

US 97 AT REED MARKET ROAD OPERATIONS AND SAFETY STUDY – FINAL REPORT

SEPTEMBER 8, 2023

PREPARED FOR:

OREGON DEPARTMENT OF TRANSPORTATION

CITY OF BEND



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EXECUTIVE SUMMARY

PROJECT PURPOSE

Reed Market Road is a critical east-west travel corridor and a priority for addressing mobility during the most recent Bend Transportation System Plan/Metropolitan Transportation Plan (TSP/MTP) update. As one of the few crossings of the Deschutes River and US 97, Reed Market Road is heavily relied upon for access to much of southern Bend, as well as popular destinations such as the Old Mill District, riverfront, Mount Bachelor, and Cascade Lakes Scenic Byway. The corridor has multiple operations and safety deficiencies that compound to create a significant east-west bottleneck. Furthermore, one of the key findings from the US 97 Parkway Plan is that Reed Market Road congestion limits the ability of any interchange improvements to function adequately, leading to queue spillback and one of the most critical bottlenecks on the Parkway.

As a result of these earlier planning efforts, the Oregon Department of Transportation and the City of Bend partnered to identify and fund concept-level improvement projects in the Reed Market Road corridor between Bond Street/Brookwood Boulevard and 4th Street through the City's Capital Improvement Program (CIP) and general obligation (GO) bonds. However, further project refinement and development of a coordinated plan were needed to support implementation. Therefore, the purpose of this study was to:

- Refine a set of complementary projects in the Reed Market Road study corridor between Brookwood Boulevard/Bond Street and 4th Street.
- Reduce congestion.
- Improve safety for all users.
- Align project cost with available and reasonably anticipated funding.

SYSTEMWIDE BENEFITS OF PROPOSED PROJECTS

The construction of the recommended projects will result in significant safety improvements, reductions in overall congestion, and lower levels of traffic stress for people walking and biking along the Reed Market Road corridor and surrounding Key Routes. The projects will also relieve one of the most critical long-range bottlenecks on the US 97 Parkway, which will have significant regional mobility benefits. While congestion will be reduced, it will still be pronounced in this corridor. Therefore, other systemwide improvements will be needed to reduce the demand on Reed Market Road, such as a new south river crossing or encouraging less travel by automobile.

Some of the systemwide benefits of the proposed projects include the following:

- The number of vehicle hours of delay experienced during the peak afternoon two-hour period on an average weekday will decrease by about 60 percent.
- Three street crossings on Key Routes will be improved to provide more protection for people walking and biking, improving safety for these vulnerable travelers and resulting in a lower level of traffic stress.
- Shorter vehicle queues and a new traffic signal will significantly improve safety for all users.

- Access to transportation options for low-income residents in the area will be improved with more comfortable walking and biking facilities along and across Reed Market Road and improved access to existing and future transit stops.

PREFERRED ALTERNATIVES

Figure 1 shows the study area and improvement locations. Figures and more details about the preferred alternatives are included in Attachment A – *Prospectus Sheets*. The text on the following pages summarizes the recommended intersection improvements, benefits, challenges, and cost.

This study also identified limited opportunities for people walking and biking to cross US 97 in the vicinity of the Reed Market Road overcrossing. While Reed Market Road is not a designated low-stress route, the City of Bend’s standard requires low-stress walking and biking facilities when a street is reconstructed. Providing low-stress walking and biking facilities along Reed Market Road would require reconstruction to widen the overall cross section. However, there are currently no planned or funded projects to do this. Therefore, this study includes several long-term cross section designs that may be considered in the future as opportunities arise (see Chapter 4). These designs generally consist of replacing on-street bike lanes with multiuse paths along Reed Market Road. The recommended intersection improvements listed below could be designed to support either the existing on-street bike lanes or a future multiuse path.

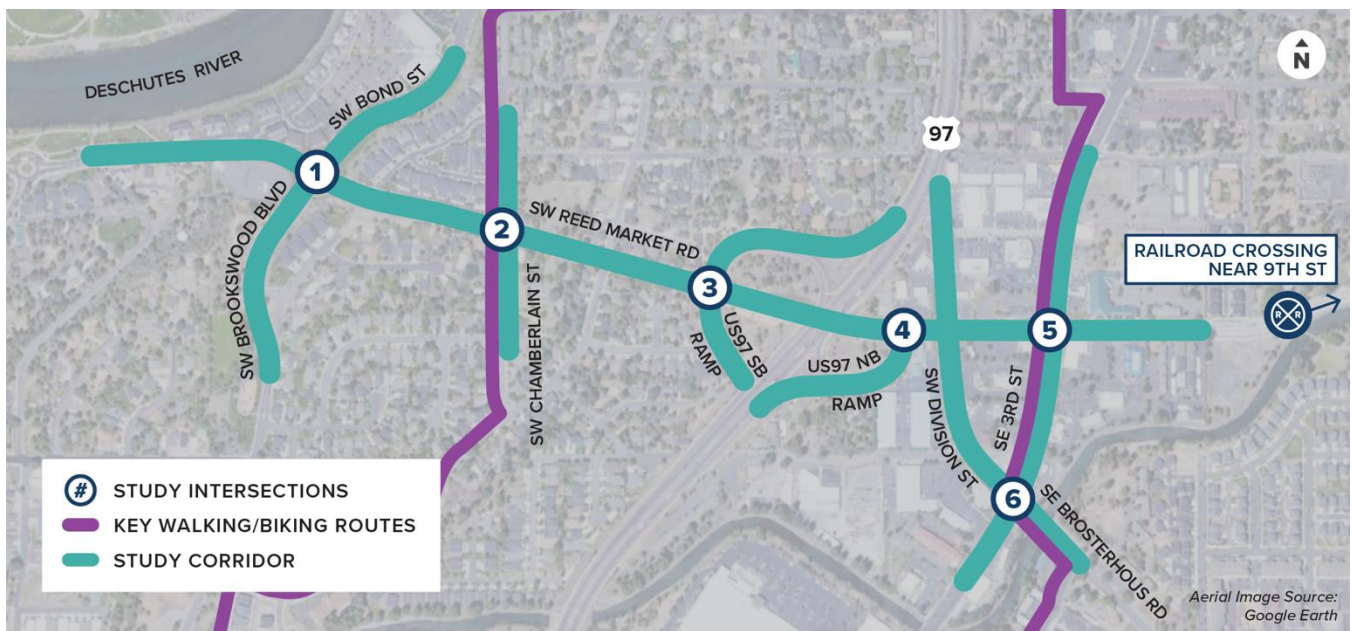


FIGURE 1. STUDY AREA AND IMPROVEMENT LOCATIONS

1. REED MARKET ROAD/BROOKSWOOD BOULEVARD/BOND STREET

Improvements

- Phase 1 - \$4 million
 - Add northbound and southbound left-turn lanes and eastbound and westbound right-turn lanes.
- Phase 2 (unfunded future phase) - \$700,000
 - Add metering signals to help balance long vehicle queues when congestion is heavy.

Benefits

- Reduces overall delay by more than 80 percent.
- Reduces the length of westbound queues and keeps them from blocking the US 97 interchange ramp intersections.
- Metering signals provide the ability to balance vehicle queues on approaches during peak times (Phase 2).
- Metering signals can provide a green light to help approaching emergency vehicles pass through the roundabout more quickly (Phase 2).

Challenges

- The metering signals will require further development of operational logic and queue detection strategies.

2. REED MARKET ROAD/CHAMBERLAIN STREET

Improvements - \$250,000

- Install a pedestrian crossing on the east approach and additional median cutouts and green pavement markings for people biking.
- Install wayfinding and warning signs for people walking and biking.
- Remove vegetation and enhance illumination for better visibility.
- Preserve space for future bus stops.

Benefits

- Improves safety and comfort for people walking and biking on the Chamberlain Street Key Route crossing Reed Market Road.

3. REED MARKET ROAD/US 97 SOUTHBOUND RAMPS

Improvements - \$5.7 million

- Construct a separate southbound right-turn lane.
- Shift the westbound bike lane adjacent to the curb and add a bike signal at the intersection.

Benefits

- Reduces conflicts between people biking and westbound right-turn vehicles.

- Improves safety by reducing the risk of vehicle queues spilling back onto the US 97 Parkway.

Challenges

- Adding a southbound right-turn lane would require widening along the US 97 off-ramp.
- Concept elements may require ODOT approval prior to implementation.
- Constructing a southbound right-turn lane could impact traffic during construction.

4. REED MARKET ROAD/US 97 NORTHBOUND RAMPS/DIVISION STREET

Improvements

- Phase 1 - \$4 million
 - Construct a traffic signal at the US 97 northbound ramp terminal and provide a northbound bike signal to provide extra protection for people biking.
 - Convert Division Street to allow only right-in and right-out movements at Reed Market Road.
 - Consider property access modifications at the north end of Division Street to increase the acceleration distance for the US 97 entrance ramp.
- Phase 2 (unfunded future phase) - \$9.4 million in total if done concurrently with Phase 1
 - Separate the northbound entrance ramp from Division Street and align the new entrance ramp with the Reed Market Road/US 97 northbound ramp signalized intersection.

Benefits

- Reduces overall delay by as much as 86 percent.
- Enhances safety for people walking and biking and reduces high-severity angle crashes by 67 percent.
- Fewer conflicting turns between Division Street and the US 97 northbound ramps could reduce overall crashes by 45 percent.
- The Phase 2 ramp realignment improves the acceleration distance for safer merging onto US 97.

Challenges

- The existing driveway access on Reed Market Road will need to be evaluated and coordinated during design.
- Concept elements may require ODOT approval prior to implementation.
- Phase 2 will require a high right-of-way cost and result in the acquisition of up to two properties.

5. REED MARKET ROAD/3RD STREET

Improvements - \$10.3 million

- Construct protected intersection treatments to improve safety for people walking and biking.
- Construct separate eastbound and westbound left-turn lanes.

Benefits

- The addition of separate left-turn lanes reduces overall delay by nearly 60 percent.

- Slows right-turning traffic, reduces pedestrian crossing distances, and protects bicycle crossings at this high-traffic intersection on the 3rd Street Key Route.
- Reduces crashes involving people walking and biking by more than 35 percent.

Challenges

- Right-of-way is constrained, with buildings present in all quadrants and overhead utilities running along the south and east sides of the streets.
- The protected intersection design will be more challenging to maintain, particularly with respect to snow removal.
- Design refinements will be needed to reduce anticipated construction costs to be more in line with available funding.

6. 3RD STREET/BROSTERHOUS ROAD

Improvements

- Phase 1 - \$130,000
 - Restripe bike lanes to reduce conflicts.
 - Improve the eastbound right-turn lane striping and signing.
 - Install lighting and reflectors.
 - Change signal timing to remove conflicts for eastbound and westbound left turns.
 - Redirect people walking and biking on the canal trail to use the traffic signal to cross Brosterhous Road.
- Phase 2 (unfunded future phase) – no cost estimate available, assumed to be \$5 to \$10 million
 - Construct protected intersection treatments to improve safety for people walking and biking.
 - Construct separate eastbound and westbound left-turn lanes.
 - Construct an eastbound right-turn lane.

Benefits

- Slows right-turning traffic, reduces pedestrian crossing distances, and protects bicycle crossings at this high-traffic intersection on the 3rd Street Key Route.
- Reduces left-turning crashes by up to 99 percent.
- Reduces eastbound vehicle queues and keeps them from spilling back to Reed Market Road.

Challenges

- Phase 2 will require a full rebuild of the intersection, and given there was no funding allocated for a long-term enhancement at the intersection, this alternative would greatly exceed expected funding.
- The protected intersection design will be more challenging to maintain, particularly with respect to snow removal.

NEXT STEPS

Now that the concepts from the Bend TSP/MTP and US 97 Parkway Plan have been refined, they can be advanced to engineering design and construction as funding becomes available. Some of the City projects are already included in the CIP and Neighborhood Street Safety Program and have approved funding. This will allow improvements at the Bond Street/Brookwood Boulevard roundabout, Chamberlain Street, and Reed Market Road at 3rd Street to advance to design as early as 2024. Phase 1 of improvements on 3rd Street at Brosterhous Road may be completed by the end of 2023.

ODOT has not yet committed funding for the improvements at the US 97 ramp intersections. Next steps include seeking funding for scoping and construction through upcoming Statewide Transportation Improvement Program (STIP) cycles.

CHAPTER 1. BACKGROUND AND GOALS

1.1 STUDY BACKGROUND AND PURPOSE

Reed Market Road was identified as a critical east-west travel corridor and priority for addressing mobility in the most recent Bend Transportation System Plan/Metropolitan Transportation Plan¹ (TSP/MTP) update and the US 97 Parkway Plan.² As one of the few crossings of the Deschutes River and US 97, Reed Market Road is heavily relied upon for access to much of southern Bend, as well as popular destinations such as the Old Mill District, riverfront, Mount Bachelor, and Cascade Lakes Scenic Byway. Additionally, one of the key findings from the US 97 Parkway Plan was that Reed Market Road congestion limits the ability of any interchange improvements to function adequately, leading to queue spillback and one of the most critical bottlenecks on the Parkway.

As a result of these earlier planning efforts, the Oregon Department of Transportation (ODOT) and the City of Bend partnered to identify and fund concept-level improvement projects in the Reed Market Road corridor through the City's Capital Improvement Program (CIP) and General Obligation (GO) bonds. However, further project refinement and development of a coordinated plan were needed to support the implementation. Therefore, the purposes of this Reed Market Road Operations and Safety Study were to:

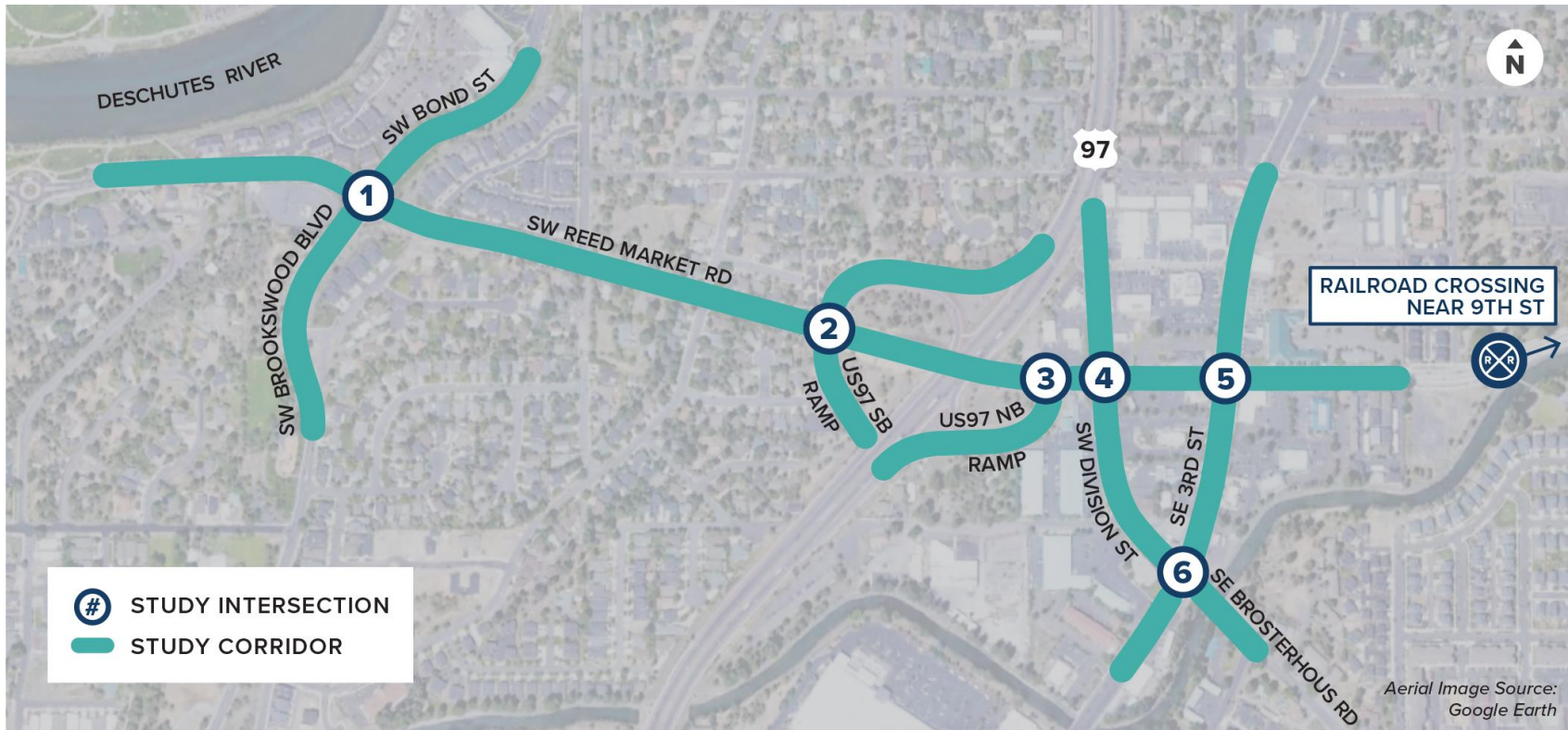
- Build upon the results of the Bend TSP/MTP and US 97 Parkway Plan and refine a set of complementary operational and safety improvement projects in the Reed Market Road study area that closely align with available funding.
- Develop planning-level concepts and updated cost estimates.
- Align existing project funding with proposed project costs and identify potential funding gaps.
- Provide a prioritized list of projects using a benefit/cost analysis.

1.2 PROJECT STUDY AREA

The study focused on Reed Market Road in the area of the US 97/Reed Market Road interchange. The western terminus was the Reed Market Road/Brookwood Boulevard/Bond Street roundabout, and the eastern terminus was the 4th Street/Reed Market Road intersection. The northern terminus was the 3rd Street/Roosevelt Avenue intersection, and the southern terminus was 3rd Street/Brosterhous Road intersection. The project study area included six study intersections where intersection operations were evaluated, as shown in Figure 2. It should be noted that operations at the Reed Market Road/Chamberlain Street intersection were not evaluated but improvements were identified.

¹ Bend Transportation System Plan, 2020, City of Bend.

² US 97 Parkway Plan, August 6, 2020, Oregon Department of Transportation.



1 REED MARKET ROAD & BROOKWOOD BOULEVARD/BOND STREET

2 REED MARKET ROAD & US 97 SOUTHBOUND

3 REED MARKET ROAD & US 97 NORTHBOUND

4 REED MARKET ROAD & DIVISION STREET

5 REED MARKET ROAD & 3RD STREET

6 3RD STREET & BROSTERHOUS ROAD

FIGURE 2. STUDY AREA

1.3 GOALS, OBJECTIVES, AND EVALUATION CRITERIA

A set of project goals, objectives, and evaluation criteria was established to guide the development of solutions for the Reed Market Road study corridor and demonstrate how well improvement alternatives met the purpose of the project. A goal is an overarching principle or a broad statement of intent that informs the range of possible transportation solutions and guides decision-making. Objectives are more specific and relevant steps that are taken to meet the goal, while evaluation criteria assess how well those objectives would be met by the alternatives considered. Table 1 shows the set of project goals, objectives, and evaluation criteria. It should be noted that the goals and objectives were numbered to facilitate referencing, but no weighting was applied and the order was not an indication of relative importance.

TABLE 1. US 97 AT REED MARKET ROAD OPERATIONS AND SAFETY STUDY GOALS, OBJECTIVES, AND EVALUATION CRITERIA

GOALS	OBJECTIVES	EVALUATION CRITERIA
1. Increase system functionality, quality, and connectivity for all users	a. Provide for efficient travel for traffic utilizing US 97.	Meets ODOT’s adopted mobility targets at the US 97 ramp terminals with Reed Market Road and Division Street through the planning horizon.
	b. Provide for efficient travel on the local roadway system in the interchange area.	Meets City of Bend mobility standards for local system study intersections through the planning horizon.
	c. Enhance bicycle and pedestrian facilities along, parallel to, and across US 97.	Based on qualitative criteria, enhances the quality of walking and biking facilities.
		Increases the frequency of low-stress pedestrian and bicycle crossings of Reed Market Road.
	Supports implementation of low-stress pedestrian and bicycle crossings of US 97.	
	Implements a planned low-stress bicycle network and key walking and biking routes in the study area.	
	d. Enhance transit facilities along, parallel to, and across US 97.	Can accommodate planned transit service improvements and expansions, including micromobility.
2. Ensure safety for all users	a. Reduce serious injuries and fatalities.	Reduces the frequency and severity of crashes, as assessed through analysis of crash data and use of Crash Modification Factors.
	b. Design and build facilities and routes that maximize safety for pedestrians and bicyclists.	Minimizes conflicts and risk factors that could lead to crashes.
		Increases the physical separation between users.
c. Move toward meeting ODOT’s adopted access spacing standards along US 97, Reed Market Road, and Division Street, or meet the standards where feasible.	Meets or improves access spacing pursuant to ODOT’s adopted access spacing standards.	
3. Support economic development	a. Maintain effective access to properties along Reed Market Road and Division Street in a manner that supports the economic development objectives of existing and future businesses, consistent with the Bend Comprehensive Plan.	Maintains accessibility to properties consistent with the documented needs of existing land uses, City of Bend standards, and anticipated potential needs of future uses based on Comprehensive Plan designations.
	b. Develop an interchange design that facilitates truck freight movement along US 97 and to and from destinations along Reed Market Road.	Proposed interchange geometry, such as curves, clearances, and grades, accommodates trucks and oversize vehicles while finding an appropriate balance with the needs of people walking and biking.
4. Protect livability and ensure equity and access	a. Incorporate a complete streets approach along the Reed Market Road corridor through the interchange area.	Based on qualitative criteria, addresses existing barriers for people walking and biking across or along Reed Market Road.
		Can accommodate planned transit service improvements and expansions.
	b. Strive for people of all income levels and abilities to have access to the transportation options that best meet their needs.	Impacts to properties owned, used by, or accessed by historically underrepresented community members are proportionate to those of other populations.
5. Steward the environment	a. Reduce vehicle emissions through reduction of vehicular delay, improved connections in the local system, and the use of alternative travel modes.	Qualitatively assesses reductions in vehicular delay and vehicle-miles traveled, as well as improvements supporting walking, biking, and use of transit.
6. Develop solutions that are cost-effective and implementable	a. Prioritize low-cost, high-benefit solutions.	Based on qualitative criteria, finds solutions that are effective at addressing goals and objectives compared to costs and would reasonably fit within funding expectations for project partners.
	b. Prioritize solutions that that leverage partnerships, existing planned projects, and programs.	Creates solutions that are compatible with recommendations from the US 97 Parkway Plan, Bend TSP/MTP, and planned Bend CIP/GO Bond projects and align with available funding.
		Can be implemented incrementally in functional phases.
	c. Develop a design that is constructable in phases and could be reasonably maintained.	Minimizes the number of potential design exceptions.
		Does not create maintenance challenges.
		Is easily constructable with regard to the ability to maintain movement of all modes during construction.

CHAPTER 2. BASELINE (NO-BUILD) CONDITIONS

The baseline (No-Build) conditions within the study area help identify the transportation system deficiencies and inform the development of solutions. This information is comprehensively documented in Attachment B - *Technical Memorandum #1: Study Background and Goals and Objectives*, Attachment C - *Technical Memorandum #2: Current Transportation System Conditions*, and Attachment D - *Technical Memorandum #3: Future Baseline (No-Build) Conditions*.

2.1 DEMOGRAPHIC INFORMATION

Households in the study area with no access to private vehicles represented 16.5 percent in the area compared to six percent for the City of Bend. The high concentration of zero-car households was due in part to the presence of several retirement and care homes in the area. In general, the percentage of residents in the study area that were 65 years of age or older, identified as minorities or live in households below the poverty level were comparable to the rest of Bend. The demographic analysis is described in more detail in Attachment B - *Technical Memorandum #1*.

2.2 TRAFFIC VOLUMES

EXISTING CONDITIONS

Turning movement counts were collected on a weekday in August 2022 during p.m. peak hour from 4:00 p.m. to 6:00 p.m. The collected counts were compared with traffic counts previously collected in April 2017 for the US 97 Parkway Plan to confirm that traffic volumes have rebounded from the reductions in vehicle travel associated with the COVID-19 pandemic. The newly collected traffic counts were generally five to 10 percent higher than the counts collected in April 2017, reflecting seasonal changes in Bend during the summer when counts were higher than counts collected in the spring. Once accounting for seasonality, the newer traffic counts reflected slightly different travel patterns than the historical counts, with nearly 10 percent less volume traveling through the US 97 ramp terminals but roughly three percent more volume travelling through the intersections at 3rd Street and Brookwood Boulevard/Bond Street. In general, traffic volumes decreased eastbound on Reed Market Road (by 10 to 15 percent) but increased westbound by a similar magnitude, with the exception of Reed Market Road/3rd Street, where westbound volumes were significantly higher in 2022. This higher volume was potentially due in part to an ongoing construction closure along Wilson Avenue, as well as changes to developments and travel patterns in the city since 2017.

Figure 3 summarizes the existing lane configurations, traffic control, and counted weekday p.m. peak-hour turning-movement traffic volumes for each study intersection and two driveways located on Division Street north of Reed Market Road. One driveway (Number 7 in Figure 2) provided access to the Chevron gas station, and the other driveway (Number 8 in the figure) provided access to BMW of Bend. Note that these driveways were modeled in the microsimulation model but were not included as study intersections. Traffic counts are included in the appendixes in Attachment C - *Technical Memorandum #2*.

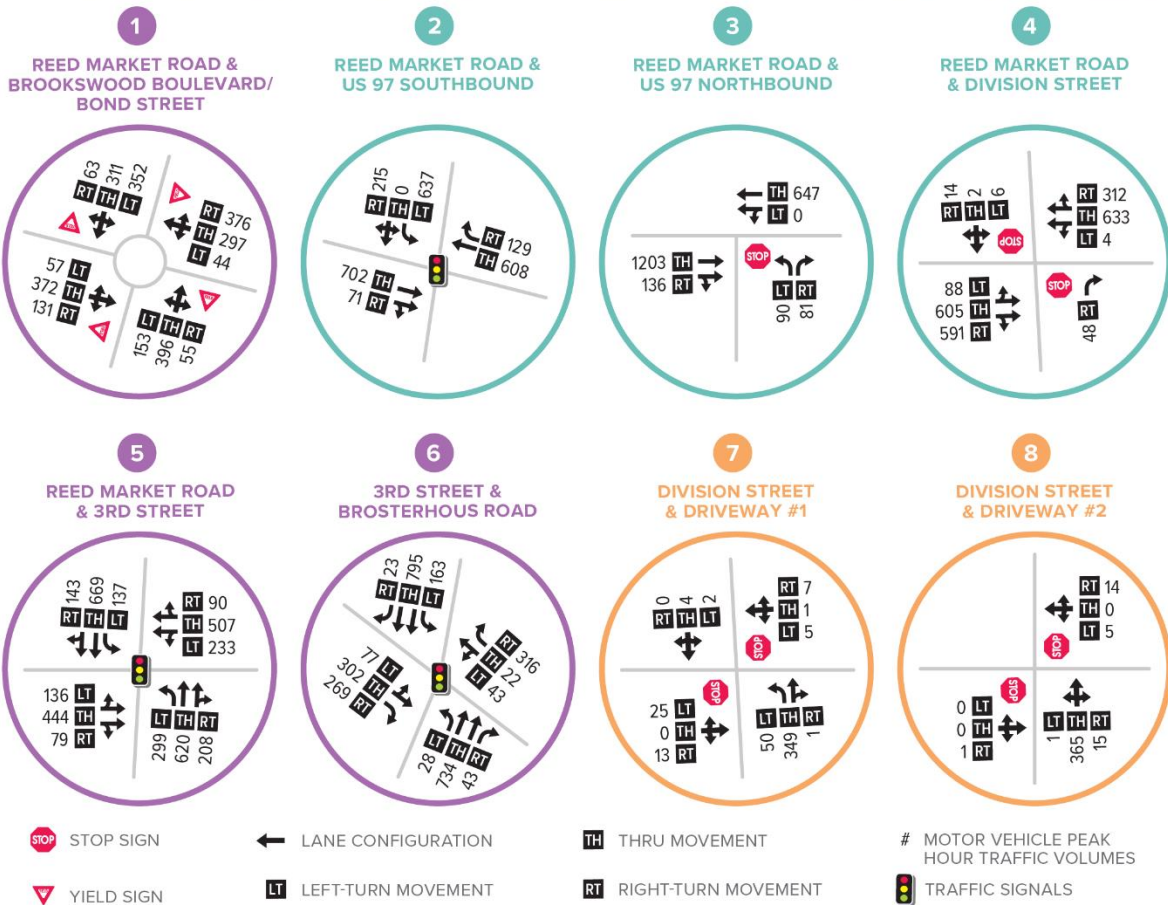
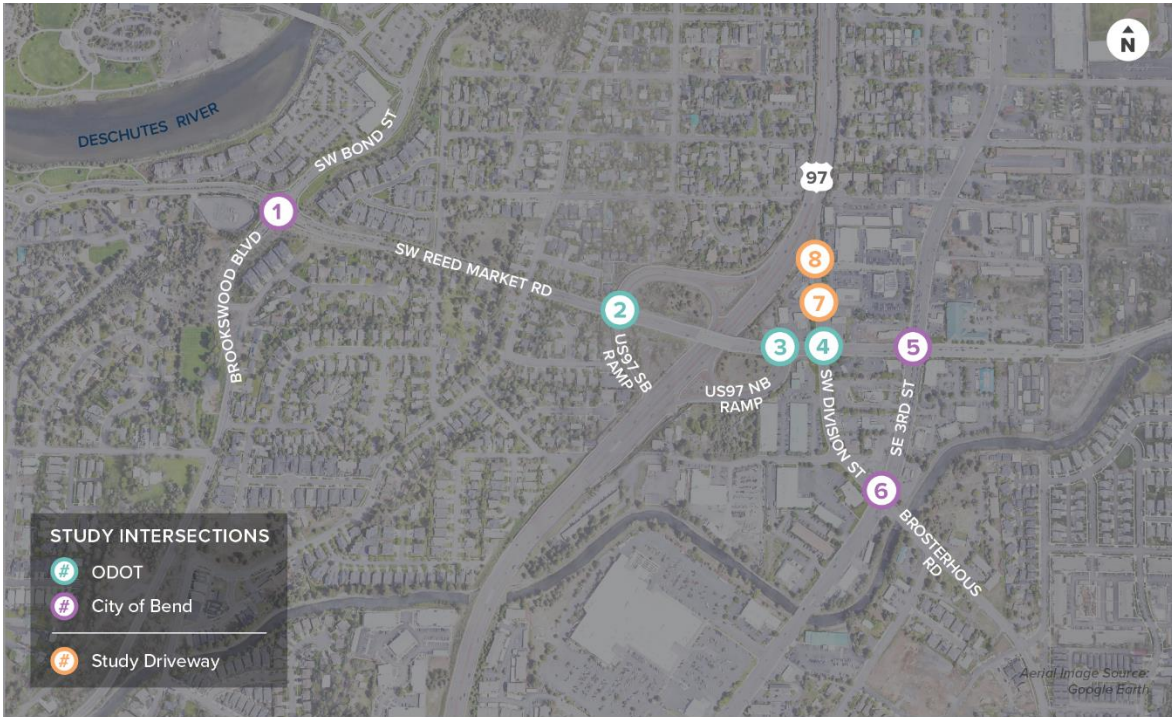


FIGURE 3. EXISTING (AUGUST 2022) BALANCED P.M. PEAK TRAFFIC COUNTS

FUTURE CONDITIONS

The future traffic volumes were forecasted for Year 2040 using the base year (2019) scenario and 2040 scenario from the Bend-Redmond Regional Travel Demand Model (BRM). The transportation network and land use assumptions and forecasting methodologies are documented in detail in Attachment D – *Technical Memorandum #3*.

A seasonal factor using guidance from the ODOT Analysis Procedures Manual (APM) was used to forecast the 2040 traffic volumes under No-Build conditions at the study intersections during the design hour (future equivalent of the 30th highest hour [30th HV] at ODOT intersections and average weekday [AWD] p.m. peak at City of Bend intersections). In general, future traffic volumes along Reed Market Road and 3rd Street were expected to grow by approximately 20 percent over the next 18 years.

Figure 4 shows the 2040 traffic volumes under future No-Build conditions at the study intersections during the design hour. Traffic travelling through the Reed Market Road/Brookwood Boulevard/Bond Street roundabout was expected to grow significantly over the next 18 years. This growth was projected at 25 percent travelling along Brookwood Boulevard/Bond Street and 30 percent travelling along Reed Market Road. On the east side of the interchange, traffic travelling through the 3rd Street/Brosterhous Road intersection saw significant growth on the westbound approach by approximately 50 percent over the next 18 years. It should be noted that study driveways (labeled as #7 and #8 in Figure 3) are not shown in Figure 4, but traffic volumes were forecasted, and the driveways were included in the microsimulation model.

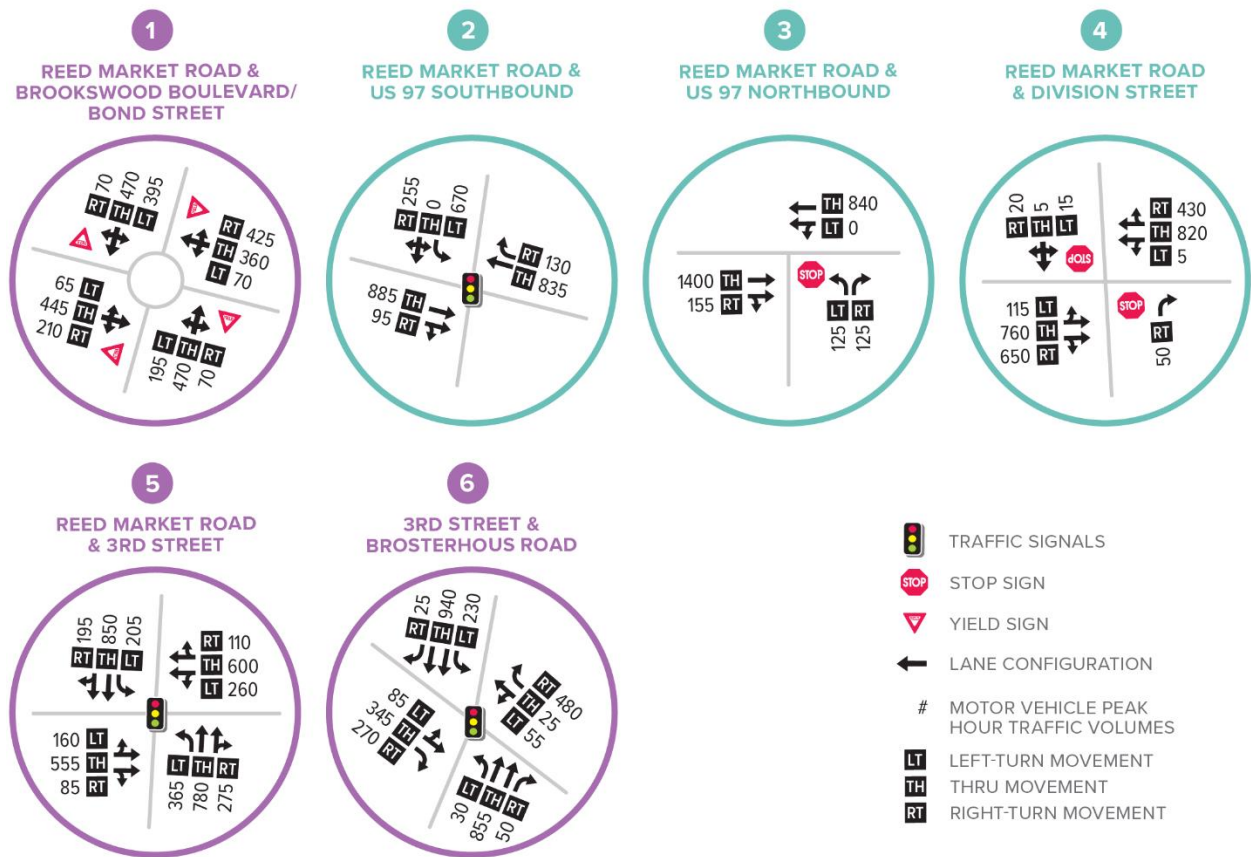
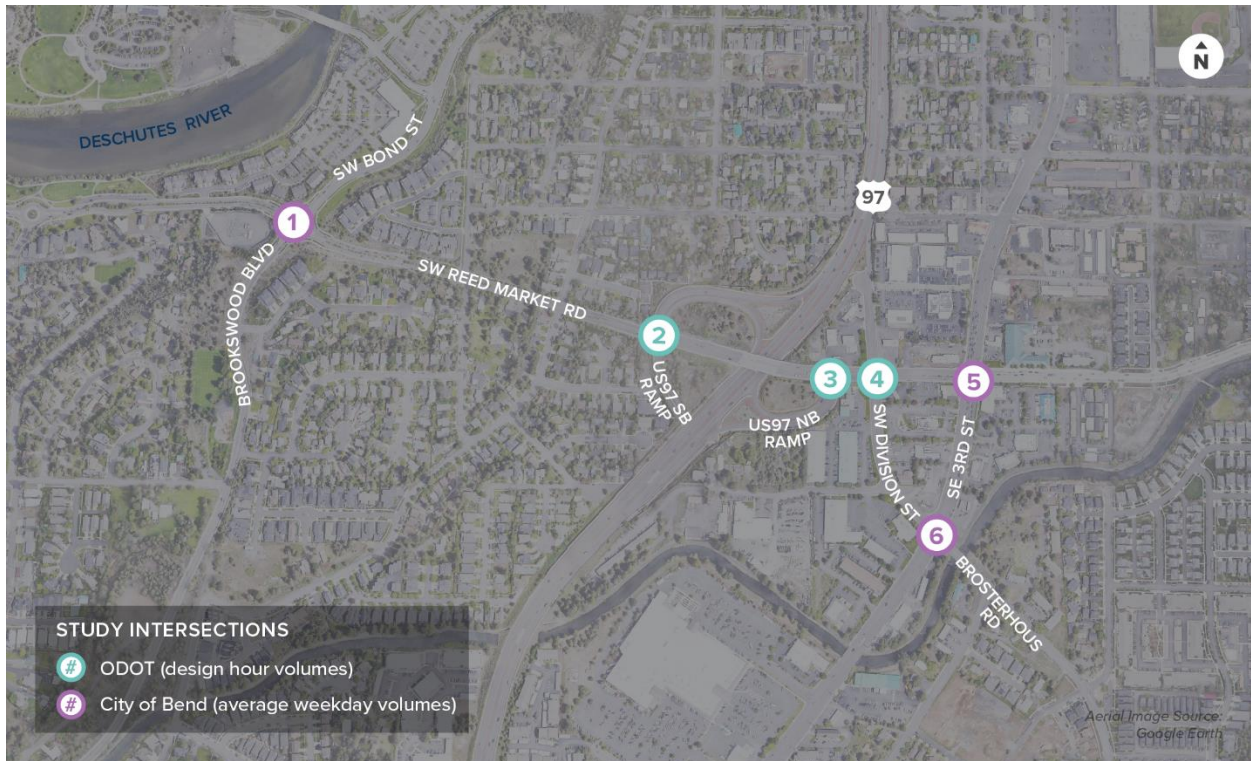


FIGURE 4. FUTURE (YEAR 2040) MOTOR VEHICLE P.M. PEAK HOUR TRAFFIC VOLUMES

2.3 INTERSECTION OPERATIONS AND QUEUEING

Performance measures used for this analysis included volume-to-capacity (v/c) ratios, level of service (LOS)³, and seconds of delay. The existing operations analysis results were obtained from the US 97 Parkway Plan, while the future No-Build intersection operations were analyzed using Synchro and Sidra software and the Highway Capacity Manual 6th Edition (HCM 6) methodology to assess the level of congestion experienced. The performance of each intersection was compared against the adopted mobility targets⁴, as shown in Table 2. The operations result from the US 97 Parkway Plan and the software reports are included in Attachment C – *Technical Memorandum #2*.

Under existing conditions, most of the study intersections failed to meet the adopted mobility targets. This indicated there was a significant amount of congestion at these study intersections during the peak hour today. Each deficiency from the study intersections created localized problems that collectively were compounded, sometimes spilling into each other, resulting in a significant east-west bottleneck that restricted access to much of southern Bend. Additionally, the Reed Market Road corridor congestion limited the interchange's ability to function adequately, leading to queue spillback onto the Parkway. This was not only a major safety concern but in the long term, will be the most critical bottleneck in the southern half of the Parkway, as identified by the US 97 Parkway Plan. This may be worsened when adjacent Parkway access ramps, such as Truman Avenue and Reed Lane, are closed, diverting additional traffic to Reed Market Road.

Under the future No-Build conditions, the same intersections that failed to meet mobility targets under existing conditions continued to fail to meet those targets. Additionally, most of the study intersections had higher v/c ratios and delays compared to the existing conditions (except Reed Market Road/US 97 southbound)⁵, indicating operational performance was expected to worsen in the future under No-Build conditions as Bend continues to grow.

Figures 5 and 6 illustrate the extents of congestion and vehicle queues through the study corridor during the existing and future No-Build peak hours, respectively. A detailed description of operations at each intersection is included in the following sections.

³ LOS is based on delay and ranges from LOS A to LOS F, similar to a report card rating.

⁴ The City of Bend mobility targets are based on the average weekday volume.

⁵ Since the completion of the US 97 Parkway Plan existing conditions analysis, the lane configuration at the US 97 southbound ramp terminal was modified to include a southbound left and shared left-through-right turn lane. This results in less delay in the future compared to the existing conditions analysis.

TABLE 2. EXISTING AND FUTURE 2040 DESIGN HOUR NO-BUILD TRAFFIC OPERATIONS AT STUDY INTERSECTIONS

INTERSECTION	JURISDICTION	CONTROL	MOBILITY TARGET	EXISTING (2017) ^A			FUTURE NO-BUILD (2040)		
				V/C ^B	LOS ^C	DELAY ^D (SEC)	V/C	LOS	DELAY (SEC)
REED MARKET RD/BROOKSWOOD BLVD/BOND ST	City (AWD)	Roundabout	≤ 1.00	1.14	F	61	1.72	F	>150
REED MARKET RD/US 97 SB	ODOT (30HV)	Signalized	≤ 0.90 ^E	0.95	C	34	0.94	C	26
REED MARKET RD/US 97 NB	ODOT (30HV)	TWSC	≤ 0.85	NA/ 1.53	NA/F	NA/>100	NA/ 2.56	NA/F	NA/ >150
REED MARKET RD/DIVISION ST	ODOT (30HV)	TWSC	≤ 1.00	0.14/ 0.12	B/C	13/17	0.46/ 0.14	B/C	14/17
REED MARKET RD/3 RD ST	City (AWD)	Signalized	≤ 1.00	1.05	F	92	1.26	F	>150
3 RD ST/BROSTERHOUS RD	City (AWD)	Signalized	≤ 1.00	-	-	-	0.89	C	21

Bold and red indicate a failure to meet the mobility target.

30HV=30th Highest Hour, AWD = Average Weekday P.M. Peak, LOS=Level of Service, TWSC=Two-Way Stop-Controlled, v/c=Volume-to-Capacity

^A Existing conditions are results from the US 97 Parkway Plan using 30HV conditions at all intersections. Future condition results represent 30HV operations for ODOT intersections and average weekday operations for City intersections, consistent with mobility targets.

^B v/c ratio reported as the overall intersection v/c ratio at signalized intersections, worse case approach v/c at roundabouts, and v/c ratio for Major Street/Minor Street at TWSC intersections.

^C LOS reported as the worst major street LOS/minor street LOS for TWSC intersections, worst case approach LOS for roundabouts, and overall intersection LOS for signalized intersections.

^D Control delay reported for worst case major street/minor street for TWSC intersections, worst case approach delay for roundabouts, and overall intersection delay for signalized intersections.

^E ODOT adopted an alternative mobility target for this intersection as part of the US 97 Parkway Plan, which assumed a 0.90 v/c ratio during 30 HV and ensuring 95th percentile queues do not extend into the portion of the exit ramp needed for deceleration.



FIGURE 5. QUEUEING PATTERNS ALONG REED MARKET ROAD UNDER EXISTING CONDITIONS



FIGURE 6. QUEUEING PATTERNS ALONG REED MARKET ROAD UNDER FUTURE (YEAR 2040)

REED MARKET ROAD AT BROOKSWOOD BOULEVARD/ BOND STREET

According to the Bend TSP, this intersection experienced heavy traffic demand during the p.m. peak hour, leading to queue spillback on all approaches. The queues from this intersection spilled back through several intersections on Reed Market Road and Bond Street. Given the severe queuing observed at this intersection, some drivers may attempt to bypass the congestion by using the local streets as an alternative route, impacting neighborhood livability. The intersection operations result from the US 97 Parkway Plan indicated this roundabout operated at capacity during average weekday conditions, likely because the intersection serves commuters in both the southbound and eastbound directions.

A pilot test⁶ was conducted for the City at this intersection in March 2020 to evaluate the ability of roundabout meters to improve operations. The results indicated the metering produced no adverse safety outcomes, but intersection capacities remained essentially the same with or without the metering system. However, metering signals were found to be generally beneficial in reducing queuing during the peak periods, especially during the morning peak. The p.m. peak was challenging because of the simultaneous heavy surges on southbound Bond Street and eastbound Reed Market Road, where metering needed to begin early enough to prevent queues from growing too quickly.

As shown in Figure 5, excessive queuing was observed under existing conditions, with queues spilling back into multiple other intersections. Significant queue spillback was observed on all approaches, especially in the eastbound and westbound directions on Reed Market Road and southbound on Bond Street. The queues observed in the field in 2022 were slightly worse than what was observed in 2017 during the US 97 Parkway Plan development. As shown in Figure 6 (**Note #1**), all four legs of the roundabout failed in the future, with v/c ratios greater than 1.09, leading to queues spilling back to nearby major intersections, including the US 97 southbound and US 97 northbound ramp terminals.

REED MARKET ROAD AT US 97 SOUTHBOUND RAMP

According to the US 97 Parkway Plan, this intersection failed to meet the mobility target under existing conditions and high traffic volumes resulted in southbound right turns spilling back and blocking access to the left-turn lane. However, the back of the queue did not spill back into the space needed for vehicles to safely exit the US 97 mainline and decelerate to a stop, also known as the *safe stopping distance*.

In August 2022, many vehicles were observed queuing in the outside turn lane (i.e., left-through-right lane) to perform the left-turn movement, likely to make an eastbound right turn at Division Street. Additionally, the efficiency of the signal was reduced, as southbound right-turning and westbound through vehicles were unable to move through the intersection due to queue spillback from the Reed Market Road/Brookswood Boulevard/Bond Street roundabout.

⁶ Bond-Reed Market-Brookswood Roundabout Metering Pilot Test, April 20, 2020, Kittelson and Associates.

It should be noted that the US 97 southbound ramp terminal was expected to operate worse than the recently adopted alternative mobility target of v/c smaller or equal to 0.90. The analysis supporting the adoption of the alternative mobility target assumed mitigated conditions at the ramp terminal, which included signal timing modifications (increased cycle length) that were not included in the No-Build analysis, as these improvements were tested as part of the study alternatives.

As shown in Figure 6 (**Note #2**), the intersection failed to meet mobility targets in the future and given the queue spillback from the Reed Market Road/Brookwood Boulevard/Bond Street roundabout, the queues will likely extend beyond the safe stopping distance on the ramp.

REED MARKET ROAD AT US 97 NORTHBOUND RAMP

Results from the US 97 Parkway Plan indicated that high volumes of traffic on Reed Market Road at this intersection resulted in northbound right-turn vehicles spilling back into the segment of the exit ramp needed for safe deceleration and stopping, indicating a safety concern. This queue spillback was not observed in August 2022. More recent observations indicated limited left-turn sight distance and high volumes along Reed Market Road, making the northbound left turn a challenging movement. The challenging northbound left turn led to significant delays, but queuing was relatively limited due to the low observed traffic volume. This could be an indicator of drivers choosing to use a different exit on the Parkway.

This intersection continued to fail to meet mobility targets in the future as an unsignalized intersection. As shown in Figure 6 (**Note #3**), the queues will likely extend towards the US 97 mainline, well beyond the safe stopping distance on the ramp as drivers struggling to find safe gaps to make a northbound left turn onto Reed Market Road and as queues from the Reed Market Road/Brookwood Boulevard/Bond Street roundabout and 3rd Street spilling back into the intersection.

REED MARKET ROAD AT DIVISION STREET

As listed in Table 2 above, the Reed Market Road at Division Street intersection met adopted mobility targets under existing conditions. Additionally, the northbound Division Street ramp that merges onto US 97 operated with a v/c ratio of 0.54, meeting the mobility target of 0.85. Around 600 vehicles were counted in 2022 that made an eastbound right turn at this intersection as drivers trying to avoid congestion at the signal at the 3rd Street/Reed Market Road intersection. Queue spillback from 3rd Street/Reed Market Road frequently blocked this intersection, as shown in Figure 5. The intersection continued to meet mobility targets in the future with similar queueing patterns from the existing conditions.

REED MARKET ROAD AT 3RD STREET

According to the US 97 Parkway Plan, travel demand exceeded the capacity of this intersection during peak summer conditions, with congestion on nearly all approaches. This intersection is at the confluence of two major arterial roadways in Bend and serves high traffic volumes on all approaches. This was consistent with the observations in August 2022.

The traffic signal under existing conditions had shared left and through traffic lanes on the eastbound and westbound approaches, which required the use of less-efficient split-phase signal timing (eastbound and westbound through traffic were not allowed to run simultaneously). The signal operated with a leading pedestrian interval (LPI) on the east and west leg crosswalks, allowing pedestrians to enter the crosswalk prior to right-turning vehicles. This intersection failed to meet mobility targets in the future, with a v/c ratio of 1.26. Northbound queues were expected to spill back beyond the intersection of 3rd Street/Brosterhous Road, while eastbound queues were expected to spill back beyond the US 97 northbound ramp terminal, as shown in Figure 6 (**Note #4**).

3RD STREET AT BROSTERHOUS ROAD

This intersection was not analyzed extensively in previous studies. From field observations in August 2022, congestion at this intersection was generally limited. However, the intersection operated with shared left-through lanes, an atypical configuration, and permissive left turns on the eastbound and westbound approaches under existing conditions, causing delay for through movements and increasing conflicts between drivers and people walking at the intersection. As shown in Table 2, this intersection met mobility targets under future conditions, indicating acceptable operational performance.

CHALLENGES AND FUTURE NEEDS

Considering the worsening intersection operations in the future, near-term improvements will be needed to address existing issues and better prepare for traffic growth. The phasing of the improvements will be critical. Additionally, the City will be implementing several construction projects over the next few years that will influence operations on Reed Market Road. For instance, the Reed Market Road railroad overcrossing project is estimated to be implemented within the next 10 years, which will close Reed Market Road near 9th Street for an extended period of time, affecting east-west travel along the road. During the closure, traffic along 3rd Street and west of 3rd Street along Reed Market Road is expected to increase, particularly for eastbound left, northbound left, and southbound right movements at the intersection. Future improvements along Reed Market Road should be phased in such a way as to support both long-term mobility needs and short-term needs during construction closures.

2.4 CONDITIONS FOR PEOPLE WALKING, BICYCLING, AND TAKING TRANSIT

WALKING AND BIKING CONDITIONS

The section discusses the walking and biking conditions within the study area, with an introduction to the current walking and biking facilities, evaluation of the level of traffic stress along the study corridors, some challenges for people walking and biking, and future needs to enhance the conditions.

Walking and Biking Facilities

Walking and biking facilities (primarily sidewalks and on-street bike lanes) were consistently provided within the study area. Sidewalks existed on both sides of nearly all major study area streets, while a relatively complete network existed on one or both sides of surrounding residential streets. Except for limited segments of Reed Market Road, most sidewalks along the study area street network were curb-tight with widths ranging between five and seven feet.

Marked pedestrian crossings primarily existed at the intersections of major streets, including controlled crossings at the signalized intersections and an enhanced crossing (median island) at Chamberlain Street. Along the segment of Reed Market Road within the study area, distances between marked crossings ranged from approximately 750 feet to 1,500 feet, with crossing treatments varying by location (e.g., transverse or continental markings, supplemental signage, and/or signalization).

Crossing opportunities along US 97 were limited to the Reed Market Road overcrossing, with the nearest adjacent crossings located at Wilson Avenue (an overcrossing approximately 2,400 feet to the north) and the canal (an undercrossing approximately 1,700 feet to the south). Along 3rd Street, there were controlled crossings at Reed Market Road and Division Street/Brosterhouse Road, and an enhanced crossing with a rectangular rapid-flashing beacon (RRFB) at the canal.

Biking facilities generally consist of on-street bike lanes in various forms. Conventional bike lanes existed along the entirety of Reed Market Road, Division Street, Brookwood Boulevard, and Bond Street within the study area. Conventional bike lanes with fading red pavement surface application existed along US 97 and on the Reed Market Road interchange ramps. Immediately west of the Reed Market Road/Brookwood Boulevard/Bond Street roundabout, the Reed Market Road bike lanes transitioned to raised bike lanes (with faded red pavement surface application). At the study area's east end, buffered bike lanes existed along 3rd Street. At most locations, bike lane widths ranged from five to six feet, while buffers typically measure about two feet wide. Shared roadway environments existed on all other study area streets.

During field observations in August 2022, deteriorating surface conditions were observed along some sidewalk and bike lane segments, including uneven walking surfaces, pavement cracking, and fading surface application on colored bike lane segments. The 2022 study area intersection turning movement counts included people walking and bicycling while using the crosswalk and were collected on a hot, sunny day. In general, less than 10 people were observed crossing any leg of the study intersections during the weekday p.m. peak hour. The low pedestrian volume may

have been influenced by the heat on the day of the counts. Micromobility travel modes (i.e., scooter, e-bike) were observed in the study area during the p.m. peak hour.

Level of Traffic Stress (LTS)

Bicycle and Pedestrian Level of Traffic Stress (LTS) was evaluated in the US 97 Parkway Plan and the Bend TSP to measure the level of comfort for people walking and bicycling. The LTS analysis scored roadway segments based on characteristics such as motor vehicle traffic volumes and speeds, presence of walking and bicycling facilities, and degree of separation between motorized and nonmotorized users. The possible scores range from 1 to 4, with 1 representing the lowest stress and 4 representing the highest stress.

Key findings from the LTS analysis provided by the City and LTS analysis documented in the US 97 Parkway Plan include the following:

- The US 97 mainline was a high-stress facility due to the close proximity of the Bend Parkway walking and bicycling facilities relative to adjacent high-speed traffic.
- Reed Market Road was identified as a high-stress roadway (Bicycle LTS 3) east of the US 97 southbound ramp.
- Division Street was identified as a high-stress roadway (Pedestrian LTS 3) in the study area.
- The US 97 northbound ramp terminal intersection was identified as a high-stress crossing location (Bicycle and Pedestrian LTS 3).
- The Reed Market Road and Division Street intersection was identified as high stress (Bicycle and Pedestrian LTS 4).

According to the Bend TSP, both 3rd Street and Chamberlain Street are identified as key walking/bicycling routes and are designated as part of Bend’s Low-Stress Network. This section of 3rd Street was designated as a low-stress route because there was no alternate north-south route between Reed Lane and Cleveland Avenue. These corridors were intended to serve bicycle riders of all ages and abilities and could benefit from enhancements to improve their LTS.

Challenges and Future Needs

Figure 7 summarizes the challenges for people walking and bicycling in the study area. Providing frequent low-stress active transportation crossings of US 97 was a strategy that scored very well relative to the US 97 Parkway Plan’s goals and objectives. As a result, improving active transportation facilities along Reed Market Road and the overcrossing was ranked as a Tier 2 priority, primarily due to safety issues and demand to use the corridor.

The first goal in the City’s TSP is to increase system capacity, quality, and connectivity for all users. In particular, policies are included in the TSP to improve safety and usability of facilities for people walking and biking and for micromobility. Policy 40 from the City’s TSP mentions all streets should be “complete streets” to allow everyone to travel safely and comfortably along and across the street by all travel modes. The transportation system is intended to increase connectivity, safety and travel time reliability while encouraging walking, biking, and opportunities for using transit and other transportation options. In addition, Policy 59 states the City will consider the environmental impacts of the overall transportation system and act to mitigate negative effects and enhance

positive features. The intention of the policy is to reduce greenhouse gases and vehicle miles traveled (VMT) by encouraging bicycling, walking, transit, and electric or other alternately fueled vehicles. The City’s TSP focuses on improving multimodal facilities and adding micromobility options to encourage more people to walk and bike. The increase in congestion and the reductions in parking for new development are likely to further increase the number of people walking and biking. To implement these goals and policies within the study area, improvements will be needed to the active transportation facilities along Reed Market Road and 3rd Street.

Bend’s TSP lists several planned projects to improve conditions for people walking and bicycling in the future. Specifically, within the study area, the planned key walking and biking route project (R9-A) on the east leg of the 3rd Street and Brosterhaus Road intersection will close a sidewalk gap between 3rd Street and Parrell Road along Brosterhaus Road and create a low-stress bikeway on both sides of the street.

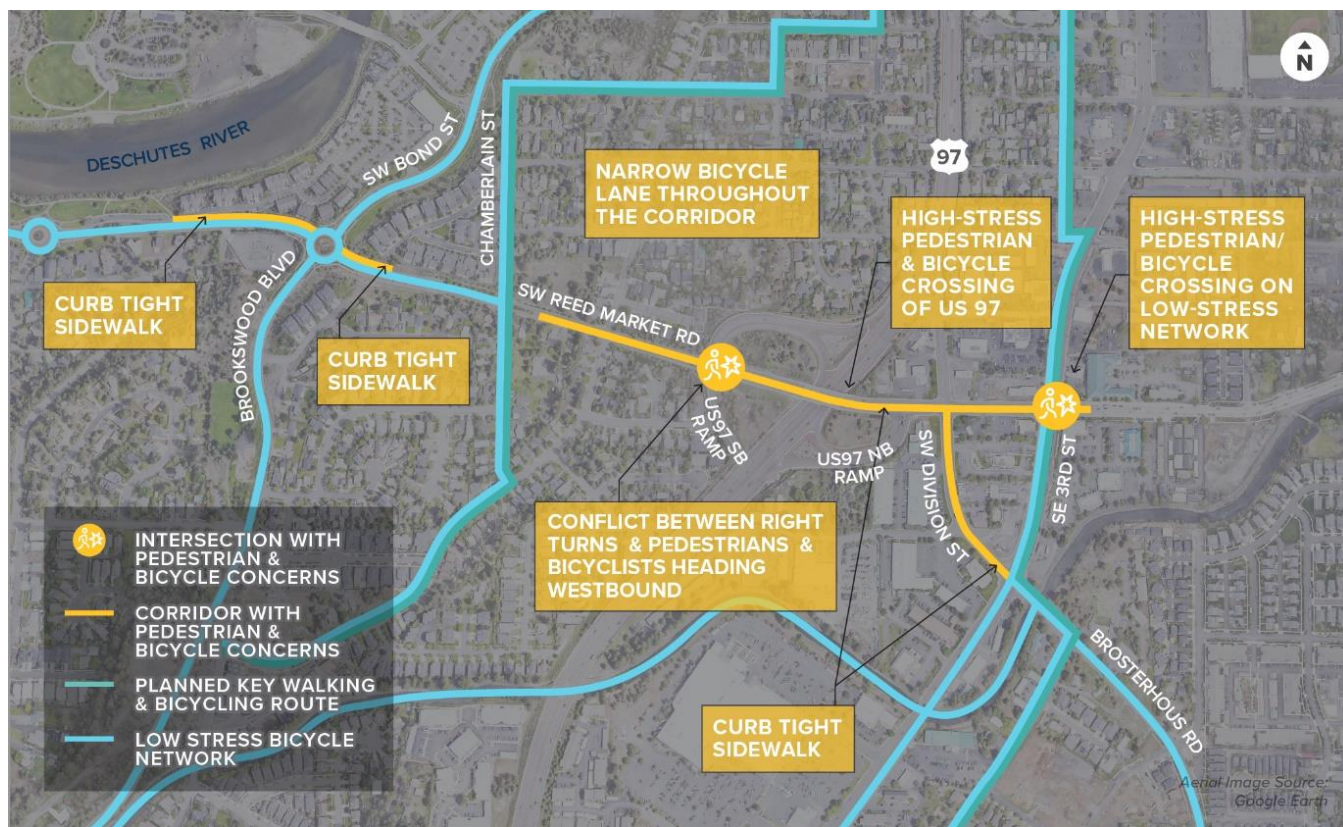


FIGURE 7. SUMMARY OF CONDITIONS FOR PEOPLE WALKING AND BIKING

TRANSIT CONDITIONS

Public transportation in and around the study area is provided by Cascades East Transit (CET) through fixed-route service, inter-city bus service, and recreational shuttle service. As shown in Figure 8, the South 3rd Street (Route 1) and Brookwood (Route 2) lines were two transit routes that pass through the study area in the north-south direction under the existing conditions.

The South 3rd Street route had four stops within the study area between Cleveland Avenue and Division Street. One set of stops was located just south of 3rd Street/Reed Market Road, and another set was just south of 3rd Street/Cleveland Avenue. Controlled, marked crosswalks to access those stops were provided at the 3rd Street/Reed Lane and 3rd Street/Brosterhus Road signals. The crossing between the stops near Cleveland Avenue was uncontrolled and unmarked but can be accessed via the 3rd Street/Reed Market Road signal or the 3rd Street/Roosevelt Avenue enhanced (RRFB) crosswalk.

The Brookwood route had stops north and south of the Reed Market Road/Brookwood Boulevard/Bond Street roundabout. Marked crosswalks to access the stops were provided on each leg of the roundabout. Previous studies indicated the congestion issues at the Reed Market Road/Brookwood Boulevard/Bond Street roundabout impacted transit service reliability, particularly during the p.m. peak hour.

Ridership over the past two years had decreased significantly due to the impacts of COVID-19. According to the CET 2040 Transit Master Plan (TMP)⁷ published in 2020, Route 1 had the highest ridership in the system with a productivity of 16.7 rides per hour, where Route 2 had a productivity of 8.6 rides per hour.

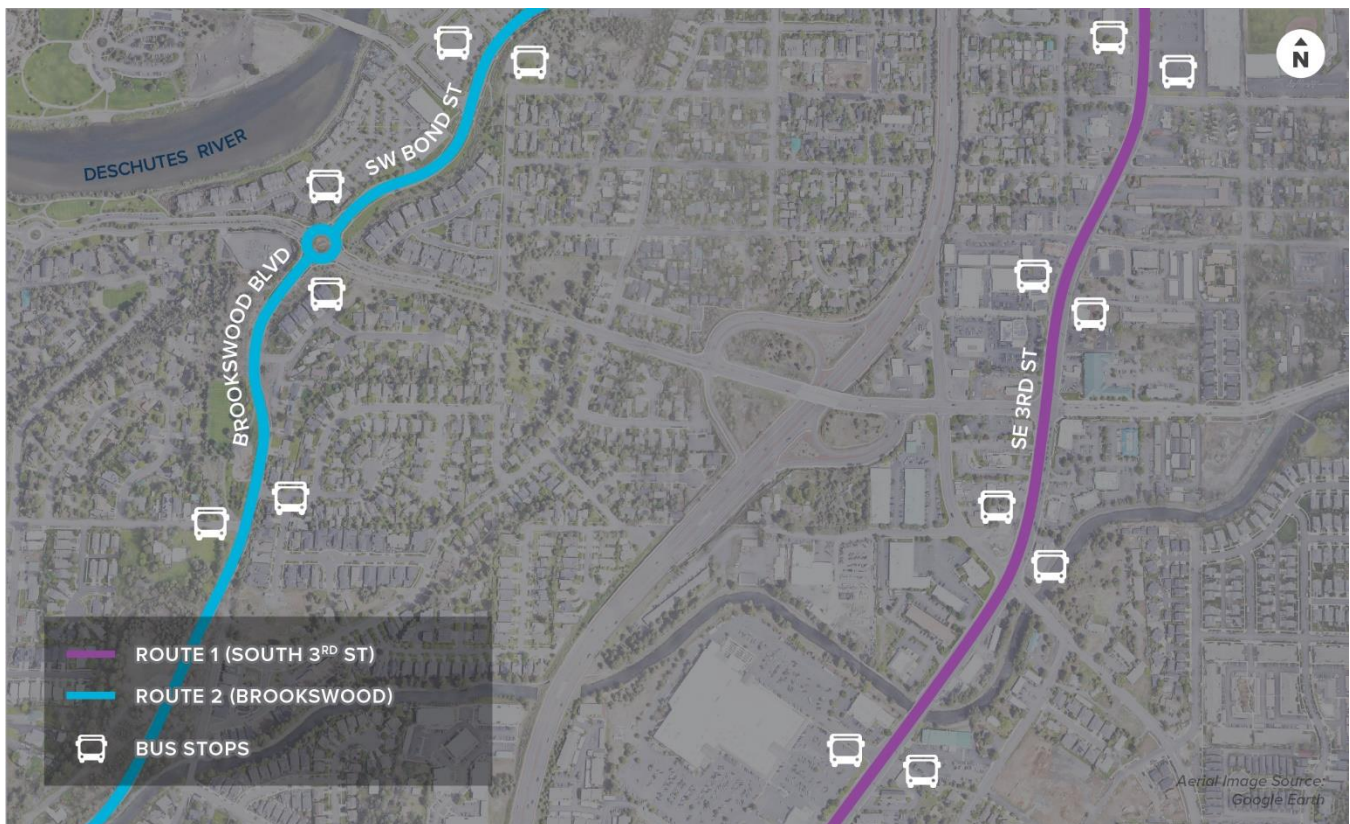


FIGURE 8. EXISTING TRANSIT ROUTES WITHIN THE STUDY AREA

⁷ Cascades East Transit 2040 Transit Master Plan, Cascades East Transit, August 2020

The CET 2040 TMP identifies several future transit service needs in Bend, including increasing route frequency and service coverage, improving bus on-time arrival and reliability, enhancing services to transit-underserved areas, expanding connections to other transportation modes, and expanding accessibility. This would include the following changes within the study area:

- More frequent service for Route 2 (Brookwood Boulevard), resulting in more buses utilizing Brookwood Boulevard through the study area.
- Combining Routes 1 (South 3rd Street) and 4 (North 3rd Street) to extend transit farther along 3rd Street without requiring a transfer, potentially resulting in more transit trips along 3rd Street.
- Modification of Route 6 (Reed Market Road/Wells Acres Road) to serve downtown and the Oregon State University Cascades Campus by traveling along Reed Market Road between 3rd Street and Brookwood Boulevard/Bond Street.

2.5 SAFETY AND ACCESS

According to the safety analysis (data from 2011 to 2016) in the US 97 Parkway Plan, Bend TSP, and Bend Area Transportation Safety Action Plan (TSAP)⁸, Reed Market Road/US 97 northbound ramps intersection was flagged as a safety focus area, as the intersection has a crash rate (0.62) much greater than the critical (0.35) and 90th percentile (0.29) crash rates. In addition, TSAP utilizes Equivalent Property Damage Only screening to measure the safety performance of the study intersections as it captures the overall frequency and severity of collisions. The intersection of Reed Market Road/3rd Street was listed in the Top 25 critical locations in the city.

Figure 9 presents the summary of safety issues and risk factors within the study area. At the US 97 southbound ramp, safety risk factors for people walking and biking included the narrow on-street walking and biking facilities and the westbound lane drop at the US 97 southbound ramp conflicted with the westbound bicycle lane. Also, there were anecdotal observations that the westbound right turn onto US 97 southbound ramp was a challenging movement for heavy vehicles to make, given the topography.

⁸ Bend Area Transportation Safety Action Plan, September 30, 2019, Kittelson and Associates.

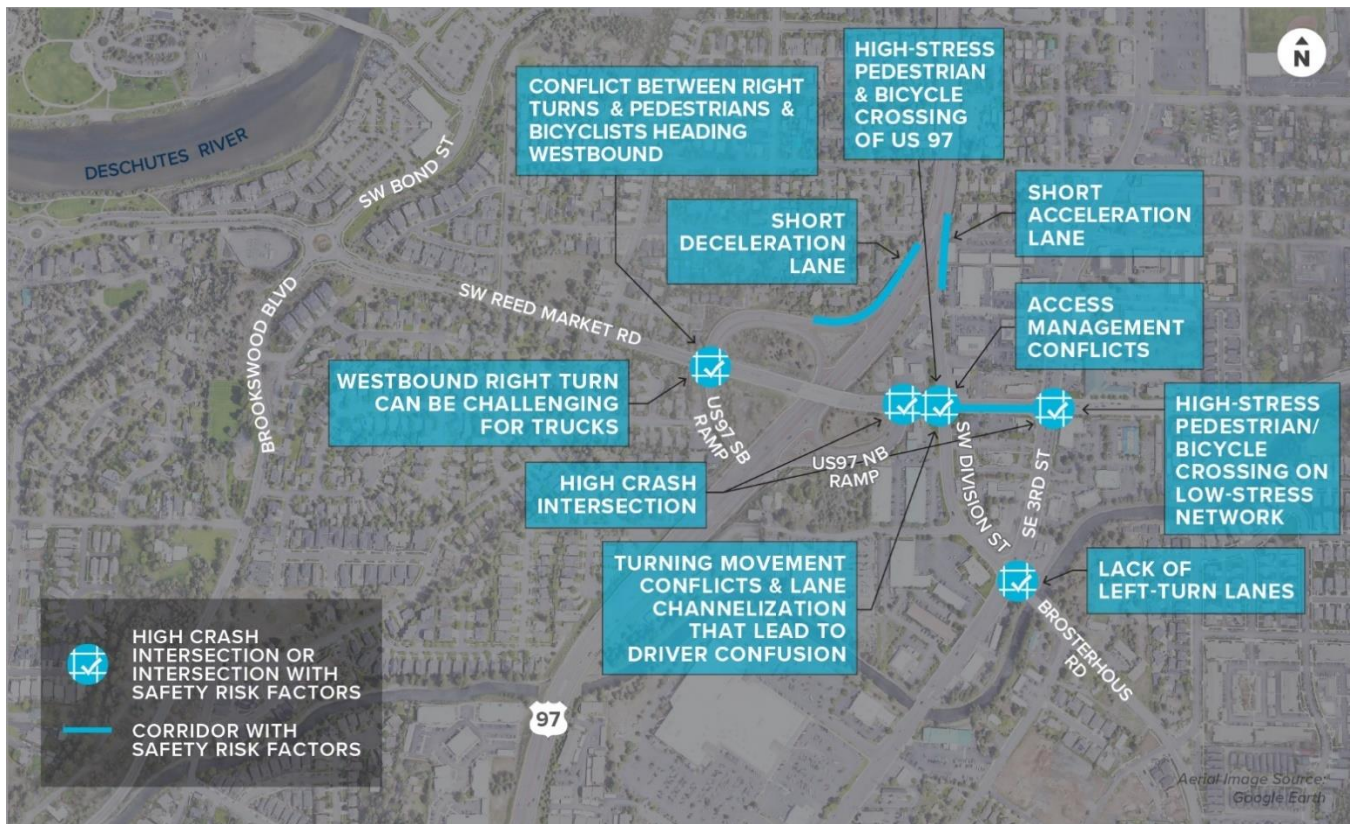


FIGURE 9. SUMMARY OF SAFETY ISSUES

Other key safety risk factors within the study area included the following:

- The north leg of Division Street/Reed Market Road served as the US 97 northbound entrance ramp but allowed for two-way traffic to serve local properties, which created turning movement conflicts on the ramp. It also created a speed differential between vehicles accelerating to merge onto US 97 and vehicles slowing down to access businesses.
- There were numerous driveways and access management conflicts between the US 97 northbound ramp terminal and 3rd Street along Reed Market Road.
- 3rd Street/Brosterhous Road was a skewed intersection with sight distance issues for eastbound and westbound vehicles. Eastbound and westbound permissive left turns also increased the number of conflicts between drivers and people walking.
- Two ramps at the Reed Market Road interchange had short deceleration and acceleration lanes that failed to meet ODOT Highway Design Manual minimum length requirements, resulting in less-than-standard distances to safely accelerate and decelerate.
- There was limited sight distance for the northbound left-turning movement at the US 97 northbound ramp.
- There were traffic separators (narrowed raised medians) along Reed Market Road between the US 97 northbound ramp and Division Street, leaving drivers to interpret the legitimacy of left-turning movements.
- Many of the study area intersections had no or minimal illumination, making visibility challenging at night, especially for people walking and biking.

Table 3 lists the most recent available five years of crash data for the study intersections. The 3rd Street/ Brosterhaus Road intersection had the most total crashes between 2016 and 2020. Several crashes within the study area were not captured in this table as they did not occur at study intersections. For example, there was a severe-injury crash located along 3rd Street between Reed Market Road and Brosterhaus Road.

TABLE 3. SUMMARY OF MOST RECENT CRASH DATA (2016-2020)

INTERSECTION	TOTAL CRASHES	FATAL OR SEVERE INJURY CRASHES	PEDESTRIAN OR BICYCLE CRASHES	MOST COMMON CRASH TYPE(S)	MOST COMMON CRASH CAUSE(S)
REED MARKET RD/BROOKSWOOD BLVD/BOND ST	12	0	0	Rear-end (67 percent) Angle (17 percent)*	Failure to avoid (42 percent) Following too closely (25 percent)
REED MARKET RD/US 97 SB	16	0	0	Rear-end (63 percent) Turning movement (25 percent)	Failure to avoid (38 percent) Too fast for conditions (25 percent) Following too closely (19 percent)
REED MARKET RD/US 97 NB	4	0	0	Turning movement (50 percent)	NA
REED MARKET RD/DIVISION ST	15	1	0	Angle (53 percent) Turning movement (27 percent)	No yielding (40 percent)
REED MARKET RD/3 RD ST	10	0	1	Rear-end (50 percent) Angle (40 percent)	Disregarded signal (40 percent) Failure to avoid (30 percent)
3 RD ST/BROSTERHOUS RD	25	1	1	Turning movement (52 percent) Rear-end (24 percent)	Failure to yield (28 percent) Disregard signal (24 percent)

* While reported as “angle” crashes, these were likely more similar to sideswipe crashes at the roundabout.

CHAPTER 3. ALTERNATIVES DEVELOPMENT PROCESS

The project team developed an initial set of concepts at each of the study intersections based on the needs identified in Technical Memoranda #1-3 and prior planning project recommendations. The initial concepts are described in Table 4 and were presented to the Technical Advisory Committee (TAC) members at an evaluation workshop held in December 2022. Note that Reed Market Road/Chamberlain Street was not listed as study intersection for operations evaluation, but improvements were identified to match the City’s funding.

TABLE 4. INITIAL CONCEPTS AT STUDY INTERSECTIONS

INTERSECTION	INITIAL CONCEPTS
REED MARKET RD/ BROOKSWOOD BLVD	<ul style="list-style-type: none"> • Convert the roundabout into a partial multilane roundabout. • Install roundabout metering.
REED MARKET RD/ CHAMBERLAIN ST	<ul style="list-style-type: none"> • Install pavement markings, street lighting, and signing.
REED MARKET RD/ US 97 SB RAMP	<ul style="list-style-type: none"> • Lengthen the deceleration lane. • Add an exclusive southbound right-turn lane. • Address westbound bike conflicts.
REED MARKET RD/ US 97 NB RAMP	<ul style="list-style-type: none"> • Install a traffic signal. • Construct a roundabout. • Realign the intersection with Division Street.
REED MARKET RD/ DIVISION ST	<ul style="list-style-type: none"> • Realign the intersection with the US 97 northbound ramp terminal. • Include in a roundabout with the US 97 northbound ramp terminal.
REED MARKET RD/ 3RD ST	<ul style="list-style-type: none"> • Add eastbound and westbound left-turn lanes by widening the intersection. • Add eastbound and westbound left-turn lanes by removing a westbound through lane. • Implement a protected intersection design. • Construct a roundabout in combination with a roundabout at the US 97 northbound ramps/Division Street. • Implement a quad road concept to displace eastbound and westbound left-turns at the intersection.
3RD ST/ BROSTERHOUS RD	<ul style="list-style-type: none"> • Convert lane configurations to protected eastbound and westbound left-turns. • Construct a roundabout. • Add bike box on all approaches.
OTHER	<ul style="list-style-type: none"> • Access management between US 97 northbound ramp and 3rd Street.

During the workshop, the concepts were discussed, and some were qualitatively scored relative to No-Build conditions and against each of the project goals. Alternatives that either had few merits based on the full range of evaluation criteria or had costs that would likely exceed current funding expectations were not considered further in the study, as described in Table 5.

TABLE 5. CONSIDERED AND DISMISSED ALTERNATIVES

INTERSECTION	ALTERNATIVE	REASON FOR DISMISSAL
REED MARKET RD/ US 97 NORTHBOUND RAMP/ DIVISION ST	<ul style="list-style-type: none"> Construct a roundabout at the US 97 northbound ramp. Realign Division St and include in a roundabout with the US 97 northbound ramp terminal. 	<ul style="list-style-type: none"> The alignment of the existing US 97 overcrossing, topography, and locations of existing development would make construction of a safe roundabout design very challenging. The implementation cost would likely significantly exceed the available funding.
	Add eastbound and westbound left-turn lanes by removing a westbound through lane.	<ul style="list-style-type: none"> The alternative provided little operational benefit as the intersection would still operate well over the capacity.
REED MARKET RD/ 3RD ST	Implement a quad road concept to relocate eastbound and westbound left turns to Division St/Brosterhouse Rd and 4 th St/Cleveland Ave.	<ul style="list-style-type: none"> The total cost involved other intersections and could be significantly greater than just improving Reed Market Rd/3rd St although the operations were slightly better. 4th St and Cleveland Ave were not designed for or intended to serve this level of traffic. Reroutes traffic through 4th St/Cleveland Ave, which is a low-income residential area. New development adjacent to the intersection on Reed Market Rd at 4th St would make necessary intersection improvements costly. Created out of direction travel and may not align with driver expectations, especially for people unfamiliar with the area.
	Construct a roundabout with US 97 northbound ramps/Division St.	<ul style="list-style-type: none"> Cost of constructing a safe roundabout at the US 97 northbound ramps/Division Street would not align with available funding previously noted.
3RD ST/ BROSTERHOUD RD	Protected eastbound and westbound left turns.	<ul style="list-style-type: none"> Without an eastbound right-turn lane, queues on Division St will spill back to Reed Market Rd.
	Construct a roundabout.	<ul style="list-style-type: none"> This intersection was included as part of a system of roundabouts with adjacent intersections. This alternative was dismissed due to constraints at other locations.

CHAPTER 4. ALTERNATIVES EVALUATION

After further discussion and consideration of the feedback received from the evaluation workshop, the preliminary and additional alternatives that were deemed to have the ability to score reasonably well against the evaluation criteria and were believed to have costs that could reasonably align with available funding were forwarded for further refinement and evaluation. The details of the alternatives' development and evaluation are included in Attachment E - *Technical Memorandum #4: Alternatives Development and Evaluation*.

4.1 REED MARKET ROAD CROSS SECTION IMPROVEMENTS

This study identified that opportunities were limited for people walking and biking to cross US 97 in the vicinity of the Reed Market Road overcrossing. While Reed Market Road is not a designated low-stress route, the City's standard requires low-stress walking and biking facilities when a street is reconstructed. Providing low-stress walking and biking facilities along Reed Market Road would require reconstruction to widen the overall cross section. However, there are currently no planned or funded projects to do this. Through the planning process, it was recommended that short-term improvements be compatible with the existing cross sections while also maintaining forward compatibility with any potential future cross section changes. Note that any changes in the cross section (such as reducing the travel lane width) at the US 97 interchange will require coordination with the Mobility Advisory Committee (MAC).

Several long-term cross section designs that may be considered along Reed Market Road in the future are shown in Figures 10 to 13. These concepts may be refined in the future, which should include consideration for providing raised or tactile delineation between people walking and people biking on the multiuse paths to aid those with limited or no vision.

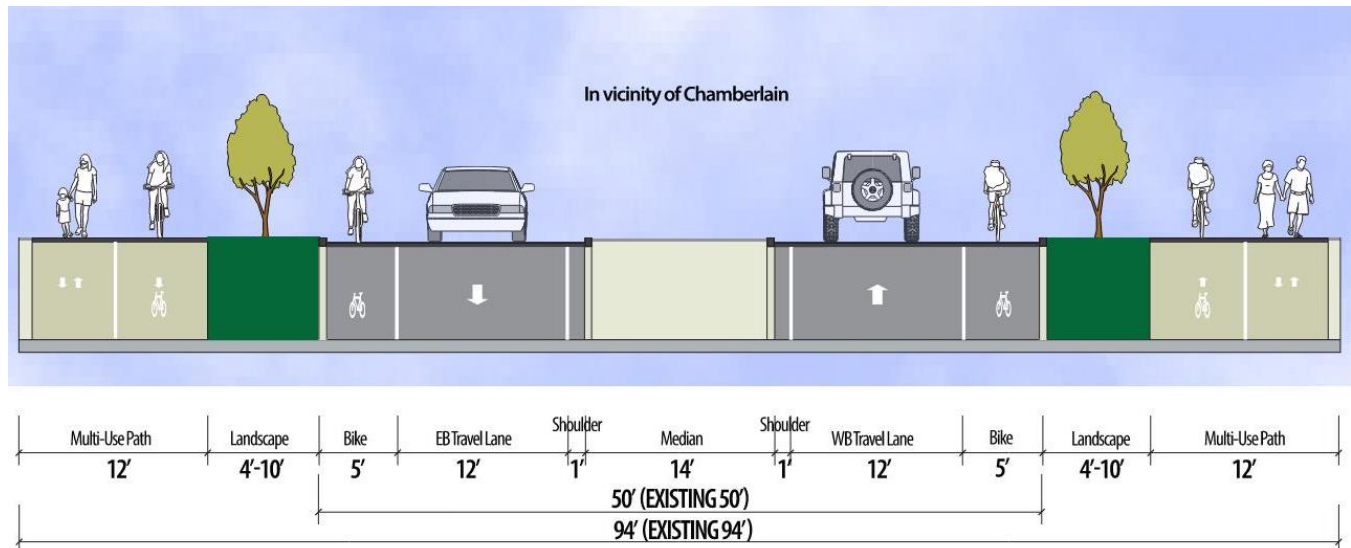


FIGURE 10. POTENTIAL LONG-TERM REED MARKET ROAD CROSS SECTION (IN VICINITY OF CHAMBERLAIN STREET)

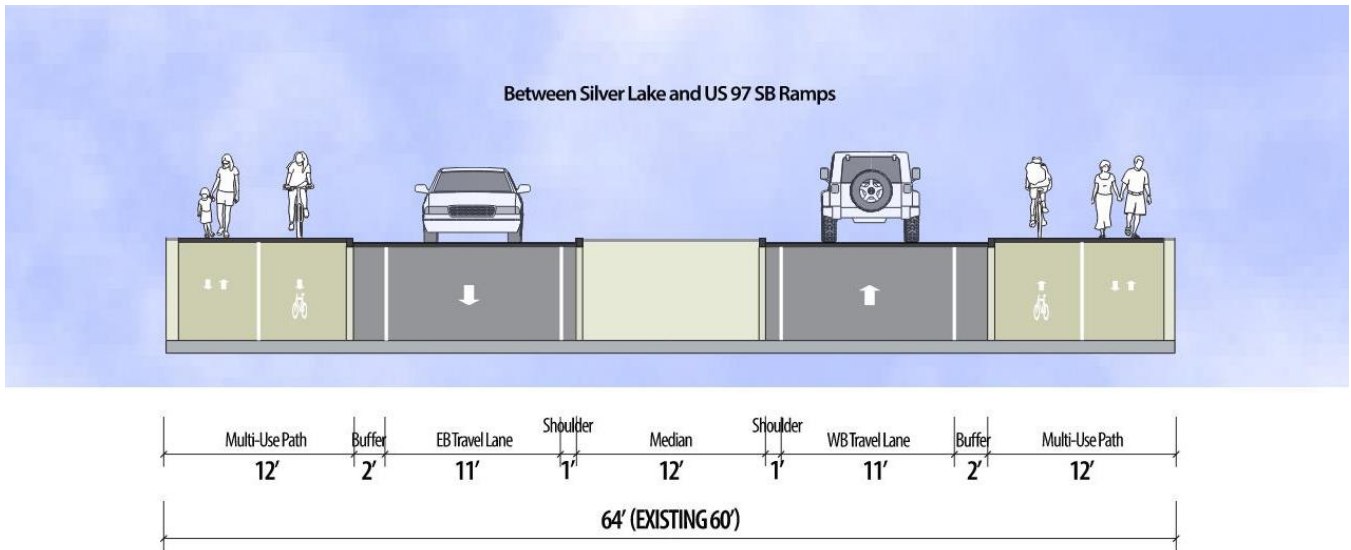


FIGURE 11. POTENTIAL LONG-TERM REED MARKET ROAD CROSS SECTION (BETWEEN SILVER LAKE BOULEVARD AND US 97 SOUTHBOUND RAMPS)

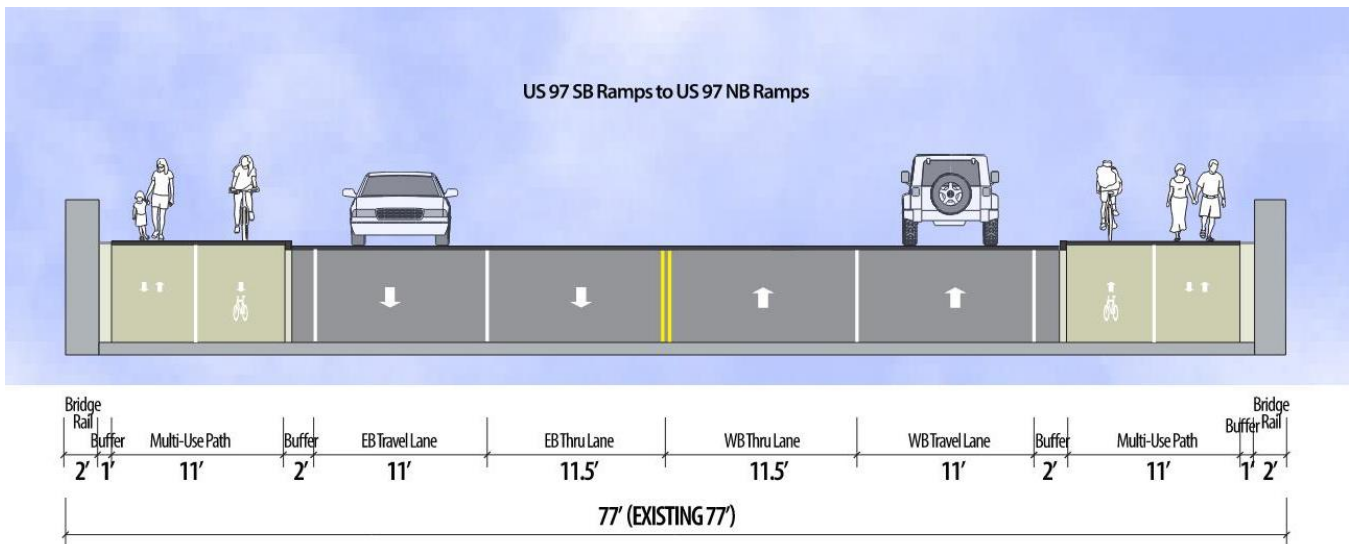


FIGURE 12. POTENTIAL LONG-TERM REED MARKET ROAD CROSS SECTION (US 97 SOUTHBOUND RAMPS TO US 97 NORTHBOUND RAMPS)

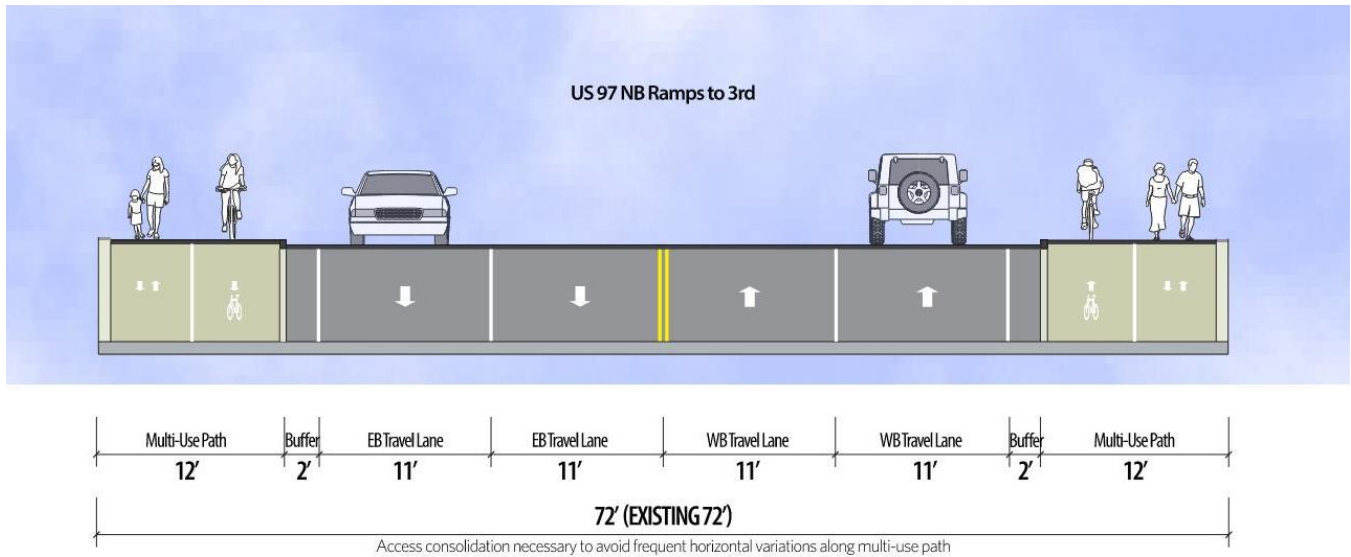


FIGURE 13. POTENTIAL LONG-TERM REED MARKET ROAD CROSS SECTION (US 97 NORTHBOUND RAMPS TO 3RD STREET)

4.2 SHORT-TERM INTERSECTION IMPROVEMENTS

Within the study area, two intersections have relatively limited (less than \$250,000) funding for improvements: Reed Market Road/Chamberlain Street and 3rd Street/Brosterhus Road. Several short-term enhancements were recommended at these two locations and are discussed in more detail below.

REED MARKET ROAD/CHAMBERLAIN STREET IMPROVEMENTS

Chamberlain Street has been identified as a key walking and biking route in the Bend TSP. The City has approximately \$250,000 in the Neighborhood Street Safety Program to pave a portion of Chamberlain Street and install crossing enhancements at Reed Market Road. It was recommended that these crossing enhancements include:

- New pedestrian crossing on the east leg.
- Wayfinding signs for people walking and biking.
- Median cutouts for a bicycle crossing and green pavement markings, such as in the example shown in Figure 14.
- Additional pedestrian and bicycle crossing warning signs, such as in the example in Figure 14.
- Possible vegetation removal in the median to improve pedestrian visibility.
- Preserving space for future bus stops along Reed Market Road.
- Adding enhanced lighting at the intersection.



FIGURE 14. EXAMPLE BICYCLE CROSSING THROUGH A MEDIAN IN PORTLAND, OR

Source: Google Streetview, Google Earth

3RD STREET/BROSTERHOUS ROAD

The City was concurrently conducting a study⁹ to evaluate potential short-term and long-term improvement options to enhance safety at this intersection. As a result of that study, several signing, striping, lighting, and signal timing treatments were recommended as short-term improvements that would use existing funding identified in the Bend CIP (\$130,000), including:

- Re-striping the eastbound and westbound approaches to move the bike lanes to the left of the right-turn lanes (consistent with the signalization at the intersection) and add bicycle conflict striping. The re-striping helps address the lane offset through the intersection.
- Re-striping the eastbound approach to make the right-turn lane channelization clearer to drivers.
- Adding signs on the eastbound approach to make the lane channelization clearer to drivers.
- Modifying the striping for the channelized right turns on the northbound and southbound approaches, adding signs, and adding reflectors to the islands.
- Installing lighting at the intersection to enhance nighttime visibility to prevent potential crashes.
- Working with the Central Oregon Irrigation District to install a gate across the canal trail to encourage people walking and biking along the Canal Trail to use the traffic signal to cross Brosterhous Road. People walking and biking along the trail (east leg of the intersection) are more likely to cross Brosterhous Road at the trail instead of using the intersection crossing,

⁹ Bend 3rd Street Evaluation and Signal Upgrade; February 2023; DKS Associates.

which contributes to safety concerns from crossing at an uncontrolled location in close proximity to the signalized intersection.

- Adding a LPI to enhance safety for people walking and biking. It should be noted that the signal timing change alone does not address motor vehicle conflicts.
- Implementing eastbound and westbound split phasing to reduce the conflicts between left-turning vehicles and other road users. It should be noted this improvement creates additional intersection delay and requires an upgrade to the signal heads and a structural analysis to determine the feasibility of the existing signal poles and span wire to accommodate the four section signal heads.






While no additional funding has been identified for this intersection, several long-term treatments are discussed in more detail later this report.

4.3 LONG-TERM INTERSECTION IMPROVEMENT ALTERNATIVES EVALUATION

The long-term alternatives were compared using the evaluation criteria listed in Table 1. Each of the alternatives was scored relative to evaluation criteria to highlight the assumed level of benefit. These qualitative scores helped guide the discussion of the key opportunities and tradeoffs associated with each alternative and led to ultimately selecting a preferred alternative. Each evaluation criterion was rated on the qualitative scale shown in Table 6.

The following sections describe the evaluation of each of the five major study intersections. The detailed evaluation and concept figures can be found in Attachment E – *Technical Memorandum #4*.

TABLE 6: ALTERNATIVE SCORING SCALE

QUALITATIVE SCORE	PERFORMANCE
	Excellent
	Good
	Fair
	Poor
	Very Poor













4.4 REED MARKET ROAD/BROOKSWOOD BOULEVARD/BOND STREET

The evaluation at the roundabout considered two alternatives:

- Alternative 1: Multilane roundabout
 - Left-turn lanes were added on the northbound and southbound approaches and right-turn lanes were added on the eastbound and westbound approaches.
 - Sidewalk and bike lanes were maintained the same as under existing conditions with the option for people biking to exit to the sidewalk or continue in the travel lane.
 - Curb lines were adjusted to make the intended movements of drivers more apparent, which may improve gap acceptance for drivers on the downstream approaches.
- Alternative 2: Multilane roundabout with metering
 - Same geometry as Alternative 1 with an added metering signal on each approach.
 - The metering signals were placed upstream of the lane additions and are intended to operate independently from the roundabout. They would be completely dynamic, turning on only during times when the metering signals would provide benefit.

The alternatives were both evaluated using Vissim microsimulation and the full details on the simulation model development and calibration are included in Attachment E – *Technical Memorandum #4*. Table 7 presents the summary of the evaluation at the intersection.

TABLE 7. REED MARKET ROAD/BROOKSWOOD BOULEVARD/BOND STREET ALTERNATIVE PERFORMANCE

GOAL	QUALITATIVE SCORE		SUMMARY
	ALT 1	ALT 2	
1 Increase System Functionality, Quality and Connectivity for All Users			<ul style="list-style-type: none"> Alternative 1 will improve operations over the No-Build scenario but will not resolve all operational issues. Alternative 2 will provide additional benefit over Alternative 1 and allow specific control of where queueing happens and the ability to control queues where other elements of the system could be impacted (e.g., the US 97 ramps).
2 Ensure Safety for All Users			<ul style="list-style-type: none"> While both alternatives will result in an increased number of conflict points over the existing single-lane roundabout, multilane roundabouts still have a better safety performance than other alternatives that would increase capacity, including signalized intersections. The addition of meters could incorporate emergency vehicle preemption to facilitate emergency response during queued conditions.
3 Support Economic Development			<ul style="list-style-type: none"> Alternative 1 will increase capacity of the intersection, reducing impacts on property access points and improving peak hour access to commercial areas. The metering condition will further improve property access by limiting excessive queue growth on any one approach.
4 Protect Livability and Ensure Equity and Access			<ul style="list-style-type: none"> Both alternatives will provide increased access to areas served by this intersection.
5 Steward the Environment			<ul style="list-style-type: none"> Both alternatives will result in emissions reduction by reducing vehicular delay. The metering alternative will result in additional delay reduction.
6 Develop Solutions That Are Cost-Effective and Implementable			<ul style="list-style-type: none"> Alternative 1 had been developed to minimize impacts during construction and the lane additions identified in this concept were not dependent on each other and could be phased over time. The addition of meters can be considered once the additional benefit justifies the additional cost.

4.5 REED MARKET ROAD/US 97 SOUTHBOUND RAMP TERMINAL













Two alternatives to address concerns at the intersection were evaluated, including:

- Alternative 1: Providing an additional southbound dedicated right-turn lane.
- Alternative 2: Extending the US 97 southbound exit ramp.

Potential options to improve westbound bicycle comfort level in both alternatives included shifting the bike lane adjacent to the curb, adding a bike ramp to provide an option to cross using the sidewalk or crosswalk, and adding a bike signal at the intersection (adding a bike signal may also require modifications to the signal such as a right-turn overlap with blank-out sign and potentially a bike level-push button).

For both alternatives, the analysis assumed that the signal cycle length would be increased and that the signal would be coordinated with a signal at the US 97 northbound ramp terminal and other signalized intersections within the study area to enhance corridor operations. Table 8 presents a summary of the evaluation of the alternatives.

TABLE 8. REED MARKET ROAD/US 97 SOUTHBOUND RAMP TERMINAL ALTERNATIVE PERFORMANCE

GOAL	QUALITATIVE SCORE		SUMMARY
	ALT 1	ALT 2	
1 Increase System Functionality, Quality and Connectivity for All Users			<ul style="list-style-type: none"> Alternative 1 will significantly reduce the overall intersection v/c ratio by adding a southbound right-turn lane, resulting in less queueing on the southbound approach and reducing delay for the eastbound and westbound movements, which may better support a planned transit route travelling along Reed Market Road. Both alternatives will equally enhance biking facilities across US 97 by addressing the conflict between people biking and westbound right-turning vehicles. A drawback of Alternative 1 will be the longer southbound crossing distance, increasing exposure for people walking and biking.
2 Ensure Safety for All Users			<ul style="list-style-type: none"> Both alternatives were expected to have similar reductions in crash frequency and severity. Both alternatives will address the conflict between people biking and westbound right-turning vehicles. In Alternative 1, adding a southbound right-turn lane will lengthen the crossing distance, increasing exposure for people walking and biking. Alternative 2 will lengthen the deceleration lane length, resulting in less distance between Reed Market Road and Colorado Avenue southbound interchange ramp tapers, worsening the already deficient access spacing.
3 Support Economic Development			<ul style="list-style-type: none"> Neither alternative was expected to impact effective access to properties along Reed Market Road. Both alternatives will have minimal impacts on facilities accommodating heavy vehicle movements along US 97 and to and from destinations along Reed Market Road.
4 Protect Livability and Ensure Equity and Access			<ul style="list-style-type: none"> Alternative 2 scored better on addressing existing barriers for people walking and biking along Reed Market Road as Alternative 1 resulted in a longer crossing distance that increased exposure for people walking and biking. Alternative 1 was expected to reduce delays for future eastbound and westbound transit along Reed Market Road and will potentially better accommodate planned transit service improvements. Both alternatives were not expected to disproportionately impact properties owned, used, or accessed by historically underrepresented community members relative to other populations.
5 Steward the Environment			<ul style="list-style-type: none"> Alternative 1 was expected to slightly reduce vehicle delays and emissions but does not perform as well with respect to people walking and biking. Alternative 2 will improve conditions for people walking and biking but slightly increase vehicle delay and emissions.
6 Develop Solutions That Are Cost-Effective and Implementable			<ul style="list-style-type: none"> Alternative 2 will be more cost-effective than Alternative 1 but could have slightly larger impacts on traffic during construction.

4.6 REED MARKET ROAD/US 97 NORTHBOUND RAMP TERMINAL/DIVISION STREET

Two alternatives to address concerns at the two intersections included:

- Alternative 1:
 - Constructing a traffic signal at the US 97 northbound ramp terminal.
 - Converting the north leg of Division Street to right-in, right-out only (the northbound Division Street entrance ramp would still not meet ODOT’s standard for acceleration lane length).
- Alternative 2:
 - Constructing a traffic signal at the US 97 northbound ramp terminal.
 - Separating the northbound entrance ramp from Division Street and aligning the new entrance ramp with the Reed Market Road/US 97 northbound ramp signalized intersection (the new entrance ramp would meet ODOT’s standard for acceleration lane length).
 - Leaving Division Street north of Reed Market Road in place to provide business access, but converting the approach to Reed Market Road to right-in and right-out movements only.
 - Converting the south leg of Division Street to right-in and right-out only.

The signal at the northbound ramp terminal was assumed to be coordinated with other signalized intersections within the study area (i.e., the US 97 southbound ramp and 3rd Street intersections). Note that with the realignment of the new US 97 entrance ramp in Alternative 2, there may be an opportunity to further lengthen the loop ramp (Reed Market Road eastbound right turn onto US 97 northbound) acceleration lane, but that option was not included in the current cost estimate.

In addition to the above improvements, a future design team should consider the implementation of partially protected intersection design features, such as a raised or protected island on both the southeast and southwest corners at the intersection of Division Street and possibly at the US 97 exit ramp to the eastbound sidewalk on the east leg. However, this treatment at the US 97 exit ramp may be less feasible due to the grades.

Also, since Brosterhous Road is a designated low-stress network, an option to improve safety will be widening the short segment of Division Street from Reed Market Road to Brosterhous Road with a shared use path for people walking and biking to access the signal crossing Reed Market Road at Division Street. This will avoid the need to use the Reed Market Road and 3rd Street intersection if the protected intersection design is not selected there.

Table 9 lists the evaluation of the alternatives at the intersections.

TABLE 9. REED MARKET ROAD/US 97 NORTHBOUND RAMP TERMINAL/DIVISION STREET ALTERNATIVE PERFORMANCE

GOAL	QUALITATIVE SCORE		SUMMARY
	ALT 1	ALT 2	
1 Increase System Functionality, Quality and Connectivity for All Users			<ul style="list-style-type: none"> Traffic operations in both alternatives at the Reed Market Road and US 97 northbound ramp terminal were significantly improved by installing a traffic signal. Reed Market Road and Division Street no longer experienced westbound and eastbound delay by restricting left-turn movements at the intersection. Traffic signal in both alternatives will provide enhanced crossings of Reed Market Road. Implementing the right-in, right-out treatment at Division Street will also help to reduce conflict points between intersection users. Alternative 2 will further support US 97 crossings by adding a north leg to Reed Market Road/US 97 northbound ramp terminal accessing US 97 and removing conflicts from the combined north Division Street and US 97 exit ramp.
2 Ensure Safety for All Users			<ul style="list-style-type: none"> Both alternatives included a new traffic signal at the US 97 northbound ramp terminal and restricted turning movements to right-in and right-out only at Division Street, similarly reducing crash frequency and severity. Alternative 2 will further enhance safety by mitigating access management conflicts on the US 97 northbound entrance ramp by removing US 97 access on north Division Street.
3 Support Economic Development			<ul style="list-style-type: none"> While the right-in and right-out restriction at Division Street in both alternatives will improve safety by eliminating closely spaced turning conflicts, it will also reduce the accessibility to some properties to and from certain directions. Furthermore, Alternative 2 will result in the acquisition of up to two properties. Both alternatives will have no negative impacts on facilities accommodating heavy vehicle movements along US 97 and to and from destinations along Reed Market Road. However, the separation of the US 97 entrance ramp from Division Street in Alternative 2 could make it easier for heavy vehicles to get up to merging speed before entering the Parkway.
4 Protect Livability and Ensure Equity and Access			<ul style="list-style-type: none"> Both alternatives will address existing barriers for people walking and biking by enhancing walking and biking facilities, providing an enhanced crossing, and reducing left-turn conflicts at Division Street. Alternative 2 will further mitigate access management conflicts and support people walking and biking on US 97 by removing US 97 access on north Division Street. Both alternatives will have minimal impacts on accommodating planned transit service improvements and expansions. Neither alternative was expected to disproportionately impact properties owned, used, or accessed by historically underrepresented community members relative to other populations.
5 Steward the Environment			<ul style="list-style-type: none"> Both alternatives significantly improved traffic operations with less vehicular delays and had similar impacts on enhancing walking and biking facilities.
6 Develop Solutions That Are Cost-Effective and Implementable			<ul style="list-style-type: none"> Alternative 1 was more cost-effective than Alternative 2 and better fit within funding expectations. Alternative 1 could be designed as a first phase of Alternative 2 to improve the acceleration lane length of the US 97 northbound entrance ramp.

4.7 REED MARKET ROAD/3RD STREET

Three alternatives to mitigate the concerns at the intersection were evaluated, including:

- Alternative 1:
 - (a) Adding eastbound and westbound left-turn lanes.
 - (b) Adding eastbound and westbound left-turn lanes and a dedicated southbound right-turn lane.
- Alternative 2:
 - (a) Implementing a protected intersection design in addition to Alternative 1(a).
 - (b) Implementing a protected intersection design in addition to Alternative 1(b).
- Alternative 3:
 - Constructing a multilane lane roundabout with northbound and southbound right-turn slip lanes.

The protected intersection design in Alternative 2 included signal timing strategies of leading pedestrian intervals (LPIs)/leading bicycle intervals (LBIs) and right-turn-on-red (RTOR) restrictions. LPIs or LBIs give people walking and biking the opportunity to enter the crosswalk approximately five seconds before vehicles are given a green signal indication, while restricting RTOR removes conflicts between motorists and people walking and biking. Note that all alternatives assumed the intersection would be shifted to the northwest to minimize right-of-way costs and impacts. A potential option for accommodating people biking in both Alternatives 1 and 2 was widening sidewalks to allow them to exit and use the crosswalks. In Alternative 3, people biking had the option to exit and use the sidewalk or stay in the lane travelling through the roundabout.

Table 10 summarizes the scoring for each of the three alternatives across the project goals.

TABLE 10. REED MARKET ROAD/3RD STREET ALTERNATIVE PERFORMANCE

GOAL	QUALITATIVE SCORE			SUMMARY
	ALT 1	ALT 2	ALT 3	
1 Increase System Functionality, Quality and Connectivity for All Users				<ul style="list-style-type: none"> All alternatives were able to meet the mobility target to a similar degree, with a significant decrease in delays based on the operational results. Alternative 1 will require roadway widening, resulting in longer crossing and increased exposure for people walking and biking. Especially in Alternative 1(b), with the additional southbound right-turn lane, people biking southbound must also cross the right-turn lane upstream of the intersection. Alternative 2 will provide physical separation, reduce vehicle speeds, improve visibility, and provide LPIs or LBIs and RTOR restrictions to support the implementation of a key walking and biking route on 3rd Street. Alternative 3 will provide a two-stage crossing for people walking and biking and reduce vehicles speeds but require drivers in both lanes of the roundabout to yield to people crossing at the intersection.
2 Ensure Safety for All Users				<ul style="list-style-type: none"> Alternative 2 was expected to best address safety for people walking and biking, followed by Alternative 3. Alternative 1 will increase exposure for people walking and biking, with longer crossings.
3 Support Economic Development				<ul style="list-style-type: none"> Alternatives 1 and 2 will have minimal impacts on maintaining effective access to properties along Reed Market Road in a manner that support the economic development objectives of existing and future businesses. In Alternative 3, the multilane roundabout will require a larger right-of-way footprint, potentially impacting more businesses. All alternatives will have minimal impacts on facilities accommodating heavy vehicle movements along US 97 and to and from destinations along Reed Market Road.
4 Protect Livability and Ensure Equity and Access				<ul style="list-style-type: none"> As noted, Alternative 2 was expected to best address conditions for people walking and biking, followed by Alternative 3. All three alternatives will have similar property impacts and were not expected to disproportionately impact properties owned, used, or accessed by historically underrepresented community members relative to other populations.
5 Steward the Environment				<ul style="list-style-type: none"> Alternative 1 will significantly reduce vehicular delays, but road widening creates a deficiency on supporting walking, biking, and use of transit. Alternative 2 notably reduced vehicular delays, but the delays would be longer than those of Alternative 1 due to the added LPIs or LBIs. However, Alternative 2 will support walking, biking, and the use of transit by reducing speed, providing physical separation and protected phases, and enhancing visibility. Alternative 3 will produce less vehicular delays than Alternative 2 while creating a lower speed environment by providing refugee islands to help support walking, biking, and use of transit at the intersection, but not as much as Alternative 2.
6 Develop Solutions That Are Cost-Effective and Implementable				<ul style="list-style-type: none"> The costs of all alternatives were expected to exceed available funding, although there was potential to reduce right-of-way costs in Alternative 1 by not adding the southbound right-turn lane to better align with available funding (i.e., selecting Alternative 1(a)). Alternatives 1 and 2 were more compatible with other projects along the corridor, as the surrounding intersections were expected to remain traffic signals. Alternative 2 will be expected to require more maintenance and provide more challenges for snow removal. Alternative 1 and 2 can be more easily constructed with regard to the ability to maintain movements of all modes during construction, while Alternative 3 would be more challenging to maintain traffic during construction.

4.8 3RD STREET/BROSTERHOUS ROAD

The City was concurrently conducting a study at this location and identified short-term improvements (described previously) that will expend the existing funds budgeted in the City's CIP (approximately \$130,000). Two long-term (and unfunded) alternatives to address remaining concerns at the intersection were evaluated, including:

- Alternative 1:
 - Converting lane configurations and signal phasing to include dedicated and protected eastbound and westbound left turns.
 - Adding an eastbound dedicated right-turn lane.
 - Adding bike boxes on all approaches.
- Alternative 2:
 - Converting lane configurations and signal phasing to include dedicated and protected eastbound and westbound left turns.
 - Adding an eastbound dedicated right-turn lane.
 - Implementing a protected intersection design.

The intersection was assumed to be coordinated with other signalized intersections within the study area to provide continuous traffic flow at the target speed (note that the cycle length was assumed to be increased from 75 seconds to 120 seconds). A protected intersection design would look similar to Alternative 2 at the Reed Market Road/3rd Street intersection. Table 11 summarizes the evaluation of alternatives at the intersection.

TABLE 11. 3RD STREET/BROSTERHOUS ROAD ALTERNATIVE PERFORMANCE

GOAL	QUALITATIVE SCORE		SUMMARY
	ALT 1	ALT 2	
1 Increase System Functionality, Quality and Connectivity for All Users			<ul style="list-style-type: none"> Both alternatives were able to meet the mobility target but result in higher delays than the No-Build condition, in part due to the increased cycle length. There was more delay in Alternative 2 because of the implementation of LPIs/LBIs. Both alternatives will reduce eastbound and westbound left-turning conflicts and ensure protected phasing for people walking and biking by providing protected eastbound and westbound left-turn phases. Alternative 1 will require roadway widening, which lengthens the crossing distance and increases exposure for people walking and biking. However, bike boxes allow people biking to locate themselves in front of vehicles for better visibility. Alternative 2 will also require roadway widening but significantly enhance the quality of walking and biking facilities by utilizing raised islands at the intersection corners to provide physical separation, providing extra crossing time associated with LPIs/LBIs, reducing vehicle turning speeds, and improving visibility. In Alternative 2, the protected intersection design will provide better access to transit.
2 Ensure Safety for All Users			<ul style="list-style-type: none"> Both alternatives were expected to significantly improve safety by adding protected eastbound and westbound left-turn phases to address a known crash history at this intersection. Alternative 1 will have less of an impact on designing and building facilities and routes that maximize safety for people walking and biking, as it will not provide physical separation between vehicles and people walking and biking. In Alternative 2, the protected intersection design will significantly minimize conflicts and risk factors that could lead to crashes by providing physical separation and LPIs/LBIs, restricting RTOR, reducing vehicle turning speeds, and improving visibility
3 Support Economic Development			<ul style="list-style-type: none"> Both alternatives will have minimal impacts on supporting economic development within the study area.
4 Protect Livability and Ensure Equity and Access			<ul style="list-style-type: none"> Alternative 2 scored better on accommodating planned transit service improvements and expansions by providing better access to transit. Both alternatives will have minimal impacts on properties owned, used, or accessed by historically underrepresented community members proportionate to those of other populations.
5 Steward the Environment			<ul style="list-style-type: none"> Alternative 1 resulted in slightly higher vehicle delay (vehicle emissions) but will enhance facilities for people walking and biking by providing protected eastbound and westbound left-turn phases. Alternative 2 generated higher vehicle delays but the protected intersection design will significantly improve safety for people walking and biking, supporting the connections in the local system and the use of alternative travel modes.
6 Develop Solutions That Are Cost-Effective and Implementable			<ul style="list-style-type: none"> Both alternatives would require a full rebuild of the intersection. Given there is no funding allocated for a long-term enhancement at the intersection, it would greatly exceed expected funding. The protected intersection design in Alternative 2 would be more challenging to maintain, particularly with respect to snow removal.

CHAPTER 5. PREFERRED ALTERNATIVES

Based on the refinement and evaluation of the alternatives, a set of preferred alternatives was recommended by the TAC and Stakeholder Advisory Committee (SAC). Attachment F - *Technical Memorandum #5: Preferred Alternatives* includes the details of development and evaluation of the preferred alternatives. Table 12 summarizes the preferred alternatives recommended at each of the study intersections. More details about the preferred alternatives are included in the prospectus sheets in Attachment F – *Technical Memorandum #5*.

TABLE 12: PREFERRED ALTERNATIVES AT EACH STUDY INTERSECTION IN THE REED MARKET ROAD CORRIDOR

INTERSECTION	RECOMMENDATION	KEY CONSIDERATIONS FOR FUTURE DESIGN TEAM
REED MARKET RD/ BROOKSWOOD BLVD/ BOND STREET	<ul style="list-style-type: none"> Phase 1: Multilane roundabout (Alt 1) Phase 2 (future): Metering (Alt 2) 	<ul style="list-style-type: none"> Include conduit to support future implementation of roundabout metering (Alt 2) Install rectangular rapid flashing beacons (RRFBs) to facilitate pedestrian crossings on the dual entry lanes.
REED MARKET RD/ CHAMBERLAIN ST	<ul style="list-style-type: none"> Crossing enhancement 	<ul style="list-style-type: none"> Install a pedestrian crossing on the east leg and implement median cutouts and green pavement marking for people biking. Install wayfinding and warning signs for people walking and biking. Remove vegetation in the median and add enhanced lighting for better visibility. Preserve space for future bus stops.
REED MARKET RD/ US 97 SOUTHBOUND RAMP	<ul style="list-style-type: none"> Add exclusive southbound right-turn lane and improve westbound bike travel (Alt 1) 	<ul style="list-style-type: none"> Dedicated westbound bicycle signal. Include a blank-out sign^A for right-turn-on-red (RTOR) restrictions in conjunction with considering bicycle signal indications. Investigate opportunities for a multiuse path for westbound people biking who are approaching the intersection.
REED MARKET RD/ US 97 NORTHBOUND RAMP	<ul style="list-style-type: none"> Phase 1: Signalized intersection (Alt 1) Phase 2 (future): Entrance ramp realignment (Alt 2) 	<ul style="list-style-type: none"> Investigate access modifications at the north end of Division St to begin US 97 entrance ramp acceleration earlier. Design the signal to allow for a future phase where Alt 2 can be implemented.

INTERSECTION	RECOMMENDATION	KEY CONSIDERATIONS FOR FUTURE DESIGN TEAM
REED MARKET RD/ 3RD ST	<ul style="list-style-type: none"> Protected intersection with eastbound and westbound left-turn lanes (Alt 2A) 	<ul style="list-style-type: none"> Remove the southbound right-turn lane from the proposed design to reduce costs and limit right-of-way impacts. Consider a multiuse path approaching the intersection (instead of bike lanes) to limit right-of-way impacts. Consider access management on all approaches at the intersection, particularly the east leg between 3rd St and 4th St. Explore other cost-saving measures through design.
3RD ST/ BROSTERHOUS RD^B	<ul style="list-style-type: none"> Phase 1: Short-term recommendations Phase 2 (future): Protected intersection with lane reconfiguration (Alt 2) 	<ul style="list-style-type: none"> Consider how this treatment functions with future improvements along Brosterhous Rd and Parrell Rd to support the implementation of a key walking and biking route (such as widening over the canal bridge for better facilities for people walking and biking). Consider speed limit reduction along Brosterhous Rd.

^A The blank out sign is an automated warning sign activated according to different times and conditions.

^B The intersection has limited funding available for improvements, and the City has planned to implement short-term enhancements at the intersection utilizing all available funding.

Figures 15 to 18 show the preferred alternative concept drawings for the study intersections along Reed Market Road (drawings were not developed for the intersections of Reed Market Road/Chamberlain Street and 3rd Street/Brosterhous Road as part of this study).



FIGURE 15. MULTILANE ROUNDABOUT AT REED MARKET ROAD/BROOKSWOOD BOULEVARD/BOND STREET

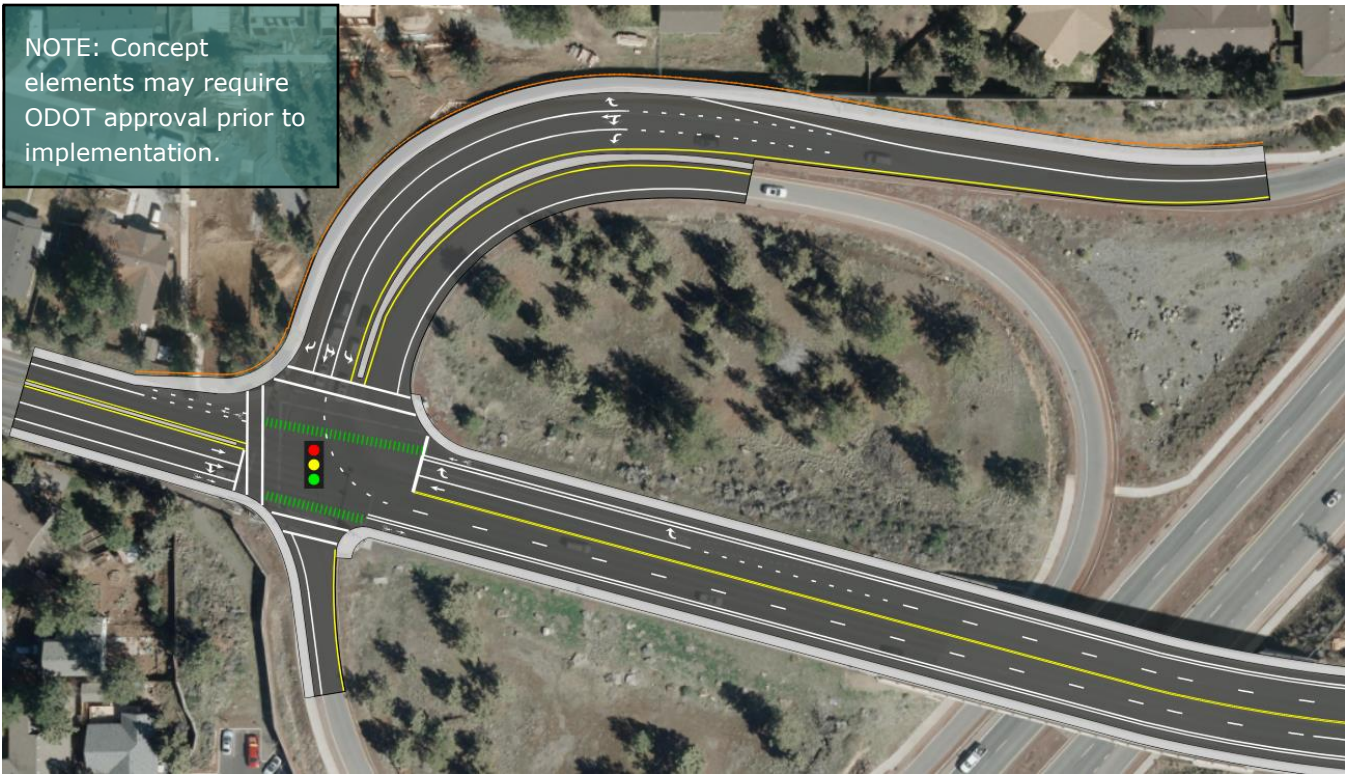


FIGURE 16. PREFERRED ALTERNATIVE AT REED MARKET ROAD/US 97 SOUTHBOUND RAMP

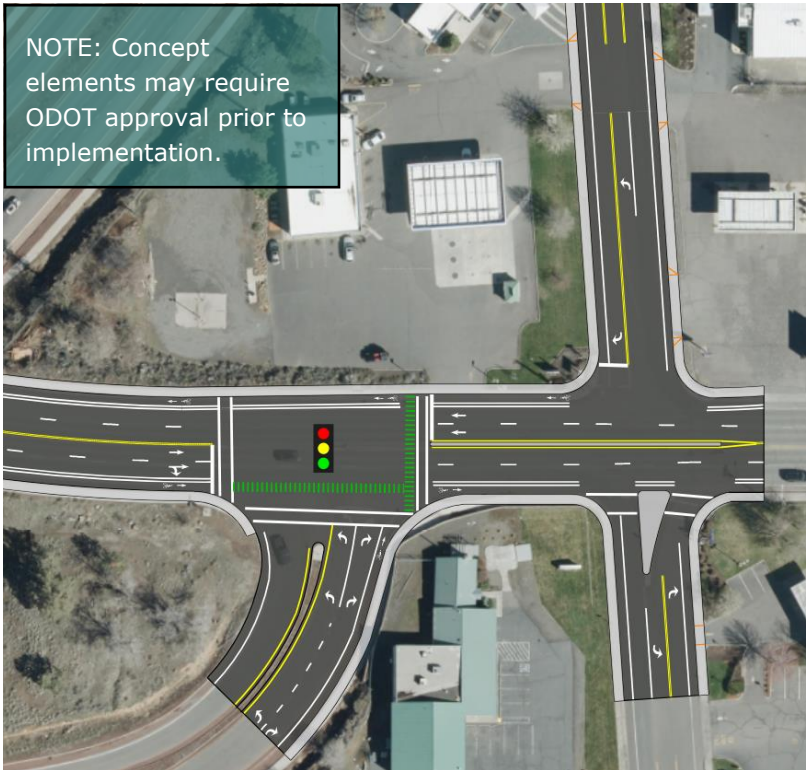


FIGURE 17. PREFERRED ALTERNATIVE AT REED MARKET ROAD/US 97 NORTHBOUND RAMP/DIVISION STREET



FIGURE 18. PREFERRED ALTERNATIVE AT REED MARKET ROAD/3RD STREET

5.1 PREFERRED ALTERNATIVE PERFORMANCE

This section discusses the performance of the preferred alternatives, starting with an assessment of individual intersection operations to determine the operational efficiency of the preferred alternatives, then a systemwide operation analysis to evaluate the effectiveness of the preferred alternatives as a whole. Also, the performance summary of this section presents a comprehensive overview of each study intersection's operational and safety performance.

INTERSECTION OPERATION ANALYSIS

The performance of each intersection with the preferred alternative in place was compared against the adopted mobility targets. It should be noted that the mobility targets for the ODOT intersections with preferred alternative were obtained from the ODOT Highway Design Manual (HDM). The ODOT HDM provides design v/c ratio standards for project development or design to provide a mobility solution that corrects those previously identified deficiencies and provides the best investment for the State in establishing a 20-year design life solution.¹⁰

As shown in Table 13, Reed Market Road/Brookwood Boulevard/Bond Street failed to meet the mobility target, however, widening the roundabout has significant benefits compared to the No-Build conditions. The operations at Reed Market Road/US 97 southbound ramp improved with preferred alternatives but fell just short of the HDM mobility target. The rest of the study intersections were able to meet the mobility target with the preferred alternatives in the future, indicating better operations to help improve the congestion concerns along the study corridor.

¹⁰ ODOT Highway Design Manual Part 1200, January 2023, Oregon Department of Transportation.

TABLE 13. FUTURE 2040 DESIGN HOUR NO-BUILD AND BUILD TRAFFIC OPERATIONS AT STUDY INTERSECTIONS

INTERSECTION	JURISDICTION	CONTROL	MOBILITY TARGET	FUTURE (2040) NO-BUILD			FUTURE (2040) BUILD		
				V/C ^A	LOS ^B	DELAY ^C (SEC)	V/C	LOS	DELAY (SEC)
REED MARKET RD/BROOKSWOOD BLVD/BOND ST	City (AWD)	Roundabout	≤ 1.00	1.72	F	>150	1.21	F	104
REED MARKET RD/ US 97 SB	ODOT (30HV)	Signalized	≤ 0.90 ^D (No-Build) ≤ 0.75 ^E (Build)	0.94	C	26	0.78	C	25
REED MARKET RD/ US 97 NB	ODOT (30HV)	TWSC (No-Build) Signalized (Build)	≤ 0.85 (No-Build) ≤ 0.75 ^E (Build)	NA/ 2.56	NA/F	NA/ >150	0.63	A	6
REED MARKET RD/ DIVISION ST	ODOT (30HV)	TWSC	≤ 1.00	0.46/ 0.14	B/C	14/17	0.43/0.14	A/C	0/17
REED MARKET RD/ 3 RD ST	City (AWD)	Signalized	≤ 1.00	1.26	F	>150	0.96 ^F	F ^F	81 ^F
3 RD ST/ BROSTERHOUS RD	City (AWD)	Signalized	≤ 1.00	0.89	C	21	0.87 ^F	D ^F	47 ^F

Bold and red indicate a failure to meet the mobility target, 30HV=30th Highest Hour, AWD = Average Weekday P.M. Peak, LOS=Level of Service, TWSC=Two-Way Stop-Controlled, v/c=Volume-to-Capacity ^A v/c ratio reported as the overall intersection v/c ratio at signalized intersections, worse case approach v/c at roundabouts, and v/c ratio for Major Street/Minor Street at TWSC intersections.

^B LOS reported as the worst major street LOS/minor street LOS for TWSC intersections, worst case approach LOS for roundabouts, and overall intersection LOS for signalized intersections.

^C Control delay reported for worst case major street/minor street for TWSC intersections, worst case approach delay for roundabouts, and overall intersection delay for signalized intersections.

^D ODOT adopted an alternative mobility target for this intersection as part of the US 97 Parkway Plan, which assumed a 0.90 v/c ratio during 30 HV and ensuring 95th percentile queues do not extend into the portion of the exit ramp needed for deceleration.

^E Mobility target obtained from the ODOT Highway Design Manual (HDM).

^F Analyzed using Highway Capacity Manual (HCM) 2000 methodology, as leading-pedestrian-interval phasing is not supported in Synchro HCM 6th Edition.

SYSTEMWIDE OPERATIONS ANALYSIS

The preferred alternatives were evaluated using a Vissim microsimulation model to assess the compatibility and effectiveness of the study intersection improvements within the overall network. The project *Methodology Memorandum* in Attachment B – *Technical Memorandum #1* and *Vissim Protocol Calibration and Validation Report*¹¹ documented the details of model development assumptions. Several operational assumptions, as described in Attachment F - *Technical Memorandum #5*, were made to enhance the system performance and evaluate the impact of the improvements when combined along the corridor.

The model evaluated the future year (2040) average weekday conditions during the p.m. peak period (4 p.m. to 6 p.m.). Several measures of effectiveness (MOEs) were obtained, including GEH¹², congestion speed plots, average and 95th percentile motor vehicle queue length, and vehicle delay. A summary of system performance compared to a No-Build scenario and MOEs are reported below. A summary of key findings is also provided at the end of this section to discuss key findings for system performance and performance at each of the study intersections.

Under No-Build conditions, several intersections operated over capacity and given this level of congestion, the No-Build scenario was not evaluated in detail in microsimulation but system performance measures (latent demand, vehicle hours of delay and latent delay) were evaluated for comparison against the preferred alternatives scenario. Compared to the No-Build scenario, the preferred alternatives:

- Significantly increased system capacity, serving over 1,000 additional vehicles in the network during the peak two-hour period.
- Resulted in savings of over 1,500 vehicle-hours of delay over the two-hour period.
- Resolved significant queueing on the ramp terminals that spilled back onto mainline US 97, as discussed below in more detail.

Congestion

The microsimulation model was used to measure queueing and delay relative to desired speed as an indicator of congestion. Figures 19 and 20 represent the relative delay averaged over 10 simulation runs for the peak 15 minutes under No-Build conditions and with the preferred alternatives, respectively. The colors shown in the figure indicate the following approximate queue states:

- Dark green represents free-flow conditions with no delay.
- Light green represents slight slowing.
- Yellow represents increased slowing, but not yet at the “stop and go” state.

¹¹ US 97 at Reed Market Road Operations and Safety Study - Vissim Protocol Calibration and Validation, March 2023.

¹² The GEH statistic is a universal measure to compare model inputs and outputs. This continuous volume tolerance formula was developed to avoid the pitfalls associated with using a simple percentage comparison of a wide range of volumes. ODOT has a criteria/threshold lower than 5.0. GEH results for the modeled area with preferred alternatives can be found in Appendix J.

- Orange represents the furthest extent of stop and go queues at any point during the entire 15-minute period (a rough approximation of 95th percentile queues).
- Red represents fluctuation between low-speed flow and stopped queues.
- Dark red represents continuous stop and go queues during the entire 15-minute period.

As shown in the figures, the overall congestion improved with the implementation of the preferred alternatives compared to the No-Build scenario, especially at the US 97 ramp terminals. Even with improvements, substantial congestion was still expected at the Reed Market Road/Brookwood Boulevard/Bond Street roundabout and on the southbound approach at Reed Market Road/3rd Street. However, that congestion was expected to have limited impact on congestion at the US 97 ramp exit approaches. The congestion plots for each 15-minute interval over the two-hour simulation period for the model with preferred alternatives are included in Attachment F – *Technical Memorandum #5*.

Queueing

Queueing results for specific movements for the modeled area with preferred alternatives can be found in Attachment F – *Technical Memorandum #5*. Similar to the discussion in the Congestion section, average and 95th percentile queues were expected to be extensive at Reed Market Road/Brookwood Boulevard/Bond Street and the southbound approach at Reed Market Road/3rd Street.

As analyzed and discussed in Attachment E - *Technical Memorandum #4* for the Reed Market Road/Brookwood Boulevard/Bond Street roundabout, the southbound and westbound approaches experienced relatively short queueing, whereas the northbound approach experienced extremely long queueing. The implementation of metering helped distribute the queues more evenly across each approach, reducing queues on the northbound approach but increasing queues on southbound and westbound approaches. However, even with the roundabout metering included in the analysis, the average westbound queues shown in this analysis were still able to stay well clear of the ramp terminals (extending 450 feet). Even with spikes in the 95th percentile queues in the westbound direction just extending to the ramp terminal, the queues on the ramp approaches were able to stay less than 325 feet long, well short of the 670 feet of queue storage available before encroaching on the safe stopping distance.

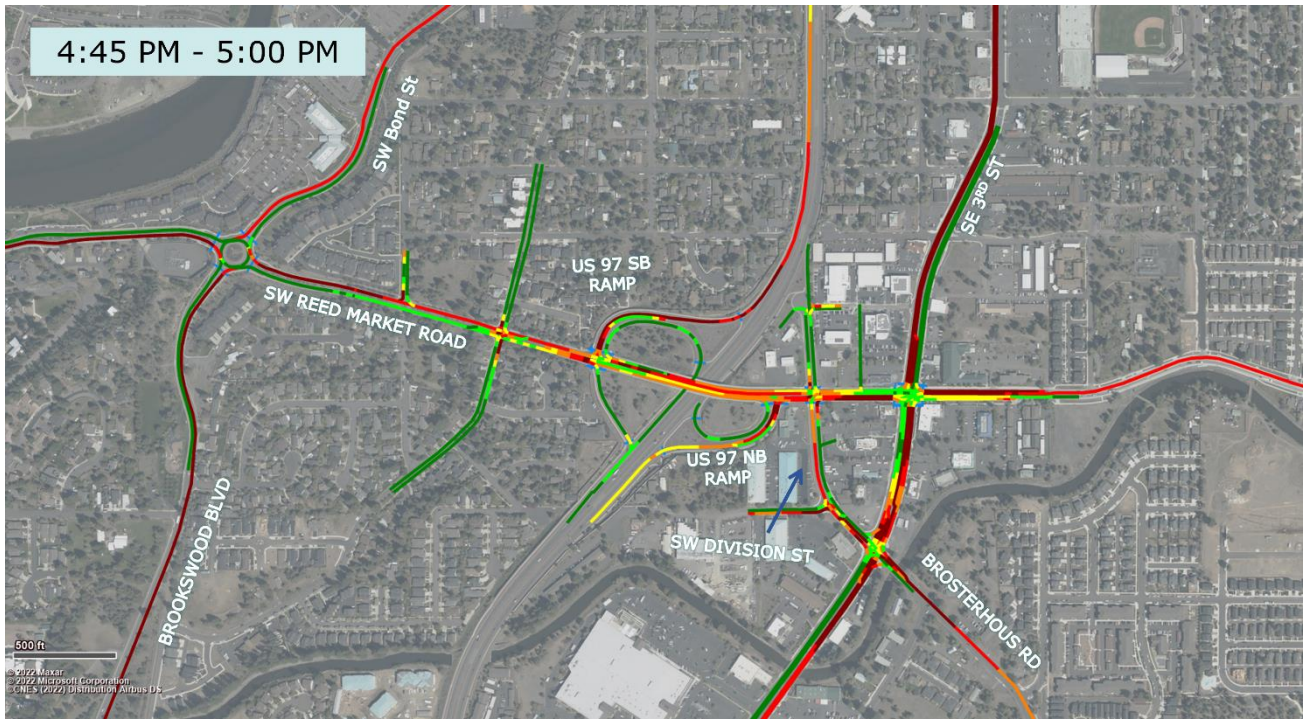


FIGURE 19. FUTURE NO-BUILD PEAK 15 MINUTE (4:45 P.M. TO 5:00 P.M.) CONGESTION PLOT WITHIN THE STUDY AREA

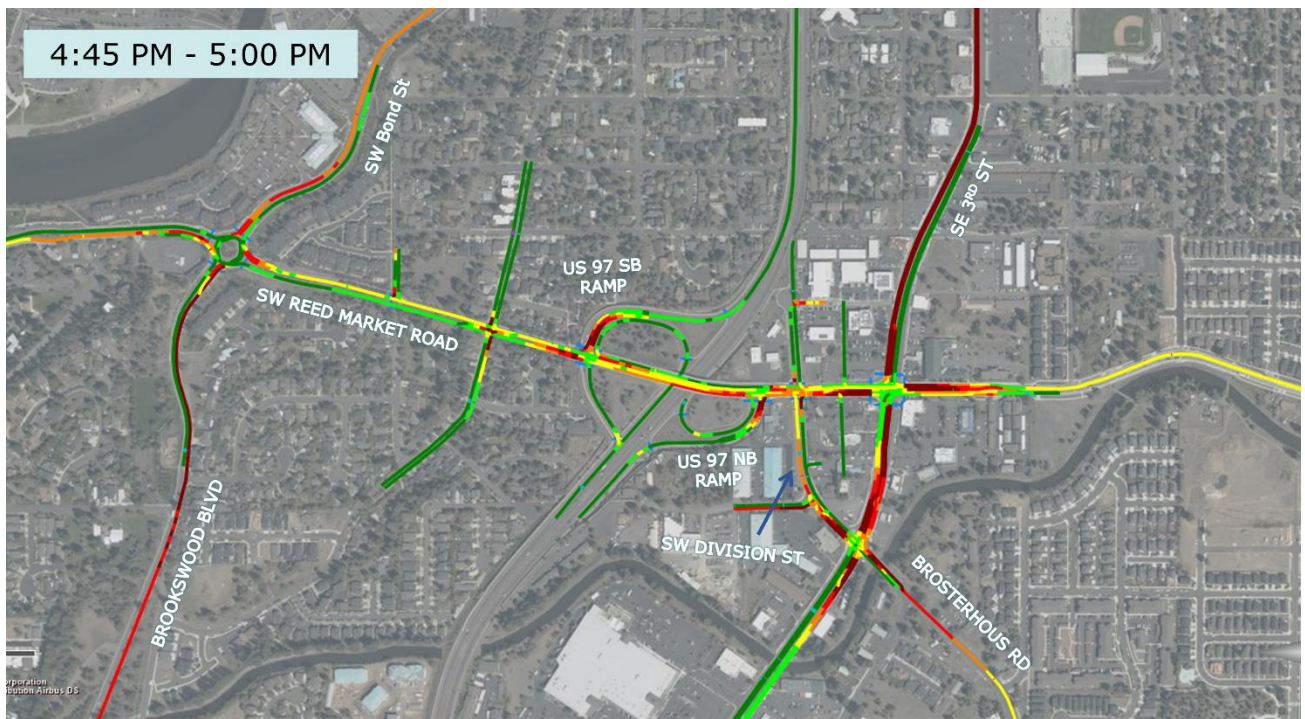


FIGURE 20. PEAK 15 MINUTE (4:45 P.M. TO 5:00 P.M.) CONGESTION PLOT WITHIN THE STUDY AREA WITH PREFERRED ALTERNATIVES

Delay

As discussed above, the average vehicle hours of delay within the simulation network significantly decreased (by more than 1,500 vehicle-hours) with the preferred alternatives compared to No-Build conditions. Detailed vehicle delay results for the modeled area with preferred alternatives can be found in Attachment F – *Technical Memorandum #5*. With the preferred alternatives:

- Average delay at the US 97 northbound and southbound ramp terminals was relatively limited (less than 35 seconds on any approach).
- Average delay was higher at the intersections on 3rd Street, which were closely spaced (leading to queue spillback) and included LPIS, which increased delay for all movements. However, the average delay for all approaches (except the southbound approach at Reed Market Road/3rd Street) was expected to be less than 80 seconds. A significant delay (greater than 5 minutes) occurred on the southbound approach at Reed Market Road/3rd Street.
- Northbound and southbound approaches at the Reed Market Road/Brookwood Boulevard/Bond Street roundabout still experienced long delays (greater than 5 minutes) with improvements but as discussed in Attachment E – *Technical Memorandum #4*, delays were reduced by over 80 percent compared to No-Build conditions with the multilane roundabout compared to the single lane roundabout.

SYSTEM PERFORMANCE SUMMARY

Based on the analysis results, the preferred alternatives at each of the intersections can operate well together as a system, greatly improving traffic operations along Reed Market Road compared to the No-Build condition while simultaneously improving conditions for people walking and biking (as noted in the evaluation discussion). However, queueing and congestion were still significant in the area, given Reed Market Road serves as a key east-west connection through Bend and provides a direct crossing of the Deschutes River, US 97, and the railroad.

To help reduce vehicle demand along Reed Market Road, other system-wide improvements could be considered:

- Bend's TSP identifies the need to study a new southern river crossing between Powers Road and Murphy Road to improve connectivity. This would help relieve vehicle demand on Reed Market Road by providing an alternate route for motor vehicle travel.
- 3rd Street is identified as a key walking and biking route and is designated as part of the City's low-stress bicycle network. While the protected intersection design with leading pedestrian intervals enhanced protection for people walking and biking, it can result in more vehicle delay. However, investments in the multimodal transportation network on 3rd Street and other City facilities in the area have the potential to encourage people to choose a different mode, reducing vehicle demand.
- As noted under the baseline condition section, many of the goals and policies in the City's TSP are intended to reduce vehicle miles traveled by encouraging the use of bicycling, walking and transit. Other citywide policies and investments could result in less growth in vehicle demand on Reed Market Road in the future.

REED MARKET ROAD/BROOKSWOOD BOULEVARD/BOND STREET PERFORMANCE SUMMARY

The preferred alternative had a cost estimate of \$4 million and the estimated cost of adding a metering signal to the multilane roundabout is \$700,000. With the preferred alternative, there was still significant congestion and queuing approaching the roundabout; however, the alternative using a multilane roundabout with metering provided better flexibility to control queuing on specific approaches and to account for different travel patterns during the weekday a.m. and midday peak periods. The longest queues occurred with northbound and southbound movements under 95th percentile conditions. This was due to the high volume of conflicting traffic circulating the roundabout that prevents traffic from being fully served. These queues were also slightly impacted by the roundabout meter operation assumption in this analysis, which was designed to prioritize keeping westbound queues away from the US 97 interchange.

While the 95th percentile westbound queue extended just into the US 97 southbound ramp, reducing the throughput at that intersection and leading to longer westbound queue spillback through the interchange area and towards 3rd Street, the queues on the ramp exits were able to remain shorter than the safe stopping distance. This westbound queuing could be managed by prioritizing the westbound approach at the roundabout even more heavily when metering. The implementation of the multilane roundabout will significantly reduce delay and reduce the risk of queue spillback impacting the US 97 southbound ramp. The implementation of metering in the future can be considered as the City and ODOT monitor congestion and queuing on Reed Market Road.

Potential safety impacts associated with the preferred alternative include:

- The multilane roundabout will introduce more conflict points and potentially increase speeds on the approaches. However, the preferred alternative maintained single lane exits at the roundabout, reducing conflicts for people crossing the intersection and facilitating crossings for people with vision impairments.
- The addition of meters could incorporate emergency vehicle preemption to facilitate emergency response during congestion.
- The multilane roundabout resulted in shorter queuing on the westbound approach, mitigating the problem where queues block the US 97 interchange ramps causing ramp queues onto the US 97 mainline.

REED MARKET ROAD/US 97 SOUTHBOUND RAMP TERMINAL PERFORMANCE SUMMARY

The preferred alternative had a cost estimate of \$5.7 million. Overall, there were minimal delays at this intersection. While 95th percentile queues in the future spillback on the eastbound and westbound approaches, no significant queues were expected on the ramp approach (less than 350 feet). Southbound queues did not spill back into the US 97 mainline and did not exceed the safe stopping distance of 670 feet. The eastbound queue spilled beyond Silver Lake Boulevard but did not extend to the Reed Market Road/Brookswood Boulevard/Bond Street roundabout. The 95th percentile westbound queue spilled beyond the US 97 northbound ramp to Division Street, due in part to occasional queue spillback at the Reed Market Road/Brookswood Boulevard/Bond Street

roundabout and friction associated with last-minute merging due to the right-turn lane drop at the intersection.

The improvements at adjacent study intersections (particularly at Brookwood Boulevard/Bond Street) had the potential to reduce the risk of queue spillback into the US 97 southbound ramp, reducing the need for widening the southbound right-turn lane. To better understand the need for it, a sensitivity test was conducted without the southbound right-turn lane. The results indicated that the southbound movement without the right-turn lane experienced an average queue length of 350 feet (compared to 200 feet) and a 95th percentile queue length of 475 feet (compared to 325 feet). This was approximately 150 feet before extending into the safe stopping distance, indicating that widening to add a southbound right-turn lane to manage queueing on the ramp may not be needed under Year 2040 average weekday conditions.

ODOT should continue to monitor queueing to assess when widening for a southbound right-turn lane may be needed. It should be noted that improvements to bicycle facilities (realigning the bike lane adjacent the curb to move the conflict with the westbound right-turn lane to the signal) at the Reed Market Road/US 97 southbound ramp intersection should still remain a priority. This portion of the preferred alternative could be implemented concurrently with the improvements at the Reed Market Road/ US 97 northbound ramp intersection.

Potential safety impacts associated with the preferred alternatives include:

- The preferred alternative will significantly reduce the risk of queues spilling back to the US 97 mainline.
- Eliminating the crossing of the westbound bike lane and right-turn lane, providing a bike signal coupled with RTOR restrictions, and potentially putting people biking westbound on a multiuse path will significantly reduce conflicts between people biking and westbound right-turning vehicles, improving bicycle safety and comfort.
- Adding a southbound right-turn lane has the potential to reduce all types of crashes by four percent¹³. However, it will lengthen the crossing distance, increasing exposure for people walking and biking.

REED MARKET ROAD/US 97 NORTHBOUND RAMP TERMINAL/DIVISION STREET PERFORMANCE SUMMARY

The first phase of the preferred alternative had a cost estimate of \$4.0 million and the second phase (Alternative 2) was estimated to cost \$5.4 million. The intersection experienced some queueing on the eastbound and westbound approaches, but overall vehicle delays at the intersection were minimal. The eastbound queue was primarily caused by queues spilling back from Reed Market Road/3rd Street and friction associated with the high volume of traffic turning right onto Division Street, with queues at Brosterhous Road/3rd Street occasionally spilling back onto

¹³ ODOT Crash Reduction Factor List, 2023, ID: H4.

Reed Market Road. It should be noted that the 95th percentile westbound queues spill beyond 3rd Street but average queues did not.

Potential safety improvements with the preferred alternatives include:

- Installing a traffic signal will provide a new enhanced crossing for people walking and biking across Reed Market Road, reducing higher severity angle crashes by 67 percent¹⁴, but increasing lower severity rear-end crashes by 143 percent¹⁵.
- Converting Division Street to right-in, right-out operations will reduce conflict points and prevent left-turning vehicles from blocking through movements. It has the potential to reduce overall crashes by 45 percent¹⁶.
- The second phase (Alternative 2) that realigned the northbound entrance ramp would improve the acceleration distance onto US 97 and mitigate access management conflicts that exist on Division Street with the current ramp placement.

REED MARKET ROAD/3RD STREET PERFORMANCE SUMMARY

The preferred alternative at the intersection had a cost estimate of \$10.3 million. The intersection experienced substantial queueing on all approaches, with particularly long queues on the southbound and westbound approaches (greater than 3,500 feet). It should be noted that the GEH statistic threshold was met at all locations except for the entry southbound movement at this study intersection. This indicated that the demand for that approach will exceed capacity with the high growth in future traffic volumes, preventing southbound vehicle demand from being fully served. This could be improved slightly with the addition of a southbound right-turn lane, particularly since through-moving vehicles would no longer be delayed by a leading pedestrian interval. But long queues would still be expected without broader system improvements to help reduce vehicle demand.

The protected intersection design will enhance the quality of walking and biking facilities in the following ways:

- Providing traffic calming via smaller curb radii.
- Minimizing pedestrian crossing distances and providing a protected bicycle crossing.
- Improving the level of traffic stress for people walking and biking.
- Providing extra crossing time associated with LPIs or LBI, which have the potential to reduce walking and biking related crashes by up to 37 percent¹⁷.

¹⁴ ODOT Crash Reduction Factor List, 2023, ID: H22.

¹⁵ ODOT Crash Reduction Factor List, 2023, ID: H23.

¹⁶ Crash Modification Factors (CMF) Clearinghouse, US DOT Federal Highway Administration, CMF ID 9821. Note: This CMF is based on a study of three-leg intersections.

¹⁷ ODOT Crash Reduction Factor List, 2023, ID: BP3.

- Mitigating conflicts with right-turning vehicles by applying RTOR restrictions, which could reduce walking and biking related crashes by up to 41 percent¹⁸.

3RD STREET/BROSTERHOUS ROAD PERFORMANCE SUMMARY

There was substantial queuing on the eastbound and westbound approaches at the intersection. The implementation of a protected intersection design with a LPI or LBI was expected to result in longer vehicle queuing and delays. In addition, the northbound left-turn queues at Reed Market Road/3rd Street spilled back to Brosterhous Road, resulting in longer queues at 3rd Street and Brosterhous Road. However, the additional eastbound right-turn lane helped mitigate eastbound queuing so that queues rarely extended back to Reed Market Road. The westbound movement experienced a long queue, primarily due to the high right-turn volume.

Potential safety improvements with the preferred alternatives included:

- The eastbound road widening will lengthen the crossing distance and increase exposure for people walking and biking. However, adding a right-turn lane has the potential to reduce all crashes by up to four percent¹⁹.
- The protected eastbound and westbound left-turn phase will reduce eastbound and westbound left-turning conflicts and ensure protected phasing for people walking and biking. It has a potential to reduce left-turning crashes by up to 99 percent²⁰.
- The protected intersection will improve the quality of walking and biking facilities as previously mentioned under the Reed Market Road/3rd Street discussion.

CHAPTER 6. NEXT STEPS

Now that the concepts from the Bend TSP/MTP and US 97 Parkway Plan have been refined, they can be advanced to engineering design and construction as funding becomes available. Additional public involvement would be included with future design efforts.

Some of the City projects are already included in the CIP and Neighborhood Street Safety Program and have approved funding. This will allow improvements at the Bond Street/Brookwood Boulevard roundabout, Chamberlain Street, and Reed Market Road at 3rd Street to advance to design as early as 2024. The first phase of improvements on 3rd Street at Brosterhous Road may be completed by the end of 2023.

ODOT has not yet committed the funding needed for the improvements at the US 97 ramp intersections on Reed Market Road. The recommended next steps for these projects include scoping the higher priority improvements at the northbound ramp and Division Street intersections during the 2027-2030 Statewide Transportation Improvement Program (STIP) development cycle

¹⁸ ODOT Crash Reduction Factor List, 2023, ID: BP25.

¹⁹ ODOT Crash Reduction Factor List, 2023, ID: H4.

²⁰ ODOT Crash Reduction Factor List, 2023, ID: I9.

with the goal of securing committed funding as part of the 2030-2033 STIP, if not sooner. Alternatively, the City could explore options to apply City matching funds to an earlier construction of the improvements at the US 97 southbound ramp intersection that would improve safety for people biking. The remaining improvements to the US 97 southbound ramp intersection are a lower priority and may not be constructed until sometime around 2040.

The assumed amounts of funding to be available for projects in the study corridor are shown in Table 14.

TABLE 14. ASSUMED FUNDING AVAILABLE FOR REED MARKET ROAD CORRIDOR IMPROVEMENTS

INTERSECTIONS	SOURCE			
	GO BOND	BEND CIP	ODOT	NEIGHBORHOOD STREET SAFETY PROGRAM
REED MARKET RD/BROOKSWOOD BLVD/BOND ST		\$4.25 million		
REED MARKET RD/CHAMBERLAIN ST				\$250,000
US 97 INTERCHANGE	\$1 million		\$9.25 million	
REED MARKET RD/3 RD ST		\$5 million		
3 RD ST/BROSTERHOUD RD		\$130,000		

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