GREAT PLACES SW Corridor
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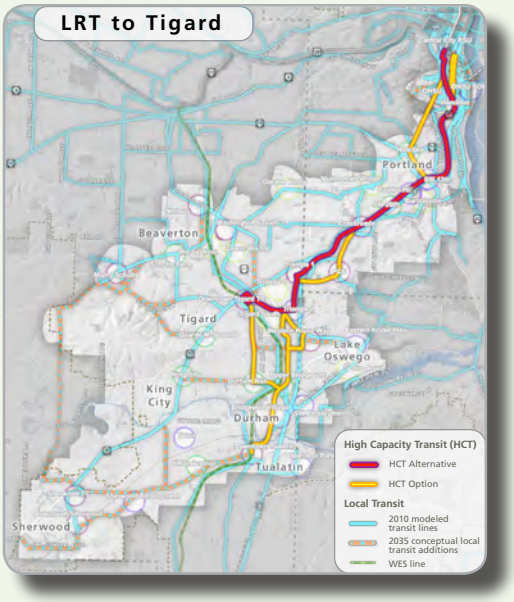
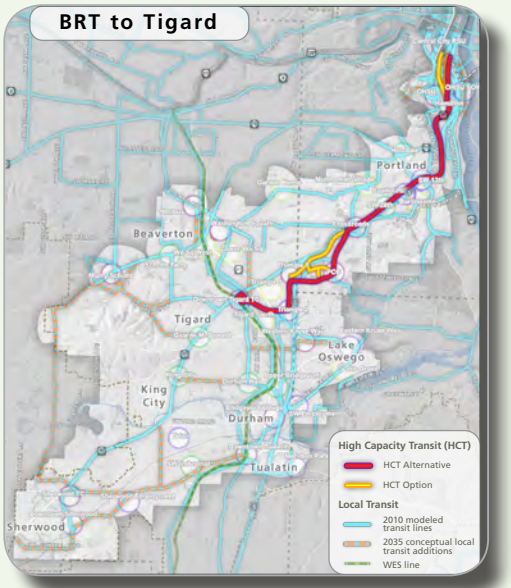
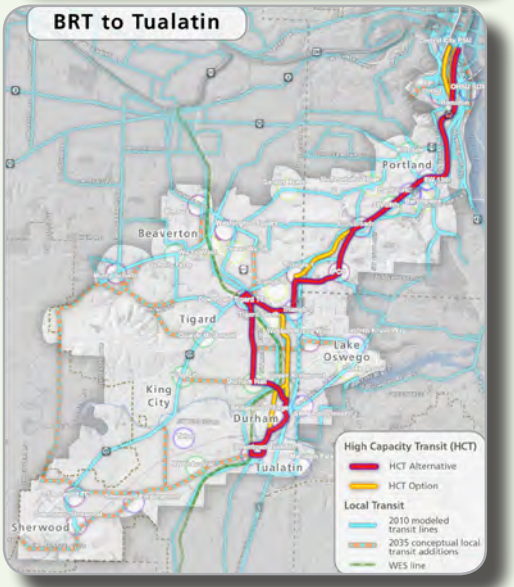
Evaluation Report: High Capacity Transit

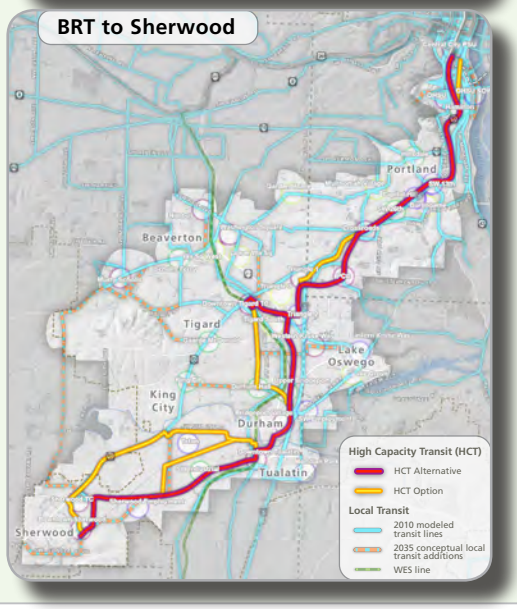
SW Corridor Plan High Capacity Transit Plan Alternatives for Evaluation

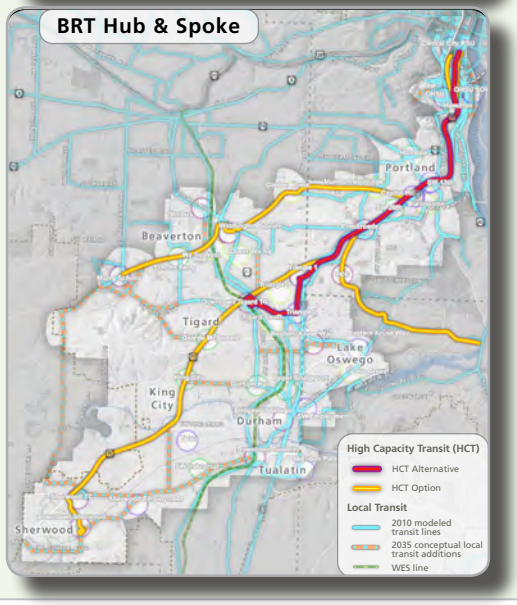
The alternatives shown in red were analyzed using the regional travel demand model. Potential impacts are analyzed at a conceptual level. Elements of each, as well as options, which are shown in yellow, would be available to mix and match to define alternatives to be studied further.











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Introduction

Purpose

The purpose of the Southwest Corridor Plan evaluation process is to assist in narrowing alternatives and defining what to continue studying to allow future definition of a preferred investment strategy for the corridor. The purpose of this report is to document the analysis of the initial set of High Capacity Transit (HCT) alignment and mode options for the Southwest Corridor Transportation Plan to support decisions about what alternatives and options to continue studying during an upcoming refinement phase of the Southwest Corridor. Modes evaluated included light rail (LRT) and a range of bus rapid transit (BRT) alternatives. The decisions to be made during this phase are:

- Destination (terminus)
- Mode or modes to carry forward for additional refinement for project development
- Level of investment for BRT performance

This report focuses on the evaluation of HCT projects. The next stage of the study and analysis will provide more details on this narrowed set of alternative and options to support future decision-making about what, if any alternative to consider for further development and eventual construction.

This report also touches on the crucial issue of transit service throughout the corridor, making connections between communities in the southwest and surrounding communities as well as connecting to HCT and existing WES. A follow-on effort will engage the public, cities, counties, businesses, neighborhoods, social service providers, and other stakeholders to define the vision for substantial increases in transit service throughout the area.

Companion evaluation reports focus on:

- Roadway projects and motor vehicle mobility
- Active transportation projects and impacts to the active transportation system

Methodology

Evaluation framework

The analysis in this report is derived from the vision, goals and objectives adopted by the SW Corridor Plan Steering Committee (Steering Committee) and focuses on the following goals and objectives:

Goal: Accountability and partnership – Manage resources responsibly, foster collaborative investments, implement strategies effectively and fairly, and reflect community support.

Objectives:

- Build upon existing plans, private development and investments in public infrastructure
- Make investments that maximize limited resources
- Equitably distribute the benefits and burdens of growth geographically and demographically

Measures used to evaluate the accountability and partnership goal and objectives include:

- Cost
- Residential and business property impacts

Goal: Access and mobility – People have a safe, efficient and reliable network that enhances economic vitality and quality of life.

Objectives:

- Improve access to places where people live, work, play and learn
- Improve access, mobility and safety for all transportation modes, ages and physical abilities
- Improve the freight transportation system to ensure that the region and its businesses stay economically competitive

Introduction

Measures used to evaluate the access and mobility goal and objectives include:

- Ridership
- Travel time
- Transit operating costs
- Operating efficiency
- Capital costs
- Households and employment within 1/2 mile of potential high capacity transit stations

High Capacity Transit Alternatives

The Steering Committee approved five project "bundles"—each of which included an HCT mode, alignment and alignment options—to evaluate as a step toward identifying an investment strategy. Each bundle also included a set of roadway and active transportation projects.

These "bundles" are representative of a wide array of options, from which the Steering Committee can mix-and-match to define alternatives for future continued analysis. Each HCT alternative was evaluated on one representative baseline alignment. Alignment options were identified, but were not included in modeling. The modeling process is described below. Alignments and options are described on the following pages.

Modeling

The assumptions for lane characteristics and general station locations were developed for each baseline alignment. A range of lane treatments and routing options were ascribed to the alternatives in order to provide a breadth of information to inform decisions on what to carry forward.

Key inputs included:

- The regionally adopted land use for the four-county area;
- Data from Metro's Household and Travel Behavior Study, which incorporates travelers' propensities to make certain types and lengths of trips;
- The 2035 Financially Constrained Regional Transportation Plan the roadway network;
- Specific road characteristics such as number of lanes, capacity, and speed limits;
- The 2035 Financially Constrained Regional Transportation Plan transit network with modifications representing initial concepts of TriMet's Service Enhancement Plan;
- Each alternative's HCT project and service, including any local service adjustments identified by TriMet, specifying mode, general stop locations, speeds, and interaction with traffic

Key outputs include:

- Transit travel times
- Transit ridership by line and by stop/station
- System transit trips
- Mode share
- Vehicle miles traveled and vehicle hours traveled by mode.

Capital cost analysis

Given that the region has decades of experience with LRT, but none with BRT, establishing a cost magnitude range for LRT is more certain. The service provided by LRT, especially since it is within an existing system is well understood, while the range of service that can be provided by BRT is quite broad. Defining the type and amount of service within that range is necessary to produce meaningful costs. Having reliable costs for LRT but not BRT makes reliable comparisons difficult. Therefore, costs for both modes should be considered preliminary and only for the purposes of magnitudes for comparison, not actual budgets for any alternative.

Cost magnitudes were developed for some alignment options, again, as representative information to help decide among broad distinctions in alternatives. More refined decisions in the future will be based on more detailed information to be develop in the next phase of the study based on the Steering Committee's direction.

Introduction

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Description of Alternatives Modeled: LRT to Tigard

The Light Rail alternative (figure 1) was evaluated with the following initial assumptions:

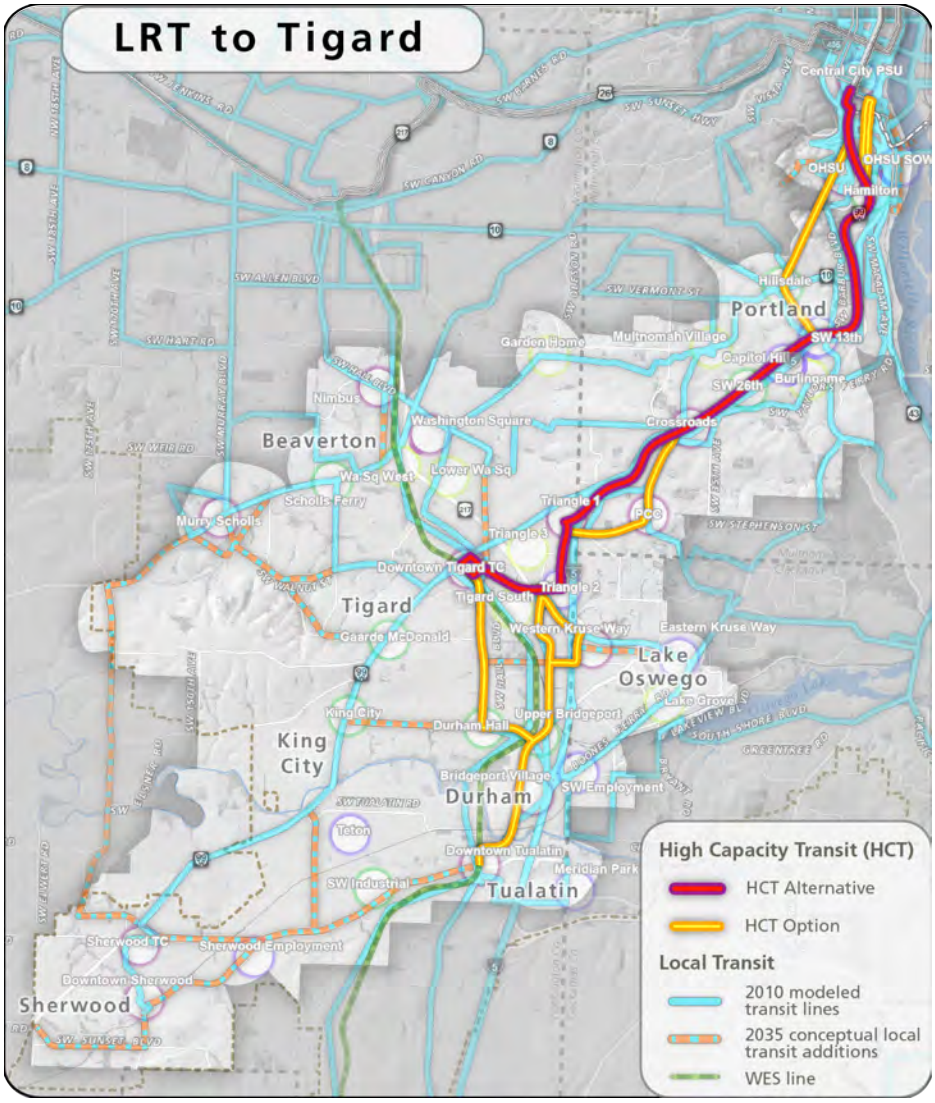
- Exclusive transit right of way
- A representative assumption of a combination of converting lanes for approximately 40 percent of the alignment and adding lanes for the remaining 60 percent
- An alignment on Naito south of downtown Portland
- Alignment on Barbur that would require a walk less than 1/3 mile to the edge of the PCC campus.

Alignment options include:

- An alignment on Barbur or a tunnel under Oregon Health & Science University (OHSU) south of downtown Portland
- Direct access to Portland Community College (PCC)
- Extension to Tualatin with alignment options on SW Hall or SW 72nd.

Each of these options could have sub-options with detailed routing to be determined in future stages.

Figure 1.



Description of Alternatives Modeled: BRT to Tigard

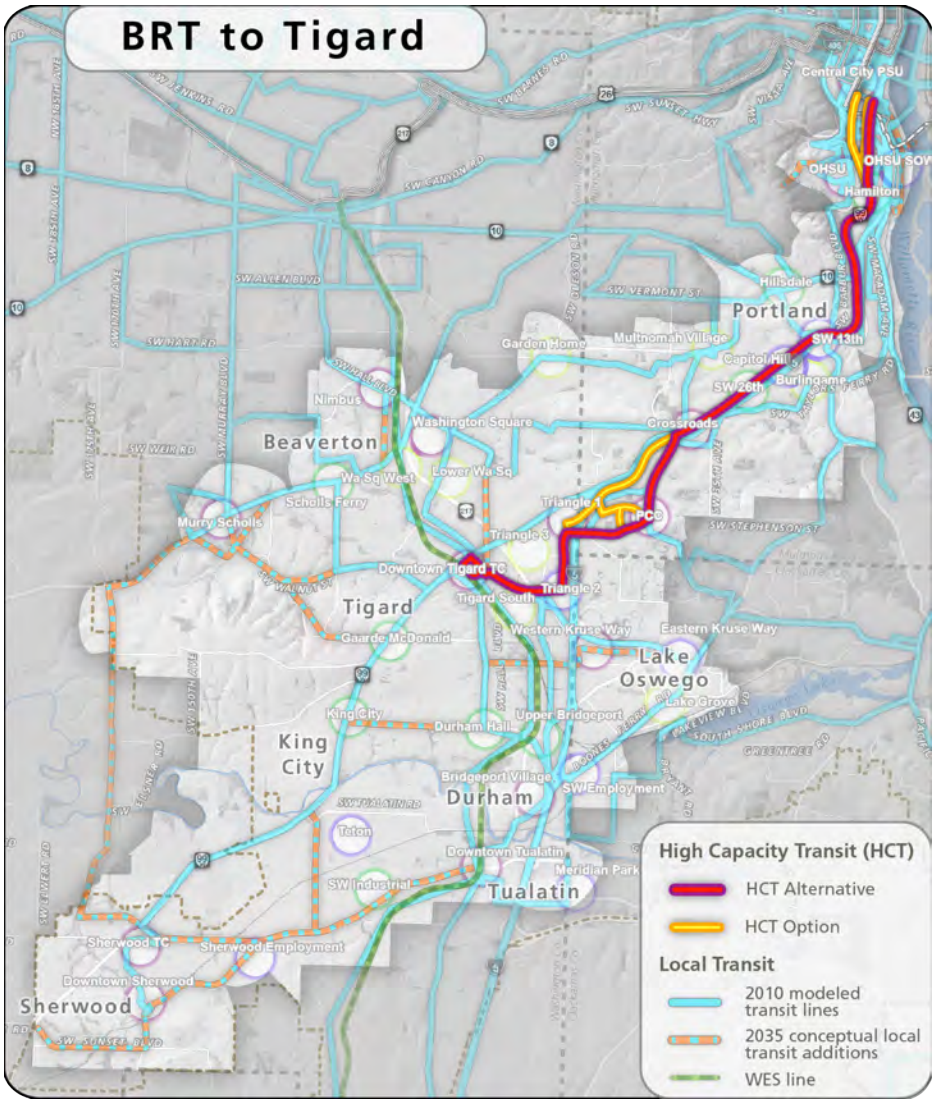
The BRT to Tigard alignment (figure 2) was evaluated with the following initial assumptions:

- Exclusive transit right of way
- An added transitway for the entire length that assumed no impact on motor vehicle travel lanes
- An alignment on Naito south of downtown Portland
- Access to PCC with a new connection that skirts the edge of the PCC campus.

Alignment options include:

- An alignment on Barbur south of downtown Portland
- Alignment on Barbur that would require a walk less than 1/3 mile to the edge of the PCC campus.

Figure 2.



Description of Alternatives Modeled: BRT to Tualatin

The BRT to Tualatin alignment (figure 3) was evaluated assuming a mix of lane configurations. The numbered list below corresponds to the segments shown in figure 4 and describes the initial assumptions made in each segment:

1. Mixed traffic southbound; convert lane to business access and transit (BAT) lanes northbound. BAT lanes allow motor vehicles to make right turns to businesses and intersecting streets, but not travel continuously in that lane.
2. BAT lanes southbound; mixed traffic northbound
3. Access to PCC with a new connection that skirts the edge of the PCC campus.

Figure 4. BRT to Tualatin segments

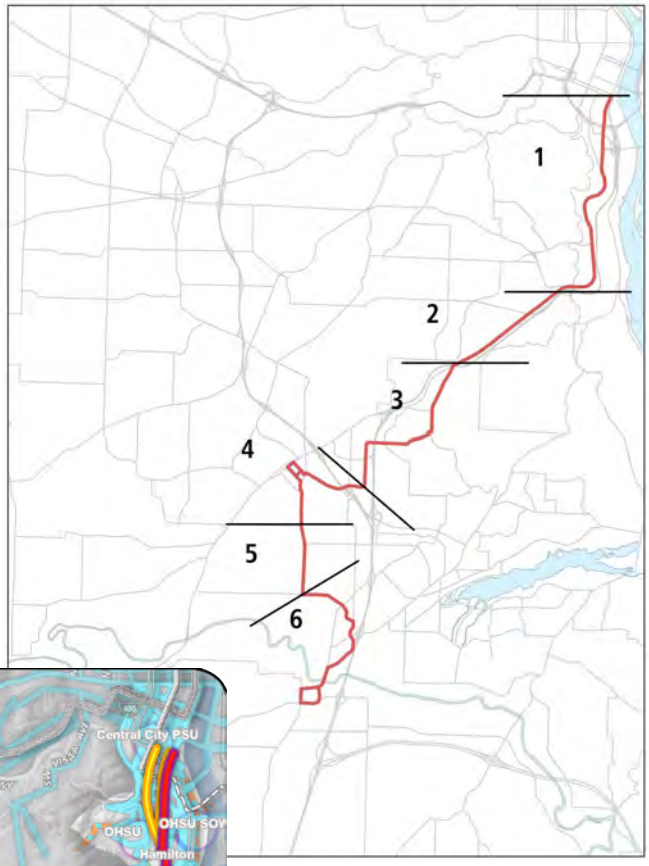
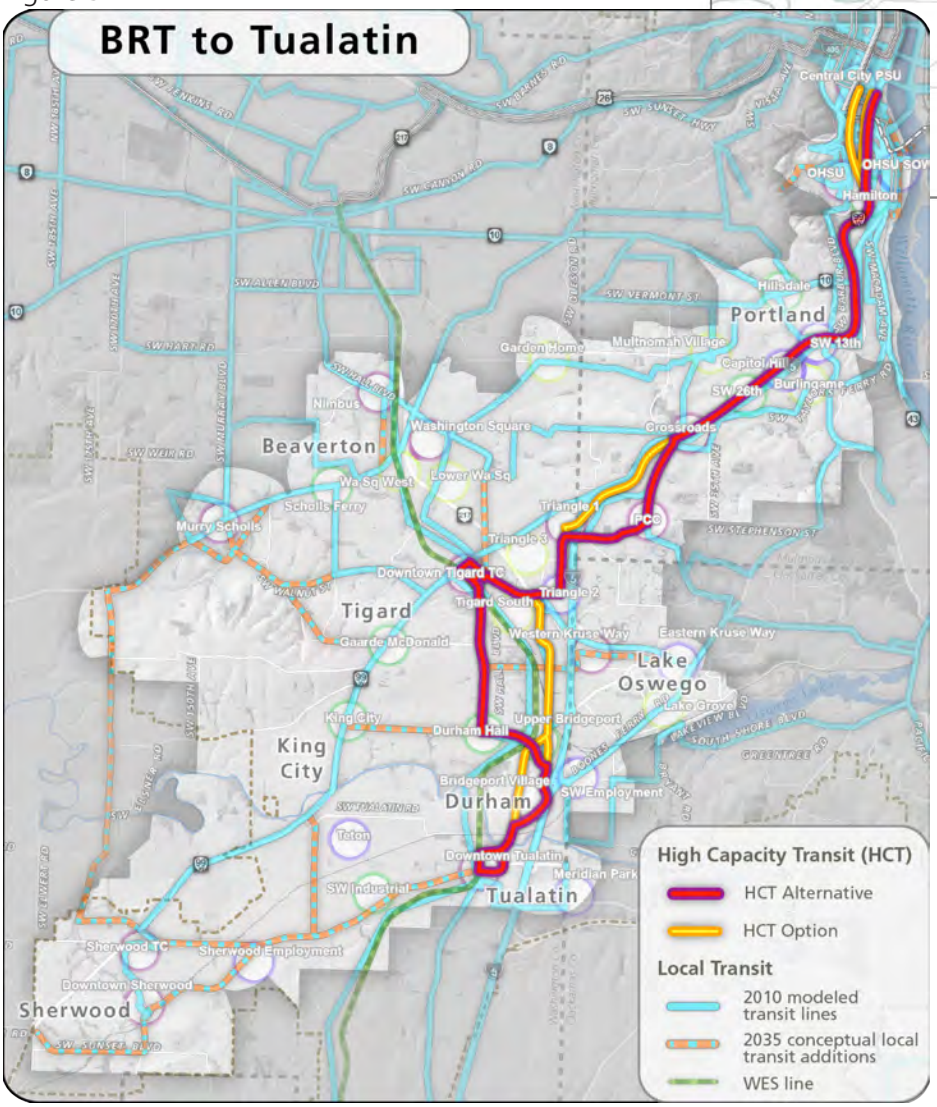


Figure 3.



4. Exclusive transit lanes on Hall Blvd. southbound; mixed traffic northbound
5. Exclusive right of way both directions
6. Mixed traffic

Alignment options include:

- An alignment on Barbur south of downtown Portland
- Alignment on Barbur that would require a walk less than 1/3 mile to the edge of the PCC campus
- Alignment on 72nd between Tigard and Tualatin.

Description of Alternatives Modeled: BRT to Sherwood

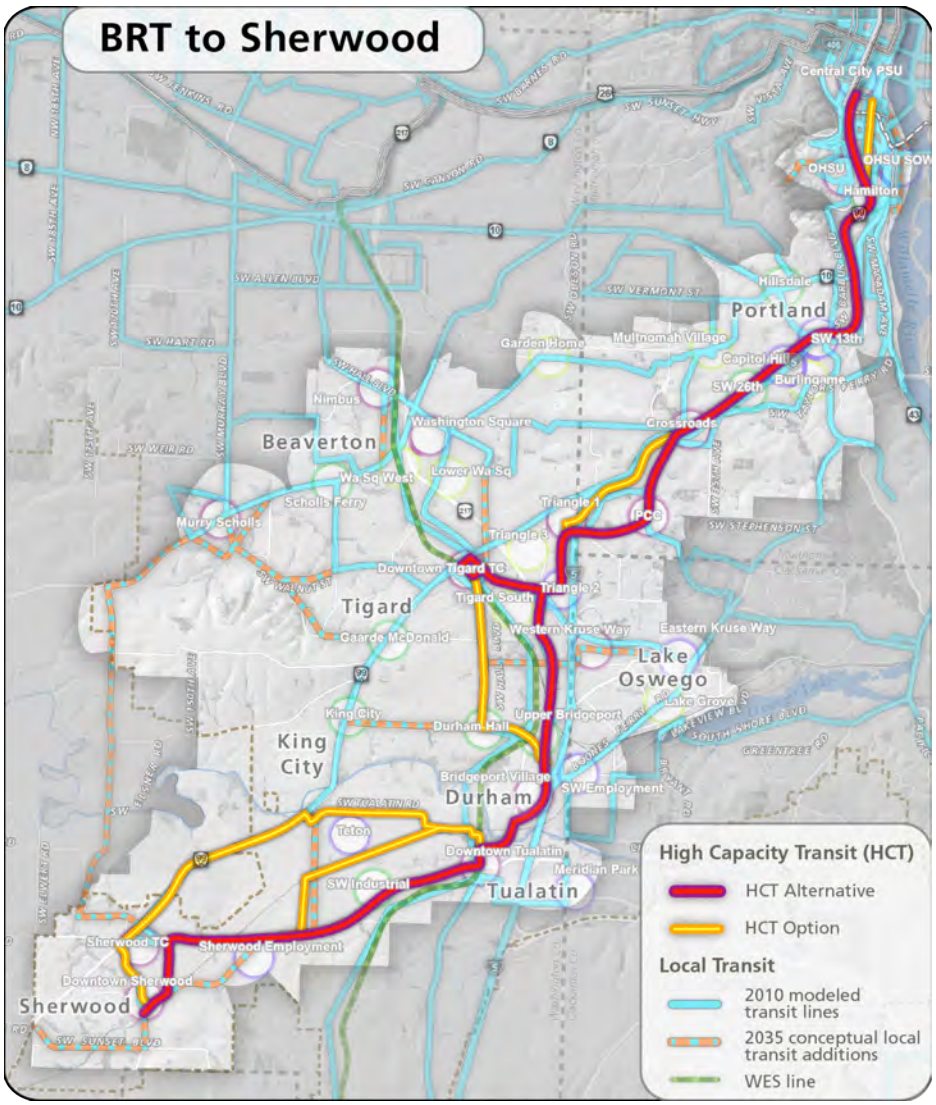
BRT to Sherwood (figure 5) was evaluated with the following initial assumptions:

- Service primarily in mixed traffic
- Targeted queue bypass lanes
- An alignment on Barbur south of downtown Portland
- Access to PCC with a new connection that skirts the edge of the PCC campus
- Alignment on Tualatin-Sherwood Road between Tualatin and Sherwood.

Alignment options include:

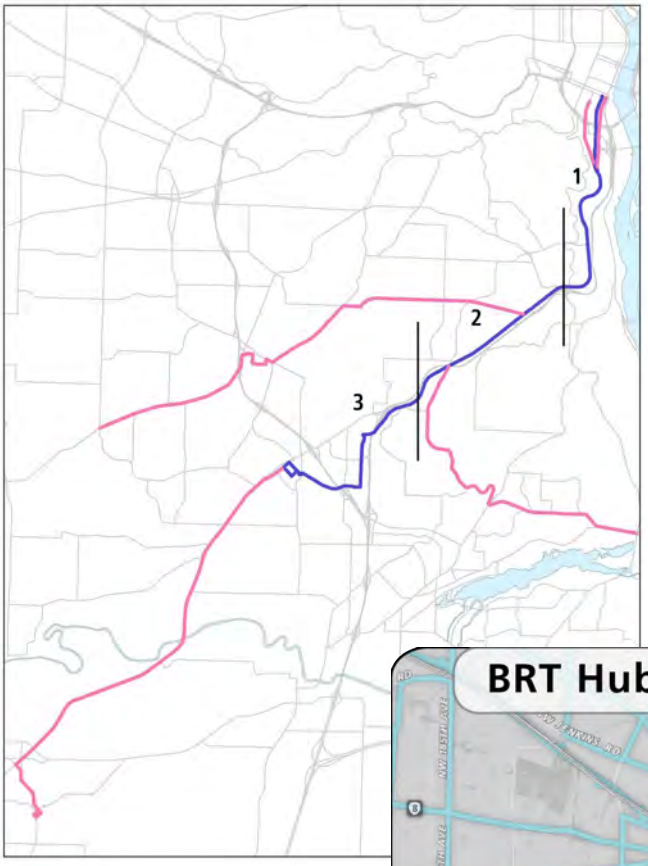
- An alignment on Naito south of downtown Portland
- Alignment on Barbur that would require a walk less than 1/3 mile to the edge of the PCC campus
- Alignment on Hall Blvd. between Tigard and Tualatin
- Alignment on Tualatin and Hwy 99 between Tualatin and Sherwood
- Alignment on Herman Road and 124th between Tualatin and Sherwood.

Figure 5.



Description of Alternatives Modeled: BRT Hub & Spoke

Figure 6. BRT Hub & spoke segments

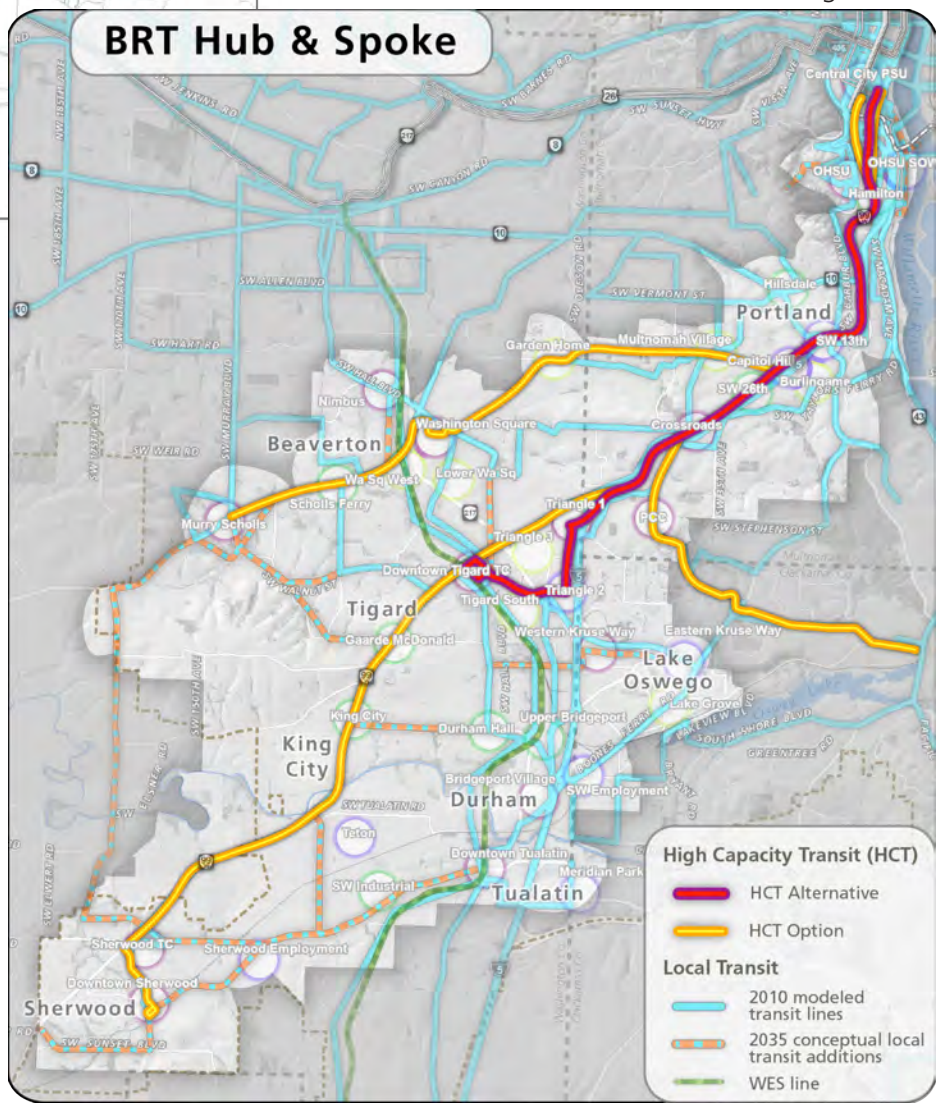


The BRT Hub & Spoke alternative (figure 7) was evaluated with a representative assumption of a combination of lane configurations. BRT would travel between Portland and Tigard. Local buses using the spoke segments would also use the mainline alignment and benefit from those BRT improvements. The numbered list below corresponds to the segments shown in figure 6.

1. Mixed traffic
2. BAT lanes southbound; mixed traffic northbound
3. Mixed traffic, with exclusive transitway on new structure over I-5 between Crossroads area and the Tigard Triangle

There is an alignment option on Barbur south of downtown Portland.

Figure 7.



Mode: Comparison of Light Rail and Bus Rapid Transit

Figure 8.

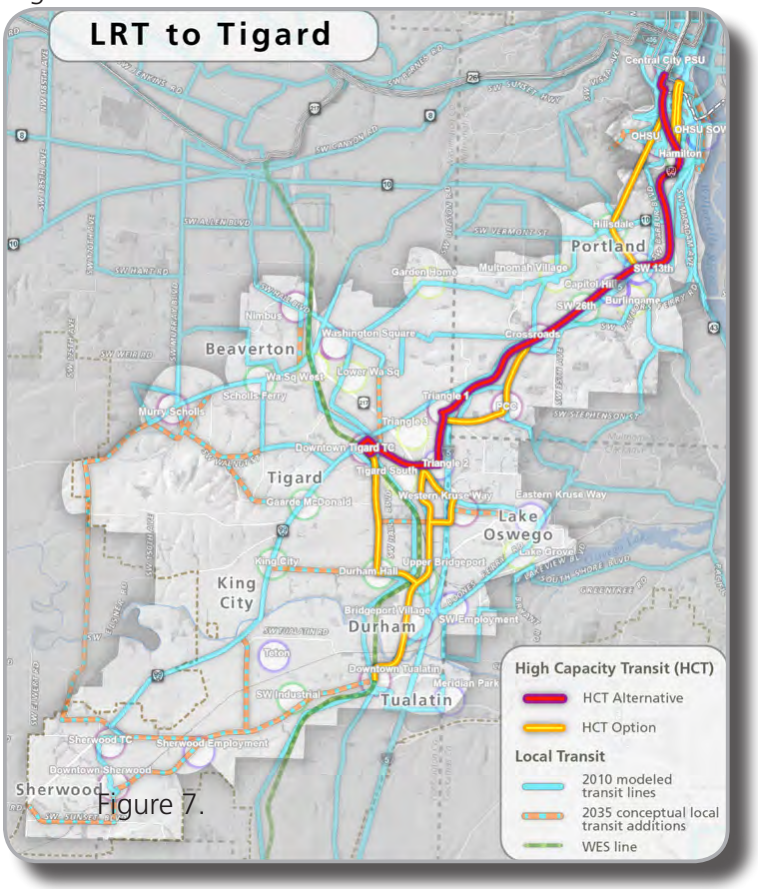
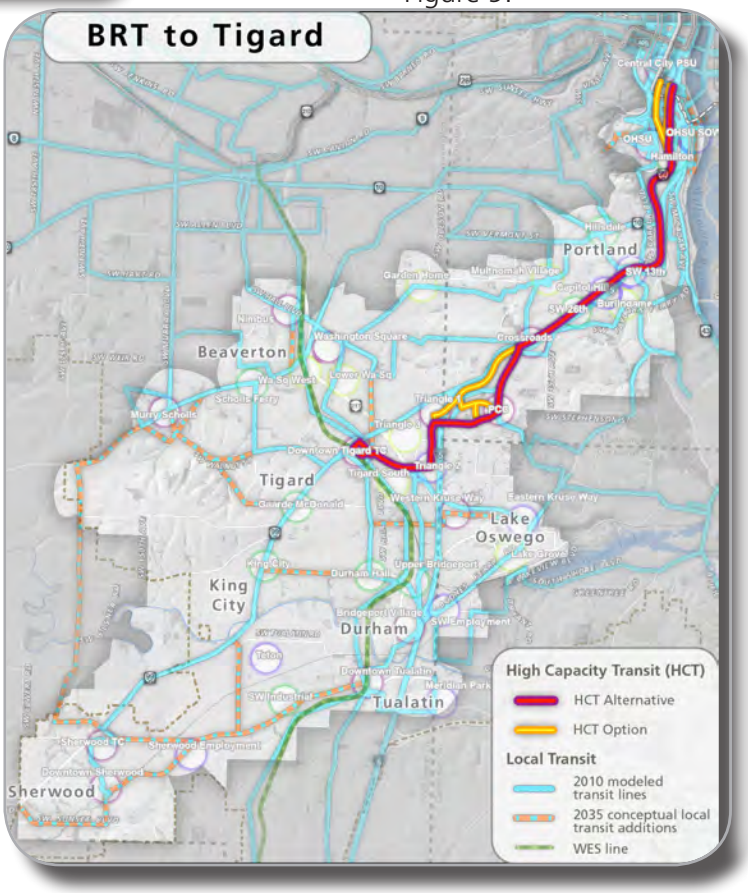


Figure 7.

Figure 9.



Mode: Comparison of Light Rail and Bus Rapid Transit

The two modes under consideration are light rail transit (LRT) and bus rapid transit (BRT), with BRT having a range of options in terms of exclusivity of transit lanes and intersection treatments. Of the BRT alternatives, the BRT to Tigard is the most comparable to the LRT alternative analyzed, as both would terminate in Tigard. See figures 8 and 9.

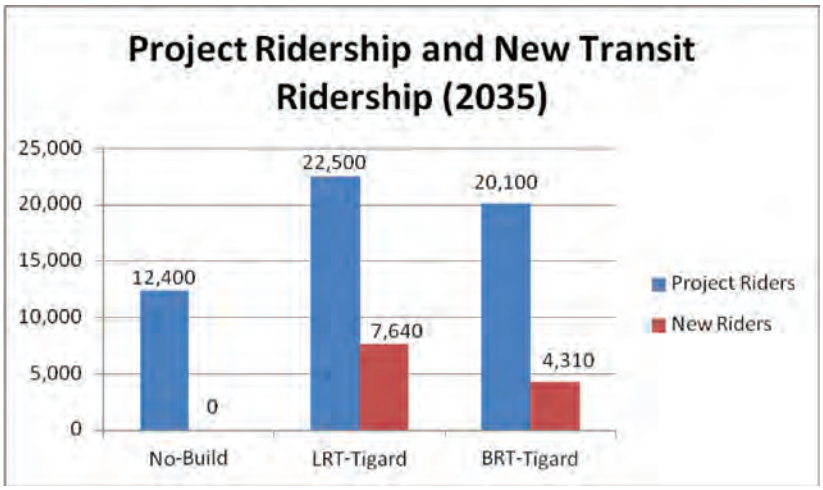
Ridership

Project ridership counts the number of riders on the HCT line in the Southwest Corridor in 2035 on an average weekday. In the No-Build, this measure includes riders on bus lines 12 and 94 between Portland and Tigard, in the two HCT alternatives it includes riders on the HCT lines only. New transit ridership measures the change in average weekday system transit ridership compared to the No-Build resulting from implementation of the project.

LRT to Tigard would have 22,500 average weekday project riders, and the BRT to Tigard would have 20,100 riders, compared to 12,400 for the No-Build (figure 10). LRT to Tigard would attract 7,640 new riders to transit while BRT to Tigard would attract 4,300 new riders to transit on an average weekday.

LRT to Tigard and BRT to Tigard were modeled with different routing assumed in the PCC area, which accounts for some variances in ridership. The BRT was routed to serve the PCC campus directly via Capitol Highway and SW 49th Avenue, while LRT was routed on Barbur Boulevard below the campus. The LRT alignment includes a station within less than a 1/3 mile walk from the edge of the campus. Routing via Capitol Highway/SW 49th Avenue would result in nearly 2,400 more riders than routing on Barbur, with 6,370 average weekday riders using the two BRT stations compared to 4,010 daily riders at the single LRT station on Barbur. However, most of the additional riders for BRT used the line 44 in the No-Build alternative, which served PCC (in the No-Build and in the LRT alternative) but was rerouted in the BRT alternative to avoid duplicating BRT service. With different assumptions in HCT or local service routing, the BRT and LRT ridership would be similar in this section.

Figure 10



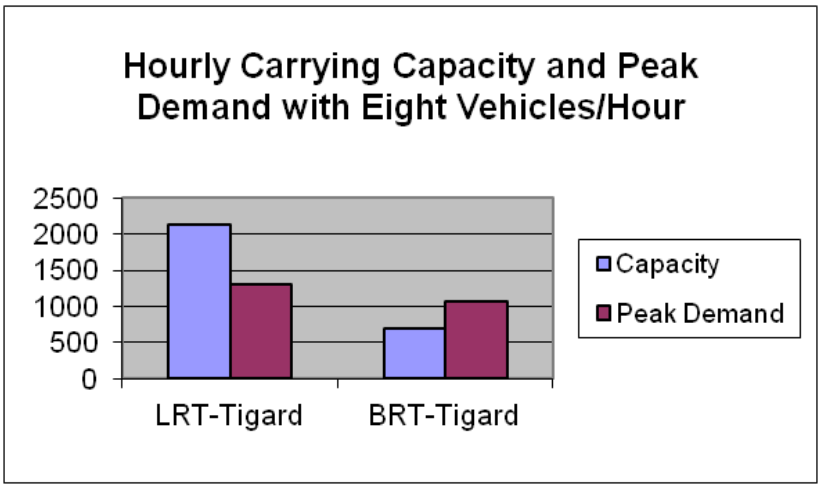
Mode: Comparison of Light Rail and Bus Rapid Transit

Service Levels

All HCT alternatives were modeled for the peak demand hours assuming 7.5 minute headways (8 vehicles per hour). For BRT to Tigard, however, those service frequencies would not be sufficient to accommodate the peak load point (the highest ridership location during the peak hour in the peak direction). Though peak loads under the LRT alternative would be higher than those for the BRT alternative, LRT would be able to accommodate the demand because of the greater passenger carrying capacity of LRT vehicles (266 for LRT compared to 87 for BRT). See figure 11.

In order to accommodate the peak demand, service frequencies for BRT to Tigard would need to increase to 13 vehicles per hour (4.6 minute headways) assuming the BRT were served with 60-foot articulated vehicles. See figure 12.

Figure 11.



Change in Annual Corridor Operating Costs

Annual corridor operating costs are based on the vehicle hours traveled for all transit service in the corridor. Vehicle hours depend on the length of each transit route and the number of vehicles in operation. Costs for the trunk corridor routes (the 12 and 94 in the No-Build, HCT lines in the build alternatives) are based on having buses in operation to accommodate the peak demand for each line. The annual operating costs of the LRT alternative would be $4.9M more than the No-Build, and the annual operating costs of the BRT would be $6.3M more than the No-Build in 2035 (figure 13). Annual operating costs for LRT would be lower than those for BRT because although a single LRT vehicle costs more per hour to operate than a single BRT vehicle, fewer vehicles and operators would be required to accommodate the peak demand.

Also, since LRT would interline with existing LRT service it would, in effect, serve as an extension of an existing line. Therefore, there would be no additional operating costs on the downtown Portland transit mall section of the route. However, since BRT would be a new mode and could not interline with other service, additional operating costs would accrue for BRT on the transit mall.

Figure 12.

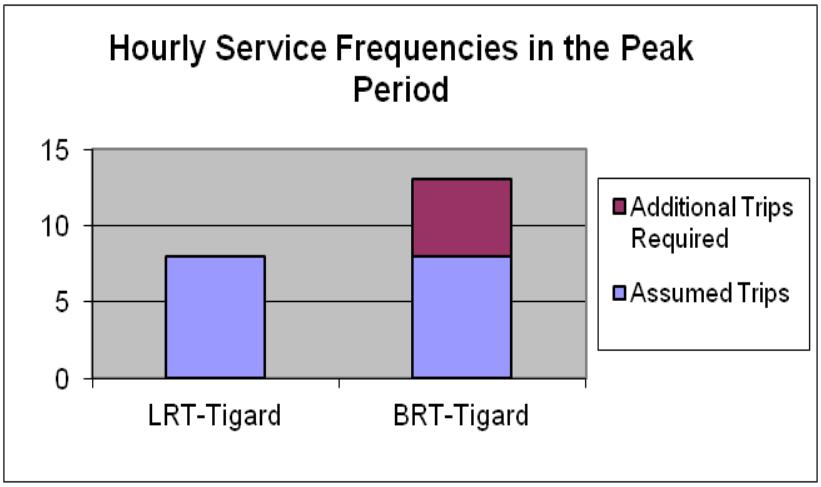
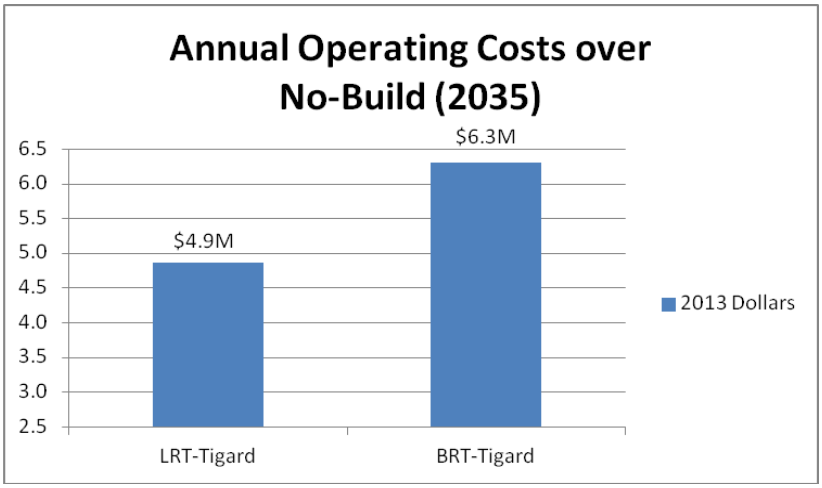


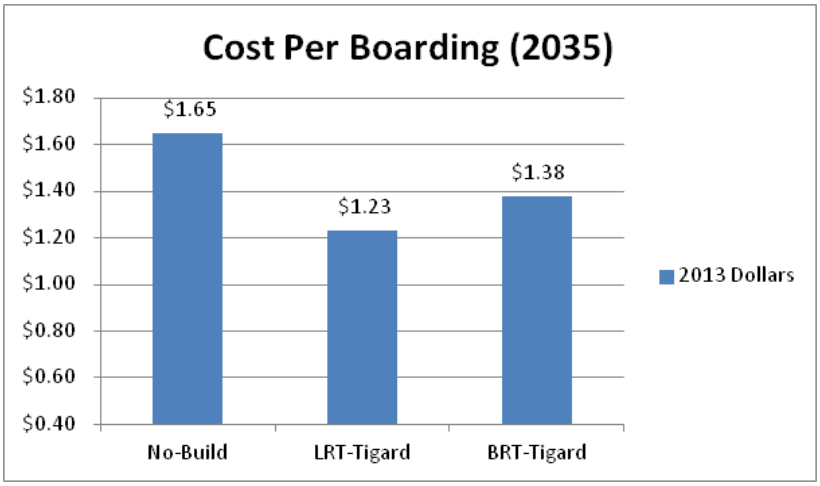
Figure 13.



Operating Efficiency

Operating efficiency is measured by cost per boarding of each corridor trunk line (the 12 and 94 in the No-Build, HCT lines in the build alternatives), calculated by dividing the annual operating costs of each HCT line by its annual boardings. These values, expressed as dollars per boarding, are useful in comparing the modeled alternatives, but are not directly comparable with TriMet's reported cost per boarding for current bus routes as TriMet's service hours are calculated differently compared to the travel demand model's vehicle hours.

Figure 14.



Cost per boarding for both LRT and BRT to Tigard would be less than cost per boarding for the local trunk lines in the No-Build, due to the increases in ridership (figure 14).

Mode: Comparison of Light Rail and Bus Rapid Transit

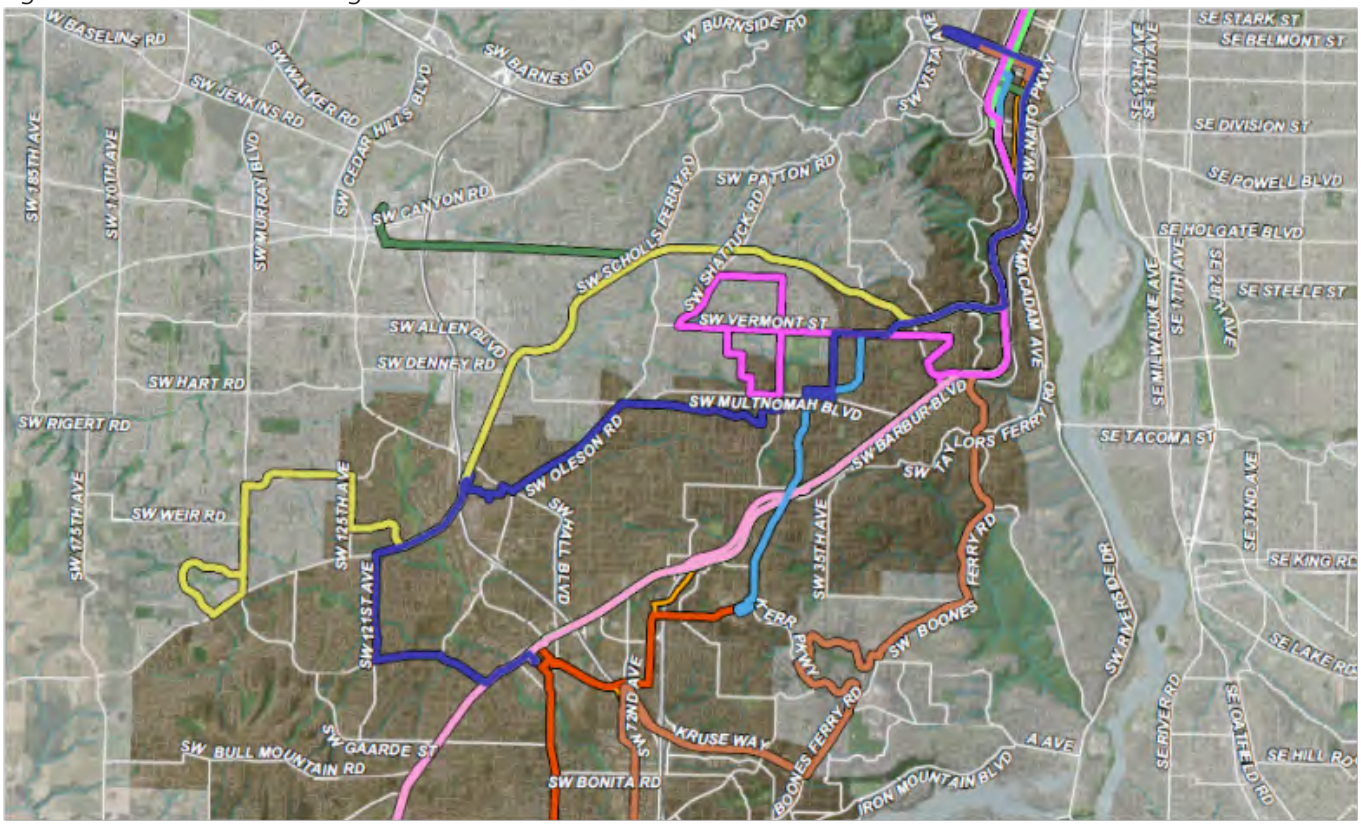
Corridor Service Reallocation

The topography in the northern section of the Southwest Corridor causes a funneling effect on bus service, with several corridor bus lines using Barbur Boulevard north of Capitol Highway (north) to enter or leave downtown Portland (figure 15). Today, these include lines 1, 12, 38, 44, 45, 54, 92, and 94, with up to 26 buses per hour in each direction in peak periods. In 2035, with service for trunk lines (the 12 and 94) adjusted to accommodate projected demand, the number of buses per hour would increase to at least 35 buses per hour in the No-Build.

Under the LRT alternative there would be an opportunity to reduce the number of buses in the northern part of the corridor and to redistribute service hours to transit to the southern part of the corridor. Because there would be capacity remaining on LRT after serving the projected peak demand, some local transit lines that would travel on Barbur could be interlined or shortened, with travelers destined to or from downtown Portland transferring to or from LRT. As a result, LRT operations would be more efficient as daily ridership would increase without additional operating cost, and bus service hours saved from interlining or shortening routes could be reallocated elsewhere in the corridor. Reallocation would provide new or enhanced connections between other communities in the corridor and surrounding areas in addition to connections to the LRT.

This opportunity would not exist under the BRT alternatives, as BRT capacity would not accommodate the projected demand without additional BRT service. Transit riders transferring to BRT from interlined or shortened local routes would require additional BRT service and result in higher BRT operating costs.

Figure 15. Local service using Barbur



Mode: Comparison of Light Rail and Bus Rapid Transit

Capital Cost Magnitudes

Subject to available funding, in the next phase somewhat more detailed design (conceptual design) will be performed that will allow the development of more traditional cost estimates. At this stage, we have a general sense of the cost magnitude of HCT. The following cost magnitude estimates are in 2022 dollars.

The highest cost magnitude combination of alternatives and options is LRT to Tualatin with a tunnel to OHSU $3.2 billion. LRT to Tualatin without a tunnel is estimated to cost $2.6 billion; LRT to Tigard without a tunnel is estimated at $1.8 billion.

The cost magnitude of BRT would vary with better performance coming with increasing investment in capital costs. The best performing BRT is expected to cost approximately 50 to 80 percent of the cost of similar LRT; the lowest performing would be less than 40 percent; and mid-level would be 40 to 50 percent.

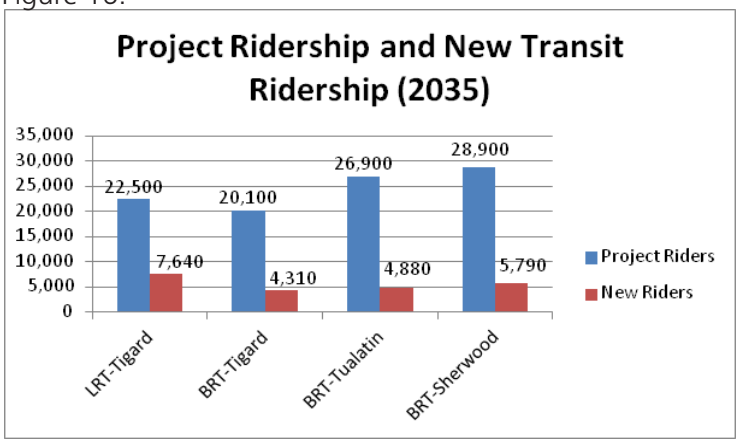
In general, an investment in capital costs reduces operating costs. In addition, federal matching funds are typically available on a competitive basis for capital costs, but are not available to assist with ongoing operations. Additional information on this trade-off will developed during the next phases of the project.

Destination: Comparison of Tigard, Tualatin and Sherwood

Ridership

Compared to BRT terminating in Tigard, an extension to Tualatin would add 6,800 project riders and 570 new transit riders (figure 16). An extension to Sherwood would add another 2,000 project riders and 910 new riders. The extension to Sherwood assumes Tualatin-Sherwood Road would be widened; the No-Build does not. This expansion would mean improved transit service for the BRT relative to the No-Build bus and results in a relatively higher number of new riders in this section compared to the number of new riders between Tigard and Tualatin.

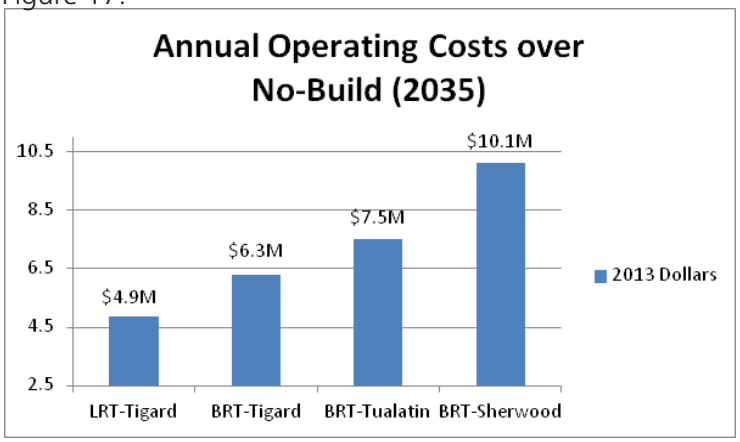
Figure 16.



Change in Annual Corridor Operating Costs

Compared to BRT terminating in Tigard, an extension to Tualatin would cost an additional $1.2 million annually to operate, and an extension to Sherwood would cost an additional $2.6 million (figure 17). The higher relative cost of extending to Sherwood, compared to extending to Tualatin, is partially due to the routing on SW 72nd Avenue, which results in slower travel times (and longer run times) than BRT to Tualatin's routing on Hall Boulevard. Another factor contributing to the higher corridor operating cost resulting from extending BRT service to Sherwood is that BRT service between Sherwood and Tualatin would be higher frequency than the assumed No-Build bus service it would replace resulting in lower operating cost savings compared to other segments where more frequent bus service would be replaced.

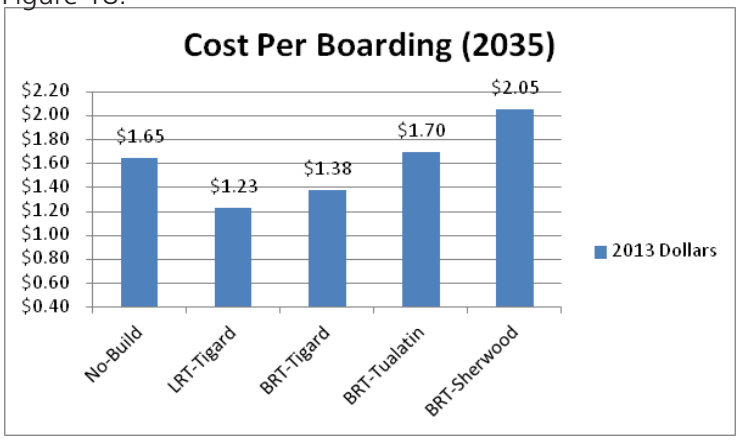
Figure 17.



Operating Efficiency

Compared to BRT to Tigard, cost per boarding would increase by $0.22 with an extension to Tualatin, and by an additional $0.25 with an extension to Sherwood (figure 18). As additional ridership would decline with longer routing, and as operating costs would increase, operating efficiency would decrease.

Figure 18.



Destination: Hub and Spoke

Spokes

In the BRT Hub and Spoke alternative, spokes are local service bus routes that would utilize the BRT capital improvements on Barbur Boulevard to expedite travel between downtown Portland and the point where the local route would access the BRT investments. The three spokes assumed for analysis were:

- A southern spoke from Sherwood, traveling on Highway 99W and accessing the BRT transitway north of Tigard
- An eastern spoke from Lake Oswego, serving PCC-Sylvania and accessing the BRT transitway at Crossroads
- A western spoke from Murray/Scholls, serving Washington Square entering the BRT transitway via SW Multnomah Boulevard.

Figure 19.

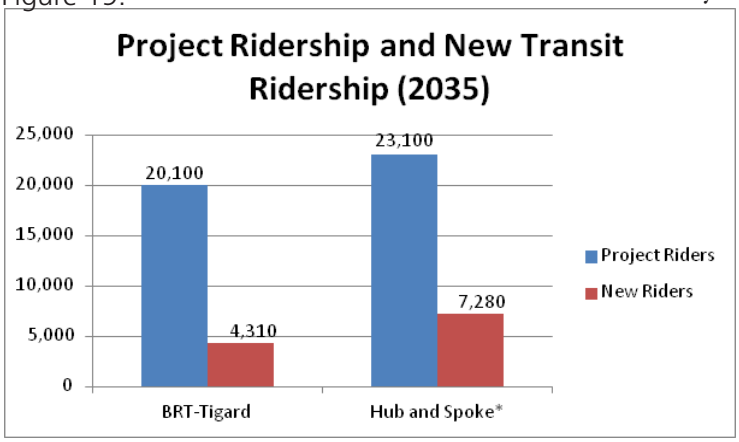
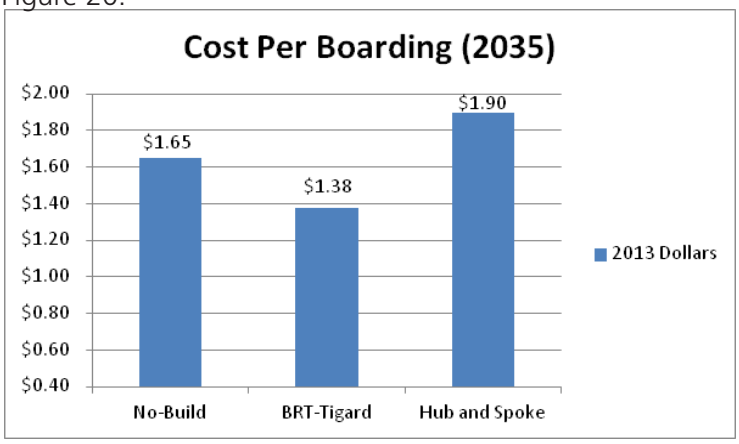


Figure 20.



Ridership

Spokes utilizing the BRT transitway would result in an increase of 3,000 daily project riders, measured on the BRT transitway between Portland and Tigard, and an increase of 2,970 new system transit riders. Of the 23,100 project riders, 12,900 (56%) would use the three spokes, and 10,200 (44%) would use the BRT (figure 19).

Change in Annual Corridor Operating Costs

Compared to BRT to Tigard without spokes using BRT transitway, BRT with spokes would cost an additional $13.2M annually to operate, for a total of $19.5M over the No-Build.

Operating Efficiency

Compared to BRT to Tigard without spokes using the BRT transitway, the cost per boarding for the BRT and spokes on the transitway would increase by $0.52 (figure 20). While the additional service provided by the spokes on the transitway would attract increased ridership, the additional cost of operating 3 additional lines on Barbur (and duplicating service) would result in less efficient operations.

BRT Design Limitations

Routing local buses onto the BRT capital improvement would complicate center-running BRT lanes and create the need to either buy many more special buses with doors on both sides to operate on those spokes, which would increase capital costs, or build only right-side platforms on the transitway, which would increase costs and impacts. BRT improvements would most likely be limited to BAT lanes, signal priority/preemption, and curbside queue bypass lanes at intersections. As a result, a high-level BRT with the highest ridership and land use and economic benefits would be difficult to attain.

Steering Committee Draft
Revised June 4, 2013

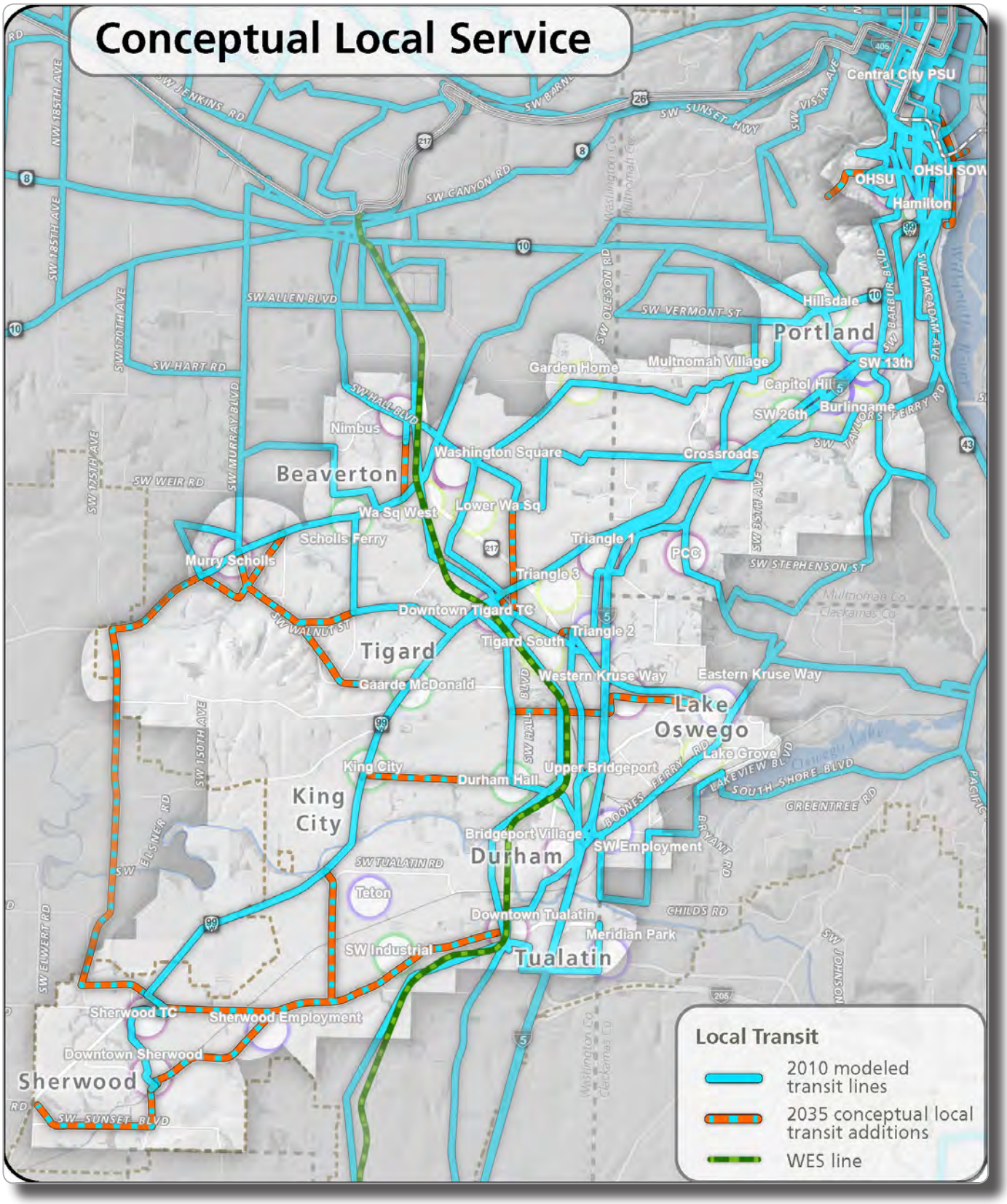
Southwest Service Enhancement Plan

TriMet is initiating its Southwest Service Enhancement Plan to identify future priorities for local service throughout the corridor. Initial concepts were developed in part through information learned during the SW Corridor Plan process, and are being tested in SW Corridor Plan modeling efforts. These improvements are included in modeling for the No-Build and all Build alternatives.

Preliminary concepts include new connections between the corridor and the other locations in Washington County, including between high employment areas in Hillsboro and both Sherwood and Tualatin, and new cross-corridor local service, such as on Tualatin-Sherwood Road, Gaarde/ McDonald Streets, Durham Road, and BonitaRd/ Kruse Way.

Through the Southwest Corridor Plan, TriMet will continue to work with corridor jurisdictions to develop the Southwest Service Enhancement Plan. As HCT alternatives become more defined, local transit connections to HCT and capital improvements necessary to enhance key transit connections throughout the corridor will be incorporated.

Figure 21. Modeled Transit Network



Environmental Evaluation

This evaluation is intended to provide a broad, high-level, planning analysis to identify the key environmental issues to be aware of in the corridor. This level of analysis differs from what would typically be conducted for specific alignments or transportation projects.

For this evaluation, locations where the transit alternatives that were developed for anaysis intersect with key natural resources or land from publicly owned parks, recreation areas, wildlife and waterfowl refuges, and public or private historic sites that could trigger regulations within the corridor planning area were identified. Identifying these locations flags potential environmental issues that should be considered as the design alternatives are developed in subsequent phases, including the environmental impact statement and permitting phases.

This analysis is undertaken in order to begin to develop an understanding environmental issues and potential environmental impacts, as well as opportunities. Identifying environmental resources at this stage flags areas for potential opportunities to improve natural resources, as well as areas of focus for alignments that continue for further study. Information developed during this phase will continue to be refined and developed and shared with the public and with regulatory agencies during the upcoming phases in compliance with local, state, and federal requirements, including the National Environmental Policy Act, the U.S. Department of Transportation.

Methodology

A GIS analysis identifies places where the of the HCT alignments might impact streams and land identified in the 2013 the Regional Conservation Strategy (RCS) in the corridor. The RCS is a science-based biodiversity guide for this region that incorporates high-resolution mapping, and scientific modeling and information from practitioners who have expert knowledge of the region to identify "High Value Habitat" lands and "High Value Riparian" land. Figures 21 though 25 show the five HCT alignments overlaid on the RCS.

Wildlife corridors were evaluated by visually studying GIS data showing surrounding vegetation, natural resources and land uses where potential habitat corridors have been identified. The rating is qualitative based on best professional judgment and has not been field verified. The rating is relative, ranging from "very likely" to "likely" to "possible" to "unlikely" to have impacts. Those locations assigned a rating of "very likely", "likely" and "possible" should be closely followed through the planning process in order to identify both the potential impacts of development to key species as well as any opportunities present that could improve connections through design that considers and incorporates the needs of these species. For example, if a culvert is being added or replaced, better design could not only address the needs for fish passage but also associated terrestrial or other wildlife that are likely to be using the area.

Potential natural resource impacts

Areas with potential impacts to consider more closely have been identified. The alignment options with the greatest differences in routes might have different impacts on natural resources. Overlaying these alternatives on the 2013 the Regional Conservation Strategy land cover data flagged a few areas where close attention to environmental impacts should be considered as the alignment is refined.

Key areas for special attention in refining transit alignments include:

- In Central Portland, two transit alignment options were studied: one using SW Naito Parkway, and one using SW Barbur Blvd. The SW Barbur Blvd. may have more potential impacts on habitat areas – likely due to topography and mature tree canopy in that area.
- In the Hillsdale area, all the transit design options included using 99W. The GIS based analysis shows there is potential for impacts on habitat and water resources including Tryon Creek headwaters.

- The alignments that serve PCC directly, which at a minimum appear to intersect Red Rock Creek, a tributary of Fanno Creek, show potentially fewer natural resource impacts than the alignment on Barbur Blvd.
- South of Tigard, an alignment that uses SW 72nd appears to have significantly fewer potential impacts than the Hall Boulevard option alignment.

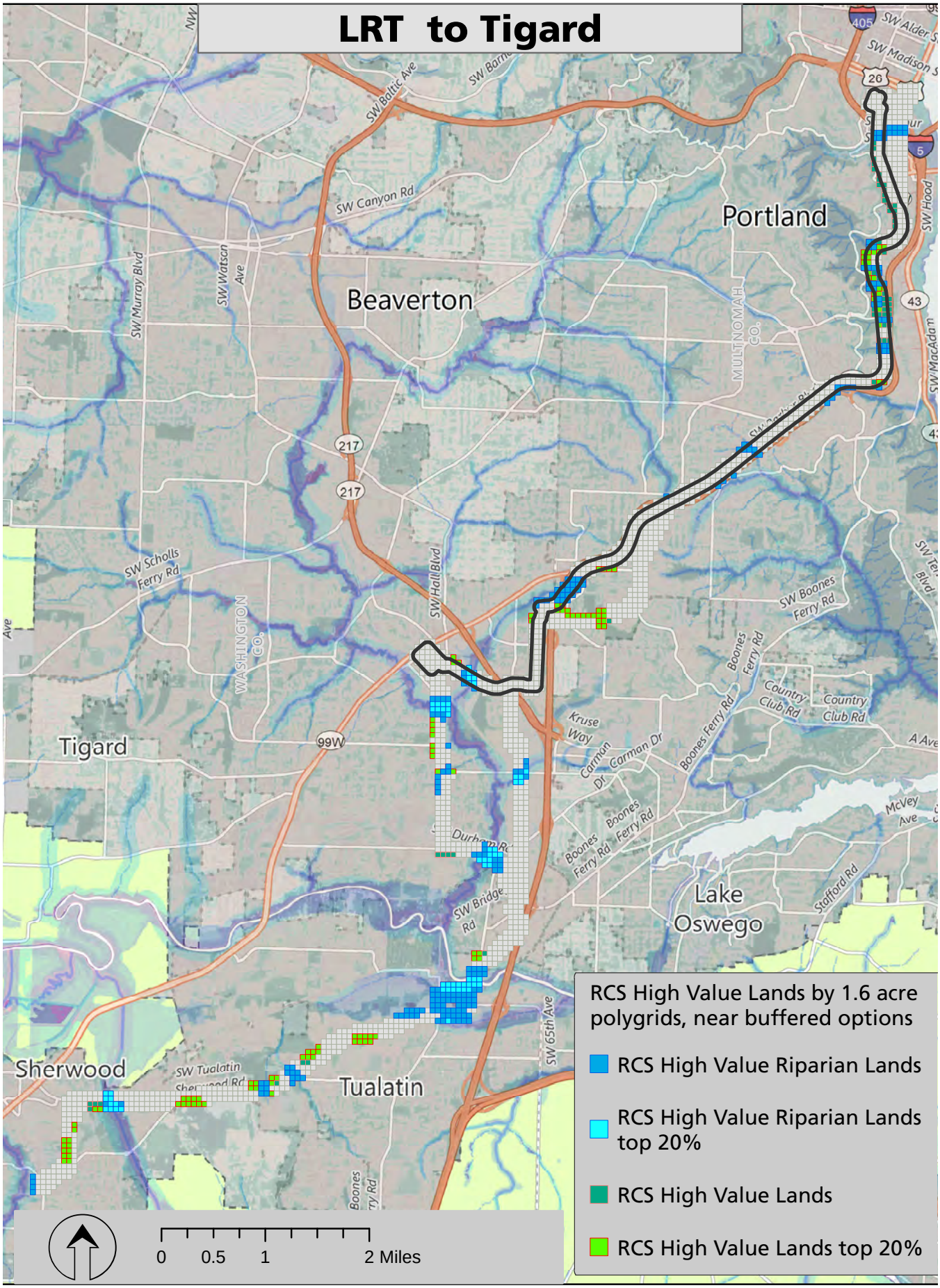
- Both design options serving the southern end of the corridor (BRT Tualatin and BRT Sherwood) indicate potential impacts to water resources (floodplain and riparian areas) connected to the Tualatin River and to Hedges Creek.

Potential 4 (f) resources

The Federal Highway Administration's (FHWA) 4(f) regulations govern the use of land from publicly owned parks, recreation areas, wildlife and waterfowl refuges, and public or private historic sites for Federal transportation projects. This analyis was undertaken in order to be aware of potential issues in the corridor.

The GIS analysis of potential 4(f) impacts of the HCT alternatives resulted in a list of approximately 40 parks within 150' of the transit alignments with potential 4(f) considerations. The analysis also included a preliminary look at publicly owned and accessible trails that are outside of parks. The analysis resulted in a list of approximately 50 trails with potential 4(f) considerations.

Figure 22.


LRT to Tigard
Portland
Beaverton
Tigard
Lake Oswego
Sherwood
Tualatin
SW Canyon Rd
SW Baltic Ave
SW Murray Blvd
SW Watson Ave
SW Scholls Ferry Rd
SW Hall Blvd
SW Boones Ferry Rd
Boones Ferry Rd
Country Club Rd
Kruse Way
Carman Dr
SW Bridge Rd
SW 65th Ave
SW Tualatin
McVey Ave
Stafford Rd
SW Hood
SW MacAdam
SW Alder St
SW Madison St
MULTNOMAH CO.
WASHINGTON CO.
217
99W
26
43
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405
0
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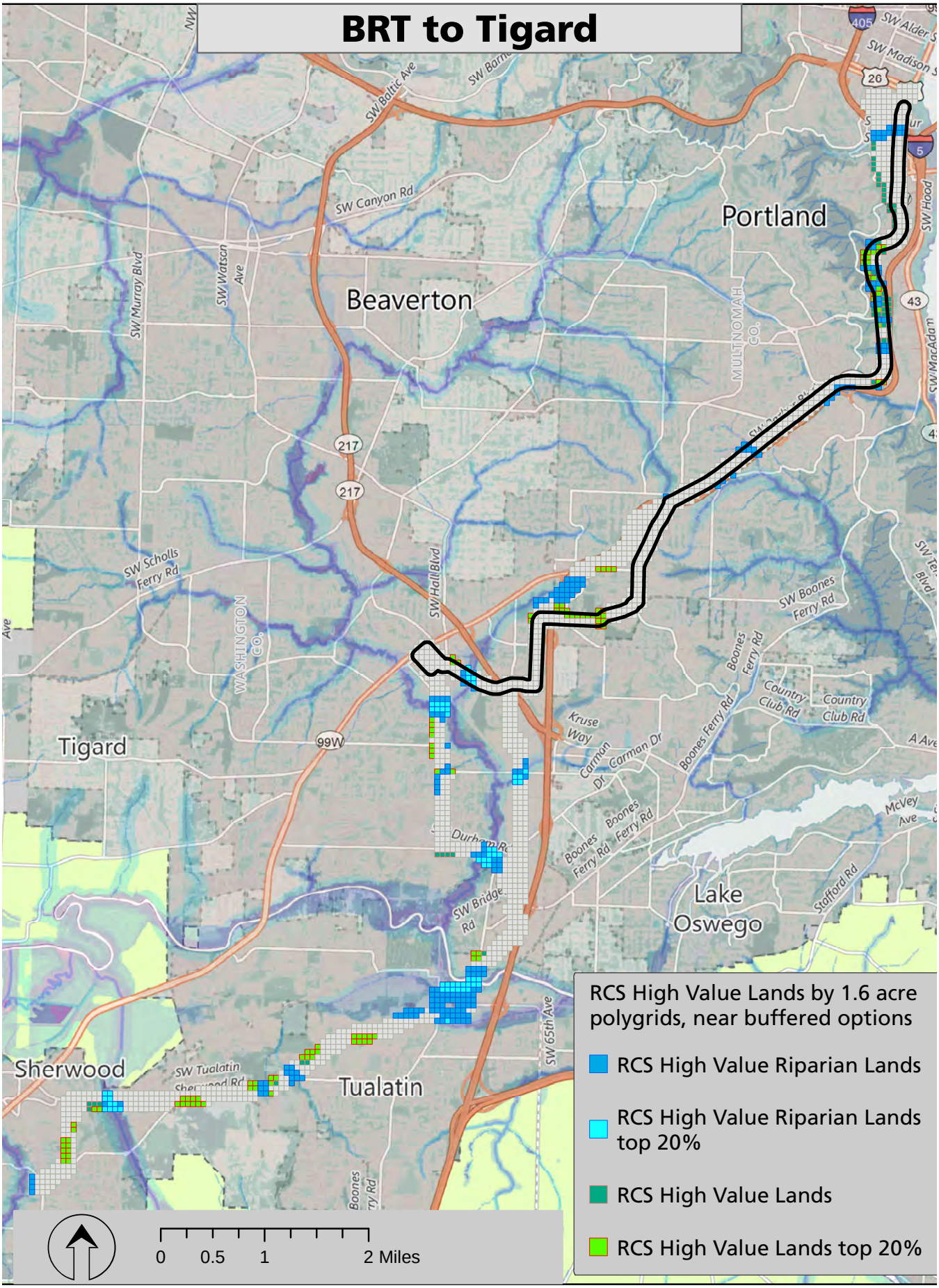
1
2 Miles
RCS High Value Lands by 1.6 acre polygrids, near buffered options
RCS High Value Riparian Lands
RCS High Value Riparian Lands top 20%
RCS High Value Lands
RCS High Value Lands top 20%

Figure 23.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Boones Ferry Rd
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RCS High Value Riparian Lands top 20%
RCS High Value Lands
RCS High Value Lands top 20%
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2 Miles

Figure 24.

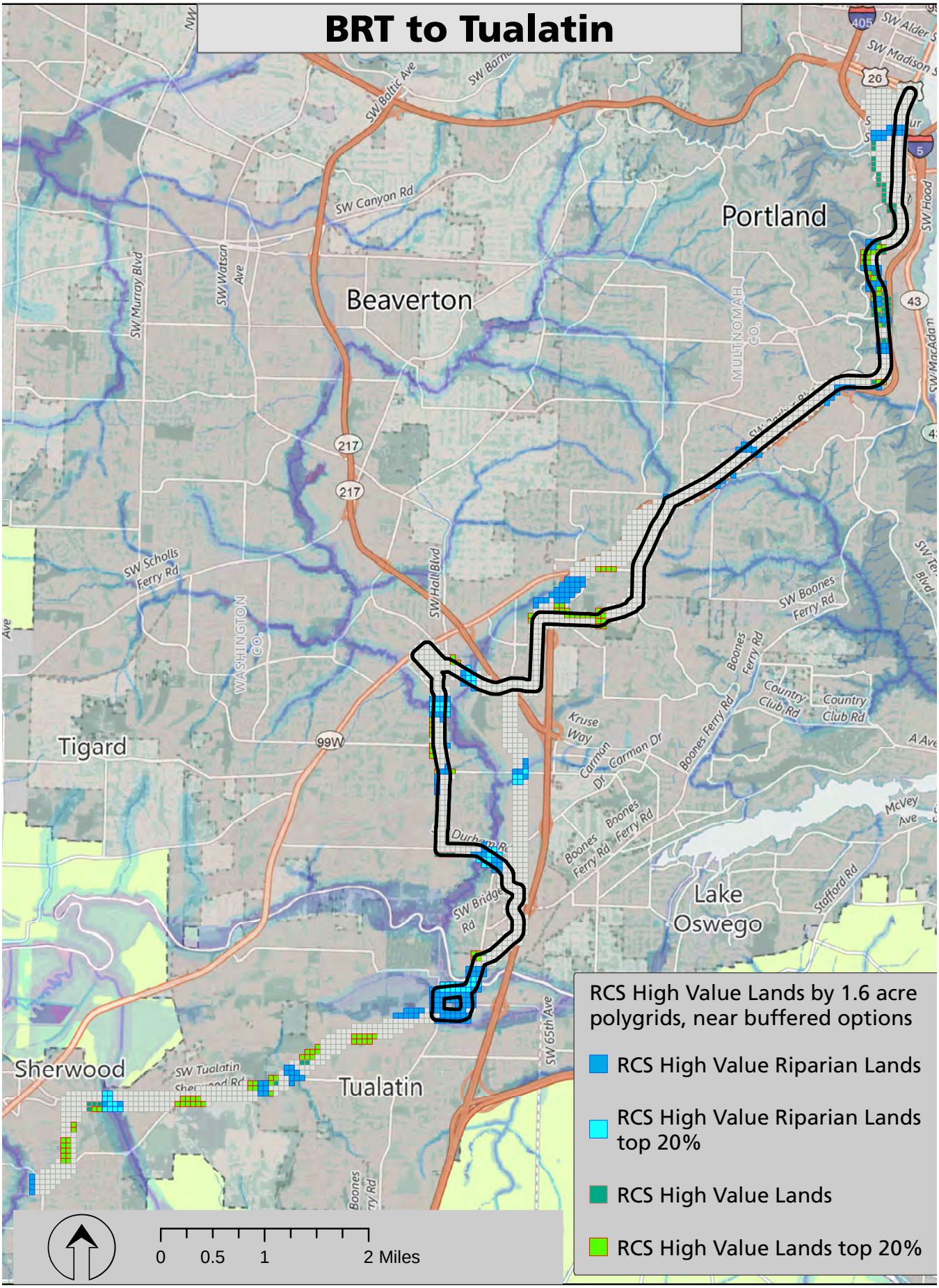
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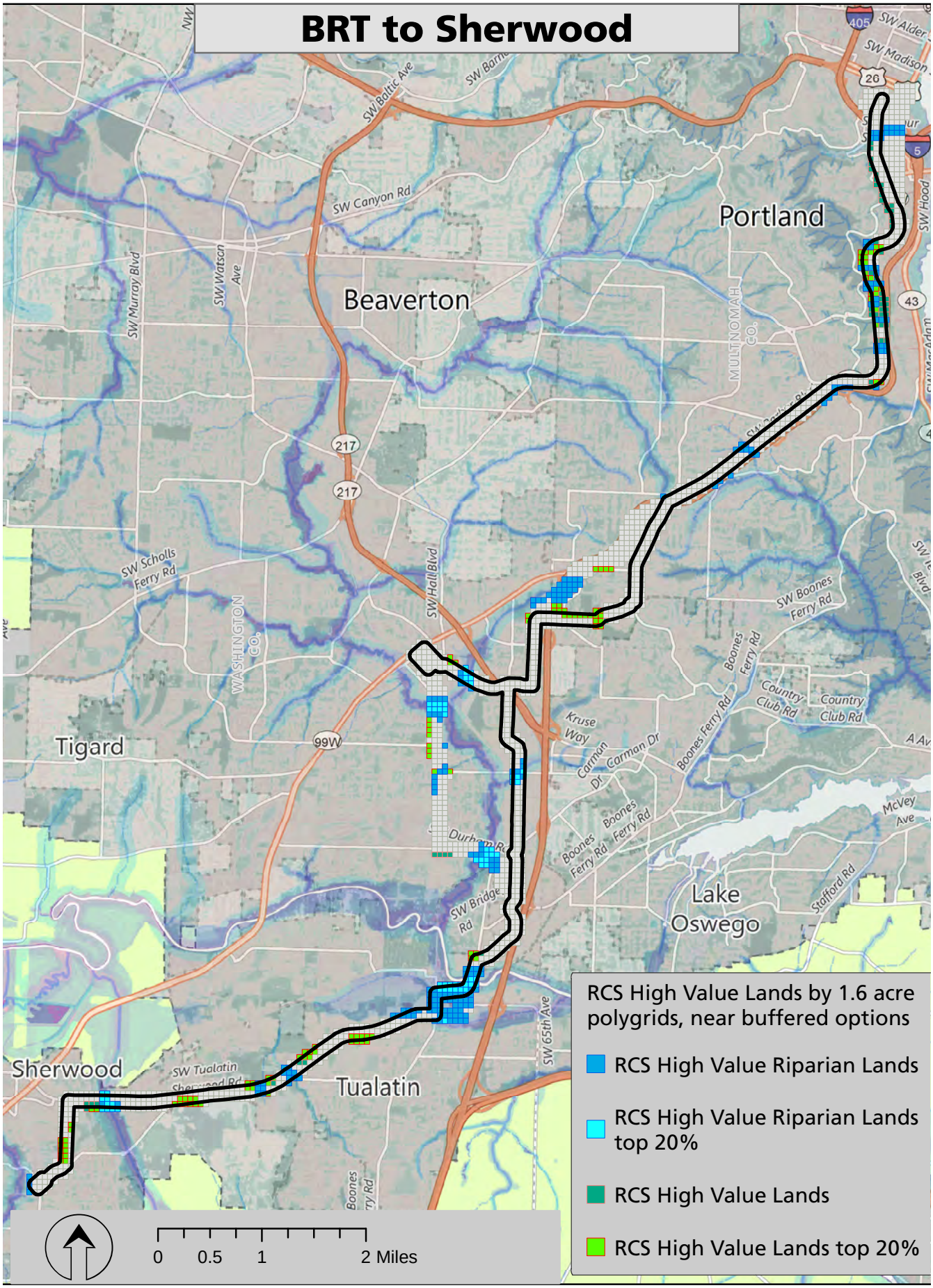
Figure 25.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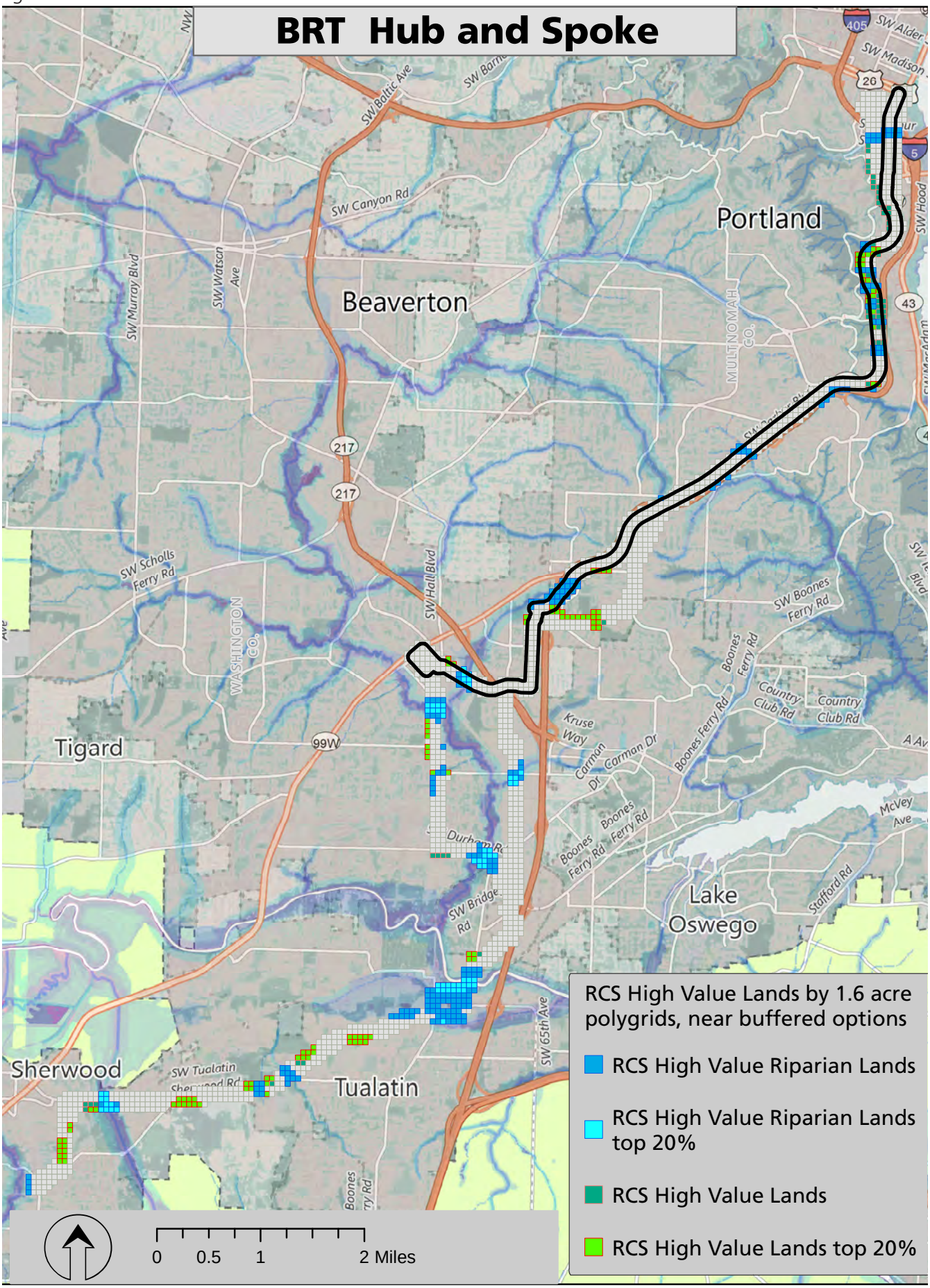
2 Miles

Figure 26.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