Lake Oswego to Portland Transit Project

Transportation Technical Report

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TriMet and Metro

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ADT	Average Daily Traffic
ARRA	American Recovery and Reinvestment Act
CAC	Citizens Advisory Committee
DEIS	Draft Environmental Impact Statement
FHWA	Federal Highway Administration
ISTEA	Intermodal Surface Transportation Efficiency Act
LOS	Level of Service
NEPA	National Environmental Policy Act
Metro	Metro Regional Government
mph	Miles per Hour
MPO	Metropolitan Planning Organization
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
OTP	Oregon Transportation Plan
PSI	Portland Streetcar, Inc.
RTO	Regional Travel Options
RTP	Regional Transportation Plan
SDEIS	Supplemental Draft Environmental Impact Statement
TriMet	Tri-County Metropolitan Transportation District of Oregon
TDM	Transportation Demand Management
TPR	Transportation Planning Rule
USC	United States Code
v/c	Volume to capacity ratio
VMT	Vehicle Miles Traveled

1. INTRODUCTION

This report contains the detailed analysis and documentation that is the basis for Chapter 4 Transportation in the Lake Oswego to Portland Transit Project (LOPT) Draft Environmental Impact Statement (DEIS) published by the Federal Transit Administration in December 2010. This chapter of the report includes a summary of the project background, the Purpose and Need, the alternatives/options considered and the description of the alternatives analyzed.

1.1 Project Background

Transit improvements in the Lake Oswego to Portland corridor have been studied several times in recent history. In the 1970s and 80s, a light rail alignment through Johns Landing was studied as part of the Westside Corridor Alternatives Analysis, and in the 1990s potential light rail alignments through Johns Landing were studied as part of the South/North Corridor Study.

The Willamette Shore Line right of way was first established in 1885-1887 as the Portland and Willamette Valley Railroad, which began operation in July 1887. The Southern Pacific Railroad (SPRR) later purchased the railway in 1914. The railroad had a major impact on the development of southwest Portland. Initially, 14 trains operated between Portland and Oswego (as it then was known), and it became the main transportation link for developing residential communities along the route. The line was electrified in 1914 and passenger traffic hit its peak in 1920 with SPRR running 64 daily trains between Portland and Oswego. Passenger service ended on October 5, 1929, while freight service continued until 1983.

In August of 1984, the Interstate Commerce Commission granted SPRR permission to abandon the line. In 1988, the Willamette Shore Line Consortium (the Consortium) purchased the 6.3-mile-long line from SPRR for approximately $2 million. The Consortium, comprised of the City of Lake Oswego, City of Portland, Oregon Department of Transportation (ODOT), Clackamas County, Multnomah County, Metro, and TriMet, purchased the line to preserve it for future passenger rail transit use. TriMet holds title for the Consortium and the City of Lake Oswego provides maintenance services funded by the Consortium.

In 2005, with the endorsement of the Joint Policy Advisory Committee on Transportation, the Metro Council directed staff to initiate the Lake Oswego to Portland Transit and Trail Alternatives Analysis. The alternatives analysis focused on improving the ability to serve travel demand in the corridor through improved transit service and development of a multi-use pathway.

1.2 Purpose and Need

The **Purpose** of the project is to optimize the regional transit system by improving transit within the Lake Oswego to Portland transit corridor, while being fiscally responsive and supporting regional and local land use goals. The project should maximize, to the extent possible, regional resources and economic development opportunities, and garner broad public support. The project should build on previous corridor transit studies, analyses, and conclusions and should be environmentally sensitive.

The **Need** for the project results from:

- Historic and projected increases in traffic congestion in the Lake Oswego to Portland corridor due to increases in regional and corridor population and employment;
- Lengthy and increasing transit travel times and deteriorating public transportation reliability in the corridor due to growing traffic congestion;
- Increasing operating expenses, combined with increasingly scarce operating resources and the demand for more efficient public transportation operations;
- Local and regional land use and development plans, goals, and objectives that target the corridor for residential, commercial, retail, and mixed-use development to help accommodate forecast regional population and employment growth, and previous corridor transit studies, analyses, and conclusions;
- The region's growing reliance on public transportation to meet future growth in travel demand in the corridor;
- The topographic, geographic, and built-environment constraints within the corridor that limit the ability of the region to expand the highway and arterial infrastructure in the corridor; and
- Limited options for transportation improvements in the corridor caused by the identification and protection of important natural, built, and socioeconomic environmental resources in the corridor.

1.3 Alternatives/Options Considered

Metro's 2004 Regional Transportation Plan (RTP) identified the need for a refinement plan for a high capacity transit option for the corridor, which included an analysis of several modal alternatives. Metro initiated the corridor refinement plan in July 2005 and issued the *Lake Oswego to Portland Transit and Trail Alternatives Analysis Evaluation Summary Public Review Draft* in June 2007.

On December 13, 2007, after reviewing and considering the alternatives analysis report, public comment, and recommendations from the Lake Oswego to Portland Transit and Trail Project Citizen Advisory Committee (CAC), the Lake Oswego to Portland Transit and Trail Project Management Group (PMG), Steering Committee, and partner jurisdictions and agencies, the Metro Council approved Resolution No. 07-3887A. The resolution adopted the *Lake Oswego to Portland Transit and Trail Alternatives Analysis: Alternatives to be Advanced into a Draft Environmental Impact Statement and Work Program Considerations* (December 13, 2007). (See Section 2.1 for additional detail on the process used to identify and narrow alternatives.) It also selected the No-Build, Enhanced Bus, and Streetcar alternatives to advance into the project's DEIS for further study, and directed staff to conduct a refinement study to identify design options in the Johns Landing Area and terminus options to advance into the project's DEIS. The resolution called for further refinement of the trail component to move forward as a separate process.

1.3.1 Alternatives Analysis

The project's alternatives analysis process developed a wide range of alternatives for evaluation and early screening, which included: a no-build alternative, widening of Highway 43, reversible lanes on Highway 43, river transit (three options), bus rapid transit (BRT) (three options); commuter rail, light rail, and streetcar (a wide range of alignment alternatives and terminus alternatives and options).

Through a screening process that assessed the ability of the alternatives to meet the project's Purpose and Need, the initial range of possible alternatives was narrowed. Appendix C of the DEIS provides a summary of the technical evaluation of the alternatives and options considered during the alternatives analysis phase.

The following alternatives were selected for further study through the alternatives analysis phase: 1) No-Build Alternative, 2) Bus Rapid Transit Alternative, and 3) Streetcar Alternative. Following is a description of those alternatives as they were studied in the alternatives analysis (see the *Lake Oswego to Portland Transit and Trail Study Evaluation Summary Public Review Draft* for more information).

- **No-Build Alternative.** Similar to the project's current No-Build Alternative, as described in Section 1.4.1.

- **Bus Rapid Transit Alternative.** The Bus Rapid Transit Alternative would operate frequent bus service with Line 35 on Highway 43 between downtown Portland and downtown Lake Oswego, generally in mixed traffic, with bus station spacing that would be longer than TriMet typically provides for fixed-route bus service. Transit queue bypass lanes would be constructed at congested intersections, where feasible.

- **Streetcar Alternative.** The Streetcar Alternative would extend the existing Portland Streetcar line, which currently operates between NW 23rd Avenue and SW Lowell Street, to downtown Lake Oswego. Study of this alternative includes an evaluation of whether the Willamette Shore Line right of way would be used exclusively or whether it would be used in combination with SW Macadam Avenue and other adjacent roadways.

1.3.2 Scoping/Project Refinement Study

This section describes the alignment and terminus options developed, evaluated, and screened in 2009 as a part of the project's scoping and refinement study phase. In November 2010, Metro published the *Lake Oswego to Portland Transit Project Refinement Report*, which detailed the study's results and summarized public comment. This phase focused on refinements in two areas: 1) alignment options for the Johns Landing area; and 2) terminus options in the Lake Oswego area. In summary, the project's Purpose Statement during the refinement phase was to:

- Optimize the regional transit system;
- Be fiscally responsive and maximize regional resources;
- Maximize the economic development potential of the project;
- Be sensitive to the built and social environments; and
- Be sensitive to the natural environment.

The options, evaluation measures, and results of the Johns Landing streetcar alignment refinement process and the Lake Oswego terminus refinement processes are summarized below.

A. Johns Landing Streetcar Alignment Refinement. For the refinement of streetcar design options within the Johns Landing area, the project used the following criteria: streetcar operations, streetcar performance, financial feasibility, traffic operations, accessibility and development potential, neighborhood sustainability, and adverse impacts to the natural environment. Measures for each of the criteria were developed and applied to each of the alignment options studied, which included:

- Hybrid 1: Macadam Avenue In-Street
- Hybrid 2: East Side Exclusive
- Hybrid 3: Macadam Avenue with New Northbound Lane
- Willamette Shore Line
- Full Macadam In-Street

B. Lake Oswego Terminus Option Refinement. For the refinement of terminus options in the Lake Oswego area, the project used the following criteria: expansion potential and regional context, streetcar operations, streetcar performance, financial feasibility, traffic operations, accessibility and development potential, and neighborhood sustainability. Measures for each of the criteria were developed and applied to each of the alignment options studied, which included: a) Safeway Terminus Option; b) Albertsons Terminus Option; and c) Trolley Terminus Option.

On June 1, 2009, in consultation with FTA and based on the findings of the analysis, public and agency comment and recommendations from the Lake Oswego to Portland Project Management Group, the Lake Oswego to Portland Transit Project Steering Committee selected the following options in the Johns Landing area to advance into the DEIS: Willamette Shore Line; Hybrid 1 – Macadam Avenue In Street (Boundary Street to Carolina Street); and Hybrid 3: Macadam Avenue with New Northbound Lane (Boundary Street to Carolina Street).

1.4 Description of Alternatives Analyzed in this Technical Report and the DEIS

This section summarizes the roadway and transit capital improvements and transit operating characteristics for the No-Build, Enhanced Bus, and Streetcar alternatives. Table 1-1 provides a summary of the transit capital improvements associated with the three alternatives, and Table 1-2 summarizes the operating characteristics of the alternatives. A more detailed description of the alternatives may be found in the *Lake Oswego to Portland Transit Project Detailed Definition of Alternatives Report* (Metro/TriMet: January 2010). Detailed drawings of the Streetcar Alternative, including the various design options, can be found in the *Streetcar Plan Set,* November 2009.

1.4.1 No-Build Alternative

This section describes the No-Build Alternative, which serves as a reference point to gauge the benefits, costs, and effects of the Enhanced Bus and Streetcar alternatives. In describing the No-Build Alternative, this section focuses on: 1) the alternative's roadway, bicycle and pedestrian, and transit capital improvements; and 2) the alternative's transit operating characteristics. This description of the No-Build Alternative is based on conditions in 2035, the project's environmental forecast year.

1.4.1.1 Capital Improvements

Following is a brief description of the roadway, bicycle and pedestrian, and transit capital improvements that would occur under the No-Build Alternative. Table 1-1 provides a summary of the transit capital improvements associated with the No-Build Alternative and Table 1-2 summarizes the operating characteristics of the alternatives. Figure 1-1 illustrates the location of those improvements.

- **Roadway Capital Improvements**. The No-Build Alternative includes the existing roadway network in the corridor, with the addition of roadway capital improvements that are listed in the financially constrained road network of Metro's 2035 RTP.[1]Following is a list of the roadway projects that would occur within the corridor by 2035.

    - *Moody/Bond Avenue Couplet* (create couplet with two lanes northbound on SW Bond Avenue and two lanes southbound on SW Moody Avenue);
    - *South Portal* (Phases I and II to extend the SW Moody Avenue/SW Bond Avenue couplet to SW Hamilton Street and realign SW Hood Avenue to connect with SW Macadam Avenue at SW Hamilton Street);
    - *I-5 North Macadam* (construct improvements in the South Waterfront District to improve safety and access); and
    - *Macadam Intelligent Transportation Systems* (install system and devices in the SW Macadam Avenue corridor to improve traffic flow).

[1] Metro, 2035 Regional Transportation Plan Project List (Appendix 1.1) approved June 10, 2010.

Table 1-1 Transit Capital Improvements for the No-Build, Enhanced Bus, and Streetcar Alternatives (2035)

Capital Improvements	No-Build	Enhanced Bus	Streetcar[1]
New Streetcar Alignment Length[2]	N/A	N/A	5.9 to 6.0
One-Way Streetcar Track Miles			
Portland Streetcar System	15.7	15.7	26.2 to 27.0
Proposed Lake Oswego to Portland Project	0	0	10.5 to 11.3
Streetcar Stations			
Portland Streetcar System	69	69	79
Proposed Lake Oswego to Portland Project	0	0	10[3]
Streetcars (in service/spares/total)			
Portland Streetcar System	17/5/22	17/5/22	27/6/33
Proposed Lake Oswego to Portland Project	N/A	N/A	10/1/11
Streetcar Operations and Maintenance (O&M) Facilities			
Number of Facilities[4]	1	1	2
Maintenance Capacity (number of Streetcars)	36	36	36
Storage Capacity (number of Streetcars)	25	25	33
Line 35 Bus Stops			
Line 35 Bus Stops (Lake Oswego to SW Bancroft St.)	26	13	0
Buses (in service/spares)			
TriMet Systemwide	607/712	619/725	601/704
Difference from No-Build Alternative	N/A	13	- 8
Transit Centers[5]	1	1	1
Park-and-Ride Facilities			
Joint Use Surface – Lots/Spaces	3/76	3/76	3/76
Surface – Lots/Spaces	0/0	0/0	1/100
Structured – Lots/Spaces	0/0	1/300	1/300

Note: LO = Lake Oswego; O&M = operating and maintenance.

[1] The transit capital improvements of the Streetcar Alternative summarized in this table would not vary by design option, except when shown as a range and as noted for new streetcar alignment length and one-way track miles. The first number listed is under the Willamette Shore Line design option and the second number listed is under the Macadam design options (in the Johns Landing Segment).

[2] Under the No-Build and Enhanced Bus alternatives, the Portland Streetcar System would include two streetcar lines: a) the existing Portland Streetcar Line, between NW 23rd Avenue and SW Bancroft Street, and b) the Portland Streetcar Loop, which is currently under construction and will be completed when the Milwaukie Light Rail and Streetcar Close the Loop project are constructed. The Streetcar Alternative would extend the existing Portland Streetcar line south, from SW Bancroft Street to Lake Oswego. One-way track miles are calculated by multiplying the mileage of double-tracked sections and adding that to the mileage of single-track sections. Alignment length and one-way track miles are presented as a range, because they would vary by design option. The number of streetcar stations, streetcars in service or as spares and the number and size of streetcar O&M facilities would not change by streetcar design option.

[3] Two optional stations are also being considered for inclusion in the Streetcar Alternative (see Figure 1-5 and Figure 1-6): 1) the Pendleton Station under the Macadam In-Street and Macadam Additional Lane design options in the Johns Landing Segment; and the E Avenue Station in the Lake Oswego Segment.

[4] There is an existing streetcar operations and maintenance (O&M) facility at NW 16th Avenue, between NW Marshall and NW Northrup streets; under the Streetcar Alternative, additional storage for eight vehicles would be provided along the streetcar alignment under the Marquam Bridge. There would be no change in the number or size of bus O&M facilities under any of the alternatives or design options. Bus stops are those that would be served exclusively by Line 35 between Lake Oswego and SW Bancroft Street

[5] Under the No-Build and Enhanced Bus alternative, the Lake Oswego Transit Center would remain at its current location (on 4th Street, between A and B avenues); under the Streetcar Alternative, the transit center would be moved to be adjacent to the Lake Oswego Terminus Station.

Source: TriMet, January 2010.

Table 1-2 Transit Operating Characteristics of No-Build, Enhanced Bus, and Streetcar Alternatives (2035)

Operating Characteristics by Vehicle Mode	No-Build	Enhanced Bus	Streetcar
Streetcar Network Operating Characteristics[1]			
Weekday Streetcar Vehicle Miles Traveled			
Systemwide	2,180	2,180	3,200 or 3,230
Difference from No-Build Alternative	N/A	0	1,020 or 1,050
Weekday Streetcar Revenue Hours			
Systemwide	267	267	326 or 332
Difference from No-Build Alternative	N/A	0	59 or 65
Corridor Weekday Streetcar Place Miles[2]	N/A	N/A	89,000 or 91,320
Corridor Streetcar Round-Trip Time[3]	N/A	N/A	37 or 44 minutes
Corridor Streetcar Headways[4]			
Lake Oswego to PSU	N/A	N/A	7.5 / 7.5 minutes
Bus Network Operating Characteristics			
Weekday Bus Miles Traveled			
Systemwide	76,560	77,560	75,520
Difference from No-Build Alternative	N/A	1,000	-1,040
Weekday Bus Revenue Hours			
Systemwide	5,300	5,400	5,210
Difference from No-Build Alternative	N/A	100	-90
Line 35 (bus) Weekday Place Miles[2]	37,000	57,840	0
Line 35 (bus) Headways[4]			
Lake Oswego to Downtown Portland	15 / 15 min.	6 / 15 min.	N/A
Oregon City to Lake Oswego	15/15 min.	15/15 min.	15/15 min.

Note: N/A = not applicable; LO = Lake Oswego; O&M = operating and maintenance; PSU = Portland State University.

[1] The operating characteristics of the Streetcar Alternative summarized in this table would not vary by design option, except when shown as a range and as noted for streetcar vehicle miles traveled, place miles, and round-trip time. The first number listed is under the Willamette Shore Line Design Option and the second number listed is under the Macadam design options (in the Johns Landing Segment).

[2] Place miles are a measure of the passenger carrying capacities of the alternatives, similar to airline seat miles. Place miles = transit vehicle capacity (seated and standing) of a vehicle type, multiplied by the number vehicle miles traveled for that vehicle type, summed across all vehicle types. The No-Build Alternative bus place miles are based on lines 35 and 36.

[3] Round-trip run time for the proposed streetcar line would include in-vehicle running time from SW Bancroft Street to the Lake Oswego Terminus Station and back to SW Bancroft Street; it does not include layover time at the terminus.

[4] Headways are the average time between transit vehicles per hour within the given time period that would pass by a given point in the same direction, which is inversely related to frequency (the average number of vehicles per hour in the given time period that would pass by a given point in the same direction). Weekday peak is generally defined as 7:00 to 9:00 a.m. and 4:00 to 6:00 p.m.; weekday off-peak is generally defined as 5:00 to 7:00 a.m., 9:00 a.m. to 4:00 p.m. and 6:00 p.m. to 1:00 a.m. There would be streetcar service every 12 minutes between SW Bancroft Street and the Pearl District (via PSU) under the No-Build and Enhanced Bus alternatives. The peak headways shown for the No-Build Alternative are the composite headways for Lines 35 and 36.

Source: TriMet – January 2010.

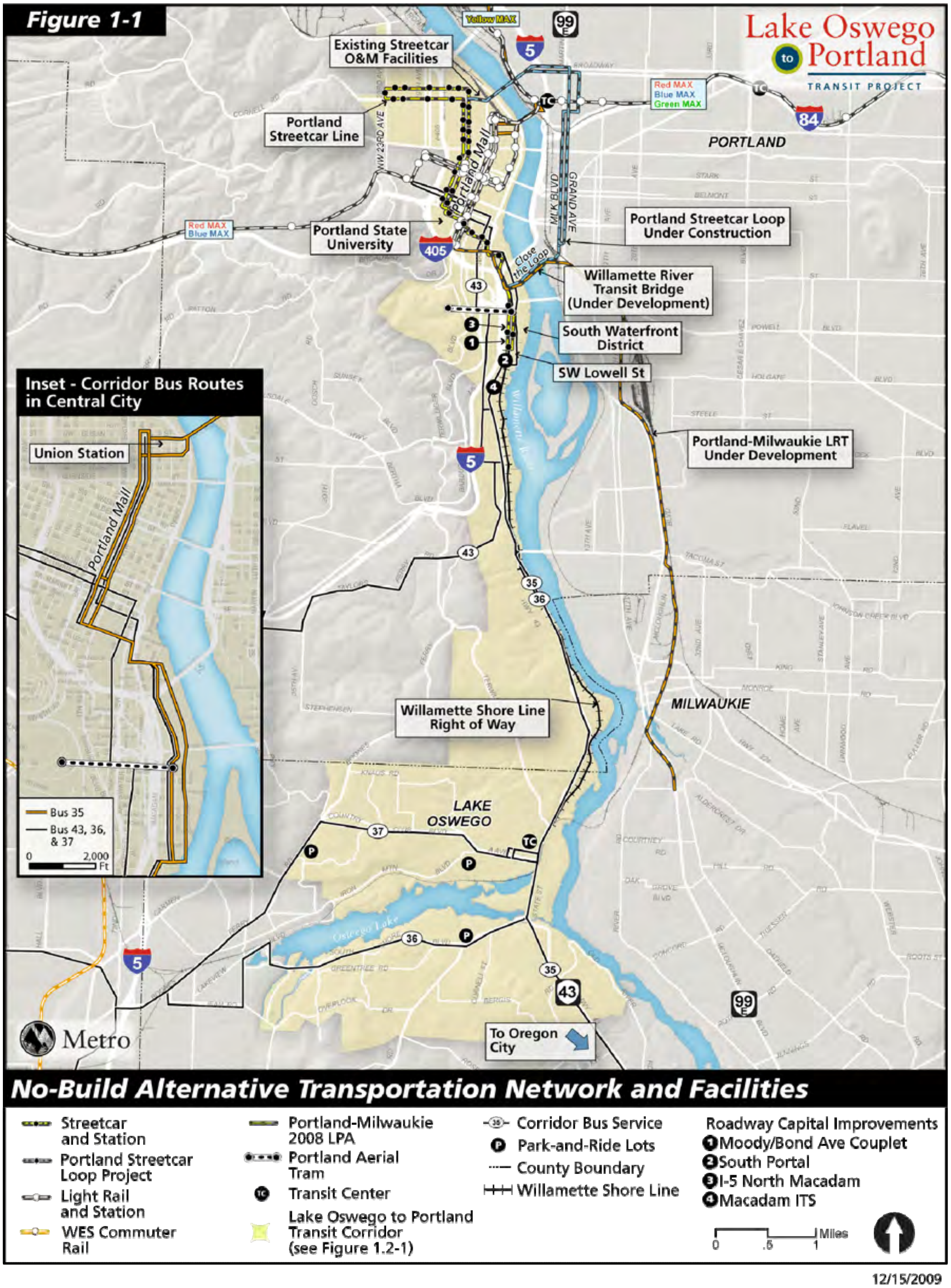


FIGURE 1-1 NO-BUILD ALTERNATIVE TRANSPORTATION NETWORK AND FACILITIES

- **Bicycle and Pedestrian Improvements**. The No-Build Alternative includes the existing bicycle and pedestrian network in the corridor, with the addition of bicycle and pedestrian capital improvements that are listed in the financially constrained road network of Metro's 2035 RTP. Following is a list of the bicycle and pedestrian projects that pedestrian projects proposed to occur within the corridor by 2035.
  - *Lake Oswego to Portland Trail* (extension of a multiuse path between Lake Oswego and Portland);
  - *I-5 at Gibbs Pedestrian/Bicycle Overcrossing* (construct a bicycle and pedestrian bridge over I-5 in the vicinity of SW Gibbs Street); and
  - *Tryon Creek Bridge* (construct a new pedestrian/bicycle bridge near the mouth of Tryon Creek).

- **Bus Capital Improvements.** There are currently two primary bus capital facilities in the corridor: *Lake Oswego Transit Center* (on 4th Street, between A and B avenues); and *Portland Mall* (bus and light rail lanes and shelters on NW/SW 5th and 6th avenues between NW Glisan Street and SW Jackson Street). These bus facilities would remain as-is under the No-Build Alternative. (The financially constrained transit project list of the RTP includes relocation of the Lake Oswego Transit Center to be adjacent to the Lake Oswego to Portland Streetcar alignment, which is also in the financially constrained project list. Neither would occur under the No-Build Alternative.) No additional bus capital improvements are planned for the corridor under the No-Build Alternative by 2035.

- **Light Rail Capital Improvements.** Under the No-Build Alternative, TriMet's existing Yellow Line light rail service would continue to operate on the Portland Mall (with a station at PSU added), across the Steel Bridge and into North Portland. Yellow Line facilities and service would be extended north from the existing Expo Center Station, across the Columbia River into Vancouver, Washington, and south from the Portland Mall, generally via SW Lincoln Street, across the Willamette River to Milwaukie, Oregon. In addition, downtown Portland would be served by the following TriMet light rail lines: Blue Line (Gresham to Hillsboro); Red Line (Beaverton to Portland International Airport); and Green Line (downtown Portland to Clackamas Town Center).

- **Excursion Trolley Capital Facilities.** Under the No-Build Alternative there would be no changes to the existing excursion trolley capital facilities that are located or operate within the corridor. Those excursion trolley capital facilities include approximately six miles of single-tracked Willamette Shore Line tracks and related facilities; stations at SW Bancroft and Moody streets and at N State Street at A Avenue; a trolley barn at approximately N State Street at A Avenue; and typically one vintage and/or other trolley vehicle propelled by externally attached diesel units.

- **Streetcar Improvements and Vehicles.** Under the No-Build Alternative, the existing Portland Streetcar Line would continue to operate between NW 23rd Avenue and SW Lowell Street. In addition, the No-Build Alternative includes the Eastside Streetcar Project (currently under construction), which would extend streetcar tracks and stations across the Broadway Bridge, serving NE and SE Portland on N and NE Broadway and NE and SE Martin Luther King Boulevard and Grand Avenue to OMSI. With the Close the Loop Project, the Eastside Streetcar will be extended across the Willamette River, to complete the planned Streetcar Loop, via a new transit, bicycle, and pedestrian bridge to be constructed under the Milwaukie Light Rail Project, connecting to the Streetcar line in the South Waterfront District. Under the No-Build Alternative in 2035, there would be 22 streetcars in the transit system (including spares), an increase of 11 compared to existing conditions.

- **Park-and-Ride Facilities.** Under the No-Build Alternative, the park-and-ride facilities in the corridor would be those that currently exist: a shared-use 30-space park-and-ride lot at Christ Church (1060 SW Chandler Road); a shared-use 34-space park-and-ride lot at Lake Oswego United Methodist Church (1855 South Shore Boulevard); and a shared use 12-space park-and-ride lot at Hope Church (14790 SW Boones Ferry Road).

- **Operations and Maintenance Facilities.** Under the No-Build Alternative, there would be one operations and maintenance facility within the corridor, which would be the existing streetcar maintenance building and storage yard on NW 16th Avenue under I-405. With the Streetcar Loop and Close the Loop Projects, the storage yard could accommodate 25 streetcars and the maintenance facility would have the capacity to service 36 streetcars (an increase in capacity of 13 and 18 vehicles, compared to existing conditions, respectively).

1.4.1.2 Transit Operations

This section summarizes the transit operating characteristics that would occur under the No-Build Alternative, focusing on bus and streetcar operations (see Table 1-2). Figure 1-1 illustrates the transit network for the No-Build Alternative in the vicinity of the corridor.

- **Bus Operations.** Bus operations under the No-Build Alternative would be similar to TriMet's existing fixed-route bus network with the addition of improvements included in the 2035 RTP's 20-year financially constrained transportation system (see Figure 1-1). Transit service improvements within the No-Build Alternative would be limited to those that could be funded using existing and readily-foreseeable revenue sources. Systemwide, those bus operations improvements would include: 1) increases in TriMet bus route frequency to avoid peak overloads and/or maintain schedule reliability; 2) increases in run times to maintain schedule reliability; and 3) incremental increases in TriMet systemwide bus service hours consistent with available revenue sources and consistent with the 2035 RTP's 20-year financially-constrained transit network, resulting in annual increases in service hours of approximately 0.5 percent per year. Specifically, the No-Build Alternative would include the operation of the TriMet bus route Line 35 between downtown Portland and Lake Oswego (continuing south to Oregon City).

- **Streetcar Operating Characteristics**. Under the No-Build Alternative, the City of Portland, through an operating agreement with the Portland Streetcar, Inc. (PSI), would continue to operate the existing Portland Streetcar line between Northwest Portland and the South Waterfront District, via downtown Portland (see Figure 1-1). On average weekdays in 2035, the Streetcar line would operate every 12 minutes during the peak and off-peak periods. Further, the City of Portland would operate the Streetcar Loop Project, serving downtown Portland, the Pearl District, northeast and southeast Portland, OMSI and the South Waterfront District. Frequency on the line for an average weekday in 2035 would be every 12 minutes during the peak and off-peak periods.

1.4.2 Enhanced Bus Alternative

This section describes the roadway, bicycle and pedestrian, and transit capital improvements and transit operating characteristics under the Enhanced Bus Alternative, generally compared to the No-Build Alternative. The intent of the Enhanced Bus Alternative is to address the project's Purpose and Need without a major transit capital investment.

1.4.2.1 Capital Improvements

This section summarizes the transit, bicycle and pedestrian, and transit capital improvements that would occur under the Enhanced Bus Alternative, compared to the No-Build Alternative (see Table 1-1 and Figure 1-2).

- **Roadway Capital Improvements.** Except for the addition of a two-way roadway connection between the proposed 300-space park-and-ride lot and Foothills Road, there would be no change in roadway improvements under the Enhanced Bus Alternative, compared to the No-Build Alternative.

- **Bicycle and Pedestrian Improvements.** There would be no change in bicycle and pedestrian improvements under the Enhanced Bus Alternative, compared to the No-Build Alternative.

- **Bus Capital Improvements.** Under the Enhanced Bus Alternative, the 26 bus stops that would be served by Line 35 between downtown Lake Oswego and SW Bancroft under the No-Build Alternative would be consolidated into 13 bus stops, which would continue to be served by the Line 35 (the other 13 bus stops would be removed). The bus stops served by Line 35 between Lake Oswego and Oregon City would be unchanged under the Enhanced Bus Alternative, compared to the No-Build Alternative.

- **Light Rail Capital Improvements.** There would be no change in light rail capital improvements under the Enhanced Bus Alternative, compared to the No-Build Alternative.

- **Excursion Trolley Capital Improvements.** There would be no change in excursion trolley capital improvements under the Enhanced Bus Alternative, from the No-Build Alternative.

- **Streetcar Improvements and Vehicles.** There would be no change in streetcar improvements and vehicles under the Enhanced Bus Alternative, compared to the No-Build Alternative.

- **Park-and-Ride Facilities.** In addition to the park-and-ride facilities included under the No-Build Alternative, the Enhanced Bus Alternative would include a 300-space structured park-and-ride lot that would be located at Oswego Village Shopping Center on Highway 43 in downtown Lake Oswego. The park-and-ride lot would be served by Lines 35 and 36.

- **Operations and Maintenance Facilities.** There would be no changes to the region's operations and maintenance facilities under the Enhanced Bus Alternative, compared to the No-Build Alternative, except that the capacity of TriMet's bus operating and maintenance facilities at either the Center or Powell facility would be expanded to accommodate the additional 13 buses under the Enhanced Bus Alternative (see the *Detailed Definition of Alternatives Report* for additional information).

1.4.2.2 Transit Operations

This section summarizes the corridor's transit operations under the Enhanced Bus Alternative, focusing on bus and streetcar operations. Figure 1-2 illustrates the transit network for the Enhanced Bus Alternative in the vicinity of the corridor.

- **Bus Operations.** Except for changes to the routing, frequency, and number of stops of Line 35 and the elimination of Line 36 service between downtown Portland and downtown Lake Oswego, bus operations under the Enhanced Bus Alternative would be identical to the bus operations under the No-Build Alternative. Under the Enhanced Bus Alternative, Line 35's routing between Oregon City and Lake Oswego would remain unchanged relative to the No-Build Alternative. Further, between Lake Oswego and downtown Portland there would be two routing changes to Line 35, compared to the No-Build Alternative: 1) the bus would be rerouted to serve the new park-and-ride lot at the Oswego Village Shopping Center; and, 2) in downtown Portland, Line 35 would be rerouted to serve SW and NW 10th and 11th avenues, generally between SW Market and Clay streets and NW Lovejoy Street/Union Station to address the travel markets.

- **Streetcar Operating Characteristics.** Under the Enhanced Bus Alternative, there would be no change in streetcar operating characteristics, compared to the No-Build Alternative.

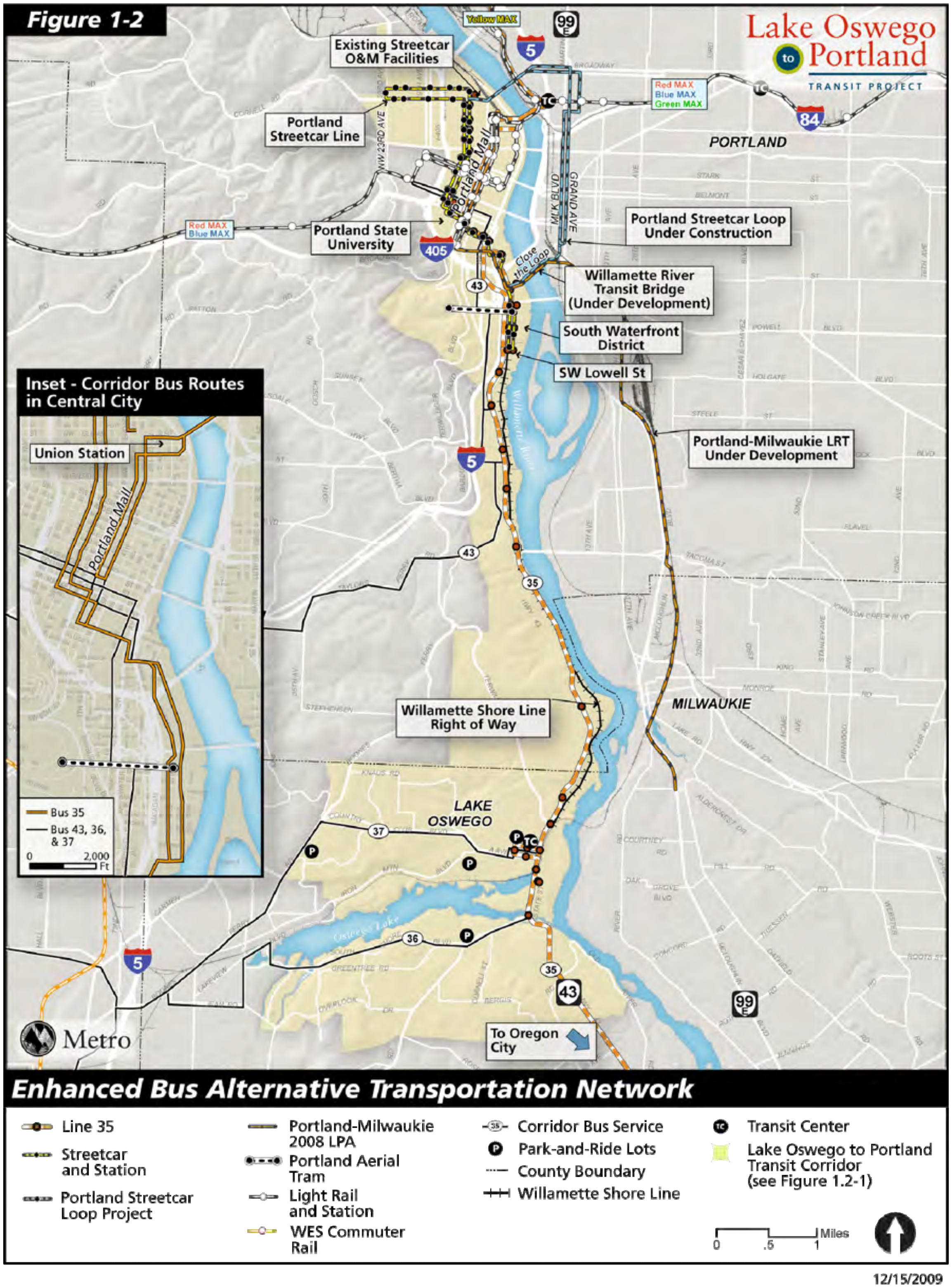


FIGURE 1-2 ENHANCED BUS ALTERNATIVE TRANSPORTATION NETWORK

1.4.3 Streetcar Alternative

This section describes the roadway, bicycle and pedestrian, and transit capital improvements and transit operating characteristics under the Streetcar Alternative, generally compared to the No-Build Alternative.

1.4.3.1 Capital Improvements

This section summarizes the transit, bicycle and pedestrian, and transit capital improvements that would occur under the Streetcar Alternative, generally compared to the No-Build Alternative (see Table 1-1 and Figure 1-3). This section provides a general description of the capital improvements that would occur under the Streetcar Alternative, independent of design option, and it highlights the differences between design options within three of the corridor's segments.

A. Summary Description

Following is a general description of the roadway, bicycle and pedestrian, and transit improvements that would occur under the Streetcar Alternative. The next section provides a description of differences in capital improvements for design options that are under consideration in three of the project's six segments. See Figure 1-4 for an illustration of the project segments and the design options under consideration.

- **Roadway Capital Improvements.** There would be no roadway improvements under the Streetcar Alternative in the following corridor segments: 1) Downtown Portland; and 2) South Waterfront. The roadway capital improvements that would occur under the other corridor segments are described below for those segments. Changes to traffic controls at signalized and non-signalized intersections would occur throughout the corridor to accommodate the safe and efficient operation of the streetcar and local traffic. The *Detailed Definition of Alternatives Report* and the *Streetcar Plan Set* provide additional details on changes to traffic operations at intersections under the Streetcar Alternative.

- **Bicycle and Pedestrian Improvements.** There would be no change in bicycle and pedestrian improvements under the Streetcar Alternative, compared to the No-Build Alternative, except as noted in the following segment-by-segment description.

  Bus Capital Improvements. Under the Streetcar Alternative, all 26 bus stops that would be served by Line 35 on Highway 43 between downtown Lake Oswego and the Sellwood Bridge and on SW Macadam Boulevard north of SW Corbett Street under the No-Build Alternative would be removed, because Line 35 service would be replaced in the corridor by streetcar service. The bus stops served by Line 35 between Lake Oswego and Oregon City would be unchanged under the Streetcar Alternative, compared to the No-Build Alternative. In addition, under the Streetcar Alternative, the Lake Oswego Transit Center would be relocated to be adjacent to the Lake Oswego Terminus Station, from its existing location on 4th Street, between A and B avenues. The changes to the bus capital improvements under the Streetcar Alternative would not vary by any of the design options under consideration.

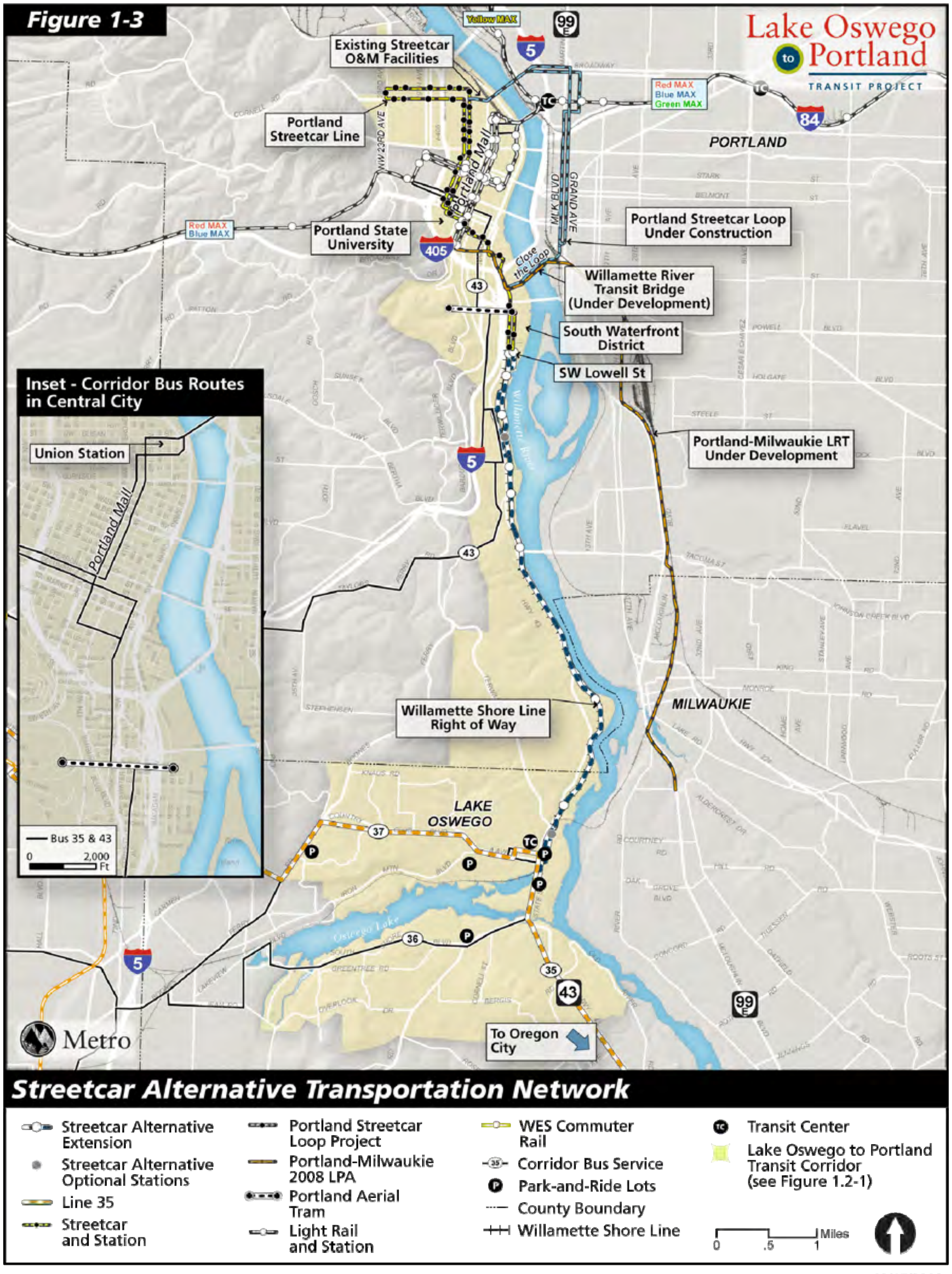


FIGURE 1-3 STREETCAR ALTERNATIVE TRANSPORTATION NETWORK

- **Light Rail Capital Improvements.** There would be no change in light rail capital improvements under the Streetcar Alternative, compared to the No-Build Alternative.

- **Interim Excursion Trolley Capital Improvements.** Under the Streetcar Alternative, there would no longer be an operating and maintenance agreement between the City of Lake Oswego and the Willamette Shore Line Consortium that would allow for the operations of the excursion trolley between SW Bancroft Street and Lake Oswego. Further, the Oregon Electric Railway Historical Society would no longer operate the vintage excursion trolley on the Willamette Shore Line alignment under agreement with the City of Lake Oswego, as they currently do and as they would under the No-Build and Enhanced Bus Alternatives.

- **Streetcar Improvements and Vehicles.** The Streetcar Alternative would extend streetcar tracks and stations south from the existing Portland Streetcar line that operates between NW 23rd Avenue and SW Bancroft Street. Compared to existing conditions and the No-Build Alternative, the Streetcar Alternative would add approximately 5.9 to 6.0 one-way miles of new streetcar tracks and catenary (overhead electrical wiring and support) and ten new streetcar stations between SW Bancroft Street and Lake Oswego. Except when crossing over waterways, roadways, or freight rail lines or through an existing tunnel, the new streetcar line would generally be at the same grade as existing surface streets. Of the approximately six miles of new streetcar tracks, 5.3 miles would be double-tracked (i.e., two one-way tracks) and 0.7 miles would be single-tracked (i.e., inbound and outbound streetcars would operate on the same tracks; see Figure 1-4 for an illustration of the location of single and double-track segments). The new streetcar stations would be of a design similar to the existing streetcar stations in downtown Portland and the Pearl District.

- **Park-and-Ride Facilities.** In addition to the park-and-ride facilities included under the No-Build Alternative, the Streetcar Alternative would include: a) a 100-space surface park-and-ride lot served by the proposed streetcar line at the B Avenue Station; and b) a 300-space structured park-and-ride lot that would be served by the proposed streetcar line at the Lake Oswego Terminus Station. The size and location of these park-and-ride lots would not vary by any of the design options under consideration.

- **Operations and Maintenance Facilities.** With the Streetcar Alternative, a new storage facility that would accommodate eight streetcars would be located adjacent to the streetcar alignment under the Marquam Bridge. The size and location of the streetcar operating and maintenance facilities would not vary by any of the design options under consideration.

B. Segment by Segment Description and Design Option Differences

For the purposes of description and analysis, the Lake Oswego to Portland Corridor has been divided into six segments for the Streetcar Alternative – those segments and design options within four of the segments are illustrated schematically in Figure 1-4. Figure 1-3 illustrates the streetcar alignment, stations, and park-and-ride lots that would occur in the corridor under the Streetcar Alternative. Figures 1-5 and 1-6 provide more detailed illustrations of the streetcar design options currently under study.

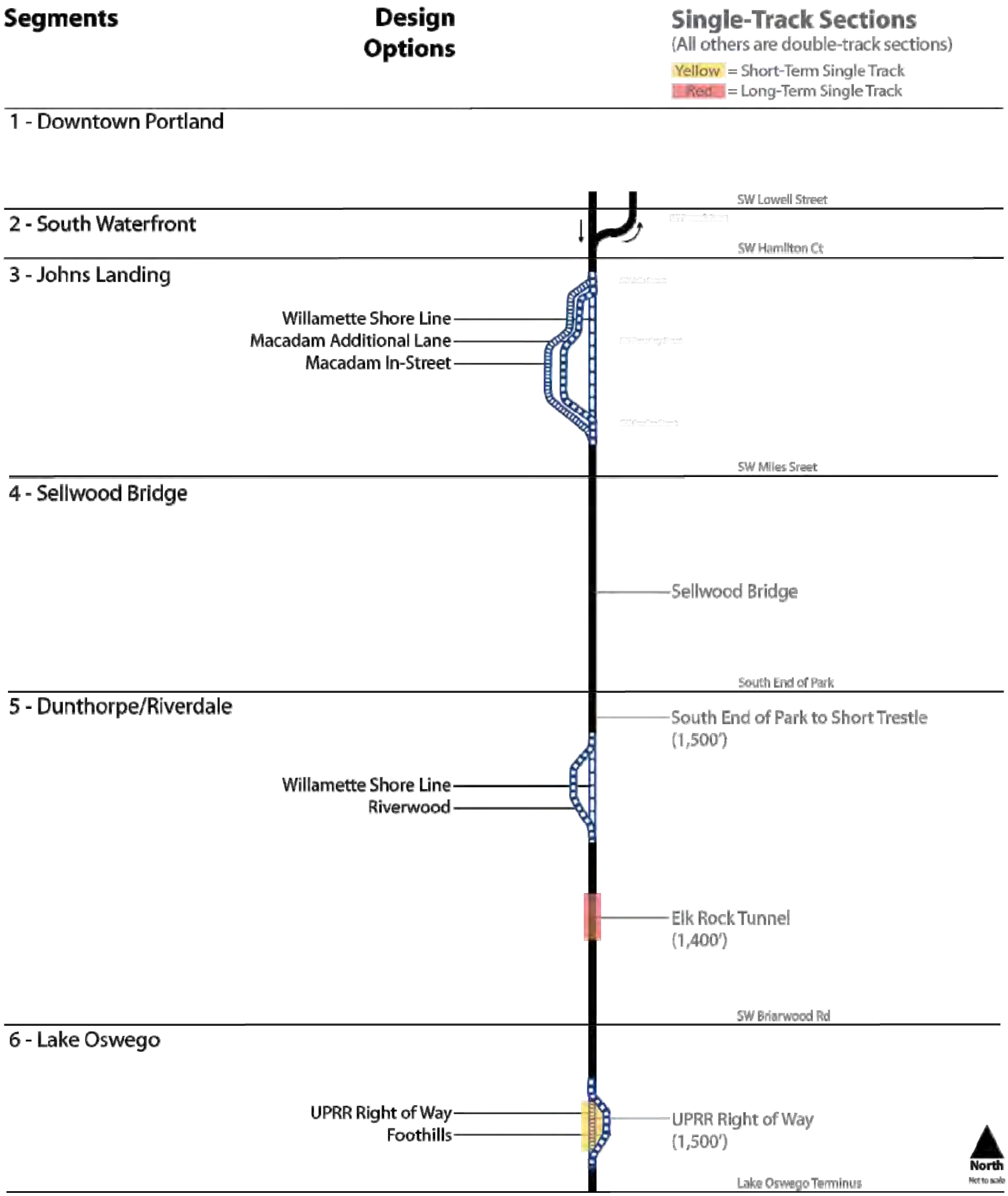
1. Downtown Portland Segment. There would be no roadway or bicycle and pedestrian improvements within the Downtown Portland Segment under the Streetcar Alternative, compared to the No-Build Alternative. Under the Streetcar Alternative, a connection would be added between westbound streetcar tracks on SW Market Street to southbound tracks on W 10th Avenue, which would allow inbound streetcars from Lake Oswego to turn back toward Lake Oswego, providing increased operational flexibility. There are no streetcar alignment design options within this segment and there would be no new streetcar stations within this segment.

2. South Waterfront Segment. The South Waterfront Segment extends between SW Lowell Street to SW Hamilton Court. Streetcar tracks would be extended south of their existing southern terminus at SW Lowell Street, within the right of way of the planned Moody/Bond Couplet extension, to SW Hamilton Street. There would be two new streetcar stations within this segment (Bancroft and Hamilton stations).

3. Johns Landing Segment. The Johns Landing Segment extends between SW Hamilton Court to SW Miles Street. This segment includes three design options: Willamette Shore Line; Macadam In-Street; and Macadam Additional Lane. Under all options, the streetcar alignment would extend south from SW Hamilton to near SW Julia Street, generally within the existing Willamette Shore Line right of way. The three design options would include two new streetcar stations at varying locations, described below. To the south, all three options would share a common alignment between SW Carolina and SW Miles Street, generally via the existing Willamette Shore Line right of way, and they would share one common station at SW Nevada. Following is a description of how the design options would differ:

- **a.** ***The Willamette Shore Line Design Option*** would continue the extension of streetcar tracks south within the existing Willamette Shore Line right of way from SW Julia Street to SW Carolina Street (extending to SW Miles Street). There would be three new streetcar stations (Boundary, Nebraska, and Nevada stations).

- **b.** ***The Macadam In-Street Design Option*** would locate the new streetcar tracks generally within the existing outside lanes of SW Macadam Avenue, approximately between SW Boundary and Carolina streets. Between approximately SW Julia and Boundary streets, the streetcar alignment would be within the right of way of SW Landing Drive, which would be converted from a private to a public street. There would be three new streetcar stations (Boundary, Carolina, and Nevada stations). An optional station at Pendleton Street is also under consideration.



Streetcar Alternative Design Option Locations ***Figure 1-4***

FIGURE 1-4 STREETCAR ALTERNATIVE DESIGN OPTION LOCATIONS

c. ***The Macadam Additional Lane Design Option*** would be similar to the Macadam In-Street Design Option, except that the new northbound streetcar tracks would be located within a new traffic lane just east of the existing general purpose lanes – streetcars would share the new lane with right-turning vehicles. Between approximately SW Julia and Boundary streets, the streetcar alignment would be within the right of way of SW Landing Drive, which would be converted from a private to a public street. There would be three new streetcar stations (Boundary, Carolina, and Nevada stations). An optional station at Pendleton Street is also under consideration.

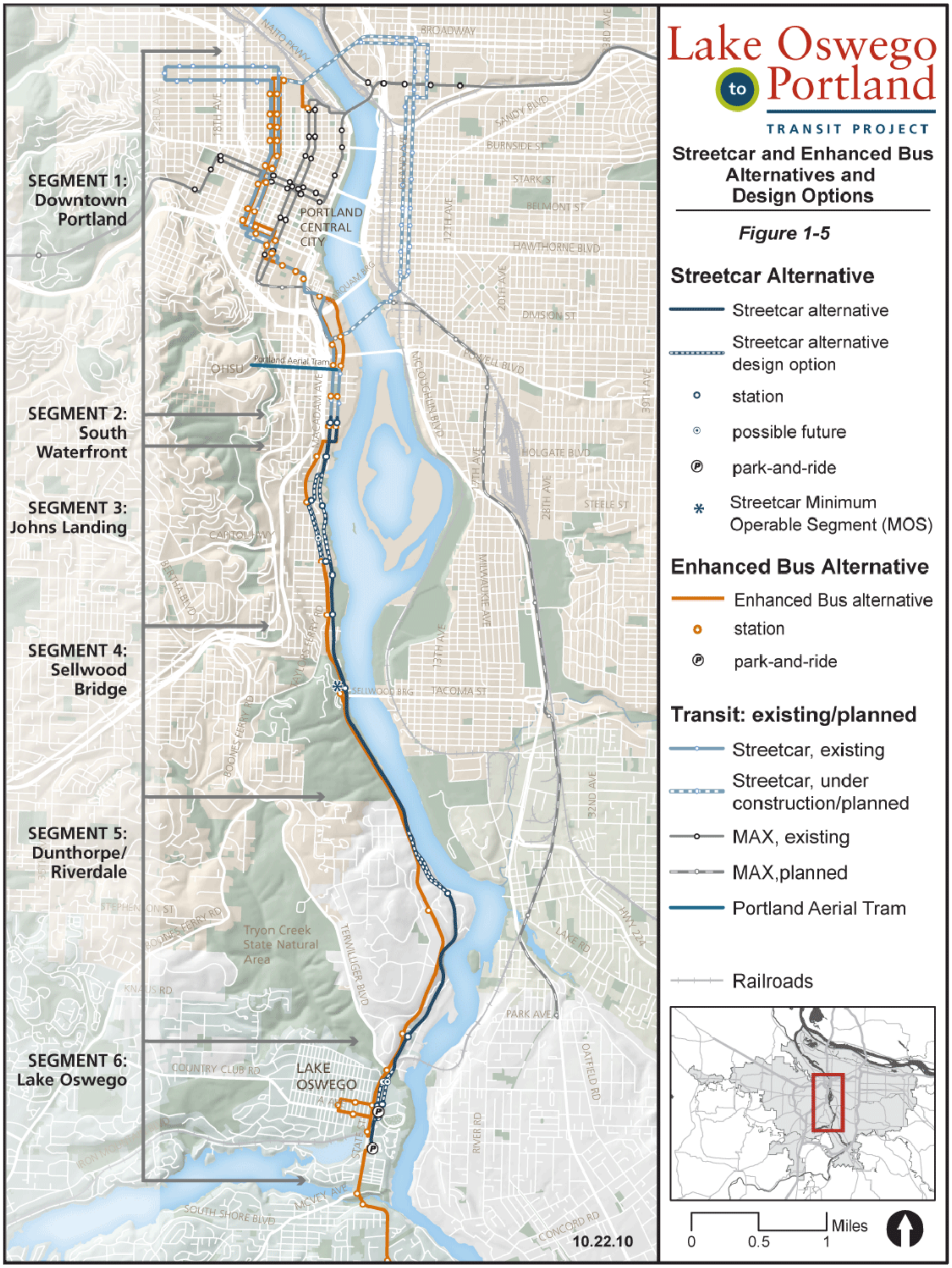


FIGURE 1-5 STREETCAR AND ENHANCED BUS ALTERNATIVES AND DESIGN OPTIONS

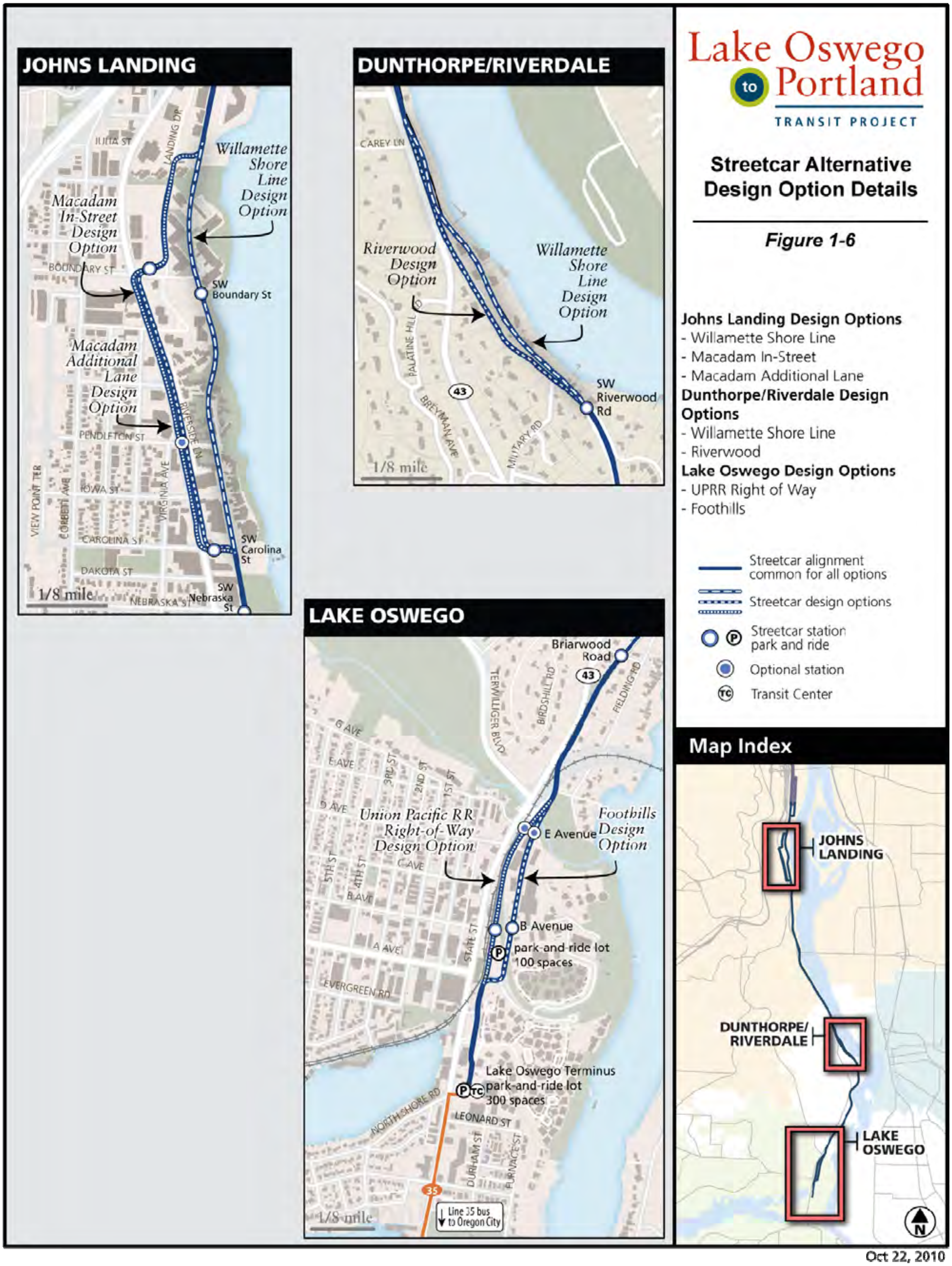


FIGURE 1-6 STREETCAR ALTERNATIVE DESIGN OPTIONS DETAILS

4. Sellwood Bridge Segment. The Sellwood Bridge Segment extends from Miles Street to the southern end of Powers Marine Park. Generally, the streetcar alignment would be located in the Willamette Shore Line right of way, except for the area between Stephens Creek and approximately 1,200 feet south of the Sellwood Bridge. In this area, the streetcar alignment would be constructed in conjunction with the planned west interchange improvements with the Sellwood Bridge (the streetcar would be located slightly east of the existing Willamette Shore Line right of way). The design and construction of the streetcar alignment under this design option would be coordinated with the design and construction of the new interchange for the Sellwood Bridge. There would be one new streetcar station within this segment (Sellwood Bridge Station).

5. Dunthorpe/Riverdale Segment. The Dunthorpe/Riverdale Segment extends between the southern end of Powers Marine Park and SW Briarwood Road. There are two design options in this segment: Willamette Shore Line Design Option and Riverwood In-Street Design Option. Both options would share a common alignment within the Willamette Shore Line right of way, generally north of where SW Riverwood Road intersects with Highway 43 and generally south of the intersection of SW Military Road and SW Riverwood Road. One new streetcar station is proposed within this segment, generally common to both design options (Riverwood Station). Following is a description of how the design options would differ:

- **a.** ***The Willamette Shore Line Design Option*** would generally locate the new streetcar alignment in the existing Willamette Shore Line right of way between the intersections of SW Riverwood Road and Highway 43 and SW Riverwood Road and SW Military Road.

- **b.** ***The Riverwood Design Option*** would locate the new streetcar alignment generally adjacent to Highway 43, north of SW Riverwood Road, and within the right of way of SW Riverwood Road, generally between where it intersects with Highway 43 (that intersection would be closed) and where it intersects SW Military Road. Except for the closure of the Highway 43 and SW Riverwood Road intersection, SW Riverwood Road would remain open to traffic with joint operation with streetcars.

6. Lake Oswego Segment. The Lake Oswego Segment extends between SW Briarwood Road and the Lake Oswego Terminus Station. There are two design options within this segment: the UPRR ROW design option and the Foothills Design Option. Both options would generally be the same in two sections: 1) the new streetcar line alignment would extend south from SW Briarwood Road to where the alignment would cross under the existing UPRR tracks; and 2) the new streetcar alignment would be located within a new roadway that would extend south from SW A Avenue to the alignment's terminus near the intersection of N State Street and Northshore Road. Both options would provide for a new bicycle and pedestrian connection under the existing UPRR tracks. There would be two stations within this segment, one that would be common to the two design options (Lake Oswego Terminus Station). An optional station at E Avenue is also under consideration.

This segment would include two park-and-ride lots, both of which would be generally common to the two design options. Following is a description of how the design options would differ:

- **a.** ***The UPRR ROW Design Option*** would extend the streetcar alignment south, generally in the UPRR right of way, from its under crossing of the existing UPRR tracks to SW A Avenue. The B Avenue Station would be located on the west side of the 100-space surface park-and-ride lot.

b. ***The Foothills Design Option*** would extend the streetcar alignment south from its under crossing of the UPRR tracks to SW A Avenue generally within the right of way of a new general purpose roadway (Foothills Road), which would be built as part of the Streetcar Alternative.

1.4.3.2 Transit Operations

This section describes transit operations under the Streetcar Alternative, generally compared to the No-Build Alternative (see Table 1-2). Figure 1-3 provides an illustration of the transit lines in the vicinity of the corridor under the Streetcar Alternative. There would be no difference in transit operations under any of the design options under consideration.

The Streetcar Alternative would extend the existing Portland Streetcar line from its current southern terminus at Lowell Street to the Lake Oswego Terminus Station in downtown Lake Oswego, expanding the streetcar length from 4 miles to 9.9 to 10 miles (depending on design option). The total round trip running time of the streetcar line between 23rd Avenue and downtown Lake Oswego (10 miles) in 2035 would be 105 or 112 minutes, excluding layover (based on the Willamette Shore Line and Macadam design options in the Johns Landing Segment, respectively). In comparison, under the No-Build Alternative the round trip running time for the streetcar line between 23rd Avenue and Lowell Street (4 miles) would be 68 minutes.

With the extension of streetcar service to Lake Oswego, Line 35 service between Lake Oswego and downtown Portland would be eliminated. The remainder of Line 35 between Oregon City and Lake Oswego would be combined with Line 78, in effect to create a new route between Oregon City and Beaverton. The new bus route and other TriMet transit routes serving downtown Lake Oswego would be rerouted to serve the relocated Lake Oswego Transit Center, which would be adjacent to Lake Oswego Terminus Station.

1.4.3.3 Construction Phasing Options

This section summarizes Streetcar Alternative construction phasing options currently under consideration – neither the No-Build Alternative nor the Enhanced Bus Alternative include construction phasing options. Currently, there are two types of construction phasing options or scenarios under consideration: 1) finance-related and 2) external project related. The Streetcar Alternative evaluated in this Technical Report and the DEIS is as Full-Project Construction. Should the Streetcar Alternative with phasing be selected as the Locally Preferred Alternative, during preliminary engineering (PE) additional analysis of environmental impacts resulting from the interim project alignment (as opposed to Full-Project Construction) will be conducted and additional opportunity for public review and comment may be required.

A. Finance-Related Phasing Options
Following is a description of the two finance-related phasing options currently under consideration.

- **Full-Project Construction.** Under the first construction phasing option, the project would be constructed and opened in its entirety as described within Section 2.2.2.

- **Sellwood Bridge Minimum Operable Segment (MOS).** Under the Sellwood Bridge MOS phasing option, the Streetcar Alternative would be initially constructed between SW Lowell Street and the Sellwood Bridge, with a second construction phase between the Sellwood Bridge and the Lake Oswego Terminus Station occurring prior to 2035. Under this construction phasing option, there would be no additional park-and-ride facilities in the corridor, compared to existing conditions. Under this phasing option, Line 35 would operate between Oregon City and the Nevada Street Station; frequencies would be adjusted to meet demand. Service and bus stops served exclusively by Line 35 would be deleted between the Nevada Station and downtown Portland.

B. External Project Coordination Related Phasing Options
Following is a description of phasing options related to the coordination of the Streetcar Alternative, if it is selected as the LPA, and other external projects. These external project coordination related phasing options represent interim steps in the construction process that would be taken to implement the Streetcar Alternative.

- **South Waterfront Segment Phasing Options.** If the planned and programmed South Portal roadway improvements are not in place or would not be constructed concurrently with the Streetcar Alternative, there would be two options for proceeding with construction of the streetcar alignment in the segment: 1) a different streetcar alignment using the Willamette Shore Line right of way would be initially constructed within the South Waterfront Segment; or 2) the streetcar alignment and its required infrastructure improvements would be constructed consistent with the alignment under the Full-Project Construction phasing option, but other non-project roadway improvements would be constructed at a later date by others. If the Willamette Shore Line right of way were to be used, then, when the South Portal roadway improvements were made, the streetcar alignment would be reconstructed consistent. The transit operating characteristics of the Streetcar Alternative would not be affected by this phasing option.

- **Sellwood Bridge Segment Phasing Options**. The Sellwood Bridge Segment includes two phasing options for the Streetcar Alternative that reflect two potential phasing options or scenarios for construction of the project in relationship to construction of a proposed new interchange that is planned to occur with the Sellwood Bridge replacement project. If the new interchange is constructed prior to or concurrently with the Streetcar Alternative, the initial and long-term streetcar alignment would be based on the new interchange design. The new interchange design is the basis for the analysis in this technical report and the DEIS. If the proposed interchange is constructed after the Streetcar Alternative, then the initial streetcar alignment to be constructed would be in the Willamette Shore Line right of way. Subsequently, when the proposed interchange is constructed, the Sellwood Bridge replacement project would relocate the streetcar alignment with the new interchange design. Therefore, the long-term streetcar alignment would be the new interchange and the Willamette Shore Line phasing option would only be implemented as an interim alignment. Therefore, the two design options in this segment do not constitute a choice of alignments – instead they represent two construction phasing scenarios, dependent upon how external conditions transpire.

- The Foothills Design Option. The Foothills design option of the Streetcar Alternative is based on roadway improvements that would occur under the City of Lake Oswego's Foothills redevelopment project. If those roadway improvements are not constructed prior to or concurrently with construction of the streetcar alignment, then the Lake Oswego to Portland Transit Project would construct the streetcar alignment and required infrastructure improvements using the same alignment and the roadway improvements would be added at a later date by others.

2. PUBLIC TRANSPORTATION

Transit service in the corridor is primarily provided by TriMet's fixed-route, fixed-schedule buses operating in mixed traffic on Highway 43 and other arterial and collector roadways. The corridor includes one transit center, which is an on-street facility located in downtown Lake Oswego. The transit center is served by four bus routes, including: two that provide a feeder function with suburb-to-suburb connections (Line 37 and Line 78); one that provides peak-only service to downtown Portland and provides suburb-to-suburb connections in the midday (Line 36); and one that provides all day trunk route service from Oregon City to downtown Portland via the Lake Oswego Transit Center (Line 35).

In the northern portion of the corridor, public transit service also includes Line 43 Taylors Ferry which operates on SW Corbett Avenue and Macadam Avenue, streetcar service on SW Moody Avenue, connecting Northwest and downtown Portland to SW Lowell Street and aerial tram service between SW Gibbs Street at SW Moody Avenue and the Oregon Health and Sciences University (OHSU). The corridor also includes an excursion trolley operating on the existing Willamette Shore Line railroad.

2.1 Public Transportation Affected Environment

There are three fixed-route transit providers in the Lake Oswego to Portland corridor. The Tri-County Metropolitan Transportation District of Oregon (TriMet) is the mass transit operating agency in the Portland metropolitan area. TriMet is the largest transit district in Oregon and the fifth largest on the West Coast. Under Oregon law (ORS 267), TriMet is a non-profit, municipal corporation operating in the urbanized portion of three Oregon counties: Multnomah, Clackamas, and Washington. Its operating area covers 575 square miles and serves a population of approximately 1.3 million.

Portland Streetcar operates between South Waterfront and Northwest Portland through downtown Portland. Portland Streetcar is managed by the Portland Bureau of Transportation, under the direction of the Commissioner-in-charge of Transportation. The City of Portland contracts with Portland Streetcar, Inc. to construct and operate the Streetcar system. Portland Streetcar, Inc. is a private non-profit corporation. PSI contracts with TriMet to operate the streetcars. OHSU, through an intergovernmental agreement with the City of Portland, operates the Portland Aerial Tram, while the City is responsible for maintenance.

The Oregon Electric Railway Historical Society (a not-for-profit Oregon Corporation) has operated weekend and special event excursion service on the Willamette Shore Trolley since 1987 through an agreement with the City of Lake Oswego and TriMet. TriMet, representing a consortium of seven local, regional and state agencies, is responsible for maintenance of the trackway.

2.1.1 Transit Lines, Operations and Facilities

TriMet's current fleet of 652 buses serves 81 bus lines and seasonal shuttles with 7,155 bus stops and 1,040 bus shelters. There are 164 miles of frequent service bus lines on 12 routes that provide 15-minute or better service throughout the day, 7 days a week. The 84-station MAX light rail system is 52 miles long and also operates at least every 15 minutes. The 14.7-mile WES Commuter Rail service provides eight peak period trips in each direction during weekdays, serving five stations. In addition to fixed-route bus and MAX service, TriMet operates 254 LIFT vehicles and 15 sedans, providing door-to-door service for people with special needs.

Table 2.1-1 summarizes TriMet's existing fixed route service. Overall, 90 percent of people in the TriMet district live within one-half mile of TriMet service.

Table 2.1-1 Number and Length of Existing TriMet Fixed Route Transit Lines

	Streetcar[1]	MAX LRT	Frequent Bus	Total Bus
Routes	1	4	12	81
Length (miles)	8	52	164	792

[1] Includes 2010 operations between NW 23rd Avenue and SW Lowell Street. The Eastside Loop Streetcar Project is currently under construction and is scheduled to open in 2012.
Source: TriMet and Portland Streetcar Inc.; February 2010.

The Portland Streetcar operates four miles between the intersection of NW 23rd Avenue and NW Northrup Street and SW Moody Avenue and SW Lowell Street. Streetcars operate approximately every 13 minutes during most of the day and less frequently in the evening and weekends. An extension of Portland Streetcar from NW Northrup Street to the OMSI district is currently under construction and scheduled to open in 2012 and will provide approximately 12-minute frequency between those two locations.

The Portland Aerial Tram generally operates daily between South Waterfront and the OHSU campus on SW Sam Jackson Park Road on Marquam Hill, with Sunday operations only in the summer. The Marquam Hill area also includes the Shriners Hospital for Children, and the Veterans Affairs Medical Center.

2.1.2 Current Ridership, Operating Revenue, and Operating Expenses

For fiscal year (FY) 2009, TriMet weekday system boarding rides (bus and light rail) averaged approximately 322,900 boarding rides, with 215,300 on bus and 107,600 on light rail. Total weekend ridership (bus and light rail) averaged 351,800 trips. In addition, weekday boarding rides on streetcar averaged 12,100 during the same period.

Between FY 1999 and FY 2009, TriMet's annual systemwide farebox revenues increased from $40.6 million to $88.7 million. Costs for operations and maintenance during this period increased from $141.5 million to $261.1 million. Fare revenue as a percentage of the cost of operation and maintenance improved from 28.7 percent to 34.0 percent and the average operations cost per boarding ride for the entire fixed-route system increased from $1.85 to $2.57, reflecting inflation and service expansion to lower ridership areas and times. Cost per boarding ride for light rail, at $1.92, is lower than that for buses, at $2.88 (FY 2009). Cost per boarding ride for the Portland Streetcar is $1.30 (FY 2009).

2.2 Travel Behavior

The basic unit of measurement used in describing travel behavior is the "person trip," which is a trip made by one person from a point of origin to a destination, via any travel mode. Several trip variables, including the origin, destination, mode and purpose of the trip, further describe travel behavior.

For 2005, the transportation facilities in the Lake Oswego-Portland Corridor carry approximately 27,200 person trips from the corridor to the Portland central business district (CBD) on an average weekday. Of these, approximately 2,100 (8 percent) were on the transit system. Of the 3,700 daily work trips from the corridor to the CBD, 700 (18 percent) were on transit.

2.3 Transit Impacts

This section presents the effects that project alternatives and options would have on the transit system in the corridor.

The No-Build Alternative represents the service characteristics of the 2035 financially constrained transit network associated with the *2035 Regional Transportation Plan* (Metro) (see Figure 2.3-1) without the proposed transit investment in the corridor. The corridor's bus network would vary by alternative, but would not be affected by the Streetcar design options under consideration. See Figures 2.3-2 and 2.3-3 for the Enhanced Bus Alternative and Streetcar Alternative transit networks. Appendix 2D includes maps (Figures 2D-1 through 2D-10) of the individual transit routes that would be modified under the No-Build, Streetcar and Enhanced Bus alternatives.

The transit analysis includes a distinction in Segment 3 Johns Landing between the Willamette Shore Line Design Option and the two design options that would operate in SW Macadam Avenue (Macadam Additional Lane and Macadam In-Street design options). The Macadam In-Street Design Option would include the streetcar operating in mixed traffic in the existing outside lanes of SW Macadam Avenue between SW Carolina Street and SW Boundary Street. The Macadam Additional Lane Design option would include a third northbound lane between SW Carolina Street and SW Boundary Street with streetcar operating in mixed traffic.

2.3.1 Amount of Service

The amount of transit service provided is measured by daily transit vehicle hours traveled (VHT) in revenue service, daily transit vehicle miles traveled (VMT) in revenue service, and daily place-miles of service. Daily VHT are the cumulative time that transit vehicles are in service and daily VMT are the distance they travel, independent of the size of the vehicle. Daily is defined as an average weekday in the year 2035. Place-miles refers to the total carrying capacity (seated and standing) of each bus or train type and is calculated by multiplying the vehicle capacity of each bus or light rail vehicle type by the daily VMT for each vehicle type. Place-miles highlight differences between alternatives caused by a different mix of vehicle types and levels of service. Table 2.3-1 summarizes these transit service characteristics.

Table 2.3-1 Average Weekday Corridor[1] Transit Service Characteristics, Year 2035

	No-Build	Enhanced Bus	Streetcar[2] Willamette Shore Line	Streetcar[2] Macadam Avenue design options
Transit VMT				
Bus	3,160	3,780	2,400	2,400
Streetcar[2]	320	320	1,300	1,330
Total	3,480	4,100	3,700	3,730
Percent Change	N/A	18%	6%	7%
Transit VHT				
Bus	200	240	140	140
Streetcar[2]	30	30	80	90
Total	230	270	220	230
Percent Change	N/A	17%	-4%	0%
Place Miles				
Bus	161,160	192,780	122,400	122,400
Streetcar[2]	29,440	29,440	119,600	122,360
Total	190,600	222,220	242,000	244,760
Percent Change	N/A	17%	27%	28%

Source: Metro, 2010.
Note: VMT = vehicle miles traveled; VHT = vehicle hours traveled; N/A = not applicable.
1 Excludes downtown Portland and NW Portland.
2 Streetcar data is from the RiverPlace Station south to Lake Oswego. In the 2005 base year the streetcar did not travel south of the RiverPlace Station. There would be differences in transit service characteristics for the Streetcar Alternative design options in Segment 3 Johns Landing. No other design options include differences in transit service characteristics.

The Enhanced Bus Alternative would increase the corridor transit VMT by 18 percent, the corridor transit VHT by 17 percent and the corridor place miles by 17 percent compared with the No-Build Alternative. The Streetcar Alternative would increase the corridor transit VMT by 7 percent (Macadam Avenue design options) and 6 percent (Willamette Shore Line design option). Although the Streetcar Alternative (with all design options) would provide more frequent service in the corridor than the No-Build Alternative bus (lines 35 and 36), it would result in less transit VHT than the No-Build Alternative because the new streetcar would connect to existing streetcar at Lowell Street, replacing the No-Build Alternative bus lines that extend through downtown to Union Station. Conversely, the transit VHT for the Enhanced Bus Alternative would increase over the No-Build Alternative because it would provide more frequent service but would also be routed to Union Station. The Streetcar Alternative would include the largest increase in place miles, with a 27 percent (Willamette Shore Line design option) to 28 percent (Macadam Avenue design options) increase over the No-Build Alternative.

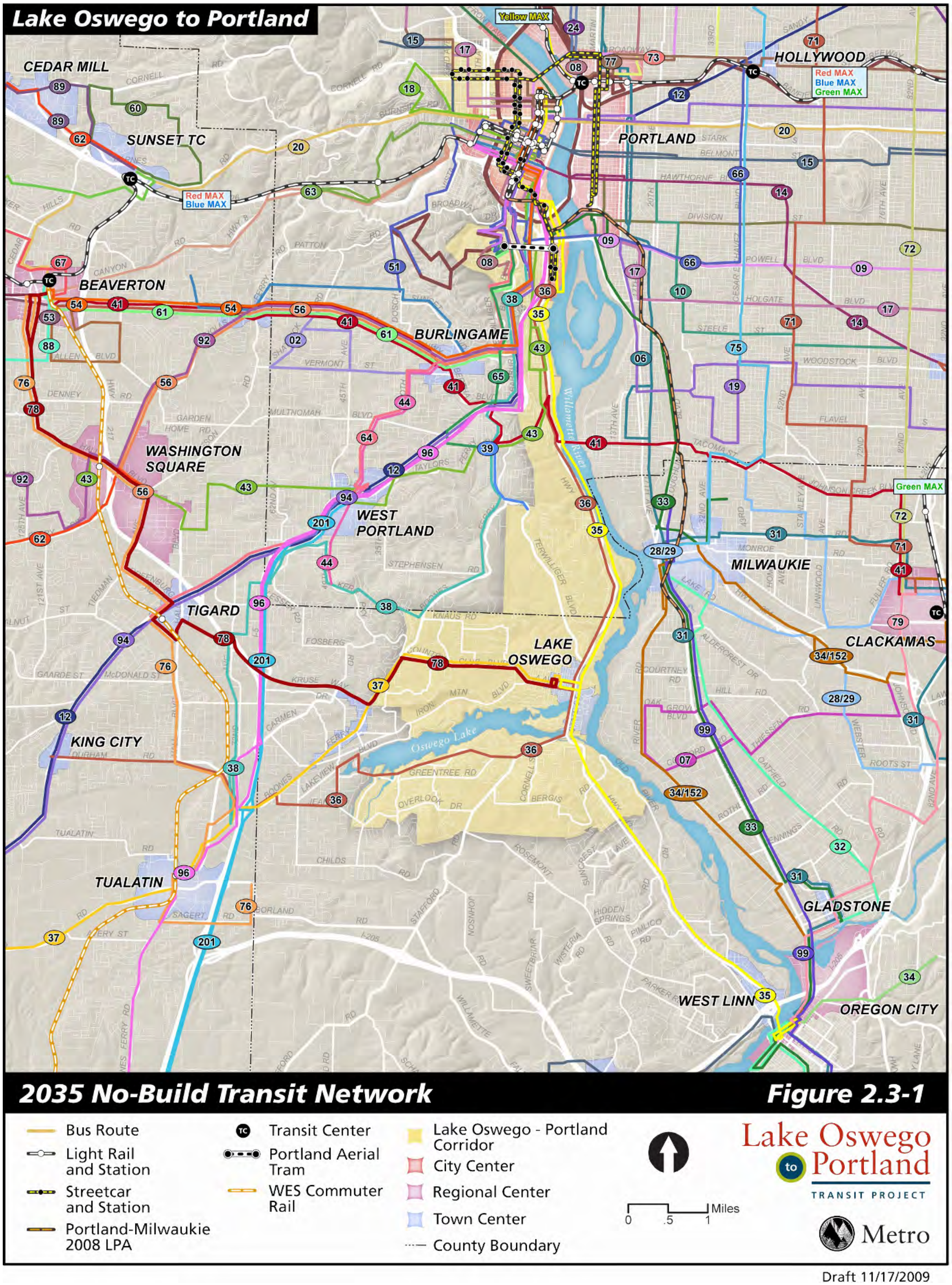


FIGURE 2.3-1 2035 NO-BUILD TRANSIT NETWORK

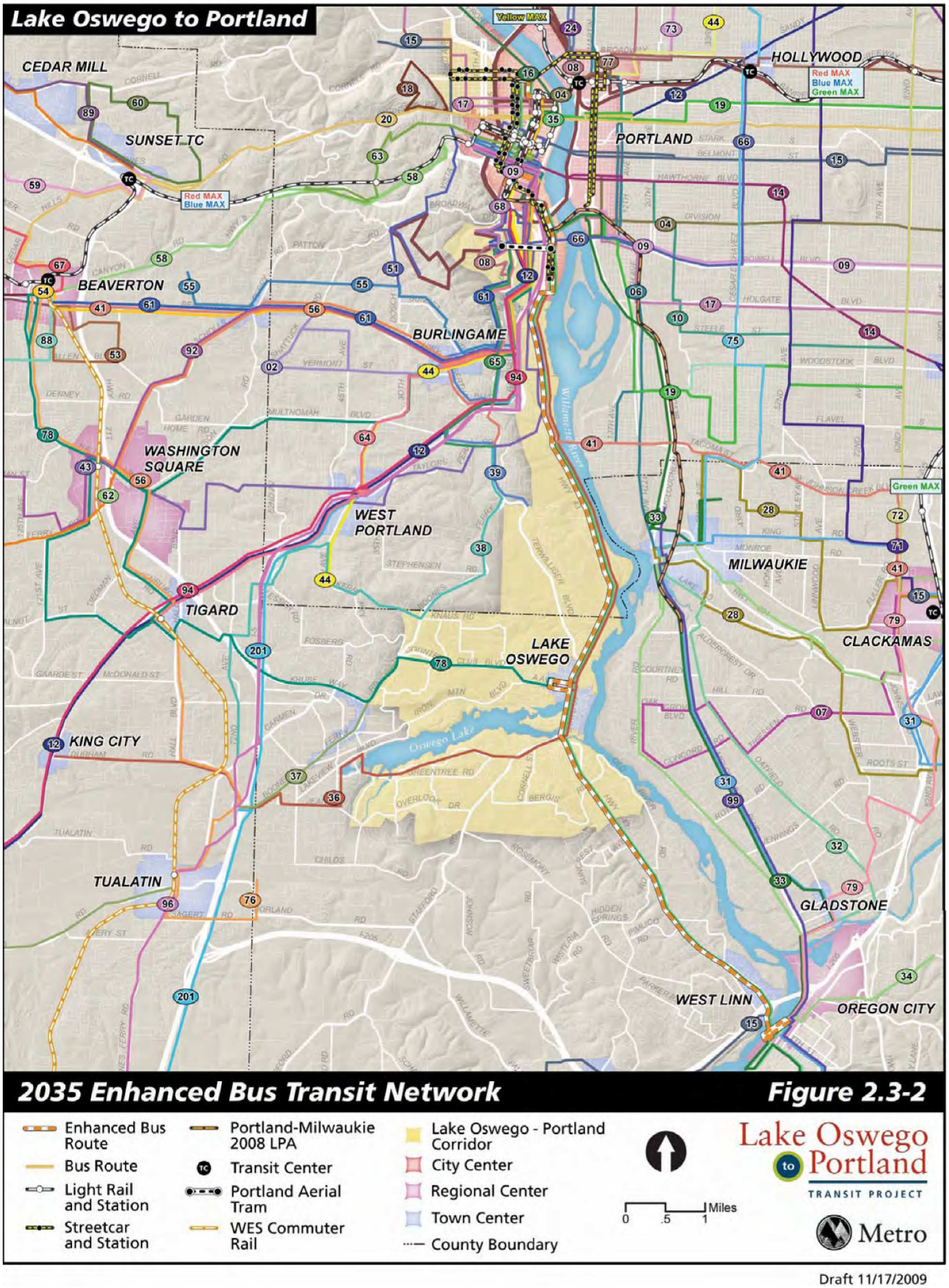


FIGURE 2.3-2 2035 ENHANCED BUS TRANSIT NETWORK

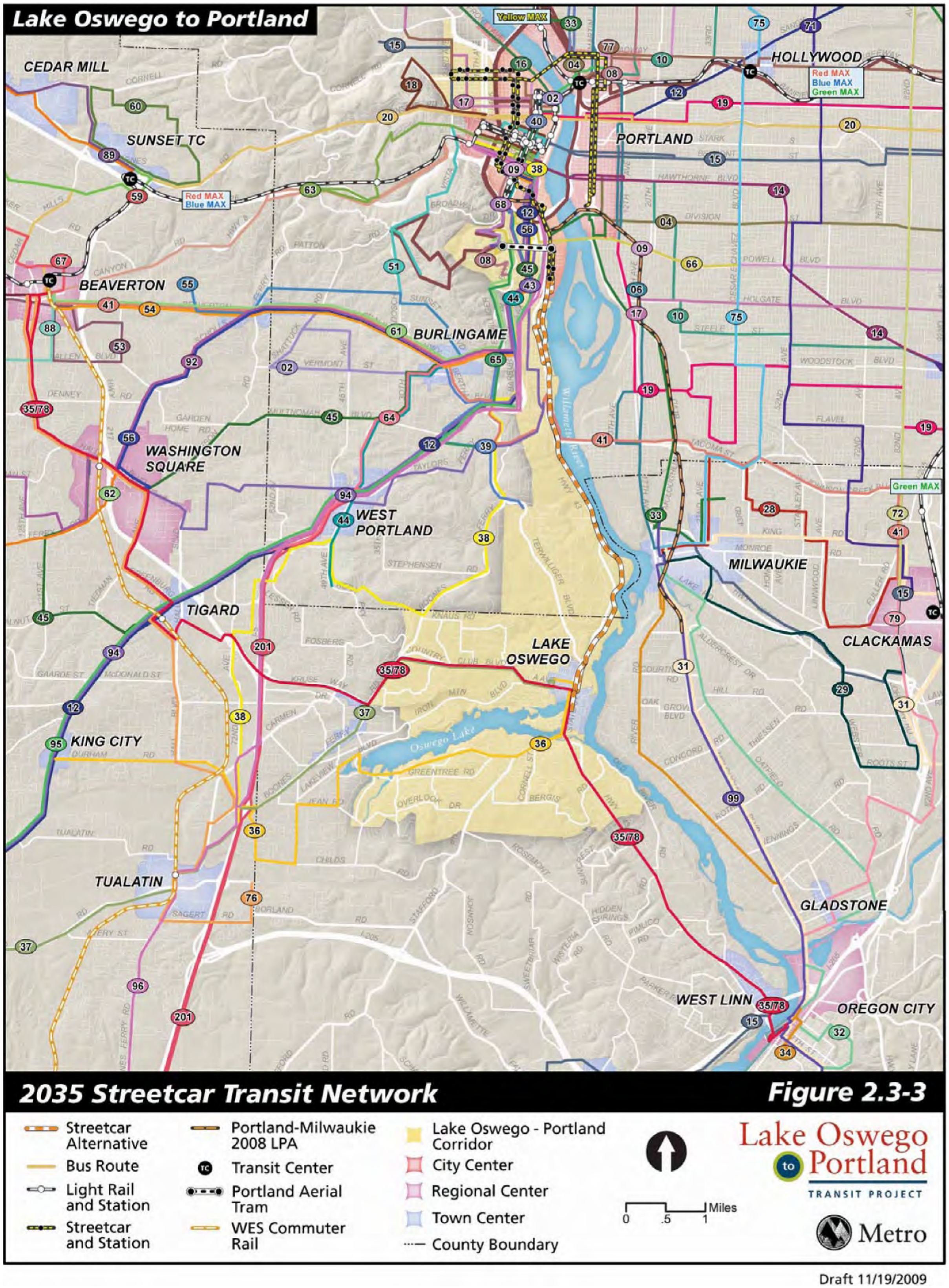


FIGURE 2.3-3 2035 STREETCAR TRANSIT NETWORK

2.3.2 Service Growth

Service growth under the No-Build Alternative would be constrained by available revenue sources, consistent with the Financially Constrained transit network in the 2035 RTP. With the No-Build Alternative, weekday corridor transit VMT and VHT would increase compared to existing levels by 41 and 53 percent, respectively. The greater percentage increase in VHT compared to VMT indicates that transit speeds in the corridor would slow relative to existing conditions due to increasingly congested and slowing traffic on highways, arterials and local streets. The build alternatives would result in increased transit capacity in the corridor and a level of service similar to the No-Build Alternative outside of the corridor.

The Enhanced Bus Alternative would operate between the Oregon City Transit Center and downtown Portland. South of Lake Oswego, service would be similar to the existing Line 35 Macadam. Modifications to existing service would occur north of Lake Oswego, including limited stop service to improve travel times in the corridor. A new park-and-ride lot at the Lake Oswego Terminus would be constructed under the Streetcar Alternative and the Enhanced Bus Alternative. A second, smaller park and ride location would be constructed at the B Avenue station under the Streetcar Alternative only.

The Streetcar Alternative would result in an approximately 5.9 to 6.0 mile extension of the existing Portland Streetcar line from SW Lowell Street in South Waterfront to downtown Lake Oswego. Streetcars would operate every 7.5 minutes along the extension in the peak direction to meet projected demand during the peak period. The bus feeder network would be reconfigured to provide connectivity with streetcar stations and transit centers. Bus service that would be parallel to and duplicative of the proposed Streetcar alignment would be eliminated[2].

2.3.3 Travel Time

Transit travel times are assessed using in-vehicle time and total travel time, as shown in Table 2.3-2. This table summarizes the change in p.m. peak hour in-vehicle and total travel time between the No-Build, Enhanced Bus and Streetcar alternatives. Transit in-vehicle travel times would be reduced under the Enhanced Bus Alternative by three minutes between Southwest Lowell Street and downtown Lake Oswego, compared to the No-Build Alternative; and transit in-vehicle travel times would be reduced by 9 to 14 minutes under the Streetcar Alternative, compared to the No-Build Alternative. Under the Streetcar Alternative, the Willamette Shore Line design option in Segment 3 – Johns Landing would reduce transit travel times between corridor destinations by approximately four minutes, compared to the two Macadam Avenue design options.

2.3.4 Reliability

Table 2.3-3 summarizes three measures of transit reliability in the corridor: miles of separated right-of-way, the number of passenger miles that would occur on that separated right-of-way, and the percentage of corridor passenger miles that would occur in separated right-of-way. In the TriMet system, transit lines, which use reserved or separated right-of-way, exhibit a greater proportion of on-time arrivals than lines operating in mixed traffic. Transit service that would utilize little or no reserved right-of-way would be subject to traffic congestion and delay which would typically result in worse on-time performance.

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[2] During project implementation, TriMet will determine the final bus operations plan to support streetcar service in the corridor.

Table 2.3-2 Transit and Auto Average Weekday P.M. Peak Hour Travel Times to Lake Oswego from Selected Locations (in minutes, year 2035)

					Streetcar[1]			
	No-Build		Enhanced Bus		Willamette Shore Line		Macadam Avenue Design Options	
Origin/Destination	Auto	Transit	Auto	Transit	Auto	Transit	Auto	Transit
In-Vehicle Travel Time[2]								
To Lake Oswego from:								
Portland State University	28	42	28	39	27	29	27	33
SW Lowell Street	22	32	22	29	22	18	22	22
Total Travel Time[3]								
To Lake Oswego from:								
Portland State University	33	53	33	48	32	38	32	42
SW Lowell Street	27	43	27	37	27	27	27	31

Source: Metro, 2010.

1 Except in Segment 3 – Johns Landing, there would be no difference in transit travel times for the Streetcar Alternative by design option. This table presents the differences in Segment 3 due to either of the two Macadam Avenue design options (i.e. Macadam Additional Lane and Macadam In-Street) and the Willamette Shore Line Design Option.

2 In minutes; in-vehicle time is the time that a passenger would spend within a public transit vehicle or an automobile.

3 In minutes; total travel time includes walk access times at the start and end of a trip, in-vehicle time and wait time, if any.

Table 2.3-3 Measures of Transit Reliability in the Corridor, Year 2035[1, 2]

			Streetcar[3]	
Rail Right of Way Measure	No-Build	Enhanced Bus	Willamette Shore Line	Macadam Avenue design options
Miles of Separated or Exclusive ROW[4]	0	0	4.8	4.0
Average Weekday Passenger Miles in Exclusive ROW[5]	0	0	39,700	32,500
Percent of Total Corridor Passenger Miles	0%	0%	71%	60%

Source: Metro, 2010.

Note: ROW = right of way.

1 Some streetcar sections would provide an exclusive grade and/or barrier-separated transit right of way.

2 Excludes Portland CBD and NW Portland districts to isolate transit lines that primarily serve the corridor.

3 Except in Segment 3 – Johns Landing, there would be no difference in transit reliability measures for the Streetcar Alternative by design option. This table presents the differences in Segment 3 due to either of the two Macadam Avenue design options (i.e. Macadam In-Street and Macadam Additional Lane) and the Willamette Shore Line Design Option.

4 Miles of Separated or Exclusive ROW based on Streetcar Alternative as modeled. The model assumed either Macadam or Willamette Shore Line design options in Segment 3, Willamette Shore Line in Segments 4 and 5 and Foothills Design Option in Segment 6.

5 Rail right of way in the corridor would also be provided by the Milwaukie Light Rail Project for all alternatives. This measure considers only additional rail in exclusive right of way provided by the Lake Oswego to Portland Transit Project.

The Enhanced Bus Alternative would result in no additional passenger miles in separated right of way in the corridor compared to the No-Build Alternative. The Streetcar Alternative includes 4.0 miles of separated right-of-way and 32,500 separated right-of-way passenger miles for the Macadam In-Street/Macadam Additional Lane design options and 4.8 miles of separated right-of-way or 39,700 separated right-of-way passenger miles for the Willamette Shore Line Design Option. Of the average weekday streetcar passenger miles in the corridor in 2035 (excluding passenger miles on the Milwaukie light rail), approximately 60 and 71 percent of transit passenger miles would be in separated or exclusive right-of-way with the Streetcar Alternative for the Macadam In-Street/ Macadam Additional Lane Design Option or the Willamette Shore Line Design Option, respectively.

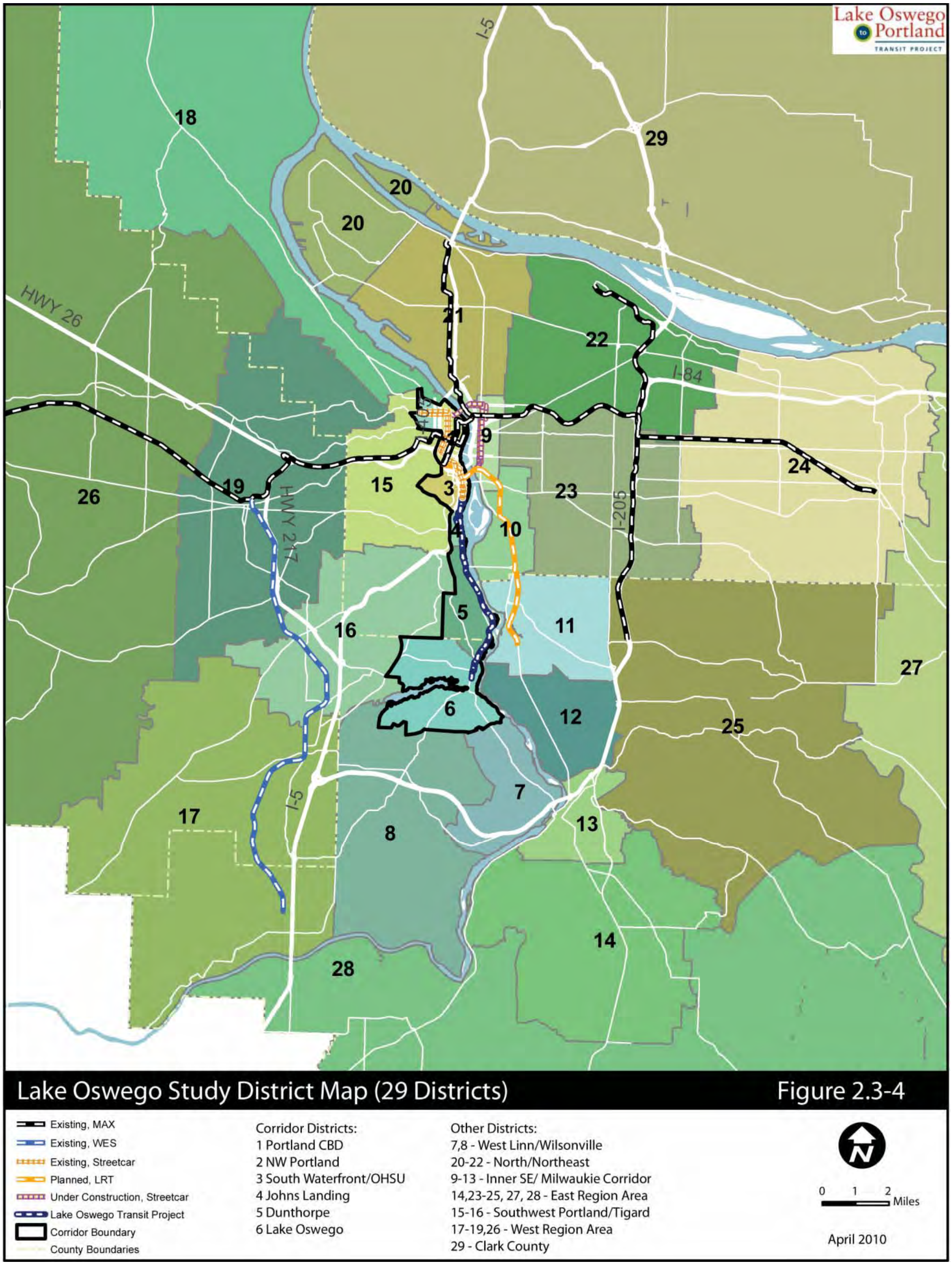
2.3.5 Transit Ridership

This section summarizes transit ridership data including; line boardings and peak load points for specific lines, corridor and total transit system ridership, work and non-work transit trips, transit mode share and Lake Oswego to Portland Streetcar and Enhanced Bus station boardings.

The transit ridership forecasts for the No-Build, Enhanced Bus and Streetcar alternatives summarized in this section were prepared using Metro's regional travel demand model for average weekdays in 2035. In Segment 3 – Johns Landing, the streetcar travel times and station locations would be similar with the Macadam In-Street and Macadam Additional Lane design options. The streetcar travel times and station locations with the Willamette Shore Line Design Option would be substantially different than the Macadam design options and would result in differences in overall streetcar ridership. The design options in all other segments would have similar streetcar travel times and station locations and there would be no difference in overall streetcar ridership due to those design options. Differences in transit ridership due to the design options in Segment 3 for the Streetcar Alternative are presented within this section.

- **Lake Oswego to Portland Line Ridership.** Table 2.3-4 summarizes average weekday boardings for corridor streetcar and bus lines in each alternative (bus lines 35, 36, 43 and 78), including the corridor boardings between Lake Oswego and Southwest Bancroft Street. In summary, the Enhanced Bus Alternative would produce a total of 19,980 daily boardings among these transit lines. In comparison, the Streetcar Alternative would result in 23,600 streetcar and bus boardings with the Willamette Shore Line design option and 23,110 streetcar and bus boardings with the Macadam Avenue design option. With the No-Build Alternative, the frequency of service assumed for the Line 35 Macadam would not be adequate to accommodate the forecast boardings. The corridor transit service assumed in each of the three build alternatives, however, was sized to accommodate the forecast demand.
- **Corridor and Total System-wide Ridership.** Table 2.3-5 shows that the total average daily transit ridership in the corridor would increase over the No-Build Alternative by 1,800 with the Enhanced Bus Alternative and by 3,100 to 3,400 with the Streetcar Alternative. Total transit ridership in the system would increase over the No-Build Alternative by 2,400 with the Enhanced Bus Alternative and by 3,600 to 3,900 with the Streetcar Alternative. The increase in ridership outside the corridor with the Streetcar Alternative is due to the ability to through-route the southern portion of Line 35 with Line 78, thus providing a through transit connection between Oregon City Transit Center and Beaverton Transit Center.
- **Transit Trip Productions.** Transit trip productions refers to the number of transit trips that would be generated or "produced" under the various alternatives, both within the corridor and in the region. Increases in the number of transit trips produced would primarily be due to reductions in transit travel time and improved transit accessibility with the proposed streetcar line and bus line modifications. Reductions in transit trip productions would occur in areas where bus line modifications would result in loss of access to transit or access to less frequent transit. In summary, the Streetcar Alternative (Willamette Shore Line Design Option) would result in an increase of approximately 3,130 trips produced in the corridor and an additional 750 transit trips produced outside of the corridor, compared to the No-Build Alternative. The Streetcar Alternative with the Macadam In-Street and Macadam Additional Lane design options would result in increases of 2,970 trips generated within the corridor and 620 trips generated outside of the corridor.

FIG



Lake Oswego Study District Map (29 Districts) Figure 2.3-4

Table 2.3-4 Average Weekday Boarding Rides and Peak Loads for Corridor Transit Routes[1,2], Year 2035

Segment	No-Build	Enhanced Bus	Streetcar: Willamette Shore Line	Streetcar: Macadam Design Options
Streetcar				
Lake Oswego to Portland Streetcar (SW Bancroft St to Lake Oswego)	N/A	N/A	**11,930**	**11,170**
Bus				
35 Macadam (SW Bancroft St to Lake Oswego)	**8,590**	N/A	N/A	N/A
35 Enhanced Bus (SW Bancroft St to Lake Oswego)	N/A	**9,810**	N/A	N/A
36 King City to Lake Oswego	600	1,070	1,230	1,200
36 King City to Portland	1,310	N/A	N/A	N/A
3578 Beaverton to Oregon City	N/A	N/A	8,110	8,060
43 Washington Square to Portland	2,590	2,550	2,330	2,680
78 Beaverton to Lake Oswego	6,500	6,550	N/A	N/A
Bus Total	**19,590**	**19,980**	**11,670**	**11,940**
Total Boardings	**19,590**	**19,980**	**23,600**	**23,110**
P.M. Peak-Hour, Peak-Direction Peak Load Point[2]				
Portland Streetcar	554	652	N/A	N/A
Lake Oswego to Portland Streetcar	N/A	N/A	974	932
35 Macadam (LO to Union Station)	460	N/A	N/A	N/A
35 Enhanced Bus (LO to Union Station)	N/A	724	N/A	N/A

Source: Metro, 2010

[1] Corridor boarding rides are per line. Boardings Linked trips are counted twice if the passenger transfers from one transit line to another line.

[2] Boardings for No-Build and Enhanced Bus 35, and LO to Portland Streetcar are restricted to the segment between Lake Oswego and SW Bancroft Street for comparative purposes.

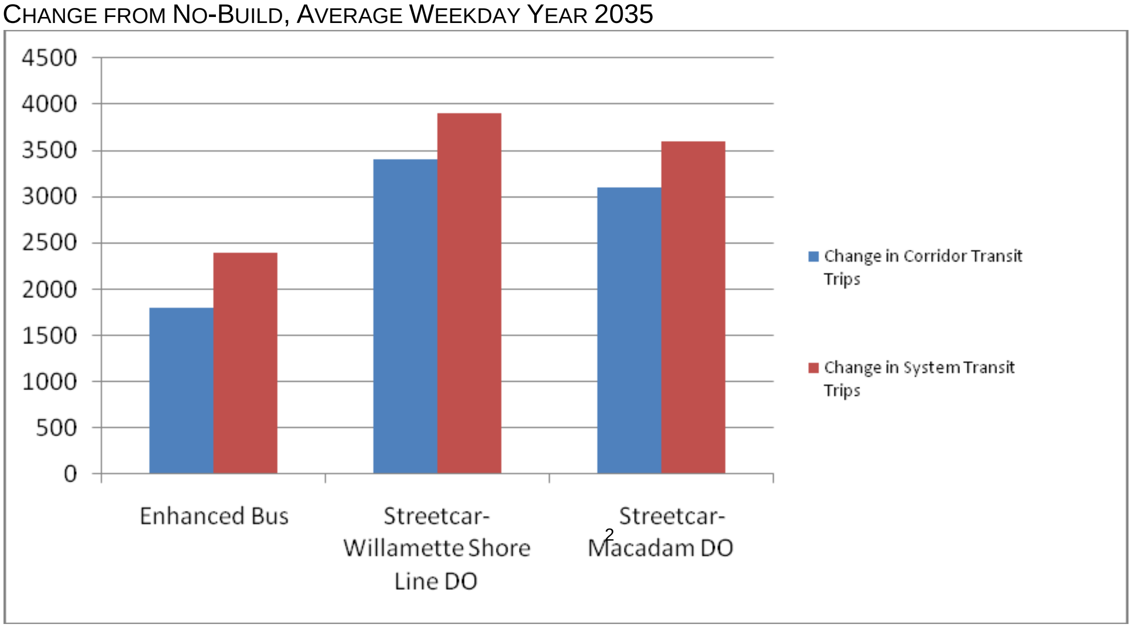
[3] The peak-load points for each line would be in the following locations: Portland Streetcar -- north of W Burnside St.; Lake Oswego to Portland Streetcar -- north of Lowell St.; Streetcar Loop -- south of NE Holladay St.; 35 Macadam -- north of Lowell St.; 35 Enhanced Bus -- north of SW Lowell St.

Table 2.3-5 Average Weekday Total Systemwide and Corridor Transit Ridership[1], Year 2035

Ridership area	Existing (2005)	No-Build	Enhanced Bus	Streetcar[2] Willamette Shore Line	Streetcar[2] Macadam Avenue design options
Total Corridor Transit Trips	103,600	231,900	233,700	235, 300	235,000
Change from Existing	N/A	128,300	130,100	131,700	131,400
Change from No-Build	N/A	N/A	1,800	3,400	3,200
Total Systemwide Transit Trips[2]	**267,300**	**583,800**	**586,200**	**587,700**	**587,400**

Source: Metro, 2010.
Note: N/A = not applicable
[1] Ridership is measured in person trips, which are also termed originating rides (i.e. one-way linked trips from an origin (e.g., home) to a destination (e.g., place of work or school), independent of whether the trip requires a transfer. A person traveling from home to work and back counts as two trips. Total corridor transit trips include all streetcar, bus, and light rail trips produced in or attracted to the Lake Oswego-Portland corridor. Excludes intra-Portland CBD and intra-NW Portland trips and trips between the Portland CBD and Northwest Portland (districts 1 and 2; see Figure 1.2-1).
[2] The design options in Segment 3 – Johns Landing would be the only design options that would result in a difference in Streetcar Alternative total corridor transit trips and total systemwide transit trips. This table presents the differences in Segment 3 due to either of the two Macadam design options (i.e. Macadam Additional Lane and Macadam In-Street) and the Willamette Shore Line design option.

FIGURE 2.3-5 ENHANCED BUS AND STREETCAR ALTERNATIVE CORRIDOR AND SYSTEM TRANSIT TRIPS[1] CHANGE FROM NO-BUILD, AVERAGE WEEKDAY YEAR 2035



Source: Metro, 2010 – see Table 2.3-5 for the illustrated data.
[1] Transit trips are one-way linked trips from an origin (e.g., home) to a destination (e.g., place of work or school), independent of whether the trip requires a transfer. A person traveling from home to work and back counts as two trips. Total corridor transit trips include all light rail, bus and streetcar trips produced in or attracted to the corridor. Intra-CBD trips are not included.
2 Except in Segment 3 – Johns Landing, there would be no difference in transit ridership for the Streetcar Alternative by design option. This table presents the differences in Segment 3 due to either of the two Macadam design options (i.e. Macadam Additional Lane and Macadam In-Street) and the Willamette Shore Line Design Option.

- **Work and Non-Work Transit Trips and Mode Share.** Table 2.3-6 shows projected transit trips and transit mode share for trips produced in the corridor that would be destined to Portland's central business district (CBD) for work and non-work purposes. The CBD is projected to have 147,830 jobs in 2035, accounting for 63 percent of the jobs in the corridor. The build alternatives would induce higher transit mode shares for home-based work trips destined to the CBD, compared to the No-Build Alternative.

- **Station Usage.** Table 2.2-7 summarizes individual station use for the Enhanced Bus and the Streetcar alternatives with the Macadam In-Street and Macadam Additional Lane and the Willamette Shore Line design options. With the Enhanced Bus alternative, the highest level of on/off activity would be at Albertsons, accounting for 16 percent of boardings and alightings between Lake Oswego and Southwest Lowell Street. With the Streetcar Alternative (under all design options), the most heavily used station along the streetcar extension would be the B Avenue station in downtown Lake Oswego. The B Avenue station would account for 29 percent of the streetcar boardings and alightings with all streetcar options.

Table 2.3-6 Average Weekday Work and Non-Work Transit Trips and Transit Mode Share Between the Corridor and Portland CBD, Year 2035

				Streetcar	
Trip Purpose	**Existing (2005)**	**No-Build**	**Enhanced Bus**	**Willamette Shore Line**	**Macadam Avenue Design Options**
Home-Based Work[1]					
Transit	940	5,860	6,380	6,920	6,860
Transit Mode Share	20%	43%	45%	49%	49%
Non-Work[2]					
Transit	1,760	9,500	9,890	9,880	9,880
Transit Mode Share	6%	14%	14%	14%	14%
Total					
Transit	2,700	15,360	16,270	16,740	16,800
Transit Mode Share	8%	19%	19%	20%	20%

Source: Metro, 2010.
Note: LRT = Light Rail Transit; N/A = not applicable.
1 Home-based work trips are defined as trips taken directly from one's home to one's place of work.
2 Non-work trips are defined as all trips that are not home-based work trips.

Table 2.3-7 Average Weekday Station Usage (Ons and Offs), Year 2035

	Enhanced Bus		Streetcar: Willamette Shore Line		Streetcar: Macadam Avenue Design Options	
Station	**Station Ons/Offs**	**% of Total Ons/Offs**	**Station Ons/Offs**	**% of Total Ons/Offs**	**Station Ons/Offs**	**% of Total Ons/Offs**
Hamilton Ct	275	3%	622	5%	583	5%
Boundary / Macadam	2,118	22%	0	0%	2,281	18%
Boundary (Shoreline)	0	0%	2,429	18%	0	0%
Carolina / Macadam	1,938	20%	0	0%	2,049	16%
Nebraska (Shoreline)	0	0%	2,178	16%	0	0%
Nevada	734	8%	755	6%	707	6%
Sellwood Bridge	116	1%	407	3%	365	3%
Riverwood Rd	136	1%	201	1%	197	2%
Briarwood Rd	62	1%	92	1%	86	1%
B Avenue	1,229	13%	3,868	29%	3,684	29%
Other Downtown LO stops (Enhanced Bus)	1,559	16%	0	0%	0	0%
Albertson's Station / P&R	1,578	16%	3,003	22%	2,832	22%
Total Station Ons/Offs	**9,745**		**13,555**		**12,784**	

Source: Metro, 2010.

3. TRAFFIC, FREIGHT AND PARKING

3.1 Methods

This section describes the approach for data collection, impacts analysis, and mitigation that the Lake Oswego to Portland Transit Project used for traffic and transit analysis. The analysis was developed to comply with the National Environmental Policy Act (NEPA), applicable state transportation policy, and local transportation planning policies and standards.

3.1.1 Related Laws and Regulations

ODOT and City of Portland Standards

Local traffic impacts were measured by impacts to intersection Level of Service (LOS), delay, and queuing. The Oregon Department of Transportation (ODOT) and the City of Portland have defined standards for intersection operations. A description of the development and application of these standards to local street operations is provided below.

The ODOT Analysis Procedures Manual (APM) requires that the performance standards from the Oregon Highway Plan (OHP) be used to analyze existing conditions and the No-Build Alternative. ODOT has jurisdiction over Highway 43, which runs north-south through the study area. The general OHP volume-to-capacity (v/c) standard for intersections on Highway 43 is 0.99 for the highest two consecutive hours of weekday traffic volumes. Two segments of Highway 43, between Bancroft Street and Taylors Ferry Road and between Terwilliger Boulevard and McVey Avenue, are designated as Special Transportation Areas (STA), which can have alternative operational standards applied.

The APM states that the LOS standards contained in the Highway Capacity Manual (HCM) should be used for the evaluation of all build alternatives. The v/c standard listed in the HDM for regional highways and for district/local roads is 0.85. For all other intersections in the study area under ODOT's jurisdiction, a v/c standard of 0.99, as stated in the OHP, will be applied to the build alternatives.

The results from the Synchro/SimTraffic intersection models for the intersections along Highway 43 are measured against the above standards for both the evening peak hours. Limited analysis of the morning peak hours was prepared for locations where the morning peak traffic could be important. Table 3.1-1 summarizes the intersection standards for ODOT.

For City of Portland roadways, driveways, and intersections in the study area, LOS standards from the Portland Bureau of Transportation (PBOT) apply. Like ODOT, PBOT has two tiers of standards—one that is used for the analysis of the No-Build Alternative and one for the build alternatives. The LOS standard in PBOT's Transportation System Plan (TSP) states that signalized intersections must meet LOS D in the No-Build Alternative. Unsignalized intersections must meet a standard of LOS E. These standards also apply to the build alternatives. However, in the case where intersections in the build alternatives do not meet the LOS standard, they are still considered to be performing acceptably if they pass PBOT's "do no worse" policy. That is, intersections in the build alternatives that fail to meet the LOS D/E standard, but perform better or the same as under the No-Build Alternative, meet PBOT's requirements. Table 3.1-1 summarizes the intersection standards for the City of Portland.

Table 3.1-1 ODOT and City of Portland Intersection Standards

Jurisdiction	Method	Existing	No Build	Build
ODOT (street intersections) [1,2]	V/C	0.99	0.99	0.99
City of Portland (signalized)[3]	LOS	D	D	D[4]
City of Portland (unsignalized)[3]	LOS	E	E	E[4]

[1] The standard stated in the Oregon Highway Plan applies to existing conditions and the No-Build Alternative.
[2] The standard stated in the Oregon Highway Design Manual applies to the build alternatives.
[3] Based on the Portland Transportation System Plan.
[4] PBOT also considers build alternatives to meet standards if they perform no worse than the No Build.

For purposes of the Draft Environmental Impact Statement (DEIS), if the project would degrade an intersection's performance to an unacceptable LOS, the project will work with the operating jurisdiction to develop a cost-effective solution to mitigate the intersection performance to the minimum of the peak hour standard. If vehicular queuing blockages occur with both the No-Build Alternative and the project, then the project would be mitigated to No-Build conditions.

If the No-Build Alternative does not meet warrants or safety criteria (e.g., traffic signal warrants, access spacing criteria) but the project does, the project would include measures to address the warrants or safety impacts.

3.1.2 Data Collection

The foundation of any traffic operations analysis is a clear and thorough understanding of existing conditions through the collection of detailed traffic data. The study area for the Lake Oswego to Portland Transit Project contains a diverse transportation system with a highway system, a network of local area roads, and bicycle and pedestrian systems. The traffic composition within the study area is mix of commuters, truck traffic, transit users, local business and residential traffic, and bicycle and pedestrian users.

The traffic data used for the analysis was collected primarily during the summer of 2009. Data included intersection turn movement counts on Highway 43 at 20 signalized intersections, 22 unsignalized intersections, and 28 driveways. AM peak hour counts were collected, at five locations that are evaluated in the PM peak hour where the total entering volume is higher in the AM peak hour. In addition, PM peak period travel time runs and queuing observations, as well as 24-hour classification counts at select locations along the highway, were collected. Bicycle and pedestrian counts were collected as part of the intersection turning movement counts. Traffic data collection occurred during August of 2009. Traffic counts were seasonally adjusted to represent the peak month of traffic volumes.

Traffic counts for this study were collected throughout the corridor. The detailed traffic count summary sheets and signal timing plans are included in a CD that accompanies this Technical Report.

The set of intersections that were evaluated is listed below.

A. OR Highway 43 in the John's Landing area at the following cross streets:

1. Bancroft Street
2. Moody Avenue
3. Hamilton Court
4. Seymore Court/Kelly Avenue
5. Julia Street
6. Richardson Court
7. Mitchell Street
8. Boundary Street/Landing Square
9. Sweeney Street
10. Riverside Lane
11. Flower Street
12. Pendleton Street
13. Iowa Street/driveway
14. Carolina Street
15. Dakota Street/driveway
16. Nebraska Street
17. Idaho Street
18. Vermont Street
19. Florida Street
20. California Street/driveway
21. Texas Street
22. Nevada Street
23. Taylor Ferry Road/Miles Street
24. Sellwood Ferry Road
25. Sellwood Bridge Connection
26. River View Cemetery Driveway
27. Radcliffe Road

B. OR Highway 43 Between John's Landing and Lake Oswego at the following cross streets:

1. Briarwood Road
2. Midvale Road/Elk Rock Road
3. Greenwood Road/Breyman Avenue
4. Military Road
5. Palatine Hill Road
6. Riverwood Road
7. Carey Lane
8. Riverdale Road

C. OR-43 in Lake Oswego at the following cross streets:

1. Terwilliger Boulevard connection/Stampher Road
2. E Avenue
3. D Avenue
4. B Avenue
5. A Avenue
6. Foothills Road
7. North Shore Road
8. Leonard Street
9. Church Street
10. Wilbur Street/Middlecrest Road
11. McVey Avenue/Green Street

3.1.3 Impact Assessment Analysis Methods

The impact assessment focused on a comparison of the alternatives and design options. At the project level, the effect of each alternative on the transportation system was evaluated with respect to its compatibility with the statewide transportation standards and guidelines, the Regional Transportation Plan and the local Transportation System Plans.

The analysis evaluated the effectiveness of the project alternatives in serving existing and future transportation demand within the corridor. The analysis of impacts included travel time and other direct impacts, indirect impacts including parking impacts, short-term construction impacts, and cumulative effects.

Direct Effects: The analysis of direct effects of the various alternatives during construction and operation addresses impacts that could result from acquisition of right-of-way, changes to traffic operations and changes to transit and parking.

Indirect Effects: This analysis considered the effects of other project influences on the transportation system. The analysis would also include assessments of the degree that potential land uses changes would affect transportation, as well as a qualitative assessment of potential changes in transportation safety related to the various alternatives.

Construction-Related Effects: This analysis evaluated the short-term impacts of the timing and duration of construction on the transportation system.

Cumulative Effects: This reviewed the extent of induced impacts resulting from the project in combination with other projects in the corridor.

3.1.4 Study Periods

The traffic analysis focused on existing conditions (generally in 2009) and projected year 2035 conditions. Current traffic volumes within the study area are typically at their highest on weekdays between 7 a.m. and 9 a.m. and between 4 p.m. and 6 p.m. This trend is expected to continue into the future. The majority of the traffic performance analyses focused on PM peak hour, with limited analysis of the AM peak hour. In addition, some data is presented for a daily (24-hour) period.

Future year traffic volumes was based on travel demand forecasts to be provided by Metro with post-processing by David Evans and Associates Inc. (DEA) using ODOT analysis procedures methodology.

3.1.5 Travel Demand Forecasting Overview

Travel demand models have been in use since the 1950s and use a market-based approach by considering both the transportation supply and travel demand for producing mobility characteristics such as roadway traffic volumes and transit ridership. Metro prepared the travel demand modeling for this project and provided model results to the project team.

The regional travel demand model uses a four-step process, which includes the following components:

- Trip generation determines the number, location, magnitude, and purpose of trips based on land use and socioeconomic input data.

- Trip distribution identifies origins and destinations of trips which allows the calculation of trip lengths and travel times from transportation system attributes.
- In mode choice, trips are sorted into the various vehicle, transit, walk and bike modes.
- Through an equilibrium assignment of trips, routing choices for vehicle and transit trips are determined for several time periods throughout the day.

The output from the regional travel models was used to develop a.m. and p.m. peak-hour directional roadway volumes and intersection turning movements. These volumes were derived using methodologies outlined in Oregon Department of Transportation Analysis Procedures Manual. This post processing method results in a year 2035 PM peak-hour turning movement volumes projection that are based on actual 2009 traffic counts with model growth from 2009 to 2035.

The regional travel demand model also provides forecasts of transit demand and boarding rides in the corridor. This is described in more detail in Chapter 2 of this technical report.

3.1.6 Modeling Tools

Various transportation modeling tools were used to forecast travel demand and evaluate traffic operations. These are defined in the following sections.

A. EMME

The EMME transportation modeling software assigns regional travel demand to a roadway network using an equilibrium assignment. The traffic assignment results in roadway link volumes where no traveler can achieve additional travel time savings by changing routes. The software program itself is used to edit networks, analyze data, display and plot results, and import and export data.

The transportation analysis used Metro's regional travel forecasting model to simulate highway and transit option packages to derive transportation performance measures. The transit assignments are based on identifying the set of transit routes that are available to complete a trip, specific route assignments consider headways, wait time and in-vehicle travel time.

B. VISSIM

VISSIM is a behavior-based multipurpose traffic simulation program. For many engineering disciplines, simulation has become indispensable to assist in understanding complex technical systems. This is especially true for transportation planning and traffic engineering, where simulation is an invaluable and cost-reducing tool.

VISSIM offers a variety of roadway and transit applications, integrating multiple modes of transportation including truck, bus, streetcar, bicycle, pedestrian, and general vehicular traffic. The traffic simulation model is able to model complex traffic conditions and is capable of analyzing traffic operations under both uncongested and congested conditions. For this analysis, VISSIM is used to model streetcar operations on Highway 43 in the John's Landing area (Bancroft Street to Taylors Ferry Road) and in the Lake Oswego area (A Avenue to North Shore Boulevard). An existing VISSIM model for the John's Landing area was provided by ODOT as a starting point for this analysis.

C. Synchro/SimTraffic

Synchro is a software application for optimizing traffic signal timing and performing intersection capacity analysis. The software optimizes traffic signal splits, offsets, and cycle lengths for individual intersections, an arterial, or a complete network. SimTraffic is a microscopic model that simulates individual vehicles using the roadway network. The Synchro/SimTraffic software was used to provide Highway Capacity Manual (HCM) based intersection analysis to support the traffic, air, noise, and energy analyses.

As a microsimulation model, SimTraffic animates traffic flow based on input volumes and signal timing and is able to model congested conditions on arterials, including overcapacity operations at signalized intersections, unbalanced lane utilization, and vehicle queue buildup, and dissipation over morning and afternoon/evening peak periods. SimTraffic models signalized and unsignalized intersections, and roadway segments with automobiles, trucks, pedestrians, and buses. By basing the traffic analysis on driver behavior (driver reaction to the environment) rather than individual capacities, SimTraffic is able to model arterials as a traffic system, where congestion at one intersection influences operations both upstream and downstream of that intersection.

3.1.7 Base Year and Forecasted Volumes

Land use is a key factor in how the transportation system operates and how many vehicle trips are on the transportation network. Projected land uses were developed for all areas within the study area reflecting comprehensive plans and Metro’s land use assumptions for year 2035. These are consistent with the adopted Regional Transportation Plan. Metro provided travel demand volumes for the following conditions using the Metro regional travel demand model (EMME):

- Existing base 2005
- Year 2035 No-Build Alternative
- Year 2035 Streetcar Alternative with Macadam In-Street and Additional Lane design options
- Year 2035 Streetcar Alternative with Willamette Shore Line Design Option
- Year 2035 Enhanced Bus Alternative

The base year used for calibration of the regional travel forecast models is year 2005. For the purposes of the existing conditions assessment of local traffic in the DEIS, 2009 is considered the base year.

The assessment of existing 2009 traffic conditions is based primarily on analysis of operations using traffic volumes collected in August, 2009. The 2009 traffic volume counts were adjusted in some locations using 2006 traffic counts to account for seasonal fluctuations and a reduction in regional traffic volumes due to the economic recession during 2009. Year 2009 traffic volumes were calculated at 59 study area intersections. Operational analysis was completed for all intersections in p.m. peak period. A.m. peak period traffic operations analysis was completed for intersections in Segments 2 (South Waterfront) and 3 (Johns Landing). The existing a.m. peak hour volumes are shown in Figure 3.1-1 the existing p.m.; peak hour volumes are shown in Figures 3.1-2 through 3.1-4.

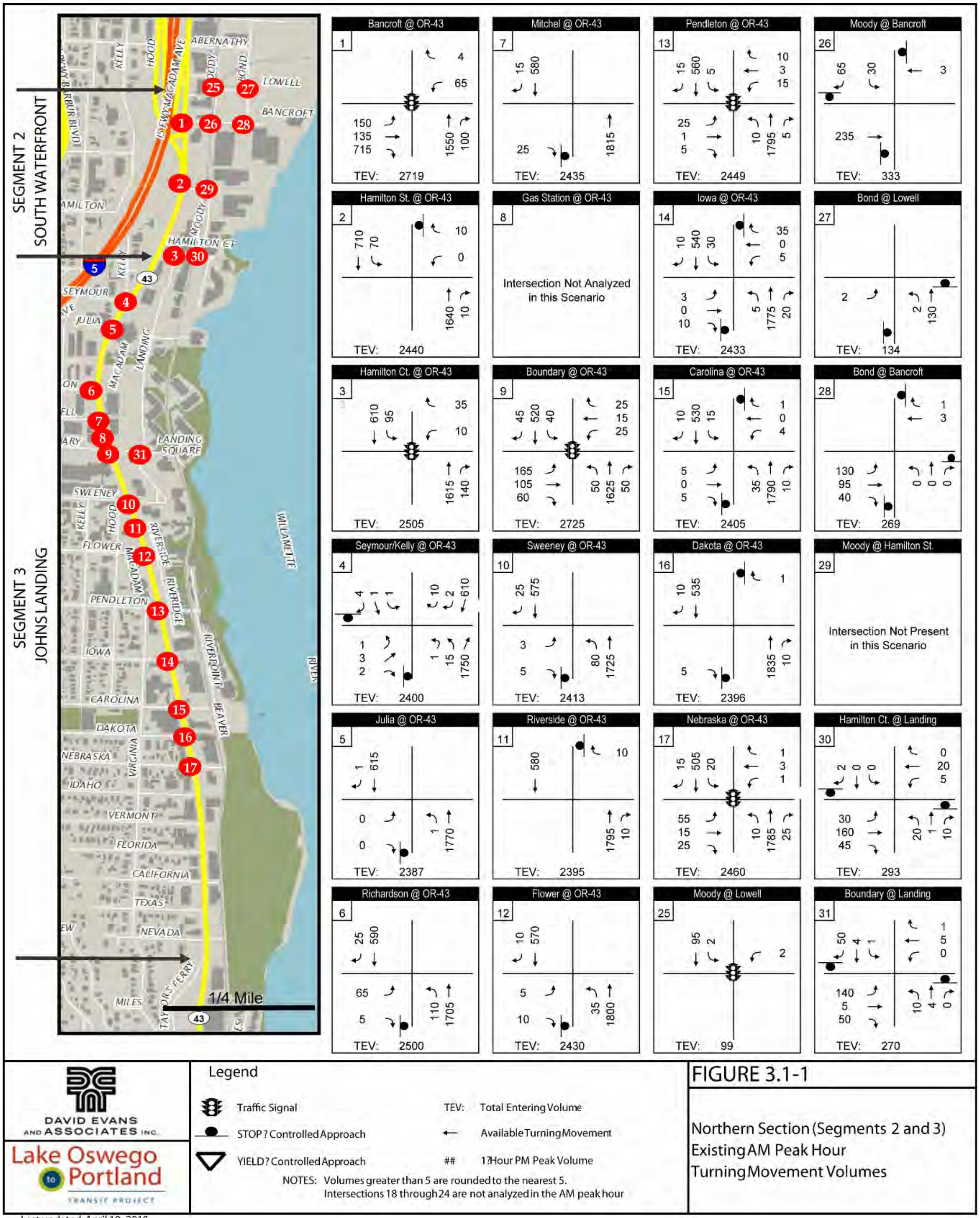


FIGURE 3.1-1 NORTHERN SECTION (SEGMENTS 2 AND 3) EXISTING AM PEAK HOUR TURNING MOVEMENT VOLUMES

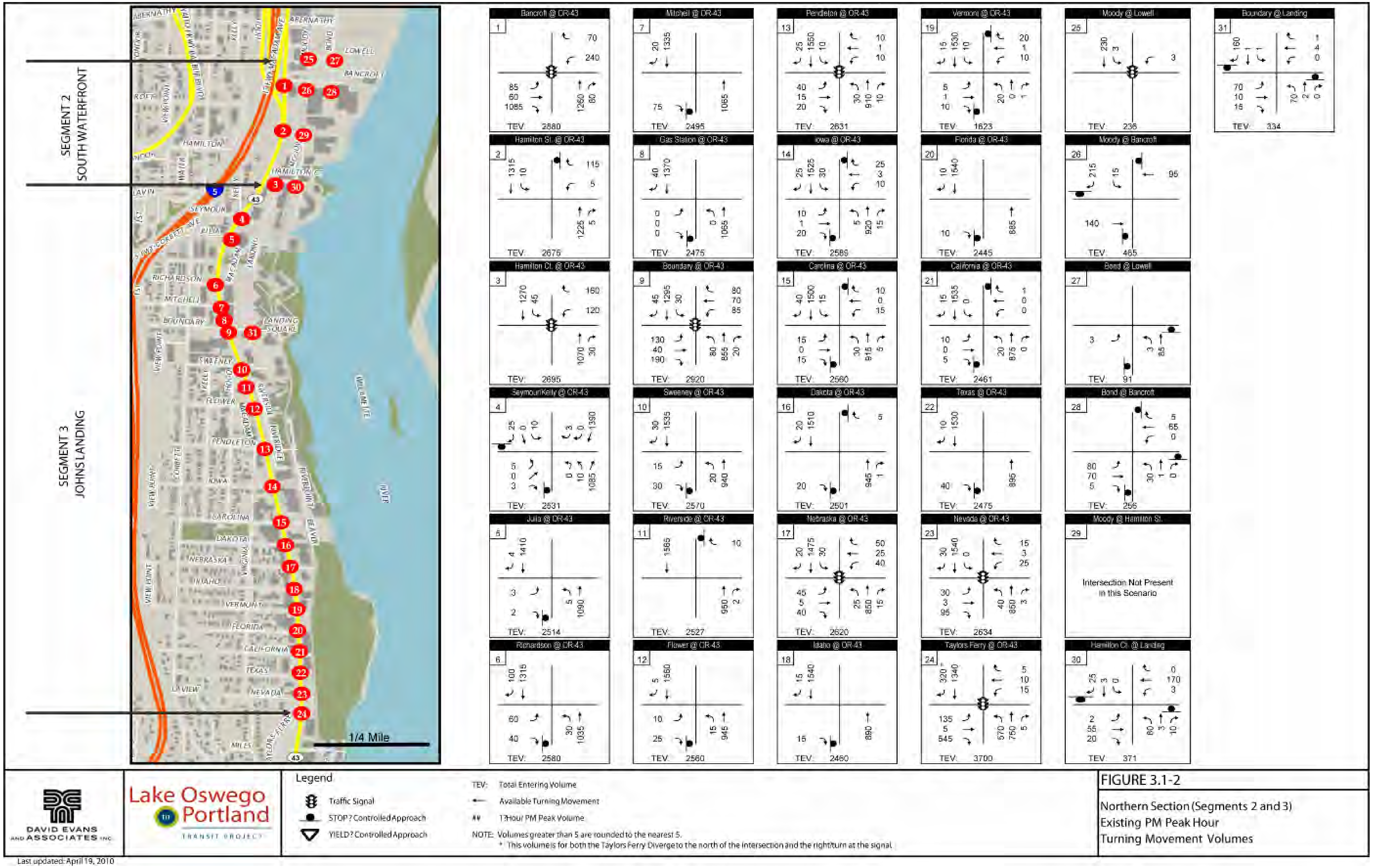


FIGURE 3.1-2 NORTHERN SECTIONS (SEGMENTS 2 AND 3) EXISTING PM PEAK HOUR TURNING MOVEMENT VOLUMES

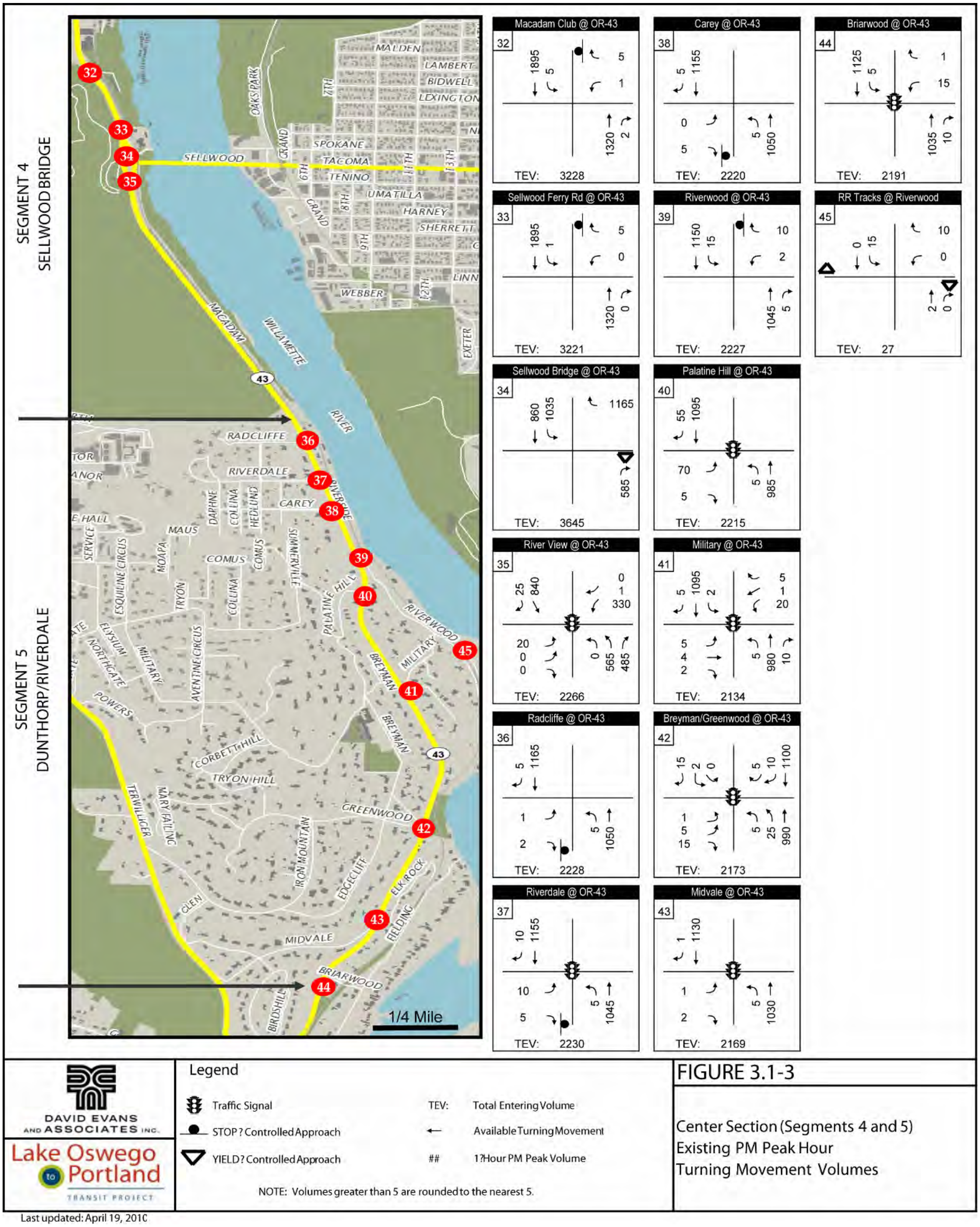


FIGURE 3.1-3 CENTER SECTION (SEGMENTS 4 AND 5) EXISTING PM PEAK HOUR TURNING MOVEMENT VOLUMES

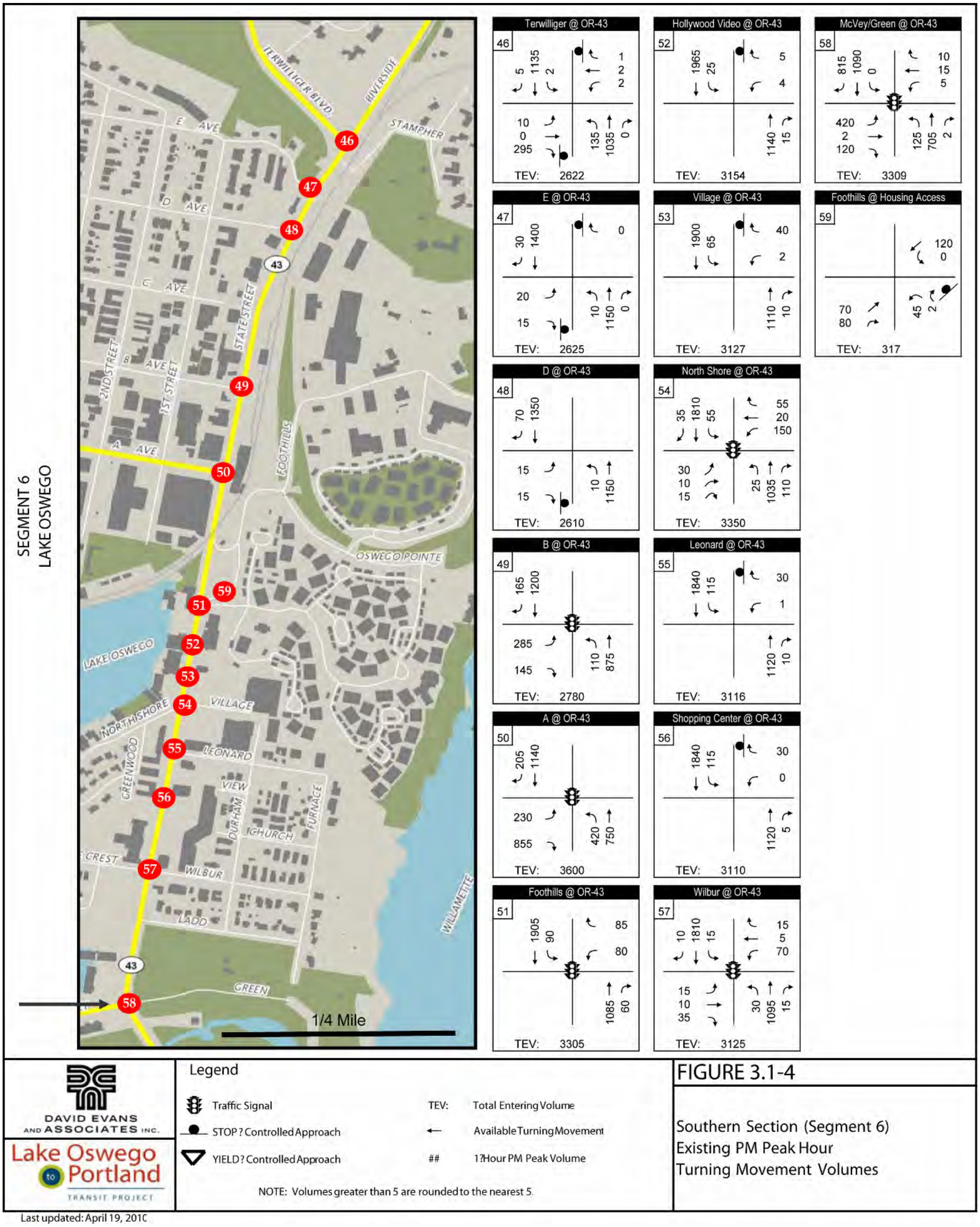


FIGURE 3.1-4 SOUTHERN SECTION (SEGMENT 6) EXISTING PM PEAK HOUR TURNING MOVEMENT VOLUMES

The existing traffic count individual intersection sheets are included in the technical CD accompanying this document.

Forecasting the amount of future traffic at the signalized and unsignalized intersections was done by using a methodology incorporating existing counts, base case travel demand model data (2005), and future travel demand model data (2035). The growth rate in volumes were determined between the two travel demand model years and applied to the existing volume counts for 2009. This methodology minimizes the effects of model error by adding the increment of growth projected by the travel demand model. Therefore, intersection approach and departure volumes used in the level-of-service (LOS) calculations have been adjusted and may not exactly match raw model volumes produced from the travel demand model. The a.m. peak hour volumes for the No-Build Alternative and the 2005 to 2035 traffic volume growth are shown in Figures 3.1-5 and 3.1-6. The p.m. peak hour volumes for the No-Build Alternative and the 2005 to 2035 traffic volume growth are shown in Figures 3.1-7 through 3.1-12. The a.m. and p.m. peak hour 2035 traffic volumes for the build alternatives are included in Appendix 3A, Figures 3A-1 through 3A-12. The detailed forecast year traffic volume calculations are included in the CD that accompanies this technical report.

The regional travel demand model also provides forecasts of transit demand and boarding rides in the corridor. This is described in more detail in Chapter 2 of this technical report.

3.1.8 Motor Vehicle Operations Definitions and Methods

This section describes the various components of the motor vehicle analysis and the standards and criteria that apply in the jurisdictions within the study corridor.

Intersection Definitions

Traffic analysis for this project is focused on intersection operations. For the purpose of this study intersections have been categorized into two groups for motorized vehicle operations analysis: signalized intersections and unsignalized intersections. The analysis includes intersection that directly interface with the proposed bus or streetcar alternatives or could be indirectly affected by transit operations. In addition, at-grade non-motorized rail crossings that serve pedestrian and bicycle traffic are evaluated.

Level of Service Definitions and Methodology

At signalized intersections, LOS is a function of control delay associated with the traffic signal, which includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay. Both delays and v/c ratios are calculated for all movements at a signalized intersection since all movements are stopped at some time during the signal cycle. Some movements, particularly side street approaches or left turns onto side streets, may experience longer delays because they receive only a small portion of the green phase during a signal cycle but their v/c ratio may be relatively low. It is important to examine both factors – delay and v/c ratio – before drawing conclusions about operational performance.

At stop sign-controlled intersections, LOS is also a function of control delay. In addition to calculating delay, the analysis also calculates v/c ratio for all stopped movements at the intersection. Although delays can sometimes be long for some movements at stop sign-controlled intersections, the v/c ratio may indicate that there is adequate capacity to process the demand for that movement.

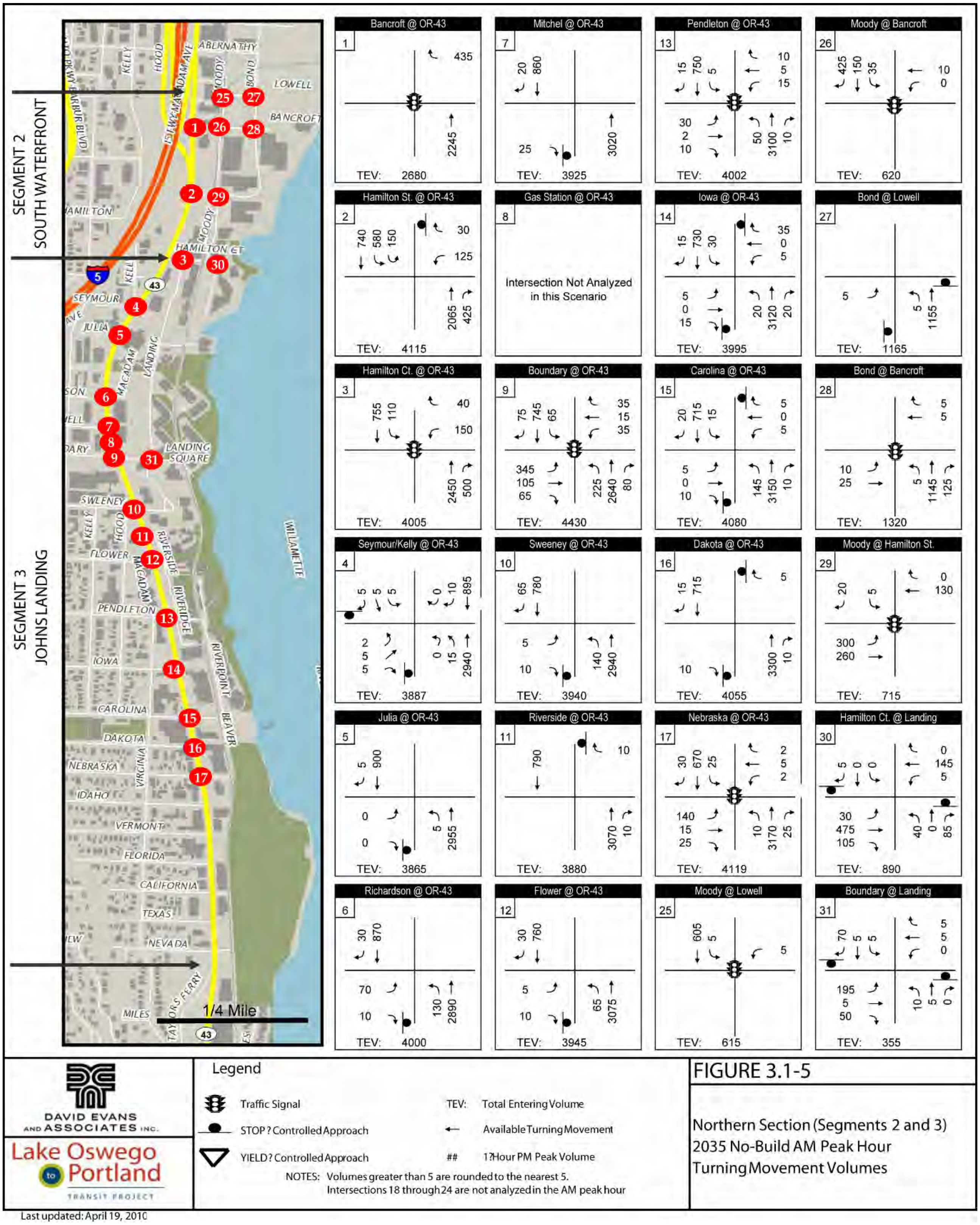


FIGURE 3.1-5 NORTHERN SECTION (SEGMENTS 2 AND 3) 2035 NO-BUILD AM PEAK HOUR TURNING MOVEMENT VOLUMES

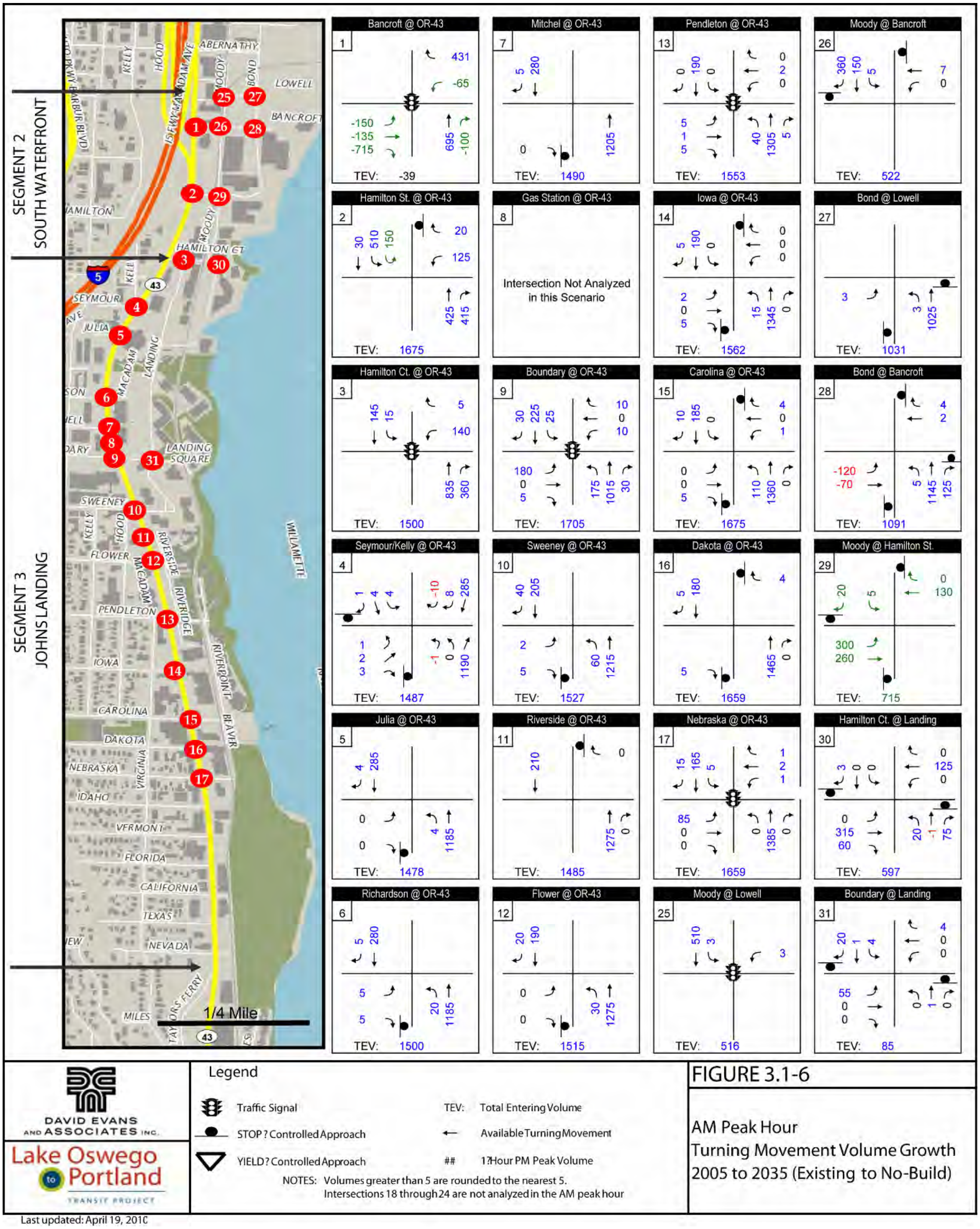


FIGURE 3.1-6 AM PEAK HOUR TURNING MOVEMENT VOLUME GROWTH 2005 TO 2035 (EXISTING TO NO-BUILD

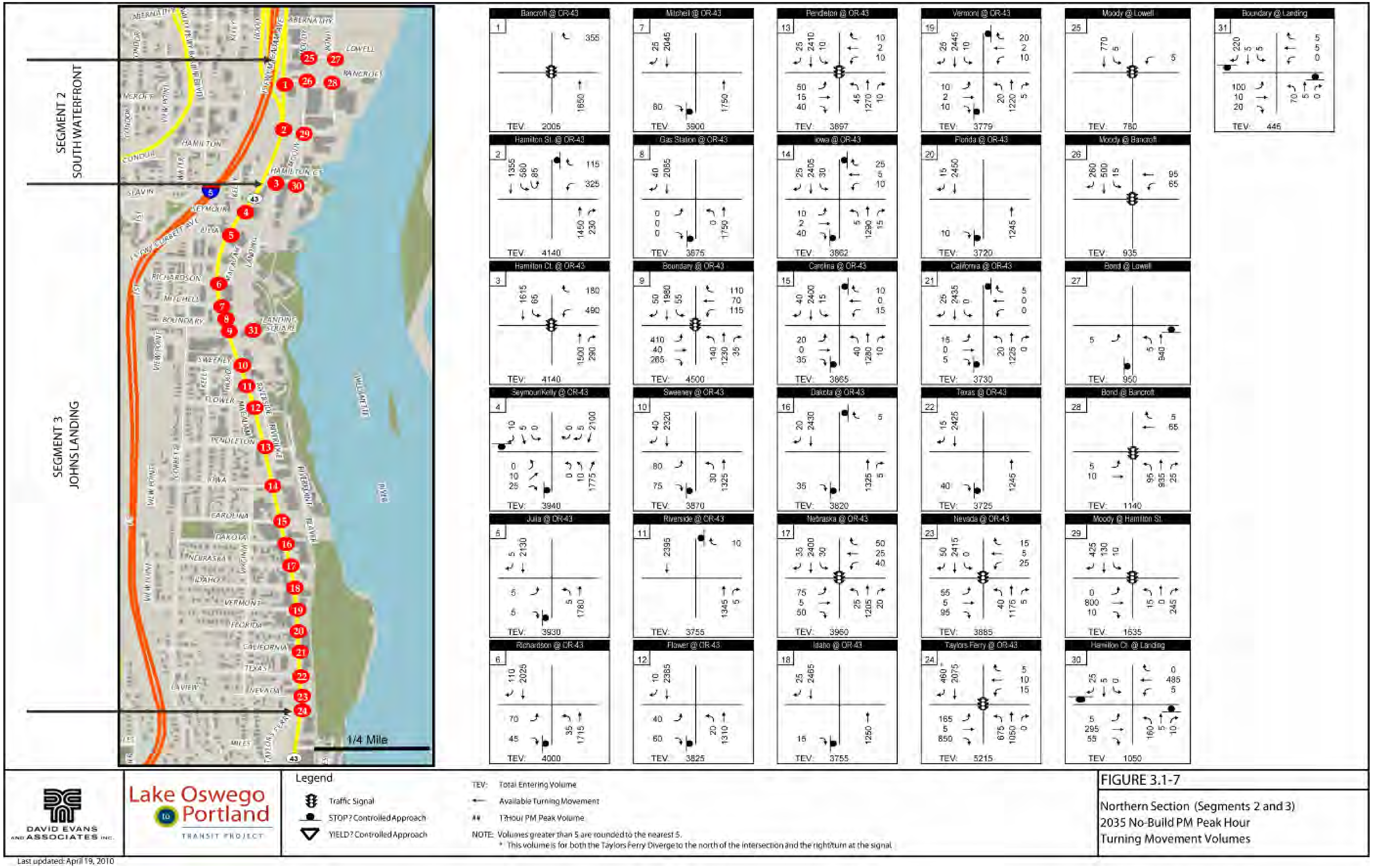


FIGURE 3.1-7 NORTHERN SECTION (SEGMENTS 2 AND 3) 2035 NO-BUILD PM PEAK HOUR TURNING MOVEMENT VOLUMES

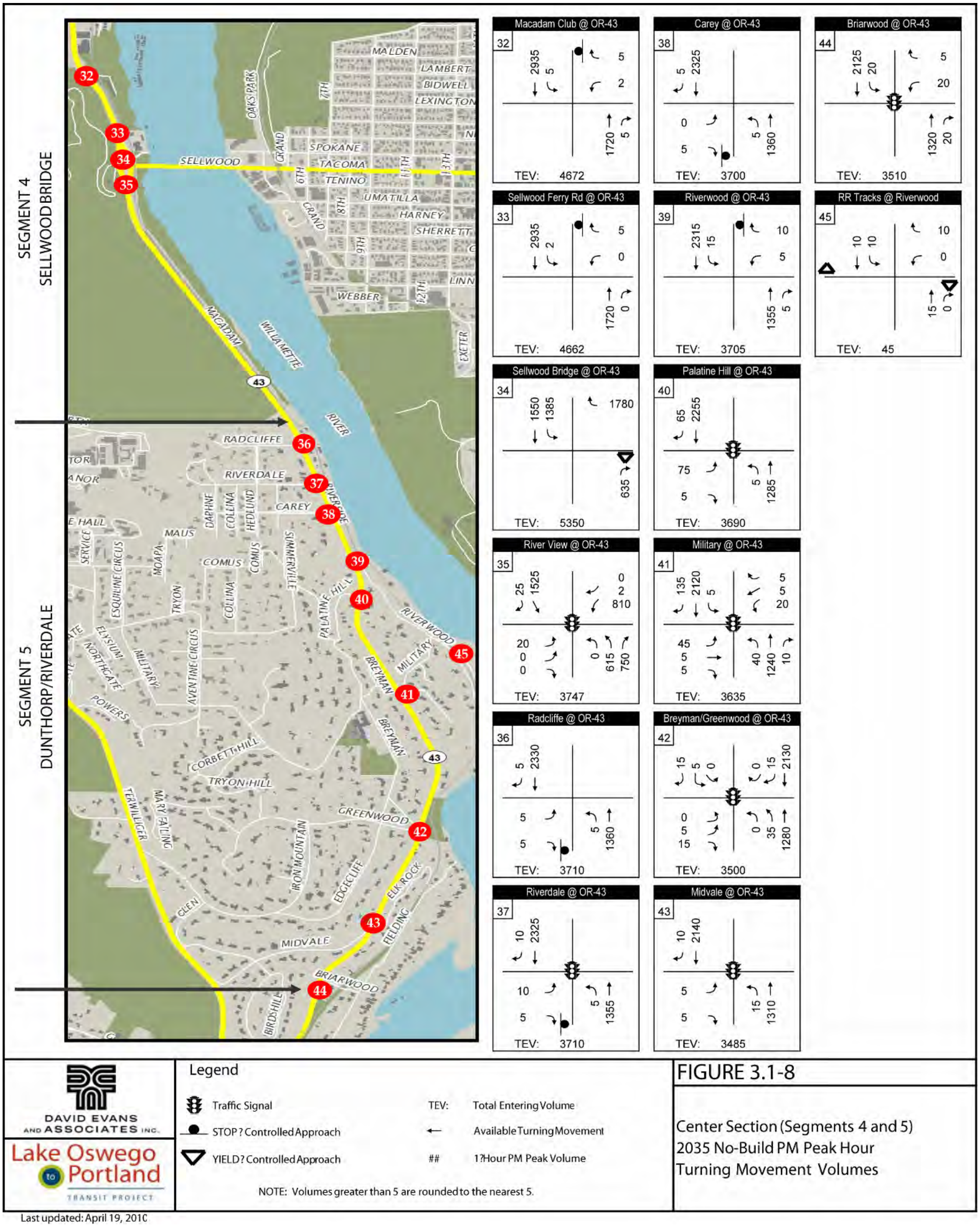


FIGURE 3.1-8 CENTER SECTION (SEGMENTS 4 AND 5) 2035 NO-BUILD PM PEAK HOUR TURNING MOVEMENT VOLUMES

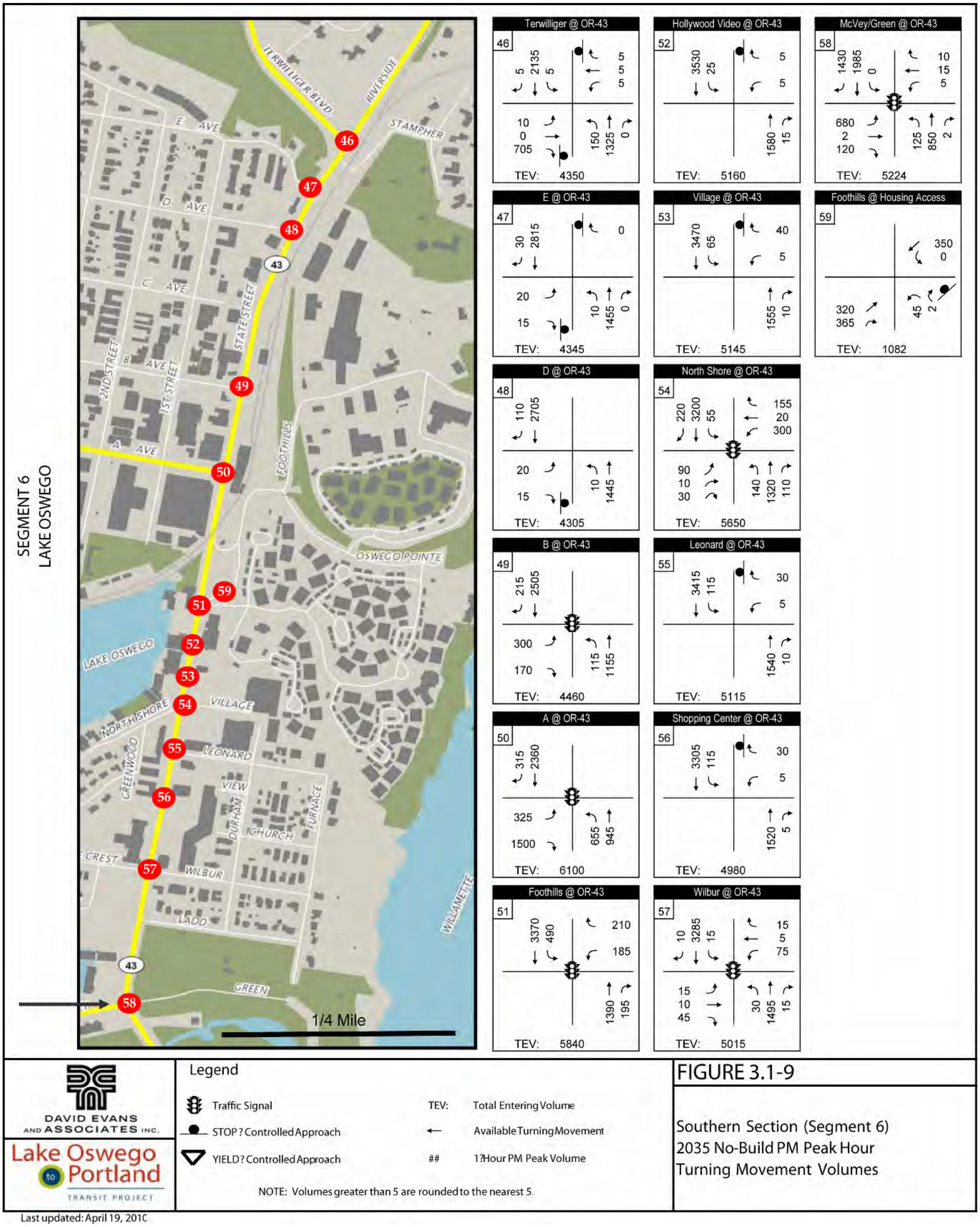


FIGURE 3.1-9 SOUTHERN SECTION (SEGMENT 6) 2035 NO-BUILD PM PEAK HOUR TURNING MOVEMENT VOLUMES

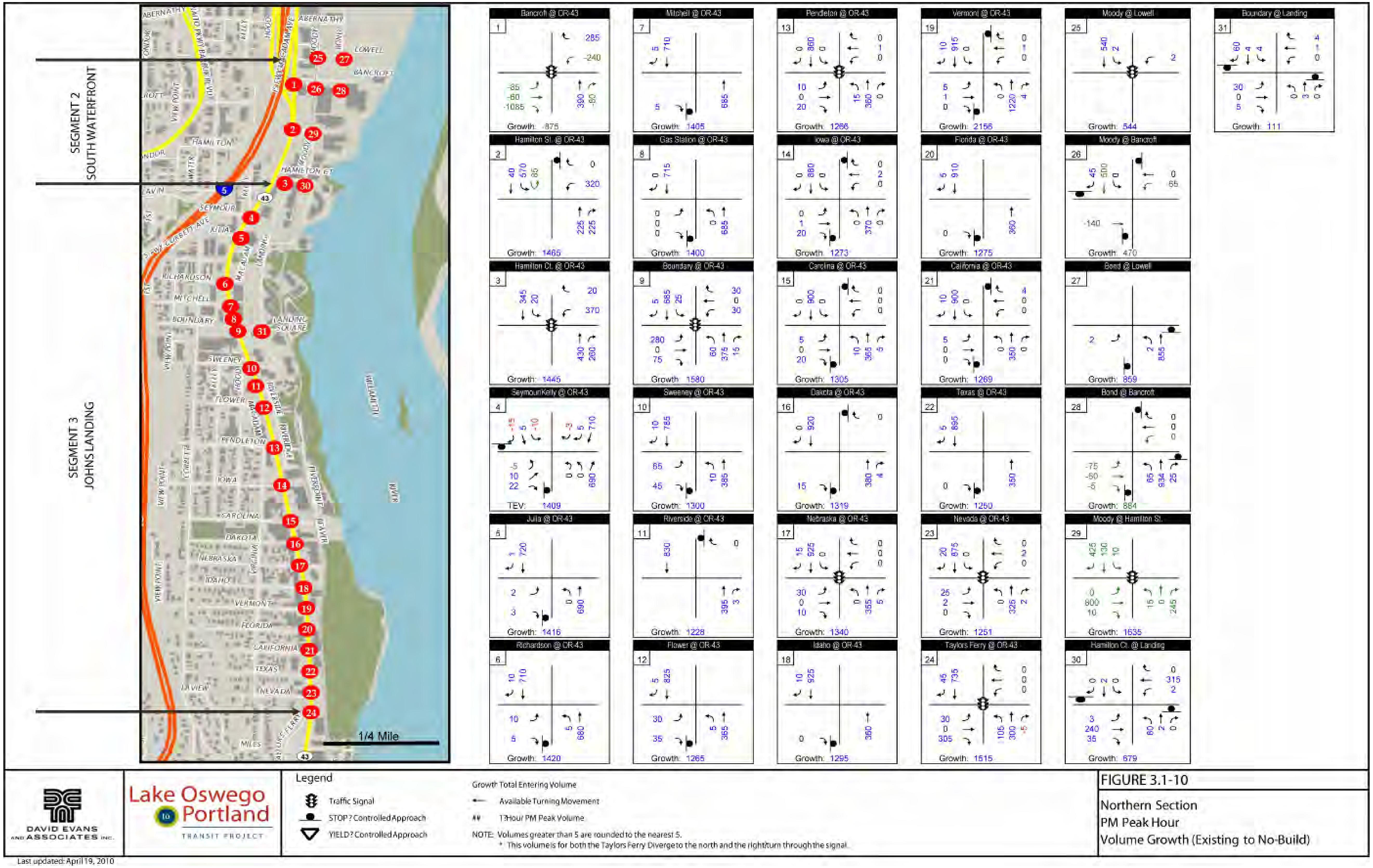


FIGURE 3.1-10 NORTHERN SECTION PM PEAK HOUR VOLUME GROWTH (EXISTING TO NO-BUILD

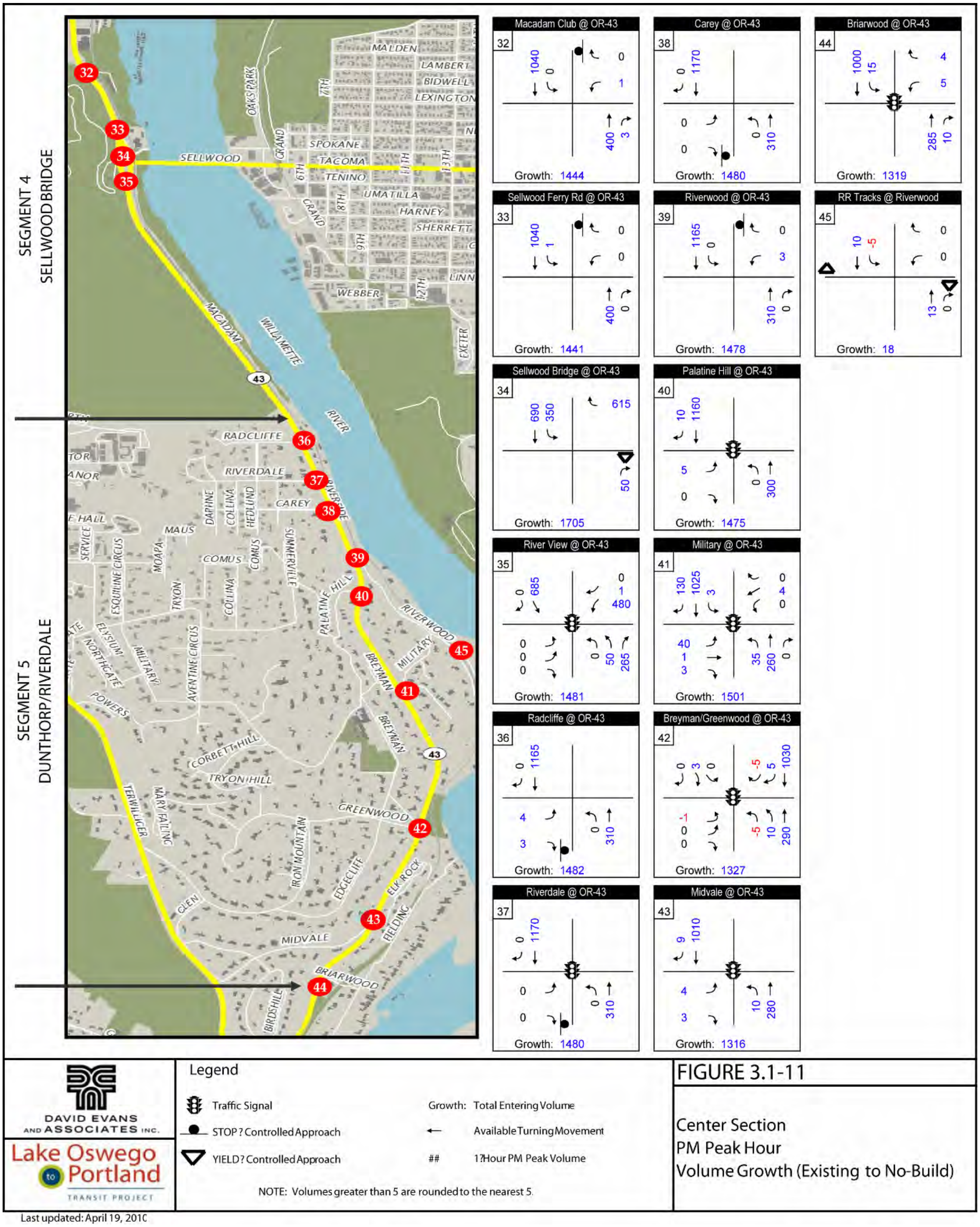
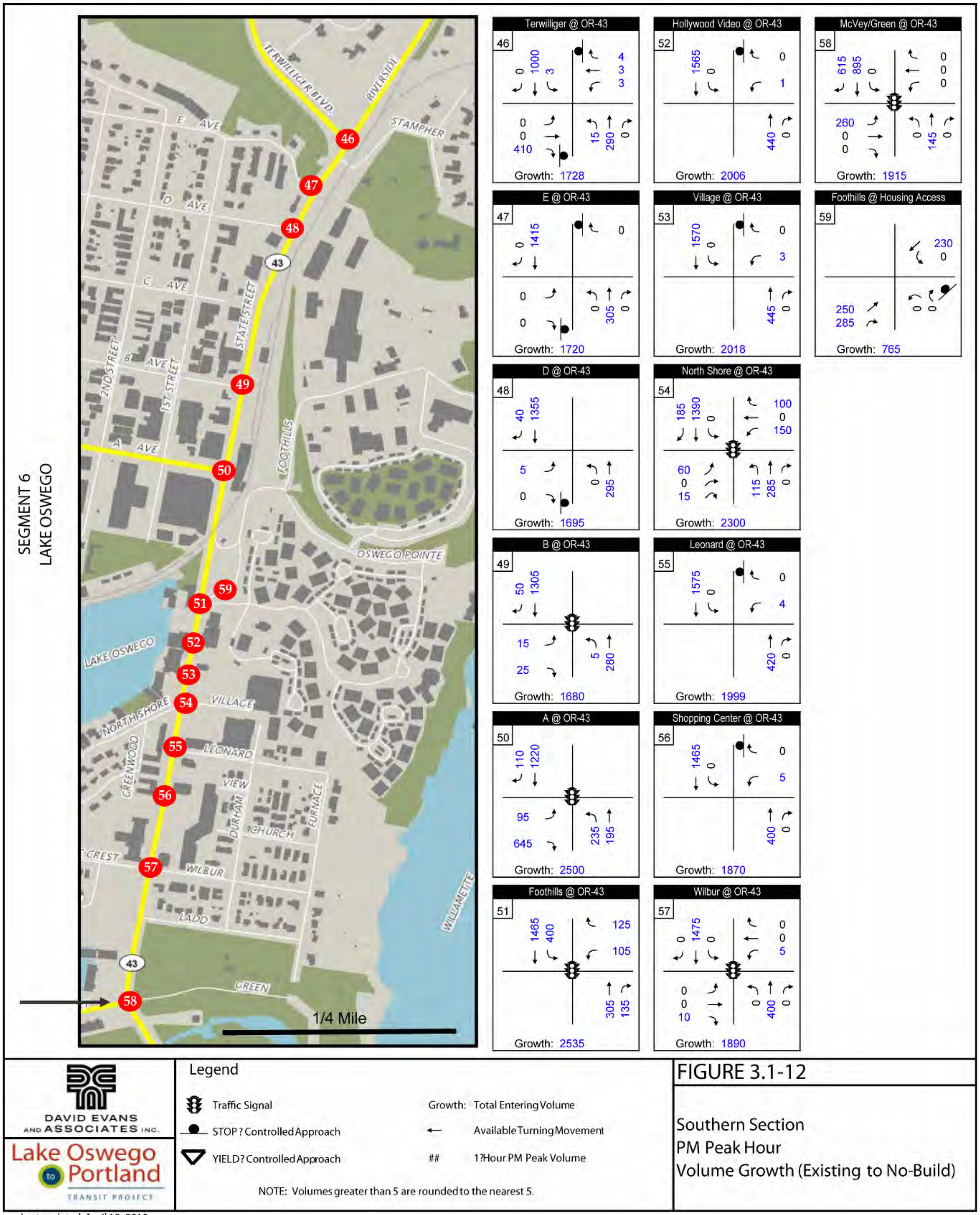


FIGURE 3.1-11 CENTER SECTION PM PEAK HOUR VOLUME GROWTH (EXISTING TO NO-BUILD)



Last updated: April 19, 2010

FIGURE 3.1-12 SOUTHERN SECTION PM PEAK HOUR VOLUME GROWTH (EXISTING TO NO-BUILD)

Table 3.1-2 summarizes the LOS criteria for both signalized and unsignalized intersections based on HCM criteria.

Table 3.1-2 Level Of Service Criteria

	Control Delay (seconds/vehicle)	
Level of Service	**Signalized Intersections**	**Unsignalized Intersections**
A	≤ 10	≤ 10
B	> 10 and ≤ 20	> 10 and ≤ 15
C	> 20 and ≤ 35	> 15 and ≤ 25
D	> 35 and ≤ 55	> 25 and ≤ 35
E	> 55 and ≤ 80	> 35 and ≤ 50
F	> 80	> 50

Note: The LOS criteria are based on control delay, which includes initial deceleration delay, queue move-up time, stopped delay, and final acceleration delay.

Source: Transportation Research Board, *Highway Capacity Manual*, 2000, p. 16-2 for signalized intersections and p. 17-2 for unsignalized intersections.

The LOS criteria for unsignalized intersections are somewhat different from the criteria used for signalized intersections. The primary reason for this difference is that drivers expect different levels of performance from different kinds of transportation facilities. In general, the expectation is that a signalized intersection is designed to accommodate higher traffic volumes than an unsignalized intersection. Additionally, several driver behavior considerations combine to make delays at signalized intersections less onerous than those at unsignalized intersections. For example, drivers at signalized intersections are able to relax during the red interval, while drivers on the minor street approaches to two-way, stop-sign-controlled intersections must remain attentive to the task of identifying acceptable gaps and vehicle conflicts. Also, there is often much more variability in the amount of delay experienced by individual drivers at unsignalized intersections than at signalized intersections. For these reasons, the total delay threshold for any given LOS is considered to be less for an unsignalized intersection than for a signalized intersection.

Queuing Definitions and Methodology

Queuing is when a line of vehicles forms at a signalized intersection waiting for a green light or at an unsignalized intersection waiting for a gap in traffic. The speed of vehicles serviced within the queue is determined by the rate of flow at the front of the queue. The storage needs of queued (or backed up) traffic can affect the design of facilities.

Queuing analysis was performed using Synchro and Vissim to estimate the 95th percentile queue for each intersection approach. Queuing was evaluated using Vissim peak hour simulation for Segments 2, 3 and 6. Synchro was used in Segments 4 and 5. The 95th percentile queue estimates that for any given cycle at a signalized intersection, the queue length calculated is representative of 95 percent of the peak fifteen-minute vehicular queues during the peak hour at that intersection. Queuing at the study area intersections was evaluated in segments 2 through 6 to determine where existing queues build up or spill back from one signalized intersection to another; or where queues overflow out of a turn lane into the adjacent through lane.

Safety and Warrants Definition and Methodology

Traffic and highway engineers are continually engaged in working to ensure that a roadway system is designed and operated such that roadway crash rates can be reduced. Improving roadway safety requires consideration of the four elements influencing traffic operations: the driver, the vehicle, enforcement, and the roadway. Unfortunately, the traffic engineer has effective control over only one of these elements – the roadway. Traffic safety can be approached in a number of different ways. They include reducing crash occurrence, reducing the severity of crashes, improving crash survivability, enforcing safety control efforts, and improving design aspects of a roadway. Crash data for the most recent available five-year period (January 1, 2004 through December 31, 2008) was obtained from the ODOT Crash Analysis and Reporting Unit for Highway 43 between Bancroft Street (M.P. 0.69) and McVey Avenue (M.P. 6.70). Crash information collected represents crashes that occurred within 265 feet of each intersection and only those crashes that were reported.

A signal warrant analysis using Manual of Uniform Traffic Control Device (MUTCD) procedures was conducted on the intersection of SW Macadam Avenue (Highway 43) and Carolina Street for all alternative and options. However, merely meeting a warrant does not necessarily mean that the warrant should be implemented. Each warrant should be evaluated on a case-by-case basis as to the appropriate implementation. The signal warrant analysis is included in the CD that accompanies this technical report.

Traffic Signal Priority

The Build Alternative does not have any locations where signal priority and/or preemption is proposed to be used. There are intersections where a special signal phase is provided for streetcar operations. The timing for these locations was first optimized using Synchro and then refined using Vissim simulations. With the exception of locations where signal timing was modified to accommodate streetcar operations, existing signal timing is used for all alternatives and options.

Transit and Park-and-Ride Lot Assessment and Methodology

Areas where park and ride lots are proposed were evaluated for impacts to the street network. Vehicle trip generation data from existing Portland and Vancouver area park and ride lots were used to estimate the number of vehicle trips generated to and from the park-and-ride lots during the a.m. and p.m. peak hours. Each park and ride lot was assumed to be 100 percent occupied during the peak hours.

Threshold Criteria

Traffic operational standards are used by agencies to assure satisfactory traffic mobility within their respective jurisdictions. Four agencies: Metro, ODOT, City of Lake Oswego and City of Portland have jurisdictional oversight within the study area. Each agency has unique operational standards that must be met before a development or roadway is approved for construction. The City of Lake Oswego and City of Portland use LOS as their criteria, while ODOT uses a volume-to-capacity (V/C) ratio as their performance criteria. Metro uses either LOS or V/C ratio criteria depending on how the traffic analysis is conducted. The V/C ratio provides a ratio of the intersection or roadway volume to the capacity of the intersection or roadway. As a roadway or intersection V/C ratio approaches 1.0 the roadway or intersection is reaching capacity and traffic flow will begin to breakdown. If a roadway or intersection has a V/C ratio over 1.0, the demand volume exceeds capacity and the roadway or intersection will have congestion and queuing. Table 3.1-3 summarizes the threshold criteria for the jurisdictional agencies.

Table 3.1-3 Summary Of Operational Standards

Criteria Thresholds	1st Hour	2nd Hour
Metro[1]		
Town Center	LOS F (V/C 1.0 to1.1)	LOS E (V/C 0.90 to 1.0)
Corridors	LOS E (V/C 0.90 to 1.0)	LOS E (V/C 0.90 to 1.0)
ODOT[2]		
Town Centers	V/C 1.1	V/C 0.99
Corridors	V/C 0.99	V/C 0.99
City of Portland[3]		
All Areas	LOS E	LOS D
City of Lake Oswego[4]		
All Areas	LOS E	LOS E

[1] Metro operating standards outlined in the 2004 RTP: Table 1.2
[2] 1999 OHP and based on v/c (Policy 1F, Table 7)
[3] Goal 6 - Transportation, Comprehensive Plan (Amended July 2006)
[4] Goal 12 - Transportation, Comprehensive Plan (Amended December 1994)

3.2 Affected Environment

Although the transportation analysis focuses on system performance within the corridor, many of the region's freeways and highways are also affected by travel choices within the study corridor. The regional facilities related to the corridor include: Interstate 5 (I-5), Interstate 405 (I-405), SE McLoughlin Boulevard, SW Macadam Avenue/SW Riverside Drive/N and S State Street (Highway 43), and SW Barbur Boulevard (OR 99W). When facilities such as I-5, Barbur Boulevard and McLoughlin Boulevard experience severe congestion, some overflow traffic is diverted to Highway 43 (SW Macadam Avenue/SW Riverside Drive/State Street).

The roadway performance evaluation focuses on a study area that includes arterial and local streets within the corridor, principally, Highway 43 (SW Macadam Avenue/SW Riverside Drive/N and S State Street) and the streets that intersect this arterial route from Lake Oswego to Portland. The extent of the roadway analysis is summarized by segment below.

Segment 1 – Downtown Portland: (Northwest Portland to SW Lowell Street) does not include any roadway network operations analysis. With the Streetcar Alternative the number of streetcars operating on the existing alignment through downtown would increase from 5 to 6 trains per hour during the peak hours. Because there are no changes to the street network, streetcar operates in mixed traffic and does not include any signal priority or preemption in downtown Portland, no intersection analysis was included in this segment.

Segment 2 – South Waterfront (SW Lowell Street to SW Hamilton Court) includes nine intersections in the roadway network analysis, either on SW Macadam Avenue (Highway 43) or on other roadways which could be impacted by one of the alternatives.

Segment 3 – Johns Landing (SW Hamilton Court to SW Miles Street) includes 22 intersections in the roadway network analysis, primarily along SW Macadam Avenue (Highway 43).

- **Segment 4 – Sellwood Bridge** (SW Miles Street to south end of Powers Marine Park) includes four intersections in the roadway network analysis, all on SW Macadam Avenue/SW Riverside Drive (Highway 43) clustered around the Sellwood Bridge.
- **Segment 5 – Dunthorpe/Riverdale** (south end of Powers Marine Park to SW Briarwood Road) includes ten intersections in the roadway network analysis, primarily along SW Riverside Drive (Highway 43).
- **Segment 6 – Lake Oswego** (SW Briarwood Road to Lake Oswego Terminus) includes 14 intersections in the roadway network analysis, primarily along N and S State Street (Highway 43).

3.2.1 Motor Vehicle Operations

Motor vehicle performance is assessed using a number of different operational measures including volume-to-capacity (V/C) ratio, level of service (LOS) and queuing. The V/C represents a comparison of vehicular demand to available throughput or capacity of an intersection and is the basic performance measure used by ODOT. Delay is used to define the LOS at intersection, which is a measure of operational conditions and how those conditions are perceived by motorists; the City of Portland and City of Lake Oswego use LOS in their performance standards. Queuing occurs as vehicles line up at either a traffic signal while waiting for the light to turn green or a stop or yield sign while waiting for a gap in the traffic flow on the major street. While none of the agencies use queuing as a performance standard, when queues build up between intersections or when they overflow out of a turn lane into the adjacent through lane, they can affect the performance of the surrounding roadway network.

The assessment of existing traffic conditions is based primarily on analysis of operations using traffic volumes collected in August, 2009. The 2009 traffic volume counts were adjusted in some locations using 2006 traffic counts to account for seasonal fluctuations and a reduction in regional traffic volumes due to the economic recession during 2009. Year 2009 traffic volumes were calculated at 59 study area intersections. Operational analysis was completed for all intersections in p.m. peak period. A.m. peak period traffic operations analysis was completed for intersections in Segments 2 (South Waterfront) and 3 (Johns Landing). The existing a.m. peak and p.m. peak intersection operations analysis is summarized in maps included in Appendix 3B, Figures 3B-1 through 3B-4. The detailed Synchro analysis worksheets are included on the CD that accompanies this technical report.

The 59 study area intersections were evaluated to determine V/C and LOS for the p.m. peak hour and 31 intersections were evaluated for the a.m. peak hour[3]. Based on the 2009 data, all of the study area intersections analyzed currently meet ODOT and local jurisdictional standards, with the exception of the unsignalized intersection at the Highway 43 southbound approach to Sellwood Bridge in the p.m. peak hour.

Queuing at the study area intersections was evaluated in segments 2 through 6 to determine: where existing queues build up or spill back from one signalized intersection to another; or where queues

[3] Traffic operations were evaluated using Synchro, which is based on the *2000 Highway Capacity Manual* methodologies.

overflow out of a turn lane into the adjacent through lane[4]. Locations where queue spillback or overflow would occur are listed in Table 3.2-1.

Table 3.2-1 Summary of Existing Queue Spillback or Overflow Locations

Intersection Location (Traffic Control)	Queue Spillback or Overflow[1] AM Peak Hour Direction[2]	Queue Spillback or Overflow[1] PM Peak Hour Direction[2]
Segment 2		
SW Moody Ave/SW Bancroft St		SB Left Turn
SW Macadam Ave (Highway 43)/SW Bancroft St.	WB Left Turn	WB Left Turn
SW Macadam Ave (Highway 43)/SW Hamilton Ct.		WB Left Turn, WB Right Turn
Segment 3		
SW Macadam Ave (Highway 43)/SW Boundary St.		EB Left Turn, WB Left Turn
SW Macadam Ave (Highway 43)/SW Nevada St.	NA	EB Right Turn, WB Approach
SW Macadam Ave (Highway 43)/SW Taylors Ferry Rd.	NA	NB Left Turn
Segment 4		
SW Macadam Ave (Highway 43)/Sellwood Bridge	NA	SB back to Pendleton
Segment 5		
None	NA	NA
Segment 6		
N State St (Highway 43)/A Ave.	NA	EB Left Turn, NB Left Turn
N State St (Highway 43)/Foothills Rd.	NA	WB Approach
S State St (Highway 43)/McVey Ave.	NA	EB Left Turn

Notes

1 Queue spillback refers to traffic queues spilling back from one signalized intersection to another. Overflow refers to traffic queues exceeding the capacity of a turn lane and overflowing into the adjacent lane.

2 Refers to the direction of travel approaching the intersection: NB = northbound, SB = southbound, EB = eastbound, WB = westbound. NA = not analyzed

Source: David Evans and Associates, Inc, 2010.

3.2.2 Freight Facilities and Activities

Highway 43 is not designated as a truck or freight route in the *1999 Oregon Highway* Plan and is not approved as a continuous route for oversized freight by the ODOT Permit Unit. Despite its lack of official designation, Highway 43 carries truck traffic. Some carriers use Highway 43 as a route for oversized freight in order to bypass sections of I-5. Truck activity on Highway 43 is generally highest during the midday period, when total traffic levels are lower, but the analysis included in this DEIS is based on the p.m. peak hour which is the most congested period of the day. Truck traffic characteristics by segment are summarized below.

Segment 2 – South Waterfront: Truck traffic accounts for 2 to 3 percent of the total daily traffic and 1 to 1.5 percent of the p.m. peak hour traffic along SW Macadam Avenue (Highway 43) in this segment. Truck volumes on the other streets within the South Waterfront segment are less

[4] Queuing was evaluated using VISSIM peak hour simulation for Segment 2, 3 and 6. Synchro was used for Segment 4 and 5.

than 2 percent of the total traffic volume. Overdimensional loads typically use SW Bancroft Street to access the South Waterfront neighborhood.

Segment 3 – Johns Landing: Truck traffic accounts for 2 to 3 percent of the total daily traffic and 1 to 2 percent of the p.m. peak hour traffic along SW Macadam Avenue (Highway 43) in this segment. Truck volumes on the other streets within the Johns Landing segment are less than 2 percent of the total traffic volume.

Segment 4 – Sellwood Bridge: North of the Sellwood Bridge, truck traffic accounts for 2 to 3 percent of the total daily traffic and 1 to 2 percent of the p.m. peak hour traffic along SW Macadam Avenue (Highway 43). South of the Sellwood Bridge, truck percentages are similar to those found north of the bridge.

Segment 5 – Dunthorpe/Riverdale: Truck traffic accounts for 1 to 2 percent of the total daily traffic and 1 to 2 percent of the p.m. peak hour traffic along SW Riverside Drive (Highway 43) in this segment. Truck volumes on the other streets within this segment are less than 2 percent of the total traffic volume.

Segment 6 – Lake Oswego: Truck traffic accounts for 2 to 3.5 percent of the total daily traffic along N and S State Street (Highway 43). During the p.m. peak hour, trucks account for 1 to 3 percent of total traffic. Cross streets with the highest truck volumes in this segment include A Avenue and Foothills Road.

3.2.3 Parking

The number of on-street and off-street parking facilities and spaces were assessed for the Segments 2 through 6. Segment characteristics are summarized below.

Segment 2 – South Waterfront: The majority of the parking in this segment is in private, off-street lots serving adjacent development. This segment has some on-street parking along the streetcar alignment and on the adjacent streets. Most on-street parking in this segment is metered with both short-term and long-term spaces.

Segment 3 – Johns Landing: Although there is no on-street parking directly on SW Macadam Avenue (Highway 43), many of the side streets in the Johns Landing neighborhood west of SW Macadam Avenue permit on-street parking. The area is also served by private, off-street parking lots serving adjacent development. There is one large pay public parking lot within Willamette Park used by boaters and other park users.

Segment 4 – Sellwood Bridge: In this segment there are public parking spaces at the Macadam Bay Club and a limited number of private lots associated with adjacent businesses. On the east side of SW Riverside Drive (Highway 43) adjacent to Powers Marine Park there are two wide gravel areas that are used as informal parking for park visitors.

Segment 5 – Dunthorpe/Riverdale: On-street parking is available in limited portions of SW Riverside Drive (Highway 43) where adequate shoulder is available. There are no public or private parking lots immediately adjacent to Riverside Drive (Highway 43) in this segment.

Segment 6 – Lake Oswego: There is no on-street parking along SW Riverside Drive or N/S State Street (Highway 43) in this segment. On-street parking is permitted along most streets in downtown Lake Oswego with many areas signed with time restrictions. South of D Avenue, numerous private, off-street parking lots serve adjacent development and public parking is available in the development adjacent to Millennium Park, on the corner of N State Street and A

Avenue. East of State Street, there is public parking associated with a public riverfront park and private parking associated with individual businesses and residential properties.

3.3 Effects on the Regional, Corridor and Local Roadways

This section presents the impacts to the regional and corridor highway and street network that would result from the project's alternatives and design options.

3.3.1 System-Wide Effects

This section addresses how the project's alternatives would affect overall transportation system demand and performance using three measures: 1) vehicle miles traveled (VMT); 2) vehicle hours traveled (VHT); and 3) vehicle hours of delay (VHD) (see Table 3.3-1). In summary, the Streetcar Alternative would reduce average weekday VMT, VHT and VHD by 68,000 miles, 5,700 hours and 400 hours, respectively, compared to the No-Build Alternative, while the Enhance Bus Alternative would reduce average weekday VMT, VHT and VHD by 41,000 miles, 3,300 hours and 200 hours, respectively, compared to the No-Build Alternative.

Average weekday peak period, peak direction vehicle volumes across three corridor screen lines in 2035 are summarized in Table 3.3-2 for the No-Build, Enhanced Bus and Streetcar alternatives. In summary, the Streetcar Alternative would reduce screen line volumes by approximately 100 vehicles in the peak direction during the two-hour peak period, compared to the No-Build Alternative, while the Enhanced Bus Alternative would not decrease screen line volumes.

Table 3.3-1 Average Weekday Regional VMT, VHT and VHD, Year 2035

System-Wide Measure	No-Build	Enhanced Bus	Streetcar[1]
VMT[2]	63,076,000	63,035,000	63,008,000
VMT Change from No-Build	N/A	-41,000	-68,000
VHT[2]	2,371,800	2,368,500	2,366,100
VHT Change from No-Build	N/A	-3,300	-5,700
VHD[3]	49,400	49,200	49,000
VHD Change from No-Build	N/A	-200	-400

Source: Metro, 2010.

Note: VMT = vehicle miles traveled; VHT = vehicle hours traveled; VHD = vehicle hours of delay.

[1] Based on Willamette Shore Line Design Option. With the Macadam In-Street and Macadam Additional Lane design options VMT would be 63,010,600, VHT would be 2,366,400, VHD would be 49,000.

[2] Based on average weekday conditions in 2035 on freeways, arterials and collector streets.

[3] Based on average weekday p.m. peak hour conditions in 2035 on freeways, arterials, and collector streets.

Table 3.3-2 Average Weekday Two Hour PM Peak Period, Peak Direction Corridor Screen Line Volumes, Year 2035

Screen line Location	No-Build	Enhanced Bus	Streetcar
SW Macadam Ave (Highway 43) and Parallel Streets in Johns Landing[1]	5,600	5,600	5,500
Change from No-Build	N/A	0	-100
N State St (Highway 43) north of Lake Oswego	6,200	6,200	6,100
Change from No-Build	N/A	0	-100
S State St (Highway 43) south of Lake Oswego	7,100	7,100	7,100
Change from No-Build	N/A	0	0

Source: Metro, 2010.[1] Screen line includes SW Macadam Avenue and SW Corbett Avenue at SW Pendleton Street.

3.3.2 Corridor and Local Roadways

This section addresses the long-term direct effects that the project's alternatives would have in 2035 on corridor and local roadways. In addition to standard intersection operations (LOS and V/C ratio), this section also addresses queuing and signal warrants. This section is organized by the corridor segments; note that traffic in Segment 1 – Downtown Portland was not analyzed for this study because there would be no changes to roadway facilities or operation within that segment under any alternative.

Standards for Considering Mitigation

Potential mitigation measures are identified in this section when specific criteria would be met. Mitigation criteria are based on LOS, V/C ratio, queuing, signal and turn lane warrants and turn lane criteria. The need for turn lanes or traffic signals is based on turn lane criteria and traffic signal warrants in the ODOT Analysis Procedures Manual Criteria. Mitigation of.intersection operations on Highway 43 would follow the ODOT Transportation Planning Rule and Oregon Highway Plan guidelines, which are dependent on whether the No-Build Alternative would meet applicable V/C ratio standards. If the No-Build Alternative would meet operational standards, then the Enhanced Bus and Streetcar alternatives must meet the same operational standards or potential mitigation measures are identified. If the No-Build Alternative would not meet operational standards, then the Enhanced Bus and Streetcar alternatives must not cause the intersection to perform worse than with the No-Build Alternative or potential mitigation measures are identified. For the cities of Portland and Lake Oswego, the compliance standard is measured by overall intersection LOS, however, all but one intersection impact would occur at intersections with Highway 43 where the ODOT standards would apply.

Mitigation for queuing is identified for locations where traffic queues from one intersection would back up through another signalized intersection under the Enhanced Bus or Streetcar alternatives, while under the No-Build Alternative queues at that intersection would not backup to another intersection. Warrants for proposed signals and for left and right turn lanes were evaluated for all alternatives.

Impacts and Potential Mitigation

The impacts and potential mitigation identified in this section will need to be evaluated and refined as part of the work for preliminary engineering and the Lake Oswego to Portland Transit Project Final Environmental Impact Statement (FEIS).

Table 3.3-3 identifies locations on an average weekday in 2035 along Highway 43 where queue spillback or overflow would occur under the No-Build Alternative. Queue spillback refers to traffic queues spilling back from one signalized intersection to another. Overflow refers to traffic queues exceeding the capacity of a turn lane and overflowing into the adjacent lane. Table 3.3-4 identifies locations where queues with the build alternatives would exceed those in the No-Build Alternative. In summary, queue spillback and overflow would occur from 31 corridor intersections under the No-Build Alternative, compared to 10 corridor intersections under existing conditions (see Table 3.2-1). Compared to the No-Build Alternative, the project's alternatives and design options would generally not result in an increase in queue spillback at corridor intersections, except potentially in Segment 6, which is discussed below.

Table 3.3-5 summarizes average weekday levels of congestion (i.e., V/C ratio or LOS with average delay) in 2035 at signalized intersections in the corridor under the No-Build, Enhanced Bus and Streetcar alternatives, in relationship to the applicable ODOT standard for the intersections (i.e., ODOT, except for SW Landing Drive and SW Hamilton Court, which is under the jurisdiction of the City of Portland). The intersections included in the table are only those that would operate at congested levels under the No-Build Alternative, based on the jurisdictional standard. The a.m. peak and p.m. peak intersection operations analysis maps are included in Appendix 3B, Figures 3B-5 through 3B-22.

In summary, all of the intersections would see the same level or slightly reduced congestion under the Enhanced Bus and Streetcar alternatives (compared to the No-Build Alternative) in segments 2, 4 and 5 – in no instances would the reduction in congestion result in an intersection meeting the jurisdictional standard. In segments 3 and 6, congestion levels at most of the intersections would also remain unchanged or become slightly reduced under the Enhanced Bus and Streetcar Alternatives (compared to the No-Build Alternative) except for five intersections, which are discussed below. The primary cause of the slight reduction in congestion at most of the corridor intersections would be the reduction of vehicle volumes on Highway 43 as a result of some automobile users shifting to transit, responding to improved transit travel times and access under the Enhanced Bus and Streetcar alternatives, compared to the No-Build Alternative.

In Segment 3, the intersection at SW Macadam Avenue and SW Carolina Street would require the installation of a traffic signal with the Macadam In-Street and Macadam Additional Lane design options of the Streetcar Alternative (which would not be required under the Willamette Shore Line Design Option or the Enhanced Bus Alternative). With a new traffic signal, the intersection of SW Macadam Avenue and SW Carolina Street would have operations exceeding the jurisdictional standard in 2035 (1.26 v/c during the AM peak hour, compared to the standard of 0.99 v/c), however, this level of congestion would be similar to or better than at intersections in the surrounding street network. The signal at the intersection at SW Macadam Avenue and SW Boundary Street would require modification to accommodate the In-Street and Additional Lane Alternatives. The modified signal timing would provide an improved v/c compared to the No-Build but would increase queuing on Landing Drive, the westbound approach, and in the northbound left-turn lane. Note that in Segment 3, Landing Drive is currently a private road serving the private businesses and residential properties. Landing Drive would be converted to a public road for the Macadam In-Street and Macadam Additional-Lane design options and it may need to be upgraded to meet City of Portland street standards.

The potential for increased queuing on Landing Drive under the In-Street and Additional Lane Alternatives would be isolated to the south end of Landing Drive and limited to the short periods in time when a streetcar is traveling along Landing Drive and passing through the intersection of SW Macadam Avenue and SW Boundary Street. Compared to the No-Build Alternative, the In-Street and Additional Lane Alternatives would improve v/c at the intersection of SW Macadam Avenue and SW Boundary Street,. However the intersection would remain well over capacity in 2035. Regardless of the alternative that is selected queuing and congestion on southbound Macadam Avenue would extend from SW Boundary Street back and through SW Bancroft Street. The future peak period congestion on SW Macadam Avenue limits the volume of traffic that can get onto southbound Macadam Avenue from SW Hamilton Court and SW Hamilton Street resulting in queuing on SW Moody Avenue in 2035 under the No-Build Alternative and all the Build Alternatives. The queuing on SW Moody Avenue would impact Streetcar operations under all the streetcar alternatives.

Table 3.3-3 Summary of Corridor No-Build Alternative Queue Spillback or Overflow Average Weekday, 2035

Segment/Intersection	Queue Spillback or Overflow[1] AM Peak Hour Direction[2]	Queue Spillback or Overflow[1] PM Peak Hour Direction[2]
Segment 2		
Highway 43/SW Hamilton St	SB Left Turn	WB Left Turn
Highway 43/SW Hamilton Ct	NB, WB Left Turn	NB, SB, WB Left Turn
SW Moody Ave/SW Hamilton St		EB
SW Landing Drive/SW Hamilton Ct		NB
Segment 3		
Highway 43/SW Richardson Ct	EB	EB
Highway 43/SW Mitchell St		EB
Highway 43/SW Boundary St	NB, NB Left Turn, EB Left Turn	SB past Bancroft, NB, NB Left Turn, EB Left Turn, WB Left Turn
Highway 43/SW Sweeney St		EB
Highway 43/SW Flower St		EB
Highway 43/SW Pendleton St	NB	NB
Highway 43/SW Iowa St	EB, WB	EB, WB
Highway 43/SW Carolina St	EB, WB	
Highway 43/SW Nebraska St	NB, SB	SB
Highway 43/SW Idaho St		EB
Highway 43/SW Vermont St		EB, WB
Highway 43/SW California St		EB
Highway 43/SW Nevada St		SB
Highway 43/SW Taylors Ferry Rd		SB, NB Left turn, EB Right Turn
Segment 4		
Highway 43/Sellwood Bridge	NA	SB Left Turn past Pendleton
Highway 43/Riverview Cemetery	NA	SB on Highway 43 and from Sellwood Bridge
Segment 5		
Highway 43 and SW Radcliff Road	NA	EB
Highway 43 and SW Riverdale Road	NA	NB
Highway 43 and SW Riverwood Road	NA	WB
Highway 43 and SW Military Road	NA	NB
Highway 43 and SW Greenwood Road	NA	SB
Highway 43 and SW Midvale Road	NA	SB
Highway 43 and SW Briarwood Road	NA	SB
Segment 6		
Highway 43/B Ave	NA	SB, EB Left Turn
Highway 43/A Ave	NA	NB Left Turn, SB EB Left Turn, EB Right Turn
Highway 43/Foothills Rd	NA	SB, SB Left Turn, WB Left Turn
Highway 43/North Shore Rd	NA	NB Left Turn, NB, SB, EB, WB, WB Left Turn
Highway 43/Middlecrest Rd	NA	SB
Highway 43/McVey Ave	NA	SB, NB, EB Left Turn

Note: NB = northbound; SB = southbound; EB = eastbound; WB = westbound; NA = not analyzed.

[1] Queue spillback refers to traffic queues spilling back from one signalized intersection to another. Overflow refers to traffic queues exceeding the capacity of a turn lane and overflowing into the adjacent lane.

[2] Refers to the through movement direction of travel approaching the intersection, unless otherwise noted.

Source: David Evans and Associates, Inc, 2010. Queuing was evaluated using Synchro for all segments

Table 3.3-4 Queue Spillback or Overflow for the Enhanced Bus and Streetcar Alternatives, Average Weekday, 2035

Segment/Time Period[1]/Intersection	No-Build	Project Queuing Impact[2]		
			Streetcar	
		Enhanced Bus	Willamette Shore Line	Macadam Avenue Design Options[3]
Segment 3 - *PM Peak Hour*				
SW Macadam Ave/SW Boundary St	SB past Bancroft, NB, NB Left Turn, EB Left Turn, WB Left Turn	**EB Left Turn**	**NB Left Turn, EB Left Turn**	**EB Left Turn, WB, WB Left Turn**
SW Macadam Ave/SW Carolina St			No Impact	**NB, SB**
Segment 3 - *AM Peak Hour*				
SW Macadam Ave/SW Boundary St	NB, NB Left Turn, EB Left Turn	No Impact	**EB Left Turn**	**EB Left Turn**
SW Macadam Ave/SW Carolina St	EB, WB	No Impact	No Impact	**NB**
Segment 6 - *PM Peak Hour*				
N/S State St/North Shore Rd	NB Left Turn, NB, SB, EB, WB	**NB Left Turn, NB, EB**	**NB Left Turn, NB, WB**	**NB Left Turn, NB, WB**
S State St/Middlecrest Rd/Wilbur St	SB	**SB**	**SB**	**SB**
S State St/McVey Ave/Green St	SB, NB, EB Left Turn	**SB, NB**	**SB, NB**	**SB, NB**

Note: **Bolded values indicate a project impact as defined by the mitigation criteria**. NB = northbound; SB = southbound; EB = eastbound; WB = westbound; NA = not analyzed. The direction refers to the through movement direction of travel approaching the intersection, unless otherwise noted.

[1] Unless noted, all intersections were analyzed for PM peak period conditions.

[2] Queuing Impact indicates increased queue spillback and/or overflow compared to the No-Build Alternative. Queue spillback refers to traffic queues spilling back from one signalized intersection to another. Overflow refers to traffic queues exceeding the capacity of a turn lane and overflowing into the adjacent lane. Generally a through movement refers to queue spillback and turn movements refer overflow.

[3] Queuing findings apply to both the Macadam In-Street and Macadam Additional Lane design options.

As noted previously, there would be no increase in congestion levels in **Segment 4** due to the Enhanced Bus or Streetcar alternatives, compared to the No-Build Alternative. In **Segment 5** the Riverwood In-Street Design Option of the Streetcar Alternative would close the existing intersection of SW Riverside Drive (Highway 43) and SW Riverwood Road to all vehicular traffic, which would require all vehicles to access the neighborhood east of SW Riverside Drive via SW Military Road. This closure would redirect vehicles to SW Military Road, however the additional vehicles would not change the overall intersection v/c ratio or LOS. The additional left-turning vehicles would increase southbound queuing at SW Military Road. The traffic volume increase would not result in queue spillback to upstream intersections or queues spilling out of a turn lane because there is no southbound left-turn lane on Highway 43 at SW Military Road. The slight increased frequency of left-turning vehicles on Highway 43 at SW Military Road could result in an increased potential for rear-end accidents. Although it would not meet specific mitigation criteria, with this design option consideration should be given to adding an exclusive southbound left turn pocket at SW Military Road.

In **Segment 6**, the 300-space structured park-and-ride lot at the Lake Oswego Village Shopping would generate additional traffic during the average weekday p.m. peak period in 2035 under the Enhanced Bus and the Streetcar alternatives, which would result in a slight increase in v/c ratios and the potential for increased queuing spillback and overflow at three intersections along N/S State Street. There would also be some increased queuing on Foothills Road due to Streetcar operations.

The three intersection with increased v/c ratios and potential for queuing on Highway 43 are at North Shore Road, Middlecrest Road/Wilbur Street and McVey Avenue/Green Street. At Highway 43 and North Shore Road, the v/c ratio would increase from 1.91 under the No-Build Alternative to 1.96 under the Enhanced Bus Alternative (and declining to 1.89 under both Streetcar design options). Potential mitigation at Highway 43 and North Shore Road would be the addition of an eastbound left-turn lane, which would reduce the intersection's v/c ratio to 1.83.

At Highway 43 and Middlecrest Road/Wilbur Street and at Highway 43 and McVey Avenue/Green Street, the v/c ratios of 1.30 and 1.15, respectively, would increase to 1.32 and 1.17 under the Enhanced Bus Alternative and both Streetcar design options, respectively. A potential mitigation measure at Highway 43 and Middlecrest Road/Wilbur Street is changing the signal phasing to provide permitted/protected northbound and southbound left-turn phases which reduces the intersection's v/c ratio to 1.25. At Highway 43 and McVey Avenue/Green Street, a potential mitigation measure of closing the intersection's westbound approach (with alternate access provided via Ladd and Wilbur streets) reduces the intersection's v/c ratio to 0.99.

3.4 Effects on Freight Movement

The Enhanced Bus and Streetcar alternatives would have little effect on freight operations, except at those locations within the study area where there would be effects to motor vehicle operations, as discussed in Section 4.2.3. No restrictions to truck movements would occur with the Enhanced Bus Alternative. No restrictions to truck movements would occur with the Streetcar Alternative. However, the Macadam design options could require raising the catenary wires to their maximum height of 20.5 feet where the wires cross SW Macadam Avenue at SW Boundary and SW Carolina streets in order to accommodate oversized loads that sometimes utilize SW Macadam Avenue to bypass I-5.

Table 3.3-5 Corridor Intersection V/C and LOS for the No-Build, Enhanced Bus and Streetcar Alternatives, Average Weekday, 2035

Segment/Time Period[1]/Intersection	Standard[2]	Alternative			Project Impact
		No-Build	Enhanced Bus	Streetcar[3]	
Segment 2					
PM Peak Hour					
SW Macadam Ave/SW Hamilton Ct	0.99	1.10	1.08	1.07	
SW Landing Dr/SW Hamilton Ct	LOS E	LOS F (103 sec)	LOS F (100 sec)	LOS F (95 sec)	
AM Peak Hour					
SW Macadam Ave/SW Hamilton Ct	0.99	1.21	1.21	1.20	
Segment 3					
PM Peak Hour					
SW Macadam Ave/SW Boundary St	0.99	1.45	1.45	1.45 / 1.32 / 1.32[4]	
SW Macadam Ave/SW Pendleton St	0.99	1.06	1.05	1.04 / 1.05 / 1.05[4]	
SW Macadam Ave/SW Carolina St	0.99	1.99[5]	1.81[5]	1.58[5] / **1.11** / **1.11**[4]	**Yes**
SW Macadam Ave/SW Nevada St	0.99	1.00	0.99	0.98 / 0.98 / 0.98[4]	
SW Macadam Ave/SW Taylors Ferry Rd/SW Miles St	0.99	1.29	1.28	1.27	
AM Peak Hour					
SW Macadam Ave/SW Boundary St	0.99	1.32	1.31	1.30 / 1.26 / 1.27[4]	
SW Macadam Ave/SW Pendleton St	0.99	1.09	1.08	1.06	
SW Macadam Ave/SW Carolina St	0.99	>2.00[5]	>2.00[5]	>2.00[5]/ **1.26** / **1.26**[4]	**Yes**
SW Macadam Ave/SW Nebraska St	0.99	1.35	1.32	1.32	
Segment 4					
Existing Intersection Configuration					
SW Riverside Dr/Sellwood Bridge[5]	0.99	1.59	1.59	1.59	
SW Riverside Dr/Riverview Cemetery	0.99	1.54	1.52	1.50	
Future Interchange Configuration					
SW Riverside Dr/Sellwood Bridge[5]	0.99	1.20	1.20	1.19	
Segment 5					
SW Riverside Dr/SW Military Rd	0.99	1.20	1.17	1.13	
SW Riverside Dr/SW Greenwood Rd/ SW Breyman Ave	0.99	1.35	1.34	1.31	
SW Riverside Dr/SW Midvale Rd/SW Elk Rock Rd	0.99	1.34	1.32	1.31	
SW Riverside Dr/Briarwood Rd	0.99	1.40	1.38	1.36	
Segment 6					
N State St/ B Ave	1.10	1.32	1.31	1.30	
N State St/A Ave	1.10	1.95	1.94	1.92	
N State St/Foothills Rd	1.10	1.30	1.29	1.27	
N/S State St/North Shore Rd	1.10	1.91	**1.96**	1.89	**Yes**
S State St/Middlecrest Rd/Wilbur St	1.10	1.30	**1.32**	**1.32**	**Yes**
S State St/McVey Ave/Green St	1.10	1.15	**1.17**	**1.17**	**Yes**

Note: **Bolded values indicate a project impact as defined by the mitigation criteria** (any worsening of V/C ratio when intersection performance does not meet operational standards of ODOT intersections). LOS = level of service; V/C = volume-to-capacity.

1 Unless noted, all intersections were analyzed for p.m. peak period conditions.

2 Except for the intersection at SW Landing Drive and SW Hamilton Court, the applicable standard for the intersection is based on V/C ratio because those intersections are under the jurisdiction of ODOT; for the intersection at SW Landing Drive and SW Hamilton Court, the City of Portland's LOS standard applies (including the length of time in seconds of delay, which is noted).

3 Unless noted, the V/C or LOS/delay applies to all Streetcar Alternative design options in the segment for that intersection.

4 V/Cs are for the Willamette Shore Line, Macadam In-Street and Macadam Additional Lane design options, respectively.

5 Unsignalized intersection highest stop controlled approach V/C ratio (Westbound approach in a.m. Eastbound in p.m.)

Source: David Evans and Associates, Inc, 2010.

3.5 Parking

This section discusses potential impacts that the project's alternatives and options would have with respect to on-street and off-street parking.

Neither the No-Build Alternative nor the Enhanced Bus Alternative would affect the supply of on- or off-street parking in the corridor (except that the Enhanced Bus Alternative would result in the construction of the 300-space structured park-and-ride lot at the Lake Oswego Village Shopping Center).

Under the Streetcar Alternative, Segment 3 is the only segment that would have a loss of parking spaces (in Segment 6, the Streetcar Alternative would result in the construction of a 100-space surface park-and-ride lot and a 300-space structured park-and-ride lot). Table 3.5-1 shows the potential loss of off-street and gain in on-street parking spaces in Segment 3 that would result from the various Streetcar Alternative design options. In summary, several privately-owned parking lots along SW Landing Drive would lose parking spaces under the Macadam In-Street and Macadam Additional Lane design options, due to property acquisitions to provide additional project right-of-way. There would be a loss of 166 and 193 spaces under the Macadam In-Street and Macadam Additional Lane design options, respectively. Both of these design options would include the addition of 18 on-street parking spaces along SW Landing Drive. Potential mitigation to offset some of the off-street parking loss could include reconfiguring affected parking lots to maximize the use of the remaining parking spaces. The Willamette Shore Line Design Option would not result in any loss of off-street parking spaces or gain in on-street parking spaces in Segment 3.

Table 3.5-1 Potential Change in Parking Spaces for Segment 3 – Johns Landing By Alternative and Streetcar Design Option

			Streetcar		
Parking Type	**No-Build**	**Enhanced Bus**	**Macadam In-Street**	**Macadam Additional Lane**	**Willamette Shore Line**
Off-Street Parking	0	0	-166	-193	0
On-Street Parking	0	0	18	18	0
Net Parking Loss	**0**	**0**	**148**	**175**	**0**

Source: David Evans and Associates, Inc (2010).

Another potential affect that the Streetcar Alternative would have on parking in Segment 3 would occur at the Willamette Sailing Club. Although there would be no loss of parking at the club, sailboats are often rigged in the parking lots west of the existing Willamette Shore Line right-of-way and then brought across the tracks to be launched from the sailing club property. Under all three Streetcar Alternative design options, sailboats would need to be rigged on the Willamette Sailing Club property east of the rail line because the reduced clearance under the catenary would be approximately 18 feet which is too low to move even the smallest rigged sailboats.

Unauthorized parking (parking within a neighborhood or a downtown area when not destined to that area) as a result of the introduction of streetcar stations would not be an issue along the majority of the alignment. However, in the Johns Landing area there could be increased potential for unauthorized parking for automobile users seeking to access the proposed streetcar station. If this type of activity is identified as a problem by the adjacent neighborhoods, TriMet would work with the local jurisdictions and neighborhood residents to assist in the evaluation of the problem and the development of potential feasible solutions.

4. BICYCLE AND PEDESTRIAN FACILITIES

This section describes the existing and planned bicycle and pedestrian facilities in study corridor and the relationship of those facilities to planned transit improvements under consideration in the corridor.

4.1 Affected Environment - Bicycle

Existing bicycle facilities in the Lake Oswego to Portland corridor include designated bike lanes, the Willamette Greenway Trail and the Tryon Creek State Park Trail. There is currently a gap in north-south bicycle facilities between the Sellwood Bridge and SW Terwilliger Boulevard in Lake Oswego. SW Macadam Avenue/SW Riverside Drive (Highway 43) provides the only through north-south route serving the corridor. South of the Sellwood Bridge, Highway 43 includes sections with no shoulders, high traffic volumes and high speeds.

In the northern portion of the corridor, Segment 2 - South Waterfront and Segment 3 - Johns Landing, includes several existing bicycle facilities; however, gaps or deficiencies are associated with them. These existing facilities include on-street bike lanes along SW Moody and SW Bond avenues and an existing portion of the incomplete Willamette Greenway Trail that meanders near the Willamette River shoreline.

Bicycle counts taken at several intersections found fewer than 5 peak hour bicycle trips being taken directly on Highway 43 in Segment 3 - Johns Landing, Segment 4 – Sellwood Bridge and Segment 5 – Dunthorpe/Riverdale. This relatively light usage could be due to safety concerns related to the narrow right of way and high traffic speeds on Highway 43. Bicycle planners have estimated latent demand for commuter and recreational bicycle travel exists in the corridor and suggested improvements to address existing safety concerns.[5] Bicycle counts taken on the Willamette Greenway Trail south of Willamette Park found daily bicycle volumes of 275 in 2009.[6]

4.2 Affected Environment - Pedestrian

The existing pedestrian facilities in the Lake Oswego to Portland corridor vary considerably among the study segments. The segment pedestrian environments are summarized below.

- **Segment 2 – South Waterfront**: This segment includes areas that are currently converting from industrial uses to residential uses. North of SW Bancroft Street most block faces include existing or new sidewalks. Portions of the Willamette Greenway Trail are being implemented as development occurs, resulting in a discontinuous bicycle and pedestrian trail at this time.
- **Segment 3 – Johns Landing**: West of SW Macadam Avenue the Johns Landing area is a traditional grid system with sidewalks on all block faces. East of SW Macadam Avenue, the development pattern is marked by office and condominium developments with private walkways and some public easements. Public pedestrian facilities are the sidewalk on the east side of SW Macadam Avenue and the Willamette Greenway Trail.
- **Segment 4 – Sellwood Bridge**: Pedestrian facilities in this segment include the Willamette Greenway Trail and a 5-foot sidewalk adjacent to Highway 43 just north of the Sellwood Bridge. South of the bridge is an informal dirt path in Powers Marine Park.

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[5] *Lake Oswego to Portland Transit and Trail Study, Evaluation Summary Public Review Draft, July 12, 2007.*
[6] *City of Portland Bicycle Counts, 2009.*

Segment 5 – Dunthorpe/Riverdale: Neighborhood streets in this segment have only occasional sidewalks and as a result most pedestrian activity occurs in the street, although most streets have low traffic volumes and low speeds.

Segment 6 – Lake Oswego: Central Lake Oswego west of State Street is a traditional grid pattern with sidewalks. East of State Street pedestrian facilities are limited but would be included in any planned Foothills area redevelopment. The Kincaid Curlicue Trail also provides pedestrian access east of State Street.

4.3 Effects on Bicycle and Pedestrian Facilities

This section provides a summary of the effects that the project's alternatives and options would have on bicycle and pedestrian facilities and behavior.

Because the No-Build Alternative would not construct any transit capital improvement projects in the corridor, it would result in no direct impacts to bicycle or pedestrian infrastructure. Compared to the No-Build Alternative, there would be no changes to corridor's bicycle and pedestrian infrastructure under the Enhanced Bus Alternative, except for new bike facilities and sidewalks associated with the 300-space structured park-and-ride lot in the vicinity of the Lake Oswego Terminus.

Table 4.3-1 summarizes the effects that the Streetcar Alternative would have on existing or funded bicycle facilities within the corridor. Along certain streets where existing or planned bike lanes would parallel the tracks, this alternative would intentionally avoid the bike facilities by running in the far left-hand lane (SW Bond Avenue south of SW Lowell Street). The majority of the remaining bicycle facilities would cross the tracks in a generally perpendicular and safe manner.

Following is a brief description, by segment, of the changes to bicycle and pedestrian facilities that would result from the Streetcar Alternative. In addition to the changes associated with existing or funded bicycle and pedestrian facilities, the Streetcar Alternative, with the Macadam In-Street and Macadam Additional Lane design options in Segment 3 – Johns Landing, could limit the ability to implement a future bike improvement on SW Macadam Avenue as identified in the Portland Bicycle Plan for 2030 (adopted in February 2010). Bicycle parking facilities would be provided at the new streetcar stations.

Similarly, in the Lake Oswego to Portland corridor, Metro and the cities of Lake Oswego and Portland show a potential regional bike or trail facility along SW Macadam Avenue, Highway 43 and the Willamette Shore Line right-of-way. Though the Streetcar Alternative may operate along portions of SW Macadam Avenue and/or the Willamette Shore Line right-of-way, the Streetcar Alternative would not preclude the implementation of a future regional bike/trail facility in the corridor.

Table 4.3-1 Summary of Impacts of Streetcar Alternative on Existing or Funded Bicycle/Pedestrian Facilities, By Segment and Design Option

Location	Facility Type	Direction	Extent of Facility in Proximity to Project	Design Considerations
Segment 1 – Downtown Portland				
None				
Segment 2 – South Waterfront[1]				
SW Moody	On-Street Bike Lane	SB	SW Lowell - SW Bancroft	Parallel; separation at station; perpendicular crossing; box left turn
SW Bond	On-Street Bike Lane	NB	SW Bancroft - SW Lowell	Bike lane on right side of street opposite streetcar tracks
SW Bond (new street)	New connection to existing Greenway Trail	EB/WB	Willamette Shore Line - Willamette Greenway Trail	Interim connection; near perpendicular crossing
Willamette Greenway Trail	Existing bike path	NB/SB	SW Bancroft - SW Moody	Extend and formalize multi-use path
Segment 3 – Johns Landing: Willamette Shore Line Design Option				
Willamette Greenway Trail	Existing/funded bike/ pedestrian path	NB/SB	SW Hamilton Ct - SW Miles Ct	Crossing improvements
Segment 3 – Johns Landing: Macadam Additional Lane Design Option				
Willamette Greenway Trail	Existing/funded bike/ pedestrian path	NB/SB	SW Hamilton Ct - SW Miles Pl	Parallel facilities; WSL right of way could potentially be used for future bike path
Segment 3 – Johns Landing: Macadam In-Street Design Option				
Willamette Greenway Trail	Existing/funded bike/pedestrian path	NB/SB	SW Hamilton Ct - SW Miles Pl	Parallel facilities; WSL right of way could potentially be used for future bike path
Segment 4 – Sellwood Bridge[1]				
Sellwood Bridge Replacement Project	Funded bike/ pedestrian facilities	EB/WB	Highway 43 - SE Grand Av	Connection with new bridge bike/pedestrian facilities
Powers Marine Park	New overcrossing connection to Powers Marine Park	EB/WB	Highway 43 - Powers Marine Park	New connection; grade-separated
Segments 5 and 6				
Kincaid Curlicue Corridor	Local Trail/Pathway	EB/WB	Foothills Road – Roehr Park	New connection

Source: City of Portland, City of Lake Oswego URS: March 2010
Notes: EB = eastbound, WB = westbound, NB = northbound, SB = southbound. Additional details of the crossings of the Willamette Shore Line right of way are noted in the track crossings table on page CS-020 of the *LOPT Transit Project Streetcar Plan Set*, November 9, 2009. Sidewalks are provided on many streets and bicycle travel is allowed on all streets in the study area.

[1] The South Waterfront and Sellwood Bridge Segments contain potential construction phasing options associated with the Streetcar alignments. See Section 3.17 Phasing for more information regarding phasing options and differences between those options.

Segment 1 – Downtown Portland – There would be no changes to existing or planned bicycle or pedestrian facilities in Segment 1. While a new rail connection between the existing tracks would be installed along SW 10th Avenue and SW Market Street, the connection would not interfere with any existing or planned bike routes or facilities.

Segment 2 – South Waterfront – In Segment 2, the Streetcar Alternative would extend the existing streetcar/bike facility pattern and design strategies already established in the district by the streetcar and other transportation projects. For example, as shown in the Figure 4.5-1, the new southbound streetcar station at SW Bancroft would position the on-street bike lane between the station platform and the sidewalk and be grade-separated from the platform. Along SW Bond Avenue, the alternative would position the northbound streetcar tracks in the left-hand lane to avoid the right-hand side bicycle lane. The existing bicycle/pedestrian path along the Willamette Shore Line right-of-way would be maintained or improved in this segment and access to the existing portion of the Willamette Greenway Trail would be maintained.

Figure 4.5-1
Bike lane at the SW Moody – Gaines station.

Segment 3 – Johns Landing – In Segment, 3 the Willamette Shore Line Design Option would change two existing bicycle and pedestrian crossings of the trackway. First, a bike/pedestrian "z-crossing" would be installed where an existing asphalt concrete pathway currently provides a direct crossing of the trackway near SW Richardson Street. Second, the current grade-separated bike/pedestrian crossing below the Jones Trestle between SW Sweeney and Flower streets would be replaced with an at-grade crossing in roughly the same location.

With either of the two Macadam design options, the curb realignment and street reconstruction could trigger the need to comply with the Oregon Highway Plan, the Oregon Bicycle and Pedestrian Plan (ODOT: June 1995) and the provisions of Oregon Revised Statute (ORS) 366.514, also known as the "Bike Bill."[7] Where the project realigns the position of roadway curbs, the project may need to provide bike facilities, provide appropriate width for future bike facilities or provide a suitable, alternate parallel bike facility. In the Macadam In-Street design option, the curb realignment is limited to the intersection of SW Macadam Avenue and SW Carolina. With the Macadam Additional Lane design option, the curb realignment is limited to the intersection of SW Macadam Avenue and SW Carolina and the eastern curb of SW Macadam Avenue from SW Carolina to SW Boundary (associated with the new northbound streetcar lane). See the *Lake Oswego to Portland Transit Project Land Use and Planning Technical Report* for a discussion of these policies.

The conceptual designs for the Macadam In-Street and the Macadam Additional Lane design options do not currently include additional bicycle or pedestrian facilities. However, with either of the Macadam design options, the Willamette Shore Line right-of-way between SW Boundary and SW Carolina could be improved by others and establish part of a regional bike facility that would parallel

[7] http://www.oregon.gov/ODOT/HWY/BIKEPED/bike_bill.shtml

the existing, more meandering Willamette Greenway Trail to the east and could potentially provide a bicycle facility parallel to SW Macadam Avenue.

Segment 4 – Sellwood Bridge – Segment 4 would include the addition of a second track at several existing bike/pedestrian crossings and a new bicycle and pedestrian overcrossing of the Willamette Shore Line right-of-way, which would be located near the south end of the City of Portland's Powers Marine Park, connecting the now informal trails of the park to Highway 43. Other trail improvement projects could lead to new bicycle and pedestrian trails in this segment, which could be facilitated through coordination of design efforts for the Streetcar and trail projects. For example, Multnomah County's Sellwood Bridge replacement project includes proposed changes to bicycle and pedestrian access to local streets and Metro's Lake Oswego to Portland Trail Project is examining options for trails within this segment.

Segment 5 – Dunthorpe/Riverdale - In Segment 5, the Streetcar Alternative would affect local bicycle and pedestrian access by changing the frequency of rail vehicle use of the existing rail right-of-way at street crossings and access ways to private residences and to a privately-owned boating facility. Figure 4.5-2 illustrates an example of an existing pedestrian crossing and the *Streetcar Alternative Plan Set* provides a list of the location of all existing private pedestrian crossings in this segment and how they would be changed under the Streetcar Alternatives' design options. In summary, the number of private accesses crossing the existing rail right-of-way would decrease if the Riverwood In-Street Design Option were selected in this segment. Additionally, new sidewalks and bicycle facilities would be included in the design of the new SW Riverwood Road. However, the new SW Riverwood Road would no longer have direct vehicle access to SW Riverside Drive (Highway 43) (bicycle and pedestrian access from SW Riverwood Road to SW Riverside Drive could be maintained); access to the highway would be provided via SW Military Road.

Figure 4.5-2
Existing Private Residence Pedestrian Crossing of Willamette Shore Line right-of-way in Segment 5

Segment 6 – Lake Oswego – In Segment 6, the Streetcar Alternative would provide a new bicycle and pedestrian connection under the existing Union Pacific Railroad (UPRR) freight tracks north and east of SW Terwilliger Boulevard. This new crossing, which would occur under both design options for this segment, would connect Fielding Road and Stampher Road, which is not possible under existing conditions. In addition, both design options would create new sidewalks and on-street bike facilities along the new or re-aligned roadways that are part of each option within the segment south from the crossing of the freight rail line to the Lake Oswego terminus. Other changes for pedestrians would include new or enlarged sidewalks near streetcar station platforms that would facilitate access to the stations.

In the Foothills Design Option, the Streetcar Alternative would intersect a local bicycle/ pedestrian pathway known as the Kincaid Curlicue Corridor along the realigned Foothills Road. This design option would provide a new connection between this pathway and new bike and pedestrian facilities along Foothills Road.

Additionally, both design options would create new sidewalks and bike facilities along the new or re-aligned roadways that are part of each option within the segment south from the crossing of the freight rail line to the Lake Oswego terminus. Other changes for pedestrians would include new or enlarged sidewalks near streetcar station platforms that would facilitate access to the stations.

5. CUMULATIVE AND INDIRECT IMPACTS

The cumulative impacts associated with the Enhanced Bus or Streetcar alternatives are taken into account through the use of regional travel forecasting models. The regional models use population and employment growth forecasts and include planned and funded transportation projects throughout the region. The models encompass the entire Portland metropolitan area, including Washington, Clackamas and Multnomah counties in Oregon and Clark County, Washington. The models account for the cumulative effect that the planned projects would have within the study corridor and the models found that there were only very minor changes in traffic volumes and transit ridership in areas outside of the study corridor.

In certain instances the potential population and employment growth and redevelopment in the corridor could be considered to be an indirect impact of the planned transit improvements. However, the regional growth forecast used in the travel models already includes aggressive assumptions regarding the potential for redevelopment in the corridor. The growth forecast includes an assumption of transit-supportive, mixed use development in the north portion of Segment 3 – Johns Landing and in the Foothills portion of Segment 6 – Lake Oswego. The traffic and transit ridership consequences of this growth is captured in the travel demand models and is included in this report under the discussion of direct effects of the project alternatives.

The transit networks developed for modeling the Enhanced Bus and Streetcar alternatives make assumptions regarding modifications to the supporting bus system. As with previous rail transit projects in the region, the final decisions on bus system modifications occur later in the project planning phase and are developed in conjunction with the local community and the TriMet Board. A possible indirect impact of the Enhanced Bus and Streetcar alternatives could be other bus route modifications that could include changes in routing and bus stop location.