

## MEMORANDUM

**DATE:** January 25, 2010  
**TO:** Mark Dorn, URS  
**FROM:** DKS Associates  
**SUBJECT:** Streetcar Alignment Alternatives: Planning Level Traffic Analysis

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This memorandum summarizes the traffic analysis performed by DKS Associates for streetcar alignment alternatives at four locations in Central Seattle for the proposed First Hill-Capitol Hill streetcar line. The potential traffic impact at each of the four locations is summarized below.

### METHODOLOGY

The purpose of the traffic analysis is to identify any operational flaws and provide planning level traffic analysis to assist with the selection of a preferred streetcar alignment. Synchro traffic analysis software was used to conduct this analysis. This software can provide useful approximations about the operations of the impacted intersections with streetcar operations but it is limited in the type and level of analysis that can be performed. Because Synchro only approximates conditions over a one-hour period, it was used to approximate impacts over the one-hour PM peak period. It does not approximate conditions that may occur for any individual event during the peak hour. Actual conditions for individual signal cycles within the peak hour may vary (especially immediately during and/or after a streetcar preempt event), but the results presented represent the average condition over the whole one-hour peak period.

For each alternative, two conditions were analyzed: 1) average intersection conditions without streetcar operations and, 2) average conditions with streetcar operations. The City of Seattle existing conditions PM peak hour Synchro model was used to report conditions at individual intersections without streetcar operations. This model was modified to reflect conditions that would result with streetcar operations. Modifications to the existing conditions model were made to reflect:

- Changes in physical intersection geometry (number of lanes)
- Changes to intersection control (unsignalized versus signalized control)
- Changes to signal timing (adding signal phases for streetcar operation)
- Changes to intersection volume (where lanes are removed and traffic is diverted to other roadways)

For this planning level analysis, several key assumptions were made:

- The streetcar will run at 10 min headways.
- A separate signal phase and signal priority will be provided to the streetcar where it turns from one street to an adjacent cross street.
- When the streetcar passes straight through an intersection, a separate signal phase will not be provided. (The streetcar will run concurrent with the through traffic phase).
- PM peak hour represents the worst case traffic condition.

## **SUMMARY OF FINDINGS**

### **Second Ave S between S Main St and S Jackson St**

Two proposed streetcar alignment options, the Center Lane/Center Platform option and the Curb Lane/Curb Platform option, were modeled and analyzed. The analysis found that both options are viable with the Center Lane/Center Platform option resulting in less change and impact on traffic because it would provide two-way traffic without significantly degrading the quality of service for general purpose traffic. The Center Lane/Center Platform option would not divert southbound traffic to adjacent streets. The analysis assumed that the Seattle Fire Station headquarters located on the southwest corner of the Main Street/Second Avenue intersection would not be used for fire and emergency vehicle response or service (streetcar operations and platform location could impact emergency vehicle response time at the fire station).

### **Intersection of Broadway Ave & E Pike St**

The proposed First Hill streetcar would run through this intersection in the center of the street along Broadway Ave and would replace the existing southbound left turn lane with a center platform. The analysis found that the southbound left turn lane volume is low (less than 50 vehicles in the PM peak hour) and the elimination of this lane would only slightly increase the overall intersection delay over the PM peak hour and this increase in average intersection delay is not significant.

### **Intersection of James St and Minor Ave**

A potential northbound streetcar alignment was proposed to cross the unsignalized intersection of James St & Minor Ave. Under existing conditions, traffic on Minor Ave is regulated by a stop sign and only allowed to make a right turn onto James St. Due to the proximity of the intersections on James St, the two signalized intersections located at the cross streets immediate to the west (Boren Ave) and east (Broadway Ave) of Minor Ave may be affected by the streetcar operations at Minor Ave, therefore these intersections were also analyzed using the Synchro model. The analysis found that this potential streetcar alignment could have an adverse impact on PM peak traffic operations by increasing westbound queues to the intersection upstream at Broadway Ave. Additional analysis using a more refined tool (such as VISSIM) would be needed to quantify the magnitude of this impact.

## **SECOND AVE S BETWEEN S MAIN ST AND S JACKSON ST**

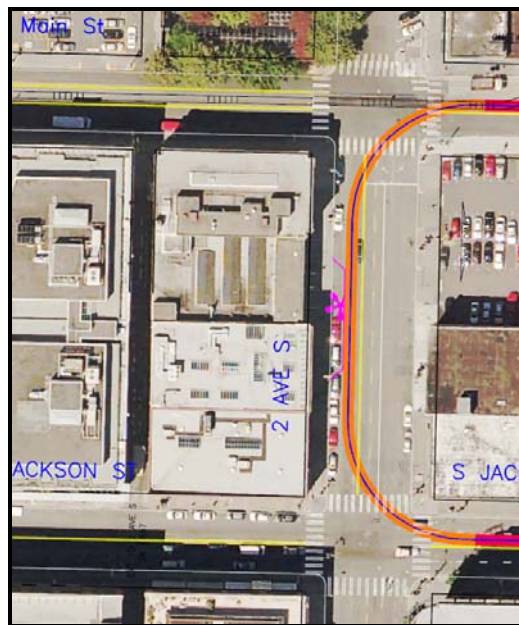
Second Ave S between S Main St and S Jackson St is currently a two way street with one lane in each direction with parking on either side. Additional travel lanes are provided at the Second Ave S/S Jackson St intersection. Second Ave S & S Main St is an all-way stop controlled intersection; while Second Ave S & S Jackson St is a signalized intersection. Within this block, besides local business, the old Seattle Fire Station 10 is located on the west side of the street. The fire station currently houses the Seattle Fire Department's headquarter staff, and for this analysis it was assumed that emergency-response vehicles do not originate from the fire station headquarters.

The streetcar station would be located on Second Ave S between S Main St and S Jackson St and the streetcar line would operate southbound on Second Ave S. Two potential streetcar track and platform alignment options including the Center Lane/Center Platform option and Curb Lane/Curb Platform option were analyzed.



**Figure 1 - Center Lane/Center Platform**

The Center Lane/Center Platform option, shown in Figure 1, was proposed to place the platform in the center of the roadway while still keeping this block as a two way street with parking but with one travelled lane in each direction.



**Figure 2 - Curb Lane/Curb Platform**

The Curb Lane/Curb Platform option, shown in Figure 2, would eliminate the southbound travelled lanes and place the platform on the westside of the block and the tracks in the curb lane. For general purpose traffic, this block would become a northbound one way street with two northbound general purpose lanes and a parking lane on the east side of the street.

The traffic impacts of the two streetcar alignment options were analyzed using Synchro for the PM peak hour condition. Intersection delay and level of service for general purpose traffic are summarized in Table 1. For unsignalized intersections, delay and level of service were reported for the approach with the worst operations. The existing condition of the two intersections was analyzed using the City's existing PM peak hour model. Changes to the existing conditions model were made to reflect proposed operations with the two streetcar alignments. For the Center Lane/Center Platform option, existing traffic volumes were assumed. For the Curb

Lane/Curb Platform option, existing southbound traffic on Second Ave S was redistributed to adjacent streets.

**Table 1 - PM Peak Signal Delay and Level of Service (Second Ave S)**

INTERSECTION	EXISTING CONDITION	STREETCAR W/ ONE-WAY TRAFFIC	STREETCAR W/ TWO-WAY TRAFFIC
S MAIN ST	A (9.0 s)*	A (5.3 s)	A (9.6 s)
S JACKSON ST	B (12.2 s)	B (11.6 s)	B (15.9 s)

\*SOUTHBOUND HAS THE WORST DELAY AND IS REPORTED FOR THE UNSIGNALIZED INTERSECTION

As shown in Table 1, traffic impacts caused by either of the two streetcar alignments would not degrade the level of service of the existing intersections. At the intersection of Second Ave S & S Jackson St, the overall intersection delay would increase slightly with the Center Lane/Center Platform option due to the fact that there would be only one lane in each direction on 2nd Avenue north of Jackson for general purpose traffic. (There are currently two lanes in each direction under existing conditions). The overall intersection delays would decrease slightly with the Curb Lane/Curb Platform option because of the one-way operations and the redistribution of the southbound traffic to adjacent streets. At the Second Ave S & S Main St, the average delay and LOS remains essentially the same.

### **INTERSECTION OF BROADWAY AVE AND E PIKE ST**

The intersection of Broadway Ave & E Pike St is currently a signalized intersection with a left turn pocket for each approach. The proposed First Hill streetcar would run through this intersection in the center of the street along Broadway Ave and would replace the existing southbound left turn lane at this intersection with a center platform (shown in Figure 3). The potential traffic impacts caused by the elimination of a southbound left turn lane were analyzed using Synchro.

The existing condition was analyzed using the City's existing PM Synchro model. The model was modified to assess the impacts of the proposed streetcar alignment. The southbound auto left turn movement was prohibited with the operation of the streetcar in this analysis because of

the location of the station platform and the conflict with the southbound streetcar operations. The southbound left turn volume was found to be less than 50 vehicles in the PM peak hour.



**Figure 3 - Center Lane/Center Platform on Broadway Ave at E Pike Street**

The intersection level of service and delay from Synchro is summarized in Table 2. The results showed that eliminating the southbound left turn lane would only slightly increase the overall intersection delay which is not significant.

**Table 2 – PM Peak Traffic Signal Delay and Level of Service (Broadway Ave at E Pike St)**

INTERSECTION	EXISTING CONDITION	WITH STREETCAR ALIGNMENT
		CENTER LANE/ CENTER PLATFORM
BROADWAY AVE/E PIKE ST	C (22.7 s)	C (23.6 s)

## INTERSECTION OF JAMES ST & MINOR AVE

A northbound streetcar alignment was proposed to cross the unsignalized intersection of James St & Minor Ave (Figure 5). Under existing conditions, traffic on Minor Ave is controlled by a stop sign and only allowed to make a right turn onto James St. Due to the proximity of the intersections on James St, the two signalized intersections located at the cross streets immediate to the west (Boren Ave) and east (Broadway Ave) of Minor Ave may be affected by the streetcar operations at Minor Ave, therefore these intersections were also analyzed.



**Figure 5 - James St at Minor Ave**

With the streetcar, a new signal and streetcar signal phase would be added to allow streetcars to cross James St. In order to analyze the impacts of the alignment, the following assumptions were made:

- Northbound Streetcar service would operate at 10-minute headway.
- A dedicated streetcar signal phase would facilitate streetcar movements across James St with a maximum signal phase of 20 seconds (including yellow and all red clearance).

The existing condition of the three intersections was analyzed using the City's existing PM Synchro model. With streetcar operations, traffic was analyzed with a new signal and streetcar

signal phase at Minor Ave. In addition to intersection signal delay and level of service, 95<sup>th</sup> percentile queue lengths on James St were also examined to evaluate the impacts to queues on James Street. The signal delay and level of service results are summarized in Table 5.

**Table 5 – PM Peak Signal Delay and Level of Service (James St)**

INTERSECTION	EXISTING CONDITION	WITH NORTHBOUND STREETCAR
BROADWAY AVE	D (36.6 s)	E (55.6 s)
MINOR AVE	A* (9.7 s)	A (6.3 s)
BOREN AVE	F (88.2 s)	F (N/A)

\*SOUTHBOUND HAS THE WORST DELAY AND IS REPORTED FOR THE UNSIGNALIZED INTERSECTION

The intersection level of service during PM peak hour is degraded at the Broadway Ave and Boren Ave intersections with the introduction of the traffic signal at Minor Ave. Even though the LOS at the Minor Ave intersection is very good (LOS A), the short spacing between the Broadway Ave, Minor Ave, and Boren Ave intersections results in the degradation of operations because of the queuing and congestion on James St. If the northbound streetcar signal phase is coordinated with the northbound phases at Broadway and Boren, this impact may be minimized or less severe than reported by Synchro. This type of coordination (constraining when the Minor St signal can go green for streetcar operations) would not allow for signal priority at the Minor Ave intersection for streetcar operations. Additional analysis using a more refined tool (such as VISSIM) would be needed to determine if signal coordination and limits on how the Minor Ave signal would operate could reduce and/or eliminate most if not all of these impacts.

Currently parking is not allowed on James St. There is no bus stop on James St in the study area. A potential streetcar alignment option would not create any impact on parking and bus operations in the study area.

In summary the introduction of a new signal at Minor Ave could disrupt traffic operations on James St by increasing westbound queues to the intersection upstream at Broadway Ave.

Placing constraints on the operations of the Minor Ave signal may mitigate these impacts but additional analysis beyond Synchro would be needed to evaluate this.