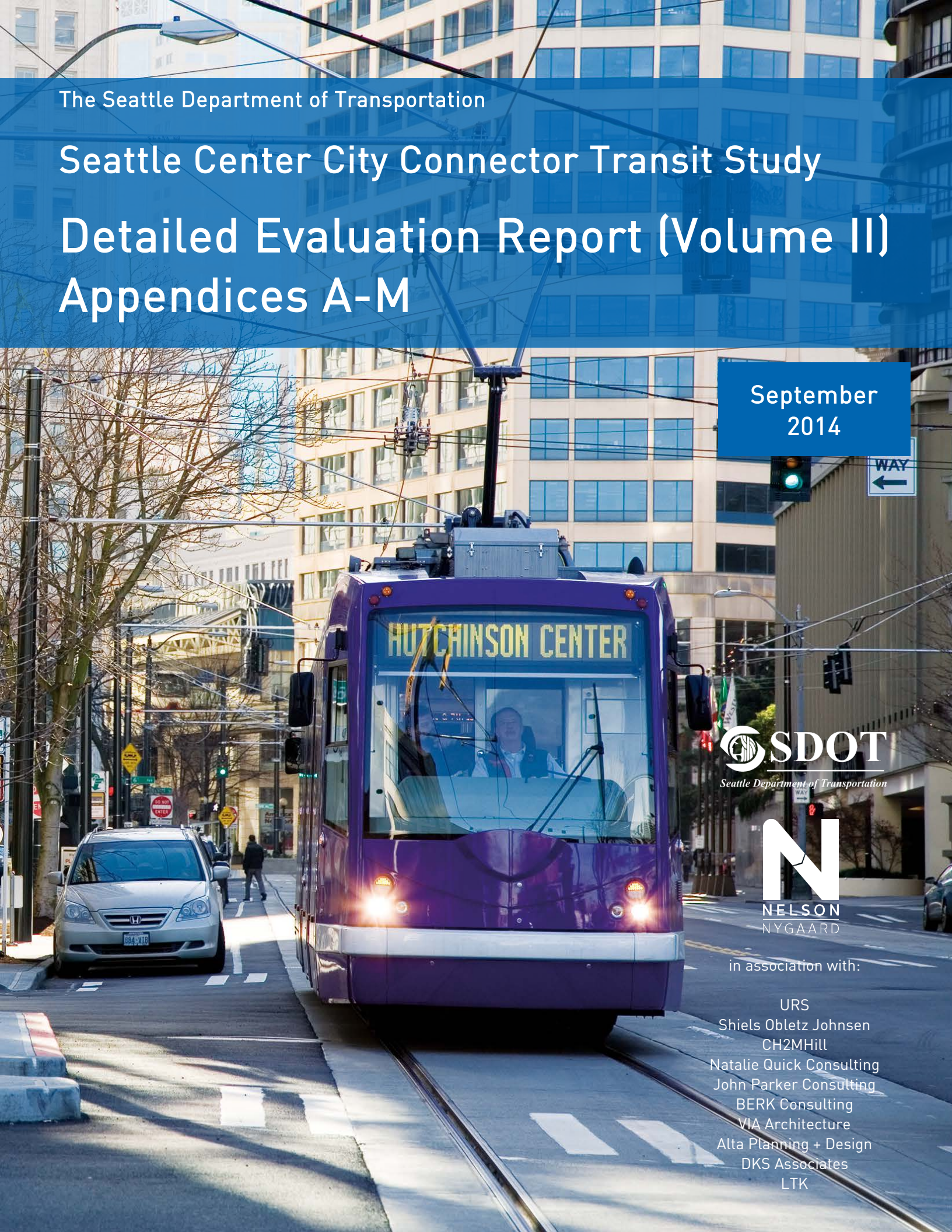
The Seattle Department of Transportation

Seattle Center City Connector Transit Study

Detailed Evaluation Report (Volume II) Appendices A-M

September 2014



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Seattle Center City Connector Transit Study

Executive Summary

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1. Project Overview
2. Purpose and Need
3. Evaluation Framework
4. Evaluation of Alternatives
5. Summary of Tier 1 Screening and Tier 2 Evaluation Results and Public Input
6. Recommended Locally Preferred Alternative
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Cover image from SDOT

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APPENDIX A RIDERSHIP PROJECTIONS

Introduction

This appendix[1] describes the ridership projections for the Center City Connector, which were developed using the Federal Transit Administration (FTA) Simplified Trips on Project Software (STOPS) ridership forecasting model. Ridership projections were developed for a No-Build alternative and two Build alternatives for a 2018 opening year. The Build alternatives were Mixed-Traffic and Exclusive Streetcar on 1st Avenue between Jackson Street and Westlake. Ridership for these alternatives was analyzed as part of an integrated streetcar system including the South Lake Union (SLU) and First Hill Streetcar lines. Two operating scenarios for the integrated streetcar system were evaluated (Hub-to-Hub and End-to-End), as described below.

This document is organized into the following sections:

- Methodology
- Assumptions
- Results

In addition, Appendix B describes a separate assessment of the visitor and special events ridership markets.

Methodology

STOPS Model Overview

The FTA Simplified Trips on Project Software (STOPS) model consists of a series of programs designed to estimate transit project ridership using a streamlined set of procedures that bypass the time-consuming process of developing and applying a regional travel demand forecasting model. STOPS is similar to regional models and includes many of the same computations of transit level of service and market shares found in models maintained by Metropolitan Planning Organizations (MPOs). What makes STOPS much simpler to use than regional models is the following:

1. Estimates of total origin-to-destination travel are derived from Census data rather than elaborate trip generation and destination choice procedures. This avoids the need to calibrate these tools to the degree of accuracy required to estimate transit ridership.
2. Representations of transit level-of-service are derived from timetable information obtained directly from the transit agency, bypassing the need to develop detailed transit

[1] Prepared by JPC and Nelson\Nygaard

networks in the planning environment. Timetable information is already available for most agencies and is much more accurate than the representations of travel time and frequencies contained in typical planning networks.

3. The model calibrates itself to represent current conditions. This means that the months, and sometimes years, that are spent developing and documenting effective forecasting tools can be avoided.

The STOPS model can be used to develop ridership forecasts for current and future (opening and horizon) years.

Although STOPS represents a significant simplification over existing procedures, it still requires careful development of input information that describes existing transit ridership, existing transit schedules, and future transit service scenarios.

Key STOPS Data Sources

The types and sources of files that are used by STOPS to arrive at transit ridership forecasts include:

- General Transit Feed (GTF) files to represent transit service networks in a nationally consistent way.
- CTPP (Census Transportation Planning Package) 2000 files to describe metro-area worker flows in a nationally consistent way (when year 2010 files are available for distribution, the STOPS model will be updated to use these files).
- Metro-area demographic forecasts.
- Metro-area highway impedances.
- A set of mode choice models that varies by trip purpose (work, home-based other, non home-based).
- Nationally developed coefficients and constants.

Some of the required inputs are available through the U.S. Census Bureau and online GTF data exchanges, which include files for many transit agencies throughout the country. The Seattle area GTF is available through an exchange, including both Sound Transit and King County Metro. The GTF files are only available for existing transit systems as they currently operate, so updated files need to be incorporated to reflect future transit system changes, including the alternatives under consideration for the Seattle Center City Connector Project. Other data inputs required assistance from the regional MPO, the Puget Sound Regional Council (PSRC). These include PSRC Traffic Analysis Zone (TAZ) definitions and demographics (for the year 2000 and any existing or horizon years desired) and travel times and distances for the PSRC TAZ system. The horizon year used for the Center City Connector analysis was the projected opening year of the Project, assumed to be 2018 for the Tier 2 evaluation. A 2035 horizon year was also included in some runs of the STOPS model.

Assumptions and Input Data

Alternatives and Operating Scenarios

Ridership projections were developed for the following alternatives and operating scenarios:

- No Build Alternative.
- Build Alternatives: Mixed-Traffic and Exclusive Streetcar along 1st Avenue alignment with a Stewart Street/Olive Way connection between 1st Avenue and Westlake.
- Operating Scenarios:
  - **Hub-to-Hub**. Operates as two independent, overlapping lines: (1) South Lake Union (Fairview & Yale Aves) – King Street Intermodal Hub. (2) Capitol Hill (Broadway & Denny Way) – Westlake Intermodal Hub.
  - **End-to-End.** Operates as a single integrated line (comprised of South Lake Union, First Hill, First Hill Broadway Extension, and Center City Connector segments) with no transfers.

See the Detailed Evaluation Report, Chapter 6, for additional description of the alternatives and operating scenarios.

Population/Employment Projections

The following describes current and future population and employment inputs:

- Shapefile with MPO (PSRC) Transportation Analysis Zones (TAZs or zones) that includes Population and Employment for the CTPP Base year (2000), a current year (2010), an opening year (2018) and forecast year (2035). The PSRC 938 zone system was used for this work.
- Current year employment data from PSRC included a number of zones where values were suppressed for confidentiality reasons. Based on discussion with PSRC, data from U.S. Census Bureau Longitudinal Employer-Household Dynamics (LEHD) On-The-Map tool was used to obtain employment data any zone that included suppressed 2010 employment values. Suppression did not affect forecast year employment for 2025 or 2035.
- For the 2018 opening year population and employment, a straight-line interpolation was done between 2010 and 2025 and the resulting values were reviewed for reasonableness by SDOT.

Transit Improvements

Figure A-1 identifies regional transit improvements that were assumed in transit networks for the No-Build and 2018 and 2035 Build Alternatives.

Figure A-1 Transit Network Assumptions by Year and Alternative

Alternative / Assumed Transit Improvement(s)	Source/Notes
2018 No Build	
First Hill Streetcar including Broadway Extension Project to Roy Street	1
University Link Extension to Capitol Hill and University of Washington	2
2018 Build – includes 2018 No-Build plus:	
Center City Connector Streetcar	3
2035 Build – includes 2018 Build plus:	
Northgate Link Extension	4
East Link Extension (Downtown Seattle to Overlake Transit Center)	5
S 200th Link Extension to the south of SeaTac	6
Lynwood Link Extension	7
Federal Way Transit Extension	8

Notes/Sources:

(1) The proposed Broadway Extension was included to be able to compare 2018 Build ridership for the integrated streetcar system, including both CCC and the Broadway extension, while isolating the effects of adding the Center City Connector.

(2) http://www.soundtransit.org/Projects-and-Plans/University-Link-Extension

(3) None

(4) http://www.soundtransit.org/Projects-and-Plans/Northgate-Link-Extension

(5) http://www.soundtransit.org/Projects-and-Plans/East-Link-Extension

(6) http://www.soundtransit.org/Projects-and-Plans/South-200th-Link-Extension. Note: this should be included in the 2018 transit network in future model runs.

(7) http://www.soundtransit.org/Projects-and-Plans/Lynnwood-Link-Extension/Location-and-stations---Lynnwood-Link-Ext

(8) http://www.soundtransit.org/Projects-and-Plans/Federal-Way-Link-Extension. The extension to Kent/Des Moines is a funded component of ST2, with a station location near Highline Community College. Possible extensions beyond a Kent/Des Moines terminus are not yet funded and were not included in the 2035 transit network.

Operating Plan

Appendix C of the Detailed Evaluation Report provides the operating plan assumptions used in the Tier 2 evaluation. Headways of 10 to 15 minutes per line were assumed; in the Hub-to-Hub operating scenario this provided headways of 5 to 7.5 minutes between Westlake and King Street Intermodal Hubs. Figure A-2 summarizes these assumptions.

Figure A-2 Center City Connector Operating Plan Assumed in Tier 2 Evaluation

	Weekday	Saturday	Sunday/Holiday
Service Span			
Service Span	5 – 1 AM	5 – 1 AM	6 AM – 11 PM
Daily Hours	20	20	17
Headway (Individual Lines*)			
Early Morning	15 min (5 – 6 AM)	15 min (5 – 8 AM)	15 min (6 – 8 AM)
Day/Early Evening	10 min (6 AM – 8 PM)	10 min (8 AM – 8 PM)	10 min (8 AM – 8 PM)
Later Evening	15 min (8 PM – 1 AM)	15 min (8 PM – 1 AM)	15 min (8 – 11 PM)

Note: *Under the Hub-to-Hub operating scenario, overlapping service between Westlake and King Street Intermodal Hubs results in 5 to 7.5 minute headways in this segment of the system.

Travel Times

Travel times for Center City Connector are based on the Tier 2 traffic analysis, which was conducted for the PM peak period using the VISSIM traffic simulation software as described in Appendix G. Travel times were provided for both the Mixed-Traffic and Exclusive operating scenarios. Travel times for the First Hill Streetcar were based on projected travel times, obtained from preliminary traffic simulation for the First Hill Streetcar. Travel times for the South Lake Union Streetcar were based on timetables from GTF files.

Auto travel times between TAZs were obtained from PSRC; these TAZs correspond to the PSRC-provided demographic projections (population and employment). General transit travel times were obtained from published agency timetables (GTF files).

Results

Overall Ridership Projections

This section describes ridership projections for the Mixed-Traffic and Exclusive Streetcar alternatives. The ridership projections assume an integrated streetcar system including the Center City Connector (CCC) and South Lake Union and First Hill Streetcars along with the First Hill Streetcar Broadway Extension to a Roy terminus.

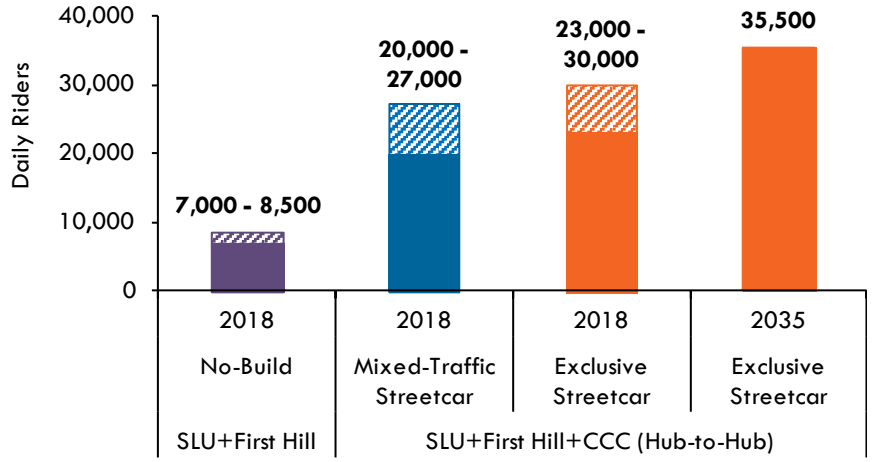
The STOPS model uses a calibration process based on boardings at fixed guideway stations in the area being studied. For stations that are part of a new project, a station type is coded based

on how similar the new stations are to others in the area. In the case of the CCC Project, the coding was varied to develop low- and high-end ranges for projected CCC ridership:

- **Low-end (based on SLU Streetcar).** The low-end of the ridership range was established based on initial STOPS model runs where new CCC stops were calibrated to characteristics of existing SLU Streetcar stops. The project team recognized that coding CCC stops in this manner would not fully capture potential visitor and non home-based trips that are likely to be very different in the CCC corridor.
- **High-end (not constrained to SLU Streetcar).** The high-end of the ridership range was set based on STOPS model runs that did not constrain the CCC to SLU characteristics. In coordination with FTA, the project team felt that the high-end of the ridership range more fully captures visitor and non-work ridership markets that the STOPS model does not explicitly address. A separate analysis was conducted to look at factors influencing visitor trips; a range of ridership potential was calculated using a peer comparison to San Francisco's F-Market Line. The analysis of visitor and special event markets is described in Appendix B.

Figure A-3 illustrates the range of weekday daily projected streetcar boardings in the anticipated Project opening year and projected daily boardings in a 2035 horizon year.

Figure A-3 Projected Weekday Daily Streetcar Boardings, 2018 and 2035



Note: The 2035 projection corresponds to the high-end of the range of the 2018 opening year projections. This figure is based on a STOPS model run that was not constrained to characteristics of the SLU line (as described above).

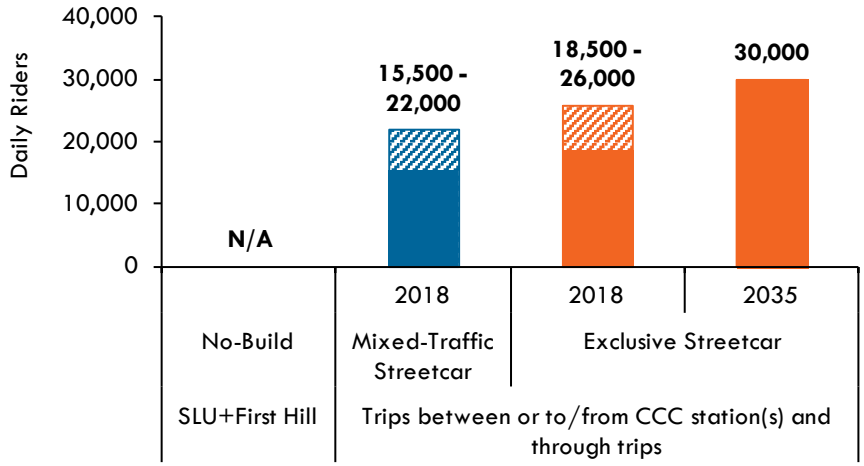
Trips on Project

"Trips on Project" represent any trip that boards or alights in the Project area (stops including or between Westlake and King Street Intermodal Hubs) and any through trip that uses the Project to travel between stations on the SLU and First Hill Streetcar lines. For example, if someone gets on the SLU portion of the system and then travels through the CCC alignment to a station

along the First Hill portion of the system, it would be considered a trip on the Project. Trips on the South Lake Union and First Hill Streetcar lines that do not utilize or pass through the Center City Connector segment are not considered Project Trips.

Figure A-4 illustrates the range of projected daily trips on the CCC Project in the anticipated Project opening year and projected daily Project trips in a 2035 horizon year.

Figure A-4 Projected Weekday Daily Trips on Project, 2018 and 2035, Hub-to-Hub Mixed-Traffic and Exclusive Streetcar



Note: The 2035 projection corresponds to the high-end of the range of the 2018 opening year projections. This figure is based on a STOPS model run that was not constrained to characteristics of the SLU line (as described above).

Markets on Project

Figure A-5 provides a breakdown of the nearly 26,000 Project trips in the Hub-to-Hub Exclusive alternative. Trips along the Center City Connector segment (including Westlake and 5th/Jackson stops) comprise 68% of Project trips. Trips between either First Hill or South Lake Union and CCC stops make up a combined 29% of Project Trips. Through trips between First Hill and South Lake Union stops represent the remaining approximately 650 daily trips.

Figure A-5 Weekday Daily Project Trips by Market, 2018, Hub-to-Hub Exclusive

Trip Movement	Daily Project Trips	% of Total
First Hill - CCC*	4,180	16%
Along CCC*	17,650	68%
SLU - CCC*	3,410	13%
Through Trips (SLU-First Hill)	650	3%
TOTAL	**25,890**	**100%**

Notes: *CCC represents stops including and between Westlake and Jackson/5th. Trips using only stops along the SLU line or along the First Hill line are not counted as Project trips.

Project Trips by Stop

2018 Opening Year

Figure A-6 shows estimated Project trips by stop for the Hub-to-Hub Exclusive and Mixed-Traffic Streetcar alternatives at existing/planned South Lake Union and First Hill Streetcar stop and Center City Connector stops; the CCC Project includes the stops at Westlake, Jackson/Occidental, and Jackson/5th.

Figure A-6 Project Trips by Stop, 2018, Hub-to-Hub Mixed-Traffic and Exclusive Streetcar

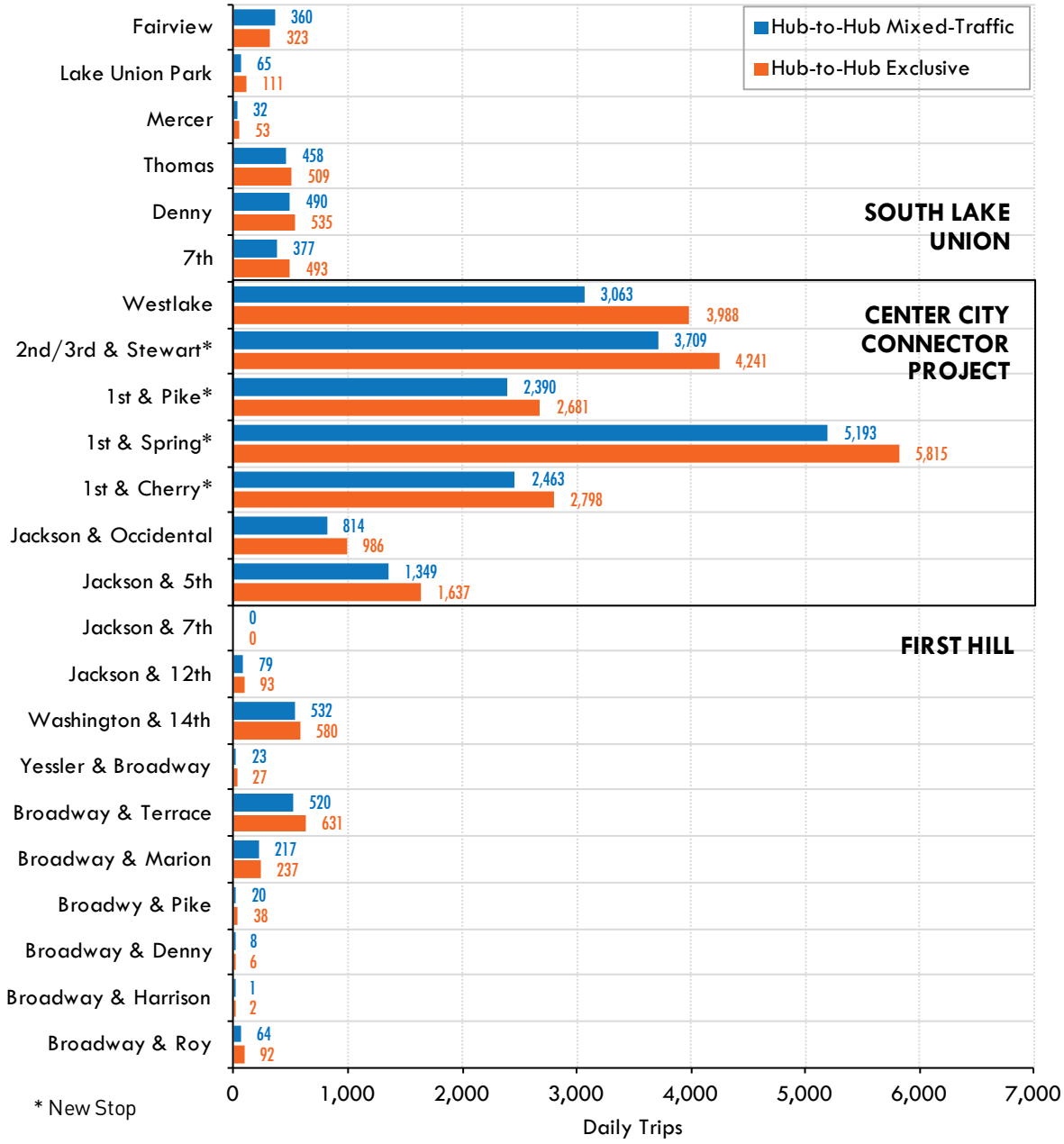


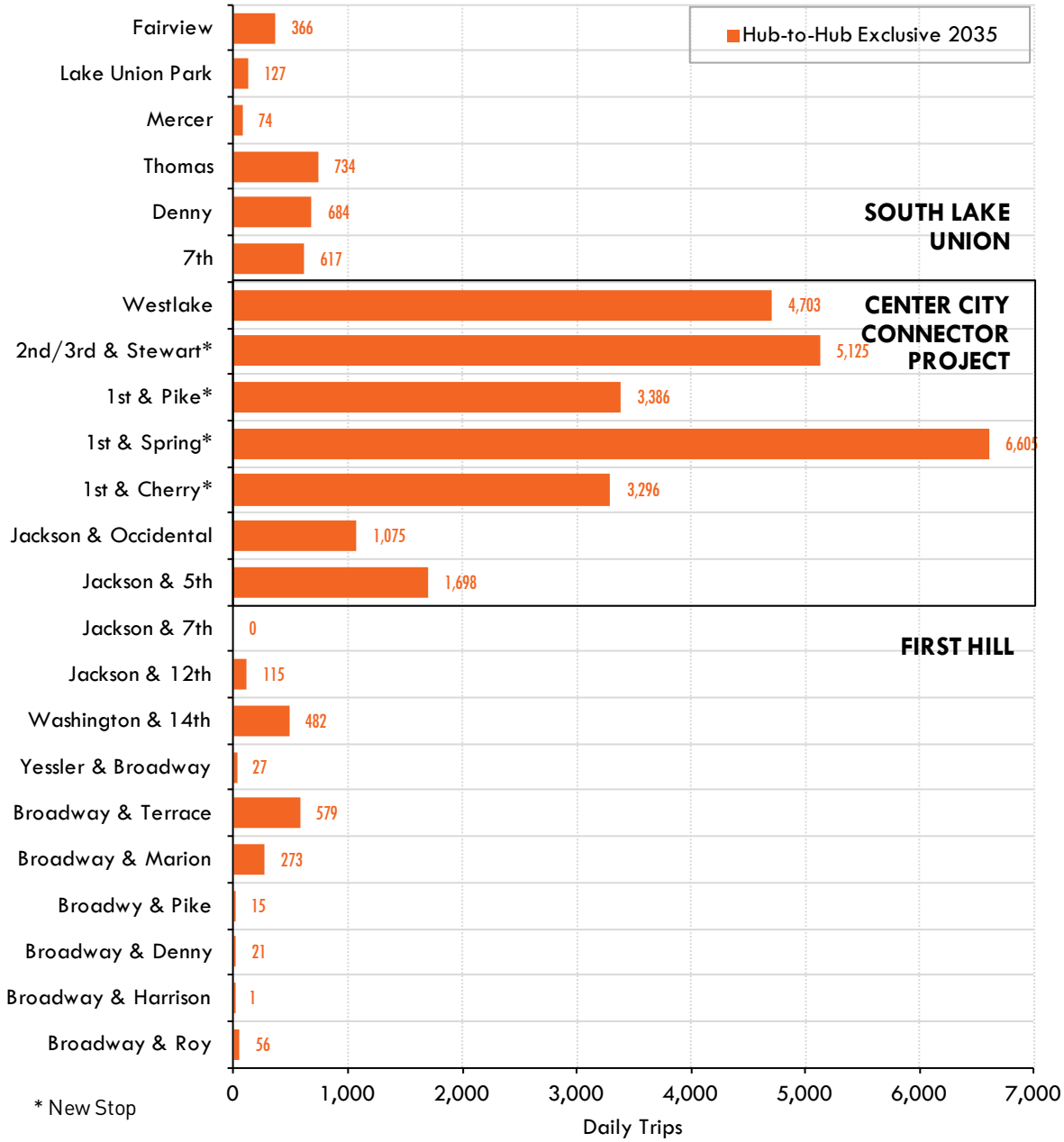
Figure A-7 illustrates Project trips utilizing the Center City Connector stations and/or segment in the projected 2018 opening year relative to total daily boardings. The map provides these results for the Exclusive Streetcar and Hub-to-Hub Operating Scenario.

Figure A-7 Daily Total Boardings and Project Trips by Stop, 2018, Hub-to-Hub Exclusive

2035

Figure A-8 shows estimated Project trips by stop in 2035 for the Hub-to-Hub Exclusive alternative.

Figure A-8 Project Trips by Stop, 2035, Hub-to-Hub Mixed-Traffic and Exclusive Streetcar



District-Level Results

The STOPS model estimated CCC Project trips between PSRC Transportation Analysis Zones (TAZs). These zones were aggregated into 16 districts for easier visualization. Figure A-8 shows the district boundaries and district-to-district travel patterns with over 500 daily trips. Figure A-9 provides these results in a table; the district-to-district pairs with over 500 daily trips are highlighted in yellow shading.

These results illustrate that of the over 25,000 projected daily Project trips:

- Over three-quarters of these trips are between districts directly served by the streetcar alignments (districts either contain or are directly adjacent to a CCC streetcar stop).
- Large shares of trips (about 43% each) of trips have an origin or destination in either the Central Waterfront district or the CBD.
- A relatively small share of trips (about 13%) is from districts outside of the Center City area to one of the districts within the Center City area that is served by the integrated streetcar system.

Figure A-9 District Boundaries and District-to-District Project Trips (500 or more trips)

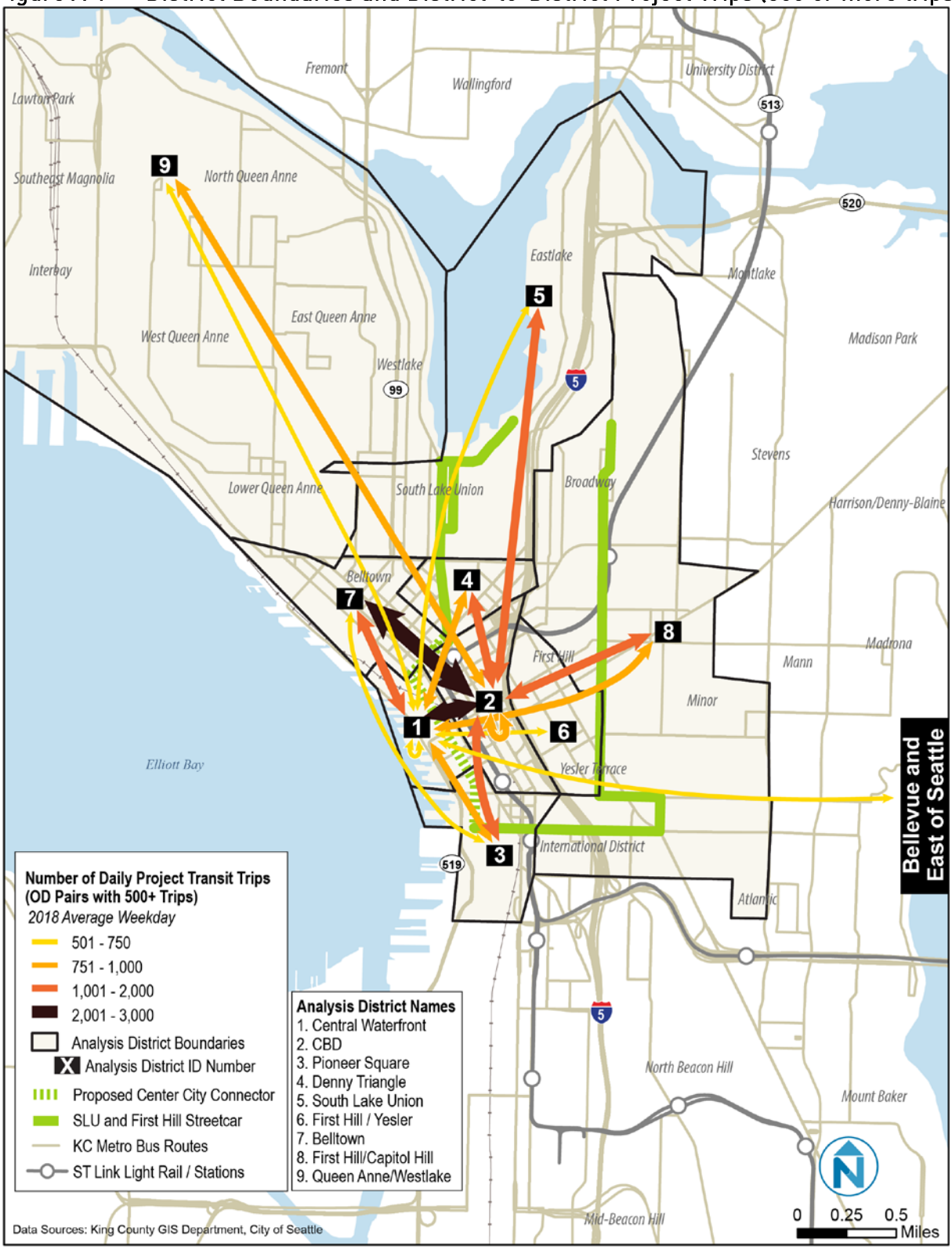


Figure A-10 District-to-District Project Trips, 2018

		Central Waterfront	CBD	Pioneer Square	Denny Triangle	South Lake Union	First Hill/ Yesler	Belltown	First Hill/ Capitol Hill	Queen Anne/ Westlake	Montlake/ Madrona	UW/U-District	Ballard/ Northgate/ Everett North	SeaTac/ FedWy/ Kent	Tacoma / Bremerton/ West of Seattle	Bellevue and East of Seattle	Far East	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
Central Waterfront	1	562	1,539	447	330	147	200	418	181	91	11	1	56	34	0	23	19	4,059
CBD	2	1,461	759	522	500	268	92	870	286	57	45	2	0	0	0	3	8	4,873
Pioneer Square	3	449	989	51	126	57	37	294	51	47	1	0	28	9	0	5	1	2,145
Denny Triangle	4	656	771	186	0	0	56	113	61	0	3	0	0	3	0	1	4	1,854
South Lake Union	5	472	791	170	0	0	33	101	32	4	1	0	0	23	0	7	2	1,636
First Hill/Yesler	6	380	393	92	80	45	0	188	2	17	0	0	0	0	0	0	0	1,197
Belltown	7	729	1,341	389	80	72	155	71	143	8	6	0	7	3	0	31	0	3,035
First Hill/ Cap. Hill	8	588	833	143	134	42	0	291	1	49	0	0	12	0	0	2	0	2,095
Queen Anne /Westlake	9	540	701	385	20	10	63	75	45	0	0	15	30	15	0	0	0	1,899
Montlake/ Madrona	10	202	257	32	32	8	0	107	0	6	0	0	3	0	0	0	0	647
UW/U-District	11	1	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	5
Ballard/ Northgate /Everett North	12	396	76	241	14	11	1	8	13	5	0	0	0	1	0	1	0	767
SeaTac/ FedWy/Kent	13	362	6	43	60	162	1	37	5	27	1	0	5	0	0	1	0	710
Tacoma/ Bremerton/ West of Seattle	14	13	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	17
Bellevue and East of Seattle	15	666	3	57	26	44	0	47	1	16	0	0	1	0	0	0	0	861
Far East	16	18	0	2	1	4	0	1	0	0	0	0	1	0	0	0	0	27
Total		7,495	8,462	2,761	1,404	872	638	2,621	821	328	68	18	143	88	0	74	34	25,827

Note: Blue shading represents intra-district trips. These figures vary slightly from stop-to-stop project trips due to rounding.

APPENDIX B ADDITIONAL RIDERSHIP MARKETS: VISITORS AND SPECIAL EVENTS

Introduction

In addition to the ridership projections developed using the Federal Transit Administration (FTA) Simplified Trips-on-Project Software (STOPS) model (discussed in Appendix A), two additional ridership markets exist for the Seattle Center City Connector (CCC) Project that the STOPS model does not directly account for, special events and visitors. These markets can both be expected to increase ridership on the Seattle Center City Connector Project. This document provides an assessment of each of these markets.

As noted, the FTA STOPS model does not account for special markets such as events or visitors. As a result, a peer-based off-model approach was recommended after consultation with FTA staff. In general, a peer-based approach to evaluating the potential ridership resulting from special events and visitors is based on information and data from similar cities and streetcar operations throughout the United States in conjunction with local data.

This document is organized into two primary sections describing (1) the special events ridership market and (2) the visitor ridership market.

Special Events Market Analysis

This section describes the basis for determining streetcar ridership resulting from special events at CenturyLink Field and Safeco Field. Both facilities are located in Seattle's Stadium District in South Downtown (SoDo) and are within one-half mile of the proposed streetcar project.

- **CenturyLink Field and Event Center.** CenturyLink Field is home to the Seattle Seahawks (NFL) and Seattle Sounders FC (MLS) teams, and WAMU theatre. These facilities host football games, soccer matches, and other events such as FanFest, exhibition shows, graduations, and concerts. Seahawks football, including pre-season and playoffs, runs from early August to early January. In 2012, there were a total of 10 home games (2 pre-season and 8 regular season) with an average attendance of 67,946. In addition to the Seahawk games, there were a number of other events held at CenturyLink Field such as Supercross, concerts, University of Washington (UW) commencement, and the Susan G. Koman 3-Day Walk event.

The Seattle Sounders season runs from the middle of March through the middle of November. In addition to the 19 home games played as part of the MLS league, the Sounders also play in a number of non-MLS leagues, including the US Open Cup and the Confederation of North, Central American and Caribbean Association Football (CONCACAF). Considering pre-season, post-season, and all league matches, the Sounders played 24 home games, averaging approximately three home games per month. In addition, a total of 116 concerts, flat shows, and other events were held at the Event Center and WAMU theatre in 2012.

- **Safeco Field.** Safeco Field is home to the Seattle Mariners (MLB) team. The regular season runs from April to early October and with the playoffs, the season generally extends through October. During the 2012 season, there were a total of 81 home games with an average attendance of 21,258.

Data Sources

Conditional to their approval, both CenturyLink Field and Safeco Field are required to maintain annual Transportation Management Programs (TMPs). Part of the requirements for the TMP is to conduct an annual survey of event attendees. TMP surveying at CenturyLink Field has historically included information related to travel to events including traffic, pedestrian, and parking demand as well as information related to travel modes used by attendees. Surveying has not included information about origins or destinations of these trips. The Safeco Field TMP program does not require the reporting of travel modes or point of origin data and as a result no current data exists related to these items. However, there is a one-time survey that includes information related to travel modes used by attendees. This survey was conducted in 2001 by the Mariners organization to establish some baseline knowledge to inform the development of the TMP for the opening of nearby CenturyLink Field in 2002.

CenturyLink Field

Annual intercept surveys conducted as part of the CenturyLink Field Transportation Management Program show that about one-half (48%) of the respondents/attendees travel to the game by some mode other than an automobile. Figure B-1 below shows that of the 48% who do not travel by car, approximately 23% walk or bike, 21% take the Sounder Train, 20% travel to the game via Metro or Sound Transit bus, 10% use the Link Light Rail, 8% use the ferry system, and the remaining 18% use either a taxi, limo, charter bus, Amtrak, or were dropped off. Of these non-auto modes, it is reasonable to assume that some portion of the walk trips, ferry trips, and perhaps the bus trips could use the proposed CCC streetcar for a portion of their trip.

Figure B-1 CenturyLink Field Survey Results (Seahawks)

Travel Mode	Survey
Bike/Walk	23%
Sounder Train	21%
Metro/Sound Transit Bus	20%
Link LRT	10%
Taxi/Limo	8%
Ferry	8%
Drop Off	5%
Charter Bus	4%
Amtrak	1%
Other	1%
Total	**100%**

Source: 2012 CenturyLink Field Survey Results Report, November 11, 2012

Safeco Field

In the 2001 Mariners survey at Safeco Field, 82% of attendees travelled by auto to the games. The remaining 18% chose to take public transit, walk, or bike. Figure B-2 below shows multimodal access for Mariners games at Safeco Field.

Figure B-2 Safeco Field Multimodal Access[1] (Mariners)

Travel Mode	Survey
Auto	82%
Transit (Bus/Train)	8%
Ferry	4%
Walk	4%
Bicycle/Other	3%
Charter Bus	0%
Totals	**100%**

Source: Seattle Arena Multimodal Transportation Access and Parking Study, May 23, 2012.

New Starts Working Group

In addition to the TMP survey data, a New Starts Working Group collected data concerning transit mode shares at various sporting event facilities throughout the United States. Figure B-3 shows transit mode shares experienced at events and venues throughout the United States for various years.

Figure B-3 Transit Mode Shares for Sports Venues

City	State	Agency	Transit Options	Facility	Event Type	Year	% Using Transit*
Portland	OR	TriMet	LRT, Bus	Rose Garden Arena	Trail Blazers Basketball Games	2004	33%
Portland	OR	TriMet	LRT, Bus	Jeld-Wen Field	Timbers Soccer Matches	2011	44%
St. Louis	MO	Metro Link	LRT	Busch Stadium Edward Jones Dome Scottrade Center	Cardinals, Rams, and Blues Games	2011	33.3%
Minneapolis	MN	Metro Transit	LRT, Comm. Rail, Bus	Target Field	Twins MLB Games	2011	13%
Minneapolis	MN	Metro Transit	LRT, Comm. Rail	Mall of America Field	Vikings NFL Games	2011	11%

City	State	Agency	Transit Options	Facility	Event Type	Year	% Using Transit*
Phoenix	AZ	Valley Metro	LRT	Chase Field, US Airways Arena, Sun Devil Stadium / Wells Fargo Arena	Diamondbacks Games, Suns Games, Arizona State University Athletics	N/A	10.7%
Phoenix	AZ	Valley Metro	LRT	Dodge Theater	Concerts	N/A	10.1%
Phoenix, Tempe	AZ	Valley Metro	LRT	Fall Frenzy (Tempe), Artlink (Phoenix), Fiesta Bowl Block Party (Tempe)	Festivals	N/A	17%
Dallas	TX	DART	LRT, Comm. Rail, Bus	American Airlines Center	Concerts, Basketball Games, Hockey Games	2010-2011	14.9%
San Diego	CA	MTS	Trolley	Qualcomm Stadium	Football Games	2008-2011	23.2%
San Diego	CA	MTS	Trolley	Petco Park	Baseball Games	2008-2011	13.3%
Cleveland	OH	Cleveland	LRT	Jacobs Field	Baseball Games	2006	6-10%
Cleveland	OH	Cleveland	LRT	Quicken Loans Arena	Hockey and Basketball Games, Concerts	2006	6-10%

City	State	Agency	Transit Options	Facility	Event Type	Year	% Using Transit*
Denver	CO	Denver RTD	LRT	Coors Field	Baseball Games	2006	7-10%
Denver	CO	Denver RTD	LRT	Pepsi Center	Baseball and Hockey Games, Concerts	2006	7-10%
Oakland	CA	BART	Rapid Transit	Oakland Coliseum	A's Baseball Games	2011	17%
Oakland	CA	BART	Rapid Transit	Oakland Coliseum	Warriors NBA Games	2010-2011	23%
Oakland	CA	BART	Rapid Transit	Oakland Coliseum	Raiders NFL Games	2010-2011	13%
Charlotte	NC	CATS	LRT	Time Warner Arena	NBA Games	N/A	7.9%
Charlotte	NC	CATS	LRT	Time Warner Arena	Hockey	N/A	5.7%
Charlotte	NC	CATS	LRT	Time Warner Arena	CIAA Basketball Tournament	N/A	3.7%
Charlotte	NC	CATS	LRT	Bank of America Stadium	College and NFL Football Games, Hockey	N/A	11.8%
San Francisco	CA	SFMTA	Trolley	AT&T Park	Football Games	2006	20%
**People using transit for at least a portion of their trips*							

Source: New Starts Working Group

Figure B-4 applies the transit usage data from the respective TMPs to average attendance figures for both CenturyLink Field and Safeco Field. Transit usage data from the New Starts working group is also included as a point of reference. For CenturyLink Field a transit mode share of 20% was assumed based on the TMP survey share for Metro and Sound Transit buses. This is perhaps a conservative estimate in that another 8% of attendees who use the ferries and another 23% who walk or bike may also be considered potential streetcar riders. For Safeco Field, 8% was used based on survey respondents who indicated they used transit (bus/train) to access the game. Again, this may be conservative in that another 4% of attendees who use the ferries or walk/bike, respectively, could also be potential streetcar riders.

Figure B-4 Seattle Center City Connector – Special Events Analysis

City	State	Transit Option	League	Event	Stadium/ Arena	Stadium Capacity[4]	Average Attendance[5]	Transit Mode Share[1,2,3]	Transit Ridership on all transit modes per Event
Seattle	WA	LRT, Comm. Rail, Bus	NFL	Seahawks	Century Link Field	67,000	67,946	20%	13,589
Seattle	WA	LRT, Comm. Rail, Bus	MLS	Sounders	Century Link Field	67,000	43,975	20%	8,795
Seattle	WA	LRT, Comm. Rail, Bus	MLB	Mariners	Safeco Field	47,476	21,258	8%	1,701
Portland	OR	LRT, Bus, Streetcar	NBA	Trailblazers	Rose Garden Arena	20,636	19,829	33%	6,544
Portland	OR	LRT, Bus, Streetcar	MLS	Portland Timbers	Jeld-Wen Field	20,438	20,674	44%	9,097
St. Louis	MO	LRT	MLB	St. Louis Cardinals	Busch Stadium	43,975	42,212	33%	13,930
St. Louis	MO	LRT	NFL	St. Louis Rams	Edward Jones Dome	66,000	56,703	33%	18,712
St. Louis	MO	LRT	NHL	St. Louis Blues	Scottrade Center	22,000	18,809	33%	6,207
Minneapolis	MN	LRT, Comm. Rail, Bus	MLB	Minnesota Twins	Target Field	39,021	31,744	13%	4,127
Minneapolis	MN	LRT, Comm. Rail, Bus	NFL	Minnesota Vikings	Mall of America Field	64,121	60,725	11%	6,680
Phoenix	AZ	LRT	MLB	Arizona Diamondbacks	Chase Field	48,633	26,518	11%	2,917
Phoenix	AZ	LRT	NBA	Phoenix Suns	US Airways Arena	19,022	15,436	11%	1,698
Phoenix	AZ	LRT	NCAA	ASU Sun Devils	Sun Devil Stadium	71,706	56,835	11%	6,252
Dallas	TX	LRT, Comm. Rail, Bus	NBA	Dallas Mavericks	American Airlines Center	19,200	20,036	15%	3,005
Dallas	TX	LRT, Comm. Rail, Bus	NHL	Dallas Stars	American Airlines Center	18,532	14,226	15%	2,134
San Diego	CA	Trolley	NFL	San Diego Chargers	Qualcomm Stadium	71,294	59,964	23%	13,792

City	State	Transit Option	League	Event	Stadium/ Arena	Stadium Capacity[4]	Average Attendance[5]	Transit Mode Share[1,2,3]	Transit Ridership on all transit modes per Event
San Diego	CA	Trolley	MLB	San Diego Padres	Petco Park	42,524	27,151	13%	3,530
Cleveland	OH	LRT	MLB	Cleveland Indians	Progressive/Jacobs Field	43,545	20,253	8%	1,620
Cleveland	OH	LRT	NBA	Cleveland Cavaliers	Quicken Loans Arena	20,562	16,192	8%	1,295
Denver	CO	LRT	MLB	Colorado Rockies	Coors Field	50,480	34,974	8%	2,798
Denver	CO	LRT	NBA	Denver Nuggets	Pepsi Center	19,155	17,819	8%	1,426
Denver	CO	LRT	NHL	Colorado Avalanche	Pepsi Center	18,007	15,498	8%	1,240
Oakland	CA	BART-Rapid Transit	MLB	Oakland Athletics	Oakland Coliseum	35,067	22,766	17%	3,870
Oakland	CA	BART-Rapid Transit	NBA	Golden State Warriors	Oakland Coliseum	19,596	19,373	23%	4,456
Charlotte	NC	LRT	NBA	Charlotte Bobcats	Time Warner Arena	19,077	15,324	8%	1,226
Charlotte	NC	LRT	AHL	Charlotte Checkers	Time Warner Arena	14,100	6,781	6%	407
Charlotte	NC	LRT	NFL	Carolina Panthers	Bank of America Stadium	73,778	73,293	12%	8,795
San Francisco	CA	Trolley	MLB	San Francisco Giants	AT&T Park	41,915	41,655	20%	8,331

[1] New Starts Working Group - Transit Mode Shares for Sports Venues
[2] Seattle Seahawks Transportation Management Plan Survey
[3] Mariners Survey 2001
[4] Capacity figures shown exclude expandable capacity.
[5] Average attendance sources: ESPN MLB and NBA Attendance Report, 2013, ESPN NFL and NHL Attendance Report 2012, AHL HockeyDB.com, 2012-2013, 2012 NCAA Division I Attendance

To further allocate total transit ridership to streetcar ridership a two-tiered approach was incorporated based on population, employment, and service level data.

Tier 1 calculates the population and employment (2010) within one-half mile of the full integrated streetcar system (including South Lake Union, Center City Connector, and First Hill) as a percentage of the total population and employment within a 30-mile radius of the Stadium District, the approximate "local" market area for events per conversations related to the Seattle Arena Draft Environmental Impact Statement (EIS), and applies the respective percentages to the total transit ridership. As shown in Figure B-5, approximately 3% of the population and nearly 14% of the employment within a 30-mile radius of the Stadium District is within one-half mile of the streetcar line.

Figure B-5 2010 Population and Employment within 0.5 miles of Streetcar Line as a percent of Total Population and Employment within 30-mile radius of Stadium District

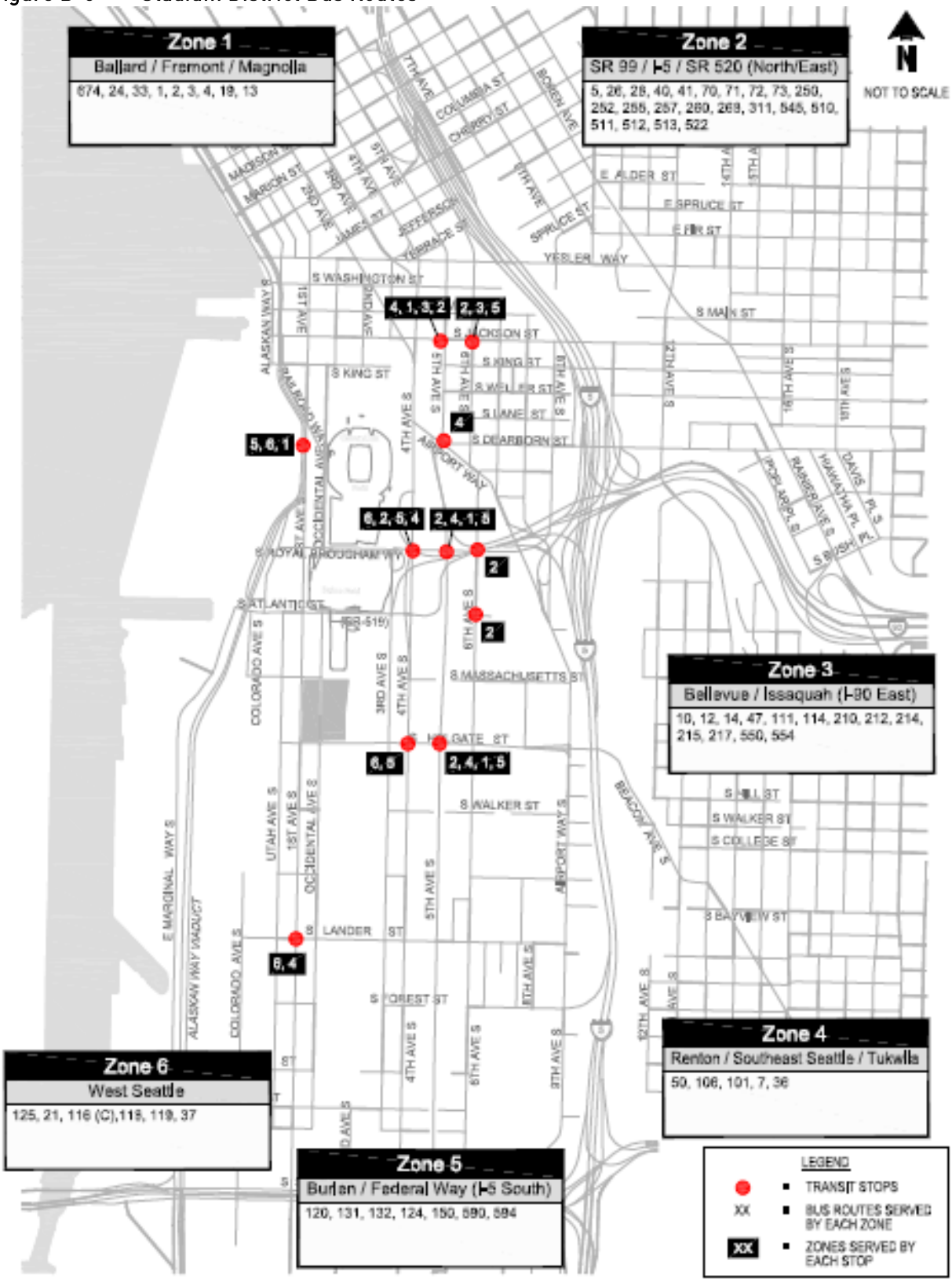
Geography	Population 2010	Employment 2010
1/2 mile	86,249	237,078
30 mile	3,234,908	1,722,799
Ratio	2.7%	13.8%

Tier 2 assesses weekday service levels for all routes available between downtown and the Stadium District during both pre-event and post-event time periods. Figure B-6, from the Seattle Arena EIS analysis, and Figure B-7 summarize bus routes serving the Stadium District by roadway, stop location, and general downtown Seattle service area.[1]

Figure B-7 shows weekday service levels for all routes (local and express) in service outbound from downtown to the Stadium District pre-event (5:00 to 7:00 PM) and inbound from the Stadium District to downtown post-event (9:00 to 11:00 PM). Including Sound Transit express routes, there are 384 buses available between downtown and the Stadium District between 5:00 and 7:00 PM. Post-event, there are 133 buses available to return to downtown between 9:00 and 11:00 PM. The addition of the streetcar at 5-minute headways in the 5:00 to 7:00 PM pre-event time period and 7.5 minute headways in the 9:00 to 11:00 PM post-event time period would add 24 vehicles available to get to an event from downtown and 16 additional vehicles to return to downtown after an event. Streetcar service resulting from the CCC Project would comprise 6% of the total service available pre-event to get to an event and approximately 11% of the available service post-event to return to downtown. Because Sound Transit express bus service is likely to be a more specific market for trips that are traveling further away, even though they may enter downtown before departing for their ultimate destination, it may make sense to exclude these from the calculations. Doing so would increase the streetcar percentages to 7% and 12%, respectively.

[1] Seattle Arena Draft EIS Appendix E – August 15, 2013

Figure B-6 Stadium District Bus Routes



Source: Seattle Arena EIS Analysis

Figure B-7 Stadium Routes Weekday Service Levels; Outbound from Downtown 5:00 to 7:00 PM and Inbound from SODO 9:00 to 11:00 PM

Monday - Friday				
	From CBD Outbound 5 to 7 PM		From SODO Inbound 9 to 11 PM	
Route[1]	# Buses	Headway	# Buses	Headway
Zone 1 (Ballard/Fremont/Magnolia)				
1	6	20	4	30
2	20	6	8	15
3	13	9	7	17
4	12	10	8	15
19	3	40	0	0
24	6	20	2	60
Zone 2 (SR99/I-5/SR520 NE)				
5	11	11	4	30
26	9	13	4	30
28	10	12	4	30
41	15	8	2	60
71	4	30	4	30
72	4	30	2	60
73	4	30	1	120
250	3	40	0	0
252	3	40	0	0
255	12	10	3	40
257	3	40	0	0
260	1	120	0	0
268	2	60	0	0
311	4	30	0	0
545	16	8	2	60
510	8	15	0	0
511	8	15	0	0

Monday - Friday				
	From CBD Outbound 5 to 7 PM		From SODO Inbound 9 to 11 PM	
Route[1]	# Buses	Headway	# Buses	Headway
513	4	30	0	0
522	7	17	2	60
Zone 3 (Bellevue/Issaquah/I-90 E)				
14	13	9	5	24
111	3	40	0	0
114	2	60	0	0
210	2	60	0	0
212	11	11	0	0
214	5	24	0	0
215	2	60	0	0
217	2	60	0	0
550	16	8	4	30
554	5	24	2	60
Zone 4 (Renton/SE Seattle/Tukwilla)				
7	13	9	9	13
36	16	8	9	13
101	7	17	1	120
106	7	17	4	30
Zone 5 (Burien/Fed. Way/I-5 S)				
131	1	120	1	120
132	7	17	6	20
124	4	30	4	30
150	19	6	8	15
590	15	8	0	0
594	1	120	4	30

Monday - Friday				
	From CBD Outbound 5 to 7 PM		From SODO Inbound 9 to 11 PM	
Route[1]	# Buses	Headway	# Buses	Headway
Zone 6 (West Seattle)				
21	17	7	12	10
37	3	40	0	0
116	1	120	0	0
118	6	20	1	120
119	2	60	0	0
125	16	8	6	20
Bus Total	384	0.31	133	0.90
Streetcar	24	5.00	16	7.50
Streetcar Service Share	5.9%	5.9%	10.7%	10.7%

If Excluding Sound Transit Express Routes as an Option

Bus Total Excluding ST Exp.	304	0.39	119	1.01
Streetcar	24	5.00	16	7.50
Streetcar Service Share	7.3%	7.3%	11.9%	11.9%

[1] Stadium routes as identified in Seattle Arena EIS Appendix E – routes in service pre and post event with bus stops near Stadium District.

Figure B-8 applies the Tier 1 population and employment percentage ratios and Tier 2 service level analysis to proportion the total transit event ridership estimated from TMP survey data to estimate streetcar event ridership. Taking into account the population and employment within one-half mile of the streetcar and service levels pre- and post-event, the proportion of total transit event ridership estimated to use streetcar per event is as follows:

- Seahawks game at CenturyLink Field streetcar ridership in the range of 135 to 270 additional riders;
- Sounders game at CenturyLink Field potential streetcar ridership of 90 to 175 additional riders;
- Mariners game at Safeco Field potential streetcar ridership of 20 to 35 additional riders.

Figure B-8 Center City Connector Streetcar Special Events Ridership Analysis

						Tier 1			Tier 2	
Stadium/ Arena	Event	Stadium Capacity[3]	Average Attendance	Transit Mode Share[1,2]	Transit Ridership on all transit modes per Event	Population Ratio[4] (2.7%)	Employment Ratio[5] (13.8%)	Sub-Total	Streetcar Proportion of Service Level[6] Low (6%)	Streetcar Proportion of Service Level[7] High (12%)
CenturyLink Field	Seahawks	67,000	67,946	20%	13,589	367	1,875	2,242	135	269
CenturyLink Field	Sounders	67,000	43,975	20%	8,795	237	1,214	1,451	87	174
Safeco Field	Mariners	47,476	21,258	8%	1,701	46	235	281	17	34

[1] Seattle Seahawks Transportation Management Plan Survey
[2] Mariners Survey 2001
[3] Capacity figures shown exclude expandable capacity.
[4] 2.7% of population (2010) within ½ mile of the streetcar line as a percentage of the total population within a 30 mile radius of the Stadium District
[5] 13.8% of employment (2010) within ½ mile of the streetcar line as a percentage of the total employment within a 30 mile radius of the Stadium District
[6] Streetcar represents approximately 6% of the total service available outbound from downtown to Stadium District between 5:00 and 7:00 PM
[7] Streetcar represents approximately 12% of the total service available inbound from Stadium District to downtown between 9:00 and 11:00 PM

Visitor Market Analysis

This section describes the analysis of potential streetcar ridership by visitors to downtown Seattle. As previously noted the basis for this analysis is a peer-based approach utilizing data and information from similar cities and transit operations in the United States. For the Seattle Center City Connector analysis, the F-Line in San Francisco was used in the analysis. Other areas will be discussed briefly below and then additional detail related to the use of San Francisco for comparisons to Seattle will be provided.

Data Sources

The project team's efforts to obtain data on the use of transit by tourists/visitors in US cities with high visitation rates comparable to Seattle found that there is limited data and research into transit use by visitors/tourists in most markets. Most surveys conducted by transit agencies or visitor attractions do not track visitors/tourists. Our research included:

- A cursory search of various transit agencies' websites, reports, and surveys
- Communication with transit agency representatives, including in Portland and New Orleans.
- Google Scholar, database, and Transportation Research Board searches. Only one Transportation Research Board committee deals with transportation and tourism, more generally (Transportation Needs of National Parks and Public Lands).

Figure B-9 and the following discussion details some general and transit characteristics of cities with tourist-based transit that connect to the greater transit system. Cities with the best information available were San Francisco, New Orleans, and Memphis, along with more basic statistics from other cities. Research into data for Vancouver BC, Charlotte, Boston, New York City, San Diego, and Honolulu did not yield results.

Figure B-9 Characteristics of Cities with Tourist-Based Transit

Measure	Seattle	San Francisco	New Orleans	Memphis	Wash. D.C.	Portland
Population	620,778 (2011)	812,825 (2011)	360,740 (2011)	652,050 (2011)	632,323 (2012)	593,820 (2011)
# of Visitors	10.2 M (2012)	16.5 M	9.0 M	10 M	17.9 M	8.1 M
Visitor-Oriented Transit	SLU Streetcar, Route 99	F-line streetcar	3 streetcar lines	3 trolley lines	D.C. Circulator (rubber-tired)	Streetcar
Annual Ridership of Above Services	700,000 (SLU, 2011) 255,000 (Rt 99, 2011)	6.0 M*	8.9 M	1.1 M	5.7 M	4.1 M (FY 2013)
Visitor Share (if known)	11% / 8% of daily boardings	18.3% of visitors rode F-Line	N/A	N/A	N/A	N/A

* Estimated based on 23,449 average daily riders in 2012 (SFMTA, September 2013) and annualization factor of 255.

Seattle

- 10.2 M visitors[2]
- Based on the onboard survey on Metro Route 99, 8% of riders are visitors to Seattle.[3]
- Based on the onboard survey on the South Lake Union Streetcar, 11% of riders are visitors to Seattle.[4]
- Former waterfront streetcar carried about 404,000 trips a year in 2003. After conversion to rubber-tired service and decreased frequency, about 252,000 in 2010 (and 204,000 in 2009). Some commuters weekdays, 400 per day; Saturday 800, Sunday 600.[5]

San Francisco

- 16.5 million visitors.[6] [1]
- 18.3% of visitors rode the F-Line streetcar. "Survey respondents were asked to indicate the modes of transportation they used (or planned to use) while in San Francisco. Four in ten report taking taxis while in the city (38.1%). Other automobile options are popular amongst San Francisco visitors, with 35.1% using a personal car and 14.6% using a rental car. Additionally, the city's public transportation options are being utilized by significant shares of visitors. Over one

[2] Visit Seattle 2013 Annual Report, 2013.

[3] South Lake Union Streetcar and Route 99 Onboard Survey, 2013.

[4] Ibid.

[5] APTA, Streetcar and Heritage Trolley Site, www.heritagetrolley.org/artcileBringBackStreetcars6.htm

[6] http://www.sanfrancisco.travel/research/

quarter (27.6%) rode the cable cars, while 22.9 % took MUNI trains and/or buses and 18.3 % rode the F-Line street cars. One in four used BART (26.7%)." [7,8]

- A study of extending the F-Line to Ft. Mason conducted an intercept survey that found 11-14% of current visitors took transit to Fort Mason and 45% of visitors said that they would have taken Muni if the F-line already served Fort Mason. Noting that stated preference surveys are not always predictors of actual behavior, this would represent approximately 675,000 visitors a year (based on 1.5 million visitors to Ft. Mason Center as of 2009), or 1,849 visitors a day. This is higher than predicted by the San Francisco County Travel demand model.[9]
- Based on existing F-Line data, the Ft. Mason EIS found a 139% seasonal maximum daily ridership differential (May vs. June).[10]
- Fisherman's Wharf
- 42% of visitors arrive by transit and 24% by walking [5b – p. 26 of PDF; 2006 visitor survey]; 8.9% take streetcar, i.e., F-Line.[11]
- New York Times: "While the F Line is fast becoming one of San Francisco's most popular tourist attractions, it may turn out to be much more. Day after day, it is reminding visitors of something they may have forgotten: that trolleys are a good way to get around congested cities."[12]

New Orleans

- 9.01 Million visitors in 2012.[13]
- Three streetcar lines: St. Charles, Canal Street, and the Riverfront. Each originates downtown. Streetcars connect to the New Orleans Museum of Art, Bestoff Sculpture Garden, CBD, Jazz and Heritage Festival sites, Fairgrounds Race Track, French Market, Aquarium, and other popular destinations.
- Though the service is popular with tourists, the low-cost and ability to transfer (compared to SF's $6, no transfer fare for the cable car) make NORTA streetcars an integrated part of the transportation system. Additionally, no parallel/ redundant service is available along much of the system.
    - 2011 Streetcar ridership: 8,984,813 unlinked trips (8,984,813/20,634,592= 43.5% of all trips).[14]

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7 http://www.sanfrancisco.travel/media/San-Francisco-Travel-Association-releases-economic-impact-figures-for-2010-and-results-of-year-long-Visitor-Profile-Research.html

8 http://media.sanfrancisco.travel/documents/2010_exec_summary.pdf

9 Fort Mason FEIS, Transit Operations Analysis. http://parkplanning.nps.gov/documentsList.cfm?parkID=303&projectID=15547

10 Ibid.

11 Fisherman's Wharf Public Realm Plan, http://www.sf-planning.org/ftp/CDG/docs/fishermans_wharf/Gehl_Report_P2.pdf

12 Prial, Frank. "New Life for Old Trolleys." http://www.nytimes.com/2001/12/09/travel/new-life-for-old-trolleys.html

13 http://www.neworleanscvb.com/articles/index.cfm?action=view&articleID=7792&menuID=1602

Washington D.C.[15,16]

- 39% of travel was for leisure/recreation
- 10% of respondents were first time riders
- 7% of respondents reside outside of the Washington D.C., Maryland, or Virginia areas

Memphis

- Over 10 million visitors per year to greater Memphis.[17]
- MATA operates a vintage trolley rail system that has "become a part of downtown Memphis culture and is a tourist attraction all on its own." The re-launched trolleys have been operating for 20 years.
- Three trolley lines: the Main Street Line, the Madison Avenue Line, and the Riverfront Line.
- The Trolley lines transport 1.1 million people per year; 259,867 revenue miles, 3 lines, 19 trolleys, 36 stations, 10 route miles of track.[18]
- Memphis notes that it is a tourist attraction on its own and it moves people to different attractions. Convention Center, Sun Studio, Beale Street, National Civil Rights Museum, FedEx Forum, Medical Center, and Historic Arts District. Three trolley lines.

Portland[19,20]

Portland's recently opened Eastside streetcar extension serves the Oregon Museum of Science and Industry, which attracts over 1 million visitors annually. The Streetcar loop project and MAX Orange Line will also serve OMSI starting in 2015. Based on consultation with agency/institution staff, data about current or projected visitor use of these transit services is not available.

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[14] http://www.ntdprogram.gov/ntdprogram/pubs/profiles/2011/agency_profiles/6032.pdf

[15] Howard University Transportation Safety Data Center, Circulator Survey, Summer 2012, Draft Report.

[16] Visitor Statistics, http://washington.org/sites/washington.org/master/files/2011_VisitorStatistics2.pdf

[17] http://www.ntdprogram.gov/ntdprogram/pubs/profiles/2011/agency_profiles/4003.pdf

[18] http://www.memphischamber.com/Articles/Community/MemphisBraggingRights.aspx

[19] http://www.travelportland.com/about-us/research/visitor-statistics-research

[20] Oregon 2011 Regional Visitor Report – Greater Portland. http://industry.traveloregon.com/wp-content/uploads/2013/03/OR-Greater-Portland-2011-Final-Report.pdf

Similarities between San Francisco and Seattle

The cities of San Francisco and Seattle are similar in many ways. Geographically, large bodies of water surround both cities – Puget Sound and San Francisco Bay – and both have steep grades in and around the downtown core. In terms of population and economies, both cities have highly educated populations and both cities are considered new economy "high-tech" cities. As for visitor attractions, both cities have instantly recognizable skylines—Seattle: Columbia Seafirst Center and Space Needle; San Francisco: Transamerica Tower and Golden Gate Bridge. Both cities have historic waterfront districts with significant visitor attractions (Fisherman's Wharf and Pike Place Market) that attract millions of visitors each year. Both cities also have major museums and sports arenas/stadiums in downtown for professional NFL, MLS, and MLB teams, which attract local and visitors alike. Finally, in terms of transit service, both cities have robust, multimodal transit systems including Light Rail, Commuter Rail, Bus, Electric Trolley Bus, and Streetcar modes with interconnection between modes, including ferries, at major hubs in downtown. In Seattle, there is the Downtown Seattle Transit Tunnel (DSTT), Westlake Intermodal Hub, King Street Intermodal Hub, and Colman Dock (Washington State Ferry terminal). In San Francisco, there are major downtown subway stations served by BART and MUNI Metro as well as the King Street Caltrain Depot. Also, the Transbay Terminal (major downtown bus transfer facility) in San Francisco is currently being redeveloped into a multimodal Transbay Center that will include an extension of the Caltrain terminal and future high-speed rail terminus. Market Street in San Francisco (as well as parallel streets such as Mission Street) is also a major on-street bus/rail facility comparable to the 3rd Avenue transit way and adjacent downtown bus streets in Seattle. Electric transit modes in both cities take advantage of clean hydroelectric power. And in both cities rail, bus, and electric trolley bus routes need to be designed to operate on steep grades in and around downtown and throughout each city.

San Francisco's F-Market Line

The F-Market Line is an integral part of San Francisco's transportation network. It carries local commuters and tourists alike, and links residential, business, and tourist attractions in San Francisco. The F-Market Line operates between the Castro District in downtown San Francisco and Fisherman's Wharf along Market Street and the Embarcadero. It operates at frequent intervals, at least every 15 minutes and as often as every 6 minutes during daylight hours, for 20 hours per day, seven days a week with standard fares required. Average daily ridership is approximately 23,500 with even higher ridership, approximately 29,000, in the summer tourist season, making it one of the highest ridership streetcar lines in the nation. Based on a yearlong visitor profile research done by the San Francisco Travel Association in 2010/2011, surveys indicate that 18.3% of visitors rode the F-Line while in San Francisco.

Fort Mason Extension

In February 2012, the National Park Service released a Final Environmental Impact Statement (FEIS) to extend the F-Market Line to Fort Mason Center. The preferred alternative (Alternative 2) would add approximately 0.85 miles of streetcar track and construct 8 to 9 station platforms to serve the approximately 1.8 million people who work or attend events at the facility annually. Intercept surveys conducted in support of the Draft Environmental Impact Statement (DEIS) and FEIS found that 11 to 14% of current visitors took transit to Fort Mason and 45% of visitors said that they would have taken MUNI if the F-Market Line already served Ft. Mason.[21]

South Lake Union Streetcar

The South Lake Union streetcar is Seattle's first operating streetcar line since the 1940s. The line is operated by King County Metro and began service between the South Lake Union neighborhood and Downtown Seattle in December 2007. Originally, the line offered 15-minute headways seven days a week. In May 2011, increasing ridership led to the purchase of additional vehicles reducing peak period service to 10-minute headways. Currently a fare of $2.50 is required per trip.

Ridership on the South Lake Union line started slowly but has consistently increased with the redevelopment of South Lake Union. In early 2010, Amazon opened its new campus adjacent to the line in the South Lake Union neighborhood and ridership increased substantially. Ridership is typically higher in the summer months with good weather and tourists, and in June 2012 the line recorded its highest-ever ridership level of 2,812 rides per weekday. Current ridership (2013) is approximately 2,800 to 3,000 riders per day, higher in the summer months.

First Hill Streetcar

In April 2013, construction began on the First Hill Streetcar line. The First Hill line is a 2.5-mile route that will connect Capitol Hill, First Hill, Central Area, Yesler Terrace, the Chinatown International District, and Pioneer Square as well as the serve employment centers, medical centers, Seattle University and Seattle Central Community College, and major sporting event locations at CenturyLink and Safeco Fields. The streetcar will operate with 10 stops along South Jackson Street, 14th Avenue, Yesler Way, and Broadway, between Occidental Avenue in Pioneer Square and Denny Way on Capitol Hill. Service is scheduled to begin in fall 2014.

[21] Environmental Impact Statement for the Extension of Historic Streetcar Service from Fisherman's Wharf to the San Francisco Maritime National Historic Park and Golden Gate National Recreation Area's Fort Mason Center Task 10 Working Paper Transit operations Plan July 2009

Comparison

Figure B-10 below provides a side-by-side comparison of Seattle and San Francisco in terms of population, visitors, major attractions, hotels, and transit service and ridership in the respective downtowns.

Figure B-10 San Francisco and Seattle Visitor Market Characteristics Comparison

Measure	San Francisco	Seattle
Population (2011)	812,825	620,778
Annual Visitors[1,4]	16,500,000	10,200,000
Daily Visitors	45,205	27,945
Visitor Oriented Transit	F-Line Streetcar	SLU Streetcar/Rt. 99
Frequency of Service	5-10 minute	10-15 min./20-30 min.
Average Daily Streetcar Ridership[7,8]		
Weekday	23,449	2,872 (SLU)/840 (Rt.99)
Saturday	15,194	2,317 (SLU)/390 (Rt.99)
Sunday	17,870	2,146 (SLU)/370 (Rt.99)

Measure	San Francisco	Seattle
Major Attractions within 1/2 mile of Streetcar Line[9,10]	▪ Pier 39 ▪ Alcatraz Island Ferries ▪ San Francisco MOMA ▪ Yerba Buena Gardens ▪ Cont. Jewish Museum of SF ▪ Davies Symphony Hall ▪ War Memorial Opera House ▪ Museum of the African Diaspora ▪ Fort Mason ▪ Ferry Building ▪ Ghirardelli Square ▪ COIT Tower ▪ California Academy of Sciences ▪ The de Young Museum ▪ SF Cable Car Museum ▪ Asian Art Museum of SF ▪ The Exploratorium ▪ Legion of Honor ▪ Moscone Center (Conv. Ctr.)	▪ Pike Place Market ▪ Space Needle ▪ Pacific Science Center ▪ Seattle Aquarium ▪ EMP Museum ▪ Seattle Art Museum ▪ Benaroya Hall ▪ WA. State Conv. Center ▪ Olympic Sculpture Park ▪ 5th Avenue Theatre ▪ The Paramount Theatre ▪ Seattle Childrens Museum ▪ Pacific Northwest Ballet ▪ Showbox at the Market ▪ Showbox SoDo ▪ Seattle Childrens Theatre ▪ Seattle Opera ▪ Seattle Repertory ▪ The Moore Theatre
Number of Hotel Rooms within 1/2 mile of Streetcar Line[6,10]	24,912	11,924
Visitor Streetcar Mode Share[2,3,5]	18.3%	11% SLU/8% Rt.99
Streetcar Visitor Ridership	8,273	See Estimates in Figure B-11

Sources:
(1) http://www.sanfrancisco.travel/research/
(2) http://www.sanfrancisco.travel/media/San-Francisco-Travel-Association-releases-economic-impact-figures-for-2010-and-results-of-year-long-Visitor-Profile-Research.html
(3) http://media.sanfrancisco.travel/documents/2010_exec_summary.pdf
(4) http://www.visitseattle.org/About-Us/Facts-And-Figures.aspx
(5) South Lake Union Streetcar and Route 99 On-Board Survey, June 2013
(6) Seattle: Visit Seattle. SF: San Francisco Planning Dept, Annual Inventory of Large Tourist Hotel Rooms, 2011.
(7) SF: F-Line boardings based on 2008 stop-level data, adjusted to 2012 based on overall 2009-2012 increase in F-Line ridership. Average overall weekday ridership of 23,449 in FY 2012.
(8) King County Metro, 2012

(9) Seattle: Visit Seattle, 2012 Visitor Impact to Seattle/King County. SF: San Francisco Travel Association, 2011.
(10) San Francisco = F-Line and Seattle = SLU/Center City Connector /First Hill Line

Visitor Ridership Estimates

Applying survey-based visitor streetcar mode shares of 10% (Seattle) and 18% (San Francisco) to the number of average daily visitors to Seattle yields a range of 2,800 to 5,000 additional streetcar riders that can be expected from visitors to the city. Figure B-11 summarizes estimated visitor ridership for streetcar in Seattle:

- **Low (existing Seattle streetcar-based mode share):** Applying a survey-based visitor streetcar mode share of 10% to the number of average daily visitors to Seattle yields an estimate of 2,800 streetcar trips by visitors per day. The Seattle visitor streetcar mode share of 10% is an average of the visitor mode share on the South Lake Union Streetcar (11%) and Route 99 (8%), based on a 2013 on-board survey.
- **High (San Francisco-based mode share):** Based on the similarity of Seattle to San Francisco in terms of the visitor attractions, the visitor market and the transit services available, particularly in with the proposed implementation of the Center City Connector providing circulation within downtown and within close proximity to the major attractions, . San Francisco's 18% visitor streetcar mode share was applied to the number of daily visitors to Seattle. This yields an estimate of just over 5,000 additional streetcar trips by visitors per day.

The methodology for developing both the low- and high-end estimates assumes visitors are evenly distributed throughout the year and ignores seasonal fluctuations in the number of visitors, which is typically higher in the summer months and during holidays.

Figure B-11 Seattle Center City Connector -- Visitor Market Analysis

Measure	Low	High
Average Daily Visitors[1]	27,945	
Visitor Streetcar Mode Share [2,3]	10% (SLU/Rt.99 Average)	18.3% (SF F-Market)
Streetcar Visitor Ridership Estimate	**2,795**	**5,030**

Notes/Sources:
(1) http://www.visitseattle.org/About-Us/Facts-And-Figures.aspx
(2) Seattle (low) South Lake Union Streetcar and Route 99 On-Board Survey, June 2013
(3) San Francisco (high): http://www.sanfrancisco.travel/media/San-Francisco-Travel-Association-releases-economic-impact-figures-for-2010-and-results-of-year-long-Visitor-Profile-Research.html; http://media.sanfrancisco.travel/documents/2010_exec_summary.pdf

Limitations/Uncertainties

The above estimates of streetcar ridership with respect to special markets are based on existing data and similar experiences in similar cities throughout the United States. However, there are uncertainties which could affect streetcar ridership positively or negatively thus making it higher or lower depending on the circumstances.

- **Economic Slowdown**. A stall or slowdown in the economic recovery typically lowers household income, which in turn typically results in a slowing of visitor travel as well as attendance to major events.
- **Sport Franchise Longevity**. Although major sports franchises are typically major investments, it is not unheard of for major sports franchises to move to a different city. Seattle itself has experienced this with its former NBA team the Seattle Supersonics, which moved to Oklahoma in 2008. Certainly, the loss of any major sport franchise in Seattle would negatively affect streetcar ridership. However, with recent investments in new, major facilities, it is likely that the major sports franchise currently in Seattle will remain for the long-term.
- **New Facilities/Arenas**. The city of Seattle is currently considering a new Seattle Arena in the SODO area adjacent to CenturyLink Field and Safeco field. The proposed multipurpose sports arena would seat approximately 18,000 to 20,000 people and be home to possibly a new NBA team and/or NHL team. The addition of another sporting venue near the streetcar line would likely add to the attractiveness of the streetcar and other non-auto modes and positively affect ridership.
- **Limited Parking Supply**. Continued limited parking and the potential addition of a Seattle Arena for NBA/NHL games, which currently is not proposing additional parking, is likely to add to attractiveness of streetcar and non-auto modes.

APPENDIX C OPERATING AND MAINTENANCE COST ESTIMATES

This document[1] describes the methodology used to develop an operations plan for the Tier 2 evaluation of alternatives for the Center City Connector. The analysis includes estimates of the total operating and maintenance costs for the Seattle Center City Streetcar System (network) comprised of four segments—South Lake Union (SLU), Center City Connector (CCC), First Hill (FH), and First Hill Broadway Extension—based on considerations such as frequency, travel speed, operating period, etc.

Tier 2 Operating Scenarios

The Center City Connector will connect the South Lake Union Streetcar line with the First Hill Streetcar line. Two operating scenarios were modeled and evaluated in the Tier 2 evaluation.

- **Hub-to-Hub**. Operates as two independent, overlapping lines, as shown in Figure C-1:
  - SLU-King Street Intermodal Hub (”Red”). One line operates between South Lake Union (Fairview & Yale Aves) and the King Street Intermodal Hub.
  - Capitol Hill-Westlake Intermodal Hub (”Blue”). One line operates between Capitol Hill (Broadway & Denny Way) and the Westlake Intermodal Hub.

  Trains on each line arrive as often as every 10 minutes. The lines provide overlapping service between these intermodal hubs in the downtown core along the CCC segment’s preferred alignment (trains arrive as frequently as every 5 minutes in this core area).
- **End-to-End**. Operates as a single integrated line (comprised of SLU, FH, Broadway Extension, and CCC segments) with no transfers, as shown in Figure C-2. Trains arrive as often as every 10 minutes along the integrated line.

The Hub-to-Hub operating scenario was recommended as the preferred operating scenario and is included in the recommended Locally Preferred Alternative (LPA).

[1] Prepared by Shiels Obletz Johnsen (SOJ) and Nelson\Nygaard

Figure C-1 Hub-to-Hub Operating Plan

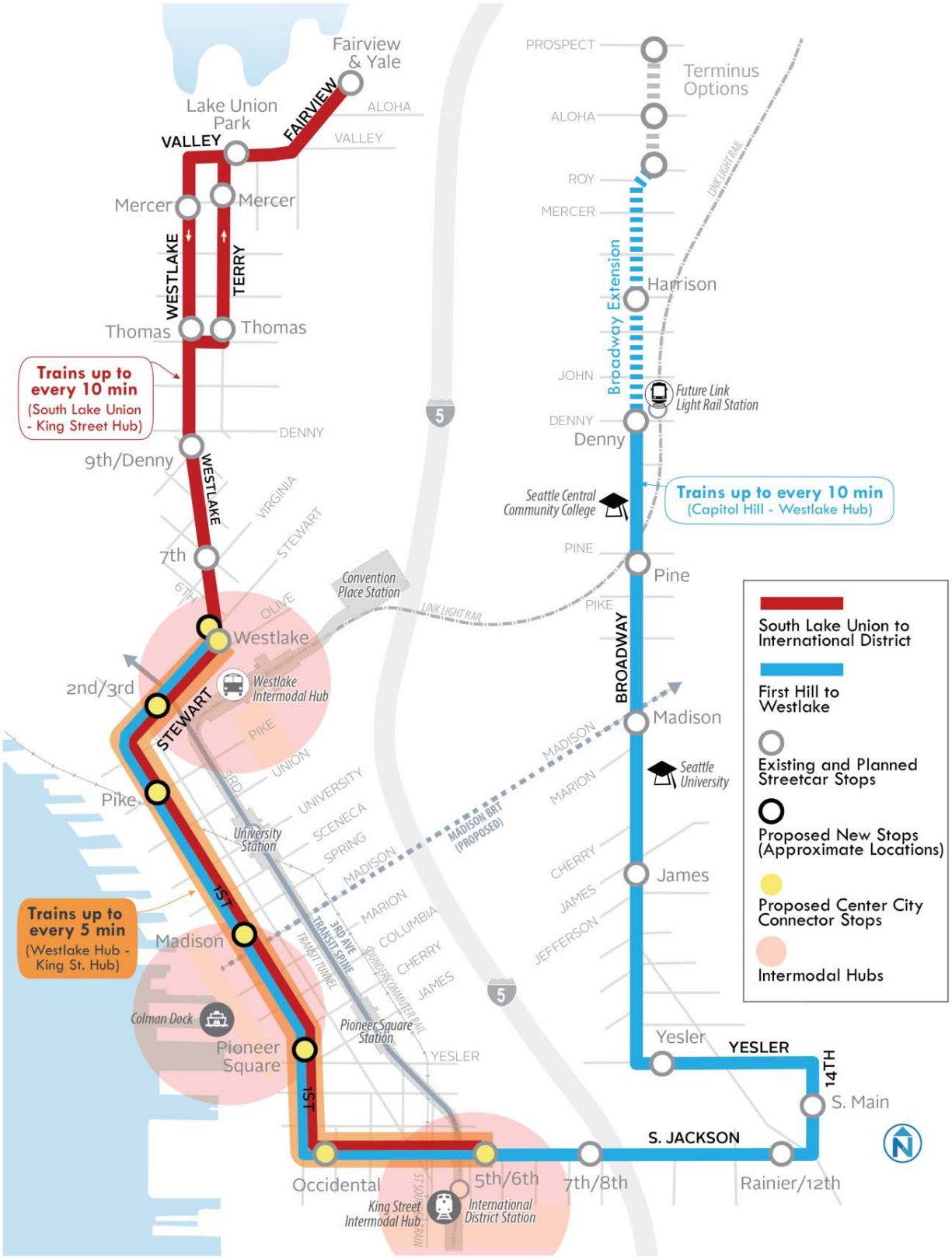
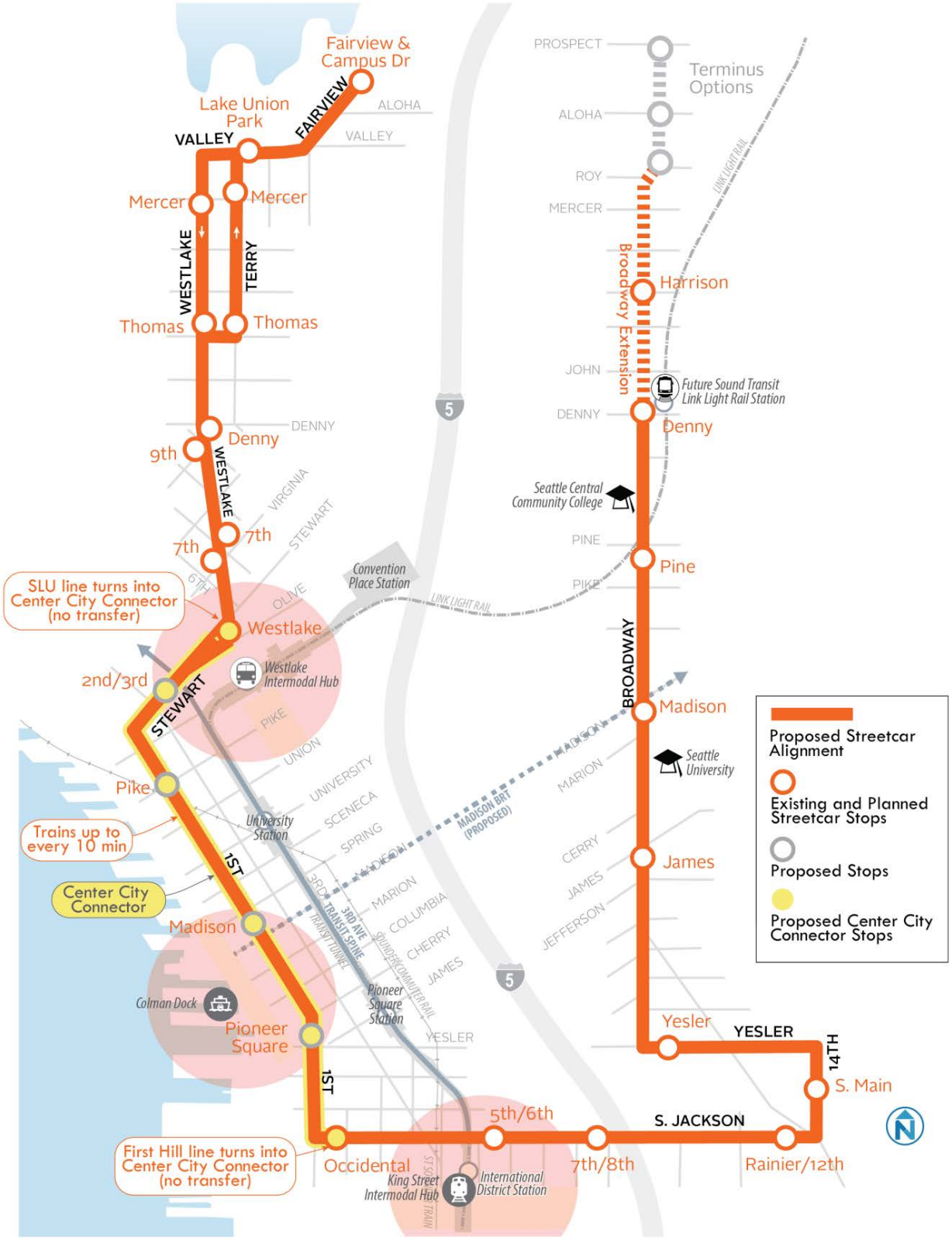


Figure C-2 End-to-End Operating Plan



Tier 2 Operating Assumptions

Figure C-3 provides the detailed operating assumptions (headway and service span) used in the Tier 2 evaluation.

Figure C-3 Tier 2 Service Hours and Headway Assumptions

	Start Time:	End Time:	Headway (Minutes)	Span (Hours)
Weekday	5:00 AM	1:00 AM	Varies	20
Weekday Early Morning	*5:00 AM*	*6:00 AM*	*15*	*1*
Weekday Day/Early Eve	*6:00 AM*	*7:00 PM*	*10*	*13*
Weekday Later Eve	*7:00 PM*	*1:00 AM*	*15**	*6*
Saturday	5:00 AM	1:00 AM	Varies	20
Saturday Early Morning	*5:00 AM*	*8:00 AM*	*15*	*3*
Saturday Day/Early Eve	*8:00 AM*	*7:00 PM*	*10*	*11*
Saturday Later Eve	*7:00 PM*	*1:00 AM*	*15*	*6*
Sunday/Holiday	7:00 AM	11:00 PM	Varies	17
Sunday Early Morning	*6:00 AM*	*8:00 AM*	*15*	*2*
Sunday Day/Early Eve	*8:00 AM*	*7:00 PM*	*10*	*11*
Sunday Later Eve	*7:00 PM*	*11:00 PM*	*15*	*4*
TOTAL HOURS / WEEK				137

Approach and Detailed Methodology

Approach

An operating cost model for the Center City Connector was initially developed for the Tier 1 screening based on the following high-level approach:

- Estimate annual operating cost of SLU, FH, and CCC segments (individually).
- Estimate annual operating cost and characteristics for combined, single-line Streetcar System network comprised of SLU, FH, Broadway Extension and CCC segments.
- Estimate annual operating cost and characteristics for other operating scenarios defined for Tier 1 analysis.

This model was adapted and refined in the Tier 2 evaluation based on the following approach:

- Estimate annual revenue hours and operating cost of the Hub-to-Hub scenario.
- Estimate annual revenue hours and operating cost of the End-to-End operating scenario.
- Model each scenario under a Mixed-Traffic condition (shares travel lane with general purpose traffic and limited signal priority) and under an Exclusive condition (exclusive lanes and traffic signal priority).

Data Inputs and Sources

The following data sources were utilized to develop and refine the operating cost model for the Center City Connector.

Figure C-4 Operating Plan Data Sources

Line	Data	Notes/Source(s)
South Lake Union Streetcar	Historic, current, and projected operating costs	SDOT
	Operating data	SDOT
First Hill Streetcar	Projected operating data	1
Center City Connector	Projected operating speed as modeled for Mixed-Traffic and Exclusive conditions	See Appendices G and H
Integrated System (Hub to Hub or End to End scenarios)		3

Notes: (1) Initially, preliminary operating plans for the First Hill Streetcar (February 2012) were used to develop the operating cost model. It was anticipated that once operating plans are formally established by the City and its operator (King County Metro), they can be used to further refine the Operating Hours and Cost Estimate model; as described in the final section of this Appendix, updated cost projections available

following completion of the Tier 2 analysis were used in preparing the Finance Plan for the Center City Connector. (2) Operating Hours and Cost Estimate Model (SOJ).

Detailed Methodology

The operations plan was based upon the distance the streetcar must travel and assumptions with regard to speed of operation. The following are key parameters:

- **Operating Speed**. Traffic analysis conducted for the Tier 2 Evaluation included simulation of Mixed-Traffic and Exclusive Streetcar alternatives. Travel time and operating speed assumptions from the traffic analysis were incorporated into the operations methodology and cost model.

  Vehicles are assumed to operate in mixed-traffic with similar operating speeds as buses, except where the design alternatives indicate otherwise. Operating speed includes dwell time or stopping to board and disembark passengers. Average speeds for streetcar in mixed-traffic range from 5.5 mph to 7.5 mph depending upon the number of stops and volume of passenger load. Peak periods with high traffic and high loads can average as low as 5 mph. The Tier 1 and Tier 2 analysis include consideration of the benefits from priority and "rapid streetcar" type features in achieving desired average speeds. The average operating speed is determined by dividing the distance by the travel time estimated. This is varied depending upon verification of estimated travel times from simulations.
- **Distance**. The distance of the line is used as a base to estimate round trip time. The distance is assumed as one-way distance with the return trip included at the same travel speed. The estimates are for round trip times.
- **Travel Time.** The actual travel time for the streetcar for each route modeled. This is estimated based upon anticipated or modeled operating speeds, and may vary for different priority scenarios.
- **Travel Time + Recovery.** A minimum of 5 minutes is added to the travel time as "recovery" time which allows for the streetcar to make up its schedule. Additional time may be required to assure proper breaks and layover for the operation. Up to an additional 5 minutes or more is included for such layover. The travel time plus recovery is divided by the number of vehicles to determine frequency.
- **Headway**. The number of minutes between vehicles traveling in the same direction, calculated as travel time and recovery divided by number of vehicles operating.
- **Vehicles.** Service headway goals and the end-to-end travel time including recovery determine the required number of vehicles on a line. The existing fleet of vehicles includes three vehicles in operation and one spare (this does not include one additional vehicle that will be funded by Amazon and used to increase peak frequency).
- **Service Span.** The operating assumptions used in the Tier 2 analysis, identified in Figure C-3 above, are similar to the First Hill Streetcar operations plan as of February 2012, but assume an additional 5 weekly service hours. Three service span categories of operation are assumed, with up to 20 daily hours on Weekdays and Saturdays and up to 17 hours on

Sundays and Holidays. The following allocation of service is used to determine the total number of annual revenue hours operated:

- **Early Morning and Evening**. 15-minute headways for 7 daily hours on weekdays, 9 hours on Saturdays, and 6 hours on Sundays and Holidays.
- **Day/Early Evening**. 10-minute headways for 13 hours on weekdays and 11 hours on Saturdays, Sundays, and Holidays.

- **Cost per Hour.** The annual operating and maintenance (O&M) cost per revenue hour is used to estimate the total cost of operations by multiplying the total modeled annual revenue hours by the cost per revenue hour. A cost of $189 (2018 dollars) is assumed, based on updated cost projections for the South Lake Union and First Hill Streetcar lines.[2,3]

[2] For purposes of the Tier 2 model, as reported at the October 29, 2013 open house, a cost per revenue hour of $200 (2013 dollars) was assumed, based on the existing Seattle South Lake Union Streetcar segment and Tacoma Link (streetcar) as a baseline. An efficiency factor was applied, recognizing that once the First Hill Streetcar segment commences, the ratio of supervision to total operating hours will drop with increased service. The opening of the First Hill segment will more than triple the length of the existing SLU segment. Once the CCC segment service commences, further efficiencies in supervision expense would be anticipated.

[3] Subsequent to the Tier 2 evaluation, an updated operations and maintenance cost estimate was developed for the Center City Connector Funding Options Report based on more recent SDOT and Metro cost projections (including 2014 staffing plans for operators, maintenance support, general administration and management, operating materials & supplies and inspections) that are lower than the initial CCC cost estimates, based on preliminary data, that were used in the Tier 1 and Tier 2 cost analysis. The 2014 cost projections were inflated to an assumed 2018 opening year. The resulting annual O&M cost per revenue hour is approximately $189 in 2018 dollars. Applied to the total modeled annual revenue hours for the recommended Center City Connector LPA with the Hub-to-Hub operating scenario, the estimated annual O&M cost is $14.96M (rounded to $15.0M). This cost estimate was incorporated into the final City Center Connector reports.

Tier 2 Operating and Maintenance Cost Model

The following tables provide Tier 2 operating plan scenarios for the Seattle Center City Streetcar System consisting of the four integrated streetcar segments under the Hub-to-Hub or End-to-End operating scenarios with travel times for Mixed-Traffic or Exclusive operating conditions based on the Tier 2 traffic analysis. Figure C-5 provides a summary of the annual service hours and cost. The total annual revenue hours under each operating scenario was modeled based on the methodology described above. The number of annual revenue hours was multiplied by the cost per revenue hour, yielding an annual O&M cost for each scenario. The total number of vehicles required for each scenario was incorporated into the capital cost for each alternative.

Figure C-5 Operating and Maintenance Cost Summary, 2018 Dollars

Operating Scenario	Operating Condition	Line	Annual Hours	Annual Cost[1]
Hub-to-Hub	Exclusive (Figure C-6)	SLU-King St.	34,424	$6.5 M
		Cap. Hill-SLU	44,668	$8.4 M
		TOTAL	79,092	$15.0 M
	Mixed-Traffic (Figure C-7)	SLU-King St.	39,364	$7.4 M
		Cap. Hill-SLU	48,048	$9.1 M
		TOTAL	87,412	$16.5 M
End-to-End	Exclusive (Figure C-8)	Single Line	63,440	$12.0 M
	Mixed-Traffic (Figure C-9)	Single Line	65,260	$12.3 M

Notes: (1) Assumes $189 cost per revenue hour (2018 dollars).

Figure C-6 Hub to Hub Operating Scenario O&M Cost Model by Segment, Exclusive Condition, 2018 Dollars

(a) South Lake Union to King Street Intermodal Hub (SLU + CCC to King Street) – Hub-to-Hub Exclusive									
	Vehicles	Distance	Travel Time [1]	Time +Recovery	Headway	Hours per week	Annual Hours	Annual Cost [2]	MPH
Weekday Early Morning	4	2.78	49	59	15	5	1,040		6.81
Weekday Peak	6	2.78	50	59	10	15	4,680		6.67
Weekday Day/Early Eve	4	2.78	49	59	15	30	6,240		6.81
Weekday Peak	6	2.78	50	59	10	20	6,240		6.67
Weekday Early Eve	4	2.78	49	59	15	20	4,160		6.81
Weekday Later Eve	4	2.78	49	59	15	10	2,080		6.81
Sat Early Morning	4	2.78	49	59	15	3	624		6.81
Sat Day/Early Eve	6	2.78	49	59	10	11	3,432		6.81
Sat Early Eve	4	2.78	49	59	15	4	832		6.81
Sat Later Eve	4	2.78	49	59	15	2	416		6.81
Sun Early Morning	4	2.78	49	59	15	2	416		6.81
Sun Day/Early Eve	6	2.78	49	59	10	11	3,432		6.81
Sun Early Eve	4	2.78	49	59	15	4	832		6.81
SUB-TOTAL	6 [a]					137	34,424	$6.5 M	

Assumptions/Notes: (1) Including spare vehicles. (2) Exclusive-running and/or priority operations. (3) Assumes $189 cost per revenue hour (2018 dollars). (a) Peak vehicle count.

(b) Capitol Hill to Westlake Intermodal Hub (First Hill with Broadway Extension + CCC to Westlake) – Hub-to-Hub Exclusive									
	Vehicles	Distance	Travel Time [1]	Time +Recovery	Headway	Hours per week	Annual Hours	Annual Cost [2]	MPH
Weekday Early Morning	5	4.16	65	73	15	5	1,300		7.68
Weekday Peak	7	4.16	65	73	10	15	5,460		7.68
Weekday Day/Early Eve	7	4.16	65	73	10	30	10,920		7.68
Weekday Peak	7	4.16	65	73	10	20	7,280		7.68
Weekday Early Eve	5	4.16	65	73	15	20	5,200		7.68
Weekday Later Eve	5	4.16	65	73	15	10	2,600		7.68
Sat Early Morning	5	4.16	65	73	15	3	780		7.68
Sat Day/Early Eve	7	4.16	65	73	10	11	4,004		7.68
Sat Early Eve	5	4.16	65	73	15	4	1,040		7.68
Sat Later Eve	5	4.16	65	73	15	2	520		7.68
Sun Early Morning	5	4.16	65	73	15	2	520		7.68
Sun Day/Early Eve	7	4.16	65	73	10	11	4,004		7.68
Sun Early Eve	5	4.16	65	73	15	4	1,040		7.68
SUB-TOTAL	7 [a]					137	44,668	$8.4 M	
TOTAL	13 [a] / 16 [b]					137	79,092	$15.0 M	

Assumptions/Notes: (1) Exclusive-running and/or priority operations. (2) Assumes $189 cost per revenue hour (2018 dollars). (a) Peak vehicle count. (b) Including spare vehicles.

Figure C-7 Hub-to-Hub Operating Scenario O&M Model by Segment, Mixed-Traffic Condition, 2018 Dollars

(a) South Lake Union to King Street Intermodal Hub (SLU + CCC to King Street) – Hub-to-Hub Mixed-Traffic									
	Vehicles	Distance	Travel Time [1]	Time +Recovery	Headway	Hours per week	Annual Hours	Annual Cost [2]	MPH
Weekday Early Morning	4	2.78	55	60	15	5	1,040		6.07
Weekday Peak	7	2.78	61	70	10	15	5,460		5.47
Weekday Day/Early Eve	6	2.78	55	60	10	30	9,360		6.07
Weekday Peak	7	2.78	61	70	10	20	7,280		5.47
Weekday Early Eve	4	2.78	55	60	15	20	4,160		6.07
Weekday Later Eve	4	2.78	55	60	15	10	2,080		6.07
Sat Early Morning	4	2.78	55	60	15	3	624		6.07
Sat Day/Early Eve	6	2.78	55	60	10	11	3,432		6.07
Sat Early Eve	4	2.78	55	60	15	4	832		6.07
Sat Later Eve	4	2.78	55	60	15	2	416		6.07
Sun Early Morning	4	2.78	55	60	15	2	416		6.07
Sun Day/Early Eve	6	2.78	55	60	10	11	3,432		6.07
Sun Early Eve	4	2.78	55	60	15	4	832		6.07
SUB-TOTAL	7 [a]					137	39,364	$7.4M	

Assumptions/Notes: (1) Including spare vehicles. (2) Mixed-traffic operations. (3) Assumes $189 cost per revenue hour (2018 dollars). (a) Peak vehicle count.

(b) Capitol Hill to Westlake Intermodal Hub (First Hill with Broadway Extension + CCC to Westlake) – Hub-to-Hub Mixed-Traffic									
	Vehicles	Distance	Travel Time [1]	Time +Recovery	Headway	Hours per week	Annual Hours	Annual Cost [2]	MPH
Weekday Early Morning	5	4.16	69	77	15	5	1,300		7.23
Weekday Peak	8	4.16	72	81	10	15	6,240		6.93
Weekday Day/Early Eve	8	4.16	69	79	10	30	12,480		7.23
Weekday Peak	8	4.16	72	81	10	20	8,320		6.93
Weekday Early Eve	5	4.16	69	77	15	20	5,200		7.23
Weekday Later Eve	5	4.16	69	77	15	10	2,600		7.23
Sat Early Morning	5	4.16	69	77	15	3	780		7.23
Sat Day/Early Eve	7	4.16	68	72	10	11	4,004		7.34
Sat Early Eve	5	4.16	69	77	15	4	1,040		7.23
Sat Later Eve	5	4.16	69	77	15	2	520		7.23
Sun Early Morning	5	4.16	69	77	15	2	520		7.23
Sun Day/Early Eve	7	4.16	68	72	10	11	4,004		7.34
Sun Early Eve	5	4.16	69	77	15	4	1,040		7.23
SUB-TOTAL	8					137	48,048	$9.1M	
TOTAL	15 [a] / 18 [b]					137	87,412	$16.5M	

Assumptions/Notes: (1) Mixed-traffic operations. (2) Assumes $189 cost per revenue hour (2018 dollars). (a) Peak vehicle count. (b) Including spare vehicles.

Figure C-8 End-to-End Operating Scenario O&M Cost Model by Segment, Exclusive Condition, 2018 Dollars

South Lake Union to Capitol Hill (SLU + CCC + First Hill with Broadway Extension) – End-to-End Exclusive									
	Vehicles	Distance	Travel Time [1]	Time +Recovery	Headway	Hours per week	Annual Hours	Annual Cost [2]	MPH
Weekday Early Morning	7	5.46	92	102	15	5	1,820		7.12
Weekday Peak	10	5.46	93	102	10	15	7,800		7.05
Weekday Day/Early Eve	10	5.46	92	102	10	30	15,600		7.12
Weekday Peak	10	5.46	93	102	10	20	10,400		7.05
Weekday Early Eve	7	5.46	92	102	15	20	7,280		7.12
Weekday Later Eve	7	5.46	92	102	15	10	3,640		7.12
Sat Early Morning	7	5.46	92	102	15	3	1,092		7.12
Sat Day/Early Eve	10	5.46	92	102	10	11	5,720		7.12
Sat Early Eve	7	5.46	92	102	15	4	1,456		7.12
Sat Later Eve	7	5.46	92	102	15	2	728		7.12
Sun Early Morning	7	5.46	92	102	15	2	728		7.12
Sun Day/Early Eve	10	5.46	92	102	10	11	5,720		7.12
Sun Early Eve	7	5.46	92	102	15	4	1,456		7.12
TOTAL	10 [a] / 12 [b]					137	63,440	$12.0M	

Assumptions/Notes: (1) Including spare vehicles. (2) Exclusive-running or Priority operations. (3) Assumes $200 cost per revenue hour; Tier 2 estimate in 2012 dollars. (a) Peak vehicle count.

Figure C-9 End-to-End Scenario Operating Cost O&M Model by Segment, Mixed-Traffic Condition, 2018 Dollars

South Lake Union to Capitol Hill (SLU + CCC + First Hill with Broadway Extension) – End-to-End Mixed-Traffic									
	Vehicles	Distance	Travel Time [1]	Time +Recovery	Headway	Hours per week	Annual Hours	Annual Cost [2]	MPH
Weekday Early Morning	7	5.46	98	105	15	5	1,820		6.69
Weekday Peak	11	5.46	102	110	10	15	8,580		6.42
Weekday Day/Early Eve	10	5.46	98	103	10	30	15,600		6.69
Weekday Peak	11	5.46	102	110	10	20	11,440		6.42
Weekday Early Eve	7	5.46	98	105	15	20	7,280		6.69
Weekday Later Eve	7	5.46	98	105	15	10	3,640		6.69
Sat Early Morning	7	5.46	98	105	15	3	1,092		6.69
Sat Day/Early Eve	10	5.46	98	103	10	11	5,720		6.69
Sat Early Eve	7	5.46	98	105	15	4	1,456		6.69
Sat Later Eve	7	5.46	98	105	15	2	728		6.69
Sun Early Morning	7	5.46	98	105	15	2	728		6.69
Sun Day/Early Eve	10	5.46	98	103	10	11	5,720		6.69
Sun Early Eve	7	5.46	98	105	15	4	1,456		6.69
SUB-TOTAL	11 [a] / 14 [b]					137	65,260	$12.3M	

Assumptions/Notes: (1) Including spare vehicles. (2) Mixed-traffic operations. (3) Assumes $189 cost per revenue hour (2018 dollars). (a) Peak vehicle count.

APPENDIX D PASSENGER LOADING ANALYSIS

Introduction

This document describes an analysis of passenger loading for the Hub-to-Hub streetcar system operating scenario. The purpose of the analysis is to compare projected passenger loads along the Center City Connector (CCC) segment to passenger-carrying capacity, given the planned streetcar operating plan and existing type of vehicle used for the Seattle Streetcar system.

Methodology and Assumptions

Daily Ridership and Streetcar Operating Plan

The analysis is based on projected Center City Streetcar System station-to-station ridership for 2035 (see Appendix A), which identified over 30,000 Project trips (using CCC stops or making through trips). In the Hub-to-Hub operating scenario two streetcar lines provide overlapping service between the King Street and Westlake Intermodal Hubs:

- South Lake Union (SLU) to King Street Intermodal Hub line
- First Hill to Westlake Intermodal Hub line

This analysis categorizes projected 2035 station-station Project trips based on which of the two lines they would be likely to use (Figure D-1). These trips fall into several categories:

- **SLU-only or First Hill-only** trips do not travel on the CCC segment. (SLU-only trips are those starting and ending north of the Westlake stop; First Hill-only trips are those starting and ending east of the stop serving King Street Intermodal Hub, i.e., 5th Avenue/Jackson Street stop).
- **Through trips** traveling between the SLU and First Hill segments would need to transfer between the two lines. A daily round trip is assumed to use one line to pass through the CCC segment in one direction, and the other line through the CCC segment in the return direction. For example, a First Hill to SLU trip would likely pass through the CCC on the First Hill to Westlake line and then transfer to an SLU train. In the return direction, such a trip would use the SLU to King Street line through the CCC segment and then transfer to a First Hill train.
- **SLU to CCC trips** would use the SLU to King Street line.
- **First Hill to CCC** trips would use the First Hill to Westlake line.
- **Hub-to-Hub trips** traveling between King Street and Westlake Intermodal Hubs, including intermediate stops, could take either line.

Figure D-1 Categorized Station-Station Project Trips, 2035

Trip Category (Directional)	Uses SLU to King Street Line	Uses First Hill to Westlake Line	Transfer Required?	TOTAL without Through Trips	TOTAL including Through Trips	Notes
SLU[1]	X			0	0	Does not use CCC segment
First Hill[1]		X		0	0	Does not use CCC segment
SLU to First Hill	X		X	0	368 [a]	Through Trips
First Hill to SLU		X	X	0	368 [a]	Through Trips
Westlake/CCC to First Hill		X		5,536	5,536	Use First Hill-Westlake line
SLU to CCC / King Street	X			2,967	2,967	Use SLU-King Street line
Westlake/CCC to King Street	X	X		21,545	21,545	Could take either line
TOTALS				**30,048**	**30,784**	

Notes: (1) Trips between Westlake Hub, 5th/Jackson, or Occidental/Jackson and new CCC stops are included in the CCC totals. (a) Not included in current version of STOPS Table 6.01 (detailed stop activity). Summary total split between the lines as each would be used for the first leg of the through trip in each direction.

Source: STOPS 2035 Model Run, Table 6.01: Avg Weekday Station Utilization by Project Trips

Based on this categorization, these trips were allocated to either the South Lake Union to King Street line or the First Hill to Westlake line (Figure D-2). This analysis indicates that passenger demand is likely to be slightly higher on the First Hill to Westlake line—about 16,700 boardings compared to just over 14,000 on the SLU to King Street line.

Figure D-2 Categorized Station-Station Project Trips

Line	Daily Boardings
SLU to King Street Line (SLU+CCC)	14,108
First Hill to Westlake Line (First Hill+CCC)	16,677
TOTAL	**30,784**

Maximum Loading Point

However, based on the above categorization of Project trips and station-station ridership projections from the STOPS model (see Appendix A), the highest passenger demand at a particular stop would occur on the SLU to King Street Station line. The Madison/Spring stop is projected to be the maximum loading point on either line. The capacity analysis determined that:

- About 5,587 daily passengers could be boarding, alighting, or traveling through the Madison/Spring stop on the SLU to King Street Station line.
- About 4,775 daily passengers could be boarding, alighting, or traveling through the Madison/Spring stop on the First Hill to Westlake line.

Time-of-Day Distribution

It is not yet known how ridership for the Center City Connector will be distributed throughout the day.[1] Project trips by time-of-day at the maximum loading point was estimated for each line based on the time distribution of riders on the existing South Lake Union Streetcar and the San Francisco (SF) F-Market line. [2] Figure D-3 provides the percentage of total daily riders by time-of-day, peaking at about 10% (AM) and 11% (PM) for the existing SLU Streetcar and at nearly 9% for the SF F-Market line.

[1] The STOPS ridership model provides average weekday daily ridership.

[2] As discussed in Appendix B, San Francisco's F-line line was identified as a peer serving both commuter and a visitor/tourist market, comparable to the travel markets that the Center City Connector is likely to serve in Seattle. In addition, the Center City Connector would also serve the special event market, which is not accounted for in the STOPS model projections and would generate high peak ridership demand. Appendix B of the Detailed Evaluation Report discusses both visitor and special event markets.

Figure D-3 Estimated Ridership Time-of-Day Distribution, 2035 Project Trips at Madison/Spring Stop by Time of Day

	Time-of-Day Percentages		SLU to King Street Line Project Trips		First Hill to Westlake Line Project Trips	
Hour	SLU %	SF F-Line %	Based on SLU	Based on F-Line	Based on SLU	Based on F-Line
5 AM	0.4%	0.5%	20	27	17	23
6 AM	2.9%	1.5%	162	82	139	70
7 AM	8.1%	4.3%	452	242	386	206
8 AM	9.9%	4.3%	551	242	471	206
9 AM	7.0%	5.1%	389	284	333	243
10 AM	4.2%	6.7%	236	374	202	319
11 AM	5.3%	6.7%	297	374	254	319
12 PM	6.6%	6.7%	369	374	316	319
1 PM	5.5%	6.7%	310	374	265	319
2 PM	6.3%	7.9%	353	442	302	377
3 PM	6.7%	7.9%	377	442	322	377
4 PM	11.1%	8.7%	618	486	528	415
5 PM	8.4%	8.7%	467	486	399	415
6 PM	4.1%	7.1%	231	396	197	338
7 PM	3.6%	4.4%	200	245	171	209
8 PM	3.2%	4.4%	179	245	153	209
9 PM	2.8%	4.4%	156	245	134	209
10 PM	2.2%	2.1%	123	115	105	98
11 PM	1.4%	1.4%	78	81	67	69
12 AM	0.4%	0.6%	20	35	17	30
TOTAL	**100%**	**100%**	**5,588**	**5,587**	**4,775**	**4,774**

Source: Time-of-day allocations based on boarding data by stop from South Lake Union Streetcar Onboard Survey, 2013, and San Francisco F-Market Line On-Board Survey, 2008.

Figure D-4 and Figure D-5 illustrate the two time distributions applied to projected daily riders at the maximum load point on the SLU to King Street and First Hill to Westlake lines, respectively. In each graphic, the distribution based on the SLU line is characterized by morning and late afternoon peaks (dashed red line) while the distribution based on the F-Market line (solid red) is characterized by more level all-day ridership, with an afternoon peak running from about 4 PM to 6 PM.

Figure D-4 Estimated Ridership Time-of-Day Distribution, Madison/Spring Stop, SLU to King Street Line (Hub-to-Hub Operating Scenario), 2035

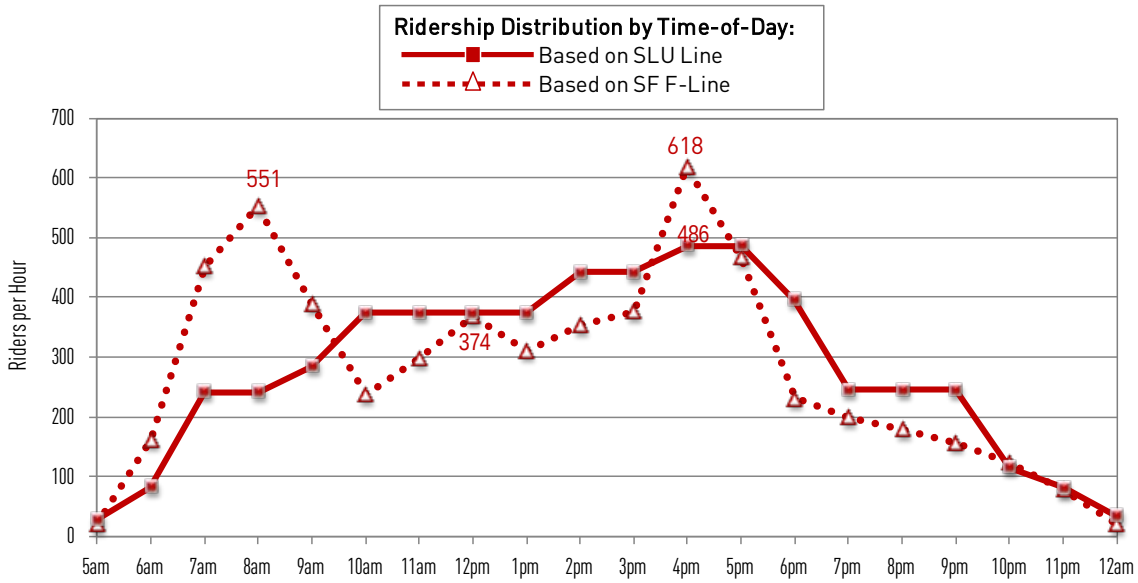
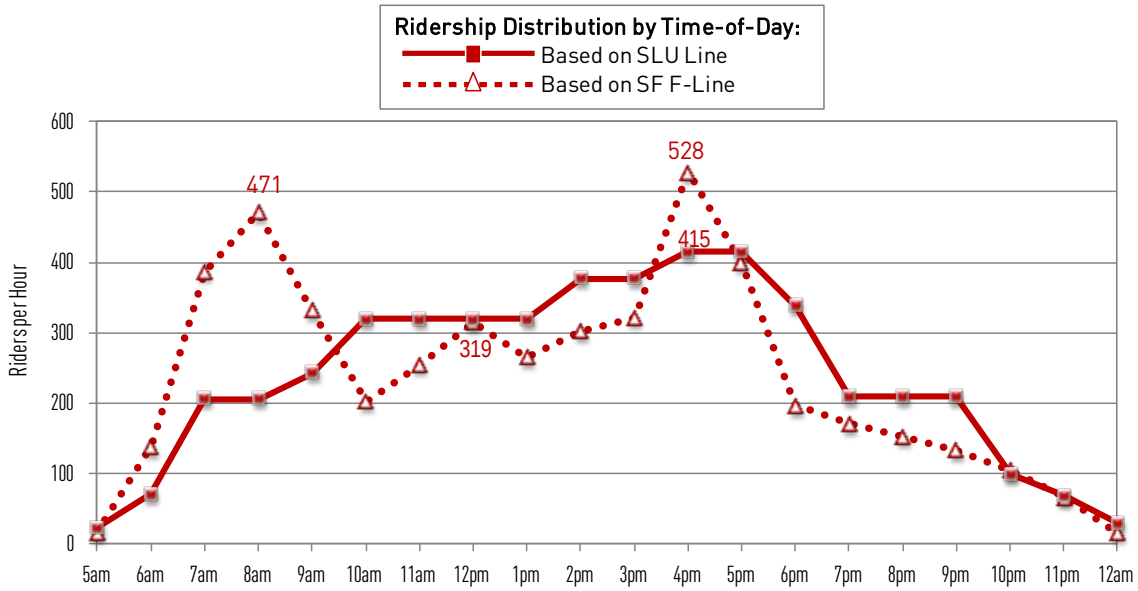


Figure D-5 Estimated Ridership Time-of-Day Distribution, Madison/Spring Stop, First Hill to Westlake Line (Hub-to-Hub Operating Scenario), 2035



Passenger Capacity Results

This section compares estimated passenger load at the projected maximum load point (Madison/Spring stop) to passenger-carrying capacity per line per direction. Passenger-carrying capacity is based on the Hub-to-Hub streetcar operating plan (10-minute headways per line between 6 AM and 7 PM, or 5-minute headways between King Street and Westlake Intermodal Hubs) and the existing streetcar vehicle type used on the SLU and First Hill lines. The graphics in this section illustrate both seated passenger capacity (29 passengers; thin blue line) and a range of comfortable passenger capacity including standees, shown with a thick blue band.

Streetcars are designed to accommodate standing passengers and many trips on streetcar are short and well-suited to standing, particularly in the Center City Connector segment. Acceptable capacity with standees is assumed to be a range between 50 to 75% of "crush" passenger load, or about 80 to 120 passengers.[3] Overcrowded streetcars impact the efficiency of passenger loading and off-loading and may cause passengers to choose an alternate travel option. This point is certainly higher than 50% of crush load, which is a comfortable carrying capacity, but may be lower than 75% of crush load.

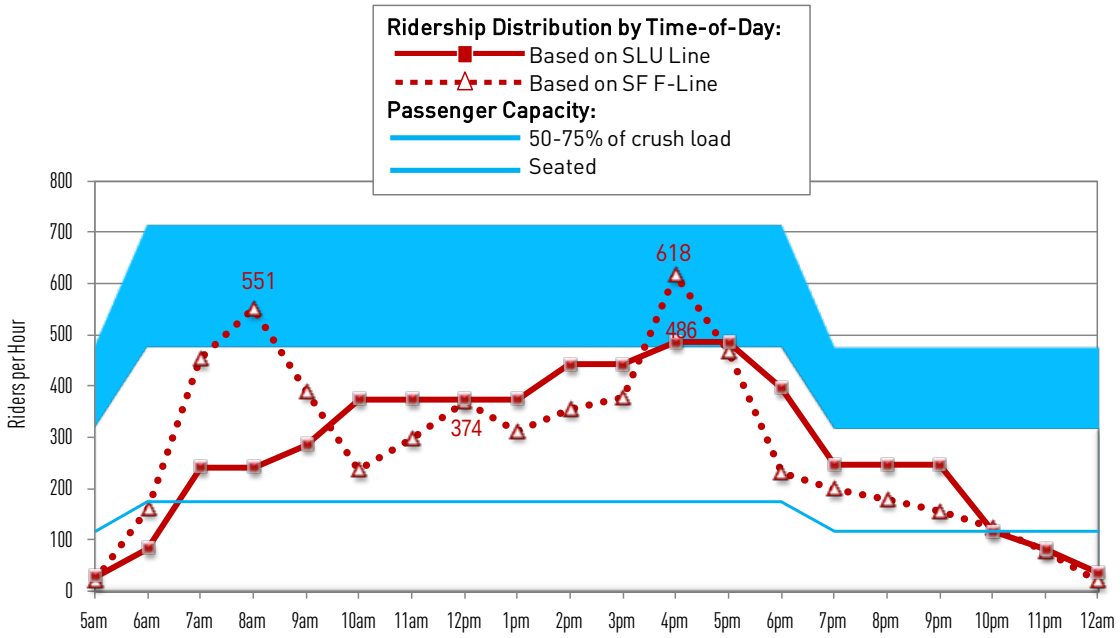
[3] Based on an assumed crush load of 159 passengers.

South Lake Union to King Street Line (SLU + CCC)

The capacity analysis described above determined that about 5,587 daily passengers could be boarding, alighting, or traveling through the Madison/Spring stop on the SLU to King Street Station line. The time of day distribution of ridership at this point was estimated based on the existing South Lake Union Streetcar (dashed red) and the San Francisco F-Market Line (solid red). As described above, the thin blue line indicates seated capacity and the thick blue band indicates a range of acceptable capacity including standing passengers. Figure D-6 illustrates that:

- Based on both time-of-day distributions, ridership exceeds seated capacity of the current type of streetcar vehicle (thin blue line) at nearly all times of the day.
- The peaks of both time-of-day distributions reach or are within the 50 to 75% of crush load range.

Figure D-6 Passenger Capacity Analysis, South Lake Union to King Street Station Line (Hub-to-Hub Operating Scenario), 2035

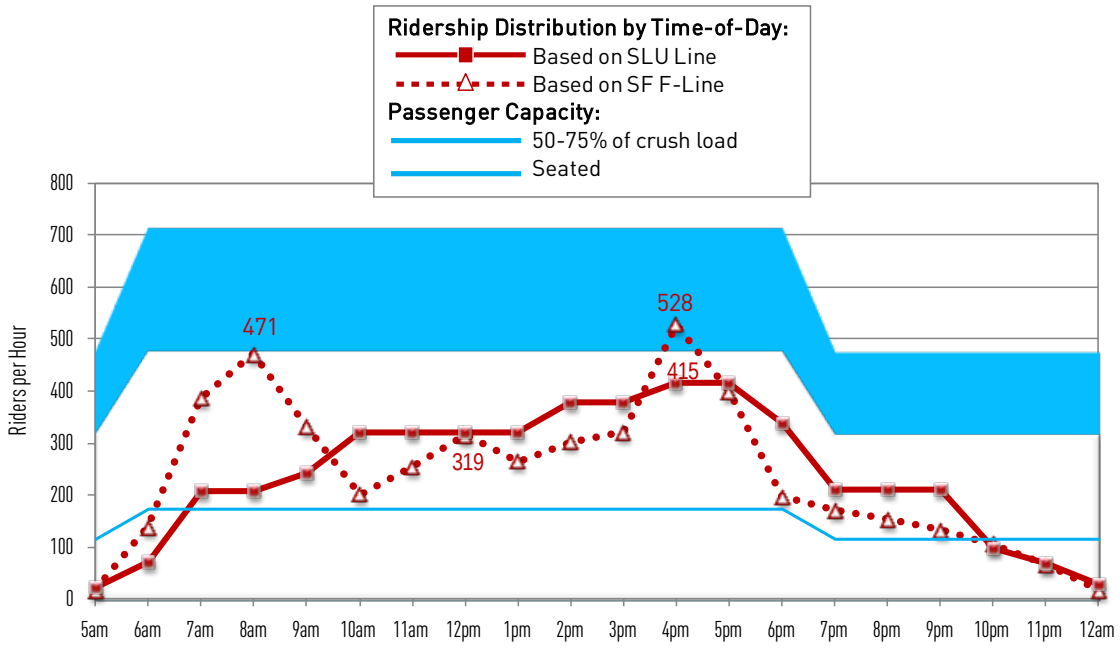


First Hill to Westlake Line (First Hill + CCC)

The capacity analysis described above determined that about 4,775 daily passengers could be boarding, alighting, or traveling through the Madison/Spring stop on the First Hill to Westlake line. As described above, the time of day distribution of ridership at this point was estimated based on the existing South Lake Union Streetcar (dashed red) and the San Francisco F-Market Line (solid red). The thin blue line indicates seated capacity and the thick blue band indicates a range of acceptable capacity including standing passengers. Figure D-7 illustrates that:

- Based on both time-of-day distributions, ridership exceeds seated capacity of standard streetcar vehicles (thin blue line) at nearly all times of the day.
- The morning peak of the SLU time-of-day distributions reaches the 50% of crush load level and the afternoon peak is within the 50 to 75% range; the afternoon peak of the F-Line time-of-day distribution approaches but does not exceed 50% of crush load.

Figure D-7 Passenger Capacity Analysis, First Hill to Westlake Line (Hub-to-Hub Operating Scenario), 2035



APPENDIX E CAPITAL COST ESTIMATES AND METHODOLOGY

Note: This appendix provides detailed capital cost estimation methodology and supplements the evaluation results that are provided in Chapter 7 of the Detailed Evaluation Report.[1]

Tier 2 Estimates

This methodology provide capital cost estimates and cost categories consistent with the FTA's Standard Cost Categories (SCC), and is formatted to be useful as the project progresses into more detailed design in preliminary engineering and final design.

Format

This methodology uses a modified Construction Specifications Institute (CSI) format that allows development of comparative cost estimates suitable for an Alternatives Analysis. The capital cost estimates developed in this format are ordered and summarized into major cost categories consistent with FTA 5309 New Starts Criteria and appropriate to the level of project definition. Cost categories can be expanded or reduced as needed to provide appropriate levels of detail.

Estimate Development

Estimates of project capital costs were developed in three general steps under this methodology. First, potential alignment alternatives identified during initial screening and scoping were defined in enough detail to enable the necessary analysis and conceptual engineering to be performed for cost estimating purposes. Second, project components, consistent with the application of unit costs and appropriate to the level of definition, were identified. Quantities and appropriate unit cost data were then be developed. The capital costs were then summarized in the various cost categories and for each alternative.

Unit Costs

Unit costs were developed from selected historical data including final engineer's estimates, completed projects, First Hill Streetcar bid information from 2012, Portland Streetcar Loop bid information from 2009, and standard estimating practices. Unit costs may include an aggregation of cost elements that are typically itemized in a detailed engineer's estimate. For example, the unit cost for the track construction includes such activities as excavation, soil

[1] Prepared by URS

preparation, aggregate base, and rail procurement. Unit costs also include allowances for contractor's margins such as overhead, profit and insurance costs.

Cost Categories

Cost categories were used to summarize the project component costs into a comprehensive total estimate for each alternative. The major cost categories are listed in Figure E-1 below and described in detail in the "Project Cost Categories" section below.

Figure E-1 Major Cost Categories

Trackwork	Traffic Control and Lighting
Stops	Right of Way Allowance
Support Facilities	Vehicle Storage and Turnback Facilities
Site Work and Special Conditions	Professional Services
Systems	Contingency
Public Utility Relocation Allowance	Vehicles

Fixed facility categories, e.g. Stop Platforms, encompass site-specific project component costs. Capital costs for these categories are typically calculated by using known unit costs and measured quantities for each component. System-wide costs, e.g. trackwork, are calculated on an alignment length instead of from measured quantities. Route-foot or track-foot unit costs were developed from historical data to apply to the length of each section.

The engineering, administration and contingency categories are dependent on the fixed facility and system-wide cost categories. The sum of the categories listed above is the total capital cost estimate for each alignment option.

Management of Costs

Project costs can often be underestimated in the early planning stages and costs tend to grow as project development progresses. The methodology employed in the Center City AA includes measures to guard against the underestimation of project costs and attempt to reduce this problem. Measures applied included comparing unit costs to historical unit cost bid estimates and construction costs for comparable work, and identifying the specific year-of-expenditure.

Cost Data Sources

The sources of data used to develop unit costs must be suitable for the type of work, local conditions and scale of the work proposed for the Project. Historical competitive bid data for comparable work is a reliable source. Recent information is the most reliable because it

relies less on escalation assumptions. Contract as-built prices are the most comprehensive sources because they include the total cost of construction at project closeout and acceptance. This methodology employed recent cost information; typically contractors bid information or engineer's estimates for the First Hill Streetcar project and other recent projects in Seattle and the Pacific Northwest.

Project Cost Categories

This section describes each of the major capital cost categories that were used to assemble the estimates, together with specific assumptions.

Trackwork – This category includes capital costs for procurement and installation of tracks, track slab, special trackwork, crossovers, turnouts, track crossings, welding, track drains and other miscellaneous track items. Embedded trackwork is assumed as the project standard consisting of girder rail with electrical isolation embedded in a concrete slab and located in an existing traffic lane. The type of trackwork to be used in later phases of design may vary depending on funding sources and availability of materials. Measurement of embedded trackway is on a track-foot basis. Measurement of special trackwork is per individual unit, e.g. per turnout or crossing.

Stops – This category includes the capital costs for fixed facilities and amenities for streetcar stops. The capital costs for stops include platforms, shelters, lighting, signage, landscaping, furnishings and sidewalks for pedestrian access. The following types of stops were measured by this methodology: side loading (incorporated into the sidewalk), center loading (in the roadway median), and special platform (usually with architectural upgrades). This category also includes an allowance to convert the existing 1st and Jackson stop from single-sided loading to double-sided. Measurement is for each complete stop platform. It is assumed that stops and amenities will be similar to South Lake Union and First Hill Streetcar stops. Consistent with cost estimates for the First Hill Streetcar, shelters are designed and constructed ready to install real-time information displays; the displays are assumed to be provided and installed by SDOT.

Appendix R provides a sample design specification for a South Lake Union streetcar shelter.

Support Facilities – This category includes an allowance for expansion of vehicle storage facilities, assumed to be two new tracks to store a maximum of four streetcar vehicles at either one of the existing maintenance facility sites. Measurement is by the lump sum with cost based on historic costs of similar facilities. Associated right of way costs are presented separately, below.

Site Work and Special Conditions – This category includes the capital costs for infrastructure improvements necessary for each alignment alternative as well as trackway

enhancements, temporary traffic control, and some of the costs associated with construction administration. System wide items estimated by the track-foot include allowances for road, curb, driveway, sidewalk, and pole foundation construction, and an allowance for anticipated costs related to modifying existing areaways (sidewalk vaults). This allowance includes overhead catenary system (OCS) pole installation; using areaway mapping from SDOT, proposed stop locations were not sited on identified areaways. Lump sums are included for mobilization, general conditions, landscaping, exclusive guideway treatments and temporary traffic control. Unit costs were based on recent projects and SDOT comments.

Systems – This category includes capital costs for the systems providing electrical power to streetcar vehicles as well as train control and signals, and fare collection. Based on the length of the track alignment it was assumed that two traction power substations would be required. It was also assumed that suitable locations for the substations exist within the public right of way and therefore purchase of real estate will not be required. The overhead catenary system (OCS) was estimated per track-foot based on recent costs of similar facilities. OCS pole foundations are included in the Site Work category. A lump sum allowance for relocating OCS for the existing electric trolley bus line on 1st Avenue was developed through discussions with SDOT; additional refinement of these costs will be conducted in the next study phase. Train control systems were included for track crossovers at Westlake/6th and Jackson/Occidental, with costs per each based on recent costs for similar systems. SDOT provided a unit cost for platform based ticket vending machines based on existing equipment.

Utility Coordination Allowance – This lump sum allowance is intended to cover project costs for coordination of public and private utility relocation and modification work as required by streetcar system infrastructure. The unit cost was provided by SDOT.

Traffic Control and Lighting – This category includes modifications to roadway signals and signing and striping to accommodate streetcar operations. For each signalized intersection along the alignment a lump sum cost was assigned based on one of four anticipated signal treatments; add new signal (to existing unsignalized intersection), modify existing signal (expand or upgrade equipment), add new signal phase to existing signal, or add new pedestrian signal. Allowances for anticipated improvements to roadway lighting, signing and striping were included, with measurement on a track-foot basis. Costs include transit signal priority (TSP) equipment.

Right of Way Allowance – This category includes the costs for acquisition of additional property to allow for construction of vehicle storage tracks. Expansion of storage tracks at either existing maintenance facility site would displace the existing or future use of that land. The right of way allowance assumes purchase of an as-yet unidentified property to accommodate the displaced use. The lump sum cost was developed in discussions with SDOT, and contingency was not applied to it in the estimate.

Vehicle Storage and Turnback Facilities – The preferred streetcar operations scenario assumes that the existing South Lake Union and First Hill Lines will overlap, providing more frequent service on the proposed Center City Connector Line. This scenario requires that new turnback facilities be constructed on the existing lines. For this analysis the preferred turnback facilities were located on Jackson at 10th Avenue and on Westlake at 6th Avenue. Costs would be similar at other feasible locations. Estimated costs for this category include crossovers and storage tracks for two vehicles at both locations, and associated roadway reconstruction and signal systems. Costs were based on historic costs of similar facilities.

Appendix R provides conceptual drawings of storage and turnback facilities.

Professional Services – This category includes the costs for engineering, administration and construction management services. Costs for these services are based on a percentage of the total cost of all direct capital cost categories. Cost items assumed for this category are as follows:

Figure E-2 Professional Services Cost Assumptions

Cost Category	Cost Assumption
Preliminary Engineering	4%
Final Design	6%
Project Management for Design Construction	4.5%
Construction Administration and Management	4%
Insurance	2%
Legal (permits and review fees by other agencies, cities, etc.)	2%
Survey, Testing, Investigation, Inspection	2%
Start-Up Costs and Agency Force Account Work	0.5%

The total percentage applied to all capital cost categories except contingencies is 25%. Percentages were based on recent projects and SDOT comments.

Contingency – This cost category accounts for the uncertainties inherent in project definition and conceptual design at the alternatives analysis phase. A contingency is added to the project cost as a percentage of all the capital cost categories except Right of Way and Professional Services. Contingency costs are calculated as twenty (20) percent for all capital costs. Contingency should reflect the degree of risk associated with the level of design detail

available and the characteristics of the design component. The contingency for future design stages will be reduced as the design process progresses.

Vehicles – This category includes capital costs for procuring new streetcar vehicles compatible with the existing streetcar system and the needs identified for this project. It was assumed that the vehicles will be Buy-America compliant. The number of vehicles for each alignment option is based on the proposed operating plans. The unit cost (per each) was provided by SDOT and is based on recent vehicle procurement experience.

Capital Cost Summary

Comparative cost estimates (opinions of cost) for each option are presented in Figure E-3.

Figure E-3 Capital Cost Estimate Summary, 2013 Dollars, and Escalated to 2017

Capital Cost Elements	Mixed-Traffic Streetcar	Exclusive Streetcar
Costs Not Including Vehicles		
Trackwork	$9,610,000	$9,610,000
Platforms	$1,730,000	$1,730,000
Support Facilities (Storage Tracks)	$1,780,000	$1,780,000
Sitework and Special Conditions	$20,580,000	$21,760,000
Systems	$10,670,000	$10,670,000
Traffic Control and Lighting	$3,610,000	$3,770,000
Utility Coordination Allowance	$500,000	$500,000
Storage @ Westlake/6th for Overlapping Service	$3,360,000	$3,360,000
Turnback @ Jackson/10th for Overlapping Service	$2,270,000	$2,270,000
SUBTOTAL	**$54,110,000**	**$55,450,000**
12% ESCALATION, 2013 - 2017	$6,490,000	$6,650,000
TOTAL NOT INCLUDING VEHICLES	**$60,600,000**	**$62,100,000**
Costs Including Right-of-Way (ROW)		
Right-of-Way (Land for Storage Tracks)	$10,000,000	$10,000,000
TOTAL INCLUDING RIGHT-OF-WAY	**$70,600,000**	**$72,100,000**
Costs Including Vehicles (Hub-to-Hub Operations)		
New Hybrid Vehicles @ $4.5M Each	8	6
Replacement Hybrid Vehicles for Non-Hybrid SLU Vehicles @ $3.0M Each (Net)	3	3
TOTAL VEHICLE COSTS	**$45,000,000**	**$36,000,000**
TOTAL INCLUDING VEHICLES AND ROW	**$115,600,000**	**$108,100,000**

Detailed Capital Costs

Figure E-4 and Figure E-5 provide more detailed cost breakdowns for the Mixed-Traffic and Exclusive Streetcar alternatives. They do not include the utility coordination, additional vehicle turnback and storage, or cost escalation.

Figure E-6 and Figure E-7 provide more detailed cost breakdowns for additional vehicle storage and turnbacks at Westlake and on Jackson Street, required to support the Hub-to-Hub operating scenario. Figure E-8 provides a more detailed cost breakdown of maintenance facility expansion costs.

Figure E-4 Detailed Capital Costs, Mixed-Traffic Alternative (Not Including Vehicles, Westlake/Jackson Storage/Turnbacks, Utility Coordination, or Escalation to 2017), 2013 Dollars

		Seattle Center City Connector Streetcar Project											
			Seattle, WA		Outbound Alignment				Inbound AlignmentAlignment				
			Order of Magnitude Opinion of Cost		Start Sta	End Sta	Length		Start Sta	End Sta	Length		
			Summary Mixed Traffic Option (Westlake to 1st and Jackson)		0+00	66+38	6,638 TF		0+00	63+71	6,371 TF	13,009 TF	1st Quarter
							1.26 TK-mile				1.21 TK-mile	1.23 Rt-mile	2013$
URS Line NO.	**Base**	**Code**	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Extension**	**E&A %**	**E&A**	**Cont%**	**Unallocated Contingency**	**Detail Total**	**Summary Total**
10.0	**TRACKWORK**												$9,611,155
10.1		10.02	Embedded Trackway Southbound	6,638	TF	$462	$3,066,756	29%	$874,025	20%	$613,351	$4,554,133	
10.2		10.02	Embedded Trackway Northbound	6,371	TF	$462	$2,943,402	29%	$838,870	20%	$588,680	$4,370,952	
10.3		10.12	Track Crossing	0	EA	$157,500	$0	29%	$0	20%	$0	$0	
10.4		10.12	Turnout	2	EA	$231,000	$462,000	29%	$131,670	20%	$92,400	$686,070	
10.5		10.12	Switch Heater	0	EA	$10,000	$0	29%	$0	20%	$0	$0	
20.0	**PLATFORMS**							29%					$1,727,055
20.1		20.01	Side Loading	1	PR	$136,500	$136,500	29%	$38,903	20%	$27,300	$202,703	
20.2		20.01	Center Loading	5	EA	$157,500	$787,500	29%	$224,438	20%	$157,500	$1,169,438	
20.3		20.01	Allowance to Modify Occidental Platform	1	LS	$50,000	$50,000	29%	$14,250	20%	$10,000	$74,250	
20.4		20.01	Special Platform (Pioneer Square)	1	EA	$189,000	$189,000	29%	$53,865	20%	$37,800	$280,665	
30.0	**SUPPORT FACILITIES**												$1,782,000
30.1		30.05	Allowance for Expansion of Storage Tracks	1	LS	$1,200,000	$1,200,000	29%	$342,000	20%	$240,000	$1,782,000	
40.0	**SITE WORK AND SPECIAL CONDITIONS**												$20,582,152
40.1		40.08	Mobilization	1	LS	$1,027,011	$1,027,011	29%	$292,698	20%	$205,402	$1,525,111	
40.2		40.08	Specified General Conditions	1	LS	$1,283,763	$1,283,763	29%	$365,873	20%	$256,753	$1,906,389	
40.3		40.08	Reimbursible General Conditions	1	LS	$2,567,527	$2,567,527	29%	$731,745	20%	$513,505	$3,812,777	
40.4		40.06	Allowance for Areaway Treatments	13,009	TF	$40	$520,360	29%	$148,303	20%	$104,072	$772,735	
40.5		40.07	Road Construction Allowance	13,009	TF	$341	$4,439,321	29%	$1,265,207	20%	$887,864	$6,592,392	
40.6		40.06	Sidewalk, Driveway and Curb Allowance	13,009	TF	$117	$1,522,053	29%	$433,785	20%	$304,411	$2,260,249	
40.7		40.01	Remove Existing Trolley Track	0	TF	$0	$0	29%	$0	20%	$0	$0	
40.8		40.07	Major Street Reconstruction Allowance	0	LS	$500,000	$0	29%	$0	20%	$0	$0	
40.9		40.06	Landscaping Allowance	1	LS	$500,000	$500,000	29%	$142,500	20%	$100,000	$742,500	
40.10		40.06	Allowance for exclusive guideway treatments	0	LS	$650,000	$0	29%	$0	20%	$0	$0	
40.11		40.08	Allowance for Temporary Traffic Control	1	LS	$2,000,000	$2,000,000	29%	$570,000	20%	$400,000	$2,970,000	
50.0	**SYSTEMS**												$10,672,510
50.1		50.03	Traction Power Substations (TPSS)	2	EA	$735,000	$1,470,000	29%	$418,950	20%	$294,000	$2,182,950	
50.2		50.04	Trolley-Bus Catenary Modifications Allowance	0	LS	$750,000	$0	29%	$0	20%	$0	$0	
		50.04	Metro ETB Relocation Allowance	1	LS	$2,500,000	$2,500,000	0%		20%	$500,000	$3,000,000	
50.3		50.04	OCS including Catenary	13,009	TF	$242	$3,141,674	29%	$895,377	20%	$628,335	$4,665,385	
50.4		50.01	Train Control System	2	EA	$157,500	$315,000	29%	$89,775	20%	$63,000	$467,775	
50.5		50.02	Allowance for Platform Fare Collection	8	EA	$30,000	$240,000	29%	$68,400	20%	$48,000	$356,400	
90.0	**TRAFFIC CONTROL AND LIGHTING**												$3,611,077
90.1		50.02	New Traffic Signal	0	EA	$168,000	$0	29%	$0	20%	$0	$0	
90.2		50.02	New Ped-only	0	EA	$100,000	$0	29%	$0	20%	$0	$0	
90.3		50.02	Modify Existing Traffic Signal	3	EA	$109,000	$327,000	29%	$93,195	20%	$65,400	$485,595	
90.4		50.02	Add Transit Phase	10	EA	$109,000	$1,090,000	29%	$310,650	20%	$218,000	$1,618,650	
90.5		50.02	Signing and Striping Alowance	13,009	TF	$28	$364,252	29%	$103,812	20%	$72,850	$540,914	
90.6		50.02	Lighting Allowance	13,009	TF	$50	$650,450	29%	$185,378	20%	$130,090	$965,918	
60.0	**RIGHT OF WAY**												$10,000,000
60.1		60.01	Allowance for Land for Vehicle Storage	1	LS	$10,000,000	$10,000,000	0%	$0	0%	$0	$10,000,000	
	SUBTOTAL						$42,793,569		$8,633,667		$6,558,714	$57,985,949	**$57,985,949**
100.0	**VEHICLES**												$0
100.1		70.01	Vehicles, Hybrid, incl. SLU Replacements	0	EA	$4,500,000	$0	10%	$0	20%	$0	$0	
	TOTAL 2013$						$42,793,569		$8,633,667		$6,558,714	$57,985,949	**$57,985,949**
	Professional Services												
		80.01	Preliminary Engineering			4.0%	$1,211,743						
		80.02	Final Design			6.0%	$1,817,614						
		80.03	Project Management for Design and Construction			6.0%	$1,817,614						
		80.04	Construction Administration & Management			6.0%	$1,817,614						
		80.05	Insurance			2.0%	$605,871						
		80.06	Legal; Permits;Review Fees by other agencies, cities, etc.			2.0%	$605,871						
		80.07	Surveys, Testing, Investigation, Inspection			2.0%	$605,871						
		80.08	Start-up Costs & Agency Force Account Work			0.5%	$151,468						
						28.5%	$8,482,199						
	Contingency												
		90.01	Unallocated Contingency				$6,558,714						

Figure E-5 Detailed Capital Costs, Exclusive Alternative (Not Including Vehicles, Westlake/Jackson Storage/Turnbacks, Utility Coordination, or Escalation to 2018) 2013 Dollars

		Seattle Center City Connector Streetcar Project											
			Seattle, WA		Outbound Alignment				Inbound AlignmentAlignment				
			Order of Magnitude Opinion of Cost		Start Sta	End Sta	Length		Start Sta	End Sta	Length		
			Summary Exclusive Option (Westlake to 1st and Jackson)		0+00	66+38	6,638 TF		0+00	63+71	6,371 TF	13,009 TF	1st Quarter
							1.26 TK-mile				1.21 TK-mile	1.23 Rt-mile	2013$
URS Line NO.	**Base**	**Code**	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Extension**	**E&A %**	**E&A**	**Cont%**	**Unallocated Contingency**	**Detail Total**	**Summary Total**
10.0	**TRACKWORK**												$9,611,155
10.1		10.02	Embedded Trackway Southbound	6,638	TF	$462	$3,066,756	29%	$874,025	20%	$613,351	$4,554,133	
10.2		10.02	Embedded Trackway Northbound	6,371	TF	$462	$2,943,402	29%	$838,870	20%	$588,680	$4,370,952	
10.3		10.12	Track Crossing	0	EA	$157,500	$0	29%	$0	20%	$0	$0	
10.4		10.12	Turnout	2	EA	$231,000	$462,000	29%	$131,670	20%	$92,400	$686,070	
10.5		10.12	Switch Heater	0	EA	$10,000	$0	29%	$0	20%	$0	$0	
20.0	**PLATFORMS**							29%					$1,727,055
20.1		20.01	Side Loading	1	PR	$136,500	$136,500	29%	$38,903	20%	$27,300	$202,703	
20.2		20.01	Center Loading	5	EA	$157,500	$787,500	29%	$224,438	20%	$157,500	$1,169,438	
20.3		20.01	Allowance to Modify Occidental Platform	1	LS	$50,000	$50,000	29%	$14,250	20%	$10,000	$74,250	
20.4		20.01	Special Platform (Pioneer Square)	1	EA	$189,000	$189,000	29%	$53,865	20%	$37,800	$280,665	
30.0	**SUPPORT FACILITIES**												$1,782,000
30.1		30.05	Allowance for Expansion of Storage Tracks	1	LS	$1,200,000	$1,200,000	29%	$342,000	20%	$240,000	$1,782,000	
40.0	**SITE WORK AND SPECIAL CONDITIONS**												$21,761,554
40.1		40.08	Mobilization	1	LS	$1,057,371	$1,057,371	29%	$301,351	20%	$211,474	$1,570,196	
40.2		40.08	Specified General Conditions	1	LS	$1,321,713	$1,321,713	29%	$376,688	20%	$264,343	$1,962,744	
40.3		40.08	Reimbursible General Conditions	1	LS	$2,643,427	$2,643,427	29%	$753,377	20%	$528,685	$3,925,489	
40.4		40.06	Allowance for Areaway Treatments	13,009	TF	$40	$520,360	29%	$148,303	20%	$104,072	$772,735	
40.5		40.07	Road Construction Allowance	13,009	TF	$341	$4,439,321	29%	$1,265,207	20%	$887,864	$6,592,392	
40.6		40.06	Sidewalk, Driveway and Curb Allowance	13,009	TF	$117	$1,522,053	29%	$433,785	20%	$304,411	$2,260,249	
40.7		40.01	Remove Existing Trolley Track	0	TF	$0	$0	29%	$0	20%	$0	$0	
40.8		40.07	Major Street Reconstruction Allowance	0	LS	$500,000	$0	29%	$0	20%	$0	$0	
40.9		40.06	Landscaping Allowance	1	LS	$500,000	$500,000	29%	$142,500	20%	$100,000	$742,500	
40.10		40.06	Allowance for exclusive guideway treatments	1	LS	$650,000	$650,000	29%	$185,250	20%	$130,000	$965,250	
40.11		40.08	Allowance for Temporary Traffic Control	1	LS	$2,000,000	$2,000,000	29%	$570,000	20%	$400,000	$2,970,000	
50.0	**SYSTEMS**												$10,672,510
50.1		50.03	Traction Power Substations (TPSS)	2	EA	$735,000	$1,470,000	29%	$418,950	20%	$294,000	$2,182,950	
50.2		50.04	Trolley-Bus Catenary Modifications Allowance	0	LS	$750,000	$0	29%	$0	20%	$0	$0	
		50.04	Metro ETB Relocation Allowance	1	LS	$2,500,000	$2,500,000	0%		20%	$500,000	$3,000,000	
50.3		50.04	OCS including Catenary	13,009	TF	$242	$3,141,674	29%	$895,377	20%	$628,335	$4,665,385	
50.4		50.01	Train Control System	2	EA	$157,500	$315,000	29%	$89,775	20%	$63,000	$467,775	
50.5		50.02	Allowance for Platform Fare Collection	8	EA	$30,000	$240,000	29%	$68,400	20%	$48,000	$356,400	
90.0	**TRAFFIC CONTROL AND LIGHTING**												$3,772,942
90.1		50.02	New Traffic Signal	0	EA	$168,000	$0	29%	$0	20%	$0	$0	
90.2		50.02	New Ped-only	0	EA	$100,000	$0	29%	$0	20%	$0	$0	
90.3		50.02	Modify Existing Traffic Signal	7	EA	$109,000	$763,000	29%	$217,455	20%	$152,600	$1,133,055	
90.4		50.02	Add Transit Phase	7	EA	$109,000	$763,000	29%	$217,455	20%	$152,600	$1,133,055	
90.5		50.02	Signing and Striping Alowance	13,009	TF	$28	$364,252	29%	$103,812	20%	$72,850	$540,914	
90.6		50.02	Lighting Allowance	13,009	TF	$50	$650,450	29%	$185,378	20%	$130,090	$965,918	
60.0	**RIGHT OF WAY**												$10,000,000
60.1		60.01	Allowance for Land for Vehicle Storage	1	LS	$10,000,000	$10,000,000	0%	$0	0%	$0	$10,000,000	
	SUBTOTAL						$43,696,779		$8,891,082		$6,739,356	$59,327,216	**$59,327,216**
100.0	**VEHICLES**												$0
100.1		70.01	Vehicles, Hybrid, incl. SLU Replacements	0	EA	$4,500,000	$0	10%	$0	20%	$0	$0	
	TOTAL 2013$								$8,891,082		$6,739,356	$59,327,216	**$59,327,216**
	Professional Services												
		80.01	Preliminary Engineering			4.0%	$1,247,871						
		80.02	Final Design			6.0%	$1,871,807						
		80.03	Project Management for Design and Construction			6.0%	$1,871,807						
		80.04	Construction Administration & Management			6.0%	$1,871,807						
		80.05	Insurance			2.0%	$623,936						
		80.06	Legal; Permits;Review Fees by other agencies, cities, etc.			2.0%	$623,936						
		80.07	Surveys, Testing, Investigation, Inspection			2.0%	$623,936						
		80.08	Start-up Costs & Agency Force Account Work			0.5%	$155,984						
						28.5%	$8,735,098						
	Contingency												
		90.01	Unallocated Contingency				$6,739,356						

Figure E-6 Detailed Capital Costs, Westlake, 2013 Dollars (Before Escalation)

		Seattle Center City Connector Streetcar Project											
			Seattle, WA			Outbound Alignment			Inbound AlignmentAlignment				
			Order of Magnitude Estimate		Start Sta	End Sta	Length		Start Sta	End Sta	Length		
			Summary Westlake Pocket Track (Modern)		0+00	7+00	700 TF		0+00	0+00	0 TF	700 TF	1st Quarter
							0.13 TK-mile				0.00 TK-mile	0.07 Rt-mile	2013$
URS Line NO.	**Base**	**Code**	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Extension**	**E&A %**	**E&A**	**Cont%**	**Unallocated Contingency**	**Detail Total**	**Summary Total**
10.0	**TRACKWORK**												$1,473,780
10.1		10.02	Embedded Trackway Southbound	700	TF	$462	$323,400	25%	$80,850	20%	$64,680	$468,930	
10.2		10.02	Embedded Trackway Northbound		TF	$462	$0	25%	$0	20%	$0	$0	
10.3		10.12	Track Crossing		EA	$157,500	$0	25%	$0	20%	$0	$0	
10.4		10.12	Turnout	3	EA	$231,000	$693,000	25%	$173,250	20%	$138,600	$1,004,850	
10.5		10.12	Switch Heater		EA	$10,000	$0	25%	$0	20%	$0	$0	
20.0	**PLATFORMS**							25%					$0
20.1		20.01	Side Loading		PR	$136,500	$0	25%	$0	20%	$0	$0	
20.2		20.01	Center Loading		EA	$157,500	$0	25%	$0	20%	$0	$0	
20.3		20.01	Allowance to Modify Occidental Platform		LS	$50,000	$0	25%	$0	20%	$0	$0	
20.4		20.01	Special Platform (Pioneer Square)		EA	$189,000	$0	25%	$0	20%	$0	$0	
30.0	**SUPPORT FACILITIES**												$0
30.1		30.05	Allowance for Expansion of Storage Tracks		LS	$1,200,000	$0	25%	$0	20%	$0	$0	
40.0	**SITE WORK AND SPECIAL CONDITIONS**												$985,187
40.1		40.08	Mobilization	1	LS	$72,891	$72,891	25%	$18,223	20%	$14,578	$105,692	
40.2		40.08	Specified General Conditions	1	LS	$91,114	$91,114	25%	$22,778	20%	$18,223	$132,115	
40.3		40.08	Reimbursible General Conditions	1	LS	$182,228	$182,228	25%	$45,557	20%	$36,446	$264,230	
40.4		40.06	Allowance for Areaway Treatments		TF	$40	$0	25%	$0	20%	$0	$0	
40.5		40.07	Road Construction Allowance	500	TF	$341	$170,625	25%	$42,656	20%	$34,125	$247,406	
40.6		40.06	Sidewalk, Driveway and Curb Allowance	400	TF	$42	$16,800	25%	$4,200	20%	$3,360	$24,360	
40.7		40.01	Remove Existing Trolley Track		TF	$0	$0	25%	$0	20%	$0	$0	
40.8		40.07	Major Street Reconstruction Allowance		LS	$500,000	$0	25%	$0	20%	$0	$0	
40.9		40.06	Landscaping Allowance		LS	$100,000	$0	25%	$0	20%	$0	$0	
40.10		40.06	Allowance for Unidentified Scope		LS	$500,000	$0	25%	$0	20%	$0	$0	
40.11		40.08	Temporary Traffic Control	1	LS	$145,782	$145,782	25%	$36,446	20%	$29,156	$211,384	
50.0	**SYSTEMS**												$631,838
50.1		50.03	Traction Power Substations (TPSS)		EA	$735,000	$0	25%	$0	20%	$0	$0	
50.2		50.04	Trolley-Bus Catenary Modifications Allowance		TF	$30	$0	25%	$0	20%	$0	$0	
50.3		50.04	OCS including Catenary	500	TF	$242	$120,750	25%	$30,188	20%	$24,150	$175,088	
50.4		50.01	Train Control System	2	EA	$157,500	$315,000	25%	$78,750	20%	$63,000	$456,750	
80.0	**UTILITIES**												$0
80.1		40.02	Parallel Water <12" dia		LF	$270	$0	25%	$0	20%	$0	$0	
90.0	**TRAFFIC CONTROL AND LIGHTING**												$264,915
90.1		50.02	New Traffic Signal		EA	$168,000	$0	25%	$0	20%	$0	$0	
90.2		50.02	New Ped-only		EA	$100,000	$0	25%	$0	20%	$0	$0	
90.3		50.02	Modify Existing Traffic Signal		EA	$84,000	$0	25%	$0	20%	$0	$0	
90.4		50.02	Add Transit Phase	2	EA	$84,000	$168,000	25%	$42,000	20%	$33,600	$243,600	
90.5		50.02	Signing and Striping Alowance	700	TF	$21	$14,700	25%	$3,675	20%	$2,940	$21,315	
90.6		50.02	Lighting Allowance		TF	$11	$0	25%	$0	20%	$0	$0	
60.0	**RIGHT OF WAY**												$0
100.0	**VEHICLES**												$0
100.1		70.01	Vehicles, Hybrid, incl. SLU Replacements		EA	$4,500,000	$0	10%	$0	20%	$0	$0	
	TOTAL 2013$								$578,572		$462,858	$3,355,719	**$3,355,719**
	Professional Services												
		80.01	Preliminary Engineering			4.0%	$92,572						
		80.02	Final Design			6.0%	$138,857						
		80.03	Project Management for Design and Construction			4.5%	$104,143						
		80.04	Construction Administration & Management			4.0%	$92,572						
		80.05	Insurance			2.0%	$46,286						
		80.06	Legal; Permits;Review Fees by other agencies, cities, etc.			2.0%	$46,286						
		80.07	Surveys, Testing, Investigation, Inspection			2.0%	$46,286						
		80.08	Start-up Costs & Agency Force Account Work			0.5%	$11,571						
						25.0%	$567,001						
	Contingency												
		90.01	Unallocated Contingency				$462,858						

Figure E-7 Detailed Capital Costs, Jackson, 2013 Dollars (Before Escalation)

		Seattle Center City Connector Streetcar Project											
			Seattle, WA		Outbound Alignment				Inbound AlignmentAlignment				
			Order of Magnitude Estimate		Start Sta	End Sta	Length		Start Sta	End Sta	Length		
			Summary Jackson/6th Turnback		0+00	0+00	0 TF		0+00	0+00	0 TF	0 TF	1st Quarter
							0.00 TK-mile				0.00 TK-mile	0.00 Rt-mile	2013$
URS Line NO.	**Base**	**Code**	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Extension**	**E&A %**	**E&A**	**Cont%**	**Unallocated Contingency**	**Detail Total**	**Summary Total**
10.0	**TRACKWORK**												$0
10.1		10.02	Embedded Trackway Southbound		TF	$462	$0	25%	$0	20%	$0	$0	
10.2		10.02	Embedded Trackway Northbound		TF	$462	$0	25%	$0	20%	$0	$0	
10.3		10.12	Track Crossing		EA	$157,500	$0	25%	$0	20%	$0	$0	
10.4		10.12	Turnout		EA	$231,000	$0	25%	$0	20%	$0	$0	
10.5		10.12	Switch Heater		EA	$10,000	$0	25%	$0	20%	$0	$0	
20.0	**PLATFORMS**							25%					$0
20.1		20.01	Side Loading		PR	$136,500	$0	25%	$0	20%	$0	$0	
20.2		20.01	Center Loading		EA	$157,500	$0	25%	$0	20%	$0	$0	
20.3		20.01	Allowance to Modify Occidental Platform		LS	$50,000	$0	25%	$0	20%	$0	$0	
20.4		20.01	Special Platform (Pioneer Square)		EA	$189,000	$0	25%	$0	20%	$0	$0	
30.0	**SUPPORT FACILITIES**												$0
30.1		30.05	Allowance for Expansion of Storage Tracks		LS	$1,200,000	$0	25%	$0	20%	$0	$0	
40.0	**SITE WORK AND SPECIAL CONDITIONS**												$0
40.1		40.08	Mobilization		LS	$0	$0	25%	$0	20%	$0	$0	
40.2		40.08	Specified General Conditions		LS	$0	$0	25%	$0	20%	$0	$0	
40.3		40.08	Reimbursible General Conditions		LS	$0	$0	25%	$0	20%	$0	$0	
40.4		40.06	Allowance for Areaway Treatments		TF	$40	$0	25%	$0	20%	$0	$0	
40.5		40.07	Road Construction Allowance		TF	$341	$0	25%	$0	20%	$0	$0	
40.6		40.06	Sidewalk, Driveway and Curb Allowance		TF	$42	$0	25%	$0	20%	$0	$0	
40.7		40.01	Remove Existing Trolley Track		TF	$0	$0	25%	$0	20%	$0	$0	
40.8		40.07	Major Street Reconstruction Allowance		LS	$500,000	$0	25%	$0	20%	$0	$0	
40.9		40.06	Landscaping Allowance		LS	$100,000	$0	25%	$0	20%	$0	$0	
40.10		40.06	Allowance for Unidentified Scope		LS	$500,000	$0	25%	$0	20%	$0	$0	
40.11		40.08	Temporary Traffic Control		LS	$0	$0	25%	$0	20%	$0	$0	
50.0	**SYSTEMS**												$0
50.1		50.03	Traction Power Substations (TPSS)		EA	$735,000	$0	25%	$0	20%	$0	$0	
50.2		50.04	Trolley-Bus Catenary Modifications Allowance		TF	$30	$0	25%	$0	20%	$0	$0	
50.3		50.04	OCS including Catenary		TF	$242	$0	25%	$0	20%	$0	$0	
50.4		50.01	Train Control System		EA	$157,500	$0	25%	$0	20%	$0	$0	
80.0	**UTILITIES**												$0
80.1		40.02	Parallel Water <12" dia		LF	$270	$0	25%	$0	20%	$0	$0	
90.0	**TRAFFIC CONTROL AND LIGHTING**												$0
90.1		50.02	New Traffic Signal		EA	$168,000	$0	25%	$0	20%	$0	$0	
90.2		50.02	New Ped-only		EA	$100,000	$0	25%	$0	20%	$0	$0	
90.3		50.02	Modify Existing Traffic Signal		EA	$84,000	$0	25%	$0	20%	$0	$0	
90.4		50.02	Add Transit Phase		EA	$84,000	$0	25%	$0	20%	$0	$0	
90.5		50.02	Signing and Striping Alowance		TF	$21	$0	25%	$0	20%	$0	$0	
90.6		50.02	Lighting Allowance		TF	$11	$0	25%	$0	20%	$0	$0	
60.0	**RIGHT OF WAY**												$0
100.0	**VEHICLES**												$0
100.1		70.01	Vehicles, Hybrid, incl. SLU Replacements		EA	$4,500,000	$0	10%	$0	20%	$0	$0	
	TOTAL 2013$								$0		$0	$0	**$0**
	Professional Services												
		80.01	Preliminary Engineering			4.0%	$0						
		80.02	Final Design			6.0%	$0						
		80.03	Project Management for Design and Construction			4.5%	$0						
		80.04	Construction Administration & Management			4.0%	$0						
		80.05	Insurance			2.0%	$0						
		80.06	Legal; Permits;Review Fees by other agencies, cities, etc.			2.0%	$0						
		80.07	Surveys, Testing, Investigation, Inspection			2.0%	$0						
		80.08	Start-up Costs & Agency Force Account Work			0.5%	$0						
						25.0%	$0						
	Contingency												
		90.01	Unallocated Contingency				$0						

Figure E-8 Detailed Capital Costs, Maintenance Facility Expansion, 2013 Dollars (Before Escalation)

		Seattle Center City Connector Streetcar Project											
			Seattle, WA		Outbound Alignment				Inbound AlignmentAlignment				
			Order of Magnitude Estimate		Start Sta	End Sta	Length		Start Sta	End Sta	Length		
			Summary MF Storage Tracks (2 tracks for 4 vehicles)		0+00	6+00	600 TF		0+00	0+00	0 TF	600 TF	1st Quarter
							0.11 TK-mile				0.00 TK-mile	0.06 Rt-mile	2013$
URS Line NO.	**Base**	**Code**	**Description**	**Quantity**	**Unit**	**Unit Cost**	**Extension**	**E&A %**	**E&A**	**Cont%**	**Unallocated Contingency**	**Detail Total**	**Summary Total**
10.0	**TRACKWORK**												$1,071,840
10.1		10.02	Embedded Trackway Southbound	600	TF	$462	$277,200	25%	$69,300	20%	$55,440	$401,940	
10.2		10.02	Embedded Trackway Northbound		TF	$462	$0	25%	$0	20%	$0	$0	
10.3		10.12	Track Crossing		EA	$157,500	$0	25%	$0	20%	$0	$0	
10.4		10.12	Turnout	2	EA	$231,000	$462,000	25%	$115,500	20%	$92,400	$669,900	
10.5		10.12	Switch Heater		EA	$10,000	$0	25%	$0	20%	$0	$0	
20.0	**PLATFORMS**							25%					$0
20.1		20.01	Side Loading		PR	$136,500	$0	25%	$0	20%	$0	$0	
20.2		20.01	Center Loading		EA	$157,500	$0	25%	$0	20%	$0	$0	
20.3		20.01	Allowance to Modify Occidental Platform		LS	$50,000	$0	25%	$0	20%	$0	$0	
20.4		20.01	Special Platform (Pioneer Square)		EA	$189,000	$0	25%	$0	20%	$0	$0	
30.0	**SUPPORT FACILITIES**												$0
30.1		30.05	Allowance for Expansion of Storage Tracks		LS	$1,200,000	$0	25%	$0	20%	$0	$0	
40.0	**SITE WORK AND SPECIAL CONDITIONS**												$508,089
40.1		40.08	Mobilization	1	LS	$41,496	$41,496	25%	$10,374	20%	$8,299	$60,169	
40.2		40.08	Specified General Conditions	1	LS	$51,870	$51,870	25%	$12,968	20%	$10,374	$75,212	
40.3		40.08	Reimbursible General Conditions	1	LS	$103,740	$103,740	25%	$25,935	20%	$20,748	$150,423	
40.4		40.06	Allowance for Areaway Treatments		TF	$40	$0	25%	$0	20%	$0	$0	
40.5		40.07	Road Construction Allowance	400	TF	$341	$136,500	25%	$34,125	20%	$27,300	$197,925	
40.6		40.06	Sidewalk, Driveway and Curb Allowance	400	TF	$42	$16,800	25%	$4,200	20%	$3,360	$24,360	
40.7		40.01	Remove Existing Trolley Track		TF	$0	$0	25%	$0	20%	$0	$0	
40.8		40.07	Major Street Reconstruction Allowance		LS	$500,000	$0	25%	$0	20%	$0	$0	
40.9		40.06	Landscaping Allowance		LS	$100,000	$0	25%	$0	20%	$0	$0	
40.10		40.06	Allowance for Unidentified Scope		LS	$500,000	$0	25%	$0	20%	$0	$0	
40.11		40.08	Temporary Traffic Control		LS	$82,992	$0	25%	$0	20%	$0	$0	
50.0	**SYSTEMS**												$210,105
50.1		50.03	Traction Power Substations (TPSS)		EA	$735,000	$0	25%	$0	20%	$0	$0	
50.2		50.04	Trolley-Bus Catenary Modifications Allowance		TF	$30	$0	25%	$0	20%	$0	$0	
50.3		50.04	OCS including Catenary	600	TF	$242	$144,900	25%	$36,225	20%	$28,980	$210,105	
50.4		50.01	Train Control System		EA	$157,500	$0	25%	$0	20%	$0	$0	
80.0	**UTILITIES**												$0
80.1		40.02	Parallel Water <12" dia		LF	$270	$0	25%	$0	20%	$0	$0	
90.0	**TRAFFIC CONTROL AND LIGHTING**												$0
90.1		50.02	New Traffic Signal		EA	$168,000	$0	25%	$0	20%	$0	$0	
90.2		50.02	New Ped-only		EA	$100,000	$0	25%	$0	20%	$0	$0	
90.3		50.02	Modify Existing Traffic Signal		EA	$84,000	$0	25%	$0	20%	$0	$0	
90.4		50.02	Add Transit Phase		EA	$84,000	$0	25%	$0	20%	$0	$0	
90.5		50.02	Signing and Striping Alowance		TF	$21	$0	25%	$0	20%	$0	$0	
90.6		50.02	Lighting Allowance		TF	$11	$0	25%	$0	20%	$0	$0	
60.0	**RIGHT OF WAY**												$0
100.0	**VEHICLES**												$0
100.1		70.01	Vehicles, Hybrid, incl. SLU Replacements		EA	$4,500,000	$0	10%	$0	20%	$0	$0	
	TOTAL 2013$								$308,627		$246,901	$1,790,034	**$1,790,034**
	Professional Services												
		80.01	Preliminary Engineering			4.0%	$49,380						
		80.02	Final Design			6.0%	$74,070						
		80.03	Project Management for Design and Construction			4.5%	$55,553						
		80.04	Construction Administration & Management			4.0%	$49,380						
		80.05	Insurance			2.0%	$24,690						
		80.06	Legal; Permits;Review Fees by other agencies, cities, etc.			2.0%	$24,690						
		80.07	Surveys, Testing, Investigation, Inspection			2.0%	$24,690						
		80.08	Start-up Costs & Agency Force Account Work			0.5%	$6,173						
						25.0%	$302,454						
	Contingency												
		90.01	Unallocated Contingency				$246,901						

APPENDIX F UNDERGROUND UTILITY IMPACTS ASSESSMENT

This appendix[1] provides additional details on utility impacts including order-of-magnitude costs.

Note: The costs identified in this appendix are not included in the Center City Connector Tier 2 capital cost estimate provided in the Detailed Evaluation Report, Chapter 7 and Appendix E. Utilities are required to relocate utility infrastructure for transportation projects at their own expense; public utility costs will be budgeted for in Seattle Public Utilities (SPU) and Seattle City Light (SCL) capital improvement plans.

Summary of Costs

Figure F-1 summarizes utility impacts for the Mixed-Traffic and Exclusive Streetcar alternatives and provides estimated order-of-magnitude costs for comparative purposes. A more detailed analysis will be required to estimate actual construction costs. Utility impacts will be more fully examined during the environmental/preliminary engineering phases of the project.

[1] Prepared by URS

Figure F-1 Preliminary Utility Impacts Assessment Summary

				Mixed Use Option					Exclusive Option	
	Qty	Unit	Unit Cost	Extension	Summary	Qty	Unit	Unit Cost	Extension	Summary
WATER					**$2,016,629**					**$1,177,102**
Distribution Main	681	LF	$220	$149,857		608	LF	$220	$133,846	
Feeder Main	4,667	LF	$400	$1,866,772		2,608	LF	$400	$1,043,256	
SEWER					**$1,389,248**					**$2,009,638**
18" VC	519	LF	$480	$249,048		1,012	LF	$480	$485,688	
24" DIP and RCP	597	LF	$520	$310,440		128	LF	$520	$66,560	
30" Detention Lateral	82	LF	$600	$49,200		0	LF	$600	$0	
33" RCP	0	LF	$580	$0		580	LF	$580	$336,400	
24" RCP w/ 48" Stl Case	605	LF	$750	$453,750		720	LF	$750	$540,000	
48" Brick	213	LF	$1,000	$212,850		462	LF	$1,000	$461,850	
Manhole/Structure	22	EA	$5,180	$113,960		23	EA	$5,180	$119,140	
ELECTRIC					**$1,724,282**					**$1,833,281**
Lines	5,011	LF	$310	$1,553,342		5,312	LF	$310	$1,646,801	
Manhole/Structure	33	EA	$5,180	$170,940		36	EA	$5,180	$186,480	
GAS					**$1,565,173**					**$910,377**
2" IP	458	LF	$350	$160,325		458	LF	$350	$160,325	
4" IP	3,512	LF	$400	$1,404,848		1,875	LF	$400	$750,052	
STEAM					**$1,720,628**					**$1,612,939**
8" Low Pressure	653	LF	$900	$587,727		696	LF	$900	$625,968	
10" Low Pressure	578	LF	$1,000	$577,520		424	LF	$1,000	$423,590	
12" Low Pressure	207	LF	$1,100	$227,381		207	LF	$1,100	$227,381	
Manhole/Structure	41	EA	$8,000	$328,000		42	EA	$8,000	$336,000	
FIBER OPTIC COMM					**$503,275**					**$370,250**
Lines	1,007	LF	$500	$503,275		741	LF	$500	$370,250	
TOTAL					**$8,919,235**					**$7,913,586**

*Notes: Preliminary alignments and GIS data were used for this analysis. A utility was considered impacted if the edge of the pipe or duct was within 8 feet of the proposed track center line.
Parallel utilities and vaults were quantified, crossing utilities were not.
This order-of-magnitude estimate is intended only for comparison of potential alignment options.
A more detailed analysis will be necessary for estimating construction costs.

Assessment Details

A tabular listing and map of the identified utility impacts is provided for each segment of the proposed alignment along 1st Avenue as well as east-west connections between 1st Avenue and Westlake.

Underground utility impacts were quantified using GIS-level mapping provided by SPU, SCL, Puget Sound Energy (PSE), and Seattle Steam. The utility mapping was overlaid on conceptual alignment layout maps. For purposes of comparison it was assumed that parallel utilities, structures and manholes within 8 feet of the track alignment center lines were considered impacted. Crossing utilities were not quantified because they can typically remain in place under streetcar tracks.

On the utility maps the 16-foot wide "utility impact zone" is shown with dashed lines. Color coding for existing utility lines is as follows:

- Red – Electrical (SCL)
- Green – Storm and Sanitary Sewer
- Blue – Water
- Yellow – Natural Gas (PSE)
- Pink – Seattle Steam

Order-of-magnitude unit costs were developed using cost data from recent local utility construction projects and information provided by utility representatives.

Alignment Segment	Table	Map
1st Avenue		
Stewart to University Streets	Figure F-2	Figure F-3
University to Columbia Streets	Figure F-4	Figure F-5
Columbia to Jackson Streets	Figure F-6	Figure F-7
East-West Connections		
Stewart Street, Westlake to 1st Avenues	Figure F-8	Figure F-9
Pike/Pine Streets, 1st to 6th Avenues	N/A	Figure F-10

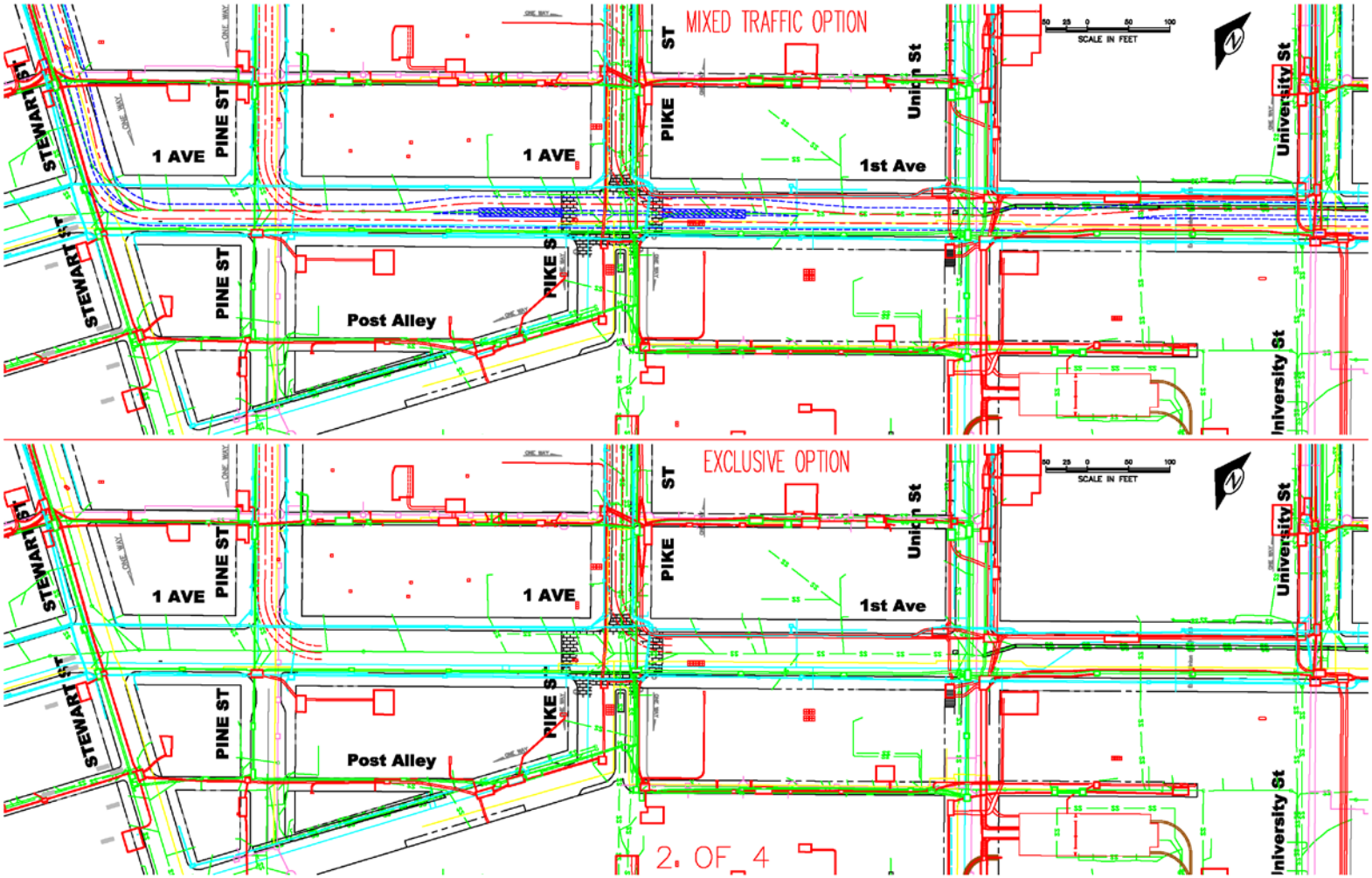
1st Avenue Alignment

Stewart to University Streets

Figure F-2 Preliminary Utility Impacts Assessment, 1st Avenue, Stewart to University Streets (Table)

	Mixed Use Option			Exclusive Option		
Utility Type	SB	NB	Size/Notes	SB	NB	Size/Notes
Water - SPU						
- Lines (LF)	1165	163	feeder main	790	291	feeder main
- Structures (EA)						
Sewer - SPU						
- Lines (LF)	166	714	12" VC and DIP	420	475	12" VC and DIP
- Lines (LF)	0	265	24" RCP w/ 48" Stl Case	0	380	24" RCP w/ 48" Stl Case
- Structures (EA)	2	6	manhole	2	5	manhole
Electric - SCL						
- Lines (LF)	587	0		43	0	
- Structures (EA)	2	0		2	2	
Gas - PSE						
- Lines (LF)	933	15	4" IP	459	15	4" IP
- Structures (EA)						
Steam - Seattle Steam						
- Lines (LF)	0	0		0	0	
- Structures (EA)	1	0	vault	1	0	vault
Fiber Optic - PSE						
- Lines (LF)	0	0		0	0	
- Structures (EA)						

Figure F-3 Preliminary Utility Impacts Assessment, 1st Avenue, Stewart to University Streets (Map)

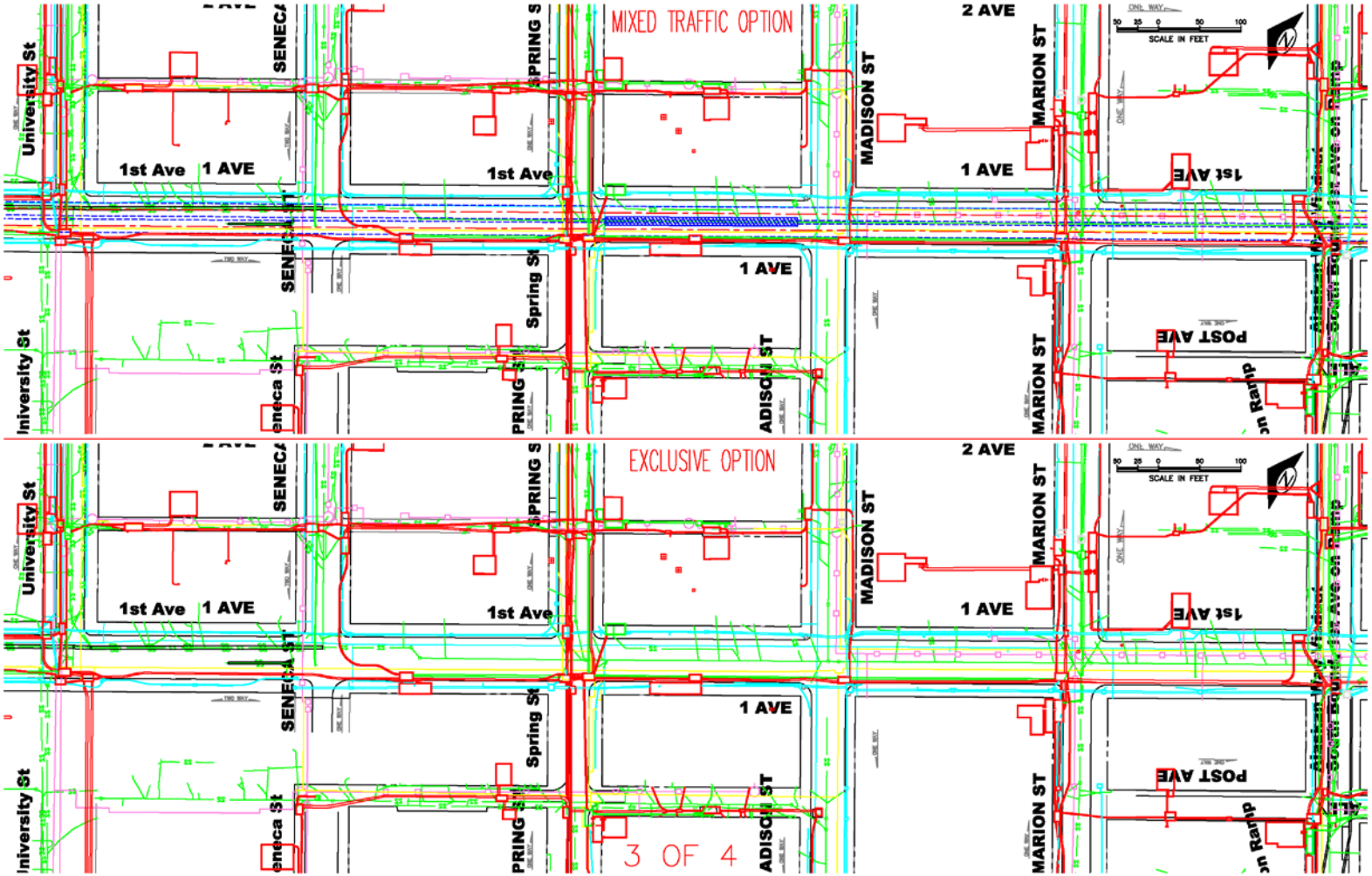


University to Columbia Streets

Figure F-4 Preliminary Utility Impacts Assessment, 1st Avenue, University to Columbia Streets (Table)

	Mixed Use Option			Exclusive Option		
Utility Type	SB	NB	Size/Notes	SB	NB	Size/Notes
Water - SPU						
- Lines (LF)	0	1270	feeder main, east edge	0	867	feeder main, east edge
- Structures (EA)						
Sewer - SPU						
- Lines (LF)	0	155	18" VC	0	494	18" VC
- Lines (LF)	0	110	24" RCP	0	128	24" RCP
- Lines (LF)	82	0	30" Detention Lateral	0	0	30" Detention Lateral
- Lines (LF)	0	0	33" RCP	580	0	33" RCP
- Lines (LF)	0	340	24" RCP w/ 48" Stl Case	0	340	24" RCP w/ 48" Stl Case
- Structures (EA)	0	6	manhole	3	7	manhole
Electric - SCL						
- Lines (LF)	119	0		34	0	
- Structures (EA)	7	0		3	0	
Gas - PSE						
- Lines (LF)	1538	41	4" IP	875	33	4" IP
- Structures (EA)						
Steam - Seattle Steam						
- Lines (LF)	0	578	10" low pressure	0	424	10" low pressure
- Structures (EA)	1	11	manhole & vault	0	11	manhole & vault
Fiber Optic - PSE						
- Lines (LF)		567	6" NA		301	6" NA
- Structures (EA)						

Figure F-5 Preliminary Utility Impacts Assessment, 1st Avenue, University to Columbia Streets (Map)

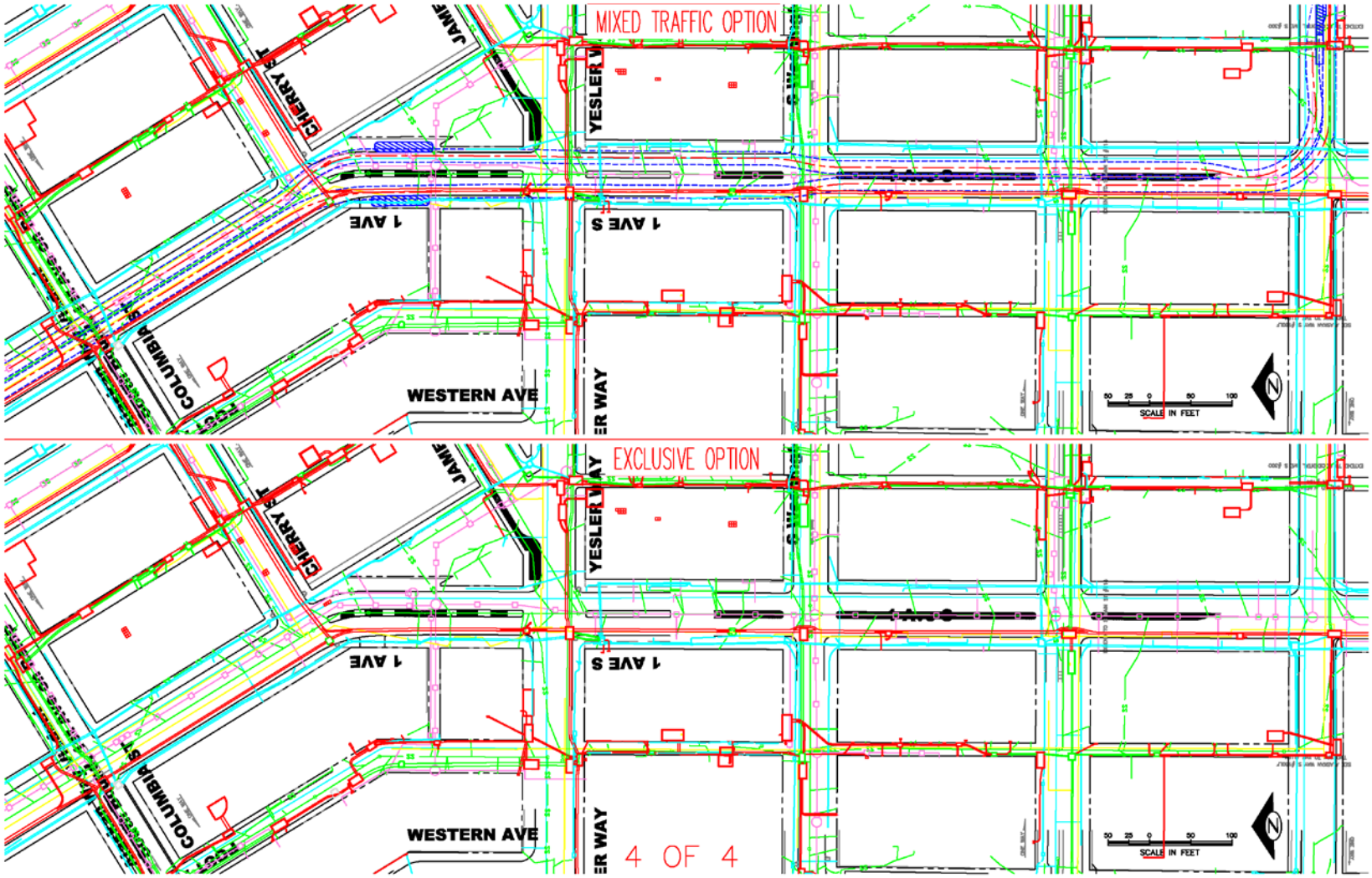


Columbia to Jackson Streets

Figure F-6 Preliminary Utility Impacts Assessment, 1st Avenue, Columbia to Jackson Streets (Table)

	Mixed Use Option			Exclusive Option		
Utility Type	SB	NB	Size/Notes	SB	NB	Size/Notes
Water - SPU						
- Lines (LF)	0	963	feeder main, east edge	0	660	feeder main, east edge
- Structures (EA)						
Sewer - SPU						
- Lines (LF)	0	213	48" Brick (deep) on RWCL	368	94	48" Brick (deep) on RWCL
- Structures (EA)	2	2	manhole	3	2	manhole
Electric - SCL						
- Lines (LF)	844	65		652	0	
- Structures (EA)	8	0		5	0	
Gas - PSE						
- Lines (LF)	985	0	4" STW IP	493	0	4" STW IP
- Structures (EA)						
Steam - Seattle Steam						
- Lines (LF)	0	653	8" low pressure	0	696	8" low pressure
- Structures (EA)	1	20	manhole & vault	1	22	manhole & vault
Fiber Optic - PSE						
- Lines (LF)	0	339			339	
- Structures (EA)						

Figure F-7 Preliminary Utility Impacts Assessment, 1st Avenue – Columbia to Jackson Streets (Map)



East-West Connections

Several east-west connections between 1st Avenue and Westlake were assessed in the early stage of the Tier 2 evaluation, and a Stewart/Olive connection was assumed in the alternatives analyzed in Tier 2. The Pike/Pine east-west connection was not included in the analysis of utility impacts conducted in the Tier 2 evaluation, and therefore only a map of utilities is included. Generally, one of the primary utility impacts related to a Pike/Pine connection is a large water main in 6th Avenue, but Pike/Pine have fewer impacts to Seattle City Light facilities than the Stewart/Olive connection and utility costs are expected to be similar or slightly higher for Pike/Pine compared to Stewart/Olive.

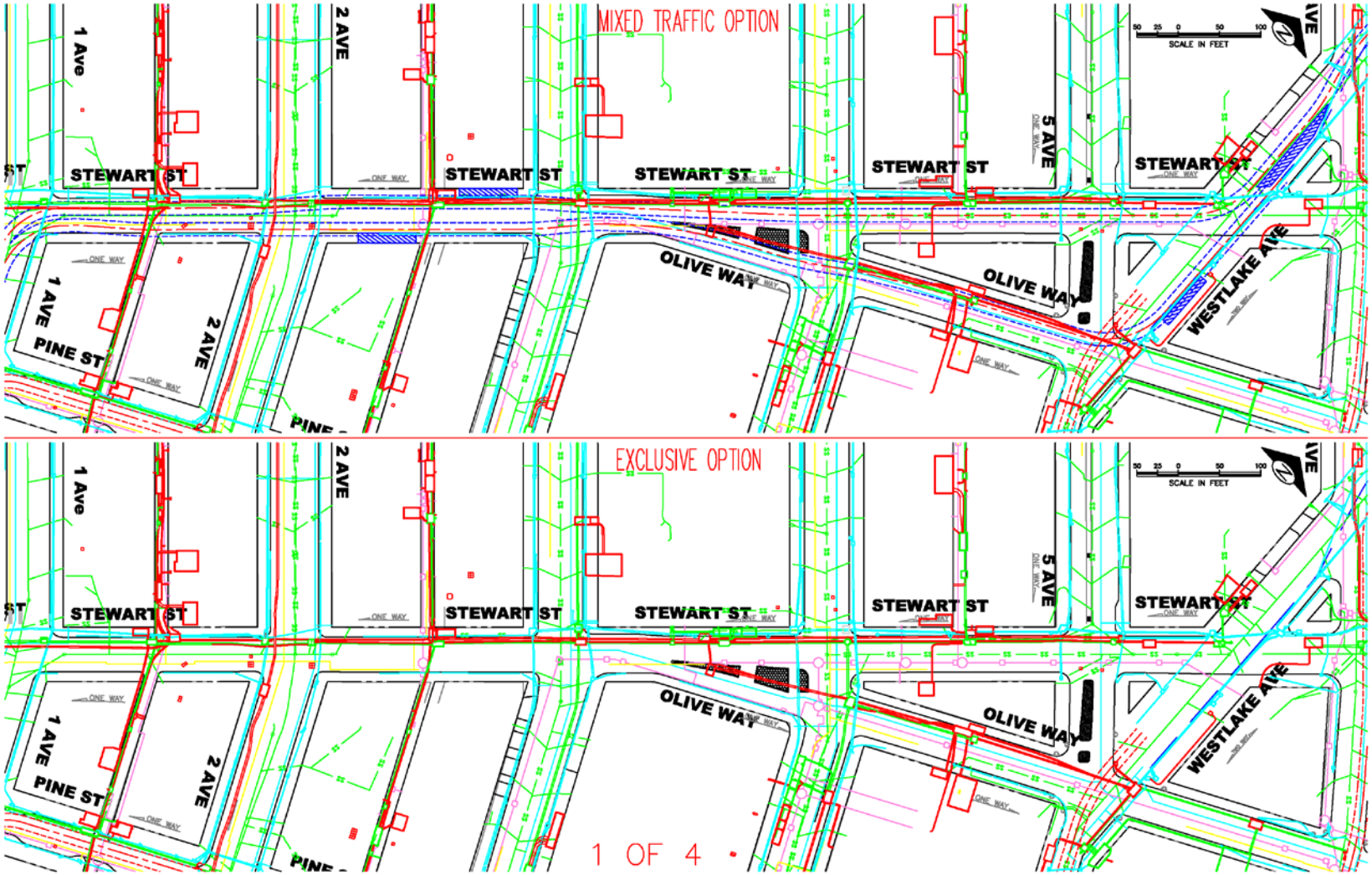
Pike and Pine Streets were included in the Center City Connector LPA and these streets will be included in the more detailed assessment of utilities that will be conducted in the next study phase (see Chapter 5 of the Detailed Evaluation Report for a discussion of the assessment of east-west connections).

Stewart Street/Olive Way, Westlake to 1st Avenue

Figure F-8 Preliminary Utility Impacts Assessment, Stewart Street/Olive Way, Westlake to 1st Avenue (Table)

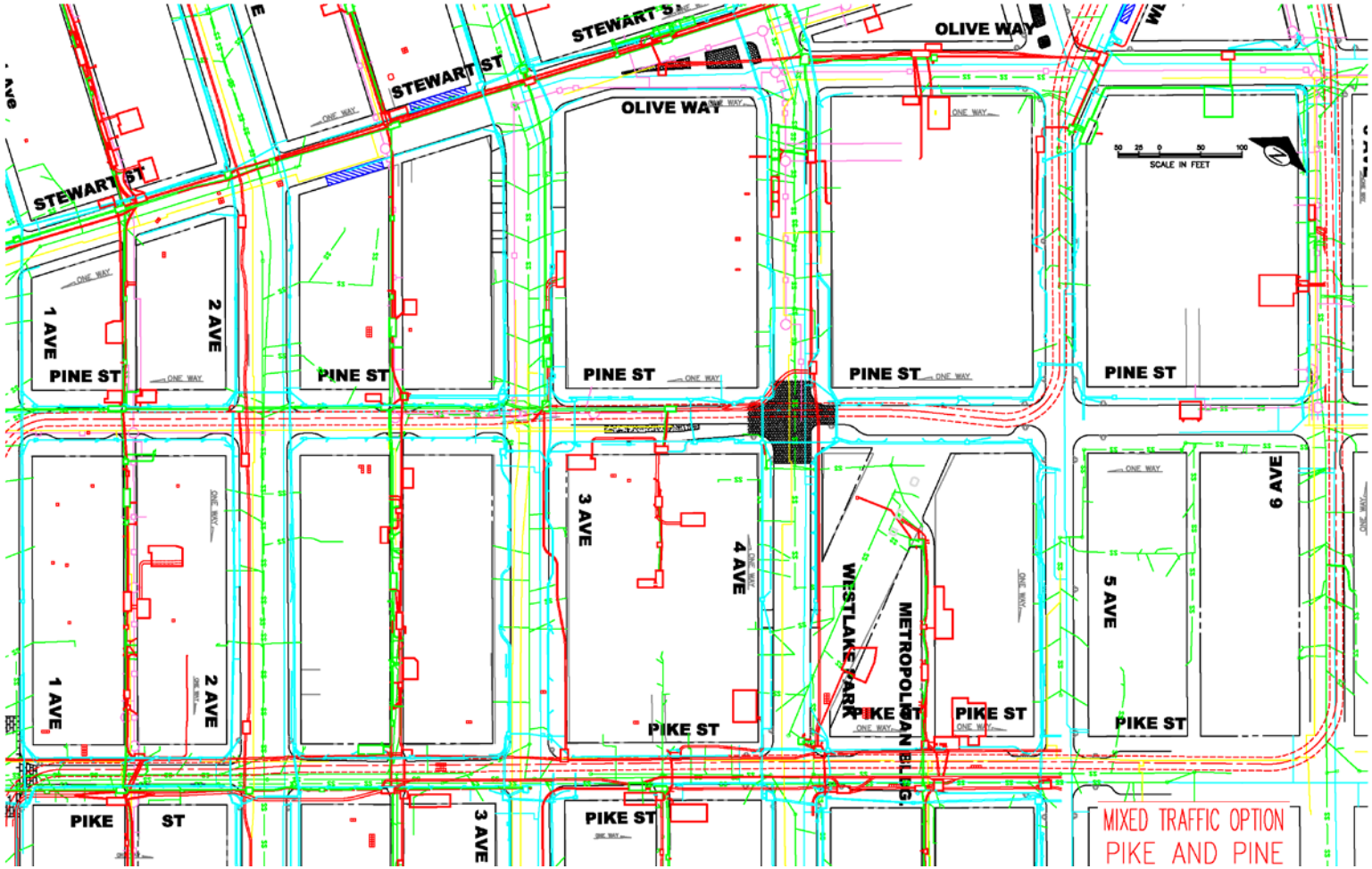
	Mixed Use Option			Exclusive Option		
Utility Type	SB	NB	Size/Notes	SB	NB	Size/Notes
Water - SPU						
- Lines (LF)	88	593	distribution main	15	593	distribution main
- Structures (EA)						
Sewer - SPU						
- Lines (LF)	357	7	18" VC	511	7	18" VC
- Lines (LF)	487	0	24" DIP and RCP	0	0	24" DIP and RCP
- Structures (EA)	4	0	manhole	1	0	manhole
Electric - SCL						
- Lines (LF)	2258	1137		3643	941	
- Structures (EA)	12	4		20	4	
Gas - PSE						
- Lines (LF)	0	458	2" IP	0	458	2" IP
- Structures (EA)						
Steam - Seattle Steam						
- Lines (LF)	0	207	12" low pressure	0	207	12" low pressure
- Structures (EA)	0	7	manhole & vault	0	7	manhole & vault
Fiber Optic - PSE						
- Lines (LF)	0	100		0	100	
- Structures (EA)						

Figure F-9 Preliminary Utility Impacts Assessment, Stewart Street/Olive Way, Westlake to 1st Avenue (Map)



Pike and Pine Streets; 4th/5th/6th Avenues

Figure F-10 Preliminary Utility Impacts Assessment, 1st Avenue – Pike and Pine Streets; 4th/5th/6th Avenues (Map)



APPENDIX G TRAFFIC ANALYSIS

This Appendix[1] describes the traffic analysis for the Tier 2 evaluation of alternatives for the Seattle Center City Connector project, supplementing the summary of analysis results included in the Detailed Evaluation Report. The appendix first documents the key assumptions and methodologies used in the traffic analysis, including analysis years, study area limits, travel demand forecasting and modeling methodologies, and operational parameters. It then provides both summary-level and more detailed analysis results.

Introduction

In the Tier 2 evaluation, a No-Build alternative and two Build alternatives along 1st Avenue were analyzed using a combination of Synchro (for signal timing information and intersection LOS results) and VISSIM (for multi-modal traffic simulation and detailed traffic operational results) traffic analysis and simulation tools. The two Build alternatives include Mixed-Traffic Streetcar and Exclusive Streetcar operating conditions that were evaluated to inform selection of a Locally Preferred Alternative (LPA). The traffic analysis for Tier 2 incorporated roadway, alignment, traffic signal/operations, and streetcar stop location options. In Tier 2, a VISSIM network was constructed to analyze and screen alternatives. Traffic Measures of Effectiveness (MOE's) produced for the Tier 2 evaluation include:

- Intersection LOS and delay
- Auto travel times
- Transit (bus and streetcar) travel times and reliability
- Vehicle throughput
- Traffic diversion in downtown street system

The Tier 2 Build alternatives in VISSIM incorporated pedestrian, bus, and parking movements. Intersection signal refinements were incorporated into VISSIM. This included separate streetcar signal phases and transit signal priority (TSP) treatments, where appropriate. These design options and treatments were screened to determine an LPA.

In Tier 2, Synchro was used as a basis to establish signal timing parameters and provide intersection LOS and delay while VISSIM directly simulated the interaction of auto, truck, bus, streetcar, and pedestrian modes of travel along the corridor. MOE's from VISSIM include travel time for autos, streetcars, and buses, as well as vehicle throughput. Person throughput was created by incorporating ridership estimates with vehicle data. Figure G-1 identifies the model used in the Tier 2 analysis.

[1] Prepared by CH2MHill

Figure G-1 Screening Levels of Analysis

Screening Levels	Tier 2 Methodology
Type of Analysis	Compare No Build and two Build alternatives and provide impacts of project
Tools	Synchro (for signal timing inputs) & VISSIM (multi-modal simulation)
Measures of Effectiveness	▪ Intersection LOS & delay (from Synchro) ▪ Auto travel time (from VISSIM) ▪ Bus travel time (from VISSIM) ▪ Streetcar travel time and reliability (from VISSIM) ▪ Vehicle throughput (from VISSIM) ▪ Level of traffic diversion

Methodology

Analysis Year and Time Period

The traffic analysis for the Tier 2 evaluation was developed for both an opening year and a horizon year. The opening year is considered to be 2018 and the horizon year was defined as 2035. The opening year traffic analysis provided detailed information on the streetcar performance and how it affects the operations along 1st Avenue while the horizon year analysis provided the long-term effects of traffic diversion in downtown.

The PM peak hour is considered to be the highest congestion time period in downtown Seattle and therefore was selected for both of the two future year analyses. The traffic forecasts used in the evaluation were based on the information provided in the Alaskan Way Viaduct (AWV) Final Environmental Impact Statement (FEIS).

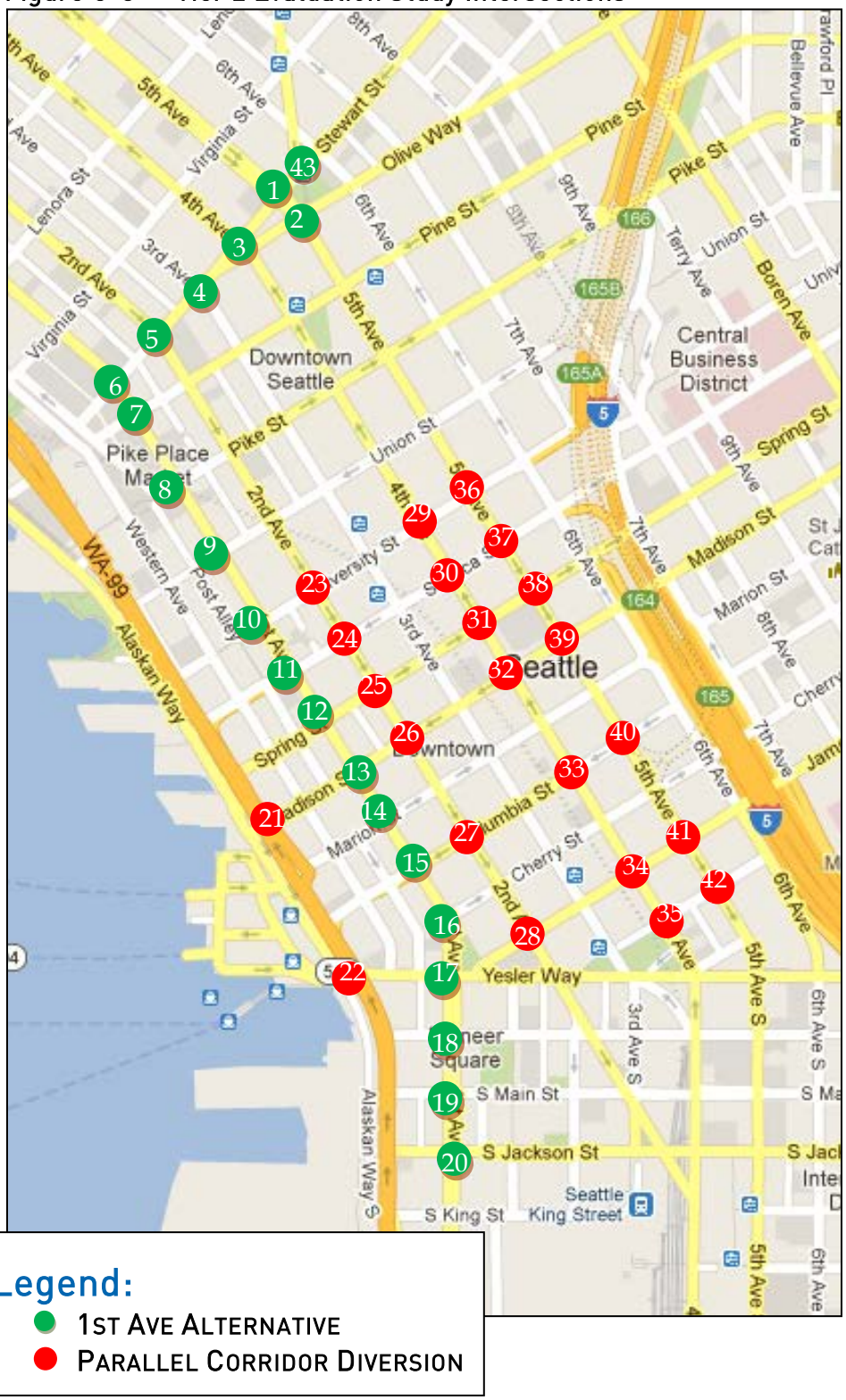
Traffic Study Area Limits

The study area includes up to 43 intersections with 20 intersections along the streetcar route of 1st Avenue and Stewart Street and 22 intersections along adjacent corridors for the diversion analysis, as identified in Figure G-2. Figure G-3 shows the location of each study intersection.

Figure G-2 Traffic Study Intersections: 1st Avenue and 4th/5th Avenues

ID #	Intersection	ID#	Intersection
1	5th & Stewart Street	23	2nd Avenue & University Street
2	5th Avenue & Olive Way	24	2nd Avenue & Seneca Street
3	4th Avenue & Stewart Street	25	2nd Avenue & Spring Street
4	3rd Avenue & Stewart Street	26	2nd Avenue & Madison Street
5	2nd Avenue & Stewart Street	27	2nd Avenue & Columbia Street
6	1st Avenue & Stewart Street	28	2nd Avenue & James Street
7	1st Avenue & Pine Street	29	4th Avenue & University Street
8	1st Avenue & Pike Street	30	4th Avenue & Seneca Street
9	1st Avenue & Union Street	31	4th Avenue & Spring Street
10	1st Avenue & University Street	32	4th Avenue & Madison Street
11	1st Avenue & Seneca Street	33	4th Avenue & Columbia Street
12	1st Avenue & Spring Street	34	4th Avenue & James Street
13	1st Avenue & Madison Street	35	4th Avenue & S Jackson Street
14	1st Avenue & Marion Street	36	5th Avenue & University Street
15	1st Avenue & Columbia Street	37	5th Avenue & Seneca Street
16	1st Avenue & Cherry Street	38	5th Avenue & Spring Street
17	1st Avenue & Yesler Way	39	5th Avenue & Madison Street
18	1st Avenue & S Washington Street	40	5th Avenue & Columbia Street
19	1st Avenue & S Main Street	41	5th Avenue & James Street
20	1st Avenue & Jackson Street	42	5th Avenue & S Jackson Street
21	Alaskan Way & Madison Street	43	Westlake Avenue & Stewart Street
22	Alaskan Way & Yesler Way		

Figure G-3 Tier 2 Evaluation Study Intersections



Legend:

- 1st Ave Alternative
- Parallel Corridor Diversion

Operational Analysis Tools and Inputs

Synchro software, version 8, was used for the intersection analysis in Tier 2. Synchro utilizes methods from the Highway Capacity Manual (HCM) 2010. The reported results include the overall intersection LOS from the HCM report for signalized locations. Level of Service (LOS) is a qualitative measurement of intersection operation based on control delay. LOS is reported as letter grades A (low delay per vehicle, favorable traffic progression) through F (extremely high delay per vehicle, could involve long queues). Critical approaches, as defined by LOS F, were reported.

For the Tier 2 evaluation, transit signal priority (TSP) was integrated with the streetcar operations through a combination of Synchro and Excel (using a methodology developed and applied through previous studies for SDOT). The TSP levels analyzed for Tier 2 provided a bookend (limited vs. more extensive) of potential TSP levels. The limited TSP signal adjustments were applied to the Mixed-Traffic Streetcar operating condition while the more extensive TSP adjustments were applied to the Exclusive Streetcar operating condition. In either of these TSP conditions, side-street green times were not reduced below minimum pedestrian street crossing thresholds and did not skip pedestrian phases. Figure G-4 shows intersection treatments that were assumed for each alternative, including signal phasing, left-turn restrictions on 1st Avenue, and TSP treatments where applicable.

In the Tier 2 evaluation, VISSIM software was also utilized to reflect a more detailed modeling of the signal and streetcar operating conditions. VISSIM has the ability to simulate multimodal traffic flows, such as cars, trucks, buses, streetcar/LRT, bicyclists, and pedestrians. The assumptions and parameters used in the Synchro model are shown in Figure G-5. Values in Figure G-5 were developed based on a combination of discussions with City staff, previous City project experience, and default values recommended from the HCM 2010. Figure G-6 identifies the parameters that were used in the VISSIM model.

Figure G-4 Tier 2 Intersection Treatments by Block

		No Build Condition		Mixed-Traffic Streetcar			Exclusive Streetcar		
Through Street	Cross Street	Signal Phasing	Lefts on 1st Allowed?	Signal Phasing	Lefts on 1st Allowed?	TSP Treatment	Signal Phasing	Lefts on 1st Allowed?	TSP Treatment
Stewart St	Westlake Ave	* 2-phase	n/a	* 3-phase: SB Streetcar protected phase	n/a	* None	* 3-phase: SB Streetcar protected phase	n/a	* Cross street reduced up to 18 sec (48%)
Stewart St	5th Ave	* 2-phase	n/a	Same	n/a	* Side street reduced up to 8 sec (20%)	Same	n/a	* Cross street reduced up to 17 sec (48%)
Olive Way	5th Ave	* 2-phase	n/a	Same	n/a	* Side street reduced up to 10 sec (18%)	Same	n/a	* Cross street reduced up to 32sec (60%)
Stewart St	4th Ave	* 2-phase	n/a	Same	n/a	* Side street reduced up to 13 sec (25%)	Same	n/a	* Cross street reduced up to 34sec (65%)
Stewart St	3rd Ave	* 2-phase	n/a	Same	n/a	* None	Same	n/a	* Cross street reduced up to 22sec (51%)
Stewart St	2nd Ave	* 2-phase	n/a	* 3-phase: EB Streetcar with South ped crosswalk; WB LT-TH Protected; SB TH-RT	n/a	* None	* 3-phase: EB/WB Streetcar-only phase; WB LT-TH with crosswalks; SB TH-RT	n/a	* EB Streetcar receives TSP; WB Streetcar receives Pre-emption
1st Ave	Stewart St	* 2-phase	NB Allowed	Same	Same	* Pre-emption for NB & WB Streetcar	Same	Restricted	* Pre-emption for NB & WB Streetcar

		No Build Condition		Mixed-Traffic Streetcar			Exclusive Streetcar		
Through Street	Cross Street	Signal Phasing	Lefts on 1st Allowed?	Signal Phasing	Lefts on 1st Allowed?	TSP Treatment	Signal Phasing	Lefts on 1st Allowed?	TSP Treatment
1st Ave	Pine St	* 2-phase	NB Allowed	Same	Same	* Side street reduced up to 5sec (20%)	* 3-phase: SB Left Prot	Same	* SB Left alt. lead/lag; Side street reduced up to 5sec (18%)
1st Ave	Pike St	* 2-phase (Ped Scramble)	NB Allowed	Same	Same	* None	Same	Restricted	* None
1st Ave	Union St	* 2-phase	NB Allowed	Same	Same	* Side street reduced up to 10 sec (30%)	Same	Restricted	* Side street reduced up to 14sec (40%)
1st Ave	University	* 2-phase (Ped Scramble)	SB Allowed	Same	Same	* None	* 3-phase: SB Left Prot	Same	* SB Left alt. lead/lag
1st Ave	Seneca	* 2-phase	Restricted	Same	Same	* Side street reduced up to 10 sec (28%)	Same	Same	* Side street reduced up to 7 sec (25%)
1st Ave	Spring	* 2-phase	SB Allowed	Same	Same	* None	* 3-phase: SB Left prot	Same	* SB Left alt. lead/lag (switched reg lag left to lead left)
1st Ave	Madison	* 2-phase	Restricted	Same	Same	* Side street reduced up to 8 sec (28%)	* 3-phase: NB Left Prot	NB Allowed	* NB Left alt. lead/lag
1st Ave	Marion	* 2-phase	SB Allowed	Same	Same	* Side street reduced up to 6 sec (20%)	Same	Restricted	* Side street reduced up to 8 sec (27%)

		No Build Condition		Mixed-Traffic Streetcar			Exclusive Streetcar		
Through Street	Cross Street	Signal Phasing	Lefts on 1st Allowed?	Signal Phasing	Lefts on 1st Allowed?	TSP Treatment	Signal Phasing	Lefts on 1st Allowed?	TSP Treatment
1st Ave	Columbia	* 2-phase	NB Allowed	Same	Same	* Side street reduced up to 12sec (30%)	Same	Restricted	* Side street reduced up to 19 sec (48%)
1st Ave	Cherry	* 3-phase: SB Left Perm-Prot; (Ped Scramble)	SB Allowed	* 3-phase; Prot SB Left & Ped Scramble	Same	* Pre-emption for NB & SB Streetcar phase	* 3-phase; SB Left Prot & Ped Scramble	Same	* SB Left alt. lead/lag
1st Ave	Yesler	* 2-phase	Restricted	Same	Same	* Side street reduced up to 7 sec (16%)	Same	Same	* Side street reduced up to 15sec (42%)
1st Ave	Washing-ton	* 2-phase	Restricted	Same	Same	* Pre-emption for NB & SB Streetcar Phases	Same	Same	* Side street reduced up to 10 sec (33%)
1st Ave	Main	* 2-phase	Restricted	Same	Same	* Side street reduced up to 10 sec (30%)	Same	Same	* Side street reduced up to 7 sec (25%)
1st Ave	Jackson	* 2-phase	NB & SB Allowed	* 4-phase; SB Perm-Prot Left; WB Perm-Prot Left	Same	* Pre-emption for SB Left Streetcar; * Protected phase for WB Right Streetcar	* 4-phase; SB Perm-Prot Left; WB Perm-Prot Left	SB Allowed; NB Restricted	* TSP for SB Left Streetcar, alt lead/lag; * Protected phase for WB Right Streetcar

Figure G-5 Synchro Parameters/Assumptions

Parameter	Future Year Assumption
Peak Hour Factor	From 2030 AWV Synchro or count, otherwise 0.92for intersection
Conflicting Pedestrians per Hour	From 2030 AWV Synchro or count, otherwise use 200 peds/hr per crosswalk
Conflicting Bicycles per Hour	From 2030 AWV Synchro or count, otherwise use 20 bicycles/hr
Area Type	CBD
Ideal Saturation Flow Rate (for all movements)	1900
Lane Width	From 2030 AWV Synchro or SDOT paint line sketches, otherwise assume 11'
Percent Heavy Vehicles	From 2030 AWV Synchro or count/current transit service, otherwise use 3% per approach (including trucks and buses)
Percent Grade	From 2030 AWV Synchro, otherwise calculated from field data
Parking Maneuvers per Hour	From 2030 AWV Synchro, otherwise assume 8 maneuvers/hr for two-way streets; assume 16 maneuvers/hr for one-way streets
Bus Blockages	From 2030 AWV Synchro, otherwise from existing transit routes and headways
Intersection Signal Phasing and Coordination	From 2030 AWV Synchro or existing data from SDOT
Intersection Signal Timing optimization limits	From 2030 AWV Synchro or existing data from SDOT (80 sec cycle length)
Minimum Green Time	From 2030 AWV Synchro or existing data from SDOT
Yellow and All-Red Time	From 2030 AWV Synchro or existing data from SDOT, otherwise use: (Y) = 3.5seconds and (R) = 1second
Right Turn on Red	Allow where currently permitted
Speed Limit	30 mph

Figure G-6 VISSIM Parameters/Assumptions (for Tier 2 Evaluation)

VISSIM Parameters	Future Year Assumption
VISSIM Version	▪ 5.40-09
Simulation Resolution	▪ 10 time steps/sec
Seeding Time	▪ 15minutes
Recording Time	▪ 1hr
# of Random Seeds	▪ Starting seed of 100, increment of 10; 10 seeds
Driver Behavior, Car Following	▪ Wiedemann 74 ▪ Add. Part of safety distance = 2.00 ▪ Mult. Part of safety distance = 3.00
Traffic Composition	▪ SDOT Data and 2030 AWV Synchro
Vehicle Types	▪ GP Car (vehicle model = Car) ▪ HGV (vehicle model = HGV, length ~ 20-70') ▪ Bus (vehicle model = Bus, length ~ 40') ▪ Streetcar (vehicle model = Tram, length ~50')
Conflicting Pedestrians per Hour	▪ SDOT Data and 2030 AWV Synchro, otherwise assume 200 peds/hr per crosswalk
Parking Maneuvers per Hour	▪ SDOT Data and 2030 AWV Synchro, otherwise 8 maneuvers/hr for two-way streets; assume 16 maneuvers/hr for one-way streets
Grade	▪ From 2030 AWV Synchro, otherwise calculated from field data
Intersection Turning Speed	▪ Right = 11-13 mph; Left = 13-17 mph
Transit Assumptions	▪ Existing Bus Routes (from KC Metro, Sound Transit, and other transit agencies) and stops along Preferred Alignment route were modeled. Data from KC Metro was utilized for boarding/alighting and dwell time at stop locations, otherwise assumed 20 second dwell time and 10 second standard deviation.

VISSIM Parameters	Future Year Assumption
	▪ For future No Build alternative, removal of AWV changes bus routes that cross 1st Avenue at Columbia (outbound from Downtown Seattle to South) and Seneca (inbound from South to Downtown Seattle) to be consolidated to Columbia Street BAT lane, as part of Central Waterfront Program improvement. ▪ For future Build alternatives, KCM Route 99 was assumed to be replaced with streetcar service.
Signal Controller Type	▪ No Build = Pre-timed ▪ Build = Actuated-Coordinated with TSP where warranted
Streetcar Headway	▪ Assume 5minute headways between Westlake and Jackson
Streetcar Signal Operations	▪ TSP to be applied where warranted; TSP parameters to be coordinated with SDOT; Exclusive Streetcar phases required at intersections where route turns across traffic
Signal Phasing, Timing, and Coordination	▪ No Build based on 2030 AWV FEIS Synchro ▪ Build modified where Exclusive Streetcar phases are required or where geometric modifications warrant changes in phasing

Data Collection

Traffic data from other relevant projects, such as Alaskan Way Viaduct (AWV) FEIS, Central Waterfront Project (CWP), and First Hill Streetcar was used to develop the traffic analysis for the Tier 2 evaluation. The data from these files, such as traffic volumes, signal timing, and roadway channelization was used to establish the project models for the alternatives.

Year 2035 traffic volumes and signal timing data was mainly based on the AWV FEIS Synchro model as it has the greatest coverage of the project's study area. Data gaps were filled in through data obtained from SDOT or other projects (SDOT Central Waterfront Project (CWP) and SDOT First Hill Streetcar project). Existing traffic signal timing and phasing was gathered from SDOT.

Future auto demand volumes were based on the 2017 and 2030 non-tolled scenario forecast developed for the AWV FEIS. This analysis used the AWV FEIS forecasts which were based on a land use estimate for the year 2030. These forecasts, produced in the mid-2000's, do not account for the recent economic recession. Therefore, the forecasts may reflect a future year beyond 2030 that is near 2035. The non-tolled forecasts were utilized since WSDOT is currently in the process of updating the tolling forecasts and these have yet to be finalized or agreed to by stakeholders. In Tier 2, a high-level travel demand forecast was conducted to determine the amount of diversion that is likely to occur from a streetcar operating condition that requires the reduction of general-purpose travel lanes on 1st Avenue.

At intersections where future forecasts are not readily available, the future intersection volumes were estimated using a combination of existing traffic counts, post-processing adjustments, and volume-balancing from nearby intersections where future forecasts are published.

Tier 2 Evaluation Traffic Measures of Effectiveness

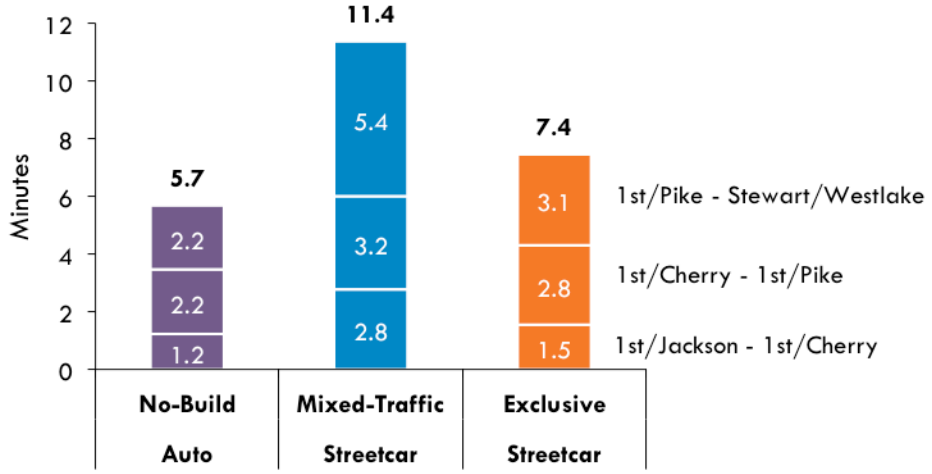
Streetcar Travel Times

Summary

Streetcar travel times were developed for the Mixed-Traffic and Exclusive Streetcar alternatives for the 2018 year of opening condition. These travel times were produced from the VISSIM simulation model. Streetcar travel times in the Exclusive Streetcar alternative (7.4 minutes) would be nearly 30% faster than in the Mixed-Traffic Streetcar alternative (11.4 minutes). Between these two alternatives, about half of the travel time difference occurs between 1st/Pike and Stewart/Westlake intersections. The main difference in travel time in this segment is caused by the different levels of TSP assumed between the two Build alternatives.

The streetcar travel times in the Exclusive Streetcar alternative are also more competitive with auto travel times in the No-Build alternative. Even though the streetcar travel times in the Exclusive Streetcar alternative are 30% longer than the No-Build auto travel time, the streetcar travel time includes the dwell time at stops. Figure G-7 shows the streetcar travel time comparison between each alternative.

Figure G-7 2018 PM Peak Hour Streetcar Travel Times: Jackson/Occidental to Stewart/Westlake (by segment)



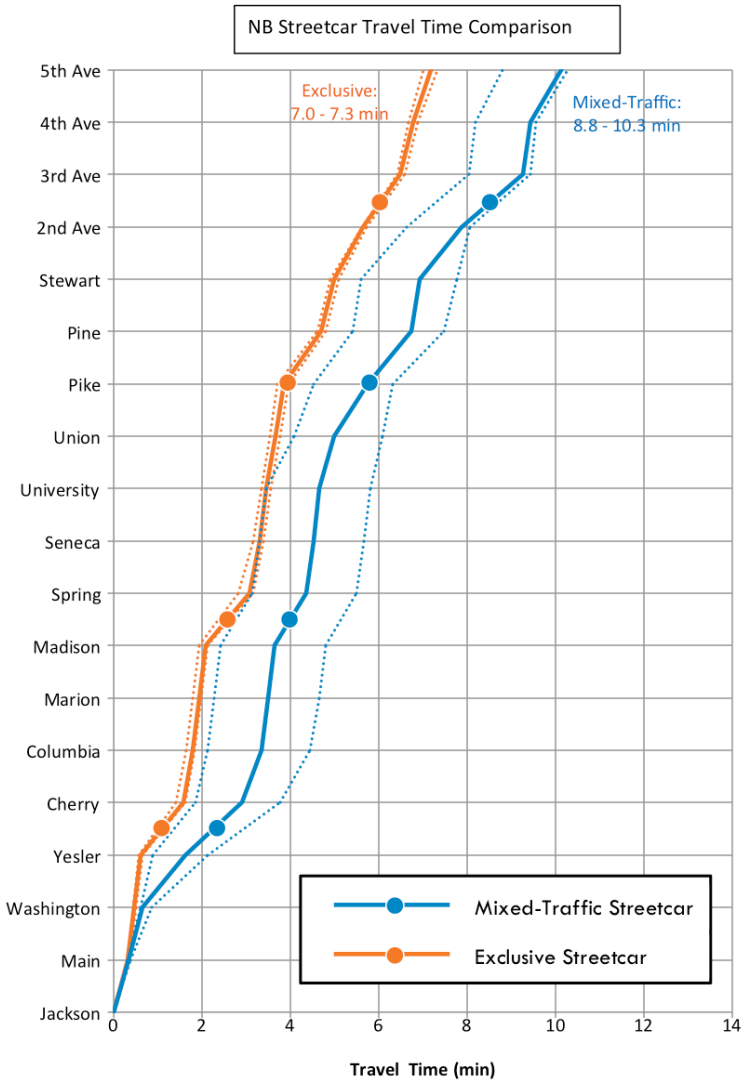
Note: Streetcar travel times include an assumed 20-second dwell time at stations. Travel times are the average of one-way northbound and southbound travel times.

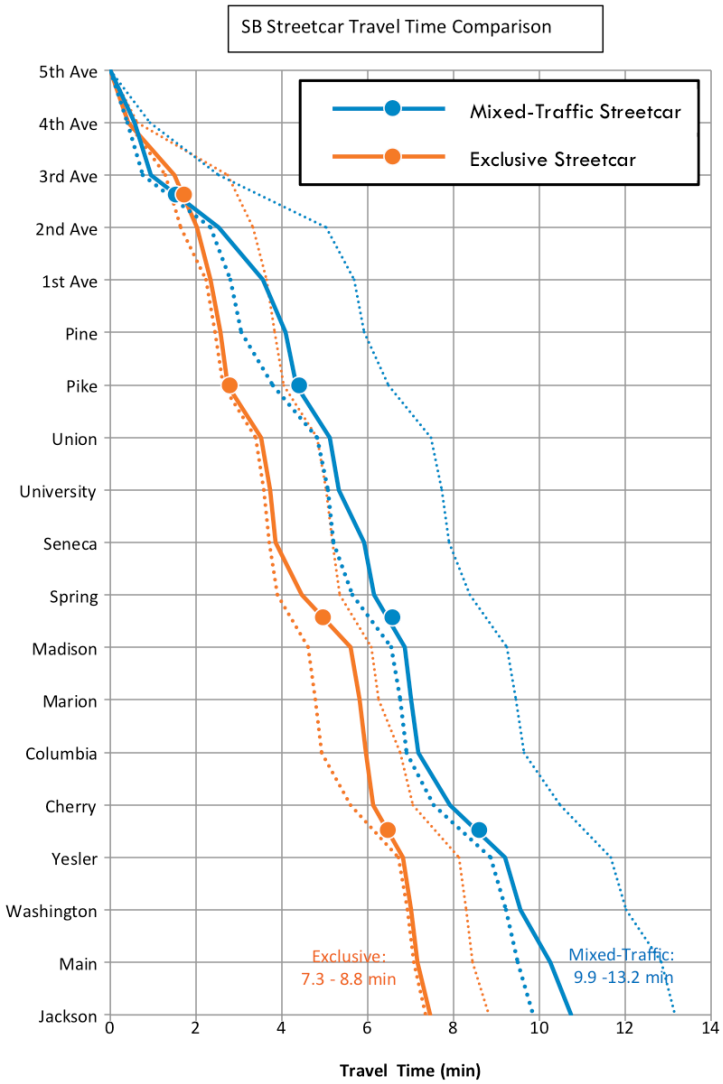
Streetcar Travel Time Reliability

Summary

In addition to streetcar travel times, the reliability of the streetcar was also compared between the two Build conditions. Reliability is measured as the variability of travel times from each streetcar trip along the route during the peak hour. The reliability accounts for delays caused by station stops, signal delay, and queuing. In both travel directions, the Exclusive Streetcar alternative has a higher reliability when compared to the Mixed-Traffic Streetcar alternative. In the Exclusive Streetcar alternative, travel times vary by about 12% in the northbound and southbound travel directions, as seen in Figure G-8. The Mixed-Traffic Streetcar alternative has a lower reliability with travel times varying by 26% during the PM peak hour. The lower reliability caused by a greater variance in travel times with the Mixed-Traffic Streetcar alternative reflects streetcar operations when it is mixed with auto traffic. With traffic congestion projected to increase in the future, the Exclusive Streetcar alternative provides a higher level of reliability for streetcar travel times.

Figure G-8 Streetcar Travel Time Reliability

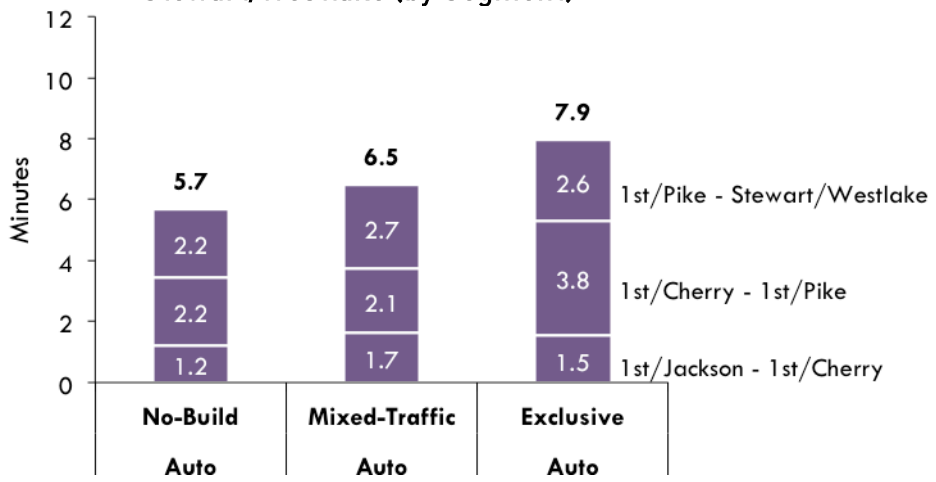




Auto Performance

In the Tier 2 evaluation, auto travel times were also produced for the 2018 year of opening condition and compared between the No-Build, Exclusive Streetcar, and Mixed-Traffic Streetcar alternatives. These travel times were produced from the VISSIM simulation model. In the Mixed-Traffic alternative, auto travel time increases by 8% compared to the No-Build alternative. Auto travel times in the Exclusive Streetcar alternative increase by about 35% from the No-Build alternative. The auto travel time increase in the Exclusive Streetcar alternative primarily occurs along 1st Avenue between the Cherry and Pike intersections where the streetcar has an exclusive travel lane.

Figure G-9 2018 PM Peak Hour Auto Travel Times - Jackson/Occidental to Stewart/Westlake (by Segment)



Note: Travel times are the average of one-way northbound and southbound travel times.

Detailed Analysis Results

Figure G-10 through Figure G-13 provide further detailed information on year 2018 PM peak hour traffic conditions. Figure G-10 and Figure G-11 provide similar information in tabular form to the data already presented in Figure G-7 through Figure G-9.

Figure G-12 provides auto throughput data for the No-Build, Mixed-Traffic, and Exclusive conditions for 2018. Similar to the auto travel time information (Figure G-7), auto throughput is expected to be similar between the No-Build and Mixed-Traffic Streetcar conditions as the streetcar does not reduce auto capacity along 1st Avenue and operates within the existing travel lanes. In the Exclusive Streetcar condition, auto throughput along 1st Avenue is between half to two-thirds of the throughput in the No-Build condition. Similarly, the intersection LOS and queuing information presented in Figure G-13 suggests that the intersection delay between the No-Build and Mixed-Traffic Streetcar conditions would be similar while the average intersection delay in the Exclusive Streetcar condition is about 10 seconds worse than in the No-Build condition along with more intersections expected to have vehicles queued back into them.

Figure G-10 2018 PM Peak Hour Auto and Streetcar Travel Time Summary

Segment	Auto									Streetcar					
	No Build			Mixed-Traffic			Exclusive			Mixed-Traffic			Exclusive		
	NB /EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)
Jackson - Cherry	1.0	1.5	1.2	1.9	1.4	1.7	1.8	1.3	1.5	2.8	2.8	2.8	1.6	1.5	1.5
Cherry - Pike	1.8	2.6	2.2	1.7	2.5	2.1	2.5	5.0	3.8	2.7	3.8	3.2	2.3	3.2	2.8
Pike - Westlake	1.6	2.8	2.2	1.7	3.7	2.7	1.5	3.8	2.6	4.2	6.6	5.4	3.3	3.0	3.1
Total =	**4.4**	**6.9**	**5.7**	**5.3**	**7.6**	**6.5**	**5.8**	**10.1**	**7.9**	**9.6**	**13.1**	**11.4**	**7.2**	**7.7**	**7.4**

Figure G-11 2018 PM Peak Hour Auto and Streetcar Travel Speed Summary

Segment	Auto									Streetcar					
	No Build			Mixed-Traffic			Exclusive			Mixed-Traffic			Exclusive		
	NB/ EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)	NB/ EB	SB/ WB	Avg (both dir)
Jackson - Cherry	13.3	9.4	11.4	7.1	11.7	9.4	8.3	8.9	8.6	4.7	6.1	5.4	8.3	8.9	8.6
Cherry - Pike	16.6	11.7	14.1	17.6	12.6	15.1	13.3	9.6	11.5	11.4	8.2	9.8	13.3	9.6	11.5
Pike - Westlake	8.5	7.6	8.1	4.0	5.9	5.0	6.7	7.2	6.9	5.3	3.4	4.3	6.7	7.2	6.9
Average =	**12.9**	**9.6**	**11.2**	**9.5**	**9.2**	**9.3**	**9.1**	**8.5**	**8.8**	**6.8**	**5.3**	**6.1**	**9.1**	**8.5**	**8.8**

Figure G-12 2018 PM Peak Hour Auto Throughput

Road	Segment	No Build		Mixed-Traffic		Exclusive	
		NB/EB	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB
Stewart Street	Westlake - 1st Avenue	190	710	190	775	195	740
1st Avenue	Stewart - Cherry	1065	680	910	690	540	455
1st Avenue	Cherry - Jackson	890	540	900	625	580	545

Figure G-13 2018 PM Peak Hour Intersection Level-of-Service and Vehicle Queue Results

			No Build				Mixed-Traffic Streetcar				Exclusive Streetcar			
ID#	Major Street	Cross Street	LOS	Delay	NB/EB Queue Spillback	SB/WB Queue Spillback	LOS	Delay	NB/EB Queue Spillback	SB/WB Queue Spillback	LOS	Delay	NB/EB Queue Spillback	SB/WB Queue Spillback
1	Stewart Street	5th Avenue	B	17	n/a	Yes	B	18	n/a	Yes	C	23	n/a	Yes
2	Olive Way	5th Avenue	A	8		n/a	A	8		n/a	A	8		n/a
3	Stewart Street	4th Avenue	B	14			B	17		Yes	C	26		Yes
4	Stewart Street	3rd Avenue	A	9			B	15	Yes	Yes	B	19		Yes
5	Stewart Street	2nd Avenue	B	14	n/a		C	26	n/a	Yes	C	21	n/a	Yes
6	1st Avenue	Stewart Street	B	12			B	20	Yes	Yes	C	22	Yes	Yes
7	1st Avenue	Pine Street	A	4			A	10		Yes	B	15		
8	1st Avenue	Pike Street	A	5			A	7			B	13		
9	1st Avenue	Union Street	B	12			B	11			C	21	Yes	Yes
10	1st Avenue	University Street	A	4		Yes	A	4			C	24		Yes
11	1st Avenue	Seneca Street	B	17		Yes	B	11	Yes		C	27	Yes	
12	1st Avenue	Spring Street	B	15			B	14		Yes	C	31	Yes	
13	1st Avenue	Madison Street	B	13	Yes		B	14		Yes	C	34	Yes	
14	1st Avenue	Marion Street	B	14			A	10			B	18	Yes	
15	1st Avenue	Columbia Street	A	8			B	13			B	20	Yes	Yes
16	1st Avenue	Cherry Street	B	12	Yes		C	24	Yes	Yes	B	18	Yes	
17	1st Avenue	Yesler Way	C	23			C	27	Yes		D	41	Yes	
18	1st Avenue	Washington Street	B	12			B	20	Yes		C	24	Yes	Yes
19	1st Avenue	Main Street	B	15			B	11			B	19	Yes	Yes
20	1st Avenue	Jackson Street	D	47	Yes	Yes	D	41	Yes	Yes	D	52		Yes
43	Stewart Street	Westlake Avenue	C	21	n/a	Yes	C	28	n/a	Yes	D	51	n/a	Yes

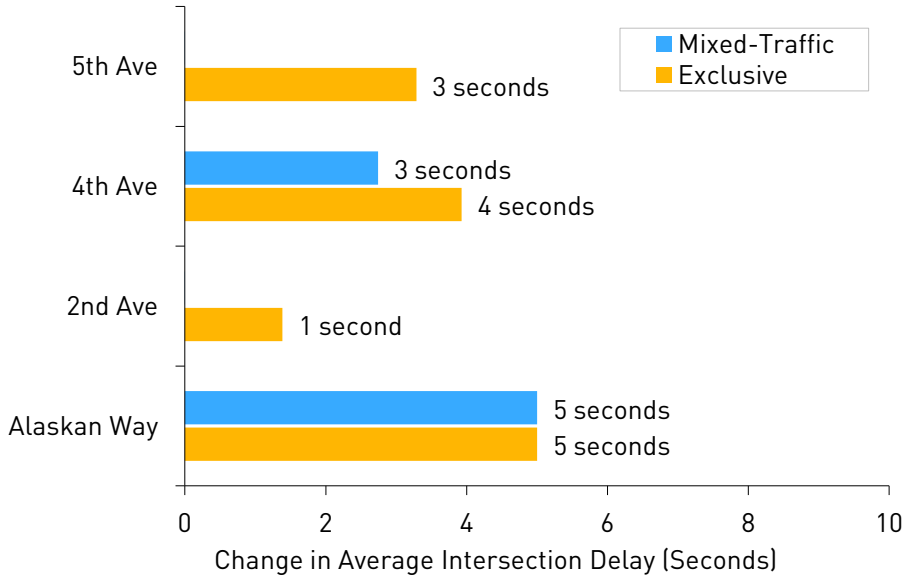
Vehicle Diversion to Parallel Streets

In addition to traffic information presented for the 2018 year of opening condition, vehicle diversion to parallel streets within downtown Seattle was also analyzed for the 2035 horizon year with Synchro software.

In the Mixed-Traffic Streetcar alternative, minor traffic diversion from 1st Avenue are expected due to the streetcar operations. Diversion with the Mixed-Traffic Streetcar alternative occurs primarily in the northbound direction as this alternative removes some roadway capacity in this direction. As a result, intersection delays on parallel streets increase slightly by an average of 2seconds. Delay impacts are not noticeable on 2nd Avenue and 5th Avenue.

In the Exclusive Streetcar alternative, up to 50% of the traffic along 1st Avenue is diverted onto parallel streets. With this amount of diversion, parallel streets would experience between a 5-11% increase in volume that creates up to a 13% average increase in intersection delay on parallel streets. Figure G-14 compares the average increase in intersection delay along the parallel corridors between the two Build alternatives. This diversion causes an average delay increase of about 3.5seconds. Figure G-15 and Figure G-16 provide more detailed information.

Figure G-14 Year 2035 PM Peak Hour Change in Traffic (Average Intersection) Delay on Parallel Streets



Note: Based on analysis of 20 intersections on Alaskan Way and 2nd, 4th, and 5th Avenues. Mixed-Traffic impacts represent increases of 6% on 4th Avenue and 13% on Alaskan Way. Exclusive alternative impacts represent 9% to 13% increases on parallel corridors relative to No-Build.

Detailed Analysis Results

Figure G-15 through Figure G-17 provide additional information on the traffic diversion analysis. Figure G-15 provides the expected amount of traffic diverted from 1st Avenue to parallel streets. The Mixed-Traffic Streetcar alternative would divert less traffic than in the Exclusive Streetcar alternative as it does not impact as much roadway capacity; capacity is only reduced in the northbound direction. It should be noted that Figure G-15 may not reflect the total amount of traffic diverted off of 1st Avenue and added to the adjacent parallel streets as some of the diverted traffic may use other routes outside of this study area. Figure G-16 and Figure G-17 provide the traffic analysis results from the diversion analysis. Figure G-16 provides corridor-level information while Figure G-17 provides the traffic results by individual intersection.

Figure G-15 Year 2035 PM Peak Hour Volume Diversion

Scenario	Alaskan Way				1st Avenue				2nd Avenue		4th Avenue		5th Avenue	
	NB		SB		NB		SB		SB		NB		SB	
	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.
1st Avenue Mixed-Traffic Streetcar	7%	100	0%	0	-17%	-200	0%	0	0%	0	7%	100	0%	0
1st Avenue Exclusive Streetcar	11%	150	3%	40	-50%	-600	-38%	-300	5%	100	6%	130	7%	120

Figure G-16 Year 2035 PM Peak Hour Average Change in Intersection Delay

Scenario	Alaskan Way				1st Avenue				2nd Avenue				4th Avenue				5th Avenue			
	Avg. No-Build Delay (in sec.)	Avg. Build Delay (in sec.)	Avg. Delay Change (in sec.)	%	Avg. No-Build Delay (in sec.)	Avg. Build Delay (in sec.)	Avg. Delay Change (in sec.)	%	Avg. No-Build Delay (in sec.)	Avg. Build Delay (in sec.)	Avg. Delay Change (in sec.)	%	Avg. No-Build Delay (in sec.)	Avg. Build Delay (in sec.)	Avg. Delay Change (in sec.)	%	Avg. No-Build Delay (in sec.)	Avg. Build Delay (in sec.)	Avg. Delay Change (in sec.)	%
1st Ave Mixed- Traffic Streetcar	40	45	5	13%	18	24	6	35%	15	15	0	0%	45	48	3	6%	24	24	0	0%
1st Ave Exclusive Streetcar	40	45	5	13%	18	44	26	152%	15	16	1	9%	45	49	4	9%	24	27	3	13%

Figure G-17 Year 2035 PM Peak Hour Intersection Level-of-Service Results

ID#	Major St	Cross St	No Build		1st Ave Mixed-Traffic Streetcar			1st Ave Exclusive Streetcar		
			LOS	Delay	LOS	Delay	Delay Change (vs. No Build)	LOS	Delay	Delay Change (vs. No Build)
Streetcar Route										
1	5th Ave	Stewart St	C	22	C	23	0	C	28	5
2	5th Ave	Olive Way	B	12	B	13	1	B	14	2
3	4th Ave	Stewart St	C	22	C	27	5	C	34	12
4	3rd Ave	Stewart St	A	8	B	12	4	D	41	33
5	2nd Ave	Stewart St	B	19	F	89	70	F	150	131
6	1st Ave	Stewart St	C	21	C	31	11	C	27	6
7	1st Ave	Pine St	A	6	A	9	3	B	11	5
8	1st Ave	Pike St	B	12	C	21	9	E	55	43
9	1st Ave	Union St	A	10	A	8	-2	B	15	5
10	1st Ave	University St	C	21	A	7	-14	C	21	0
11	1st Ave	Seneca St	B	18	B	17	-1	C	33	15
12	1st Ave	Spring St	C	24	B	12	-12	E	56	32
13	1st Ave	Madison St	B	12	B	12	1	C	28	16
14	1st Ave	Marion St	B	16	C	27	12	E	71	56
15	1st Ave	Columbia St	A	10	B	10	1	F	84	75
16	1st Ave	Cherry St	D	39	D	47	9	C	23	-16
17	1st Ave	Yesler Way	C	32	D	39	8	E	71	39
18	1st Ave	Washington St	B	11	A	9	-2	C	23	12
19	1st Ave	Main St	B	16	B	14	-2	C	21	5
20	1st Ave	Jackson St	B	18	D	39	21	E	68	50
Adjacent Corridors										
21	Alaskan Way	Madison St	C	31	D	41	10	D	39	8
22	Alaskan Way	Yesler Way	D	49	D	49	0	D	52	3
23	2nd Ave	University St	C	27	C	25	-2	C	28	2
24	2nd Ave	Seneca St	A	6	A	6	0	A	6	-1
25	2nd Ave	Spring St	B	12	B	12	0	B	15	3
26	2nd Ave	Madison St	B	15	B	15	1	B	17	2
27	2nd Ave	Columbia St	B	11	B	11	0	A	8	-3
28	2nd Ave	James St	B	18	B	18	1	C	23	5
29	4th Ave	University St	C	22	C	20	-2	C	27	5
30	4th Ave	Seneca St	D	37	D	53	16	D	54	17
31	4th Ave	Spring St	B	16	B	15	-1	C	30	14
32	4th Ave	Madison St	E	58	E	65	7	E	70	12
33	4th Ave	Columbia St	D	38	D	38	0	E	55	17
34	4th Ave	James St	B	19	B	18	-1	C	22	4
35	4th Ave	Jackson St	F	122	F	122	0	F	81	-42
36	5th Ave	University St	B	18	B	18	0	C	20	3
37	5th Ave	Seneca St	B	19	B	19	0	C	23	5
38	5th Ave	Spring St	B	16	B	16	-1	B	17	1
39	5th Ave	Madison St	C	29	C	29	0	D	38	9

ID#	Major St	Cross St	No Build		1st Ave Mixed-Traffic Streetcar			1st Ave Exclusive Streetcar		
			LOS	Delay	LOS	Delay	Delay Change (vs. No Build)	LOS	Delay	Delay Change (vs. No Build)
40	5th Ave	Columbia St	B	11	B	11	0	B	11	1
41	5th Ave	James St	B	15	B	15	0	B	17	2
42	5th Ave	Jackson St	E	64	E	64	0	E	67	4

APPENDIX H EVALUATION OF WESTLAKE AND JACKSON PRIORITY TREATMENTS

Overview

The published/scheduled one-way travel time for the South Lake Union Streetcar is currently nearly 11 minutes in the northbound direction and slightly less than 10 minutes in the southbound direction. The Center City Connector (CCC) project team estimates that typical one-way travel times are more likely to be in the 15 to 18 minute range during peak periods and King County Metro streetcar operations staff have indicated that travel times can be as long as 20-25 minutes during heavy congested periods. Improving the performance of the streetcar would be necessary to realize the maximum potential of the Exclusive Streetcar alternative.

To assess the potential for such improvements from priority treatments on the existing/planned lines, the project team evaluated potential design and operational features that could be implemented to improve speed and reliability along the South Lake Union (SLU) Streetcar alignment and the Jackson segment of the First Hill Streetcar alignment. These features were identified based on the team's working knowledge of the streetcar alignments, riding the SLU streetcar with King County Metro streetcar operations staff, input from SDOT staff, and/or public input at the October 29, 2013 Center City Connector open house.

This document[1] identifies a proposed set of improvements. Following initial discussion/review of these improvements with SDOT staff, the project team quantified the potential benefits from these improvements, i.e., shorter or more reliable travel times. These improvements will be incorporated into the refinement of the operating plan for the Center City Connector Exclusive Streetcar alternative in a future design phase.

Methodology

Two alternatives were evaluated along the South Lake Union and First Hill Streetcar routes using a combination of Synchro (for signal timing information and intersection LOS [Level-of-Service] results) and VISSIM (for multimodal traffic simulation and future travel time estimates). The baseline alternative, known as the Mixed-Traffic Streetcar alternative, is

[1] Prepared by CH2MHill, Nelson\Nygaard, and URS

reflective of the current or planned streetcar operations while the build alternative, known as the Exclusive Streetcar alternative, proposes improvements to the streetcar and roadway system to improve streetcar travel times. The analysis assumed 10-minute streetcar headways along both the SLU and First Hill Streetcar lines.

Both the 2030 Alaskan Way Viaduct (AWV) PM FEIS Toll Free Synchro network and 2030 AWV Mercer VISSIM model were used to develop the SLU area streetcar analysis. The 2013 First Hill Streetcar Synchro and VISSIM networks were used to develop the Jackson area streetcar analysis. Traffic data from these files such as volumes, alignments, signal timings, and traffic operations were used to establish the model for the alternatives.

Traffic measures of effectiveness (MOE's) provided for the analysis include vehicle and streetcar travel times, intersection level-of-service (LOS), and delay.

Figure H-1 lists the potential treatment options that were identified based on an initial assessment of the SLU and First Hill Streetcar lines. These treatments were applied to specific locations along the South Lake Union and First Hill Streetcar routes as described in the following sections.

Figure H-1 Potential Priority Treatment Options

Identifier	Priority Treatments	Additional Information
A	Install "Do Not Block Intersection" Signage/Striping	
B	Add Traffic Signal Priority (TSP)	
C	Apply traffic law enforcement	
D	Adjust traffic signal timing	
E	Create exclusive streetcar lane (may be accomplished by various means including removal of parking, access and turn restrictions, track reconstruction, etc.)	
F	Convert lane to Business Access and Transit (BAT) lane	
G	Add part-time illuminated LED signage depicting crossing or parallel streetcar vehicle approaching	See Figure H-2
H	Add signalization to intersection	
I	Add extra measures to clear streetcar lane, e.g., signage, raised pavement markings, and rough pavement treatment	
J	Modify existing Opticom system to provide traffic signal pre-emption or extension of "green time"	
K	Clear upstream merge lane by adding striped gore and signage (allow traffic to re-enter lane after trackway)	
L	Install permanent "No Turn On Red" sign	
M	Delay pedestrian signal to give priority to right turning streetcars when present	
N	Relocate far-side bus stop to near side of intersection	

Figure H-2 Part-Time Illuminated "Streetcar Approaching" Signage

Treatments and Results for South Lake Union Line (Westlake)

Proposed Priority Treatments

Based on the project team's assessment of the SLU streetcar alignment, incorporating staff and public input provided to the project team, Figure H-3 (map) and Figure H-4 (table) identify priority features that could be implemented along the SLU streetcar alignment.

Figure H-3 South Lake Union: Proposed Priority Treatments (Map)

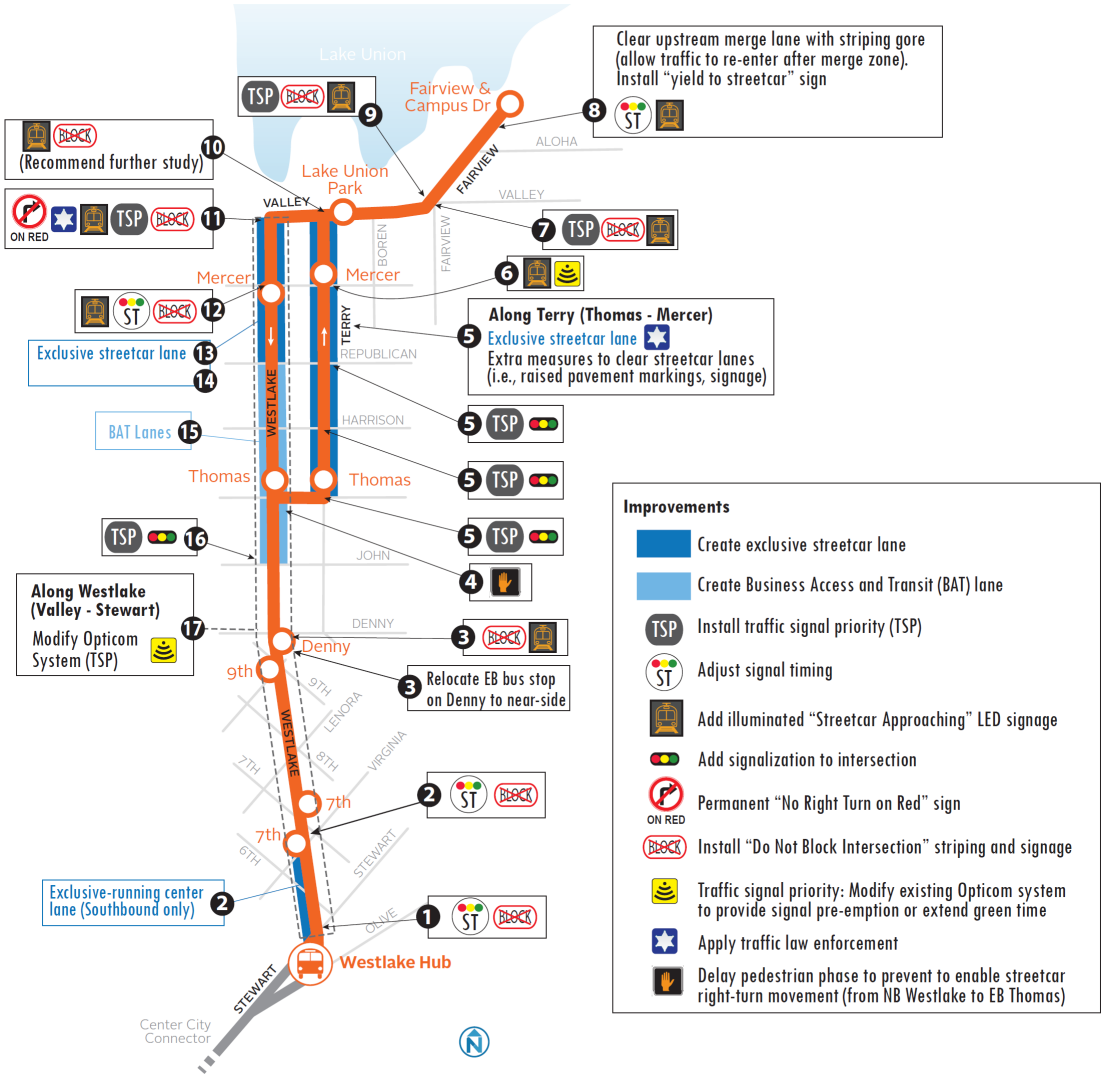


Figure H-4 South Lake Union: Assessment of Delay to Streetcar and Proposed Priority Treatments (Table)

Map Identifier	Location	Reason for Delay to Streetcars	Potential Measures for Improvement	A – Do Not Block Intersection	B – Add TSP	C – Enforcement	D – Adjust signal timing	E –Exclusive Lane	F – Create BAT lane	G –Illuminated Streetcar Approaching Signage	H - Signalization	I –Clear streetcar lane measures	J – Modify Opticom system (TSP)	K – Clear upstream lane treatment	L – No Turn on Red Sign	M - Delay pedestrian signal	N– Relocate far-side bus stop to near-side	Additional Notes/Discussion
1	NB/SB Westlake, Stewart	Traffic blocks intersection at Westlake Station	A,D	✓			✓											
2	SB Westlake, 7th/Virginia	Traffic blocks intersections	A,D,E	✓			✓	✓										
3	NB Westlake, Denny	Traffic blocks intersection	A,D, G,N	✓			✓			✓							✓*	▪ Adjust signal timing so northbound Westlake traffic can proceed through Blanchard and Denny intersections with less delay. (*) Relocation of the far-side bus stop to near-side was initially included as a potential treatment but was not observed as a contributing factor to streetcar delay.
4	NB Westlake, Thomas	Pedestrians in east leg crosswalk delay right turns	M													✓		
5	NB Terry, Thomas to Mercer	Traffic congestion blocks travel lanes	B,C,E,H,I		✓	✓		✓			✓	✓						▪ Creating exclusive lane, Thomas-Valley, e.g., by eliminating west-side parking ▪ Signalize Thomas, Harrison, Republican intersections
6	NB Terry, crossing Mercer	Potential signal detection failures	G,J							✓			✓					

Map Identifier	Location	Reason for Delay to Streetcars	Potential Measures for Improvement	A – Do Not Block Intersection	B – Add TSP	C – Enforcement	D – Adjust signal timing	E –Exclusive Lane	F – Create BAT lane	G –Illuminated Streetcar Approaching Signage	H - Signalization	I –Clear streetcar lane measures	J – Modify Opticom system (TSP)	K – Clear upstream lane treatment	L – No Turn on Red Sign	M - Delay pedestrian signal	N– Relocate far-side bus stop to near-side	Additional Notes/Discussion
7	NB at Valley/Fairview	Traffic blocks intersection	A,B,G	✓	✓					✓								
8	SB at Fairview Terminus	Traffic congestion prevents streetcar from entering lane	D,G,K				✓			✓				✓				
9	SB at Valley/Fairview	Traffic blocks intersection	A,B,G	✓	✓					✓								
10	SB Valley/Terry at parking lot access	Vehicles waiting in driveway block trackway crossing	A,G	✓						✓								▪ Further study recommended of South Lake Union parking lot ingress/egress
11	SB Valley/Westlake	Traffic blocks intersection; WB right turns wait on tracks	A,B,C,G,L	✓	✓	✓				✓					✓			▪ See also #13/14, 17
12	SB Westlake, Mercer	Traffic congestion blocks travel lanes	A,D,G	✓			✓			✓								▪ See also #13/14, 17
13	SB Westlake, Valley to Mercer	Shared travel lane could delay streetcar	E					✓										▪ Block has been operating streetcar only during construction

Map Identifier	Location	Reason for Delay to Streetcars	Potential Measures for Improvement	A – Do Not Block Intersection	B – Add TSP	C – Enforcement	D – Adjust signal timing	E –Exclusive Lane	F – Create BAT lane	G –Illuminated Streetcar Approaching Signage	H - Signalization	I –Clear streetcar lane measures	J – Modify Opticom system (TSP)	K – Clear upstream lane treatment	L – No Turn on Red Sign	M - Delay pedestrian signal	N– Relocate far-side bus stop to near-side	Additional Notes/Discussion
14	SB Westlake, Mercer to Republican	New Amazon parking lots could increase congestion	E					✓										▪ Amazon garage will have a mid-block access on Westlake, as well as access from Republican. Assuming Westlake garage access can be exit only, and "No Right Turn" from EB Mercer to SB Westlake (vehicles would use 9th), streetcar would be exclusive through the Mercer intersection to the stop platform far side of Mercer. Exiting vehicles may need to continue through Westlake/Republican intersection, rather than having a BAT lane at Republican. If so, provide BAT lane at Harrison.
15	SB Westlake, Republican to John	Traffic congestion blocks travel lanes	F						✓									▪ Would require eliminating parking on west side of Westlake ▪ See #16
16	SB Westlake, John	Traffic congestion blocks travel lanes	B,H		✓						✓							▪ See #15
17	SB Westlake, Valley to Stewart	Loss of Opticom priority at intersections	J										✓					

Analysis Results

This section describes analysis results for the South Lake Union Streetcar route between Republican and the northern terminus at Fairview/Yale as well as at the Westlake Avenue and Denny Street intersection. These areas were selected because they represented the most congested part of the corridor and had readily available information to conduct the analysis. Following this discussion is an estimate of the potential travel time improvement for the SLU system between Fairview Avenue and Westlake Center based on the partial VISSIM analysis, field observations, and professional judgment.

Study Intersections and Treatments

Priority treatments at five intersections along the existing South Lake Union Streetcar route were modeled, as shown in Figure H-5 below. As already identified, similar improvements could be considered at other intersections in the South Lake Union Streetcar system.

Figure H-5 South Lake Union: Traffic Study Intersections/Improvements

ID #	Intersection	Improvements
1	Westlake Avenue & Valley Street	▪ No Right Turn on Red ▪ Add TSP ▪ Traffic Law Enforcement ▪ Do Not Block Intersection signage/striping ▪ Illuminated "Streetcar Approaching" signage
2	Westlake Avenue & Mercer Street	▪ Do Not Block Intersection signage/striping ▪ Illuminated "Streetcar Approaching" signage ▪ Signal Timing Adjustments
3	Westlake Avenue & Denny Way	▪ Do Not Block Intersection signage/striping ▪ Illuminated "Streetcar Approaching" signage ▪ Signal Timing Adjustment
4	Valley Street & Fairview Avenue	▪ Add TSP ▪ Do Not Block Intersection signage/striping ▪ Illuminated "Streetcar Approaching" signage
5	Terry Avenue & Mercer Street	▪ Modify Existing Opticom System ▪ Illuminated "Streetcar Approaching" signage

Existing Conditions Travel Time Study

An Existing Conditions travel time study of the entire SLU route was conducted on March 19th, 2014, to help understand the causes of delay to the streetcar. The travel time study was conducted during the PM peak period from 4:00 to 6:00 p.m., with 4 runs completed in each direction and results averaged. Travel time along the route was broken down at each block by run time, station dwell time, signal delay (delay attributable to waiting at a red signal at an intersection), queue delay (delay attributable to waiting in a queue of vehicles caused by downstream congestion), or pedestrian conflict delay (delay attributable to waiting to turn right at intersections across cross walks with high volumes of pedestrians). Streetcar travel time results for Existing Conditions is presented below in Figure H-6 and Figure H-7 for the northbound and southbound directions, respectively.

In the northbound direction, the streetcar experiences approximately four minutes of queue and signal delay along Westlake Avenue between 9th Avenue/Blanchard Street and Denny Way. At the Westlake Avenue and Denny Street intersection, existing observations of the streetcar in the northbound direction on Westlake Avenue between 7th Avenue and Denny Way revealed signal coordination that caused noticeable streetcar delays. The signal timings along Westlake Avenue between 9th Avenue/Blanchard Street and Denny Way is such that when the northbound approach at Denny Way is green, the eastbound approach at 9th Avenue/Blanchard Street is green. This results in the northbound approach of 9th Avenue/Blanchard Street receiving a green signal when the northbound approach of Denny Way is receiving a red signal. KC Metro Route 40 uses Blanchard Street to travel northbound and turn left onto northbound Westlake Avenue, while Sound Transit Route 554 uses northbound Blanchard Street to turn right onto southbound Westlake Avenue. A few other KC Metro routes were observed using Blanchard Street to either return to their base or start a new route.

In the southbound direction, the streetcar experiences approximately four minutes of delay at the intersection of Valley Street/Fairview Avenue. The delay is caused by vehicle queues spilling back from the intersection of Mercer Street and Fairview Avenue. An additional 35 seconds of queue delay was observed at the intersection of Westlake Avenue/Mercer Street.

Figure H-6 South Lake Union: Existing Conditions Northbound Travel Time Results, PM Peak

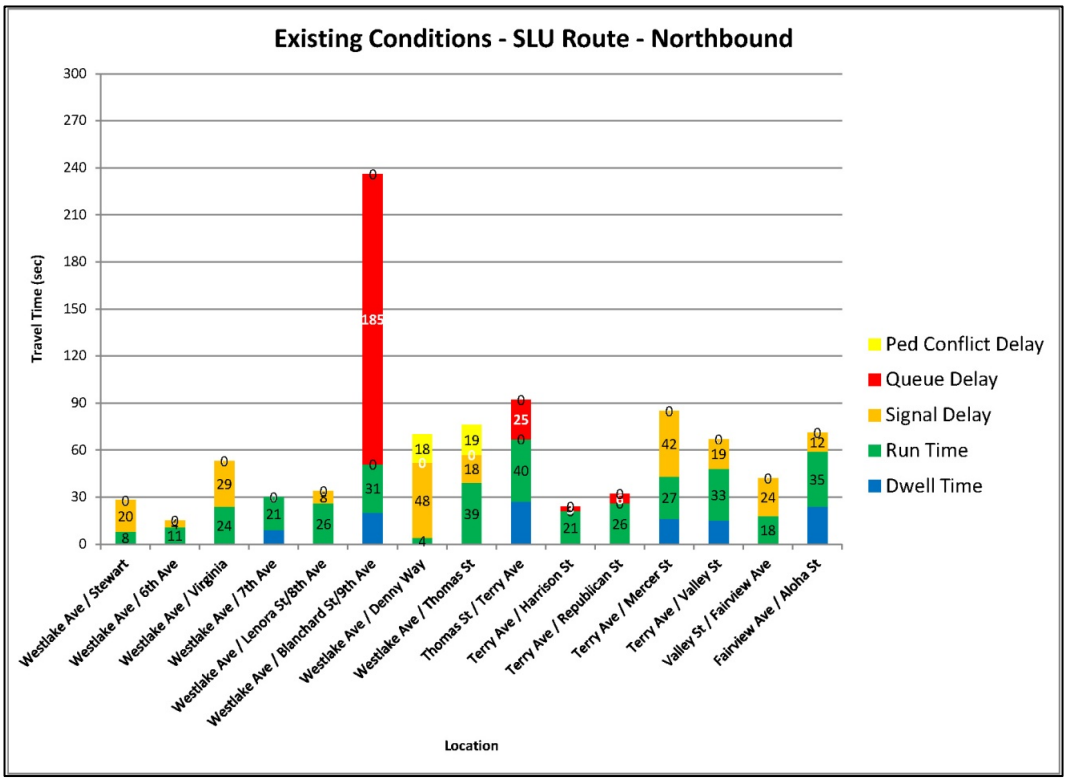
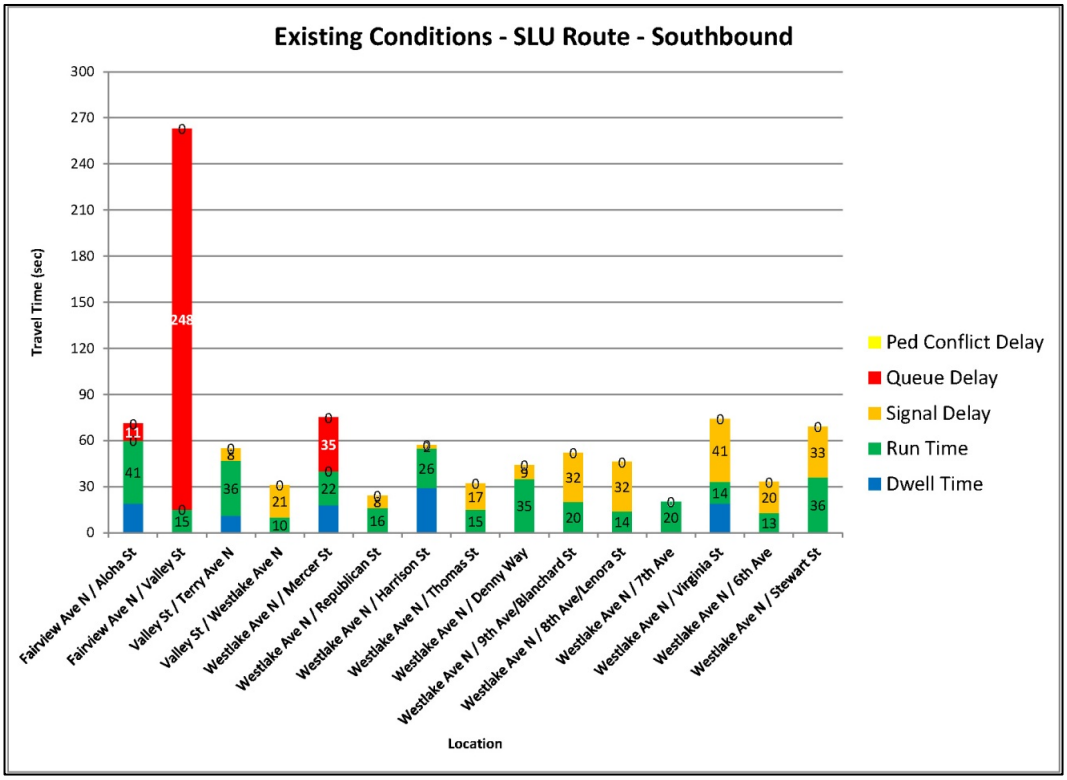


Figure H-7 South Lake Union: Existing Conditions Southbound Travel Time Results, PM Peak



Intersection LOS

Figure H-8 compares the year 2030 intersection Level of Service (LOS) of the Mixed-Traffic Streetcar alternative with the Exclusive Streetcar alternative. Overall, average vehicle delay at the intersections is similar between the Mixed-Traffic and Exclusive Streetcar alternatives.

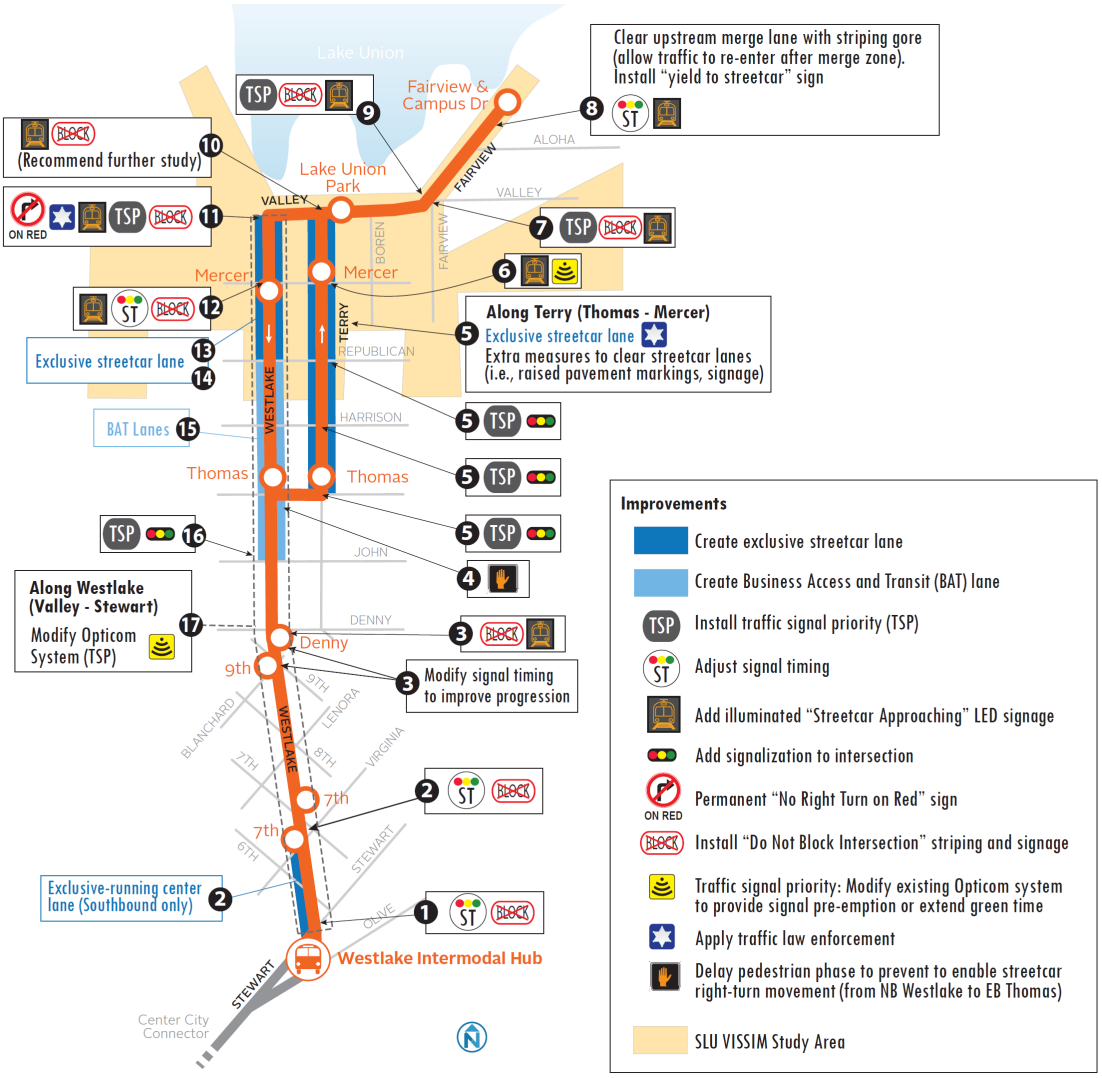
Figure H-8 South Lake Union: 2030 Synchro LOS and Delay (Seconds), PM

			2030 Mixed-Traffic Streetcar		2030 Exclusive Streetcar	
ID#	Major Street	Cross Street	LOS	Delay (in sec.)	LOS	Delay (in sec.)
1	Westlake Avenue	Valley Street	F	80	F	81
2	Westlake Avenue	Mercer Street	F	156	F	156
3	Westlake Avenue	Denny Way	F	121	F	121
4	Fairview Avenue	Valley Street	E	67	E	72
5	Terry Ave	Mercer Street	C	34	C	30
	Average Intersection Delay		**N/A**	**87.6**	**N/A**	**88.0**

Streetcar Travel Time Results

Northbound and southbound streetcar travel times between the Mixed-Traffic Streetcar and Exclusive Streetcar alternatives were compared using VISSIM. The study area for the VISSIM modeling is shown below in Figure H-9. Northbound streetcar travel time was measured from the intersections of Republican Street/Terry Street to Fairview Avenue/Aloha Street, while southbound streetcar travel time was measured from the intersections of Fairview Avenue/Aloha Street to Westlake Avenue/Republican Street.

Figure H-9 South Lake union: Study Area (Map)



With the Exclusive Streetcar alternative, the proposed improvements resulted in about a two minute travel time savings for the northbound direction, with most of the savings occurring along Terry Ave between Republican Street and Mercer Street where TSP is provided. In the southbound direction, a majority of streetcar savings (about three minutes) is along Westlake Avenue where TSP and an exclusive streetcar lane are provided to prevent general traffic from blocking the streetcar. Figure

H-10 shows the average travel time savings between the Mixed-Traffic Streetcar and Exclusive Streetcar alternatives.

Figure H-10 South Lake Union: 2030 PM Peak Hour Northbound Streetcar Travel Time Comparison

Travel Time (Min)	Northbound Streetcar			Southbound Streetcar		
Road Segment	Mixed	Exclusive	Delta	Mixed	Exclusive	Delta
1) Republican Street to Valley Street	4.8	2.8	-2.0	2.0	1.2	-0.8
2) Valley Street to Fairview Turnaround	2.2	2.1	-0.1	9.1	7.0	-2.1
Total =	7.0	4.9	-2.1	11.1	8.1	-2.9

At the Westlake Avenue and Denny Street intersection, existing observations of the streetcar in the northbound direction on Westlake Avenue between 7th Avenue and Denny Way revealed poor signal progression which caused noticeable streetcar delays. A VISSIM model of the two intersections along Westlake Avenue between Denny Way and 9th Avenue/Blanchard Street was created to analyze the proposed signal timing adjustments. Modifying the signal timing between these two intersections would likely result in a streetcar travel time savings of up to three minutes in the northbound direction, with minor delays on the eastbound approach of Blanchard Street.

Auto Travel Time and Throughput

Auto travel times along Mercer Street were compared between the two alternatives to understand if the proposed streetcar improvements would affect traffic flow in the study area. Figure H-11 shows the estimated auto travel time along Mercer Street. East and westbound trips continue to experience congestion but the proposed streetcar improvements do not noticeably impact the auto travel time. Figure H-12 shows the estimated auto vehicle throughput comparison for Mercer Street and Westlake Avenue. For both roads, the auto throughput is the similar between the two alternatives.

Figure H-11 South Lake Union: 2030 PM Peak Hour Mercer Street Auto Travel Time

Travel Time (Min)	Eastbound		Westbound	
Segments of Mercer Street	Mixed	Exclusive	Mixed	Exclusive
1) I-5 Off-Ramp to Terry	0.9	0.8	2.4	2.8
2) Terry to Dexter	1.7	1.5	2.5	1.6
Total =	2.6	2.3	4.8	4.4

Figure H-12 South Lake Union: 2030 PM Peak Hour Auto Vehicle Throughput

Road Segment	Mixed-Traffic Streetcar		Exclusive Streetcar	
	NB/EB	SB/WB	NB/EB	SB/WB
Mercer Street - Westlake Ave to Fairview Ave	1861	1612	1947	1670
Westlake Avenue - Valley St to Mercer St	1080	190	1073	208

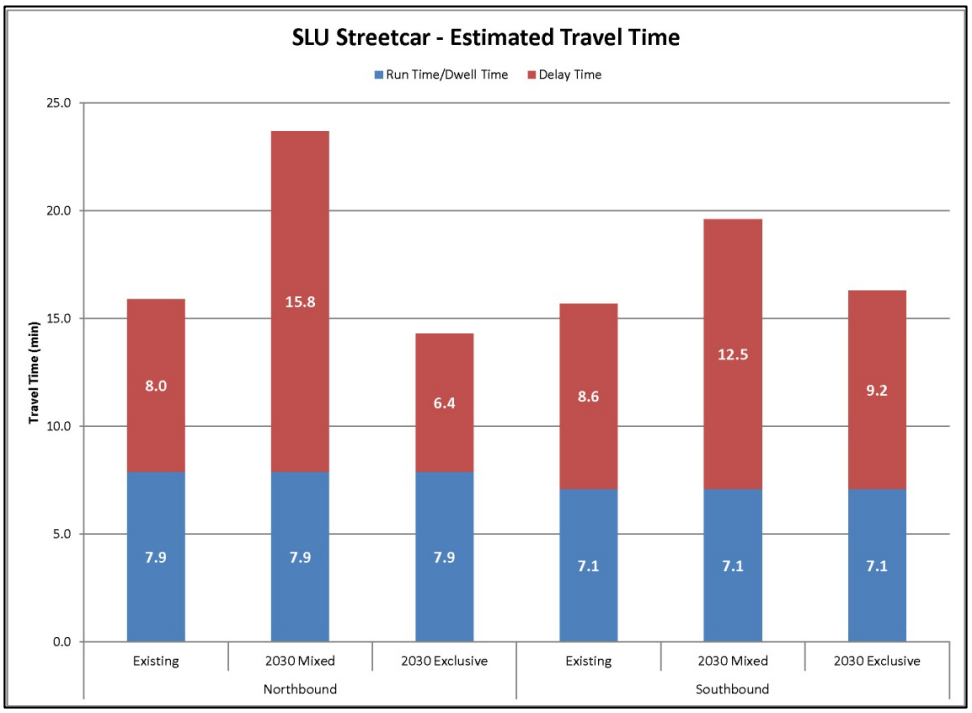
Preliminary Estimate of Full SLU Corridor Travel Time Improvements

This section provides an estimate of potential travel time improvement throughout the entire SLU area based on the VISSIM analysis, field observations, and application of the analysis results based on professional judgment. The streetcar travel time through the SLU area for the 2030 Mixed-Traffic Streetcar alternative was estimated from the existing streetcar travel time determined from field observations with an estimate of the additional delay in the future based on the VISSIM modeling of the 2030 Streetcar Mixed-Traffic alternative. The travel time for the 2030 Exclusive Streetcar alternative was estimated by utilizing the same run time and station dwell time from the existing streetcar field observations and estimating the travel time savings from the countermeasures analyzed at specific locations in the VISSIM modeling in the northern part of the study area and applying them throughout the SLU corridor.

The travel times for the Existing Condition, 2030 Mixed-Traffic Streetcar, and 2030 Exclusive Streetcar alternatives are presented below in Figure H-13. In the northbound direction, the delay experienced by the streetcar is estimated to be reduced approximately 60% (from about 16 to about 6.5 minutes) with the proposed countermeasures. This would reduce the total northbound streetcar travel time from about 24 minutes in the 2030 Mixed-Traffic alternative to slightly less than 15 minutes in the 2030 Exclusive alternative, which would be a slightly lower than existing streetcar travel time. The locations that would experience the most benefit in the northbound direction include Westlake Avenue between 9th Avenue/Blanchard Street and Denny Way (due to proposed signal timing adjustments) and Terry Avenue between Thomas Street and Mercer Street (due to new signals along Terry Avenue and TSP at the Mercer Street/Terry Avenue intersection).

In the southbound direction, the delay experienced by the streetcar would be reduced by approximately 25% (from about 12.5 to about 9 minutes). This would reduce the total southbound streetcar travel time from slightly less than 20 minutes in the 2030 Mixed-Traffic Streetcar alternative to about 16 minutes in the Exclusive Streetcar alternative, which would be within 1 minute of the existing streetcar travel time. The locations that would experience the most benefit in the southbound direction include Fairview Avenue between Aloha Street and Valley Street (due to signal timing adjustments, TSP and "Don't Block Box" restrictions), Westlake Avenue between Valley Street and Republican Street (due to TSP and an exclusive streetcar lane), and Westlake Avenue between Virginia Street and Stewart Street (due to an exclusive streetcar lane).

Figure H-13 South Lake Union: Estimated Travel Time Results



Treatments and Results for First Hill Line (South Jackson Street)

Proposed Priority Treatments

The First Hill Streetcar line is currently under construction with service on South Jackson Street scheduled to begin in 2014. As such, there are no specific locations currently identified as needing improvements to improve the streetcar performance. However, traffic models developed during the First Hill Streetcar project design anticipate peak hour congestion on Jackson Street. The project team identified several potential measures that could be applied on Jackson, as shown in Figure H-14 and Figure H-15 below:

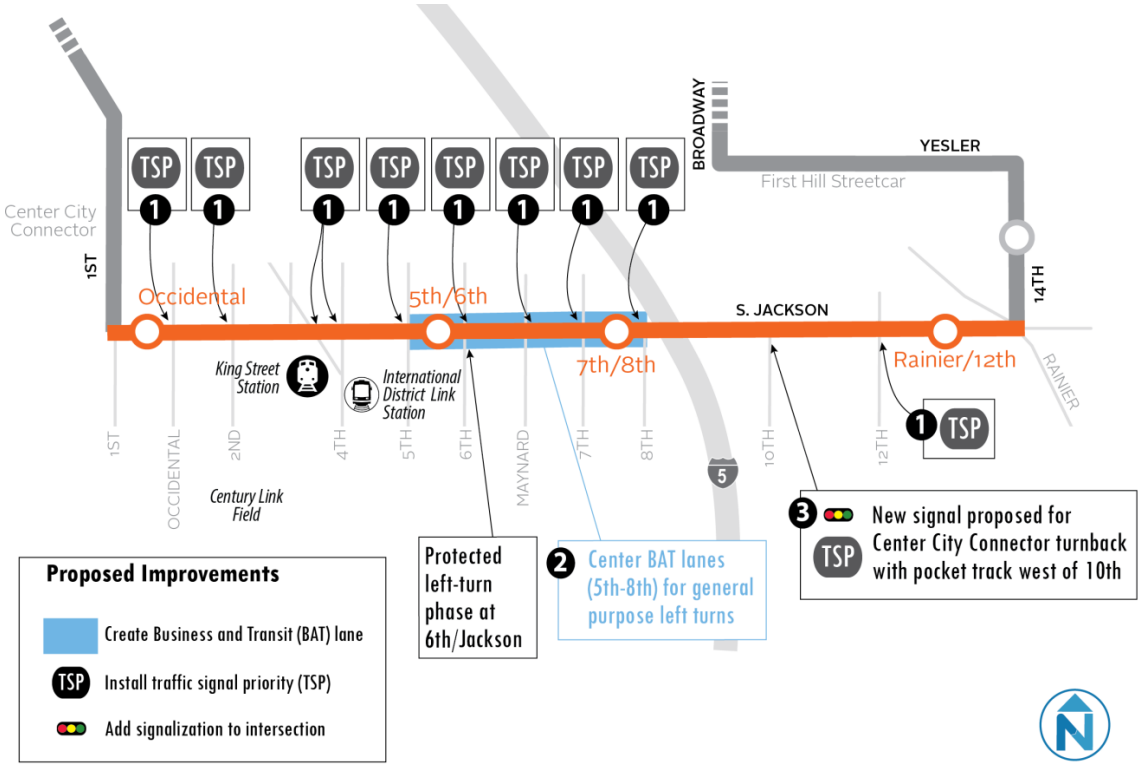
- Adding TSP via Opticom at all signalized intersections would provide signal pre-emption and/or extend "green time"
- Designating the center lanes between 5th and 8th Avenues as BAT lanes would reserve the center travel lanes on Jackson for transit and left-turning vehicles only

Figure H-14 First Hill (S. Jackson Street): Proposed Priority Treatments (Table)

Map Identifier	Cross-Streets	Purpose of Treatment	Potential Measures for Improvement	B – Add TSP	F – Create BAT lane	G - Signalization	Additional Notes/Discussion
1	Occidental – 12th	TSP and/or signal timing to reduce delay to streetcar	B	✓			
2	5th-8th	Center BAT lanes to reduce delay to streetcar	F	✓	✓		
3	10th	New signal for streetcar turnback and storage	B, G	✓		✓	Turnback with storage is required for Hub-to-Hub Center City Connector operating scenario.

Note: It is assumed that signal timing on South Jackson would be adjusted in conjunction with opening of the First Hill Streetcar.

Figure H-15 First Hill (South Jackson Street): Potential Priority Treatments



Analysis Results

This section describes analysis results for the portion of the First Hill Streetcar route along South Jackson Street. The traffic analysis focused on the orange-highlighted area shown in Figure H-15. The 1st Avenue/ South Jackson Street intersection that was included in the Center City Connector Tier 2 evaluation is not included in this analysis.

Study Area, Intersections and Assumptions

The area considered for improvements along the First Hill Streetcar route includes South Jackson Street between 1st Avenue and 12th Avenue. VISSIM models previously developed for the First Hill Streetcar route were used to evaluate the proposed improvements on South Jackson Street.

Streetcar and auto travel time results are provided along South Jackson Street between 2nd Avenue and 10th Avenue, while intersection analysis was conducted at four study intersections, as seen in Figure H-16. The Seattle Center City Connector route along 1st Avenue was also integrated into the First Hill Streetcar VISSIM model with a turnaround signal located at South Jackson Street/10th Avenue for streetcars just carrying passengers between Jackson Street and Westlake Hub. Streetcars using the Center City Connector route were assigned ten minute headways and travelled between 1st Avenue and the turnaround at 10th Avenue, while streetcars traveling the First Hill route were also assigned ten minute headways but were offset from the Center City Connector route by 5 minutes. This

results in an effective headway of 5 minutes on South Jackson Street west of 10th Avenue and a 10 minute headway east of 10th Avenue.

Figure H-16 First Hill (S. Jackson Street): Traffic Study Intersections and Exclusive Alternative Improvements

ID #	Intersection	Exclusive Alternative Improvements
9	S Jackson Street & 2nd Avenue	▪ Add TSP ▪ BAT Lane
7	S Jackson Street & 4th Avenue	▪ Add TSP ▪ BAT Lane
8	S Jackson Street & 5th Avenue	▪ Add TSP ▪ BAT Lane
6	S Jackson Street & 6th Avenue	▪ Add TSP ▪ BAT Lane ▪ Add Protected Left-Turn Phase

Intersection LOS

Figure H-17 provides an intersection LOS comparison between the Mixed-Traffic Streetcar alternative and the Exclusive Streetcar alternative. Three of the four study intersections along South Jackson Street (2nd Avenue, 4th Avenue, and 5th Avenue) operate at LOS C or better under either alternative, while South Jackson Street / 6th Avenue experiences deterioration from LOS C in the Mixed-Traffic Streetcar alternative to LOS E in the Exclusive Streetcar alternative. The increase in average delay at South Jackson Street / 6th Avenue in the Exclusive Streetcar alternative is caused by a combination of the high volume of westbound left-turns and the eastbound through and right-turning vehicles consolidated into one shared travel lane. The protected westbound left-turn phase assumed in the Exclusive Streetcar alternative takes green time away from vehicles traveling north and south on 6th Avenue.

Figure H-17 First Hill (S. Jackson Street): 2030 Synchro LOS and Delay

ID#	Major St	Cross St	2030 Mixed-Traffic Streetcar		2030 Exclusive Streetcar	
			LOS	Delay (in sec.)	LOS	Delay (in sec.)
9	Jackson St	2nd Ave	B	14	B	14
7	Jackson St	4th Ave	C	26	C	26
8	Jackson St	5th Ave	B	16	C	21
6	Jackson St	6th Ave	C	24	E	56
	Average Intersection Delay		N/A	20	N/A	29

Streetcar and Auto Travel Times

Figure H-18 shows the travel time summary for both auto vehicles and streetcar. The streetcar would experience a 15% savings in travel time in the Exclusive Streetcar alternative compared to the Mixed-Traffic Streetcar alternative with little change in travel time for auto vehicles. Figure H-19 shows the average speed for both autos and streetcar on South Jackson Street. As with travel time, average speed for streetcar vehicles would increase by 17% in the Exclusive Streetcar alternative compared to the Mixed-Traffic Streetcar alternative with a small change to auto speeds.

Figure H-18 First Hill (S. Jackson Street): 2030 Travel Time Summary (Minutes)

Segment of Jackson	Auto							Streetcar						
	Mixed-Traffic Streetcar			Exclusive Streetcar				Mixed-Traffic Streetcar			Exclusive Streetcar			
	EB	WB	Avg (both dir)	EB	WB	Avg (both dir)	% Change from Mixed-Traffic	EB	WB	Avg (both dir)	EB	WB	Avg (both dir)	% Change from Mixed
2nd to 6th Ave	2.2	2.2	2.2	2.3	1.9	2.1	-5%	3.0	3.2	3.1	2.3	2.4	2.4	-23%
6th to 10th Ave	1.2	1.3	1.3	1.2	1.3	1.3	0%	1.7	2.4	2.1	1.9	2.1	2.0	-5%
Total =	**3.4**	**3.5**	**3.5**	**3.5**	**3.2**	**3.4**	**-3%**	**4.7**	**5.6**	**5.2**	**4.2**	**4.5**	**4.4**	**-15%**

Figure H-19 First Hill (S. Jackson Street): 2030 Average Speed Summary (mph)

Segment of Jackson	Auto							Streetcar						
	Mixed-Traffic Streetcar			Exclusive Streetcar				Mixed-Traffic Streetcar			Exclusive Streetcar			
	EB	WB	Avg (both dir)	EB	WB	Avg (both dir)	% Change from Mixed-Traffic	EB	WB	Avg (both dir)	EB	WB	Avg (both dir)	% Change from Mixed-Traffic
2nd to 6th Ave	8	8	8	8	10	9	6%	6	6	6	8	8	8	32%
6th to 10th Ave	16	15	16	16	15	16	-1%	12	8	10	10	9	10	-1%
Average =	**11**	**11**	**11**	**11**	**12**	**11**	**3%**	**8**	**7**	**7**	**9**	**8**	**9**	**17%**

Auto Throughput

Figure H-20 shows vehicle throughput on Jackson Street between 2nd Avenue and 6th Avenue. Vehicle throughput is similar between the Mixed-Traffic Streetcar and Exclusive Streetcar alternatives.

Figure H-20 First Hill (S. Jackson Street): 2030 Vehicle Throughput

Segment of Jackson	Mixed-Traffic Streetcar		Exclusive Streetcar	
	EB	WB	EB	WB
2nd Ave to 6th Ave	506	738	503	748

BAT Lane Conflict with Curbside Bus Stops

The proposed BAT lane on South Jackson Street between 5th Avenue and 8th Avenue could create a potential conflict between autos and buses. The proposed BAT lane would be intended for transit vehicles (bus and streetcar) only and autos turning left at intersections. KC Metro currently has two curbside bus stops on South Jackson Street in each direction between 5th Avenue and 8th Avenue. When buses are stopped at these curb-side bus stops they would block autos from traveling through on South Jackson Street. This could potentially cause autos to weave into and use the BAT lane to drive around the stopped buses. In addition, buses with stops on South Jackson Street between 5th Avenue and 8th Avenue (such as routes 1, 7, 14, 36, 49, 99, and 984) may avoid using the BAT lane so they can stay in the right-side curb lane to arrive at their bus stop. This potential vehicle-bus conflict would need to be evaluated and designed further.

Key Findings

Figure H-21 summarizes estimated travel time improvements from the South Lake Union Streetcar line and the South Jackson Street segment of the First Hill Streetcar line for a 2030 analysis year.

Figure H-21 Average One-Way Travel Time by Direction with/without Modeled Treatments

Line (Segment)	Direction	Before Improv. (Min)	With Improv. (Min)	Improv. (Min)	% Change (Improv.)
South Lake Union (Westlake Station to Fairview Turnaround)	NB	23.7	14.3	-9.4	-40%
	SB	19.6	16.3	-3.3	-17%
	Average 1-Way	21.7	15.3	-6.4	-29%
	Total Round Trip	43.3	30.6	-12.7	-29%
First Hill (South Jackson Street from 2nd Avenue to 10th Avenue)	EB	4.7	4.2	-0.5	-11%
	WB	5.6	4.5	-1.1	-20%
	Average 1-Way	5.2	4.4	-0.8	-16%
	Total Round Trip	10.3	8.7	-1.6	-16%

South Lake Union:

- The streetcar would experience about a 17-40% improvement in travel time between Fairview Avenue/Valley Street and Republican Street, or an average of approximately six minutes per direction.
- Auto trips on Mercer Street would see no change in east-west travel time or vehicle throughput as a result of the Exclusive Streetcar alternative.
- The proposed signal adjustments along Westlake Avenue at Denny Way and 9th Avenue/Blanchard Street would result in a travel time savings of three minutes in the northbound direction.
- In the future, without improvements, SLU streetcar peak period travel times are expected to typically range from 20 to 24 minutes. The estimated benefit from the proposed treatments would reduce average streetcar travel time to approximately 14 to 16 minutes,

which would be similar to the current operating travel times typically experienced in the peak period.

First Hill (South Jackson Street):

- The streetcar would experience about a 10% to 20% improvement in travel time between 2nd and 10th Avenues, or slightly less than one minute per direction.
- There seems to be sufficient auto capacity on South Jackson Street to handle TSP and a BAT lane. Therefore, only minimal impacts to auto performance (travel time and throughput) are expected. A potential vehicle conflict that would require further evaluation is autos that may use the BAT lane to pass buses stopped at the existing curbside stops.
- The analysis showed the Jackson Street/6th Avenue intersection is at capacity and would degrade to LOS E with the exclusive scenario. This is caused by high turning volumes that take signal time away from through movements. Further evaluation of this intersection would be required, however creating small north and south-bound turn pockets on 6th Avenue could help offset the increased delay. This would require trimming curb bulbouts on 6th Avenue (similar to the existing curb bulbs that are being trimmed on Jackson Street as part of First Hill Streetcar construction). Some parking spaces may need to be eliminated near the intersection. Another possibility would be to restrict some left-turns during peak periods.

Next Steps

The results of this analysis will be incorporated into traffic analysis and refinements to the streetcar operating plan in the subsequent design and environmental phase of the Center City Connector Project.

APPENDIX I PARKING AND LOADING IMPACTS ASSESSMENT

Note: This appendix provides additional details on the Tier 2 parking and loading impact analysis, which was summarized in Chapter 7 of the Detailed Evaluation Report.[1]

Introduction

This appendix describes the methodology used for the Tier 2 assessment of potential parking, loading zone, and driveway impacts of alternatives for the Center City Connector. This assessment was conducted based on preliminary conceptual designs for the Mixed-Traffic and Exclusive Streetcar alternatives as well as a No-Build alternative. Final parking and loading impacts will be determined during preliminary engineering and final design.

Approach/Methodology

Existing conditions were initially evaluated through a visual survey of the project corridor using Google Street View. This approach allowed for a quick survey of the study area without requiring a site visit. Limitations of the imagery, however, such as obstructed views or blurry signs, necessitated certain assumptions and estimations which are described below. A follow-up field survey was conducted to fill in gaps in the web-based visual survey.

Counts for the two alternatives describe the number of spaces that would be retained or created under each alternative. It was assumed that parking spaces and loading zones would be retained under the Mixed-Traffic Streetcar alternative except on blocks where the alignment runs in the curbside lane. For the Exclusive Streetcar alternative, it was assumed that spaces would only be retained as shown in the project design. It was assumed that the No-Build alternative would have the same parking, loading, and driveway configuration as current conditions.

Parking

Parking spaces were inventoried including any spaces which are available for parking for any duration of time and during any period of the day. For blocks without delineated parallel parking spaces, the space available for parking was divided into twenty-foot long parking spaces. In some cases the length of parking zones was estimated due to obstructions in the Street View imagery that made it difficult to delineate the edges of parking zones.

[1] Prepared by URS and Nelson\Nygaard

Loading Zones

Curb spaces were counted as loading zones if they were identified by signage or curb painting; yellow-painted curbs indicate general loading zones and white-painted curbs indicate loading zones. Each vehicle space was counted as one loading zone, so a single signed or painted zone with space for two vehicles was counted as two zones. Many of the loading zones are also general parking zones during off-peak hours. In a few instances, obstructed views required estimation of loading zone boundaries.

Driveways

Driveways were counted if they served as unique in/out access points, which did not include all curb cuts. One alleyway curb cut was counted as a driveway because it fed directly into a surface parking lot. It was assumed that driveway access would not be affected by either alternative.

Field Verification

The Google Street View imagery for the project alignment was captured in June 2011, while the Seattle City Center Connector parking analysis was performed in October 2013. Due to the more than two-year time lapse, there was the potential that parking and loading locations and restrictions had changed since the imagery was originally captured. In addition, obstructed views of curbs and signs made it difficult to determine with certainty the parking status of various points along the project alignment. To account for these uncertainties, a field check of the parking and loading assessment was conducted on foot along 1st Avenue between S Jackson Street and Pine Street. Parking and loading area counts were updated accordingly.

Assessment

Figure I-1, Figure I-2, and Figure I-3 provide detailed parking and loading zone analysis results in tabular form. Figure I-4 and Figure I-5 present the parking and loading zone impacts graphically.

Figure I-1 All Day Parking Summary

1st Avenue All Day Parking		West Side/ North Side (Stewart Blocks)			East Side/ South Side (Stewart Blocks)			Total Spaces		
Block #	Block Name	Existing	Mixed	Exclusive	Existing	Mixed	Exclusive	Existing	Mixed	Exclusive
1	Jackson - Main	0	0	0	0	0	0	0	0	0
2	Main - Washington	0	0	0	0	0	0	0	0	0
3	Washington - Yesler	0	0	0	0	0	0	0	0	0
4	Yesler - Cherry	0	0	0	0	0	0	0	0	0
5	Cherry - Columbia	0	0	0	0	0	0	0	0	0
6	Columbia - Marion	0	0	3	0	0	0	0	0	3
7	Marion - Madison	0	0	0	0	0	0	0	0	0
8	Madison - Spring	0	0	0	0	0	0	0	0	0
9	Spring - Seneca	0	0	0	0	0	0	0	0	0
10	Seneca - University	5	5	5	0	0	0	5	5	5
11	University - Union	0	0	5	0	0	0	0	0	5
12	Union - Pike	0	4	0	0	0	0	0	4	0
13	Pike - Pine	0	0	0	0	0	0	0	0	0
14	Pine - Stewart	0	0	0	0	0	0	0	0	0
15	Stewart/1st - 2nd	7	3	3	9	3	3	16	6	6
16	Stewart/2nd - 3rd	0	0	0	0	0	3	0	0	3
17	Stewart/3rd - 4th	0	0	0	0	0	0	0	0	0
18	Stewart/Olive/4th - 5th	0	0	0	6	0	0	6	0	0
19	Stewart/Westlake/ 5th - 6th	0	0	0	0	0	0	0	0	0
	Total # of Parking Spaces:	**12**	**12**	**16**	**15**	**3**	**6**	**27**	**15**	**22**

Figure I-2 Peak-Restricted Parking Summary

1st Avenue Peak-Restricted Parking		West Side/ North Side (Stewart Blocks)			East Side/ South Side (Stewart Blocks)			Total Spaces		
Block #	Block Name	Existing	Mixed	Exclusive	Existing	Mixed	Exclusive	Existing	Mixed	Exclusive
1	Jackson - Main	5	0	0	3	3	0	8	3	0
2	Main - Washington	9	9	0	9	9	0	18	18	0
3	Washington - Yesler	3	0	0	8	0	0	11	0	0
4	Yesler - Cherry	7	0	0	0	0	0	7	0	0
5	Cherry - Columbia	6	6	0	8	8	0	14	14	0
6	Columbia - Marion	4	4	0	6	6	0	10	10	0
7	Marion - Madison	0	0	0	0	0	0	0	0	0
8	Madison - Spring	5	0	0	6	0	0	11	0	0
9	Spring - Seneca	9	9	0	9	7	0	18	16	0
10	Seneca - University	0	0	0	8	6	0	8	6	0
11	University - Union	0	0	0	4	0	0	4	0	0
12	Union - Pike	7	3	0	4	0	0	11	3	0
13	Pike - Pine	0	0	0	5	5	0	5	5	0
14	Pine - Stewart	0	0	0	4	0	0	4	0	0
15	Stewart/1st - 2nd	0	0	0	0	0	0	0	0	0
16	Stewart/2nd - 3rd	0	0	0	4	0	0	4	0	0
17	Stewart/3rd - 4th	0	0	0	0	0	0	0	0	0
18	Stewart/Olive/4th - 5th	10	7	7	0	0	0	10	7	7
19	Stewart/Westlake/ 5th - 6th	0	0	0	0	0	0	0	0	0
	Total # of Parking Spaces:	**65**	**38**	**7**	**78**	**44**	**0**	**143**	**82**	**7**

Figure I-3 Loading Zone Summary

1st Avenue Loading Zones		West Side/ North Side (Stewart Blocks)			East Side/ South Side (Stewart Blocks)			Total Loading Zones		
Block #	Block Name	Existing	Mixed	Exclusive	Existing	Mixed	Exclusive	Existing	Mixed	Exclusive
1	Jackson - Main	1	1	0	2	2	0	3	3	0
2	Main - Washington	1	1	0	2	2	0	3	3	0
3	Washington - Yesler	2	0	0	2	0	0	4	0	0
4	Yesler - Cherry	0	0	0	0	0	0	0	0	0
5	Cherry - Columbia	2	2	0	0	0	0	2	2	0
6	Columbia - Marion	2	2	0	3	3	0	5	5	0
7	Marion - Madison	2	2	2	3	3	2	5	5	4
8	Madison - Spring	4	0	0	4	0	0	8	0	0
9	Spring - Seneca	2	2	0	0	0	0	2	2	0
10	Seneca - University	3	3	5	2	2	0	5	5	5
11	University - Union	3	3	0	3	3	0	6	6	0
12	Union - Pike	4	0	1	5	1	3	9	1	4
13	Pike - Pine	4	3	0	2	1	0	6	4	0
14	Pine - Stewart	0	0	0	1	0	0	1	0	0
15	Stewart/1st - 2nd	1	1	1	2	0	0	3	1	1
16	Stewart/2nd - 3rd	0	0	0	0	0	0	0	0	0
17	Stewart/3rd - 4th	0	0	0	0	0	0	0	0	0
18	Stewart/Olive/4th - 5th	2	2	0	8	8	0	10	10	0
19	Stewart/Westlake/ 5th - 6th	0	0	0	0	0	0	0	0	0
	Total # of Loading Zones:	33	22	9	39	25	5	72	47	14

Figure I-4 Parking Impacts

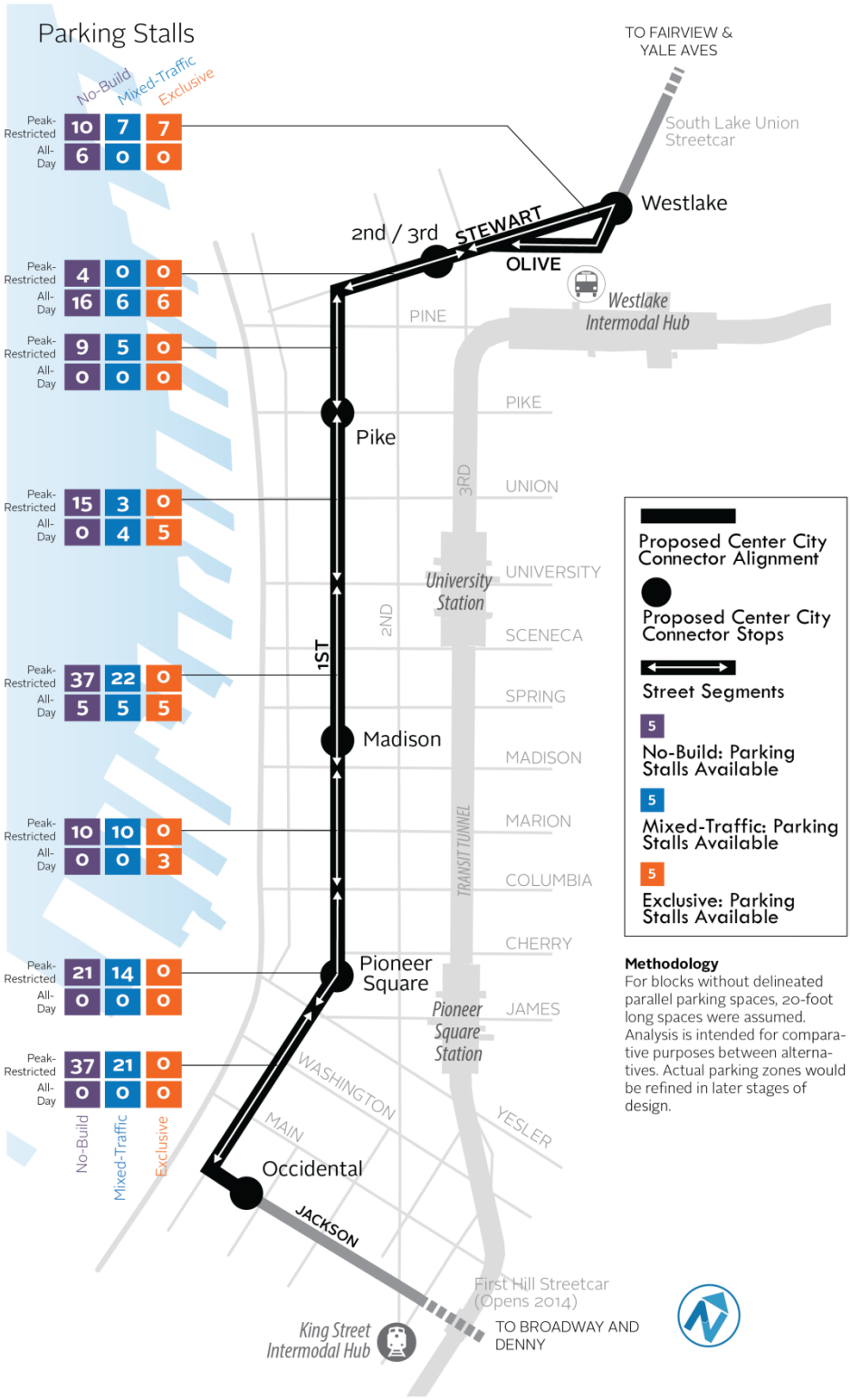
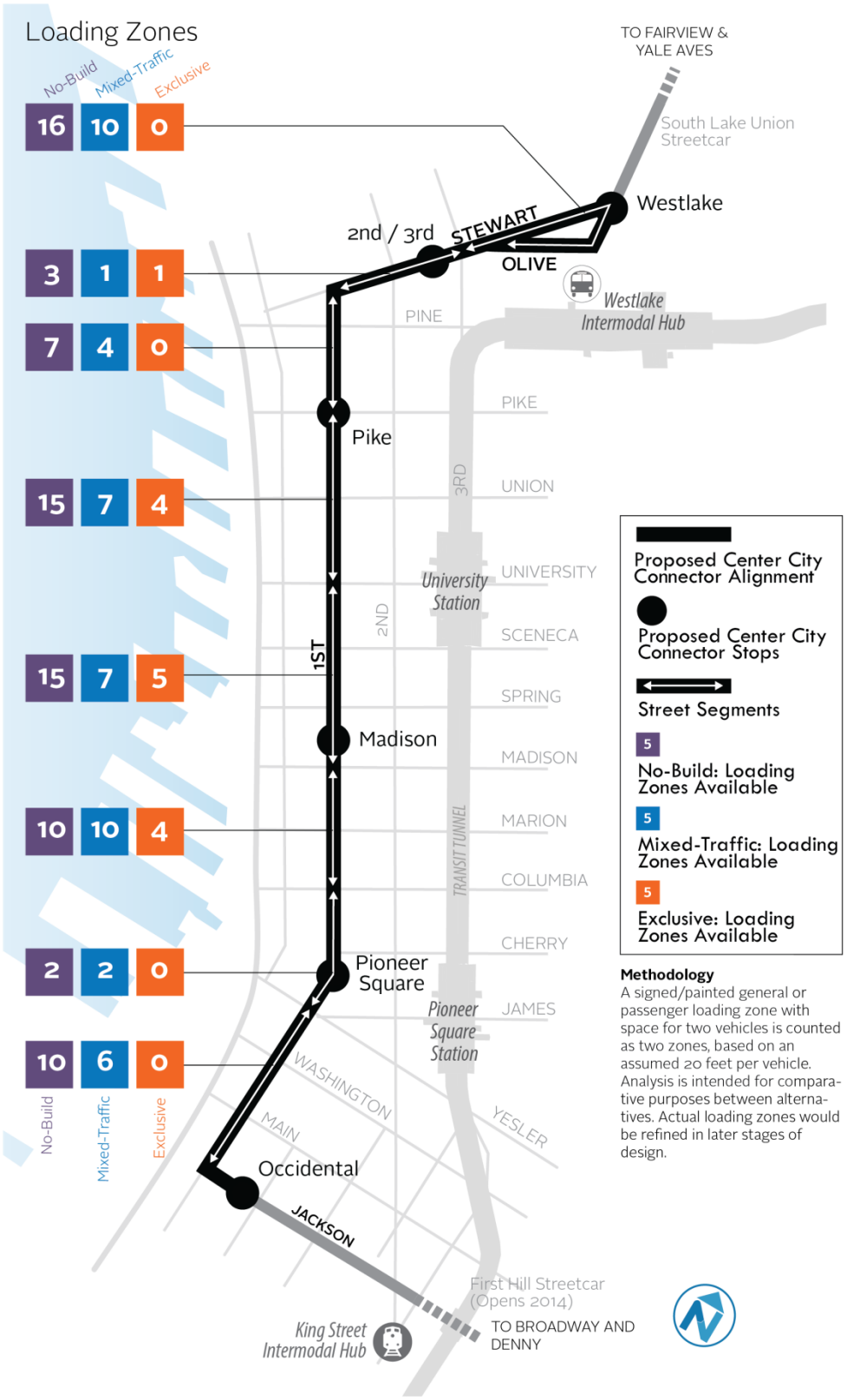


Figure I-5 Loading Impacts



APPENDIX J BUS OPERATIONS ANALYSIS

This appendix describes the methodology used to assess impacts to transit operations as part of the Tier 2 evaluation of alternatives for the Center City Connector. The Tier 2 evaluation of impacts to transit operations focused on potential bus vehicle delay resulting from the Mixed-Traffic and Exclusive Streetcar alternatives for the Stewart Street/Olive Way east-west connection between 1st Avenue and Westlake Avenue.

Alternatives Analyzed

The Tier 2 bus operations analysis was conducted only for the Stewart Street/Olive Way connection alternative, which was the east-west connection alternative that was included in the Tier 2 evaluation.

It is assumed that the 1st Avenue alignment would have minimal impacts to transit service since there is currently only one route operating on 1st Avenue (Route 99) with only two trips per hour during peak periods; moreover, this route would likely be restructured if a 1st Avenue streetcar alignment is developed, as was assumed in the Tier 2 traffic analysis.

Additional east-west connection options using Pike and Pine Streets will be analyzed in the environmental and design phase, including impacts to bus operations. Impacts on other bus services using portions of 1st Avenue will also be assessed.

Tier 2 Analysis Methodology

Study Area and Bus Volumes

The bus delay analysis conducted for the Tier 2 evaluation assessed impacts to bus routes operating on Stewart and Olive on weekdays between 5:00 and 6:00 p.m. Stewart Street and Olive Way are used by King County Metro, Community Transit, and Sound Transit buses. Bus volumes were obtained using these agencies' route alignments and published schedules as of Summer 2013. The analysis is for the 2018 opening year and therefore did not include any routes currently operating in the DSTT that may be routed on surface streets if buses are moved out of the DSTT in the future.

Stewart Street is one-way westbound between 1st Avenue and 3rd Avenue; mid-block between 3rd and 4th Avenues, Stewart Street (westbound) becomes a one-way couplet with Olive Way (eastbound). Westbound buses turn from Stewart Street onto either 3rd or 2nd Avenues.

All downtown Seattle-bound Community Transit routes use a significant portion of Stewart in either the AM or PM peak, depending on the route's downtown travel direction. A small number of King County Metro local routes and several suburban routes use portions of

Stewart and Olive. Sound Transit currently only uses Stewart between 5th and 6th Avenues and Olive between 4th and 5th Avenues.

Total bus volumes for buses operating on Stewart and Olive between 1st Avenue and 6th Avenue are shown in Figure J-1 and Figure J-2.[1]

[1] Volume data was compiled for the AM period however only the PM period was analyzed in Tier 2 (corresponding to the traffic analysis period); the AM period could also be evaluated in a future study phase.

Figure J-1 Stewart St./Olive Way AM Peak Hour Bus Volumes (7-8 AM)

	Block	BUS ROUTES																																															Total
		25	64	66	70	111	114	150	152	177	178	190	192	212	214	215	250	252	257	260	265	268	308	311	355	402	405	410	412	413	415	416	417	421	422	424	425	435	510	511	513	545	578	590	592	594	595	
WB	Stewart 5th-6th	1	4	2	4												2	4	2	2	3	1	1	4		7	2	3			3		2			1		3	5	4	1	7						68
	Stewart 4th-5th	1		2	4																		1			7	2	3			3		2			1		3										29
	Stewart 3rd-4th	1		2	4																		1			7	2	3			3		2			1		3										29
	Stewart 2nd-3rd																						1			7	2	3			3		2			1		3										22
	Stewart 1st-2nd																																															
EB	Olive 4th-5th	1		2		3	1		2	3	3			6	4	2	2								4				3	5		3		2			2		2	4		7		11	4		3	79
	Olive 3rd-4th	1		2																					4																							7
	Total	5	4	10	12	3	1		2	3	3			6	4	2	4	4	2	2	3	1	4	4	8	28	8	12	3	5	12	3	8	2		4	2	12	7	8	1	14		11	4		3	234

Note: Provided for reference; the AM peak period was not evaluated in this study phase.

Figure J-2 Stewart St./Olive Way PM Peak Hour Bus Volumes Trips (5-6 PM)

	Block	BUS ROUTES																																															Total
		25	64	66	70	111	114	150	152	177	178	190	192	212	214	215	250	252	257	260	265	268	308	311	355	402	405	410	412	413	415	416	417	421	422	424	425	435	510	511	513	545	578	590	592	594	595	
WB	Stewart 5th-6th	1		3	6					2	3	2	1												2				2	3		2		2			1		2	4		6						42
	Stewart 4th-5th	1		3	6					2	3	2	1												2				2	3		2		2			1											30
	Stewart 3rd-4th	1		3	6					2	3	2	1												2				2	3		2		2	1		1											31
	Stewart 2nd-3rd									2	3	2	1																2	3		2		2			1											18
	Stewart 1st-2nd																																																
EB	Olive 4th-5th	1	2	3								3					2	2	2	1	2	2		3		5	1	2			3		1		1	1		2	6	3	1	9	2	2		2		64
	Olive 3rd-4th	1		3																																													4
	Total	5	2	15	18					8	12	11	4				2	2	2	1	2	2		3	6	5	1	2	8	12	3	8	1	8	2	1	4	2	8	7	1	15	2	2		2		189

Bus Vehicle Delay Results

Inputs and Calculations

Bus Vehicle Travel Time and Delay by Block

Average travel time and delay per bus vehicle in the PM peak hour was obtained by block from VISSIM traffic analysis results for 2018. The inputs from the VISSIM model are shown in Figure J-3 for the No-Build, Mixed-Traffic Streetcar, and Exclusive Streetcar conditions.

Figure J-4 shows the conceptual right-of-way design for each streetcar alternative. In the westbound direction on Stewart Street, the Mixed-Traffic streetcar uses the middle lane, shifting to a stop on the northern curb west of 3rd Avenue. In the Exclusive Streetcar alternative, the streetcar uses a transit-only lane shared by buses and streetcar. The design concepts are similar in the eastbound direction.

The analysis indicates that both streetcar alternatives reduce bus travel time slightly relative to the No-Build condition. This is attributed to transit signal priority and improved signal timing coordination in both alternatives.

However, comparing the two streetcar alternatives, the Exclusive Streetcar alternative increases bus travel times slightly (by two seconds) compared to the Mixed-Traffic Streetcar alternative. The analysis shows that, compared to the Mixed-Traffic configuration, the Exclusive configuration has slightly lower bus travel times between 5th and 4th Avenues, but slightly higher bus travel times between 3rd and 2nd Avenues.

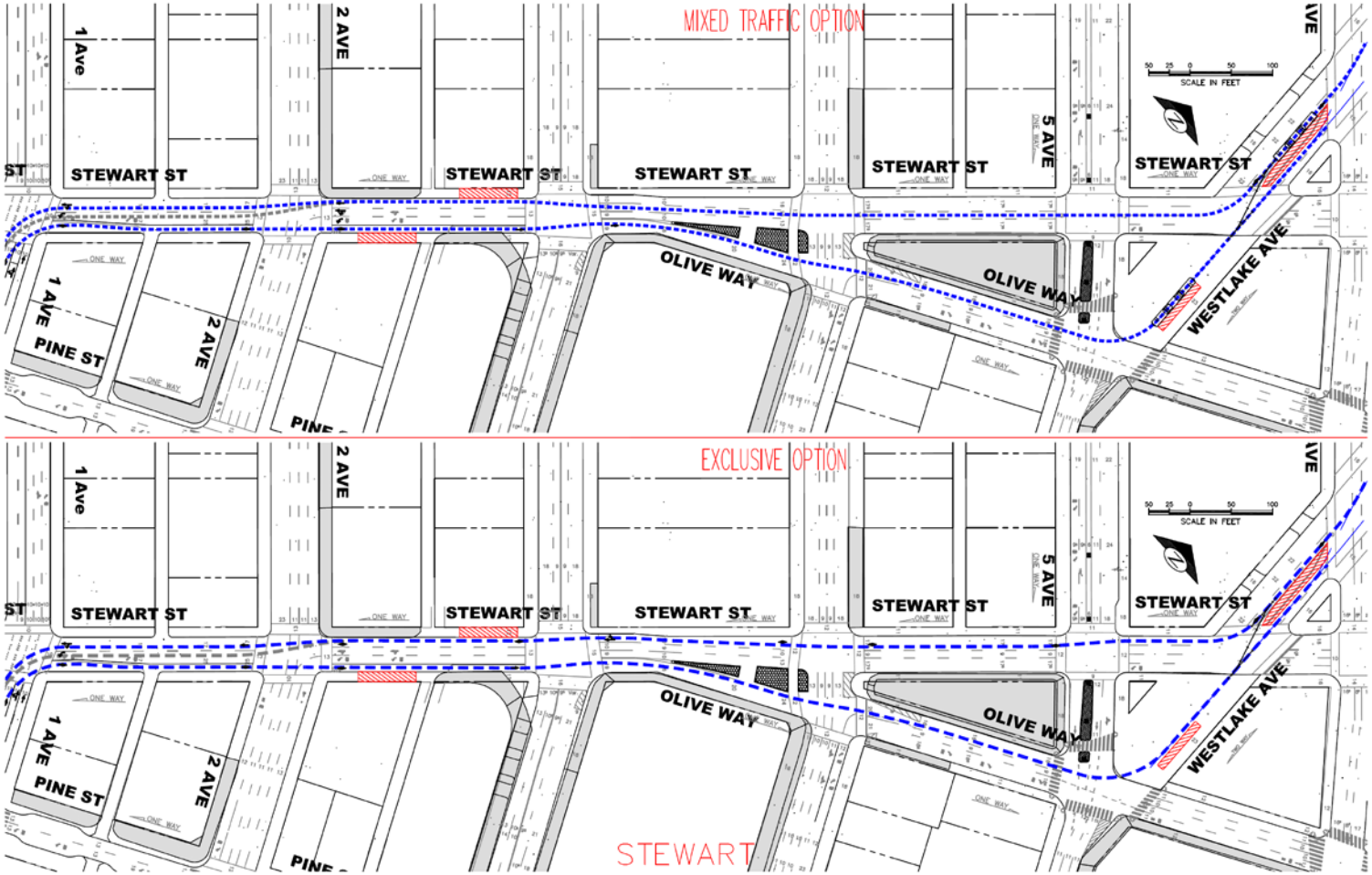
The travel time calculations include dwell time at the Stewart/4th Avenue bus stop for westbound routes that use this segment of Stewart and dwell time for the bus stop at Olive/4th Avenue for eastbound routes that operate on this segment.

Figure J-3 Stewart/Olive Bus Travel Times (sec/veh), 2018, PM Peak

					No Build		Mixed		Exclusive	
Roadway	From	To	Direction	Free-Flow Travel Time	Travel Time	Delay	Travel Time	Delay	Travel Time	Delay
Stewart	Westlake	5th Ave	WB	4	11	7	5	1	7	3
Stewart	5th Ave	4th Ave	WB	9	28	19	34	25	25	16
Stewart	4th Ave	3rd Ave	WB	9	65	56	43	43	44	35
Stewart	3rd Ave	2nd Ave	WB	9	15	6	31	31	38	29
				Total =	119	88	113	82	115	84
				Average =	30	22	28	21	29	21

					No Build		Mixed		Exclusive	
Roadway	From	To	Direction	Free-Flow Travel Time	Travel Time	Delay	Travel Time	Delay	Travel Time	Delay
Olive Way	3rd Ave	4th Ave	EB	6	86	80	85	79	85	79
Olive Way	4th Ave	5th Ave	EB	9	64	55	54	45	54	45
				Total =	*150*	*135*	*140*	*125*	*140*	*125*
				Average =	*75*	*68*	*70*	*62*	*70*	*62*

Figure J-4 Stewart/Olive Conceptual Right-of-Way Design, Mixed-Traffic and Exclusive Streetcar Alternatives



Aggregate Bus Delay Results

Aggregate bus delay was calculated to account for the number of bus trips utilizing each block of the Stewart/Olive alignment. Delay per bus vehicle for each block within this study area was multiplied by the number of PM peak hour bus trips for each route utilizing that block, resulting in an estimate of net bus vehicle delay for each route during the PM peak. Figure J-5 provides aggregate bus delay results for all routes.

These results indicate that both streetcar alternatives slightly reduce aggregate bus delay, and therefore do not appear to have overall adverse impacts on bus operations.

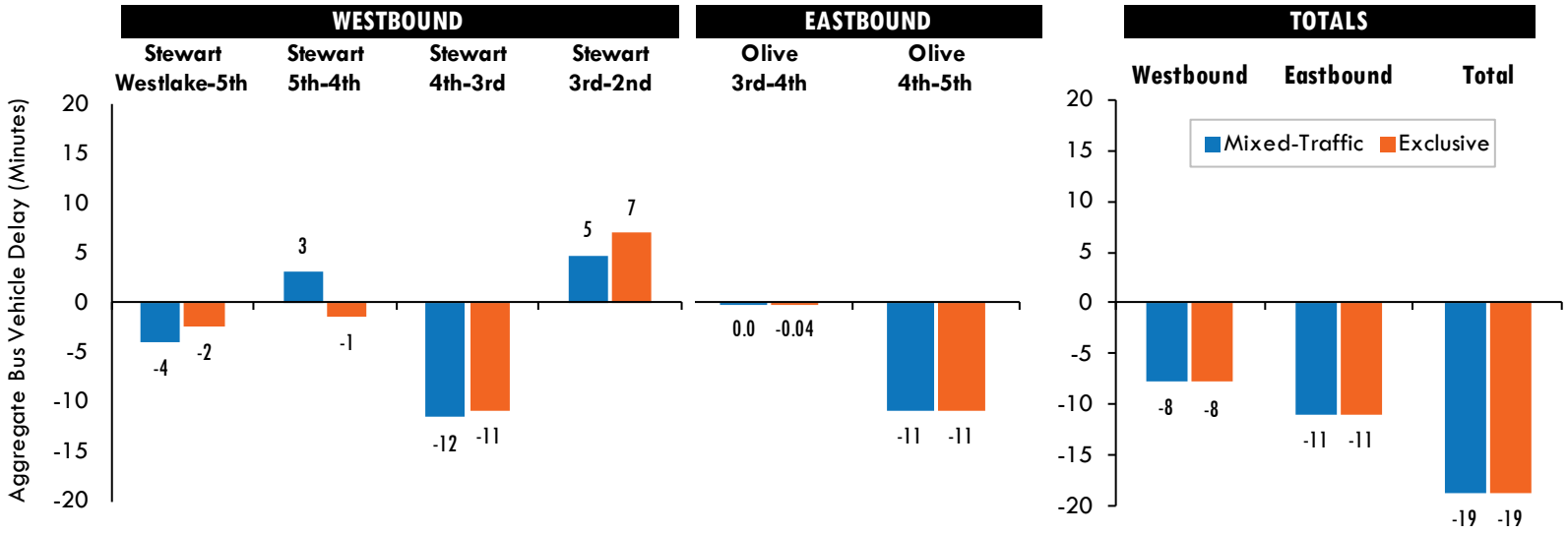
Figure J-6 illustrates both the overall result and where the change in bus delay occurs by direction and block. In the Mixed-Traffic condition, aggregate westbound bus delay increases between 5th and 4th Avenues and between 3rd and 2nd Avenues, but decreases in other blocks. In the Exclusive condition, aggregate westbound bus delay increases between 3rd and 2nd Avenues, but decreases in other blocks. Both alternatives would reduce net aggregate bus delay by about 19 minutes in the PM peak hour.

Figure J-5 Aggregate Bus Delay, 2018, PM Peak Hour

	Peak-Hour Bus Volumes		Total Travel Delay (Min)			Aggregate Bus Delay (Min)			Change in Aggregate Bus Delay (Min)	
	AM Total 1	PM Total	No Build	Mixed-Traffic	Exclusive	No Build	Mixed-Traffic	Exclusive	Mixed-Traffic	Exclusive
WESTBOUND										
Stewart Westlake-5th	68	42	11	5	7	7.7	3.6	5.2	-4.0	-2.5
Stewart 5th-4th	29	30	28	34	25	14.1	17.2	12.6	3.1	-1.5
Stewart 4th-3rd	29	31	65	43	44	33.6	22.0	22.8	-11.6	-10.8
Stewart 3rd-2nd	22	18	15	31	38	4.5	9.3	11.5	4.8	7.0
Total	**148**	**121**	**119**	**113**	**115**	**60**	**52**	**52**	**-7.7**	**-7.8**
EASTBOUND										
Olive 3rd-4th	7	4	86	85	85	5.7	5.7	5.7	0.0	-0.04
Olive 4th-5th	79	64	64	54	54	68.7	57.9	57.9	-10.9	-10.9
Total	**86**	**68**	**150**	**140**	**140**	**74**	**64**	**64**	**-10.9**	**-10.9**
OVERALL TOTAL										
Overall Total						**134**	**116**	**116**	**-18.7**	**-18.7**

Notes: (1) AM peak hour volumes are listed for reference. Delay for the AM period was not quantified for this study.

Figure J-6 Change in Aggregate Bus Vehicle Delay, Streetcar Build Alternatives Compared to No-Build, PM Peak, 2018, Minutes



APPENDIX K ECONOMIC DEVELOPMENT ASSESSMENT

1. Introduction

This document[1] provides information related to the Center City Connector Project and its performance relative to the Federal Transit Administration (FTA) evaluation criteria for economic development and transit-supportive land use.

The Center City Connector Project Goal statement includes the following goal:

Develop: Support local and regional economic development goals.

The following Project Objectives relate to this goal:

- Provide transit capacity to support and attract residential and commercial growth.
- Support small and local businesses in Center City business and retail districts.
- Support local and regional goals to foster compact and mixed-use development.

The FTA's New and Small Starts Policy Guidance document[2] provides project justification criteria related to economic development and transit-supportive land use, including the following criteria:

- Transit-Supportive Corridor Policies
- Supportive Zoning Near Transit
- Tools to Implement Transit-Supportive Plans and Policies
- Performance of Transit-Supportive Plans and Policies
- Potential Impact of Transit Project on Regional Development
- Plans and Policies to Maintain or Increase Affordable Housing in Corridor

Economic development criteria were assessed in the Tier 1 screening of 4th/5th Avenue (couplet) and 1st Avenue alignments. The Tier 2 evaluation focused on more detailed development of the 1st Avenue alignment and did not specifically assess economic development criteria. However, substantial land use and economic development planning has been done in the corridor and ample documentation of existing local plans and policies are available for addressing the FTA topic areas.

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[1] Prepared by Via Architecture and Nelson\Nygaard

[2] FTA, "New and Small Starts Evaluation and Rating Process Final Policy Guidance," August 2013, http://www.fta.dot.gov/documents/NS-SS_Final_PolicyGuidance_August_2013.pdf

This appendix provides FTA guidelines for rating the economic development effects of a project and summarizes applicable local plans and policies that should be submitted to the FTA for future evaluation and rating of the Project's economic development effects.

FTA Criteria

Each project requesting FTA New or Small Starts funding is evaluated on a number of criteria including Economic Development Effects. The FTA provides policy guidance for assessing how well a project meets these criteria.[3] Projects are rated either "high", "medium," or "low" on each criterion or topic area. Figure K-1 describes what is needed to achieve a "high" rating for each economic development-related topic area[4] and summarizes the local policies and plans that demonstrate how the Project meets FTA objectives for maximizing economic development and transit supportive development policies. The remainder of this document describes these plans and policies in more detail.

[3] In addition, an assessment of existing affordable housing units in the study area can be found in Appendix L.

[4] Associated with the Small Starts Construction Grant Agreement (SSGA) and Full Funding Grant Agreement (FFGA) project development phases; separate breakpoints are associated with the Engineering phase. The policy guidance document also provides breakpoints for low and medium ratings.

Figure K-1 FTA Guidelines and Assessment Criteria for Economic Development Effects

Topic Area	FTA Guidelines for High Rating	Applicable Local Plans and Policies
Transit-Supportive Corridor Policies	▪ Conceptual plans have been developed for the corridor and station areas. ▪ Comprehensive and/or small area plans adopted/revised in most or all station areas. ▪ Development patterns proposed in conceptual plans and plan revisions are strongly supportive of a major transit investment.	▪ 2.1 Seattle Urban Center/Urban Village Strategy ▪ 2.2 Seattle Comprehensive Plan Transit Communities Element ▪ 2.3 Context-based Area Plans and Urban Design Frameworks ▪ 2.4 Parking Policies
Supportive Zoning Near Transit	▪ Local jurisdictions have adopted zoning changes that strongly support a major transit investment in most or all transit station areas.	▪ 3.1 Downtown ▪ 3.2 South Lake Union ▪ 3.3 International District – Pioneer Square – SODO ▪ 3.4 Design Standards (Urban Center/Urban Villages and Downtown)
Tools to Implement Transit-Supportive Plans and Policies	▪ Transit/regional agencies are working proactively with local jurisdictions, developers, and the public to promote transit-supportive planning and station area development. ▪ Transit agency has established a joint development program and identified development opportunities ▪ Agencies have adopted effective regulatory and financial incentives to promote transit-oriented development.	▪ 4.1 State Environmental Protection Act SEPA /Planned Action Ordinance ▪ 4.2 Multifamily Tax Exemption ▪ 4.3 Seattle Housing Levy, Acquisition and Opportunity Loan Program ▪ 4.4 Neighborhood Equitable TOD (NET) Initiative ▪ 4.5 Benefit Assessment District: Landscape Conservation and Local Infrastructure Program

Topic Area	FTA Guidelines for High Rating	Applicable Local Plans and Policies
	▪ Public and private capital improvements are being programmed in the corridor and station areas which implement the local policies and which leverage the Federal investment in the proposed major transit investment corridor.	▪ 4.6 Growing Transit Communities Partnership (GTC)
Performance of Transit-Supportive Plans and Policies	▪ A significant number of development proposals are being received for transit supportive housing and employment in station areas. ▪ Significant amounts of transit-supportive development have occurred in other, existing transit corridors and station areas.	▪ 5.1 Terry Avenue, Westlake Avenue, and Amazon.com Headquarters ▪ 5.2 Yesler Terrace, Seattle Housing Authority Redevelopment ▪ 5.3 New Holly HOPE VI / Othello Light Rail Station Stop ▪ 5.4 Stadium North Lot/Stadium District/King Street Station ▪ 5.5 Capitol Hill TOD LINK Light Rail Station
Potential Impact of Transit Project on Regional Development	▪ A significant amount of land in station areas is available for new development or redevelopment at transit-supportive densities. ▪ Local plans, policies, and development programs, as well as real estate market conditions, strongly support such development.	▪ See Section 6 graphics
Plans and Policies to Maintain or Increase Affordable	▪ Comprehensive affordable housing plans have been developed and are being implemented that identify and address the current and prospective housing affordability needs along the corridor. The plans include efforts to preserve existing	▪ 7.1 City of Seattle, Office of Housing, Housing Levy ▪ 7.2 Consolidated Plan ▪ 7.3 Incentive Zoning

Topic Area	FTA Guidelines for High Rating	Applicable Local Plans and Policies
Housing in Corridor	affordable housing (both legally binding affordability restricted housing and market-rate affordable housing.) The plans also explicitly address the housing affordability and quality needs of very- and extremely-low income households. ▪ Financing commitments and/or sources of funding and robust financial incentives are secured and available at the local and/or regional level and along the proposed corridor to support affordable housing acquisition (including acquisition of land and/or properties intended to be converted to affordable housing), development and/or preservation consistent with adopted plans and policies. These commitments may include early phase or acquisition financing as well as permanent financing. ▪ Local policies and zoning codes support and encourage significant affordable housing development in transit corridors. ▪ Developers are actively working in the corridor to secure priority development sites and/or maintain affordability levels in existing housing units.	▪ 7.4 Transferable Development Rights Potential (TDP)

2. Transit-Supportive Corridor Policies

Background

Seattle first implemented policies related to Transit Oriented Development to prepare for Sound Transit's Central Link light rail.[5] From 1998-2001, the Department of Planning and Development (DPD) in collaboration with the Seattle Department of Transportation (SDOT) crafted a series of Station Area Overlay Districts (SAODs) that were adopted alongside Neighborhood Plans in the Rainer Valley, First Hill, Capitol Hill and the University District. Applicable to mixed-use zones within a quarter-mile of light rail stations (excluding single-family zoned parcels), SAODs support transit by prohibiting uses such as drive-through businesses and non-residential stand-alone parking, and by permitting some limited up-zoning.

In the decade following the opening of Central Link, Seattle experienced rapid growth as well as fluctuating real estate market cycles. In response to this uneven development—particularly in station locations in the Rainier Valley—the City has reviewed the performance of its transit-related policies, mapped opportunities, and produced a more coherent transit oriented development strategy.[6] The changes are particularly suited to support the success of the Center City Connector Project, major forthcoming public investment in light rail expansion, as well as prioritization of a citywide Frequent Transit Network. The following sections summarize core elements of Seattle's transit supportive policies.

2.1 Seattle Urban Center/Urban Village Strategy

Seattle's planning framework is derived from statewide growth management (Growth Management Act RCW 36.70A, adopted 1990) and mandated comprehensive planning. The 1994 Comprehensive Plan Urban Village/Urban Center (UV/UC) strategy is still Seattle's most critical growth management tool. Urban Centers are regionally defined as the city's most dense areas, while Urban Villages are locally defined as residential, commercial or manufacturing hubs. The UV/UC policy describes a series of connected neighborhoods with diverse housing and employment growth, and sufficient densities to take advantage of significant investment in public transportation infrastructure. The Center City Connector touches on or passes through ten adjacent Urban Centers (see Figure K-3).

Seattle's Comprehensive Plan establishes housing and employment targets to accommodate projected future growth. As of 2013, 58% of future housing and 73% of employment

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[5] Council Resolution 29867 adopted in 1998 established the goals and strategies to promote transit-oriented development in light rail stations.

[6] Seattle Planning Commission, "Seattle Transit Communities: A Citywide Strategy to Integrate Neighborhoods with Transit," March 2013. http://www.seattle.gov/planningcommission/docs/STC_report_to_Council_vers3.pdf

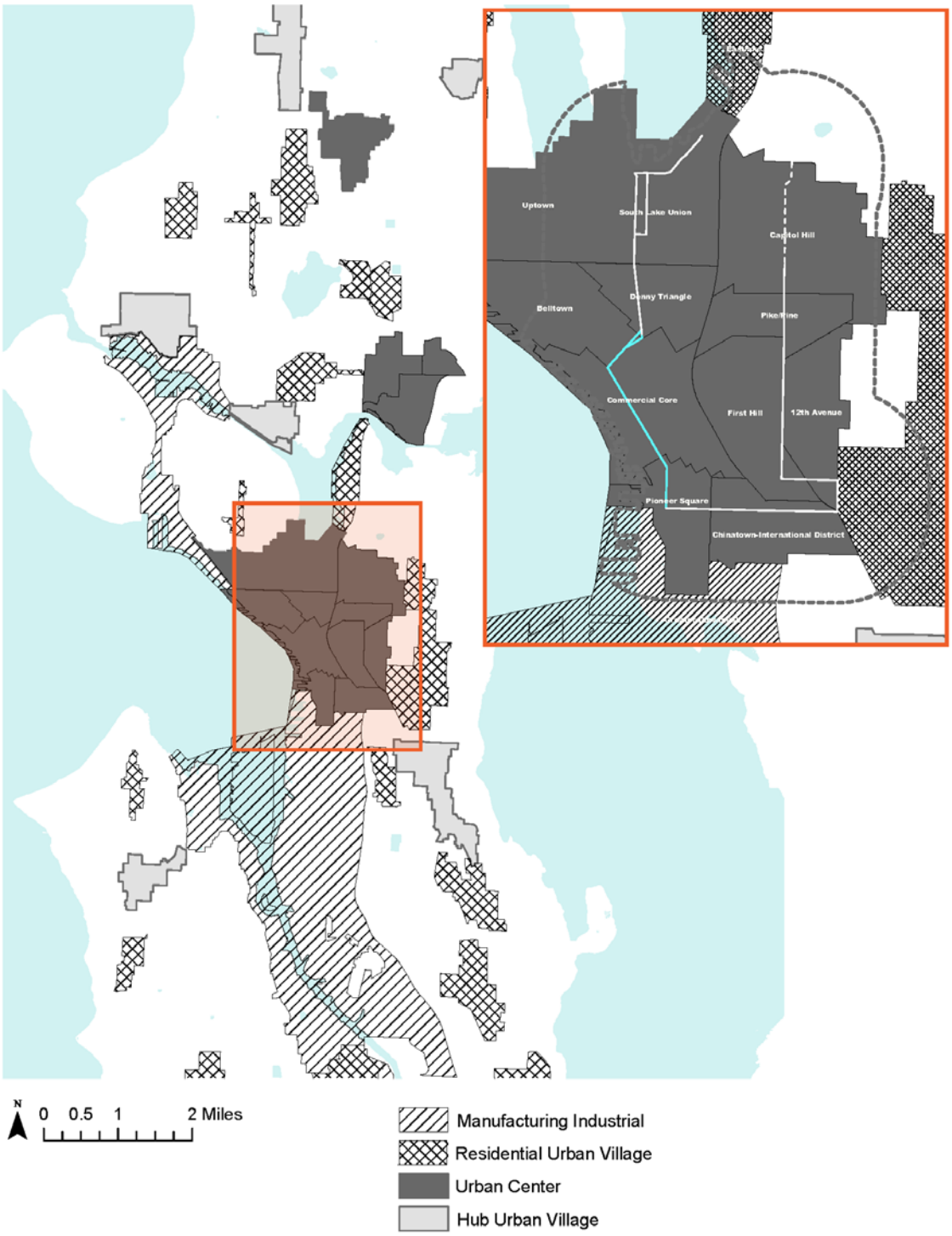
growth is aimed within the boundaries of UV/UCs, with the greatest percentage of that growth directed at the Urban Centers of Greater Downtown. Downtown Urban Centers are projected to account for over 44% of overall population growth and 63% of overall job growth between 2008 and 2030, with residential densification occurring in adjacent neighborhoods, particularly Belltown, Capitol Hill, Yesler Terrace and South Lake Union. Seattle is on track or exceeding growth targets in its Urban Centers (see Figure K-2).

Figure K-2 Urban Center/Urban Village Residential Growth7

	New Net Units		Progress Towards Targets (as of 3rd quarter 2013)	
Urban Center	Growth target 2005-2013	Growth Target 2005-2024	% of Target met (constructed)	% of Target met (permitted)
Downtown Urban Center	5,365	10,000	54%	89%
First Hill/ Capitol Hill Urban Center	3,322	3,500	95%	123%
South Lake Union	2,295	8,000	29%	41%

[7] Department of Planning and Development, Data Warehouse, 10-3-2013. http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/dpdd017580.pdf

Figure K-3 Urban Village/Urban Center Locations



Source: Via Architecture

2.2 Seattle Comprehensive Plan Transit Communities Element

The 2013 Seattle Comprehensive Plan "Transit Communities" Element underscores the mutually reinforcing benefits that arise from mixed-use, compact land use patterns when combined with accessible, frequent transit. A "Transit Community" (usually overlapping with UV/UC's) is envisioned as "A place where a neighborhood is integrated with transit, where coordinated public and private investments improve neighborhood quality, and where proactively planning for change can create or enhance a place where people of all ages and income levels can live in a complete community and access frequent, reliable transit."[8]

This policy framework is coordinated with recommendations in the Transit Master Plan (TMP, 2012) and Seattle Transit Plan (2005) for a network of high-capacity transit and bus priority corridors. The Center City Connector was included in the TMP as a priority transit investment. Figure K-4 shows the frequent transit network outlined in the Seattle Transit Communities Report.

2.3 Context-based Area Plans and Urban Design Frameworks

Seattle has 38 Neighborhood Plans that steer the placement, scale and intensity of future development. As of 2009, Seattle Ordinance #122799 directed DPD to prioritize Plan updates where transit stations are proposed and where significant new population and business growth is expected.[9] In transit locations, Neighborhood Plans are accompanied by Urban Design Frameworks (UDF), Station Area Plans (SAP), and Corridor Plans to distill a shared vision of urban form and vet potential future alternatives. Together these plans provide recommendations for street design and network characteristics, potential redevelopment catalyst sites, short- and long-term actions for neighborhood growth, as

Figure K-4 Seattle Frequent Transit Network Map

Source: Seattle Transit Communities Report, 2010

[8] City of Seattle, Seattle Comprehensive Plan, Towards a Sustainable Seattle, Land Use Element 2013

[9] In anticipation of light rail commencing service in Seattle in 2009, Ordinance #122799 prioritizes the review and update of Neighborhood Plans where transit stations are proposed and where significant new population and business growth is expected. The Neighborhood Plan Update process for the North Beacon Hill, North Rainier, and MLK Jr. and Holly station areas began in fall 2008. http://www.seattle.gov/neighborhoods/npi/updates.htm

well as partnerships between the community and stakeholders. Greater Downtown has benefited from organized planning efforts that tie land use with significant transit access. Recent plans relevant to the Center City Connector project are:

- **South Lake Union:** South Lake Union Urban Design Framework/Implementation Plan, South Lake Union Height and Density Study, Uptown Urban Center Plan (currently active)
- **South Downtown:** South Downtown Livable Plan, King Street Station Area Plan (Currently Active), Stadium District Plan
- **Center City:** Downtown Neighborhood Plan, the Pike/Pine Corridor Study, Downtown Waterfront Vision and Plan
- **First Hill/Capitol Hill:** Capitol Hill Urban Design Framework/ Development Agreement

2.4 Parking Policies

The City of Seattle is a national leader in parking and mobility strategies for parking provision in growth areas. Excess parking can be an impediment to community goals and can impact project design and feasibility, while too little parking affects market viability and may result in spillover parking problems. As a result, SDOT in coordination with DPD has implemented programs to encourage station areas in particular to develop as "places"—synergistic communities of people, jobs, retail, and other amenities—and avoid accommodation of large quantities of parking at Link stations. Furthermore there are no minimum residential parking requirements in Urban Centers, Urban Villages and Station Overlay areas. Parking policies applicable in the Center City area include:

- Residential permit parking zones
- On-street priced parking
- No parking minimums in Urban Centers, and parking maximums for residential and commercial uses
- Design standards for parking in "pedestrian overlay areas" and commercial districts to mitigate the impact of parking on the quality of the street environment
- Pass programs (ORCA business[10]) for employers to provide a financial incentive for employees to use transit
- Unbundling parking spaces from residential and commercial leases

Within the Downtown Core, on-street spaces are also subject to resource management. SDOT's parking approach is to "price and manage parking to support healthy business districts and transit use and manage curb space to recognize the importance of principle

[10] https://www.orcacard.biz/ERG-Seattle-Institution/ProgramsRedirect.do

arterials in moving people, goods and services." Commercial-area curb space is to be used first for transit, then loading, short-term parking, shared-vehicle parking, and, lastly, for ordinary private-car parking.

3. Supportive Zoning Near Transit

The Center City Connector includes the city's most intensive land use districts, many of which have recently undergone revision to meet policy objectives identified in Seattle's Comprehensive and Neighborhood Plans. These areas already exhibit many of the qualities that support transit use, including walkable block lengths, interesting and comfortable streetscapes, a mix of uses, and many popular destinations. The following sections provide an overview of zoning within the Center City area.

Downtown

In 2006, the City adopted land use code changes to "create more vibrant neighborhoods, encourage affordable housing, stimulate job growth, support transit, encourage urban sustainability, and support historic preservation." Under the revised code, downtown zones can make use of incentives that allow for higher floor area ratio (FAR) and/or building height than the base zoning allows in exchange for meeting LEED standards or providing project components such as affordable housing, public open space, or pedestrian connections.

Figure K-5 provides an overview of the land use code in Downtown Seattle. The Downtown land use code also relies upon location-specific overlays to regulate street level uses and building design attributes such as transparency requirements, property line façade locations, and pedestrian and green street standards. Seattle's Design Review program contributes to achieving high-quality buildings and pedestrian-friendly qualities.

Figure K-5 Downtown Seattle Land Use Code Overview

Zone	Base FAR	Maximum FAR	Public Amenity Incentive Program	Parking Requirements
Downtown Mixed Commercial (DMC) 65' -400'	3	10*	Incentive system includes a bonus ratio of 5:1 (up to 5 sq. ft. granted for 1 sq. foot of bonus amenity) for various urban park and public open space amenities. Urban plazas, commercial or residential parks, Green Street improvements, Public atriums and pedestrian connections such as Hill climbs. A bonus amenity also addresses Transit Station Access for a maximum gain of 1.0 FAR.	Downtown zones require no parking, either long- or short-term. Parking is limited to 1 space per 1,000 sq ft of residential gross floor area. No surface parking is allowed. A Transportation Demand Management program is in place in the Downtown Urban Centers for new structures that contain more than 10,000 sq ft of space. A transportation coordinator, ridesharing, and carpooling are encouraged. A subsidized transit pass program is also available.
Downtown Office Core (DOC) 1	6	20		
Downtown Office Core (DOC) 2 500/300-500	5	14		
Downtown Retail Core (DRC) 85/150	3	5		
PMM (Pike Place Market Mixed) 100/100-130	7	7	No amenity program applicable. This area is addressed by Special Review and/or Historic District regulations.	

*Capacity depends on zoned height limitations, maximums range from 4-10 FAR.

South Lake Union

From 1990 to 2010, SLU has grown at an average annual rate of 18% a year.[11] In 2006, a public-private partnership created a Local Improvement District to help fund the initial leg of the Seattle streetcar system, which opened in 2007 with ten stations. The area now houses Amazon.com headquarters, University of Washington (UW) Medical Center, Fred Hutchinson Cancer Research Center, and REI's flagship store as well as new parks and major infrastructure investments.

A legislative package adopted in 2012 was the result of a decade-long, communitywide discussion about Seattle's increasingly urban future. The rezoning included in this package introduced a "Seattle Mixed" zone to create a pedestrian-friendly environment and ensure a workable mix of both residential and non-residential uses (Figure K-5). The zoning regulations include targets for over 11,000 additional housing units and 22,000 jobs by 2031. Of the 11,000 housing units, 4,000 of the housing units are targeted to be affordable to households earning 0-80% of the area median income (AMI).[12]

The revised zoning supports transit use by allowing added height and FAR as an incentive to provide neighborhood amenities and includes amendments that encourage compact, vertical growth. This rezoning is complemented by the South Lake Union Mobility Plan (2011) and a series of major public sector investments to improve mobility throughout the district. The South Lake Union rezone accomplished the following:

- Reclassified remaining Industrial Commercial (IC) zoned properties in the neighborhood to Seattle Mixed (SM) to promote development of a balanced variety of land uses including additional residential development
- Expanded the City's incentive zoning program, creating opportunities for affordable housing and community infrastructure
- Better addressed design, size, and shape of buildings relative to the site
- Emphasized strong, pedestrian-oriented building forms with flexibility to allow a broad range of uses
- Provided parking standards to reinforce the City's transportation goals of balanced mobility

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[11] City of Seattle, Office of Housing and Economic Development, "Public and Private Investments in South Lake Union," July 2012, p.6. http://www.seattle.gov/EconomicDevelopment/pdf_files/SLU%20Public%20Private%20Report%20Final%202012_0703_small.pdf

[12] City of Seattle Department of Planning and Building, Housing: South Lake Union, 2012 Update. http://www.seattle.gov/dpd/cms/groups/pan/@pan/@plan/@proj/documents/web_informational/dpdp022279.pdf

Figure K-6 South Lake Union Land Use Code Overview

Zone	Base FAR	Maximum FAR	Public Amenity Incentive Program	Parking requirements
Seattle Mixed (Heights variable 65-400')	4.5 -5.0	Up to 7 - 10 in some zones	Provisions for increased floor plates, height and density tied to affordable housing as first priority, as well as open space and mid-block corridors, etc.	No parking minimums in Seattle Urban Centers. Parking for non-residential uses maximum 1:1000 gross sq. ft. Maximums also apply for non-residential uses. Surface parking prohibited throughout most SM zones.

3.3 International District – Pioneer Square – SODO

The First Hill Streetcar, currently under construction, will operate from Pioneer Square to Capitol Hill. The City rezoned five neighborhoods of South Downtown in 2011: Pioneer Square, Little Saigon, Chinatown, Japan Town, and SODO. Much of the South Downtown area was built out during the city's founding years and contains a number of significant historic buildings and landmarks. The "Livable South Downtown Plan" sought to balance preservation of historic sites while also increasing housing to attract more residents and stimulate economic development. Figure K-7 provides an overview of the 2011 zones in this area. The updated standards also sought to reduce vacancy and promote new affordable housing. The rezone included the following elements:

- Reclassified areas in the International District from Industrial Commercial (IC) zoning to Downtown Mixed-Use (DMU)
- Provided a supplementary bonus system for building heights to increase to up to 150' in some cases
- Prioritized residential uses, open space, street improvements, and affordable housing through the incentive zoning program
- Provided regulatory standards to break down larger blocks, and identified a series of "green streets"

Figure K-7 South Downtown Land Use Code Overview

Zone	Base FAR	Maximum FAR	Public Amenity Incentive Program	Parking requirements
PSM (Pioneer Square Mixed) 100-120'	NA	NA	Historic Transfer in Density Rights program in place. Programs are also focuses on the provision of residential use, specifically low income.	No parking required
IDM (International District Mixed) 75-150'	3 (6 for hotels)	3 except 6 for hotels	Focus in the amenity program on providing affordable housing.	No parking required except for theaters and other entertainment uses in the International District.
IDR (International District Residential)	1	Up to 2 with 50% residential use	Focus in the amenity program on providing affordable housing.	

3.4 Design Standards

Seattle has a variety of context-sensitive and area-based design standards that help to maintain the quality of the street environment in most of Seattle's Urban Centers / Urban Villages and in all of the Downtown Zones. Design standard overlays contribute to land use patterns that engage pedestrians and provide comfort and safety at the street-level through weather protection, entrances, and lighting. Standards also identify modal priorities. Overlays include the following elements:

- Street Level Use
- Property Line Façade requirements
- Overhead weather protection
- Green Street standards
- Pedestrian street standards
- Parking uses permitted, etc.

In addition, the Seattle Green Factor is a unique performance-based, point-based program that increases overall livability and comfort in Seattle's mixed-use zones by requiring creative provision of green landscaped areas and low impact development.

4. Tools to Implement Transit-Supportive Plans and Policies

4.1 State Environmental Protection Act SEPA /Planned Action Ordinance

Washington state law allows for a plan-level review of impacts through an upfront State Environmental Policy Act (SEPA) process designed to eliminate SEPA appeals (SEPA, RCW 43.21C). The planned action ordinance process allows one in-depth Environmental Impact Statement (EIS) evaluation for the entirety of a plan area. If a project proposal falls within the scope of the planned action, the City is not required to make a threshold determination and is not allowed to require any further environmental review.[13]

Combining a planned action ordinance with an area plan and rezone is an increasingly popular tool for cities seeking to adapt station locations, downtowns, and regional centers to changing circumstances and to facilitate infill redevelopment. In 2010, a version of the planned action ordinance (PAO, Planned Action Transit Infill II) was tailored specifically to promote transit–friendly land use actions and expedite TOD. Tacoma adopted the first Transit Infill PAO in 2013. In April 2011, the City of Seattle adopted a Planned Action Final EIS for Yesler Terrace, a Seattle Housing Authority-led TOD redevelopment adjacent to the First Hill Streetcar, the first application of this approach in Seattle.

4. 2 Multifamily Tax Exemption

The Multifamily Tax Exemption program (MFTE) is a component of a financing package for multifamily development, available for use in all of Seattle's existing light rail station areas. To participate, the program requires that 20% of all units be made affordable for up to 12 years, with a range of affordability levels tied to different unit types.[14] According to Seattle City Council member Richard Conlin, "The MFTE program is one of the few tools provided by the legislature to the City to encourage the private sector to build housing that is affordable to the 'in-between households'—those who make too much to be served by low-income housing programs but make too little to be served by market-rate developers." [15]

Two recent unsubsidized projects, the Station at Othello Park and GreenHouse in Columbia City, both near light rail stations, were developed using the City of Seattle's MFTE program.

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[13] Eckert, Jeremy, "Using SEPA to Encourage Economic Development and Sustainable Communities," Foster Pepper, 2012

[14] City of Seattle Office of Housing website, 11-05-2013, http://www.seattle.gov/housing/incentives/mfte.htm

[15] Conlin, Richard, "Why does Seattle have a Multifamily Tax Exemption" blogpost 06-16-2011page viewed 11-05-2013, http://conlin.seattle.gov/2011/06/16/why-does-seattle-have-a-multi-family-tax-exemption-program/

The Station and GreenHouse are offering affordability for middle-income households (80-90% AMI) for 96 of 476 total units.

4. 3 Seattle Housing Levy, Acquisition and Opportunity Loan Program, Seattle Office of Housing

This program provides short-term loans to help make strategic purchases of buildings or land for long-term affordable housing units. The program prioritizes "projects that produce or preserve low-income housing located in a high-capacity transit station area or a high-frequency transit service area." The Acquisition and Opportunity Loan program is funded at $6.5M through a 2009 voter approved seven-year tax on property values, called the Seattle Housing Levy. Another program funded through the Housing Levy, the Rental Preservation and Production Program, also prioritizes the preservation of affordable housing in high-capacity transit areas.

4. 4 Neighborhood Equitable TOD (NET) Initiative

Seattle's Neighborhood Equitable TOD (NET) initiative is a new, three-year $8.9 million program that will produce and support affordable housing as well as commercial and community space. The NET initiative aims to ensure that new development around transit stations benefits rather than displaces existing communities in the Rainier Valley. As part of the NET initiative, the City of Seattle Office of Housing established the Equitable TOD Loan Pilot Program to provide up to $7 million to support transit-oriented development. The Program makes available up to $3 million in City of Seattle Office of Housing funds, up to $1.2 million in HUD Community Challenge Grant funds, and up to $2.8 million from funding partners. A TOD Combined Funders Group has also formed to advise and participate in the deployment of Program funds. This group is composed of representatives from:

- Seattle Office of Housing
- Rainier Valley Community Development Fund
- Impact Capital
- Enterprise Community Loan Fund Inc.

The first program loans were planned for 2013 to provide financing to secure potential development sites near Link Light Rail stations for mixed-income housing, preferably in combination with commercial uses. The TOD NET initiative funds seek to allow developers to take advantage of low acquisition prices, secure sites that present a strategic use of funding relating to transit access, and/or provide significant permanent financing leverage. Capital funds for property acquisition are the program's top priority.

This program will generate new models of mixed-income housing production, minimizing public gap subsidy. Creation of affordable workforce housing (affordable to 30-80% AMI) is

a top program priority. However, some units affordable to households at or below 30% AMI are allowed. A minimum of 20% of all units affordable to households making at or below 50% AMI, or 40% of all units affordable to households at or below 60% AMI, are required in every funded project. Units must be made affordable for a minimum of 50 years. Additional program priorities include mixed-use and family size housing.

4.5 Benefit Assessment District: Landscape Conservation and Local Infrastructure Program (South Lake Union /Downtown)

According to a King County press release, the Landscape Conservation and Local Infrastructure Program (LCLIP) program was developed by the City of Seattle, King County, and the environmental organization Forterra.[16] It is the first to be developed under 2012 state legislation that enables cities to access a portion of incremental county property tax gains from new development, when a certain percentage of the new development results from the use of transferable development rights (TDRs). TDRs are created by the permanent protection from future development of the region's working forest and farmlands. Under the program, a portion of incentive zoning (5% in Downtown and 33% in South Lake Union) would be gained through the purchase of regional TDRs. In exchange, the City will receive a portion of future county property tax revenue from new development occurring in the area for up to 25 years. In this case it is estimated that Seattle will receive 17.4% of the property tax revenue from new development occurring in the Local Infrastructure Project Area, resulting in $27.5M in infrastructure investments over 25 years. The program would support future transit-oriented development by providing a new revenue stream to fund local infrastructure improvements, including new sidewalks, parks, and potentially a community center in the South Lake Union neighborhood.

4.6 Growing Transit Communities Partnership (GTC)

In the coming decades, the central Puget Sound region will be making a voter-approved $15 billion investment in regional rapid transit. The Puget Sound Regional Council and a variety of organizations, institutions and municipalities developed the Growing Transit Communities Partnership (GTC) in 2010. Funded by a grant from the federal Partnership for Sustainable Communities, the GTC focuses on developing policies and tools applicable to key transit nodes within the region's long-range light rail corridors.

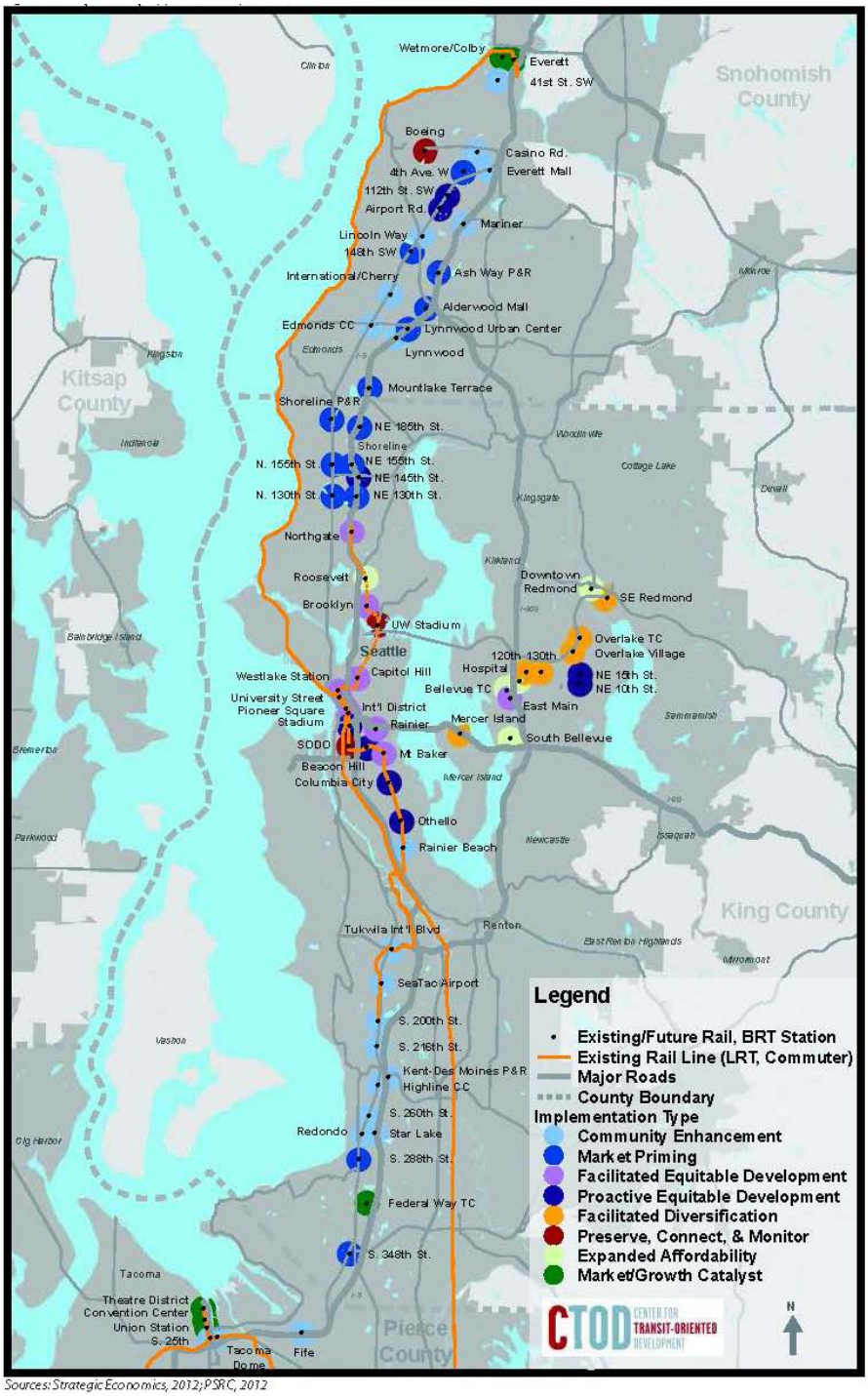
The GTC has been a resource for transit-related infill redevelopment efforts by providing research, demonstration projects, catalyst projects, and extensive outreach. A GTC- initiated Typology Framework released in 2013 provides technical support for the numerous study areas including Capitol Hill, Westlake Station, University Street, Pioneer Square,

[16] http://www.kingcounty.gov/exec/news/release/2012/July/23_partnerships.aspx

International District, and Stadium District, shown in Figure K-8. [17] The report helps to shape actionable strategies and prioritizes improvements and programming needed to achieve equitable transit communities.

[17] Strategic Economics, Center for Transit Oriented Development Prepared for PSRC, Growing Transit Communities Partnership "Implementing Equitable Transit Communities: Regional and local recommendations for the central Puget Sound region," January 2013

Figure K-8 Growing Transit Communities Project Map

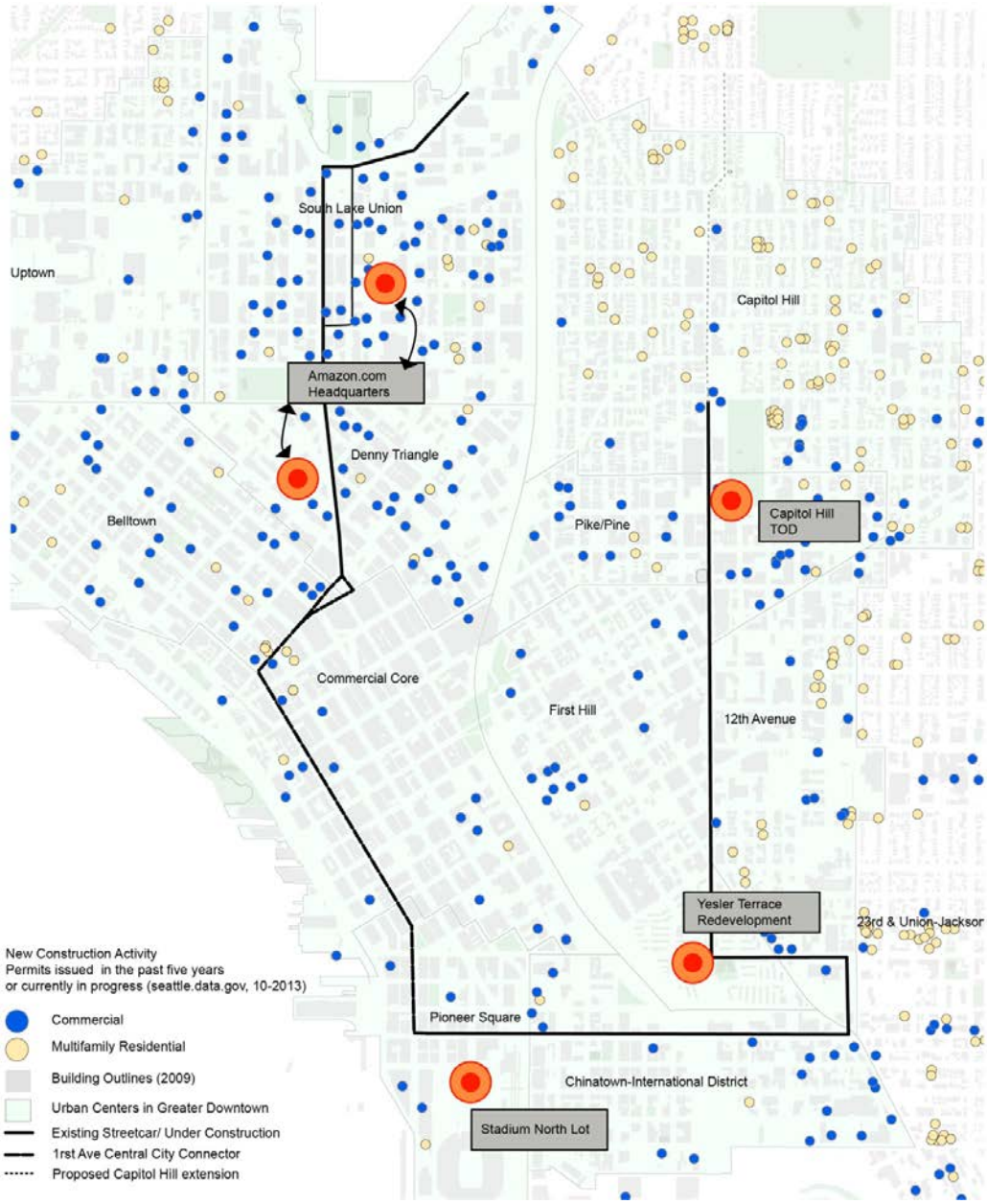


Source: GTC Implementing Equitable Transit Communities Report

5. Performance of Transit-Supportive Plans and Policies

Figure K-9 shows development activity in the Center City study area by development permits issued for commercial and multifamily residential buildings in the past 5 years. The following sections highlight several TOD projects, also shown on the map, and evaluate their performance.

Figure K-9 Development Activity and Permits in Center City



Source: Via Architecture

5.1 Terry Avenue, Westlake Avenue, and Amazon.com Headquarters

The redevelopment of South Lake Union includes several projects that are pedestrian-oriented, relate well to streetcar stations, achieve generous open space requirements, or use historic TDRs help to preserve and enhance the public realm. One recent example is the headquarters of Amazon.com, which included three office towers with nearly 3.3 million sq. ft. of office space and 66,000 sq. ft. of commercial space on three blocks near to the Westlake/ 7th Avenue streetcar stop. As part of the Amazon.com headquarters public benefits package, the developer agreed to fund $5.5 million in enhanced South Lake Union Streetcar service, including the purchase of a fourth streetcar and enhancements to streetcar stops. This will results in increased frequencies, and trains that will come every ten minutes, twelve hours a day. Amazon's headquarters complex will also provide access to Zipcar, electric-car charging stations, bike storage rooms, and showers in each building. Additionally, the project features wayfinding for transit routes and streetcar stops and midblock pedestrian walkways. The public benefits package provides for planning and construction of a cycle track along 7th Avenue in downtown Seattle and the extension of pedestrian boulevard treatments on Westlake Avenue.

5.2 Yesler Terrace, Seattle Housing Authority Redevelopment

Seattle Housing Authority has spent the past eight years working to replace Yesler Terrace's aging public housing buildings with a new mixed-income community, in partnership with a private sector master developer. The thirty-acre site is located adjacent to a station on the First Hill Streetcar alignment. The site offers opportunities for a mixed-use, mixed-income community well-served by transit, increased affordable housing, and a high level of sustainability and urban design. Seattle City Council passed supportive implementing agreements, including the Cooperative Agreement between the City and Seattle Housing Authority, the Land Use Code amendment and rezone ordinance, the Street Vacation Petition, and the Planned Action Ordinance in 2012.[18] Under the adopted rezone the existing 561 homes will be replaced by:

- 661 units serving people with incomes below 30% AMI, consisting of 561 units to replace those currently there and 100 additional units developed with partners
- 290 additional low-income units affordable for 30-60% AMI
- 850 workforce housing serving people with incomes below 80% AMI
- 1,200-3,200 market-rate housing units

[18] http://www.seattle.gov/council/issues/yesler_terrace.htm

- 16 acres of park and open space
- Up to 900,000 square feet of office, medical services, and lodging
- Up to 150,000 square feet of retail and services

The first private sector project broke ground in June of 2013. The a six-story workforce- and transit-oriented project has a fifth of the units set aside for households earning up to 50% AMI ($34,700 for a family of two). The remaining units will be for households earning up to 85% AMI, or nearly $52,600 for a two-person family.

5.3 New Holly HOPE VI / Othello Light Rail Station Stop (not shown)

Othello Station is one of 12 stations built during the first segment of the Central Link light rail, completed in 2009. The City of Seattle, Sound Transit, and the Seattle Housing Authority began working to prepare this site for light rail when the station was initially selected in the late 1990's. Developer-community conversations facilitated by the Othello Station Community Advisory team were supported by Small Sparks and Small and Simple Grants.

- The urban town center features a 7.6 acre park, and a culturally diverse small business district.
- Seattle Housing Authority leveraged local and federal funding sources to build 1,400 units of mixed-income rental and affordable housing. Funding for the New Holly project came from the Federal HOPE VI program.
- TOD developer Othello Partners constructed 351 units of market-rate apartments in a 6-story mixed-use project bordering the station and a new park (Othello Park). The project opened in 2012. There are only 200 parking spaces in the building, leased separately.

According to PSRC's TOD Fund Report, "Over the five year period between when construction began on Central Link in 2004 and it was completed in 2009, the values of the mixed-use zoned parcels in Othello station's vicinity rose by 585 percent […] This was a period of active growth in the larger real estate market, as commercial land in all of south Seattle appreciated by 180 percent over the same time period, but the appreciation in the Othello Station area was more than 400 percent higher." [19]

[19] PSRC, A Regional TOD Fund, Ensuring that Transit Communities Grow Equitably, September 2012, p.12. http://www.psrc.org/assets/8674/TODFundWhitePaperReport12-17-12.pdf

5.4 Stadium North Lot/Stadium District/King Street Station

Directly to the south of the proposed 1st Avenue streetcar corridor at Jackson Street near 2nd Avenue, Stadium Place is a mixed-use, transit-oriented development under construction on the largest piece of previously undeveloped land (3.85 acres) in Seattle's urban core. The lot is arguably the most transit-rich location in the city. It is located on a former parking lot adjacent to the King Street Station/International District Multimodal Hub and north of CenturyLink Field. When all phases of Stadium Place are complete, it will feature up to 740 residential units, 170,000 square feet of office space, 50,000 square feet of retail space, and a 297-room hotel and conference center.

The $517 million development's first tower is a 10-story building with 109 apartments. It is part of 1.5 million square feet of residential, office, retail and hotel space that eventually will cover two square blocks. This action is in direct response to the rezone of the South Downtown area and Livable South Downtown Plan, which encourages greater density and mixed-use development and enhancements of the public realm.

A Stadium District Plan for the area surrounding the north lot was released in 2012. The plan represents actions taken by the private sector development community to improve and intensify the area, using transit as a key strategy. The District plan guides development to ensure it is complementary to the public interest and a catalyst for economic development.

5.5 Capitol Hill TOD LINK Light Rail Station

Sound Transit has been working collaboratively with the community and the City of Seattle since 2008 on an Urban Design Framework for the Capitol Hill station area to carefully consider the opportunities and constraints for future redevelopment. Sound Transit and City staff have negotiated a development agreement term sheet to provide land use guidance for future development. Released in April 2013, the TOD plans outline design and use goals for five sites adjacent to the station, with 100,000 sq. ft. of planned development. Building heights were increased to 85 feet, with less parking than typical developments nearby. This agreement also represents the first time the City of Seattle has established a parking maximum for a site—set at a unit to parking ratio of 0.7. Developers will ultimately be responsible for building on the sites, estimated at 400 apartments, 36% of which will be affordable (up to 50% AMI). A developer Request for Qualifications will be initiated by the City in 2014. Nearby, SRM and RD Merrill are currently building a 235 unit apartment building on the block next to the Capitol Hill station. Three blocks north of the station Avalon Bay is planning a project that will feature 380 apartments and 12,000 square feet of retail.

6. Potential Impact of the Center City Connector Project on Regional Development

As part of the Center City Connector Tier 1 screening process (analyzing 1st Avenue and 4th/5th Avenue streetcar alignments), preliminary economic development analysis was conducted to understand how well the 1st Avenue Streetcar corridor would promote new development. This analysis considered the capacity for new investment, potential for transit to influence future development, and connections to jobs and housing. Figure K-10 highlights assets and opportunities within a half-mile of the Seattle Streetcar alignment, including the Center City Connector, South Lake Union, and First Hill Streetcar alignments.

A qualitative property assessment of economic and property characteristics, including average building and parcel size, building age and quality, and percent of space built or renovated since 1990 within a half-mile of the proposed 1st Avenue corridor alignment was also completed. Existing development capacity and distance from other transit service create the potential for transit investment to influence development. Figure K-11 illustrates recent investment or reinvestment along the corridor and Figure K-12 identifies vacant or redevelopable parcels, including older or low quality buildings, vacant lots, or surface parking.[20]

However, the greater impact of a 1st Avenue Streetcar on the region will be its status as a connecting link between employment centers, and as a tool to resolve constraints on downtown economic expansion resulting from congestion, and limited options for north-south travel. The 1st Avenue Streetcar alignment leverages existing City and regional partner investments by linking existing transportation termini at the north and south ends of downtown (Westlake and King Street Intermodal Hubs). This is consistent with the long-term economic development strategies for the City and the region. The Seattle Jobs Plan for 2012 calls for connecting "Seattle's neighborhoods with high capacity transit, including rail, to provide residents and businesses with an affordable, reliable way to get around (the) city."[21]

[20] SDOT, Center City Connector Transit Study Tier 1 Screening Report, July 2013 (Appendix N of Detailed Evaluation Report).

[21] Seattle Jobs Plan, 2012, p. 6. http://www.seattle.gov/mayor/jobsplan/

Figure K-10 Seattle Streetcar Assets and Opportunities

1 **Mercer Corridor**: A major realignment of Mercer is underway to alleviate congestion, reduce conflict, and improve east-west connections.

2 **Not your Typical Substation**: To keep pace with the needs of high-tech and biotech businesses, Seattle is investing in reliable, clean electricity. The design of the substation will also be designed to meet community goals.

3 **Amazon.com Headquarters**: Amazon's planned campus shifts south into the Denny Triangle with three new high rise towers now under construction.

4 **Gates Foundation:** A $38 billion endowment helps to supports Seattle's high tech and biotech investments and brings approximately 1,200 - 2,000 jobs as a new a visitor center.

5 **Waterfront For All**: together these plans aim to redesign and open up 26 waterfront blocks. Plans also include measures to imporve surface connections between 1rst avenue and the waterfront.

6 **3rd Ave Design Upgrades**: The City, King County and the DSA will collaborate to improve 3rd Ave, including more outreach, support services, and infrastructure improvements.

7 **King Street Station Renovation:** WSDOT and Amtrak recently completed a $55 million dollar renovation of the busiest train station in the Pacific Northwest.

8 **Hotels + Visitors:** The downtown contains the greatest share of Seattle's visitors and tourist attractions. There are 54 hotels within the 1/2 radius from the streetcar alignment and 11,924 rooms. An estimated 15.1 million visits to local attractions take place annually.

9 **Heath Care:** Seattle's largest hospitals: Harborview Medical Center, Swedish Medical Center and Virginia Mason Medical Center and 70 percent of Seattle's Health Care jobs are located on First Hill.

10 **Arts and Culture**: The Arts is a $447 million dollar industry in Seattle, bringing in more than 10,000 jobs. Arts and Cultural Districts in both Capitol Hilll and Pioneer Square will be connected to major arts destinations in the Commercial Core and South Lake Union.

Source: Via Architecture

Figure K-11 Recent Investment/Reinvestment

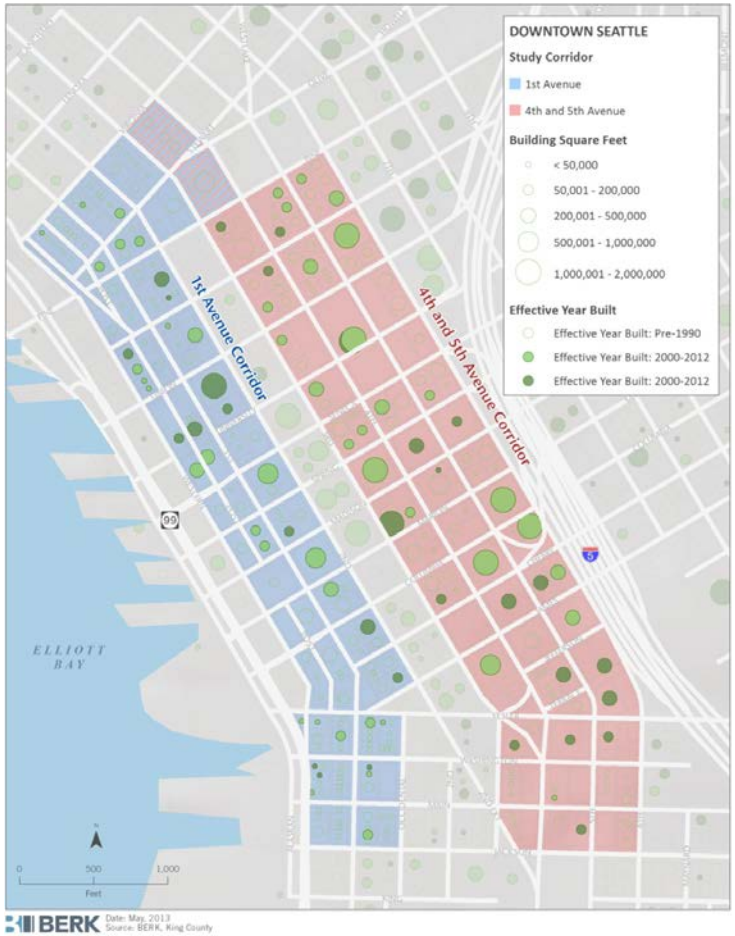


Figure K-12 Vacant and Redevelopable Parcels

7. Plans and Policies to Maintain or Increase Affordable Housing in Corridor

Seattle has a range of plans and policies in place related to support affordable housing, using both public and private market tools. Seattle's Comprehensive Plan Housing element identifies policies and goals for supplying a variety of housing addressing a variety of income levels, and promotes the use of incentives, financial assistance, and other tools. A few key goals and policies are highlighted below.

- Comprehensive Plan Policy H34(a) indicates that Seattle plans for at least 25% of the housing supply in the city to be affordable to households who have very low incomes (up to 50% of AMI).
- Comprehensive Plan Policy H30 contains affordable housing production targets for three income categories (0-50% AMI, 50-80% AMI, and 80-120% AMI) tied to the City's overall housing growth target. Affordable housing production targets for the first two of these AMI income categories were adopted into Seattle's Comprehensive Plan based on specific policy direction in Countywide Planning Policies.
- Additionally, a fundamental affordable housing goal in Seattle's Comprehensive Plan, HG12, is to reduce the number of low-income households in need of housing assistance.
- In line with these policies and goals, Comprehensive Plan policies H37-H44 calls for using a combination of tools—including local discretionary housing subsidy resources, partnerships, and public funds—to encourage the preservation, rehabilitation and development of affordable housing.

The Planning Commission's 2011 Housing Seattle report provides recommendations to tailor the Comprehensive Plan policies listed above to current housing needs. In particular, the Commission recommends "linking housing affordability to transportation costs," a recognition that low- and very low-income households are more likely to be transit dependent. As such, the City is working to create new policy goals that will direct the vast majority of new affordable housing into transit communities, with frequent and reliable transit.

Seattle's Regulatory Reform legislation adopted in 2012 addresses housing affordability. This legislation does the following:

- Streamlines regulatory requirements in Urban Centers and station areas.
- Provides greater ability to mix residential uses on the ground floor of commercial zones
- Expands opportunities for accessory dwelling units such as backyard cottages

In addition to City policy, there are a variety of efforts underway to alleviate the lack of affordable housing in Seattle. Programs that provide funding to subsidize affordable housing, such as the Seattle Housing Levy, Incentive programs and Seattle Housing Authority housing assistance are described in the following sections.

7.1 City of Seattle, Office of Housing, Housing Levy

In 2013, the City of Seattle's Office of Housing (OH) directed $34.8 million towards affordable housing through the City's Rental Housing Program. Much of this funding is generated by Seattle's voter-approved, seven-year Housing Levy. Passed in 2009 for a fifth time, the levy generates $145 million for programs to create and preserve affordable housing, provide homebuyer assistance, rental assistance, and acquisition and opportunity loans. The Seattle Housing Levy Report (2012) details accomplishments, some of which are shown in Figure K-13. From 2005-2015 the Housing Levy (and other City sources) helped to develop a total of 3,671 rental units.

Figure K-13 Seattle Housing Levy Goals and Outcomes

Levy program	Housing Produced Levy Goals 2010-2016	Housing Outcomes 2010-2012
Rental Production and Preservation	1,670 rental units	1,371
Acquisition and Opportunity	175 housing units	225
Operating and Maintenance	220 rental units	71
Homebuyer Assistance	180 homes purchased	74
Rental Assistance	3,025 households (over five years)	554 (one year)

7.2 Consolidated Plan

The City's Consolidated Plan (2009-2012) is in the process of being updated.[22] This plan implements the Comprehensive Plan and includes a detailed strategic plan outlining priorities for the City's housing and community development programs for the US Department of Housing and Urban Development (HUD). The Office of Housing (OH) uses federal CDBG (Community Development Block Grant) and HOME funds to provide

[22] 2014-2018 Consolidated Plan For Housing and Human Development 9-5-2013 http://www.seattle.gov/HumanServices/community_development/conplan/Draft_Consolidated_Plan.pdf

for the preservation and development of affordable housing, assistance to qualifying homeowners in need of home repairs, and assistance benefiting qualifying homebuyers.

7.3 Incentive Zoning

Seattle allows additional residential or non-residential floor area beyond base height or FAR limits to be achieved in certain zones. SMC 23.58A (Incentive Provisions) is Seattle's primary land use code chapter guiding incentive zoning (IZ). Generally, residential developers opting to seek additional floor area in IZ-eligible zones with maximum height limits < 85' must include a percentage of units as affordable to households with incomes up to 80% of AMI (rental) or 100% of AMI (ownership). Non-residential and high rise residential developers also have the option of making a cash contribution (in-lieu fee) to the City to contribute to a low-income housing fund.

The City is currently undertaking a review of its affordable housing incentive zoning program.[23]

7.4 Transferable Development Rights Potential (TDP)

This option helps Seattle maintain a more variable building scale by allowing density to be moved from one site to another.[24] Excess development rights from a certified TDP site can be sold to developers needing residential floor area beyond a base height or floor area ratio (FAR) limit. The proceeds of TDP sales are used for preservation of priority uses. The TDR Agreement includes covenants that will run with the land including 50 years of affordable housing primarily affordable to households with incomes up to 50% of AMI.

Appendix L provides an estimate of affordable housing currently available in the Center City area.

[23] http://www.seattle.gov/council/issues/affordablehousing/default.html

[24] http://www.seattle.gov/housing/incentives/TDPbonus.htm

APPENDIX L AFFORDABLE HOUSING ASSESSMENT

Introduction

This document[1] summarizes a preliminary assessment of affordable housing supply in the Center City. The housing supply assessment was prepared during the Tier 1 stage of evaluation based on the data available at the time (2013). This assessment is related to Project Goals and Objectives that address affordable housing. The Project goal statement includes the following goal:

Thrive: Strengthen downtown and Center neighborhood.

The following Project Objectives relate to this goal:

- Increase access to affordable housing and social services.
- Improve transportation options for Seattle's most vulnerable residents.

The FTA's New and Small Starts Policy Guidance document[2] includes project justification criteria related to affordable housing (within the Economic Development Effects topic area). Additional review of plans and policies related to preserving and increasing affordable housing is included in Appendix K.

Affordable Housing Supply

Citywide Affordable Housing

Subsidized affordable housing units typically have eligibility requirements based on the percentage of Area Median Income (AMI) the household earns. The city of Seattle has approximately 24,000 subsidized rental units citywide, with roughly 16,000 serving households with incomes of up to 50% AMI. More than 12,000 of these units are available only to households with extremely low incomes (0-30% AMI).[3] The Seattle Planning Commission's 2011 Housing Seattle report contained several findings regarding housing and transit service:

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[1] Prepared by Nelson\Nygaard and VIA Architecture

[2] FTA, "New and Small Starts Evaluation and Rating Process Final Policy Guidance," August 2013, http://www.fta.dot.gov/documents/NS-SS_Final_PolicyGuidance_August_2013.pdf

[3] Seattle Planning Commission, Housing Seattle, 2011 http://www.seattle.gov/documents/departments/seattleplanningcommission/housingseattlereport/housingseattleweb.pdf

- Urban Centers and Urban Villages contain 40% of the total housing units in Seattle and more than half of the city's rental units.
- Because of higher concentrations of rental and multifamily units, housing is generally more affordable in areas with frequent transit service and in Urban Centers and Urban Villages.
- Almost three-quarters of market-rate rentals in complexes with 20 or more units are near frequent transit service.[4]

Center City Affordable Housing

The Center City Connector Tier 1 screening included an assessment of subsidized (income-restricted) affordable housing supply in the Center City. The Center City area includes the neighborhoods of Uptown, South Lake Union, Capitol Hill, Belltown, Denny Triangle, Pike/Pine, Downtown Commercial Core, First Hill, Pioneer Square, and the Chinatown/International District. This analysis was comparative, intended to evaluate 4th/5th Avenue and 1st Avenue Streetcar alignments based on the project goals and objectives related to affordable housing.

The analysis was based on the existing data sources available to the project team. It is anticipated that this analysis would be updated in the future based on more recent and comprehensive data that may be available. The data was provided by the City of Seattle for all City-funded and other income-restricted housing. Multiple inventories were synthesized to develop the estimate.

Figure L-1 shows the total Center City affordable housing supply, including income-restricted units and non-restricted units in buildings that contain both subsidized and market-rate units. There are nearly 9,000 income-restricted units in the Center City, representing a large share of the city's overall affordable housing supply.

Figure L-1 Estimate of Total Center City Income-Restricted Housing Supply, 2012

Income-Restricted Units	Unrestricted Units	Total Units
8,972	1,317	10,289

Data sources: (1) Seattle Office of Housing survey of all project-based affordable housing (conducted in 2009) and supplemented with housing funded by the Office of Housing through 2011. (2) Inventory of all affordable rental housing that the City has funded as of early 2013.

[4] Seattle Planning Commission, Seattle Housing Needs, 2011, p. 19
http://www.seattle.gov/planningcommission/docs/HousingSeattle.pdf

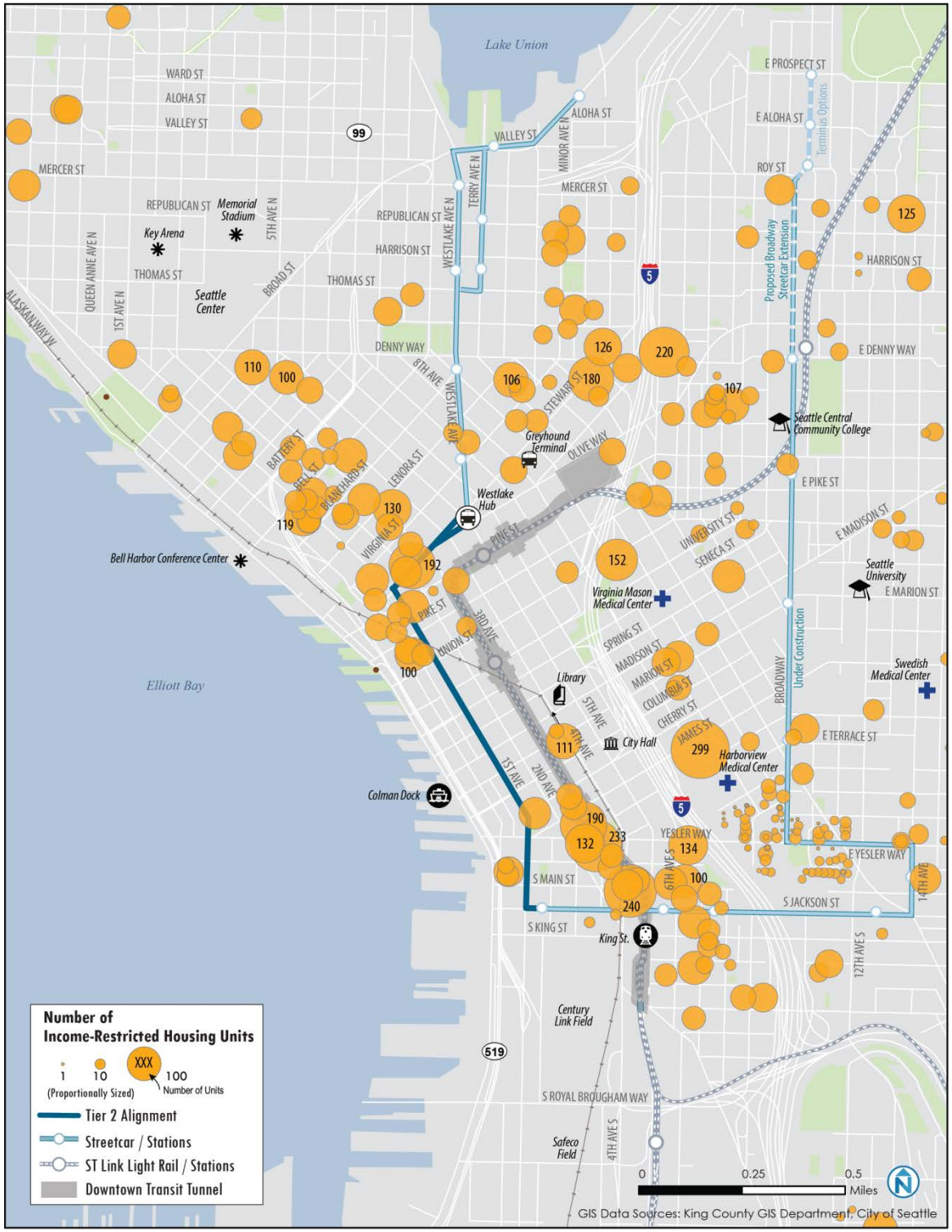
Figure L-2 shows the number of units for each AMI category. More than half of units (54%) are limited to very low income households (earning up to 30% of AMI). Nearly three-quarters of income-restricted units are available to households earning up to 50% of AMI; nearly 90% are limited to households with incomes of 60% of AMI or less.

Figure L-2 Number of Center City Units by Income Restriction, 2013

	30% AMI	40% AMI	50% AMI	60% AMI	65% AMI	70% AMI	80% AMI	Total
TOTAL	4,811	199	1,590	1,287	13	55	1,017	8,972
% of income-restricted	54%	2%	18%	14%	0%	1%	11%	100%
Cumulative %	54%	56%	74%	88%	88%	89%	100%	

Figure L-3 shows the location of buildings with income-restricted units that were identified in the analysis and the number of income-restricted units in each building. For the most part, affordable housing is located at either end of the Center City Streetcar alignment, in Pioneer Square or Belltown.

Figure L-3 Center City Income-Restricted Housing Locations



APPENDIX M INITIAL SCREENING

This appendix provides additional detail regarding the initial screening of mode and alignment alternatives for the Seattle Center City Connector based on the Project Purpose and Need.

Initial Screening Methodology

The Center City Connector Project evaluation framework defined several key questions to be addressed in the initial screening of alternatives with the aim of removing alternatives that clearly do not meet the stated Project Purpose and Need from further consideration. Figure M-1 describes the evaluation process and data sources used to support the evaluation.

Figure M-1 Initial Screening Criteria

Criteria	Quantitative Data or Data Sources
Consistency with local and regional plans	Qualitative assessment based on: ▪ Seattle Transit Master Plan (TMP), 2012 ▪ Seattle Comprehensive Plan, written in 2005, last updated in 2009 ▪ Seattle Streetcar Network Development Report, 2008 ▪ Seattle Transportation Strategic Plan (TSP), 2005 ▪ Seattle Bicycle Master Plan (BMP), 2005 ▪ Seattle Center City Circulation Strategy Report, 2004 ▪ Seattle Center City Access Strategy, 2003
Meets identified needs (mobility/connectivity): ▪ Significant existing population and employment and projected growth in the Seattle Center City ▪ Growth in demand for Center City circulation trips ▪ Constraints on expansion of Center City transportation	Quantitative assessment based on: ▪ Total population and employment; population and employment density[1] ▪ Projected 2030 total population and employment; 2030 population and employment density ▪ Physical constraints (e.g., impacting directness, conflicts with other

Criteria	Quantitative Data or Data Sources
capacity ▪ Special mobility needs of tourists, visitors, and casual users in the Center City ▪ Affordable transportation access to key social and human services located in the Center City ▪ Connections for low-income workers who live in the Center City to jobs in the Center City ▪ Reduction in greenhouse gas (GhG) emissions from private vehicle travel and traffic congestion	modes) ▪ Number of landmarks/attractions[2] and number per alignment mile ▪ Number of social service sites and number per alignment mile ▪ Number and density of low-income workers who live and work in Center City (home and work locations) Qualitative assessment based on: ▪ Physical constraints (e.g., impacting directness, conflicts with other modes)
Serves key destinations and anchors	Qualitative assessment
Public and stakeholder support	Qualitative assessment based on stakeholder interviews and open house #1 feedback
Transit capacity	Qualitative assessment (mode screening only)
Reduction in GhG emissions	Qualitative assessment (mode screening only)

Notes: (1) Density evaluated based on a 1/8 mile buffer of each alignment. (2) As identified in the Project Purpose and Need statement.

Initial Screening Results

This section presents findings from the initial screening process, including how well each alterative met the evaluation criteria described in Figure M-1. Modes and street alignments were assessed separately.

Modes

The Transit Master Plan proposed that modern streetcar (with a range of transit priority improvements) be considered as the mode for the Center City Connector. Based on input

received at the February 6, 2013 open house and through stakeholder interviews, Mixed-Traffic and Exclusive Streetcar[1], Enhanced Bus, Light Rail (Sound Transit Link), and Monorail modes were screened against the Project Purpose and Need. Figure M-2 provides a summary of the initial mode screening against established screening criteria.

Figure M-2 Initial Screening Mode Evaluation Results

	Mode				
Evaluation Measures	Mixed-Traffic Streetcar	Exclusive Streetcar	Enhanced Bus	Monorail	Link Light Rail
Consistent with Local/Regional Plans	Best	Good	Fair	Poor	Poor
Meets Identified Needs (Mobility/ Connectivity)	Best	Good	Fair	Poor	Fair
Public/Stakeholder Support	Best	Good	Fair	Poor	Poor
Potential Right-of-Way Impacts	Best	Fair	Best	Fair	Poor
Overall	Best	Good	Fair	Poor	Poor

The following sections provide additional detail on the assessment of each mode.

Mixed-Traffic Streetcar

The Mixed-Traffic Streetcar mode was rated "best" overall based on the following evaluation. It was recommended for further study in Tier 1.

- Consistent with the TMP, Seattle Streetcar Network Plan, and others.
- Meets Project Need and could connect South Lake Union (SLU) and First Hill (FH) Streetcars.
- Strong stakeholder support.
- Minimal impacts to right-of-way.

Exclusive Streetcar

The Exclusive Streetcar mode was rated "good" overall based on the following evaluation. It was recommended for further study in Tier 1.

- Not specifically identified for the Center City Connector corridor in the TMP, but compatible with existing streetcars; a related mode (Rapid Streetcar) was identified as a potential mode option for other corridors in the TMP.

[1] The TMP distinguished between Local and Rapid Streetcar modes, with Rapid Streetcar contrasted by design features including extensive transit priority and dedicated right-of-way; higher-capacity vehicles; and a higher level of investment in station design and amenities. For the purpose of the Center City Connector alternatives evaluation, "Local Streetcar" was represented in the Mixed-Traffic Streetcar mode while "Rapid Streetcar" was represented in the Exclusive Streetcar mode. The evaluation primarily differentiated the two modes in terms of a high level of transit priority and use of dedicated right-of-way.

- Meets Project Need and could connect SLU and FH streetcars.
- Good stakeholder support; stakeholders also emphasized importance of transit priority.
- Significant impacts to right-of-way.

Enhanced Bus

Enhanced Bus was rated "fair" overall and was not recommended for further consideration. The evaluation included the following assessment:

- Not specifically identified for the Center City Connector corridor, but compatible with the corridor and identified as a potential mode option for other corridors in the TMP.
- Could meet a subset of Project needs, but is not compatible with establishing a seamless connection between the SLU and FH streetcars, which represent a substantial investment in Center City transit mobility.
- Limited stakeholder support.
- Minimal impacts to right-of-way.

Monorail

Monorail was rated "poor" overall and was not recommended for further consideration based on the following assessment:

- Not recommended for the Center City or any other corridors in current plans.
- Limited ability to meet Project needs given incompatibility with other modes.
- No recorded stakeholder support.
- Significant impacts to right-of-way.

Link Light Rail

Link Light Rail was rated "poor" overall and was not recommended for further consideration based on the following evaluation:

- Surface-running option would be unlikely to meet Sound Transit design criteria and has not been recommended in other plans.
- Limited ability to meet Project needs such as short-distance trips and not compatible with goal of creating a seamless connection between the SLU and FH streetcars.
- No recorded stakeholder support.
- Surface-running option would have significant right-of-way impacts.

Street Alignments

The TMP proposed potential Center City Connector alignments on 4th/5th Avenues (couplet) and 1st Avenue. The project team solicited public input on these and other potential alignments at the February 6, 2013 open house. Several additional alignments identified by the public were included in the range of alignments considered. A total of seven alignments were evaluated in the initial screening process, as shown in Figure M-3.

Figure M-3 Alignments Evaluated in Initial Screening

Figure M-4 shows the results of the initial screening. The 4th/5th Avenue (couplet) and 1st Avenue alignments were rated "good" and "best," respectively. These two alignments were recommended for further consideration in the Tier 1 evaluation. All other alignments received overall ratings of "fair," and were not recommended for further consideration.

Figure M-4 Initial Screening Alignment Evaluation Results

	Alignment						
Evaluation Measures	4th/5th Aves	1st Ave	1st Ave to Uptown	3rd Ave to Seattle Center	3rd Ave to Westlake	1st Ave-SODO Extension	Waterfront Streetcar
Consistent with Local/Regional Plans	Good	Best	Good	Poor	Poor	Fair	Fair
Meets Identified Needs (Mobility/ Connectivity)	Good	Good	Fair	Fair	Fair	Poor	Fair
Serves Key Destinations/ Attractions	Good	Best	Good	Good	Good	Fair	Fair
Public/Stakeholder Support	Fair	Best	Fair	Fair	Poor	Good	Fair
Overall	Good	Best	Fair	Fair	Fair	Fair	Fair

The following sections provide additional detail on the evaluation of each alignment.

Alignment A: 4th/5th Avenues

This alignment was rated "good" overall and was recommended for further evaluation in Tier 1. The evaluation was based on the following assessment:

- Included in TMP as Corridor CC2, not included in Seattle Streetcar Network Plan, could conflict with Seattle Bicycle Master Plan (BMP).
- Serves mobility needs and provides connections to human services and low-income workers' home and job locations in the Center City, but is more strongly oriented to downtown commuters than to tourists/visitors.
- Serves some key destinations and attractions.
- Limited stakeholder support primarily due to modal conflicts; use of couplet and land use/demand factors were also raised as concerns.

Alignment B: 1st Avenue

The 1st Avenue alignment was rated "best" overall and was recommended for further evaluation in Tier 1. The evaluation was based on the following assessment:

- Included in multiple plans including Seattle Center City Circulation Strategy Report (2004), Seattle Streetcar Network Plan (2008), and Seattle TMP (2012).
- Serves tourist/visitor mobility needs and provides connectivity to human services and home/job locations for low-income workers.
- Serves numerous key destinations and attractions.

- Strong stakeholder and public support for a 1st Avenue alignment with a connection to Westlake and the South Lake Union streetcar.

Alignment C: 1st Avenue to Uptown

The 1st Avenue to Uptown alignment (without a direct connection to Westlake) was rated "fair" overall based on the following assessment:

- Included in Seattle Streetcar Network Plan and Seattle TMP.
- Provides mobility for tourists/visitors and connectivity to human services and low-income workers, but without the Westlake connection provided by Alignment B it does not serve the Project Purpose of connecting the SLU and First Hill streetcars.
- Serves numerous key destinations and attractions.
- The connection to Uptown/Lower Queen Anne provided by this alignment received moderate stakeholder and public support but this alignment would not meet the Project Need for connecting to the South Lake Union Streetcar without a Westlake connection.

The 1st Avenue to Uptown alignment was not recommended for further consideration in Tier 1 because it did not meet the Project Purpose and Need without a connection to Westlake. However, the corridor between North Downtown and Seattle Center/Lower Queen Anne was analyzed in the Ballard-to-Downtown High Capacity Transit Study. This work will be used to determine next steps in developing a high-capacity transit connection.

Alignments D1 and D2: 3rd Avenue to Seattle Center or Westlake

The 3rd Avenue alignments were both rated "fair" based on the following assessment:

Alignment D1: 3rd Avenue to Seattle Center

The 3rd Avenue to Seattle Center alignment was rated "fair" overall based on the following assessment:

- Not consistent with current City, Sound Transit, or King County Metro plans.
- Provides good mobility for tourists/visitors and good connectivity to human services and low-income worker home locations.
- Serves some key destinations and attractions and provides connections between Intermodal Hubs but duplicates service provided by existing bus and Link light rail.
- Limited stakeholder support; significant transit conflicts.

Alignment D2: 3rd Avenue to Westlake

The 3rd Avenue to Westlake alignment received an overall evaluation of "fair" based on the following assessment:

- Not consistent with current City, Sound Transit, or King County Metro plans.
- Provides good mobility for tourists/visitors and good connectivity to human services and low-income worker home locations.
- Serves some key destinations and attractions and provides connections between Intermodal Hubs but duplicates service provided by existing bus and Link light rail.
- Poor stakeholder support; significant transit conflicts.

Both 3rd Avenue alignments would cause significant conflicts with current transit operations unless service was operated using the Enhanced Bus mode. The initial mode screening found that Enhanced Bus did not meet the Project Purpose and Need and may duplicate some existing service on this alignment. A circulator operating on 3rd Avenue could be challenging to implement without negatively impacting important local and regional bus operations because 3rd Avenue is currently near peak period bus capacity. Neither alignment was recommended for consideration in Tier 1.

Alignment E: 1st Avenue-SODO Extension

Alignment E would extend alignment B or C to the Stadium District/South Downtown (SODO). This alignment received an overall rating of "fair" based on the following assessment:

- Has not been included in current plans, but does not conflict with local plans.
- Does not meet overall mobility needs for tourists/visitors and/or provide connectivity to social services and low-income worker home and job locations. This alignment would not meet the Project Purpose and Need in isolation.
- Serves some significant destinations and attractions, but in isolation does not connect major tourist and visitor destinations.
- Moderate stakeholder support.

A SODO alignment was not recommended for further consideration in Tier 1 but may be suitable for consideration as part of a future study.

Alignment F: Waterfront Streetcar

The Waterfront Streetcar alignment was rated "fair" overall based on the following assessment:

- Has been included in past plans (Seattle Center City Circulation Study, 2004; Seattle Center City Access Study, 2003), and was assessed for feasibility in the Seattle Waterfront Streetcar Reactivation Study (2011). This alignment is currently under consideration as part of the Central Waterfront Project.
- Provides moderate mobility for tourists/visitors and moderate-to-poor connectivity to low-income home and job locations.

- Serves few key destinations and attractions due to limited walkshed.
- Limited stakeholder support; stakeholders did not feel that this alignment would provide adequate urban circulation due to grade and walking distance from the downtown core.

This alignment was not recommended for further study in Tier 1, however the alignment was under consideration as part of the Central Waterfront Project when the initial screening was conducted and a final decision was deferred pending the outcome of the Central Waterfront process. Additionally, a limited number of stakeholders expressed interest in incorporating the historic waterfront streetcars into the Center City Connector Project.

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