FINAL

CORRIDOR SYSTEM MANAGEMENT PLAN (CSMP)
SAN BERNARDINO COUNTY I-10
COMPREHENSIVE PERFORMANCE ASSESSMENT
AND
CAUSALITY ANALYSIS

May 4, 2009

System Metrics Group, Inc.

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EXECUTIVE SUMMARY
San Bernardino/Riverside I-10
Comprehensive Performance Assessment

This final Comprehensive Performance Assessment Report represents the fifth and sixth milestones of the Corridor System Management Plan (CSMP) development process. It expands upon the preliminary performance assessment milestone by providing updated corridor performance data; finalizing a list of bottleneck locations through additional field visits; and identifying the causes of each bottleneck location.

Background

In November 2006, California voters approved Proposition 1B, a measure which allocated $4.5 billion of bond funds to the Corridor Mobility Improvement Account (CMIA). The CMIA will fund improvements to the state highway system that relieves congestion by expanding capacity, enhancing operations, or otherwise improves travel times within high-congestion travel corridors. The projects that have been proposed for the San Bernardino/Riverside I-10 Corridor include a westbound mixed flow lane addition from Live Oak Canyon to Ford Street, and improvements to the Cherry, Citrus, and Cedar interchanges. As a requirement to obtain CMIA funding for these projects, Caltrans District 8 is developing the San Bernardino/Riverside I-10 CSMP to be submitted to the California Transportation Commission (CTC). When finalized, the CSMP will provide an assessment of existing and future conditions of the corridor; an evaluation of proposed projects using micro-simulation modeling; and an analysis of project benefits and costs.

Caltrans and the CTC defined the San Bernardino/Riverside I-10 study corridor as the 37 mile stretch from the I-15 (Ontario Freeway) in San Bernardino County (CA PM 9.5) to the SR-60 (Moreno Valley Freeway) in Riverside County (CA PM 6.8). The corridor passes through the cities of Ontario, Fontana, Rialto, Colton, San Bernardino, Loma Linda, Redlands, Yucaipa, Calimesa, and Beaumont.

Corridor-wide Performance and Trends

In order to identify how well or poorly the corridor is performing, the existing conditions of the I-10 study corridor were analyzed using the performance measures of mobility, reliability, safety, productivity, and pavement condition. These performance measures were based on 2007 and 2008 available data. Analyzing performance data on I-10 presents a unique challenge due to the limited availability of PeMS detection data. PeMS data is only available west of I-215. Since the mobility, reliability, and productivity performance measures rely on PeMS data, these measures focus on the segment of the study corridor west of I-215. However, the safety and pavement condition measures analyze the entire length of the study corridor. The following briefly summarizes the results of each performance measure by the portion of the corridor analyzed:

- *Mobility* (west of I-215) – in both directions of travel, delay was greater in the PM peak than the AM peak period. In 2007, PM delay (347,000 vehicle-hours) exceeded AM delay (16,000 vehicle-hours) by over 2,000 percent in the eastbound direction. In the westbound direction, PM delay (179,000 vehicle-hours) exceeded AM delay (111,000 vehicle-hours) by roughly 60 percent. The eastbound direction experienced about 10 percent more delay than the westbound direction in 2007. From 2007 to 2008, delay significantly decreased from roughly 960,000 vehicle-hours to 300,000 vehicle-hours.

- *Reliability* (west of I-215) – The variability of travel time during peak periods declined between 2007 and 2008. In the eastbound direction travel time variability decreased from eight (8) minutes in 2007 to four (4) minutes in 2008. In the westbound direction, travel time variability decreased from six (6) minutes in 2007 to two (2) minutes in 2008.

- *Safety* (entire study corridor) – the number of accidents were similar in both eastbound and westbound directions between 2004 and 2006, according to the latest available accident data from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). Each direction experienced about 100 accidents per month on average or 3,900 accidents during the three-year period. The year 2006 experienced the most accidents with about 1,300 in the eastbound direction and 1,400 in the westbound direction.

- *Productivity* (west of I-215) – The trends in productivity losses are comparable to the delay trends. The largest productivity losses occurred during the PM peak hours in the eastbound (2.8 lost lane-miles) and westbound directions (2.2 lost lane-miles), which relatively correspond to the time period and direction which experienced the most delay. Productivity improved on the corridor from 2007 (9.5 lost lane-miles) to 2008 (4.2 lost lane-miles).

- *Pavement Condition* (entire study corridor) – the pavement condition on I-10 is better than many freeways in the Inland Empire. Major pavement distress is found primarily in the western portion of the corridor, although there are small sections with major pavement distress near Fontana and Redlands. The total number of distressed lane-miles has generally increased since 2003 (with the exception of a decline in 2005). In 2003, the corridor comprised about 50 distressed lane-miles, which increased to 80 lane-miles in 2006-2007. From 2003 to 2004, the growth was due to an increase in minor pavement distress, while major pavement distress became more prominent in 2005. In 2006-2007, pavement distress issues were replaced by ride quality issues.

Bottleneck Locations and Areas

Verified bottlenecks that lead to degraded performance and diagnoses of the causes for these bottlenecks are detailed in this report. Data analyses from 2007 PeMS and probe vehicle runs, combined with extensive field visits, confirmed bottlenecks at locations along the corridor as listed in Exhibits ES-1 and ES-2. The tables also show the corresponding "bottleneck areas" for each bottleneck location. Bottleneck areas refer to segments of the corridor that extend from one bottleneck location to the next.

Exhibit ES-1: Eastbound I-10 Identified Bottleneck Locations and Areas

Bottleneck Location	Bottleneck Area	Active Period		From			To			Distance
		AM	PM	Abs	CA	County	Abs	CA	County	
I-15 On	I-15 Off to I-15 On*		✓	56.3	9.5	SBD	56.5	9.7	SBD	0.2
Etiwanda On	I-15 On to Etiwanda On		✓	56.5	9.7	SBD	58.5	11.7	SBD	2.0
Cherry On	Etiwanda On to Cherry On		✓	58.5	11.7	SBD	60.1	13.3	SBD	1.6
Sierra On	Cherry On to Sierra On		✓	60.1	13.3	SBD	63.2	16.4	SBD	3.1
Riverside On	Sierra On to Riverside On		✓	63.2	16.4	SBD	66.9	20.1	SBD	3.7
Pepper On	Riverside On to Pepper On		✓	66.9	20.1	SBD	67.9	21.1	SBD	1.0
I-215 On	Pepper On to I-215 On		✓	67.9	21.1	SBD	70.6	R23.8	SBD	2.7
Waterman On	I-215 On to Waterman On		✓	70.6	R23.8	SBD	72.3	25.5	SBD	1.7
Tippecanoe On	Waterman On to Tippecanoe On		✓	72.3	25.5	SBD	72.8	26	SBD	0.5
Mountain View On	Tippecanoe On to Mountain View On		✓	72.8	26	SBD	74.3	27.5	SBD	1.5
California On	Mountain View On to California On		✓	74.3	27.5	SBD	75.3	28.5	SBD	1.0
6th Street On	California On to 6th Street On		✓	75.3	28.5	SBD	78.0	31.2	SBD	2.7
Not a bottleneck location	6th Street On to SR-60	N/A		78.0	31.2	SBD	92.7	6.8	RIV	14.7

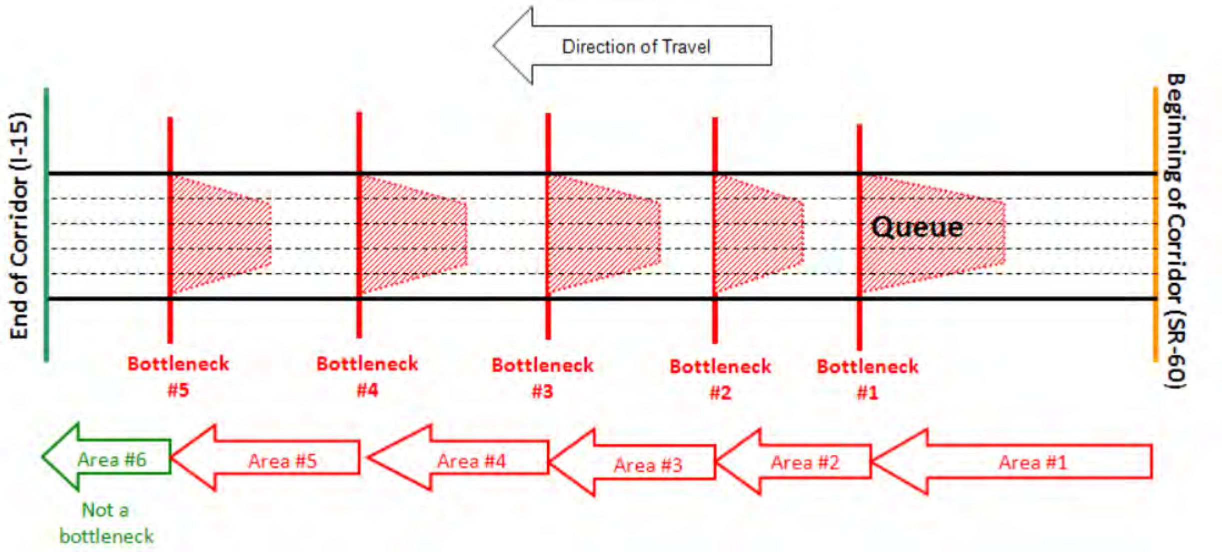
* segment is not included in the bottleneck area analysis due to the short distance in length

Exhibit ES-2: Westbound I-10 Identified Bottleneck Locations and Areas

Bottleneck Location	Bottleneck Area	Active Period		From			To			Distance
		AM	PM	Abs	CA	County	Abs	CA	County	
University On	SR-60 to University On	✓		92.7	6.8	RIV	78.5	31.8	SBD	14.2
California On	University On to California On	✓		78.5	31.8	SBD	74.7	28.0	SBD	3.8
9th Street On	California On to 9th Street On	✓	✓	74.7	28.0	SBD	69.3	R22.5	SBD	5.4
Cedar On	9th Street On to Cedar On	✓		69.3	R22.5	SBD	65.1	R18.4	SBD	4.2
Citrus On	Cedar On to Citrus On	✓	✓	65.1	R18.4	SBD	61.8	15.1	SBD	3.3
Not a bottleneck location	Citrus On to I-15	N/A		61.8	15.1	SBD	56.0	9.5	SBD	5.8

Exhibit ES-3 illustrates the concept of bottleneck areas in the westbound direction. Dividing the corridor into bottleneck areas makes it easier to compare the various segments of the freeway with each other.

Exhibit ES-3: Dividing a Corridor into Bottleneck Areas



Mobility and safety performance statistics were presented for each bottleneck area as well as for the entire corridor. This allows for the relative contribution of each bottleneck area to the degradation of the corridor to be gauged. The analysis of bottleneck areas is based on 2007 data. Due to limited detection available on the corridor, the reliability and productivity performance measures could not be analyzed by bottleneck area.

- *Mobility by Bottleneck Area* – two sources were used to calculate delay for each bottleneck area: PeMS data calculated delay west of I-215 and probe vehicle run data calculated delay east of I-215. It should be noted that delay quantities calculated from these two separate data sources are different and are not compatible. Caution should be exercised when comparing them. In the eastbound direction during the PM peak, the segment from Etiwanda to Cherry experienced the most delay west of I-215 with slightly under 100,000 vehicle-hours of delay; and the segment from California to 6th Street experienced the most delay east of I-215 with about 600,000 vehicle-hours of delay. In the westbound direction during the AM peak, the bottleneck area from 9th Street to Cedar experienced the highest delay west of I-215 with roughly 37,000 vehicle-hours of delay; and the segment between the Riverside County Line to University exhibited the most delay east of I-215 with 700,000 vehicle-hours.

- *Safety by Bottleneck Area* – between 2005 and 2006 (the latest available data from TASAS), the bottleneck area between I-15 and Etiwanda experienced the most accidents in the eastbound direction with almost 490 accidents, while the area between SR-60 to University experienced the most accidents in the westbound direction at nearly 670 accidents.

Causality

By definition, a bottleneck is a condition where traffic demand exceeds the capacity of the roadway facility. In many cases, the cause of the bottlenecks is attributed to such conditions such as a sudden reduction in capacity, roadway geometry, heavy merging and weaving, driver distractions, or a surge in demand that the facility cannot accommodate. Through numerous field visits conducted in December 2008 and January 2009, the cause of each bottleneck location was identified on I-10. Some of the contributing causes of the bottleneck locations are related to:

- Cross weaving traffic at interchanges
- Heavy ramp volumes merging on to the mainline facility when mainline traffic is already heavy
- Platoon merging from the on-ramp
- Uphill vertical grade or roadway curvature that affects sight-distance.

A detailed description of the causality of each bottleneck location is provided in Section 5 of this report. It should be noted that many of the bottlenecks that were visible in 2006 and early part of 2007 have now disappeared with the reduction in demand likely associated with the I-210 extension, higher gas prices, and the depressed economy; however, should mainline traffic growth reach 2006 levels, these bottlenecks are likely to reoccur.

The bottleneck locations identified in Exhibits ES-1 and ES-2, along with the results from the causality analysis will be used for the I-10 micro-simulation model calibration process.

Next Steps

Subsequent to this Comprehensive Performance Assessment, alternative investment strategies will be modeled and evaluated to understand their relative benefits to the corridor as compared to their costs. The results from this evaluation will form a recommended implementation plan that identifies existing and potential future funding opportunities that will improve the corridor's future performance.

1. INTRODUCTION

This document represents the draft for the fifth and sixth milestones of the San Bernardino County Interstate 10 (I-10) Corridor System Management Plan (CSMP) development process, which is required by the California Transportation Commission (CTC) for corridors that received funding from the Corridor Mobility Improvement Account (CMIA) approved by the voters in 2006.

These two milestones are called the Comprehensive Performance Assessment and the Causality of Performance Degradation. They build on the third milestone, the “Preliminary Performance Assessment” (already developed), and the fourth milestone, “Ensure Adequate Corridor Detection.” The milestones, eight in total, were documented in the CSMP guidelines distributed by Caltrans Headquarters.

The main purpose of the Comprehensive Performance Assessment is to detail the performance of the corridor so that future investment decisions can build on its findings and conclusions, and investment alternatives are tested to ensure reasonable returns on investment for public funds.

This report presents performance measurement findings, identifies bottlenecks that lead to less than optimal performance, and diagnoses the causes for these bottlenecks in detail. Once this report has been finalized, alternative investment strategies will be modeled and evaluated to understand their relative benefits and eventually develop a recommended implementation plan for existing and potential future funding.

This report and the associated CSMP (eighth milestone in the CSMP guidelines) should be updated on a regular basis since corridor performance can vary dramatically over time due to changes in demand patterns, economic conditions, and delivery of projects and strategies among others. Such changes could influence the conclusions of the CSMP and the relative priorities in investments.

Therefore, updates should probably occur no less than every two to three years. To the extent possible, this document has been organized to facilitate such updates so that Caltrans can insert new and updated sections without re-writing the entire document.

After this introduction, the report is organized into four sections:

2. *<u>Corridor Description</u>*
   This section describes the corridor, including the roadway facility, major interchanges and relative demands at these interchanges, rail and transit services along the freeway facility, major Intermodal facilities around the corridor, and special even facilities/trip generators. This section has been expanded since the Preliminary Performance Assessment milestone to include a subsection on corridor demand profiles.

3. *Corridor-wide Performance and Trends*
   This section presents multiple years of performance data for the freeway portion of the defined CSMP corridor. Statistics are included for the mobility, reliability, safety, and productivity performance measures. Wherever possible, this section has been expanded from the preliminary performance assessment by adding performance results through December 2008. A new section on pavement conditions on the freeway was also added.

4. *Bottleneck Identification and Analysis*
   This section identifies the locations of bottlenecks, or choke points, on the freeway facility. These bottlenecks are generally the major cause for mobility and productivity performance degradations and are often related to safety degradations as well. This section has also been augmented. It now has performance results for delay and safety by major "bottleneck area." This addition allows for the relative prioritization of bottlenecks in terms of their contribution to corridor performance degradation.

5. *Causality Analysis*
   This section diagnoses the bottlenecks identified in Section 4 and identifies the causes of each bottleneck through additional data analysis and significant field observations. Electronic videos were taken for many of the major bottlenecks (to the extent possible) to verify our conclusions. Sections 4 and 5 provide valuable input to selecting projects to address the critical bottlenecks. Moreover, they provide the baseline against which micro-simulation models will be validated. Finally, this section represents the sixth milestone of the CSMP development process.

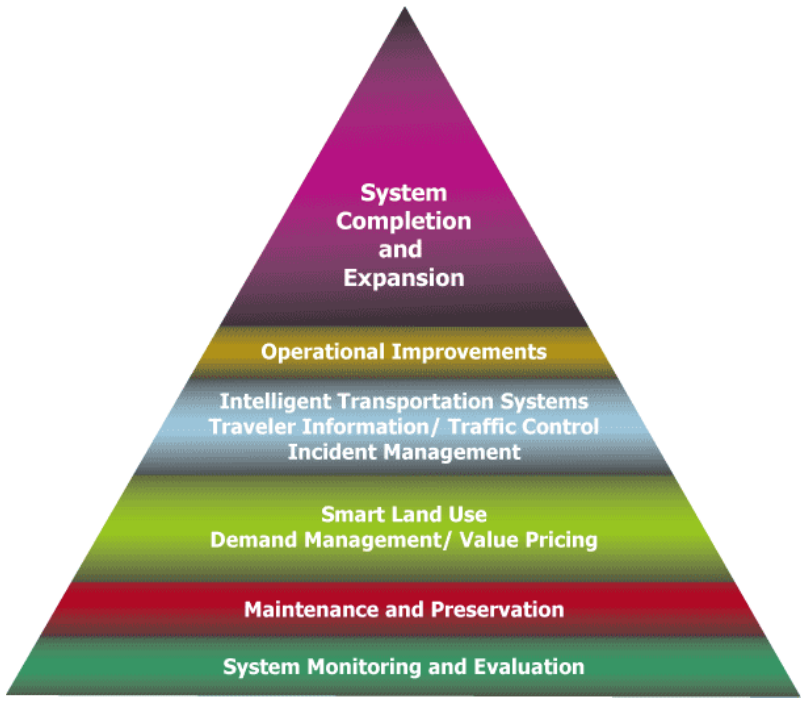
The remainder of this introduction provides some background on system management, a framework that eventually led to the CSMP requirement. It also includes a discussion on data sources and the state of detection on the I-10 freeway facility.

Background

Over the last few years, Caltrans and its stakeholders and partner agencies have been developing and committing to a framework called "System Management" which is depicted in Exhibit 1-1. This framework aims to get the most of our transportation infrastructure through a variety of strategies, not just through the traditional and increasingly expensive expansion projects. System management has been embraced by the current California Administration as part of its Strategic Growth Plan and by the Southern California Association of Governments (SCAG), the Metropolitan Planning Organization for Southern California and the counties of San Bernardino and Riverside.

One major new aspect of system management is an increased focus on operational strategies and investments. Operational solutions are generally less expensive, can often be implemented much faster, and can produce results that, when compared to traditional expansion projects, often provide much higher returns on the scarce transportation funding available. Partly because of the focus on operational strategies, System management relies on much more detailed data.

Exhibit 1-1: System Management Pyramid



The base of the System management "pyramid" is titled "System Monitoring and Evaluation." It is the foundation of all other decisions, and it includes identifying problems, evaluating solutions (and combinations thereof), and eventually funding the most promising strategies. This document represents the first version of this foundation for the defined I-10 Corridor.

Existing Data Sources

The available data analyzed for the comprehensive performance assessment includes the following sources:

- Caltrans Highway Congestion Monitoring Program (HICOMP) report and data files (2004 – 2007)
- Caltrans Freeway Performance Measurement System (PeMS)
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS) from PeMS

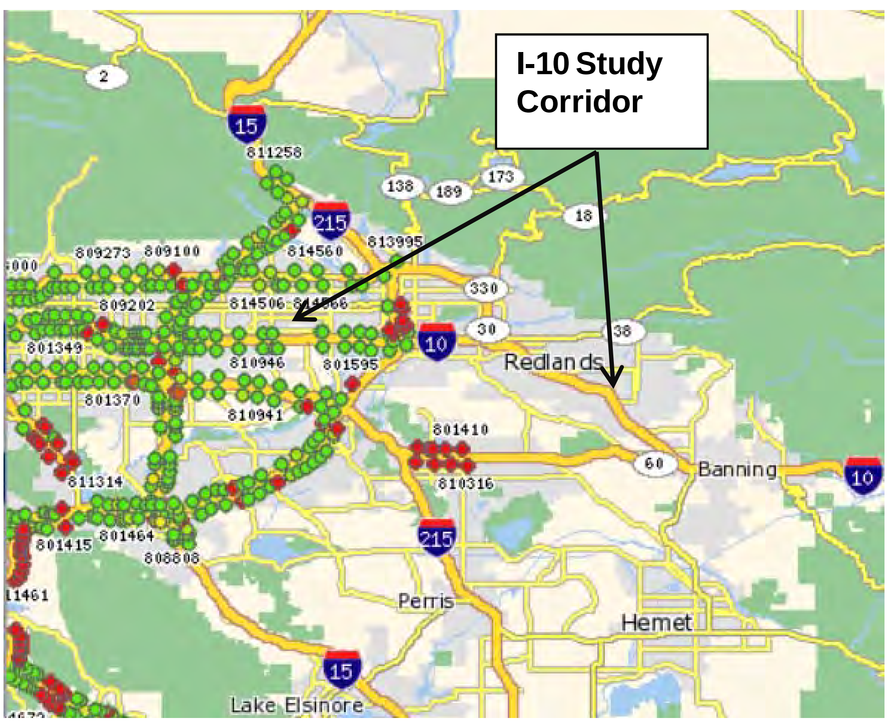
- Traffic study reports (various)
- Aerial photographs (Microsoft Virtual Earth and Google Earth) and Caltrans photologs
- Internet (i.e. Omnitrans, Metrolink websites, etc.).

There are numerous documents that describe these data sources, so they are not discussed in detail here. However, given the need for comprehensive and continuous monitoring and evaluation, detection coverage and quality are discussed in more detail below.

Freeway Detection Status

Exhibit 1-2 depicts the corridor freeway facility with the detectors in place as of December 23, 2008. This data was chosen randomly to provide a snapshot of the detection status. The exhibit illustrates the availability of detection west of I-215 and the absence of detection east of I-215. As noted by the green color, the majority of existing detectors west of I-215 were functioning well on this specific date. However, among these detectors, there are some seemingly large gaps that exist.

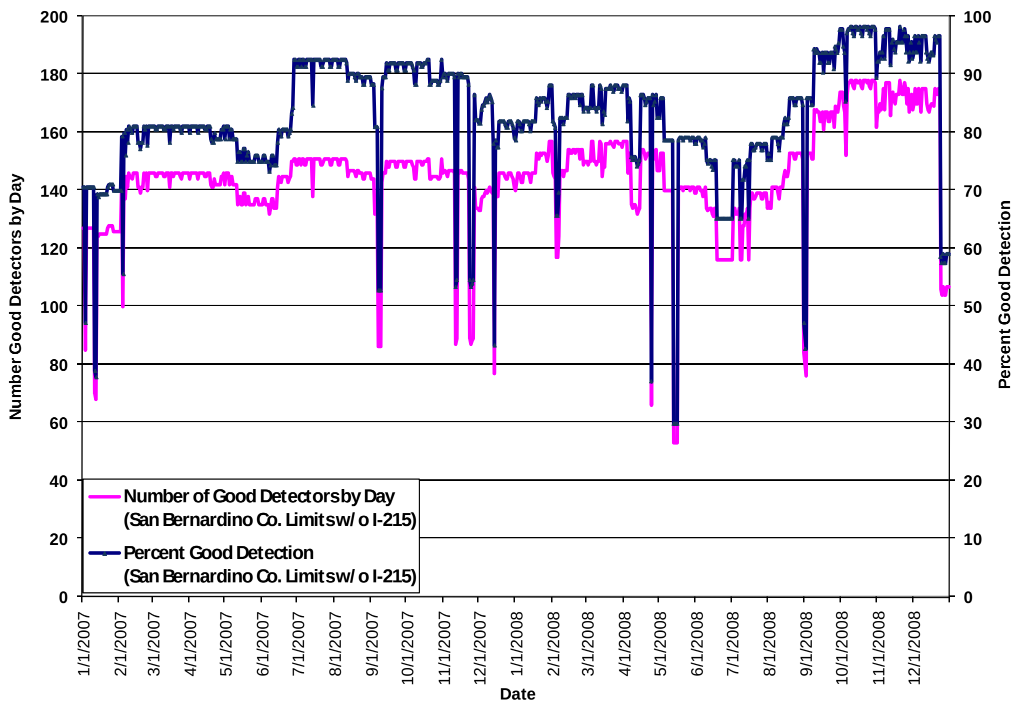
Exhibit 1-2: I-10 Sensor Status (December 23, 2008)



Source: PeMS data

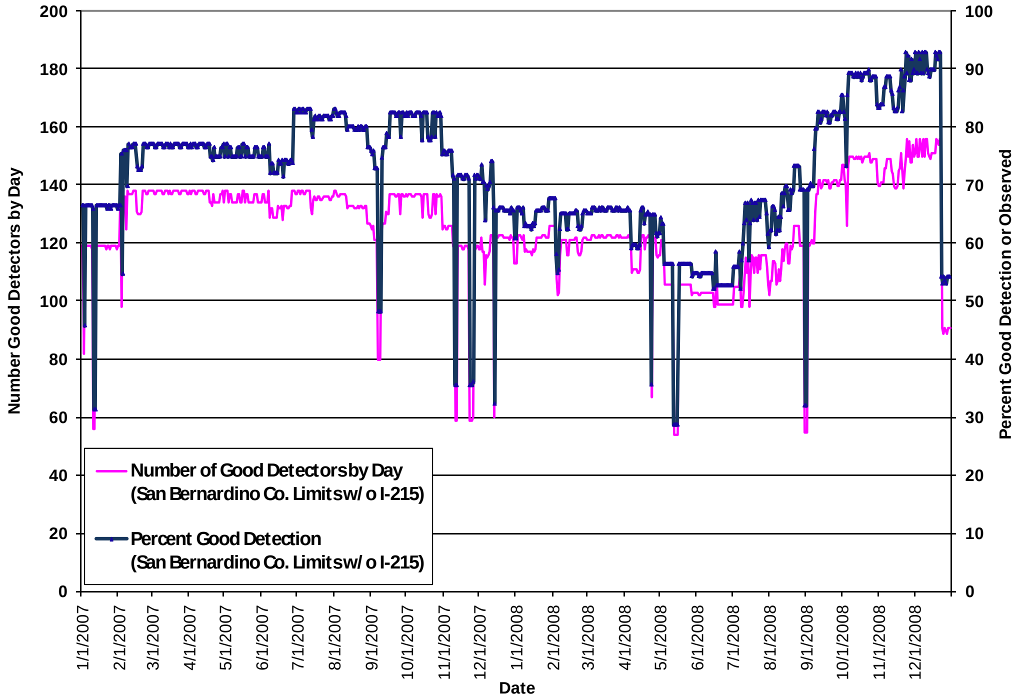
The following exhibits provide a better picture of how the detectors on the corridor performed over a longer period of time. Exhibits 1-3 and 1-4 report the number and percentage of “good” detectors by day for the entire I-10 corridor in San Bernardino County (west of I-215) from 2007 to 2008. The left y-axis shows the scale used for the number of detectors, while the right y-axis shows the scale used for the percent good detectors. These exhibits suggest that detection in the eastbound direction (Exhibit 1-3) was slightly better than the westbound direction (Exhibit 1-4), particularly in the last months of 2008 when the percentage of good detectors in the eastbound direction reported almost 100 percent compared to 90 percent in the westbound direction. The difference appears to be due to the addition of a large number of operating detectors during the summer months of 2008 in the eastbound direction.

Exhibit 1-3: Number and Percentage of Good Detection on Eastbound I-10 (San Bernardino Co. Limits w/o I-215)



Source: SMG analysis of PeMS data

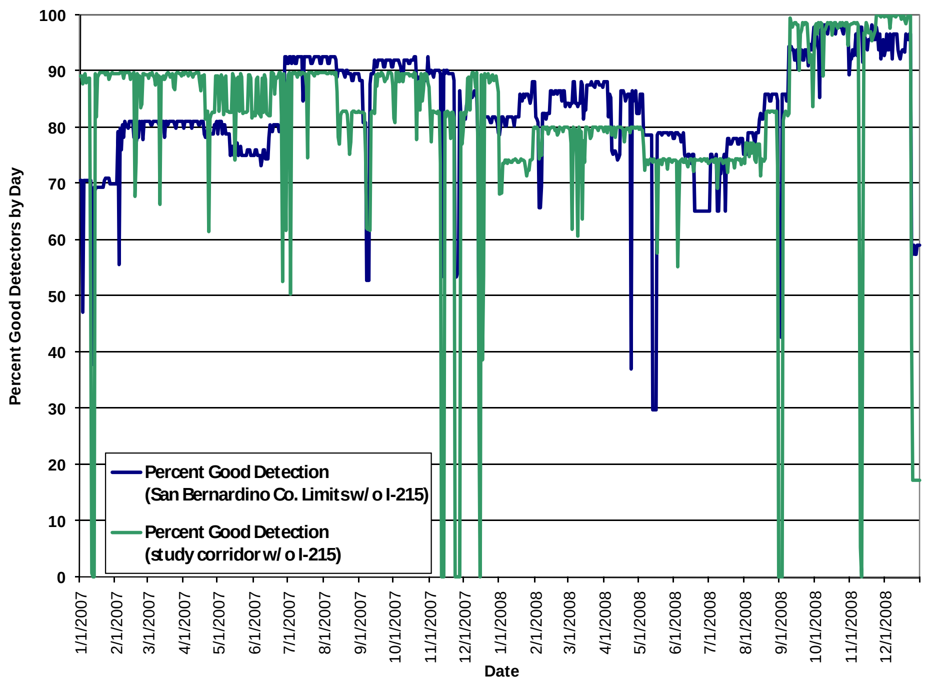
Exhibit 1-4: Number and Percentage of Good Detection on Westbound I-10 (San Bernardino Co. Limits w/o I-215)



Source: SMG analysis of PeMS data

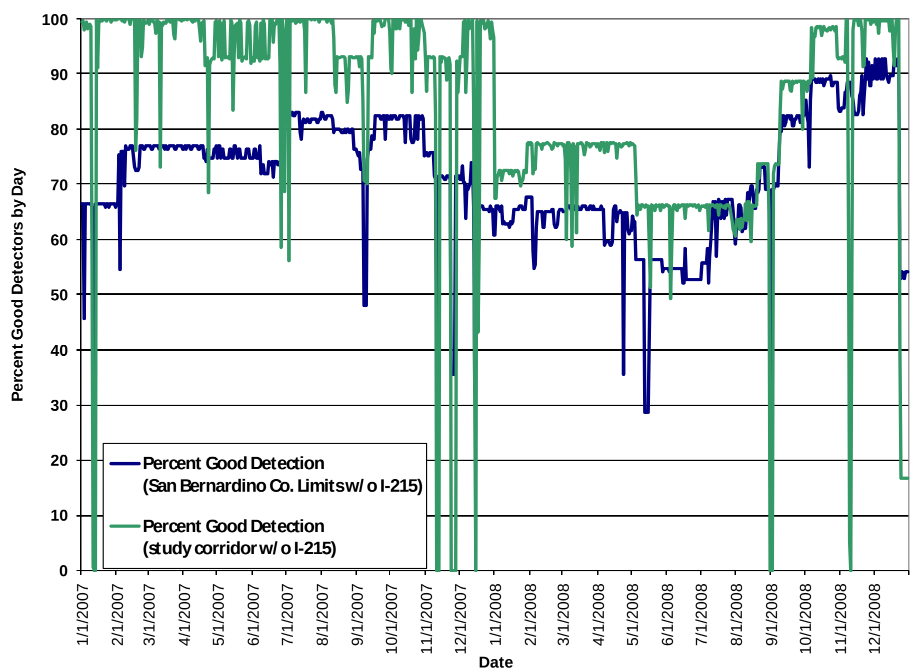
Exhibits 1-5 and 1-6 isolate the I-10 study corridor west of I-15 (in green) and reports the percentage of good detectors within the I-10 corridor limits compared to all of San Bernardino County west of I-215 (in blue). As the exhibits illustrate, the eastbound direction has comparable detection and the westbound direction has better detection relative to the freeway as a whole (in San Bernardino County west of I-215).

Exhibit 1-5: Percentage of Good Detection on Eastbound I-10 (Project Limits w/o I-215)



Source: SMG analysis of PeMS data

Exhibit 1-6: Percentage of Good Detection on Westbound I-10 (Project Limits w/o I-215)



Source: SMG analysis of PeMS data

Overall, the detection on the I-10 study corridor (west of I-215) during 2007-2008 is considered excellent with the majority of detectors reporting over 80 percent good data in both directions. In both directions, detection improved significantly starting in July 2008. Part of the increased detection quality in 2008 may be attributed to improved maintenance of the existing detection. Regardless of the reason, this trend is very encouraging and should allow for detailed analysis capabilities now and in the future. By comparing detectors in detail, we identified several detectors that were added in 2007 and 2008. These are shown in Exhibit 1-7.

Exhibit 1-7: I-10 Detection Added (2007-2008)

VDS	Location	Type	CA PM	Abs PM	Date Online
EASTBOUND					
813057	E/B ETIWANDA LOOP	On Ramp	11.09	57.855	12/13/2007
813058	E/B ETIWANDA LOOP	Mainline	11.09	57.855	12/13/2007
813078	E/B ETIWANDA ON	On Ramp	11.20	57.965	12/13/2007
813079	E/B ETIWANDA ON	Mainline	11.20	57.965	12/13/2007
813332	E/B SIERRA ON	On Ramp	16.34	63.112	12/13/2007
813333	E/B SIERRA ON	Mainline	16.34	63.112	12/13/2007
WESTBOUND					
813047	W/B ETIWANDA ON	On Ramp	11.03	57.795	12/13/2007
813048	W/B ETIWANDA ON	Mainline	11.03	57.795	12/13/2007
813067	W/B ETIWANDA LOOP ON	On Ramp	11.16	57.925	12/13/2007
813068	W/B ETIWANDA LOOP ON	Mainline	11.16	57.925	12/13/2007
813315	W/B SIERRA ON	On Ramp	16.24	63.012	12/13/2007
813316	W/B SIERRA ON	Mainline	16.24	63.012	12/13/2007
813317	W/B SIERRA OFF	Off Ramp	16.24	63.012	4/19/2008

Source: SMG analysis of PeMS data

Finally, an analysis of gaps without detection is shown in Exhibit 1-8. The most glaring gap is evident between I-215 and SR-60, a distance of over 22 miles. Additionally, there are various other locations west of I-215 that have gaps of over 0.75 miles without detection. These should be considered for deployment of additional detection when funding becomes available.

Exhibit 1-8: I-10 Gaps In Detection (December 23, 2008)

Location		Abs PM		Length (Miles)
From	To	From	To	
EASTBOUND				
4th Street (ML)	Vineyard (ML)	52.1	53.022	**0.92**
2000' e/o Haven (ML)	M .21 e/o Milliken (ML)	55.308	56.145	**0.84**
0.21 e/o Milliken (ML)	0.61 e/o I-15 (ML)	56.145	57.295	**1.15**
0.88 e/o Etiwanda (ML)	1.73 e/o Etiwanda (ML)	58.555	59.462	**0.91**
1.73 e/o Etiwanda (ML)	1.0 e/o Cherry Ave (ML)	59.462	60.862	**1.40**
1.0 e/o Cherry Ave (ML)	0.37 e/o Citrus Ave (ML)	60.862	62.372	**1.51**
0.56 e/o Sierra Ave (ML)	0.45 w/o Cedar Ave (ML)	63.352	66.092	**2.74**
0.75 e/o Cedar Ave (ML)	0.48 w/o Pepper Ave (ML)	66.172	67.532	**1.36**
0.48 w/o Pepper Ave (ML)	0.52 w/o Rancho Ave (ML)	67.532	68.472	**0.94**
0.52 w/o Rancho Ave (ML)	0.5 e/o Rancho Ave (ML)	68.472	69.252	**0.78**
0.5 e/o Rancho Ave (ML)	0.53 w/o I-215 (ML)	69.252	70.392	**1.14**
0.53 w/o I-215 (ML)	SR-60 (east limit of study)	70.392	92.7	**22.31**
WESTBOUND				
1.0 w/o 4th Street (ML)	4th Street (ML)	50.925	51.929	**1.00**
4th Street (ML)	Vineyard (ML)	51.929	52.81	**0.88**
Archibald (ML)	0.35 e/o Archibald (ML)	53.579	54.395	**0.82**
Haven Loop (ML)	0.21 e/o Milliken (ML)	55.055	56.145	**1.09**
0.21 e/o Milliken (ML)	0.61 e/o I-15 (ML)	56.145	57.295	**1.15**
0.88 e/o Etiwanda (ML)	1.73 e/o Etiwanda (ML)	58.555	59.462	**0.91**
1.73 e/o Etiwanda (ML)	1.0 e/o Cherry Ave (ML)	59.462	60.862	**1.40**
1.0 e/o Cherry Ave (ML)	0.37 e/o Citrus Ave (ML)	60.862	62.372	**1.51**
W/B Sierra On (ML)	0.45 w/o Cedar Ave (ML)	63.012	66.092	**3.08**
0.75 e/o Cedar Ave (ML)	0.48 w/o Pepper Ave (ML)	66.172	67.532	**1.36**
0.48 w/o Pepper Ave (ML)	0.52 w/o Rancho Ave (ML)	67.532	68.472	**0.94**
0.52 w/o Rancho Ave (ML)	0.5 e/o Rancho Ave (ML)	68.472	69.252	**0.78**
0.5 e/o Rancho Ave (ML)	0.53 w/o I-215 (ML)	69.252	70.392	**1.14**
0.53 w/o I-215 (ML)	SR-60 (east limit of study)	70.392	92.7	**22.31**

Source: SMG analysis of PeMS data

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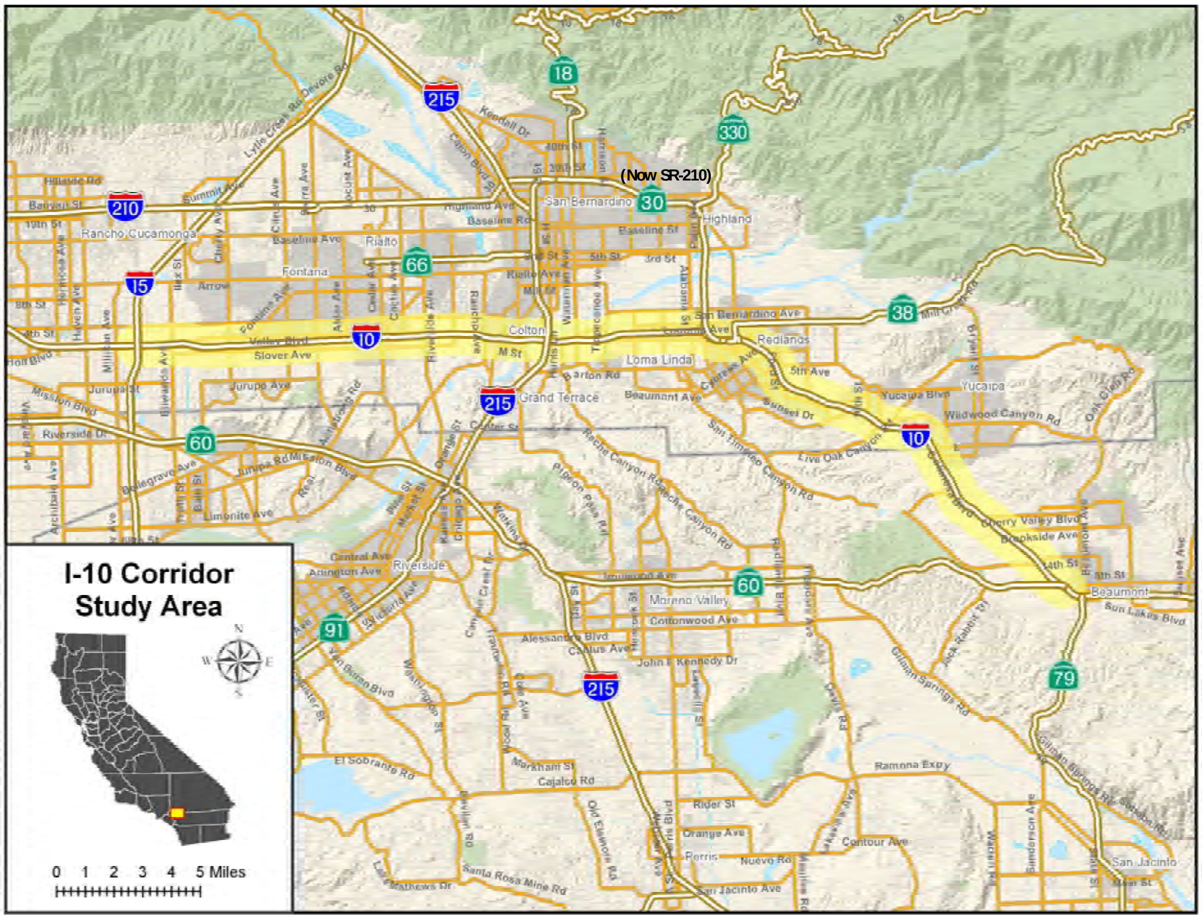
2. CORRIDOR DESCRIPTION

The San Bernardino/Riverside County I-10 corridor begins from the I-15 (Ontario Freeway) in San Bernardino County (post mile 9.5) to the SR-60 (Moreno Valley Freeway) in Riverside County (post mile 6.8). It extends approximately 30 miles in San Bernardino County and 7 miles in Riverside County. This study corridor traverses through the cities of Ontario, Fontana, Rialto, Colton, San Bernardino, Loma Linda, Redlands, Yucaipa, Calimesa, and Beaumont.

Exhibit 2-1: Map of Study Area



Corridor Roadway Facility

Major interchanges along the I-10 study corridor include the following:

- I-15, which provides north-south access from the San Bernardino Mountains to San Diego.

- Sierra Avenue, which provides north-south connection from the I-15 up by the San Bernardino Mountains to the SR-60.
- I-215 (Riverside Freeway), which provides north-south access from San Bernardino County to Riverside County.
- SR-210, which connects the end of the I-210 freeway to the I-10 freeway.
- Live Oak Canyon Road/Oak Glen Road, which provides northeasterly access from the San Bernardino Mountains to mountains south of Redlands.
- SR-60, which provides east-west access from Los Angeles County to Riverside County.

The I-10 Corridor generally has three to five through lanes in each direction of travel with intermittent auxiliary lanes. Directions of travel are divided by a concrete median or metal beam guard rails. Exhibit 2-2 shows the lane configurations along the I-10 Corridor.

Exhibit 2-2: I-10 Corridor Lane Configuration

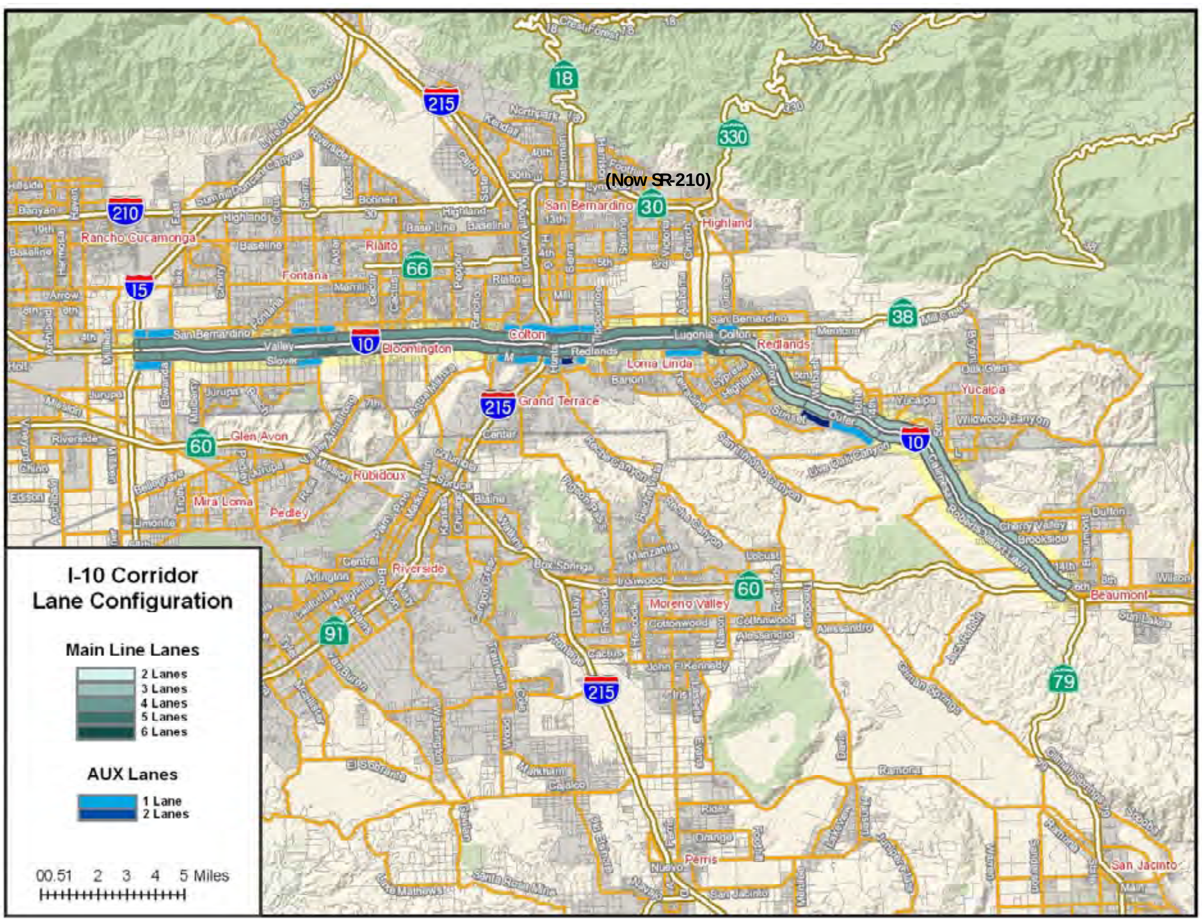
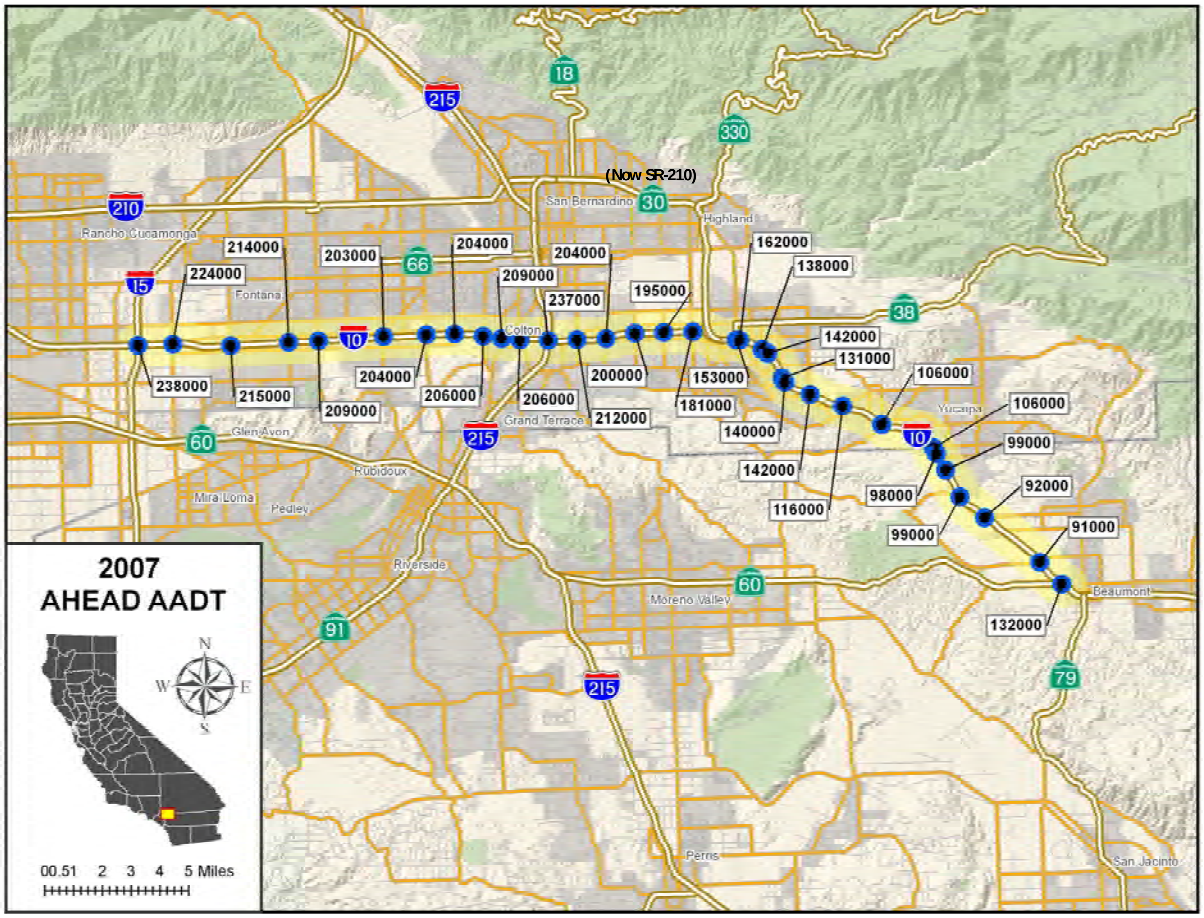


Exhibit 2-3: Major Interchanges and AADT along the I-10 Corridor



Source: AADT is from the Caltrans Traffic and Vehicle Data Systems Unit[1]

The 2007 Caltrans Traffic and Volume Data Systems indicate that the annual average daily traffic (AADT) ranges from 92,000 to 240,000 vehicles per day, as illustrated in Exhibit 2-3. The highest AADT was reported at the I-15 interchange with 240,000 vehicles per day.

I-10 is also a part of the STAA National Truck Network, as shown in Exhibit 2-4. According to the 2007 Annual Average Daily Truck Traffic on the California State Highway System published by Caltrans in September 2008, this corridor's daily truck traffic ranges from 9.9 to 13.5 percent of the total daily traffic. Exhibit 2-5 shows the truck percentages throughout the I-10 study corridor.

[1] http://www.dot.ca.gov/hq/traffops/saferesr/trafdata/

Exhibit 2-4: San Bernardino/Riverside County Truck Networks

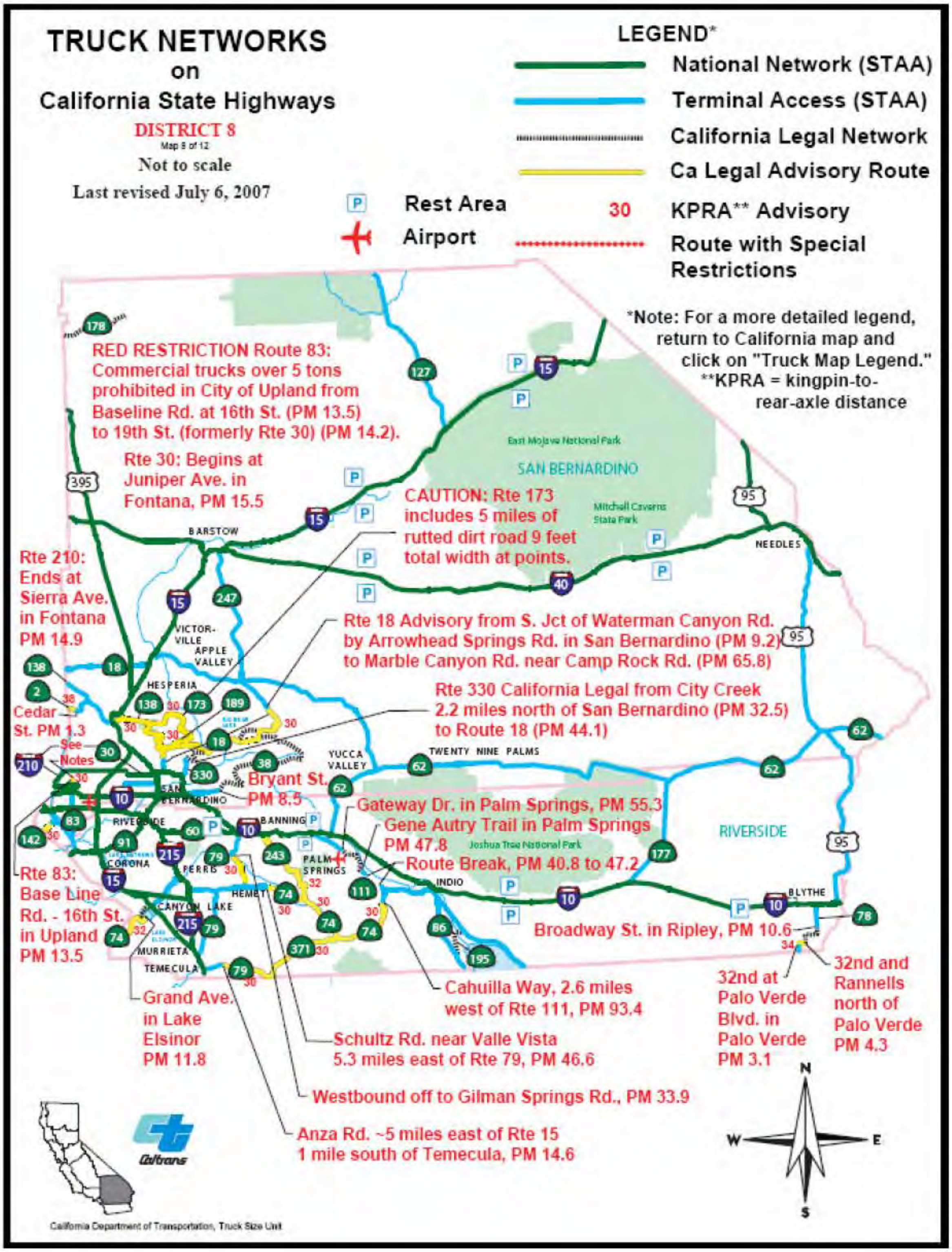
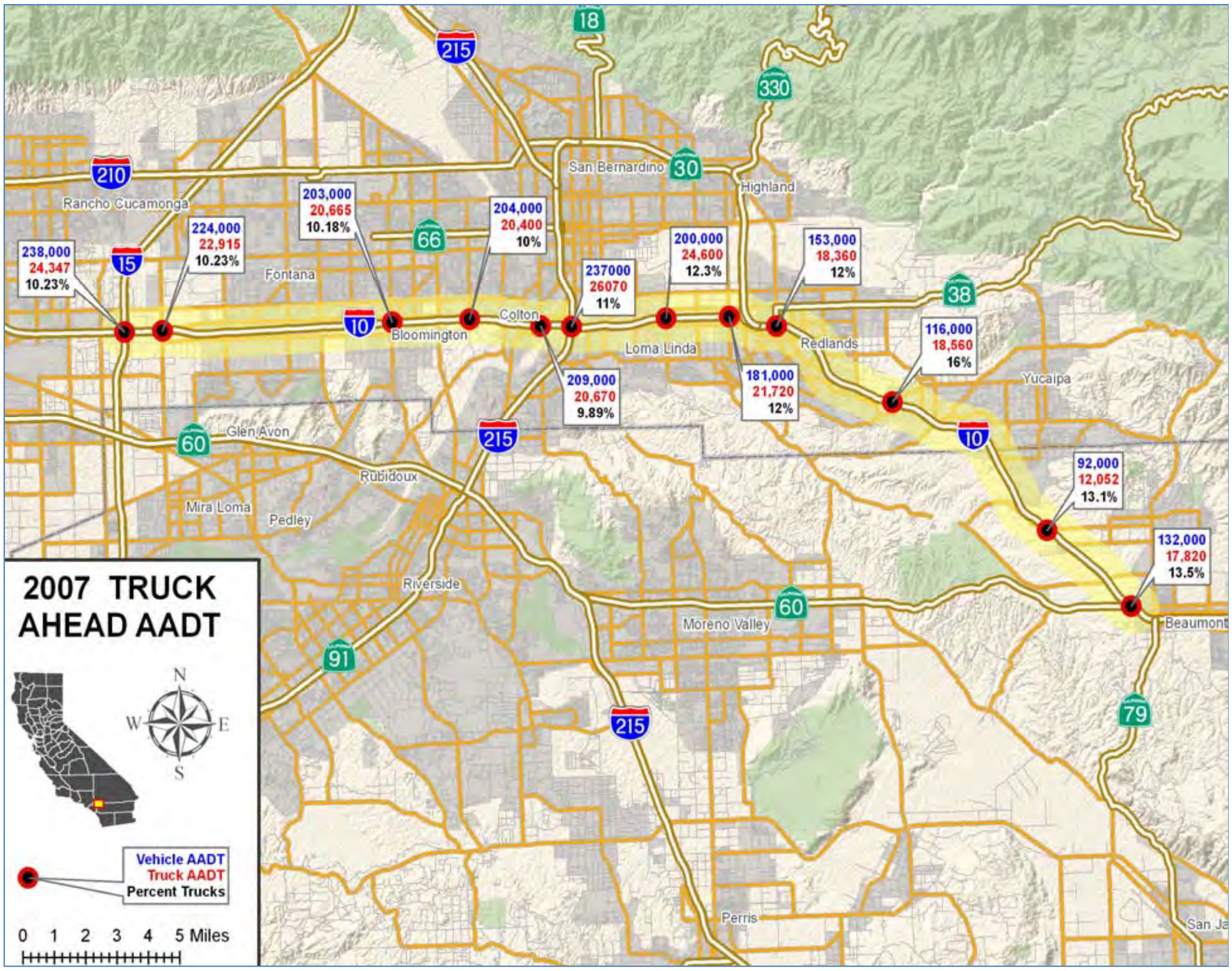


Exhibit 2-5: Truck Percentages on I-10 Corridor



Recent and Planned Roadway Improvements

In review of the major recent roadway improvements completed by Caltrans along the I-10 corridor, there were two projects recently implemented and open to traffic that may have significantly impacted the I-10 corridor traffic conditions. These include:

- The 2.5-mile widening of I-10 from six to eight lanes between Orange Street and Ford Street in the City of Redlands. The two lanes opened in November and December of 2007.
- The I-210 extension, a 7.25-mile segment between Rialto and San Bernardino that connects to Highway 30, opened in July 2007.

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Corridor Transit Services

Major transit operators within the I-10 study corridor include Riverside Transit Agency, Metrolink commuter rail service, and Omnitrans. The Riverside Transit Agency (RTA) was established in 1975 and provides 38 fixed routes, 5 commuter routes, and Dial-A-Ride services in western Riverside County. It provides transit services linking communities in San Bernardino County and Riverside County along the I-10. Exhibit 2-6 shows the transit lines servicing the I-10 study corridor area. Route 35 travels along SR-60, south of the I-10 from the Moreno Valley Mall to the cities of Beaumont and Banning just east of the I-10/SR-60 interchange. Route 36 travels along the I-10 from Sun Lakes just east of the I-10/SR-60 interchange to the city of Yucaipa.

Southern California Regional Rail Authority (SCRRA) is a joint powers authority that operates the Metrolink regional rail service throughout Southern California. Two lines service the areas along the study corridor. The Riverside Line provides service from Los Angeles Union Station to Riverside Downtown running parallel to south of the I-10 corridor with stops in Montebello/Commerce, Industry, Pomona, Pedley, and Ontario. This line operates 12 trains on the weekdays and averages nearly 5,200 riders per day, which reflects an increase of approximately 9 percent from 2006. The San Bernardino Line provides service from Los Angeles Union Station to San Bernardino running parallel to north of the I-10 corridor with stops at Cal State Los Angeles, Baldwin Park, Claremont, Montclair, Rancho Cucamonga, Fontana, Rialto, and San Bernardino. This line operates 34 trains on the weekdays and averages over 12,000 riders per day, which reflects an increase of approximately 2 percent from 2006.

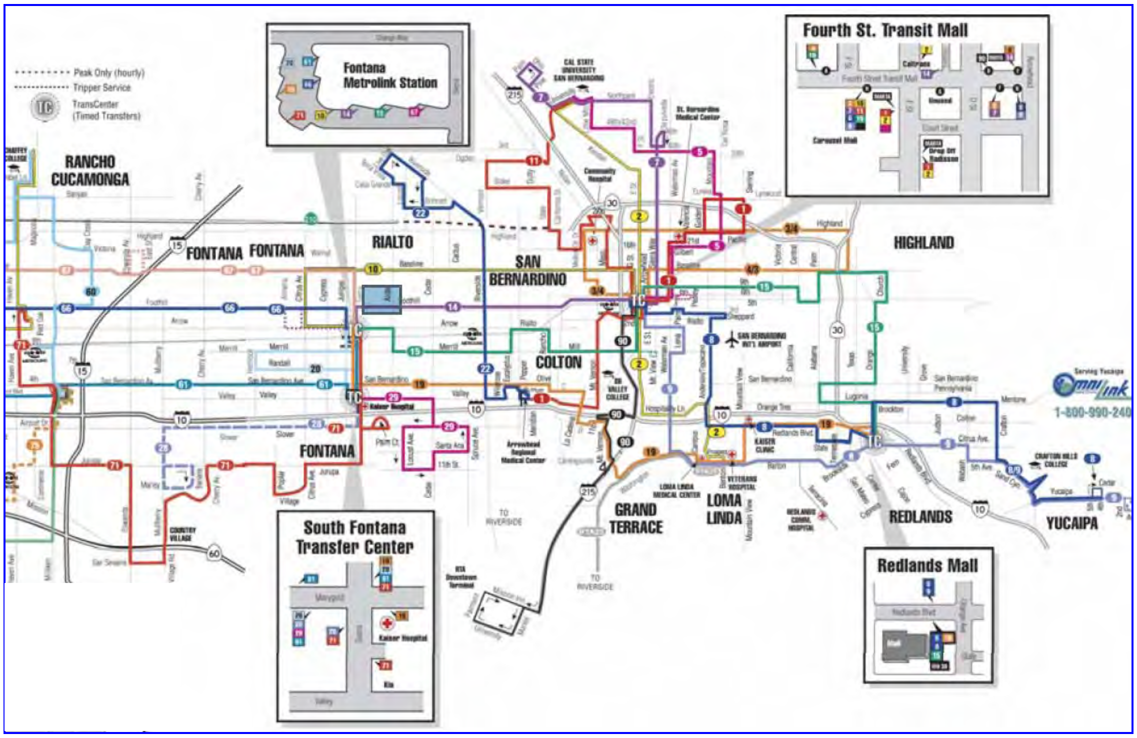
Omnitrans is a joint powers authority representing the County of San Bernardino and the 15 cities served by Omnitrans. There are many routes that operate within the proximity of the I-10 study corridor. These Routes include: 1, 2, 8, 9, 15, 19, 20, 22, 29, 61, 66, 67, 82, and 215. System-wide ridership for Omnitrans Routes was down slightly by 1 percent from 2006 to 2007. Estimated ridership for 2007-2008 is projected to decrease by more than 6 percent from approximately 15.5 million to 14.5 million.

Exhibit 2-6: Riverside Transit Authority Map Servicing the I-10 Corridor

Exhibit 2-7: Metrolink System Map

Source: Metrolink

Exhibit 2-8: Omnitrans Area Map Servicing the I-10 Corridor

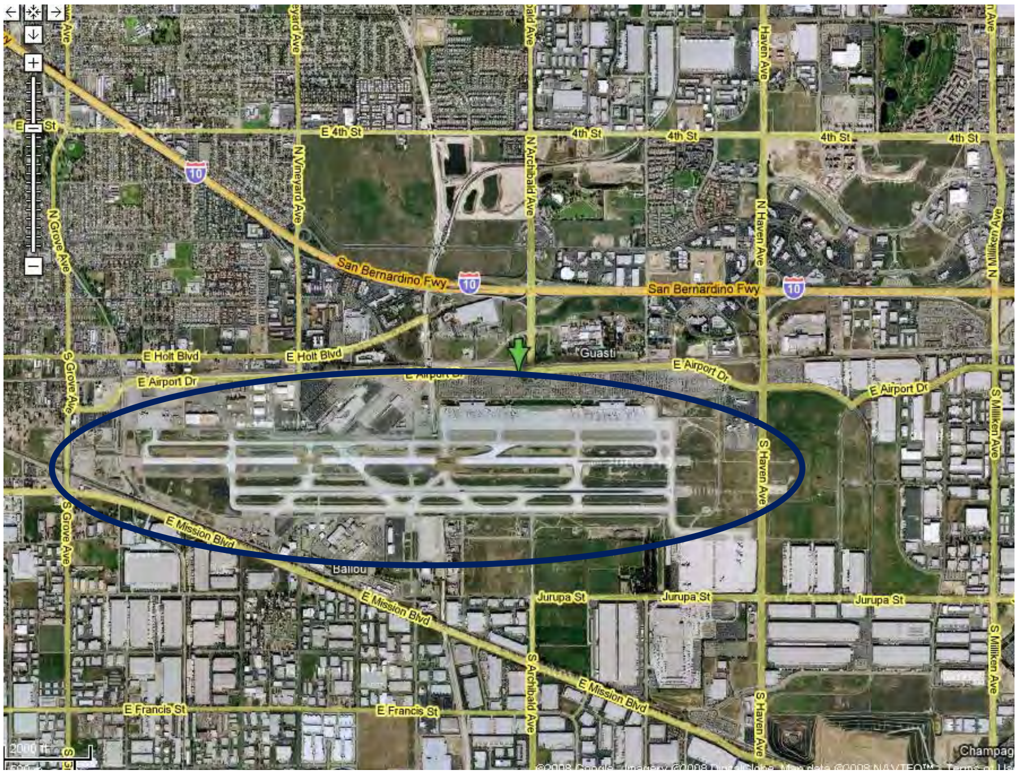


Intermodal Facilities

Several airports operate within the vicinity of the I-10 study corridor. The Ontario International Airport is a full-service airport with commercial jet service to major U.S. cities and through service to many international destinations. It is located in the city of Ontario, approximately 35 miles east of downtown Los Angeles, just west of the I-10/I-15 Interchange. This airport provides air passenger service with the following airlines: Aeromexico, Alaska, American, Continental, Delta, ExpressJet, Jet Blue, Southwest, United, United Express, and US Airways. It also operates freight services with cargo airlines such as DHL, UPS and FedEx. This airport serves as a convenient alternative to the Los Angeles International Airport (LAX). Exhibit 2-9 shows the location of the airport in relation to the I-10 study corridor. Exhibit 2-10 shows the airport's historical passenger counts from 1992 to 2006.

The San Bernardino International Airport is a full-service airport providing regional air traffic for both domestic and international service, both commercial and cargo. This airport operates over 60,000 annual flights comprised mainly of charter, corporate, and general aviation users. Exhibit 2-11 shows the location of the airport in relation to the I-10 study corridor. The Redlands Municipal Airport, as shown in Exhibit 2-12 is owned by the City of Redlands and is located two miles northeast of downtown Redlands. This is a general aviation services airport with one runway and an average of 120 aircraft operations per day.

Exhibit 2-9: Ontario International Airport



Source: Google Maps

Exhibit 2-10: Ontario International Airport Passenger Count

LA/ONTARIO INTERNATIONAL AIRPORT *PASSENGER COUNT*					
PASSENGER COUNT				**FREIGHT**	**ANNUAL OPERATIONS**
Year	Departures	Arrivals	Total	Freight is listed per year in TONS. *Totals include U.S. mail.*	Includes all commercial aircraft, air taxi, alternates, military, and general aviation.
1992	3,067,671	3,053,952	6,121,623	306,973	151,836
1993	3,105,181	3,086,854	6,192,035	353,302	154,944
1994	3,200,836	3,185,164	6,386,000	379,911	159,895
1995	3,210,582	3,194,515	6,405,097	386,953	156,283
1996	3,132,803	3,120,035	6,252,838	437,139	154,314
1997	3,153,825	3,147,037	6,300,862	461,747	154,332
1998	3,212,487	3,222,371	6,434,858	454,231	144,949
1999	3,268,661	3,309,344	6,578,005	488,774	156,607
2000	3,359,978	3,396,108	6,756,086	511,758	155,501
2001	3,354,400	3,348,000	6,702,400	462,758	154,715
2002	3,259,866	3,257,184	6,516,858	547,461	149,292
2003	3,285,577	3,262,300	6,547,877	571,892	146,413
2004	3,473,284	3,464,053	6,937,337	605,132	152,870
2005	3,611,978	3,601,550	7,213,528	575,369	143,249
2006	3,533,858	3,516,046	7,049,904	602,326	136,261

Exhibit 2-11: San Bernardino International Airport

Source: Google Maps

Exhibit 2-12: Redlands Municipal Airport

Source: Google Maps

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Special Event Facilities and Trip Generators

Special event facilities may generate significant trips along the I-10 corridor. A number of the major facilities are shown in Exhibit 2-13.

There are several major universities/colleges near the I-10 corridor:

- Crafton Hills College is located one mile northeast of the I-10 off Sand Canyon Road. It is part of the California community college system with an enrollment of 5,100 students. It offers two-year Associate degrees in 32 programs and 25 occupational certificate plans.
- The University of Redlands is located just south of the I-10 off Colton Avenue. It is a private, liberal arts university with the College of Arts and Sciences offering 42 programs to undergraduate students. It also offers advanced degrees in the School in Education and School in Business. The College of Arts and Sciences has approximately 2,500 students while the Schools of Education and Business have approximately 500 and 1,000 students, respectively.
- Loma Linda University is a Seventh-day Adventist educational health-sciences institution with 3,000 students. It is located south of the I-10 off Tippecanoe/Anderson and north of Barton Road. There are more than 55 programs that are offered by the various schools within the university. Loma Linda University is a part of the Loma Linda University Adventist Health Sciences Center, which comprises the Loma Linda University Medical Center and its various affiliates.
- San Bernardino Valley College is located one and a half mile north of the I-10, just west of the I-215 off Mount Vernon Avenue. It is part of the California community college system with an enrollment of over 25,000 students. It offers over 100 Associate degrees and certificate programs.

The hospital facilities located within close proximity to the study corridor include:

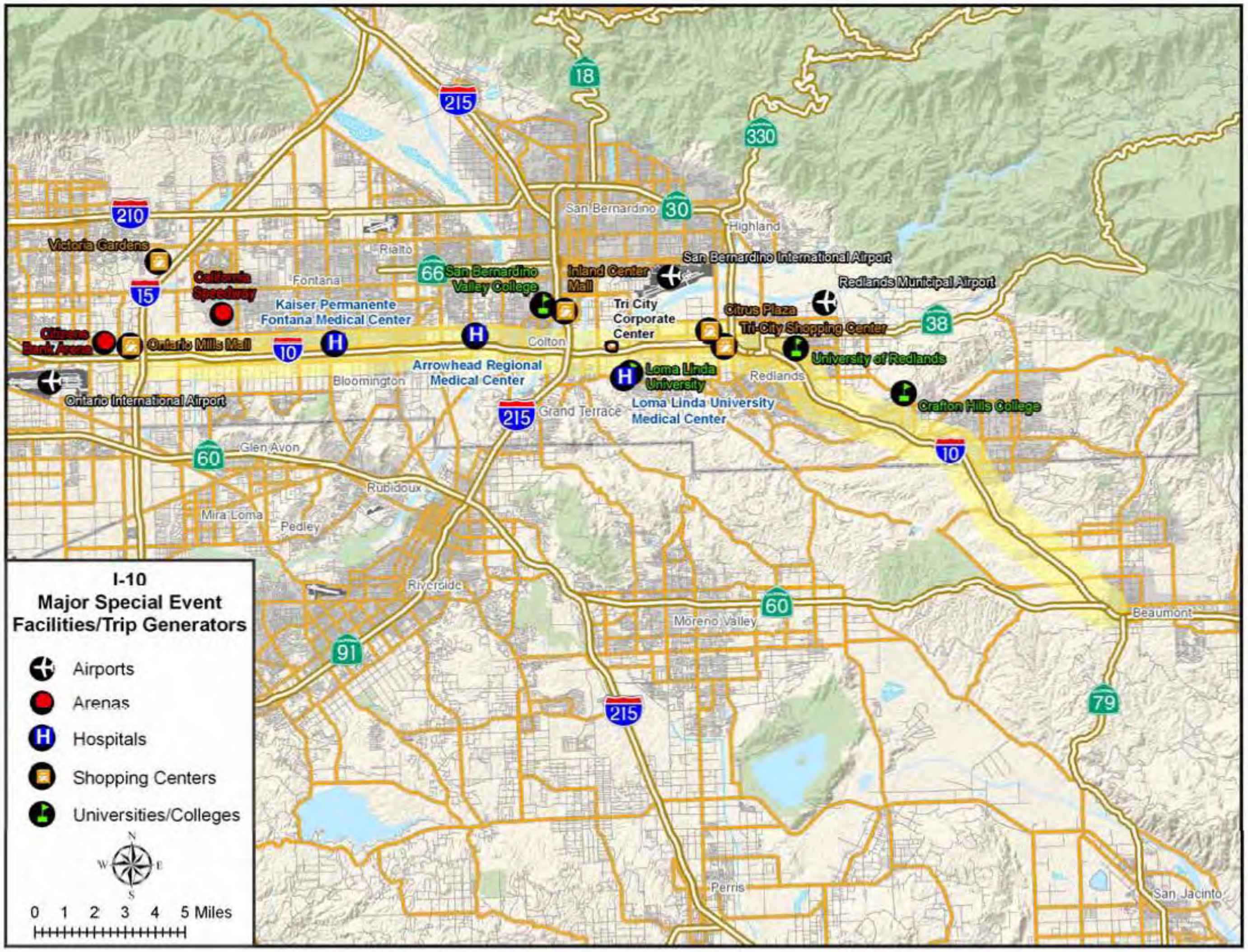
- Loma Linda University Medical Center is a 900-bed hospital located adjacent to the Loma Linda University south of the I-10 off Tippecanoe/Anderson. It includes a Children's Hospital, a Medical Center East Campus, and a Behavioral Medicine Center. This hospital serves more than 33,000 inpatients and half a million outpatients each year. It is the only level one regional trauma center for the Inyo, Mono, Riverside, and San Bernardino counties.
- Kaiser Permanente Fontana Medical Center is located north of the I-10 at the corner of Sierra Avenue and Valley Boulevard. It is a full service hospital offering preventive care, prenatal care, emergency services, screening diagnostics, and pharmacy services. It serves part of Kaiser Permanente's 6.5 million members in California.

- Arrowhead Regional Medical Center is located just north of the I-10 at Pepper Avenue. It is a 373-bed teaching facility with a Level II trauma center, an emergency department and other specialty services serving the San Bernardino, Riverside, Inyo, and Mono counties.

Other facilities that may generate significant trips include:

- California Speedway, which is located just one mile north of I-10 off Cherry Avenue. It provides over 92,000 grandstand seating and is accessible by car as well as Metrolink train services during race event weekends. It is the site of various racing events including the American Motorcyclist Association (AMA) and the National Association for Stock Car Auto Racing (NASCAR) races.
- The San Bernardino Stadium is located approximately two miles north of the I-10, east of the I-215. It is home to the Inland Empire 66ers, San Bernardino's single-A minor league baseball team in the California League.
- The Citizens Bank Arena, formerly the Ontario Community Events Center, hosts local events and concerts. The arena's capacity is approximately 11,000. It is located less than a mile north of I-10 and west of I-15.
- Victoria Gardens is a large shopping mall in Rancho Cucamonga, located approximately four miles north of the I-10/I-15 interchange.
- Ontario Mills Mall is located just west of the I-10/I-15 interchange and is the largest outlet mall in California with over 200 discount stores and entertainment venues.
- The Inland Center Mall, approximately two miles north of the I-10, just east of the I-215, has over 100 specialty shops.
- Tri-City Shopping Center is located just south of I-10 between Alabama Street and Tennessee Street. It has over 60 specialty shops.

Exhibit 2-13: Major Special Event Facilities/Trip Generators



Source: SMG mapping of trip generators

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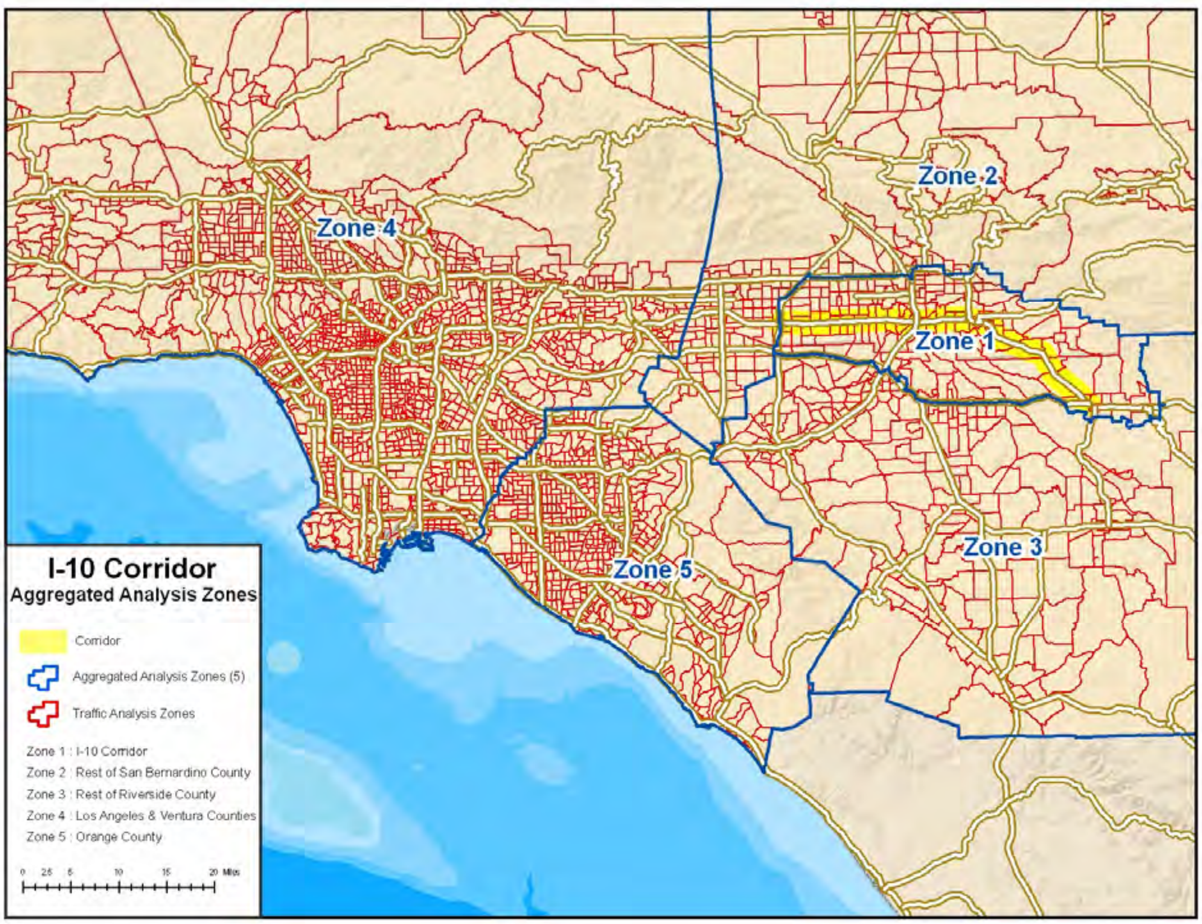
Demand Profiles

An analysis of origins and destinations was conducted to determine the travel pattern of trips made on the I-10 CSMP study corridor. Based on SCAG's travel demand model, this "select link analysis" isolated the I-10 study corridor and identified the origins and destinations of trips made on the corridor. The origins and destinations were identified by Traffic Analysis Zone (TAZ), which were grouped into four aggregate analysis zones shown in Exhibit 2-14.

Exhibit 2-14: Aggregate Analysis Zones for Demand Profile Analysis



Based on this aggregation, demand on the corridor was summarized by aggregated origin-destination zone as shown on Exhibits 2-15 and 2-16 for the AM and PM peak periods. This analysis shows that the majority of trips using the I-10 CSMP study corridor represent travel within San Bernardino and Riverside Counties.

During the AM peak period, about 76 percent of all trips originate and terminate in San Bernardino or Riverside Counties (Zones 1, 2, or 3). The remaining trips originate in San Bernardino or Riverside Counties and terminate in another county (16 percent); originate outside San Bernardino and Riverside Counties and terminate in San Bernardino or Riverside Counties (6 percent); or originate and terminate outside San Bernardino and Riverside Counties (2 percent).

Exhibit 2-15: AM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE					
	AM Trips	I-10 CSMP Corridor	Rest of SBD Co	Rest of RIV Co	LA & Ventura Co	Orange Co	Outside Zones
FROM ZONE	I-10 CSMP Corridor	38,790	13,689	10,800	9,960	2,980	187
	Rest of SBD Co	14,828	3,634	3,781	4,506	668	133
	Rest of RIV Co	9,334	3,753	4,463	2,547	420	347
	LA & Ventura Co	4,393	984	1,019	43	0	1,040
	Orange Co	881	148	131	1	0	167
	Outside Zones	134	86	259	1,093	167	315

76.0%	Trips starting and ending in SBD and RIV Counties
16.0%	Trips starting in SBD or RIV Counties and ending outside of SBD and RIV Counties
5.9%	Trips starting outside of SBD and RIV Counties and ending in SBD or RIV Counties
2.1%	Trips starting and ending outside of SBD and RIV Counties

During the PM peak period (which experiences around 64 percent more demand than the AM), the picture is similar. Roughly 75 percent of trips originate and terminate in San Bernardino and Riverside Counties. The remaining trips originate in San Bernardino or Riverside Counties and terminate in another county (8 percent); originate outside San Bernardino and Riverside Counties and terminate in San Bernardino or Riverside Counties (14 percent); or originate and terminate outside San Bernardino and Riverside Counties (3 percent).

Exhibit 2-16: PM Peak Origin Destination by Aggregated Analysis Zone

		TO ZONE					
	PM Trips	I-10 CSMP Corridor	Rest of SBD Co	Rest of RIV Co	LA & Ventura Co	Orange Co.	Outside Zones
FROM ZONE	I-10 CSMP Corridor	60,715	21,230	15,014	8,857	1,714	222
	Rest of SBD Co	21,768	5,119	6,376	2,553	490	132
	Rest of RIV Co	16,540	6,232	6,063	1,843	222	464
	LA & Ventura Co	13,564	5,530	3,940	66	3	1,297
	Orange Co	3,454	806	495	3	0	283
	Outside Zones	462	271	1,009	2,760	331	1,500

75.3%	Trips starting and ending in SBD and RIV Counties
7.8%	Trips starting in SBD or RIV Counties and ending outside of SBD or RIV Counties
14.0%	Trips starting outside of SBD or RIV Counties and ending in SBD or RIV Counties
3.0%	Trips starting and ending outside of SBD and RIV Counties

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3. CORRIDOR-WIDE PERFORMANCE AND TRENDS

This section summarizes the analysis results of the performance measures used to evaluate the existing conditions of the I-10 Corridor. The primary objectives of the measures are to provide a sound technical basis for describing traffic performance on the corridor.

The performance measures focus on four key areas:

- **Mobility** describes how well the corridor moves people and freight
- **Reliability** captures the relative predictability of the public's travel time
- **Safety** captures the safety characteristics in the corridor such as collisions
- **Productivity** describes the productivity loss due to inefficiencies in the corridor
- **Pavement Condition** describes the structural adequacy and ride quality of the pavement.

MOBILITY

Mobility describes how well the corridor moves people and freight. The mobility performance measures are both readily measurable and straightforward for documenting current conditions and are readily forecast making them useful for future comparisons. Two primary measures are typically used to quantify mobility: delay and travel time.

Delay

Delay is defined as the total observed travel time less the travel time under non-congested conditions, and is reported as vehicle-hours of delay. Delay can be computed for severe congested conditions using the following formula:

$$(\text{Vehicles Affected per Hour})\times(Distance)\times(Duration)\times\left[\frac{1}{(\text{Congested Speed})}-\frac{1}{\text{35mph}}\right]$$

In the formula above, the *Vehicles Affected per Hour* value depends on the methodology used. Some methods assume a fixed flow rate (e.g., 2,000 vehicles per hour per lane), while others use a measured or estimated flow rate. The distance is the length under which the congested speed prevails and the duration is the hours of congestion experience below the threshold speed.

However, all delays can be computed by replacing the “35 mph” with “60 mph” in the previous formula. Different reports and studies use one of the two versions of this formula. The HICOMP report discussed next uses the 35 mph formula and assumes

2,000 vehicles per hour per lane are experiencing the delay. HICOMP therefore reports on only severe delay, while the PeMS results shown after use the 60 mph formula and uses the actual number of vehicles reported by the detection systems and therefore represents overall delay. The results of these two sources are difficult to compare due to the methodological differences. Each is therefore discussed separately.

Caltrans HICOMP

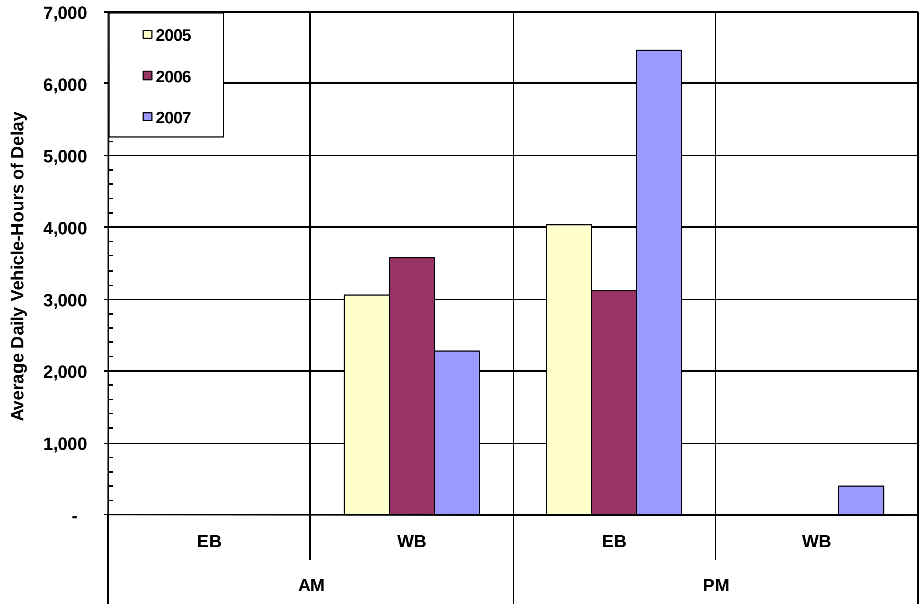
The HICOMP report has been published annually by Caltrans since 1987.[2] Delay is presented as average daily vehicle-hours of delay (DVHD). The HICOMP defines delay as travel time in excess of free-flow travel time when speeds dip below 35 mph for 15 minutes or longer.

For the HICOMP report, probe vehicle runs are performed at most only two to four days during the entire year (ideally, two days of data collection in the spring and two in the fall of the year, but resource constraints may affect the number of runs performed during a given year.). As will be discussed later in this section when discussing the PeMS data, congestion levels vary from day to day and depend on any number of factors including accidents, weather, and special events.

[2] Located at: http://www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/index.htm

Exhibit 3-1 shows the yearly delay trends from 2005 to 2007 for the AM and PM peak travel period for both directions along the I-10 corridor. As indicated, the westbound corridor had the most significant congestion during the AM peak period while the eastbound corridor experienced the most congestion during the PM peak period. The only congestion measured for 2007 was in the eastbound direction during the PM peak period. The pattern of congestion differs by direction. In the westbound direction, congestion increased from 2005 to 2006, but decreased from 2006 to 2007 by almost 36 percent. In the eastbound direction, congestion decreased from 2005 to 2006, but increased by almost 100 percent from 2006 to 2007.

Exhibit 3-1: Average Daily Vehicle-Hours of Delay (2005-2007)



Source: Caltrans HICOMP Reports for 2005-2007

Exhibit 3-2 shows the complete list of congested segments reported by the HICOMP report for the I-10 corridor. "Generalized" congested segments are presented so that segment comparisons can be made from one year to the next since a given congested segment may vary in distance or size from one year to the next as well as from day-to-day.

Exhibit 3-2: HICOMP Congested Segments (2005-2007)

Period	Dir	Generalized Congested Area	Generalized Area Congested		
			Hours of Delay		
			2005	2006	2007
AM	WB	Live Oak Canyon Rd to e/o Redlands OH	1,853	2,371	-
		West of SR-215 to Loma Linda/Redlands City Limit	223	223	-
		West of I-215 to Etiwanda Ave	984	984	-
		I-10/I-215 to Etiwanda	-	-	275
		Live Oak Canyon Rd to 6th St	-	-	1,997
		AM PEAK PERIOD SUMMARY	3,059	3,577	2,272
PM	EB	East of I-15 split to Citrus Ave	-	-	-
		Citrus Ave to e/o Sierra Ave	-	-	-
		East of Mt Vernon Ave to e/o I-215	-	-	-
		East of I-215 to e/o San Bernardino/Loma Linda City Limit	-	-	-
		Tippecanoe Ave to Mt View Ave	-	-	-
		West of Alabama St to Redlands Blvd/Ford St	-	-	-
		East of I-15 to w/o Cherry Ave	950	918	2,143
		East of Cherry Ave to w/o Cedar Ave	250	-	1,151
		Cedar Ave to Rancho Ave	180	175	-
		Mt Vernon Ave to I-215	450	-	-
		I-215 to w/o Tippecanoe Ave	272	-	-
		West of Alabama St to SR-210	300	-	-
		SR-210 to Redlands OH	1,630	-	-
		East of Cherry Ave to e/o Sierra Ave	-	240	-
		Mt Vernon Ave to California St	-	573	-
		Tennessee St to University St	-	1,210	-
		I-10/I-15 to I-10/SR-210	-	-	971
		I-10/SR-210 to Ford St	-	-	2,206
	WB	I-215 to Rancho Ave	398	343	-
		Tippecanoe to B/n Sierra & Cherry	-	-	402
		PM PEAK PERIOD SUMMARY	4,430	3,458	6,873
		TOTAL CORRIDOR CONGESTION	**7,489**	**7,036**	**9,145**

The most congested segment on the corridor varied from year to year (most likely due to construction and detection availability). The highest delays were reported for the westbound segment during the AM peak period, between Live Oak Canyon Road and east of Redlands Boulevard. Delay in this segment totaled roughly 2,371 hours in 2006, an increase of approximately 28 percent from 2005. However, congestion at almost the same location (from Live Oak Canyon Road to 6th Street) decreased in 2007 to 1,997 hours. The eastbound direction also experienced high levels of congestion around the same location but during the PM peak. In 2007, the segment from SR-210 (formerly SR-30) to Ford Street recorded the highest delay of any segment on the corridor during the three-year period with 2,206 hours of delay. A similar segment from SR-210 to Redlands also recorded high delay in 2005 with 1, 630 hours of delay in the eastbound direction.

Exhibits 3-3 and 3-4 provide maps illustrating the 2007 congested segments during the AM and PM peak commute periods for the I-10. The approximate locations of the congested segments, the duration of that congestion, and the reported recurrent daily delay are identified in the exhibit.

Exhibit 3-3: HICOMP Congested Segments Map - AM Peak Period (2007)

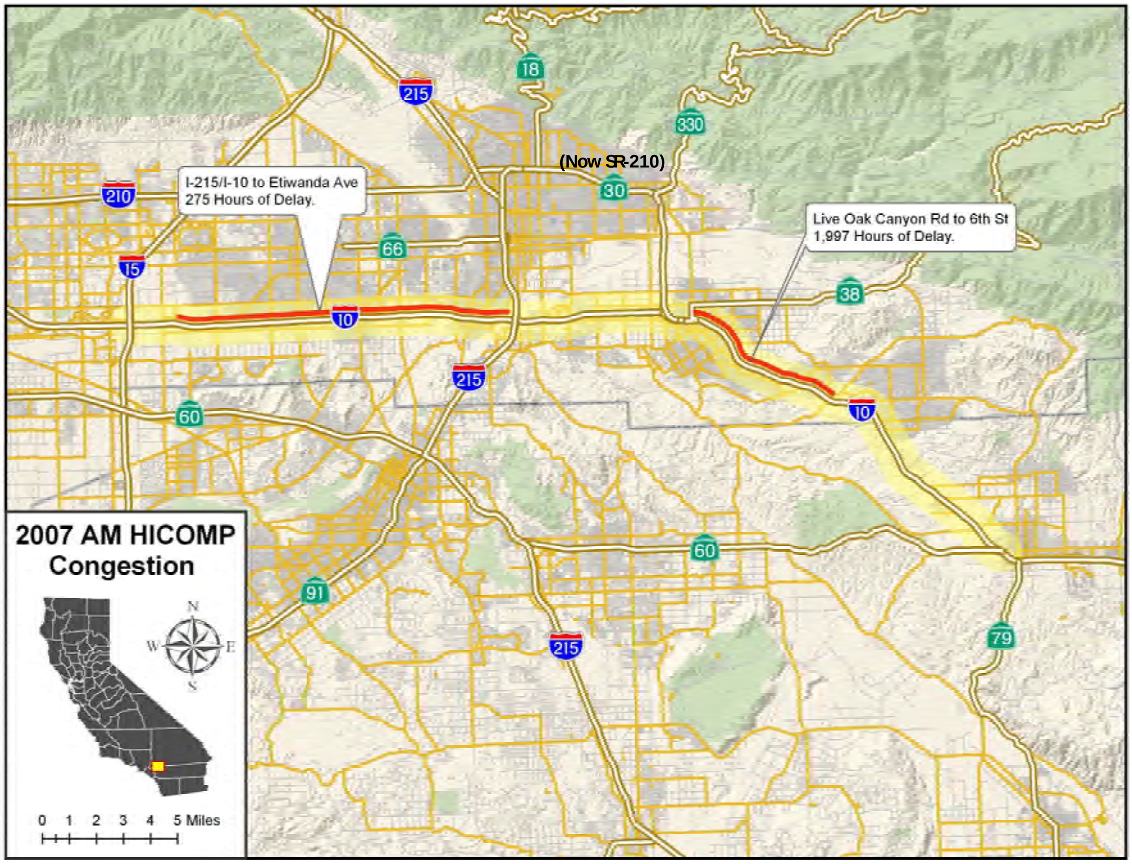


Exhibit 3-4: HICOMP Congested Segments Map - PM Peak Period (2007)

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Freeway Performance Measurement System (PeMS)

Freeway detector data obtained from PeMS can be used to calculate daily delay, which is not possible through probe vehicle runs. The ability to capture daily delay enables delay to be presented in different ways, such as by time period, month, day of the week, or time of day. For the I-10 study corridor, detector data was only available from the I-15 to the I-215 starting in October 2006. Therefore, the initial performance assessments include only analysis for the complete year of 2007 data, west of the I-215. Updates were recently conducted through December 2008.

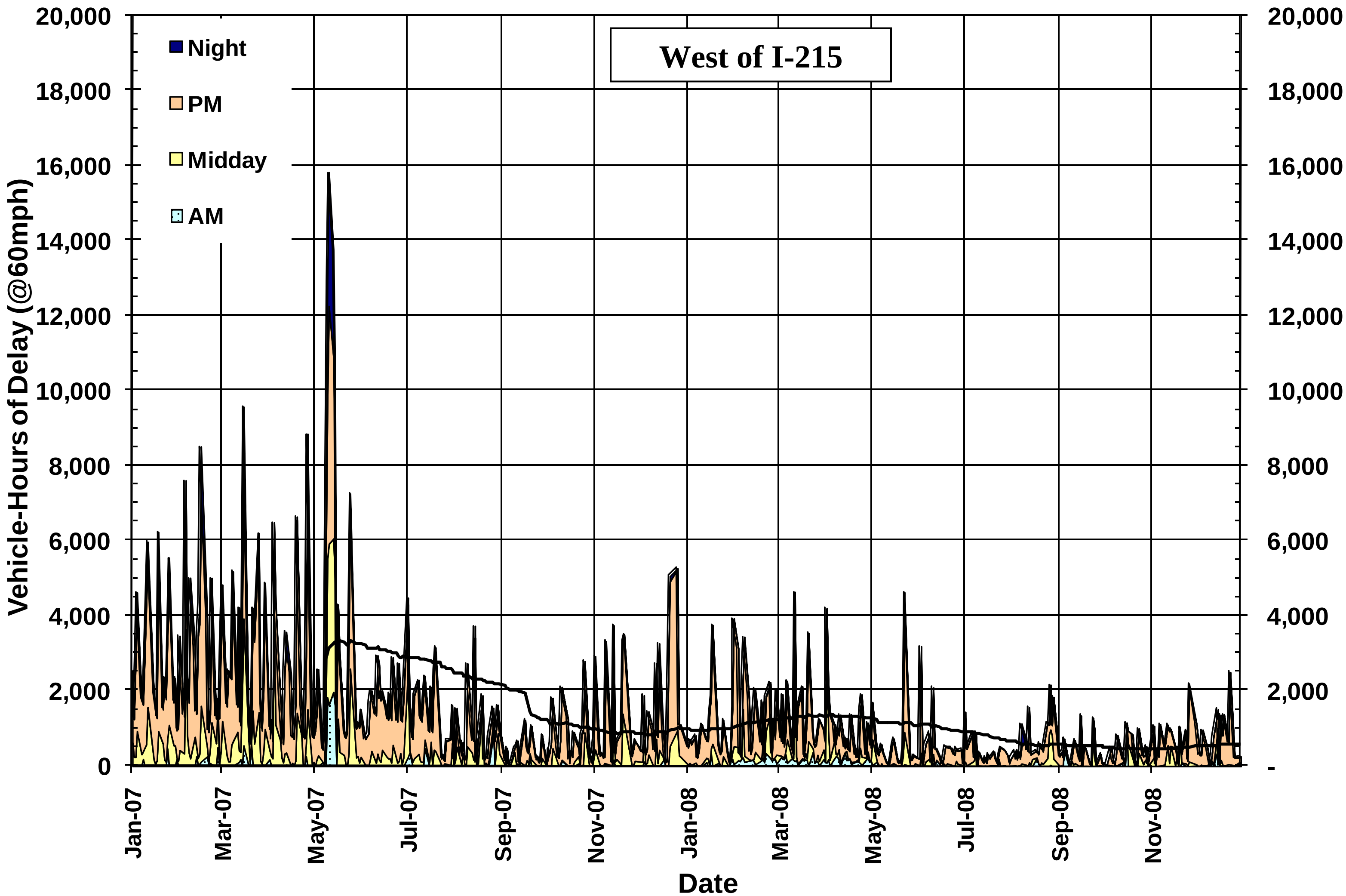
Unlike HICOMP where delay is only considered and captured for speeds below 35 miles per hour and applied to an assumed output or capacity volume of 2,000 vehicles per hour, delays presented hereon using PeMS represent the difference in travel time between actual conditions and free-flow conditions at 60 miles per hour, applied to the actual output flow volume collected from a vehicle detector station. The total delay by time period for the I-10 west of the I-215 for each direction is shown in Exhibits 3-5 to 3-6.

Exhibits 3-5 and 3-6 show the 24-month trend in weekday (i.e., excluding weekends and holidays) delay for the I-10 corridor west of the I-215 in the eastbound and westbound directions respectively. The exhibits also show a 90-day moving average that reduces the day-to-day variations and more easily illustrates the seasonal and annual changes in congestion over time.

As indicated in Exhibit 3-5, the highest daily congestion occurred during the PM peak period in the eastbound direction. Total eastbound delay decreased significantly during the last half of 2007 through 2008 with a spike of delay experienced in May 2007.

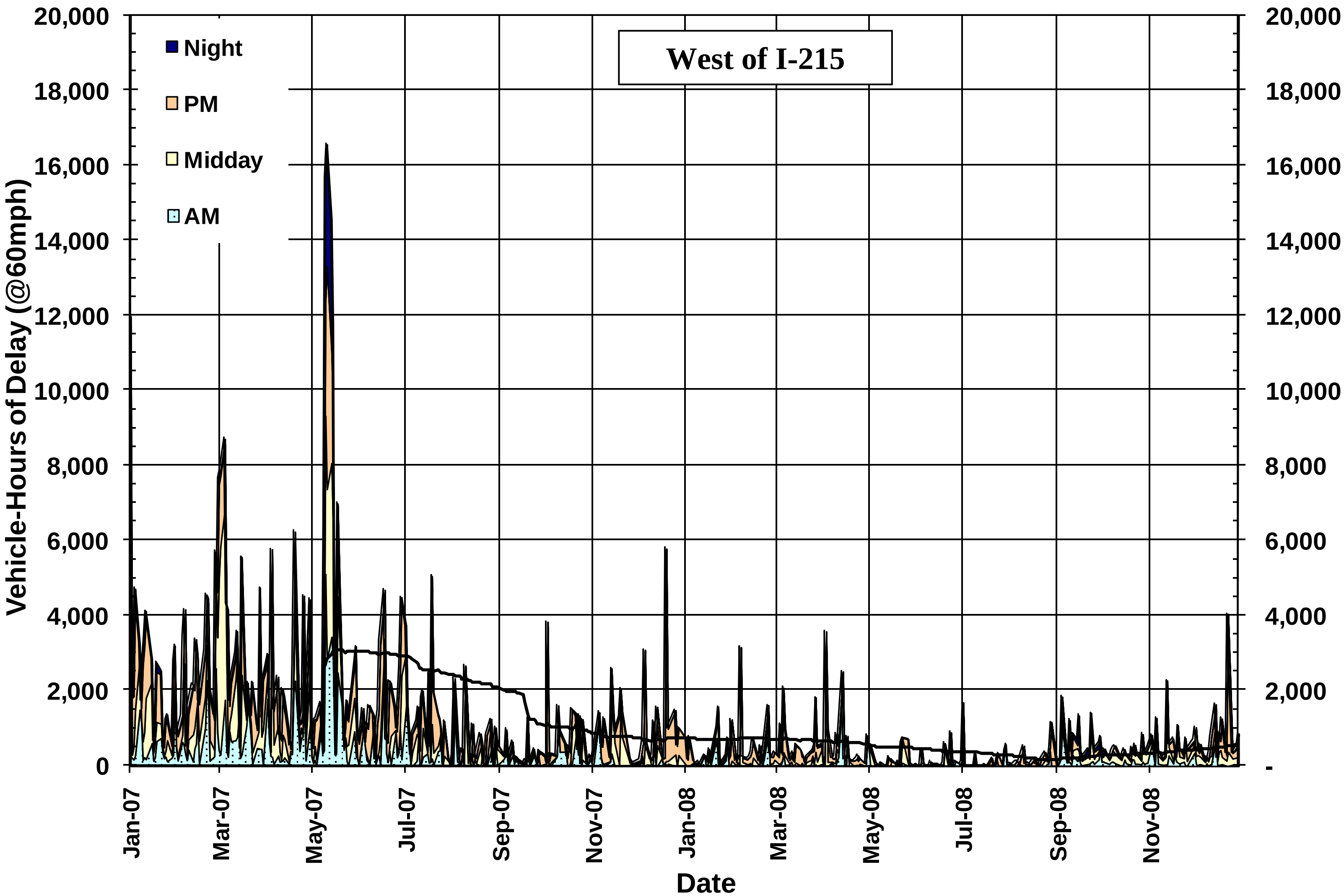
Similarly in the westbound direction, Exhibit 3-6 shows that the highest daily congestion also occurred during the PM peak period with some delay in the AM peak period. The pattern of delay in the westbound direction is similar to the eastbound direction with delay having decreased during the last half of 2007 through 2008 with a spike in delay having occurred in May 2007. The decline in delay in both directions is likely attributed to the opening of the I-210 extension in July 2007, which may have diverted vehicles from I-10.

Exhibit 3-5: Eastbound I-10 Average Daily Delay by Time Period (2007-2008)



Source: SMG analysis of PeMS data

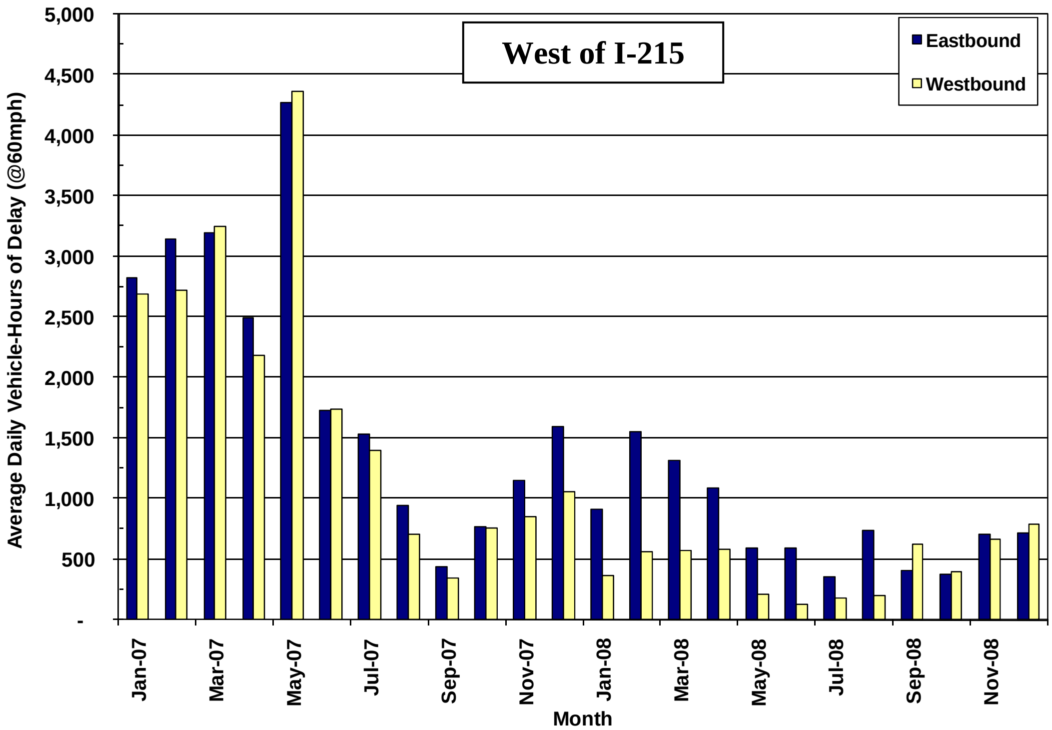
Exhibit 3-6: Westbound I-10 Average Daily Delay by Time Period (2007-2008)



Source: SMG analysis of PeMS data

Exhibit 3-7 shows the average daily weekday delay for the I-10 Corridor west of the I-215 by month and direction. As indicated in this exhibit, the average weekday delay varies month to month, ranging from approximately 400 vehicle-hours to 10,000 vehicle-hours. The eastbound corridor consistently experienced more congestion than the westbound. Again, May 2007 experienced the highest levels of congestion during the two-year period with over 4,250 vehicle-hours of delay in both directions. As illustrated, average delay decreased significantly from 2007 to 2008.

Exhibit 3-7: I-10 Average Weekday Delay by Month (2007-2008)



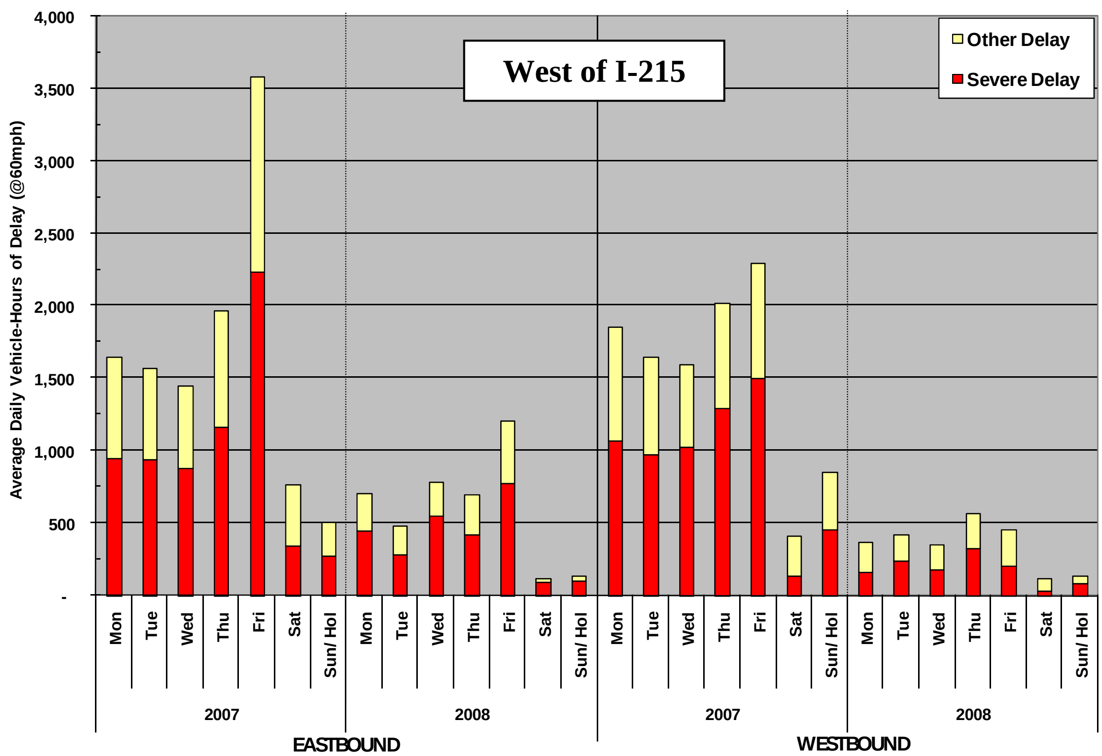
Source: SMG analysis of PeMS data

Delay presented to this point represents the difference in travel time between "actual" conditions and free-flow conditions at 60 miles per hour. This delay can be segmented into two components as shown in Exhibit 3-8:

- Severe delay – delay occurring when speeds are below 35 miles per hour
- Other delay – delay occurring when speeds are between 35 and 60 miles per hour.

Severe delay in Exhibit 3-8 represents breakdown conditions and is the focus of most congestion mitigation strategies. "Other" delay represents conditions approaching the breakdown congestion, leaving the breakdown conditions, or areas that cause temporary slowdowns rather than widespread breakdowns. As depicted in Exhibit 3-8, the eastbound direction on Fridays in 2007 experienced the highest "severe" delay at about 2,250. Similarly, in the westbound direction, Fridays in 2007 experienced the highest "severe" delay with 1,500 vehicle-hours. Overall, delay in both directions decreased significantly from 2007 to 2008, most notably on Fridays.

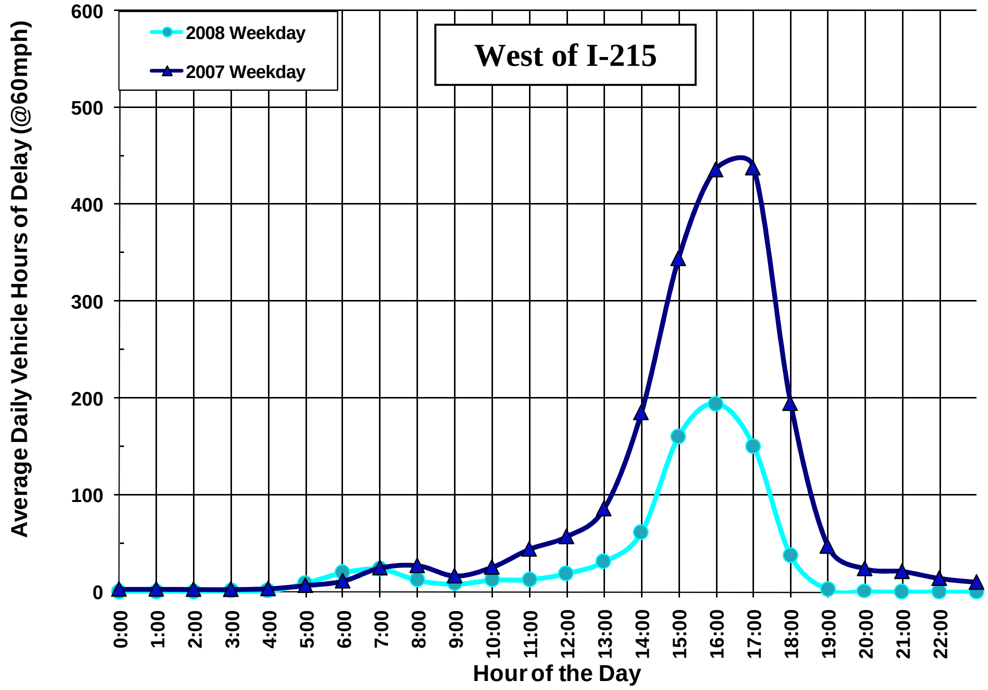
Exhibit 3-8: I-10 Average Delay by Day of Week by Severity (2007-2008)



Source: SMG analysis of PeMS data

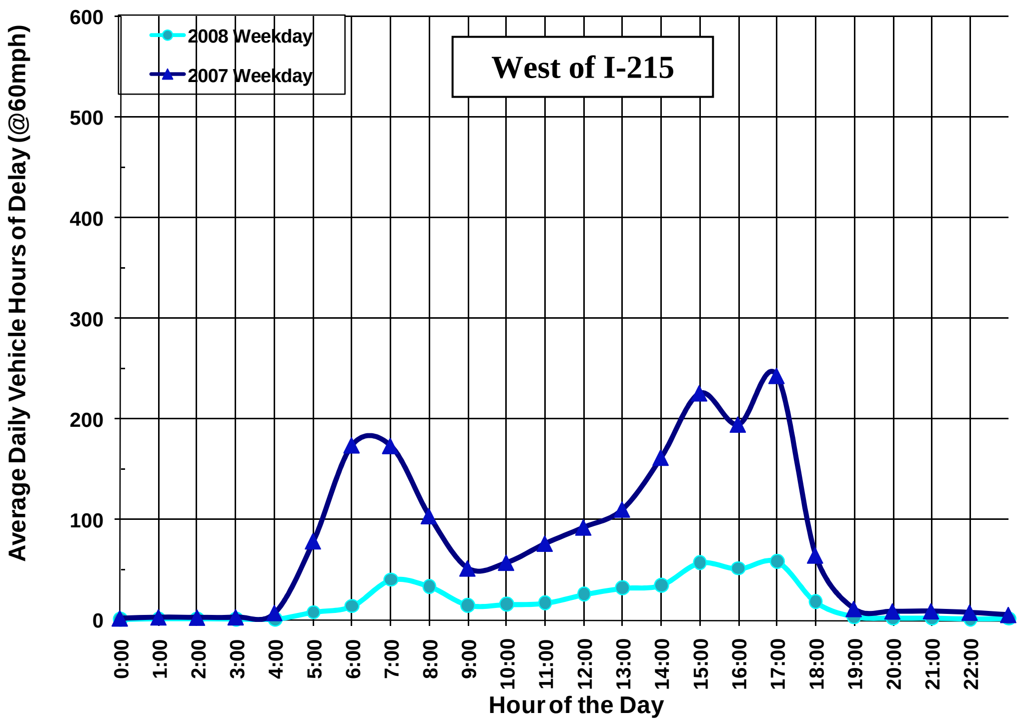
Another way to understand the characteristics of congestion and related delays is to examine average weekday delays by hour. Exhibits 3-9 and 3-10 summarize average weekday hourly for the 18-months from 2007 to mid-2008. Each point represents the total delay for the hour. For example, the 7:00 AM point is the sum of delay from 7:00 AM to 8:00 AM. The exhibits show the peaking characteristics of congestion and how the peak period changes over time. The exhibits highlight the highly directional aspects of travel on the I-10 Corridor, west of I-215. Exhibit 3-9 shows the eastbound average weekday hourly delay for 2007 and 2008. Peak hourly delay in the eastbound direction (at 4:00 PM) was approximately 440 vehicle-hours in 2007 and decreased to 200 vehicle-hours in 2008. In the westbound direction, Exhibit 3-10 reveals the peak hourly delay (at 5:00 PM) was approximately 250 vehicle-hours in 2007, which decreased to 60 vehicle-hours. As previously noted, the decline in delay in both directions is likely attributed to the opening of the I-210 extension in July 2007, which may have diverted vehicles from I-10.

Exhibit 3-9: Eastbound I-10 Average Weekday Hourly Delay (2007-2008)



Source: SMG analysis of PeMS data

Exhibit 3-10: Westbound I-10 Average Weekday Hourly Delay (2007-2008)



Source: SMG analysis of PeMS data

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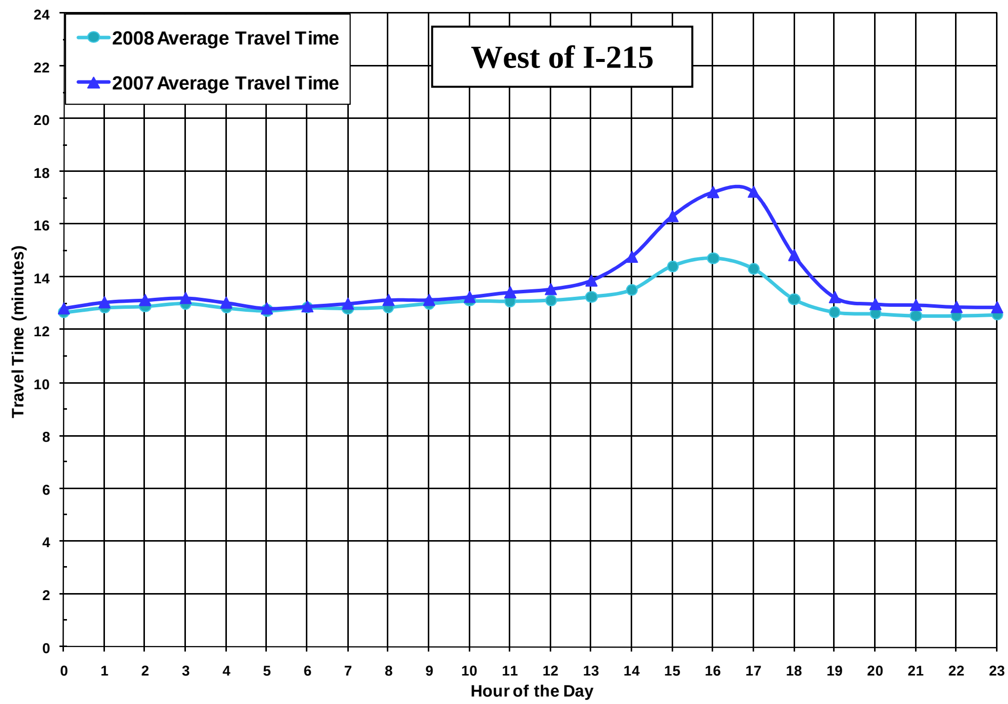
Travel Time

Travel time is reported as the amount of time for a vehicle to traverse between two points on a corridor. For the travel time analysis, PeMS data was analyzed for the 14-mile corridor from the I-15 to the I-215. The performance measure is reported in terms of time to travel from one end of the corridor to the other along the freeway. Travel time on parallel arterials is not included in the analysis.

Exhibits 3-11 and 3-12 depict the travel times calculated for the I-10 Corridor, west of the I-215 for 2007 and 2008. Both Exhibits 3-11 and 3-12 show that travel times decreased from 2007 to 2008. Again, the decline in travel times is likely attributed to the opening of the I-210 extension in July 2007, which may have diverted vehicles from I-10.

At the 4:00 PM peak hour, the eastbound direction experienced a travel time of about 17 minutes in 2007, which declined to 15 minutes in 2008.

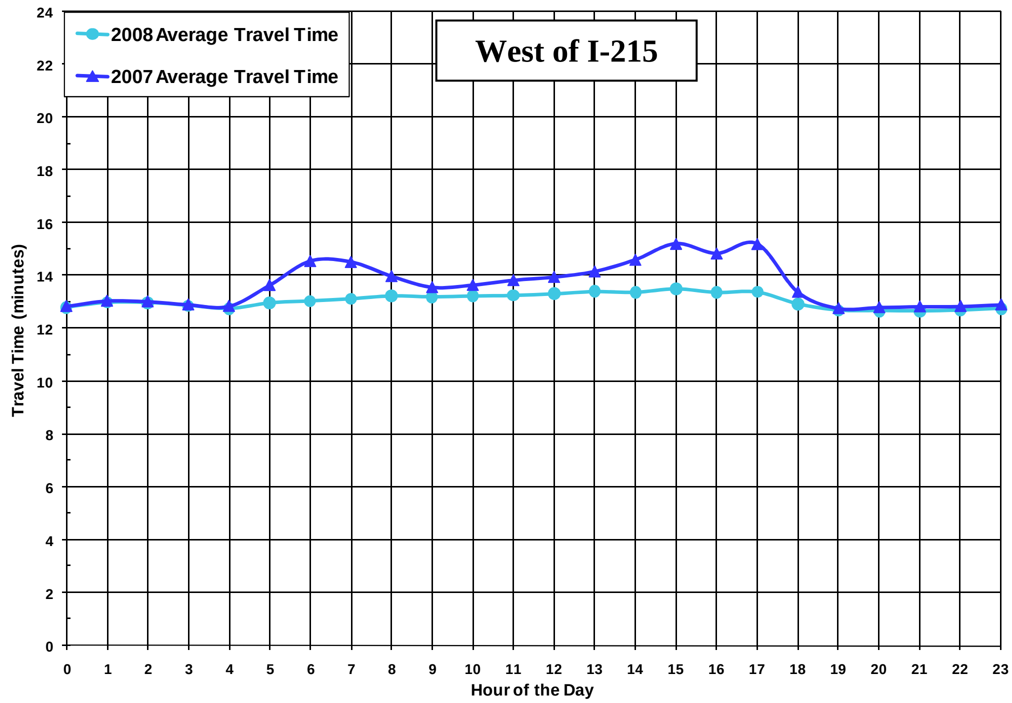
Exhibit 3-11: Eastbound I-10 Travel Time by Time of Day (2007-2008)



Source: SMG analysis of PeMS data

Similarly, the westbound corridor had an average travel time of approximately 15 minutes during the PM peak hour (4:00-5:00 PM) in 2007, which declined to approximately 14 minutes in 2008. Travel time variability throughout the two year-period is consistent with the delay trends observed for this corridor west of the I-215. As delay improves, travel time also improves.

Exhibit 3-12: Westbound I-10 Travel Time by Time of Day (2007-2008)



Source: SMG analysis of PeMS data

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RELIABILITY

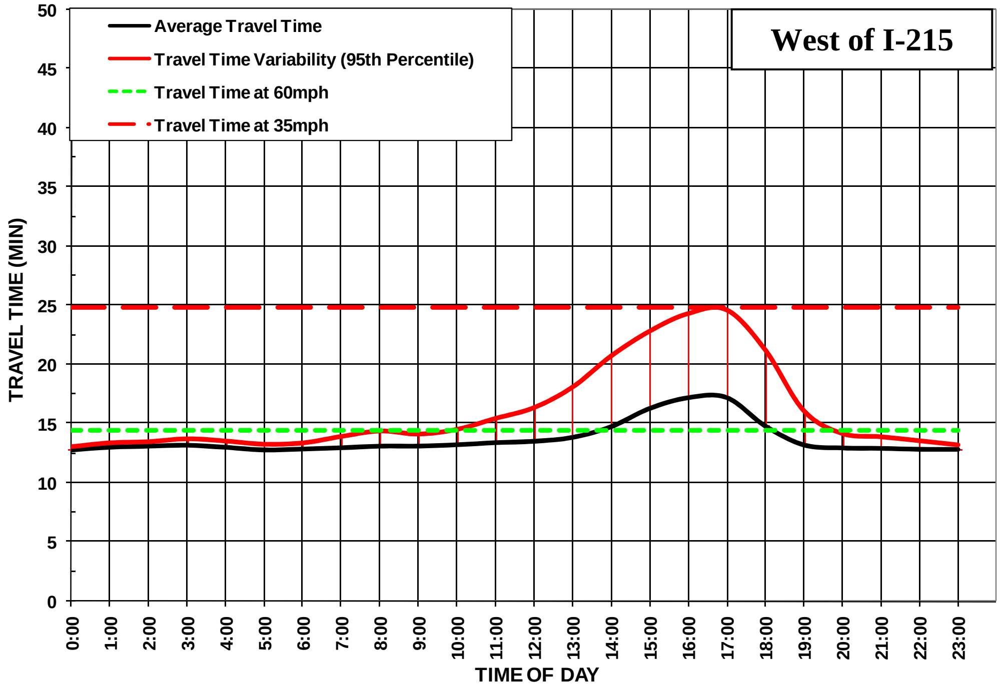
Reliability captures the degree of predictability in the public's travel time. Unlike mobility, which measures the rate of travel, the reliability measure focuses on how travel time varies from day to day. To measure reliability, the study team used statistical measures of variability on the travel times estimated from the PeMS data. The 95th percentile was chosen to represent the maximum travel time that most people would experienced on the corridor. Severe events, such as fatal collisions, could cause longer travel times, but the 95th percentile was chosen as a balance between extreme events and a "typical" travel day.

Exhibits 3-13 to 3-16 on the following pages illustrate the variability of travel time along the I-10 Corridor (west of I-215) on weekdays for 2007 and 2008. Exhibits 3-13 through 3-14 show travel time variability for the eastbound direction in 2007 and 2008, while Exhibits 3-15 and 3-16 show the same data for the westbound direction.

For the eastbound direction, the 4:00 PM peak hour was the most unreliable in addition to being the slowest hour. In 2007 (shown in Exhibit 3-13), motorists driving the entire length of the corridor had to add 8 minutes to an average travel time of 17 minutes (for a total travel time of 25 minutes) to ensure that they arrived on time 95 percent of the time. This is 10 minutes longer than the 15-minute travel time at 60 mph. In 2008 (Exhibit 3-14), a driver needs to add 4 minutes to an average travel time of 14 minutes (for a total travel time of 18 minutes) to arrive on time 95 percent of the time improved. Travel time variability decreased by 4 minutes from 2007 to 2008 in the eastbound direction.

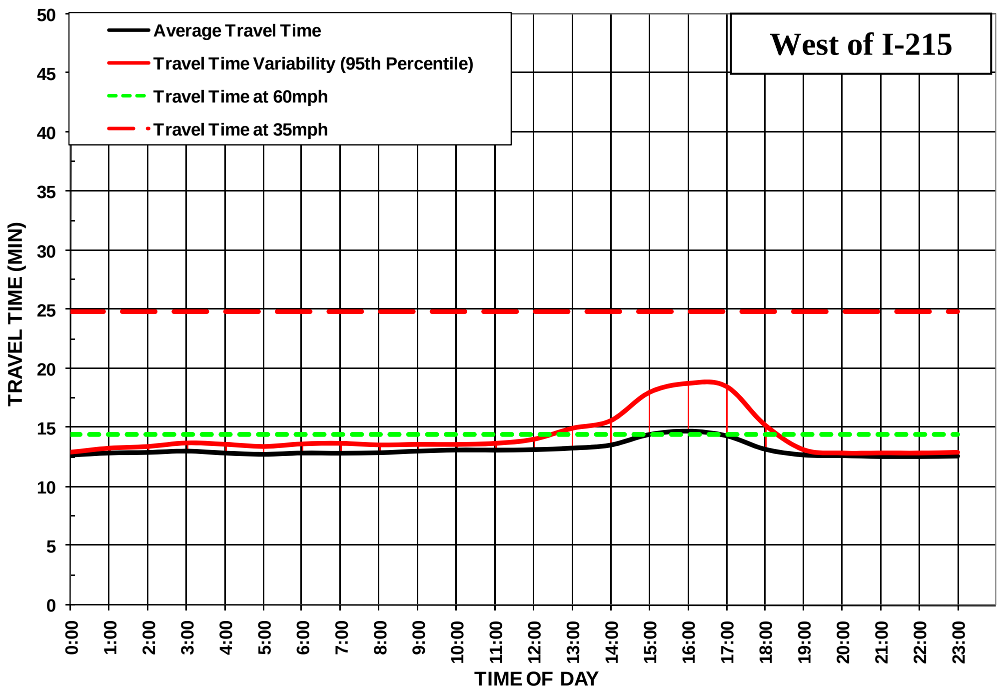
Unlike the eastbound direction, the westbound does not have as distinct of a peak hour. During the 7:00 AM and 5:00 PM peak hours (Exhibit 3-15 and 3-16), a driver needs to add 6 minutes to an average travel time of 15 minutes to ensure an on-time arrival 95 percent of the weekdays in 2007. This corresponds to a total travel time of 21 minutes. In 2008, a driver needs to add about 2 minutes to an average travel time of 13 minutes to ensure an on-time arrival 95 percent of the weekdays (for a total travel time of 15 minutes). The improved travel variability from 2007 to 2008 is likely attributed to the opening of I-210 extension in July 2007, which may have diverted vehicles from I-10.

Exhibit 3-13: Eastbound I-10 Travel Time Variation (2007)



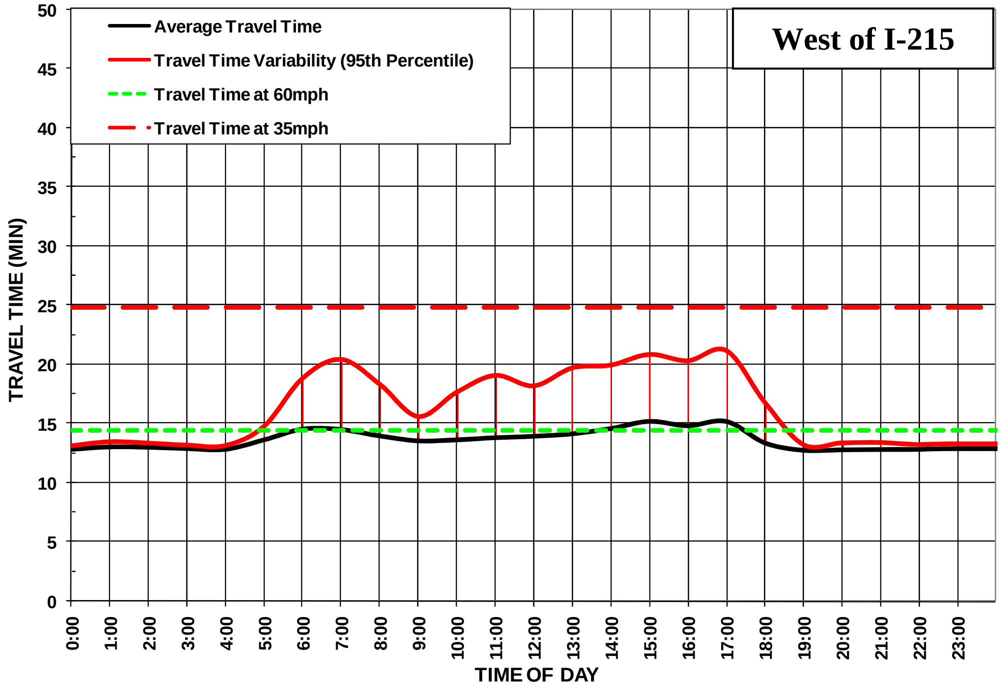
Source: SMG analysis of PeMS data

Exhibit 3-14: Eastbound I-10 Travel Time Variation (2008)



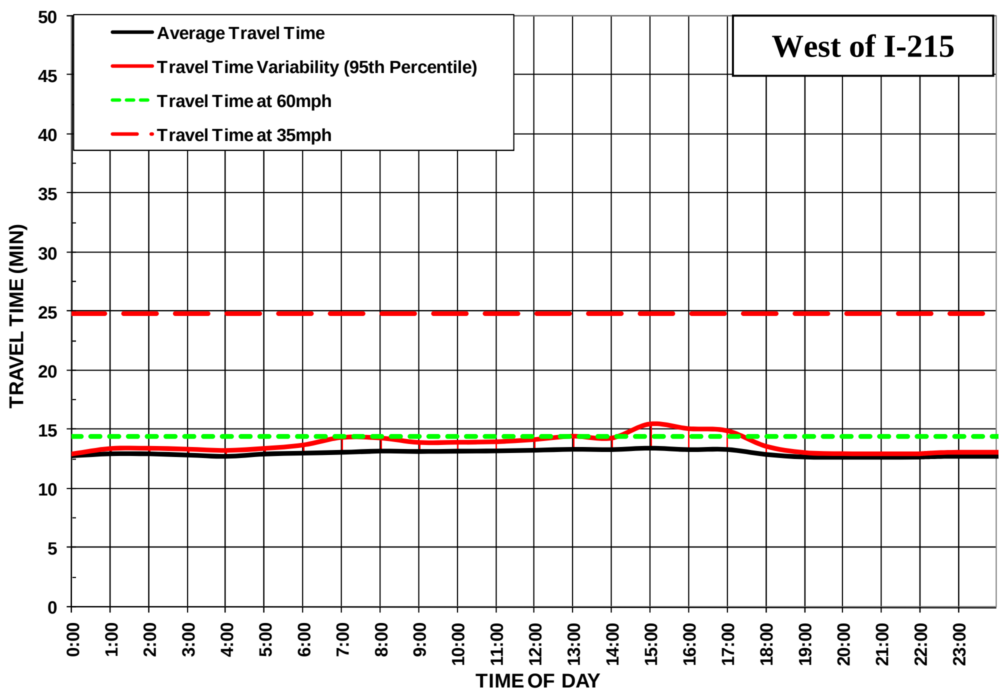
Source: SMG analysis of PeMS data

Exhibit 3-15: Westbound I-10 Travel Time Variation (2007)



Source: SMG analysis of PeMS data

Exhibit 3-16: Westbound I-10 Travel Time Variation (2008)



Source: SMG analysis of PeMS data

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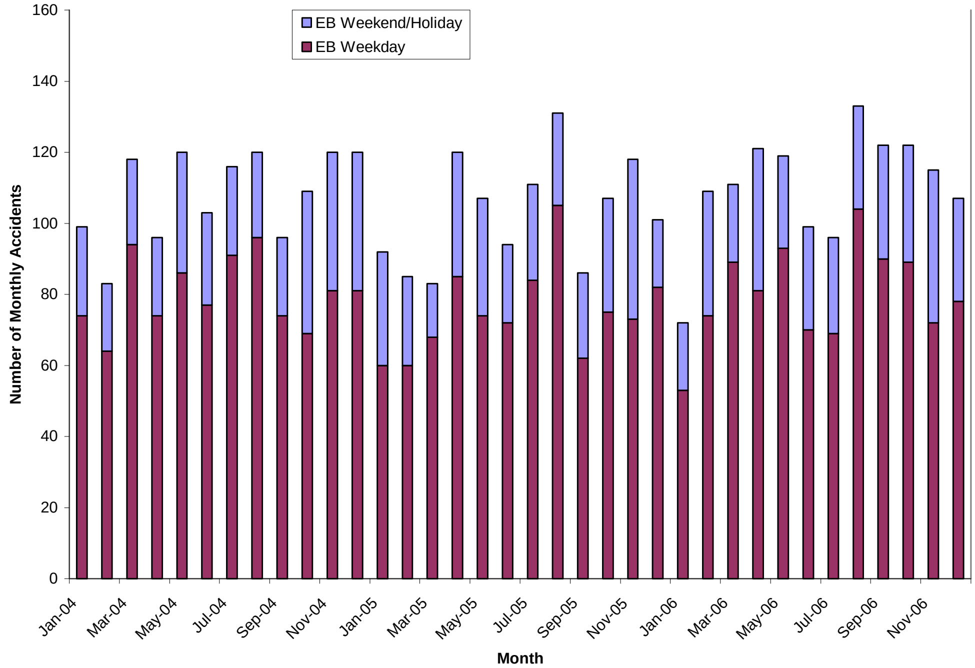
SAFETY

Collision data in terms of the number of accidents and accident rates from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS) were used for the safety measure. TASAS is a traffic records system containing an accident database linked to a highway database. The highway database contains description elements of highway segments, intersections and ramps, access control, traffic volumes and other data. TASAS contains specific data for accidents on state highways. Accidents on non-state highways are not included (e.g., local streets and roads).

The safety assessment in this report is intended to characterize the overall accident history and trends in the corridor, and to highlight notable accident concentration locations or patterns that are readily apparent. This report is not intended to supplant more detailed safety investigations routinely performed by Caltrans staff.

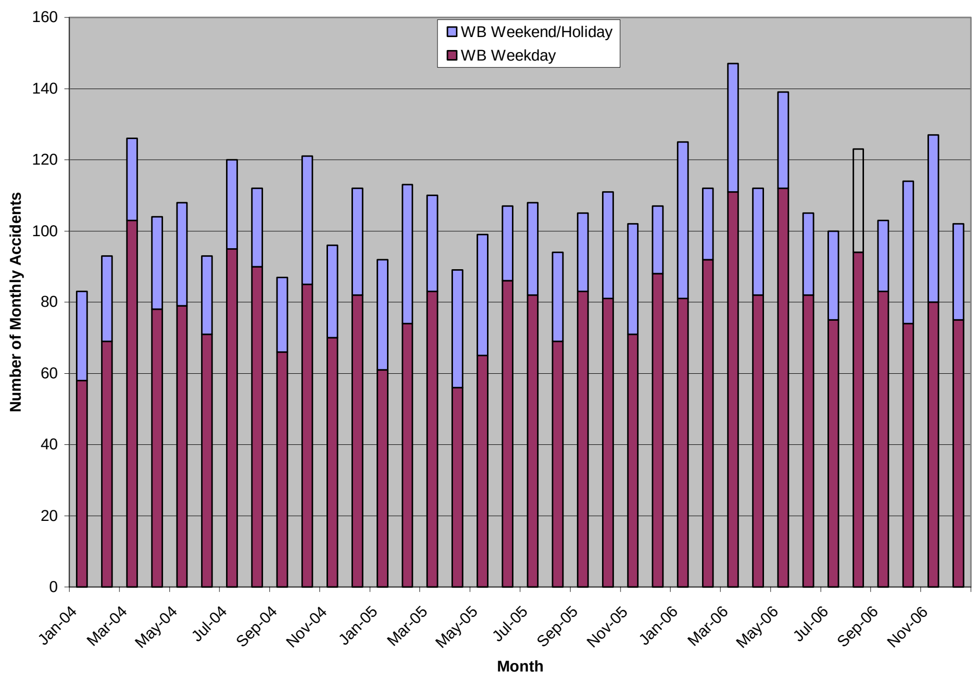
Exhibits 3-17 and 3-18 show the I-10 Corridor (from the I-15 to the SR-60) eastbound and westbound accidents by month respectively. The monthly accidents are broken down by weekdays and weekends. Caltrans typically analyzes the latest three-year safety data. TASAS data is currently available only through December 31, 2006. Therefore, monthly data for the three-year period from January 1, 2004 through December 31, 2006 were analyzed. Note that these are comprehensive and do not rely on automatic detection systems. As indicated, both the eastbound and westbound corridor experienced similar total collisions for the combined three years, approximately 3,900 each. The eastbound corridor averaged 107 collisions per month while the westbound corridor averaged 108 collisions per month. In addition, both directions experienced slightly fewer collisions in 2005 than in 2004 or 2006.

Exhibit 3-17: Eastbound I-10 Monthly Accidents (2004-2006)



Source: SMG analysis of PeMS data

Exhibit 3-18: Westbound I-10 Monthly Accidents (2004-2006)



Source: SMG analysis of PeMS data

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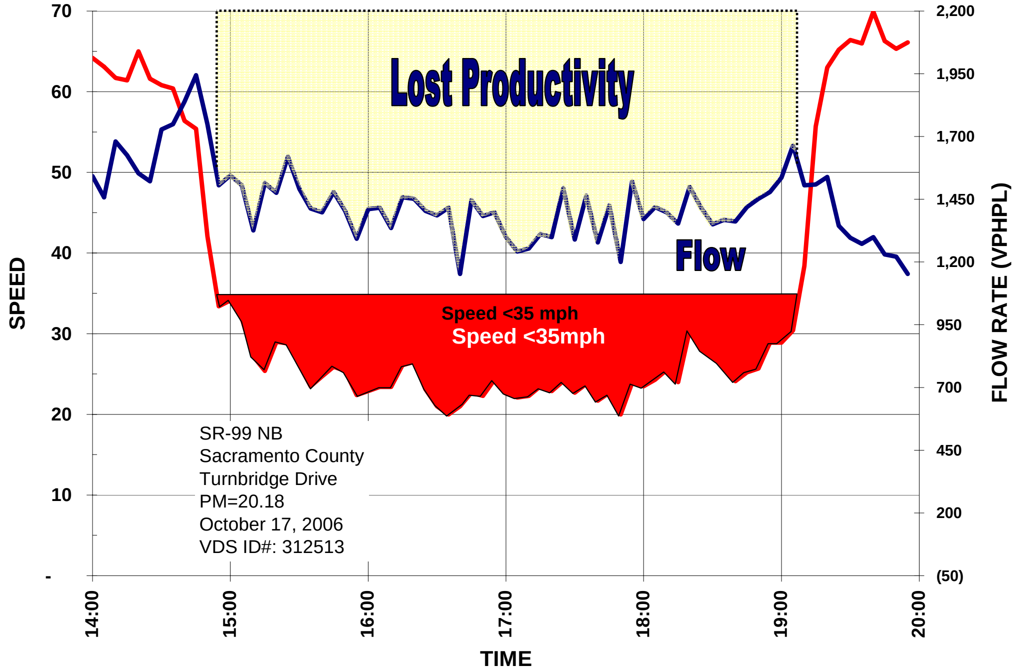
PRODUCTIVITY

Productivity is a system efficiency measure used to analyze the capacity of the corridor, and is defined as the ratio of output (or service) per unit of input. In the case of transportation, it is the amount of people served divided by the level of service provided. Specific to highways, the input to the system is the capacity of the roadways. In transit, it is the number seats provided.

For the corridor analysis, productivity is defined as the percent utilization of a facility or mode under peak conditions. The highway productivity performance measure is calculated as actual volume divided by the capacity of the highway. Travel demand models do not generally project capacity loss for highways, but detailed micro-simulation tools can forecast productivity. For highways, productivity is particularly important because where capacity is needed the most, the lowest "production" from the transportation system often occurs.

This loss in productivity example is illustrated in Exhibit 3-19. As traffic flow increases close to the capacity limits of a roadway, speeds decline rapidly and throughput drops dramatically. This loss in throughput is the lost productivity of the system. There are a few ways to estimate productivity losses. Regardless of the approach, productivity calculations require good detection or significant field data collection at congested locations. One approach is to convert this lost productivity into "equivalent lost lane-miles." These lost lane-miles represent a theoretical level of capacity that would need to be added in order to achieve maximum productivity. For example, losing six lane-miles implies that adding a new lane along a six-mile section of freeway to improve productivity.

Exhibit 3-19: Lost Productivity Illustrated



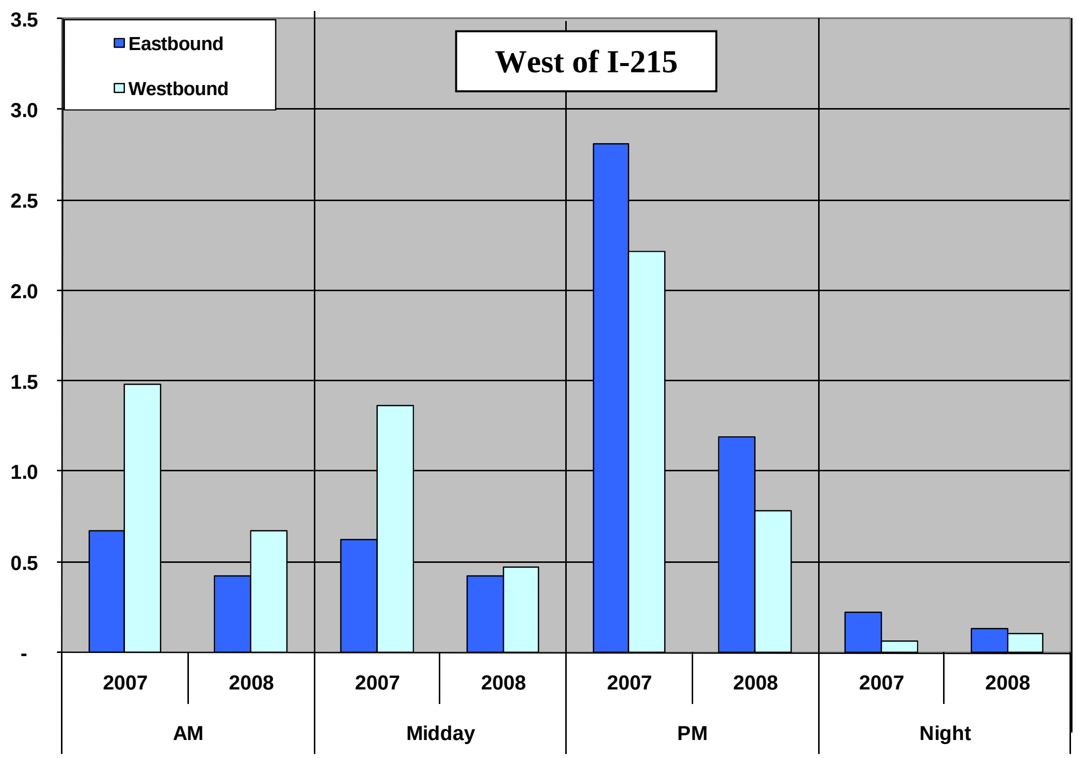
Equivalent lost lane-miles is computed as follows (for congested locations only):

$$LostLaneMiles = \left(1 - \frac{ObservedLaneThroughput}{2000vphpl}\right) \times Lanes \times CongestedDistance$$

Exhibit 3-20 summarizes the productivity losses on the I-10 Corridor (west of the I-215) for the 18-months analyzed for the respective directions of travel. The trends in the productivity losses are comparable to the delay trends. The largest productivity losses (measured in lost-lane miles) occurred during the PM peak hours in the eastbound direction, which is the time period and direction that experienced the most congestion. Productivity during the AM and PM peak periods in both directions improved from 2007 to 2008. This is likely attributed to the opening of I-210 extension in July 2007.

Strategies to combat such productivity losses are primarily related to operations. These strategies include: building new or extending auxiliary lanes, developing more aggressive ramp metering strategies without negatively influencing the arterial network, and improving incident clearance times.

Exhibit 3-20: I-10 Average Lost Lane-Miles by Direction, Time Period, and Year



Source: SMG analysis of PeMS data

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PAVEMENT CONDITION

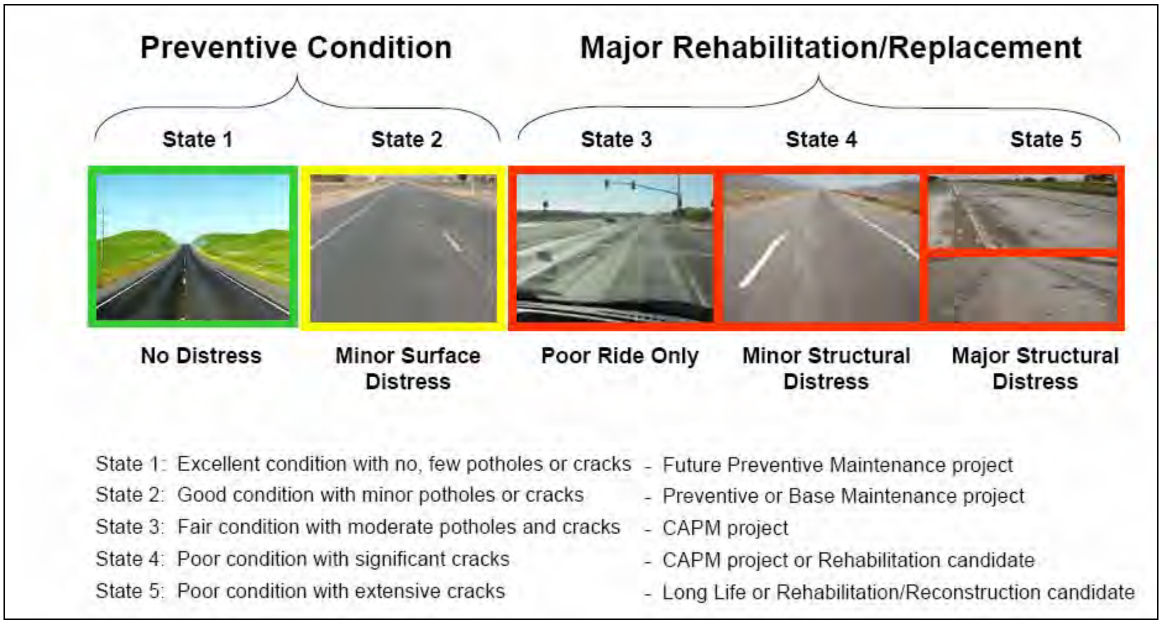
The condition of the roadway pavement (or ride quality) on the corridor can influence its traffic performance. Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor, whereas smooth pavement can have the opposite effect. Pavement preservation refers to maintaining the structural adequacy and ride quality of the pavement. It is possible for a roadway section to have structural distress without affecting ride quality. Likewise, a roadway section may exhibit poor ride quality, while the pavement remains structurally adequate.

Performance Measures

Caltrans conducts an annual Pavement Condition Survey (PCS) that can be used to compute two performance measures commonly estimated by Caltrans: distressed lane miles and International Roughness Index (IRI). Although Caltrans generally uses distressed lane miles for external reporting, this report uses the Caltrans data to present results for both measures.

Using distressed lane miles allows us to distinguish among pavement segments that require only preventive maintenance at relatively low costs and segments that require major rehabilitation or replacement at significantly higher costs. All segments that require major rehabilitation or replacement are considered to be distressed. Segments with poor ride quality are also considered to be distressed. Exhibit 3-21 provides an illustration of this distinction. The first two pavement conditions include roadway that provides adequate ride quality and is structurally adequate. The remaining three conditions are included in the calculation of distressed lane-miles.

Exhibit 3-21: Pavement Condition States Illustrated



Source: Caltrans Division of Maintenance, 2007 State of the Pavement Report

IRI distinguishes between smooth-riding and rough-riding pavement. The distinction is based on measuring the up and down movement of a vehicle over pavement. When such movement is measured at 95 inches per mile or less, the pavement is considered good or smooth-riding. When movements are between 95 and 170 inches per mile, the pavement is considered acceptable. Measurements above 170 inches per mile reflect unacceptable or rough-riding conditions.

Existing Pavement Condition

The most recent pavement condition survey, completed in November 2007, recorded 12,998 distressed lane-miles statewide. Unlike prior surveys, the 2007 PCS included pavement field studies for a period longer than a year, due to an update in the data collection methodology. The survey includes data for 23 months from January 2006 to November 2007.

The field work consists of two parts. In the first part, pavement raters visually inspect the pavement surface to assess structural adequacy. In the second part, field staff uses vans with automated profilers to measure ride quality. The 2007 PCS revealed that the majority of distressed pavement was on freeways and expressways (Class 1 roads). This is the result of approximately 56 percent of the State Highway System falling into this road class. As a percentage of total lane miles for each class, collectors and local roads (Class 3 roads) had the highest amount of distress.

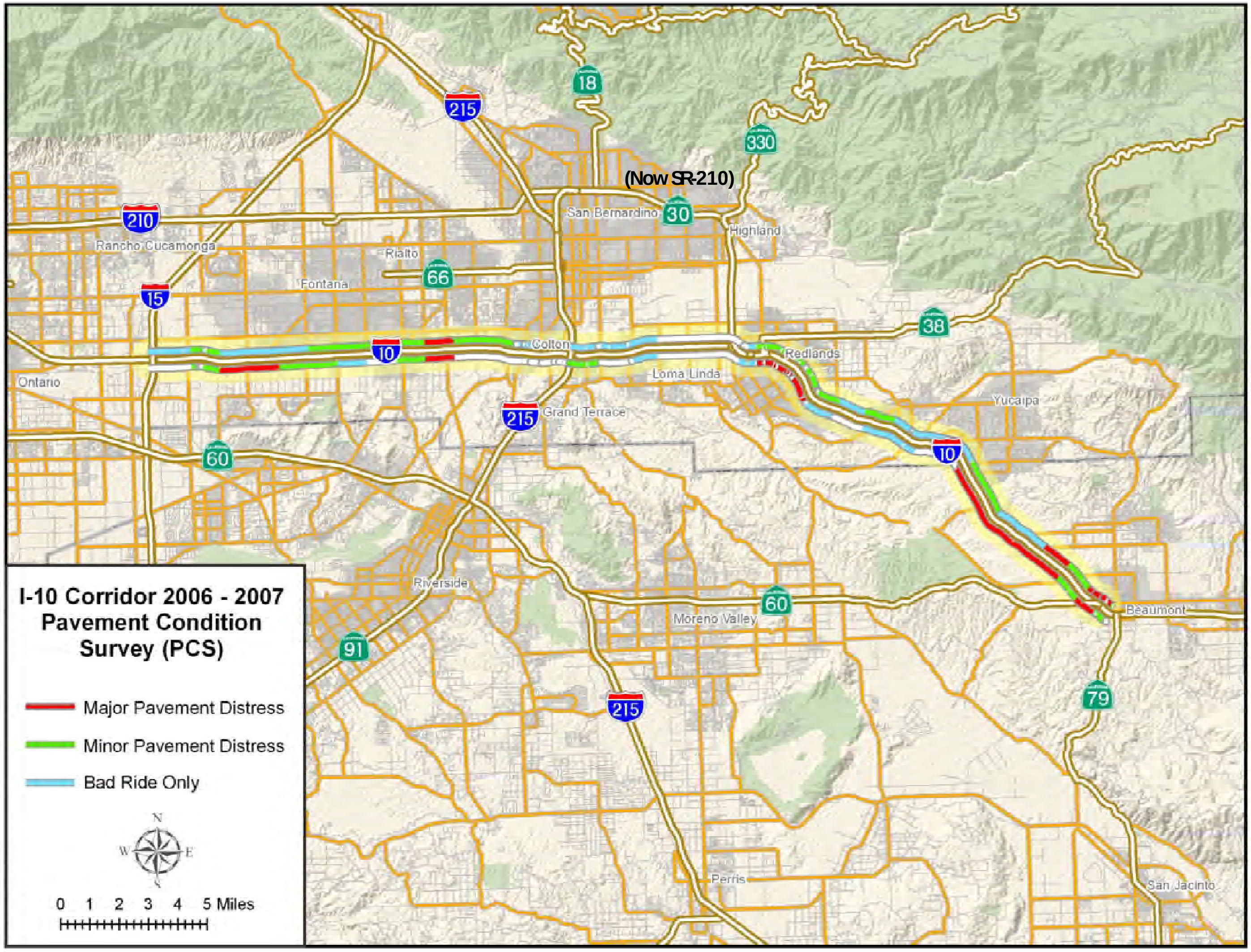
Exhibit 3-22 shows the pavement distress along the I-10 Corridor measured in the 2007 PCS data. The three categories shown in this exhibit represent the three distressed conditions that require major rehabilitation or replacement and were presented earlier in Exhibit 3-21.

The I-10 Corridor is in better condition than many freeways in the Inland Empire. Major pavement distress is found primarily in the western portion of the corridor, although there are small sections with major pavement distress near Fontana and Redlands. The rest of the corridor exhibits mostly either minor pavement distress or poor ride quality only. There are some sections with no distress of any kind.

Exhibit 3-23 compares results from prior pavement condition surveys along the I-10 Corridor. The total number of distressed lane-miles has generally increased since 2003 (with the exception of a decline in 2005). From 2003 to 2004, the growth was due to an increase in minor pavement distress, while major pavement distress became more prominent in 2005. In 2006-2007, pavement distress issues were replaced by ride quality issues.

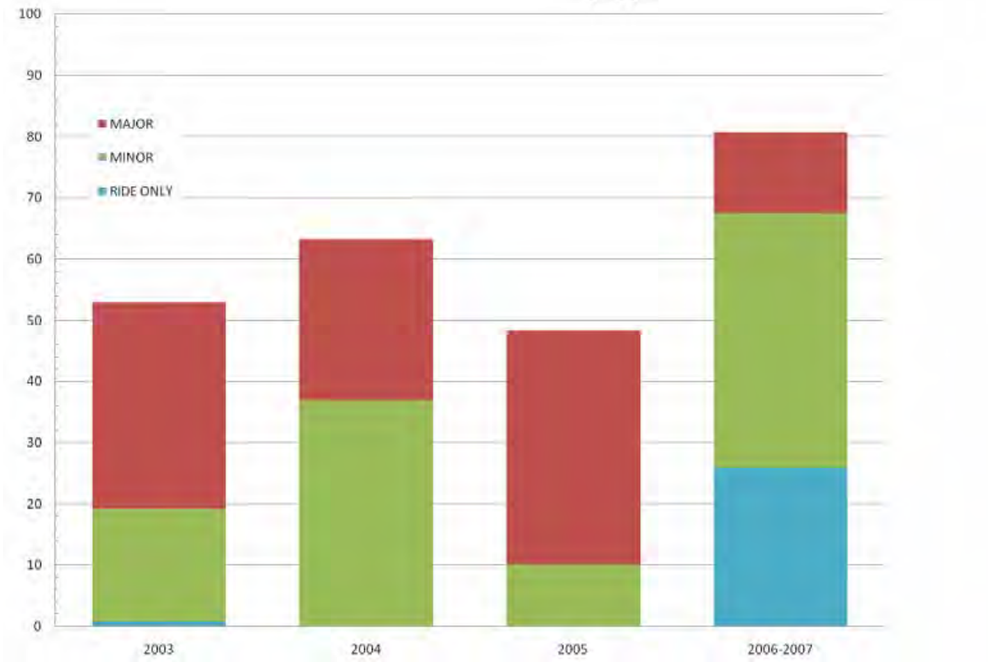
The change in the percent mix of distressed lane-miles is presented more clearly in Exhibit 3-24. As the exhibit shows, major pavement distress has been reduced since 2005. In 2006-2007, roughly half of the distressed lane-miles represented minor pavement distress while only a third was due to ride quality issues.

Exhibit 3-22: Distressed Lane-Miles on I-10 Corridor (2006-2007)



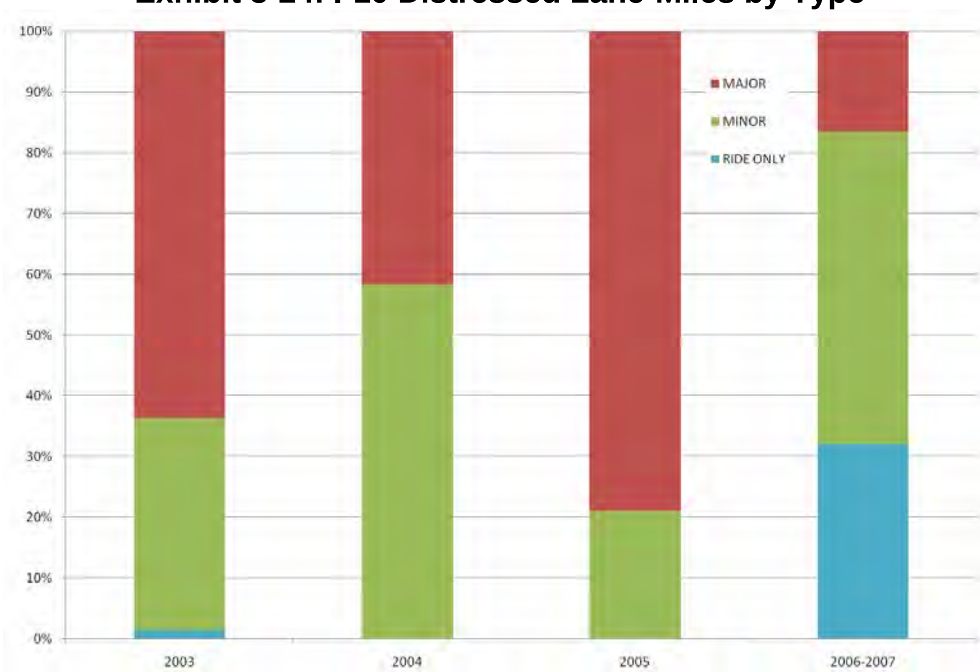
Source: SMG mapping of 2007 Pavement Condition Survey data

Exhibit 3-23: I-10 Distressed Lane-Miles Trends



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-24: I-10 Distressed Lane-Miles by Type



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

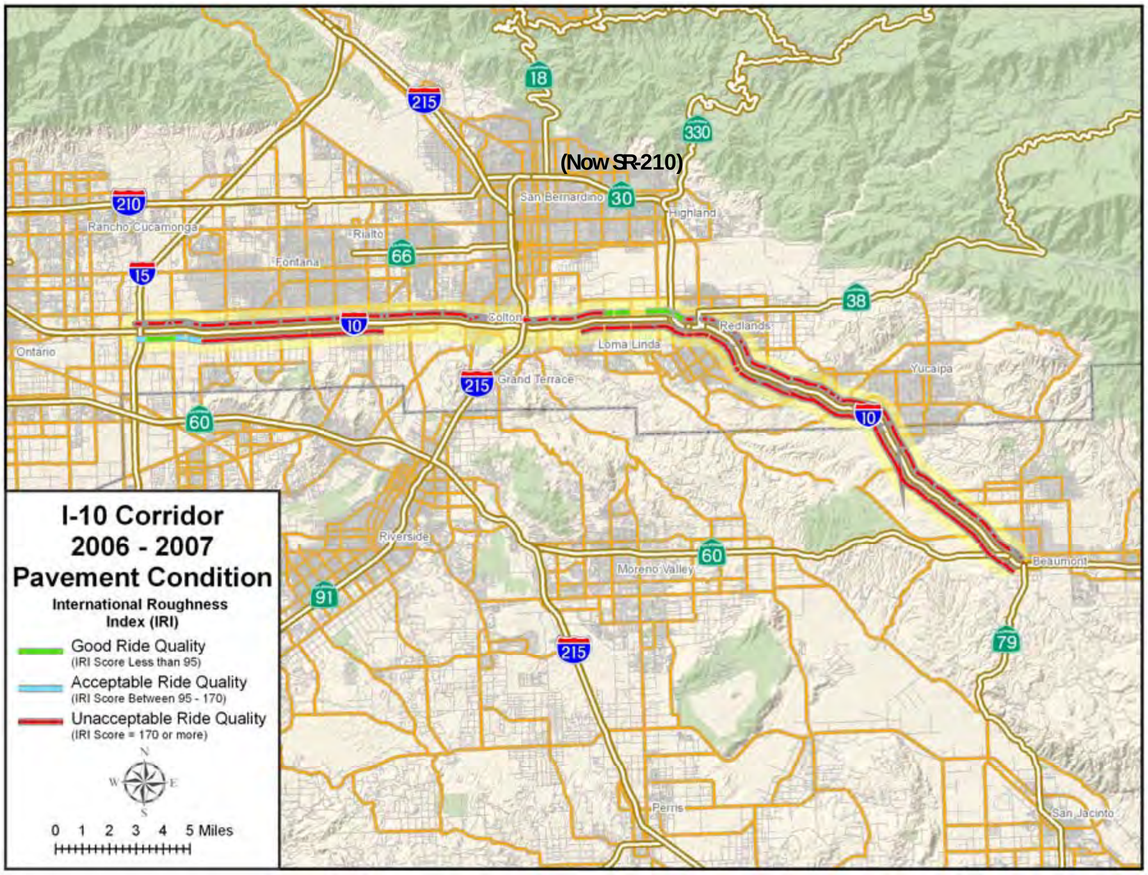
Exhibit 3-25 shows IRI along the study corridor for the lane with the poorest pavement condition in each freeway segment. The worst pavement quality is shown because pavement investment decisions are made on this basis. As seen in the exhibit, over half of the corridor has ride quality issues (IRI greater than 170). However, large sections between Ontario and Redlands have at least one direction in which the worst lane has good or acceptable ride quality. In addition, some lanes have better quality than others within the same roadway section.

The relatively good ride quality is more apparent when the conditions on all lanes are considered. The study corridor is comprised of roughly 166 lane-miles, of which:

- 93 lane-miles, or 56 percent, are considered to have good ride quality (IRI ≤ 95)
- 2 lane-miles, or 1 percent, are considered to have acceptable ride quality (95 < IRI ≤ 170)
- 70 lane miles, or 42 percent, are considered to have unacceptable ride quality (IRI > 170)

Note: the lane-miles do not add due to rounding.

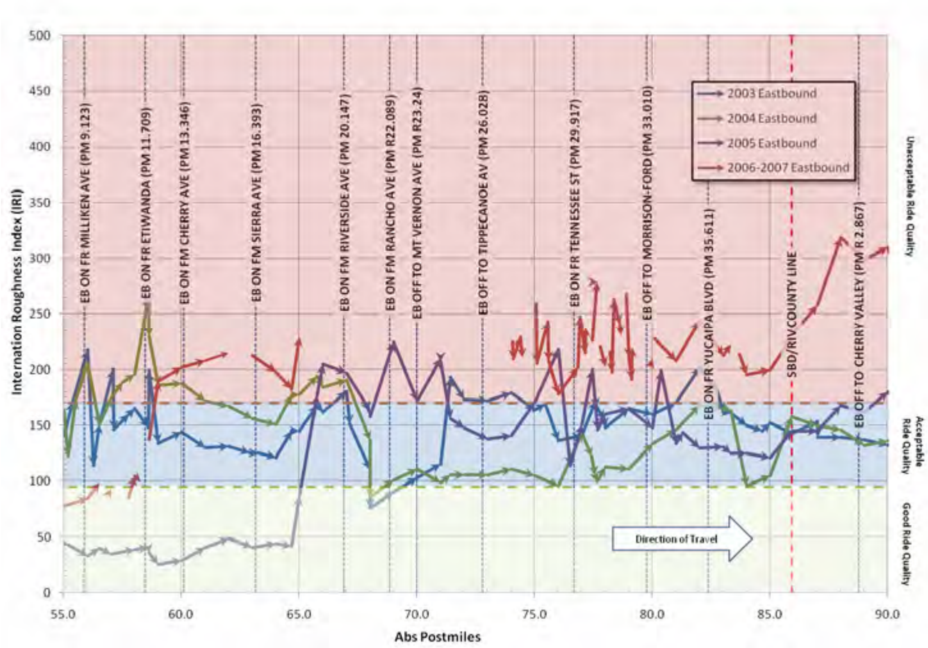
Exhibit 3-25: I-10 Road Roughness (2006-2007)



Source: SMG mapping of 2007 Pavement Condition Survey data

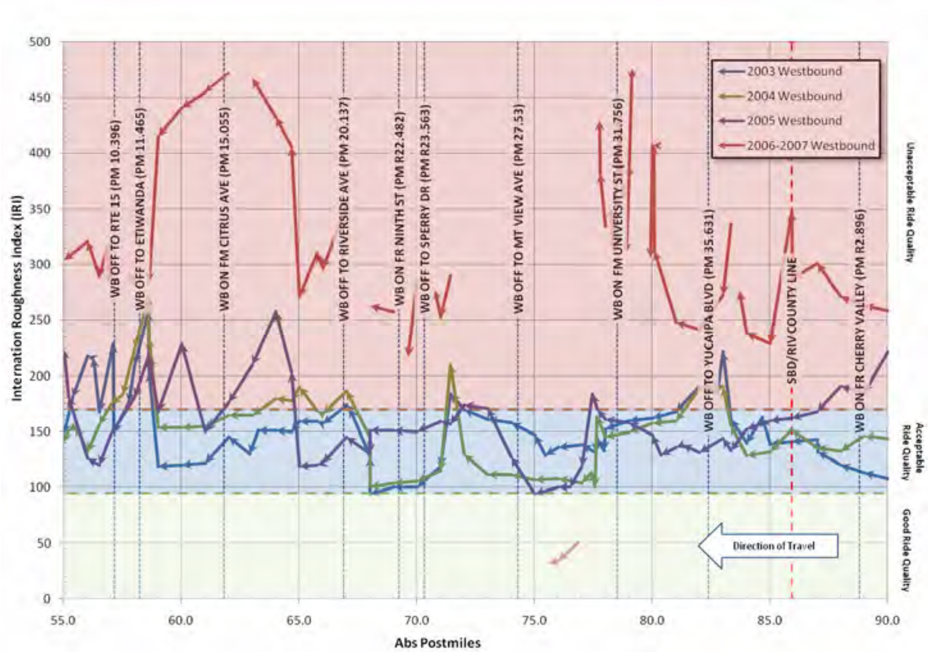
Exhibits 3-26 and 3-27 present ride conditions for the worst lanes on the I-10 Corridor using IRI from the last four pavement surveys. The information is presented by postmile and direction. The exhibits include color-coded bands to indicate the three ride quality categories defined by Caltrans: good ride quality (green), acceptable ride quality (blue), and unacceptable ride quality (red). The surveys show consistent patterns of good, acceptable, and unacceptable ride quality. Ride quality has worsened over the last few surveys, but this is expected with the aging of the freeway. The exhibits exclude a number of sections that were not measured or had calibration issues (i.e., IRI = 0) during the 2006-2007 PCS survey.

Exhibit 3-26: Eastbound I-10 Road Roughness (2003-2007)



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-27: Westbound I-10 Road Roughness (2003-2007)



Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

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4. BOTTLENECK IDENTIFICATION AND ANALYSIS

Potential bottlenecks were identified in the Preliminary Performance Assessment document in July 2008. They were identified based on a variety of data sources, including HICOMP, probe vehicle runs, and PeMS. Limited field observations were conducted as well, but not enough to verify each bottleneck. Since the Preliminary Performance Assessment, significant field observations as well as additional analysis of PeMS data have been conducted. As a result of these additional efforts, the consistent bottlenecks are identified for both directions. The initial analysis from the Preliminary Performance Assessment is found in the Appendix.

Eastbound Bottlenecks

Starting from I-15 and moving eastbound, the following bottlenecks were identified during the PM peak period only:

- I-15 On-ramp: the I-15 connector on-ramps add heavy traffic volume to the mainline with merging and cross weaving traffic, resulting in a bottleneck.
- Etiwanda On-ramp: platoon merging from the collector-distributor contributes to this bottleneck location.
- Cherry On-ramp: data from PeMS and probe vehicle runs identified a bottleneck and congestion at this location in 2007.
- Sierra On-ramp: data from PeMS and probe vehicle runs identified a bottleneck and congestion at this location in 2007
- Riverside On-ramp: data from PeMS and probe vehicle runs identified a bottleneck and congestion at this location in 2007.
- Pepper On-ramp: data from PeMS and probe vehicle runs identified a bottleneck and congestion at this location in 2007.
- I-215 On-ramp: the I-15 connector on-ramps add heavy traffic volume to the mainline with consecutive on-ramps, resulting in a bottleneck when the mainline traffic is heavy.
- Waterman On-ramp: heavy platoon ramp traffic merging with the mainline traffic breaks down the freeway mainline flow.
- Tippecanoe On-ramp: platoon merging from the on-ramp contributes to this bottleneck location.
- Mountain View On-ramp: platoon merging from the on-ramp contributes to this bottleneck location.
- California On-ramp: probe vehicle runs identified a bottleneck and congestion at this location in 2007.
- 6th Street On-ramp: probe vehicle runs identified a bottleneck and congestion at this location in 2007.

Westbound Bottlenecks

Starting from SR-60 and moving westbound, the following bottlenecks were identified from data based on PeMS and probe vehicle runs:

- University On-ramp: a bottleneck condition is likely to form during the AM peak when the on-ramp experiences high volumes and mainline traffic is high.
- California On-ramp: a bottleneck condition is likely to form when the on-ramp experiences high volumes and mainline traffic is high.
- 9th Street On-ramp: an uphill vertical grade and roadway curve to the left approaching the 9th Street on-ramp affect sight distance, contributing to this bottleneck location.
- Cedar On-ramp: a bottleneck condition is likely to form when the on-ramp experiences high volumes and mainline traffic is high.
- Citrus On-ramp: a bottleneck condition is likely to form when the on-ramp experiences high volumes and mainline traffic is high.

ANALYSIS OF BOTTLENECK AREAS

Once the bottlenecks were identified, the corridor is divided into "bottleneck areas." Bottleneck areas represent segments that are defined by one major bottleneck (or a number of smaller ones). By segmenting the corridors into these bottleneck areas, the performance statistics that were presented for the entire corridor can then be broken down by bottleneck area. This way, the relative contribution of each bottleneck area to the degradation of the corridor performance can be gauged. Due to limited detection available on the corridor, the reliability and productivity performance measures could not be analyzed by segment. Nevertheless, the performance statistics that lend themselves to such segmentation include:

- Mobility
- Safety

Based on this approach, the study corridor comprises several bottleneck areas, which are different by direction. Exhibit 4-1 illustrates the concept of bottleneck areas in the westbound direction. Given the large number of bottleneck locations in the eastbound direction, the westbound direction is depicted in Exhibit 4-1. The red vertical lines represent the bottleneck locations, while the arrows identify the bottleneck areas.

Exhibit 4-1: Dividing a Corridor into Bottleneck Areas

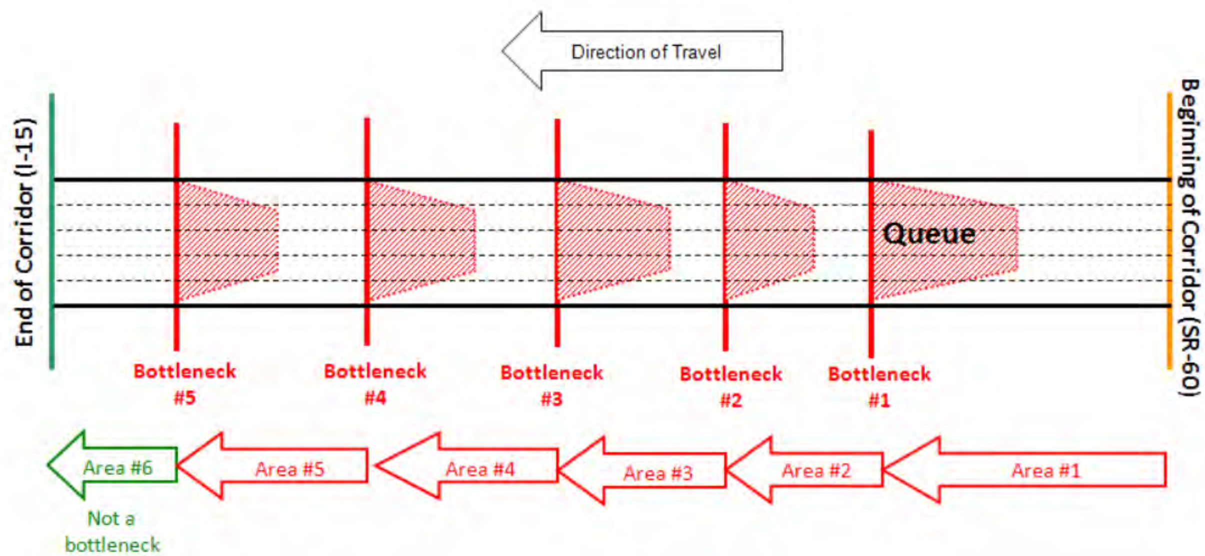
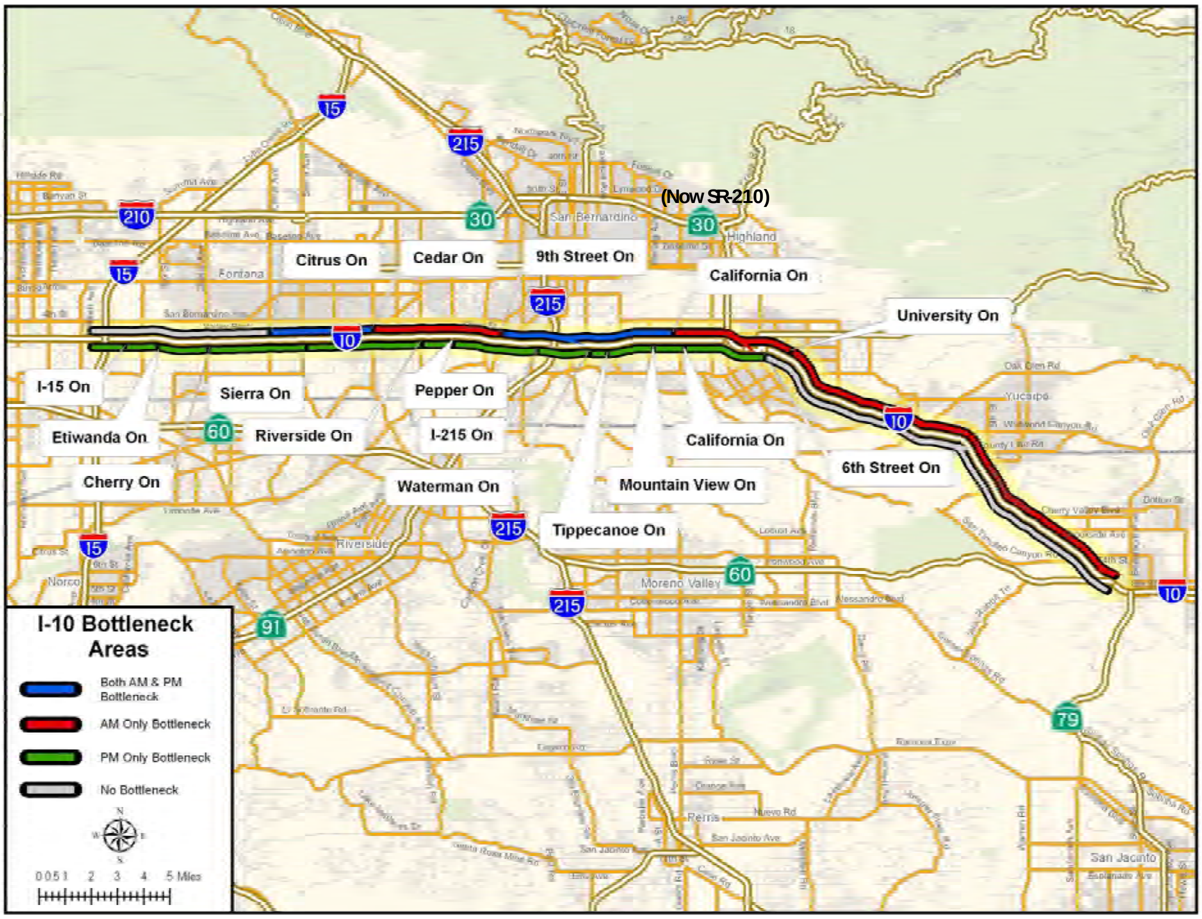


Exhibit 4-2 graphically illustrates the location of each of the bottleneck locations and areas for the I-10 Corridor. The bottleneck locations and areas are also listed in Exhibits 4-3 and 4-4.

Exhibit 4-2: I-10 Bottleneck Locations and Bottleneck Areas



Source: SMG mapping of bottleneck locations and areas

Dividing the corridor into bottleneck areas makes it easier to compare the various segments of the freeway with each other. This section will use the previously discussed performance measures of mobility, safety, productivity, and pavement condition to evaluate each bottleneck area. The results from this bottleneck analysis will reveal which segments of the corridor should be prioritized for improvements.

Exhibit 4-3: Eastbound I-10 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From			To			Distance
		AM	PM	Abs	CA	County	Abs	CA	County	
I-15 On	I-15 to I-15 On*		✓	56.3	9.5	SBD	57.3	10.5	SBD	1.0
Etiwanda On	I-15 On to Etiwanda On		✓	57.3	10.5	SBD	58.5	11.7	SBD	1.2
Cherry On	Etiwanda On to Cherry On		✓	58.5	11.7	SBD	60.1	13.3	SBD	1.6
Sierra On	Cherry On to Sierra On		✓	60.1	13.3	SBD	63.2	16.4	SBD	3.1
Riverside On	Sierra On to Riverside On		✓	63.2	16.4	SBD	66.9	20.1	SBD	3.7
Pepper On	Riverside On to Pepper On		✓	66.9	20.1	SBD	67.9	21.1	SBD	1.0
I-215 On	Pepper On to I-215 On		✓	67.9	21.1	SBD	70.6	R23.8	SBD	2.7
Waterman On	I-215 On to Waterman On		✓	70.6	R23.8	SBD	72.3	25.5	SBD	1.7
Tippecanoe On	Waterman On to Tippecanoe On		✓	72.3	25.5	SBD	72.8	26	SBD	0.5
Mountain View On	Tippecanoe On to Mountain View On		✓	72.8	26	SBD	74.3	27.5	SBD	1.5
California On	Mountain View On to California On		✓	74.3	27.5	SBD	75.3	28.5	SBD	1.0
6th Street On	California On to 6th Street On		✓	75.3	28.5	SBD	78.0	31.2	SBD	2.7
Not a bottleneck location	6th Street On to SR-60	N/A		78.0	31.2	SBD	92.7	6.8	RIV	14.7

* segment is not included in the bottleneck area analysis due to insufficient PeMS detection

Exhibit 4-4: Westbound I-10 Identified Bottleneck Areas

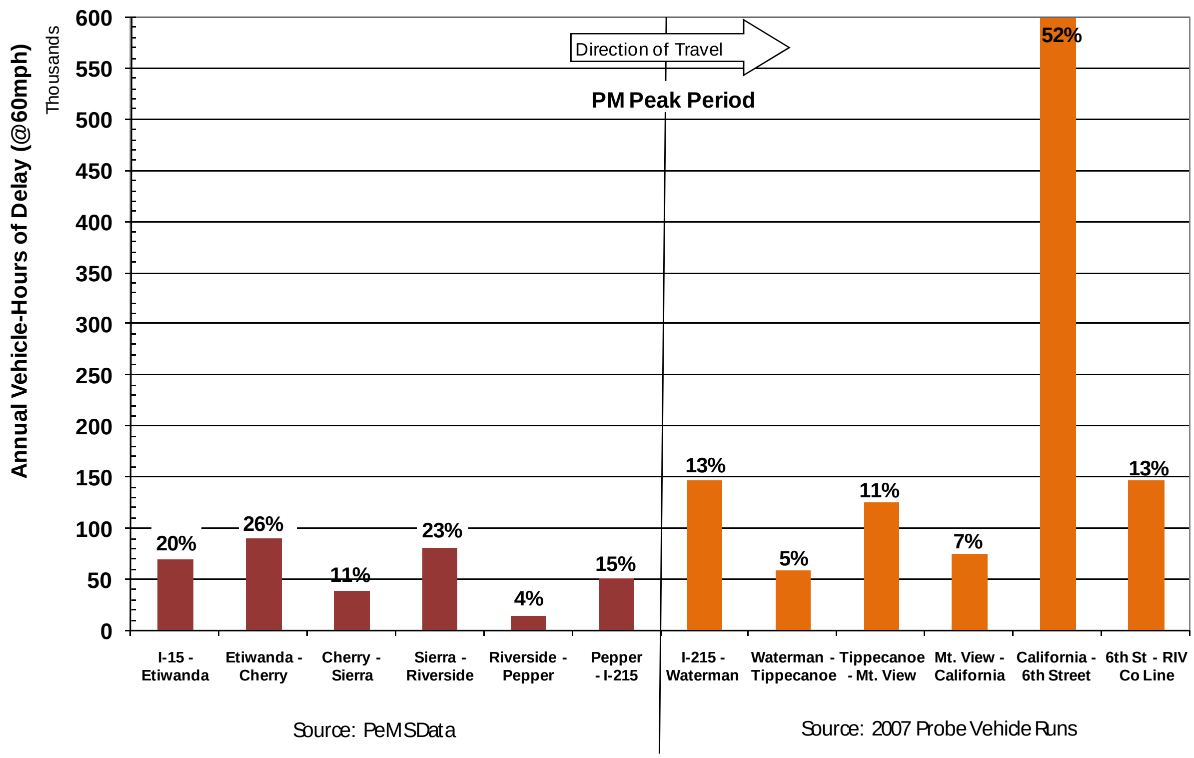
Bottleneck Location	Bottleneck Area	Active Period		From			To			Distance
		AM	PM	Abs	CA	County	Abs	CA	County	
University On	SR-60 to University On	✓		92.7	6.8	RIV	78.5	31.8	SBD	14.2
California On	University On to California On	✓		78.5	31.8	SBD	74.7	28.0	SBD	3.8
9th Street On	California On to 9th Street On	✓	✓	74.7	28.0	SBD	69.3	R22.5	SBD	5.4
Cedar On	9th Street On to Cedar On	✓		69.3	R22.5	SBD	65.1	R18.4	SBD	4.2
Citrus On	Cedar On to Citrus On	✓	✓	65.1	R18.4	SBD	61.8	15.1	SBD	3.3
Not a bottleneck location	Citrus On to I-15	N/A		61.8	15.1	SBD	56.0	9.5	SBD	5.8

Mobility by Bottleneck Area

Mobility describes how efficiently the corridor moves vehicles. To evaluate how well (or poorly) each bottleneck area moves vehicles, vehicle-hours of delay were calculated for each segment. The results reveal the areas of the corridor that experience the worst mobility. Two different sources of data are used to calculate delay for the corridor since PeMS detection is limited to west of I-215. For each direction of travel, there are two sides of the chart that express delay; one side illustrates the bottleneck areas west of I-215 where PeMS detection exists and is used to calculate delay, while the other side depicts bottleneck areas east of I-215, where PeMS data is unavailable and probe vehicle run data is used to calculate delay. Since the travel pattern on I-10 is highly directional and probe vehicle run data exists only during peak periods, delay is presented by peak period in the following charts. It should be noted that delay quantities calculated from the two separate data sources are different and are not compatible. Caution should be exercised when comparing them.

Exhibit 4-5 illustrates the vehicle-hours of delay experienced by each bottleneck area during the PM peak on I-10. The percentages assigned to each bottleneck area are relative to the areas presented on each side of the chart, and not to the entire corridor. As depicted in Exhibit 4-5, the segment from Etiwanda to Cherry experienced the most delay west of I-215 with slightly under 100,000 vehicle-hours of delay; and the segment from California to 6th Street experienced the most delay east of I-215 with roughly 600,000 vehicle-hours of delay.

Exhibit 4-5: Eastbound I-10 Annual Vehicle-Hours of Delay (2007)



Delay in the westbound direction during the AM peak is shown in Exhibit 4-7. The bottleneck area from 9th Street to Cedar experienced the highest delay west of I-215 with roughly 37,000 vehicle-hours of delay; and the segment between the Riverside County Line to University exhibited the most delay east of I-215 with 700,000 vehicle-hours.

Exhibits 4-6 and 4-8 have been normalized to reflect delay per lane-mile. The delay calculated for each bottleneck area was divided by the total lane-miles for each bottleneck area to obtain delay per lane-mile. In both directions, normalizing lane-miles resulted in similar delay results as Exhibits 4-5 and 4-7. Exhibit 4-6 shows that the bottleneck areas of Etiwanda to Cherry (west of I-215) and California to 6th Street (east of I-215) experienced the most delay in the eastbound direction. Similarly, Exhibit 4-8 shows the most delay occurred from 9th Street to Cedar (west of I-215) and from the County line to University (east of I-215) in the westbound direction.

Exhibit 4-6: Eastbound I-10 Delay per Lane-Mile (2007)

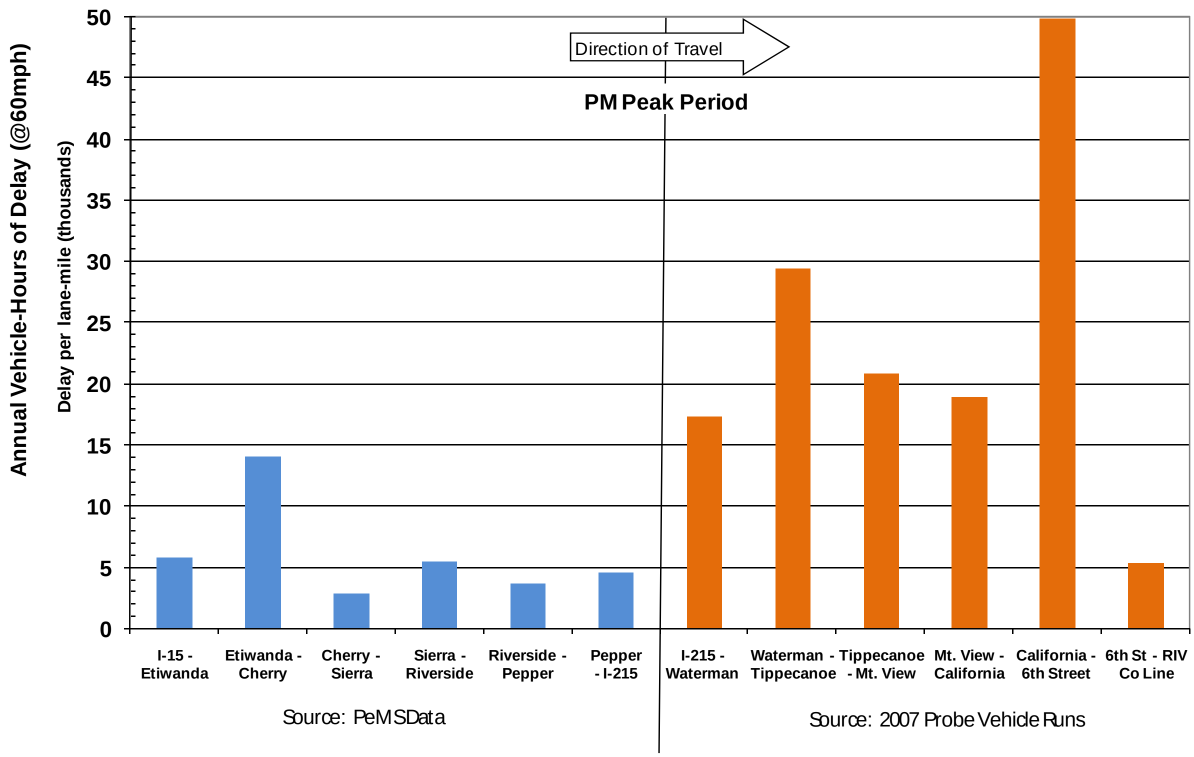


Exhibit 4-7: Westbound I-10 Annual Vehicle-Hours of Delay (2007)

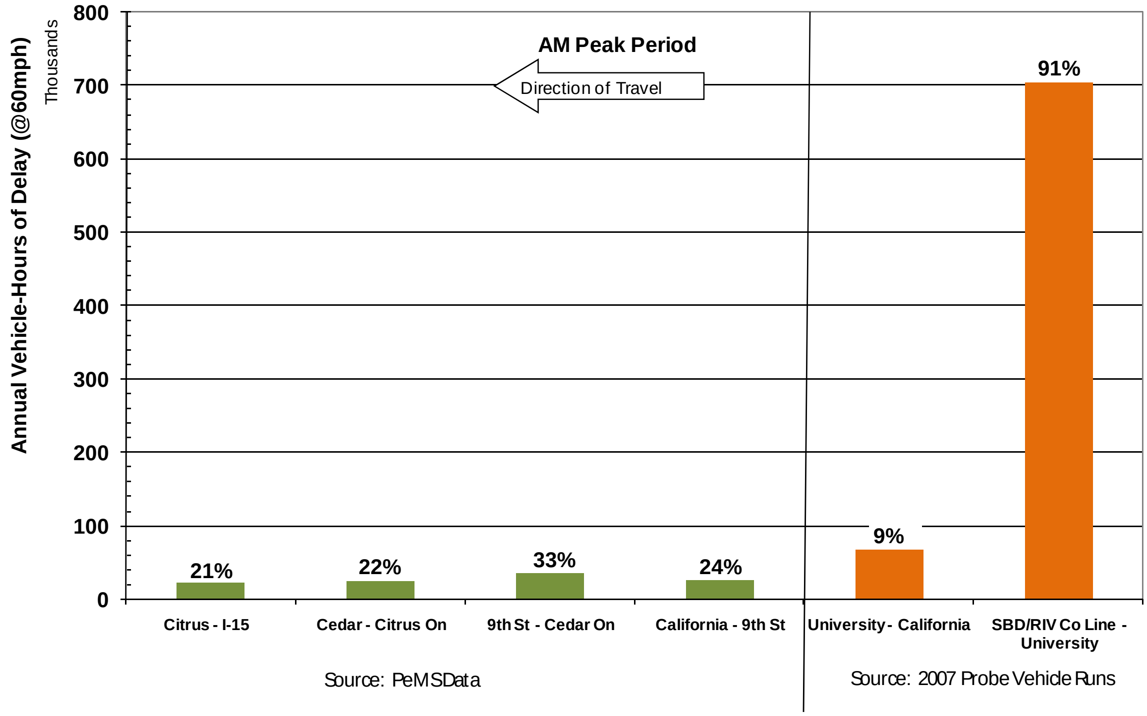
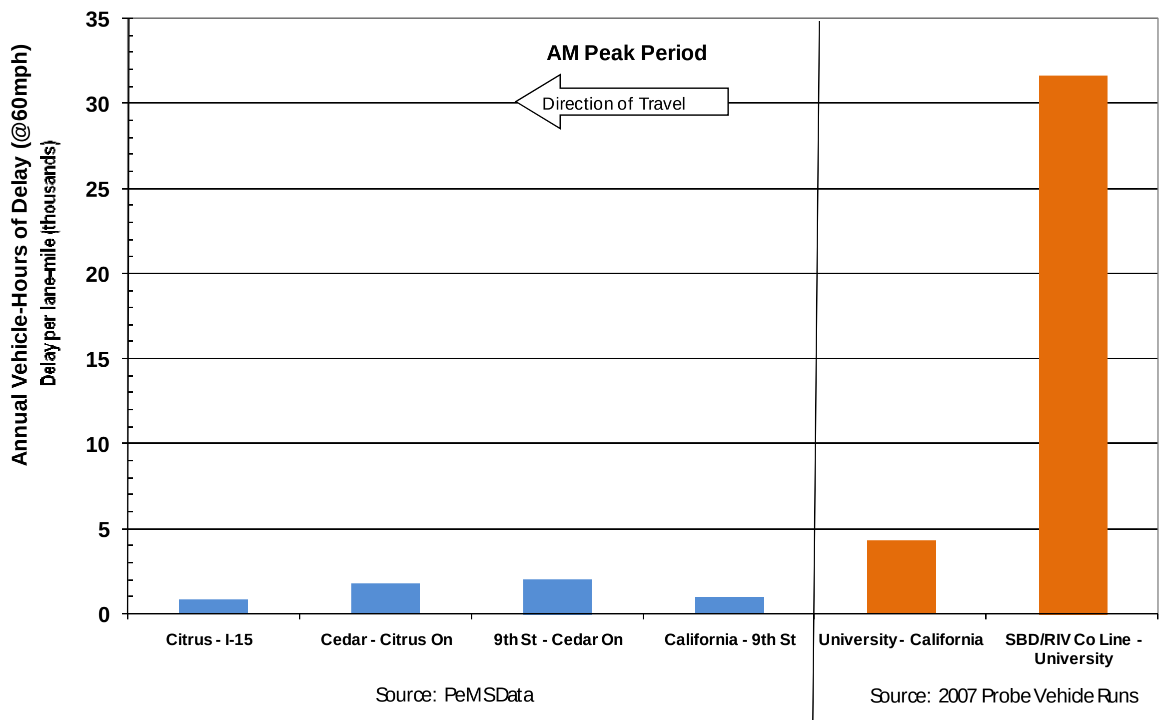


Exhibit 4-8: Westbound I-10 Delay per Lane-Mile (2007)



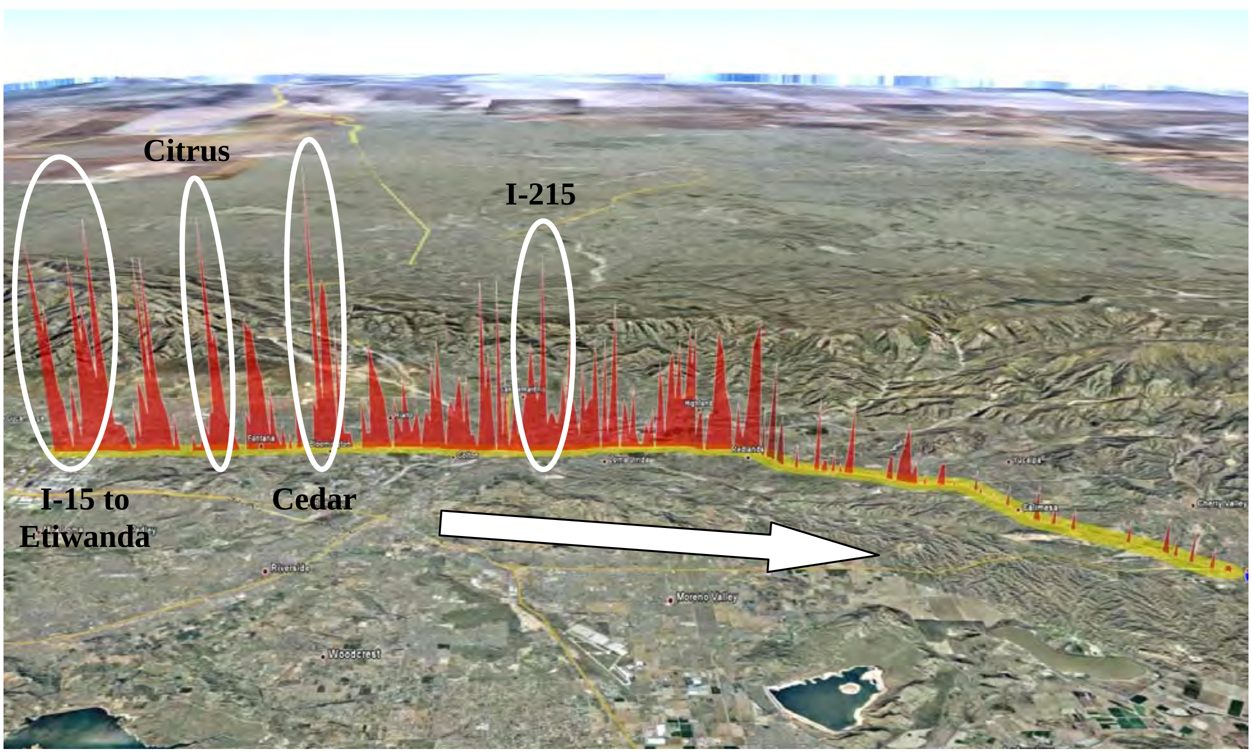
Safety by Bottleneck Area

As previously indicated in Section 3, the safety assessment in this report is intended to characterize the overall accident history and trends in the corridor, and to highlight notable accident concentration locations or patterns that are readily apparent. The following discussion examines the pattern of collisions by bottleneck areas.

Exhibit 4-9 shows the location of all collisions plotted along the I-10 Corridor in the eastbound direction. The spikes show the total number of collisions (fatality, injury, and property damage only) occurring within 0.1 mile segments during 2006. The highest spike corresponds to roughly 24 collisions in a single 0.1 mile location. The size of the spikes is a function of how collisions are grouped. If the data were grouped in 0.2 mile segments, the spikes would be higher.

As evident in Exhibit 4-9, the study corridor has a higher concentration of collisions on the western portion of the corridor compared to the eastern. Starting from I-15 and moving eastbound, a large number of collisions occurred between I-15 and Etiwanda; around Citrus Avenue; near Cedar Avenue; and around the I-215 Interchange. In many cases, a spike in the number of collisions occurred in the same location as a bottleneck. For example, a spike occurred at Etiwanda, which is also a bottleneck location.

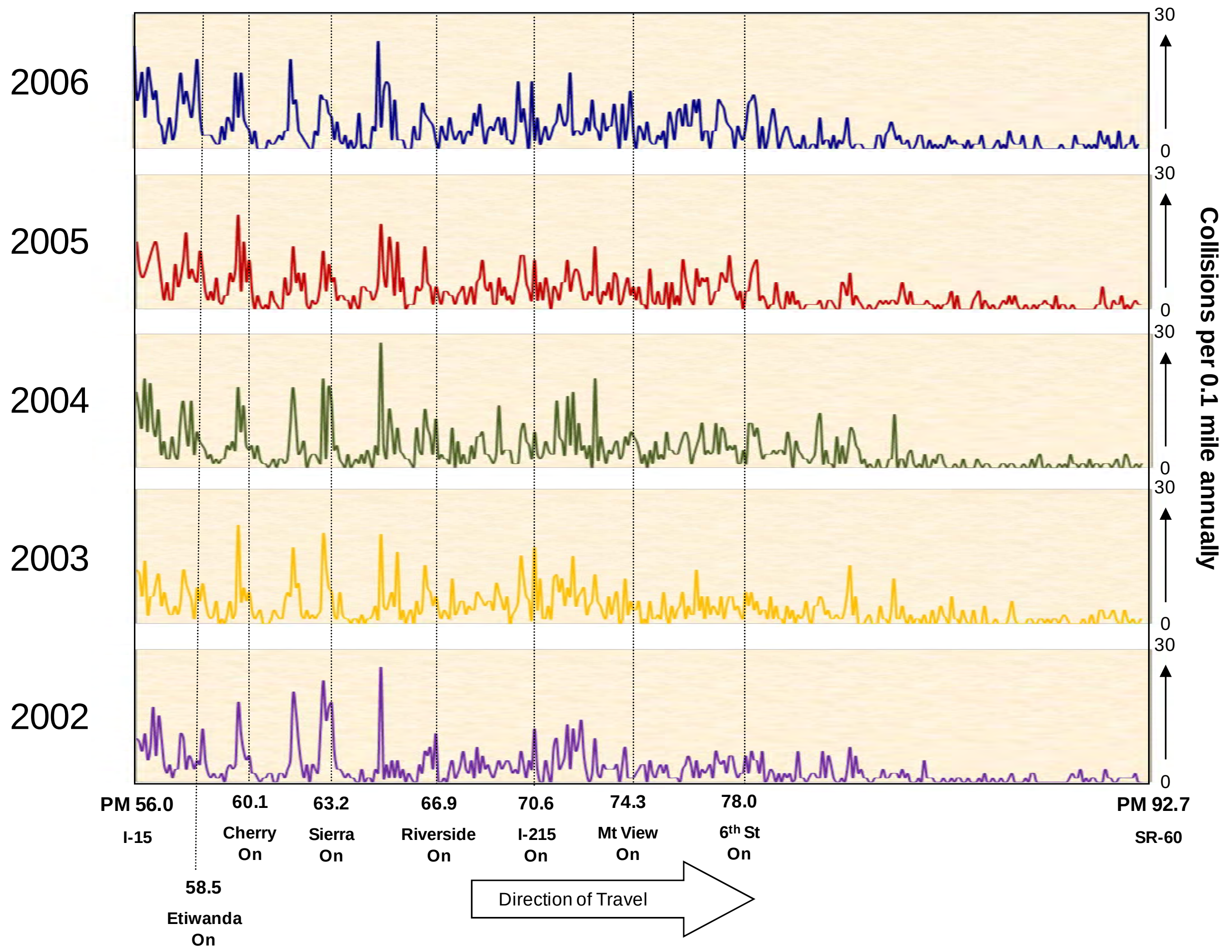
Exhibit 4-9: Eastbound I-10 Collision Locations (2006)



Source: SMG analysis of TASAS data

Exhibit 4-10 illustrates the same data for the five-year period between 2002 and 2006. The vertical lines in the exhibit separate the corridor by bottleneck area. Since the eastbound direction comprised a large number of bottleneck locations in 2007, not all of them are depicted in the exhibit below. Exhibit 4-10 suggests that the pattern of collisions remained consistent during the five-year period with an overall increase of collisions between 2002 and 2006. The exhibit also suggests that the high accident locations identified in 2006 (Exhibit 4-9) were the same as the preceding years: between I-15 (PM 56.0) and Etiwanda (PM 58.5); around Citrus Avenue (PM 61.8); near Cedar Avenue (PM 65.6); and around the I-215 Interchange (PM 70.6).

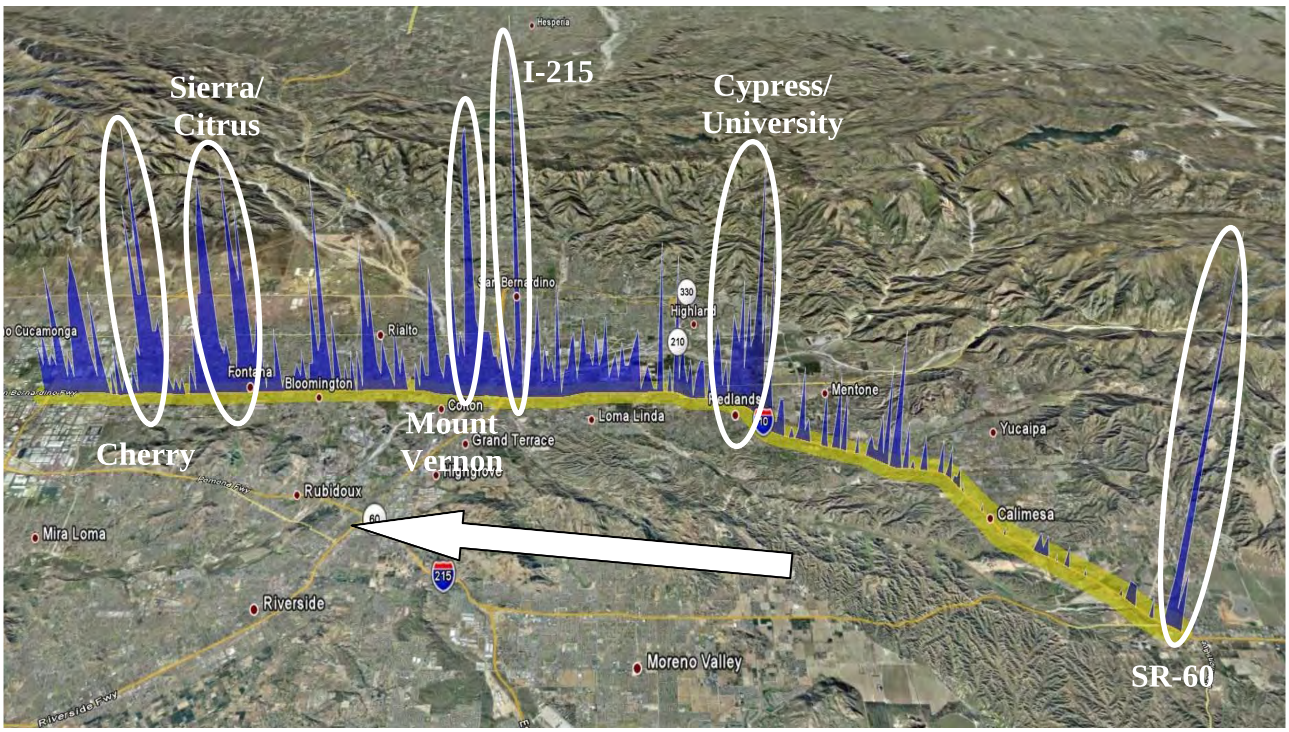
Exhibit 4-10: Eastbound I-10 Collision Locations (2002-2006)



Source: SMG analysis of TASAS data

Westbound collision data for 2006 is illustrated in Exhibit 4-11. The largest spike in this exhibit corresponds roughly to 30 collisions per 0.1 miles. Comparing the spikes in the westbound direction to the eastbound (Exhibit 4-9) reveals that no one direction experienced significantly more collisions than the other. Exhibit 4-11 groups the high accident locations into six clusters. Moving westbound, these clusters are at the SR-60 Interchange; around Cypress/University Street; at the I-215 Interchange; around Mount Vernon Avenue; near Sierra and Citrus Avenue; and at Cherry Avenue.

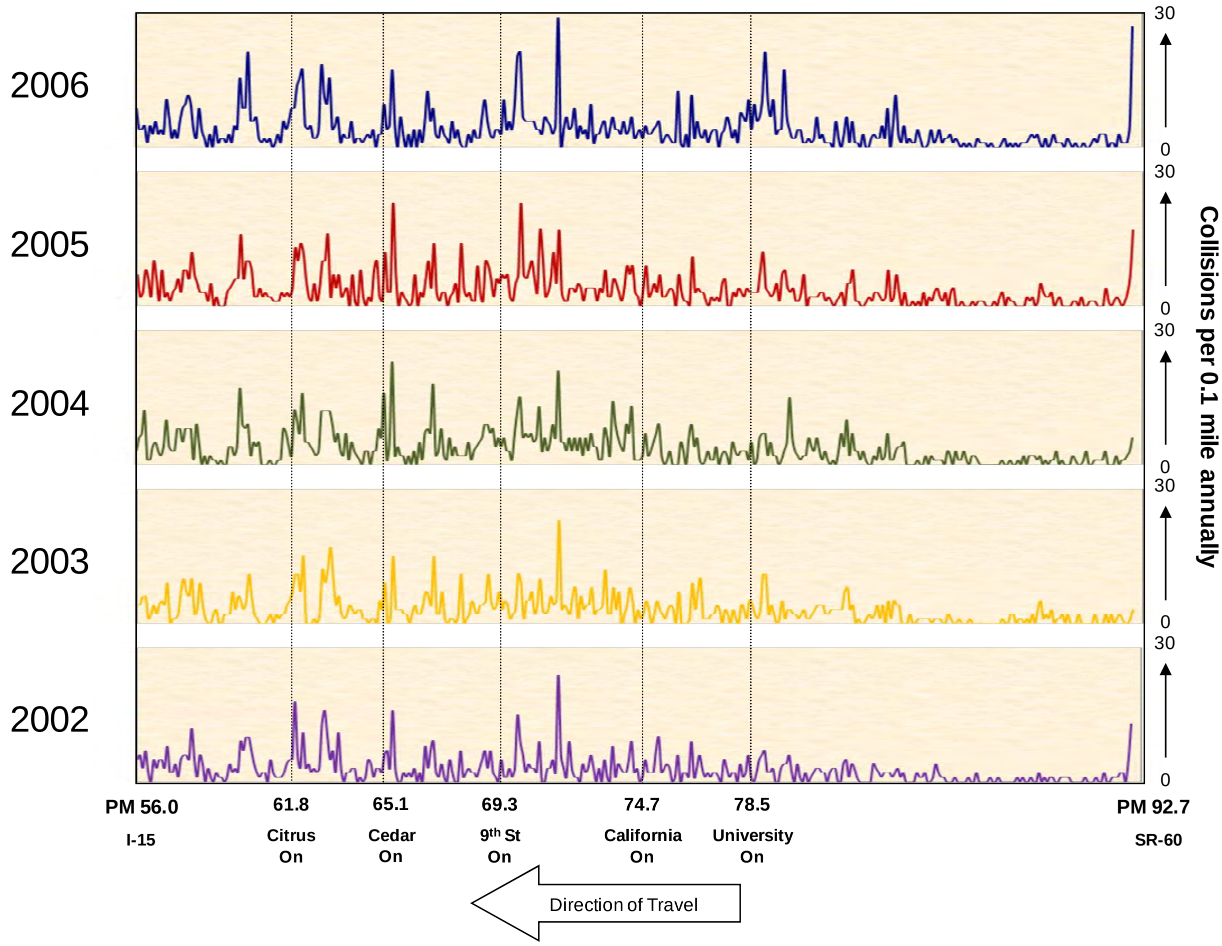
Exhibit 4-11: Westbound I-10 Collision Locations (2006)



Source: SMG analysis of TASAS data

Exhibit 4-12 shows the trend of collisions for the westbound direction from 2002 to 2006 period. The pattern of collisions has been fairly steady from one year to the next. The high accident locations depicted in Exhibit 4-11 reappear in the preceding years. These locations are at the SR-60 Interchange (PM 92.7); around Cypress/University Street (PM 79.0); at the I-215 Interchange (PM 71.5); around Mount Vernon Avenue (PM70.0); near Sierra and Citrus Avenue (PM 62.8); and at Cherry Avenue (PM 60.1). There are several instances where a spike in the number of collisions occurred in the same location as a bottleneck, such as at University Street and Citrus Avenue.

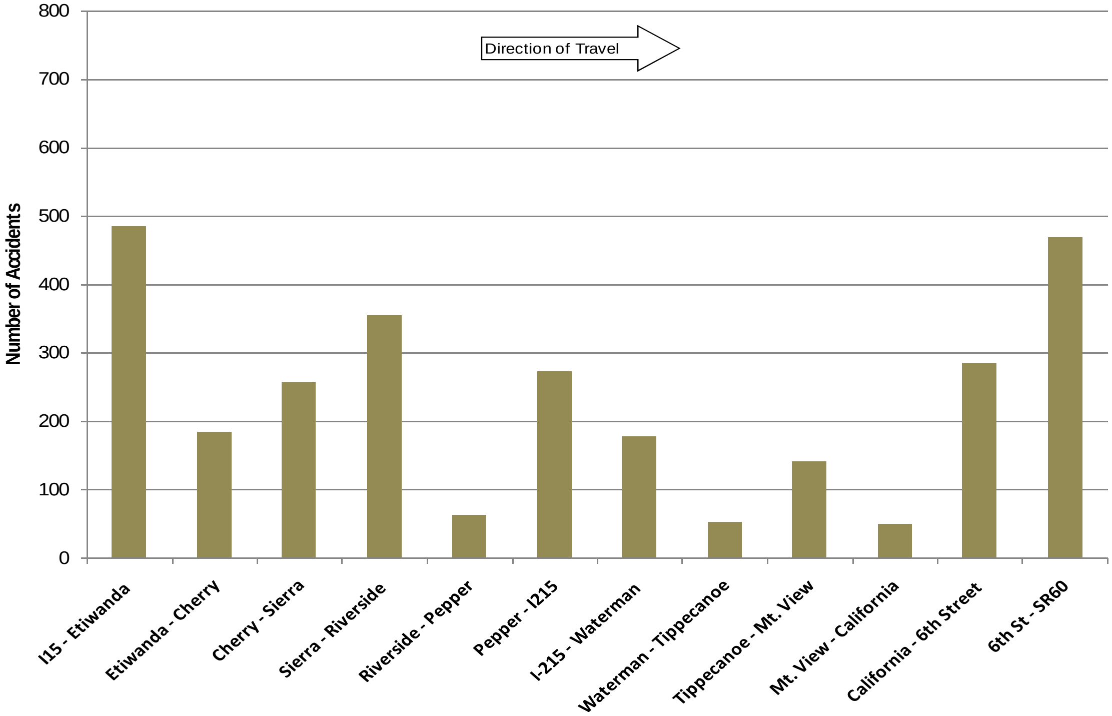
Exhibit 4-12: Westbound I-10 Collision Locations (2002-2006)



Source: SMG analysis of TASAS data

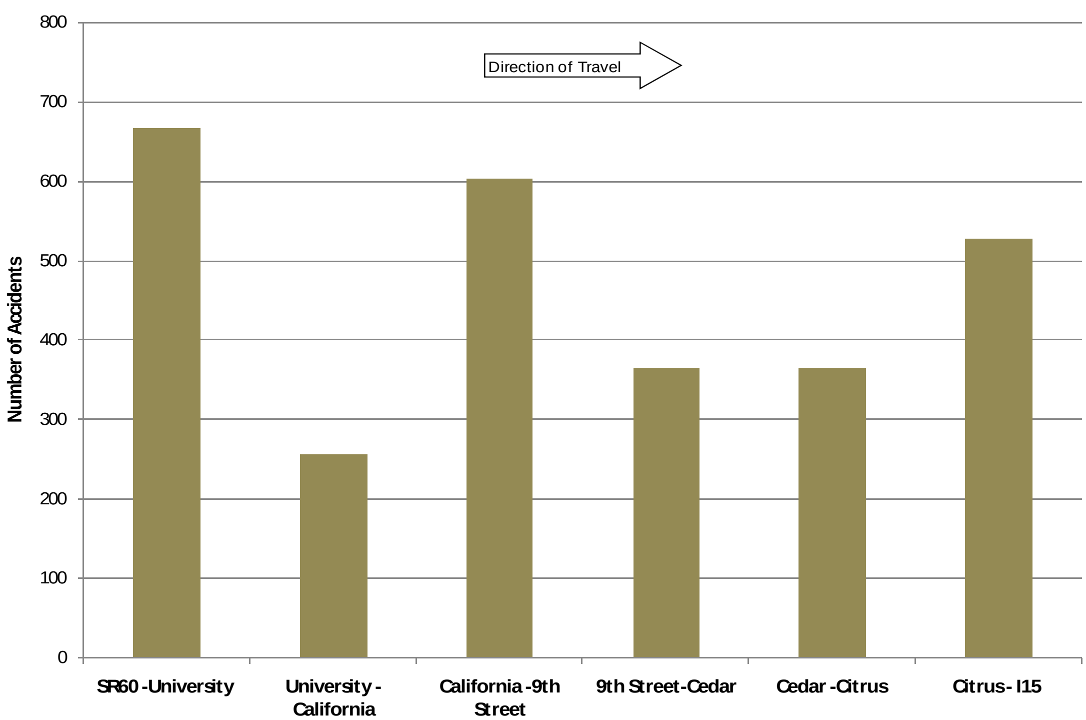
Exhibits 4-13 and 4-14 summarize the total number of accidents reported in TASAS by bottleneck area. The bars show the total of accidents that occurred in 2005 and 2006, the latest two years available in TASAS. During this two-year period, the bottleneck area between I-15 and Etiwanda experienced the most accidents in the eastbound direction, while the area between SR-60 to University experienced the most accidents in the westbound direction.

Exhibit 4-13: Eastbound I-10 Total Accidents (2005-2006)



Source: SMG analysis of TASAS data

Exhibit 4-14: Westbound I-10 Total Accidents (2005-2006)



Source: SMG analysis of TASAS data

Page Intentionally Left Blank for Future Updates on Bottleneck Identification, Bottleneck Area Definition, and Performance Measures by Bottleneck Area

5. CAUSALITY

Major bottlenecks are the location of corridor performance degradation and resulting congestion and lost productivity. It is important to verify the specific location and cause of each major bottleneck to determine appropriate solutions to traffic operational problems.

The actual location of each major bottleneck is verified by multiple field observations on separate days. The cause or causes of each major bottleneck is also identified by field observations and additional traffic data analysis. For the I-10 Corridor, field observations were conducted by the project consultant team on multiple days (midweek) in November and December 2008, and January 2009, during the AM and PM peak hours.

By definition, a bottleneck is a condition where traffic demand exceeds the capacity of the roadway facility. In most cases, the cause of bottlenecks is related to a sudden reduction in capacity, such as roadway geometry, heavy merging and weaving, and driver distractions; or a surge in demand that the facility cannot accommodate. In many cases, it is a combination of increased demand and capacity reductions. Below is a summary of the causes of the bottleneck locations.

Eastbound Bottlenecks and Causes

Major eastbound bottlenecks and congestion occurs mostly during the PM peak hours. In fact, no significant amount of congestion was observed during the AM peak hours during field site visits in the eastbound direction. The following is a summary of the eastbound bottlenecks and their identified causes.

I-15 On

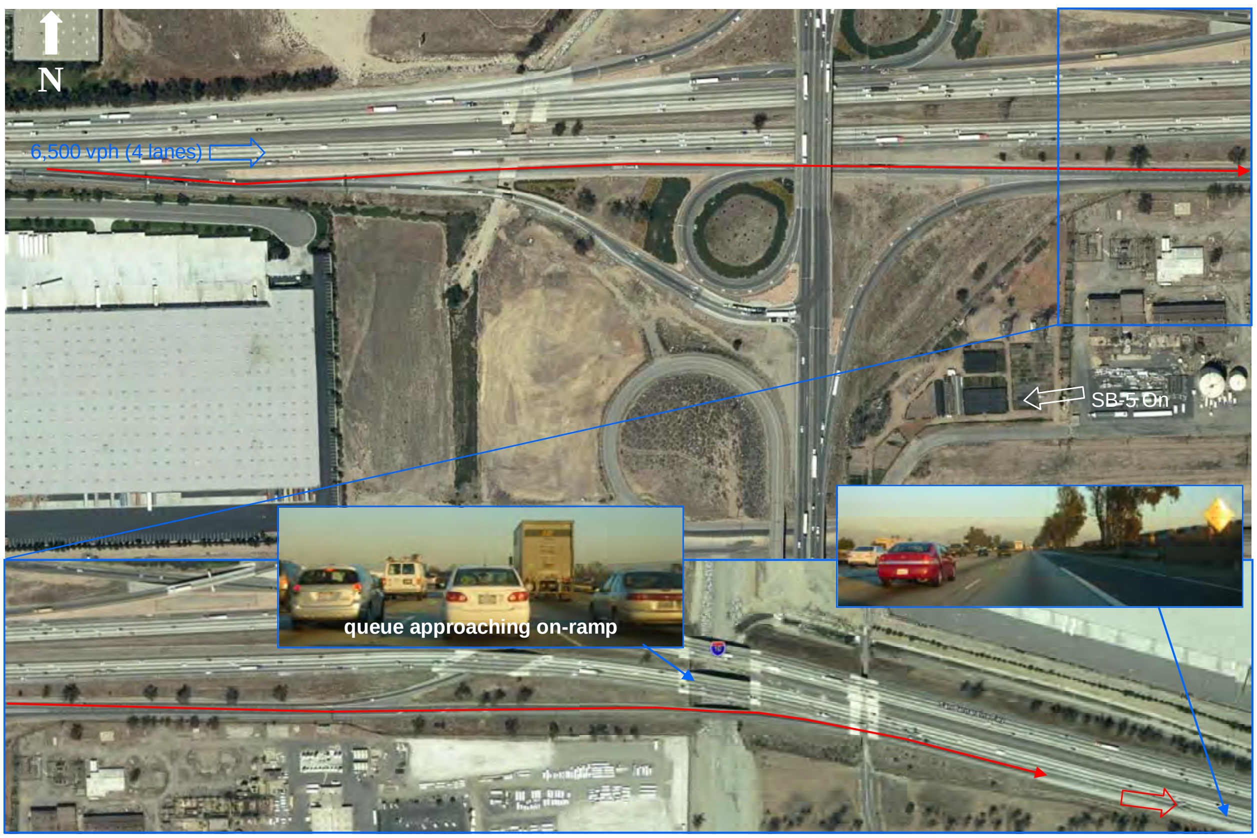
Exhibit 5-1 is an aerial photograph of the I-15 mainline connector on-ramps to the eastbound I-10. During the PM peak hours, the volume of traffic from I-10 mainline reaches over 6,500 vehicles per hour (vph) in four lanes. The I-15 connector on-ramps add roughly 2,000 vph to the mainline during the PM peak hours. These vehicles have to then merge into the mainline traffic. In addition, downstream off-ramp traffic to Etiwanda Avenue creates cross weaving with the I-15 on-ramp traffic. Although not substantial, bottleneck and traffic congestion was observed at this location during the field reviews. The high volume of traffic merging and weaving at this location is found to be the cause of this bottleneck location.

Exhibit 5-1: Eastbound I-10 at I-15 On

Etiwanda Avenue On

Exhibit 5-2 is an aerial photograph of the Etiwanda Avenue interchange. As shown, this interchange includes a collector-distributor (C-D). Both northbound and southbound on-ramp traffic to the eastbound I-10 mainline occur via the C-D road. Although both ramps have ramp metering systems, active application was not observed during any of the field reviews regardless of the mainline roadway conditions. During several field visits, heavy platoon merging from the C-D road (on-ramp to freeway) was observed to affect the mainline flow. This bottleneck condition is likely to be caused by the inability of the mainline facility to accommodate the surge of additional demand from the Etiwanda Avenue C-D road on-ramp. Because of the C-D road, active metering of the two on-ramps is not likely to break up the platoon merging of the C-D road traffic entering the freeway mainline.

Exhibit 5-2: Eastbound I-10 at Etiwanda Avenue Interchange



Cherry Avenue On/Sierra Avenue On/Riverside Avenue On/Pepper Avenue On

Exhibit 5-3 is an aerial photograph of the four on-ramps to eastbound I-10. Although a bottleneck condition at these locations were not observed during any of the field visits, vehicle detector data from PeMS and travel data from District 8 probe vehicle runs indicated that bottleneck and congestion conditions occurred at these locations in 2006. The reduction in the overall mainline demand as a result of the I-210 extension completed in 2007 is likely to have impacted conditions at these locations.

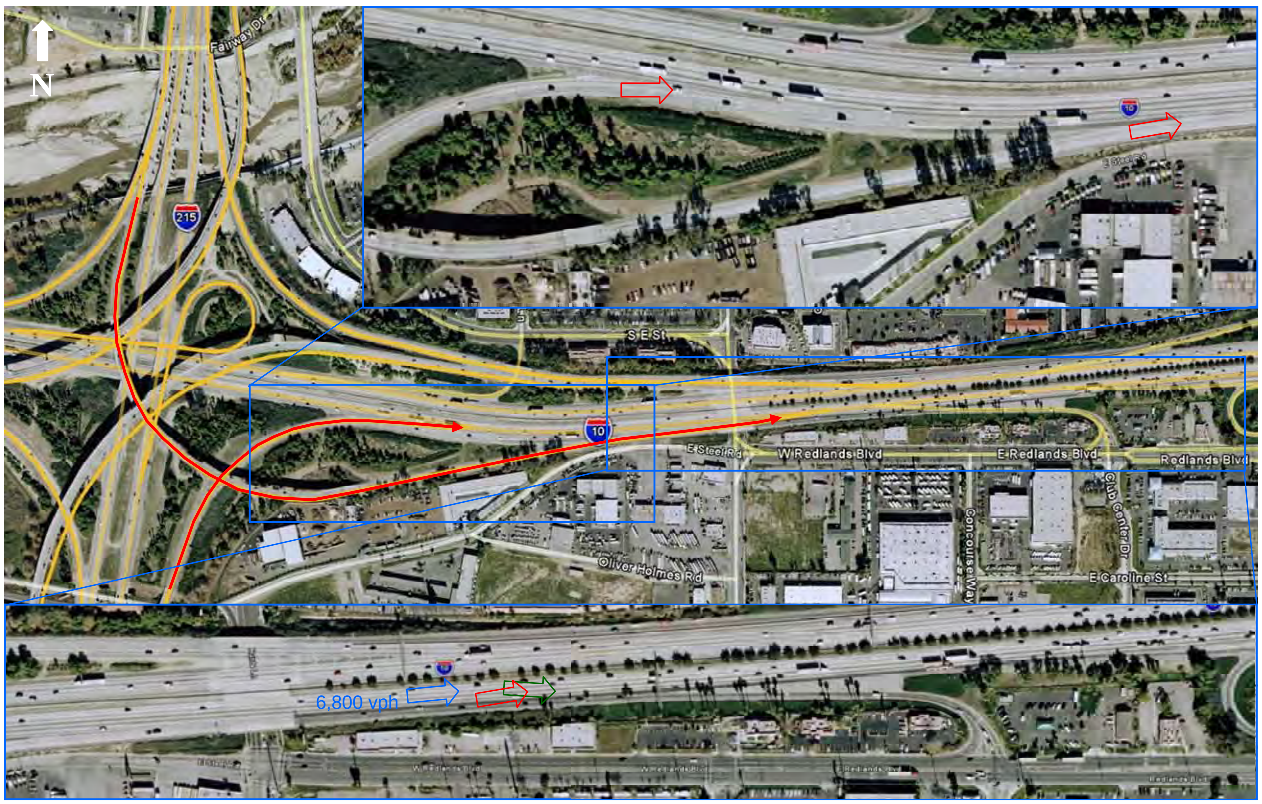
As shown in the aerial photographs, traffic demand at each of the on-ramps range from 600 vph to as much as 1,400 vph during the PM peak hours. When the mainline volume reaches near the threshold level (near 2,000 vph per lane), a bottleneck condition is likely to occur from the merging (i.e. mainline at above 7,600 vph and ramp volume at 600 vph will result in LOS F without ramp metering based on Highway Capacity Manual). Also as shown, only the Sierra Avenue on-ramp is equipped with a ramp metering system. However, the system did not appear to be operational during any of the site visits. Platoon vehicle merging at all four of these on-ramps were observed. However, due to the lack of density on the mainline, the merges did not appear to have had any adverse impact to the mainline flow.

Exhibit 5-3: Eastbound I-10 at Cherry, Sierra, Riverside, and Pepper On

I-215 On

Exhibit 5-4 is an aerial photograph of the I-215 connector on-ramps to eastbound I-10. During the PM peak hours, the I-15 connector on-ramps add heavy traffic volume to the mainline with consecutive on-ramps. When the mainline traffic is heavy and dense, it cannot accommodate this additional demand. In addition, downstream off-ramp traffic to Waterman Avenue creates cross weaving with the I-215 on-ramp traffic. Although not substantial, bottleneck and traffic congestion were observed at this location during the field reviews.

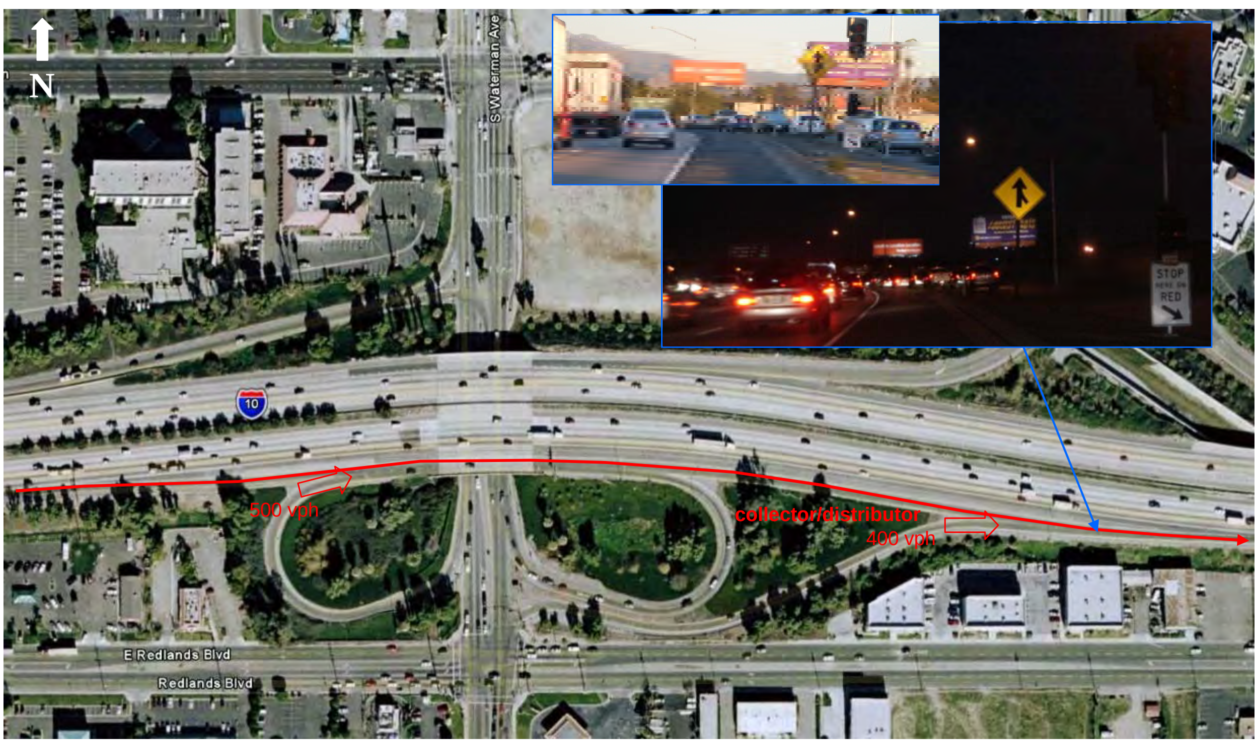
Exhibit 5-4: Eastbound I-10 at I-215 On



Waterman Avenue On

Exhibit 5-5 is an aerial photograph of the eastbound I-10 at the Waterman Avenue interchange. As shown, this interchange includes a collector-distributor. Both northbound and southbound on-ramp traffic to the eastbound I-10 mainline occur via the C-D road. Although not shown in the aerial photograph, a new ramp metering system has been installed at the C-D on-ramp, as shown in the inset digital photographs. However, operation of the ramp metering system has not been observed on any of the field visits (under construction and implementation). Also shown in the inset photographs are heavy platoon ramp traffic merging with the mainline traffic, breaking down the freeway mainline flow. This bottleneck condition is likely to be caused by the inability of the mainline facility to accommodate the surge of additional demand from the Waterman Avenue C-D road on-ramp with the heavy platoon merging. The roadway geometrics here are also likely to adversely affect the effective capacity of the mainline, exacerbating the condition.

Exhibit 5-5: Eastbound I-10 at Waterman Avenue On



Tippecanoe Avenue On

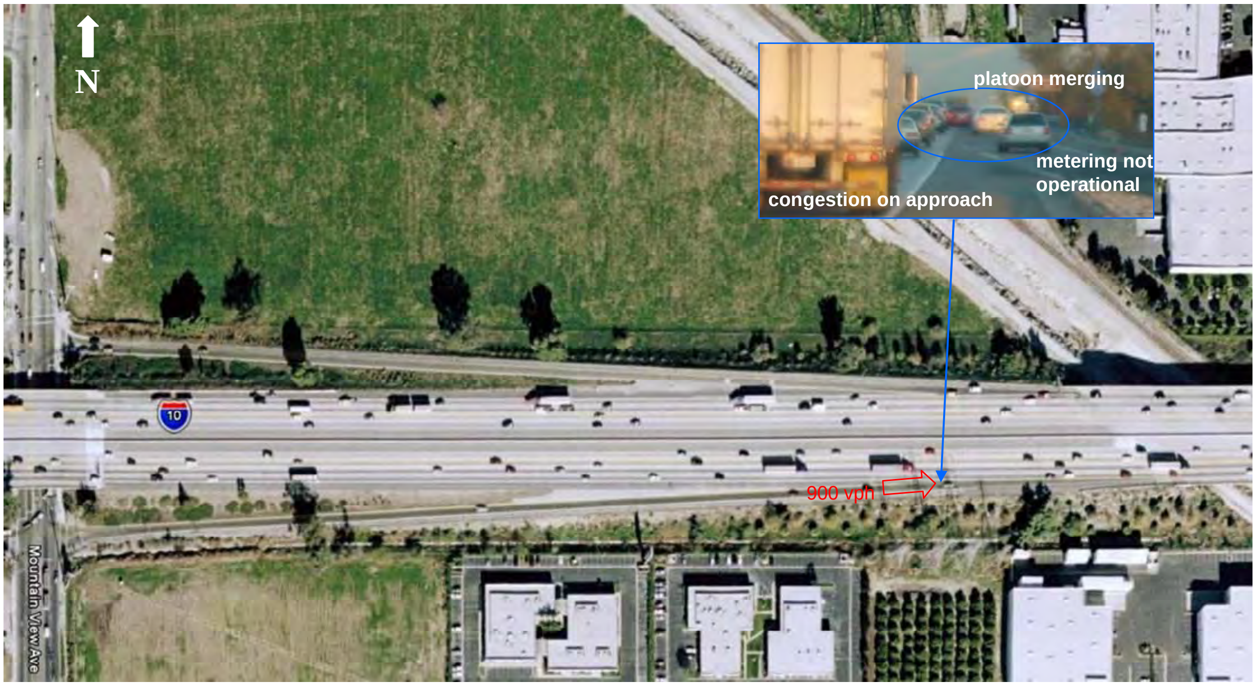
Exhibit 5-6 is an aerial photograph of the eastbound I-10 at the Tippecanoe Avenue on-ramp. As indicated, approximately 800 vph enters the freeway during the PM peak hours. When the mainline demand is high, near the threshold level, the freeway facility cannot accommodate the surge in demand, particularly with platoon merging from the ramp (i.e. above 7,400 vph, where 800 vph ramp volume added will result in LOS F without ramp metering based on Highway Capacity Manual). Although not shown in the aerial photograph, a new ramp metering system has been installed at this on-ramp; however, operation of the ramp metering system has not been observed on any of the field visits.

Exhibit 5-6: Eastbound I-10 at Tippecanoe Avenue On

Mountain View Avenue On

Exhibit 5-7 is an aerial photograph of the eastbound I-10 at the Mountain View Avenue on-ramp. From the field visits, this is a major bottleneck location that results in significant traffic congestion and queuing. As indicated, approximately 900 vph enters the freeway during the PM peak hours. Although this may not seem excessive, it is about half of a mainline lane. When the mainline demand is high, near the threshold level, the freeway facility cannot accommodate this surge in demand, particularly with platoon merging from the ramp, as shown in the inset photograph. Although not shown in the aerial photograph, a new ramp metering system has been installed at this on-ramp; however, operation of the ramp metering system has not been observed on any of the field visits.

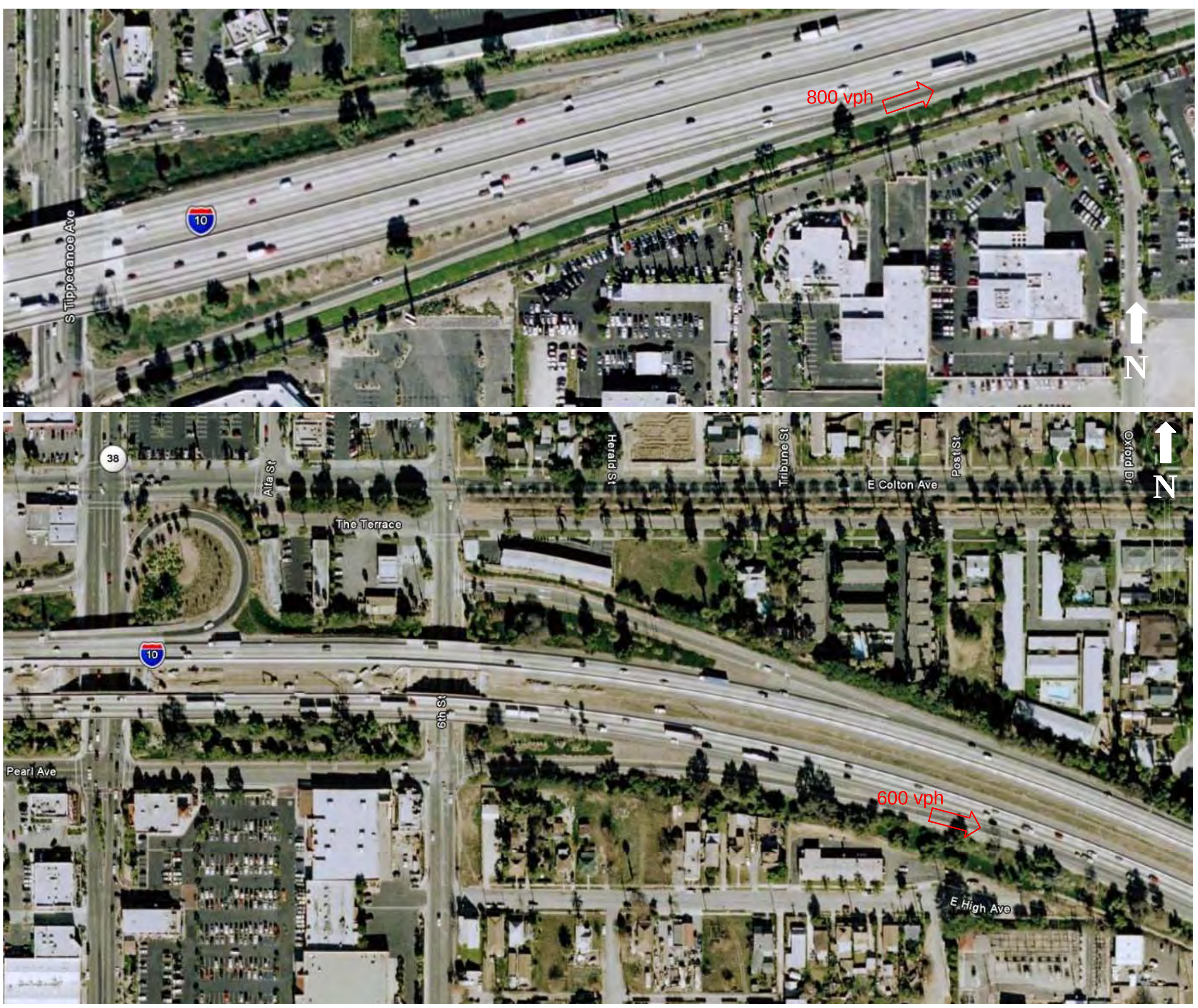
Exhibit 5-7: Eastbound I-10 at Mountain Avenue On



California Street On & 6th Street On

Exhibit 5-8 is an aerial photograph of the eastbound I-10 at the California Street on-ramp and at the 6th Street on-ramp. Although no bottleneck condition or any significant queuing was observed at either of these two locations during any of the site visits, data analysis from District 8 probe vehicle runs indicated that these were in fact bottleneck locations. As shown, over 800 vph enters the freeway during the PM peak hours from these two locations. When the mainline demand is high as was the case in 2007, it is likely that the freeway facility cannot accommodate the additional demand from the ramps. At 6th Street, the condition is likely to be exacerbated by the roadway curve to the right, reducing sight distance, and the ramp merging in the middle of the turn. The 2007 mainline traffic volume data was not available for review for this location.

Exhibit 5-8: Eastbound I-10 at California Street On and 6th Street On



Westbound Bottlenecks and Causes

Unlike the eastbound direction, no major bottleneck conditions or significant traffic congestion were observed during any of the westbound site visits conducted during the AM and PM peak hours. Nevertheless, data from PeMS and probe vehicle runs indicate the presence of bottlenecks and ensuing congestion. The following is a summary of the westbound bottlenecks and their causes.

<u>University Street On</u>

Exhibit 5-9 is an aerial photograph of the westbound I-10 mainline at the University Street on-ramp. As indicated, the on-ramp at this location exceeds 1,200 vph during the AM peak hours. Due to this high volume of traffic, it is likely that bottleneck condition and traffic congestion will form when the mainline traffic demand is high. Without ramp metering control, significant disruption to the mainline flow can be expected considering the high volume of traffic entering from this ramp. A ramp metering system has not been implemented at this location.

Exhibit 5-9: Westbound I-10 at University Street On

California Street On

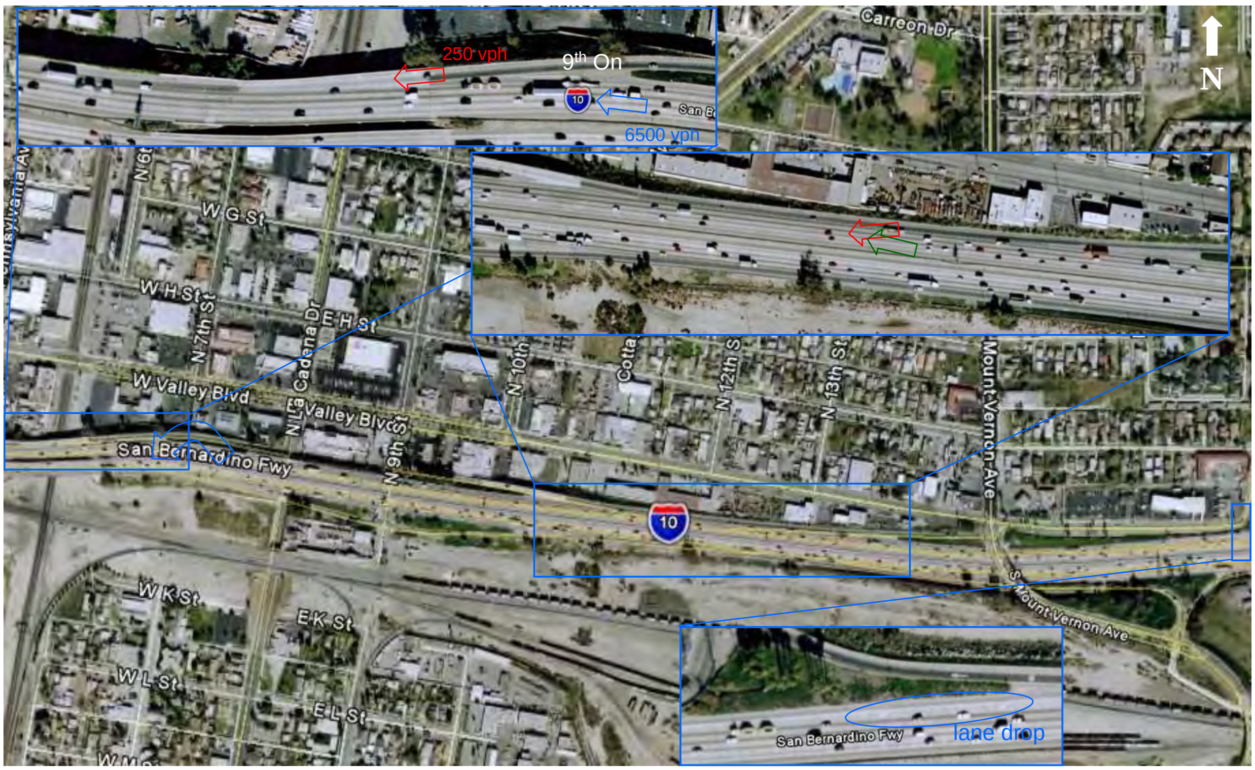
Exhibit 5-10 is an aerial photograph of the westbound I-10 mainline at the California Street on-ramp. As indicated, the on-ramp at this location exceeds 600 vph during the AM peak hours. Although not substantial, it is likely that bottleneck conditions and traffic congestion form when the mainline traffic demand is high (i.e. above 7,600 vph, where 600 vph ramp volume added will result in LOS F without ramp metering based on Highway Capacity Manual). A bottleneck condition, small amounts of congestion, and brief queuing were observed at this location during the field visits. A ramp metering system has also not been implemented at this location.

Exhibit 5-10: Westbound I-10 at California Street On

9th Street

Exhibit 5-11 is an aerial photograph of the westbound I-10 at 9th Street and Mount Vernon interchanges. Although not substantial, there is an uphill vertical grade and roadway curve to the left approaching the 9th Street on-ramp which is likely to affect sight distance. In addition, there is a short auxiliary lane between Mount Vernon Avenue and 9th Street with cross weaving effects. This is compounded by the lane drop approaching the Mount Vernon Avenue. Although the ramp volumes are fairly low, it is likely that roadway geometrics affect the travel speeds such that bottleneck condition and congestion occurs when the mainline volume density is high. A ramp metering system has not been implemented at the 9th Street or Mount Vernon Avenue on-ramps.

Exhibit 5-11: Westbound I-10 at 9th Street



Cedar Avenue On and Citrus Avenue On

Exhibit 5-12 is an aerial photograph of the westbound I-10 mainline at the Cedar Avenue on-ramp and the Citrus Avenue on-ramp. Although bottleneck conditions and resulting congestion at these locations were not observed during any of the field visits, vehicle detector data from the Caltrans PeMS and travel data from the Caltrans District 8 probe vehicle runs indicated that bottleneck and congestion occurred at these locations in 2007. As shown in the aerial photographs, traffic demand at each of the on-ramps ranged from 800 vph to as much as 1,000 vph during the AM peak hours, which is fairly high. When the mainline volume density is high, a bottleneck condition is likely to occur. Also as shown, a ramp metering system has not been implemented at these locations. Due to the lack of density on the mainline flow today, the ramp merges did not appear to have had any adverse impact to the mainline flow, which is in contrast to the conditions in 2007.

Exhibit 5-12: Westbound I-10 at Cedar Avenue On and Citrus Avenue On

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APPENDIX

This appendix is an exact copy of Section 4 of the Preliminary Performance Assessment document developed and submitted to Caltrans in July 2008. It is included for reference purposes and also to allow future updates to this analysis. The analysis identified potential bottlenecks based on a number of data sources and very limited field observations. However, it represented the foundation for the conclusions in Section 4 of this Comprehensive Performance Assessment report, which built on the original findings and then revised and/or confirmed these conclusions with significant field observations and additional data analysis.

A4. BOTTLENECK ANALYSIS

In this section, the results of the bottleneck analysis are presented. The bottleneck analysis was conducted to identify potential bottleneck locations. Potential freeway bottleneck locations that create mobility constraints are identified and documented, and their relative contribution to corridor-wide congestion is reported.

A variety of sources were used to identify bottlenecks, individually and in combination. They include the following:

- Caltrans Highway Congestion Monitoring Program (HICOMP) 2006 report
- Caltrans District 8 probe vehicle runs (electronic tachometer runs)
- Freeway Performance Measurement System (PeMS)
- Aerial photos (Google Earth) and Caltrans photologs

HICOMP

In review of the Caltrans 2006 Highway Congestion Monitoring Program (HICOMP) Report, potential problem areas are initially identified. As illustrated in Exhibit 4-1 and 4-2, the downstream end of congested segments could potentially be bottleneck areas in the westbound direction, as outlined in red circles, and in the eastbound direction, as outlined in blue circles.

- As indicated, in the AM peak, there are potentially three major bottlenecks in the westbound direction and none in the eastbound direction, as identified in the 2006 HICOMP:
    - University Street (westbound)
    - California Street (westbound)
    - Etiwanda Avenue (westbound)

- As indicated, in the PM peak, there is potentially one major bottleneck in the westbound direction and five major bottlenecks in the eastbound direction, as identified in the 2006 HICOMP:
    - Rancho Avenue (westbound)
    - Cherry Avenue (eastbound)
    - Sierra Avenue (eastbound)
    - Rancho Avenue (eastbound)
    - California Street (eastbound)
    - University Street (eastbound)

Further analysis would be needed, however, to determine their actual locations and possibly any other bottlenecks along the corridor not identified in the HICOMP. The review of the HICOMP provides a good starting point to keep in mind of the congested areas and possible bottleneck locations as more detailed analysis is conducted.

Exhibit A4-1: 2006 HICOMP AM Congestion Map with Potential Bottlenecks

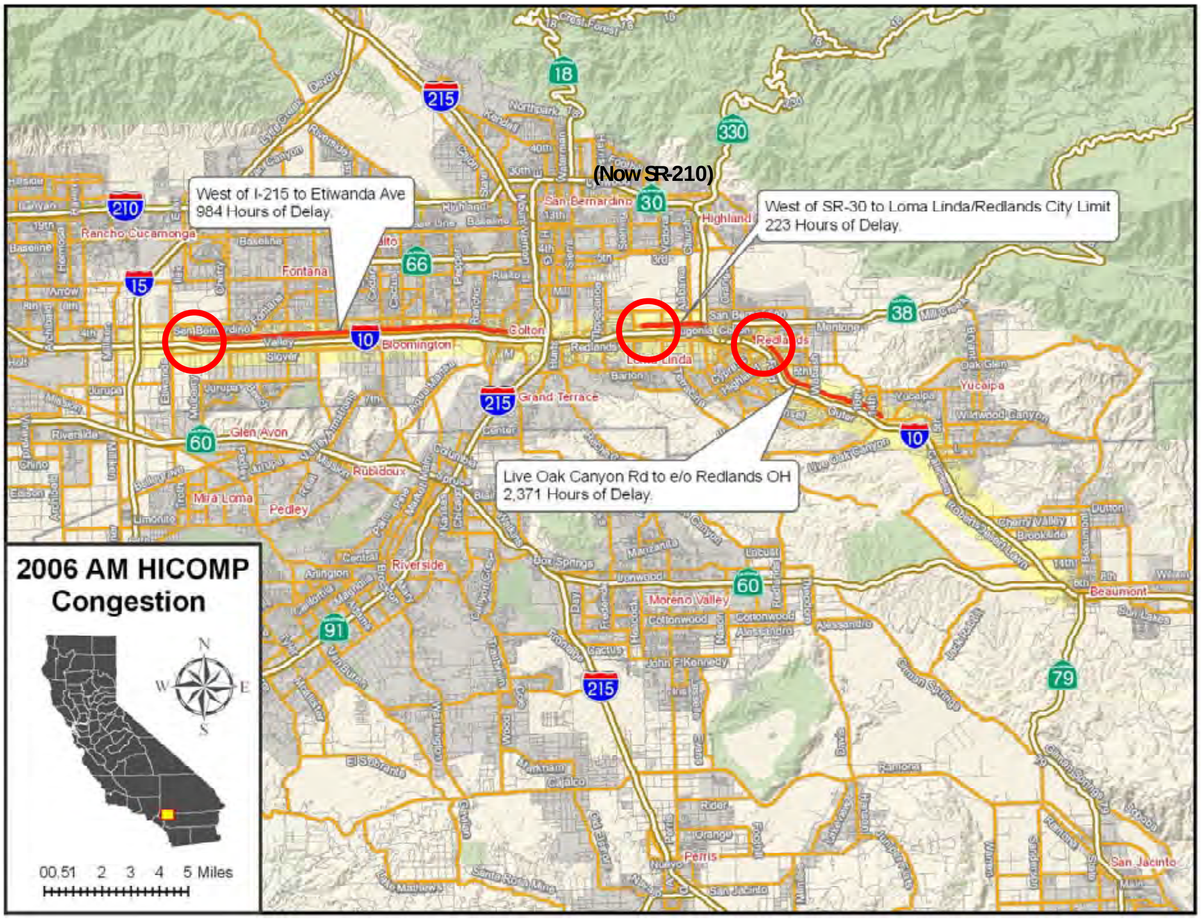
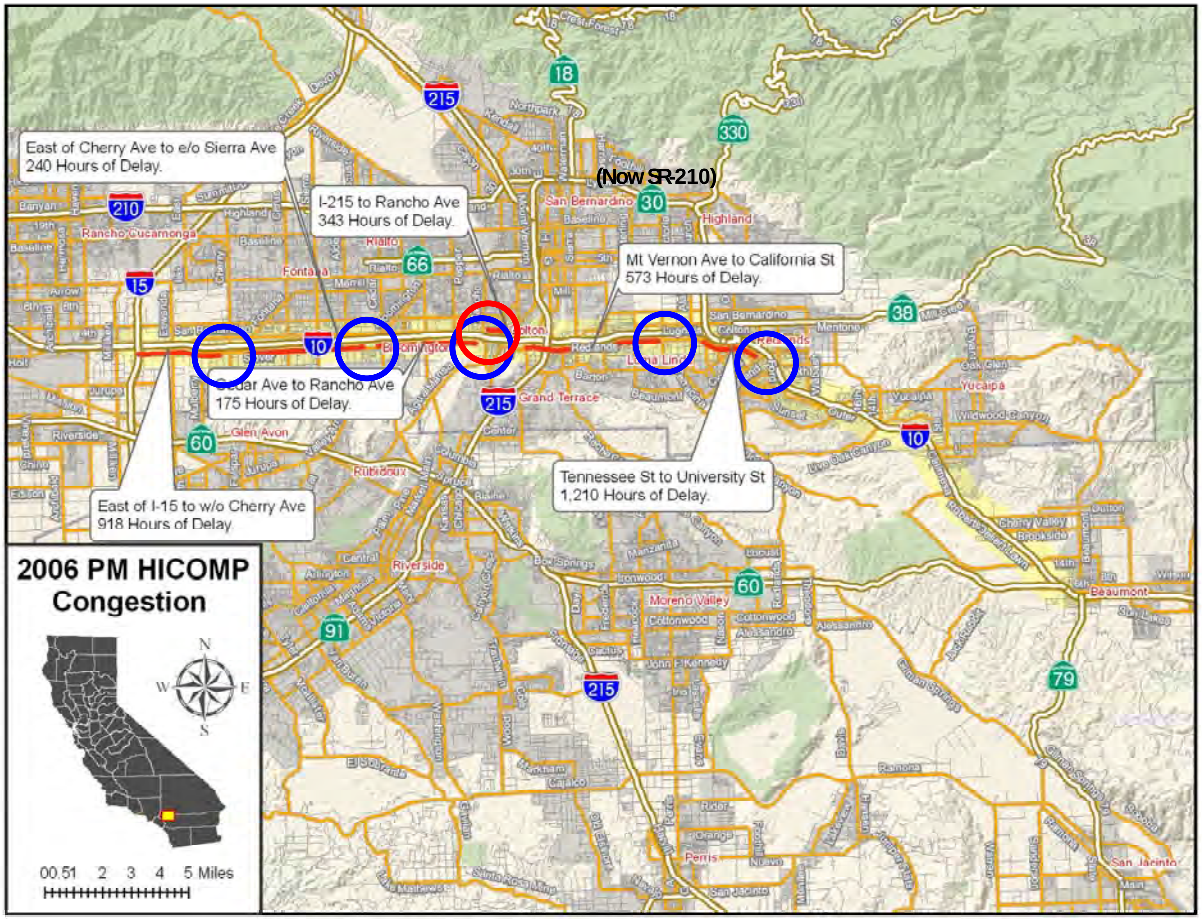


Exhibit A4-2: 2006 HICOMP PM Congestion Map with Potential Bottlenecks

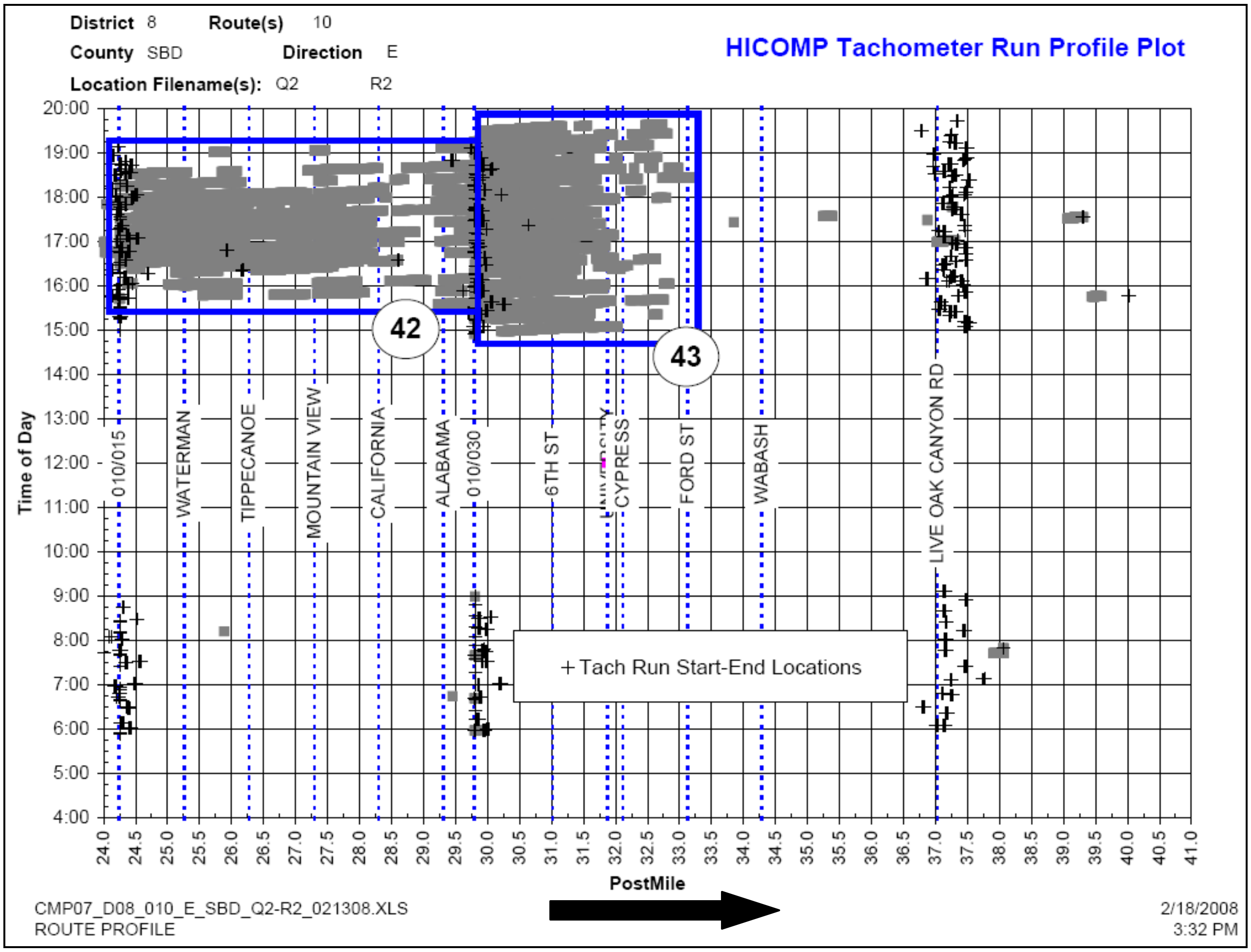


Probe Vehicle Runs

The probe vehicle runs (electronic tachometer runs) provide speed plots across the corridor at various departure times. A vehicle equipped with an electronic (GPS or tachometer) device is driven along the corridor at various departure times, typically in a middle lane, during the peak period, at regular, 15 to 30 minute intervals. Actual speeds are recorded as the vehicle traverses the corridor length. Bottlenecks can be found at the end of a slow congested speed location where speeds pick up to 30 miles per hour to 50 miles per hour.

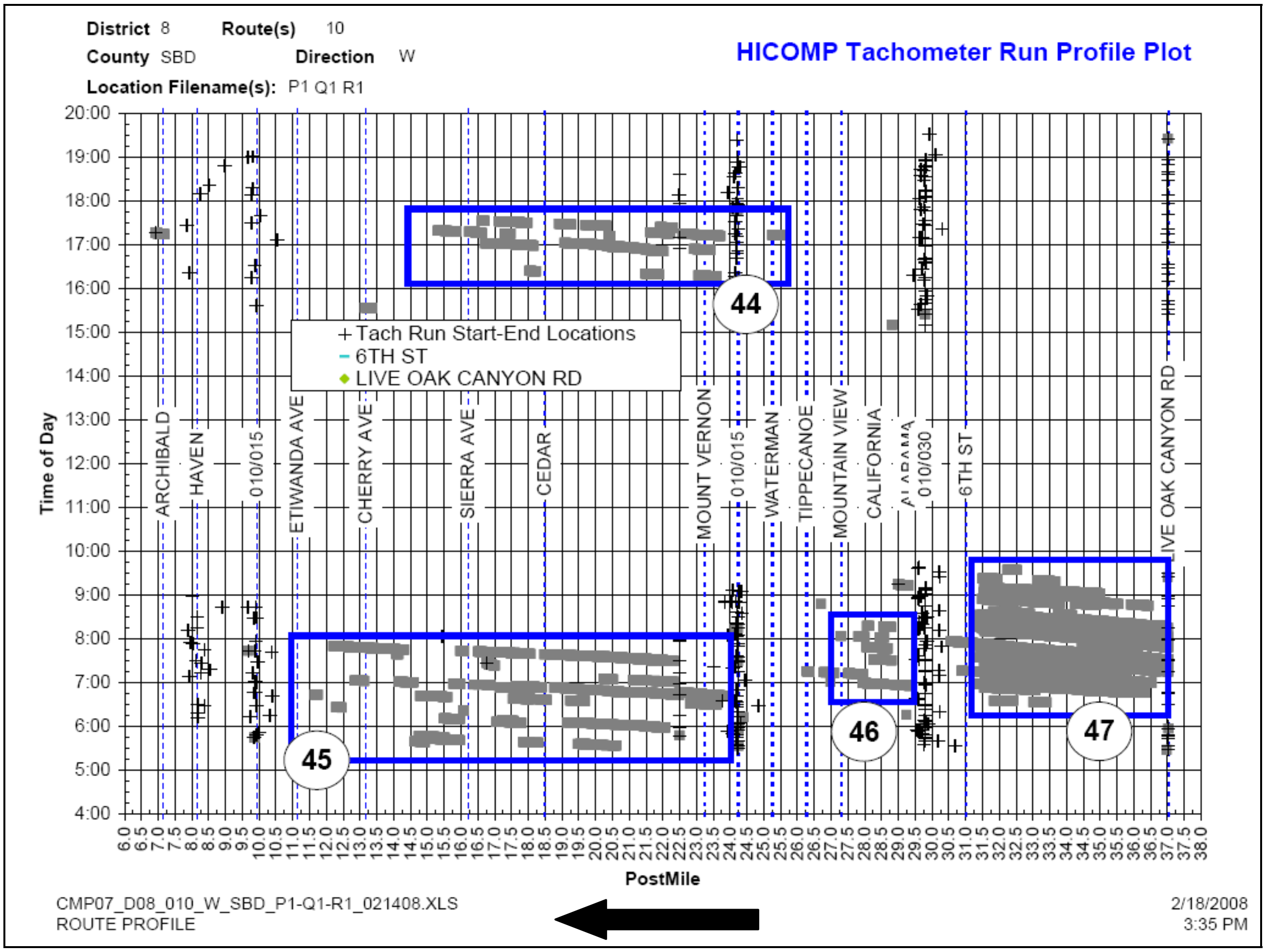
Caltrans District 8 collected probe vehicle run data on multiple mid-week days in February 2007 for the I-10 freeway from the I-15 interchange to the Riverside County Line. Exhibit 4-3 illustrates the eastbound and Exhibit 4-4 illustrates the westbound probe vehicle runs presented in speed contour diagram from 4AM to 8PM.

Exhibit A4-3: Eastbound I-10 Probe Vehicle Runs (2007)



- As indicated, the major <u>eastbound</u> bottlenecks from the 2007 probe vehicle runs were identified at:
    - SR-210 (PM)
    - Ford Street (PM)

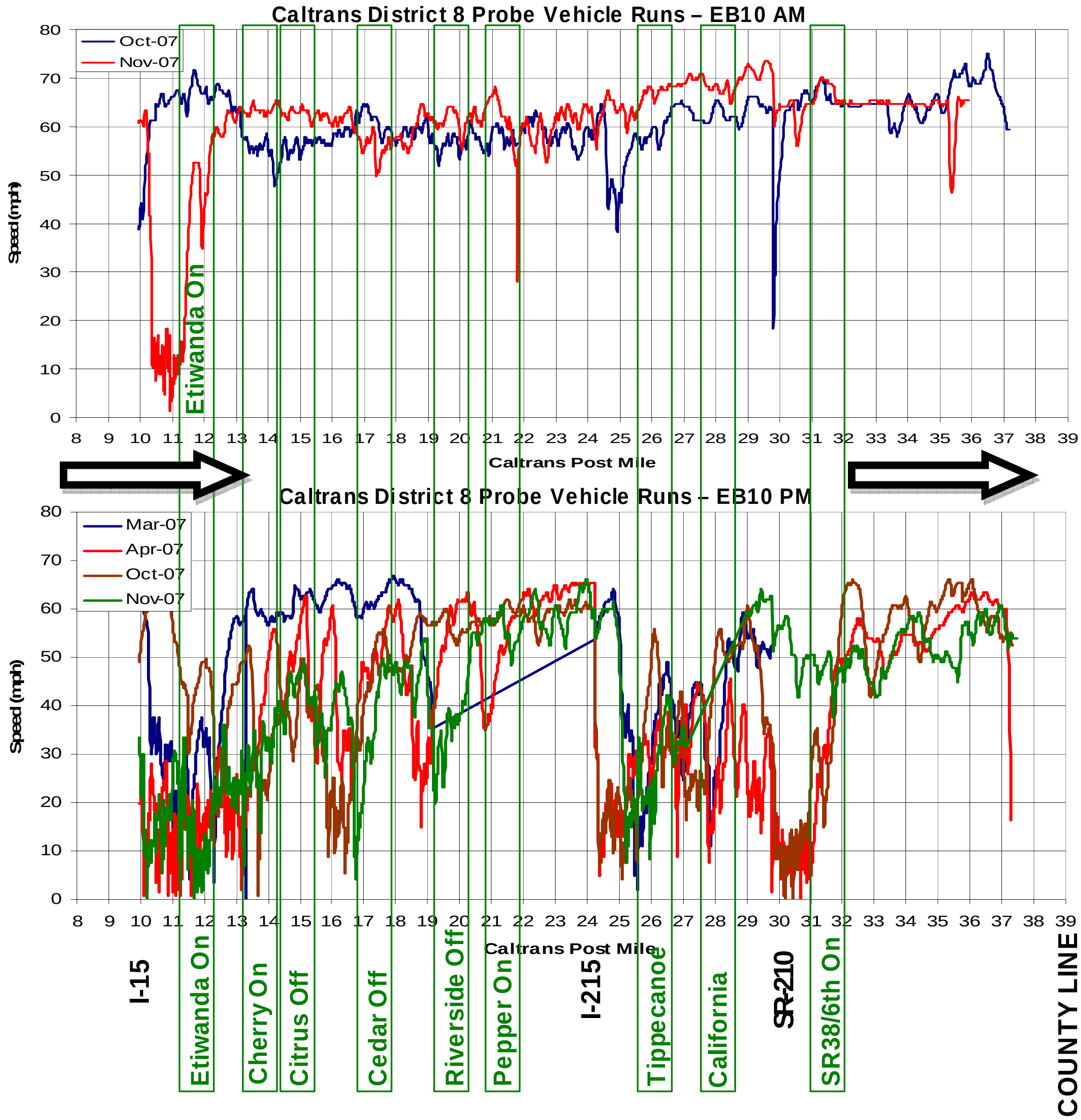
Exhibit A4-4: Westbound I-10 Probe Vehicle Runs (2007)



- As indicated, the major <u>westbound</u> bottlenecks from the 2007 probe vehicle runs were identified at:
  - 6th Street (AM)
  - Tippecanoe Avenue (AM)
  - Cherry Avenue (PM)
  - Etiwanda Avenue (AM)

Caltrans District 8 also collected probe vehicle run data on multiple mid-week days in both the spring (March and April) and fall (September and November) of 2007. Exhibit 4-5 illustrates the eastbound and Exhibit 4-6 illustrates the westbound probe vehicle runs presented in speed flow diagram for the AM and PM peak hour typical sample runs. The identified bottlenecks are illustrated with the green boxes with the noted specific location in the AM and/or PM runs.

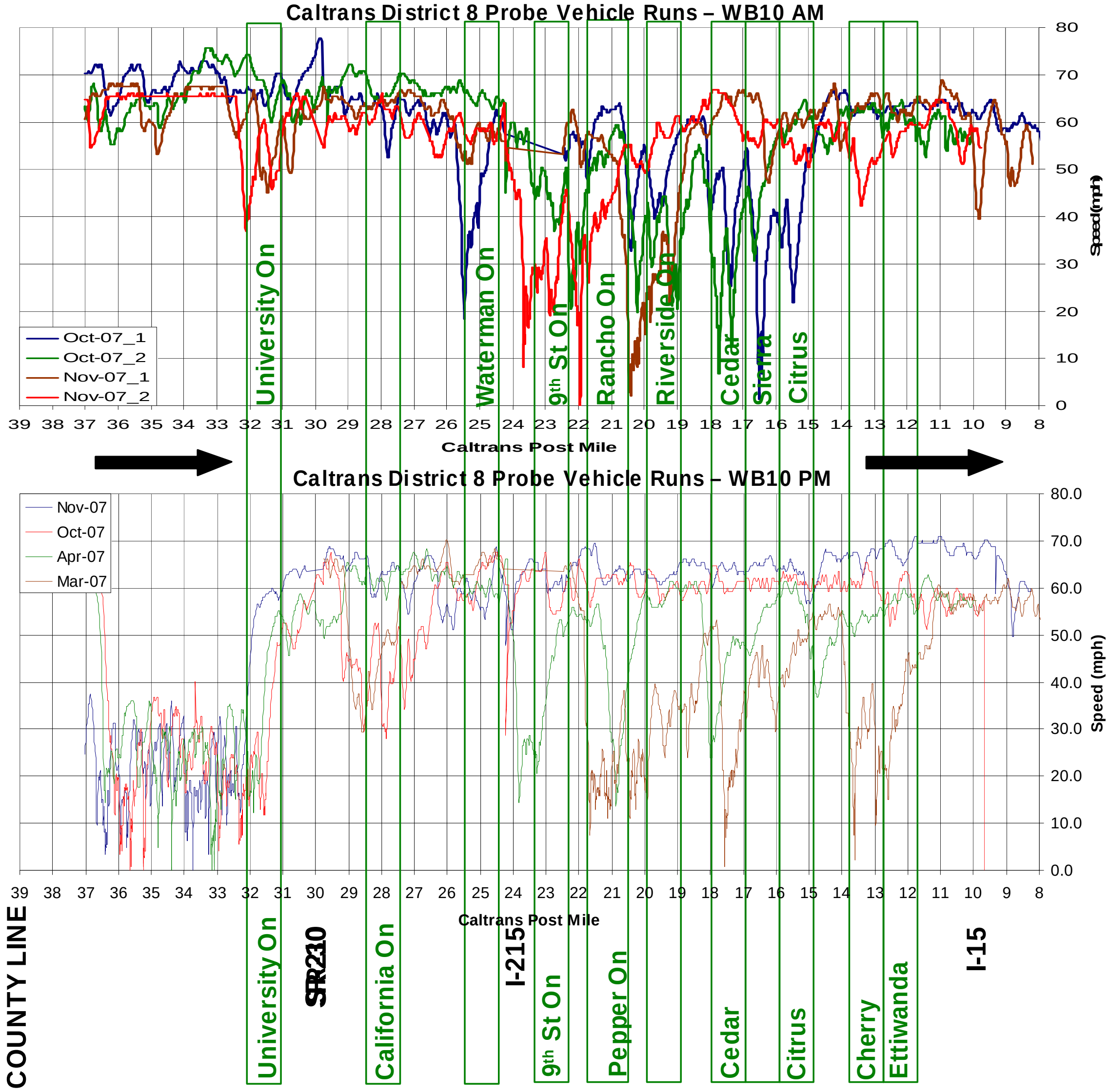
Exhibit A4-5: Eastbound I-10 Probe Vehicle Runs (2007)



- As indicated, the major eastbound bottlenecks from the 2007 probe vehicle runs were identified at:
    - o Etiwanda Avenue On (AM and PM)
    - o Cherry Avenue On (PM)
    - o Citrus Avenue Off (PM)
    - o Cedar Avenue Off (PM)
    - o Riverside Avenue Off (PM)

- o Pepper Avenue On (PM)
- o Tippecanoe Avenue (PM)
- o California Street (PM)
- o SR-38/6th Street (PM)

Exhibit A4-6: Westbound I-10 Probe Vehicle Runs (2007)



- As indicated, the major westbound bottlenecks from the 2007 probe vehicle runs were identified at:
    - University Street On (AM and PM)
    - California Street On (PM)
    - Waterman Avenue On (AM)
    - 9th Street On (AM and PM)
    - Rancho Avenue On (AM)
    - Pepper Avenue On (PM)
    - Riverside Avenue On (AM)
    - Cedar Avenue (AM and PM)
    - Sierra Avenue (AM)
    - Citrus Avenue (AM and PM)
    - Cherry Avenue (PM)
    - Etiwanda Avenue (PM)

Freeway Performance Measurement System (PeMS)

In PeMS, speed plots are also used to identify potential bottleneck locations. Speed plots are very similar to probe vehicle run graphs. Unlike the probe vehicle runs, however, each speed plot has universally the same time across the corridor. For example, an 8AM plot includes the speed at one end of the corridor at 8AM and the speed at the other end of the corridor also at 8AM. With probe vehicle runs, the end time, or time at the end of the corridor is the departure time plus the actual travel time. Despite this difference, they both identify the same problem areas. These speed plots are then compiled at every five minutes and presented in speed contour plots.

The conditions of the corridor vary from 2007 to 2008. Although 2007 is the base year of analysis, PeMS data reflecting 2008 were also included in the report to show the most current conditions of the corridor. Many of the bottlenecks identified in 2007 have essentially disappeared in 2008, and the bottlenecks identified in 2008 are minor in terms of magnitude of congestion that it creates.

EASTBOUND (2008)

Speed contour and profile plots for sample days in April 2008 and 2008 quarterly weekday average long contours were analyzed for the eastbound direction. Exhibits 4-7 and Exhibit 4-8 illustrate the speed contour plots for the I-10 freeway corridor in the eastbound direction (traffic moving left to right on the plot). Along the vertical axis is the time period from 4AM to 8PM. Along the horizontal axis is the corridor segment from the I-15 interchange to the I-215 interchange. Unlike the westbound 2008 PeMS speed contour analysis results, the 2008 PeMS eastbound speed contour analysis results indicated reoccurring bottleneck locations across multiple weekdays and quarterly averages.

- As indicated from Exhibits 4-7 and 4-8, the major eastbound bottlenecks identified from the 2008 PeMS data plots were identified at:
    - I-15 On (AM)
    - Etiwanda Avenue Off (PM)
    - Etiwanda Avenue On (PM)

Exhibit A4-7: PeMS Eastbound I-10 Speed Contour Plots (April 2008)

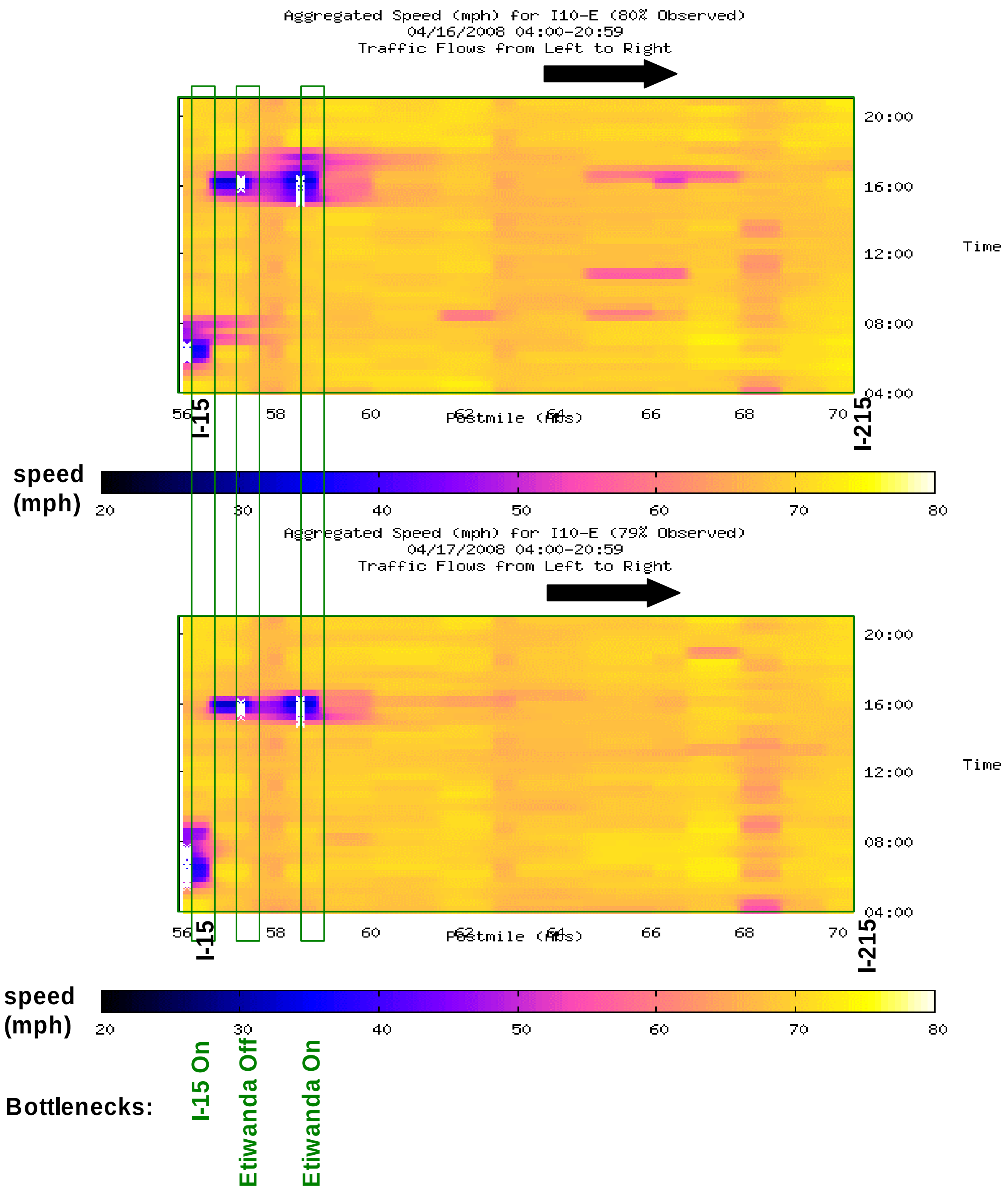
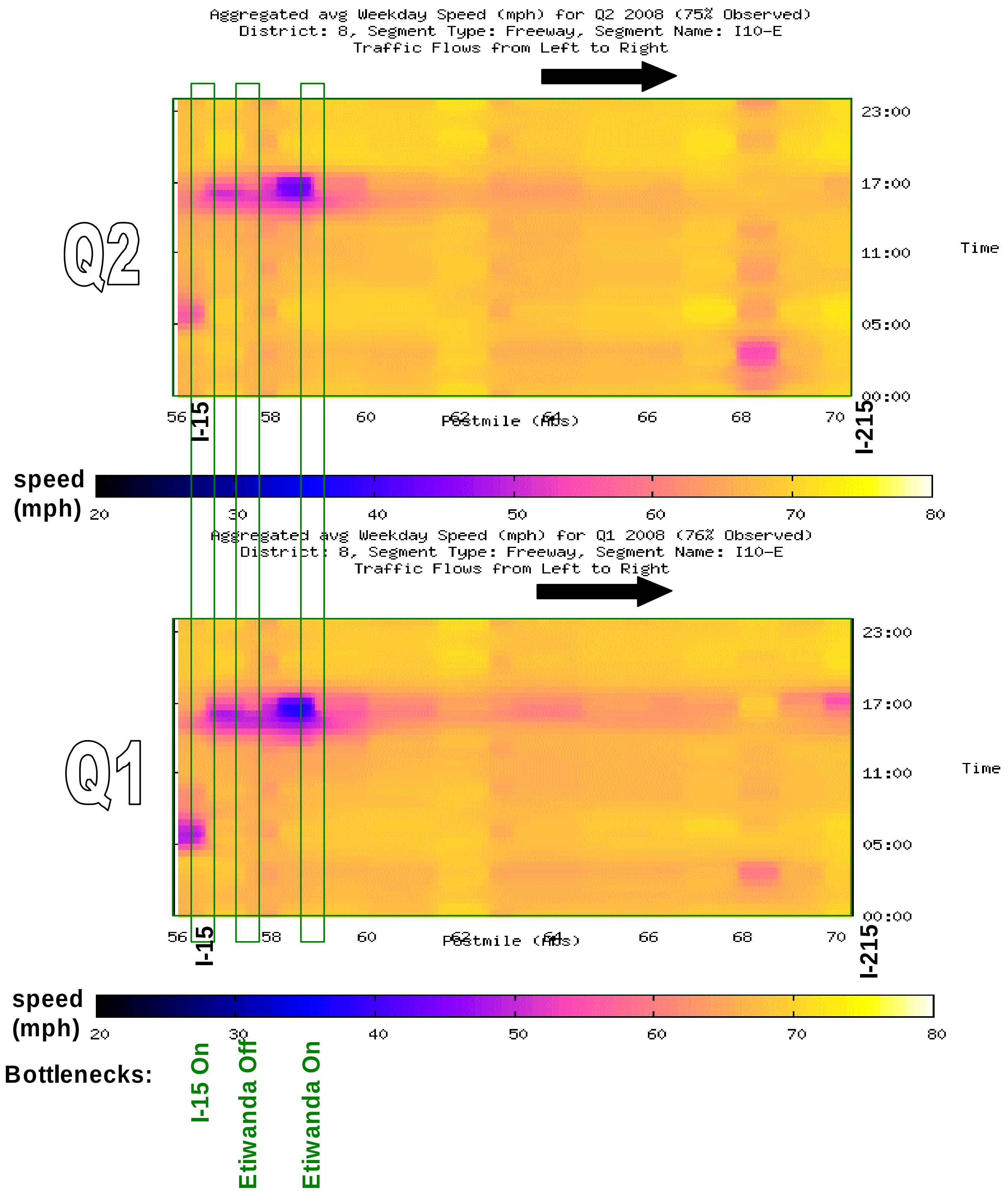


Exhibit A4-8: PeMS Eastbound I-10 Long (Speed) Contours (2008 Avg by Qtr)

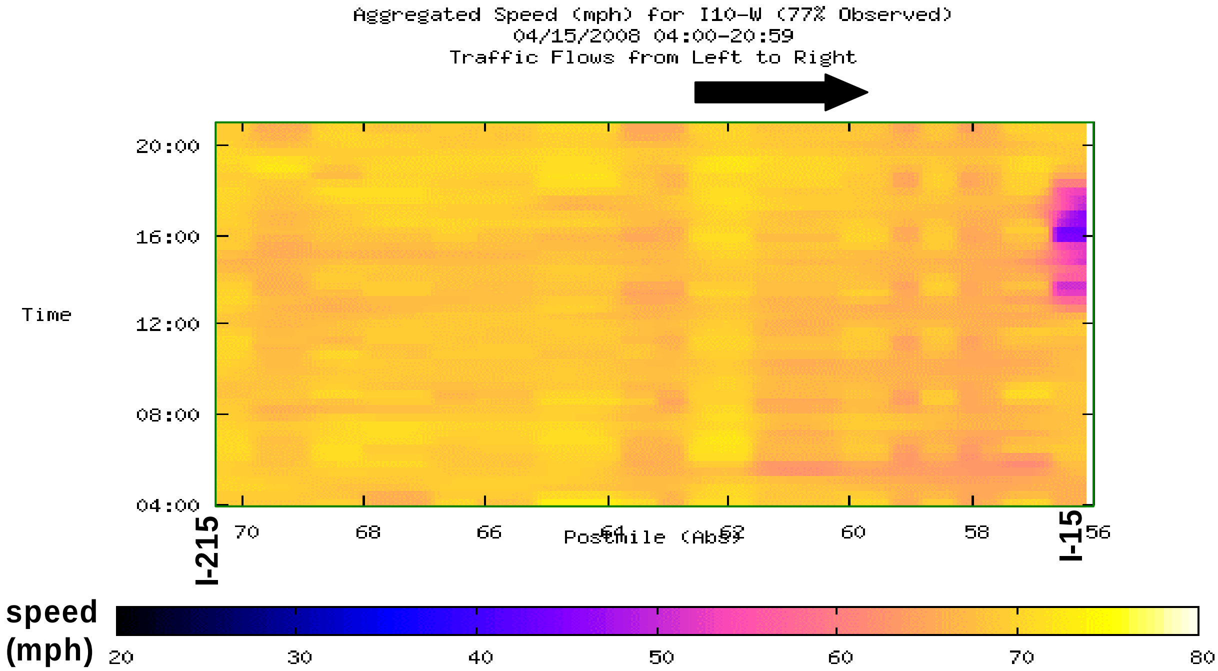


WESTBOUND (2008)

Exhibit 4-9 are speed contour plots from Tuesday, April 15, 2008 and Wednesday, April 16, 2008. These plots illustrate the typical speed contour diagram for the I-10 freeway in the westbound direction (traffic moving left to right on the plot). Along the vertical axis is the time period from 4AM to 8PM. Along the horizontal axis is the corridor segment from the I-215 interchange to the I-15 interchange. There is no detection data to the east of the I-215 interchange. The various colors in the speed contour plots represent the average speeds corresponding to the color speed chart shown below the diagram. As shown, the dark blue blotches represent congested areas where speeds are reduced. The ends of each dark blotches represent bottleneck areas, where speeds pickup after congestion, typically to 30 to 50 miles per hour. The horizontal length of each blotch is the congested segment, queue lengths. The vertical length is the congested time period. As illustrated in Exhibit 4-9, there were no bottlenecks evident on April 15, 2008.

In addition to the sample days, larger averages were also analyzed. Exhibit 4-10 illustrates the weekday averages by each quarter of 2008. Again, no bottleneck locations are evident.

Exhibit A4-9: PeMS Westbound I-10 Speed Contour Plots (April 2008)



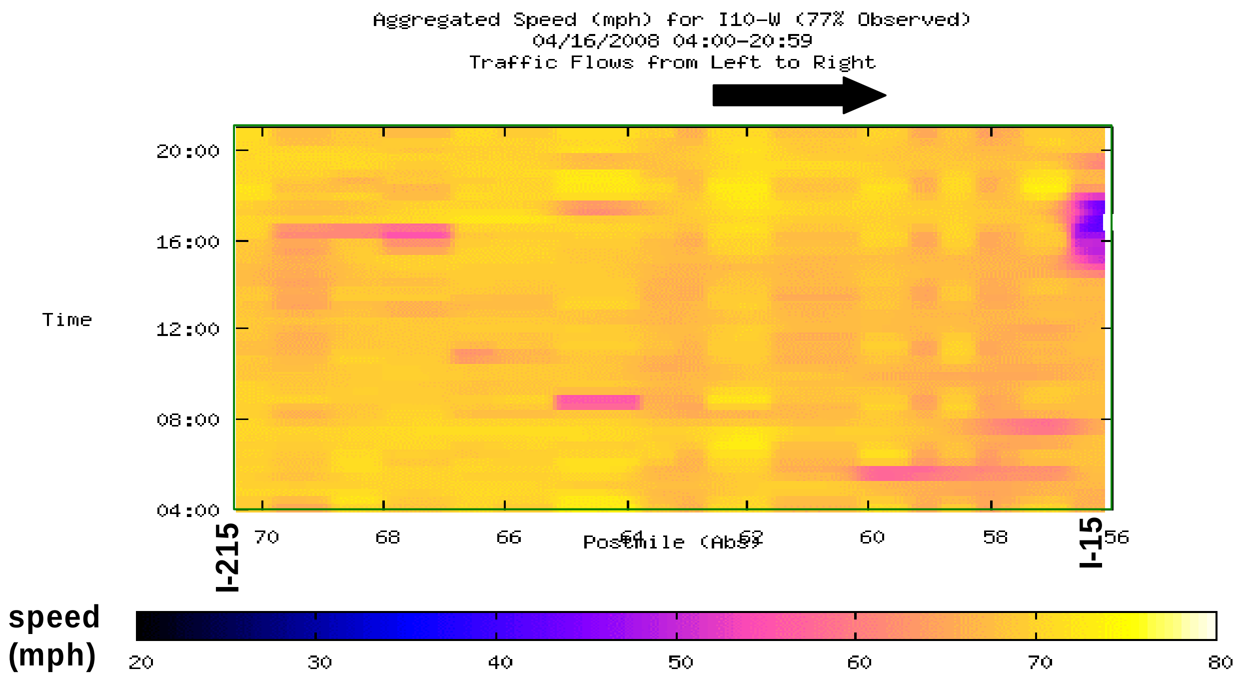
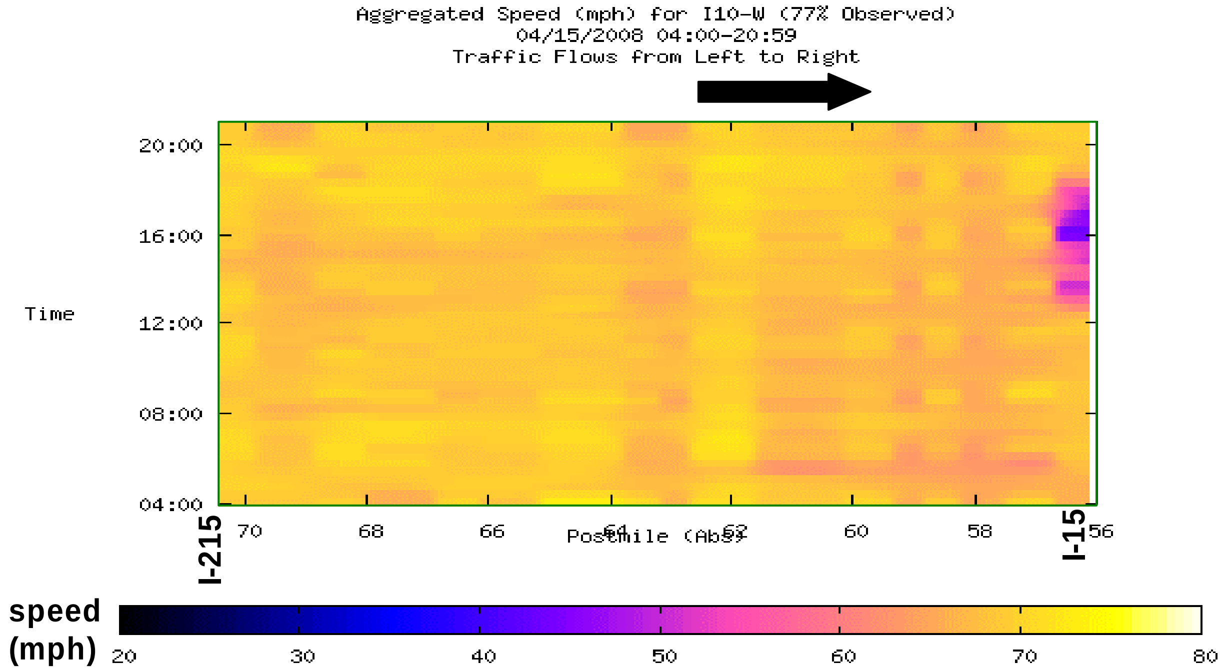
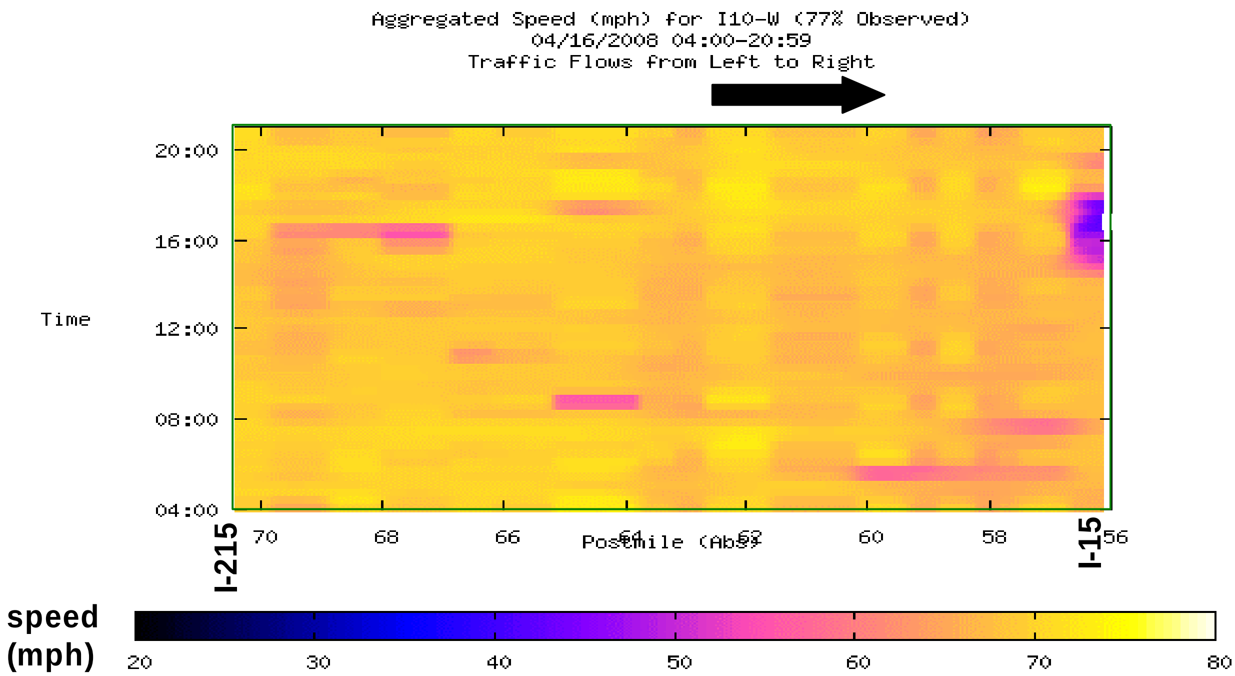


Exhibit A4-10: PeMS Westbound I-10 Long (Speed) Contours (2008 Avg by Qtr)





EASTBOUND (2007)

Exhibit 4-11 illustrates the speed contour plots on Tuesday, September 11, 2007 and Wednesday, September 12, 2007. As opposed to the 2008 conditions, the 2007 conditions included a number of additional bottleneck locations as illustrated in the exhibit.

Exhibit 4-12 illustrates the speed profile plots on Wednesday, September 12, 2007. The speed profile plots represent a typical weekday sample to illustrate the bottleneck locations and congestion formed from them at a particular time in the day, in this case at 8AM in the morning and 4PM in the evening. The speed profile plots illustrate the typical speed profile diagram for the I-10 freeway in the eastbound direction (traffic moving left to right on the plot). As indicated the same bottleneck locations are evident.

Exhibit 4-13 illustrates the weekday averages by each quarter of 2007. Again, the same bottleneck locations are identified. From the long contours, the same bottlenecks are evident, further validating the reoccurring pattern of the bottleneck locations. The eastbound direction experienced a significant reduction in traffic congestion and improvement in the traffic flow in the latter half of the year.

- As indicated from Exhibits 4-11 to 4-13, the major eastbound bottlenecks identified from the 2007 PeMS data plots were identified at:
    - Etiwanda Avenue Off (PM)
    - Etiwanda Avenue On (PM)
    - Cherry Avenue On (PM)
    - Cedar Avenue Off (PM)
    - Riverside Avenue On (PM)

Exhibit A4-11: PeMS Eastbound I-10 Speed Contour Plots (September 2007)

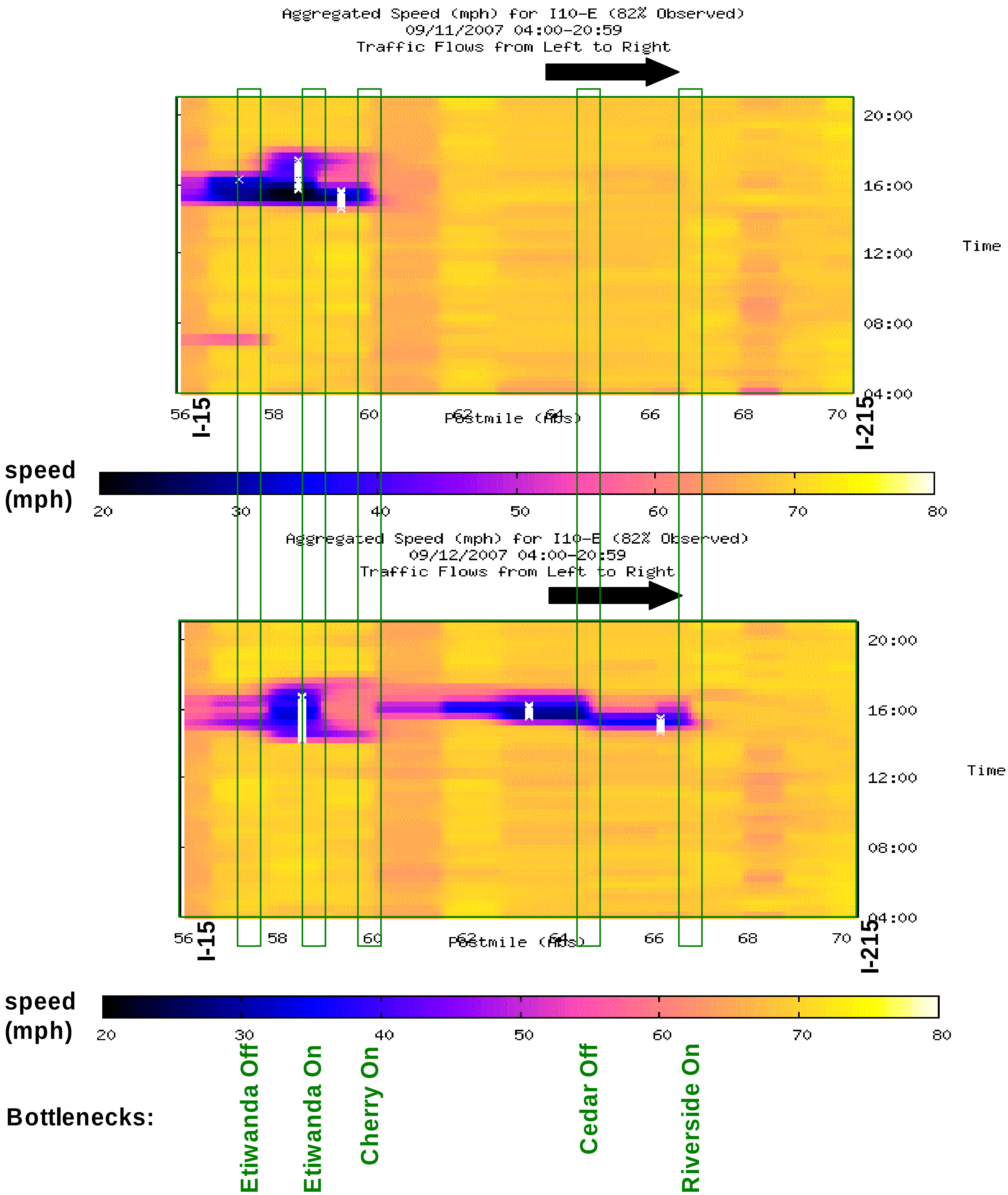


Exhibit A4-12: PeMS Eastbound I-10 Speed Profile Plots (September 12, 2007)

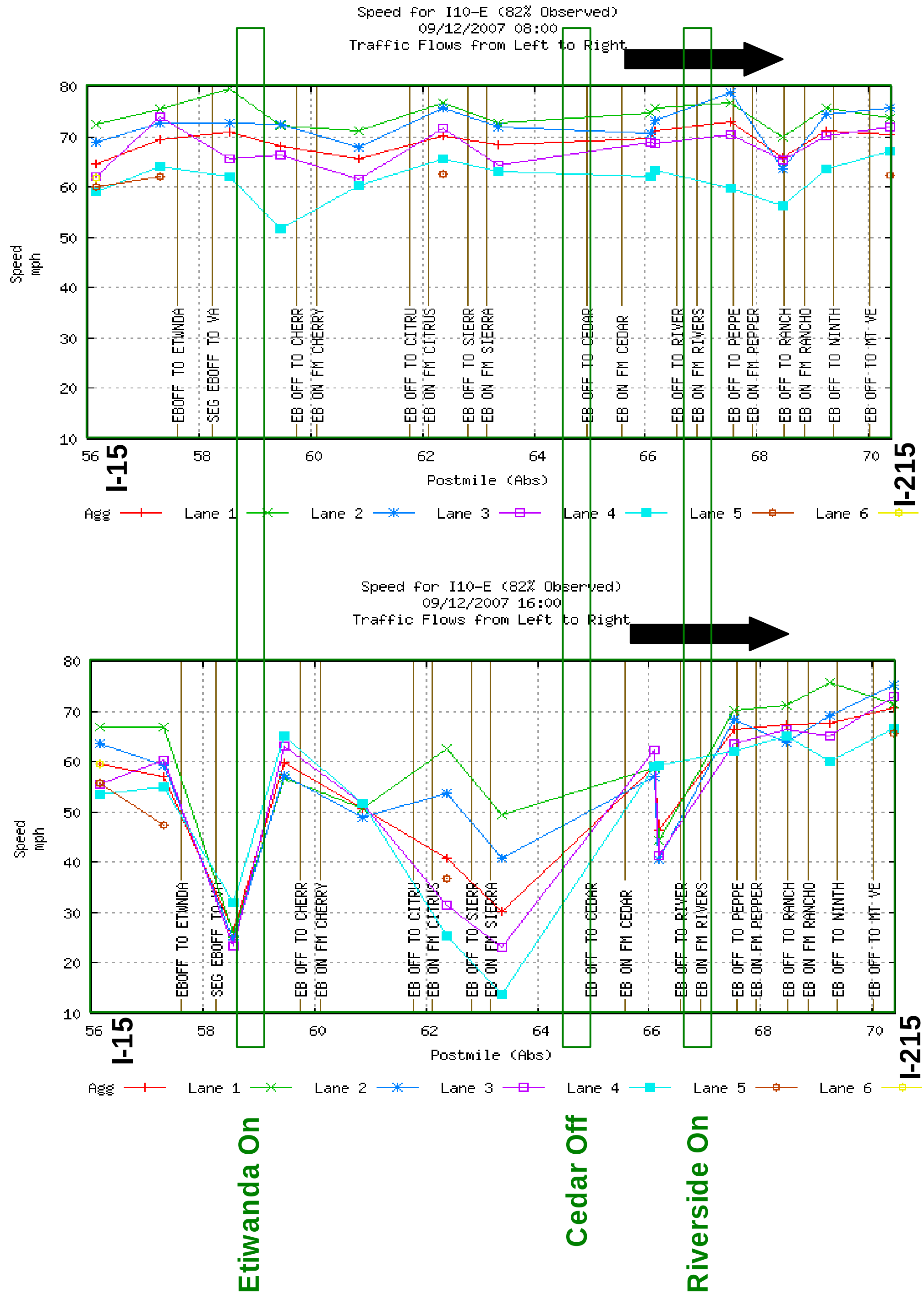
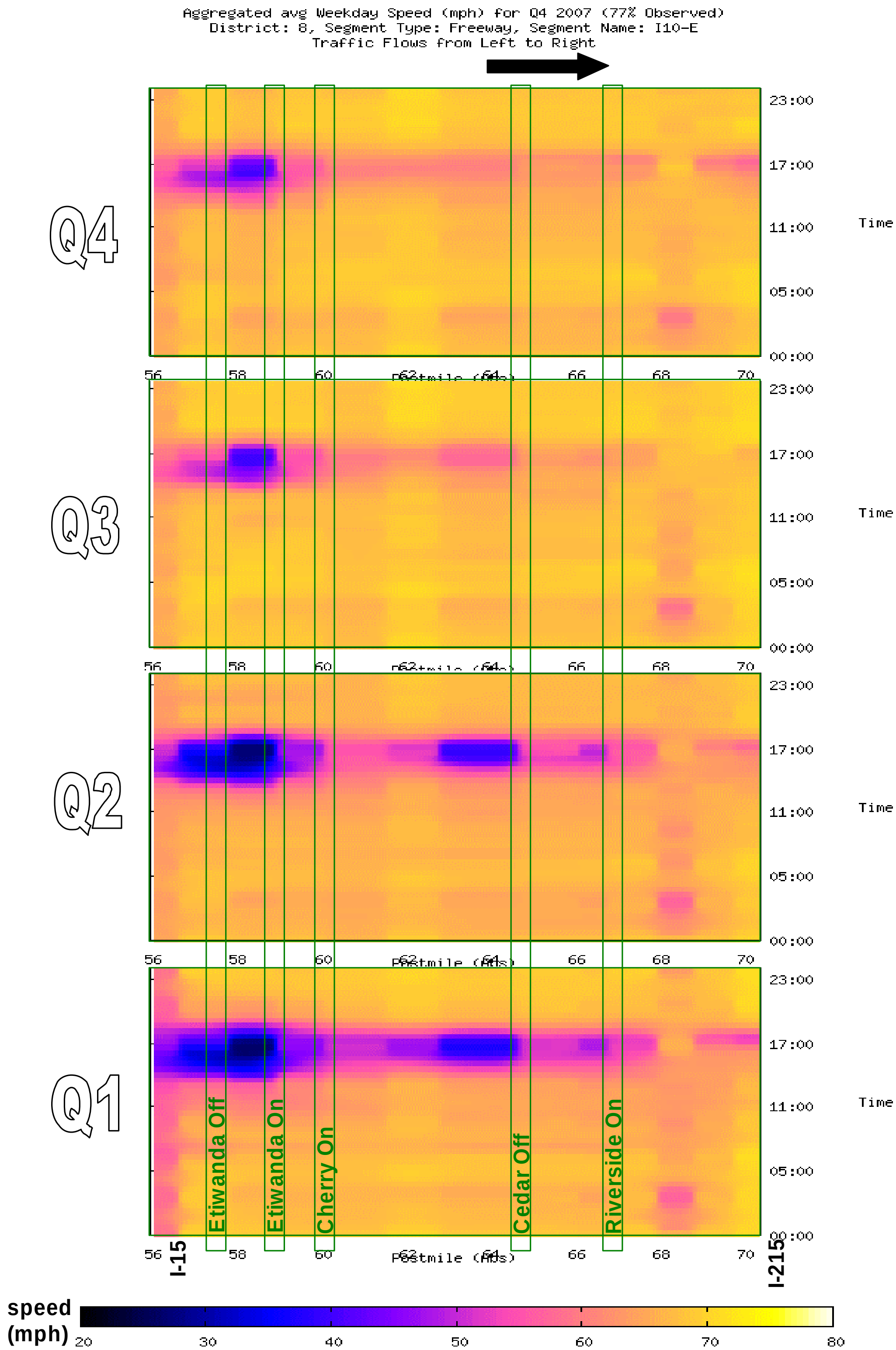


Exhibit A4-13: PeMS Eastbound I-10 Long (Speed) Contours (2007 Avg by Qtr)



WESTBOUND (2007)

Exhibit 4-14 illustrates the speed contour plots on Tuesday, September 18, 2007 and Wednesday, September 19, 2007. As with the 2008 sample plots, the speed contour plots represent a typical weekday sample to illustrate the bottleneck locations and congestion formed from them for the same corridor segment and time period. As the exhibit illustrates, there is very little congestion with three minor bottlenecks evident at Cedar, Citrus, and I-15 interchanges.

In addition to sample days in September 2007, additional sample days were also analyzed in the spring. Exhibit 4-15 illustrates the speed contours of additional weekday samples in April 2007. The same bottleneck locations are identified on each of the two different sample days, indicating a reoccurring pattern of the bottleneck locations. Unlike the September conditions, however, the April conditions were much more severe with significant traffic congestion and pronounced bottlenecks.

Exhibit 4-16 illustrates the speed profile plots on Wednesday, April 26, 2007. The speed profile plots represent a typical weekday sample to illustrate the bottleneck locations and congestion formed from them at a particular time in the day, in this case at 7:30AM in the morning and 5PM in the evening. The speed profile plots illustrate the typical speed profile diagram for the I-10 freeway in the westbound direction (traffic moving left to right on the plot). As indicated, the same bottleneck locations are evident.

Exhibit 4-17 illustrates the weekday averages by each quarter of 2007. Again, the same bottleneck locations are identified. From the long contours, the same bottlenecks are evident, further validating the reoccurring pattern of the bottleneck locations. Also evident is the significant reduction in traffic congestion and improvement in the traffic flow from the first half of the year to the second half of the year.

- As indicated from Exhibits 4-14 to 4-17, the major westbound bottlenecks identified from the 2007 PeMS data plots were identified at:
  - 9th Street On (AM and PM)
  - Cedar Avenue On (AM)
  - Citrus Avenue On (AM and PM)
  - I-15 Off (PM)

Exhibit A4-14: PeMS Westbound I-10 Speed Contour Plots (September 2007)

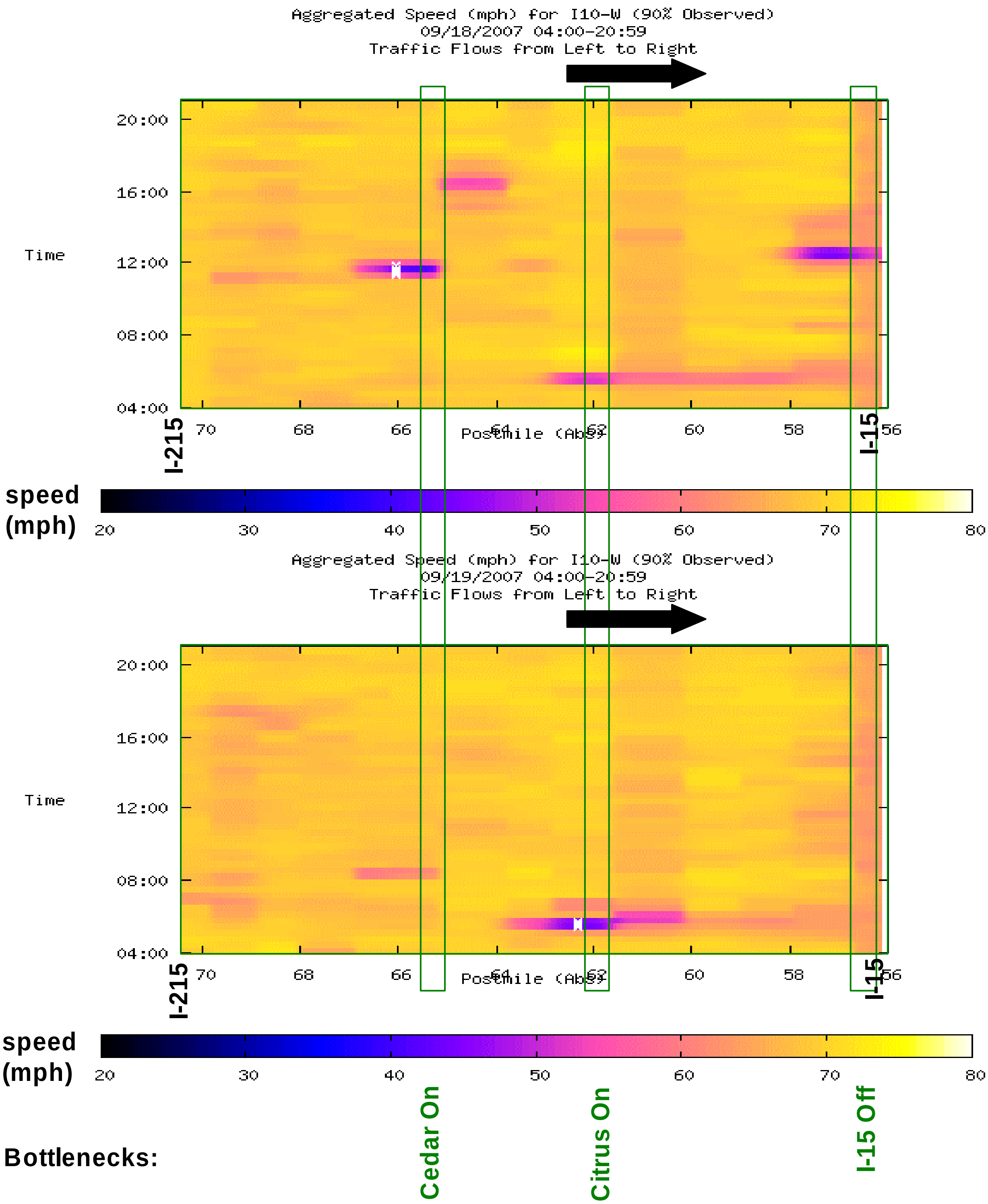


Exhibit A4-15: PeMS Westbound I-10 Speed Contour Plots (April 2007)

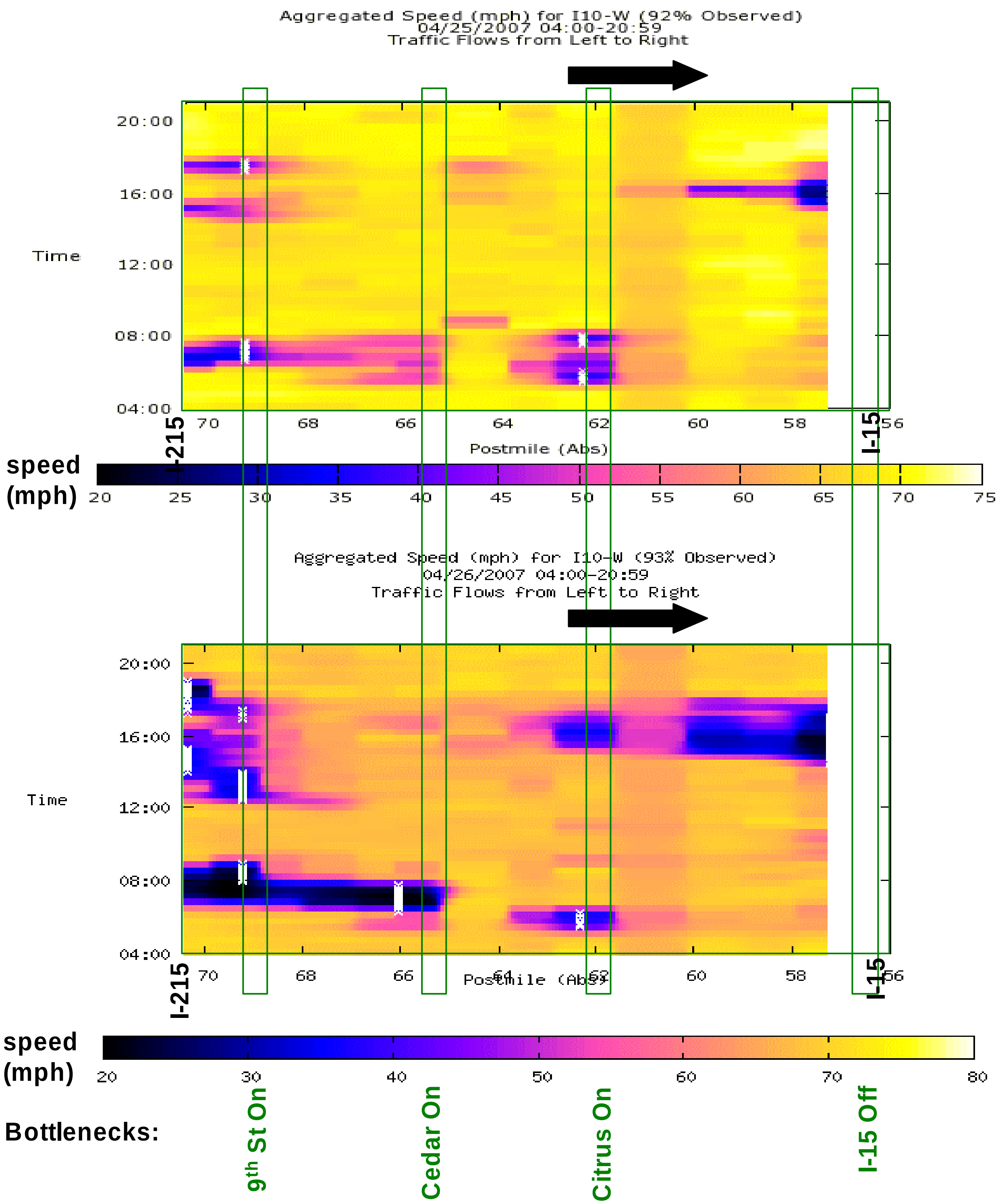


Exhibit A4-16: PeMS Westbound I-10 Speed Profile Plots (April 26, 2007)

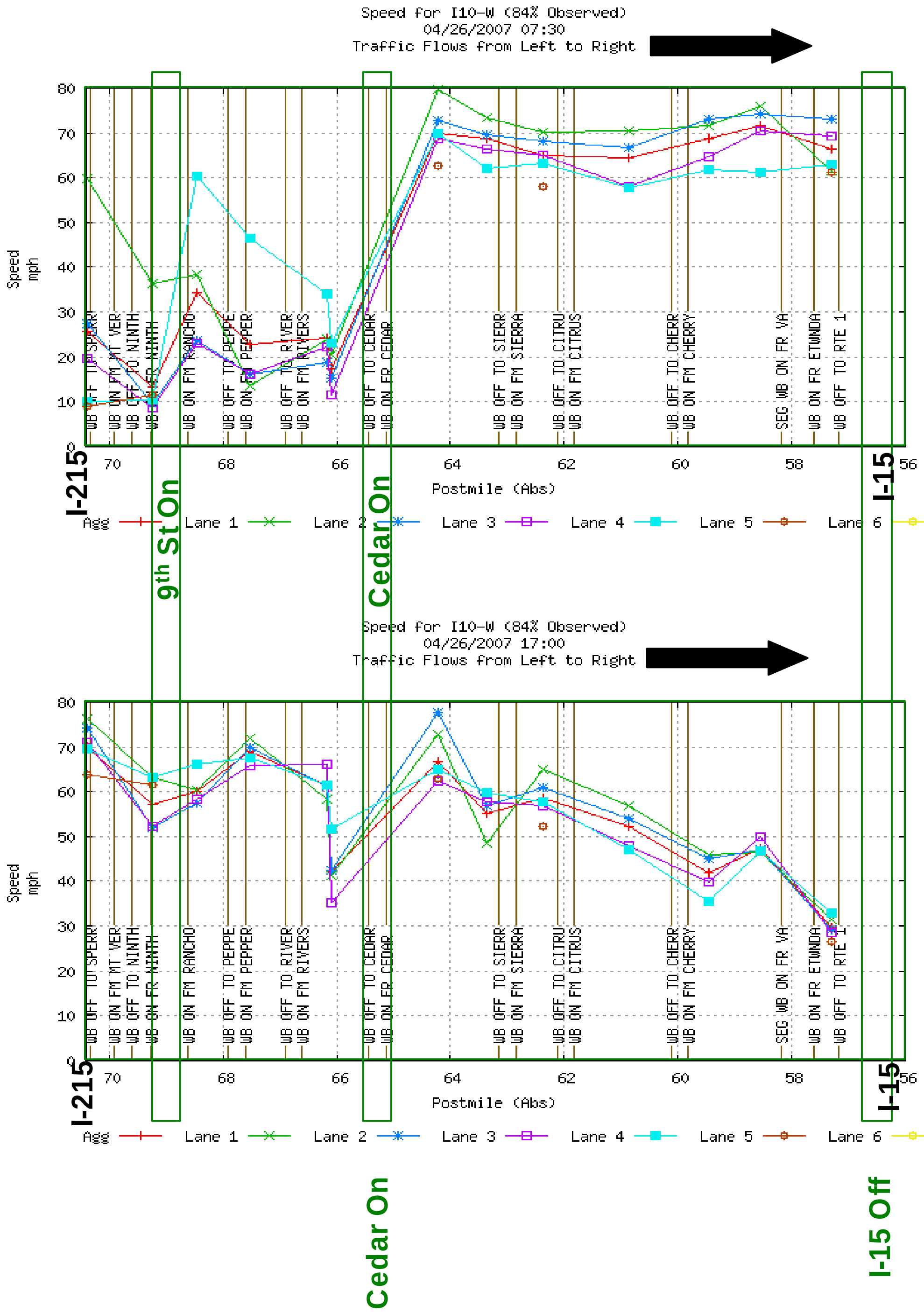
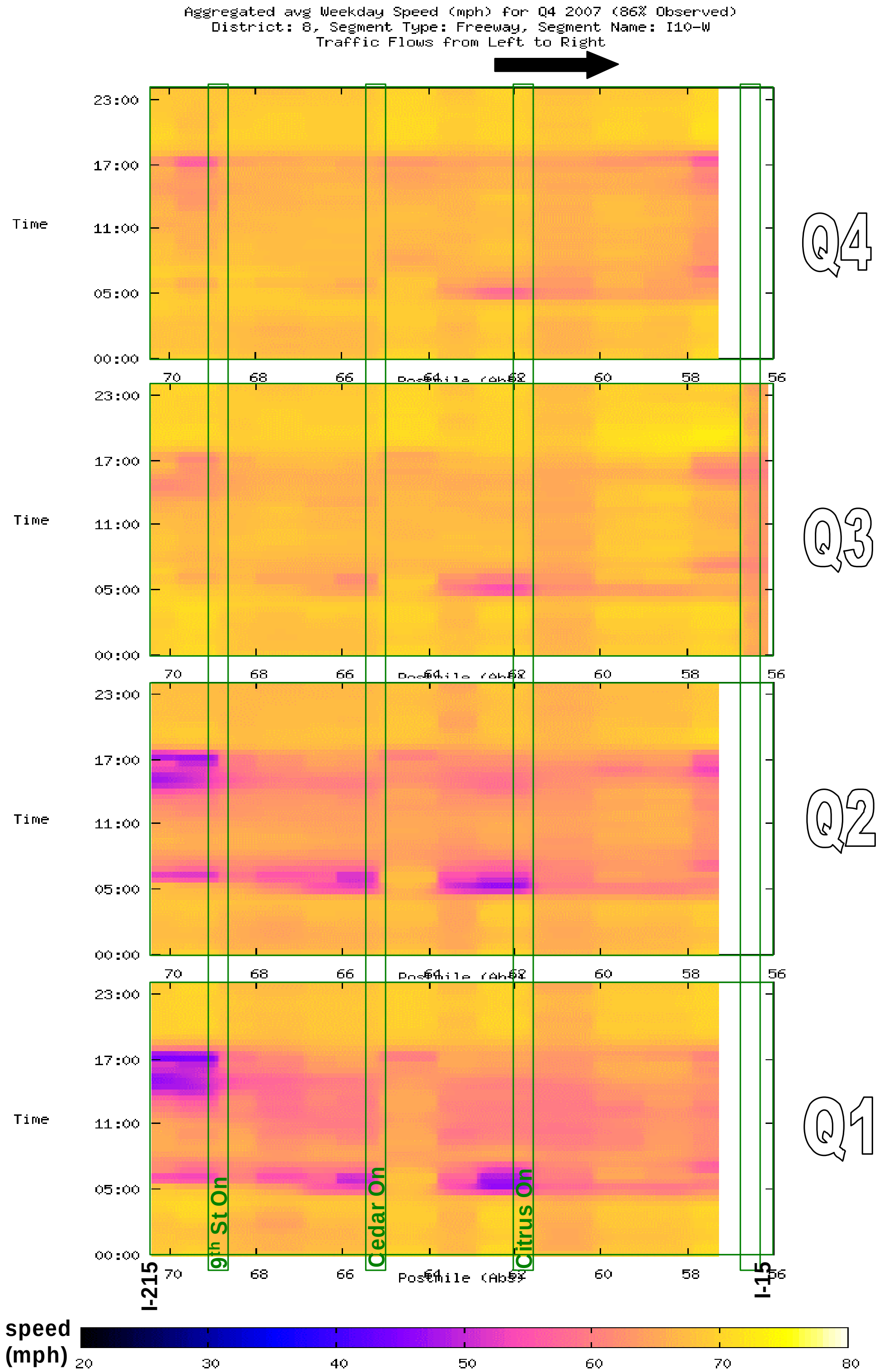


Exhibit A4-17: PeMS Westbound I-10 Long (Speed) Contours (2007 Avg by Qtr)



Bottleneck Summary

Exhibit 4-18 provides a summary of the bottleneck locations based on the various sources from 2008 data: Caltrans District 8 probe vehicle runs and PeMS speed contour plots. Exhibit 4-19 provides a summary of the bottleneck locations based on the various sources from the 2007 data: 2007 HICOMP report, Caltrans District 8 probe vehicle runs, and PeMS speed contour and profile plots. The rows in bold represent the bottlenecks that were identified from multiple sources and are most likely to be major reoccurring bottlenecks.

It should be noted that these locations have not been field-verified. Additional data and/or extensive field reviews will be necessary to confirm their actual locations and identify causes of the bottlenecks.

Exhibit A4-18: I-10 Identified Bottlenecks Summary Table (2008 Data)

	Bottleneck Area Post Mile Range		**Caltrans** [a] **Probe Veh. Runs**		**PeMS** [b] **Speed Contours**	
BOTTLENECK LOCATION	**ABS**	**CT**	**AM**	**PM**	**AM**	**PM**
WESTBOUND						
6th Street	77.9	31.2	✓	-	-	-
Tippecanoe Avenue	73.0	26.2	✓	-	-	
Cherry Avenue	60.0	13.2	-	✓	-	
Etiwanda Avenue	58.2	11.4	✓	-	-	-
EASTBOUND						
I-15 On	57.3	10.5	-	-	✓	-
Etiwanda Avenue Off	57.6	10.8	-	-	-	✓
Etiwanda Avenue On	58.5	11.7	-	-	-	✓
SR-210	76.2	29.4	-	✓	-	-
Ford Avenue	80.0	33.2	-	✓	-	-

NOTES:
[a] Based on Caltrans District 8 sample probe vehicle runs, taken in February 2007.
[c] Based on Performance Measurement System (PeMS) sample daily speed contours taken from April 2008, and
- No indication of bottleneck from this source.
✓ Bottleneck location identified from this source.

Exhibit A4-19: I-10 Identified Bottlenecks Summary Table (2007 Data)

BOTTLENECK LOCATION	Bottleneck Area Post Mile Range		HICOMP [a] Report		Caltrans [b] Probe Veh. Runs		PeMS [c] Speed Contours	
	ABS	CT	AM	PM	AM	PM	AM	PM
WESTBOUND								
University Street On	78.5	31.8	✓	-	✓	✓	-	-
California Street On	74.7	28.0	✓	-	-	✓	-	-
Waterman Avenue On	72.2	25.4	-	-	✓	-	-	-
9th Street On	69.3	R22.5	-	-	✓	✓	✓	✓
Rancho Avenue On	68.6	R21.9	-	✓	✓	-	-	-
Pepper Avenue On	67.6	20.8	-	-	-	✓	-	-
Riverside Avenue On	66.6	19.8	-	-	✓	-	-	-
Cedar Avenue On	65.1	R18.4	-	-	✓	✓	✓	-
Sierra Avenue	63.0	16.2	-	-	✓	-	-	-
Citrus Avenue On	61.8	15.1	-	-	✓	✓	✓	✓
Cherry Avenue	60.0	13.2	-	-	-	✓	-	-
Etiwanda Avenue	58.2	11.4	✓	-	-	✓	-	-
I-15 Off	57.2	10.4	-	-	-	-	-	✓
EASTBOUND								
Etiwanda Avenue Off	57.6	10.8	-	-	-	-	-	✓
Etiwanda Avenue On	58.5	11.7	-	-	✓	✓	-	✓
Cherry Avenue On	60.1	13.3	-	✓	-	✓	-	✓
Citrus Avenue Off	61.8	15.0	-	-	-	✓	-	-
Sierra Avenue	63.0	16.2	-	✓	-	-	-	-
Cedar Avenue Off	64.9	R18.2	-	-	-	✓	-	✓
Riverside Avenue Off	66.6	19.8	-	-	-	✓	-	-
Riverside Avenue On	66.9	20.1	-	-	-	-	-	✓
Pepper Avenue On	67.9	21.1	-	-	-	✓	-	-
Rancho Avenue	68.6	R21.8	-	✓	-	-	-	-
Tippecanoe Avenue	73.0	26.2	-	-	-	✓	-	-
California Street	75.0	28.2	-	✓	-	✓	-	-
SR-38/6th Street	78.0	31.2	-	-	-	✓	-	-
University Street	78.5	31.7	-	✓	-	-	✓	✓

NOTES:
[a] Based on 2006 HICOMP report.
[b] Based on Caltrans District 8 sample probe vehicle runs, taken in March/April and October/November 2007.
[c] Based on Performance Measurement System (PeMS) sample daily speed contours taken from April & September 2007, and 2007
- No indication of bottleneck from this source.
✓ Bottleneck location identified from this source.

In comparison, many of the bottlenecks identified in 2007 have essentially disappeared in 2008, and the bottlenecks identified in 2008 are minor in terms of magnitude of congestion that it creates. In fact, the PeMS contour diagrams shown in Exhibits 4-14 and 4-17 indicate that there have been significant improvements in traffic flow since the latter half of 2007. Several reasons could potentially explain the improved traffic flow. There were two major recently completed roadway improvement projects opened to traffic in 2007:

- The 2.5-mile widening of I-10 from six to eight lanes between Orange Street and Ford Street in the City of Redlands. The two lanes opened in November and December of 2007.
- The I-210 extension, a 7.25-mile segment between Rialto and San Bernardino that connects to Highway 30, opened in July 2007.

These improvements are likely to have had the most significant impact to the current traffic conditions on the I-10 corridor. In addition, the increase in fuel prices and poor real estate market conditions may also have affected travel demand in recent years. Exhibit 4-20 illustrates the weekday average daily traffic from PeMS vehicle detector station just to the west of the Cedar Avenue interchange. As indicated, travel demand has steadily declined since 2005.

This concludes the Appendix of the Comprehensive Performance Assessment. Again, this Appendix is a copy of the Preliminary Performance Assessment, the third milestone of the CSMP process, which used data analyses and initial field observations to preliminarily identify potential bottleneck locations. The Preliminary Performance Assessment is included in the Appendix of this Comprehensive Performance Assessment as a reference to enable readers to follow the entire process of how bottleneck locations were identified. This Comprehensive Performance Assessment builds on the findings of the Preliminary Assessment by providing updated corridor performance data; finalizing a list of bottleneck locations through additional field visits; and most importantly, identifying the causes of each bottleneck location. The final list of bottleneck locations identified for the I-10 Corridor can be found on page 74.

Exhibit A4-20: Average Daily Traffic (ADT) West of Cedar Avenue from 2006-2008 (Eastbound and Westbound)