SOUND TRANSIT

HCT Planning

Sound Transit Long-Range Plan Update

Issue Paper S.1: Tacoma Link Integration with Central Link

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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. Introduction and Purpose

Sound Transit's existing Regional Transit Long-Range Plan calls for light rail transit (LRT) service to operate between downtown Tacoma and downtown Seattle. Sound Transit (ST) could reach this goal through gradual extension of LRT from the terminus at S. 200th in SeaTac that is included in Phase 1 of ST's Long-Range Plan. ST could also connect downtown Tacoma and Seattle with LRT by extending northward from downtown Tacoma and eventually connecting with southbound rail extensions originating in the SeaTac area.

The purpose of this issue paper is to evaluate the options and issues associated with how Tacoma Link might ultimately be integrated with Central Link. This paper provides the following information:

- Background information from existing plans and studies for potential LRT operating between downtown Tacoma and the Central Link line operating between downtown Seattle and SeaTac.
- Potential operating scenarios for an extension of the system currently serving downtown Tacoma (Tacoma Link) that would eventually meet an LRT extension south from SeaTac. This concept for an extension north from downtown Tacoma would take advantage of existing infrastructure for Tacoma Link.
- Options for potential multi-car LRT serving downtown Tacoma (based on the potential operating scenarios).

Information provided in this issue paper will present options as to how LRT service can be implemented and phased. This phasing could transition from the current single-car operations using a low-floor light rail vehicle (LRV) operated under Sound Move to multi-car LRT operations using Central Link type vehicles that could be provided under Sound Transit 2 (ST2) or subsequent phases of the Long-Range Plan's implementation.

This issue paper presents three major information items relating to future extensions of LRT service from downtown Tacoma:

- Characteristics of potential LRT service affecting downtown Tacoma, including design considerations for the existing Tacoma Link system, that are intended to address future LRT service.
- Potential options that can be considered for future LRT extensions, including phasing. These include extensions to/from Federal Way as well as to West Tacoma and East Tacoma. (See separate issues papers for the West Tacoma and East Tacoma rail extensions.)
- Implications of any potential extensions on Link operating conditions and facility needs.

2. Key Findings

The following are key findings from the review of potential issues relating to future integration of Tacoma Link with Central Link service:

- Depending on lengths of LRT trains accessing downtown Tacoma from the north (e.g., Seattle), minor to major changes to Tacoma Link alignment would be necessary to facilitate any multi-car operations beyond the Tacoma Dome Station to central downtown Tacoma.
- Ridership models show lower ridership between Tacoma and Federal Way versus Federal Way and Seattle.
- Four-car operations on the Tacoma Link alignment would require major revisions potentially up to complete replacement of current stations and some track segments.
- Consideration should be given as to the best transfer point for Tacoma Link and Central Link, at either the Tacoma Dome Station or in the Federal Way area.
- Additional capacity for light rail maintenance and operations would be required to accommodate additional and larger rail vehicles.

3. Direction from Current Long-Range Plan and Follow-up Analyses

Future extension of LRT service from downtown Tacoma connecting to Central Link will be governed by the Regional Transit Long Range Plan, related environmental assessments, long-range rail operations plans, and design of facilities. This section describes major elements from plans and studies that affect existing and future LRT development in downtown Tacoma as well as future connections to Central Link.

3.1 Central Link – Direction from Environmental Assessments

The Final Environmental Impact Statement (FEIS) for Central Link identified several important items that help define how future integration with Tacoma Link will occur. One item is the operation of four-car trains that will serve the corridor between downtown Seattle to SeaTac[1].

3.2 Service Plans and Ridership Estimates

An operations plan that was prepared in 1998 prior to the Central Link FEIS publication evaluated an LRT line between downtown Seattle and downtown Tacoma operating four-car trains every 7.5 minutes[2]. Since this line would involve continuous one-seat/no transfer service between Tacoma and Central Link, four -car trains would be necessary.

[1] *Central Link Light Rail Transit Project – Final Environmental Impact Statement; Section 2.1.3.9 – Capital Equipment and Operations* (Sound Transit/Federal Transit Administration; November 1999)
[2] *Draft Long Range Plan Operations Analysis* (Puget Sound Transit Consultants; May 1998)

The Draft Supplemental Environmental Impact Statement (DSEIS) for the Regional Transit Long-Range Plan (December 2004) also evaluated a rail service plan involving four-car trains operating between downtown Tacoma and downtown Seattle.

As part of the DSEIS for the Regional Transit Long-Range Plan, ridership estimates were developed for potential rail lines in ST's service area. Figure 1 shows the daily ridership levels for these lines. As indicated by the figure, daily ridership between Federal Way and downtown Tacoma by year 2030 is estimated at 20,400 trips which would require at least two-car trains (Source: ST Ridership Forecasting model). The ridership levels north of Federal Way to downtown Seattle and beyond would require four-car trains.

With the above ridership demand and the anticipated need for four-car rail operations north of Federal Way, operating two-car trains between downtown Tacoma and Federal Way would require transfers at Federal Way to four-car trains. An interim alternative is two-car service that connects Tacoma and Seattle until such time that demand requires conversion to four-car trains north of Federal Way.

The evaluation of potential train capacity for downtown Tacoma rail service also needs to recognize potential 2030 demand within downtown Tacoma at the existing Tacoma Link Stations. This capacity is particularly important if rail service to West Tacoma is included as part of the updated Regional Transit Long-Range Plan. The Sound Transit ridership model identified almost 13,000 daily riders by 2030 at the north end of the existing Tacoma Link line. This ridership is for a downtown Seattle/downtown Tacoma LRT that stops at the Tacoma Dome Station. It also included a potential extension of rail from the existing Theater District/S. 9th Station to Tacoma Community College. With this ridership level, LRT rail service using Central Link LRV vehicles would be more appropriate than using the existing Tacoma Link low-floor LRVs.

Given the potential for either two-car or four-car LRT service operating between downtown Tacoma and Federal Way by 2030 or before, this issue paper identifies options for future rail in downtown Tacoma as well as between downtown Tacoma and Federal Way. Section 4 further describes the option as well as advantages and disadvantages for each one.

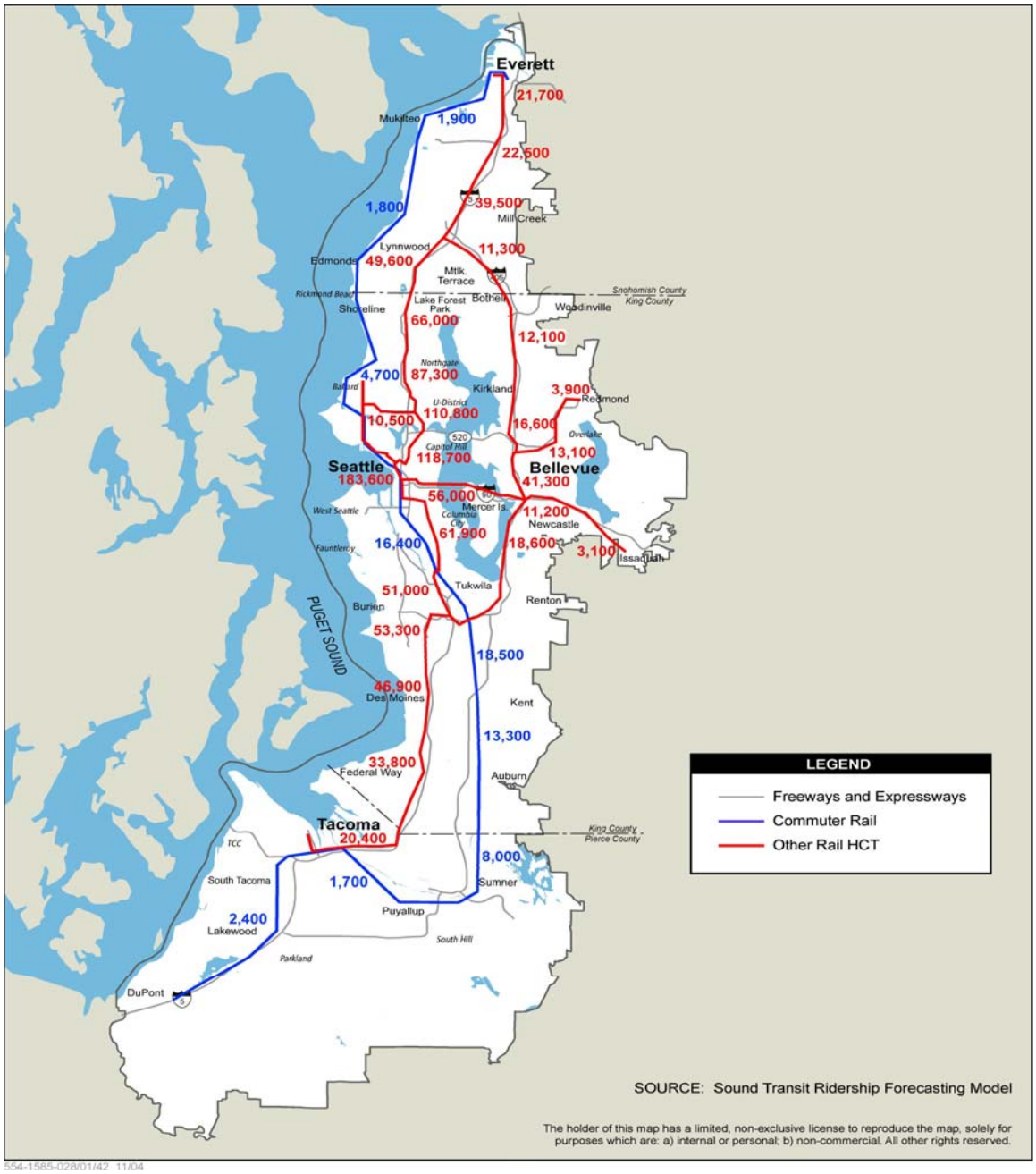

Figure 1: 2030 Daily Rail Passenger Volumes

Source: Sound Transit Regional Transit Long Range Plan Draft SEIS (December 2004)

3.3 Operations and Maintenance Plan for Tacoma Link

Current Tacoma Link service involves a 1.6 mile L-shaped route between the Tacoma Dome Station on 25th Street and the Theater District/S. 9th Stations at S. 9th Street and Commerce Street. Figure 2 shows the existing alignment. Service is provided by single-car operations at five stations using the same type of vehicles as the existing downtown Portland streetcar. The vehicles are 60 feet long and can attain a maximum speed of 42 miles per hour. Consistent with the operations plan, Tacoma Link generally operates every ten minutes. On Sundays and holidays, ten-minute service is provided except during morning and evening periods when 20-minute service is available.

Prior to the August 2003 opening of Tacoma Link, ST prepared an *Operations and Maintenance Plan* for Tacoma Link[3]. The Plan provided important information on key design features of the stations and alignment, including accommodation of future extensions and potential integration with Central Link service.

The following summarize key items from the Tacoma Link Operations and Maintenance Plan.

3.3.1 Vehicle Operations

Tacoma Link currently operates a different light rail vehicle (LRV) than those being used by Central Link. Also, the LRVs for Central Link and related extensions will have multi-car trains, while the specifications for existing Tacoma Link vehicles prevent them from being coupled together. If specified accordingly, the Tacoma Link low-floor LRVs (the current vehicles in service are manufactured by Skoda) could be coupled; however, there are few examples of these types of units operating in multi-car trains.

3.3.2 Station Platforms

Tacoma Link stations were designed and built to allow future multi-car LRT operations using LRVs similar to those that will operate on Central Link. The following further identifies key features that provide accommodation of future LRT service.

- Most existing station platforms in downtown Tacoma are 90 feet in length and can accommodate one 90-foot LRV similar to those that will operate on Central Link. The one exception is at Union Station which is longer than 90 feet.
- Most station/track way designs can accommodate future extensions of platforms to 180 feet or enough for two -car trains. The one exception is the Tacoma Dome Station.
- Where any future extension of the platform will require changes to the driveway and building garage entrance to the adjacent building on E. 25th Street. Further, to accommodate both two-car Tacoma Link trains and four-car trains from Seattle would likely require major revisions at the station.
- Platform heights are currently 8 inches to allow low-level boarding by passengers; in the future, platforms could be raised to 14 inches to accommodate LRVs similar to those that will operate on Central Link.

[3] *Tacoma Link Light Rail – Operations and Maintenance Plan* (Sound Transit; August 2003)

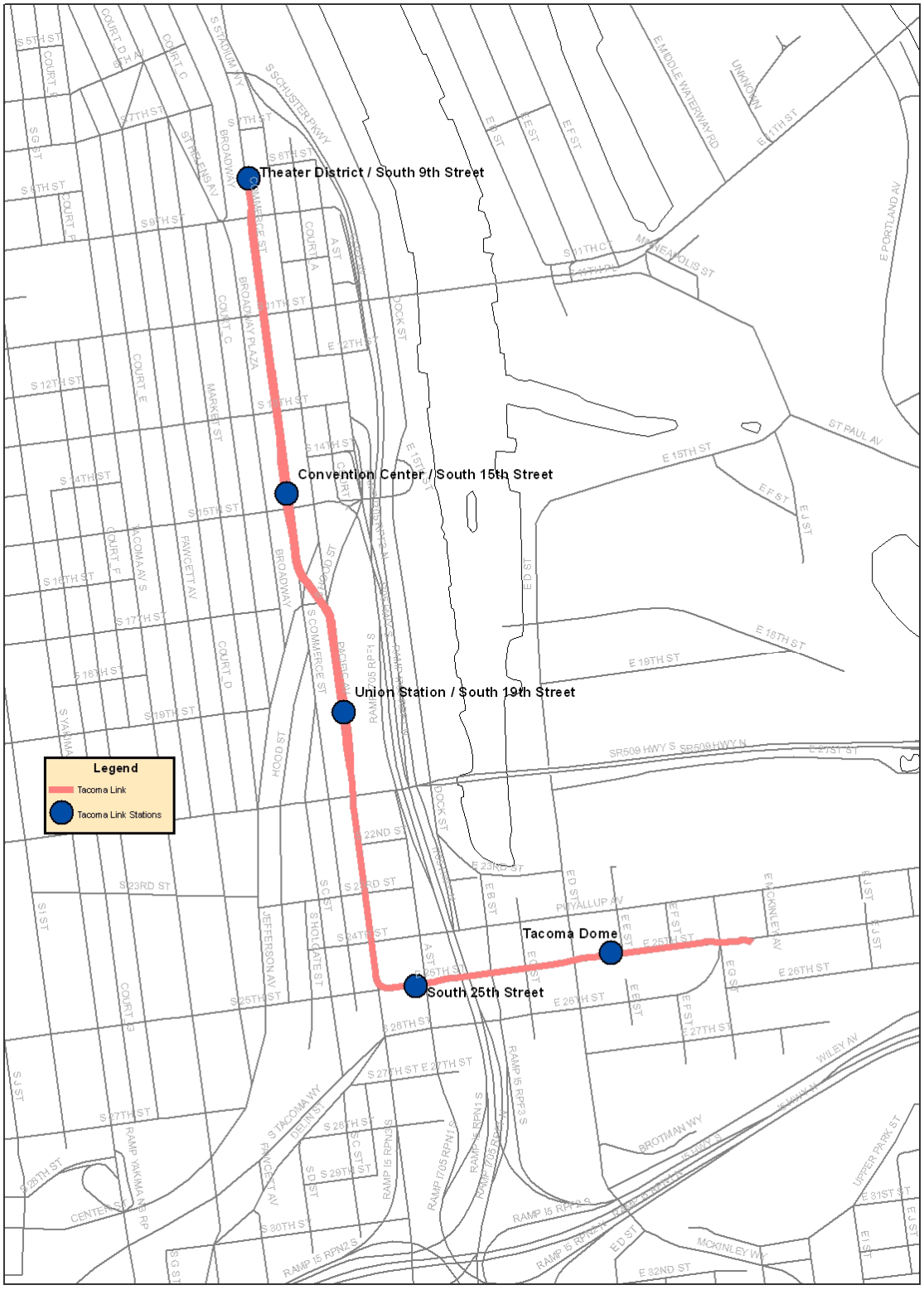

Figure 2: Tacoma Link Service Assignment

3.3.3 Fare Payment

- Currently, Tacoma Link is fare-free.
- Provisions have been made to station designs to accommodate ticket vending machines. (*Note: Although not addressed in the Operations and Maintenance Plan, when Link is extended, service within downtown Tacoma could remain fare-free.*)

3.3.4 Power

- Tacoma Link operates on 750 volts; Central Link will operate on 1,500 volts; however, future conversion to 1,500 volts could be provided without a new electrical system being necessary.
- The Operations and Maintenance Plan notes that the height from the top of the rail to existing overhead wire needs to be 20 feet (for 1,500 volt power). In areas with less than 20-feet clearance a code variance by the City of Tacoma would be required.

3.3.5 Track Radius

- The track radii for existing Tacoma Link service using low-floor LRVs vary by location. At the intersection of S. 25th Street and Pacific Avenue, the turn radius is 90 feet. This is the tightest radius on the Tacoma Link line and the only one of concern. .
- Design criteria for Central Link LRVs calls for a minimum turning radius of 100 feet for in-street operations[4]. These criteria are applied to vehicles that will operate on Central Link and any extensions. As is the case with other types of rail configurations such as aerial structures and subway sections, reduction of the radius would require ST approval. If this approval were provided, there may be lower speeds for rail.
- Given the difference between the existing turning radius at S. 25th Street and Pacific Avenue and the Link design criteria, further analysis would be needed for any necessary modifications to accommodate future LRT operations vs. the current service that uses low-floor LRVs.

3.3.6 Maintenance and Operations Facility

The existing maintenance facility for Tacoma Link is located on E. 25th Street east of the Tacoma Dome Station. The Operations and Maintenance Plan for Tacoma Link indicated that the existing building can accommodate up to four rail vehicles[5]. Given the existing fleet of three vehicles (two in service and one spare), the building can accommodate one additional vehicle. Also, there is storage outside the building for one more vehicle. Therefore, the existing facility could accommodate up to two additional vehicles.

The extension of rail service north to Federal Way and eventually to downtown Seattle would require additional vehicles beyond what can be accommodated at the existing Tacoma Link facility. The operations and maintenance facility for Central Link is expected to have sufficient capacity to accommodate LRT operations for Northgate to SeaTac (S. 200th Street Station). Therefore, any additional maintenance and operations needs for an extension of LRT from downtown Tacoma would require capacity beyond what is available at the existing Tacoma Link facility or the new facility for Central Link.

[4] Design Criteria for Link Light – Track and Alignment Clearances (Sound Transit; December 4, 2001, Revision #1)
[5] Sound Transit Tacoma Link Vehicle – Operations and Maintenance Plan, Section 6.2: Maintenance Facility and Equipment (Sound Transit; August 2003)

4. Potential Operating Scenarios for LRT Extensions from Downtown Tacoma

Previous operating plans for regional Link service as well as design features for the existing Tacoma Link system provide background information for potential rail extension options originating in Tacoma. This section of the issue paper identifies these potential operating scenarios.

Two general operating scenarios have been identified: two-car and four-car operations. These options were selected in part since they reflect potential capacity requirements of LRT service extensions from downtown Tacoma. The options also reflect either long-range operations plans (four-car trains) as well as design allowances for the existing Tacoma Link facilities (two-car trains) within downtown Tacoma.

In addition to the characteristics that are specific to either two- or four-car service, the phasing of future Tacoma Link development will need to be addressed. Planning for ST2 implementation will evaluate potential LRT extensions north of Tacoma to Federal Way as well as south of SeaTac to Federal Way. However, complete integration of Tacoma Link with Central Link that provides one-seat/no transfer service between downtown Tacoma, downtown Seattle, and locations to the north is not anticipated until after ST2 has been implemented.

Future operating scenarios also need to address limitations with the existing Tacoma Link in terms of some single track operations. The lack of complete double-track operations prevents lower headways (time between cars) from the existing ten minutes. However, one of the Regional Transit Long-Range Plan Options includes a potential rail extension from the north terminus of Tacoma Link (Theater District/S. 9th Station) to West Tacoma. Such an extension of the service would allow increased operating flexibility to the point that lower service headways could be provided without adding additional double-track.

Table 1 provides an overview of potential extension options for LRT from downtown Tacoma as well as transfer locations. The following sections further describe the service extension options:

4.1 Option A: Two-Car Operations

Two-car LRT operations recognize the ability of the existing Tacoma Link system to accommodate further development, including the design of existing Link stations in downtown Tacoma. The option also recognizes the relatively lower ridership demand between Tacoma and Federal Way, versus the demand between Federal Way and downtown Seattle.

In assessing potential extension scenarios under the two-car option, several key considerations should be kept in mind. These considerations are:

- Given potential ridership levels between Tacoma and Federal Way, at least two-car trains would be needed for any extension from downtown Tacoma.

- It is important to note that a service operating two-car trains between the Tacoma Dome station and Seattle would have viability only for a limited time. Eventually, demand for the Federal Way-Seattle segment would require four-car trains (at minimum during peak commute periods.) Under this scenario, converting to two-car train operation between Tacoma Dome and Federal Way would necessitate a transfer at Federal Way to continue a trip (northbound toward Seattle, southbound toward Tacoma.)
- LRVs similar to those for Central Link would be needed for the extension.
- No major changes to existing stations would be necessary.
- With an LRT extension to Federal Way, the additional vehicles and associated maintenance needs would exceed the available capacity of the existing Tacoma Link facility.
- There is potential for extensions of Tacoma Link to West Tacoma from the Theater District/S. 9th Station and to East Tacoma from the Tacoma Dome Station. These extensions are being addressed in separate issue papers.
- A potential extension of Tacoma Link to West Tacoma would provide an opportunity for ST to reduce service headways in the event that this is justified by ridership levels. The lengthening of operations beyond the existing north terminus at the Theater District/S. 9th Station would provide operation conditions that would allow some reductions in headways without requiring extensive track work. Under the current alignment for Tacoma Link, reductions in headways are limited due to single-track operations along some portions of the line.
- There may be a need for modifications to the horizontal alignment of the tracks at 25th Street/Pacific to allow trains to make the turn. As noted in above in Section 2.2 (Track Radius), design criteria for Link facilities call for a minimum 100-foot turning radius while the existing radius at 25th Street/Pacific Avenue is 90 feet.
- Under ST2, ridership estimates for any extensions will need to be identified to confirm adequacy of any future two-car Tacoma Link service operating to Federal Way (i.e., will there be enough capacity?)

Table 1 - Summary of Potential LRT Extensions between Downtown Tacoma and Federal Way[1]

Potential Extension Options	Location of Service	Train Lengths and Types	Transfer Locations	Potential Advantages	Potential Disadvantages
A.1 - Extension North to Federal Way with 2-car trains; transfer at Tacoma Dome to local rail service operating in downtown Tacoma	Tacoma Dome-Federal Way (and points north)	2-car LRV's	Tacoma Dome	With downtown Tacoma and Tacoma/Federal Way service separated, allows service capacity to match demand levels along each segment	Lack of continuous/no transfer service between downtown Tacoma and Federal Way. The need to transfer could affect ridership levels for Federal Way/downtown Tacoma service. Limitations on how long two-car trains could operate along entire length to Seattle before demand requires more than 2-car trains.
	Tacoma Dome-Theater District/9th Station	Single-car LRV's Single or 2-car LRV's	Tacoma Dome		
A.2 - Extension North to Federal Way with single-seat/no transfer service with 2-car trains	Downtown Tacoma (Theater District/9th Station) to Federal Way (and points north)	2-car LRV's. These trains lengths and vehicle types will likely be required to meet likely demand levels between downtown Tacoma and Federal Way; existing Tacoma Link vehicles will not likely be adequate.	None	Continuous single seat/no transfer service between central downtown Tacoma and Federal Way	Possible excess service capacity between Tacoma Dome and North end of downtown Tacoma. Limitations on how long two-car trains could operate along entire length to Seattle before demand requires more than 2 car trains.
B.1 - Extension North to Federal Way using 4-car LRV trains; transfers at Tacoma Dome	Tacoma Dome-Federal Way (and points north)	4-car LRV's	Tacoma Dome	With downtown Tacoma and Tacoma/Federal Way service separated, allows service capacity to match demand levels along each segment. Provides single-seat ride between Tacoma Dome, Federal Way, and Seattle. The option will not require major changes to rail stations and track within downtown Tacoma with the possible exception of Tacoma Dome Station. If rail is extended to West Tacoma using 2-car LRV's, continuous service will be available between West Tacoma and the Tacoma Dome Station.	Lack of continuous/no transfer service between central downtown Tacoma and Federal Way. Possible excess service capacity if LRT operates only between Federal Way and downtown Tacoma.
	Tacoma Dome-Theater District/9th Station	2-car LRV's			
B.2 - Extension North to Federal Way using 4-car LRV trains; single-seat/no transfer service between central downtown Tacoma and Federal Way	Downtown Tacoma (Theater District/9th Station) to Federal Way (and points north)	4-car LRV's	None	This scenario will provide continuous, single seat rail service between central downtown Tacoma, Federal Way, and downtown Seattle.	4-car LRV service in central downtown Tacoma will require major infrastructure changes. Any service to West Tacoma will likely require transfers at the Theater District/9th Station

1. Assumes that a train traveling northbound would continue past Federal Way to downtown Seattle and possibly further. Likewise southbound trains would continue past Federal Way to Tacoma.

4.1.1 A.1 – Extend North (to Federal Way) Using Two-Car Operations with Transfers at Tacoma Dome

Under this option, two-car LRT operations connecting to Federal Way, SeaTac, downtown Seattle, and locations to the north will operate to the Tacoma Dome station. Transfers would occur at Tacoma Dome Station between two-car northbound trains and the service along the existing Tacoma Link line.

The Tacoma Link service could operate with either a single-car that uses low-floor LRVs or a single-car that uses larger LRVs similar to what will be operating on Central Link. Although the LRVs could be operated as individual cars, the design for the Tacoma Link stations allows up to two-car trains using this type of vehicle.

4.1.2 A.2 – Extend North (to Federal Way) with Single-Seat/Two-Car Operations

This option would allow use of existing Tacoma Link stations that have been designed to accommodate potential service with two-car trains. The design also recognizes future operations that use LRVs that are similar to those that will be operating on Central Link. The option will be considered as part of potential high-capacity transit packages that will be evaluated for the South Corridor under ST2 of ST's Long Range Plan implementation.

This extension would provide one-seat/no transfer service from central downtown Tacoma to Federal Way. Any final determination for two-car LRT service will be dependent in part on estimated ridership levels between downtown Tacoma and Federal Way. These ridership estimates will be evaluated under ST2 planning to be carried out in 2005.

NOTE: There is potential for an A.3 scenario that would extend the existing Tacoma Link low-floor LRVs from downtown Tacoma to Federal Way. However, this vehicle has lower travel speeds, versus the Central Link LRV (45 miles per hour vs. 55 miles per hours as maximum speeds). This limitation will be particularly acute along some portions of SR 99 south of Federal Way where grades are substantial. Also, as compared to Central Link LRV trains, the single unit operations using a small vehicle would provide more limited capacity to meet estimated ridership for rail service between downtown Tacoma and Federal Way. (maximum capacity of 56 vs. 144 for Central Link LRV).

4.2 Option B: Four-Car Operations

Four-car operations would provide single-seat service connecting Central Link and Tacoma Link. Capacity provided by four-car trains will be needed to meet expected demand levels between downtown Seattle and Federal Way. They would also provide the convenience of no-transfer service between Central Link and downtown Tacoma.

In assessing potential extension scenarios under the four-car option, several key considerations should be kept in mind. These considerations are:

- Light rail vehicles similar to those for Central Link will be needed for the extension.
- Four-car trains will be needed to meet expected demand north of Federal Way.
- If transfers occur at the Tacoma Dome Station, accommodation of four-car trains will be necessary beyond what is currently available at the existing Tacoma Dome Station on Tacoma Link. This accommodation could include a different routing of Federal Way/Tacoma four-car trains than the current approach to the Tacoma Dome along 25th Street.
- Transfers at the Tacoma Dome could affect ridership.
- Ridership estimates for the extension will need to be identified to confirm any requirement for four-car service between downtown Tacoma and Federal Way.

4.2.1 B.1 – Extend North (to Federal Way) Using Four-Car Operations/Transfer at Tacoma Dome Station

Under this option, four-car LRT operations connecting to Federal Way, SeaTac, downtown Seattle, and locations to the north would operate to the Tacoma Dome Station. Due to capacity limits of existing Tacoma Link stations (maximum of two-car trains can be accommodated), transfers would occur at Tacoma Dome Station between four-car trains and service along the existing Tacoma Link line.

One advantage of this option is that, for each major segment of the service, it provides service capacity that can better match estimated demand. These major segments are the existing Tacoma Link alignment and between the Tacoma Dome Station and Federal Way. Ridership along the Tacoma Dome/Federal Way segment is expected to be significantly higher than what is estimated for the segment along the existing Tacoma Link line.

A second major advantage of this option is that, by operating two-car trains within downtown Tacoma, it avoids major infrastructure changes necessary for four-car operations. To accommodate two-car rail service some relatively minor facility changes would be required. As noted above, the operation of four-car LRV trains to Tacoma Dome would require accommodation beyond what is available at the existing Tacoma Dome Station for Tacoma Link. This accommodation could include a different routing of Federal Way/Tacoma four-car trains than the current approach to the Tacoma Dome along 25th Street.

4.2.2 B.2 – Extend North from Central Downtown Tacoma (to Federal Way) with Single-Seat/Four-Car Operations

A major advantage of this option is that it would provide one-seat service connecting Central Link with downtown Tacoma using four-car trains. No transfers would be needed in downtown Tacoma.

A major disadvantage of the option is that it would require major infrastructure changes within downtown Tacoma. To accommodate four-car trains, major reconfiguration of the downtown Tacoma rail alignment would be required. Since the service involves rail operations between downtown Tacoma and Central Link, it will not likely occur until after ST2 or beyond 2020.