City of Seattle

SoundTransit

TRANSIT EXPANSION STUDY

BALLARD TO DOWNTOWN SEATTLE

05/16/2014

Final Report

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Acronyms and Abbreviations

ACS	American Community Survey
BAT	Business and Transit
BMP	Bicycle Master Plan
BRT	Bus Rapid Transit
CBD	Central Business District
CTR	Commute Trip Reduction
EIS	Environmental Impact Statement
ETC	Elevated Transportation Company
FTA	Federal Transit Administration
HCT	High Capacity Transit
ICT	Intermediate Capacity Transit
LRT	Light Rail Transit
MSF	Maintenance and Storage Facility
O&M	Operations and Maintenance
OCS	Overhead Catenary System
PSRC	Puget Sound Regional Council
ROW	Right-of-Way
SDOT	Seattle Department of Transportation
SR	State Route
ST	Sound Transit
ST2	Sound Transit 2008
TMP	Transit Master Plan
VMT	Vehicle Miles Traveled
WSDOT	Washington State Department of Transportation

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EXECUTIVE SUMMARY

Sound Transit and the City of Seattle partnered on a conceptual-level study exploring opportunities for improving transit connections between Ballard and Downtown Seattle. By partnering and increasing efficiencies, Sound Transit and the City of Seattle saved planning dollars during this project development phase.

The purpose of the Ballard to Downtown Seattle Transit Expansion Study was to:

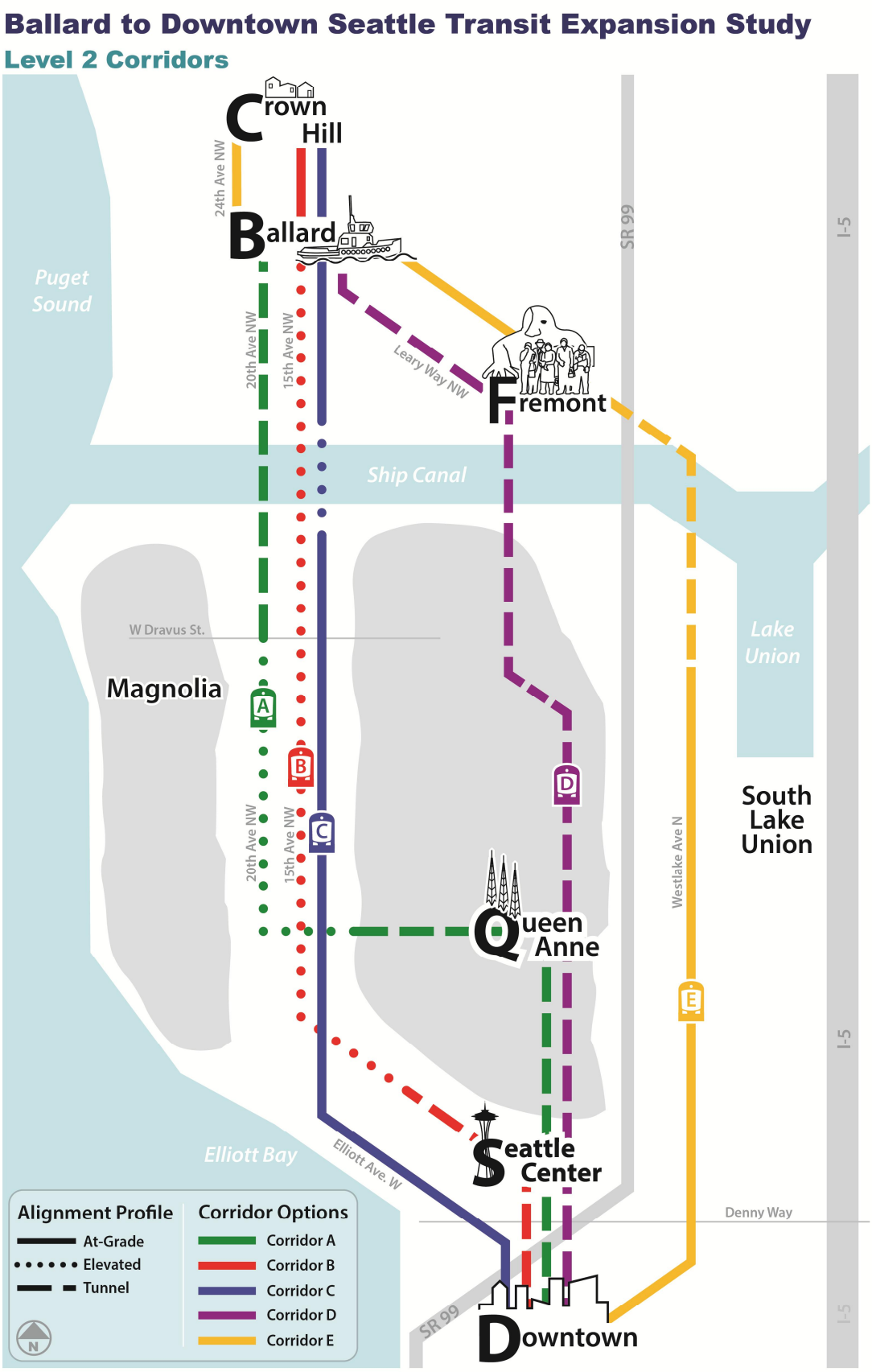
1. Support implementation of the City of Seattle Transit Master Plan.
2. Support future Sound Transit Board discussions on long-range high capacity transit (HCT) options and update to the Sound Transit Long-Range Plan.

The results of this study will inform future decisions regarding mode, alignment and implementation responsibilities to be included in an updated Sound Transit Long-Range Plan. It will also help establish priorities for the next phase of possible investments in a higher capacity mode of transit by the City of Seattle.

Public input solicited throughout the course of the study helped the project team evaluate corridors between Ballard and Downtown Seattle, serving neighborhoods such as Fremont, Queen Anne, Interbay and Belltown. Three open houses and interactive online tools drew the interest of over 2,500 stakeholders.

STUDY CORRIDORS

Through a three-step screening and evaluation process and in coordination with public involvement throughout the study, five corridors were identified for the final level of evaluation (Level 2). These are illustrated on the following page.


Ballard to Downtown Seattle Transit Expansion Study
Level 2 Corridors
Crown Hill
Ballard
Fremont
Puget Sound
Ship Canal
Lake Union
Magnolia
South Lake Union
Queen Anne
Seattle Center
Downtown
Elliott Bay
24th Ave NW
20th Ave NW
15th Ave NW
Leary Way NW
W Dravus St.
Elliott Ave. W
Westlake Ave N
Denny Way
SR 99
I-5
A
B
C
D
E
Alignment Profile
At-Grade
Elevated
Tunnel
Corridor Options
Corridor A
Corridor B
Corridor C
Corridor D
Corridor E
N

KEY FINDINGS

Based on the results of the Level 2 evaluation, a summary was prepared for each of the Level 2 corridors. The evaluation results and a map of the corridors are summarized in a matrix and discussed below and on the following pages. More detailed information is available in the *Level 2 Corridors Analysis and Evaluation Technical Memo* (Sound Transit, January 2014).

Ridership: Corridors A and D were rated highest performing for ridership. Both corridors would be fully exclusive and serve many key transit markets, including Upper Queen Anne. Corridor B was the next highest performing option, with significantly higher ridership than Corridor C due to a faster travel time, a better downtown connection, and a more centrally located Uptown station. Corridors C and E were the lowest performing corridors with lower ridership projections due to slower travel times and service to fewer transit markets.

Reliability: Corridors A and D were the most reliable corridors because of their fully grade-separated profiles (elevated and/or tunnel). No at-grade signalized intersections would be traversed and a tunnel crossing ship canal would not experience any delays as a result of boat traffic. The Corridor A option with a bridge over the ship canal received a slightly lower performance rating due to some delays to transit operations caused by bridge openings. Corridor B was the next highest performing corridor with only 11 signalized intersections traversed along 15th Ave NW and a bridge crossing the ship canal. The Corridor E tunnel option scored slightly lower in reliability performance due to a high number of intersections traversed. The Corridor E bridge option and Corridor C were the lowest rated due to the greatest number of signalized intersections traversed combined with a bridge crossing the ship canal.

Travel Time Improvement: Corridors A, B, and D performed the highest for travel time improvement with similar travel times between Ballard and Downtown Seattle. In general, faster travel times were related to greater grade separation, fewer stations, and shorter total distances. Corridors C and E received slightly lower ratings due to slower travel times resulting from minimal grade separation and more stops.

Disruption to Other Modes: Corridors A and D received the highest performance rating for being least disruptive to other modes. Full grade-separation for both corridors would cause little to no impact on traffic operations and multimodal mobility. Corridors B and E received lower performance ratings for having moderate impacts to traffic operations, parking, and freight mobility. The fully at-grade profile of Corridor C, particularly through Belltown and Uptown, resulted in this corridor being the most disruptive to other modes.

Station Area Development Potential: Corridors A and D received the highest performance ratings due to the high development propensity in the potential station areas, particularly with the inclusion of Upper Queen Anne. Corridor E received a medium-high rating, followed by Corridors B and C with medium ratings.

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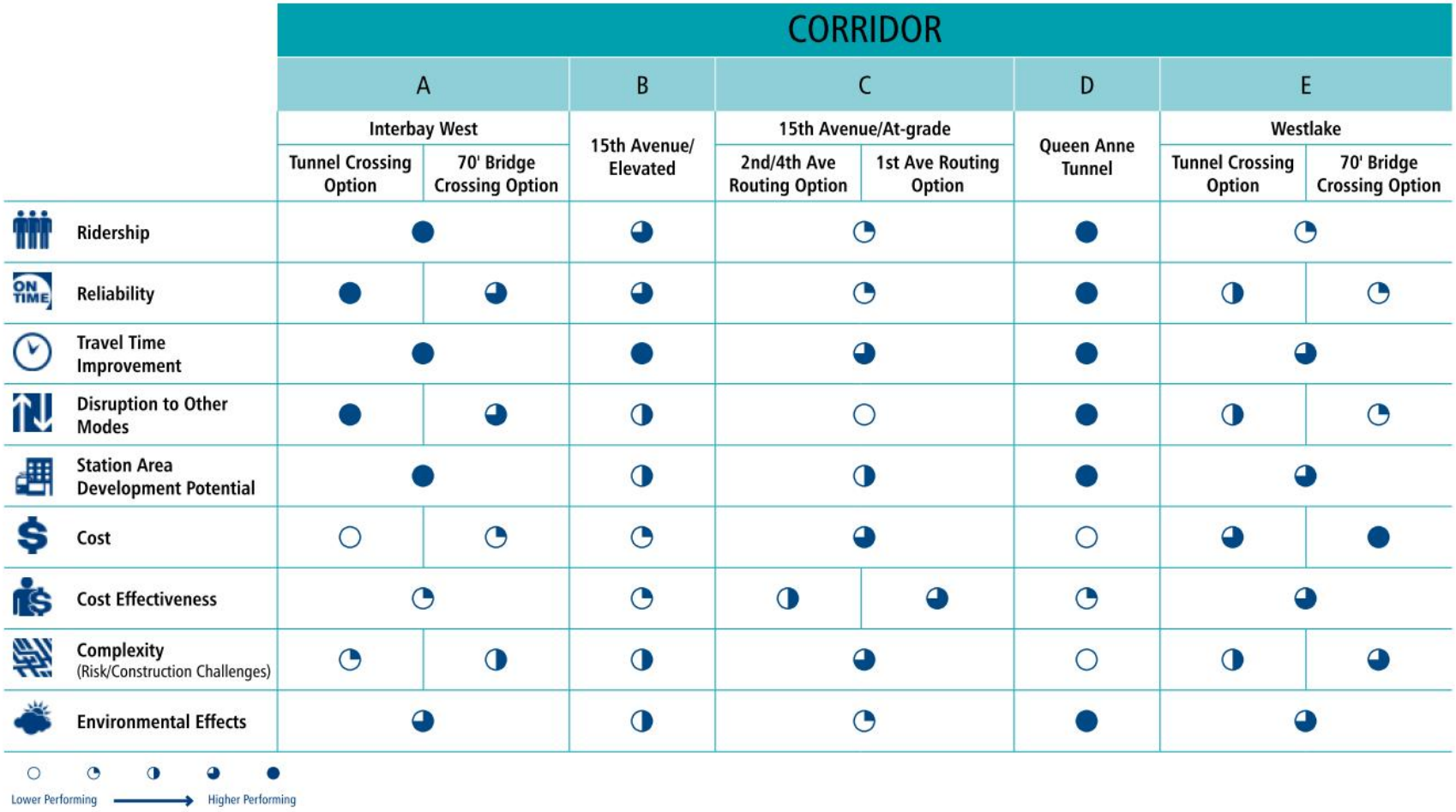
LEVEL 2 EVALUATION RESULTS



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Cost: The primarily grade-separated corridors and corridors with long tunnel segments had the highest cost estimates. The Corridor E bridge option received the highest performance rating with the lowest capital cost estimate, followed by Corridor C and the Corridor E tunnel option with a medium-high rating. The Corridor A bridge option and Corridor B received medium-low ratings, while the Corridor A tunnel option and Corridor D received the lowest ratings with the highest capital cost estimates.

Cost Effectiveness: Corridor E was the most cost effective due to the lowest cost per rider, followed by Corridor C. Corridors A, B, and D received low performance ratings for having higher costs per rider.

Complexity (Risk/Construction Challenges): Similar to the cost ratings, the primarily grade-separated corridors performed the highest in terms of complexity, while corridors featuring long tunnels performed the lowest. Corridor C and the Corridor E bridge option received the highest rating, followed by the Corridor A bridge option, Corridor B, and the Corridor E tunnel option. The Corridor A tunnel option received a medium-low rating, while Corridor D received the lowest rating due to the fully-below grade profile and deep tunnel station.

Environmental Effects: Corridor D received the highest performance rating primarily due to the lack of visual impacts (being fully below grade) and highest potential reduction in VMT. Corridor C received the lowest rating due to visual impacts of a new bridge combined with vulnerability to sea level rise in the Interbay area and the lowest potential reduction in VMT.

Construction of any potential future rail extensions would be subject to Sound Transit and City policy decisions and identification of funding sources. Voter approval is required for potential Sound Transit investments.

Public Engagement: The majority of comments received through a public open house and online engagement indicated a preference for Corridor D (76%), followed by 9% for Corridor B, 7% for Corridor A, 5% for Corridor E, and 2% for Corridor C.

STUDY PROCESS

The following steps were completed in the development and evaluation of rail alternatives:

- **Initial Screening Evaluation**

  Review transit alignment link options for consistency with goals and objectives

  Advance options that meet goals and objectives, are consistent with rail design criteria, and align with public input

- **Level 1 Evaluation**

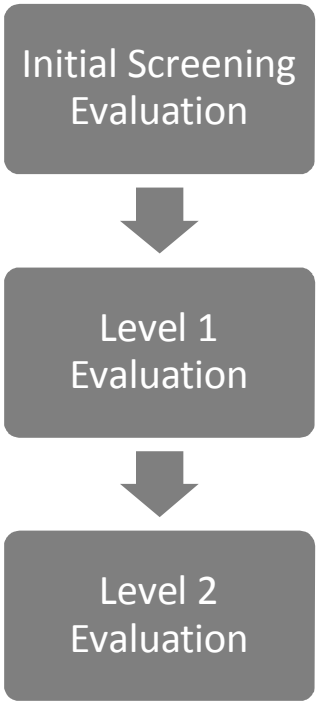
  Refine transit link options to a set of corridors based on Initial Screening results

  Perform evaluation based on mostly qualitative criteria and measures

- **Level 2 Evaluation**

  Refine transit corridors based on Level 1 evaluation results and public input

  Perform more detailed evaluation based on more quantitative criteria and measures



Initial Screening

In March 2013, over 400 people (nearly 150 at an open house and nearly 270 online) provided input on study goals and objectives, commute origins and destinations, and ideas for potential routes. The project team utilized input gathered through the open houses and interactive online tools to evaluate public feedback and develop a set of initial alternative alignment links to represent the range of potential corridors along which new rail service could connect Downtown Seattle with Ballard and potentially other neighborhoods in the study area. The Initial Screening evaluation reviewed the transit alternatives for consistency with the study's goals and objectives. This evaluation considered the full range of transit alternatives identified through the stakeholder and public input process and narrowed down the set of alternatives to a set of corridors to be considered in the Level 1 evaluation. A detailed summary of public input can be found in the *Public Meeting and Engagement Summary "Open House #1" Technical Memo* (Sound Transit, April 2013).

Level 1 Evaluation

Following the initial review of alternative concepts, eight preliminary corridors were identified for Level 1 evaluation. These eight corridors provided a range of representative routes that included various combinations of rail transit running in at-grade, elevated, and tunnel profiles.

Level 1 evaluation was based on an analysis of potential benefits and impacts including travel time, cost, and land use integration. In June 2013, more than 1,350 people (over 165 at a public meeting and over 1,200 online) provided feedback on their preferred corridor, Ship Canal crossing, Downtown Seattle connection, and other study elements. More detail can be found in the *Public Meeting and Engagement Summary "Open House #2" Technical Memo* (Sound Transit, September 2013).

Level 2 Evaluation

The project team refined the potential rail corridor options with consideration of Level 1 evaluation results and public input received from the June open house and web-based tool. Based on Level 1 evaluation results and public input, five corridors were advanced and refined for Level 2 evaluation. The five corridors are described below, with a map and major findings on the following page.

- **Corridor A – Interbay West:** connects Ballard to Downtown Seattle via Interbay with a completely grade-separated route. Corridor A presents two Ship Canal crossing options: a tunnel and a 70' movable bridge.
- **Corridor B – 15th Avenue/Elevated:** provides the most direct connection between Ballard and Downtown Seattle via Interbay using a combination of profiles. A tunnel through Downtown, Belltown, and Uptown/Lower Queen Anne would shift to an elevated profile through Interbay along 15th Avenue until touching down to grade in Ballard. It would then continue at-grade in an exclusive lane along 15th Avenue NW to NW 85th. Corridor B would include a proposed 70' movable bridge across Salmon Bay.
- **Corridor C – 15th Avenue/At-Grade:** would follow a similar alignment to Corridor B, including a 70' movable bridge crossing option for the Ship Canal, except with a fully at-grade profile in an exclusive lane. This corridor has two routing options through Downtown Seattle and Belltown: running along 1st Avenue, and a couplet running along 2nd and 4th Avenues.
- **Corridor D – Queen Anne Tunnel:** is completely grade-separated with a tunnel from Ballard to Downtown Seattle that serves both Upper Queen Anne and Fremont, and includes a tunnel crossing under the Ship Canal.
- **Corridor E – Westlake:** runs at-grade in an exclusive lane through South Lake Union along Westlake Avenue. This corridor has two Ship Canal crossing options: tunnel through Fremont, and a 70' movable bridge returning to an at-grade profile in Fremont.

The Level 2 evaluation was the final analysis step in the Ballard to Downtown Seattle Transit Expansion study. The results, shown previously in the Key Findings, were presented to the public at a third open house on December 5th, 2013. More detail can be found in the *Public Meeting and Engagement Summary "Open House #3" Technical Memo* (Sound Transit, 2014).

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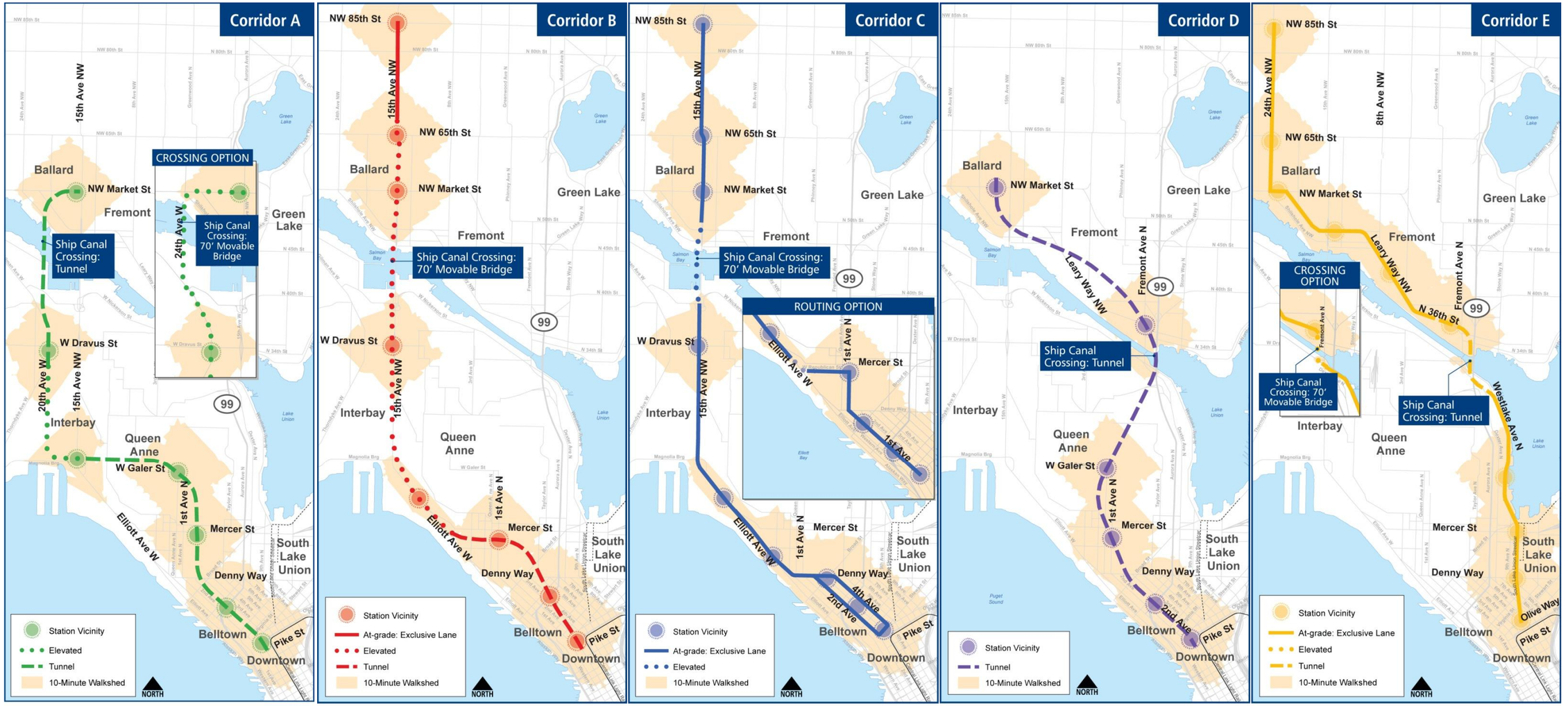

Interbay West/Ship Canal Tunnel

Capital Cost (million)
Market St to Downtown Seattle: $3,200 - 3,600
With Crossing Option: $2,800 - 3,200

Peak Period Travel Time:
Market St to Downtown Seattle: 13 - 15 min

Daily Ridership
Market St to Downtown Seattle: 24,000 - 28,000

15th Avenue/Elevated

Capital Cost (million)
Market St to Downtown Seattle: $2,400 - 2,800
Extension to NW 85th St: + ~$150

Peak Period Travel Time:
Market St to Downtown Seattle: 11-13 min
Extension to NW 85th St: + 4 - 5 min

Daily Ridership
Market St to Downtown Seattle: 22,000 - 26,000
Extension to NW 85th St: + 5,000

15th Avenue/At-grade

Capital Cost (million)
Market St to Downtown Seattle: $800 - 1,200
With Routing Option: $800 - 1,200
Extension to NW 85th St: + ~$150

Peak Period Travel Time:
Market St to Downtown Seattle: 15 - 19 min
Extension to NW 85th St: + 4 - 5 min

Daily Ridership
Market St to Downtown Seattle: 14,000 - 18,000
Extension to NW 85th St: + 4,000

Queen Anne Tunnel

Capital Cost (million)
Market St to Downtown Seattle: $3,200 - 3,600

Peak Period Travel Time:
Market St to Downtown Seattle: 12 - 14 min

Daily Ridership
Market St to Downtown Seattle: 26,000 - 30,000

Westlake/Ship Canal Tunnel

Capital Cost (million)
Market St to Downtown Seattle: $800 - 1,200
With Crossing Option: $400 - 800
Extension to NW 85th St: + ~$100

Peak Period Travel Time:
Market St to Downtown Seattle: 17 - 21 min
Extension to NW 85th St: + 4 - 5 min

Daily Ridership
Market St to Downtown Seattle: 14,000 - 18,000
Extension to NW 85th St: + 2,000

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1 INTRODUCTION

The Ballard to Downtown Seattle Transit Expansion Study was a collaboration between Sound Transit and the City of Seattle to explore opportunities for improving transit connections between Ballard and Downtown Seattle. The study results will inform future decisions regarding mode, alignment and implementation responsibilities to be included in an updated Sound Transit Long-Range Plan. It will also help establish priorities for the next phase of possible investments in a higher capacity mode of transit by the City of Seattle.

Ballard, Fremont, and other adjacent neighborhoods have experienced significant population and employment growth in the past several years. This trend is forecasted to continue, along with increasing traffic congestion and reduced reliability of bus transit service between these neighborhoods and Downtown Seattle, which is the primary employment destination for residents of the area. The limited number of crossings of the Ship Canal (Ballard, Fremont, and Aurora bridges) present chokepoints for north-south movement of both general purpose traffic and transit service through this study area. As a result, both regional and local transit planning efforts have identified the need for improved transit service between Ballard and Downtown Seattle.

The Ballard-to-Downtown Seattle corridor is identified as a potential rail corridor in the Sound Transit Long-Range Plan. This study is one of nine HCT corridor studies that were called for in the ST2 package approved by voters in 2008. The results of these studies will be used by Sound Transit staff and board members to inform the update of Sound Transit's Long-Range Plan, as well as development of a potential future system expansion program.

In April 2012, the Seattle City Council adopted the Transit Master Plan (TMP), which focuses on using transit to connect communities in the City of Seattle. The TMP indentified a series of HCT corridors that would connect dense Seattle neighborhoods with limited stop, high quality service running at-grade in exclusive transit lanes. The Ballard to Downtown Seattle corridor

was recommended for further study in coordination with Sound Transit, with rapid streetcar identified as the preferred mode.

2 PREVIOUS STUDIES AND FINDINGS

The purpose of this compilation was to document the studies conducted and the pertinent findings that might affect this study. The following planning documents and previous studies were selected as the most relevant to the Ballard to Downtown Study:

- Sound Transit Long Range Plan
- Sound Transit 2
- Seattle Transit Master Plan
- Trans-Lake Washington Project
- Seattle Transit Study for Intermediate Capacity Transit
- Seattle Popular Transit Plan (Seattle Monorail Project)/FEIS

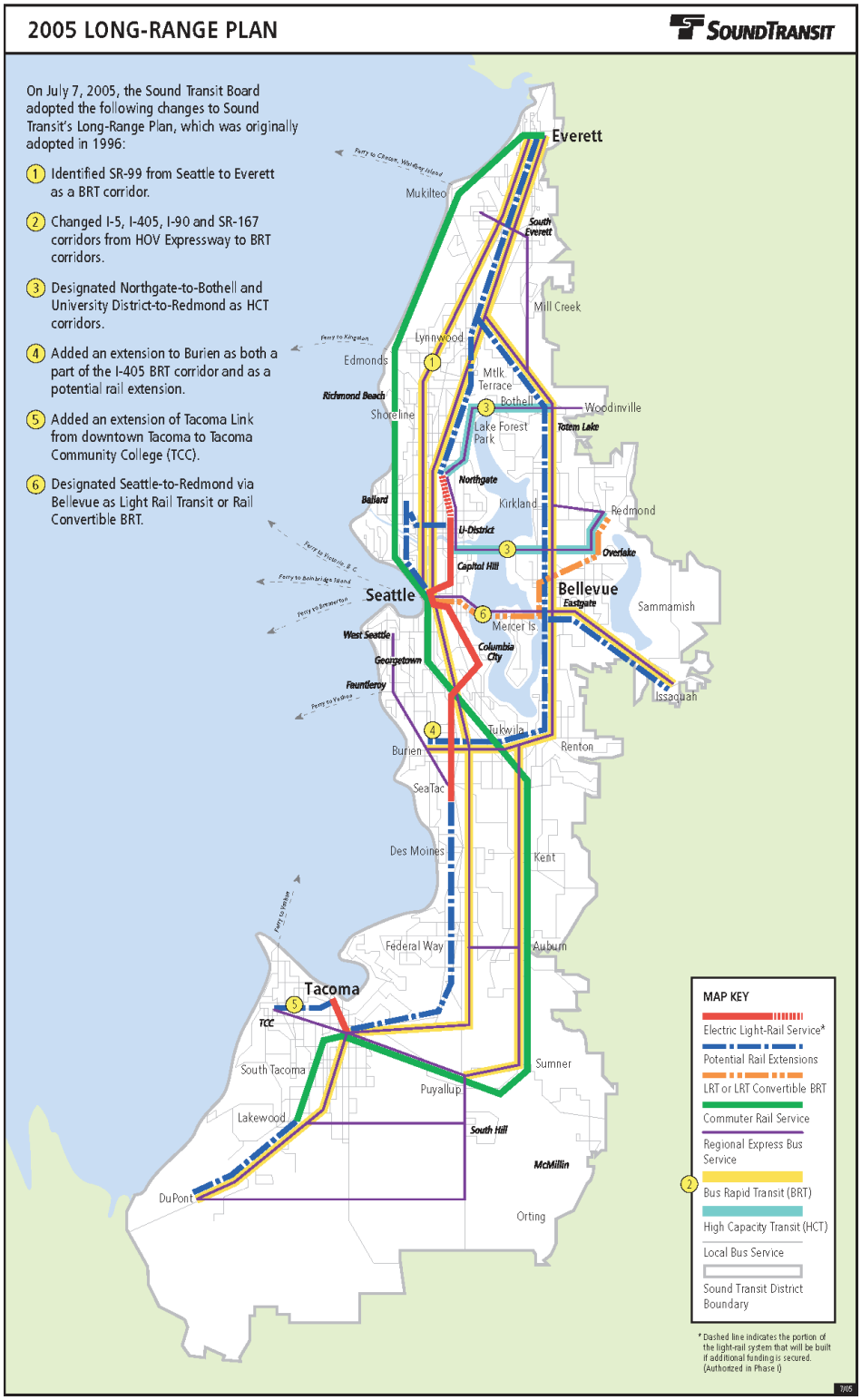
Below is an overview of each relevant planning document and previous study. Additional information can be found in the *Previous Studies and Findings Technical Memorandum* (Sound Transit, April 2013), as well as in the respective reports for each.

2.1 Planning Documents

Sound Transit Long Range Plan

The Regional Transit Long-Range Plan (Sound Transit 2005) first was developed in 1996 as part of the original Sound Move package of projects. The Long-Range Plan was updated in 2005 prior to development of the Sound Transit 2 plan that was approved by voters in 2008. The plan provides a vision of the unconstrained build-out of the regional High-Capacity Transit system. The map (Figure 2-1) identifies a corridor between Ballard and Downtown Seattle as a potential rail extension. This plan is currently being updated.

Figure 2-1. Sound Transit 2005 Long-Range Plan Map



Source: Regional Transit Long-Range Plan, 2005

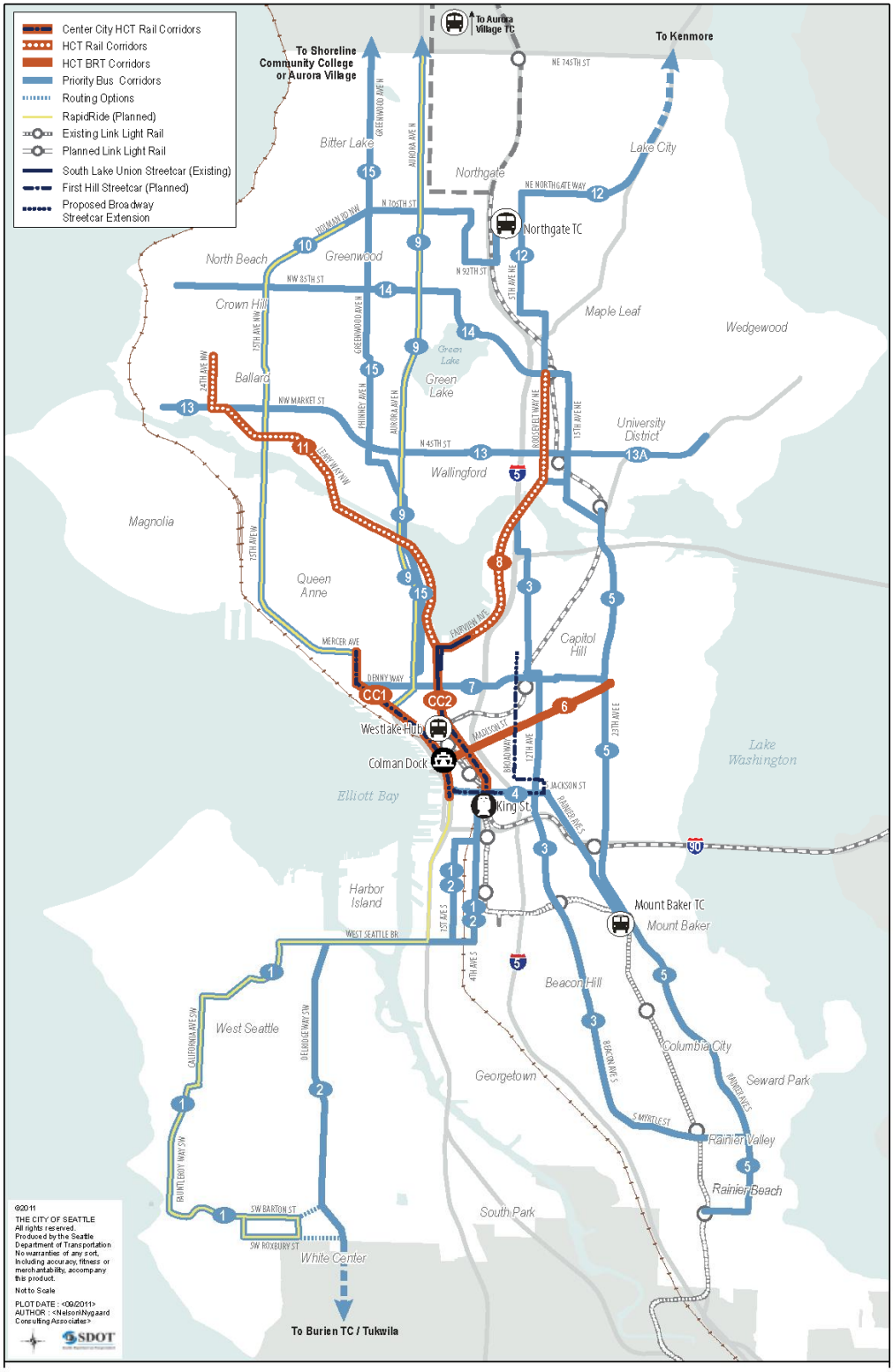
Sound Transit 2

In November 2008, voters in the Puget Sound region approved a package of projects (called ST2 [Sound Transit 2008]) to extend the regional transit system. Along with extensions of light rail north to Lynnwood, east to Overlake, and south of Sea-Tac Airport, as well as other system improvements, the ST2 plan includes funding for a series of system planning studies. These studies include a study of high-capacity transit from the University District to Ballard to Downtown Seattle. This study focused on the portion of that corridor between Ballard and Downtown. A separate HCT study will focus on the portion between Ballard and the University District.

Seattle Transit Master Plan

The Seattle City Council approved and adopted the Transit Master Plan (TMP) (SDOT 2012) in April 2012. The TMP, which is an update to the 2005 Seattle Transit Plan, examined existing and potential future high ridership corridors and travel markets in the city, as well as integration with walking and bicycling infrastructure and enhancement of bus transit performance through roadway investments. Based on these analyses, the plan identifies a prioritized set of corridors for capital investment (Figure 2-2). Of these priority corridors, a seven-mile long Loyal Heights-Ballard-Fremont-South Lake Union-Downtown corridor was identified as a high-capacity transit corridor. Multiple modes were considered for the corridor, including rail, Bus Rapid Transit (BRT), and enhanced bus. Based on the vehicle capacity needs to meet projected ridership, rail (rapid streetcar) was selected as the recommended mode for the corridor.

Figure 2-2. Transit Master Plan – High Priority Corridors



Source: Transit Master Plan: Final Summary Report and Appendices, 2012

Figure 2-3. Transit Master Plan – Corridor 11

Source: Transit Master Plan: Final Summary Report and Appendices, 2012

2.2 Previous Studies

Trans-Lake Washington Project

From 1999 to 2002, the Washington State Department of Transportation (WSDOT) and Sound Transit engaged in the Trans-Lake Washington Project (Trans-Lake Washington Project Team 2001) to explore options for improving mobility and access across Lake Washington. A wide range of options was considered in the study, including replacement of existing bridges, new bridges at various locations, and transit alternatives. Alternatives considered included fixed-guide way alignments that would cross the lake along the SR 520 corridor to the University District and then Ballard before turning south to Downtown Seattle.

Seattle Transit Study for Intermediate Capacity Transit

Released in 2001, the Seattle Transit Study for Intermediate Capacity Transit (ICT) (City of Seattle 2001) examined the feasibility of developing new ICT corridors in the city, including BRT, streetcars and trams, and elevated transit. ICT service would connect neighborhoods to each other, to major destinations, and to transit transfer stations. The service would include fewer stops than regular bus service to improve travel speeds. Based on technical studies, stakeholder meetings, and input from the public, the report recommended moving ahead with ICT from West Seattle through Downtown Seattle to Ballard and Northgate. The corridor extends from 145th Street NE, along Lake City Way, west to Northgate and Crown Hill, south to Ballard, Interbay, Lower Queen Anne, and to Downtown Seattle. In the study, primary and secondary route were developed for various transit technologies in the corridor (BRT, streetcar system, and elevated transit).

Seattle Popular Transit Plan (Seattle Monorail Project) / FEIS

Initiative 41 was passed by Seattle voters in November 1997. Initiative 41 created the Elevated Transportation Company (ETC) to study the possibility of building a 40-mile monorail system in Seattle. Initiative 53, passed in 2000, provided funding to ETC to create a plan for building a monorail system. Based in part on the findings of the Intermediate Capacity Transit Study, the ETC, selected a 14-mile corridor that would extend from Ballard through Downtown Seattle to West Seattle. This corridor was studied in an Environmental Impact Statement (EIS) (ETC 2002), and examined various alignment options, including a West Alternative, an East Alternative, and other options/linkages. In 2005, another vote (Proposition 1) resulted in a decision to end the monorail project. The Seattle Monorail Authority was dissolved in 2008.

3 MARKET ANALYSIS

A market analysis was conducted to identify potential transit markets, service levels, ridership, operating issues, and performance in the Ballard to Downtown Seattle Transit Expansion Study corridor. Key findings from this analysis were presented at a public open house on March 12, 2013. The analysis was used in the development of potential alternatives for the study.

Data collected as part of this analysis include the following:

- Current and projected demographics
- Traffic data
- Modeled daily transit trips to and from Ballard and Fremont
- Existing land use
- Vehicle ownership
- Peak period traffic congestion

The market analysis results are discussed below. More information can be found in the *Market Analysis Results Technical Memorandum* (Sound Transit, May 2013).

3.1 Daily Transit Trips

Figure 3-1 shows the distribution of daily transit trips traveling to and from Ballard and Fremont. The information displayed in the figure is based on output from the Sound Transit Ridership Forecasting Model, and shows that for both Ballard and Fremont, the largest transit market is Downtown Seattle. As shown in the figure and in Table 3-1, other major transit markets include Belltown, First Hill, the Central Area/Madrona, the University District, the University of Washington, and trips between Ballard and Fremont. Markets with less than 2% of the trips were not shown.

Table 3-1. Daily Transit Trips

Neighborhood	Trips to/from Ballard	Trips to/from Fremont
Downtown Seattle	16%	18%
UW Campus	9%	9%
University District	8%	6%
First Hill	7%	7%
Central Area / Madrona	6%	4%
Belltown	5%	6%
South Lake Union	4%	5%
Northgate	4%	4%
Queen Anne	4%	2%
Fremont	5%	-
Ballard	-	5%

Many of the same neighborhoods highlighted in Table 3-1 are also expected to see significant growth in transit trips in the future. Table 3-2 shows the forecasted growth in daily transit trips between Ballard and Fremont and selected neighborhoods from 2011 to 2035.

Table 3-2. Growth in Daily Transit Trips: 2011 to 2035

Neighborhood	Trips to/from Ballard		Trips to/from Fremont	
	Total Growth	Percentage Growth	Total Growth	Percentage Growth
Downtown Seattle	567	54%	825	64%
UW Campus	215	35%	216	35%
University District	106	21%	111	28%
First Hill	254	55%	258	53%
Central Area / Madrona	54	14%	107	6%
Belltown	287	81%	105	80%
South Lake Union	225	92%	228	66%
Northgate	192	75%	158	56%

Queen Anne	86	28%	61	32%
Fremont	202	59%	-	-
Ballard	-	-	202	59%

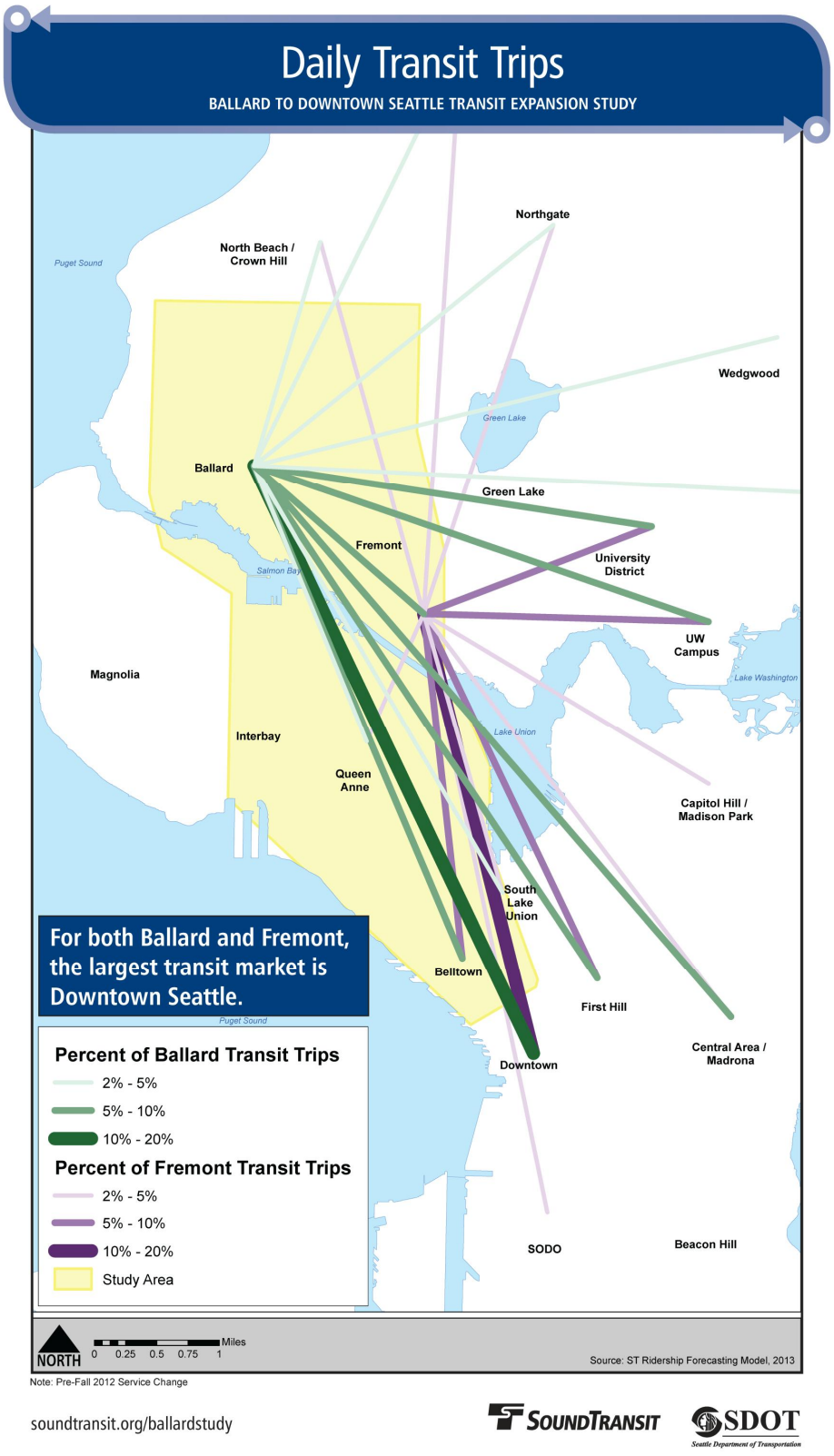
Commute Trips

In addition to modeled transit trips, data from the Commute Trip Reduction (CTR) survey (surveys conducted between 2007 and 2011) were reviewed. Table 3-3 shows the percent of commute trips taken by transit for selected locations from Ballard and Fremont. The CTR survey is conducted every two years by employers with more than 100 employees (commute trips to the University of Washington are not included in this data set). The transit share for commute trips from Ballard and Fremont to Downtown Seattle is strong, with 60% or more of trips being made by transit. In addition, almost half of all Ballard and Fremont-based commute trips to Belltown are made by transit, as are a third of trips to SODO and more than a quarter of the trips to South Lake Union.

Table 3-3. Transit Share of Commute Trips

Neighborhood	Trips from Ballard	Trips from Fremont
Downtown Seattle	60%	63%
Belltown	47%	49%
First Hill	39%	42%
University District	34%	31%
SODO	31%	31%
South Lake Union	27%	32%
Interbay	26%	25%

Figure 3-1. Daily Transit Trips



Note: Pre-Fall 2012 Service Change

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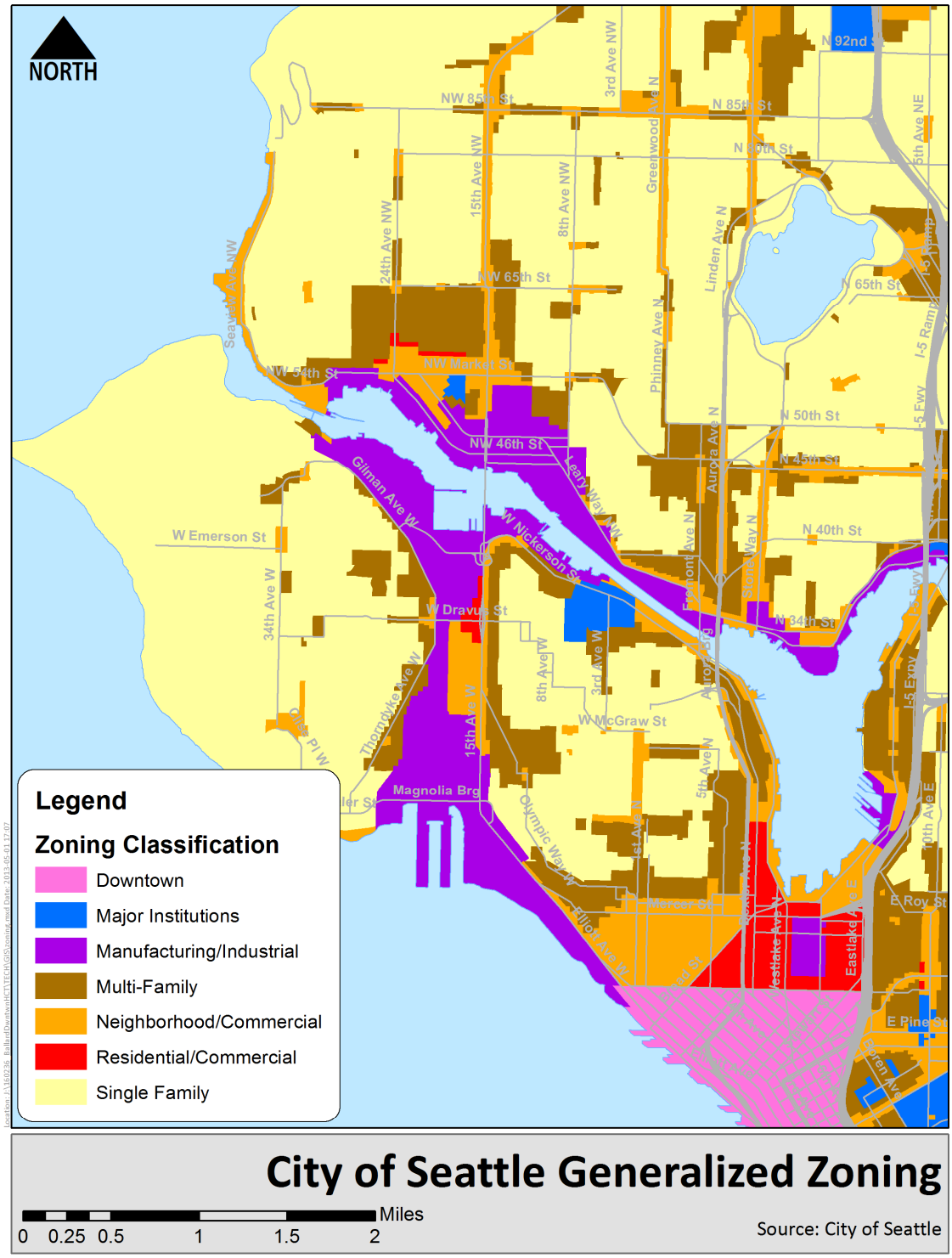
3.2 Existing Zoning

Figure 3-2 shows existing zoning the project study area from City of Seattle data. The figure highlights the locations of major concentrations of multi-family, neighborhood/commercial, and manufacturing/industrial zoning in the study area. The centers of Ballard and Fremont show a concentration of multi-family and neighborhood/commercial zoning which are highly supportive of transit.

Figure 3-2. City of Seattle Generalized Zoning



3.3 Population and Employment

Figure 3-3 shows the historic (1985-2010) and forecasted (2035) growth in population and employment in the study area. Historic population and employment data were obtained from the Puget Sound Regional Council (PSRC) and adjusted to match the boundaries shown on the map. Current and forecasted population and employment data were also obtained from PSRC. As shown in the figure and in Table 3-4, significant population and employment growth occurred in the study area between 1985 and 2010 and is forecasted to occur by 2035. Downtown, South Lake Union, and Belltown continue to have more employment than population, while Ballard, Fremont, and other areas remain more residential in character (although Ballard and Fremont have experienced an increase in higher density, multi-family development). Table 3-4 also shows the total forecasted population and employment for 2035 and orders the neighborhoods in the table from largest to smallest based upon this. While Downtown, South Lake Union, and Belltown are at the top of the list, the combined forecasted population and employment of both Ballard and Fremont are greater than several other Seattle neighborhoods.

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Table 3-4. Population and Employment

	Population				Employment				Total Population and Employment
Neighborhood	**1985**	**2010**	**2035**	**Δ 10-35**	**1985**	**2010**	**2035**	**Δ 10-35**	**2035**
Downtown	6,415	16,090	26,570	65%	100,952	149,790	181,100	21%	207,670
South Lake Union	9,340	16,430	33,160	102%	41,531	52,930	70,050	32%	103,210
Belltown	4,584	15,410	29,880	94%	36,090	52,250	68,380	31%	98,260
Fremont	25,298	28,230	31,810	13%	11,521	13,650	24,070	76%	55,880
Ballard	27,329	29,580	33,820	14%	11,014	12,010	16,630	38%	50,450
Queen Anne	23,202	25,320	27,350	8%	7,455	11,730	15,620	33%	42,970
Green Lake	16,208	17,240	20,460	19%	2,859	4,330	6,270	45%	26,730
Interbay	9,102	9,390	10,350	10%	5,938	8,390	12,690	51%	23,040
Magnolia	12,239	12,040	12,380	3%	1,126	2,440	3,830	57%	16,210

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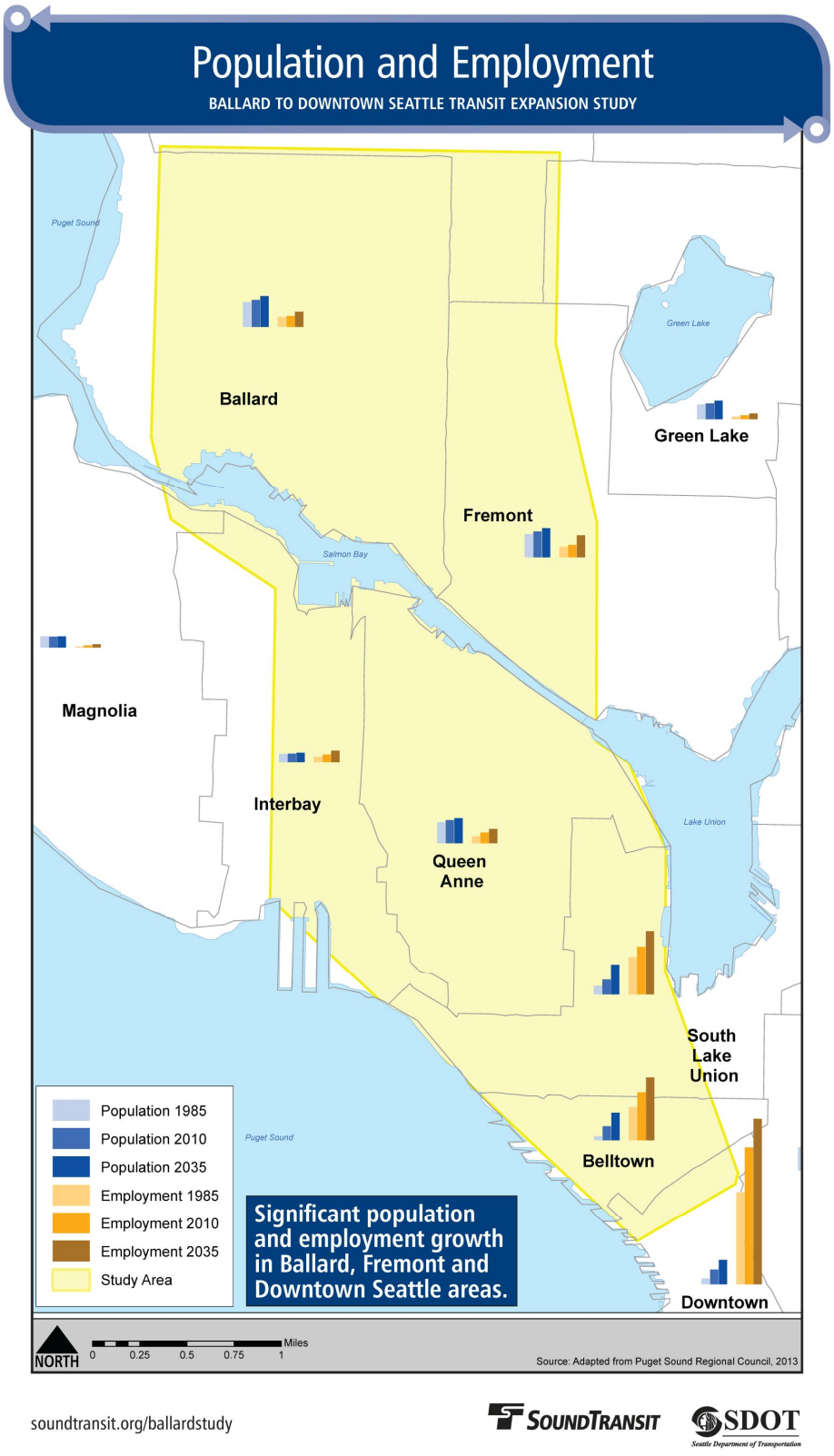
Figure 3-3. Population and Employment



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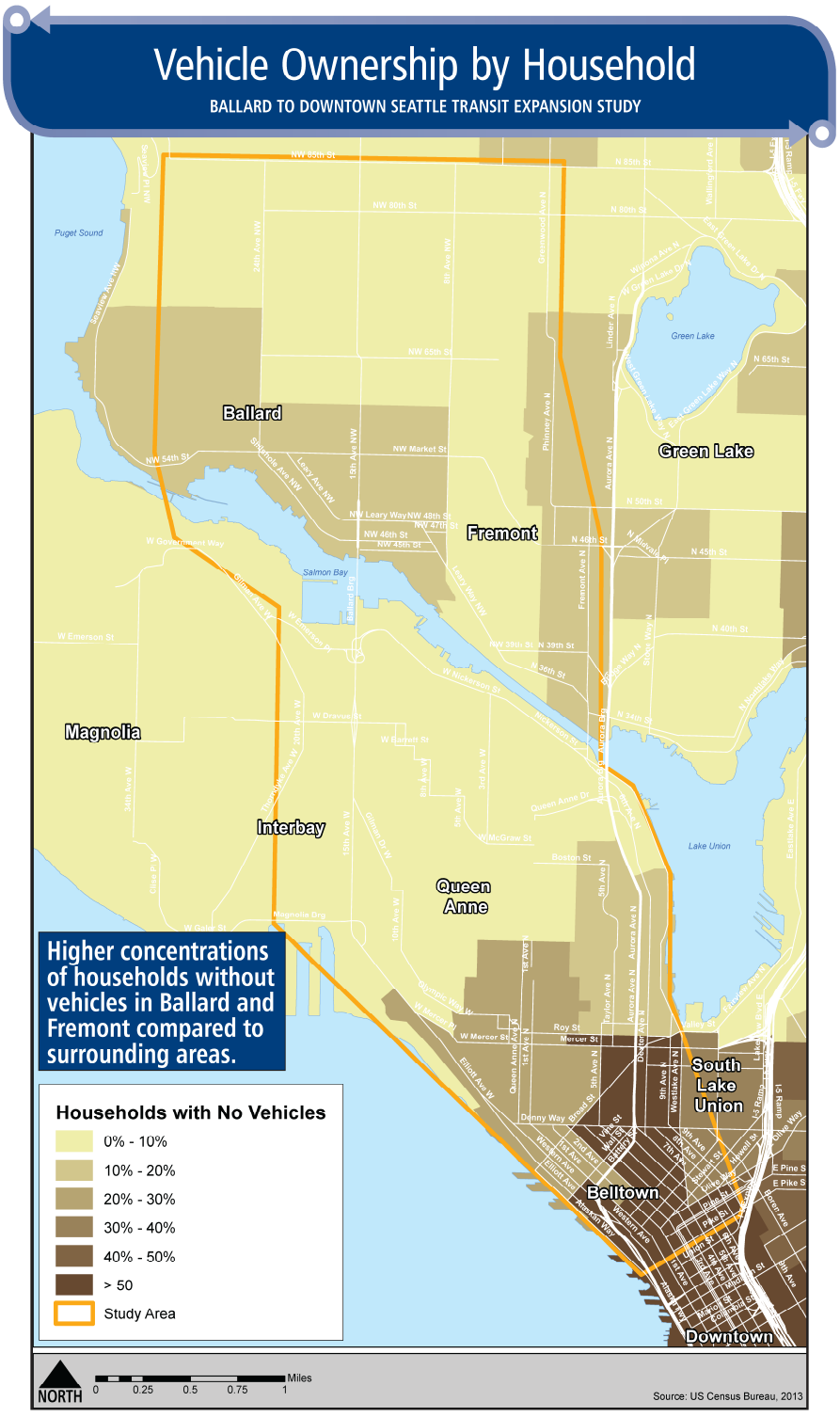
SOUNDTRANSIT SDOT Seattle Department of Transportation

3.4 Vehicle Ownership

Figure 3-4 illustrates levels of vehicle ownership in the study area. Vehicle ownership information was collected from the American Community Survey (ACS) 2007-2011 5-year dataset, which is the most recent and comprehensive dataset available. As shown in the figure, the percentage of households without vehicles in Ballard and Fremont (10 - 20%) is higher than in the surrounding areas, where 0 to 10% of households have no vehicles. The highest percentages of households without vehicles are in the southern portion of the study area, including Lower Queen Anne, South Lake Union and Belltown.

Figure 3-4. Vehicle Ownership by Household

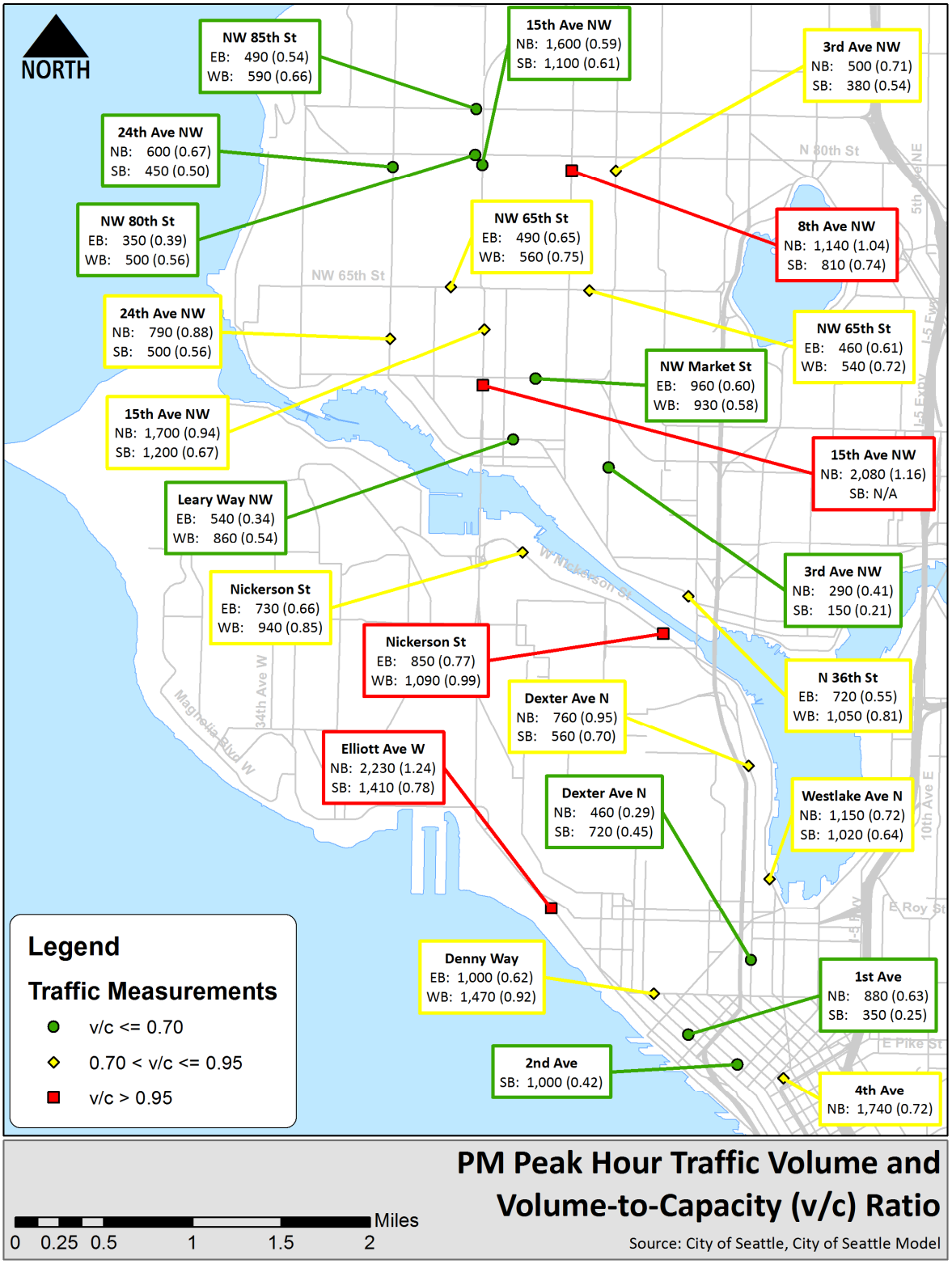


soundtransit.org/ballardstudy

3.5 Peak Period Traffic Congestion

Figure 3-5 shows PM peak period traffic volumes and volume-to-capacity (v/c) ratios for selected arterials in the study area. Volumes were provided by the City of Seattle, while roadway capacities were derived from the City of Seattle travel demand forecasting model. Arterials labeled in green are those with an estimated v/c ratio of 0.70 or less, which indicates moderate congestion or better. Arterials labeled in yellow indicate moderate to high levels of congestion, while arterials labeled in red often experience significant levels of congestion during the PM peak period. The most congested arterials where data was available include Elliott Avenue, 15th Avenue south of Market Street, and Nickerson Street, while arterials with moderate to high levels of congestion include Westlake Avenue, Dexter Avenue, Denny Way, and 15th Avenue north of Market Street.

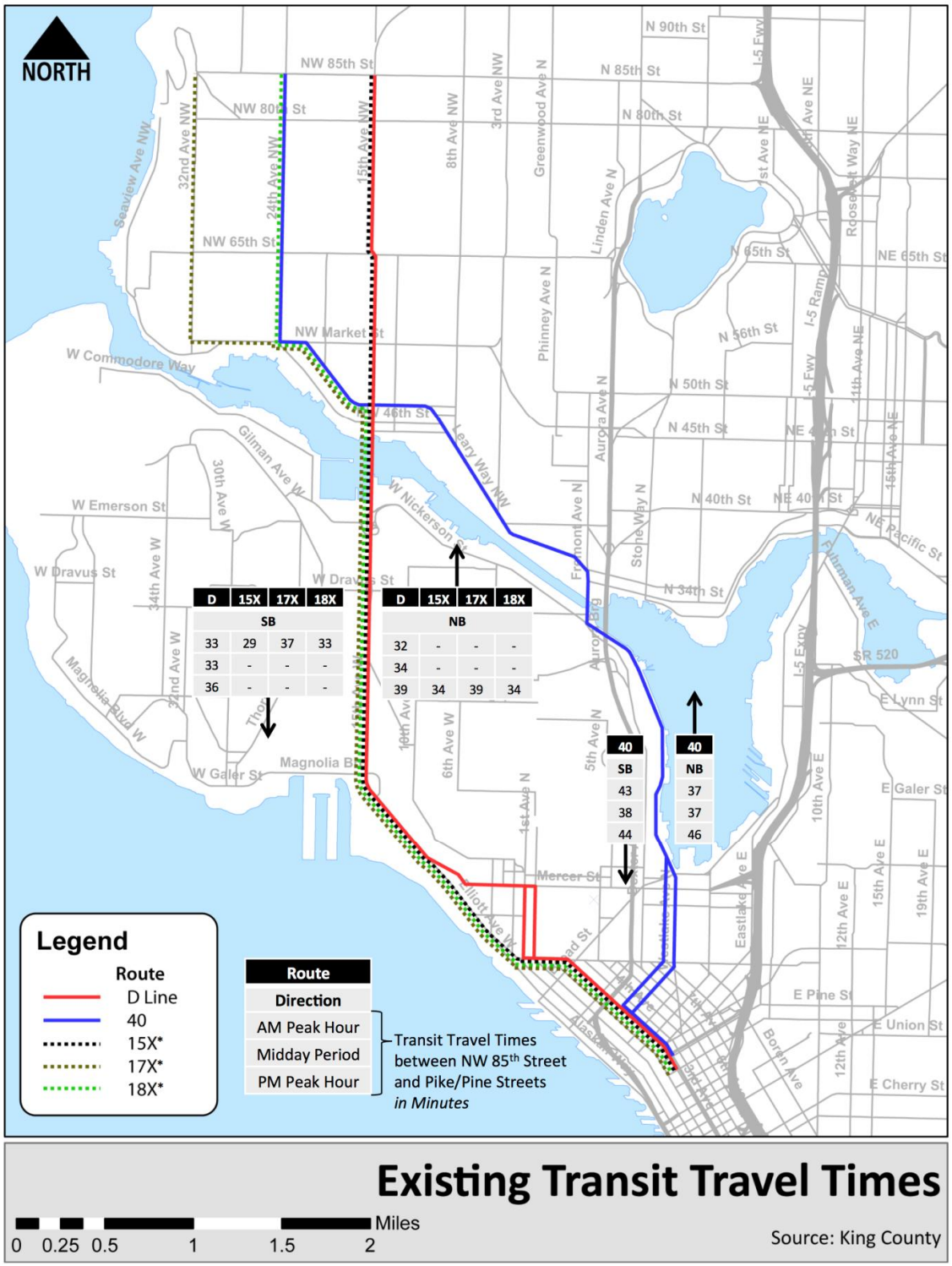
Figure 3-5. PM Peak Period Congestion



3.6 Existing Transit Travel Times

Figure 3-6 shows existing transit travel times for selected King County Metro bus routes that serve the study corridor between Ballard and Downtown Seattle. These include the 15, 17, and 18 Express routes, the RapidRide D line, and route 40. Travel times shown in the figure are for travel between NW 85th Street and Pike/Pine Streets in Downtown Seattle. Overall, travel times for the routes shown range from 29 to 43 minutes southbound during the AM peak hour and from 34 to 46 minutes northbound during the PM peak hour. Variability, expressed by the difference in travel time for the peak hour compared to mid-day operations, shows that the RapidRide D line travel time increases by as much as 5 minutes in the peak hour compared to mid day, while the travel time for route 40 increases by as much as 9 minutes in the peak hour versus mid day operations.

Figure 3-6. Existing Transit Travel Times



*Express routes only operate in the peak direction of travel during the peak hours.

Source: King County Metro's Automatic Vehicle Location system, January-February 2013.

3.7 Conclusions

Based on the review of existing and forecasted transit market conditions, there is a significant level of existing and future forecasted demand for transit between the neighborhoods of Ballard and Fremont and Downtown Seattle. Output from the Sound Transit Ridership Forecast Model shows that for both Ballard and Fremont the largest transit market, of all the neighborhoods studied, is Downtown Seattle. Currently 16% and 18% of daily transit trips are comprised of trips between Ballard and Downtown Seattle and Fremont and Downtown Seattle respectively. The forecasted growth in daily transit trips between the years of 2011 and 2035 for Ballard and Fremont shows that Downtown Seattle will continue to be the largest transit market for both of these neighborhoods. About 54% and 64% growth is expected for transit trips between Ballard and Downtown Seattle and Fremont and Downtown Seattle respectively. Data from the CTR survey, conducted between 2007 and 2011, show the transit share for commute trips from Ballard and Fremont to Downtown Seattle is strong, with 60% or more trips being made by transit. It should be noted, however, that the transit market between Ballard and Fremont is not as strong as the market between each neighborhood and Downtown Seattle.

Ballard and Fremont residents and employers are supportive of transit in terms of existing zoning, forecasted population and employment growth, and vehicle ownership. Areas in the immediate vicinity of downtown Ballard and Fremont show a concentration of commercial/mixed-use and multi-family zoning, which is highly supportive of transit. Future forecasted growth in population and employment for both Ballard and Fremont is expected, with 14% growth in population and 38% growth in employment in Ballard from 2010 to 2035. During that same time period, 13% growth in population and 76% growth in employment is expected in Fremont. Additionally, the higher percentage of households without vehicles in Ballard and Fremont (10-20%) compared to the surrounding areas (0-10%) make these neighborhoods more supportive of transit and indicates potential for increased transit ridership with the introduction of higher capacity service.

One of the challenges to the development of new higher capacity transit connecting Ballard with Downtown Seattle is the existence of moderate to high levels of traffic congestion along key arterials in the study corridor, particularly Denny Way, Westlake Avenue, Elliott Avenue, 15th Avenue, and Nickerson Street. Congestion on arterial streets in the study area is also reflected in the variability in existing transit travel times, with RapidRide D line travel times varying by as much as 5 minutes between mid-day and the peak hour, and travel times for the route 40, varying by as much as 9 minutes.

4 PROJECT GOALS AND OBJECTIVES

The goals and objectives of the study are outlined in Table 4-1.

Table 4-1. Project Goals and Objectives

Goal	Objectives
1. Improve connection to the regional transit system	• Connect communities in the corridor to the regional transit network and other regional centers • Provide user-friendly connections between regional and local transit services
2. Increase transit ridership by providing services that are reliable, frequent, and efficient	
3. Improve mobility options for residents and businesses between Ballard and Downtown Seattle	• Preserve mobility of people and goods in the corridor • Improve connections between neighborhoods by providing higher capacity transit service • Seek to improve multimodal access
4. Preserve and enhance the environment	• Avoid impacts to existing natural and cultural resources in the corridor • Improve local air quality by providing alternative to travel by single occupant vehicle
5. Provide equitable access for residents and businesses	• Improve transit access to jobs, education, and other regional resources for a broad cross-section of socio-economic groups, ethnicities, and household types
6. Support sustainable urban growth	• Support economic and transit-oriented development in the corridor • Support development of compact and sustainable communities
7. Make efficient use of public financial resources	

5 EVALUATION CRITERIA AND METHODOLOGIES

The study's evaluation methodology included the development and evaluation of transit alternatives using three steps:

- **Initial Screening Evaluation**

  Review transit alignment link options for consistency with goals and objectives

  Advance options that meet goals and objectives, are consistent with rail design criteria, and align with public input

- **Level 1 Evaluation**

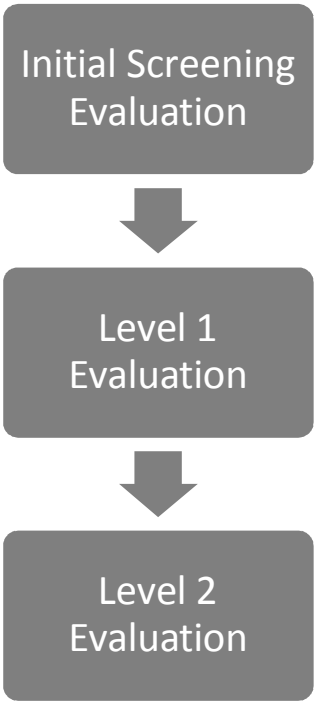
  Refine transit link options to a set of corridors based on Initial Screening results

  Perform evaluation based on mostly qualitative criteria and measures

- **Level 2 Evaluation**

  Refine transit corridors based on Level 1 evaluation results and public input

  Perform more detailed evaluation based on more quantitative criteria and measures



6 DEFINITION AND REVIEW OF INITIAL CONCEPTS

This section describes the process by which an initial set of transit options for connecting Ballard with Downtown Seattle was developed and then screened. The results of this initial screening were used in the identification and refinement of corridors for Level 1 evaluation, which is described in section 7.

6.1 Initial Options Definition

The initial set of transit options was developed by the project team through multiple avenues:

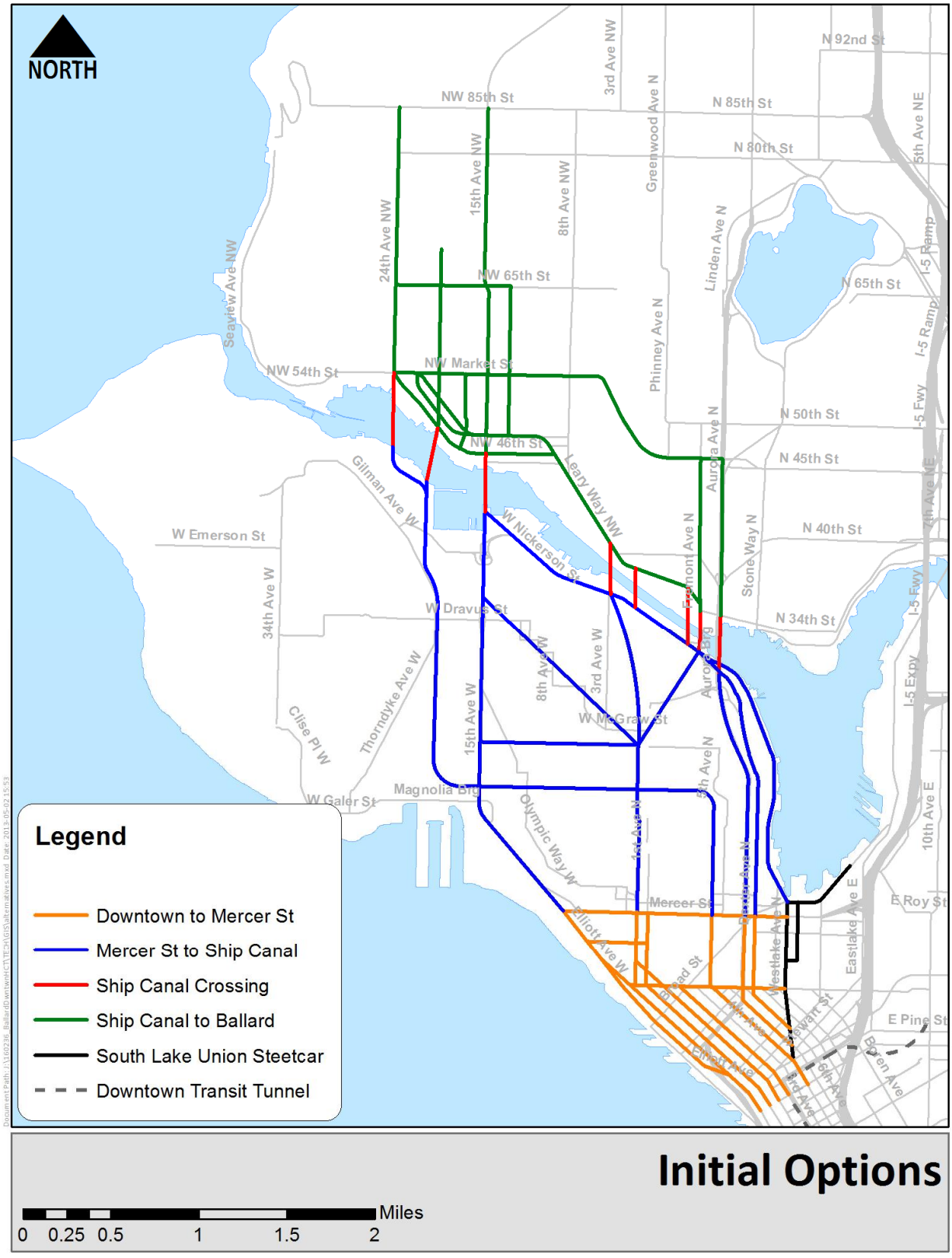
- Input from public meeting held on March 12, 2013
- Input through web-based interactive mapping tool
- Meeting with the United States Coast Guard
- Brainstorming by consultant team
- Review of previous studies

The results of the public input obtained through the March 12, 2013 public meeting and the public input collected from the web-based tool were mapped and reviewed by the project team, along with comments submitted by the public. Based on this input, a set of initial options was developed to represent the range of potential corridors along which new transit rail service could be established to connect Downtown Seattle with Ballard and potentially other neighborhoods in the study area. This initial set of options was then reviewed by the project team to identify additional issues and opportunities that should also be considered to further develop the range of options.

Figure 6-1 shows the initial set of alignment options that were identified based on the process described above. The corridor is divided into four main segments for the purpose of identifying and screening alignment segments, shown in the different colors in the figure:

1. Downtown to Uptown – CBD core to Mercer Street
2. Uptown to Ship Canal – Mercer Street to Ship Canal
3. Ship Canal Crossing – utilizing existing or new bridges or tunnel
4. Ship Canal to Ballard – Ship Canal to Market Street or NW 85th Street

Figure 6-1. Initial Options



6.2 Initial Screening

After the review with ST and SDOT staff, the initial set of options was screened using the methodology outlined in Table 6-1. As indicated in the table, most evaluation conducted at this level was qualitative in nature, drawing from knowledge of the study area, public input, previous studies, and GIS information provided by the City of Seattle. For more details on the overall evaluation process, see the *Evaluation Criteria and Methodologies Technical Memorandum* (Sound Transit, October 2013).

The Initial Screening evaluation reviewed the transit options for consistency with the study's goals and objectives. This evaluation considered the full range of transit alternatives identified through the stakeholder and public input process and advanced a set of corridor options to be considered in the Level 1 evaluation. Table 6-1 describes the Initial Screening criteria and measures that correlate to each of the goals and objectives.

The consultant team met on April 29, 2013 to identify options that should be screened out due to issues related to inconsistencies with the project goals and objectives and/or inconsistencies with rail design criteria, or which were significantly contrary to public input. In Figure 6-2, the links labeled with red numbers are those that were screened out through this process. Table 6-2 provides a description and explanation for each link that was screened out, along with the applicable screening criteria.

Table 6-1. Initial Concept Development Screening Criteria and Measures

Goals and Objectives	Screening Criteria	Measure
Improve connection to the regional transit system • Connect communities in the corridor to the regional transit network and other regional centers • Provide user-friendly connections between regional and local transit services	Connections to the regional system	Proximity to Link station(s) in Downtown
	Connections to local transit services	Serve King County Metro key transfer points? • NW Market St & Ballard Ave • Fremont Ave & N 34th St • 1st Ave N & Mercer St
Increase transit ridership by providing services that are reliable, frequent, and efficient	Directness of route	Qualitative
	Amenable to exclusivity	Qualitative
Improve mobility options for residents and businesses between Ballard and Downtown Seattle • Preserve mobility of people and goods in the corridor • Improve connections between neighborhoods by providing higher capacity transit service • Seek to improve multimodal access	Effects on mobility of people and goods	Qualitative
	Service to urban centers and urban villages, defined by Seattle's Comprehensive Plan	Number served
	Multimodal access opportunities	Qualitative
Preserve and enhance the environment • Avoid impacts to existing natural and cultural resources in the corridor • Improve local air quality by providing alternative to travel by single occupant vehicle	Negative environmental impacts	Qualitative
Provide equitable access for residents and businesses • Improve transit access to jobs, education, and other regional resources for a broad cross-section of socio-economic groups, ethnicities, and household types	Service to transit-dependent populations	Qualitative
Support sustainable urban growth • Support economic and transit-oriented development in the corridor • Support development of compact and sustainable communities	Opportunity for economic and transit-oriented development	Qualitative
Make efficient use of public financial resources	Major cost and constructability issues	Qualitative

Figure 6-2. Alignment Link Options Screened Out

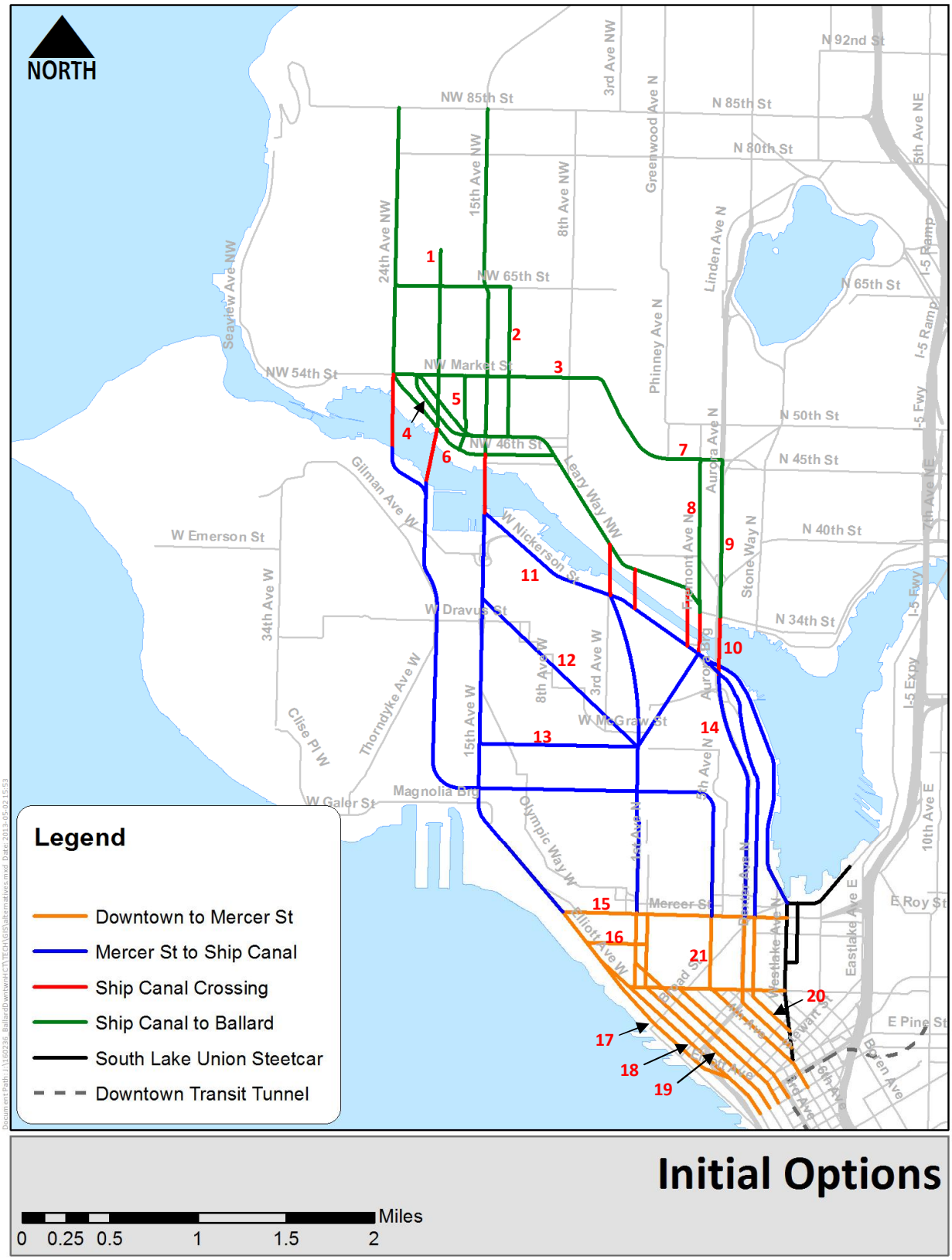


Table 6-2. Alignment Link Options Screened Out

Number	Link	Reason for Screening Out	Applicable Screening Criteria
1	20th Ave NW	Dead-ends at Salmon Bay Park; does not serve commercial areas as well as 24th and 15th Ave options	Directness of route; Service to urban centers and urban villages
2	14th Ave NW	Dead-ends at Ballard High School; park space currently under development within street ROW	Directness of route; Negative environmental impacts
3	NW Market St	Potential traffic impacts to major east-west arterial; steep grades would be at upper limits for rail transit; would increase travel time between Fremont and Ballard compared with alternative routes	Effects on mobility of people and goods; Major cost and constructability issues; Directness of route
4	Ballard Ave NW	Historic district along Ballard Ave NW	Negative environmental impacts
5	17th Ave NW	Narrow ROW; requires multiple turns at north and south ends	Effects on mobility of people and goods; Directness of route
6	Shilshole Ave NW	Potential impacts to freight mobility in industrial area; does not serve neighborhood as well as alternative routes	Effects on mobility of people and goods; Service to urban centers and urban villages
7	N 46th St	Connects to Aurora Ave N and NW Market St, both screened out (see 3 and 9)	Effects on mobility of people and goods; Major cost and constructability issues; Directness of route
8	Fremont Ave N	Steep grades would be at upper limits for rail transit; would increase travel time between Fremont and Ballard compared with alternative routes	Major cost and constructability issues; Directness of route
9	Aurora Ave N	Potential traffic impacts to state highway with significant traffic volumes	Effects on mobility of people and goods
10	Aurora Bridge	Potential traffic impacts to state highway with significant traffic volumes; would not serve Fremont neighborhood well; would increase travel time to Ballard; bridge structure would likely need to be replaced or widened and strengthened significantly for LRT vehicles[1]	Effects on mobility of people and goods; Service to urban centers and urban villages; Directness of route; Major cost and constructability issues
11	W Nickerson St	Accessing Ballard Bridge from the east would be difficult due to alignment of adjacent roadways	Major cost and constructability issues
12	Tunnel under NW Queen Anne hill	Unnecessarily long tunnel to reach Interbay (shorter alternative routes available); travels under cemetery	Directness of route; Negative environmental impacts
13	Tunnel under W Queen Anne hill	Unnecessarily long tunnel to reach Interbay (shorter alternative routes available)	Directness of route
14	Aurora Ave N	Potential traffic impacts to state highway with significant traffic volumes	Effects on mobility of people and goods

[1] *Analysis of the Rhododendron Line Concept: At-Grade Light Rail Transit (LRT) on State Route 99*, Regional Transit Project, September 1991.

Number	Link	Reason for Screening Out	Applicable Screening Criteria
15	W Mercer St	Potential traffic impacts to major east-west arterial; narrow ROW on west end	Effects on mobility of people and goods
16	W Harrison St	Narrow ROW; multiple turns required	Effects on mobility of people and goods; Directness of route
17	Elliott Ave W	Potential traffic impacts to major waterfront access arterial; on waterfront away from CBD core	Effects on mobility of people and goods; Service to urban centers and urban villages
18	Western Ave W	Potential traffic impacts to major waterfront access arterial; on waterfront away from CBD core	Effects on mobility of people and goods; Service to urban centers and urban villages
19	1st Ave	Likely route of Center City Connector	Effects on mobility of people and goods
20	7th Ave	Planned cycle-track on 7th Ave	Effects on mobility of people and goods
21	5th Ave	Monorail is historic landmark	Negative environmental impacts

7 DEFINITION AND EVALUATION OF LEVEL 1 CORRIDORS

This section describes the refinement and evaluation of Level 1 corridors. The results of the Level 1 evaluation were used in the further refinement of corridors for Level 2 evaluation, which is described in section 8.

7.1 Level 1 Corridors Definition

Following the initial review of options, a set of eight corridors was identified to be carried forward into Level 1 evaluation. These eight corridors provide a range of representative alignments that include various combinations of rail transit running in at-grade, elevated, and tunnel profiles. Initial options that were not screened out in the initial screening step but that were not included in the Level 1 corridors are considered design variations that could be considered in future phases of study. Also, some components of the Level 1 corridors could be intermixed to create different combinations. Approximate station vicinities were selected to serve key travel markets while maintaining station spacing appropriate for high capacity transit service.

The conceptual definition of these corridors was provided in the *Conceptual Definition of Level 1 Corridors Technical Memorandum* (Sound Transit, July 2013). Summary information about the eight corridors is provided in Table 7-1, with more detailed information and illustrative figures for each corridor following the table.

Table 7-1. Corridors for Level 1 Evaluation

Corridor	Downtown -Mercer St	Mercer St-Ship Canal	Ship Canal Crossing	Ship Canal-Ballard	Corridor Length (mi)	Neighborhoods Served	Potential Stations in the vicinity of:	Average Station Spacing (mi)
1 Interbay West/ New Bridge	At-grade	Elevated	New bridge (140’)	Elevated	5.5	Downtown Uptown Interbay Ballard	2nd/3rd @ Stewart 2nd/3rd @ Bell 2nd/3rd @ Broad Elliott @ Prospect 20th W @ Dravus Market @ 20th NW	1.1
2 Interbay West/ Ship Canal Tunnel	Tunnel	Elevated	Tunnel	Tunnel	5.4	Downtown Uptown Interbay Ballard	2nd @ Pine 2nd @ Battery 2nd N @ Republican 15th W @ Garfield 20th W @ Dravus Market @ 17th NW	1.1
3 15th Avenue/ Elevated	Tunnel	Elevated	New bridge (140’)	Elevated	5.1	Downtown Uptown Interbay Ballard	2nd @ Pine 2nd @ Battery 1st N @ John Elliott @ Prospect 15th W @ Dravus 15th NW @ Market	1.1
4 15th Avenue/ At-grade	At-grade	At-grade	New bridge (70’)	At-grade	6.4 (4.9 to Market)	Downtown Uptown Interbay	2nd/4th @ Stewart 2nd/4th @ Bell 2nd/4th @ Broad Elliott @ Prospect	1.1

Corridor	Downtown -Mercer St	Mercer St-Ship Canal	Ship Canal Crossing	Ship Canal-Ballard	Corridor Length (mi)	Neighborhoods Served	Potential Stations in the vicinity of:	Average Station Spacing (mi)
						Ballard Crown Hill	15th W @ Dravus 15th NW @ Market 15th NW @ NW 85th	
5 Queen Anne Tunnel	Tunnel	Tunnel	New bridge (70')	At-grade	5.4	Downtown Uptown Queen Anne Fremont Ballard	2nd @ Pine 2nd @ Battery 2nd N @ Republican QA Ave @ Blaine N 36th @ Phinney Market @ 17th NW	1.1
6 Westlake/ Ship Canal Tunnel	At-grade	At-grade; Preserve existing travel lanes	Tunnel	Tunnel/At-grade	6.5 (5.0 to Market)	Downtown Westlake Fremont Ballard Crown Hill	Westlake @ Stewart Westlake @ Denny Westlake @ Mercer Westlake @ Galer Fremont Pl @ Evanston Leary @ 17th NW Market @ Ballard Av 24th NW @ NW 65th 24th NW @ NW 85th	0.9
7 Dexter	At-grade	At-grade	Fremont Bridge	At-grade	6.3 (4.8 to Market)	Downtown SLU Westlake	Westlake @ Stewart 6th @ Bell Dexter @ Harrison Dexter @ Galer Dexter @ Wheeler	0.7

Corridor	Downtown -Mercer St	Mercer St-Ship Canal	Ship Canal Crossing	Ship Canal-Ballard	Corridor Length (mi)	Neighborhoods Served	Potential Stations in the vicinity of:	Average Station Spacing (mi)
						Fremont Leary Ballard Crown Hill	N 36th @ Dayton Leary @ 8th NW Market @ 15th NW 15th NW@ NW 65th 15th NW @ NW 85th	
8 Westlake/ New Bridge	At-grade	At-grade; Displace existing travel lanes	New bridge (70')	At-grade	6.6 (5.1 to Market)	Downtown Westlake Fremont Leary Ballard Crown Hill	Westlake @ Stewart Westlake @ Thomas Westlake @ Galer Nickerson @ 4th N Nickerson @ Dravus Leary @ 3rd NW Leary @ 15th NW Market @ Ballard Av 24th NW @ NW 65th 24th NW @ NW 85th	0.7

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Figure 7-1. Corridor 1

- At-grade surface couplet on 2nd and 3rd Avenues between Stewart Street and Denny Way
- At-grade on Denny Way, Western Avenue and Elliott Avenue West between the Seattle Center and W Mercer Place
- Elevated on Elliott from Mercer Place to the NW then around the east end of the Magnolia Bridge onto a new bridge over 15th Ave West and BNSF tracks
- Elevated on edge of Port of Seattle property and on 20th Avenue West and Gilman Avenue West to 24th Ave W
- New fixed span bridge over Salmon Bay to Ballard (140' clearance over water surface)
- Elevated on NW Market Street from 24th Ave NW to 17th Ave NW
- Light rail is the potential mode for this corridor

Figure 7-2. Corridor 2

- Tunnel under 2nd Avenue, Seattle Center, and Southwest Queen Anne from Pine Street to Interbay
- New Bridge over 15th Ave West and BNSF tracks
- Elevated on edge of Port of Seattle property and 20th Ave West to West Dravus St
- At-grade on 20th Ave West from West Dravus St to tunnel portal
- Tunnel from 20th Avenue West, under Salmon Bay, and into Ballard, terminating under NW Market Street
- Light rail is the potential mode for this corridor

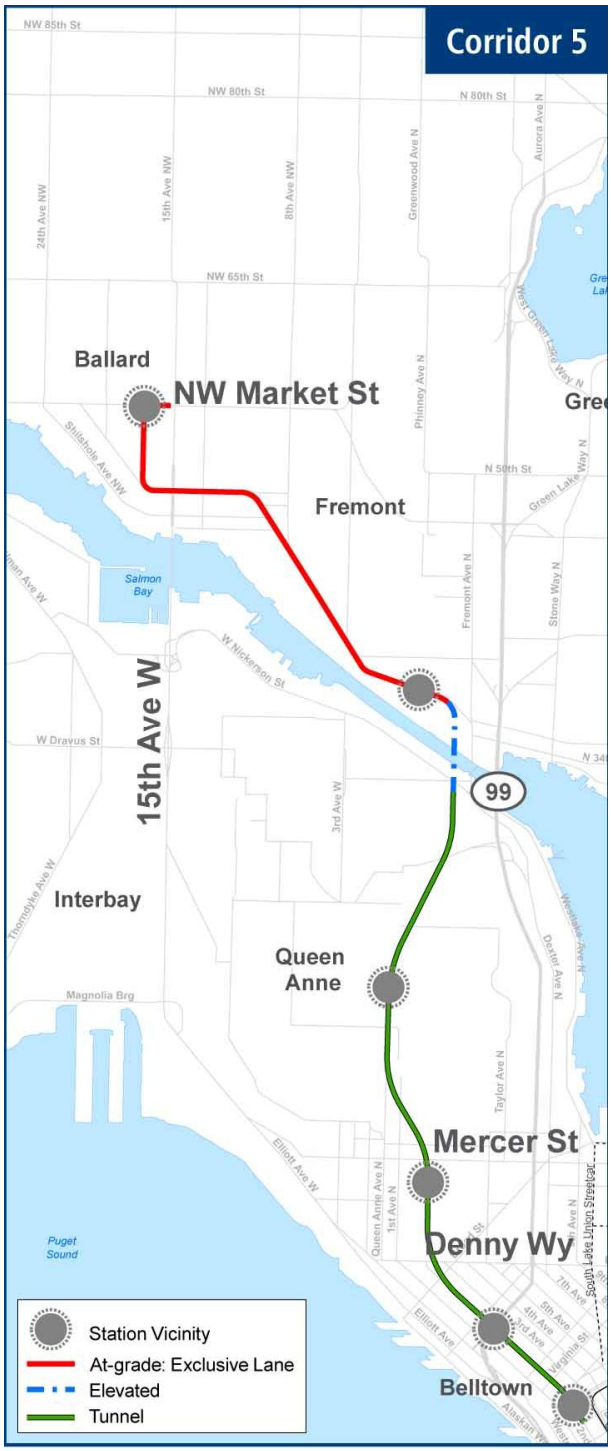
Figure 7-3. Corridor 3

- Tunnel under 2nd Avenue and Lower Queen Anne to Elliott Avenue West
- Elevated along Elliott Avenue West
- Elevated around east end of Magnolia Bridge to 15th Ave West
- Elevated on west side of 15th Ave West between the Magnolia Bridge and the Ballard Bridge
- New bridge adjacent to the Ballard Bridge (140’ clearance over water surface)
- Elevated on NW Market Street from 15th Ave NW to 11th Ave NW
- Light rail is the potential mode for this corridor

Figure 7-4. Corridor 4

- At-grade surface couplet on 2nd and 4th Avenues between Stewart Street and Denny Way
- At-grade in the center of Denny Way, Western Avenue and Elliott Avenue West between the Seattle Center and the Magnolia Bridge
- At-grade in the center of 15th Ave West from Magnolia Bridge to W Bertona Street.
- New bridge adjacent to the Ballard Bridge (70’ clearance over water surface)
- At-grade on 15th between NW Market St and NW 85th Street
- Light rail or rapid streetcar could be accommodated in this corridor

Figure 7-5. Corridor 5



- Tunnel under 2nd Avenue, Seattle Center, and Queen Anne from Pine Street to 3rd Ave N near Fulton Street
- New bridge over the Ship Canal (70' clearance over water surface)
- At-grade on N 36th Street and NW Leary Way from Evanston Ave N to 17th Ave NW.
- At-grade on 17th Ave NW from NW Leary Way to NW Market Street
- At-grade on NW Market Street from 17th Ave NW to 15th Ave NW
- Light rail is the potential mode for this corridor

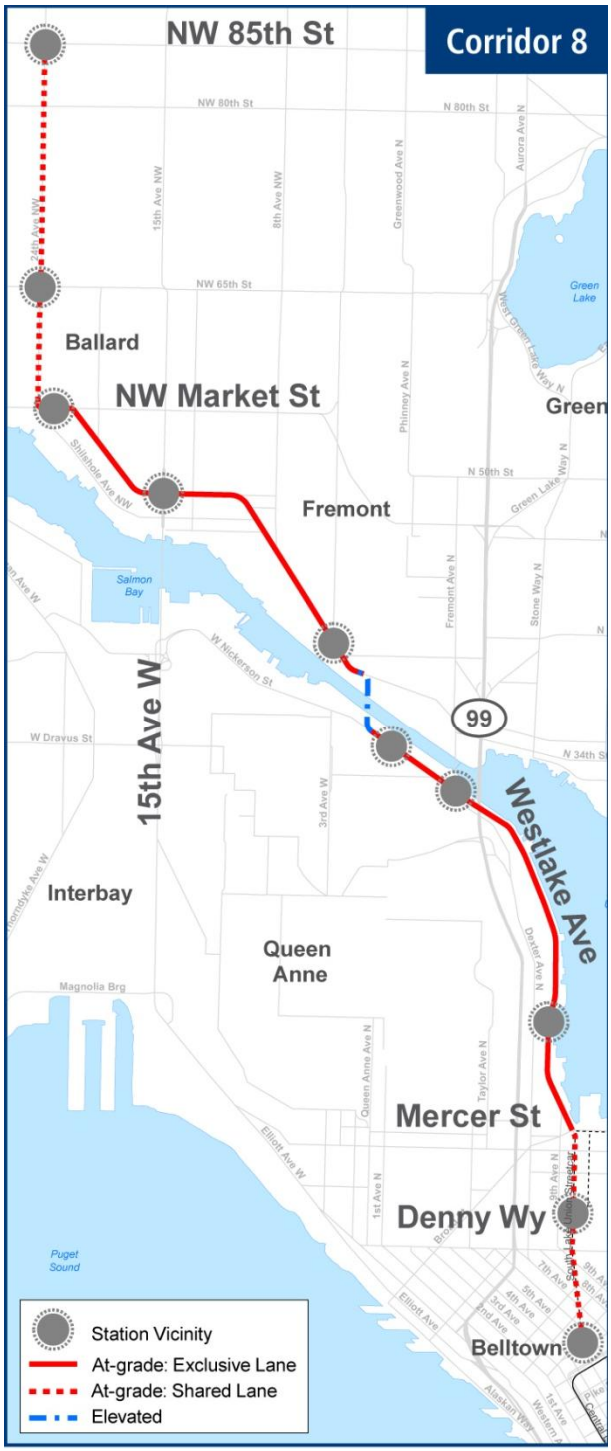
Figure 7-6. Corridor 6

- At-grade on 5th Avenue from Pike Street to Olive Way
- At-grade on Westlake from Olive Way to McGraw Street
- New tunnel under Lake Union and Fremont from McGraw Street to Leary Way west of 15th Ave NW
- At-grade on Leary Way NW from west of 15th Ave NW to Market Street.
- At-grade on Market Street from Leary Way to 24th Ave NW
- At-grade on 24th Ave NW from Market Street to NW 85th St
- Rapid streetcar is the potential mode for this corridor

Figure 7-7. Corridor 7

- At-grade on 5th Ave from Pike Street to Olive Way
- At-grade on Westlake from Olive Way to 6th Ave
- At-grade on 6th Ave from Westlake to Battery Street
- At-grade on Battery Street from 6th Ave to Denny Way
- At-grade on Dexter Ave from Denny Way to the Fremont Bridge
- Cross the Ship Canal on the existing Fremont Bridge
- At-grade on N 36th Street and NW Leary Way from the Fremont Bridge to 14th Ave NW.
- At-grade on 14th Ave NW from NW Leary Way to NW Market Street
- At-grade on NW Market Street from 14th Ave NW to 15th Ave NW
- At-grade on 15th Ave NW between NW Market St and NW 85th Street
- Rapid streetcar is the potential mode for this corridor

Figure 7-8. Corridor 8



- At-grade on 5th Avenue from Pike Street to Olive Way
- At-grade on Westlake from Olive Way to Nickerson Street
- At-grade on Nickerson Street from Westlake to 3rd Ave N
- New bridge on 3rd Ave N/Evanston Ave N over Ship Canal (70' clearance over water surface)
- At-grade on N 36th Street and NW Leary Way from Evanston Ave N to NW Market Street
- At-grade on NW Market Street from NW Leary Way to 24th Ave NW
- At-grade on 24th Ave NW from NW Market Street to NW 85th St
- Rapid streetcar is the potential mode for this corridor

7.2 Level 1 Analysis and Evaluation

The Level 1 evaluation refined the transit corridors based on the Initial Screening results and performed an evaluation based on mostly qualitative criteria and measures. The Level 1 evaluation was based on an analysis of potential benefits and impacts including travel time, cost, and land use integration. The analysis for the Level 1 evaluation was not as detailed or as quantitative as the analysis for the Level 2 evaluation.

Table 7-2 describes the Level 1 evaluation criteria and measures that correlate to each of the goals and objectives. Table 7-3 summarizes the Level 1 evaluation results. More information can be found in the *Level 1 Analysis and Evaluation Technical Memorandum* (Sound Transit, July 2013).

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Table 7-2. Level 1 Evaluation Criteria and Measures

Goals and Objectives	Evaluation Criteria	Measure	Methodology
Increase transit ridership by providing services that are reliable, frequent, and efficient	Transit travel markets	Service to key transit travel markets	For each corridor, identify the potential markets served from the following list of markets in the study area: Ballard, Fremont, Upper Queen Anne, Lower Queen Anne, South Lake Union, Belltown, Denny Triangle, and Downtown.
	Schedule reliability	Number of at-grade signalized intersections traversed	Count the at-grade signalized intersections that would be traversed by each corridor alignment.
		Reliability of Ship Canal crossing	Consider exclusive crossings that do not require openings to be more reliable than exclusive crossings requiring non-peak period openings. Consider non-exclusive existing bridges to be less reliable than a new exclusive moveable bridge because the train would be mixed with general purpose traffic and subject to more frequent openings during off-peak periods.
	Travel time	Peak period travel time from Ballard to Downtown Seattle	Estimate the travel time from Ballard (Market Street) to Downtown Seattle (Stewart Street) using alignment length and estimated running speed given alignment characteristics. Movable bridges are assumed to not open during peak periods.
Improve mobility options for residents and businesses between Ballard and Downtown Seattle • Preserve mobility of people and goods in the corridor • Seek to improve multimodal access	Effects on traffic operations	Effects on traffic operations (general purpose traffic, freight mobility, local circulation, and parking)	Qualitatively assess impacts to traffic operations, including potential lane restrictions, special signal phasing requirements, and loss of parking.
	Effects on multimodal mobility	Effects on multimodal mobility (pedestrians, bicycles, and transit)	Qualitatively assess issues and impacts related to other transportation modes, including potential barriers to pedestrian and/or bicycle access across the corridor and connections to local bus service.
Support sustainable urban growth • Support economic and transit-oriented development in the corridor • Support development of compact and sustainable communities	Land use integration	Opportunity for economic and transit-oriented development	Evaluate the number of urban areas that would be served by stations associated with each corridor as well as the quality/performance of that station. The urban areas include those recognized in the City of Seattle Comprehensive plan (Urban Centers, Hub Urban Villages, and Residential Urban Villages). Because the type, size and location of the proposed stations within each area vary significantly, also make a detailed qualitative assessment of each station in order to more accurately capture current ridership opportunities and the relative economic development potential. Determine the potential for economic and transit-oriented development by assigning a value to the proposed station based upon the type of center and the amount of urban area within a half mile catchment area of the station location, also considering grades (topography) and other potential impediments to access. In situations where an urban area contains more than one station or multiple station catchment areas overlap, scoring would be adjusted down for those stations. Category and rating assignments of station locations are as follows: • Urban Center Stations –20 points for a central location, 15 points for central location with significant catchment overlap, 12 points for an edge location • Hub Urban Village Stations –12 points for a central location, 8 points for an edge location • Residential Urban Village Stations – 6 points for a central location, 4 points for an edge location • Commercial District Stations (non-designated areas) –6 points for a central location, 4 points for an edge location • Lower Density Stations (narrow corridor of employment) – 2 points for a central location, 1 point for an edge location
Improve connection to the regional transit system • Connect communities in the corridor to the regional transit network and other regional centers • Provide user-friendly connections between regional and local transit services	Connections to the regional rail system	Ease of pedestrian connection to Westlake Link station	Qualitatively assess the ease of a pedestrian connection between the south end of the corridor and Westlake tunnel station. Assume that corridors that include a tunnel connection to downtown would provide an underground pedestrian connection to the Westlake Link station and therefore receive a higher rating than corridors with an at-grade downtown connection, which would require patrons to connect to the Westlake Link station via surface streets.
	Connections to local transit services	Connectivity to local bus network	Identify existing bus routes that are intersected by corridors near potential station locations. Give added weight to east-west routes compared with north-south routes, with the assumption that east-west routes would provide better feeder service; give less weight to peak period-only routes. To better differentiate between corridors, do not include bus routes at the downtown stations.
Make efficient use of public financial resources	Cost and ease of implementation	Capital cost	Estimate a conceptual capital cost for each corridor, using historical data for similar modes and alignments

Goals and Objectives	Evaluation Criteria	Measure	Methodology
		O&M cost	Develop a generalized assessment of conceptual operations and maintenance (O&M) cost for each corridor based on the following six factors, all of which correlate with higher O&M cost: • Route Length: more miles equates to more operating cost • Number of Stations: more stations means more passenger interface elements such as informational signs, fare collection equipment, and shelters that need to be kept clean and working • Grade-separated Stations: these require more sophisticated safety systems than at-grade stations, and vertical circulation elements (elevators and escalators) require electricity and frequent maintenance • Number of Vehicles: more vehicles to maintain means more cost for staff and the operation of storage facilities • Grade-separated guideway: tunnel and elevated trackways take more staff hours per track mile to maintain • New movable bridge: power and sophisticated monitoring systems are required to open a movable bridge for marine traffic to pass through it.
		Construction challenges of major infrastructure elements	For each corridor, identify major bridge and tunnel elements. For this evaluation, it is assumed that more of these elements included in a corridor would correlate with more complex construction in terms of cost, coordination, and schedule.
		Potential conflicts with major water, sewer, and power utilities	Identify potential conflicts with major water, sewer, and power utilities using geographic information systems (GIS). Consider major utilities to be water mains larger than 18 inches in diameter, sewers larger than 36 inches in diameter, and any overhead or buried electrical transmission lines.
		Potential availability and ease of access to maintenance and storage facility	Qualitatively assess the proximity of each corridor to a potential maintenance and storage facility location. In addition to proximity, assess whether complex traffic impact mitigation measures or flyover structures would be required for trains to access the potential facility location.
Preserve and enhance the environment • Avoid impacts to existing natural and cultural resources in the corridor • Improve local air quality by providing alternative to travel by single occupant vehicle	Environmental screening	Potential visual and cultural resource impacts	Qualitatively assess potential visual impacts (particularly new elevated structures) and environmental impacts (e.g., historic districts, greenbelts) for each corridor, using environmental documentation from other projects and agencies in the study area.
Provide equitable access for residents and businesses • Improve transit access to jobs, education, and other regional resources for a broad cross-section of socio-economic groups, ethnicities, and household types	Service to transit-dependent populations	Number of census tracts served with medium and high concentrations of zero-car households	Identify census tracts that would be served by potential stations in which more than 10% of households do not own a car.

Table 7-3. Level 1 Evaluation Results

	CORRIDOR							
	1 Interbay West/ New Bridge	2 Interbay West/ Ship Canal Tunnel	3 15th Avenue/ Elevated	4 15th Avenue/ At-grade	5 Queen Anne Tunnel	6 Westlake/Ship Canal Tunnel	7 Dexter/ Fremont Bridge	8 Westlake/ New Bridge
▶ Goal: Increase transit ridership by providing services that are reliable, frequent, and efficient								
Service to key transit travel markets	Ballard, Uptown, Belltown, Downtown	Ballard, Uptown, Belltown, Downtown	Ballard, Uptown, Belltown, Downtown	Ballard, Uptown, Belltown, Downtown	Ballard, Fremont, Upper QA, Uptown, Belltown, Downtown	Ballard, Fremont, SLU, Denny Triangle, Downtown	Ballard, Fremont, SLU, Denny Triangle, Downtown	Ballard, Fremont, SLU, Denny Triangle, Downtown
Number of at-grade signalized intersections traversed	16	0	0	28	10	19	36	27
Reliability of Ship Canal crossing	140′ fixed bridge (no openings)	Tunnel (no openings)	140′ fixed bridge (no openings)	70′ movable bridge (reduced off-peak openings)	70′ movable bridge (reduced off-peak openings)	Tunnel (no openings)	Fremont Bridge (off-peak openings)	70′ movable bridge (reduced off-peak openings)
Peak period travel time (min) (with no bridge openings)	14–19	12–17	11–16	13–18	15–20	14–19	18–25	17–24
▶ Goal: Improve mobility options for residents and businesses between Ballard and downtown Seattle								
Effects on traffic operations (general purpose traffic, freight mobility, local circulation and parking)	Moderately High Impacts	Low Impacts	Low Impacts	High Impacts	Moderate Impacts	Moderate Impacts	Moderately High Impacts	High Impacts
Effects on multimodal mobility (pedestrians, bicycle, and transit)	Moderately High Impacts	Low Impacts	Low Impacts	High Impacts	Moderate Impacts	Moderately High Impacts	Moderate Impacts	Moderate Impacts
▶ Goal: Support sustainable urban growth								
Opportunity for economic and transit-oriented development	Low	Moderately Low	Moderately Low	Moderately Low	Moderately High	High	High	Moderately High
▶ Goal: Improve connection to the regional transit system								
Ease of pedestrian connection to Westlake Link station	Moderately High	High	High	Moderately High	High	Moderately High	Moderately High	Moderately High
Connectivity to local bus network	High	High	High	High	Moderate	Moderately Low	Moderately Low	Moderately Low
▶ Goal: Make efficient use of public financial resources								
Conceptual cost etimate (2013 $M)	$750–$1,000	$2,500–$3,000	$1,500–$2,000	$500–$750	$2,000–$2,500	$1,000–$1,500	<$500	<$500
Conceptual operations and maintenance cost estimate	Low Cost	Low Cost	Low Cost	Moderate Cost	High Cost	High Cost	High Cost	Moderate Cost
Construction challenges of major infrastructure elements	•Bridge over BNSF •140′ bridge over Salmon Bay	•Very long tunnel from CBD to SW Queen Anne via Seattle Center •Bridge over BNSF •Tunnel under Salmon Bay	•Long tunnel from CBD to SW Queen Anne •Elevated 15th Ave guideway •140′ bridge over Ship Canal	•70′ movable bridge	•Very long tunnel from CBD to Nickerson •Deep tunnel station under QA •70′ movable bridge	•Tunnel under Lake Union	•Use existing Fremont Bridge	•70′ movable bridge
Potential conflicts with major water, sewer, and power utilities	Moderate Conflicts	Moderately High Conflicts	Moderate Conflicts	Moderately High Conflicts	High Conflicts	Moderately High Conflicts	Moderately High Conflicts	Moderately High Conflicts
Potential availability and ease of access to maintenance and storage facility	North Port: High	North Port: High	Interbay/15th: Moderate	Interbay/15th: Moderate	Leary: Low	Leary: Low	Leary: Low	Leary: Low
▶ Goal: Preserve and enhance the environment								
Potential visual and natural environment impacts	Moderately High Impacts	Moderately Low Impacts	Moderately High Impacts	Low Impacts	Moderately Low Impacts	Low Impacts	Low Impacts	Moderately Low Impacts
▶ Goal: Provide equitable access for residents and businesses								
Number of census tracts served with medium and high concentrations of zero-car households	6	7	6	6	8	8	8	8

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8 DEFINITION AND EVALUATION OF LEVEL 2 CORRIDORS

This section describes the refinement and evaluation of Level 2 corridors.

8.1 Level 2 Corridors Definition

The Level 2 evaluation refined the eight transit alternatives from Level 1 based on Level 1 evaluation results and public feedback. A detailed summary of public input can be found in the *Public Meeting and Engagement Summary "Open House #2" Technical Memorandum* (Sound Transit, September 2013). Based on evaluation results and public input, the project team worked together to identify five corridors to undergo further analysis in Level 2.

Corridor 7 was not advanced due to the lack of available right-of-way on Dexter Avenue N as well as a high level of anticipated traffic impacts; it would not have improved travel time due to operating in mixed-traffic and poor transit reliability resulting from use of the Fremont Bridge. In addition, a new 140' fixed bridge across the Ship Canal was originally included as a crossing option that would not require openings; however, for all corridors, a 140' fixed bridge was not advanced due to significant visual impacts and its inability to accommodate pedestrians and cyclists. Finally, due to the strong preference for transit operating in exclusive right-of-way, options with transit operating in shared lanes (e.g., segments of Corridors 7 and 8) were not advanced to further consideration.

Elements from Level 1 corridors that increased ridership, minimized travel time, improved mobility options, regional connections and accessibility, supported sustainable urban growth, and made efficient use of public resources were advanced into Level 2 evaluation. Also advanced were corridors that provided a range of applicable potential modes (i.e., corridors that would be appropriate for light rail, rapid streetcar, or both). Five corridors were advanced for a more detailed evaluation based on more quantitative criteria and measures. These included an all-tunnel corridor that addressed the strong preference indicated by public comments for a completely grade-separated corridor serving Upper Queen Anne and Fremont. Also, some station vicinities were refined to address public input and the refined alignments. These included inclusion of an Upper Queen Anne station in Corridor A, a relocated Uptown station in Corridor B, inclusion of a NW 65th Street station in Corridors B and C, and inclusion of an Elliott/Thomas station in Corridor C.

Table 8-1 provides information on profile type (at-grade, elevated, tunnel), corridor length, neighborhoods served, potential station vicinities, and average station spacing for the five Level 2 corridors. Figures 8-1 through 8-5 illustrate the alignment, profile type, and potential station vicinities for each of the five Level 2 corridors.

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Table 8-1. Corridors for Level 2 Evaluation

Corridor	Downtown-Mercer St	Mercer St-Ship Canal	Ship Canal Crossing	Ship Canal-Ballard	Corridor Length (mi)	Neighborhoods Served	Potential Stations in the Vicinity of:	Average Station Spacing (mi)
A Interbay West	Tunnel	Tunnel and Elevated	New Bridge (70') or Tunnel	Tunnel or At-Grade	5.6	Downtown Uptown Upper Queen Anne Interbay Ballard	2nd @ Pine 2nd @ Battery 2nd N @ Republican Queen Anne Ave @ Galer 15th W @ Garfield 20th W @ Dravus Market @ 17th NW	0.9
B 15th Avenue/ Elevated	Tunnel	Elevated	New Bridge (70')	At-Grade	6.5	Downtown Uptown Interbay Ballard Crown Hill	2nd @ Pine 4th @ Battery 1st N @ Republican Elliott @ Prospect 15th W @ Dravus 15th NW @ Market 15th NW @ NW 65th 15th NW @ NW 85th	0.9
C 15th Avenue/ At-Grade	At-Grade	At-Grade	New Bridge (70')	At-Grade	6.3	2nd/4th Ave Option Downtown Uptown 1st Ave Option Downtown Uptown 2nd/4th & 1st Ave Options Interbay	 2nd/4th @ Stewart 2nd/4th @ Bell 2nd/4th @ Broad Elliott @ Thomas 1st @ Stewart 1st @ Bell 1st @ Broad 1st N @ Republican Elliott @ Prospect	0.8

Corridor	Downtown-Mercer St	Mercer St-Ship Canal	Ship Canal Crossing	Ship Canal-Ballard	Corridor Length (mi)	Neighborhoods Served	Potential Stations in the Vicinity of:	Average Station Spacing (mi)
						Ballard Crown Hill	15th W @ Dravus 15th NW @ Market 15th NW @ NW 65th 15th NW @ NW 85th	
D Queen Anne Tunnel	Tunnel	Tunnel	Tunnel	Tunnel	5.3	Downtown Uptown Queen Anne Fremont Ballard	2nd @ Pine 2nd @ Battery 2nd N @ Republican Queen Anne Ave @ Galer N 36th @ Phinney Market @ 17th NW	1.0
E Westlake	At-Grade	At-Grade	New Bridge (70') or Tunnel	At-Grade	6.6	Downtown SLU Westlake Fremont Leary Ballard Crown Hill	Westlake @ Stewart Westlake @ Denny Westlake @ Mercer Westlake @ Galer N 36th @ Dayton Leary @ 6th Ave NW Leary @ 14th NW 24th NW @ Market 24th NW @ NW 65th 24th NW @ NW 85th	0.7

Figure 8-1. Corridor A

- Tunnel under 2nd Ave, Seattle Center, and Queen Anne from Pine Street to Interbay
- New bridge over 15th Ave W and BNSF tracks, north of Magnolia Bridge, with station near 15th Ave W
- Elevated on edge of Port of Seattle property and 20th Ave W to south of W Dravus St
- Tunnel portal on 20th Ave W south of W Dravus St
- Tunnel from 20th Ave W/W Dravus St, under Salmon Bay, and into Ballard, terminating under NW Market St
- Crossing Option: Elevated on edge of Port of Seattle property and on 20th Ave W and Gilman Ave W via 70' movable bridge to 24th Ave NW and along NW Market St to elevated station at 15th Ave NW
- Light rail is the potential mode for this corridor

Figure 8-2. Corridor B

- Tunnel under Belltown and Lower Queen Anne to Elliott Avenue W
- Elevated along Elliott Ave W, in center alignment
- Elevated around east end of Magnolia Bridge to 15th Ave W
- Elevated on west side of 15th Ave W (side running) between the Magnolia Bridge and the Ballard Bridge
- New bridge adjacent to the Ballard Bridge (70' clearance over water surface)
- Elevated on 15th Ave NW in center alignment to NW Market St
- Transition to at-grade center alignment in 15th Ave NW from NW 58th to NW 85th St
- Light rail is the potential mode for this corridor

Figure 8-3. Corridor C

- At-grade surface couplet on 2nd and 4th Avenues between Stewart St and Denny Way
- At-grade on north side of Denny Way from 4th to Western Ave. One or two track options under consideration.
- Routing Option: Streetcar in center alignment on 1st Ave, crossing Denny Way, extending to Republican, then west to bridge connection to center alignment in Elliott Ave W. Center at-grade alignment on Elliott Ave W and 15th Ave W
- New bridge adjacent to the Ballard Bridge (70' clearance over water surface) with transition to/from center alignment to new bridge
- At-grade center alignment on 15th Ave NW between new bridge and NW 85th St
- Light rail or rapid streetcar could be accommodated in this corridor

Figure 8-4. Corridor D

- Tunnel under 2nd Avenue, Seattle Center, and Queen Anne
- Tunnel under the Ship Canal
- Tunnel through Fremont to Ballard at NW Market Street near 17th Ave NW
- Light rail is the potential mode for this corridor

Figure 8-5. Corridor E

- At-grade on Westlake Ave from Stewart Street to Valley Street, with revised alignment both directions in exclusive lanes. Center or curb alignment to be determined.
- At-grade in center alignment where development exists on both sides and then along west side of Westlake Avenue N to portal at approximately Halliday Street.
- Tunnel under ship canal with tunnel station west of Fremont Ave N
- Optional bridge over ship canal would run center alignment through Fremont Ave N intersection into Nickerson Street to bridge approach.
- At-grade center alignment along N 36th Street, Leary Way NW to NW Market Street at 24th Ave NW
- Keep two travel lanes on Leary Way NW, remove parking. Shared lane is required under 15th Ave NW overpass.
- At-grade center alignment on 24th Ave NW to NW 85th Street, with single lane and parking each direction. Removes center turn lane
- Rapid streetcar is the potential mode for this corridor

8.2 Level 2 Analysis and Evaluation

The Level 2 evaluation consisted of a more detailed evaluation based on more quantitative criteria and measures, as described in the *Evaluation Criteria and Methodologies Memorandum* (Sound Transit, October 2013).

Table 8-2 presents the Level 2 evaluation criteria. Results of the Level 2 evaluation are shown in Table 8-3, with summary results shown in Table 8-4. The *Level 2 Alternatives Analysis and Evaluation Technical Memorandum* (Sound Transit, January 2014) provides further detail of the methodology and evaluation results for each measure.

Table 8-2. Level 2 Evaluation Criteria

Goals and Objectives	Evaluation Criteria	Measure	Methodology
Increase transit ridership by providing services that are reliable, frequent, and efficient	Ridership	2035 daily riders on the proposed rail line	Estimate daily boardings on the proposed rail line for year 2035 using the ridership forecasting model. For comparison purposes, ridership modeling results will be presented for Market Street to Downtown Seattle for all corridors. For corridors that extend north of Market Street, incremental additional ridership will also be provided.
		2035 daily new transit trips	Compare daily linked transit trips assuming the proposed rail line for year 2035 with the daily linked transit trips assuming the 2035 baseline system
	Transit travel markets	Service to key transit travel markets	For each corridor, identify the potential markets served from the following list of markets in the study area: Ballard, Fremont, Upper Queen Anne, Lower Queen Anne, South Lake Union, Belltown, Denny Triangle, and Downtown.
	Schedule reliability	Number of at-grade signalized intersections traversed	Count the at-grade signalized intersections that would be traversed by each corridor alignment Give consideration to level of daily traffic volumes when assessing potential impacts to reliability.
		Reliability of Ship Canal crossing during non-peak hours	Consider exclusive crossings that do not require openings to be more reliable than exclusive crossings requiring non-peak period openings. Consider non-exclusive existing bridges to be less reliable than a new exclusive moveable bridge because the train would be mixed with general purpose traffic and subject to more frequent openings during off-peak periods.
	Travel time	2035 PM peak period travel time from Downtown Seattle to Ballard	Using the travel forecasting model, estimate the 2035 PM peak period travel time from 5th South & South Jackson and from Westlake Hub to Ballard (Market Street).
Improve mobility options for residents and businesses between Ballard and Downtown Seattle • Preserve mobility of people and goods in the corridor • Seek to improve multimodal access	Effects on traffic operations	Effects on traffic operations (general purpose traffic, freight mobility, local circulation, and parking)	Qualitatively assess impacts to traffic operations, including potential lane restrictions, special signal phasing requirements, and loss of parking. In key locations, use a traffic operations simulation model to estimate increase in traffic delay (compared to existing conditions). Key locations to be identified based on where the proposed rail line would reduce or restrict existing capacity and streets that are part of important freight corridors.
	Effects on multimodal mobility	Effects on multimodal mobility (pedestrians, bicycles, and transit)	Qualitatively assess issues and impacts related to other transportation modes, including potential barriers to pedestrian and/or bicycle access across the corridor and connections to local bus service. Consider both existing and future planned non-motorized network.

Support sustainable urban growth
• Support economic and transit-oriented development in the corridor
• Support development of compact and sustainable communities
	Land use integration	Opportunity for economic and transit-oriented development	Update Level 1 analysis of urban areas that would be served based on station locations for Level 2 corridors:
			• Identify station-area factors that would support transit use and the formation of compact, sustainable communities:
			  ○ Diversity of land use mix (e.g., single-family, multi-family, retail/service, office)
			  ○ Proximity to major employers (threshold based on # employees for required CTR program participation)
			  ○ Proximity to destination locations (tourist/institutional – e.g. Seattle Center, SPU)
			• Identify opportunities for expanding station access via improvements in pedestrian and bicycle facilities and/or integration with other modes
			• Based on individual station-area characteristics and assets, assign station-area typologies based on Seattle Transit Communities designations to inform development propensity analysis
			• Conduct a development propensity analysis to estimate land use capacity under three scenarios: 1) existing zoning, 2) existing zoning plus transit investment, and 3) a potential station area zoning response catalyzed by transit investments (based on Seattle Transit Communities station-area typology and policy guidance). Factors to be considered in this analysis include:
			  ○ Improvement-to-value ratio
			  ○ Existing-to-allowable FAR ratio
			  ○ Historic sales and development data
			  ○ Comparison with established PSRC and/or Comprehensive Plan growth targets and estimates
			• Describe potential land use impacts of potential maintenance yard locations

	Employment served	2035 employment density	Calculate the 2035 employment density within 0.5 miles of the corridor's proposed rail stations
	Population served	2035 population density	Calculate the 2035 population density within 0.5 miles of the corridor's proposed rail stations

Goals and Objectives	Evaluation Criteria	Measure	Methodology
Improve connection to the regional transit system • Connect communities in the corridor to the regional transit network and other regional centers • Provide user-friendly connections between regional and local transit services	Connections to the regional Link light rail system	2035 PM peak period travel time from Ballard to Sea-Tac Airport	Using the travel forecasting model, estimate the 2035 PM peak period travel time from Ballard (Market Street) to Sea-Tac Airport.
	Connections to local transit services	Connectivity to local bus network	Identify existing bus routes that are intersected by corridors near potential station locations. Give added weight to east-west routes compared with north-south routes, with the assumption that east-west routes would provide better feeder service; give less weight to peak period-only routes. Identify potential station locations that provide high frequency of connecting bus service due to combined local routes. To better differentiate between corridors, do not include bus routes at the downtown stations.
Make efficient use of public financial resources	Cost and ease of implementation	Capital cost	Estimate a conceptual capital cost for the proposed rail line in each corridor and a operations and maintenance facility, using historical data for similar modes and alignments. For corridors that extend north of Market Street, costs will be broken out for the corridor segments north and south of Market Street.
		O&M cost	Estimate a conceptual operating and maintenance cost for the proposed rail line in each corridor.
		Cost per rider	Estimate the annual capital and operating cost per trip on the proposed rail line. Use the annualized capital cost plus annual operating cost of the project divided by the annual number of estimated trips on the project in 2035.
		Construction challenges of major infrastructure elements	For each corridor, identify major bridge and tunnel elements. For this evaluation, it is assumed that more of these elements included in a corridor would correlate with more complex construction in terms of cost, coordination, and schedule.
		Potential conflicts with major water, sewer, and power utilities	Identify potential conflicts with major water, sewer, and power utilities using geographic information systems (GIS). Consider major utilities to be water mains larger than 18 inches in diameter, sewers larger than 36 inches in diameter, and any overhead or buried electrical transmission lines.
		Potential availability and ease of access to maintenance and storage facility	Identify potential maintenance and storage facility location for each corridor and qualitatively assess the proximity of the corridor alignment to the potential facility location. In addition to proximity, assess whether complex traffic impact mitigation measures or flyover structures would be required for trains to access the potential facility location.
Preserve and enhance the environment • Avoid impacts to existing natural and cultural resources in the corridor • Improve local air quality by providing alternative to travel by single occupant vehicle	Environmental screening	Potential visual and natural environment impacts	Qualitatively assess potential visual impacts (particularly new elevated structures) and environmental impacts (e.g., historic districts, greenbelts) for each corridor, using environmental documentation from other projects and agencies in the study area.
			Identify corridor elements that could potentially be vulnerable to sea level rise, and describe potential associated impacts to the facility, the community, and the environment.
		Environmental benefits	Estimate the reduction in 2035 daily vehicle miles travelled (VMT) for a system with the proposed rail line compared to the 2035 baseline system.
Provide equitable access for residents and businesses • Improve transit access to jobs, education, and other regional resources for a broad cross-section of socio-economic groups, ethnicities, and household types	Service to transit-dependent households	Number of transit dependents using the project	Estimate daily boardings for year 2035 on the proposed rail line by persons in the lowest income bracket using the ridership forecasting model

Table 8-3. Level 2 Evaluation Results

	CORRIDOR							
	A Interbay West		B	C 15th Avenue/At Grade		D	E Westlake	
	Tunnel Crossing Option	70' Crossing Bridge	15th Avenue/ Elevated	2nd/4th Avenue Routing Option	1st Avenue Routing Option	Queen Anne Tunnel	Tunnel Crossing Option	70' Bridge Crossing Option
▸ Goal: Increase transit ridership by providing services that are reliable, frequent, and efficient								
Daily project riders	24,000-28,000		22,000-26,000	14,000-18,000		26,000-30,000	14,000-18,000	
Annual new transit trips (millions)	1.0		0.8	0.3		1.2	0.4	
Service to key transit travel markets	Ballard, Upper Queen Anne, Uptown, Belltown, Downtown		Ballard, Uptown, Belltown, Downtown	Ballard ,Uptown, Belltown, Downtown		Ballard, Freemont, Upper Queen Anne, Uptown, Belltown, Downtown	Ballard, Fremont, South Lake Union, Denny Triangle, Downtown	
Number of at-grade signalized intersections traversed	0	0	11	50	49	0	51	53
Reliability of Ship Canal crossing	Tunnel (no openings)	70' Movable Bridge (reduced off-peak openings)	70' Movable Bridge (reduced off-peak openings)	70' Movable Bridge (reduced off-peak openings)		Tunnel (no openings)	Tunnel (no openings)	70' Movable Bridge (reduced off-peak openings)
Peak period travel time (min) (with no bridge openings)	14-19		12-17	16-21		13-18	18-23	
Extension to NW 85th St (min)	n/a		+4-5	+4-5		n/a	+4-5	
▸ Goal: Improve mobility options for residents and businesses between Ballard and downtown Seattle								
Effects on traffic operations (general purpose traffic, freight mobility, local circulation, and parking)	Low Impacts		Moderate Impacts	High Impacts		No Impacts	Moderate Impacts	
Effects on multimodal mobility (pedestrians, bicycles, and transit)	Low Impacts		Moderate Impacts	High Impacts		No Impacts	Moderate Impacts	
▸ Goal: Support sustainable urban growth								
Opportunity for economic and transit-oriented development	High		Moderate	Moderate		High	Moderately High	
Employment served (2035 employment)	170,000		170,000	160,000	150,000	170,000	155,000	
Population served (2035 population density - people per acre)	32.90		36.77	37.89	36.20	38.26	35.04	
▸ Goal: Improve connection to the regional transit system								
Peak period travel time from Ballard to Sea-Tac Airport (min)	55-58		53-56	57-62		54-57	59-64	
Connectivity to local bus network	High		High	High		High	Moderate	
▸ Goal: Make efficient use of public financial resources								
Conceptual cost estimate (2013 $M) - Market St to Downtown Seattle	$3,200-3,600	$2,800-3,200	$2,400-2,800	$1,200-1,600	$800-1,200	$3,200-3,600	$800-1,200	$400-800
Conceptual operations and maintenance cost estimate (annual 2013 $M)	$11.00	$11.60	$11.10	$10.50	$8.80	$11.00	$7.70	$8.30
Cost per rider	$11.73	$10.54	$10.20	$9.67	$8.14	$10.10	$7.56	$6.32
Construction challenges of major infrastructure elements	Fair		Fair	Good		Poor	Good	
Potential conflicts with major water, sewer, & power utilities	Poor	Fair	Fair	Good		Fair	Poor	Fair
Potential availability and ease of access to maintenance and storage facility	Good		Good	Good		Poor	Very Good	
▸ Goal: Preserve and enhance the environment								
Potential visual and natural environment impacts	Moderately Low Impacts		Moderately Low Impacts	Low Impacts		Low Impacts	Low Impacts	
Vulnerability to sea level rise	Moderate Potential Vulnerability		Moderate Potential Vulnerability	Highest Potential Vulnerability		Low Vulnerability	Low Vulnerability	
Environmental benefits (annual VMT reduction in millions)	8		6	2		8	2	
▸ Goal: Provide equitable access for residents and businesses								
Percentage of population using the project that is transit-dependent	29%		29%	29%		29%	28%	

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Table 8-4. Summary Level 2 Evaluation Results

	CORRIDOR							
	A		B	C		D	E	
	Interbay West		15th Avenue/ Elevated	15th Avenue/At-grade		Queen Anne Tunnel	Westlake	
	Tunnel Crossing Option	70' Bridge Crossing Option		2nd/4th Ave Routing Option	1st Ave Routing Option		Tunnel Crossing Option	70' Bridge Crossing Option
Ridership	●		◕	◔		●	◔	
Reliability	●	◕	◕	◔		●	◑	◔
Travel Time Improvement	●		●	◕		●	◕	
Disruption to Other Modes	●	◕	◑	○		●	◑	◔
Station Area Development Potential	●		◑	◑		●	◕	
Cost	○	◔	◔	◕		○	◕	●
Cost Effectiveness	◔		◔	◑	◕	◔	◕	
Complexity (Risk/Construction Challenges)	◔	◑	◑	◕		○	◑	◕
Environmental Effects	◕		◑	◔		●	◕	

○ ◔ ◑ ◕ ●
Lower Performing → Higher Performing

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The general methodology and evaluation results are summarized below.

Ridership: rating based on forecasted ridership between Ballard (Market Street) and Downtown Seattle for year 2035 using the Sound Transit ridership forecasting model.

Corridors A and D are rated highest performing for ridership. Corridor D has the highest ridership (26,000-30,000 daily project riders) because of its fully exclusive profile, fast travel time, and service to the most key transit markets. Corridor A has the second-highest ridership (24,000-28,000), primarily because it serves Upper Queen Anne and is also fully exclusive.

Corridor B is the next highest performing option (22,000-26,000), with significantly higher ridership than Corridor C due to a faster travel time, a better downtown connection for patrons to connecting transit services in the Downtown Seattle Transit Tunnel, and a more centrally-located Uptown station.

Corridors C and E are the lowest performing corridors with low ridership projections (both with 14,000-18,000) due to slower travel times and service to fewer transit markets.

Reliability: rating based on the number of at-grade signalized intersections traversed and the type of ship canal crossing (tunnel or movable bridge).

Corridors A and D are the most reliable corridors because of their fully grade-separated profiles (elevated and/or tunnel). No at-grade signalized intersections would be traversed and a tunnel crossing ship canal would not experience any delays as a result of boat traffic. The Corridor A option with a bridge over the ship canal received a slightly lower performance rating due to some delays to transit operations caused by bridge openings.

Corridor B is the next highest performing corridor with only 11 signalized intersections traversed along 15th Ave NW and a bridge crossing the ship canal. The Corridor E tunnel option scored slightly lower in reliability performance due to a high number of intersections traversed.

The Corridor E bridge option and Corridor C are the lowest performing for reliability due to the greatest number of at-grade signalized intersections traversed combined with a bridge crossing the ship canal.

Travel Time Improvement: estimated travel time from Market Street to Downtown Seattle based on corridor length, curves, number of stations, and operating environment. Movable bridges are assumed to not open during peak periods. Ratings based on comparison with existing peak period bus travel times (40 and RapidRide D).

Corridors A (13-15 min), B (11-13 min), and D (12-14 min) perform the highest for travel time improvement with similar travel times between Ballard and Downtown Seattle. In general, faster travel times are related to greater grade separation, fewer stations, and shorter total distances.

Corridors C (15-19 min) and E (17-21 min) received slightly lower ratings due to slower travel times resulting from minimal grade separation and more stops. For Corridors B and C, travel times to 85th Street were estimated at an additional 4 to 5 minutes. The total of 14-18 minutes for Corridor B and 19-24 minutes for Corridor C compare with existing transit peak hour, peak direction travel times of 29-46 minutes for travel between 85th Street and downtown Seattle.

Disruption to Other Modes: rating based on a combination of impacts to traffic operations, freight mobility, local circulation, parking, pedestrians, bicycles, and local bus service. Consideration was give to added pedestrian and bicycle connectivity provided by options with a new movable bridge.

Corridors A and D received the highest performance rating for being least disruptive to other modes. Full grade separation for both corridors causes little to no impact on traffic operations and multimodal mobility. The Corridor A bridge option received a slightly lower rating because the elevated profile column locations would displace some parking and potentially affect general-purpose and bus operations in travel lanes.

Corridors B and E received lower performance ratings for having moderate effects to traffic operations, parking, and freight mobility. Moderate effects to multimodal mobility primarily involve creating barriers to bicyclists and pedestrians with an at-grade rail profile.

Corridor C is the most disruptive to other modes. The fully at-grade profile, particularly through Belltown and Uptown, results in a significant impact on surface traffic and transit operations due to the removal of travel and transit lanes, signal delay effects, the inability to maintain freight access, and the loss of parking, as well as high impacts to bicycle and pedestrian mobility.

Station Area Development Potential: rating based on quantitative assessment of relative economic development potential of station areas, based on diversity of land use mix, proximity to major employers, and proximity to destination locations. Development propensity analysis was conducted to estimate land use capacity for development around stations.

Corridors A and D received the highest performance ratings due to the high development propensity in the potential station areas, particularly with the inclusion of Upper Queen Anne. Corridor E received a medium-high rating, followed by Corridors B and C with medium ratings.

Cost: capital cost estimate based on combination of unit costs from recent Sound Transit projects at Alternatives Analysis level and SDOT streetcar project costs. Ratings were based on cost of corridors between Market Street and Downtown Seattle.

The primarily at-grade corridors performed the highest in terms of cost (i.e., had lower costs), while the primarily grade-separated corridors, especially those with long tunnel segments, performed the lowest (i.e., had higher costs). Also, corridors with rapid streetcar as the

potential mode generally performed higher than those with light rail as the potential mode, primarily due to being mostly at-grade and lower unit costs for rapid streetcar. The Corridor E bridge option received the highest performance rating with the lowest capital cost estimate ($400-$800 million), followed by Corridor C and the Corridor E tunnel option (both at $800-$1,200 million) with a medium-high rating. The Corridor A bridge option ($2,800-$3,200 million) and Corridor B ($2,400-$2,800 million) received medium-low ratings, while the Corridor A tunnel option ($3,200-$3,600 million) and Corridor D ($3,200-$3,600 million) received the lowest ratings with the highest capital cost estimate.

Cost Effectiveness: rating based on cost per rider – annualized capital cost estimate plus annual O&M cost estimate, divided by number of forecasted annual project riders.

Corridor E is the most cost effective due to the lowest cost per rider, followed by Corridor C. Corridors A, B, and D received low performance ratings for having higher costs per rider.

Complexity (Risk/Construction Challenges): rating based on a combination of risk and construction challenges related to major bridge and tunnel elements; potential conflicts with major water, sewer and power utilities; and availability and ease of access to potential MSF locations.

Similar to the cost ratings, the primarily grade-separated corridors performed the highest in terms of complexity, while corridors featuring long tunnels performed the lowest. Corridor C and the Corridor E bridge option received the highest rating, followed by the Corridor A bridge option, Corridor B, and the Corridor E tunnel option. The Corridor A tunnel option received a medium-low rating, while Corridor D received the lowest rating due to the fully-below grade profile and deep tunnel station.

Environmental Effects: rating based on a combination of a qualitative assessment of potential visual and environmental impacts, vulnerability to sea level rise, and potential reduction in annual vehicle miles traveled (VMT). Corridor D received the highest performance rating primarily due to the lack of visual impacts (being fully below grade) and highest potential reduction in VMT. Corridor C received the lowest rating due to visual impacts of a new bridge combined with vulnerability to sea level rise in the Interbay area and the lowest potential reduction in VMT.

9 PUBLIC ENGAGEMENT

The Ballard to Downtown Seattle Transit Expansion Study involved three rounds of outreach. The first two public meetings were held in March and June 2013, respectively. Sound Transit and the City of Seattle subsequently incorporated public feedback received at the public meetings and through the online engagement tools, and conducted a technical analysis of possible alignments for future high capacity transit (HCT) between Ballard and Downtown Seattle. On December 5, 2013, a third and final open house and interactive web tool were hosted to report back to the community on how the project team used public input in the analysis and the results of the Level 2 evaluation.

9.1 Public Meeting #1

During the week of March 11, 2013 Sound Transit and the City of Seattle hosted a public meeting and online engagement tool to explore HCT options between Ballard and Downtown Seattle. This launched the public involvement process for the Ballard to Downtown Seattle Transit Expansion Study. During this period, Sound Transit and the City of Seattle provided a variety of methods to get the word out about the study, resulting in strong participation both in-person and virtually, including:

- Nearly 150 people attended an open house on March 12, 2013 at Ballard High School
- Nearly 270 people participated in the online tool
- Two articles appeared in local media
- Five blog and community calendar posts
- Five advertisements in print and online media

An online interactive mapping tool was created to supplement the open house and allow people unable to attend the meeting an opportunity to provide input. The mapping tool provided the same interactive exercises as the open house, and was posted to Sound Transit's website the week of the open house, from March 11 through March 15, 2013.

9.1.1 Purpose

Public feedback gathered through this initial engagement process was intended to help identify a range of potential alignments between Ballard and Downtown Seattle. Questions posed through this process therefore focused on:

- Prioritizing study goals and objectives;
- Understanding participants' current commute origins and destinations;
- "First glance" ideas on route options and considerations; and
- Ideas related to connecting with existing and future transit

Feedback supported the development of potential alignments and profiles. A summary of the results are discussed below. Further detail can be found in *Public Meeting and Engagement Summary: "Open House #1"* (Sound Transit, April 2013).

9.1.2 Participation Results and Comment Themes

The following key themes from public comments have emerged across this participation effort:

- People are open to the intents of the study as a broad-brush effort to consider HCT in this study area. Commenters are interested in a system that **mobilizes and connects people and places reliably, efficiently and without redundancy**.
- **A single route did not emerge** from comments received; however the study area appeared to respond to a need for improved transit. Two corridors south of the Ship Canal emerged: Westlake Ave N and 15th Ave W.
- If a new system is to be built, commenters prefer prioritizing **reliability** and **speed**. To that end, they identify **grade-separation** for either transit mode to minimize interference with existing traffic and bus service.
- Existing bridges are already congested, and a **new Ship Canal crossing** is preferred.
- **Connections** with the existing and future **transit system**, including Sound Transit's Link Light Rail and the City of Seattle's South Lake Union Streetcar, should be prioritized.

9.2 Public Meeting #2

Following an initial round of outreach in March 2013, Sound Transit and the City of Seattle conducted a technical analysis of possible alignments for future high capacity transit (HCT) between Ballard and Downtown Seattle. On June 27, 2013, a second open house and online engagement tool were hosted to report back to the community on how the project team used public input in the analysis, and provide the public with an opportunity to share their input on the analysis of the eight Level 1 corridors.

Sound Transit and the City of Seattle utilized a variety of methods to share information about the study and encourage community members to participate in the second community engagement opportunity. There was strong in-person participation, including:

- Over 165 people attended an open house on June 27, 2013 at Ballard High School
- Over 1,200 people participated online
- 15 articles appeared in local media and blogs

An online interactive web tool was created to supplement the open house, so that people who were not able to attend the meeting in person could provide input. The web tool provided the same content and solicited the same feedback on the Level 1 Analysis and eight resulting

corridors as the open house comment form. The online interactive web tool was posted to Sound Transit's website from June 27 through July 5, 2013.

9.2.1 Purpose

Key topics of the open house and online engagement tool focused on the following:

- Results of the goals and objectives ranking
- The universe of route ideas provided by the public during the initial engagement process
- Screening criteria used to evaluate corridors and options
- Eight corridors, including cross sections
- Level 1 analysis results

Feedback from the second outreach effort supported evaluation of the eight Level 1 Corridors and identification of five Level 2 corridors between Ballard and Downtown Seattle. A summary of the results are discussed below. Further detail can be found in *Public Meeting and Engagement Summary: "Open House #2"* (Sound Transit, September 2013).

9.2.2 Participation Results and Comment Themes

The following key themes from public comments emerged across this participation effort:

Corridors

- **Corridor #5 – Queen Anne Tunnel was the most popular route overall**. Participants cited connectivity between densely populated neighborhoods (Queen Anne, Fremont, SPU, Seattle Center and Belltown) and efficiency/reliability related to tunnels as key reasons for choosing this route.
- Corridor #2 – Interbay West/Ship Canal Tunnel was the second most popular route. Participants cited connectivity to densely populated neighborhoods, fast/reliable connection between Ballard and Downtown and the lowest visual and environmental impacts as key reasons for choosing this route.
- Participants **strongly encouraged the consideration of a new "Corridor #9"** as suggested by the Seattle Transit Blog. "Corridor 9" would include two rail lines: a fully-grade separated light rail transit line serving Downtown, Belltown, Uptown, Upper Queen Anne, Fremont, Ballard and Crown Hill, and a rapid streetcar line serving Downtown, South Lake Union, Westlake, Fremont, Phinney Ridge and Greenwood.

Service and connections

- People felt that **efficient and reliable service** is a **high priority.**

- Participants said that **connecting densely populated** neighborhoods is a **high priority**, with many participants indicating **support for serving upper and lower Queen Anne**, **Fremont and north of Market St.** respectively.
- Comments indicated that **100 percent grade separation** is necessary to meet the goals of the project.
- Majority preference was given to tunnels, followed by a 140' bridge for the Ship Canal Crossing. **Overall, tunnels were preferred for both the ship canal crossing and downtown connection.**
- Some participants noted that it would be **difficult to serve all of the neighborhoods with only one line.**

Cost

- People who supported at-grade and elevated options cited cost and affordability as reasons for choosing those routes.
- People who supported tunnels noted that the additional cost is worth the added benefits in the long term.

9.3 Public Meeting #3

On December 5, 2013, a third and final open house and interactive web tool were hosted to report back to the community on how the project team used public input in the analysis and the results of the Level 2 evaluation. Comment forms and the interactive web tool provided the public with opportunities to share their input on the analysis of the five Level 2 corridors.

Sound Transit and the City of Seattle utilized a variety of methods to share information about the study and to encourage community members to participate in the third community engagement opportunity. As a result, there was strong participation both in-person and virtually, including:

- Over 100 people attended an open house on December 5, 2013 at Ballard High School
- Over 750 people participated online
- 14 articles appeared in local media and blogs

9.3.1 Purpose

Outreach efforts for this third engagement period were intended to solicit feedback on the Level 2 evaluation of corridors and options for the Ballard to Downtown Seattle Transit Expansion Study. Key topics focused on the following:

- Public feedback regarding the eight Level 1 corridors

- Public input received on the Level 1 analysis
- Screening criteria used to evaluate corridors and options
- Resulting corridors, including cross sections
- Level 2 analysis results
- Next steps

Feedback supported evaluating the five Level 2 corridors. A summary of the results are discussed below. Further detail can be found in *Public Meeting and Engagement Summary: "Open House #3"* (Sound Transit, January 2014).

9.3.2 Participation Results and Comment Themes

The following key themes from public comments have emerged across this participation effort:

Embrace a specific corridor – but be mindful of cost

- Participants were most enthusiastic about Corridor D – Queen Anne Tunnel. Three-quarters of participants selected this corridor as the "best configuration for future rail transit between Ballard and Downtown Seattle." Participants were supportive of a fully grade-separated option, below ground, providing fast service and efficient connections to dense neighborhood centers.
- Other corridors were typically chosen as a compromise due to the high cost of Corridor D.

Provide fast and convenient connections

- Travel time improvement, ridership, and reliability were identified as the three most important factors in evaluating rail options between Ballard and Downtown Seattle. Most participants strongly believed that tunnels, due to grade separation and lack of disruption to other modes, allow for faster and more reliable transit than at-grade or elevated options.

Anticipate future growth now

- The majority of public input indicated that the cost of constructing a new rail line should not be a concern. Rather, the corridor that provides the best opportunity for Seattle's future growth and development should be prioritized.
- A large proportion of comments encouraged Sound Transit and the City of Seattle to consider a new Ballard to Downtown Seattle rail line in the context of other proposed rail projects.

These comment themes were largely similar to those found in previous outreach efforts, including the March and June 2013 public meetings and online engagement tools.

Table 9-1 shows the results for public input on the favorite corridor. Corridor D received the highest number of votes, with 76% of the total.

Table 9-1. Public Input Results: Favorite Corridor

Corridor	Identified as favorite corridor (Number of participants)	Identified as favorite corridor (Percentage of participants)
Corridor A: Interbay West/Ship Canal Tunnel	35	7%
Corridor B: 15th Avenue/Elevated	45	9%
Corridor C: 15th Avenue/At-Grade	12	2%
Corridor D: Queen Anne Tunnel	374	76%
Corridor E: Westlake/Ship Canal Tunnel	26	5%

Note: Some participants selected more than one corridor on the comment forms; all selections are displayed here.

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