

## Measure 4: Pedestrian Activity at Bus Zones

### Monitoring Objectives

The purpose of monitoring pedestrian activity at bus zones is to quantitatively assess pedestrian congestion at critical bus stops within the Seattle CBD. In particular, the study focuses on the impacts that transit tunnel closure had on pedestrian congestion at or near bus stops on surface streets. This portion of the study aims to answer the following key questions:

- How crowded are bus stops after tunnel closure?
- How easily can pedestrians flow through the bus stop area after tunnel closure?
- Does the tunnel closure have significant impacts on the pedestrian environment at or near bus stops?

### Methodology

This study focused on two elements of pedestrian congestion: pedestrian crowding and pedestrian flow.

Pedestrian crowding is applicable to waiting and queuing areas, and is based on the average space available per person. The *Transit Cooperative Research Program (TCRP) Transit Capacity and Quality of Service Manual* specifies criteria for Level of Service (LOS) designations ranging from A to F for queuing and waiting areas (Part 7, Chapter 3). In addition to these national guidelines, Metro applied its own criteria to the amount of space available per person in bus stop waiting areas. Metro established these criteria because of the unique operating requirements and observed pedestrian behavior at bus stops within the Seattle CBD.

The criteria for pedestrian crowding are shown in Figure 12. For each bus stop, the LOS for standing pedestrians will be reported separately for both the full bus zone waiting area, and for the critical loading area defined as the space within 100 feet behind the head of the bus stop.

**Figure 12. National and King County Metro criteria for Standing Pedestrian Level of Service (LOS)**

HCM Criteria	ft <sup>2</sup> /ped
LOS A	> 13
LOS B	10 -13
LOS C	6 - 10
LOS D	3 - 6
LOS E	2 - 3
LOS F	< 2

KCM Criteria	ft <sup>2</sup> /ped
Desirable	>17
Constrained	17 - 8
Uncomfortable	< 8

Pedestrian flow is applicable to the movement through the bus zone and is based on the number of pedestrians passing per minute passing through a walkway of limited width. The *2000 Highway Capacity Manual* specifies criteria for LOS designations of A through F for walkways. In addition to these criteria, pedestrian level of service will be further evaluated using procedures outlined in *Urban Spaces for Pedestrians* by Pushkarev and Zupan (1975), Figure 13 shows how these criteria relate to the number of pedestrians passing per minute through and area of unit width.

**Figure 13. Criteria used for Walking Pedestrian Level of Service (LOS)**

<b>HCM Criteria</b>	<b>pedestrians/feet/ minute</b>	<b>Pushkarev &amp; Zupan Criteria</b>	<b>pedestrians/feet/ minute</b>
LOS A	< 5	Open	< 0.5
LOS B	5 - 7	Unimpeded	0.5 - 2
LOS C	7 - 10	Impeded	2 - 6
LOS D	10 - 15	Constrained	6 - 10
LOS E	15 - 23	Crowded	10 - 14
LOS F	>23	Congested	14 - 18

To measure the pre-tunnel closure conditions, an initial pedestrian congestion study was conducted at 19 selected bus zones in spring of 2005<sup>1</sup>. For the subsequent after-tunnel closure study, conducted in fall 2005, six additional bus zones were added to the study, including newly installed zones, bringing the total number of zones counted to 25.

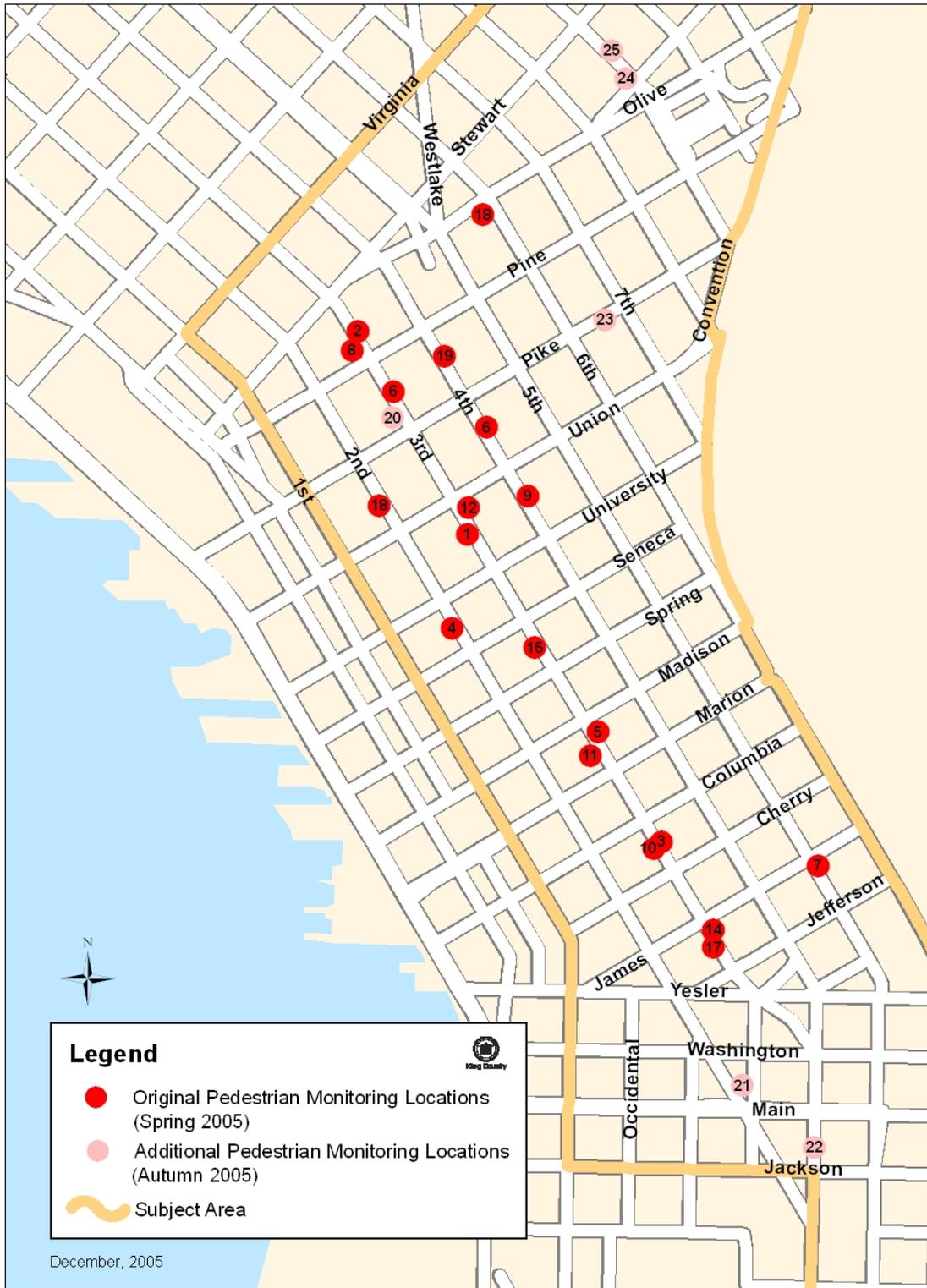
Each bus stop was observed for two days, during a two-hour period within the PM peak (3-7 p.m.) only. Data collection was done only on a Tuesday, Wednesday, or Thursday, between the dates of 10-04-2005 and 10-20-2005. Some data collectors counted the number of people waiting within the pre-defined waiting areas, and were responsible for taking a count every two to five minutes at the bus stop. Other data collectors continuously observed each bus stop, counting the number of people walking through the bus stop area in two to five minute intervals. In addition, staff noted the amount of sidewalk width available for pedestrians walking through the bus zone, since waiting passengers can reduce the amount of available width.

Additional pedestrian counts may be collected to assess follow-up efforts and to measure conditions after the tunnel is re-opened. The summary discussion at the end of this section provides some recommendations for a follow-up study.

Figure 14 shows the 25 bus stops that were surveyed in the fall 2005 post tunnel closure study.

<sup>1</sup> Pedestrian Congestion Study, Existing Conditions Analysis. 7-18-2005

Figure 14. Bus Stops Surveyed for Pedestrian Congestion Counts



## Comparisons with Pre-Tunnel Closure Conditions

Figure 15 summarizes the results of the before-closure and after-closure studies as they relate to pedestrians walking through the bus zones. Figure 16 summarizes the results of the before-closure and after-closure studies as they relate to pedestrians waiting at the bus stops. In both figures, hot spot locations are identified with light shading. These hot spot locations are discussed in more detail in the next subsection.

**Figure 15. Walking Pedestrian Rank and Level of Service by Bus Stop**  
(Map ID# corresponds to locations shown on Figure 14)

Location				Spring 2005 (before closure)		Autumn 2005 (after closure)	
Map ID #	Bus Stop #	Dir	On-street/Cross-street	Pushkarev & Zupan Rank	HCM LOS	Pushkarev & Zupan Rank	HCM LOS
1	450	SB	Third Ave./Union St.	Unimpeded	A	Unimpeded	A
2	590	NB	Third Ave./Pine St.	Unimpeded	A	Impeded	A
3	538	NB	Third Ave./Columbia St.	Unimpeded	A	Impeded	A
4	315	SB	Second Ave./University St.	Impeded	A	Impeded	A
5	548	NB	Third Ave./Madison St.	Unimpeded	A	Unimpeded	A
6	690	NB	Fourth Ave./Union St.	Impeded	A	Constrained	C
7	860	NB	Fifth Ave./James St.	Impeded	A	Impeded	A
8	430	SB	Third Ave./Pine St.	Impeded	A	Impeded	A
9	682	NB	Fourth Ave./University St.	Unimpeded	A	Impeded	A
10	490	SB	Third Ave./Columbia St.	Unimpeded	A	Impeded	A
11	531	NB	Third Ave./James St.	Unimpeded	A	Impeded	A
12	570	NB	Third Ave./Union St.	Impeded	A	Impeded	A
13	1040	EB	Olive Way/Sixth Ave.	Impeded	A	Constrained	C
14	480	SB	Third Ave./Marion St.	Unimpeded	A	Impeded	A
15	468	SB	Third Ave./Seneca St.	Impeded	A	Impeded	A
16	578	NB	Third Ave./Pike St.	Impeded	A	Impeded	A
17	500	SB	Third Ave./James St.	Unimpeded	A	Unimpeded	A
18	300	SB	Second Ave./Pike St.	Impeded	A	Impeded	A
19	700	NB	Fourth Ave./Pike St.	Unimpeded	A	Impeded	A
20	431	SB	Third Ave./Pike St.	[not counted]		Impeded	A
21	515	SB	Third Ave./Main St.	[not counted]		Unimpeded	A
22	619	NB	Fourth Ave./Jackson St. (Island)	[not counted]		NA	NA
23	1191	EB	Pike St./Sixth Ave.	[not counted]		Impeded	A
24	1913	SB	Ninth Ave./Howell St.	[not counted]		Impeded	A
25	1917	NB	Ninth Ave./Howell St.	[not counted]		Impeded	A

Most of the sidewalk segments within the bus stop zones currently operate at a high level of service, LOS A as measured by the HCM method, during the evening peak 15 minutes. However, two of the sidewalk segments have degraded to LOS C after the tunnel closure. A greater number of zones now operate with 'impeded' conditions according to the Pushkarev and Zupan ranking, which is a more stringent standard. The worsening of level-of-service in these cases is due to a combination of higher volumes of people walking on the sidewalks, and narrower effective widths available for walking due to some constriction.

**Figure 16. Standing Pedestrian Level of Service for Full Bus Stop Area and Critical Loading Zone**  
 (Map ID# corresponds to locations shown on Figure 14)

Location			Spring 2005 (before closure)				Autumn 2005 (after closure)			
			Full Zone		Critical Zone		Full Zone		Critical Zone	
Map ID #	Bus Stop #	On-street/Cross Street	HCM LOS	King County Rank	HCM LOS	King County Rank	HCM LOS	King County Rank	HCM LOS	King County Rank
1	450	Third Ave./Union St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
2	590	Third Ave./Pine St.	A	Desirable	A	Desirable	A	Constrained	A	Constrained
3	538	Third Ave./Columbia St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
4	315	Second Ave./University St.	A	Desirable	A	Constrained	A	Desirable	B	Constrained
5	548	Third Ave./Madison St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
6	690	Fourth Ave./Union St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
7	860	Fifth Ave./James St.	A	Desirable	B	Constrained	B	Constrained	C	Uncomfortable
8	430	Third Ave./Pine St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
9	682	Fourth Ave./University St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
10	490	Third Ave./Columbia St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
11	531	Third Ave./James St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
12	570	Third Ave./Union St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
13	1040	Olive Way/Sixth Ave.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
14	480	Third Ave./Marion St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
15	468	Third Ave./Seneca St.	A	Desirable	A	Desirable	A	Desirable	A	Constrained
16	578	Third Ave./Pike St.	A	Desirable	A	Desirable	A	Desirable	A	Constrained
17	500	Third Ave./James St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
18	300	Second Ave./Pike St.	A	Desirable	A	Constrained	A	Desirable	B	Constrained
19	700	Fourth Ave./Pike St.	A	Desirable	A	Desirable	A	Desirable	A	Desirable
20	431	Third Ave./Pike St.	[not counted]				A	Desirable	A	Desirable
21	515	Third Ave./Main St.	[not counted]				A	Desirable	A	Desirable
22	619	Fourth Ave./Jackson St. (Island)	[not counted]				A	Desirable	A	Constrained
23	1191	Pike St./Sixth Ave.	[not counted]				A	Desirable	A	Desirable
24	1913	Ninth Ave./Howell St.	[not counted]				A	Desirable	A	Desirable
25	1917	Ninth Ave./Howell St.	[not counted]				A	Desirable	A	Desirable

During the PM peak period, most of the bus zones included in this study still operate at a high level of service, LOS A, as defined by the nationally accepted guidelines in the Highway Capacity Manual, and considering the entire bus zone waiting area. However, one full bus zone, NB Fifth Avenue at James Street has degraded to LOS B since tunnel closure.

Using a more stringent methodology developed by King County, the critical loading areas for seven of the bus zones experience some constraints or uncomfortable crowding. These degradations in levels-of-service are largely due to an increase in the number of people waiting at a bus stop at one time.

## Summary Observations

Based on the findings of the after-tunnel closure pedestrian congestion study, six hot spot locations were identified and further evaluated. The hotspots were defined as locations exhibiting at least one of the following: 'Constrained' walking conditions, 'constrained' waiting conditions in the full bus zone area, or HCM LOS B or worse conditions in the critical loading zone.

- **Zone 860 (NB Fifth Ave & James St):** Constrained waiting conditions and uncomfortable crowding in the critical loading area were observed. The excessive crowding has been attributed to the narrow sidewalk, and also due to service delays which increase the number of waiting passengers. Many transit routes that serve this bus zone originate in the north CBD area, and these buses were caught in delays on Stewart Street. Since the study was conducted in the first few weeks of tunnel closure, service reliability has improved. A follow-up study is recommended for this location to assess the impacts of a set of improvements on Stewart that will be fully implemented by January, 2006.
- **Zone 690 (NB Fourth Ave & Union St):** Constrained walking conditions were observed, this was attributed to the temporary construction fencing obstructing the sidewalk. The fencing has since been removed. Re-evaluating this bus zone with the new sidewalk width is recommended, but a re-count is not needed.
- **Zone 1040 (EB Olive Way & Sixth Ave):** Constrained walking conditions were observed, attributed to a narrow sidewalk and street furniture. The placement of street furniture was re-evaluated, but few opportunities were found for improvement. A follow up study is not recommended at this location, as conditions are not expected to change.
- **Zone 315 (SB Second Ave & University St):** Constrained waiting conditions in the critical loading area were observed, although the total bus zone area operated with desirable waiting conditions. To help improve pedestrian circulation around the zone, bus shelter side-panels have been removed. A follow up study is recommended to measure the effectiveness of this measure.
- **Zone 300 (SB Second Ave & Pike St):** Conditions similar to the bus zone at Second Avenue and University were observed at this location. A possible mitigation measure that could be taken is to remove the rear panels and benches of some of the bus shelters, to improve pedestrian circulation around the bus zone. The pedestrian crowding observed during the study may also be partly attributable to delays on Stewart Street, so it is recommended that no action be taken at this time. A follow-up study is recommended for this location.
- **Zone 590 (NB Third Ave & Pine St):** Constrained waiting conditions were recorded for the full bus zone area as initially defined. However, the bus zone waiting area defined for this stop did not include the area adjacent to the Macy's loading dock, to the north of the bus zone. During the survey, surveyors observed that transit passengers used this area during busy conditions. Since the zone functionally includes this area, a follow-up count is recommended to capture these additional waiting passengers and to then re-compute the level of service using the larger effective waiting area.