Appendix F:
Traffic Analysis, I-280

MEMORANDUM

Date: April 30, 2015

To: Susan Gygi, San Francisco Planning Department

From: Dennis Lee and Eric Womeldorff

Subject: Deterministic Model Queue Results for I-280/Railyards/Boulevard Project

SF14-0738

OBJECTIVE

Forecast the estimated queue length for northbound I-280 under various lane configurations at the 16th Street touchdown location and determine how many northbound "boulevard" travel lanes would be required to prevent queues from spilling back south of the US-101/I-280 interchange.

MODEL METHODOLOGY AND ASSUMPTIONS

A deterministic model was developed to forecast estimated queue lengths on I-280 northbound resulting from the reconfigured terminus at 16th Street. The evaluation concentrated on a 6-hour AM time period where northbound queues were observed to begin building during the 6:00 AM hour and dissipate by 12:00 PM noon. The model uses the following metrics to forecast queue lengths:

- Mainline demand
- Outbound capacity (i.e., northbound street capacity)
- Queue storage capacity
- % of right-turning vehicles at the touchdown location

24-hour (hourly) counts were provided by Caltrans at various sections of mainline and on/off ramps. The counts at each location were collected for several weeks' time between October 2010 and September 2011. Note that the widened 18th Street off-ramp and new Owens Street connection are not included as part of the analysis as that project is currently under construction.

Traffic counts are an appropriate proxy for actual demand if the counts are taken on a freeway segment under freeflow conditions. According to field observation and Google Maps historical traffic, I-280 between the US-101 and Cesar Chavez is under freeflow conditions during the AM peak hour. The counts between 6:00 AM and 12:00 PM at this location were used to derive northbound demand on the mainline across the 6-hour time period[1].

The outbound capacity of the Sixth Street and King Street exits were represented by observed volumes flowing from the freeway onto surface streets. Counts for Sixth Street / Brannan Street were collected in 2012, and the counts for Fourth Street / King Street were collected in 2013. For existing conditions, these two exits were collectively used to represent outbound capacity. It should be noted that the mainline and exit ramp counts are from different years, but both years are post-national economic recovery when average daily traffic levels entering and exiting downtown had begun to climb back near historic levels. The data are thus sufficient for this preliminary sensitivity test, but further data collection and micro-simulation analysis is recommended for a more detailed analysis.

Under existing conditions, the queue storage capacity on the freeway consists of two-lanes each at the Sixth Street and King Street exits and three-lanes combined south of the 18th Street on-ramp. There is an auxiliary lane between the 25th Street on-ramp and the 18th Street off-ramp which is not included as part of the queue storage capacity for the purposes of this sensitivity test.

Vehicle storage length in the queue was assumed to be 30 feet per vehicle, as is typical for ramp metering operations when vehicles are moving at stop-and-go speeds.

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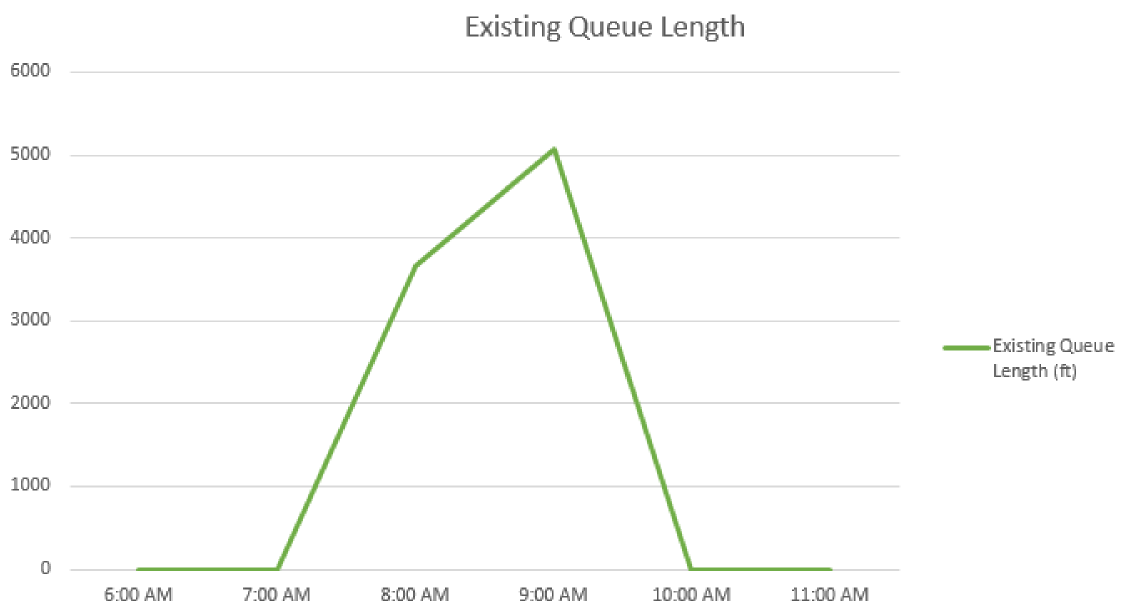
[1] Count data were incomplete with respect to all ramp locations upstream of the 6th Street and King Street exits. There are three lanes at the freeflow section of I-280 between US-101 and Cesar Chavez. The projected demand of 6,500 vehicles at this location is a conservative estimate, assuming a freeflow capacity of more than 2,000 vehicles per lane per hour. Demand was adjusted to account for the on and off volumes at the 18th Street/Mariposa Street and Indiana/Cesar Chavez Street ramps.

RESULTS

Existing Conditions

Results of the model for existing conditions show a maximum queue of approximately 5,000 feet, which would put the maximum end-of-queue around 20th Street and the queue would dissipate during the 9:00AM hour. This result is consistent with field observations and Google Maps historical traffic data.

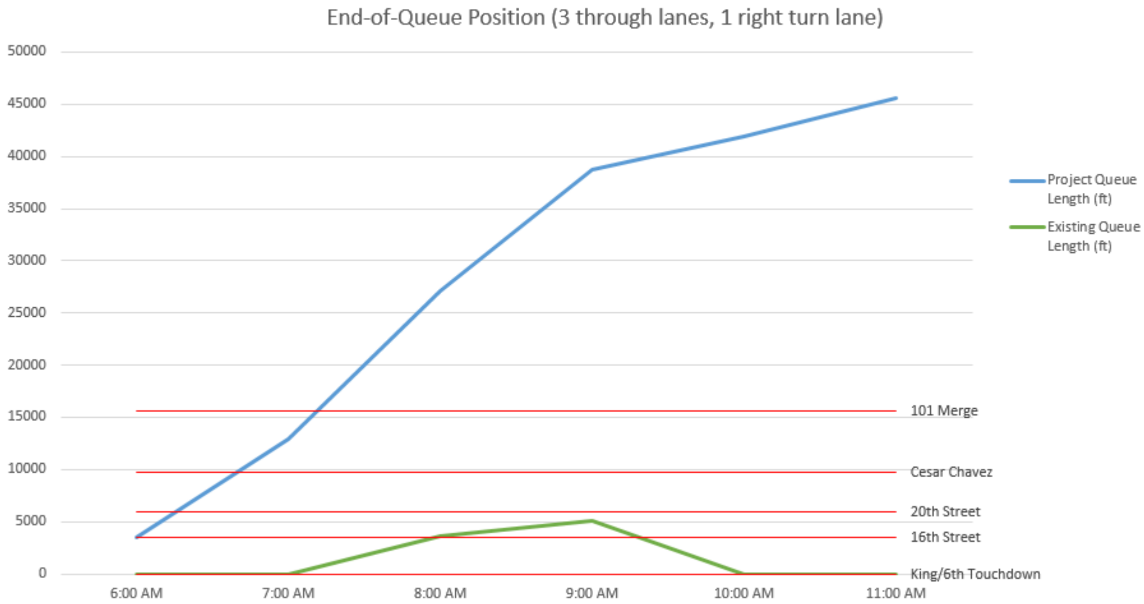


Touchdown with Three Through Lanes/One Right-Turn Lane

With the model calibrated, the first 16th Street touchdown configuration that was tested was with three through lanes and one right-turn lane at the approach to 16th Street. The queue storage space along the mainline was assumed to be three lanes wide, with a 500 foot right turn pocket before the intersection at 16th Street. The same demand as under existing conditions was used.

Under existing conditions, there is a high percentage of right-turners at the 6th Street exit. For the 16th Street touchdown configuration, the right-turn usage would be dependent on the destination of demand, which is unknown. Right-turns at 6th Street onto Brannan would likely shift to the through movement at the 16th Street touchdown, so it is expected that the right-turn percentage would be lower than under existing conditions. The right-turn percentage is 25% under existing conditions, while a lesser amount of 15% was used for the 16th Street touchdown.

As shown in the below figure, the touchdown configuration with three through lanes and one right-turn lane would result in a very long queue length, reaching well past the US-101 merge and theoretically extend nearly 9 miles long. The capacity of this configuration is unable to serve the cumulative demand in the 6-hour time period.



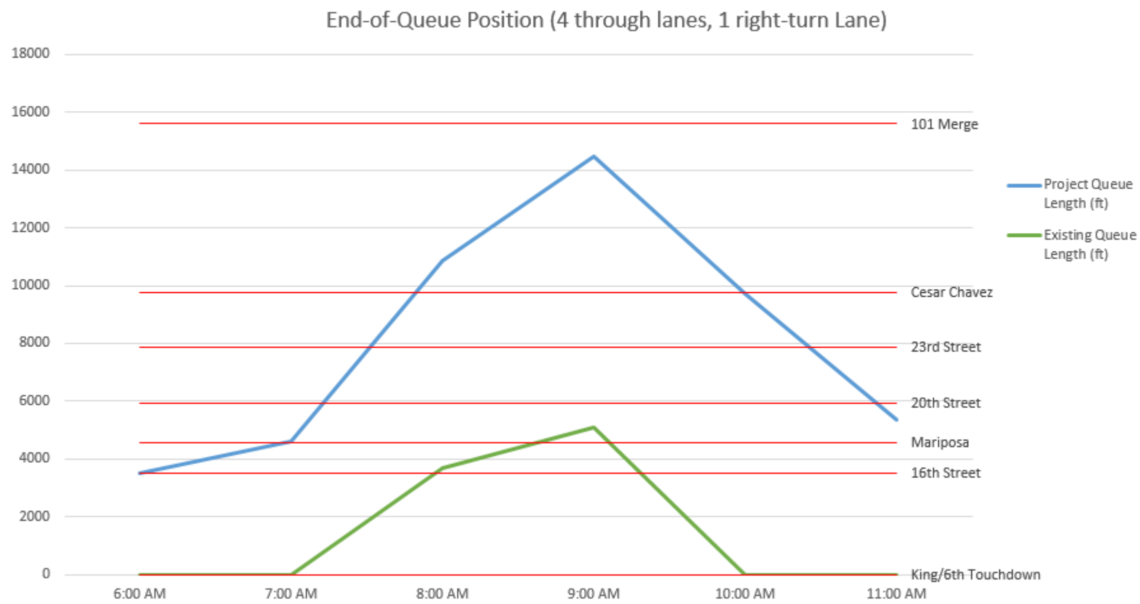
Touchdown with Four Through Lanes/One Right-Turn Lane

The touchdown configuration with four through lanes and one right-turn lane was tested next. The queue storage space along the mainline was assumed to be three lanes wide, opening to four lanes for 1000 feet before the intersection with a 500 foot right turn pocket. The right-turn percentage was also assumed to be 15%.

The above mock-up illustrates the extents of the four-lane portion of the exit ramp, along with the 500 foot right-turn pocket.

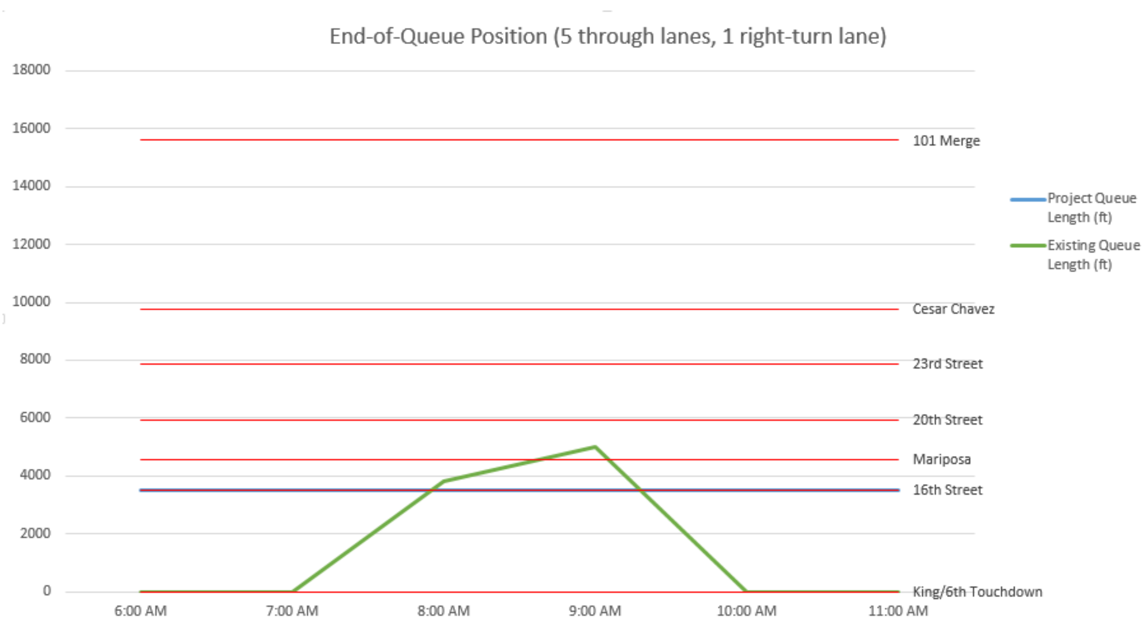
Although the demand and capacities are theoretically the same as existing conditions, the result is a curve that is different in shape to the existing queue curve. The queue length growth is much steeper due to the lower right-turn percentage, which shifts demand from the right-turn capacity and adds demand to the through movement. Additionally, differing queue storage capacities (the touchdown configuration has a much shorter 4-lane storage section) also causes the queue length growth to be steeper.

With this configuration, the theoretical end-of-queue is expected to reach just north of the US-101 merge and would not dissipate during the 6-hour time period.



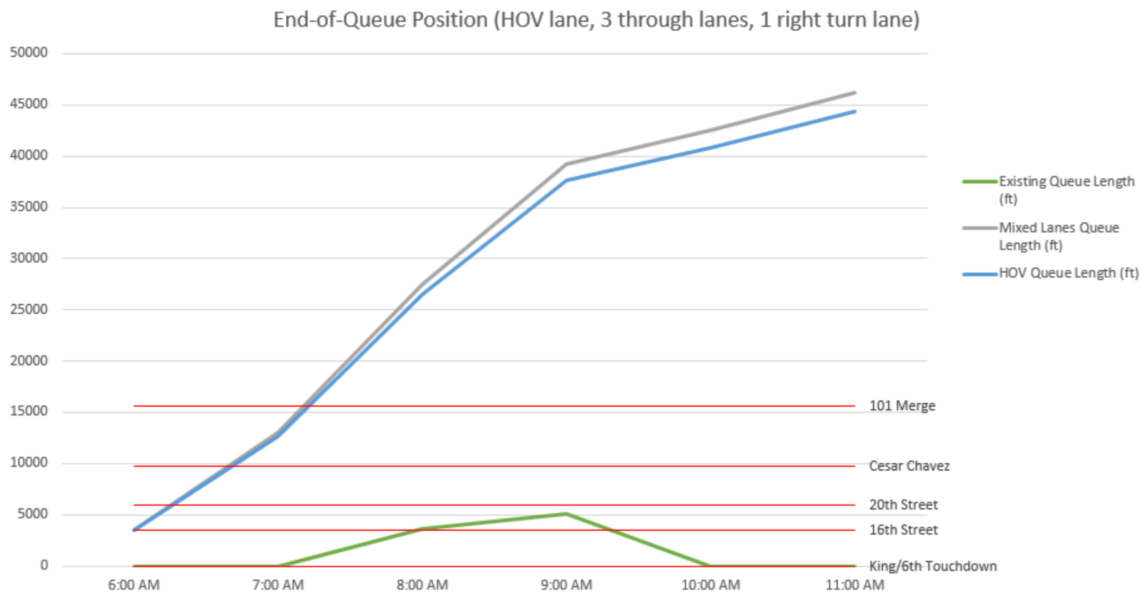
Touchdown with Five Through Lanes/One Right-Turn Lane

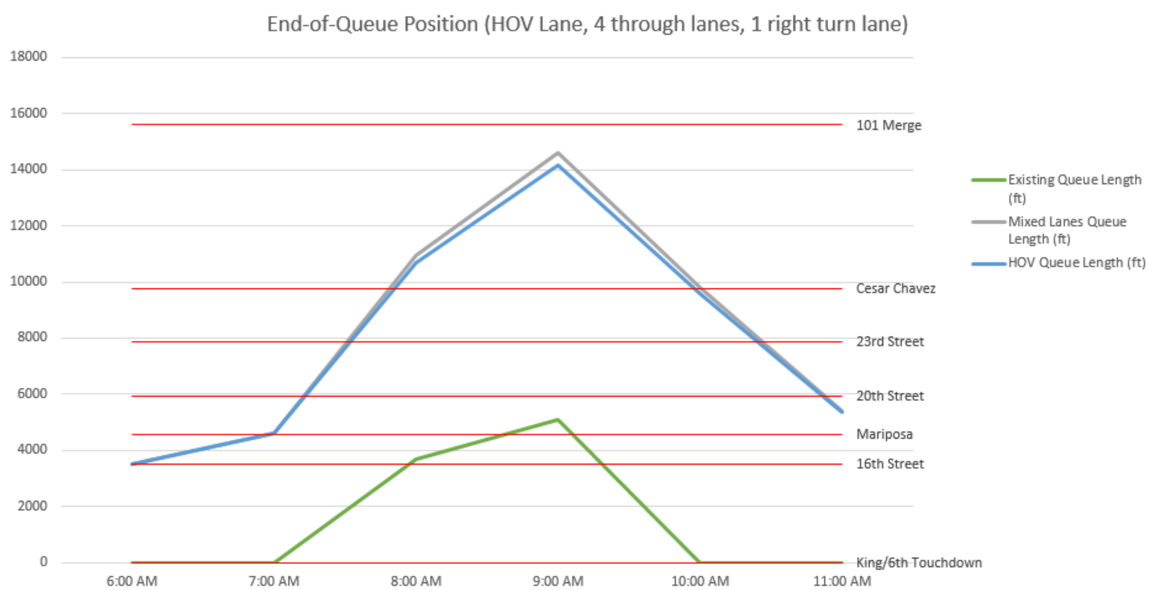
For a touchdown configuration with five through lanes under the same assumptions above, the model indicates that the queues would be at a minimum since the capacity of the bottleneck is greater than the demand. This conclusion is caveated by the fact that demand is less than 200 vehicles from the theoretical capacity, well within daily volume fluctuation for such a facility. Also, the model does not account for queue spillback on the boulevard due to downstream lane drops or other bottlenecks. The resulting curve is shown below.



Configuration with HOV Lane on I-280

Another scenario was tested with an HOV lane replacing one of the mixed-flow lanes on I-280. This configuration would have one HOV lane on I-280 which would continue onto the boulevard after the touchdown at 16th Street. HOV demand was assumed to fill the lane to freeflow capacity, 1450 vehicles per lane, and assigned to the HOV lane. The remaining demand was assigned to the two mixed flow lanes. The rest of the assumptions were the same as the above scenarios. The three- and four- lane results are shown below.





The curves are shaped similarly to the non-HOV scenarios, with the mixed-lane queues to be slightly longer than the HOV lane queue. This is expected as the demand assumption for the HOV lane was slightly lower than the demand per lane for the mixed flow traffic. The HOV scenario with 5 through lanes and 1 right-turn lane is not shown, as the result and caveats are identical to the non-HOV scenario with 5 through lanes and 1 right-turn lane.

Vehicle-Delay Calculation

Vehicle-delay was calculated using the hourly departures and estimated queue lengths for each hour. The following table presents the net change in vehicle delay for each scenario over existing conditions. Note that the HOV lane scenario results are not included since they are similar to the non-HOV lane scenarios.

NET DELAY PER VEHICLE (MIN)			
	3-LANE CONFIG	**4-LANE CONFIG**	**5-LANE CONFIG[1]**
6:00 AM	0	0	0
7:00 AM	19	2	0
8:00 AM	39	5	0
9:00 AM	60	8	0
10:00 AM	80	11	0
11:00 AM	88	4	0
12:00 PM	0	0	0

Notes:

1. The 5-lane configuration generates minimum queues and causes negligible delay over existing conditions

Caveats

- Since the observed right-turn capacity is high, the model results are heavily affected by the % of right-turning vehicles at the touchdown. The exact mix is unknown at this time, but could be further informed by additional research.
- The existing model assumes that the Sixth Street and King Street exits represent collective capacity. In reality, the demand for the two exits are different. However, the demand would be difficult to determine, since conditions are congested during the time period of interest.
- The model assumes demand stays constant, regardless of the queues and congestion. This does not represent real-life behavior, as there is some point of queue or congestion that would cause a driver to take an alternate route.
- The model assumes northbound traffic will be metered by the signalized 16th Street terminus intersection. Throughput capacity is based on data collected at the existing 6th Street and King Street termini.

- The model does not account for downstream queues on the surface boulevard which may spill back to the 16th Street terminus intersection, resulting in reduced capacity assumptions and longer queues. However, it is assumed that the touchdown will operate similarly to the existing 6th Street and King Street intersections, the capacities of which account for downstream queues.
- Only hourly demand and capacity data were available; therefore the model cannot analyze demand fluctuations within the hour intervals. Further data collection is recommended for a more detailed analysis.