CITY OF BEND

kpff Parametrix

DKS

October 2022

Final Report – Bend Midtown Pedestrian and Bicycle Crossings Feasibility Study

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EXECUTIVE SUMMARY

In 2020, City of Bend voters passed a bond measure ultimately funding a key City of Bend Transportation System Plan (TSP) project known as the Midtown Pedestrian and Bicycle Crossings. This project includes a study to determine the feasibility and needs for new or improved crossings of US Highway 97/Bend Parkway and the BNSF Railroad tracks for walking and bicycling in Bend's Midtown at three locations: Greenwood Avenue, Hawthorne Avenue, and Franklin Avenue.

This study evaluates the feasibility and merit of potential crossing improvement options at each crossing location. A major focus of the project is developing crossing concepts that improve conditions for people walking, using mobility devices, or riding bikes on Greenwood Avenue, Hawthorne Avenue, and Franklin Avenue in the City of Bend. This study refines projects within the TSP, as well as other local planning documents. The TSP already establishes the need for and intent of improvements at these locations, which resulted from substantial public engagement; this study developed and recommends alternatives for crossing improvements at each location. While the City of Bend is evaluating complementary corridor improvements on Greenwood Avenue, Franklin Avenue, and Hawthorne Avenue, the focus of this report is on the feasibility of upgrading the Greenwood and Franklin Crossings and providing a new crossing at Hawthorne Avenue.

Project Approach

The project team first developed a set of project core values and goals to guide the development and evaluation of concepts throughout the process. These were derived from existing planning documents, including the Bend TSP. A list of potential crossing improvements that could address issues and needs at each crossing location was then generated. This list of ideas, including all potential ideas for improving the crossings, was evaluated and summarized in a Fatal Flaw Analysis memorandum (Appendix A). That narrowed the potential alternatives for each crossing down to two for Greenwood Avenue, three for Hawthorne Avenue, and two for Franklin Avenue. The refined list of alternatives was then further developed to establish the layout, footprint, major components, and costs of each concept. Finally, these alternatives were evaluated using criteria derived from the project's core values and goals as well as a set of feasibility criteria.

Figure ES-1. Open House

The project team also conducted outreach to engage the community around the needs and improvement ideas at each crossing location. Outreach included an online and in-person open house as well as some targeted outreach to the Bend Latinx community. Public input showed a minor preference for **constructing a new Hawthorne Avenue crossing (40 percent)** as the corridor participants would like to see it worked on first. This was followed by improving the existing Franklin Avenue undercrossing (32 percent) and improving the existing Greenwood Avenue undercrossing (28 percent).

Alternatives Evaluation and Recommendation

Table ES-1 shows the alternatives considered for each crossing location and a summary of the evaluation results for each.

Table ES-1. Alternatives Summary

Alternative	Evaluation Results	Estimated Cost	Recommendations
Greenwood Avenue			
Concept 1: Shared-use path • Shared-use path on both sides with a rolled curb separating vehicle traffic from the path. • Existing elevated sidewalk remains the same with an upgraded railing. • Current four-lane traffic configuration changes to three lanes.	• Provides modest improvements to safety and comfort for people walking, rolling, and bicycling. • Community preference essentially equal for Concepts 1 and 2. • Does not address personal security issues related to the existing narrow and confined pedestrian tunnels.	$3.0 million	Concept 2 is recommended as It better reflects community goals of improving both safety and comfort. It has minimal feasibility issues and provides greater benefits compared to Concept 1.
Concept 2: Lower and Widen Sidewalks • Lowers and widens the existing sidewalks for people walking and biking. • Current four lane traffic configuration changes to three lanes. • At-grade bike lanes.	• Provides greater enhancement for people walking, rolling, and bicycling by lowering and widening the grade-separated tunnels. • Community preference essentially equal for Concepts 1 and 2. • Presents more constructability issues than Concept 1, but is feasible.	$7.9 million	
Hawthorne Avenue			
Concept 1: Straight Bridge and Approach Ramps 1A: 14-foot deck 1B: 20-foot deck • Bridge with long ramps located on the south side of Hawthorne Avenue. • Approach ramps include slopes up to a 7.5% grade with a few landings to rest or slow wheels. • Structure is evocative of the Three Sisters and creates a unique signature bridge.	• This concept outperforms Concepts 2 and 3in all of the criteria related to community needs and goals, as well the feasibility criteria. • Scored moderate or better on all criteria	1A: $19.7 million 1B: $23.0 million	Concept 1 is recommended as it better addresses community needs and goals and presents fewer feasibility issues compared to the other concepts.
Concept 2: Switchback Ramps/Maintain 4.5% Slope 2A: 14-foot deck 2B: 20-foot deck • Features ramps with switchbacks for a more comfortable slope of 4.5%.	• Performed similar to Concept 1 with respect to feasibility, except greater right-of-way acquisition needs and maintenance requirements.	2A: $21.0 million 2B: $24.0 million	

Alternative	Evaluation Results	Estimated Cost	Recommendations
• Design might be able to accommodate stairs to allow people walking to bypass the switchbacks. • Main span is supported between a pair of splayed steel arches. Provides an elegant structure, but not a unique signature structure as in Concept 1.	• Generally performed worse in the community needs and goals criteria. • Switchbacks in Concept 2 would harm visual appeal of the bridge.		
Concept 3: Stair and Elevator Bridge Access/No Ramps 3A: 14-foot deck 3B: 20-foot deck • Concept features an elevator and stairs but no ramps. • Allows the potential for the development of plaza areas near the elevators. • Main span deck is supported on suspension cables running between the elevator towers. • Elevators are sized to accommodate bikes and enable direct in-and-out movement.	• ADA users lose access when the elevators are down. • Low public support with only 5% of the responses in favor. • Similar facilities in other places indicate that maintenance and cleanup is a constant and costly problem.	3A: $18.9 million 3B: $22.0 million	
Franklin Avenue			
Concept 1: Widen and Level East Access – Plaza • Widens the approaches on the east side of the crossing only. • Moderately improves the line of sight in and out of tunnels, lighting, and accessibility • Better accommodates people walking and biking within the same space.	• Provides minor improvement to the user experience by widening the approaches to the crossing, improving access for people who have disabilities, and modestly improving sight lines to the existing tunnel. • Far less costly alternative than Concept 2. • Presents few feasibility issues than Concept 2.	$6.8 million	Concept 1 is recommended as a minor standalone improvement that could be completed as part of other work (e.g., planned drainage improvements). Concept 2 better addresses community needs and goals but presents major feasibility issues and has very high costs. Substantial new funding would be required to implement. It may be considered in the future when full replacement of the bridge structure is needed.
Concept 2: Full Rebuild/Widen Undercrossing Opening • Rebuilds and widens the undercrossing allowing for a standard two-lane road and separated sidewalk and bike lanes. • Sidewalk may need to remain raised above the street to maintain a gentler slope.	• Provides substantial benefit by constructing a modern facility with wider and more comfortable tunnels and approaches. • Strong public support for this Concept over Concept 1. • Major feasibility issues with this concept given the scope and scale of construction, impact to BSNF and ODOT facilities, and right-of-way needs.	$46.9 million	

ODOT = Oregon Department of Transportation; TSP = 2020 City of Bend Transportation System Plan

Next Steps

The results of this crossing feasibility study along with the several other corridor and funding considerations will be presented to City Council by City staff, to request direction for future project steps and funding prioritization. The improvements considered in this report will also be evaluated with complementary corridor improvement needs. Ultimately, available funding, stakeholder support and interest, and the results of this feasibility study will be considered in the final decisions to advance improvements at one or more crossing and complementary corridor locations.

1. INTRODUCTION

In 2020, City of Bend voters passed a bond measure which includes funding a key City of Bend Transportation System Plan (TSP) project known as the Midtown Pedestrian and Bicycle Crossings. Initial project steps include a feasibility study to determine the feasible crossing improvements of US Highway 97/Bend Parkway and the BNSF Railroad tracks for walking and bicycling in Bend's Midtown at three locations: Greenwood Avenue, Hawthorne Avenue, and Franklin Avenue.

A major focus of the project is developing crossing concepts that improve conditions for people walking, using mobility devices, or riding bikes on Greenwood Avenue, Hawthorne Avenue, and Franklin Avenue in the City of Bend. This study refines projects within the TSP, as well as other local planning documents. The TSP already establishes the need for and intent of improvements at these locations, which resulted from substantial public engagement; this study developed and recommends alternatives for crossing improvements at each location.

This final report provides an analysis of proposed design concepts, an evaluation of the alternatives based on community goals and feasibility, and a design concept recommendation for each crossing location. This report also provides detailed construction cost estimates and a feasibility analysis within its appendices. Geotechnical evaluation and traffic analysis was also conducted to support the development of this report and can be found in Appendix E and F, respectively.

1.1 Core Values and Goals

The project team developed "core values and goals" to guide the development and evaluation of crossing concepts. These core values and goals were derived from the Bend TSP (2020), Bend Core Area Project Report (2020), Bend Central District Initiative – Midtown Crossings, US 97 Parkway Plan (Draft 2021), and Transportation General Obligation (GO) Bond Project List. The core values and goals were used as overarching guidance for the project team, City, and stakeholders to guide decision-making over the course of the feasibility study, and include the following:

Mobility and Safety – Develop improvements that create safe and low-stress crossings for people walking, using a mobility device, and riding a bike. Ensure at least one crossing maximizes opportunities for reducing user stress and increasing safety.

Equity – Ensure vulnerable users (people walking, using a mobility device, or riding a bike) are benefited and that any negative impacts from crossing investments are not disproportionately borne by underserved populations. [1]

Economic Development – Provide improvements that help catalyze private economic development to support the vision of the Bend Core Area Plan.

[1] "Underserved populations" are people who are low-income, minority, over 65, or under 18 years old.

Fiscal Responsibility – Ensure crossing improvements provide the most benefit possible to people walking, using a mobility device, or riding a bike, compared to the cost of improvements. Maximize the utility of existing infrastructure.

1.2 Study Area

The general study area and crossing locations are shown in Figure 1.

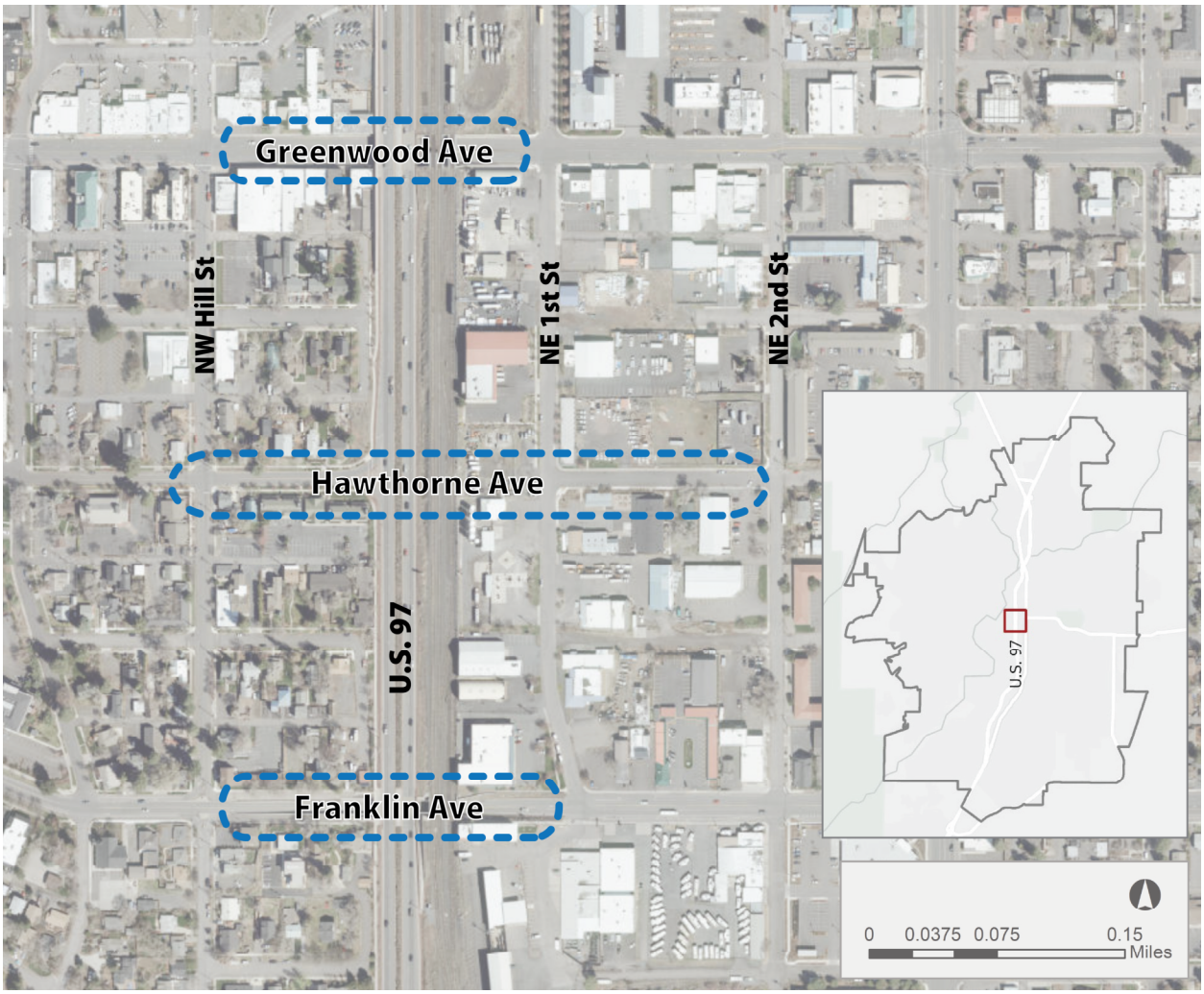

Figure 1. Study Area

1.2.1 Greenwood Avenue Context

Figure 2. Greenwood Avenue at US 97. Left image: looking east, right image: looking west

Greenwood Avenue is classified as a Minor Arterial by the City of Bend with a posted speed of 25 miles per hour (mph). The Greenwood Avenue curb-to-curb cross section is approximately 64 feet wide as it passes under US 97 and approximately 57 feet wide as it passes under the BNSF railroad bridge; total ROW is approximately 80 feet. This section of Greenwood Avenue consists of four travel lanes: two eastbound and two westbound (see Figure 2). The travel lanes range from approximately 11 to 16 feet wide. Greenwood Avenue does not have existing bike lanes but has sidewalks on both sides of the street that are approximately 6 feet wide with a section that narrows to less than 4 feet. Greenwood Avenue is not identified as a planned Low Stress Network bicycle routes in the City of Bend TSP. The City design standards for urban walkways on arterial streets are 8 to 10 feet wide. The design standard for bike lanes on arterial streets is 5.5 feet wide with a 2.5 feet buffer. The elevated sidewalk is grade-separated from the roadway by a concrete wall and chain link fence.

1.2.2 Hawthorne Avenue Context

Hawthorne Avenue is classified as a Major Collector by the City of Bend with a posted speed of 20 mph on the west side and no posted speed limit on the east side. The Hawthorne Avenue right-of-way width is 60 feet on the west and east sides (between NE 1st Street and NE 2nd Street). Currently, there is private property between NE 1st Street and the railroad. This study will address the feasibility of adding a crossing over US 97 and the BNSF Railroad as well as surface improvements and utility impacts from NW Hill Street to NE 2nd Street. Additional study outside of this project area will need to be completed to address connectivity with the remainder of the corridor.

Hawthorne Avenue has been classified as a Neighborhood Greenway on the east side from NE 1st Street to Juniper Park on NE 5th Street. According to the 2019–2022 Neighborhood Greenways map, Hawthorne Avenue was included in phase 4 which is still being constructed. Hawthorne Avenue is also identified as a planned Low Stress Network Bicycle key route.

The curb-to-curb cross section west of US 97 is approximately 33 feet. This section of Hawthorne Avenue consists of two travel lanes—one eastbound and one westbound—with a narrow, mountable curb between the travel lanes. The travel lanes are approximately 16 feet wide. Hawthorne Avenue does not have existing bike lanes but has sidewalks on both sides of the street that are approximately 5 feet wide. There is an approximately 7-foot-wide landscape strip between the sidewalk and the street.

The curb-to-curb section east of NE 1st Street is approximately 36 feet wide. This section of Hawthorne Avenue consists of two travel lanes and parallel parking on both sides. The travel lanes range from

approximately 10 to 11 feet wide, and the parking is approximately 7 to 8 feet wide. There are curb-tight sidewalks on both sides of the street that are approximately 6 feet wide.

Figure 3. Hawthorne Crossing

Figure 4. Hawthorne Avenue. Left image: looking east from Hill Street, right image: looking west from NE 1st Street

1.2.3 Franklin Avenue Context

Franklin Avenue is classified as a Minor Arterial by the City of Bend with a posted speed of 25 mph. The Franklin Avenue curb-to-curb cross section, as it passes under US 97 and the railroad, is approximately 25 to 26 feet wide. This section of Franklin Avenue consists of two travel lanes: one eastbound and one westbound. The travel lanes are approximately 12 feet wide. Franklin Avenue does not have existing bike lanes in this area but is marked with sharrows east of the railroad crossing overpass and west of the overpass near NW Hill Street. From NW Hill Street to the US 97 overpass, a 17- to 19-foot-wide paved path exists for non-motorized traffic, and there are approximately 5- to 6-foot-wide sidewalks on both sides of the street. As one approaches the structure, a path ramps up to connect to the path running north/south adjacent to US 97 while an 8-foot-wide sidewalk dives down to go under the US 97 structure where it remains elevated above the Franklin roadway surface. The elevated sidewalk is separated from the roadway by a decorative concrete fence west of the US 97 overpass, a concrete wall and a chain link fence as it runs under the overpass, and a 12-foot-wide planting strip east of the railroad crossing. Where the sidewalk passes under the railroad tracks, the path is contained in a 5-foot-wide by 7-foot tall, enclosed tunnel.

Figure 5. Franklin Ave at US 97. Left image: looking east, right image: looking west

1.3 Project Approach

1.3.1 Fatal Flaw Analysis

During the first phase of the study, the project team developed fatal flaw criteria for screening potential improvement concepts at each site. Given that there is a wide range of possible improvement solutions at each crossing, this fatal flaw analysis reviewed a comprehensive list of ideas considered and identified those that were most aligned with project goals to be further developed as alternatives. These considerations were necessarily qualitative because of the very early stage of concept development and evaluation. The criteria (all being weighted equally) for this fatal flaw evaluation of each concept were as follows:

- Cost
- Constructability and technical feasibility
- Community impacts
- Alignment and benefits with respect to project core values and goals
- Legal, environmental, permitting, or property ownership barriers

The project team explored a range of ideas for each crossing location in collaboration with the City and stakeholders. The concepts were then evaluated based on the criteria above and categorized as follows:

- **Do Not Advance** – Concepts that do not provide high value; have very high costs relative to benefits; have permitting, legal or other issues; or do not align with the project core values and goals.
- **Potentially Advance** – Concepts that may have merit but require further discussion with City staff or stakeholders before determining whether they should advance or not.
- **Advance** – Concepts recommended to advance for further refinement.

While all the criteria were considered for the ideas and concepts which have been categorized as Potentially Advance and Advance, some ideas may have been categorized as Do Not Advance based on a single criterion due to a fatal flaw. For more details about the fatal flaw process, see Appendix A, Fatal Flaw Analysis.

The outcome of this first step of the process was a narrowed set of alternatives for each crossing location that were refined and reviewed with the public. The concepts advanced included the following

Greenwood Avenue

Concept 1: Shared use path

- Shared-use path on both sides with a rolled curb separating vehicle traffic from the path.
- Existing elevated sidewalk remains the same with an upgraded railing.
- Current four-lane traffic configuration changes to three lanes.

Concept 2: Lower and widen sidewalks

- Lowers and widens the existing sidewalks for people walking and biking.
- Current four lane traffic configuration changes to three lanes
- At-grade bike lanes

Hawthorne Avenue

Concept 1: Straight Bridge and Approach Ramps

1A: 14-foot deck

1B: 20-foot deck

- Bridge with long ramps located on the south side of Hawthorne Avenue.
- Approach ramps include slopes up to a 7.5 percent grade with a few landings to rest or slow wheels.
- Structure is evocative of the Three Sisters and creates a unique, signature bridge.

Concept 2: Switchback Ramps/Maintain 4.5 percent Slope

2A: 14-foot deck

2B: 20-foot deck

- Features ramps with switchbacks for a more comfortable slope of 4.5 percent.
- Design might be able to accommodate stairs to allow people walking to bypass the switchbacks.
- Main span is supported between a pair of splayed steel arches. Provides an elegant structure, but not a unique signature structure Concept 1.

Concept 3: Stair and Elevator Bridge Access/No Ramps

3A: 14-foot deck

3B: 20-foot deck

- Concept features an elevator and stairs but no ramps.
- Allows the potential for the development of plaza areas near the elevators.
- Main span deck is supported on suspension cables running between the elevator towers. E
- Elevators are sized to accommodate bikes and enable direct in-and-out movement.

Franklin Avenue

Concept 1: Widen and Level East Access – Plaza

- Widens the approaches on the east side of the crossing only.
- Moderately improves the line of sight in and out of tunnels, lighting, and accessibility
- Better accommodates people walking and biking within the same space.

Concept 2: Full Rebuild/Widen Undercrossing Opening

- Rebuilds and widens the undercrossing allowing for a standard two-lane road and separated sidewalk and bike lanes.
- Sidewalk may need to remain raised above the street to maintain a gentler slope.

1.3.2 Outreach and Community Input

Outreach Strategy

This project was identified by the community as a need during two large planning efforts for the future of Bend's transportation system and the "Core Area." It is an identified project in both the TSP and the Core Area Tax Increment Finance Plan and Report. The project team shared preliminary design concepts after the Fatal Flaw Analysis for each crossing and asked for community feedback in a variety of formats during the study. The project team developed **online and in-person open houses** to gather community input on preliminary design concepts and priorities for future investments. In addition, open house materials were used for targeted outreach to the Bend Latinx community where open house surveys were conducted at two focused events. Participants were also given an opportunity to provide general comments on the project. For a full summary of outreach conducted, see Appendix B: Outreach Summary.

- **Open House: June 22, 2022 | 5–7 p.m., Open Space Event Studios, 220 NE Lafayette Avenue** – The in-person open house was designed as an informal drop-in format with the same information as the online open house. Overall, about 80 people attended. The event did not include a formal presentation. Participants were provided with a paper version of the survey questions. Survey questions were provided in English and Spanish.
- **Online Open House: June 13–July 3, 2022** – English and Spanish language options were available. Overall, 123 people participated in the English-language online open house. The Spanish-language survey was open through July 15, 2022.

Community members were informed about the online open house through the following:

- Postcard mailed to 678 addresses in the project area
- Flyers distributed directly to businesses and organizations in the project area
- Project website
- Local television, radio, print, and digital media outlets
- Emails sent to those who signed up for project updates
- Social media posts
- High touch outreach including texts and incentives (stipends) to encourage Latinx community feedback

Public Feedback

This section provides a high-level overview of feedback received through the online and in-person open houses, as well as by email.

Overall, public input showed a minor preference for **constructing a new Hawthorne Avenue crossing (40 percent)** as the corridor participants would like to see it worked on first. This was followed by improving the existing Franklin Avenue undercrossing (32 percent) and improving the existing Greenwood Avenue undercrossing (28 percent).

Greenwood Avenue

- When combining online and in-person responses, results were split, and no clear preference on alternatives emerged. However, most in-person participants preferred Concept 2: Lower and Widen Sidewalks (concepts are discussed in the next section).

Hawthorne Avenue

- Overall, there is excitement for a new Hawthorne Avenue Crossing, and many felt that it will elevate Bend to a "new level as a sustainable, healthy, and people-forward city."
- Most participants prefer Concept 1: Straight Bridge and Approach Ramps (65 percent).
- Strong concern about elevators with most participants *except* for people with disabilities.
- Strong concern about slope grade, *particularly for* community members with disabilities.

Franklin Avenue

- Strong preference for Concept 2: Full Rebuild and Widening (81 percent).
- There is a strong desire for protected bike lanes that are separated from traffic by bollards or railing.
- Concerns and questions about ongoing maintenance of future improvements due to a historical lack of maintenance on all three project corridors. This includes weather-related maintenance related to flooding in underpasses and snow and debris clearing on overpasses, as well as impacts from the houseless community.
- Many participants showed a high understanding of the project and GO Bond, and they expected more information such as funding estimates, traffic counts and road diet impacts.
- Some want to fix what they can now, and some want to wait and "go big."

1.3.3 Selection of Preferred Alternatives

After the initial fatal flaw analysis, the project team conducted a technical evaluation of the alternatives to recommend a single alternative for each crossing location under consideration; the alternatives are described in Section 2. The project team's recommendations will be reviewed by City staff and key stakeholders to confirm or modify the recommendations. The preferred alternatives will then be reviewed and confirmed by the City Council.

2. CROSSING ALTERNATIVES

2.1 Design Standards and Specifications

This section outlines design standards and specifications used during the development of design concepts for all locations. Design exceptions may be required at each crossing location; however, any potential design exceptions would be determined during advanced design and be approved through the appropriate process. Table 1 assesses relevant roadway design standards and proposes exceptions within the study area crossings at Greenwood Avenue and Franklin Avenue. Table 2 is applicable to Hawthorne Avenue. Roadway element design standards within the City of Bend are based on the following:

- City of Bend Standard and Specifications, January 2022 (COB Standards and Specifications, 2022)
- Bend Transportation System Plan, 2020
- American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, 2018
- Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way, 2011
- Oregon Bicycle and Pedestrian Guide, 2011
- American Association of State Highway and Transportation Officials (AASHTO), Guide for the Development of Bicycle Facilities, 2012

Table 1. Standard Roadway Elements of Design – Arterials

Criterion	Standard	Source	Proposed Exception
Design Speed	Minor Arterial: 35 mph	Section 3.3.3, COB Standards and Specifications, 2022	Posted speed, 25 mph
Pavement Width	Varies, 56 to 72 feet	Standard Drawing R-1A, COB Standards and Specifications, 2022	Greenwood A1: 30 feet (min.) Greenwood A2: 47 feet (min.) Franklin A1: 26 feet (min.) Franklin A2: 28 feet (min.)
Curb-to-Curb Clear Width	20 feet, min., between raised median and curb	Oregon Fire Code fire lane requirements and Section 3.4.2.1, COB Standards and Specifications, 2022	
Travel Lane Width	11 feet	Standard Drawing R-1A, COB Standards and Specifications, 2022	
Left-Turn Lane Width	12 feet	Standard Drawing R-1A, COB Standards and Specifications, 2022	

Criterion	Standard	Source	Proposed Exception
Bike Lane Width	Varies: 8 feet: 5.5-foot lane + 2.5-foot buffer 11 feet: 6-foot lane + 5-foot buffer	Standard Drawing R-1A, COB Standards and Specifications, 2022	Greenwood A1 and A2: 6-foot lane + 2.5-foot buffer Franklin A1: no bike lane, shared-use path Franklin A2: 6-foot lane + 2.5-foot buffer
Shared-Use Path Width	8 feet, min.	Section 3.6.1, COB Standards and Specifications, 2022	
Sidewalk Width	Varies, 8 to 10 feet	Standard Drawing R-1A, COB Standards and Specifications, 2022	Franklin: 5 feet (min.) Greenwood: 6 feet (min.)
Planter Strip	Varies, 5 to 11 feet	Standard Drawing R-1A, COB Standards and Specifications, 2022	No planter strips
Raised Median Width	9 feet	Standard Drawing R-1A, COB Standards and Specifications, 2022	Greenwood A1 and A2: 5 feet (min.)
Shy Distance	1.5 feet (face of curb to center of stripe)	Standard Drawing R-1A, COB Standards and Specifications, 2022	
Pavement Width Transitions	Taper length, $L=(WS^2)/60$ (for speeds less than 45 mph)	Section 3.5.2.4, COB Standards and Specifications, 2022	
Roadway Longitudinal Grade	Min. 1.0% Max. 6.0%	Section 3.5.3.2 and 3.5.3.3, COB Standards and Specifications, 2022	Franklin A2 varies: 3% to 9% (max.)
Shared-Use Path Running slope	Running slope shall not exceed the general grade established by the adjacent street.	Section 3.6.16, COB Standards and Specifications, 2022 and PROWAG R302.5	
Vertical Curves – Sag	Designed to accommodate stopping sight distance, 155 feet Kmax = 167; Kmin = 26	Section 3.5.3.4, COB Standards and Specifications, 2022 AASHTO 2018 equations 3-48 through 3-50	
Vertical Curves – Crest	Designed to accommodate stopping sight distance, 155 feet Kmin = 12	Section 3.5.3.5, COB Standards and Specifications, 2022 AASHTO 2018 equations 3-42 through 3-45	
Curb Ramps	Two paired curb ramps per corner	Section 3.6.2.2, COB Standards and Specifications, 2022	

AASHTO = American Association of State Highway and Transportation Officials; COB = City of Bend; max. = maximum; min. = minimum; mph = miles per hour; PROWAG = Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way

Table 2. Standard Roadway Elements of Design – Pedestrian and Bicycle Crossing at Hawthorne

Criterion	Standard	Source	Proposed Exception
Design Speed (Bicycle)	Path: 18 mph	Section 5.2.4, AASHTO Guide for the Development of Bicycle Facilities, 2012	
Shared-Use Path Width	8 feet, min.	Section 3.6.1, COB Standards and Specifications, 2022	
	Varies, 10 to 14 feet	Section 5.2.1, AASHTO Guide for the Development of Bicycle Facilities, 2012	

Criterion	Standard	Source	Proposed Exception
Structures Width	Path width plus 2-foot optional shy distance on both sides	Chapter 7, Oregon Bicycle and Pedestrian Guide, 2011	
Overcrossings ADA	<=5% grade; 1:12 rise with level landing for every 2.5 feet in rise	Chapter 5, Oregon Bicycle and Pedestrian Guide, 2011	
Vertical Clearance	19 feet 0 inches, min., over US 97 23.5 feet, min., over BNSF tracks 14 feet, min., over NE 1st Street	Section 316, ODOT Highway Design Manual, 2023	
Curb-to-Curb Clear Width	20 feet, min., between raised median and curb	Oregon Fire Code fire lane requirements and Section 3.4.2.1, COB Standards and Specifications, 2022	
Travel Lane Width	11 feet	Standard Drawing R-1C, COB Standards and Specifications, 2022	Eastbound lane closed
Bike Lane Width	Varies: 8 feet: 5.5-foot lane + 2.5-foot buffer 11 feet: 6-foot lane + 5-foot buffer	Standard Drawing R-1C, COB Standards and Specifications, 2022	North side: 7.5 feet South side: Shared-use path in lieu of
Sidewalk Width	10 feet (no parking)	Standard Drawing R-1C, COB Standards and Specifications, 2022	North side: 6 feet South side: Shared-use path in lieu of
Planter Strip	9 feet	Standard Drawing R-1C, COB Standards and Specifications, 2022	No planter strips
Pavement Width Transitions	Taper length, $L=(WS^2)/60$ (for speeds less than 45 mph)	Section 3.5.2.4, COB Standards and Specifications, 2022	
Roadway Longitudinal Grade	Min. 1.0% Max. 6.0%	Sections 3.5.3.2 and 3.5.3.3, COB Standards and Specifications, 2022	
Shared-Use Path Running slope	Running slope shall not exceed the general grade established by the adjacent street.	Section 3.6.16, COB Standards and Specifications, 2022 and PROWAG R302.5	
Curb Ramps	Two paired curb ramps per corner	Section 3.6.2.2, COB Standards and Specifications, 2022	

AASHTO = American Association of State Highway and Transportation Officials; ADA = Americans with Disabilities Act; COB = City of Bend; max. = maximum; min. = minimum; mph = miles per hour; ODOT = Oregon Department of Transportation; PROWAG = Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way

2.2 Greenwood Avenue

Two alternatives were considered for the Greenwood Avenue undercrossing: Concept 1 includes relatively minor grade changes and development of an at-grade shared-use path adjacent to the travel lanes, while Concept 2 includes reconstruction of the existing underpass to widen and lower the existing grade-separated pedestrian and bicycle crossing. Both concepts assume a lane reconfiguration is implemented to reduce the current cross section to a single travel lane in each direction and turn lane

on either side of the crossing; corridor alternatives were developed to support these crossing concepts through a separate project funded with and All Roads Transportation Safety (ARTS) grant.. For full concept details and cost estimates, see Appendix C, Designs, and Appendix D, Cost Estimates

2.2.1 Concept 1: Shared-Use Path

This design concept adds a shared-use path on both sides with a rolled curb separating vehicle traffic from the path. The existing elevated sidewalk remains the same with an upgraded railing. The current four-lane traffic configuration changes to three lanes to allow space for the at-grade shared-use path. The rolled curb allows for the 20-foot minimum clear width required for emergency vehicle access under the overpass. The road section transitions on either side of the undercrossing to allow for a left-turn lane at NE 1st Street and NW Hill Street.

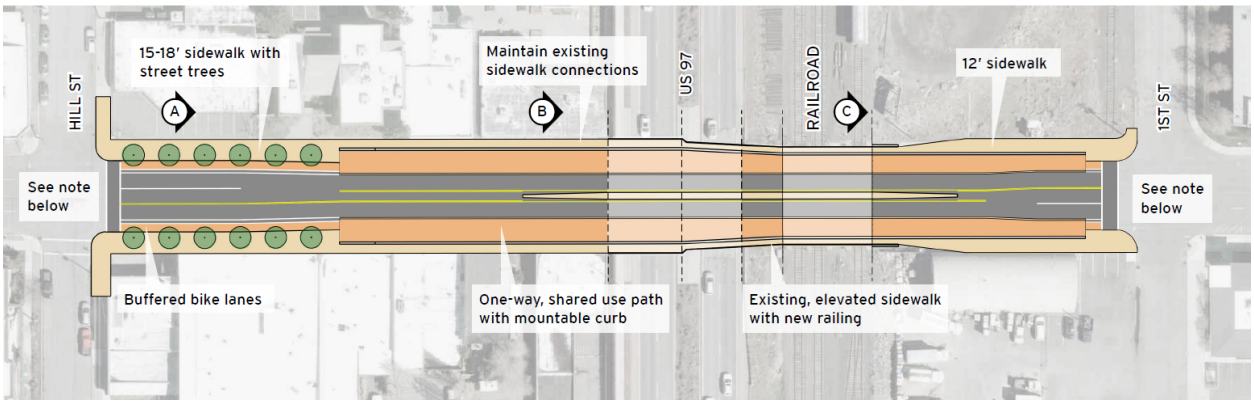

Figure 6. Greenwood Avenue Concept 1
Shared-Use Path / Three-Lane Configuration (east and west of undercrossing)

Notes: Additional study outside of this project area will be completed to address connectivity with the remainder of the corridor. Future consideration during design phase: Explore alternative vertical separation between travel lane and shared-use path, i.e. collapsible delineators, retaining wall to elevate shared-use path (requires EMS review and approval)

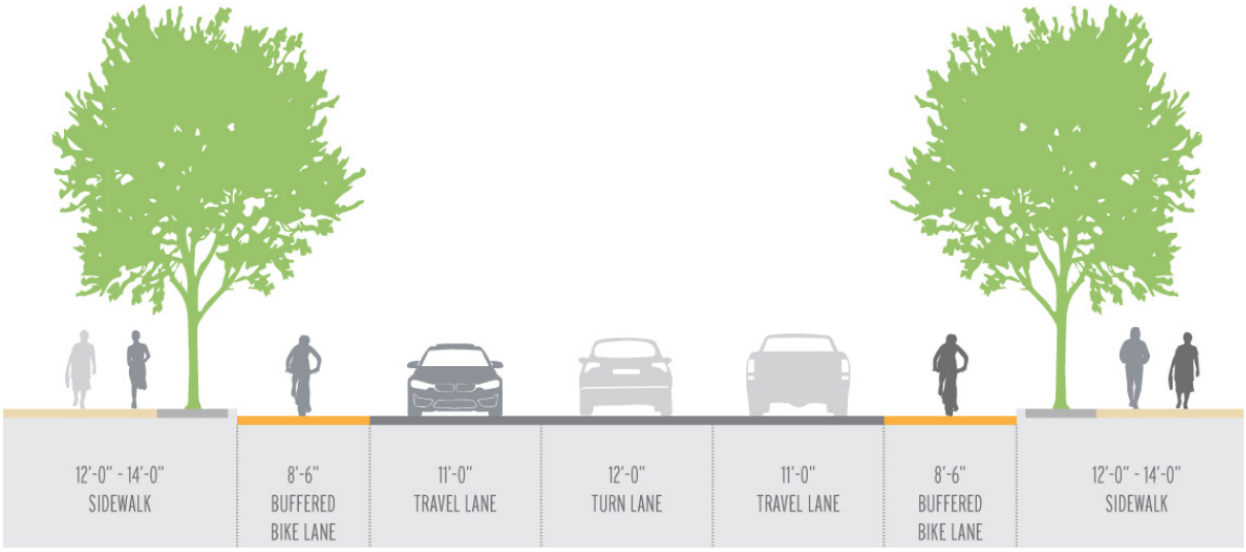

Figure 7. Greenwood Avenue Concept 1: Cross Section A

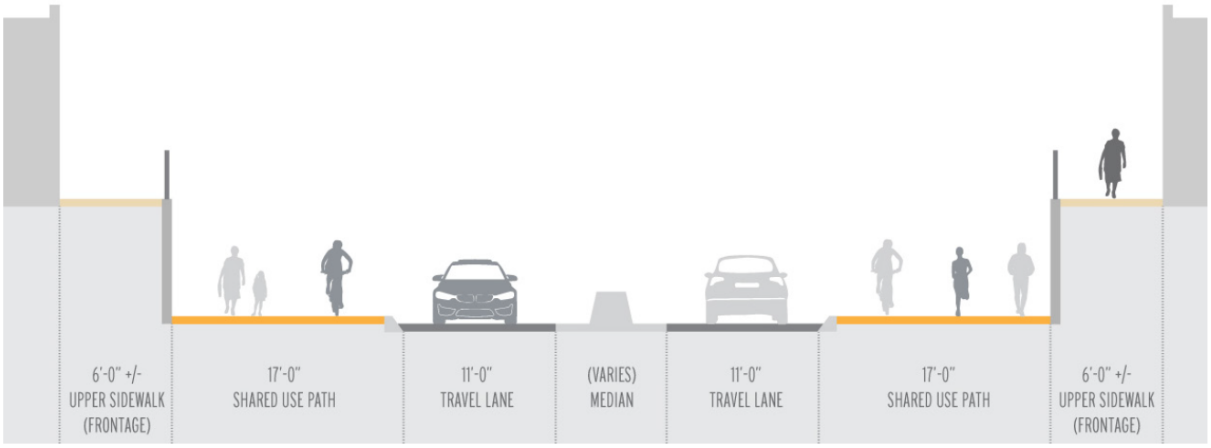

Figure 8. Greenwood Avenue Concept 1: Cross Section B

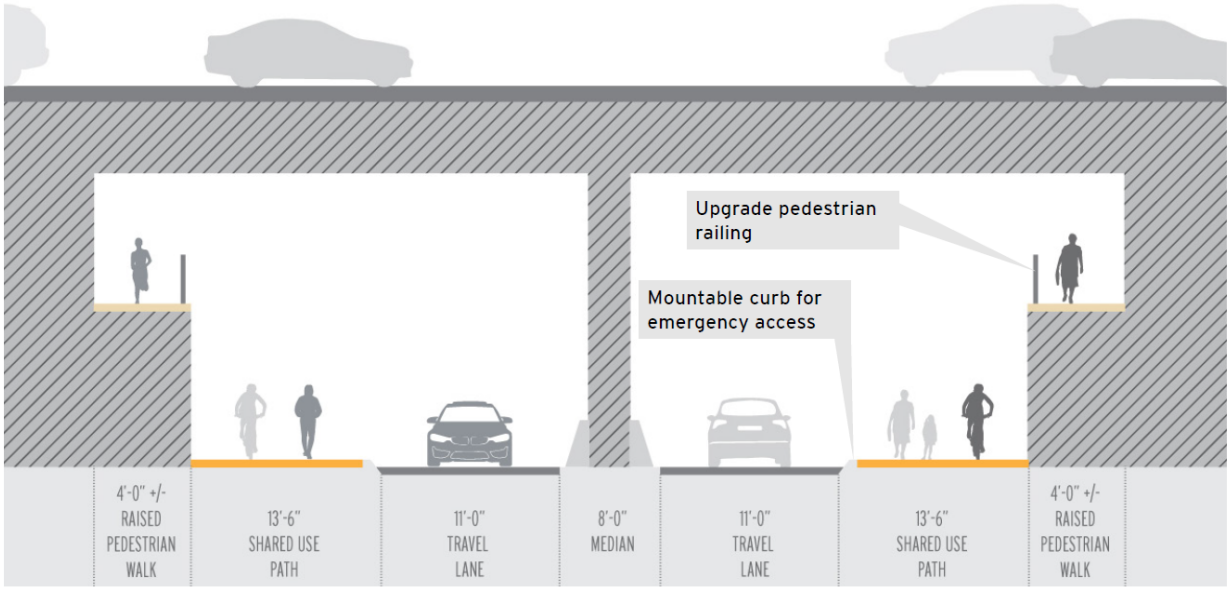

Figure 9. Greenwood Avenue Concept 1: Cross Section C

Table 3. Cost Estimates – Greenwood Avenue Concept 1: Shared-Use Path

Project Element	Cost Estimate
Construction subtotal	$1,639,600
Construction total with contingency	$2,295,400
Soft costs (design, permitting, construction services)	$683,000
Total Project Cost	**$2,978,400**
Stormwater Improvements	$2,500,000

Allowance for stormwater improvements, based on City of Bend estimates from 2023-2027 CIP
Federal funding would require additional costs associated with administrative and environmental documentation.

2.2.2 Concept 2: Lower and Widen Sidewalks

This concept lowers and widens the existing sidewalks for people walking and biking. The current four -lane traffic configuration would change to three lanes to allow for the widened sidewalk and at-grade bicycle lanes. This concept would require more coordination due to excavation potentially affecting BNSF- and Oregon Department of Transportation (ODOT)-owned structures.

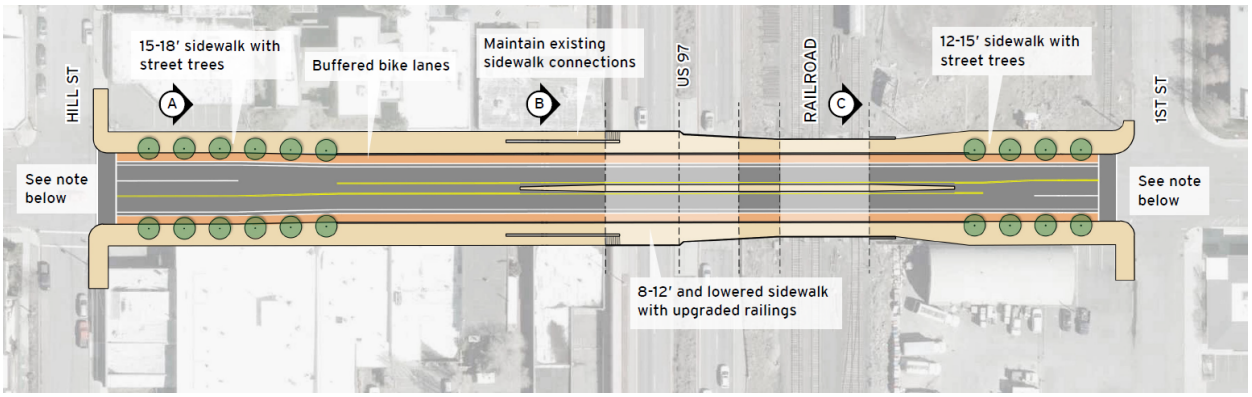

Figure 10. Greenwood Avenue Concept 2
Lower and Widen Sidewalks / Three-Lane Configuration (east and west of undercrossing)
Notes: Additional study outside of this project area will be completed to address connectivity with the remainder of the corridor. Future consideration during design phase: Explore alternative vertical separation between travel lane and shared-use path, i.e. collapsible delineators, retaining wall to elevate shared-use path (requires EMS review and approval).

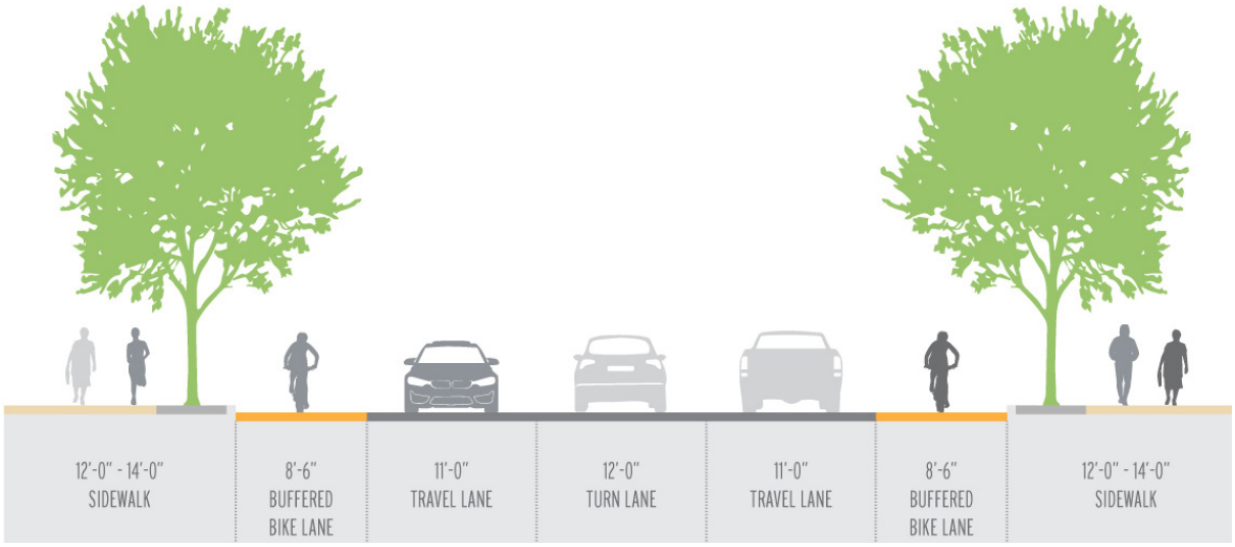

Figure 11. Greenwood Avenue Concept 2: Cross Section A

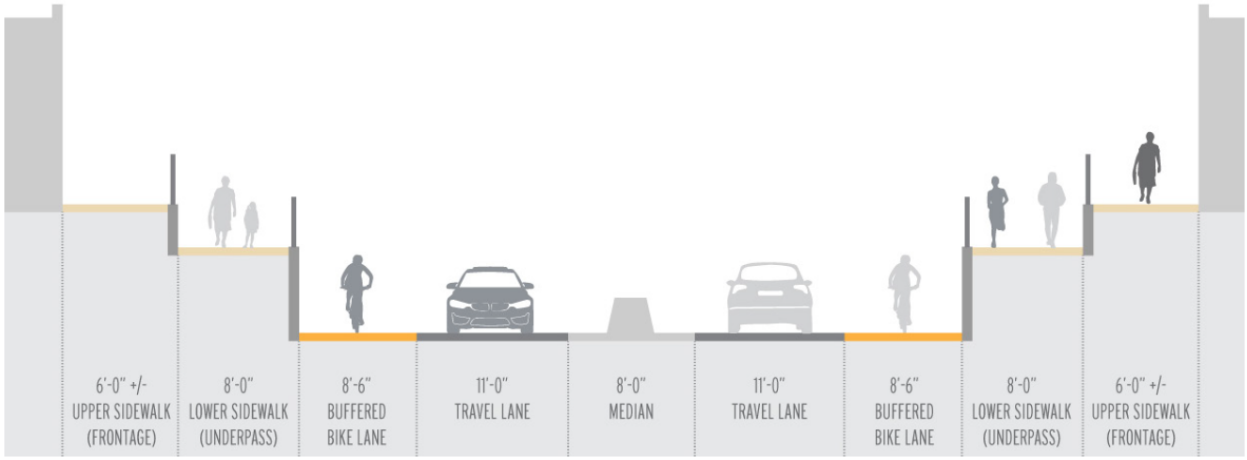

Figure 12. Greenwood Avenue Concept 2: Cross Section B

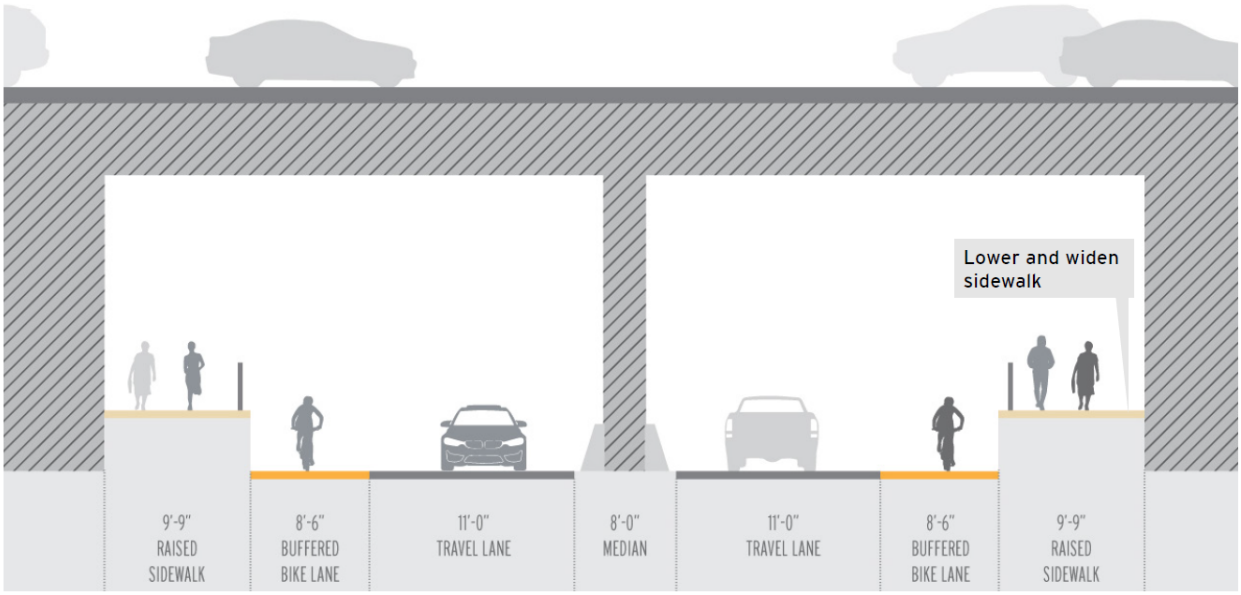

Figure 13. Greenwood Avenue Concept 2: Cross Section C

Table 4. Cost Estimates – Greenwood Avenue Concept 2: Lower and Widen Sidewalks

Project Element	Cost Estimate
Construction subtotal	$4,535,675
Construction total with contingency	$6,349,975
Soft costs (design, permitting construction services)	$1,534,000
Total Project Cost	**$7,883,975**
Stormwater Improvements	$2,500,000

Allowance for stormwater improvements, based on City of Bend estimates from 2023-2027 CIP
Federal funding would require additional costs associated with administrative and environmental documentation.

2.3 Hawthorne Avenue

Three alternatives were considered for the new Hawthorne Avenue overcrossing: Concepts 1 and 2 consist of long ramps to accommodate a bridge tall enough to span US 97. Concept 3 uses elevators and stairs to access the bridge. All three bridge concepts require an easement or acquisition of the private property on the east side directly adjacent to the railroad property. The three concept structures would span both US 97 and the BNSF railroad with supports placed outside of the ODOT and BNSF right-of-way.

All three concepts require occupying the south (eastbound) lane of Hawthorne Avenue from Hill Street to the Parkway and NE 1st Street to NE 2nd Street. Concepts 1 and 2 use the space for the bridge approaches and a shared-use-path, while Concept 3 uses this space for just the shared-use-path. West of the parkway, all concepts eliminate parking on the north side and close the southbound on--ramp to the parkway. ODOT already anticipates closing this southbound on-ramp to US 97 as part of the *US 97 Bend Parkway Plan* (2021). East of the railroad tracks, between 1st Street and 2nd Street, parking is eliminated on both sides of the street, while two-way traffic is maintained within a 22-foot-wide road section to be located on the north side of the street. The area freed up by the elimination of parking will be utilized for the bridge access ramps for Concepts 1 and 2 and shared-use-path for Concept 3.

The costs for the three 14-foot-wide deck concepts range from $18.9 million to $21.0 million, with Concept 3 being the lowest, Concept 2 being the highest and Concept 1 being $19.7 million. The 20-foot-wide option would add roughly $3 million to these totals. All three concepts meet ADA requirements, although Concept 3 will have times ADA users will lose bridge access due to temporary closure of the elevators for maintenance, power outages, and other unforeseen events. For full concept details and cost estimates, see Appendix C, Designs, and Appendix D, Cost Estimates

2.3.1 Bridge Deck Width

The initial screening resulted in the selection of a 14-foot-wide bridge deck for all three bridge alternatives. This width was based on the current version of the Oregon Bike and Pedestrian Design Guide (Appendix L of the ODOT Highway Design Manual) which indicates a 12-foot minimum paved width plus 1-foot shy from railings on the structure. However, ODOT updated the Highway Design Manual, effective January 2023. This update indicates that the minimum total width required for a mode-separated path is a typical 16-foot section comprised of two 5-foot bike lanes and a 6-foot walking area. In areas of very high use, the overall minimum width is increased to 18 or 20 feet.

Based on this recent information, late in the feasibility study a high-level analysis was performed for a 20-foot deck (18 feet plus 1-foot shy on each side). The analysis included an assessment of the feasibility from a structural and layout perspective, as well as for developing very high-level cost estimates. The following concepts (1A, 2A, and 3A) are based on the original 14-foot deck width, followed by a brief summary of findings and impacts related to the 20-foot concepts (1B, 2B, and 3B).

2.3.2 Concept 1: Straight Bridge and Approach Ramps

This design concept features a bridge with long ramps located on the south side of Hawthorne Avenue. To accommodate a bridge tall enough to span US 97, the ramps include slopes up to a 7 percent grade—with a few landings for wheelchair users. The west ramp stops short of NW Hill Street and allows for a flat area before the intersection. The east ramp ends at the high point on Hawthorne Avenue.

Concept 1 presents a single, direct pathway across the bridge for all users. A series of ramps and landings on the east and west approaches accommodate use by bicyclists and pedestrians of all abilities without requiring out-of-direction travel. The structure is a prismatic assembly of plate steel shaped to form three primary spans evocative of the Three Sisters, the most prominent form in the local landscape. This structure supports the deck and creates a signature bridge design unique to Bend, Oregon.

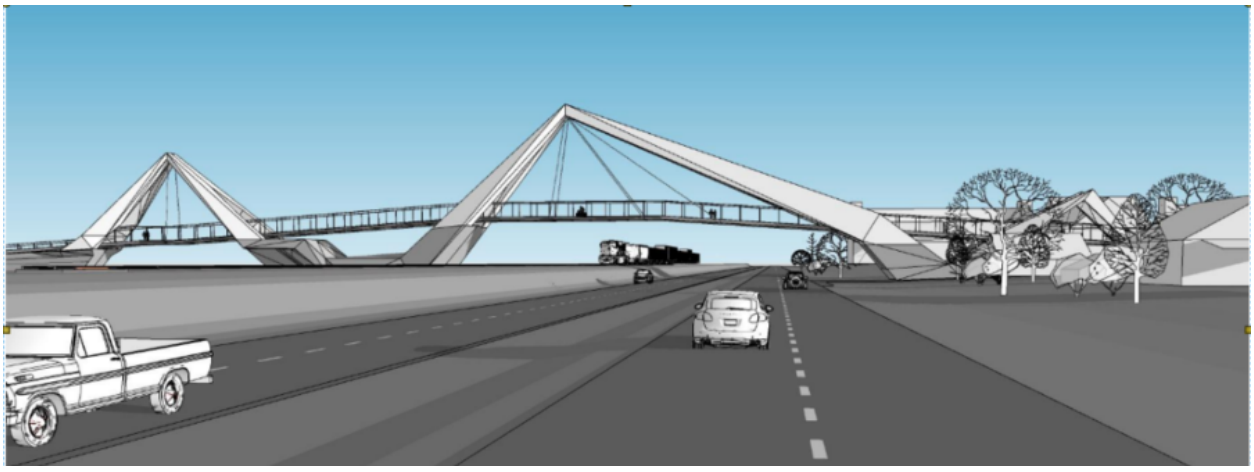

Figure 14. Hawthorne Avenue Concept 1: Straight Bridge and Approach Ramp

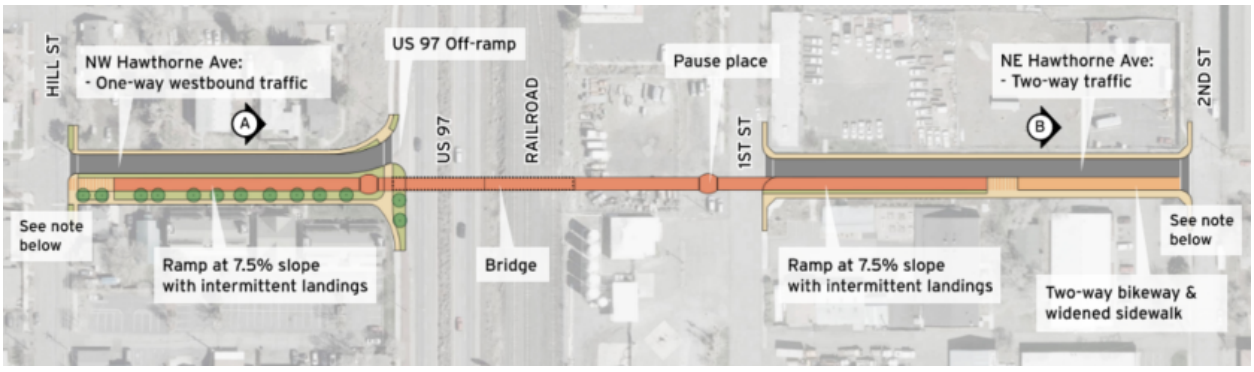

Figure 15. Hawthorne Avenue Concept 1A: Plan View

Notes: Additional study outside of this project area will be completed to address connectivity with the remainder of the corridor. Future consideration during design phase: Explore driveway access to properties at the SE corner of Hill Street and Hawthorne Avenue.

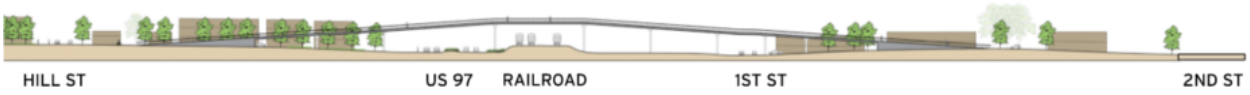

Figure 16. Hawthorne Avenue Concept 1A: South Profile

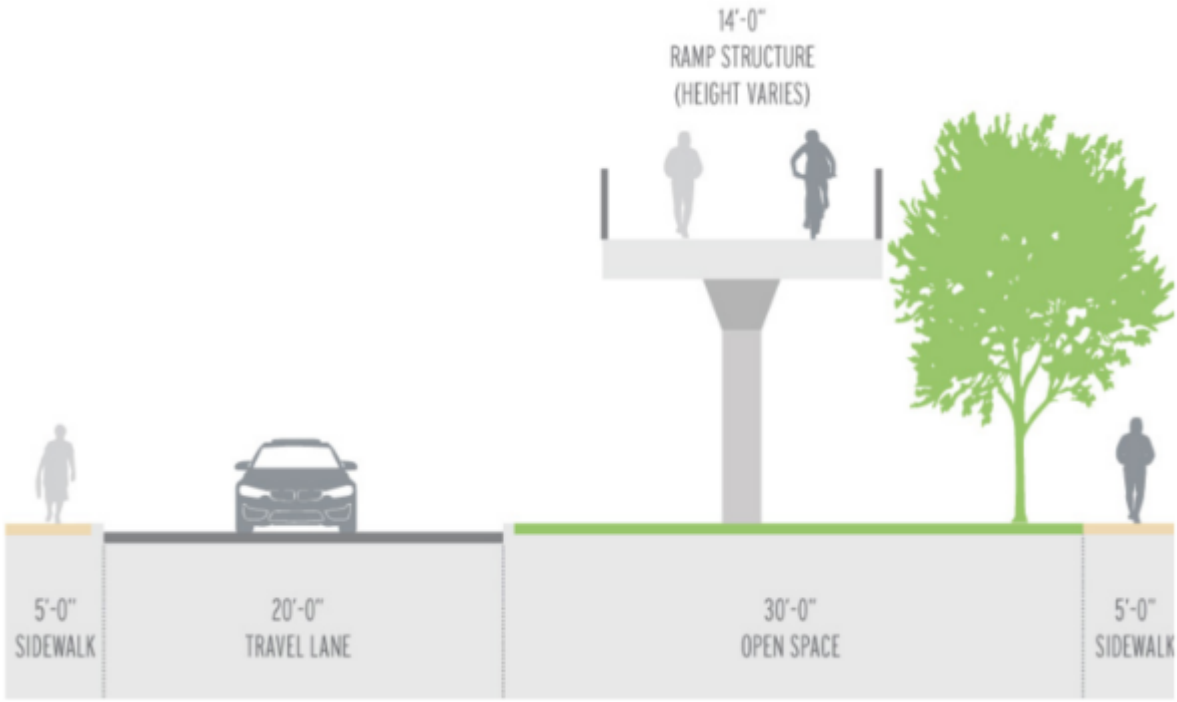

Figure 17. Hawthorne Avenue Concept 1A: Cross Section A

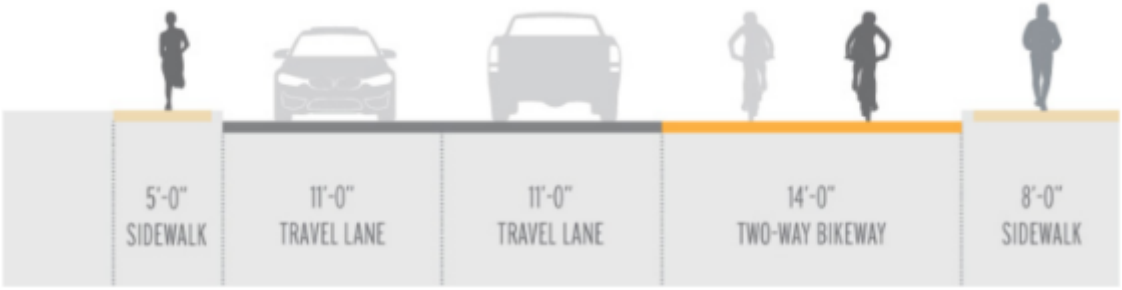

Figure 18. Hawthorne Avenue Concept 1A: Cross Section B

Concept 1B: 20-foot Deck Width

Figure 19 is a plan view of the Three Sisters bridge concept with a 20-foot deck width indicating a high\-level view of the potential impacts and requirements to accommodate the wider deck.

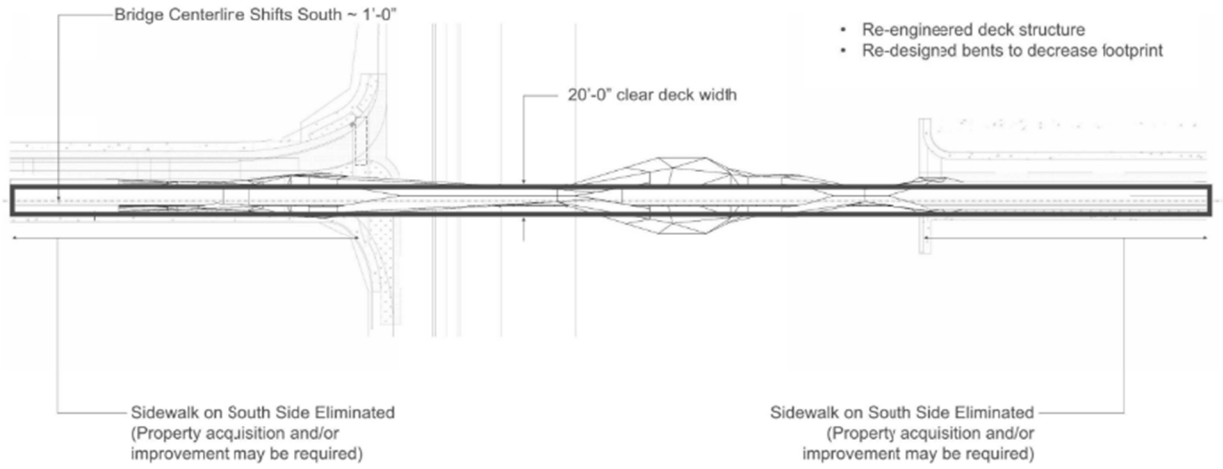

Figure 19. Hawthorne Avenue Concept 1B: 20-foot Deck Width

Table 5. Cost Estimates – Hawthorne Avenue Concept 1: Straight Bridge and Approach Ramps

Project Element	Cost Estimate Concept 1A 14 feet wide	Cost Estimate Concept 1B 20 feet wide
Construction subtotal	$11,466,000	$13,000,000
Construction total with contingency	$16,053,000	$19,000,000
Soft costs (design, permitting, construction services)	$3,654,000	$4,000,000
Total Project Cost	$19,707,000	$23,000,000
Right-of-way/Easements (Allowance)	$1,200,000	$1,200,000

Temporary and construction easements and property/right-of-way acquisition will be required and assessed during the next phase of the project. Federal funding would require additional costs associated with administrative and environmental documentation.

2.3.3 Concept 2: Switchback Ramps, Maintain 4.5 percent Slope

Concept 2 is similar to Concept 1, but it features ramps with switchbacks for a more gradual 4.5 percent longitudinal slope. This design might be able to accommodate stairs between the switchback loops to allow some pedestrians to bypass the switchbacks.

The west ramp is routed onto the City-owned property and back to the south side of Hawthorne Avenue. The proposed ramp location does not impact ODOT's ability to lengthen the deceleration lane on US 97 in the future.

The main span of Concept 2 across the railroad and highway is supported between a pair of splayed steel arches. The approach ramps on the east and west have a gradual slope that avoids the need for intermediate landings. The necessary ramp length is provided by a hairpin turn extension to the north on both the east and west sides of the main span. Further design work is needed to verify if short flights of stairs along the main axis of the bridge are possible; these would enable some users to avoid the extended distance of the hairpins and move across the bridge in a direct line of travel.

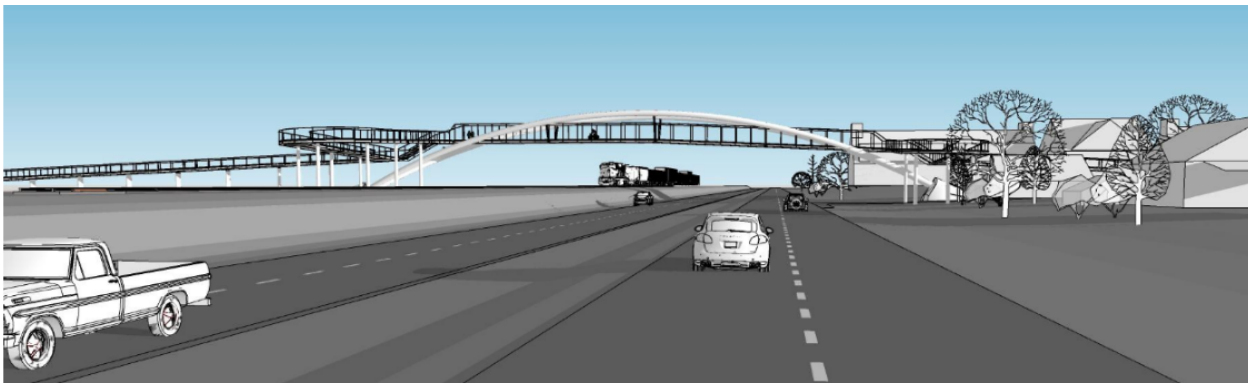

Figure 20. Hawthorne Avenue Concept 2: Switchback Ramps, Maintain 4.5 percent Slope

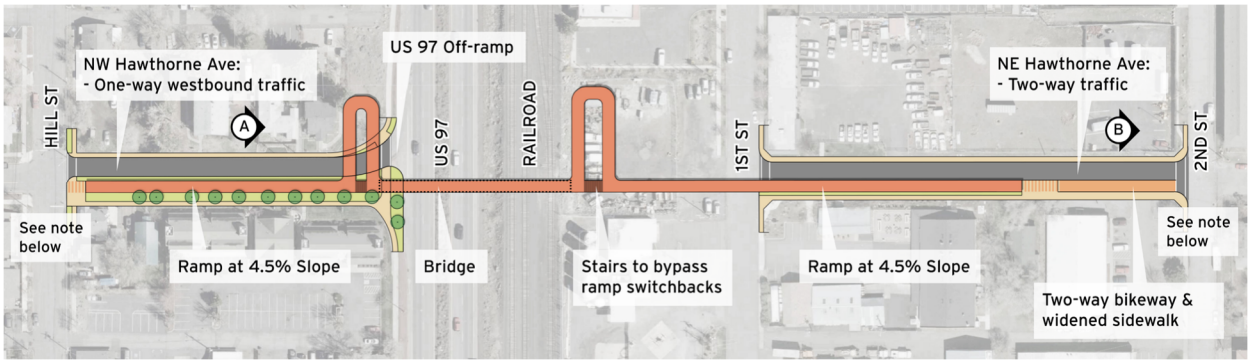

Figure 21. Hawthorne Avenue Concept 2A: Plan View

Notes: Additional study outside of this project area will be completed to address connectivity with the remainder of the corridor. Future consideration during design phase: Explore driveway access to properties at the SE corner of Hill Street and Hawthorne Avenue.

Figure 22. Hawthorne Avenue Concept 2A: South Profile

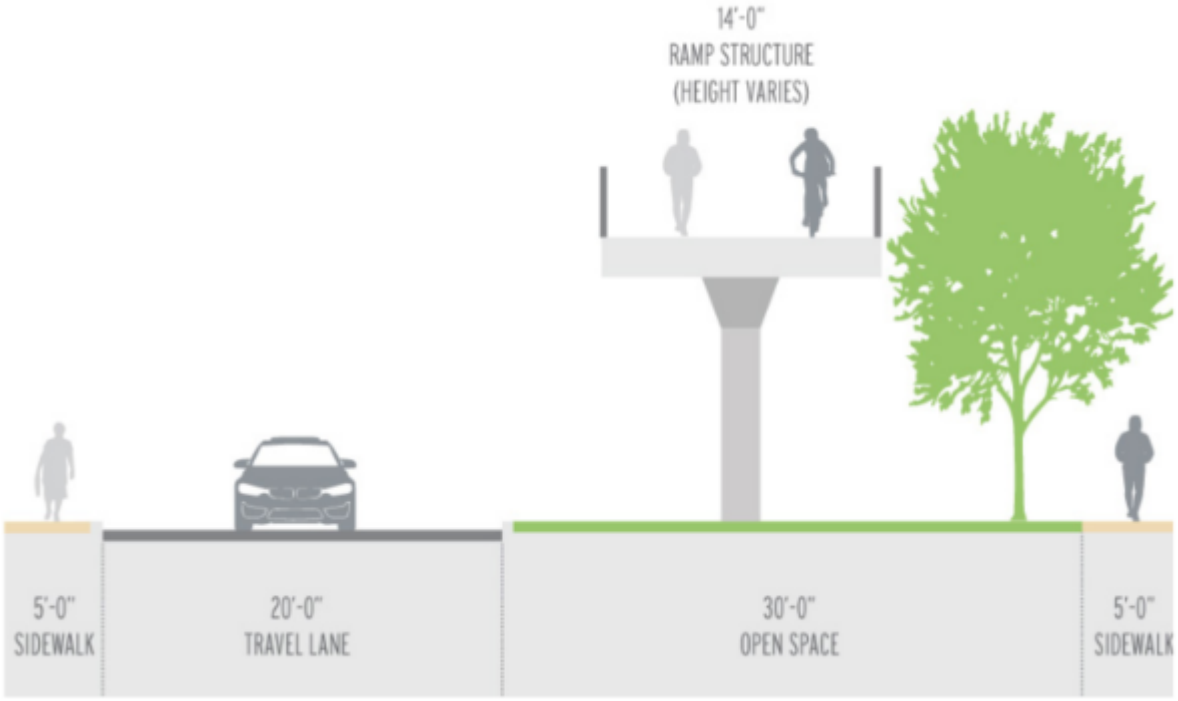

Figure 23. Hawthorne Avenue Concept 2A: Cross Section A

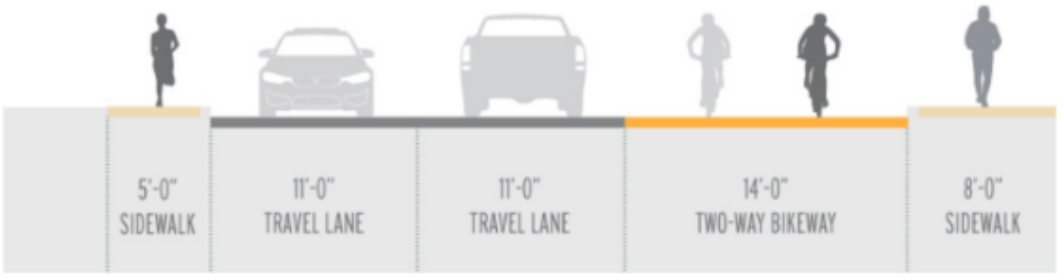

Figure 24. Hawthorne Avenue Concept 2A: Cross Section B

Concept 2B – 20-foot Deck Width

Figure 25 is a plan view of the Hairpin bridge concept with a 20-ft deck width indicating a high-level view of the potential impacts and requirements to accommodate the wider deck.

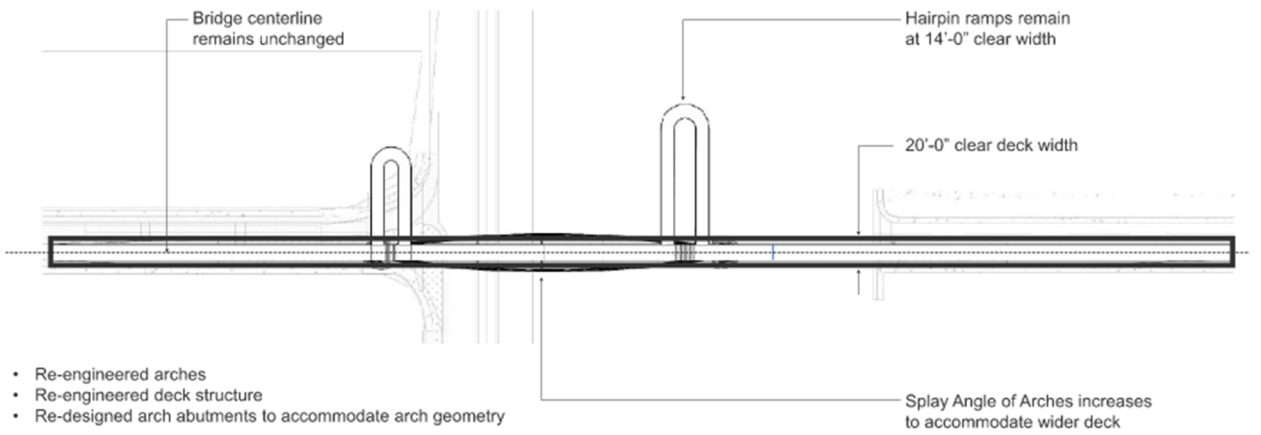

Figure 25. Hawthorne Avenue Concept 2B: 20-foot Deck Width

Table 6. Cost Estimates – Hawthorne Avenue Concept 2: Switchback Ramps, Maintain 4.5 percent Slope

Project Element	Cost Estimate Concept 2A 14 feet wide	Cost Estimate Concept 2B 20 feet wide
Construction subtotal	$12,213,000	$14,000,000
Construction total with contingency	$17,098,000	$20,000,000
Soft costs (design, permitting, construction services)	$3,877,000	$4,000,000
Total Project Costs	$20,975,000	$24,000,000
Right-of-way/Easements (Allowance)	$2,300,000	$2,300,000

Temporary and construction easements and property/ROW acquisition will be required and assessed during the next phase of the project. Federal funding would require additional costs associated with administrative and environmental documentation.

2.3.4 Concept 3: Stair and Elevator Bridge Access, No Ramps

Concept 3 features an elevator and stairs but does not include ramps. This allows the potential for the development of a plaza area between the elevator and NE 1st Street and a shared-use path on the south side of Hawthorne Avenue between NE 1st Street and NE 2nd Street.

The elevator and stairs are located close to the railroad and ODOT right-of-way. The approach to the elevator on the west side of US 97 slopes up to create a vertical separation between the highway deceleration lane and the shared-use path approaching the elevator.

In Concept 3, the vertical movement to and from the main bridge span is accomplished with an elevator tower and a staircase at both the east and west ends of the bridge. The main span deck is supported on

suspension cables running between the elevator towers. The elevators are sized to accommodate bicycles and are equipped with doors on two sides to enable direct, in-and-out movement without the need to turn bicycles around in the elevator cab.

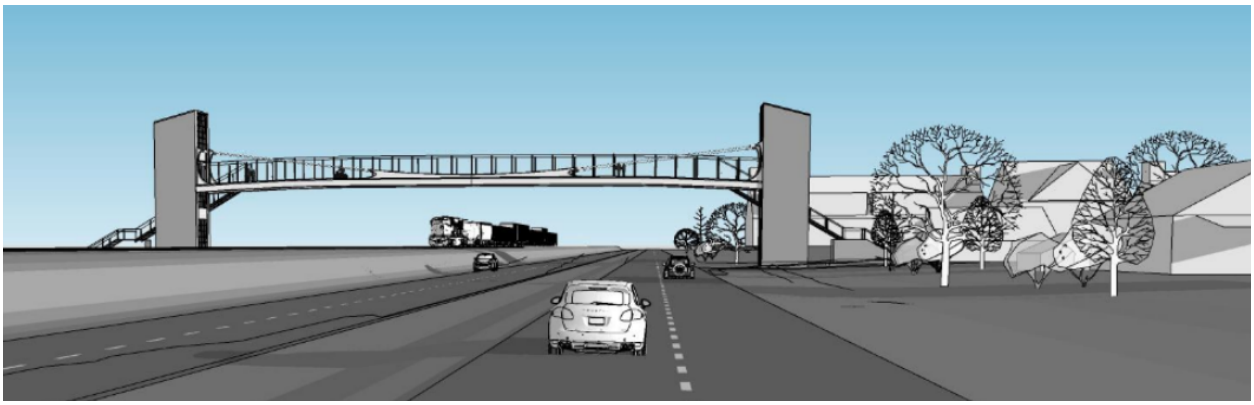

Figure 26. Hawthorne Avenue Concept 3: Stair and Elevator Bridge Access, No Ramps

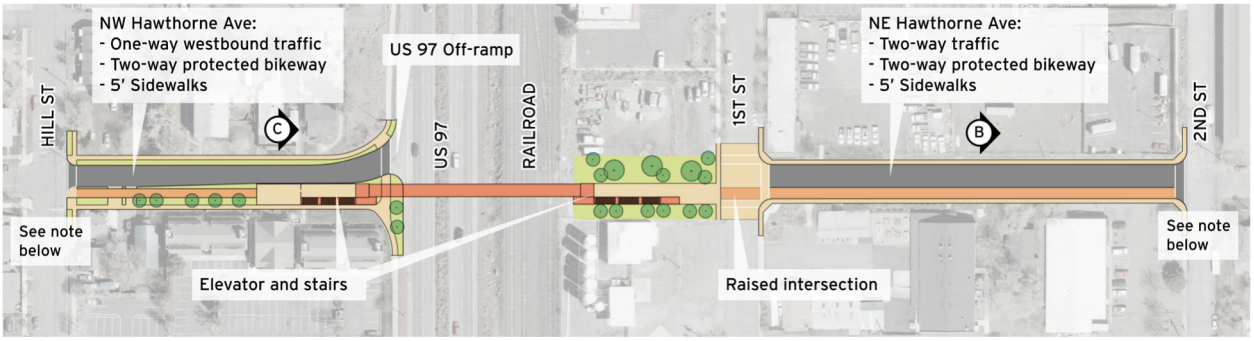

Figure 27. Hawthorne Avenue Concept 3A

Notes: Additional study outside of this project area will be completed to address connectivity with the remainder of the corridor. Future consideration during design phase: Explore driveway access to properties at the SE corner of Hill Street and Hawthorne Avenue.

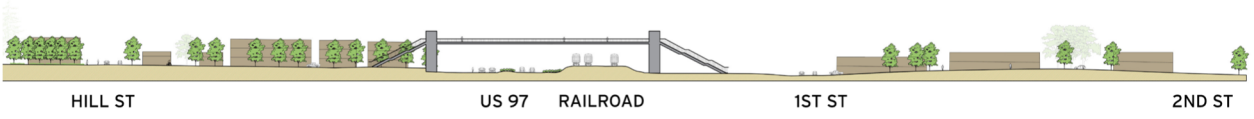

Figure 28. Hawthorne Avenue Concept 3A: South Profile

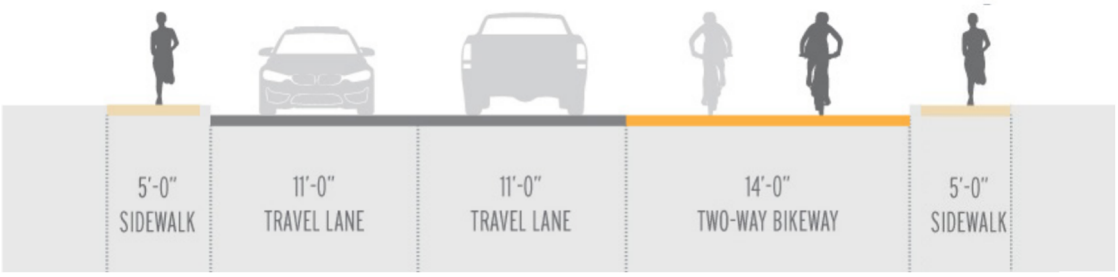

Figure 29. Hawthorne Avenue Concept 3A: Cross Section B

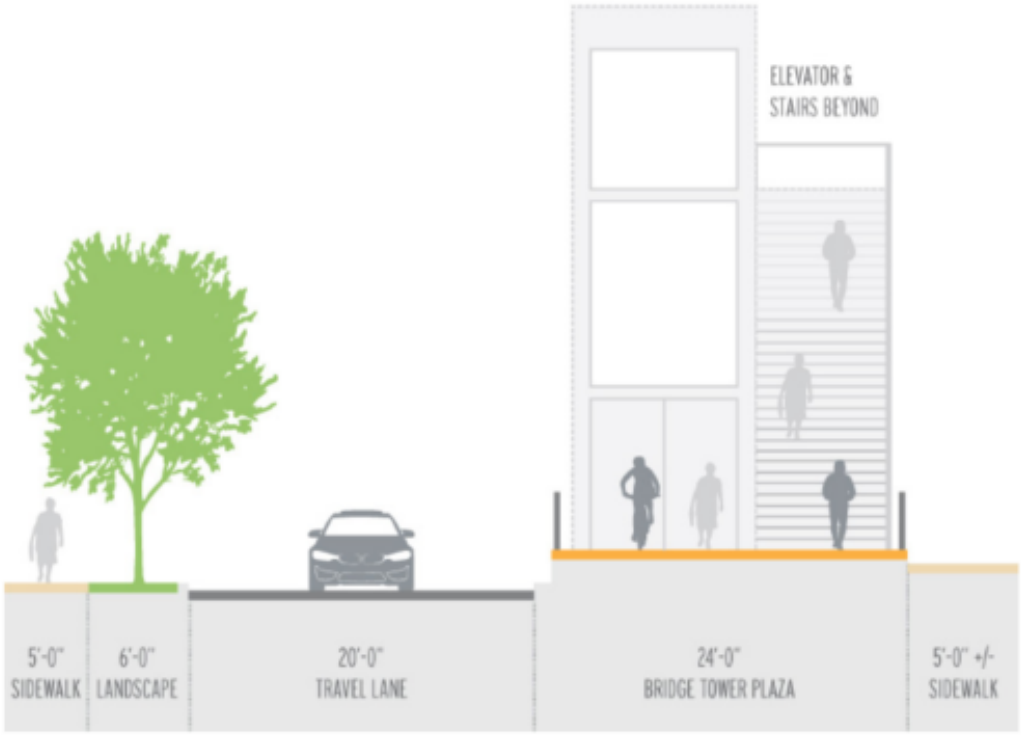

Figure 30. Hawthorne Avenue Concept 3A: Cross Section C

Concept 3B – 20-foot Deck Width

Figure 31 is a plan view of Concept 3B with a 20-foot deck width indicating a high-level view of the potential impacts and requirements to accommodate the wider deck.

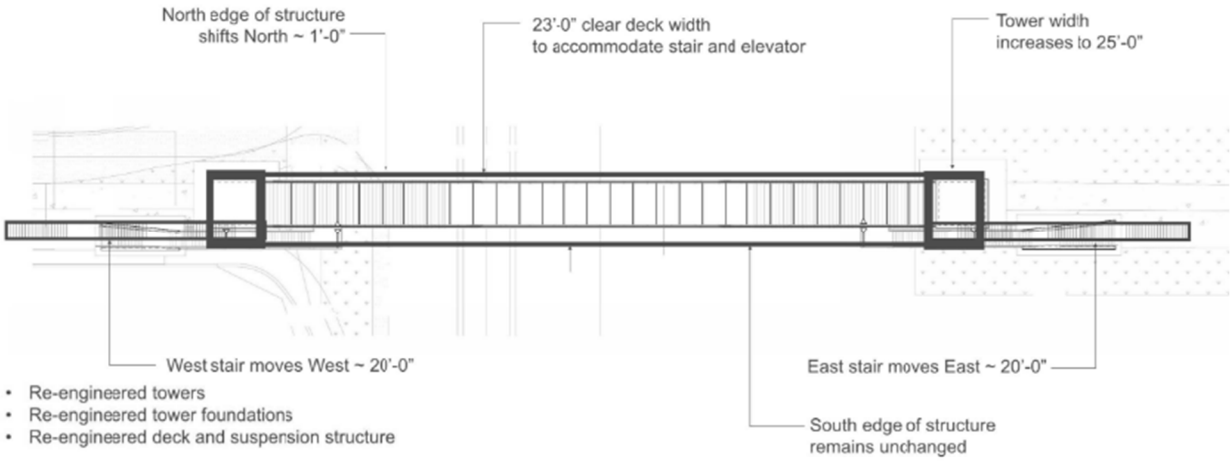

Figure 31. Hawthorne Avenue Concept 3B: 20-foot Deck Width

Table 7. Cost Estimates – Hawthorne Avenue Concept 3: Stair and Elevator Bridge Access, No Ramps

Project Element	Cost Estimate Concept 3A 14 feet wide	Cost Estimate Concept 3B 20 feet wide
Construction subtotal	$10,972,000	$13,000,000
Construction total with contingency	$15,361,000	$18,000,000
Soft costs (design, permitting, construction services)	$3,505,000	$4,000,000
Total Project Cost	**$18,866,000**	**$22,000,000**
Right-of-way/Easements	$1,200,000	$1,200,000

Temporary and construction easements and property/ROW acquisition will be required and assessed during the next phase of the project. Federal funding would require additional costs associated with administrative and environmental documentation.

2.4 Franklin Avenue

Two alternatives were considered for the Franklin Avenue undercrossing: Concept 1 includes a new, wider path and wall construction on the east side, while Concept 2 includes new shared-use paths up to 18 feet wide and replacement of both the US 97 and railroad bridges with longer spans. Concept 1 would address some safety and user comfort concerns. However, it is less expensive and likely much quicker to complete. Concept 2 would fully address all safety concerns, but would cost significantly more and take longer to complete.

2.4.1 Concept 1: Widen and Level East Access – Plaza

This design concept would widen the approaches on the east side of the crossing only. This would moderately improve the line of sight in and out of tunnels, lighting, and accessibility, and it would better accommodate people walking and biking within the same space.

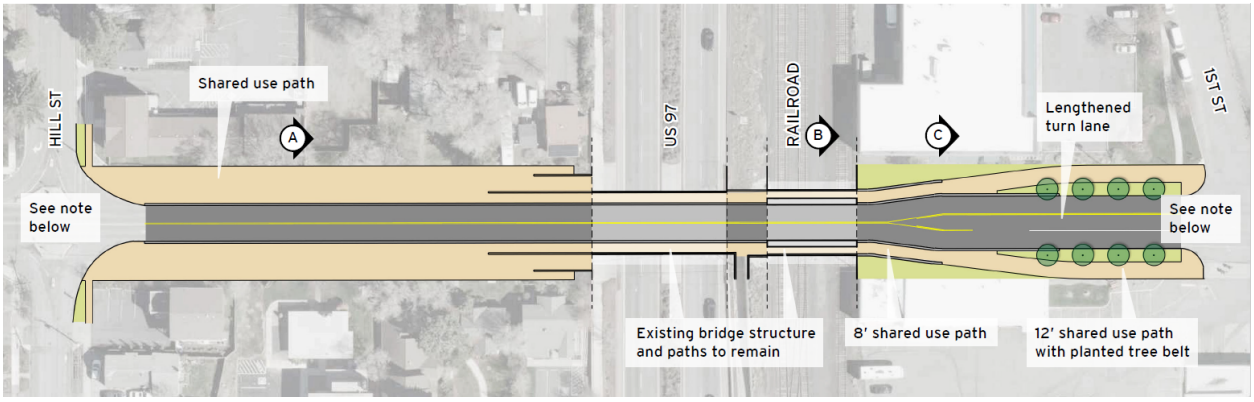

Figure 32. Franklin Avenue Concept 1: Widen and Level East Access – Plaza

Note: Additional study outside of this project area will be completed to address connectivity with the remainder of the corridor.

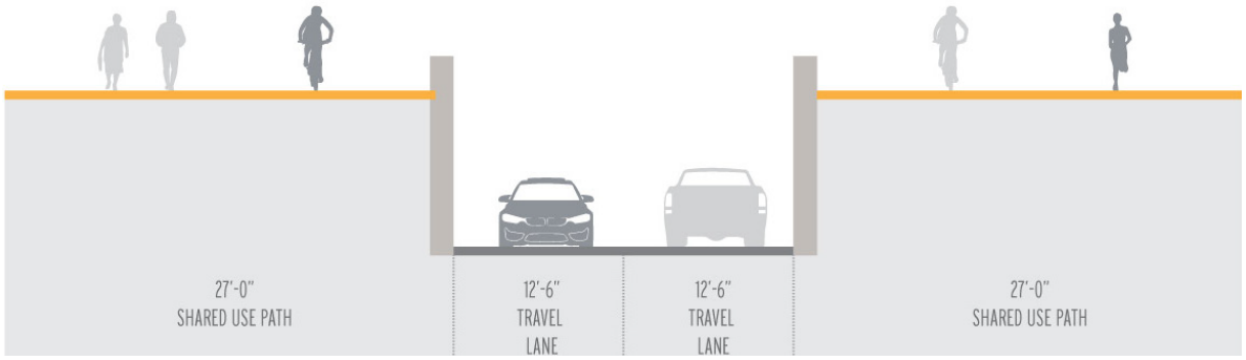

Figure 33. Franklin Avenue Concept 1: Cross Section A

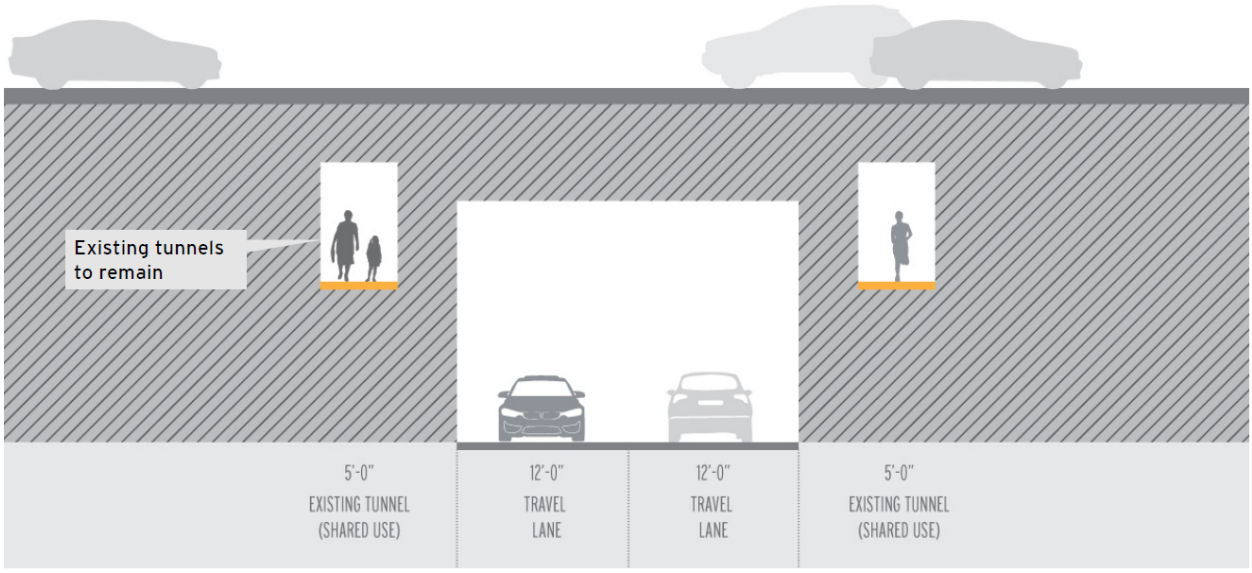

Figure 34. Franklin Avenue Concept 1: Cross Section B

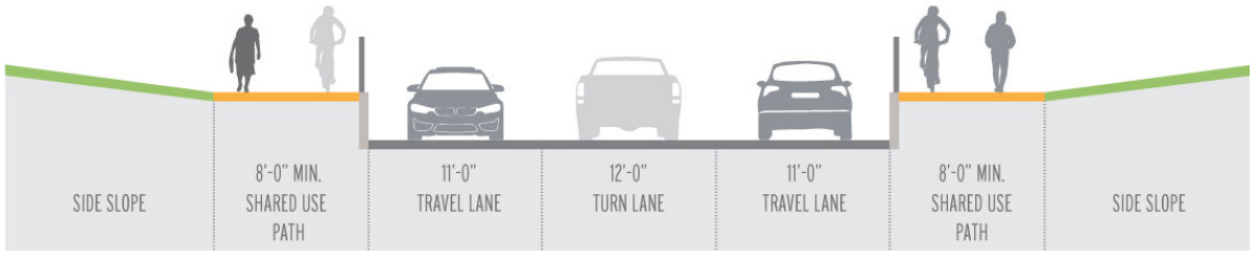

Figure 35. Franklin Avenue Concept 1: Cross Section C

Table 8. Cost Estimates – Franklin Avenue Concept 1: Widen and Level East Access – Plaza

Project Element	Cost Estimate
Construction total with contingency	$5,452,000
Soft costs (design, permitting, construction services)	$1,347,000
Total Project Cost	**$6,799,000**
Stormwater Improvements	$1,750,000

Allowance for stormwater improvements, based on City of Bend estimates from 2023–2027 CIP
Federal funding would require additional costs associated with administrative and environmental documentation.

2.4.2 Concept 2: Full Rebuild/Widen Undercrossing Opening

This design concept rebuilds and widens the undercrossing allowing for a standard two-lane road and separated sidewalk and bike lanes on either side. The sidewalk may need to remain raised above the street to maintain a gentler slope and meet accessibility requirements. The existing rail bridge is a potentially historic structure. This concept could involve removing this structure, thus presenting potential permitting issues and significantly more coordination requirements with BNSF and ODOT.

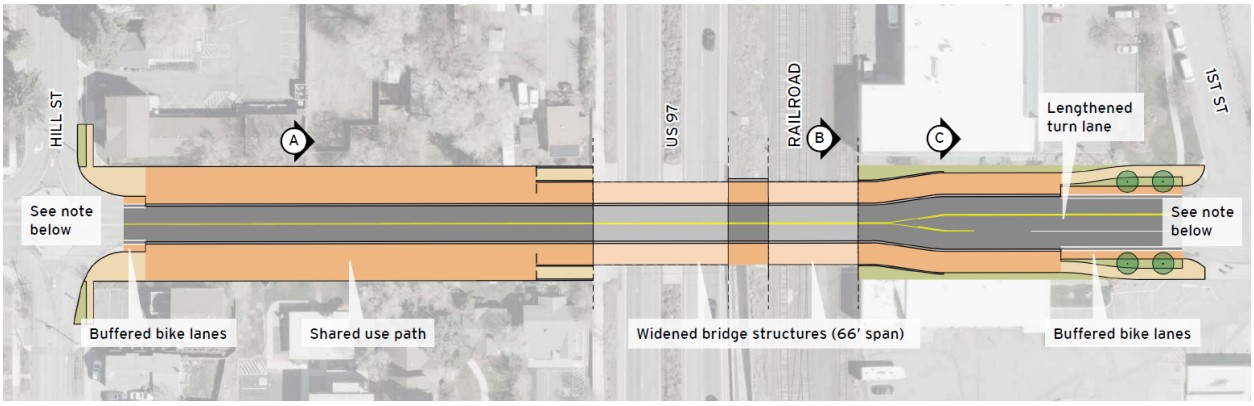

Figure 36. Franklin Avenue Concept 2: Full Rebuild / Widen Undercrossing Opening
Note: Additional study outside of this project area will be completed to address connectivity with the remainder of the corridor.

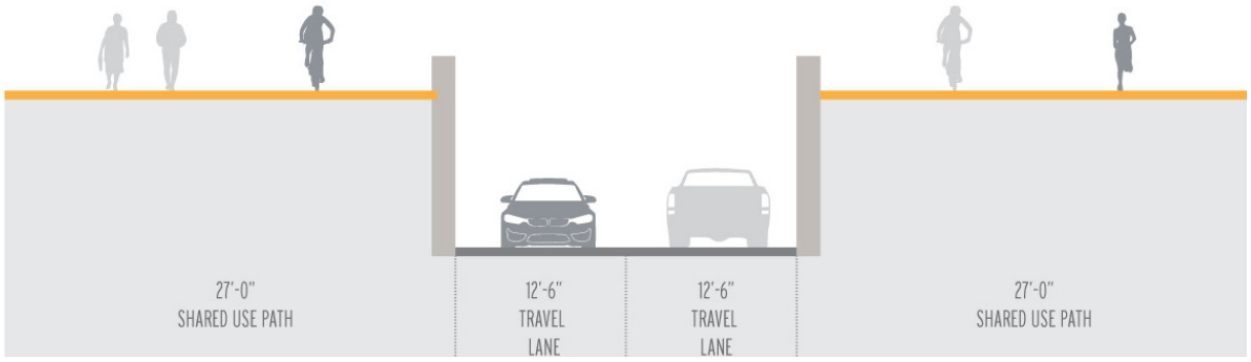

Figure 37. Franklin Avenue Concept 2: Cross Section A

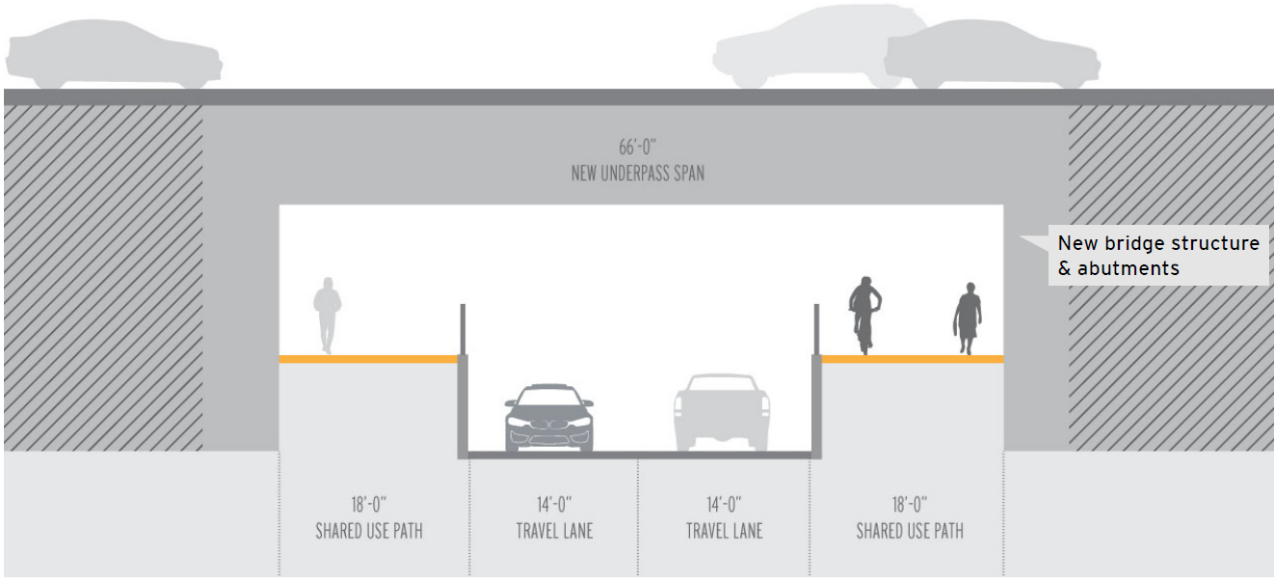

Figure 38. Franklin Avenue Concept 2: Cross Section B

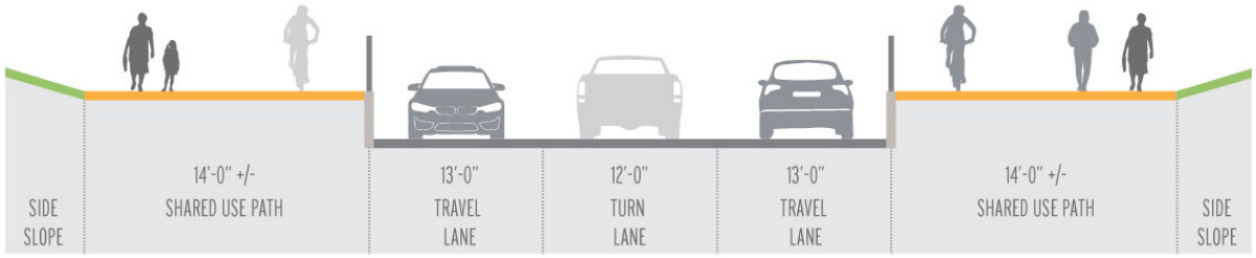

Figure 39. Franklin Avenue Concept 2: Cross Section C

Table 9. Cost Estimates – Franklin Avenue Concept 2: Full Rebuild / Widen Undercrossing Opening

Project Element	Cost Estimate
Construction subtotal	$23,363,930
Construction total with contingency	$32,709,530
Anticipated items (Railroad costs with contingency, utility reimbursement.)	$7,300,000
Soft costs (design, permitting, construction services)	$6,871,000
Total Project Cost	**$46,880,530**
Stormwater Improvements	$1,750,000

Allowance for stormwater improvements, based on City of Bend estimates from 2023-2027 CIP
Temporary and construction easements and property/ROW acquisition will be required and assessed during the next phase of the project.
Federal funding would require additional costs associated with administrative and environmental documentation.

3. ALTERNATIVE EVALUATION

3.1 Approach to Selecting the Preferred Alternatives

The project team conducted a technical evaluation of the alternatives based on the criteria below in order to recommend a single alternative for each crossing location.

3.1.1 Alternatives Selection Evaluation Criteria

Table 10 describes the evaluation criteria for the alternatives. The evaluations in Table 11 through Table 13 include additional comments and justification for the scores as appropriate. The evaluation criteria were derived from the project's core values and goals and are separated into *community needs and goals* and *feasibility*. The criteria are not weighted.

Table 10. Evaluation Criteria

Criterion	Description	How did we evaluate?
Community Needs and Goals		
Alignment with community goals	Goals include those from the TSP and Core Area Plan.	Qualitative assessment of alignment with TSP and Core Area Plan
Safety, security, and user comfort	Safety improvements for walking, cycling, or using a mobility device including perceptions of safety and security. Comfort is important to ensuring the improvements encourage cycling and walking by all ages and abilities of users. **Aligns with project core value of mobility and safety**	Degree to which alternatives separate users from vehicle traffic and enhance personal security.
Equitable outcomes	Ensure that alternatives benefit vulnerable users and populations to the maximum extent possible. **Aligns with project core value of equity**	Qualitative assessment based on the needs of vulnerable populations (racial and ethnic minorities, youth, older adults, and other groups).
Urban design	Whether the alternatives result in a "marquee" or signature enhancement to the urban context of Bend, and whether the alternative would support redevelopment **Aligns with project core value of economic development**	Degree to which improvements enhance urban design and/or create a marquee improvement; assessment of the degree to which a crossing alternative would result in changes that boosted redevelopment potential.
Public support	Stakeholder and public support for a given alternative.	Degree of support based on outreach conducted.

Criterion	Description	How did we evaluate?
Feasibility		
Design feasibility	The fundamental ability to implement the design given the constraints known at this early stage of design.	Assessment of the feasibility, risks, and constructability of a given design.
Cost	The projected cost. **Aligns with project core value of fiscal responsibility**	Costs will be presented without a rating.
Temporary construction impacts	Alternatives would have varying degrees of impact to traffic, private property, US 97, and rail.	Duration and level of impact of temporary construction impacts to the transportation system, businesses, and residents including the degree to which these can be mitigated.
Environmental and cultural resource constraints	Potential effects on known resources at each location.	Potential for alternatives to cause significant impacts to known resources based on available data.
ROW acquisition needs	Many alternatives are likely to require new ROW acquisition.	Amount of ROW acquisition anticipated and difficulty level of acquisition.
Maintenance requirements	Alternatives will have varying long-term maintenance needs.	Anticipated maintenance needs and costs.
Feasibility with respect to BNSF and ODOT facilities	ODOT and BNSF have major facilities at each crossing location that impact many aspects of feasibility.	Likely feasibility based on conversations with BNSF and ODOT or based on experience on past similar projects.

ODOT = Oregon Department of Transportation; ROW = right-of-way; TSP = 2020 City of Bend Transportation System Plan

3.1.2 Evaluation

The criteria were evaluated using a Consumer Reports–style evaluation:

- ● Best performance
- ◒ Neutral or moderate performance
- ○ Poor performance
- N/A Not applicable

Greenwood Avenue

Table 11 shows the technical evaluation for Greenwood Avenue alternatives.

Table 11. Evaluation Matrix – Greenwood Avenue

Criterion	Concept 1: Shared-Use Path	Concept 2: Lower and Widen Sidewalks	Comments
Community Needs and Goals			
Alignment with community goals	◒	●	Concept 2 better reflects community goals of improving both safety and comfort of this crossing location.
Safety, security, and user comfort	◒	●	Concept 2 would significantly improve the experience for pedestrians and less-comfortable bike riders due to grade-separated sidewalks; Concept 2 also provides a buffered bike lane at grade for confident cyclists. Concept 1 provides benefits but would not substantially improve the existing pedestrian tunnel and the at-grade shared path may still not be comfortable for some users due to proximity to traffic.
Equitable outcomes	◒	◒	No substantial difference between the concepts. Both concepts would provide benefits to communities of concern and would have similar improvements for people with disabilities. Concept 1 – 5.8% grade Concept 2 – 4.5% grade
Urban design	◒	●	Concept 2 would provide a somewhat greater benefit by implementing a more robust facility that could better support economic development goals. Concept 1 would not substantially improve the existing pedestrian tunnels.
Public support	◒	◒	Public support was approximately equal for both concepts.
Feasibility			
Design feasibility	●	◒	Overall, both concepts are feasible with Concept 2 presenting somewhat more design issues and unknowns. May be some impact to railroad footing for Concept 2. Both concepts could be completed concurrently with the required storm drainage improvements which are being funded separately.
Cost (2022 Dollars)	$3 M	$8 M	Concept 1 is significantly less expensive than Concept 2.
Temporary construction impacts	◒	○	Concept 1 would not impact the existing tunnel walkways. Concept 2 has greater impact to businesses due to construction of a new retaining wall in front of businesses (1-2 lots adjacent to structure); pedestrian detour reroutes from existing walk would be required. Both concepts would require some temporary impacts to traffic under the bridges.
Environmental and cultural resource constraints	◒	◒	Based on information available at this level of the study, both alternatives are expected to have similar impacts from an environmental perspective.

Criterion	Concept 1: Shared-Use Path	Concept 2: Lower and Widen Sidewalks	Comments
ROW acquisition needs	N/A	N/A	No ROW acquisition needed for either concept.
Maintenance requirements	◒	●	Wider sidewalks included in Concept 2 would be easier for equipment to maintain.
Feasibility with respect to BNSF and ODOT facilities	●	◒	Concept 1 has few issues. Concept 2 requires more coordination due to excavation potentially affecting BNSF- and ODOT-owned structures.

M = million; ODOT = Oregon Department of Transportation; ROW = right-of-way

Discussion

- Overall, Concept 1 is significantly less expensive than Concept 2, but scores more poorly compared to Concept 2 in terms of alignment with the Community Needs and Goals criteria. Concept 1 does not provide improvement to the existing confined tunnels and the proposed shared use path would be curb-tight to the travel lanes under the crossing itself. These conditions do not provide the same level of user safety and comfort improvement as Concept 2.
- Concept 2 would improve the sidewalks by widening and lowering them, improving lines of sight and increasing the amount of grade-separated space for users. This would better address issues with the existing crossing that stem in large part from the existing confined tunnels.
- At-grade bicycle lanes provided with Concept 2 would provide separated space for confident cyclists who travel at higher speeds to cross, while less adept cyclists (such as youth and older adults) could use the expanded grade-separated sidewalk option which provides a high degree of separation from traffic.
- With respect to public outreach, when online and in-person responses were combined, results were split and no clear preference on alternatives emerged. There were 121 responses to the question of which alternative design concept respondents preferred; combined participants were almost evenly split between Concept 1 (49 percent) and Concept 2 (51 percent). However, for in-person participants, most (69 percent) preferred Concept 2 and 31 percent favored Concept 1.
- With respect to feasibility, both concepts are feasible. Concept 2 involves more intensive work on the existing structure and walls; due to the limitations of this Study, there are unknowns such as the exact location and depth of utilities under the existing elevated sidewalk and the extent of work required with respect to the existing crossing structures. These are not major concerns, but do increase the level of risk associated with Concept 2.

Hawthorne Avenue

Table 12 shows the technical evaluation of the Franklin Avenue alternatives.

Table 12. Evaluation Matrix – Hawthorne Avenue

Criterion	Concept 1: Straight Bridge and Approach Ramps	Concept 2: Switchback Ramps/Maintain 4.5% Slope	Concept 3: Stair and Elevator Bridge Access/No Ramps	Comments
Community Needs and Goals				
Alignment with community goals	●	●	◒	Concepts 1 and 2 best align with community goals by improving safety, security, and comfort for people walking, cycling, and rolling Concept 3 provides less improvement in meeting the goal of reducing user stress and increasing safety due to the elevators and the confined spaces.
Safety, security, and user comfort	●	◒	○	Concept 1 provides the highest level of improving both safety and comfort with the straight ramp and no blind spots on the crossing. Visibility is somewhat compromised on Concept 2 because of the switchbacks. Concept 3 is further compromised due to the confined space of the elevator and problems with cleanliness of outdoor public elevators.
Equitable outcomes	◒	◒	○	Concept 1 provides access for all users, although the average slope of 7.5% is more difficult for ADA users, particularly during winter conditions. Concept 2 provides comfortable access at 4.5% grade for ADA users, although there is a bit of a compromise for bikers to navigate the switchbacks and the extended distance that ADA users would have to travel compared to able-bodied users. Concept 3 provides access for all users, but it is compromised by the elevator and the potential for the elevator to be inoperable periodically. The elevator is favored by people with disabilities and ADA needs, while it acts as a deterrent to cyclists and ADA hand cyclist users.

Criterion	Concept 1: Straight Bridge and Approach Ramps	Concept 2: Switchback Ramps/Maintain 4.5% Slope	Concept 3: Stair and Elevator Bridge Access/No Ramps	Comments
Urban design	●	○	◒	All three concepts provide a significant improvement for a new crossing and would boost redevelopment potential. However, Concept 1 provides the best opportunity for a signature enhancement. The switchbacks in Concept 2 distract from the visual appeal of the bridge and provide additional covered space that may present safety concerns to nearby residents and sidewalk users. The corridor is identified as a key route in the TSP and completes a larger community vision to connect Juniper Park to Downtown with a ped/bike crossing, which all three alternatives would accomplish.
Public support	●	◒	○	Public outreach indicated greater support for Concept 1 (65% of respondents support). Concept 2 was next with 31% support, while Concept 3 only had 4% support.
Feasibility				
Design feasibility	◒	◒	●	Concept 3 requires a smaller footprint and ROW requirements and therefore has fewer design restrictions and/or issues.
Cost (2022 Dollars)	$20 M	$21 M	$19 M	There are only minor capital improvement cost differentials between the three concepts. The more significant cost impact is for the maintenance and cleaning requirements associated with the elevator in Concept 3. Concepts 1 and 2 would likely have more snow removal expenses.
Temporary construction impacts	◒	◒	●	Concept 3 has less impact due to the reduced structure footprint. Concepts 1 and 2 have comparable temporary construction impacts related to transportation and adjacent properties.
Environmental and cultural resource constraints	◒	◒	◒	Based on information available at this level of the study, all three alternatives are anticipated to have similar impacts from an environmental perspective.
ROW acquisition needs	●	◒	●	Concepts 1 and 3 require the same ROW acquisition. Concept 2 requires additional ROW to accommodate the switchbacks.
Maintenance requirements	●	◒	○	Concept 1 requires the least amount of maintenance due to the lack of switchbacks and elevator. Concept 3 requires the most maintenance due to the elevator.

Criterion	Concept 1: Straight Bridge and Approach Ramps	Concept 2: Switchback Ramps/Maintain 4.5% Slope	Concept 3: Stair and Elevator Bridge Access/No Ramps	Comments
Feasibility with respect to BNSF and ODOT facilities	●	●	●	All three concepts have a similar feasibility with regards to the BNSF and ODOT facilities.

M = million; ODOT = Oregon Department of Transportation; ROW = right-of-way

Discussion

- The Hawthorne crossing would require significant improvements on the east and west ends of the crossing including coordination with ODOT on modifications to the right-in/right-out onto US 97. Initially this crossing may not provide as relevant connections as the other two locations, as Greenwood and Franklin are already heavily used corridors..
- Concepts 1 and 2 performed better in the evaluation in terms of alignment with community needs and goals.
- Concepts 1 and 3 performed better in the evaluation in terms of feasibility criteria. Overall, Concept 1 performed best in the evaluation criteria.
- Concept 3 is a little less expensive than the other two, while Concept 1 is the next lowest.
- While Concepts 1 and 2 provide a more open crossing, they both require long approach ramps that extend into the Hawthorne right-of-way from Hill Street to the middle of NE 1st Street and NE 2nd Street, while the elevator and stairs for Concept 3 require a smaller footprint and are less imposing to the adjacent properties along Hawthorne.
- Concepts 1 and 2 provide a more equitable crossing for ADA users than Concept 3, due to the occasional closures required for maintenance and occasional power outages.
- Concept 3 performed poorly regarding equitable outcomes, public support and safety, security, and user comfort. The poor performance in these three evaluation criteria could be an indication that Concept 3 would see less use than the other concepts.
- With respect to feasibility, all three concepts are feasible, although Concepts 1 and 2 require more existing right-of-way due to the long approach ramps and larger footprints. The ramps affect access to the two lots, that front Hawthorne, at the corner of Hill Street. The following are two potential options for maintaining access to these lots, that have been identified as part of this feasibility study:
  - Provide a shared driveway off Hill Street between the proposed bridge and the homes.
  - For the second home from the corner, provide alley-type access from the south side, off the existing adjacent parking lot. The corner lot would utilize a driveway, off Hill Street, between the proposed bridge and the home.

  Further analysis, design and coordination with the property owners is required to determine the preferred option for modifying and maintaining access to these lots.

- With respect to public outreach, when online and in-person responses were combined, results indicated a clear preference for Concept 1. There were 121 responses to the question of which alternative design concept respondents preferred; combined participants preferred Concept 1 at 65 percent, followed by Concept 2 at 30 percent, and Concept 3 at 5 percent.

Franklin Avenue

Table 13 shows the technical evaluation of the Franklin Avenue alternatives.

Table 13. Evaluation Matrix – Franklin Avenue

Criterion	Concept 1: Widen and Level East Access – Plaza	Concept 2: Full Rebuild /Widen Undercrossing Opening	Comments
Community Needs and Goals			
Alignment with community goals	○	●	Concept 1 may not provide substantial benefits relative to community goals.
Safety, security, and user comfort	○	●	Concept 1 would still place cyclists on the roadway and would provide less headroom clearance. Concept 2 is a substantial improvement with a separated pedestrian and cyclist tunnel, thus improving safety, comfort, and security.
Equitable outcomes	◒	●	Concept 1 remedies grades that are a barrier to ADA users. Concept 2 is a substantial improvement for all users.
Urban design	○	●	Concept 1 is a modest change to existing conditions while Concept 2 provides a marquee-level investment and would better support economic development and urban design goals. Franklin Avenue is identified as a key walking/biking route in the TSP, and with two large mixed-use developments being considered, there is significant redevelopment potential.
Public support	○	●	Public outreach indicated greater support for Concept 2 (81% of respondents supported).
Feasibility			
Design feasibility	●	○	Concept 1 drainage design may affect feasibility, while Concept 2 is a substantial project with multiple design issues, including the replacement of both existing rail and highway overcrossing structures. Concept 1 could be completed concurrently with the required storm drainage improvements which are being funded separately.
Cost (2022 Dollars)	$7M	$47M	Costs are significantly higher for Concept 2.
Temporary construction impacts	●	○	Concept 2 requires more substantial impacts to rail lines and US 97.
Environmental and cultural resource constraints	●	○	The existing rail bridge is an old traditional structure with classic architectural features. Concept 2 would potentially remove this structure, thus presenting potential permitting issues with respect to historic resources.
ROW acquisition needs	●	TBD	Concept 1 would be accomplished within existing ROW. Concept 2 on the east side of railroad structure may require ROW acquisition.

Criterion	Concept 1: Widen and Level East Access – Plaza	Concept 2: Full Rebuild /Widen Undercrossing Opening	Comments
Maintenance requirements	◒	●	Concept 1 retains the existing, older structure and would require more maintenance. Concept 2 would remove and replace all structures, thus resulting in lower long-term maintenance costs.
Feasibility with respect to BNSF and ODOT facilities	●	○	Significantly more coordination would be required for Concept 2; Concept 1 would require less coordination.

M = million; ODOT = Oregon Department of Transportation; ROW = right-of-way

Discussion

- Concept 1 overall provides minimal benefit relative to the estimated cost. While access for people with disabilities and sightlines improves to increase safety and personal security within the existing tunnels, Concept 1 does not provide a substantial benefit with respect to the identified issues and needs.
- Concept 1 is much lower cost and presents fewer feasibility concerns compared to Concept 2. Concept 1 avoids major impacts to the existing structures and involves less construction disruption to the community and rail/highway traffic compared to Concept 2. Concept 2 costs substantially more due to the greater scope and scale of the project.
- Concept 2 scored highest on the Alignment with Community Goals and Needs criteria, but not as strongly with respect to the Feasibility criteria. Concept 2 completely replaces the existing crossing to create a modern, comfortable, up-to-standard facility that would increase user safety, comfort, and personal security.
- Concept 2 presents more substantial feasibility issues. Replacing both the rail and highway crossing structures would create major, though temporary, impacts during construction. The exact plan for decommissioning each structure would require close coordination with BNSF and ODOT to determine what is acceptable.
- Concept 1 provides minimal benefits over existing conditions. However, investing in Concept 1 improvements may not be the best use of funding as a standalone project, but would still provide some utility and could be considered by the City as a component of a larger corridor wide and storm drainage improvement project. Concept 1 could provide benefit as an early, standalone phase of a larger concept.

4. RECOMMENDATIONS

The following recommendations are based on the results of the scoring for each design concept. These recommendations do not heavily consider available budgets or corridor-wide improvements, but instead focus on alignment with community goals and feasibility of construction (as identified through the evaluation criteria). Availability of funding and stakeholder and public input will ultimately weigh into the final selection of concepts for each location. As part of the decision-making process, the Transportation Bond Oversight Committee, Core Area Advisory Board, and City staff will provide recommendations to City Council. City Council will then decide on the concepts that will move forward to construction.

4.1 Greenwood Avenue

The project team recommends *Greenwood Avenue Concept 2: Lower and Widen Sidewalks* as the preferred alternative (see Figure 40 and Figure 41). This concept better reflects community goals of improving both safety and comfort of this crossing location. Concept 2 would significantly improve the experience for people walking and using bicycles due to safer, more visible, and more accessible grade-separated sidewalks, while Concept 1 would not substantially improve the existing pedestrian tunnel, and the at-grade shared path may still not be comfortable for some users due to proximity to traffic. Concept 2 would implement a more robust facility that could better support economic development goals.

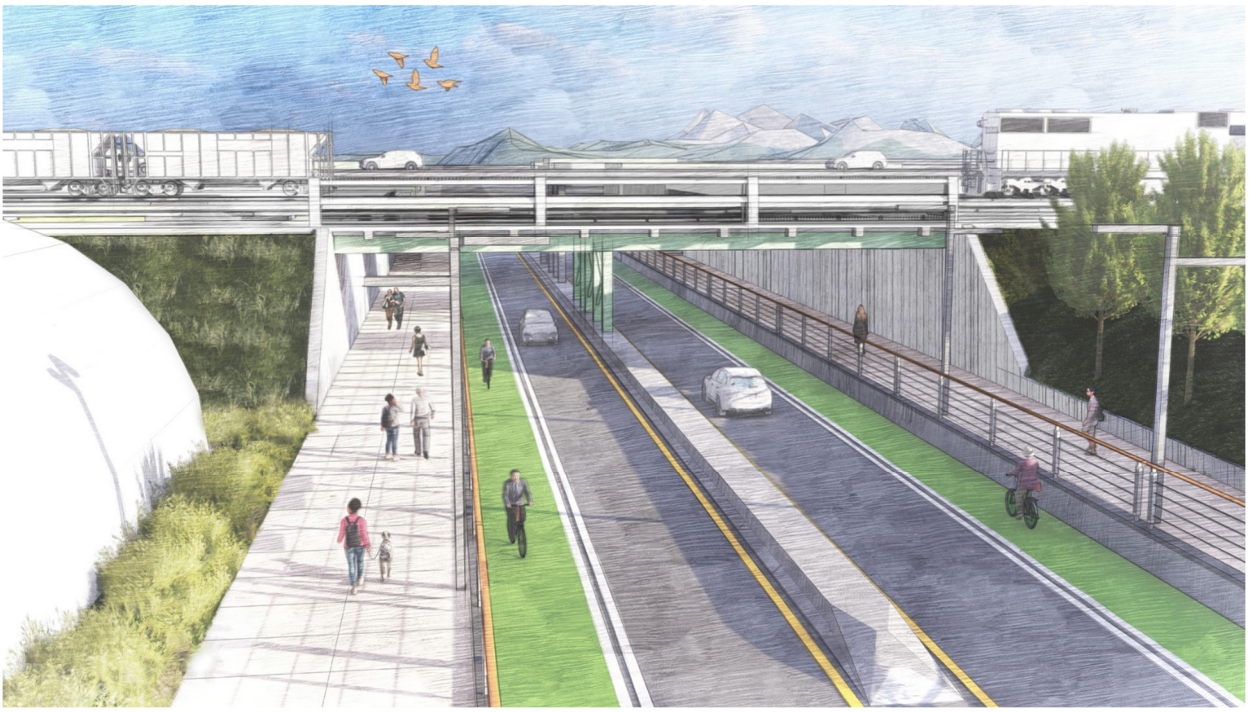

Figure 40. Preferred Greenwood Avenue Concept (Concept 2)
Lower and Widen Sidewalks / Three-Lane Configuration (east and west of undercrossing)

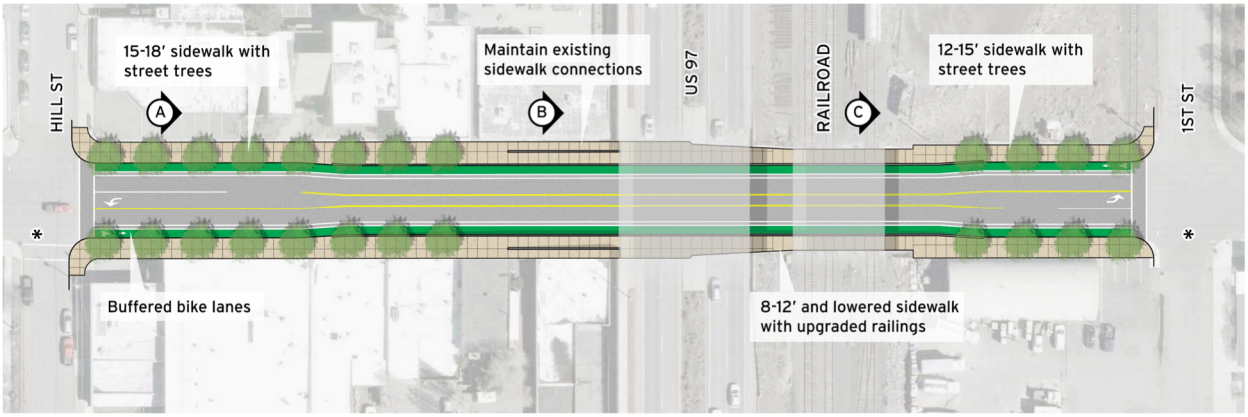

Figure 41. Preferred Greenwood Avenue Concept (Concept 2): Plan View

4.2 Hawthorne Avenue

The project team recommends *Hawthorne Avenue Concept 1: Straight Bridge and Approach Ramps* as the preferred alternative (see Figure 42 through Figure 44). This concept better reflects the community needs and goals while having a slight edge in the overall feasibility criteria. Concept 1 significantly improves the experience for pedestrians and bicyclists with a single, direct pathway across the bridge. Since the concept does not include angles or corners, visibility and safety are significantly improved. The structure type for Concept 1 (Sisters) forms three primary spans evocative of the Three Sisters and creates a signature bridge design unique to Bend, Oregon. The signature bridge design, in addition to providing another connecting corridor, will be key to addressing the urban design goals and spurring economic development. In addition to the public being in support of a new Hawthorne crossing, they also favored Concept 1 (65 percent of respondents were in support).

Figure 42. Preferred Hawthorne Avenue Concept (Concept 1): Straight Bridge and Approach Ramp

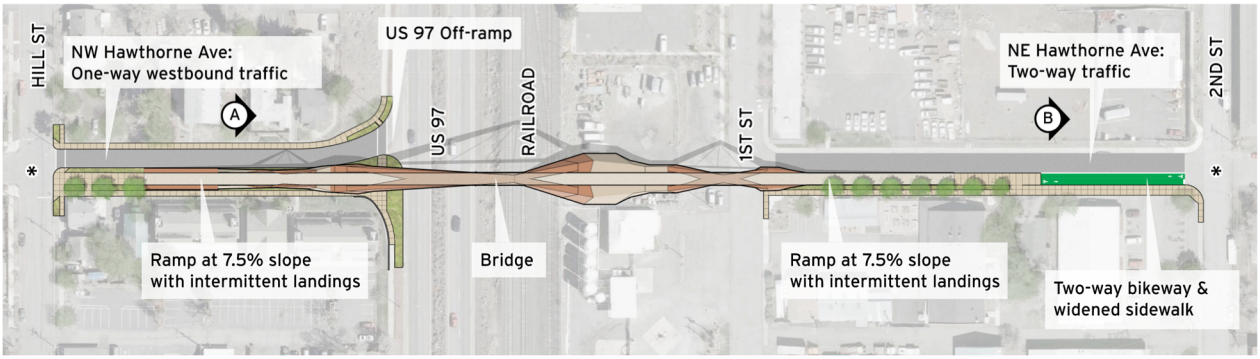

Figure 43. Preferred Hawthorne Avenue Concept (Concept 1): Plan View

Figure 44. Preferred Hawthorne Avenue Concept (Concept 1): Elevation View (Southbound on US 97)

4.3 Franklin Avenue

The *Franklin Avenue Concept 2: Full Rebuild/Widen Undercrossing Opening* ultimately scored highest based on the evaluation criteria, particularly in terms of alignment with community needs and goals. This concept improves almost all safety, mobility, and comfort issues for the undercrossing including improving visibility and widening space for people walking and bicycling (see Figure 45 and Figure 46). Concept 2 accomplishes this by providing separate, dedicated facilities for each mode of transportation (people driving, walking, and riding bicycles). With respect to urban design goals and economic development, Concept 2 provides a marquee-level investment and significantly improved design. Additionally, public outreach indicates a clear preference for Concept 2 (81 percent of respondents were in support). However, the significant cost and impacts during construction make this concept an unlikely option for the near term.

Although Concept 1 would provide minimal benefits over existing conditions, the City should consider these improvements in conjunction with the City's planned storm drainage and corridor improvements to improve safety on the east-west connections.

Figure 45. Preferred Franklin Avenue Concept (Concept 1)
Widen and Level East Access – Plaza

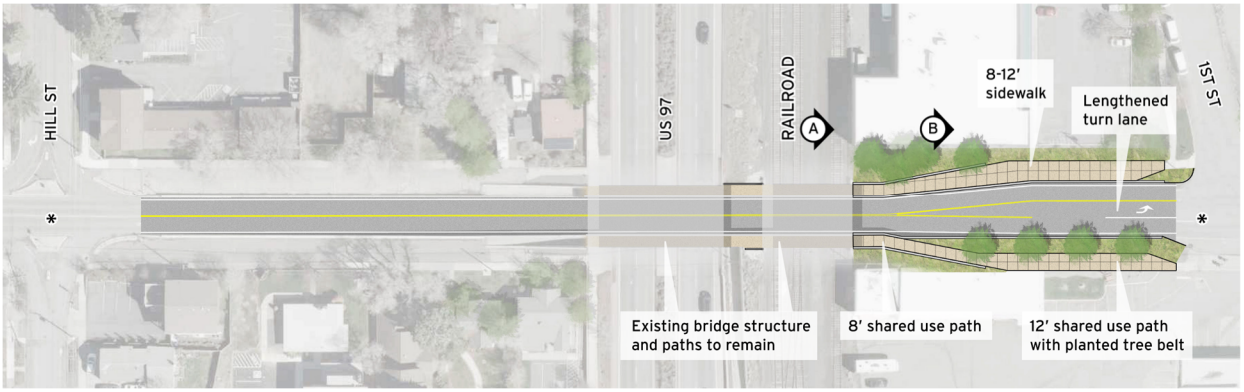

Figure 46. Preferred Franklin Avenue Concept (Concept 1): Widen and Level East Access – Plaza

For full concept details and cost estimates, see Appendix C, Designs, and Appendix D, Cost Estimates

5. NEXT STEPS

The recommendations in this report will be reviewed by the Transportation GO Bond Committee, City Council, Core Area Advisory Board, and City staff. Ultimately, available funding, stakeholder support and interest, and the results of this feasibility study will be considered in the final decisions to advance improvements at one or more crossing locations.

This report presents initial design concepts, cost estimates, and considerations for crossing improvements at Franklin Avenue, Hawthorne Avenue, and Greenwood Avenue. There are inherent limitations to the findings contained in this study due to the very preliminary level of design, cost estimating, and limited data on each site. Once preferred crossing improvements are chosen, future work is required to confirm the overall approach to the design of crossing improvements at each location, confirm costs, and confirm the likely impacts and permitting requirements.

Greenwood Concept 2 – Design considerations to address in next phase:

- Review options for a physical separation between bike lanes and vehicles that provide acceptable clearance for emergency service vehicles.
- Stormwater design (pump station, property acquisition)
- Corridor improvements and connectivity
- Utility exploration/relocation (i.e., reroute existing sewer, water, service connections)
- Impact to existing railroad bridge foundation during construction

Hawthorne Concept 1 – Design considerations to address in next phase:

- Access to driveways for lots on the southeast corner of Hill Street and Hawthorne
- Closure of southbound access to US 97
- Assess impacts to southbound off-ramp from US 97
- Assess impacts to adjacent intersections
- Corridor improvements
- Water line relocation on Hawthorne west of US 97
- Easement or property acquisition for parcel east of the railroad

Franklin Concept 1 – Design considerations to address in next phase:

- Stormwater design (pump station, property acquisition)
- Corridor improvements
- Ramps/connection to US 97 path
- Access to properties on west side of structure
- Proposed development on east side of structures

Appendix A

Fatal Flaw Memorandum

Appendix B

Outreach Summary

Appendix C

Designs

Appendix D

Cost Estimates

Appendix E

Geotechnical Report

Appendix F

Traffic Analysis