



## TECHNICAL MEMORANDUM 6

DATE: June 17, 2022

TO: Don Morehouse | ODOT

FROM: John Bosket, PE; Kayla Fleskes, PE | DKS Associates

SUBJECT: US 97 Baker Road IAMP  
Preferred Alternative Concept

Project #20020-006

This memorandum documents the concept for the preferred alternative for the US 97 Baker Road Interchange Area Management Plan (IAMP) and the process used to select it. It also describes potential triggers for when elements of the preferred alternative should be implemented to meet safety and operational needs of the transportation system and includes a recommended phasing plan.

This memorandum is organized into the following sections:

- **Process for Developing and Evaluating Alternative Concepts** - In this section, the process for developing and evaluating the initial and refined interchange alternative concepts is summarized.
- **Preferred Alternative Concept and Refinements** - In this section, refinements to the preferred alternative concept based on feedback from the Technical Advisory Committee, Community Advisory Committee, and public input are discussed.
- **Preferred Alternative Concept Construction Phasing** – In this section, considerations for phasing of the recommended improvements are discussed, as well as potential triggers for those improvements.

### PROCESS FOR DEVELOPING AND EVALUATING ALTERNATIVE CONCEPTS

Eight initial concepts were screened and discussed during a concept evaluation workshop with the Technical Advisory Committee (TAC). Based on direction received during the concept evaluation workshop, the following top three alternative concepts were selected for further refinement and evaluated against the goals and evaluation criteria from *Technical Memorandum #1*:

- Alternative 1 – Enhance Existing Ramp Terminals
- Alternative 2 – Tight Urban Diamond Interchange (with roundabouts)
- Alternative 3<sup>1</sup> – Southbound On- and Off-Ramp Flyovers with Roundabout Intersection

---

<sup>1</sup> Previously referred to as Alternative 4 but was renamed after the initial screening process.

The assessment of the three refined alternative concepts (described in *Technical Memorandum #5: Concept Development and Evaluation*) helped guide the discussion of the key opportunities and tradeoffs associated with each alternative to ultimately select a preferred concept. The refined alternative concepts were discussed with the project TAC and Community Advisory Committee (CAC) and were presented at an online open house and virtual public meeting for additional public input. The following themes were seen in much of the feedback on the refined alternatives:

- Roundabouts are generally preferred over traffic signals.
- The ability to accommodate evacuation needs is essential.
- There is a desire to get improvements soon and recognition that project costs will impact this.
- There is concern about the need to serve more traffic than anticipated due to the amount of future growth expected.
- Would like more focus on improving Baker Court accessibility.
- There is interest in phasing the improvements to get construction underway sooner.

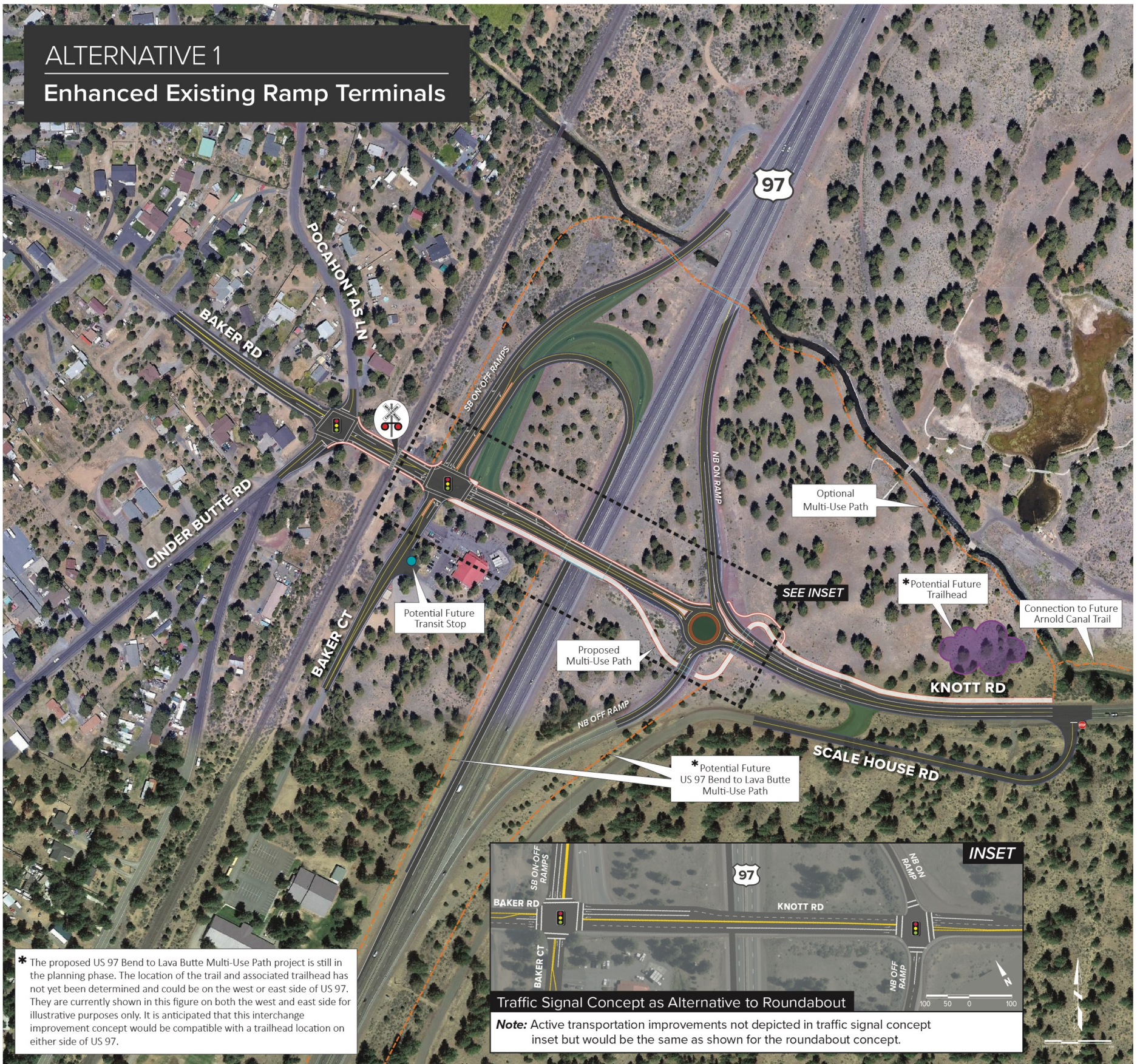
Based on the feedback received and direction from the Bend MPO Policy Board, Alternative 1 was selected as the preferred alternative concept for additional refinement and inclusion in the Interchange Area Management Plan. While Alternative 1 is projected to function well through the 20-year planning horizon, it was agreed that the ability to implement Alternative 3 should be retained if growth exceeds expectations and sufficient funding becomes available. Therefore, the design and construction of Alternative 1 should consider forward compatibility with Alternative 3.

## PREFERRED ALTERNATIVE CONCEPT AND REFINEMENTS

The preferred alternative concept focuses on enhancing the existing ramp terminals to address the operational deficiencies along Baker Road, reduce the potential for queue spillback onto US 97, and eliminate turning conflicts between closely spaced intersections. The key feature that differentiates this alternative from the others is the realignment of the southbound ramp terminal opposite Baker Court and installation of a traffic signal, as shown in Figure 1. While ODOT access spacing standards related to the separation between ramp terminal intersections and access points on interchange crossroads are not met in this alternative, realigning the US 97 southbound ramp opposite Baker Court eliminates the existing problem with the offset intersections. In addition, the US 97 southbound off-ramp is lengthened to prevent queue spillbacks onto the US 97 mainline and the US 97 southbound on-ramp is lengthened to meet current ODOT standards and improve the ability to accelerate to merging speeds.



**ALTERNATIVE 1**  
**Enhanced Existing Ramp Terminals**



**FIGURE 1. PREFERRED ALTERNATIVE (ALTERNATIVE 1) CONCEPT DRAWING**



## PREFERRED CONCEPT INTERSECTION IMPROVEMENTS AND LANE CONFIGURATIONS

Table 1 summarizes the lane configurations and intersection controls shown in Figure 1 for the preferred alternative concept, which differs slightly if a roundabout or a traffic signal is implemented at the northbound ramp terminal.

**TABLE 1: RECOMMENDED INTERSECTION CONTROL AND LANE CONFIGURATION**

INTERSECTION	WITH ROUNDABOUT AT NB RAMPS		WITH TRAFFIC SIGNAL AT NB RAMPS	
	Intersection Control	Lane Configuration	Intersection Control	Lane Configuration
<b>US 97 SB RAMPS/ BAKER CT/ BAKER RD</b>	Traffic Signal	WBL, WBT, WBR NBL, NBTR EBL, EBTR SBL, SBT, SBR	Traffic Signal	WBL, Dual WBT, WBR NBL, NBTR EBL, EBTR SBL, SBT, SBR
<b>US 97 NB RAMPS/ KNOTT RD</b>	Roundabout	Single lane roundabout with a WBR turn slip lane	Traffic Signal	EBL, EBT Dual WBT, WBR NBLT, NBR
<b>CINDER BUTTE ROAD/ BAKER RD</b>	Traffic Signal	WBL, WBT NBLT, NBR EBL, EBT SBLTR	(same as shown at left)	

Note: WB = Westbound; EB = Eastbound; NB = Northbound; SB = Southbound; R = Right; T = Through; L = Left

To increase motor vehicle capacity at the northbound ramp terminal, a single lane roundabout with a westbound right turn slip lane is recommended. A roundabout at the US 97 ramp terminal would be subject to the stakeholder engagement process for approval outlined in ODOT Highway Directive DES 02. If during the stakeholder engagement process it was determined a roundabout would be infeasible at the US 97 ramp terminal, a traffic signal would be necessary instead. A traffic signal would require additional lanes to achieve a similar level of mobility as a roundabout, which would require two additional lanes across the US 97 bridge. This could increase the cost by an additional \$3-5 million dollars.

The new signalized intersection on Baker Road at Baker Court/US 97 southbound ramps would be coordinated with a widened and improved railroad crossing and a new traffic signal at Cinder Butte Road. While this intersection would operate well under this configuration (volume to capacity ratio of 0.81 in 2040), adding a second eastbound through lane would help the intersection nearly meet ODOT's mobility standard in the Highway Design Manual (volume to capacity ratio of 0.76 compared to the standard of 0.75). However, since this extra eastbound lane is not needed at the northbound ramp terminal roundabout, it would likely be dropped before the overcrossing to avoid

costly bridge widening. The resulting second eastbound through lane would then only extend about 300 feet past the southbound ramp terminal intersection. Since many regular motorists would choose not to use that lane to avoid the downstream merge the actual capacity benefit would be diminished. Adding this lane would be more beneficial if the northbound ramp terminal were improved with a traffic signal, since the signalized northbound ramp terminal intersection needs two eastbound approach lanes (a left and a through). Therefore, the second eastbound through lane from the southbound ramp terminal could be carried to the northbound ramp terminal and dropped as the left turn lane. This would significantly improve the available capacity at the ramp terminals but would add cost to the project to widen the overcrossing even more.

At the intersection on Baker Road at Cinder Butte Road, signalization of this intersection is recommended, primarily to help manage vehicle queues along Baker Road due to the proximity of the railroad and the proposed signal at the southbound ramps/Baker Court. While shown as back-to-back left turn lanes in the figure above, it is likely that given the close intersection spacing, side-by-side left turn lanes will be needed between Cinder Butte Road and Baker Court.

To improve the spacing between intersections and busy interchange ramp terminals, Scale House Road will be relocated further to the east (approximate location to be determined in the access management plan). The relocation of this intersection must include an evaluation of safe intersection sight distance to ensure the horizontal and vertical curves are not obstructing needed sight lines.

## **PREFERRED CONCEPT ACTIVE TRANSPORTATION IMPROVEMENTS**

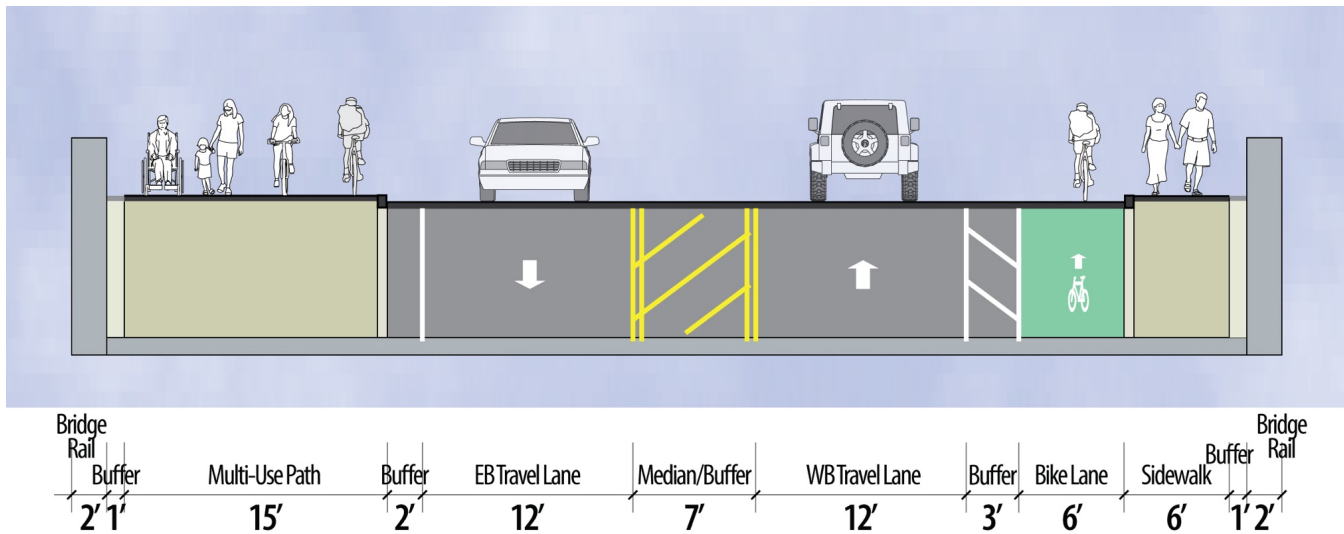
---

The active transportation improvements included as part of the preferred concept provide low-stress facilities along Baker Road for traveling through the interchange area, as well as connections to proposed regional trails.

A key element of the low-stress facilities along Baker Road is a 15-foot multi-use path for walking and biking along the south side of the road between the two ramp terminal intersections. On the north side of Baker Road, a nine-foot buffered bike lane and six-foot sidewalk would be provided. Figure 2 provides a concept drawing of the proposed bridge cross section of Baker Road as it crosses over US 97.<sup>2</sup>

---

<sup>2</sup> Note that this cross section assumes a roundabout would be constructed at the northbound ramps. If a traffic signal is constructed instead, the median/buffer could be narrowed but as many as two additional travel lanes may be needed.



**FIGURE 2. CROSS SECTION OF THE BAKER ROAD OVERCROSSING OF US 97, FACING WEST (ASSUMES A ROUNDABOUT IS CONSTRUCTED AT THE NORTHBOUND RAMPS)**

Further refinements that could be considered during project design include adding a vertical barrier/rail between the multi-use path and eastbound travel lane and replacing the sidewalk and bike lane on the north side with another 15-foot multi-use path to match the south side. Including another 15-foot multi-use path on the north side could be done by narrowing the median/buffer and shifting the westbound lane to the south by two feet. In addition, the westbound bike lane could be held to the right as it approaches the southbound ramp terminal signal instead of crossing over the right turn lane, possibly using a protected intersection-style design, to improve safety and comfort.

On the west end of the interchange, the multi-use path would connect to Baker Court, providing access to Riverwoods Country Store and Morning Star Christian School. The local transit stop was recently relocated from River Woods Baptist Church on Cinder Butte Road to be closer to the interchange, near the Riverwoods Country Store. Between Baker Court and Cinder Butte Road, sidewalks and buffered bike lanes would be provided, transitioning to only bike lanes west of Cinder Butte Road per County standards. A protected intersection design (similar to the example shown in Figure 3) could be considered at the US 97 southbound ramp terminal to enhance safety and comfort for people biking, particularly for westbound cyclists that conflict with the westbound right turn onto US 97 southbound.



**FIGURE 3. EXAMPLE OF A PROTECTED INTERSECTION TREATMENT TO MITIGATE CONFLICTS BETWEEN RIGHT TURNING VEHICLES AND PEOPLE BIKING**

Source: Still from <https://www.youtube.com/watch?v=FIAbxLz6pA> (1:44)

On the east end of the interchange, the multi-use path tunnels under the US 97 northbound off-ramp and Knott Road. Grade separation will improve safety for people walking and biking by eliminating conflicts with motor vehicles when crossing these roads. Crossing the multi-use path under Knott Road to the north allows the path to connect to the future Arnold Canal Trail. An optional path on the north side of the interchange is shown under US 97 along the Arnold Canal. This path could be constructed if clearance under US 97 can be obtained.

The Bend to Lava Butte Multi-Use Path project, which would construct a path from Lava Lands Visitor Center to Baker Road, is still in the planning phase. The alignment of the path and location of an associated trailhead have not yet been determined and could be on the west or east side of US 97. The path and trailhead locations shown in Figure 1 are for illustrative purposes only. It is anticipated that the improvements associated with the preferred alternative will be compatible with path, trailhead, and transit stop locations on either side of US 97.

## PREFERRED ALTERNATIVE CONCEPT CONSTRUCTION PHASING

This section includes a recommendation for phasing the construction of improvements, as well as some potential triggers that may drive the need for specific improvements. The phasing plan is only for the preferred alternative (Alternative 1). Alternative 3 will still be mentioned in the IAMP as a long-term option for consideration.

## NEED FOR IMPROVEMENTS AND POTENTIAL IMPROVEMENT TRIGGERS

---

Specific safety and operational concerns and future developments or transportation projects that may increase the priority for certain elements to be implemented sooner within the 20-year planning horizon are discussed below.

### EXISTING NEEDS

The existing safety and operational issues described below (as documented in Technical Memoranda #2B and #3) could make certain improvements from the preferred alternative a higher priority for implementation.

- **Safety focus areas** were flagged at the intersections of Cinder Butte Road, Baker Court, US 97 southbound ramps, and US 97 northbound ramps.
- **Congestion is significant at the US 97 southbound and northbound ramp terminals**, with both intersections failing to meet mobility targets.
- **US 97 southbound ramp queues** currently extend into the safe stopping distance on the ramp, particularly during railroad crossing events.
- **Facilities for people walking and biking** in the interchange area are extremely limited, with no sidewalks or bike lanes, leading to a high-stress environment for people walking and biking.
- **Access spacing** standards are currently not met near the interchange and in particular, Baker Court is closely spaced with the US 97 southbound ramp terminal, causing operational and safety issues that are expected to worsen as motor vehicle volumes continue to grow in the area.
- **US 97 southbound acceleration lane** does not meet current standards for acceleration lane length (950 feet compared to 1350 feet), meaning that larger vehicles likely have difficulty accelerating to speed when merging onto US 97 southbound.
- **Vehicle queues extending back to the railroad** from Cinder Butte Road was noted under existing and future no-build conditions, which is a safety risk.

These key deficiencies are expected to remain in the future if no improvements are made, with some conditions worsening. Given that many of the transportation needs in the area are existing needs, the preferred concept should be implemented as soon as funding becomes available.

### AREA DEVELOPMENT AND TRANSPORTATION PROJECTS

In addition to the existing safety and operational issues listed above, there are three other considerations that could trigger the need for improvements in the interchange area:

- **Development in the “thumb”** or additional UGB expansion to the southeast of Bend could trigger the need for capacity improvements at the interchange earlier within the 20-year planning horizon, as this interchange serves as one of the primary access points to the “thumb” area from US 97.
- **The China Hat Road Overcrossing** is critical for serving future travel demand in the “thumb” area by limiting traffic increases on Parrell Road and reducing traffic impacts on the US 97/Baker Road interchange.



- **US 97 Bend to Lava Butte Path** is currently planned to extend from Lava Butte to the US 97/Baker Road interchange area. The timing of construction of this path, as well as the future Arnold Canal Trail, could drive the need to add the multi-use path on the south side of the Baker Road overcrossing and construct the tunnels to eliminate at-grade crossings at the northbound ramp terminal.

## RECOMMENDED PHASING

---

Given that the preferred alternative addresses many existing needs and deficiencies in the area (rather than just future deficiencies or needs), all the improvements identified in the preferred concept should be implemented as soon as funding becomes available. However, it is possible that given the total cost of interchange improvements, available funding will only cover a portion of the identified improvements. Therefore, based on the needs of the area, constructability constraints, and likely timing of additional development or projects in the area, a recommendation for phasing improvements is proposed. Table 2 summarizes the recommended phasing, although based on available funding or the timing of area developments and transportation projects, the improvements could be phased in a different way.

The recommended costs shown in Table 2 were based on 2021 construction costs but projected out to an assumed year of expenditure of 2029. The costs listed in Table 2 more appropriately reflect recent inflation and increases in construction bid prices than cost estimates that were previously provided in *Technical Memorandum #5*. Detailed cost estimate worksheets are included in Appendix A.

**TABLE 2: US 97 BAKER IAMP PREFERRED ALTERNATIVE PHASING RECOMMENDATIONS**

PHASE	ELEMENTS	DESCRIPTION	ESTIMATED COST
<b>PHASE 1 – WEST SIDE IMPROVEMENTS</b>	Cinder Butte Road realignment and turn lanes	Realign Cinder Butte Road slightly to the west, construct westbound and eastbound left turn lanes and a northbound right turn lane (side-by-side left turn lanes between Cinder Butte Road and Baker Court). Improvements on Baker Road west of Cinder Butte Road would be to County standards, with six-foot bike lanes and no sidewalks.	\$14.8 million
	US 97 SB ramps realignment and traffic signal and RR crossing improvements	Realign the US 97 southbound ramp with Baker Court and signalize the intersection. This includes reconstruction of the BNSF railroad crossing and coordination with the new traffic signal.	
	US 97 acceleration and deceleration lanes	Lengthen the existing US 97 southbound on-ramp acceleration lane and US 97 southbound off-ramp deceleration lane.	
	Baker Road/ Cinder Butte Road signalization	Construct a traffic signal and coordinate it with the railroad crossing and the new US 97 southbound ramp terminal signal.	
<b>PHASE 2 – BRIDGE AND EAST SIDE IMPROVEMENTS</b>	Baker Road bridge widening	Widen the existing Baker Road/Knott Road bridge over US 97 to accommodate the preferred concept (and added lanes if a signal is constructed at the northbound ramps).	\$23.2 million
	US 97 NB ramps roundabout	Install a roundabout at the US 97 NB ramp terminal and the associated multi-use path undercrossings.	
	Multi-use path connections	Complete the multi-use path network, connecting the US 97 Bend to Lava Butte and Arnold Canal facilities.	
	Realign Scale House Road	Realign Scale House Road to the east.	
<b>Total Estimated Cost</b>			<b>\$38 million</b>

## PHASE 1 – WEST SIDE IMPROVEMENTS

The following improvements, which include all improvements west of the US 97 overcrossing, are recommended as part of the first phase:

- **Cinder Butte Road realignment** - Realign Cinder Butte Road slightly to the west and construct a northbound right turn lane on Cinder Butte Road. The realignment also includes widening of Baker Road to add westbound and eastbound left turn lanes and bicycle lanes to meet current Deschutes County standards<sup>3</sup>.
- **US 97 Southbound ramps realignment and traffic signal** - Realign the US 97 southbound ramp with Baker Court and signalize the intersection on Baker Road. This work must include widening of Baker Road to include all needed lanes (from Cinder Butte to the US 97 overcrossing) and reconstruction of and coordination with the BNSF railroad crossing.
- **US 97 acceleration and deceleration lanes** - Lengthen the existing US 97 southbound on-ramp acceleration lane and US 97 southbound off-ramp deceleration lane.
- **Cinder Butte signalization** - A traffic signal at the intersection on Baker Road with Cinder Butte Road may not meet warrants until much later in the planning horizon. However, there are few routes available for access to and from the Deschutes River Woods neighborhood and the signalization of the US 97 southbound ramp terminal on Baker Road could cause some queue spillback, particularly during the a.m. peak period<sup>4</sup>, that could block the Cinder Butte intersection. Therefore, signalizing this intersection and coordinating it with the US 97 southbound ramp terminal signal and railroad crossing is included as an improvement that may be more cost-effective to construct concurrently with the southbound ramp terminal and railroad improvements.

Many of the existing and future needs in the Baker Road interchange area are driven by conflicts in the west side of the interchange. The southbound ramp experiences significant delay and queuing and there are existing challenges with the close spacing of Baker Court, the railroad, and Cinder Butte Road. Therefore, it is recommended that the west side be improved first. Also, moving the southbound ramps further to the west will give the contractor more space to work when widening the overcrossing in the next phase.

Many of the identified improvements on the west side of the interchange will influence one another and could be challenging to phase separately. For example, realigning Cinder Butte Road, adding turn lanes on Baker Road, or realigning the US 97 southbound ramps would likely all trigger the requirement for a railroad crossing order. Additionally, realigning the US 97 southbound ramp terminal with Baker Court will modify the on and off-ramp alignments, which may involve reconstruction of the merging and diverging connections to the highway.

It is also important to note that while the phase 1 improvements would address the majority of the deficiencies in this area, the lack of an eastbound left turn lane at the northbound ramp terminal could represent a downstream bottleneck until phase 2 improvements can be constructed.

---

<sup>3</sup> Deschutes County Code 17.48 Table A and Table B

<sup>4</sup> While a.m. peak period was not analyzed, reports from stakeholders indicate this could be a challenge.



## PHASE 2 – BRIDGE AND EAST SIDE IMPROVEMENTS

The following improvements, which include the overcrossing and all other improvements to the east, are recommended as part of a second phase:

- **Baker Road bridge widening** – Widen the existing Baker Road/Knott Road bridge over US 97 to accommodate the preferred alternative active transportation improvements. If the option to construct a traffic signal at the northbound ramp terminal is chosen, additional bridge widening will be needed to accommodate added lanes on Baker Road.
- **US 97 northbound ramps roundabout** – Install a roundabout at the US 97 northbound ramp terminal and the associated multi-use path undercrossings. This includes improvements to the northbound on and off-ramps. If the option to construct a traffic signal at the northbound ramp terminal is chosen, this would include the construction of a traffic signal (in lieu of a roundabout), additional lanes on the east, west, and south approaches, and coordination with the southbound ramp terminal traffic signal.
- **Multi-use path connections** – With the bridge widening and northbound ramp terminal undercrossings completed, connect the multi-use path system through the interchange area, bringing the US 97 Bend to Lava Butte and Arnold Canal facilities together.
- **Realign Scale House Road** – Realign Scale House Road further to the east (approximate location to be determined in the access management plan and pending the ability to achieve adequate sight distance).

After addressing the safety, access, and capacity issues on the west side of the interchange, phase 2 will complete the active transportation network and relieve congestion at the northbound ramp terminal. This would include addressing a potential eastbound bottleneck at the northbound ramp terminal that could limit the effectiveness of some phase 1 improvements.

To provide a connected network for people walking and biking through the interchange area, the US 97 northbound ramp improvements (including tunnels) should be constructed at the same time as the bridge widening. However, that work could be deferred if needed, by using temporary at-grade path crossings.

## FUTURE ALTERNATIVE 3 IMPROVEMENTS

While Alternative 1 is projected to function well through the 20-year planning horizon, it was agreed that the ability to implement Alternative 3 should be retained if growth exceeds expectations and sufficient funding becomes available. Specifically, the design and construction of any improvements in Phase 2 should consider the ability for future southbound flyover ramps to be connected to the US 97 northbound ramp terminal.