



Sound Transit Long-Range Plan Update

Issue Paper S.4: Potential Tacoma Link Extension – West

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Sound Transit

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FINAL

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Foreword

This issue paper is part of a series of reports designed to inform the Sound Transit Board in its decision-making on the Regional Transit Long-Range Plan update for the Sound Transit service area. Each issue paper provides information about a specific element or area of the Long-Range Plan and potential options. These reports focus on issues such as costs, ridership, engineering feasibility and operations.

The environmental impacts of the updated Long-Range Plan and Options, as well as potential mitigation measures, are examined in the Draft Supplemental EIS for the Regional Transit Long-Range Plan (December 2004). The Draft SEIS supplements the 1993 EIS prepared on the Regional Transit System Plan, and it generally updates that information and analysis through the year 2030. Public and agency comments on the 2004 Draft Supplemental EIS have been received and will be responded to in a final SEIS to be issued in June 2005.

The Sound Transit Board anticipates identifying a draft updated Long-Range Plan in the spring of 2005. There will be an opportunity for public review and comment on the draft Plan. The Board will adopt a final updated Long-Range Plan after public comments are received on the draft plan and the final SEIS is issued.

References in these reports to Sound Transit's existing Long-Range Plan are to the 1996 Regional Transit Long-Range Vision, which functions as the agency's Long-Range Plan. Discussion of the updated Long-Range Plan refers to the Plan being developed by Sound Transit over the coming months.

The following issue papers are being prepared:

East Corridor

E.1 – I-90/East King County High-Capacity Transit (HCT) Analysis

North Corridor

N.1 – Bus Rapid Transit (BRT) in SR 99 Corridor

N.2 – I-5 Corridor Northgate to Everett HCT Assessment

N.3 – Seattle Streetcar Options

N.4 – SR 522 Corridor HCT Assessment

N.5 – Convertibility of BRT to Light Rail

South Corridor

S.1 – Tacoma Link Integration with Central Link

S.2 – Potential Rail Extensions to Frederickson and Orting

S.3 – HCT System Development Issues in the South Corridor

S.4 – Potential Tacoma Link Extension - West

S.5 – Rail between Burien and Renton

S.6 – Potential Tacoma Link Extension - East

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1. Study Purpose

The purpose of this analysis is to help answer the question whether the existing Tacoma Link light rail transit (LRT) service should be extended west in the future as part of Sound Transit's updated Long Range Plan (LRP). To help answer this question, several options have been evaluated for conceptual-level alignments. The Tacoma Community College Transit Center is identified as the potential west terminal station of all of the Options. All of the Options were assumed to operate at-grade in mixed traffic, i.e., other vehicles (autos, bicycles, etc.) could travel in the same lane as the LRT and could cross the line as well. The extension west has been assumed to function as a standalone extension of the existing Tacoma Link light rail, i.e., this report does not assume or require that the extension west would be integrated with any future potential future extension of LRT to Tacoma from Federal Way or Seattle.

To determine potential costs, it was necessary to develop several options for conceptual alignments and analyze the interplay between ridership demand, operation characteristics to meet this demand, and station sizing. Should the rail extension west be included in the updated Regional Transit Long-Range Plan, additional planning and engineering will be required to determine a final alignment.

2. Key Findings

The alignment options serve a diverse mix of land uses in the study area and would complement and support the neighboring communities. If this extension were added to Sound Transit's LRP, further study would be done on routing, station locations, etc.

Conceptual level cost estimates indicate a range of between \$400 million and \$600 million dollars, depending on the alignment option. Options 1 and 2 are estimated to have similar costs since their alignments are generally similar in length. Costs for Option 3 are the highest due to a longer alignment versus Options 1 and 2.

Ridership projections are for approximately 15,500 daily trips between downtown Tacoma and Tacoma Community College. Several factors are expected to contribute to this demand estimate. These factors include: service headways of ten minutes in peak periods, connections with local service at Tacoma Community College, transfer opportunities with future Tacoma/Federal Way/Seattle LRT service at the Tacoma Dome Station, and park-and-ride access to the rail line at the Tacoma Dome Station.

3. Major Study Elements

The major study elements include:

- Alignment Options
- Vehicle technology
- Ridership
- System operations
- Costs

These study elements provide preliminary information on this possible Tacoma Link Extension under Sound Transit's overall long-range planning process.

3.1 Alignment Options

Three potential alignment concepts for the extension to West Tacoma were selected for evaluation and preliminary consideration. The conceptual options are shown on Figure 1 and examples of possible street cross-sections at various locations are contained in the Appendix. Land uses vary along the Options, providing a mix of commercial and residential uses, which can support and generate peak and non-peak ridership for the alignment.

3.1.1 Option 1 – 6th Avenue Corridor

As shown on Figure 1, Option 1 follows a 5.7-mile alignment extending from the existing Tacoma Link Station at 9th Street, north along Stadium Way, turning onto “E” Street and again at N. 1st Street, continuing along Division Avenue and 6th Avenue, turning onto S. Pearl Street and again at S. 19th Street until reaching the Tacoma Community College Transit Center. The alignment would consist entirely of an at-grade profile.

A variation to Option 1 would be to adjust the alignment near Tacoma Community College and align it along S. Mildred Street to reach 6th Avenue, consistent with the existing route followed by Pierce Transit’s Route 1. This option would add approximately 700 feet to the overall system length and one more horizontal curve.

3.1.2 Option 2 – South 19th Street Corridor

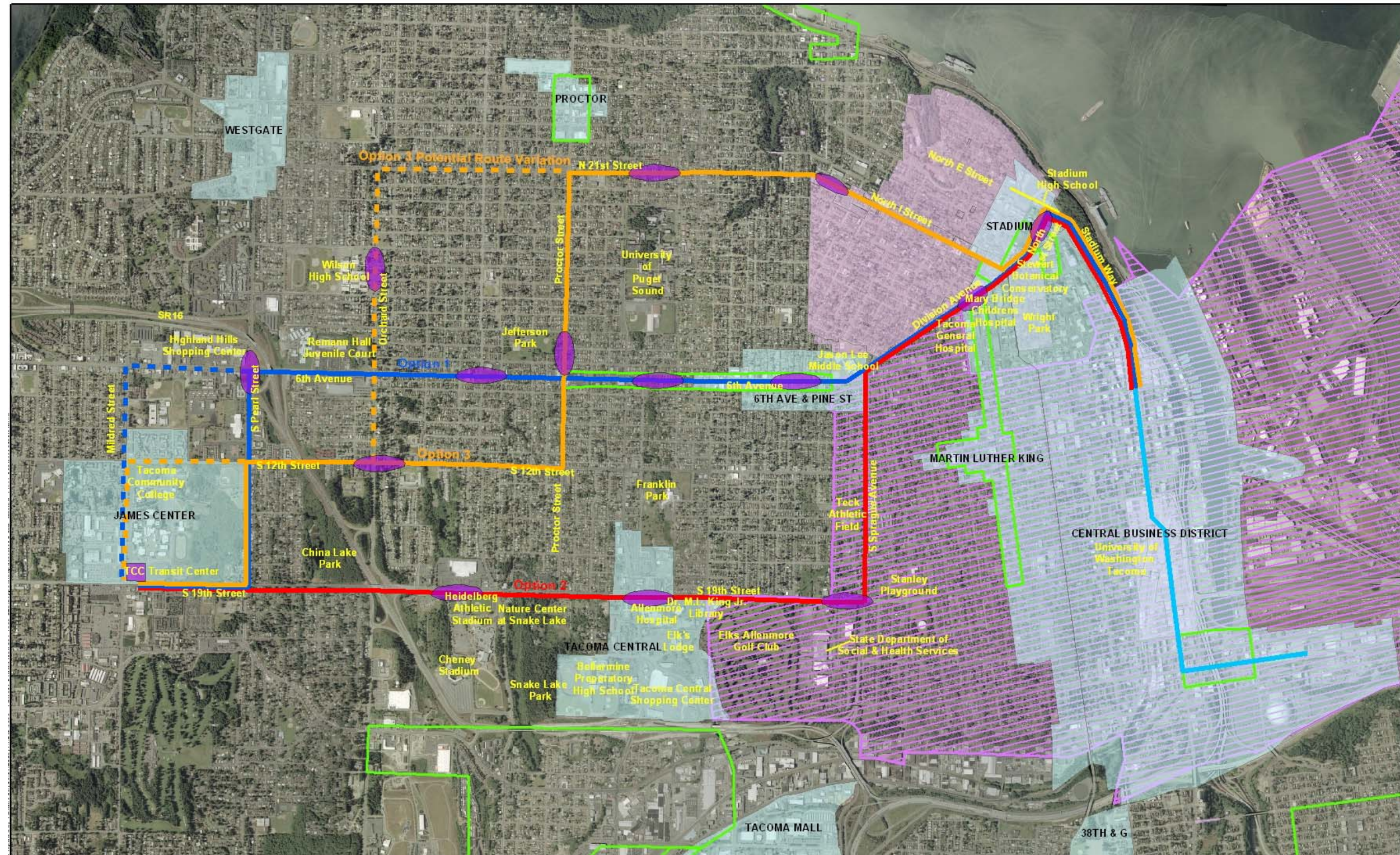
As shown on Figure 1, Option 2 follows a 5.7-mile alignment extending from the existing Tacoma Link north terminus at 9th Street, north along Stadium Way, turning onto “E” Street and again at N. 1st Street, continuing along Division Avenue, turning onto Sprague Avenue and again at S. 19th Street until reaching the Tacoma Community College Transit Center. The alignment would consist entirely of an at-grade profile.

3.1.3 Option 3 – North 21st Street and South 12th Street Corridors

As shown on Figure 1, Option 3 follows a 6.5-mile alignment extending from the existing Tacoma Link north terminus at 9th Street, north along Stadium Way, turning onto “E” Street and again at N. 1st Street, continuing along Division Avenue, turning onto N. “I” Street and continuing onto N. 21st Street, turning onto Proctor Street, S. 12th Street, S. Pearl Street, and S. 19th Street until reaching the Tacoma Community College Transit Center. The alignment would consist entirely of an at-grade profile.

A variation for Option 3 would be to adjust the alignment on N. 21st Street to turn at Orchard Street instead of Proctor Street. The variation would provide an opportunity to serve Wilson High School as well as enhance the neighborhood west of Proctor Street if overhead power lines currently running down a median were removed from view as part of the rail transit project. This option would add approximately 100 feet to the overall system length.

Another potential variation would continue the alignment on S. 12th Street to turn at S. Mildred Street instead of S. Pearl Street, which would be similar to the routing of Pierce Transit’s Route 1. This variation would add approximately 500 feet to the overall system length and one more horizontal curve.



Parametrix

1 inch equals 2,000 feet
0 1,000 2,000 Feet



- | | | |
|-----------------------------|------------------------------------|---|
| Light Rail Options - Tacoma | Light Rail Option 3 | Potential Light Rail Station Area |
| Existing Light Rail | Option 1 Potential Route Variation | Neighborhood Shopping Areas |
| Light Rail Option 1 | Option 3 Potential Route Variation | Mixed-Use Centers |
| Light Rail Option 2 | | Historical Areas |
| | | HUD Renewal Community/State Community Empowerment Zones |

Figure 1
Tacoma Extension
Light Rail Options
PRELIMINARY DRAFT

3.1.4 Shared Segment Option –Stadium Way vs. St. Helens Avenue

The alignment segment from the end of the existing Tacoma Link line to the Stadium High School area north of downtown is shared by all Options. As described above, the alignment for all the Options assumes that the line would be extended north along Stadium Way until reaching “E” Street where it would turn west to head toward Division Avenue.

An option to this shared alignment would be to instead extend the line up St. Helens Avenue to reach Division Avenue. St. Helens Avenue is one block west of Commerce Street and uphill from it. For the line to travel along St. Helens Avenue it would have to deviate from Commerce Street at some point near the northern terminus of the existing line. It may be possible to make the transition to St. Helens Avenue somewhere along the block just south of the Theater District/S. 9th Street station, between S. 9th Street and S. 11th Street. This routing would require a 90 degree turn at either S. 9th or S. 11th Street, and climbing a short one-block grade of approximately thirteen percent along the street.

Alternatively, the line could angle across the block bounded by S. 9th Street, S. 11th Street, Commerce Street and Broadway Plaza, where a transit plaza, theater and other commercial uses exist, in order to reach the intersection of S. 9th Street, St. Helens Avenue and Broadway Plaza. This latter approach could result in a line grade of approximately eight percent along the transition segment.

All of the St. Helens Avenue options described here would require the existing Theater District/S. 9th Street station to be relocated. A likely candidate location for this relocated station would be on St. Helens just north of S. 9th Street. This location would be only one block to the west of the existing station and would serve the same market.

Extending Tacoma Link along St. Helens Avenue may have some advantages over the Stadium Way alignment:

- The east side of Stadium Way is a steep bluff. This could present some engineering challenges, particularly if the roadway needed to be widened.
- Traffic along Stadium can be heavy during peak periods, since it serves as the Stadium District's access point to SR 705.
- Following Stadium Way results in the alignment utilizing N. “E” Street and N. 1st Street to reach Division, which makes the line slightly longer than the St. Helens, and still results in a short, steep segment for the line along N. 1st Street (though not as steep as between Commerce and Broadway).
- Following St. Helens creates the potential for an additional station in the north downtown area, an area that is targeted for future commercial and high-density residential development.

As with all the Options, further project-level analysis would have to be performed in the future to assess the desirability and feasibility of a St. Helens routing.

3.2 Vehicle Technology

Two possible light rail vehicle (LRV) types are considered for rolling stock: 1) a low-floor LRV similar to that currently operating on the Tacoma Link system, and, 2) the Central Link system vehicles. Other vehicle types are available but these two vehicle types would provide some consistency and compatibility with existing Tacoma Link or planned Central Link maintenance facilities. Table 1 summarizes key differences between vehicles selected for Central Link and Tacoma Link.

Table 1: Vehicle Technology Comparison

Characteristics	Central Link LRV	Tacoma Link LRV
Minimum horizontal curve radius	100 feet	82 feet
Maximum speed (mph)	55 mph	45 mph
Crush load (passengers per car)	200	171
Nominal passenger capacity per car	144	56
Seated passenger capacity per car	72	30
Standee passenger capacity per car	72	26
Maximum number of cars in train	4	1*
Car length	90 feet	60 feet

* The manufacturer's brochure indicates that there is a possibility to use multiple control of coupled vehicles; however, the existing vehicles in use for Tacoma Link do not have the capability to operate under train control.

In comparison to the technology in use at Tacoma Link, the Central Link cars have more passenger capacity and a higher top speed but take up more length at stations and have a larger minimum horizontal curve radius. The maximum negotiable grade would not significantly differ between vehicle choices because drive motors can be specified for different design conditions and for that reason is not shown in the above table. There are advantages and disadvantages to each vehicle, and ultimately the line capacity requirements and route headways will significantly affect the selection of a vehicle. These are issues that would require additional analysis in future planning if the LRP is amended and if this concept is considered as part of a future phase of Sound Transit projects. In addition, even if a Central Link type vehicle were used with the extension, this paper does not assume or require that the extension would interlink with Central Link.

3.3 Ridership Estimates

This section identifies ridership for the West Tacoma extension. Ridership estimates for the potential extension were prepared for Year 2030 using Sound Transit's ridership forecasting model for an option with routing similar to Option 1. Ridership for the potential Tacoma Link extension to West Tacoma was estimated to be 15,500 daily trips with peak hourly one-direction ridership of 980. The peak in-vehicle volume occurred approximately two miles north of the Tacoma Dome Station, in downtown Tacoma north of S. 9th Street along Stadium Way. The in-vehicle volume west of downtown Tacoma progressively declined.

3.4 System Operations

The system operations plan assumed a standalone extension of Tacoma Link to West Tacoma and would be similar across alignment Options. This plan does not evaluate the possibility of connecting to the Central Link system north of the Tacoma Dome. The ridership estimates identified in the previous section have been assumed to be consistent among the Options for this initial consideration. Station spacing and location differ between Options, although headways and vehicles considered for use with the system remain the same. Costs also differ between Options and are discussed later in this issue paper under Section 3.5.

3.4.1 Station Spacing and Locations

The potential light rail station area locations are shown on Figure 1. Potential light rail station areas were identified by considering nearby land uses that would be served by an extension of the existing system. The Tacoma Community College Transit Center is identified as the potential west terminal station of all of the Options. With seven stations, Option 1 has one more station than Options 2 or 3.

Potential station areas are spaced on Option 1 at an average of 4,300 feet or 0.8 miles; on Option 2 at an average of 5,000 feet or 0.9 miles; and on Option 3 at an average of 5,600 feet or 1.1 miles. There is a difference in spacing because of the land uses near the alignment Options. In comparison, the existing Tacoma Link stations are spaced at an average of 2,000 feet or 0.4 miles; however, this existing system is located in downtown Tacoma where closer spacing is appropriate.

Existing Tacoma Link station platforms have been constructed to accommodate one-car trains, however, designs have allowed for future expansion to two-car trains. This station platform expansion would be sufficient to accommodate the capacity levels required to meet demand for the West Tacoma extension.

3.4.2 Headways and Vehicles

Headways are the same among alignment Options, but differ depending on the vehicle being used for the system. A ten-minute headway was used to initially estimate the year 2030 ridership and vehicle needs.

Based on the lengths for the alignment option, the trip time between the Tacoma Dome Station and Tacoma Community College station would be approximately 30 minutes in each direction. This time estimated is based on, 1) an assumed 20 mph average travel speed (including acceleration and deceleration at stations), 2) allowances for vehicle dwell time at each rail station, and 3) schedule recovery and layover time. Because the service is assumed to operate in mixed traffic, the actual travel time could vary depending on traffic conditions and other factors.

Given the one-way trip time of approximately 30 minutes, the passenger capacity (seating and standing) of light-rail vehicles, and estimated one-way passenger demand in the peak hour, headways have been calculated. The calculations used the current Tacoma Link vehicles (manufactured by Skoda), the light rail vehicles (LRVs) planned for service on the Central Link, and an unspecified vehicle that would be capable of serving the peak passenger load operating with a ten-minute headway.

Under existing specifications, the LRV currently in use on Tacoma Link cannot be coupled with another car; however, the manufacturer does provide variations that would permit coupling. Using a single-unit LRV, three-minute headways would be required to serve the peak ridership demand through the system. This headway may be too short given the station spacing and potential system delays that could cause trains to follow too close to one another. If two vehicles of this type were coupled together and train-controlled, six-minute headways could be used instead of three-minute headways. In either case, 20 cars would need to be in the system to serve the peak hour system ridership.

An LRV with a nominal passenger capacity of 164 passengers per car would be able to provide enough capacity to operate at ten-minute headways during the design peak hour. Only six cars would need to be in the system during the peak hour.

Central Link vehicles in one-car trains would need to operate on 7.5-minute headways to provide a design capacity that meets peak ridership. During the peak hour, eight cars would need to be in the system to provide 7.5-minute headways and satisfy the ridership demand. However, a variation of this scenario would have these LRVs operating one two-car train in addition to five one-car trains during the peak hour. This approach would allow ten-minute headways while still providing adequate passenger capacity to meet estimated peak demand. Under this variation, station platforms along the rail extension would need to accommodate two-car trains.

Table 2 summarizes the number of vehicles needed to serve peak ridership levels for the different vehicle types and operating headway.

Table 2: System Capacity and Vehicle Requirements

System Capacity	Tacoma Link LRV (Single Car)	Tacoma Link LRV (Coupled)	Central Link LRV	LRV Serving Ten-Minute Passenger Load
Planned Peak Headway (min)	3	6	7.5	10
Trains per Hour during Peak	20	10	8	6
Passenger Capacity per car (riders)	56	56	144	164
Cars per Train	1	2	1	1
Peak Capacity per Hour (each direction)	1120	1120	1152	984
In-System Fleet Requirements (cars)	20	20	8	6

As shown in Table 2, operating at ten-minute headways requires the use of an LRV with a greater passenger capacity than that being used for Central Link. An operating scenario using the current Tacoma Link LRVs' results in headways that are too short for an at-grade system; the scenario also has a strong potential for system delays.

If a suitable LRV cannot be found to provide ten-minute headways, there is the option of using Tacoma Link LRVs in a coupled train (which is possible according to the manufacturer) or a Central Link single-car light rail vehicle operating at shorter headways. The coupled train potential would require two-car-length stations along the extension. Cost estimates presented in Section 3.5 include these two-car-length stations.

3.5 Estimated Costs for Alignment Options

As identified above under System Operations, there are several possibilities for rail service for the West Tacoma extension. The costing estimate described in this section assumes that the extension will use LRVs similar to what are being acquired for Central Link. Using these higher capacity vehicles (vs. a Tacoma Link low-floor LRV) will result in a significantly lower number of vehicles required for the extension. Also, the Central Link LRVs will likely be more compatible with potential future light rail transit service along the existing Tacoma Link alignment. The estimated cost range is identified in Table 3. A range of potential costs for each option is presented in the table.

Table 3
Range of Conceptual Cost Estimates for West Tacoma Rail Extension Options
(millions of dollars; 2005)

Option	Low	High
Option 1	\$400	\$500
Option 2	\$400	\$500
Option 3	\$400	\$600

The cost estimates are at a *conceptual design level* only and did not involve any engineering or environmental analysis beyond that discussed in the DSEIS which was published in December 2004. The estimates used available information, including cost estimates carried out for the Trans-Lake Washington Study. The following further describes background information for several cost items:

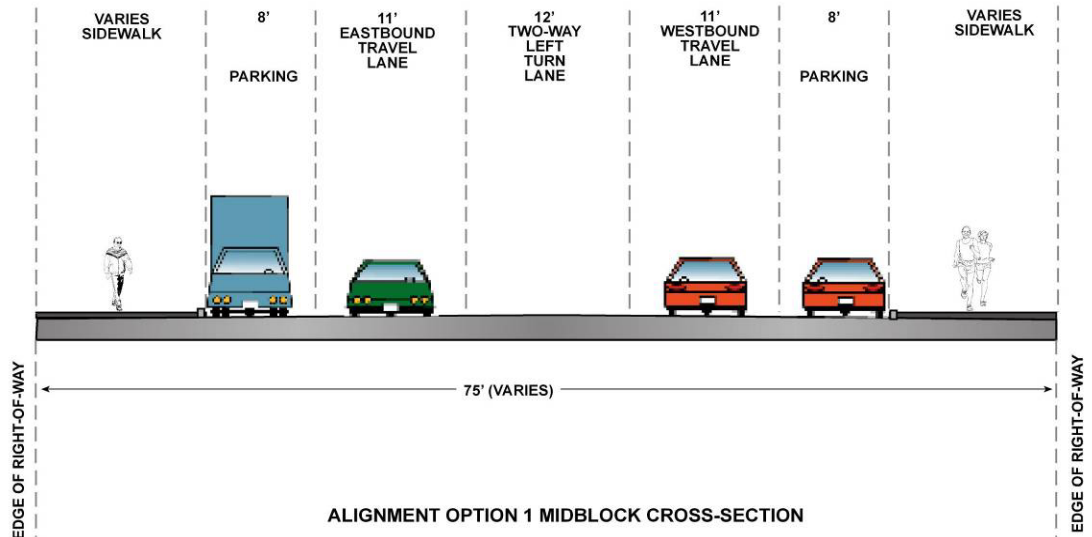
- *Direct Fixation Track Installation:* This type of track installation is assumed for the entire lengths of each option.
- *At-Grade Crossings:* Crossings are anticipated at each signalized intersection along each alignment option.
- *Roadway Modifications:* Includes potential improvements along cross-sections.
- *Stations:* two-car length stations to accommodate multi-unit LRV trains.
- *Kiss-and-Ride Facility:* One facility is assumed at the Tacoma Community College station.
- *System Communications:* This was applied based on unit cost per route foot.
- *Maintenance Base Requirements:* The estimate of requirements is based on the estimated number of additional LRVs, including spares for each alignment option.
- *Vehicles:* The number of vehicles is based on the operational analysis identified in this paper plus spares. For each option, ten LRVs are identified including spares.
- *Design and Construction Contingencies:* Design and construction contingencies have been applied to each construction-related item.
- *Environmental Mitigation:* An overall factor has been applied to total estimated construction costs.
- *Agency Costs:* This factor was applied to all construction costs, including environmental mitigation costs, as well as for vehicle acquisitions.

Appendix

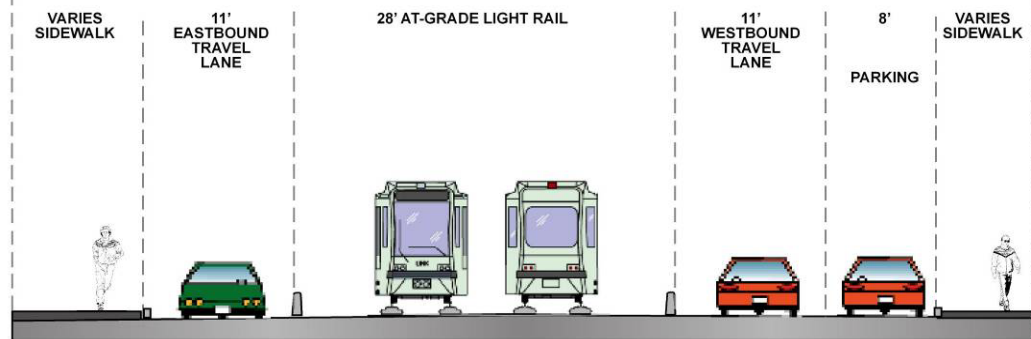
Existing and Conceptual Profiles for Potential Tacoma Link Extension – West

WEST TACOMA EXTENSION - 6TH AVENUE WEST OF ANDERSON STREET

EXISTING CROSS-SECTION

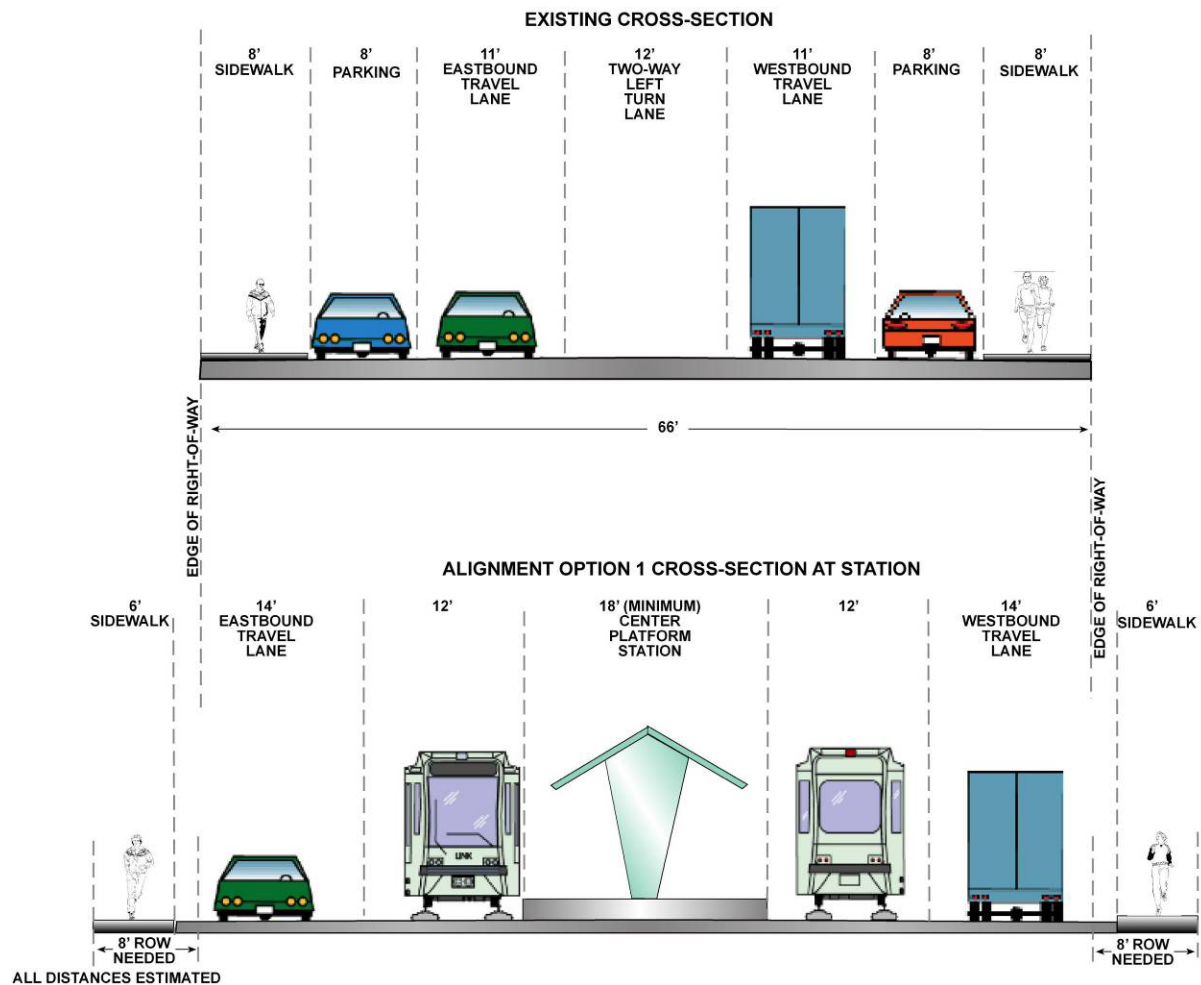


ALIGNMENT OPTION 1 MIDBLOCK CROSS-SECTION

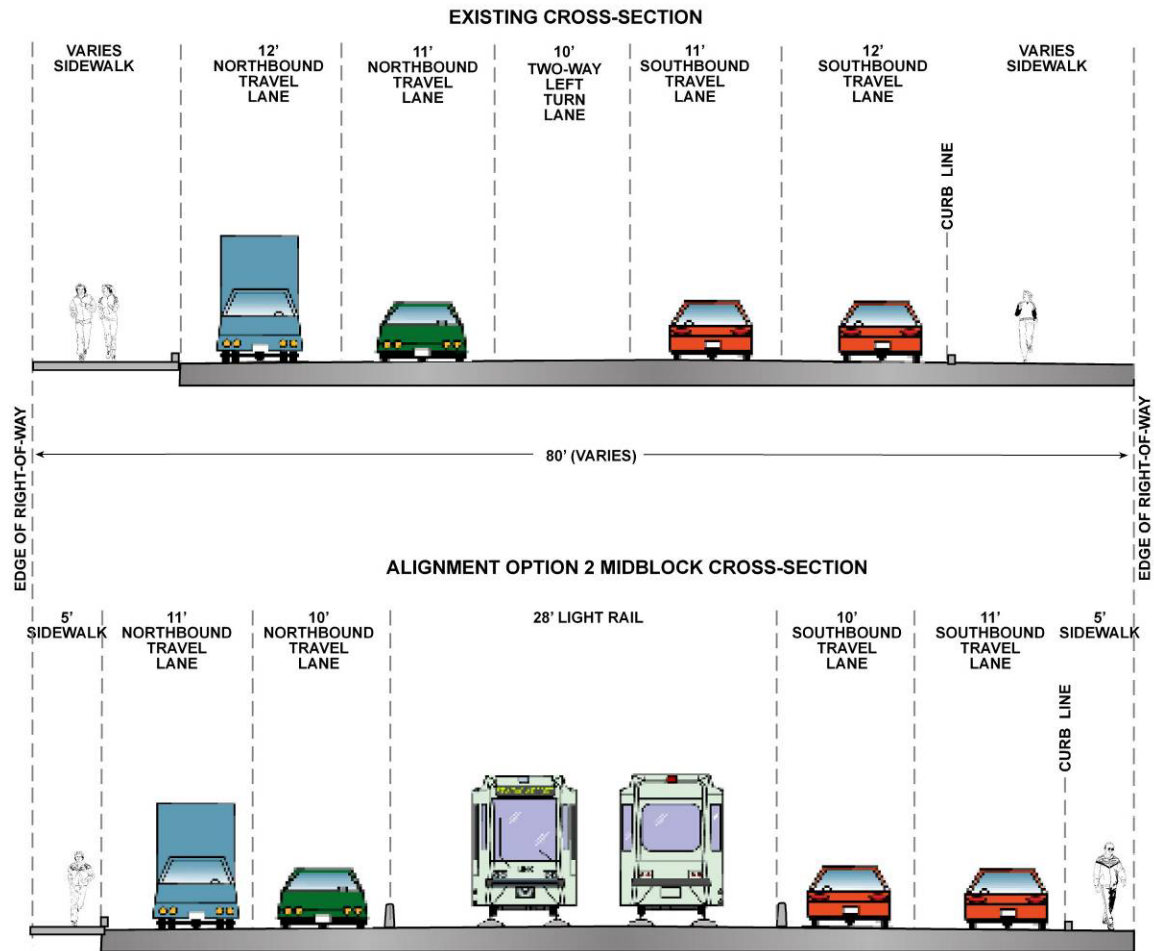


ALL DISTANCES ESTIMATED

WEST TACOMA EXTENSION- 6TH AVENUE BETWEEN WARNER STREET AND LAWRENCE STREET



WEST TACOMA EXTENSION- SPRAGUE AVENUE CROSS-SECTION NORTH OF SOUTH 19TH STREET



ALL DISTANCES ESTIMATED

WEST TACOMA EXTENSION- NORTHEAST LEG OF DIVISION AVENUE / K STREET INTERSECTION

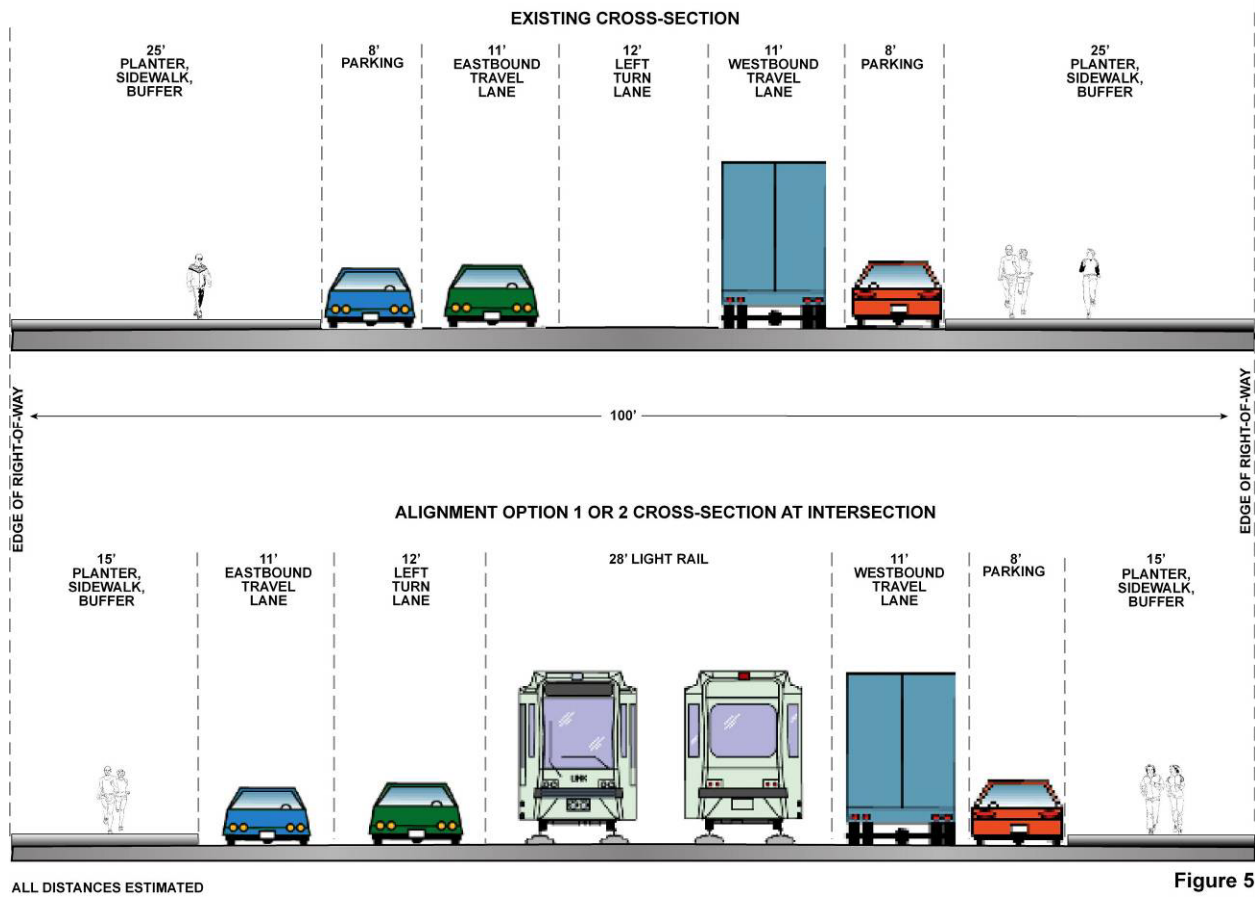
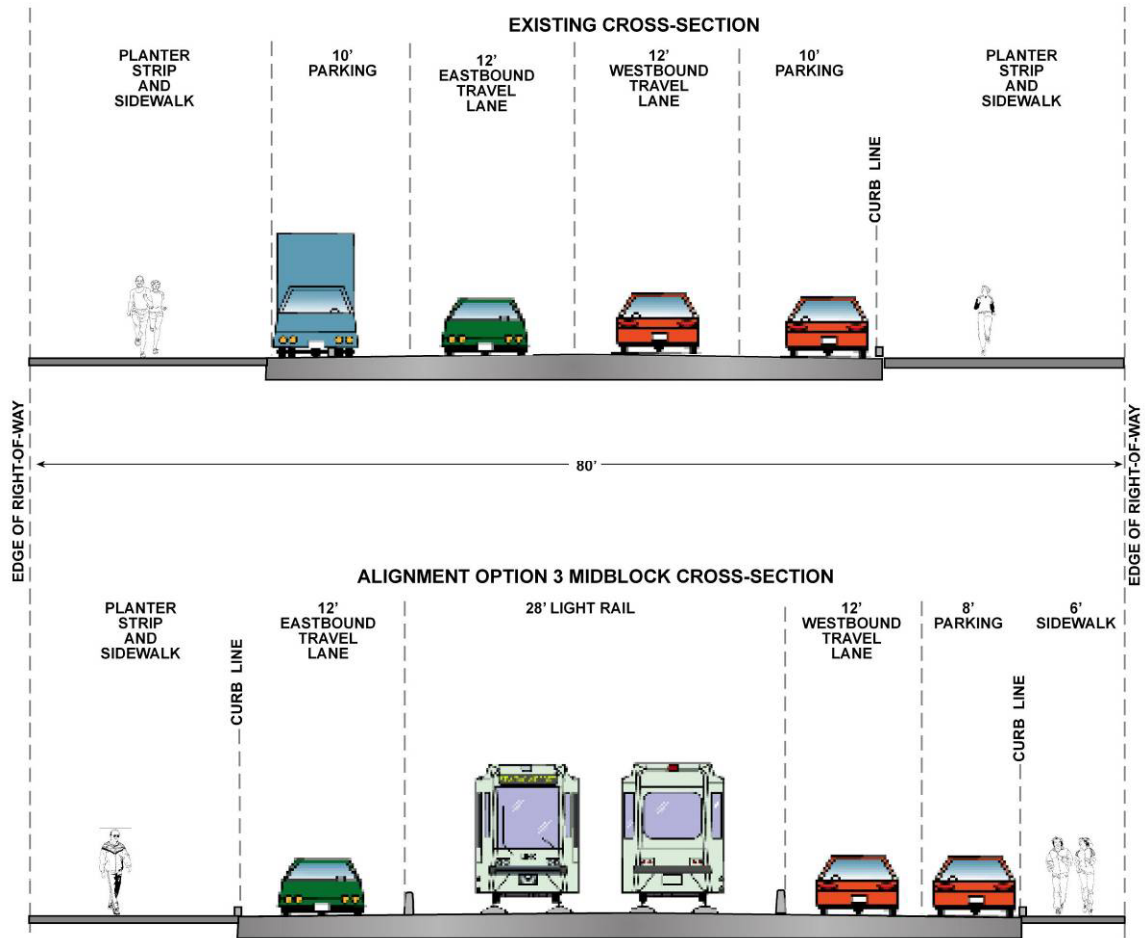


Figure 5

WEST TACOMA EXTENSION- I STREET - EAST OF NORTH 8TH STREET



ALL DISTANCES ESTIMATED