# UVTN Monitoring Project

## FINAL REPORT

**February 2007**

**Seattle Department of Transportation**

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# Executive Summary

## Background

The purpose of the UVTN Performance Monitoring and Implementation Project is to report on the performance of the Urban Village Transit Network (UVTN), or "Seattle Transit Connections." The UVTN is Seattle's vision for a network of high quality, reliable transit corridors that support and connect Seattle's urban villages, as set forth in the Seattle Comprehensive Plan. The UVTN represents the backbone of transit service in Seattle. The goal for the UVTN is service at least every 15 minutes (in both directions), 18 hours a day, seven days a week.

This report is the first in a series of annual reports that will measure the performance of the UVTN and make recommendations on where improvements can be made to ensure the network is meeting all established standards.

Figure ES-1 below presents a map of the entire UVTN, highlighting segments of the UVTN that have no transit service or where service is far below the requirements of the UVTN.

It should be noted that the Seattle Transit Connections map (Figure 1) identifies several "alternative" UVTN corridors. These alternative corridors were developed in areas where multiple streets could be used, such as the connection between Fremont and the University District. For the purposes of this first monitoring report, however, only the corridors that are closest to having UVTN levels of service were monitored.

*Figure ES-1 UVTN and Segments with No Existing Transit Service*

## Performance System Implementation

The performance of the UVTN will be monitored using **five** independent quality of service (QOS) measures. These measures describe the key quantifiable features of service quality from the passenger perspective.

1. **Frequency** is described by the duration of the maximum scheduled gap between consecutive buses on the route. When all service is on schedule, this gap, called the "headway," is the maximum waiting time a customer will experience.
2. **Span of service** describes the number of hours in the day that a service runs at UVTN frequencies (every 15 minutes or better).
3. **Reliability** describes the degree to which the schedule is achieved.
4. **Travel speed** is average speed, not top speed. It describes how long the service takes to traverse each mile, including all sources of delay
5. **Passenger Loading, or Overloading**, is an important measure that provides insight into a range of issues affecting transit, including:
    - Passenger comfort, both in terms of finding a seat and crowding levels on the vehicle.
    - The need from the transit operator's perspective to increase service frequency or vehicle size to improve passenger comfort.
    - The risk of "pass-ups," where a transit vehicle bypasses waiting passengers because it is too full.

To determine how the UVTN is performing in each of the five measures discussed above, the network will need to be monitored annually. Although the methodology is based on Chapter 4 of the Seattle Transit Plan (adopted fall 2005), the actual measurements included in this report vary slightly depending on data availability. The following outlines the proposed methodology and how these measures are to be evaluated and scored with regard to their quality of service.

### Frequency

The minimum passing threshold for the Frequency measurement is exactly the same as that discussed in the Seattle Transit Plan, or any value less than 15 minutes is considered passing and any value greater than 15 is considered deficient.

### Span of Service

The proposed scoring criteria for the Span of Service measure is different than what was presented in the Seattle Transit Plan, which required a minimum of 16 hours of service to receive a passing score. Based on this threshold, the large majority of the system would fail. For this reason, the minimum threshold for passing was reduced to every 12 hours for this first monitoring process. Over time, the optimal minimum threshold should be increased to 16 hours as shown in the Seattle Transit Plan.

### Passenger Loading (Overloading)

The proposed methodology for this measure is somewhat different from what was proposed in the Seattle Transit Plan. The Seattle Transit Plan suggested evaluating passenger load as a percent of vehicle capacity rather than a traditional load factor (passengers divided by seated capacity). However, due to the availability and accuracy of data, a "load factor," or passenger load as a percent of seat capacity, was viewed as the best method for this measure.

The minimum passing threshold for the overloading measure is 90% of seated capacity. Any value that is over 90% of seated capacity is considered deficient. It should be noted that Metro's definition of "overloading" is 120% of seated capacity for 20 minutes or more, and therefore the worst value is anything "approaching overloaded" which is greater than 110% of seated capacity.

### Speed

The proposed methodology for this measure is simplified from what was proposed in the Seattle Transit Plan. Rather than evaluate different ranges of the percent of posted speed limit, all services are measured in simple value ranges, such as: "Transit services operate between 40-50% of the posted speed limit." The minimum threshold as a percent of posted speed limit is 30%. UVTN segments where transit operating speed drops below 30% of posted speed limit are considered deficient.

### Reliability

The Reliability measure used for this UVTN monitoring report evaluates actual travel times versus base travel times to produce a coefficient of travel time variation (see page 16 for full description). The proposed methodology for this measure is simplified from what was proposed in the Seattle Transit Plan based on available data. It is recommended that if data becomes available, this measure evaluate headway reliability rather than travel time reliability.

## UVTN Performance

UVTN corridor performance for the five performance measures is summarized below. Two products were developed as part of this analysis:

- **A series of maps displaying the values of each performance measure.** The maps display the values by each individual street segment where transit services currently operate, rather than being aggregated by UVTN corridor. Values are presented as the actual values, but are color-coded by the quality of service score they receive.
- **A table displaying the performance of each UVTN corridor.** Based on Table 11 in the Seattle Transit Plan, the performance of the transit network is aggregated by corridor since it is important to emphasize the cumulative performance of a larger corridor rather than the performance of a particular segment of that corridor.

### Frequency

As shown in Figure ES-2 below, midday headway between buses is currently meeting or exceeding the minimum threshold of 15 minutes in many UVTN corridors. As expected, midday headways are the lowest on some of the major transit corridors, such as:

- 23rd Avenue E between Madison and the University District

- Fairview Avenue N between Eastlake Avenue and the University District
- Pacific Street and 15th Avenue NE in the University District
- Aurora Avenue N between Fremont and W Mercer Street
- The bus lane between Spokane Street and Jackson Street
- Spokane Street between West Seattle and the E-3 busway
- Several portions of Rainer Avenue S
- Meridian Avenue N near North Seattle Community College
- Most major transit streets downtown.

Several corridors do not have any midday service:

- 14th Avenue E between Jackson Street and Union Street
- Montlake Boulevard on the University of Washington campus
- SW Spokane Street between 1st Avenue S and the E-3 busway
- Highway 99 south of E Marginal Way
- Leary Avenue NW between 8th Avenue NW and 15th Avenue NW and between 3rd Avenue NW and Fremont Avenue
- Weedin Place and 5th Avenue NE (south of N 80th Street)
- Lake City Way between NE 75th Street and NE 95th Street
- N 115th Street between Aurora and Northwest Hospital

**Span of Service**

As shown in Figure ES-3 below, service span for services with frequencies every 15 minutes or better pass on many UVTN corridors in central Seattle, as well as between downtown and Fremont, downtown and Ballard and downtown and the University District. Likewise, the four major transit corridors south of downtown (1st Avenue S, the E-3 busway, Rainer Avenue S and Beacon Avenue S) all pass the Service Span measure.

Some of the corridors with the least amount of high frequency service include:

- 15th Avenue NW between Leary Avenue NW and NW 85th Street
- Greenwood Avenue N between N 105th Street and N 130th Street
- 3rd Avenue W between Nickerson Street and W McGraw Street
- Denny Way between 5th Avenue N and Olive Way
- Broadway Avenue/Boren Avenue between Madison Street and Jackson Street
- 35th Avenue SW between SW Morgan Street and SW Barton Street
- Highway 99 south of Marginal Way
- Jackson Street between Rainier Avenue S and 23rd Avenue E

There are also a number of UVTN segments that currently do not have any service that operates every 15 minutes, including:

- 14th Avenue E between Jackson Street and Union Street
- Yesler Way between Boren Avenue and 23rd Avenue E
- Most of Admiral Way in West Seattle

- S Myrtle Place and Othello Street
- Most of 15th Avenue S between Beacon Avenue and I-5
- W Olympic Place, Olympic Way W and 10th Avenue W
- Westlake Avenue between Valley Street and Denny Way
- NW Leary Way between 15th Avenue N and Aurora Avenue N
- N 34th Street and N Pacific Street
- E Green Lake Way and N 50th Street
- All of Holman Road NW
- NE Northgate Way between Roosevelt Way and Lake City Way

**Passenger Loading (Overloading)**

As shown in Figure ES-4 below, failures on this performance measure occur in the following main corridors:

- Lake City Way NE between NE 125th Street and Roosevelt Way NE
- 25th Avenue NE between NE 45th Street and NE 65th Street
- NE 45th Street between I-5 and 15th Avenue NE
- 3rd and 4th Avenues in downtown Seattle
- 1st Avenue S between Jackson Street and S Spokane Street
- E-3 Busway between Jackson Street and S Spokane Street
- SW Spokane Street between 1st Avenue S and Delridge Way SW
- Admiral Way between California Avenue SW and the West Seattle Bridge
- Rainier Avenue S between S Dearborn Street and MLK Jr Way S
- E Pike Street between 4th Avenue and Broadway
- 1st Avenue N between Denny Way and W Mercer Street
- 15th Avenue NE between NE 45th Street and NE Pacific Street

**Speed**

Figure ES-5 below shows one of the critical components of the UVTN, travel speed as percent of the posted speed limit. As shown in the map, many of the UVTN streets in downtown Seattle and around the University District are deficient in this measure. Outside of these districts, there are several major corridors where travel speed is low compared to posted speed limit:

- Most of 45th Street and NW Market Street between the University District and Ballard
- 11th/12th Avenue NE and Roosevelt Way NE between the University District and NE 75th Street
- 85th Street between Wallingford Avenue and 15th Avenue NW
- All of Broadway south of Roy Street
- Jackson Street west of 23rd Avenue South
- All of Denny Way
- Queen Anne Avenue N between Denny Way and Mercer Street

**Reliability**

Reliability, shown in Figure ES-6, tracks very closely with Travel Speed; i.e. segments deficient in one tend to be deficient in both. As with Speed, poor Reliability scores show up on many segments downtown and in surrounding neighborhoods, as well as in the University District. The entire Ballard-University corridor also stands out as deficient for Reliability, as it is for Speed.

The five performance maps of the UVTN are presented in Figures ES-2 through ES-6 on the following pages.

*Figure ES-2 Service Frequency in Relation to Proposed UVTN Criteria*

***Figure ES-3 Service Span in Relation to Proposed UVTN Criteria***

*Figure ES-4 Passenger Load in Relation to Proposed UVTN Criteria*


* This value is the ratio of passenger load to seated capacity (load factor) on the most crowded route, 85% of the time.

*Figure ES-5 Travel Speed in Relation to Proposed UVTN Criteria*

*Figure ES-6 Reliability in Relation to Proposed UVTN Criteria*


* Coefficient of variation representing the highest observed travel time standard deviation divided by the expected travel time.

## Recommendations

Based on the analysis of performance measures for the UVTN corridors, SDOT has been working with its partner transit agencies, primarily King County Metro, to develop recommended service and infrastructure improvements to improve UVTN performance.

Infrastructure recommendations will generally be improvements to streets and signals to smooth and expedite the flow of bus service. The benefits of these recommendations accrue mostly in two measures: Speed and Reliability. The other three measures – Frequency, Span, and Passenger Load – are largely a function of the quantity of service provided, as opposed to the fixed infrastructure. These service quality issues must be an area of separate effort between the City and King County Metro (and other transit providers, to a lesser extent).

## Next Report

While the purpose of the monitoring process should remain consistent over time, the format is flexible to reflect changing conditions and data availability as the UVTN develops. As noted earlier in this report, the goal of monitoring the five quality of service measures is to determine how well each of the UVTN corridors (and individual street segments) are performing and to identify specific locations where corrective actions should be taken to achieve the goals of the UVTN. To ensure that this happens on a regular basis, this monitoring report should be updated **at least every year** (as discussed in TSP Strategy TR1.3). Annual monitoring will enable SDOT and King County Metro to measure their progress, through the combined efforts of service and infrastructure, in their effort to bring the UVTN to fruition.

# Chapter 1. Introduction and Background

The purpose of the UVTN Performance Monitoring and Implementation Project is to report on the performance of the Urban Village Transit Network (UVTN), or "Seattle Transit Connections," the city's core network of high quality transit service and facilities designed to connect the highest concentration of riders and most densely developed neighborhoods. This project will also provide new information on how the City and its partner transit agencies – primarily King County Metro – can implement the network.

During the planning phases of the UVTN, and now for this first performance monitoring project, King County Metro has supported the concept of a UVTN. Metro has been a critical partner with the City in this project by providing the necessary data to evaluate the UVTN and by developing a methodology for assessing performance. The methodology is discussed later in this report.

## About "Seattle Transit Connections" and the Seattle Transit Plan

"Seattle Transit Connections", or the Urban Village Transit Network (UVTN), is Seattle's vision for a network of high quality, reliable transit corridors that support and connect Seattle's urban villages, as set forth in the Seattle Comprehensive Plan. The UVTN represents the backbone of transit service in Seattle. The goal for the UVTN is service at least every 15 minutes (in both directions), 18 hours a day, seven days a week. The Seattle Transit Connections network is shown below in Figure 1. It has been revised, since its adoption in September 2005, to delete the Monorail Green Line and show UVTN service in the same corridor.

The Seattle Transit Plan provides direction on how to achieve the UVTN and recommends Transportation Strategic Plan (TSP) strategies for making transit a "real choice" in Seattle. The main purposes of the Seattle Transit Plan are (verbatim from the Seattle Transit Plan):

- *To get Seattle moving again and support economic growth. Seattle needs a transit plan that clearly shows how the Seattle urban village strategy will be supported. It will support updates of other City plans: Comprehensive Plan, Transportation Strategic Plan, neighborhood plans.*
- *To enable the City to be more proactive on the future of transit in Seattle. We want to know how various transit services and programs work together in an integrated transit network. The plan timeframe is 2005 to 2030.*
- *To help the City work better with our partner transit agencies by identifying Seattle's key transit corridors and needs. Each of these agencies do planning for Seattle, e.g., King County's Six-Year Transit Development Plan, Sound Transit's Phase 2 planning.*
- *To link City transit strategies to specific connections or corridors, i.e. making City policies and SDOT strategies operational.*
- *To estimate transit service funding needs by more clearly identifying the City transit priorities and corridor needs.*

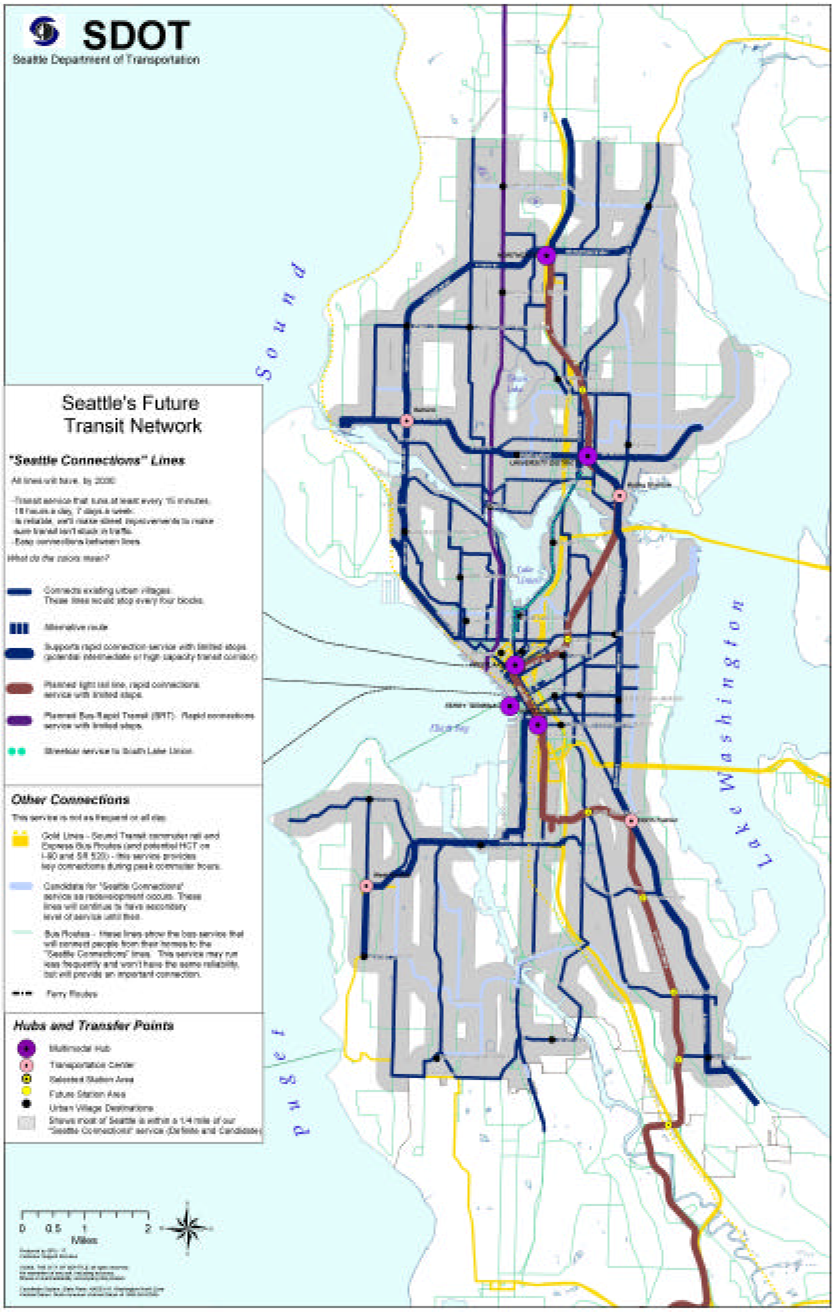
There are six main elements of the Seattle Transit Plan:

- Seattle Transit Connections – the Urban Village Transit Network.
- Major Transfer Points – Multimodal Hubs & Transportation Centers
- Criteria for Evaluating Technologies

- Transit Classifications
- Transit Quality of Service (QOS) Measures & Transit Priority Treatment Toolbox
- Estimate of Service Funding Needs to Build the UVTN and Priorities for Transit Service Investment.

This report is the first in a series of annual reports that will measure the performance of the UVTN to initiate work on where improvements can be made to ensure the network is meeting all established standards.

***Figure 1 Seattle Transit Connections***



## Importance of the Urban Village Transit Network

The UVTN shows key, priority transit corridors that connect Seattle's urban villages and must …
… have at least 15 minute service, 18 hours a day, 7 days a week, in both directions.
…be fast and reliable
… be focused on performance not technology; it includes regional high capacity, intermediate capacity and local transit
… have easy connections between lines
… have a sense of permanence to support transit oriented development (TOD) and promote economic development, and.
… be monitored for performance using quality of service measures for service frequency, span of service, transit travel speed, passenger loadings and reliability.

### The Transit Priority Treatment Toolbox

Recurrent traffic congestion can create longer travel times for passengers and, over time, higher operating costs for transit agencies as they try to maintain headways. As a component of the Seattle Transit Plan, the City has created a transit priority treatment toolbox to help maintain and improve transit service quality, especially for UVTN corridors. Since many of Seattle's rail investments will be provided in exclusive right-of-way with limited at-grade crossing, the toolbox will mainly be applied to bus and streetcar corridors. There is a special focus on the UVTN corridors because of the City's strong commitment to achieve good transit performance standards, especially transit speed and reliability.

Transit preferential treatments are a cost-effective way to improve transit service through a strategic, one-time capital investment rather than an on-going investment of service hours to achieve schedule maintenance. By delaying the need to add service only to maintain current quality of service, service investment can be used to increase service frequency and span of service. The following is a list of low- to medium-cost transit preferential treatments that could be applied to improve transit service speed and reliability. These treatments are discussed in more detail in the Seattle Transit Plan.

- Exclusive Transit Lanes
- Signal Priority
- Queue Bypass
- Curb Extension
- Boarding Islands
- Parking Restrictions/Parking Management
- Turn Restriction Exemption
- Transit Stop Relocation
- Transit Stop Consolidation
- Skip-Stops
- Platooning
- Design Standards

### Phase I Implementation

The Seattle Transit Plan identified 53 UVTN corridors for implementation by 2030. Of these 53 corridors, 24 of them were identified for Phase I implementation. These corridors were selected because they have:

- Significant Existing Service Investment
- Existing Speed/Reliability Initiatives
- Plausible Speed/Reliability Initiatives
- Part of the 2030 UVTN

Some of the corridors selected for Phase I implementation were noted as "difficult" because they are already operating at or below the UVTN speed standard, which is 30% of the posted speed limit (discussed in Chapter 2). Figure 2 below presents each of the 53 corridors in the UVTN and the corridors that were selected for Phase I implementation. A map of the Phase I UVTN corridors is presented in Figure 3. SDOT is also considering the former Seattle Monorail Project's Green Line corridors as part of Phase I.

***Figure 2 UVTN Corridors for 2030 and Phase I Implementation***

| No. | Primary Street of Corridor Segment | Between … | And … | Phase 1 Implementation | | |
|---|---|---|---|---|---|---|
| | | | | Yes | Yes But Difficult | Defer |
| 1 | Fairview, Stewart/Virginia OR Westlake, Fairview, Eastlake | Stewart | University Dist. | ✓ | | |
| 2 | 1st, Cedar | Denny & QA Ave | 3rd & Cedar | | | ✓ |
| 3 | 3rd | Cedar | Jackson | | ✓ | |
| 4 | James OR Yesler, 9th | 3rd | 9th & Jefferson | | | ✓ |
| 5 | Olive OR Stewart OR Virginia | 1st | I-5 | | ✓ | |
| 6 | Pike/Pine | 1st & Pike/Pine | Pine & Summit | | ✓ | |
| 7 | Yesler OR Jackson | 1st | MLK | | | ✓ |
| 8 | 14-15 Av, Boston, 10th Av E, Roanoke, Harvard | Jackson | University Dist. | | | ✓ |
| 9 | Broadway, 10th Av E, Roanoke, Harvard | Jackson | University Dist. | | | ✓ |
| 10 | Jefferson, Cherry | 9th & Jefferson | MLK & Cherry | | ✓ | |

*Figure 2 UVTN Corridors for 2030 and Phase I Implementation (continued)*

| No. | Primary Street of Corridor Segment | Between … | And … | Phase 1 Implementation: Yes | Yes, But Difficult | Defer |
|---|---|---|---|---|---|---|
| 11 | Madison | 6th Av | 23rd Ave | | | ✓ |
| 12 | Madison, Marion | Western Av | 6th Av | | | ✓ |
| 13 | Olive, John, Thomas | Pine & Summit | 23rd & Thomas | | | ✓ |
| 14 | Pine, Union | Pine & Summit | MLK & Union | | ✓ | |
| 15 | 23-24th Av | Montlake Stn | McClellan LRT | ✓ | | |
| 16 | 92nd St, 1st Av NE | 92th & Meridian (NSCC) | Northgate LRT | | | ✓ |
| 17 | Aurora LIMITED STOP | Denny | 145 St | ✓ | | |
| 18 | Green Lake, 65th. (Options for Aurora to Wallingford Ave: Either Green Lake OR 85th, Wallingford) | 85th & Aurora | Roosevelt LRT | | | ✓ |
| 19 | Greenwood, Phinney, 43 St, Fremont | Fremont Br & Nickerson | NW 145 St (City limits) | ✓ | | |
| 20 | N 45 St OR N 50 St. | Stone Way | University Dist. | | ✓ | |
| 21 | Wallingford, Meridian (NSCC) | 85th & Aurora | Northgate LRT | | | ✓ |
| 22 | N 115 St, Meridian Av | 115 & Aurora | 105 & Meridian | | | ✓ |
| 23 | N/NE 40 St OR N/NE Pacific St. | Stone Way | University Dist. | ✓ | | |
| 24 | Holden, NE 105 St, Northgate Way | Crown Hill | Northgate LRT | | | ✓ |
| 25 | 5 Av NE | Roosevelt LRT | Northgate LRT | ✓ | | |
| 26 | 15 Av NE | University Dist. | Roosevelt LRT | | | ✓ |
| 27 | 15 Av NE, Pinehurst | Northgate LRT | 145 St | ✓ | | |
| 28 | 25 Av NE | University Dist. | NE 65 St | | | ✓ |
| 29 | Lake City Way | Roosevelt LRT | 145 St | ✓ | | |
| 30 | Montlake Av | Montlake Stn | NE 45 St | | | ✓ |
| 31 | NE 45 St, Sand Point | University Dist. | Princeton/Sand Pt (NE 50 St) | | | ✓ |
| 32 | NE 65 St | Roosevelt LRT | 25 Av NE | | | ✓ |
| 33 | Pacific St | Montlake Stn | University Dist. | ✓ | | |
| 34 | 24 Av NW | NW 65 St | NW 85 St | | | ✓ |
| 35 | Leary, 20 Av NW | 20 Av & Market | 14 Av NW & Leary | | | ✓ |
| 36 | Leary, NW 39 St | 14 Av NW & Leary | Stone Way | | | ✓ |
| 37 | Market, N 46 St | 32 Av NW & Market | Stone Way | | ✓ | |
| 38 | NW 85 St | 24 Av NW | Aurora | ✓ | | |
| 39 | 1 Av S | Yesler | Spokane | ✓ | | |
| 40 | 15 Av S, Albro, through Georgetown and South Park to White Ctr | Jackson | Westwood Vlg. / White Center | | | ✓ |
| 41 | 4 Av S, Michigan, 1 Av S Br, SR 99 LIMITED STOP | Spokane | South Park is last Seattle stop. Could continue to Burien. | | | ✓ |

*Figure 2 UVTN Corridors for 2030 and Phase I Implementation (continued)*

| No. | Primary Street of Corridor Segment | Between … | And … | Phase 1 Implementation | | |
|---|---|---|---|---|---|---|
| | | | | Yes | Yes But Difficult | Defer |
| 42 | Beacon, Myrtle, Othello | 12th & Jackson | East end of Othello | ✓ | | |
| 43 | E3 Transitway, LIMITED STOP | King St LRT | Spokane | ✓ | | |
| 44 | Rainier, Rainier Beach | Jackson | Henderson LRT | ✓ | | |
| 45 | Columbia, Alaska, Spokane, Admiral | Rainier & Alaska | 63 Av SW & Admiral | | | ✓ |
| 46 | California | Admiral | Morgan Jct | | | ✓ |
| 47 | Delridge | Spokane | Westwood Vlg. / White Center | ✓ | | |
| 48 | Morgan, 35 Av SW, Roxbury | Morgan Jct | Westwood Vlg. / White Center | | | ✓ |
| 49 | 5 Av N, Taylor Av N, Boston | Denny & 5 Av N | 3 Av W & McGraw | ✓ | | |
| 50 | Dexter, Nickerson | Denny & Dexter | Fremont Br & Nickerson | ✓ | | |
| 51 | Nickerson, 15 Av W | Dravus & 15 Av NW | Fremont Br & Nickerson | | | ✓ |
| 52 | Olympic, 10 Av W, Gilman Dr W | Denny & QA Ave | Dravus & 15 Av NW | | | ✓ |
| 53 | Queen Anne Ave., McGraw, 3rd Av W | Denny & QA Ave | Nickerson & 3rd Av NW | | | ✓ |

*Figure 3 Phase I UVTN Corridors*

# Chapter 2. UVTN Performance Monitoring System

The performance of the UVTN will be monitored using five independent quality of service (QOS) measures. These measures describe the key quantifiable features of service quality from the passenger perspective[1].

1. Frequency
2. Span of service
3. Reliability
4. Travel speed
5. Overloading

Specific thresholds are set for good and poor performance, or quality of service. In each case, a policy threshold is set for each factor. A score below this threshold, in any category, would automatically mean that remedial actions or strategies are necessary, even if a UVTN segment scores well in all other measures.

Following an overview of each performance measure, a proposed methodology for UVTN performance evaluation is presented that is generally similar to the one presented in the Seattle Transit Plan yet has some differences, based on the availability of existing operational data.

**Frequency**

Frequency is described by the duration of the maximum scheduled gap between consecutive buses on the route. When all service is on schedule, this gap, called the "headway," is the maximum waiting time a customer will experience.

Frequency can never be described in terms of averages, only in terms of worst case. If four buses are scheduled to come at the same time each hour, this could be construed as an "average 15-minute frequency," but for the purposes of this report, and the customer's experience, it is hourly service.

The passing threshold for the Frequency measure, as described in the Seattle Transit Plan (Table 15), is 15 minutes. UVTN segments with headways higher than 15 minutes are considered below the passing threshold and remedial actions or strategies are necessary.

**Span of Service**

Span describes the number of hours in the day that a service runs at UVTN frequencies (every 15 minutes or better). The passing threshold for the Span of Service measure, as described in Table 16 of the Seattle Transit Plan, is at least 16 hours for services with frequencies every 15 minutes or better. UVTN segments with a service span less than 16 hours are considered below the passing threshold and remedial actions or strategies are necessary.

[1] Taken from the Transit Capacity and Quality of Service Manual, 2nd edition (TCRP Report 100), 2003, Transportation Research Board, Part 3

### Passenger Loading (Overloading)

This is an important measure that provides insight into a range of issues affecting transit, including:

- Passenger comfort, both in terms of finding a seat and crowding levels on the vehicle.
- The need from the transit operator's perspective to increase service frequency or vehicle size to improve passenger comfort.
- The risk of "pass-ups," where a transit vehicle bypasses waiting passengers because it is too full.

Many agencies measure loading in terms of a "load factor," defined as the ratio between the number of passengers and the number of seats. Historically, when bus designs were uniform, a load factor in the range of 150% (one passenger standing for every two seated) described a crush-loaded vehicle.

However, as transit vehicles have become more diverse, standard load factors have become less useful. Low-floor buses, for example, typically have fewer seats than standard buses of the same size, but the same amount of standing space, so they can tolerate a higher load factor.

For this reason, a measure of percentage of vehicle capacity (% capacity) was chosen as a way to provide a more level means of comparison between different vehicles serving different needs. The capacity of a transit vehicle describes the number of passengers (seated and standing) that can safely and comfortably travel on the vehicle. It generally also reflects the operational needs of the vehicle such as passenger circulation (within the vehicle and boarding and alighting).

Since the vehicle capacity includes the passengers who can stand safely, the passing threshold is less than 100% of this capacity. If loads in a UVTN corridor are greater than 100% of vehicle capacity, this is considered deficient in the Overloading measure. Table 18 in the Seattle Transit Plan also describes these thresholds.

### Reliability

Whereas the Frequency measure describes the scheduled elapsed time between transit vehicles, Reliability describes the degree to which the schedule is achieved. The minimum passing thresholds for the Reliability measure is that greater than 60% of all services are less than 1 minute late, 90% of all services are less than 3 minutes late, and less than 3% of all services are over 5 minutes late. If more than 3% of services are more than 5 minutes late, then that UVTN segment is considered deficient. Table 17 in the Seattle Transit Plan also describes these thresholds.

### Speed

Speed is average speed, not top speed. It describes how long the service takes to traverse each mile, including all sources of delay.

As discussed in the Seattle Transit Plan, transit service in Seattle continues to be slow. On key downtown Seattle streets, average operating speeds never top 10 miles per hour (mph). On some streets during the PM peak period (3:30 p.m.- 6 p.m.), speeds fall below 5 mph. This is not unique to the Puget Sound region – many agencies across the country are losing 1% or more per year in average operating speed.

The system of measurement proposed in the Seattle Transit Plan is the travel speed as a proportion of posted speed limit, or the Percentage of Posted Speed Limit (%PSL). The measurement of travel speed needs to include all aspects of the trip, including dwell time at stops and traffic signals, delays caused by traffic congestion and mechanical faults. The minimum passing thresholds for the Speed measure is that all services operate at 30% of PSL, at least 70% of services operate at 50% of PSL, and at least 5% of all services operate at 70% of PSL. If more than 70% of services are operating at 50% of PSL, and more than 5% of services are operating less than 30% of PSL, then that UVTN segment is considered deficient. Table 19 in the Seattle Transit Plan provides more detail on this measure.

## Proposed UVTN Monitoring Methodology

To determine how the UVTN is performing in each of the five measures discussed above, the network will need to be monitored annually, as discussed in TSP Strategy TR1.3. As the first official monitoring of the network, the following proposed methodology outlines exactly how these measures are to be evaluated and how each of the measures are scored with regard to their quality of service.

As in the Seattle Transit Plan, the measures describe the service from a customer's perspective. Their purpose is to identify problems for action, not to diagnose the problems themselves. Monitoring these indicators provides an oversight of likely areas of concern of success in the transit system. The measures suggest potential problem areas that warrant additional analysis. They should not be used to suggest a specific corrective action.

Although the methodology is based on Chapter 4 of the Seattle Transit Plan, the actual measurements included in this report vary slightly depending on data availability, as discussed below.

### General Notes about the Data

All performance indicators are based on King County Metro's data sources. King County Metro, with input from SDOT and Nelson\Nygaard, developed this proposed methodology. Three primary sources are used:

- **Schedule database 'TED' (Transit Enterprise Database).** This data describes the design of the service (routes and schedules) as opposed to its operation. TED data is created as part of the scheduling and service planning process and updated three times a year as part of the service change process. Schedule data is available approximately two-weeks before the service change period begins. Service changes occur in late January, May and September. This data is used for **Frequency** and **Span of Service**.

- **Automatic Passenger Collection (APC) database.** This data is collected through the automatic passenger counter program. Metro has APC equipment on approximately 12% of the fleet. A sample of service is done over the course of one service change period, with a goal of sampling every scheduled trip at least once during the period. This data is used for **Passenger Loading** and as proxy data for **Travel Speed** and **Reliability**.

- **Automatic Vehicle Location (AVL) data.** This data is collected daily through the AVL/Radio system. Metro has AVL equipment on 100% of the fleet. Vehicle location data is processed daily, with approximately 85% or more successfully matched to service schedules and appropriate for analysis. This data is used for the **Travel Speed** and **Reliability** indicators to provide a more confident and complete indicator.

In each case, the indicators are reported at the street segment level. A street segment is very short: typically, it runs just from one intersection to the next. The data, however, is collected or created at the timepoint level – or more specifically the segment between two consecutive timepoints, called a timepoint interchange (TPI). To achieve a street segment level analysis, speed and reliability performance data across the TPI was assigned to each street segment based on a weighting. The weight for each street segment was determined by comparing the expected travel time on that street segment to the expected travel time across the TPI. Expected travel times were determined from the distance and posted speed limit. This was done to account for the varying travel conditions on a TPI that included varying road classifications such as having minor arterials and freeways within the same TPI.

One major limitation of current data sources is that they do not separate the two directions of service. As a result, good performance in the reverse-peak direction can average out bad performance in the peak direction, yielding an inaccurately good result. In the case of Frequency and Span of Service, data was adjusted based on known schedules for the two directions. However, there was no way to distinguish the two directions for Speed, Reliability, and Passenger Loading.

The data is aggregated by time of day for passenger load and travel time measurements. Metro uses five standard time of day periods:

- AM (6:00 am – 9:00 am),
- Midday (9:00 am - 3:30 pm),
- PM (3:30 pm – 6:00 pm),
- Evening (6:00 pm – 9:00 pm) and
- Overnight (9:00 pm – 6:00 am).

As a rule of thumb, the indicators reflect the least desirable conditions (most crowded, least frequent, etc.) observed in the data during the day.

These aspects of the data are consistent with the use of the measures as indicators. The purpose of this type of high level analysis is to get a broad view of transit performance in terms of the customer's perspective, and indicate where more detailed analysis may reveal factors to be improved.

**Frequency**

The Frequency indicator is derived from the current schedule database (TED). The value is determined by finding the number of scheduled midday trips on a road segment (in either direction) on the weekday schedule. Daytime is defined as the 4-hour period from 10:00 am to 2:00 pm. The number of trips in this period is divided into 240 minutes (12 hours) to determine the average number of minutes between trips. The number of trips is divided by the number of flow directions (1 or 2). It should be noted that the reported value is the wait time for any service route, not for a particular service route.

There are daily variations in the schedule between peak and off-peak periods where the service frequency can be more or less frequent than indicated. It also represents all scheduled service, so it should not be interpreted as the wait time for a specific destination. This indicator is best used as a first look for comparing density of service compared to other corridors, and the availability for mobility within a corridor.

To validate this data, ten road segments were randomly selected throughout the UVTN and average headways for all services were calculated for one midday hour (between 12:00 pm and 1:00 pm). Based on this small sample, the proposed method for determining headways is accurate. Although four hours were used (10:00 am to 2:00 pm) and then averaged for one hour, this comparison revealed that the reported data for all ten randomly selected road segments had headways that were within 1 or 2 minutes of the actual scheduled headway.

The minimum passing threshold for the Frequency measurement is exactly the same as that discussed in the Seattle Transit Plan, or any value less than 15 minutes is considered passing and any value greater than 15 is considered deficient.

**Span of Service**

The Span of Service indicator is derived from the current schedule database (TED). Both sides of street are analyzed together and then divided by the number of flow directions (1 or 2) in this indicator. The value is determined by finding the number of hours per weekday where a minimum level of transit service operates. A minimum level of service is defined as the minimum headway that is considered passing, or 4 trips per hour in each direction (i.e., 15 minutes). The intent of this indicator is to show how many hours of "high-frequency" service are available along this road segment.

The proposed scoring criteria for the Span of Service measure is different than what was presented in the Seattle Transit Plan, which required a minimum of 16 hours of service to receive a passing score. Based on this threshold, the large majority of the system would fail – only portions of major transit corridors such as 23rd Avenue E, E Jefferson Street and Rainer Avenue S would be considered passing. For this reason, the minimum threshold for passing was reduced to every 12 hours for this first monitoring process. Over time, the optimal minimum threshold should be increased to 16 hours as shown in the Seattle Transit Plan.

**Passenger Loading (Overloading)**

The Overloading indicator is derived from the automatic passenger collection (APC) database. This value is based on the ratio of passenger load to seated capacity (load factor) on the most crowded route. The data is measured for each time-of-day period (AM, Midday, PM, Evening, Overnight) and the highest load factor on the most crowded service route is reported. Rather than report the *average* load factor for the most crowded route on the most crowded time period, the value that is reported is the *average load factor plus one standard deviation*. This value then represents the load factor condition that occurs about 85% of the time on the most crowded route during the most crowded time period.

Because Metro evaluates overloading based on customer feedback (as opposed to using this data), some questions about overcrowding on individual corridors may arise from this data. It should be noted that this data should not be construed as representing the absolute worst case scenario of any route on a particular corridor. First of all, passenger loads on *the most crowded route on the segment* are averaged over each time period (AM, Midday, PM, Evening, Overnight), and then the standard deviation during that period is added to the average. This can result in some diluting of peak loads that may occur on a specific trip, although the average plus one standard deviation is used to compensate for this dilution. Second, *the most crowded route* over the time period is used, rather than the most crowded trip on *any* route. As a result, a route that may experience overcrowding on several peak trips, but is not the most crowded route during a period, would not show up in this data.

The proposed methodology for this measure is somewhat different from what was proposed in the Seattle Transit Plan. The Seattle Transit Plan suggested evaluating passenger load as a percent of vehicle capacity rather than a traditional load factor (passengers divided by seated capacity). However, due to the availability and accuracy of data, the load factor was viewed as the data for this measure.

The minimum passing threshold for the overloading measure is 90% of seated capacity. Any value that is over 90% of seated capacity is considered deficient. It should be noted that Metro's definition of "overloading" is 120% of seated capacity for 20 minutes or more, and therefore the worst value is anything "approaching overloaded" which is greater than 110% of seated capacity.

**Travel Speed**

The Travel Speed indicator is derived from Automatic Vehicle Location (AVL) data. The actual value is derived by taking the lowest ratio of average speed divided by the assumed posted speed limit from each time of day period (AM, Midday, PM, Evening and Overnight). The posted speed limit is based on the road classification in the King County GIS road network:

- Local = 25 mph,
- Collectors and minor arterials = 30 mph,
- Principal arterials = 40 mph,
- Freeway = 60 mph.

It should be noted that actual posted speed limits may not always match the speed limits assigned to the King County road classification. For the purposes of this monitoring project, however, the classification-based speed limits are assumed to be accurate. *This is an area of refinement for future iterations.* When assessing speed deficiencies, it will be important to check the SDOT database of posted speeds, to ensure that it does not differ from the classification-based speed. The posted speed should prevail if there is a discrepancy.

The proposed methodology for this measure is simplified from what was proposed in the Seattle Transit Plan. Rather than evaluate different ranges of the percent of posted speed limit (as is done in Table 19 of the STP), all services are measured in simple value ranges, such as: "Transit services operate between 40-50% of the posted speed limit." This method was selected due to the complexity related to reporting different ranges of the percent of posted speed limit. Because of the speed limits on the road classifications (ranging from 25 to 60 mph), the minimum passing speed on the UVTN is 7.5 miles per hour (i.e., 30% x 25 mph = 7.5 mph). The minimum threshold as a percent of posted speed limit is 30%. UVTN segments where transit operating speed drops below 30% of posted speed limit are considered deficient.

**Reliability**

The Reliability indicator is derived from the Automatic Vehicle Location (AVL) data. The value is a coefficient that is determined from calculating the *standard deviation of actual travel time* (in minutes) divided by the *base travel time* (in minutes). The value measures the effect of headway variation for a trip lasting 30 minutes.

The *base travel time* (or expected travel time) is determined from the posted speed limit (using the King County street classifications, as discussed in the "Travel Speed" section above) and street segment length in miles. For example, if a street segment has a posted speed limit of 25 mph and a distance of 1 mile, the base travel time is estimated as 2.4 minutes (1 mile/25 miles per hour x 60 minutes per hour). The *actual travel time* is estimated by a weighted share of the TPI (trip between timepoints) actual travel time using posted speed and segment length to disaggregate to the individual street segments. The *standard deviation of actual travel time* is then taken for all recorded values during the AM, MID and PM time periods and the least desirable value from each of these periods is selected.

The *standard deviation of actual travel time* is then divided by the *base travel time* to produce a coefficient that represents reliability, akin to a coefficient of variability. Because bus travel times are expected to be higher than base travel times, this calculation results in ratios that are almost always over 1 (indicating that the standard deviation is greater than the expected travel time). The reliability value is then adjusted down to account for slower acceptable transit speeds, as discussed above. The ratio is multiplied by 30%, the minimum passing value for transit speed. Although 30% was chosen because it is the minimum passing value, this is a somewhat arbitrary figure. However, because all values were consistently multiplied by 30%, the ratio between *actual* and *expected* travel time remains accurate.

Although the proposed methodology for this measure is different from that shown in the Seattle Transit Plan, the ultimate goal of measuring variation in headway is still accomplished. Any UVTN segment with a Reliability value between 0 and 0.4 is considered passing, while any segment with a value over 0.4 is considered deficient.

# Chapter 3. UVTN Corridor Performance Analysis

This chapter summarizes the results of the UVTN corridor performance analysis for the five performance measures discussed in Chapter 2. Two products are presented in this chapter:

- **A series of maps displaying the values of each performance measure.** The maps display the values by each individual street segment where transit services currently operate, rather than being aggregated by UVTN corridor. Values are presented as the actual values, but are color-coded by the quality of service score they receive.
- **A table displaying the performance of each UVTN corridor.** Based on Table 11 in the Seattle Transit Plan, the performance of the transit network is aggregated by corridor since it is important to emphasize the cumulative performance of a larger corridor rather than the performance of a particular segment of that corridor.

Since this is the first official monitoring of the UVTN, it is also important to note where existing transit service does not currently exist, and therefore a particular segment of the UVTN cannot be monitored. This consists of street segments that have no transit service, as well as those street segments where bus service does exist but service levels are well below that needed to satisfy the requirements of the UVTN.

Currently, four UVTN segment do not have any existing transit service, or if there is service it is well below the requirements of the UVTN:

- Gilman Drive W and Howe Street W between 10th Avenue W and 15th Avenue W.
- 15$^{th}$ Avenue E (north of Galer) and E Boston Street between 15$^{th}$ Ave E and 10$^{th}$ Ave E.
- 14$^{th}$ Avenue E between Madison and Jackson.
- Spokane Street between 1$^{st}$ Avenue S and the bus lane.

Figure 4 presents a map of the entire UVTN, highlighting the segments of the UVTN that have no transit service or that service is far below the requirements of the UVTN.

It should be noted that the Seattle Transit Connections map (Figure 1) identifies several "alternative" UVTN corridors. These alternative corridors were developed in areas where multiple streets could be used, such as the connection between Fremont and the University District. For the purposes of this first monitoring report, however, only the corridors that are closest to having UVTN levels of service were monitored. It is recommended that future iterations of the UVTN monitoring process be clear about the alternative corridors, and that a policy decision be made that selects a preferred corridor for inclusion in the UVTN.

*Figure 4 UVTN and Segments with No Existing Transit Service*

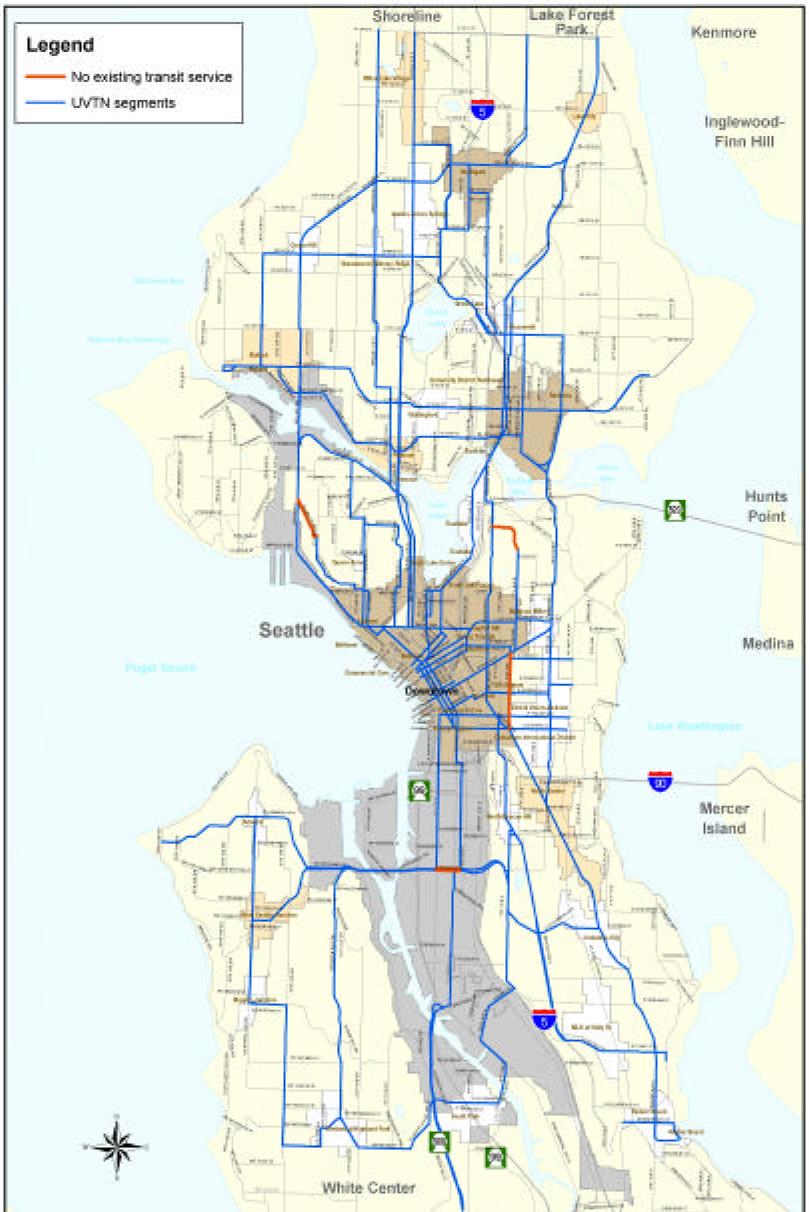



Figure 4: UVTN Network and Segments with No Existing Transit Service

## Evaluation of UVTN Corridors

The following section evaluates how the entire UVTN performs with regard to the five performance measures. Each individual performance measure is discussed separately and the maps show performance for each individual street segment where bus service currently exists.

Following this section will be an evaluation of the UVTN corridors as presented in Table 11 of the Seattle Transit Plan. Rather than evaluate the performance of each individual street segment in the UVTN, this section will aggregate the performance data to each UVTN corridors. This performance will be displayed in the UVTN report card (Figure 10).

### Frequency

As shown in Figure 5 below, midday headway between buses is currently meeting or exceeding the minimum threshold of 15 minutes in many UVTN corridors. As expected, midday headways are the lowest on some of the major transit corridors, such as:

- 23rd Avenue E between Madison and the University District
- Fairview Avenue N between Eastlake Avenue and the University District
- Pacific Street and 15th Avenue NE in the University District
- Aurora Avenue N between Fremont and W Mercer Street
- The bus lane between Spokane Street and Jackson Street
- Spokane Street between West Seattle and the E-3 busway
- Several portions of Rainer Avenue S
- Meridian Avenue N near North Seattle Community College
- Most major transit streets downtown.

Several corridors do not have any midday service:

- 14th Avenue E between Jackson Street and Union Street
- Montlake Boulevard on the University of Washington campus
- SW Spokane Street between 1st Avenue S and the E-3 busway
- Highway 99 south of E Marginal Way
- Leary Avenue NW between 8th Avenue NW and 15th Avenue NW and between 3rd Avenue NW and Fremont Avenue
- Weedin Place and 5th Avenue NE (south of N 80th Street)
- Lake City Way between NE 75th Street and NE 95th Street
- N 115th Street between Aurora and Northwest Hospital

*Figure 5 Service Frequency in Relation to Proposed UVTN Criteria*


* Frequency of Service is the longest actual headway between buses.

**Service Span**

As shown in Figure 6 below, service span for services with frequencies every 15 minutes or better pass on many UVTN corridors in central Seattle, as well as between downtown and Fremont, downtown and Ballard and downtown and the University District. Likewise, the four major transit corridors south of downtown (1st Avenue S, the E-3 busway, Rainer Avenue S and Beacon Avenue S) all pass the Service Span measure.

Some of the corridors with the least amount of high frequency service include:

- 15th Avenue NW between Leary Avenue NW and NW 85th Street
- Greenwood Avenue N between N 105th Street and N 130th Street
- 3rd Avenue W between Nickerson Street and W McGraw Street
- Denny Way between 5th Avenue N and Olive Way
- Broadway Avenue/Boren Avenue between Madison Street and Jackson Street
- 35th Avenue SW between SW Morgan Street and SW Barton Street
- Highway 99 south of Marginal Way
- Jackson Street between Rainier Avenue S and 23rd Avenue E

There are also a number of UVTN segments that currently do not have any service that operates every 15 minutes, including:

- 14th Avenue E between Jackson Street and Union Street
- Yesler Way between Boren Avenue and 23rd Avenue E
- Most of Admiral Way in West Seattle
- S Myrtle Place and Othello Street
- Most of 15th Avenue S between Beacon Avenue and I-5
- W Olympic Place, Olympic Way W and 10th Avenue W
- Westlake Avenue between Valley Street and Denny Way
- NW Leary Way between 15th Avenue N and Aurora Avenue N
- N 34th Street and N Pacific Street
- E Green Lake Drive and N 50th Street
- All of Holman Road NW
- NE Northgate Way between Roosevelt Way and Lake City Way

*Figure 6 Service Span in Relation to Proposed UVTN Criteria*

**Passenger Loading**

As shown in Figure 7 below, failures on this performance measure occur in the following main corridors:

- Lake City Way NE between NE 125th Street and Roosevelt Way NE
- 25th Avenue NE between NE 45th Street and NE 65th Street
- NE 45th Street between I-5 and 15th Avenue NE
- 3rd and 4th Avenues in downtown Seattle
- 1st Avenue S between Jackson Street and S Spokane Street
- E-3 Busway between Jackson Street and S Spokane Street
- SW Spokane Street between 1st Avenue S and Delridge Way SW
- Admiral Way between California Avenue SW and the West Seattle Bridge
- Rainier Avenue S between S Dearborn Street and MLK Jr Way S
- E Pike Street between 4th Avenue and Broadway
- 1st Avenue N between Denny Way and W Mercer Street
- 15th Avenue NE between NE 45th Street and NE Pacific Street

*Figure 7 Passenger Load in Relation to Proposed UVTN Criteria*


* This value is the ratio of passenger load to seated capacity (load factor) on the most crowded route, 85% of the time.

### Travel Speed

Figure 8 below shows one of the critical components of the UVTN, travel speed as percent of the posted speed limit. As shown in the map, many of the UVTN streets in downtown Seattle and around the University District are deficient in this measure. Outside of these districts, there are several major corridors where travel speed is low compared to posted speed limit:

- Most of 45th Street and NW Market Street between the University District and Ballard
- 11th/12th Avenue NE and Roosevelt Way NE between the University District and NE 75th Street
- 85th Street between Wallingford Avenue and 15th Avenue NW
- All of Broadway south of Roy Street
- Jackson Street west of 23rd Avenue South
- All of Denny Way
- Queen Anne Avenue N between Denny Way and Mercer Street

*Figure 8 Travel Speed in Relation to Proposed UVTN Criteria*

### Reliability

Reliability, shown in Figure 9, tracks very closely with Travel Speed; i.e. segments deficient in one tend to be deficient in both. As with Speed, poor Reliability scores show up on many segments downtown and in surrounding neighborhoods, as well as in the University District. The entire Ballard-University corridor also stands out as deficient for Reliability, as it is for Speed.

*Figure 9 Reliability in Relation to Proposed UVTN Criteria*


* Coefficient of variation representing the highest observed travel time standard deviation divided by the expected travel time.

## Review of Aggregated UVTN Corridors

This section evaluates corridor performance (based on the five performance measures) for the 53 UVTN corridors, as shown in Table 11 of the Seattle Transit Plan. In addition, eight more corridors that were shown in the Seattle Transit Connections map (Figure 11 in the Seattle Transit Plan) but not shown in Table 11 have been added as part of this monitoring process, notably the former Green Line monorail alignment and the proposed alignment of the South Lake Union streetcar. This results in a total of 61 unique UVTN corridors.

Some of the corridors (such as Corridor No. 17 in Table 11 – Aurora Avenue) are too long to evaluate as a whole. Therefore, some of the 60 UVTN corridors were broken into one or two different segments. Corridors were broken where existing transit lines enter or exit the UVTN corridor or where they intersect a major transit center (e.g., Montlake Station, University District, etc.). For example, the Aurora Avenue corridor (No. 17) was broken into three different segments:

- between NW 145th Street and NW 85th Street,
- between NW 85th Street and NW 45th Street and
- between NW 45th Street and Denny Way.

These three corridors were re-numbered as 17.1, 17.2 and 17.3, respectively. Following a similar procedure for the entire UVTN resulted in a total of 83 separate UVTN segments.

Performance in each of the 83 segments was then evaluated based on performance data aggregated to that entire UVTN corridor. When aggregating data for each corridor, it was necessary to make assumptions about how the data is reported. Four of the five performance measures (Frequency, Service Span, Reliability and Passenger Load) were reported by representing the worst case scenario. For example, if a corridor has headways that are greater than 10 minutes on some, *but not all*, of the corridor, then the worst headway is reported and the entire corridor is considered to be deficient with regard to the Frequency measure. The same would apply to the Service Span, Reliability and Passenger Load measures.

The only exception is the Speed measure, which was reported based on an average along the UVTN corridor. This approach, authorized by the definition of this measure in the Seattle Transit Plan reflects the focus on customer experience. In overall customer experience, speed on one segment can make up for slowness on another in determining overall travel time. Thus, a UVTN corridor can still be passing, even if transit speeds are slow at certain points along the corridor, so long as other points on the same corridor are correspondingly faster.

A summary of how each of the performance measures are aggregated is as follows:

- **Frequency:** maximum value
- **Service Span:** minimum value
- **Passenger Load:** maximum value
- **Travel Speed:** average value
- **Reliability:** maximum value

Figure 10 below presents a "UVTN Report Card" for all 83 UVTN segments and how they perform based on the five performance measures. The shaded cells in the five performance measures columns indicate that that corridor is deficient for that measure and an unshaded cell indicates a corridor is passing for that measure. The shading in the table indicate deficient scores (corresponding to the legends in Figures 5-9 above), with the darker shade indicating a worse score. It should be noted that an electronic version of this table also exists that allows sorting by each of the five performance measure columns to determine which corridors are passing and which corridors are deficient.

*Figure 10 UVTN Report Card*

| UVTN | UVTN Segment | | | Values | | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Primary Street of Corridor Segment | Between… | And… | **Frequency (MAX)** | **Service Span (MIN)** | **Speed (AVG)** | **Reliability (MAX)** | **Passenger Load (MAX)** |
| 1 | Fairview, Steward/Virginia | Steward | University Dist. | 15.00 | 12 | 23.56% | 1.86512 | 0.89429 |
| 2 | 1st, Broad | Denny & QA Ave | 3rd & Broad | 8.57 | 18 | 24.11% | 0.26756 | 1.42355 |
| 3 | 3rd | Cedar | Jackson | 8.57 | 1 | 20.72% | 1.18453 | 1.42355 |
| 4 | James | 3rd | 9th & Jefferson | 9.80 | 18 | 13.55% | 1.44084 | 1.0554 |
| 5 | Olive | 1st | I-5 | 30.00 | 7 | 21.91% | 0.88086 | 0.98103 |
| 6 | Pike/Pine | 1st & Pike/Pine | Pine & Summit | 30.00 | 10 | 15.59% | 1.9903 | 1.10913 |
| 7.1 | Yesler | 1st | MLK | 30.00 | 12 | 31.46% | 0.64712 | 0.89149 |
| 7.2 | Jackson | 1st | MLK | 30.00 | 1 | 22.96% | 7.66199 | 1.13789 |
| 8.1 | Boston/15th Ave[2] | 10th/Boston | Madison | 30.00 | 1 | 34.07% | 0.95277 | 0.56969 |
| 8.2 | 14th Ave[3] | Madison | Jackson | | | | | |

[2] This segment will also include the portion of 15th Ave E north of Galer Street and Boston Street between 15th Ave E and 10th Ave E. Currently, no bus service exists in this corridor, and therefore these values only represent service on 15th Avenue E south of Galer Street.

[3] No data is available for this segment of 14th Avenue E because only Owl service is provided.

| UVTN ID | UVTN Segment Primary Street of Corridor Segment | Between… | And… | Values Frequency (MAX) | Service Span (MIN) | Speed (AVG) | Reliability (MAX) | Passenger Load (MAX) |
|---|---|---|---|---|---|---|---|---|
| 9.1 | Broadway, 10th Ave E | Eastlake | Thomas | 15.00 | 14 | 33.53% | 0.65656 | 0.56666 |
| 9.2 | Broadway | Thomas | Yesler | 43.64 | 3 | 23.66% | 0.5105 | 0.82164 |
| 10 | Jefferson, Cherry | 9th & Jefferson | MLK & Cherry | 30.00 | 1 | 26.79% | 1.41001 | 1.03714 |
| 11.1 | Madison | 6th Ave | 14th Ave | 20.00 | 6 | 17.72% | 0.96154 | 0.82164 |
| 11.2 | Madison | 14th Ave | 23rd Ave | 30.00 | 3 | 26.17% | 0.44383 | 0.85778 |
| 12 | Madison, Spring, Marion | Western Ave | 6th Ave | 15.00 | 12 | 13.12% | 1.4476 | 0.81874 |
| 13 | Olive, John, Thomas | Pine & Summit | 23rd & Thomas | 12.00 | 12 | 23.04% | 0.6457 | 0.98103 |
| 14.1 | Pine | Pine & Summit | Madison | 10.00 | 16 | 20.49% | 0.58003 | 1.07802 |
| 14.2 | Union | Madison | MLK & Union | 15.00 | 10 | 27.60% | 0.29666 | 0.57047 |
| 15.1 | 23rd/24th Ave | Montlake Station | Thomas | 6.86 | 19 | 33.28% | 0.33344 | 0.9984 |
| 15.2 | 23rd/24th Ave | Thomas | Rainier | 15.00 | 13 | 27.88% | 0.60103 | 0.65623 |
| 16 | 92nd St, 1st Ave NE | 92nd & Meridian (NSCC) | Northgate LRT | 7.38 | 14 | 45.57% | 1.09308 | 0.97118 |
| 17.1 | Aurora | Denny | 45th St | 15.00 | 13 | 31.66% | 0.65971 | 0.53268 |

| UVTN ID | UVTN Segment: Primary Street of Corridor Segment | Between… | And… | Values: Frequency (MAX) | Service Span (MIN) | Speed (AVG) | Reliability (MAX) | Passenger Load (MAX) |
|---|---|---|---|---|---|---|---|---|
| 17.2 | Aurora | 45th St | 85th St | 15.00 | 13 | 35.81% | 0.35738 | 0.60217 |
| 17.3 | Aurora | 85th St | 145th St | 15.00 | 13 | 39.29% | 0.36963 | 0.90404 |
| 18 | Green Lake, 65th St, Wallingford, 85th St | 85th St & Aurora | Roosevelt LRT | 15.00 | 11 | 27.72% | 0.601 | 0.92443 |
| 19.1 | Greenwood | 85th St | 145th St | 30.00 | 1 | 35.83% | 0.48723 | 0.47157 |
| 19.2 | Greenwood, Phinney, Fremont | 85th St | Fremont Bridge | 14.55 | 11 | 34.66% | 0.72513 | 0.69454 |
| 19.3 | Fremont | Fremont Bridge | Nickerson | 10.00 | 14 | 37.34% | 0.46157 | 0.9831 |
| 20 | N 45th St | Stone Way | University Dist. | 15.00 | 14 | 22.46% | 2.19562 | 1.12869 |
| 21 | Wallingford, College Wy, Meridian (NSCC) | 85th St | Northgate Wy | 20.00 | 5 | 41.56% | 0.28012 | 0.64504 |
| 22 | N 115th St, Meridian Av | 115th St & Aurora | Meridian & Northgate Wy | 15.00 | 12 | 45.46% | 0.19916 | 0.50928 |
| 23 | N/NE 40th St | Stone Way | University Dist. | 15.00 | 10 | 36.67% | 0.91818 | 1.26603 |
| 24 | Holden, NE 105th St, Northgate Wy | Crown Hill | 1st Ave NE | 30.00 | 1 | 34.82% | 0.39778 | 0.77486 |
| 25 | 5th Ave NE, Weedin Pl, 103rd St | Roosevelt LRT | Northgate LRT | 15.00 | 13 | 41.12% | 1.13693 | 0.77486 |

| UVTN | UVTN Segment | | | Values | | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Primary Street of Corridor Segment | Between… | And… | Frequency (MAX) | Service Span (MIN) | Speed (AVG) | Reliability (MAX) | Passenger Load (MAX) |
| 26 | 15th Ave NE | University Dist | Roosevelt LRT | 15.00 | 13 | 30.71% | 0.85981 | 1.02822 |
| 27 | 15th Ave NE, Pinehurst | Northgate Wy | 145th St | 15.00 | 13 | 36.37% | 0.33101 | 0.82287 |
| 28 | 25th Ave NE | NE 45th St | NE 65th St | 14.55 | 12 | 37.13% | 0.14409 | 1.39688 |
| 29.1 | Lake City Wy | NE 65th St | Northgate Wy | 19.20 | 9 | 38.86% | 0.47053 | 1.16869 |
| 29.2 | Lake City Wy | Northgate Wy | 145th St | 15.00 | 6 | 36.30% | 0.25848 | 1.16869 |
| 30 | Montlake | Montlake Station | NE 45th St | 18.46 | 3 | 21.07% | 0.78731 | 1.39688 |
| 31 | NE 45th St, Sand Point | University Dist | Princeton/Sand Pt (NE 50th St) | 60.00 | 4 | 31.49% | 2.19562 | 1.12869 |
| 32 | NE 65th St | Roosevelt LRT | 25th Ave NE | 30.00 | 5 | 32.11% | 0.46282 | 0.8028 |
| 33 | Pacific St | Montlake Station | University Dist. | 20.00 | 4 | 20.61% | 0.72123 | 1.02822 |
| 34 | 24th Ave NW | NW 65th St | NW 85th St | 12.00 | 13 | 43.54% | 0.30206 | 0.57558 |
| 35 | Leary, 20th Ave NW | 20th Ave & Market | 14th Ave NW & Leary | 30.00 | 16 | 27.60% | 1.96484 | 0.81483 |
| 36 | Leary, NW 39th St | 14th Ave NW & Leary | Stone Way | 30.00 | 2 | 36.63% | 0.67771 | 0.86118 |
| 37 | Market, N 46th St | 32nd Ave NW & Market | Stone Way | 15.00 | 14 | 26.31% | 1.14816 | 0.92409 |

| UVTN ID | UVTN Segment Primary Street of Corridor Segment | Between… | And… | Values Frequency (MAX) | Service Span (MIN) | Speed (AVG) | Reliability (MAX) | Passenger Load (MAX) |
|---|---|---|---|---|---|---|---|---|
| 38 | NW 85th St | 24th Ave NW | Aurora | 15.00 | 12 | 33.03% | 0.54 | 0.88211 |
| 39 | 1st Ave S | Yesler | Spokane | 14.55 | 13 | 31.64% | 0.76274 | 1.27079 |
| 40.1 | 14th Ave S | Jackson | Beacon | 20.87 | 3 | 33.94% | 0.41383 | 1.05917 |
| 40.2 | 15th Ave S, Albro, through Georgetown and South Park to White Ctr | Beacon | Delridge & Barton | 34.29 | 1 | 39.42% | 0.36806 | 1.12869 |
| 41.1 | 4th Ave S | Spokane | Michigan St | 15.00 | 14 | 42.47% | 0.19822 | 0.6604 |
| 41.2 | 1st Ave S Bridge ,SR 99 Limited Stop | Michigan | SR 99 | 240.00 | 2 | 48.74% | 0.16693 | 1.12869 |
| 42.1 | Beacon | Beacon & 14th Ave S | Beacon & Myrtle | 10.00 | 13 | 43.74% | 0.50991 | 0.99804 |
| 42.2 | Myrtle, Othello | Beacon & Myrtle | East end of Othello | 30.00 | | 35.60% | 3.70247 | 0.62597 |
| 43 | E3 Transitway, Limited Stop | King Street LRT | Spokane | 5.00 | 18 | 37.91% | 0.4918 | 1.44 |
| 44.1 | Rainier | Yesler | Rainier & McClellan | 240.00 | 6 | 28.56% | 0.43272 | 1.06286 |
| 44.2 | Rainier | Rainier & McClellan | Rainier & Seward Park | 8.57 | 16 | 33.59% | 0.51695 | 1.06286 |
| 44.3 | Henderson, Seward Park | Henderson & MLK | Seward Park & Rainier | 11.71 | 13 | 40.61% | 0.52065 | 0.50363 |

| UVTN ID | UVTN Segment: Primary Street of Corridor Segment | Between… | And… | Values: Frequency (MAX) | Service Span (MIN) | Speed (AVG) | Reliability (MAX) | Passenger Load (MAX) |
|---|---|---|---|---|---|---|---|---|
| 45 | Spokane | 1st Ave S | 4th Ave S | | 2 | 26.09% | 1.08595 | 0.80636 |
| 45.1 | Admiral Way | 63rd Ave SW | Spokane & Admiral | 30.00 | 4 | 48.34% | 0.31378 | 1.19324 |
| 45.2 | Spokane | Spokane & Admiral Wy | Spokane & 1st Ave S[4] | 30.00 | 2 | 43.43% | 0.348 | 1.26222 |
| 45.3 | Columbian | Spokane & 4th Ave S | Columbian & Beacon | 30.00 | 2 | 37.54% | 0.46064 | 1.08621 |
| 45.4 | Columbian & Alaska Wy | Columbian & Beacon | Alaska & Rainier | 30.00 | 11 | 28.09% | 0.7751 | 0.80636 |
| 46.1 | California | Admiral Wy | Alaska Wy | 60.00 | 16 | 39.89% | 2.87946 | 0.51714 |
| 46.2 | California | Alaska Wy | Morgan Jct. | 30.00 | 16 | 40.07% | 0.19384 | 0.5175 |
| 47 | Delridge | Spokane | Westwood Vlg. / White Center | 16.00 | 11 | 41.81% | 0.29855 | 1.26222 |
| 48 | Morgan, 35th Ave SW, Roxbury | Morgan Jct. | Westwood Vlg. / White Center | 30.00 | 1 | 39.62% | 0.41513 | 0.81504 |
| 49 | 5th Ave N, Taylor Ave N, Boston | Denny & 5th Ave N | Boston & Queen Anne Ave | 20.00 | 6 | 33.90% | 0.39187 | 0.81166 |
| 50 | Dexter, Nickerson | Denny & Dexter | Fremont Bridge & Nickerson | 15.00 | 13 | 39.84% | 0.37776 | 0.99315 |
| 51 | Nickerson, 15th Ave W | Dravus & 15th Ave NW | Fremont Bridge & Nickerson | 30.00 | 3 | 36.72% | 0.53111 | 0.9831 |

[4] The section of Spokane between 1st Avenue N and the bus lane is part of the UVTN but not reported in this table because no continuous bus service operates here.

| UVTN ID | UVTN Segment Primary Street of Corridor Segment | Between… | And… | Values Frequency (MAX) | Service Span (MIN) | Speed (AVG) | Reliability (MAX) | Passenger Load (MAX) |
|---|---|---|---|---|---|---|---|---|
| 52 | Olympic, 10th Ave W, Gilman Drive W | Denny & QA Ave | Dravus & 15th Ave NW | 20.00 | 3 | 40.70% | 0.67847 | 0.65858 |
| 53 | Queen Anne Ave, McGraw, 3rd Ave W | Denny & QA Ave | Nickerson & 3rd Ave NW | 30.00 | 2 | 28.83% | 0.92073 | 1.42355 |
| 54.1 | 15th Ave NW | Leary | 85th St | 20.00 | 2 | 29.69% | 0.5319 | 0.79199 |
| 54.2 | 15th Ave W, Elliott | Leary Ave NW | Denny Wy | 17.78 | 2 | 46.06% | 0.26861 | 0.84245 |
| 55 | Denny Wy | Western Ave | Olive | 30.00 | 2 | 18.80% | 2.16377 | 1.05143 |
| 56 | Avalon, Alaska | Avalon & Spokane | Alaska & California | 15.00 | 2 | 38.76% | 1.84216 | 0.81504 |
| 57 | 2nd Ave | Stewart | Jackson | 5.33 | 20 | 16.58% | 1.30419 | 1.13789 |
| 58 | 4th Ave | Stewart | Jackson | 4.53 | 20 | 18.31% | 0.78456 | 1.44 |
| 59 | 5th Ave NE, Northgate Wy | 5th Ave NE & 103rd St | Northgate Wy & Lake City Wy | 30.00 | 1 | 30.23% | 0.3156 | 0.77486 |
| 60 | 11th Ave NE, Roosevelt Wy | NE 40th St | NE 65th St | 30.00 | 3 | 26.41% | 1.11327 | 0.79373 |
| 61 | South Lake Union Streetcar | Olive & Westlake | Fairview & Valley | 30.00 | 3 | 18.57% | 1.1068 | 0.68891 |

# Chapter 4. Improving Performance Measure Monitoring and Methodologies

The goal of the performance monitoring process is to evaluate quality of service (QOS) measures that focus on the customer's use of transit. The desired outcome of this process is to establish transit service in the UVTN that, over time, provides a "real choice" for how people travel in Seattle.

As noted in Chapter 2, the methodology used for this first performance monitoring of the UVTN differs somewhat from the methodology presented in the Seattle Transit Plan. In keeping with the spirit of the Seattle Transit Plan, the following adjustments to the methodology are recommended **if data becomes available, or an improved methodology can be developed**:

### Reliability

The Reliability measure used for this UVTN monitoring report evaluates actual travel times versus base travel times to produce a coefficient of variation (see page 16 for full description). This methodology is based on available data from King County Metro's AVL database, which measures travel times and calculates base travel times using posted speed limits.

Although this methodology was determined to be an adequate measure of travel time variation, the intention of Table 17 in the Seattle Transit Plan was to measure the reliability of *headway*. In high-frequency operations, such as the UVTN, customers typically do not plan their trip around a particular scheduled bus, but instead count on a bus to come soon whenever they arrive at a stop. A published headway of 5 minutes, say, should mean that a customer will never wait more than 5 minutes for a bus, and an effective reliability measure would capture this. The schedule-based measure of reliability is not adequate on this score. For example, if all the buses on a route were 6 minutes late, the route would still be perfectly reliable from this customer-centered perspective, but the schedule-based measure of reliability would describe this state as total failure.

Schedule based measures are perfectly appropriate for infrequent services where passengers must plan around a particular scheduled trip, but at very high frequencies, such as prevail on the UVTN, they can become misleading. It is recommended that if data becomes available, this measure evaluate headway reliability rather than travel time reliability.

### Passenger Loading (Overloading)

The Overload measure used for this report evaluated the load factor, which is the passenger load divided by seated capacity). Although this methodology is based on the ratio of passenger load to seated capacity (load factor) on the most crowded route, the intention of the Passenger Loading Measurement (Table 18 in the Seattle Transit Plan) was to measure the percent of *vehicle* capacity.

In keeping with the sprit of the Seattle Transit Plan, it is recommended that if data becomes available, this measure evaluate passenger load as a percent of vehicle capacity rather than a traditional load factor.

## Recommendations for Improving UVTN Performance

Based on the analysis of performance measures for each of the 83 UVTN corridors, SDOT has been, and will be, working with its partner transit agencies to improve performance of the UVTN. This will include developing infrastructure recommendations for specific locations, estimating costs, securing project funding, and developing project scopes, schedules and budgets.

Infrastructure recommendations will generally be improvements to streets and signals to smooth and expedite the flow of bus service. The benefits of these recommendations accrue mostly in two measures: Speed and Reliability. The other three measures – Frequency, Span, and Passenger Load – are largely a function of the quantity of service provided, as opposed to the fixed infrastructure. These service quality issues must be an area of separate effort between the City and King County Metro.

SDOT and King County Metro have already held two workshops (mid and late 2005) to begin developing an initial list of capital improvements for the UVTN. The last workshop included coordination with implementation of the "Bridging the Gap and "Transit Now" transportation funding measures that were approved by voters in fall 2006.

# Chapter 5. Next Report

This concludes the first performance monitoring report of the Seattle UVTN. While the purpose of the monitoring process should remain consistent over time, the format is flexible to reflect changing conditions and data availability as the UVTN develops. As noted earlier in this report, the goal of monitoring the five quality of service measures is to determine how well each of the UVTN corridors (and individual street segments) are performing and to identify specific locations where corrective actions should be taken to achieve the goals of the UVTN. To ensure that this happens on a regular basis, this monitoring report should be updated **at least every year** (as discussed in TSP Strategy TR1.3). Annual monitoring will enable SDOT and King County Metro to measure their progress, through the combined efforts of service and infrastructure, in their effort to bring the UVTN to fruition.

The key elements of the next report that require updating include:

- **UVTN map (Figure 4).** This map should be updated as needed as the UVTN evolves.
- **Performance maps (Figures 5 through 9).** These maps should be updated to reflect current performance of each of the five performance measures.
- **UVTN report card (Figure 10).** This table aggregates performance from each individual street segment to the 83 UVTN corridors and should be updated to reflect current system performance.
- **Recommended Infrastructure and Service Improvements.** Provide information on capital and service improvements that have been made to improve UVTN performance and, if possible, recommendations for future capital and service investment. .

This report is accompanied by several electronic files that were created especially for this project. These files are required to update the UVTN monitoring report in the future.

**GIS files:**

- **UVTN (by street segment**). This GIS file includes the entire UVTN that corresponds to the King County street network. It was necessary to develop the UVTN corresponding to the King County street network so that the performance data generated by King County Metro could be linked and ultimately mapped.

**Excel files:**

- **UVTN report card.** This file includes a list of the 83 aggregated UVTN corridors, along with conditional formatting that highlights segments that are deficient for each of the five performance measures. This file also includes a "Pass-Fail" column that identifies whether or not each corridor has passing performance for *all* five performance measures or is deficient (failing) in *any* of the five performance measures.

## Process for Updating This Report

As discussed earlier, King County Metro (KCM) and SDOT worked collaboratively to compile the performance data required for this project. KCM provided performance data for all street segments that currently have some level of transit service[5]. This data was delivered in the form of a database (DBF) file that included the five performance measures and a field identifying the appropriate King County street segment. It is expected in the future that SDOT and King County Metro will work together in a similar process.

Because the UVTN developed in GIS for this report is based on the King County street network, these two data sets could easily be linked. The common field name for the performance data is "Trans_Link" and the common field for the UVTN (or King County street network) is "Ramkey."

Once these two files were joined, it was then possible to display the performance data in gradients of red and green, indicating how each street segment performs in relation to the passing and deficient thresholds established for each performance measure (the legends of Figures 5 through 9 for the specific threshold values). These maps are a basis for developing infrastructure improvement recommendations.

This data was then aggregated to each of the 83 UVTN corridors, as shown in Figure 10. This was done using the "Dissolve" feature in GIS which aggregates data based on a common attribute – in this case, the UVTN identification number. Each street segment in the UVTN was assigned a corridor ID corresponding to the numbers in Table 11 of the Seattle Transit Plan. The Dissolve feature allows data to be aggregated by Average, Sum, Minimum Value, Maximum Value, Standard Deviation and Variance values. The header row of Figure 10 above shows how each of the five performance measures is aggregated (e.g., Frequency (MAX), Service Span (MIN), Speed (AVG), etc.). Through this process, a new GIS file was created that includes aggregated performance data for each of the 83 corridors. This data was then imported into Excel and used for the UVTN Report Card (Figure 10).

[5] As discussed above, the only UVTN segment that does not have existing bus service is Gilman Drive W and Howe Street W between 10th Avenue W and 15th Avenue W, and therefore no data exists for this segment. There were also three segments where the level of service is so far below UVTN requirements that no data is available.