City of Bend Roundabout Design Consistency Guidelines, November 2009

SB = southbound

V = velocity (design speed)

Proposed Design

This section presents the proposed project design. Design considerations discussed are horizontal and vertical alignment, typical sections, pavement design, right-of-way, traffic volume and analysis, staged construction and traffic control, utility relocation, environmental considerations, geotechnical, drainage and stormwater management, and Murphy Road Overcrossing/3rd Street Overcrossing Bridges Type, Size, and Location (TS&L) Narrative. Project costs and schedule are also addressed at the end of this section.

3.1 Design Exception Request Proposed List

The proposed design of the US 97/Murphy Road project will request a design exception for the following features:

- Interchange Spacing for 3rd Street to Powers Road
- Left and right shoulder widths for US 97
- Right side roadside barrier shy distance

Appendix C contains the design exception requests for US 97/Murphy Road.

3.1.1 Interchange Spacing – 3rd Street to Powers Road

The proposed design lessens the interchange spacing between 3rd Street and Powers Road to 1.02 miles. The ODOT HDM, 2003 Table 9-2, Urban, Non-Freeway, requires 1.9 miles between interchanges, measured from crossroad to crossroad.

Moving the proposed 3rd Street interchange south to provide standard interchange spacing with Powers Road would locate the proposed interchange less than 1 mile from the existing Knott Road interchange, also in violation of ODOT HDM, 2003 standards. Moving the proposed 3rd Street interchange would also require a needed extension of 3rd Street the same distance to provide an outlet onto US 97, thus creating significant residential impacts east of US 97.

3.1.2 Shoulder Width – US 97 Inside and Outside Shoulders

The proposed design reduces the left (inside) shoulder widths along US 97 (Bend Parkway) at the two proposed bridges. The ODOT HDM, 2003 Table 8-1 specifies that 4-foot inside and 8-foot outside shoulders are required for Urban Expressways. The proposed inside shoulder width is narrowest at the bridge piers – 2 feet of shoulder plus 2 feet of shy distance. The proposed outside shoulder width along US 97 is 6 feet through the entire project.

The existing inside shoulder on US 97 is 2 feet from the fog line to the face of curbed median. The proposed design increases this space from existing conditions by 2 feet at the pinch points with bridge piers and by 6 feet everywhere else. The outside shoulder width will remain unchanged from existing conditions, therefore matching adjacent outside shoulder widths of 6 feet.

To meet standard inside shoulder widths required by the ODOT HDM, 2003, US 97 would need to be widened at each bridge location approximately 300 feet in both directions. Additional pavement would also be required to meet the outside shoulder width dimension required by the HDM. Widening US 97 would also require longer bridge spans and increased right-of-way impacts.

3.1.3 Shy Distance – 3rd Street Right Side Shoulder Barrier

The proposed design of the 3rd Street shoulders does not account for the 2 foot “E” offset required for right side roadside barriers. The ODOT HDM, 2003 Chapter 5.4 stipulates that for right side roadside barriers an additional 2 feet of shoulder must be provided if the proposed shoulder width is less than 12 feet. The proposed design of the 3rd Street shoulders is 6 feet with no additional shy distance.

To meet standard shoulder and shy distances required by the ODOT HDM, 2003, additional paving would be required for approximately 600 feet in the northbound and southbound directions along 3rd Street between the proposed 3rd Street overpass structure and the southern Les Schwab driveway. Proposed walls adjacent to 3rd Street must be heightened and impacts to right-of-way would increase to account for higher embankment slopes.

3.2 Horizontal Alignments

3.2.1 3rd Street

The location of the 3rd Street overcrossing is primarily dictated by right-of-way constraints along both sides of 3rd Street as well as by construction staging concerns. The proposed alignment, in conjunction with a small retaining wall along the east side of the roadway, minimizes right-of-way impacts to residential homes along the east side of 3rd Street. The alignment location also eliminates right-of-way impacts to the Les Schwab property west of 3rd Street through the use of a small retaining wall. Ideally, the construction staging of this overcrossing would maintain traffic on existing 3rd Street and the existing northbound US 97 off-ramp while building the entire structure. This allows for uninterrupted traffic along the existing system while a large portion of the overcrossing is constructed. The proposed crossing location meets these staging needs, thus keeping an entire phase of construction open to existing traffic.

The proposed horizontal alignment for 3rd Street begins on a 1676.96-foot long tangent and matches the existing legal centerline from Sta. ‘3rd’ 176+23.04 to Sta. ‘3rd’ 193+00.00. From here, the alignment continues through the rest of the project on a construction alignment offset from the legal centerline. The construction centerline begins off set from the legal centerline at 18 feet right and matches the bearing of the existing legal centerline for 4.8 feet before entering a 2-degree, 17-minute, 4-second (equivalent radius of 2,508 feet) curve to the left. The 18-foot offset distance locates the alignment down the middle of the two southbound travel lanes and provides a constant tangent to taper 3rd Street from a 5-lane section to a 2-lane section. Once at the 2-lane section the offset alignment is centered along the 2-lane section. After a 406.51-foot tangent, the alignment enters a 29-degree, 59-minute, 52-second (equivalent radius of 191 feet) curve to the right and ends on a bearing parallel to the Murphy Road alignment. The 191-foot radius was chosen based on the low-speed urban table within AASHTO, *A Policy on Geometric Design of Highways and Streets*, 2004. A reversing curve super elevation of 2 percent at 25 miles per hour (mph) reveals a radius of

167 feet. This 167-foot radius was set down the centerline of the southbound (inside) shoulder. From a design speed standpoint, if a vehicle were to off-track onto the furthest inside shoulder, a driver would be able to maintain a 25 mph speed.

Use of spiral curves is impractical for 3rd Street because of the sharp curvature required for the proposed overcrossing location. Introducing spiral curvature at the 191-foot curve at the needed deflection angle eliminates the entire circular curve and pushes the spirals through the ramp terminals and onto the bridge based on the ODOT HDM, 2003 spiral tables. Eliminating the circular curve violates general design and construction practices which would require completely shifting the proposed overcrossing location and thus create more impacts to right-of-way. As previously discussed, the alignment has been optimized to limit right-of-way impacts on both sides of 3rd Street.

3.2.2 Southbound On-Ramp

The southbound on-ramp starts on the proposed 3rd Street centerline at Sta. '3rd' 203+80.31, 67.33 degrees from parallel with 3rd Street. One spiral curve is designed to tie the proposed alignment into the existing US 97 alignment at an angle of 2-degrees, 30-minutes. The spiral curve is 5 degrees with 250-foot entrance and exit spirals and a super elevation rate of 9.5 percent. The proposed on-ramp alignment requires closure of the at-grade intersection at Romaine Village Way and US 97. An offset cul-de-sac is proposed to turn traffic around as well as maintain access to business and residents at the end of Romaine Village Way.

3.2.3 Northbound Off-Ramp

The northbound off-ramp starts on the proposed 3rd Street centerline at Sta. '3rd' 201+10.92, 62.84 degrees from parallel with 3rd Street. One spiral curve is designed to tie the proposed alignment into the existing US 97 alignment at an angle of 4-degrees, 15-minutes. The spiral curve is 8 degrees with 250-foot entrance and exit spirals and a super elevation rate of 10.5 percent. The existing northbound off-ramp from US 97 to 3rd Street exits the highway on an existing US 97 spiral curve. This creates an adverse turning movement for drivers attempting to exit the highway as they have already entered the mainline curve. The proposed off-ramp alignment has been extended to the south so as to exit US 97 on tangent instead of on a curve. The existing northbound off-ramp was constructed so that there was no horizontal curvature between the highway exit and entering the urban 3rd Street cross section. There is adequate distance to decelerate, however there are no geometric constraints to slow drivers down as they approach an active urban environment. To help eliminate this subtle variance, the proposed off-ramp exits the highway and immediately curves to parallel existing US 97 before terminating at the proposed elevated 3rd Street bridge crossing.

3.2.4 Brookswood Boulevard

The proposed horizontal alignment of Brookswood Boulevard was designed to closely follow the existing road centerline into the proposed roundabout, thereby reducing the impact to adjacent properties. The horizontal curvature was also designed to maintain normal crown for the assigned design speed.

3.2.5 Murphy Road

The proposed horizontal alignment of Murphy Road begins by tying into Larkwood Drive, a low-speed residential neighborhood street with a 125-foot horizontal curve. The alignment extends through the proposed roundabout and begins the new alignment that connects Brookswood Boulevard to Parrell Road. Within 400 feet of exiting the Brookswood Boulevard roundabout, the alignment closely matches the Old Scanlon Logging Road legal centerline, but is offset approximately 5 feet. The alignment does match the bearing however, of the tangent for 241 feet before the alignment turns to the east. As the alignment turns to the east, the first horizontal curve radius is 250 feet which based on the design speed, requires a 4 percent super elevation. The east-west tangent exiting the curve was placed to equalize impacts to the adjacent property owners to the north and south sides along this confined corridor width. This new Murphy Road alignment then continues easterly across the proposed US 97 overpass, crossing 3rd Street and meets the existing Murphy Road at Parrell Road.

3.2.6 Parrell Road

The proposed realignment of Parrell Road shifts the road west from its current location to create a 90-degree intersection with Murphy Road, thus allowing for better entry and exit geometry for the proposed roundabout. The alignment begins with a compound curve. This first curve is a 955-foot radius horizontal curve which ties into Parrell Road's legal centerline, followed by a 333-foot radius curve. The proposed alignment was designed to minimize impacts to the adjacent properties while also optimizing the property parcel impacts. After exiting the roundabout, the horizontal alignment ties back into Parrell Road's legal centerline via a 300-foot radius horizontal curve.

3.2.7 Bike and Pedestrian Path

The proposed horizontal alignment of the bike and pedestrian path is designed to provide a multi-use path connection to and from Murphy Road to US 97 and to provide a connection separated from traffic between US 97 and Romaine Village. The path design runs along a fairly linear alignment between Murphy Road and Romaine Village with slight horizontal jogs to divert around the southbound on-ramp to US 97 horizontal clear zone. There is one switchback connection north of the proposed 3rd Street overpass which connects the path to US 97. During final design, steps will be taken to minimize and/or eliminate impacts to the existing irrigation canal which runs north to south along the west side of US 97.

3.2.8 Roundabout Approaches

Horizontal alignments/curvature as they approach the entries/exits of the proposed roundabouts are not discussed in this section because of their varying nature. The entering/exiting lanes don't follow the horizontal alignment through the proposed roundabout. Roundabout entry/exit design speeds as they relate to this project are less than the design speed of the facility they are located on. See Appendix D for the fastest path analysis for the approximate entry/exit speeds for the proposed roundabouts. Appendix A contains plan sheets showing the alignments and their detailed curve information.

3.2.9 Typical Roadway Sections

The proposed 3rd Street section north of the new roundabout has two 12-foot travel lanes in each direction, a 14-foot striped median, 6-foot bike lanes, 6-foot landscape areas, and 6-foot sidewalks before tapering/widening out into the roundabout. South of the roundabout, the street section transitions to two 12-foot travel lanes in each direction, a 12-foot striped median, 6-foot bike lanes, and 6-foot, curb-tight sidewalks. This section continues south past both sets of driveways to Les Schwab Tire Center and Central Lakes Marina. South of these business accesses, 3rd Street transitions from the five-lane section to a two-lane section, with one lane running southbound and one lane northbound until the 3rd Street overpass. Across the 3rd Street overpass, the 3rd Street section is only one lane southbound connecting to the southbound on-ramp to US 97. The northbound US 97 off-ramp transitions to the northbound lane of 3rd Street at the 3rd Street overpass.

Both the northbound off-ramp and the southbound on-ramp have 14-foot travel lanes, 2-foot inside shoulders, and 6-foot outside shoulders. Guardrail is required on the inside shoulder for a portion of the northbound off-ramp and is designed without shy distance per ODOT HDM, 2003 Section 5.4.

The proposed Brookswood Boulevard section has one 12-foot travel lane in each direction, 6-foot striped bike lanes, 8-foot-wide landscape areas, and 5-foot sidewalks.

The proposed Murphy Road section west of US 97 has one 11-foot travel lane in each direction, 6-foot striped bike lanes, 8-foot wide landscape areas, and 5-foot sidewalks. Just prior to the proposed Murphy Road overpass, Murphy Road tapers out to provide an additional 4-foot striped median across the proposed structure. The proposed Murphy Road section east of US 97 includes a 12-foot center turn lane, one 12-foot travel lane in each direction, 6-foot striped bike lanes, 8-foot wide landscape areas, and 5-foot sidewalks.

The proposed Parrell Road section consists of one 12-foot travel lane in each direction, 6-foot striped bike lanes, 8-foot wide landscape areas, and 5-foot sidewalks.

The proposed bike and pedestrian path west of US 97 is 12 feet wide.

The maximum cut/fill slope from the back of the proposed roadway sections will be 1 foot vertical, 2.5 foot horizontal (1V:2.5H), except for locations described in further detail in this section. Roadside slopes behind guardrail are 1V:3H. In areas with excavation where rock is known to be near the surface, the roadside slopes can be increased to 1V:1H. Around the bridge abutment wing walls, roadside slopes can be constructed to 1V:2H provided they are constructed of adequate material (see Appendix E1 for further discussion).

3.3 Vertical Alignment

3.3.1 3rd Street

The proposed 3rd Street profile north of the roundabout is designed to raise the road from its current elevation to meet the proposed elevation of the new roundabout intersection. South of the roundabout, the profile has three vertical curves and a maximum upgrade of 5.97 percent. All three curves meet K value standards as specified in *City of Bend Design Standards, June 2006* for 25 mph.

3.3.2 Southbound On-Ramp

The southbound on-ramp has two vertical curves, one crest and one sag, with a maximum downgrade of 2 percent and maximum upgrade of 2.51 percent. K values for both curves meet ODOT HDM, 2003 standards for 60 mph. The proposed ramp pavement will be warped to match grades and cross slope of the proposed 3rd Street alignment.

3.3.3 Northbound Off-Ramp

The northbound off-ramp has two vertical curves, one crest and one sag, with a maximum downgrade of 2 percent and maximum upgrade of 2.19 percent. K values for both curves meet ODOT HDM, 2003 standards for 50 mph. The proposed ramp pavement will be warped to match grades and cross slope of the proposed 3rd Street alignment.

3.3.4 Brookwood Boulevard

The proposed Brookwood Boulevard profile is designed to closely match the existing roadway profile to lessen impact to existing grades through the roundabout. The proposed profile consists of two vertical curves. The last sag curve also fixes a deficient existing sag vertical curve that doesn't meet 35 mph design parameters. The existing sag vertical curve has an approximate K value of 26, which relates to approximately a 25 mph design speed. The proposed profile has a maximum grade of 5.73 percent, and all vertical curves exceed the minimum K values for the 35 mph design speed.

3.3.5 Murphy Road

The proposed profile for Murphy Road is designed to provide positive drainage and adequate vertical clearance under the structure of the new proposed US 97 overcrossing. The proposed profile has a maximum grade of 6 percent, and all vertical curves exceed the minimum K values for the 35 mph design speed.

3.3.6 Parrell Road

The proposed Parrell Road profile is designed to match the existing ground to limit impacts to adjacent properties. The proposed profile consists of two vertical curves, both of which exceed the minimum K values for the 30 mph design speed. The proposed profile has a maximum grade of 3 percent.

3.3.7 Bike and Pedestrian Path

The proposed profile for the bike and pedestrian path uses a 5 percent maximum grade. Where applicable, the path follows the existing ground topography along the proposed route.

3.4 Intersection Forms

As part of this project, the Brookwood Boulevard at Murphy Road intersection and Parrell Road at Murphy Road intersections were not analyzed as signalized intersections. This project concentrated on the design and refinement of these intersections in the roundabout form. The Murphy Road at 3rd Street intersection however, was analyzed as both a roundabout and signalized intersection. A discussion of both intersection forms is included below.

3.4.1 Murphy Road/3rd Street Intersection

The traffic analysis was completed for Murphy Road at the 3rd Street intersection for both roundabout and signalized intersection forms. Both performed adequately well under future projected traffic volumes, but the roundabout exceeded that of the signal in maintaining full access to several key driveways.

For traffic modeling of the signalized concept, it was determined that both of the east-west Murphy Road approaches required three lanes — one thru and both a left- and right-turn lane. The same was true for the north-south 3rd Street approaches, with the exception of the northbound approach, which did not require a right-turn pocket. From the traffic model, queue/storage lengths were determined to provide adequate storage to accommodate the turning movements. After the signal concept was developed, several potentially expensive issues arose.

The first issue results from the required storage for the eastbound left turn from Murphy Road onto 3rd Street and impacts the cost of the project. The storage length needed to accommodate the turning movement requires a 200-foot left turn lane. Since the bridge abutment for the Murphy Road Overcrossing of US 97 is within 400 feet of the Murphy Road/3rd Street intersection, this lane would need to be carried across the bridge before standard pavement widths tapers could be constructed. The needed bridge width is much less in the roundabout intersection form because this turning movement is provided within the roundabout. The current roundabout design provides a 4-foot striped median across the Murphy Road Bridge to provide a separation of the opposing travel lanes. Thus, the bridge would need to be 10 feet wider to provide a full 14-foot left turn lane across the bridge, which would result in a higher bridge cost.

The second potentially expensive impact is the inability of the signal concept to replace an existing driveway and maintain access to a business property in the northeast corner of the intersection, which is currently occupied by ARCO. The loss of a second driveway to this parcel could most likely require the entire property/business to be purchased which would cause another potentially sizeable financial impact on the project cost. The existing access driveway could not be replaced because of the property's close proximity to the intersection and the required storage lengths needed on Murphy Road and 3rd Street. The roundabout concept however, has the opportunity to replace the existing driveway and provide an access point off Murphy Road. A "right-in, right-out" driveway could be achieved along Murphy Road, which should not dramatically impact the onsite circulation of the property, therefore resulting in significantly less impact to the property.

3.5 Access Modifications

3.5.1 Murphy Road and 3rd Street

This section summarizes the access modifications triggered by the project. ODOT has prepared an Official Project Access List and Access Management Strategy.

The existing Murphy Road at 3rd Street intersection is currently a full access signalized intersection, located 350 feet north of the proposed roundabout. The existing Murphy Road at 3rd Street intersection is located within the influence area of the proposed relocated Murphy Road intersection, which does not allow them to operate independently. The

existing intersection will be modified so that it can adequately function in close proximity to the proposed roundabout. The modifications include removing the existing signal and converting the intersection to a “left-in, right-in/right-out.” To accomplish this change, striping will be modified and islands will be constructed in existing Murphy Road and in the Albertson’s driveway. The complete removal of this intersection would result in access to several businesses being removed.

Along the city streets, all driveways will be replaced at existing driveway locations unless otherwise deemed unnecessary. In certain instances where two replacement driveways could not be provided, a single joint driveway will serve as access for both properties. In locations where existing private access to property is impacted with a proposed roundabout, special accommodations will be made. The flag-lot property located in the northwestern corner of the Brookwood Boulevard/Murphy Road roundabout will receive a driveway that feeds directly into the circulating roadway of the roundabout to maintain access to the property which has no alternative access.

3.5.2 US 97 and Pinebrook Boulevard

The existing US 97 and Pinebrook Boulevard signalized intersection currently allows full access for Pinebrook Boulevard turning movements onto US 97 and no left-turning movements for US 97 onto Pinebrook Boulevard. This project proposes median modifications to include paving and a concrete median barrier centered on US 97. This will eliminate the need for a signalized intersection by making it a “right-in, right-out” only to and from US 97.

3.5.3 US 97 and Romaine Village Way

The existing intersection of US 97 and Romaine Village Way currently allows for “right-in, right-out” turning movements to and from US 97. The proposed design eliminates access from US 97 to Romaine Village Way because of the southbound on-ramp. The proposed on-ramp tapers onto US 97 at the existing location of the intersection with Romaine Village Way. An offset cul-de-sac is proposed as part of the project at the end of Romaine Village Way for vehicles to turn around.

South of Romaine Village Way, there are four permitted private access driveways to US 97 between Romaine Village Way and Ponderosa Street. The close proximity of these access points to the southbound on-ramp poses a safety risk. To remove this potential conflict, these accesses will be purchased and a road will be constructed following a future frontage road alignment from Ponderosa Street north approximately 300 feet to provide access to a large parcel that would otherwise have no access.

3.5.4 Northbound Off-Ramp to Les Schwab Tire Center and Central Lakes Marina Driveways

The proposed distance between the northbound off-ramp terminal at 3rd Street and the first Les Schwab Tire Center driveway is 585 feet. The first Central Lakes Marina driveway is 600 feet from the same 3rd terminal. Highway approaches, access control, and spacing standards on Oregon highways are governed through Oregon Administrative Rules (OAR) Chapter 734, Division 51. According to Table 7 in OAR 734 Division 51, the minimum spacing dimension between a ramp terminal and the first approach on the crossroad should

be 1,320 feet. Both Les Schwab Tire Center and Central Lakes Marina have secondary driveways farther from the ramp terminal at distances of 900 feet and 877 feet, respectively.

3.6 Geotechnical

A geotechnical exploration program and laboratory testing program was performed for the project. The purpose of the exploration program was to evaluate subsurface conditions and to determine the necessary requirements to support bridge and retaining wall foundations, for approach fill slopes and roadway cut slopes, and for pavement subgrade conditions. The exploration program consisted of drilling 20 soil and rock borings and excavating 9 test pits. These explorations were performed between September and November 2010. Laboratory testing consisted of unconfined compression tests on intact rock samples to determine rock strengths. Detailed geotechnical data, including boring and test pit location plans and logs, and laboratory testing results are included in the Geotechnical Data Report, located in Appendix E2.

The generalized subsurface conditions at the site are zero to 5 feet of soil, consisting of silty sand with gravel and cobbles underlain by hard basalt bedrock. The subsurface conditions at the site are generally favorable for conventional shallow footings, founded on the bedrock, to support the Murphy Road and 3rd Street bridges overcrossing the Bend Parkway/US 97.

In addition to the bridge foundations, cast-in-place concrete retaining walls and wing walls with architectural treatment will be constructed at the bridge abutments as they transition to approach fill and adjacent site grading features. These walls will also be supported on conventional shallow foundations and be constructed up to 16 feet high. On the east side of the Bend Parkway/US 97, a mechanically stabilized earth (MSE) wall will be constructed to support the approach fill for the north bound off-ramp to 3rd Street. This wall will be 330 feet long and vary from approximately 4 to 15 feet high. Details of the bridge layout and walls are shown on the preliminary design drawings included as part of this DAP. The preliminary foundation report includes preliminary geotechnical and bridge foundation design and construction recommendations, seismic design parameters, and general pavement subgrade design parameters is included in Appendix E2.

3.7 Structures

The structures for the proposed project include a new bridge on Murphy Road that crosses over US 97 (Bend Parkway), a new southbound flyover bridge from 3rd Street (business US 97) to US 97, and several retaining walls at the bridge abutments and along the proposed roadway alignment.

A brief summary of the proposed bridges and retaining walls is provided below. A more detailed description is provided in the TS&L report (Appendix F) which documents the preliminary design decisions for the Murphy Road Bridge, 3rd Street Bridge, and retaining walls. The TS&L report also includes drawings and construction cost estimates for the proposed structures.

3.7.1 Murphy Road Bridge

The proposed Murphy Road Bridge provides a link between the proposed Murphy Road alignments east and west of the existing US 97 and eliminates an existing signalized intersection at Pinebrook Boulevard and US 97. The proposed Murphy Road Bridge is 185 feet long with two spans. The intermediate bent is centered within the existing US 97 median between the northbound and southbound roadways. The bridge length accommodates the existing US 97 northbound and southbound roadways and 22-foot-wide clear zones normal to proposed future ramp roadways in each direction. The bridge is located on an approximate west to east tangent horizontal alignment crossing over the existing US 97 northbound and southbound roadways at approximately a 65 degree angle. The bridge width is 53 feet, 3 inches. This includes two traffic lanes, a median, two bike lanes/shoulders, two sidewalks, and two 3-tube curb mount rails. .

3.7.2 3rd Street Bridge

The proposed 3rd Street Bridge eliminates an existing signalized intersection at US 97 and 3rd Street. The proposed 3rd Street Bridge is 140 feet long with two spans. The intermediate bent is centered within the existing US 97 median between the northbound and southbound roadways. The proposed span lengths accommodate the existing US 97 northbound and southbound roadways and 22-foot-wide clear zones normal to the northbound and southbound roadways. The bridge is located on an approximate east to west tangent horizontal alignment crossing the existing US 97 at approximately a 65 degree angle. The bridge width is approximately 32 feet and includes a single traffic lane, a left and right shoulder, and two 3-tube curb mount rails. A future widening is anticipated for the 3rd Street Bridge which would result in an overall width of 87 feet, 3 inches. The widened bridge will include four traffic lanes, a median, two shoulders, two sidewalks, and two 3-tube curb mount rails.

Superstructure types recommended for the bridges include precast prestressed concrete box beam, or precast prestressed concrete girders. Precast prestressed box beam superstructures will have variable depths similar to existing bridges located on the US 97 Bend Parkway. Options for providing a precast variable depth fascia will also be evaluated for the precast concrete girders. Precast prestressed concrete box beams and girders require minimal shoring to be installed, which maximizes construction clearances and eliminates the need for temporary detours during construction. Precast prestressed concrete girders will provide lower construction costs. The bridges will include aesthetic treatments similar to existing bridges located within the US 97/Bend Parkway corridor. A discussion of the advantages and disadvantages of each of these types and costs associated with each are included in the TS&L report in Appendix F.

The Murphy Road and 3rd Street bridge abutment walls and columns are located within areas of shallow silty soils with cobbles over basalt rock. Spread footings founded in basalt are the recommended foundation type for the proposed Murphy Road and 3rd Street bridges.

Cast-in-place concrete retaining walls are proposed adjacent to the bridge abutment wingwalls at each end of the proposed Murphy Road and 3rd Street bridges. The footings for these walls will be founded either on basalt or in suitable overburden above the basalt a minimum of 2 feet below the existing ground surface.

Retaining Wall W1 is proposed adjacent to, and parallel with, the northbound US 97 off-ramp to 3rd Street located to the south of the 3rd Street Bridge. The northern portion of Retaining Wall W1 provides the footing and backwall for the abutment for the future bridge widening. South of the cast-in-place retaining wall portion, a MSE retaining wall is proposed. The cast-in-place portion of the retaining wall will be founded on basalt. The MSE retaining wall will be founded 2 feet below existing ground.

3.8 Pavement Design and Pavement Typical Sections

Eleven pavement sections were developed for this project based on the 2007 ODOT *Pavement Design Guide* and were designed in accordance with American Association of State Highway and Transportation Officials (AASHTO) *Guide for Design of Pavement Structures*. All of the roundabouts were designed for construction with Portland Cement Concrete Pavement (PCCP) and all other roads and pathways were designed for construction with Asphalt Concrete Pavement (ACP).

Recommendations for the 11 typical pavement sections proposed for use within the project are summarized in Table 3-1 which also contains the full design life Equivalent Single Axle Loads (ESALs) used for their design. Segments to be constructed in ACP have a 20 year design life and those in PCCP have a 30-year design life.

TABLE 3-1
 Preliminary Pavement Sections by Project Segment

Section No.	Location	Design ESALs ^a	Pavement Thickness (inches)	Crushed Aggregate Base Thickness (inches)	Total Pavement Thickness (inches)
1	Murphy Road (Brookwood Blvd to 3rd Street)	2,925,000	8 ACP	10	18
2	Murphy Road (3rd Street to Parrell Road), 3rd Street Tie-in, and Parrell Road Tie-ins	4,683,000	8 ACP	10	18
3	US 97 Southbound On-ramp	6,850,000	8 ACP	10	18
4	US 97 Northbound Off-ramp	3,184,000	8 ACP	10	18
5	3rd Street (US 97 to Murphy Road)	7,452,000	8 ACP	10	18
6	Brookwood Blvd (West of Murphy Road) and Larkwood and Pinebrook Tie-ins	6,275,000	8 ACP	10	18
7	Brookwood Blvd PCCP Roundabout	24,940,000	11 PCCP	6	17
8	3rd Street PCCP Roundabout	45,010,000	12 PCCP	6	18
9	Parrell Road PCCP Roundabout	26,520,000	11 PCCP	6	17
10	Alternative ACP section over Competent Rock	Up to 7,500,000	Maintain 8 ACP	Minimum of 6	14
11	Pedestrian and Bicycle Pathway	N/A	3 ACP	6	9

TABLE 3-1

Preliminary Pavement Sections by Project Segment

Notes:

^a 20 years for ACP and 30 years for PCCP

All pavement sections include a soil separation geotextile fabric between the native subgrade and crushed aggregate base. A minimum of 6 inches of crushed aggregate should be placed over this fabric. ACP = Asphalt Concrete Pavement

ESAL = equivalent single-axle load

N/A = not applicable

PCCP = Portland Cement Concrete Pavement

ACP= Asphalt Concrete Pavement

See Appendix G for the completed pavement thickness designs and associated assumptions and narratives.

3.9 Right-of-Way

The general goal with this project is to design the roadway elements to reduce the right-of-way when possible. Alignment modifications have been selected to minimize property relocations. In select locations, steps have been taken to reduce the right-of-way impacts by eliminating landscape planter strips and moving the sidewalk directly adjacent to the curb. Steepened slopes and/or retaining walls are also proposed in several locations to reduce the project footprint. There are several undeveloped properties adjacent to 3rd Street and US 97 within the project footprint that are already owned by ODOT.

The proposed alignment of Murphy Road will require a significant amount of new right-of-way. At the Parrell Road intersection, construction of the proposed roundabout will require the full acquisition of three residential properties. There are no other full acquisitions identified within the Murphy Road corridor, although there are several homes where the project may impact the homes' septic systems, which may lead to acquiring these homes if the system cannot be relocated. There are right-of-way needs from businesses along 3rd Street, but no relocations are anticipated. Access changes are discussed in Section 3.5.

The proposed alignment along 3rd Street uses the existing right-of-way and ODOT-owned parcels as much as possible, but some acquisition will be required south of the Murphy Road/3rd Street roundabout and temporary easements will be necessary to reconstruct existing driveways. Right-of-way will be required along the west side of US 97 from the bridge south along the southbound on-ramp to Romaine Village Way. Between Romaine Village Way and Ponderosa Street, several private access permits will be purchased and a portion of the future frontage road right-of-way will be acquired to provide access to a parcel that would be otherwise land locked following the purchase of the accesses to US 97.

3.10 Traffic

3.10.1 Traffic Operations

Study Year and Peak Hour

A brief summary of the traffic operations analysis is provided below. A more detailed description is provided in the Traffic Analysis report (Appendix H). The US 97/Murphy Road Future Build project level traffic was analyzed using a study year of 2030, the forecast year of the Bend MPO EMME travel demand model. The analysis traffic volumes for the future 2030 project level were post-processed following guidelines in National Cooperative Highway Research Program (NCHRP) 255 to ensure feasible volumes. The basic forecasting post-processing method applied traffic growth that occurred between the 2030 MTP model's calibrated existing year and the future 2030 Future Build scenario and applied that growth to the existing turning movement counts.

The traffic analysis was based on the PM peak hour.

Study Area Intersections

The following intersections were analyzed as part of the Future Build project level traffic analysis:

1. Pinebrook Boulevard/Brookwood Boulevard
2. Pinebrook Boulevard/3rd Street
3. Murphy Road/Brookwood Boulevard
4. Murphy Road/3rd Street
5. Murphy Road/Parrell Road

The locations of the study intersections are shown in **Figure 1**.

Traffic Analysis Tools

For signalized and stop-controlled intersections the Synchro/SimTraffic traffic analysis software program was used to analyze operations. For roundabout intersections, the Sidra traffic analysis program was used to analyze operations.

Operational Results

An operational and queuing analysis was conducted at the study intersections. All intersections meet their respective jurisdictional mobility standards, with the exception of Murphy Road/Brookwood Boulevard roundabout. This location is forecasted to have a V/C ratio of 1.13, which exceeds the City of Bend mobility standard of less than 1.0 V/C. This intersection is also the only study location expected to experience queuing deficiencies. In this scenario, the US 97 ramps to and from the north to Murphy Road are not provided; therefore, additional traffic is present on the local arterials.

This problem will be alleviated with the completion of the interchange ramps to and from the north and the construction of the local street network surrounding the interchange. The ramp and local street improvements are expected to occur in the 20-year planning horizon, so no mitigation is proposed for the Murphy Road/Brookwood Boulevard intersection.

A freeway segment analysis was conducted. All segments are forecast to pass in the Future Build Scenario.

Table 3-2 provides intersection operational results for the Future Build scenario.

TABLE 3-2
 Future Build Traffic Analysis Results

ID	Intersection	Control Type	Mobility Standard	Average Vehicle Delay (sec)	Level-of-Service	V/C Ratio
1	Pinebrook Blvd/Brookswood Blvd	TWSC	< 50s and < 1.0 V/C	51.4	F (WB)	0.64/ 0.36 ^a
2	Pinebrook Blvd/3rd Street	Roundabout	< 1.0 V/C	15.8	C	0.67
3	Murphy Road/Brookswood Blvd	Roundabout	< 1.0 V/C	33.5	D	1.13
4	Murphy Road/3rd Street	Roundabout	< 1.0 V/C	15.4	C	0.82
5	Murphy Road/Parrell Road	Roundabout	< 1.0 V/C	7.8	A	0.70

Notes:

^a V/C is reported for major/minor approach

Black highlighting indicates intersection does not meet mobility standards

Reported roundabout MOE are based on NCHRP 572 Methodology. Reported level-of-service is based on HCM signalized thresholds; worst operating movement shown for two-way stop controlled intersections.

TWSC = two-way stop controlled
 WB =

3.10.2 Construction Staging and Temporary Protection

The proposed bridge concepts for this project include several different bridge types. The staging concept presented assumes the selected bridge type will utilize precast prestressed concrete box beams or precast prestressed girders. A different bridge type will require a variation to the construction methods, staging, and associated traffic control discussed below.

Stage 1

The main goal of this stage is to construct both the Murphy Road and 3rd Street structures while maintaining most of the existing traffic movements through the project corridor. In addition to the two structures, Murphy Road will be constructed from the west concrete edge of the 3rd Street roundabout to the east concrete edge of the Brookswood Boulevard roundabout. The entire southbound on-ramp will also be constructed along with the pedestrian and bike path west of US 97. Construction activities on US 97 will include median paving and a concrete median barrier. The new concrete median barrier on US 97 will only be constructed to Pinebrook Boulevard. The existing intersection of Pinebrook Boulevard and US 97 will remain open to left turning movements onto US 97 for Stages 2 and 3. Temporary paving will be required along the outside shoulders of US 97 at both structures in order to shift traffic away from bridge pier construction in the median. Existing traffic will be maintained on 3rd Street, Brookswood Boulevard, and Parrell Road.

Stage 2

Elements of Stage 2 will be to construct the western half of the Brookswood Boulevard roundabout and alignments including Larkwood Drive, all of the northbound off-ramp, 3rd Street from the overpass to Sta. '3rd' 192+75, and the eastern half of the 3rd Street

roundabout including Murphy Road east to the concrete edge of the Parrell Road roundabout. Station '3rd' 192+75 is an ideal work zone limit because the vertical differences between the existing and proposed design are minimal and local access can be maintained to the northern driveways to Les Schwab Tire Center and Central Lakes Marina.

Construction in this stage will close the existing northbound off-ramp from US 97 to 3rd Street and the existing 3rd Street at-grade intersection with US 97. Only local access will be allowed south of the existing 3rd Street and Murphy Road intersection. This provided local access will use the two southbound lanes of 3rd Street, converted to one southbound and one northbound, for Les Schwab Tire Center and Central Lakes Marina.

Northbound Brookswood Boulevard traffic will be maintained during Stage 2. However, southbound Brookswood Boulevard will require a detour to bypass the work zone via Pinebrook Boulevard, US 97, and Ponderosa Street before returning to the southbound Brookswood Boulevard route.

Existing traffic on 3rd Street will be directed to US 97 through Pinebrook Boulevard. A temporary signal is proposed at the intersection of 3rd Street and Pinebrook Boulevard to help facilitate increased traffic volumes that will be redirected through this intersection.

Stage 3

The main goal of this stage is to construct the eastern half of the Brookswood Boulevard roundabout and alignment, the western half of the 3rd Street roundabout, and the entire Parrell Road roundabout including all approach legs. A side street approach will also be constructed to connect the new Murphy Road to existing Murphy Road just west of the proposed Murphy Road/Parrell Road roundabout.

Northbound Brookswood Boulevard traffic will shift to the completed half of the Brookswood Boulevard roundabout and Larkwood Drive will be open to traffic. Southbound Brookswood Boulevard traffic will use the same detour as in Stage 2 to bypass construction. Detouring northbound Brookswood Boulevard would require motorists to travel south to the Knott Road interchange, the first available outlet to northbound US 97. This seemed impractical and was eliminated as a detour option.

Local access to Les Schwab Tire Center and Central Lakes Marina will shift to the completed half of the 3rd Street roundabout.

Traffic approaching the Parrell Road roundabout from Murphy Road and Parrell Road will be detoured around the construction zone. Existing traffic westbound on Murphy Road wanting to go northbound on 3rd Street or US 97 will be detoured through Tapadera Street, Silver Sage Street, Parrell Road, and Badger Road.

Westbound Murphy Road traffic wanting to travel southbound on US 97 will be detoured to the Knott Road interchange via Country Club Drive.

Southbound Parrell Road traffic wanting to continue on Parrell Road will be detoured through Silver Sage Street, Tapadera Street, Murphy Road, Country Club Drive, Knott Road, and China Hat Road before returning to Parrell Road.

Southbound Parrell Road traffic wanting to access Murphy Road will only use the Silver Sage Street and Tapadera Street portion of the detour.

Northbound Parrell Road traffic wanting to access Murphy Road will use the China Hat Road, Knott Road, and Country Club Drive portions of the detour.

Stage 4

The final stage of construction will consist of minor activities including finishing splitter island work at the Brookswood Boulevard and 3rd Street roundabouts, intersection paving at Pinebrook Boulevard and Brookswood Boulevard as well as at 3rd Street and existing Murphy Road, and a new concrete median barrier through the Pinebrook Boulevard and US 97 intersection. All new roads will be open to traffic at the start of this stage.

3.11 Stormwater

The *US 97 Murphy Road- Brookswood Boulevard to Parrell Road Project* entails both new and redevelopment of city right-of-way along the Murphy Road Corridor between Brookswood Boulevard and Parrell Road. The majority of the project is owned by the City of Bend, with portions owned by ODOT. Accordingly, the proposed stormwater management plan was designed to meet the most stringent of the City of Bend, Central Oregon Stormwater Management (COSM), and ODOT standards. A more complete report of the stormwater management plan and analysis is provided in Appendix I.

Existing drainage within the project right-of-way is limited. The project location makes discharging stormwater runoff to the Deschutes River unfeasible. Consequently, what limited drainage does exist consists primarily of inlets and dry wells. Injection systems, such as dry wells, are regulated by the Oregon Department of Environmental Quality as underground injection controls (UICs). The City has expressed a preference for avoiding UICs for stormwater purposes where possible.

In order to meet the most stringent design standards and avoid using drywells, a system combining six vegetated infiltration swales and one vegetated filter strips is proposed. Both treatment facilities are approved in the COSM and ODOT Hydraulics Manual as stormwater Best Management Practices for removing pollutants of concern such as total suspended solids, oils and grease, heavy metals, and polycyclic aromatic hydrocarbons (PAHs) (COIC, 2010, Ch. 6; ODOT, 2003, Ch. 14). The infiltration swales are designed to serve as storage for runoff during the 25-year design storm, in accordance with COSM requirements, to avoid using dry wells.

Stormwater will be collected with CG-3 (Sidewalk Catch Basin) inlets along Brookswood Boulevard, Murphy Road, 3rd Street, and Parrell Road, including roundabouts. G-2 (Catch Basin Double) inlets will be used along the US 97 northbound ramp down-station to B505+00. Beyond that point, runoff will be collected in a vee-ditch. Stormwater draining off the US 97 southbound ramp is designed to run off and collect on the vegetated filter strip system. It does not require inlets. Inlet placement analysis was not performed as a part of this design effort, but will be performed in the next design phase.

3.12 Utility Conflict Analysis

Existing utility locations that are shown in the plans of Appendix A were obtained from several sources including field surveys of the One-Call field marks, as-built drawings, and communications with utility owners. Direct contact with the utility owners has provided

additional verification of their location, and reinforced a tentative project schedule relative to possible relocation requirements. Contact with the utility owners also provided information regarding prior rights to current locations, and reimbursement if relocation becomes necessary. Of the seven franchise utilities and one public agency that may be impacted and required to relocate, preliminary reviews indicate that three will fall into the reimbursable category and will be included in the overall project construction cost. Unless otherwise mentioned below, the relocation costs will be covered by the private utility company.

Impacts to utilities from the preliminary project designs vary with each utility and range from a watch condition during construction to some that will require relocation. Each utility owner will be responsible for the design and construction of their facility. Relocation notices and schedules will be according to ODOT processes and the OAR Chapter 734-055.

In some cases the preliminarily identified conflicts will require a closer evaluation to determine a more exacting vertical and horizontal location. This will be completed during the next phase of design and will aid in the development of the final conflict list and the ODOT certification of the proposed relocation designs.

Table 3-3 includes current contact information for utilities in the project area.

TABLE 3-3
 Utility Company Contact Information

Utility	Company Name	Contact Person	Phone
Sanitary Sewer	City of Bend, Public Work Department	Jim Wodrich	541-693-2190
Irrigation Water Supply	Arnold Irrigation	Shawn Gerdes	541-382-7664
Cable Communications Service	Bend Broadband	Jeff Liberty	541-388-5820
Natural Gas Supply	Cascade Natural Gas	Donna Dunlap	541-382-6465
Electric Power Supply	Pacific Power	Mike Bower	541-388-7167
Communication Service	Qwest	Bob Kitchen	541-385-0224
Potable Water Supply	Roats Water	Casey Roats	541-382-3029
Potable Water Supply	Avion Water Company	Mike Heffernan	541-382-5342

A preliminary status of each utility is summarized in the following paragraphs.

Arnold Irrigation

Arnold Irrigation has buried piped and ditch facilities west and generally parallel to the US 97 Parkway. They hold easements for access and maintenance of these facilities that are required to remain open at all times.

There are potential conflicts with this irrigation water supply system at the west end of both proposed bridges. The proposed roadway on the west side of the Murphy Road Bridge will cross over the buried pipeline portion of the facility approximately 75 feet south of the

concrete vault outlet structure. It appears that direct impacts to the vault will be avoided. Because this is a gravity system, vertical relocation is not feasible. Roadway construction may require that the pipe be horizontally relocated to gain minimum cover for the new pavement section, or be encased for the required roadway support.

A second conflict will occur with a segment of the open ditch at the west side of the 3rd Street Bridge. At this location, direct impacts from embankment construction are expected where the roadway turns southbound to the US 97 on-ramp. A concrete inlet structure located approximately 25 feet north of the proposed embankment may or may not also be impacted. Relocation of this structure may be required as a result of a south-end pipeline extension under the proposed roadway embankment.

A third potential conflict occurs with the construction of the northbound off ramp to 3rd Street. At this location a buried irrigation supply pipe extends east-west under US 97 and the existing off-ramp to supply water to the east side of these roadways, which may or may not need to be maintained. Direct conflict may be avoided however; extensive embankment fill to 10 feet above the existing ground is expected at the crossing that may create issues for access and service. Close coordination with Arnold Irrigation will be necessary to resolve these conflicts and identify a best place for relocation.

Existing conditions including easements and previous relocations during construction of the US 97 Parkway indicate that costs to resolve these conflicts will be part of the overall project costs. Steps will be taken during final design to minimize impacts to this facility.

Bend Broadband

Bend Broadband has cable facilities generally limited to three areas of the project. These include the Murphy Road intersections with Brookswood Boulevard, 3rd Street, and Parrell Road. The majority of Bend Broadband facilities are overhead on Pacific Power poles where conflicts will be resolved with the pole relocations. Underground conflicts will occur when a pole is required to relocate and is connected to underground facilities, or where conflicts occur from direct project construction of roadway or storm water conveyance. A verification of horizontal and vertical location will be necessary during final design to identify the direct underground conflicts.

At the Brookswood Boulevard intersection, a relocation of at least two poles and one underground line will be required. The underground cable drops from one of the power poles and extends westerly from the intersection to serve a residential network.

At the 3rd Street intersection, all Bend Broadband cable is overhead and will be impacted with the required move of at least three power poles.

The Parrell Road impacts include one underground cable that extends south from the south leg of the roundabout and the required relocation of at least six poles.

Coordination will be necessary with Bend Broadband during final design to verify any requests they have that incorporates their facilities into duct banks of the proposed bridges.

Cascade Natural Gas

Cascade Natural Gas has pipeline facilities at the three project intersections of Brookswood Boulevard, 3rd Street, and Parrell Road. These transmission pipelines provide

local service to businesses and residential areas. Potential impacts to the gas lines exist at each location from direct construction of the roadway elements and storm drainage conveyance system. Depths for the pipes have not been verified, but are assumed to be within the typical range of 3 to 4 feet. Conflicts and pipe relocations may be avoided if roadway excavation depths do not exceed the specified maximum that allows sufficient cover. Potholing will be necessary during final design to verify clearance.

At the Brookswood Boulevard intersection, a gas line extends along the north side of the right-of-way through the project limits with a T-connection at Larkwood Drive that provides service to residential areas north of the project. Conflicts at this intersection are possible based on the preliminary location of the roundabout and required storm system.

The 3rd Street roundabout may also create impacts to Cascade Natural Gas facilities. At this location, two pipelines extend north-south on each side of 3rd Street. The project proposes to construct a roundabout that is elevated above the existing surface by as much as 2 feet – which could help eliminate conflicts by allowing construction to occur over the top of these existing facilities. The gas lines connect to one pipe south of the roundabout and extend further south along the west side of 3rd Street eventually crossing US 97. Coordination with Cascade Natural Gas will include evaluating their existing location along this corridor south of the roundabout relative to the proposed project that includes constructing embank fills with depths to 15 feet above the existing surface. The fill are proposed as the approach to the US 97 crossover bridge.

Gas lines currently extend along the east side of Parrell Road north of the intersection and along the west side of Parrell Road south of the intersection with Murphy Road. These are supplied with a pipeline from the existing Murphy Road, with connections on the south side of the intersection. Conflicts at this intersection are possible based on the preliminary location of the roundabout and required storm system.

Pacific Power

Pacific Power is the only electric power service provider within the project limits having both overhead and underground facilities. Significant impacts are expected to these facilities and include removals and relocations in all areas that they currently exist.

Design of the Brookswood Boulevard roundabout and approaches will require relocation of several poles including at least two along the new south leg alignment of Murphy Road, and the possible relocation of several underground facilities. Direct impacts to existing buried lines will occur where poles that supply these underground facilities are required to move. Existing buried electric lines are located at the east and west end limits of Brookswood Boulevard, and the ends of the proposed Larkwood Drive and Pinebrook Boulevard. Each of these project locations will need to be coordinated with Pacific Power to identify conflicts and design resolutions.

The proposed construction of the 3rd Street roundabout with Murphy Road and the 3rd Street extension to the bridge over US 97 will create numerous impacts to Pacific Power. These include the relocation of a transmission line and at least three supporting steel poles on the east side of 3rd Street. This transmission line corridor extends through the project limits on steel poles. Several of these poles adjacent to the new 3rd Street alignment south of the roundabout fall within the embankment fill limits and may also need to be relocated.

Close coordination will be necessary during final project design to evaluate alternatives and need for the relocation of these poles.

Other conflicts may occur with the existing underground power lines and supply poles that extend along the existing off-ramp to 3rd Street. At this location, a new off-ramp is proposed that will include embankment fill over these existing buried power lines.

Power poles on the west side, south of the proposed 3rd Street Bridge, will not all be clear of conflict. At this location, at least three wood transmission poles will be impacted by the proposed southbound on-ramp. These poles and alignment will need to be designed for relocation or eliminated with an underground design.

At the proposed Parrell Road roundabout with Murphy Road, no underground facilities have been identified within the project limits. Pacific Power conflicts are all expected to be resolved with pole relocation designs.

Coordination will be necessary with Pacific Power during final design to verify any requests they have that incorporates their facilities into duct banks of the proposed bridges.

Qwest

Qwest owns communication facilities at each of the three existing roadway locations proposed for reconstruction including Brookswood Boulevard, 3rd Street, and Parrell Road. The majority of Qwest is underground and provides service to businesses and residential areas, but also includes a network distribution center near the proposed 3rd Street roundabout. Potential impacts to these facilities are likely from direct construction of the roadway elements and storm drainage conveyance systems. Depths for the lines vary, but have been typically placed at approximately 2.5' below the existing surface. Preliminarily identified conflicts will need a closer review with possible potholing during final design to verify relocations needs.

At the Brookswood Boulevard intersection, Qwest has fiber optic lines that extend along the south side of Brookswood Boulevard west of the proposed roundabout, and along the north side of Brookswood Boulevard east of the roundabout. They also own service lines that branch into Larkwood Drive and Pinebrook Boulevard. Coordination will be necessary with Qwest to verify any request to construct new facilities along the proposed new alignment of Murphy Road and within the duct banks of the proposed bridge between the roundabouts at Brookswood Boulevard and 3rd Street.

The proposed roundabout at 3rd Street will generate conflicts with the Qwest underground facilities. The existing locations include various lines that extend north and south along both sides of 3rd Street through the project limits. Qwest also owns a distributions shack located southwest of the proposed roundabout that does not appear to be directly impacted with the project. The nearby facilities that lead to this distribution center may, however, require relocation.

At the Parrell Road intersection, Qwest owns several communication lines that include fiber optic on the north side of Murphy Road and extending through the project limits. They also have facilities on the east and west sides of Parrell Road that will likely be impacted with the proposed roundabout.

Roats Water

Roats Water has a network of water supply pipelines that extend throughout the project limits. Impacts to these pipelines are likely at each of the proposed project intersections from the direct construction of roadway, bridge, and storm drainage conveyance systems. Roadway construction may require that pipe be horizontally or vertically relocated to gain minimum cover for the new pavement section or may require relocation to provide adequate spacing to a proposed storm drain system. Depths vary throughout each construction area which confirms the need to identify potential conflicts with a closer review of available as-built drawings and potholing during final design.

At the Brookwood Boulevard intersection, Roats Water has a line that extends along the south side of Brookwood Boulevard east of the proposed roundabout then connects to a pipeline that runs south along Pinebrook Boulevard. Conflicts with Roats Water in this area may be avoided based on current project match limits on Brookwood and Pinebrook Boulevards.

Roats Water has joined Avion Water with a request that would allow construction of a new 16-inch Murphy Road water supply main between US 97 and the proposed Brookwood Boulevard roundabout. This water main would follow the new Murphy Road alignment and optimally be constructed after the permanent right-of-way has been acquired, but before the beginning of roadway construction.

It appears that construction of the proposed 3rd Street roundabout may have little direct impact to the Roats Water system. However, the south and east legs of the roundabout cross water mains that will need further evaluation for conflicts. The new alignment of Murphy Road west of the roundabout crosses over US 97 with a proposed bridge. Both bridge abutments create a direct impact to a 12-inch Roats Water main that will need to be relocated. Close coordination with Roats Water will be necessary to resolve this conflict and identify a best place for relocation. Existing conditions including easements and previous relocations during construction of the US 97 Parkway indicate that costs to resolve these conflicts may be part of the overall project costs.

Roats Water has pipelines at and near the intersection of Murphy Road and Parrell Road, where conflicts are likely with construction of the proposed roundabout. It appears that some water pipelines are in locations where impacts can be avoided. These include segments of the north and east legs of the roundabout. Preliminarily identified conflicts will need a closer review with potholing during final design to verify relocation needs.

Avion Water

Avion Water is limited to the Brookwood Boulevard intersection where a roundabout with the new Murphy Road is proposed. Impacts to their pipelines are likely from the direct construction of roadway elements and storm drainage conveyance systems. Roadway construction may require that the pipe be horizontally or vertically relocated to gain minimum cover for the new pavement section or may require relocation to provide adequate spacing to a proposed storm drain pipe. Depths vary through the construction limits, which confirms the need to identify potential conflicts with a closer review of available as-built drawings and potholing during final design.

West of the Brookswood Boulevard intersection with Larkwood Drive, Avion Water has an 8-inch supply line that extends along the south side of Brookswood Boulevard to the intersection, then crosses and runs along the north side. They also own a 12-inch water main that crosses Brookswood Boulevard and extends north into Larkwood Drive and south along a gravel alleyway. This south extension is the location of the proposed south leg of the roundabout and the new Murphy Road alignment.

Avion Water has joined Roats Water with a request that would allow construction of a new 16-inch Murphy Road water supply main between US 97 and the proposed Brookswood Boulevard roundabout. This water main would follow the new Murphy Road alignment and optimally be constructed after the permanent right-of-way has been acquired, but before the beginning of roadway construction.

City of Bend Public Works, Sanitary Sewer

Impacts to the City of Bend sanitary sewer system are expected in two general areas of the project. These include 3rd Street from the northern limits of the project to the bridge for the southbound US 97 on-ramp, and the Parrell Road and Murphy Road intersection. Results from conflicts with the sanitary sewer system will range from required relocations to manhole rim adjustments. Final resolution to these conflicts will involve further investigation that identifies impacts to existing local service lines and alternative analysis for the realignment designs. Close coordination will be required with the City of Bend to develop adequate resolutions to conflicts.

The most significant impacts involve the 3rd Street 15-inch crossing of US 97 and the 12-inch sanitary main that extends north-south along the west side of 3rd Street. The 15-inch main that crosses US 97 is in direct conflict with the west abutment of the proposed southbound on-ramp bridge and will need to be relocated. The 12-inch main and connecting manholes are in direct conflict with the embankment fill to construct the bridge approach and northbound US 97 off-ramp. The preliminary roadway design shows as much as 15 feet above the existing ground at the ramp end. These two sanitary mains are connected in one run of pipe and allow a more simplified approach to the analysis and design for the relocation.

At the proposed Parrell Road roundabout with Murphy Road, the City of Bend has sanitary sewer mains that extend east-west through the intersection along Murphy Road and north-south along Parrell Road. Project impacts to these pipelines will likely be limited to minor realignments and manhole surface rim adjustments.

ODOT Region 4

ODOT has buried electrical lines that will be directly impacted by the project at the existing intersection of US 97 and 3rd Street. The majority of these are service lines providing power for illumination, and traffic signals. Partial relocation of these facilities may be required during construction to accommodate the staging. Any permanent conflicts will be resolved through the ultimate removal of the signal system. Verified locations and temporary connections will be required before and during construction.

3.13 Environmental Impacts and Mitigation Measures

Environmental Considerations

Archaeological. A late-historic domestic debris scatter and six modern or historic-era rock features were identified during the field investigation. The rock features could not be dated to a specific year, nor could their construction be associated with a specific person. The debris scatter dates to the late 1950s or early 1960s. Because the scatter is not 75 years of age or older, it does not meet the Oregon State Historic Preservation Office guidelines for site recordation and was not recorded as a historic-era archaeological site. No prehistoric (Native American) archaeological sites were discovered.

In the unlikely event that archaeological material is encountered during construction of the proposed roadways, an archaeologist should be notified immediately and work halted in the vicinity of the finds until they can be inspected and assessed. The Oregon Revised Statutes (ORS) 358.905 to 955 should also be consulted for inadvertent discovery requirements.

Biological Resources. The investigation found no state or federal threatened, endangered, or candidate plant species and no plant species identified as federal species of concern, state-sensitive, or state-strategy plant species.

The investigation found suitable habitat for migratory birds in the ponderosa-pine-forested area west of US 97. Impacts to migratory birds could be avoided by conducting any tree cutting, grubbing, or clearing activities between September 1 and March 1 to avoid disturbance to nesting birds and their young. If such activities need to be conducted during the nesting season (March 1 through August 31), a qualified wildlife biologist will be required to survey the area for the presence of active nests. If active nests were present, all efforts will be required to modify the project activities to avoid disturbing the nests.

If potential impacts to nesting birds are anticipated, the Animal and Plant Health Inspection Service (APHIS) at the U.S. Department of Agriculture (USDA) would be notified well in advance of project activities.

Hazardous Materials. Sixteen sites were identified as features of potential environmental concern. Of those sites, 4 are within or adjacent to the footprint of the primary study area (the proposed roadway alignments) and 12 are within the secondary study area (0.5 mile from project improvements).

Construction activities in and around these features of potential environmental concern could disturb hazardous materials (also called contaminated media or contaminants of potential concern [COPCs]), if present. This disturbance, in turn, could result in potential risk to the environment or human health. COPCs at these sites include total petroleum hydrocarbons (TPH) and a range of other chemicals. Table 3-4 shows the name, address, and possible COPCs that may be associated with each of the 16 features of potential environmental concern identified.

TABLE 3-4
 Features of Potential Environmental Concern

Feature ID	Contaminant of Potential Concern ^a	Name	Address	Federal or State Program	Source ^b
Primary Study Area (parcel within project footprint)					
1	TPH, PAH, VOC, inorg ^c	WalMart	20120 Pinebrook Boulevard	UIC	EDR
2	VOC	Central Oregon Dry Cleaner	61137 South 3rd Street	ECSI	EDR, ECSI
3	TPH, PAH, VOC	Arco AM/PM	61122 South 3rd Street	UST	EDR
4	TPH, PAH, VOC	Bend Chevron #80	61160 South 3rd Street	UST	EDR, ECSI
Secondary Study Area (0.5 mile of project footprint)					
5	TPH, PAH, VOC	Butler Market Store	61396 South 3rd Street	LUST	EDR
6	TPH, PAH, VOC	Tosco 4753	61345 South 3rd Street	LUST	EDR
7	TPH, PAH, VOC, inorg	Goodyear	61335 South 3rd Street	LUST	EDR, ECSI
8	TPH, PAH, VOC	Prosser Rentals	61331 S. 3rd Street.	UST	EDR
9	VOC, inorg	Nosler Bullets Inc.	61396 Parrell Road	ECSI	EDR, ECSI
10	TPH, PAH, VOC, PCB, inorg	Jake's Truck Stop	61260 S. 3rd Street	ECSI/VCP	EDR, ECSI
11	TPH, PAH, VOC, PCB, inorg	Pacific Auto Wrecking	20135 Badger Road	ECSI	EDR, ECSI
12	TPH, PAH, VOC	Bend Oil Company	61221 South 3rd Street	UST	EDR, ECSI
13	TPH, PAH, VOC, PCB	Briteway Collision & Glass LLC	61235 Parrell Road	RCRA	EDR, ECSI
14	VOC, PAH,TPH	Porcupine Subdivision	19920 Porcupine Road	UIC	EDR
15	VOC, PAH,TPH	Laurel Springs Subdivision	20021 Bader Road	UIC	EDR
16	VOC, PAH,TPH	Fox Hills Mobile Park	61030 Lodge Pole Drive	UIC	EDR

Notes:

^a This list is based on the Environmental Data Resources, Inc., (EDR) report (EDR, 2010a), the ECSI database (Oregon Department of Environmental Quality [DEQ], 2010), and best professional judgment.

^b EDR source is the EDR, report (EDR, 2010a)

^c inorg stands for inorganic constituents such as lead, copper, chromium, and zinc.

LUST = leaking underground storage tank programs

PAH = polycyclic aromatic hydrocarbon, a by-product of incomplete combustion

RCRA = Resource Conservation and Recovery Act of 1976

TPH = total petroleum hydrocarbons, such as gasoline, diesel, heating oil, and motor oil

UIC = underground injection control

UST =underground storage tank programs

VOC =volatile organic compound, such as cleaning solvents, degreasers, and paint thinners

VCP =

Waterways. An unnamed canal flows southwest to northeast through the study area. It flows above ground north and south of the proposed extension of Murphy Road west of US 97, and adjacent to a proposed off-ramp in the southern portion of the study area. An approximately 1,300-foot segment of this stream flows in a pipe or culvert below ground. The proposed extension of Murphy Road would cross the canal where it is below ground. The canal is connected upstream to the Arnold Canal and downstream to the Central Oregon Canal.

Permits. The environmental permits and approvals will be sought during the final design process. Anticipated permits are shown in Table 3-5.

TABLE 3-5
Anticipated Permits

Regulatory Agency	Permit/Action Required	Comments
Oregon Department of Environmental Quality	National Pollutant Discharge Elimination System 1200-C	Section 402 of the Clean Water Act
Oregon State Historic Preservation Office	Archaeology survey concurrence	
United States Department of Agriculture	Migratory Bird Take permit	Required only if nesting birds are impacted
City of Bend	Noise variance	Construction work outside of permissible hours and noise level

Mitigation Measures and Environmental Commitments

Table 3-6 summarizes project-specific mitigation measures and environmental commitments from the environmental documentation phase of the project.

TABLE 3-6
Summary of Mitigation Measures and Environmental Commitments

Biological Resources

If feasible, conduct tree cutting, grubbing, or clearing activities between September 1 and March 1 to avoid disturbance to nesting birds and their young. If such activities must be conducted during the nesting season (March 1 through August 31), a qualified wildlife biologist should survey the area for the presence of active nests. If active nests are present, all efforts will be made to modify the project activities to avoid disturbing the nests.

If potential impacts to nesting birds are anticipated, the Animal and Plant Health Inspection Service (APHIS) at the United State Department of Agriculture (USDA) should be notified in advance of project activities. The local contact person for this APHIS service in the Bend area is:

Diane Winterboer
Wildlife Biologist
P.O. Box 533
Lebanon, OR 97355
(541) 258-2189

Cultural Resources

In the unlikely event that archaeological material is encountered during construction:

- Notify the Oregon Department of Transportation (ODOT) archaeologist and immediately halt work in the vicinity of the finds until they can be inspected and assessed.
- Consult Oregon Revised Statutes (ORS 358.905 to 955) for inadvertent discovery requirements.

Hazardous Materials

- Conduct a lead and asbestos survey of the existing bridge before construction or demolition. This work should include an analysis of existing paint layers for total and toxicity characteristic leaching procedures for heavy metals, such as cadmium, chromium, zinc, and lead.
 - Investigate and address areas of known contaminated soil before or during construction to limit exacerbation. These measures could include direct removal of contaminated media, capping or covering contaminated soils, and pumping contaminated groundwater from impacted aquifers.
 - Implement construction-phase monitoring to identify and manage unknown or unanticipated media.
 - Characterize waste generated during construction (such as excavated soil, wastewater, and construction debris) and assign each waste stream to appropriate waste-disposal facilities.
 - Avoid cross-contamination or carryover of contaminated material to clean areas.
 - Control stormwater runoff from the construction site.
 - Identify appropriate waste disposal for all waste streams.
 - Limit access to contaminated areas.
-

3.14 Construction Cost Estimate Summary

Preliminary construction costs have been estimated for both the roadway and bridge improvements. Appendix J contains the detailed cost estimates. The estimated costs are presented in 2014 dollars which approximately represents the middle of the three year construction project. Project construction costs vary based on the bridge type. The estimate included in Appendix J assumes the precast prestressed box beam bridge type for the Murphy Road and 3rd Street bridges. The estimated construction cost for the project is \$17,574,000.

The cost estimate includes a contingency calculated on construction costs, accounting for the preliminary design level of this project. Final project costs will vary from those presented in this document and will depend on actual labor and material costs, competitive market conditions, and final project scope, among other variables.

3.15 Project Schedule

Construction Schedule Summary

A preliminary construction schedule is provided in Appendix K. The construction duration of the project is estimated to be 32 months from the construction notice to proceed to final completion. Assuming an April 2013 start, the project would be completed and opened to traffic by October 2015.

The critical path for the preliminary schedule, described by major construction activities, is as follows:

- Begin 3rd Street Bridge construction
- Begin Murphy Road Bridge construction
- Build detours and temporary roadways
- Construct roundabouts
- Complete paving and drainage

The preliminary construction schedule was developed assuming that minimal construction work will occur in the winter season. The work window for structures was assumed to be from April 1 through October 31 and from June 1 to October 31 for road construction.

SECTION 4

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. *A Policy on Geometric Design of Highways and Streets*.

American Association of State Highway and Transportation Officials (AASHTO). 1990. *A Policy on Geometric Design of Highways and Streets*.

Central Oregon Intergovernmental Council (COIC). 2010. *Central Oregon Stormwater Manual*. Updated August.

City of Bend. 2006. *Design Standards*. June.

Oregon Department of Transportation (ODOT). 2003. *Highway Design Manual*.

