FINAL

CORRIDOR SYSTEM MANAGEMENT PLAN (CSMP)
LOS ANGELES COUNTY I-5
FROM I-10 TO I-210
COMPREHENSIVE PERFORMANCE ASSESSMENT
AND
CAUSALITY ANALYSIS

April 15, 2009

System Metrics Group, Inc.

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List of Exhibits

1. INTRODUCTION

This document represents the final for the sixth and seventh milestones of the Los Angeles County Interstate 5 (I-5) Corridor System Management Plan (CSMP) development process, which is required by the California Transportation Commission (CTC) for corridors that have received funding from the Corridor Mobility Improvement Account (CMIA) approved by voters in 2006. The CMIA will partially fund the construction of High Occupancy Vehicle (HOV) lanes from State Route (SR) 134 to the SR-170.

The two milestones are called the Comprehensive Performance Assessment and the Causality of Performance Degradation. They build on the fourth milestone, the "Preliminary Performance Assessment" (already developed), and the fifth 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 decision can build on its findings and conclusions, and investment alternatives are tested to ensure reasonable returns on investment for public funds.

This report is very long and 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 is 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.

The remainder of this report is organized into four sections (Section 1 is this introduction):

2. *Corridor Description*
   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 event 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*
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, productivity, 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 the micro-simulation models will be validated. Finally, this section represents the seventh 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-5 freeway facility.

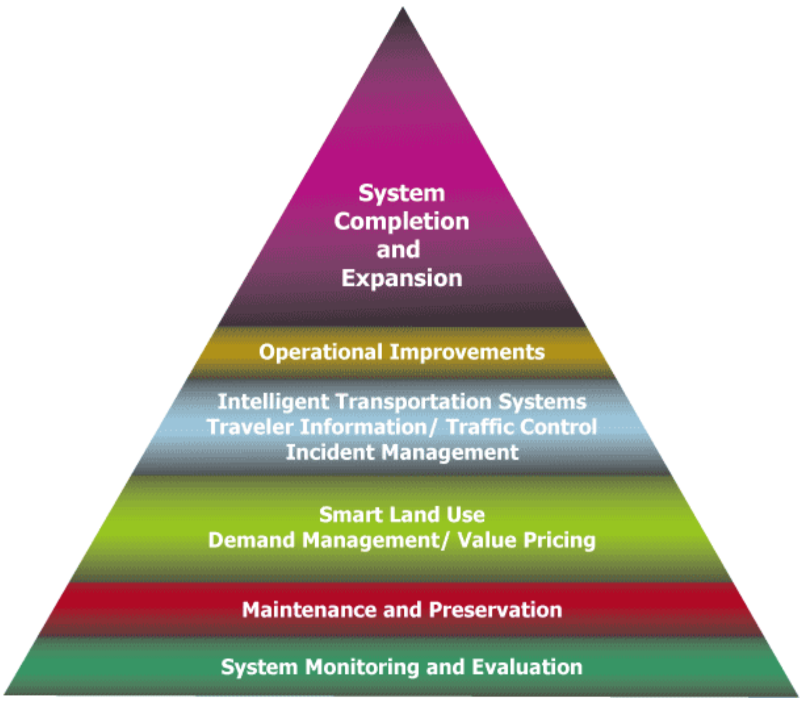
Background

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 Los Angeles County.

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-5 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)

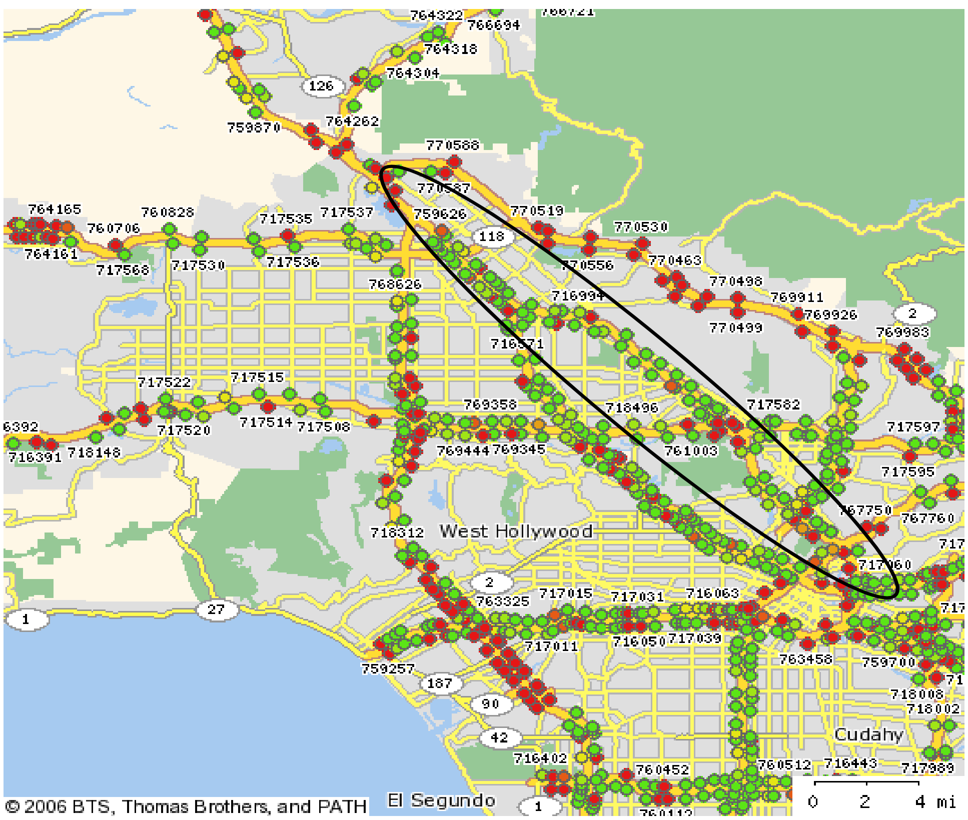
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS) from PeMS
- Traffic study reports (various)
- Aerial photographs (Microsoft Virtual Earth and Google Earth) and Caltrans photologs
- Internet (i.e. Metro website, Metrolink website, etc.).

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

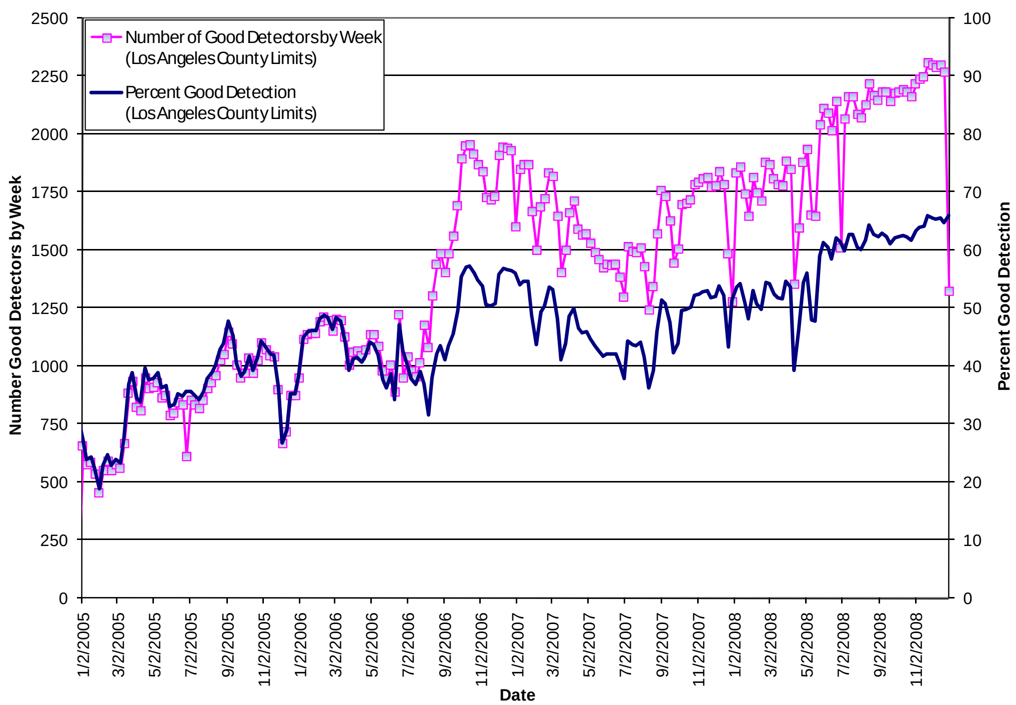
Exhibit 1-2 depicts the corridor freeway facility with the detectors in place as of November 25, 2008. This date was chosen randomly to provide a snapshot of the detection status. The exhibit shows that there are many detectors on the mainline, almost all functioning well (based on the green color). Furthermore, it illustrates some seemingly small gaps between detectors at some locations.

Exhibit 1-2: I-5 Sensor Status (November 25, 2008)



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 week for all of I-5 in Los Angeles County from 2005 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 northbound direction (Exhibit 1-3) was slightly better than the southbound direction (Exhibit 1-4), particularly in 2007 and 2008 when the percentage of good detectors in the northbound direction reported around 50-60 percent compared to 40-50 percent in the southbound direction. The difference appears to be due to the addition of a large number of operating detectors at the end of 2006 in the northbound direction.

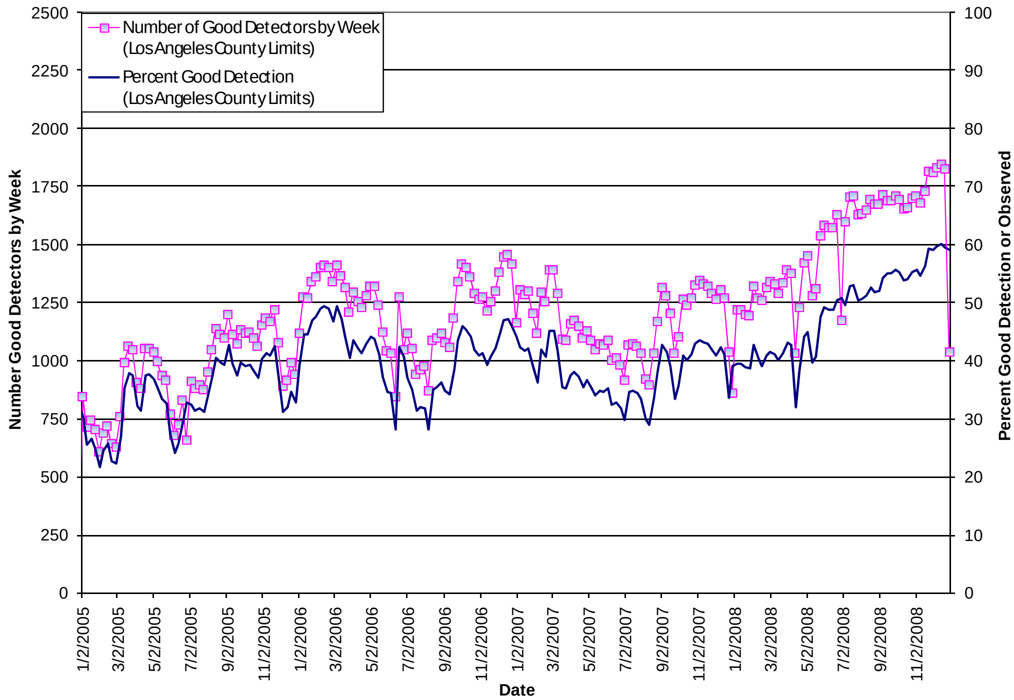
Exhibit 1-3: Number and Percentage of Good Detection on Northbound I-5 (Los Angeles County Limits)



Source: SMG using PeMS data
Note: Number of Good Detectors can be divided by seven (7) to estimate number of good detectors in the field.

Exhibits 1-3 and 1-4 also show that detection on the entire I-5 Los Angeles corridor experienced a general improvement from 2005 to 2008, reaching or exceeding 60 percent of good detection in 2008.

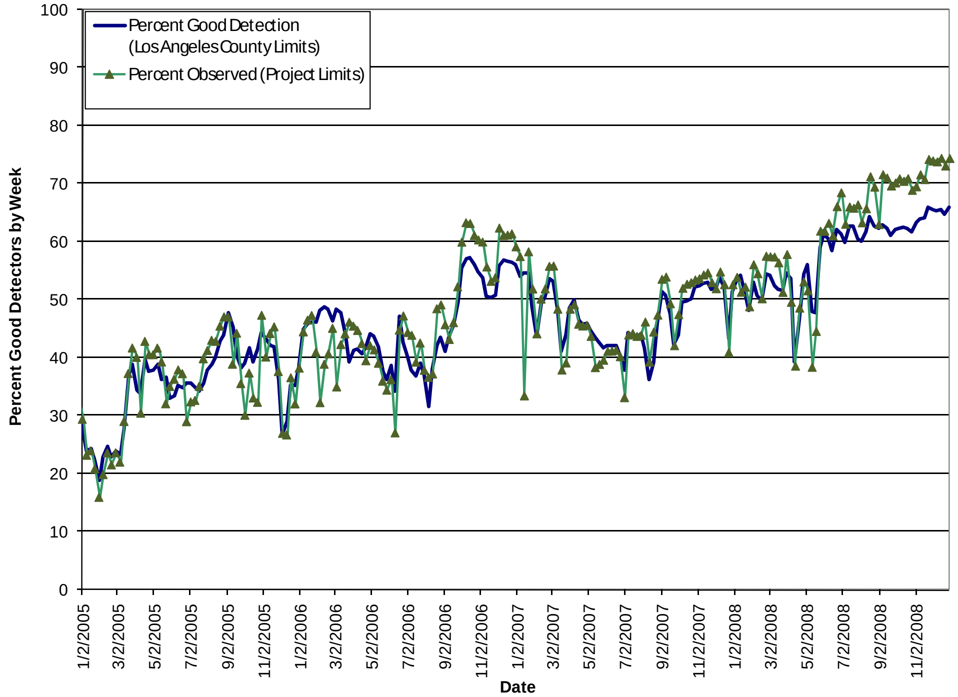
Exhibit 1-4: Number and Percentage of Good Detection on Southbound I-5 (Los Angeles County Limits)



Source: SMG using PeMS data
Note: Number of Good Detectors can be divided by seven (7) to estimate number of good detectors in the field.

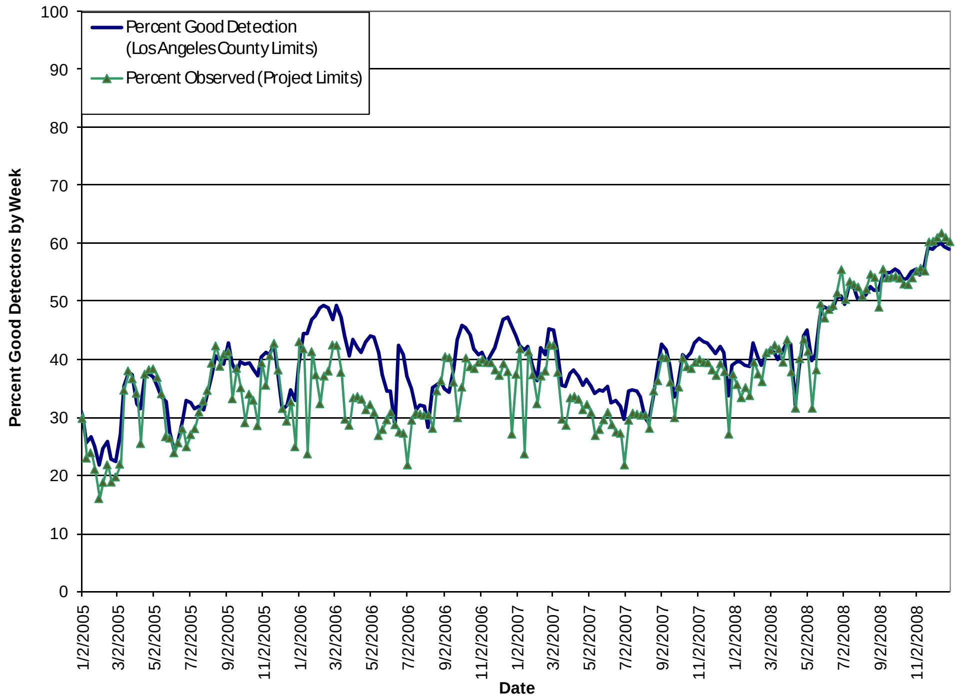
Exhibits 1-5 and 1-6 isolate the I-5 study corridor (in green) and reports the percentage of good detectors within the I-5 corridor limits compared to all of LA County (in blue). As the exhibits illustrate, the I-5 corridor has better detection in both directions relative to the freeway as a whole (in LA County). Similar to the countywide statistics reported in the previous exhibits, the northbound direction (Exhibit 1-5) of the study corridor exhibited better detection compared to the southbound direction (Exhibit 1-6). The detection on the study corridor generally improved between 2005 and 2008, reaching 75 percent in the northbound direction and 65 percent in the southbound direction.

Exhibit 1-5: Percentage of Good Detection on Northbound I-5 (Project Limits)



Source: SMG using PeMS data

Exhibit 1-6: Percentage of Good Detection on Southbound I-5 (Project Limits)



Source: SMG using PeMS data

Detection improved significantly in 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 for the I-5 study corridor, we identified eight detectors that were added between I-10 and I-210 in 2008. These are shown in Exhibit 1-7.

Exhibit 1-7: I-5 Detection Added (2008)

VDS	Location	Type	CA PM	Abs PM	Date Online
NORTHBOUND					
771135	Rte 118CN	HOV	39.51	156.143	9/11/2008
771143	San Fernando 1	HOV	40.17	156.803	9/11/2008
771155	Roxford	HOV	42.75	159.383	9/11/2008
771157	N of 210	HOV	R44.32	160.73	9/11/2008
771158	NB 5 Truck Route	Fwy-Fwy	R44.32	160.73	9/11/2008
SOUTHBOUND					
771136	Rte 118 CN to Paxton	Off-Ramp	39.51	156.08	9/11/2008
771147	San Fernando 2	HOV	40.31	156.88	9/11/2008
771153	Roxford	HOV	42.42	158.99	9/11/2008

Source: System Metrics Group (using PeMS data)

Finally, an analysis of gaps without detection is shown in Exhibit 1-8. There are several segments extending over 0.75 miles without detection in each direction. These should be considered for deployment of additional detection when funding becomes available.

Exhibit 1-8: I-5 Gaps In Detection (November 25, 2008)

Location	Abs PM		Length (Miles)
	From	To	
NORTHBOUND			
Marengo to Pasadena	135.34	136.63	1.29
Pasadena to Riverside	136.63	137.73	1.10
Los Feliz 2 to Colorado	141.17	142.53	1.36
Colorado to N of 134	142.53	143.51	0.98
Alameda 2 to Olive	145.08	145.90	0.82
Buena Vista to Hollywood Way	148.04	149.04	1.00
Hollywood Wayto Sunland	149.04	150.21	1.17
Lankershim to Sheldon	151.70	152.47	0.77
Sheldon to Branford 2	152.47	153.55	1.08
Van Nuys 2 to Paxton	155.18	155.94	0.76
WB 210 to NB 5 (Fwy-Fwy) to Rte 14 CN -Truck Route (ML)	160.73	162.01	1.28
Rte 14 CN - Truck Route (ML) to Weldon Canyon	162.01	163.18	0.76
SOUTHBOUND			
Broadway to Ave 26	136.02	136.90	0.88
Duvall to Dorris	137.27	138.04	0.77
Griffith Park to Colorado	141.11	142.42	1.31
WB 134 to SB 5 (Fwy-Fwy) to Victory TR	142.92	143.77	0.85
Verdugo to Burbank EB OR	145.47	146.25	0.78
Buena Vista to Hollywood Way	147.99	148.85	0.86
Hollywood Way to Roscoe	148.85	149.80	0.95
Lankershim to Sheldon	151.64	152.41	0.77
Sheldon to Branford 1	152.41	153.32	0.91
San Fernando 2 to Roxford	156.88	158.99	2.11
WB 210 to NB 5 (Fwy-Fwy) to Rte 14 CN -Truck Route (ML)	159.96	161.95	1.99
Rte 14 CN - Truck Route (ML) to Weldon Canyon	161.95	162.92	0.97

Source: System Metrics Group (using PeMS data)

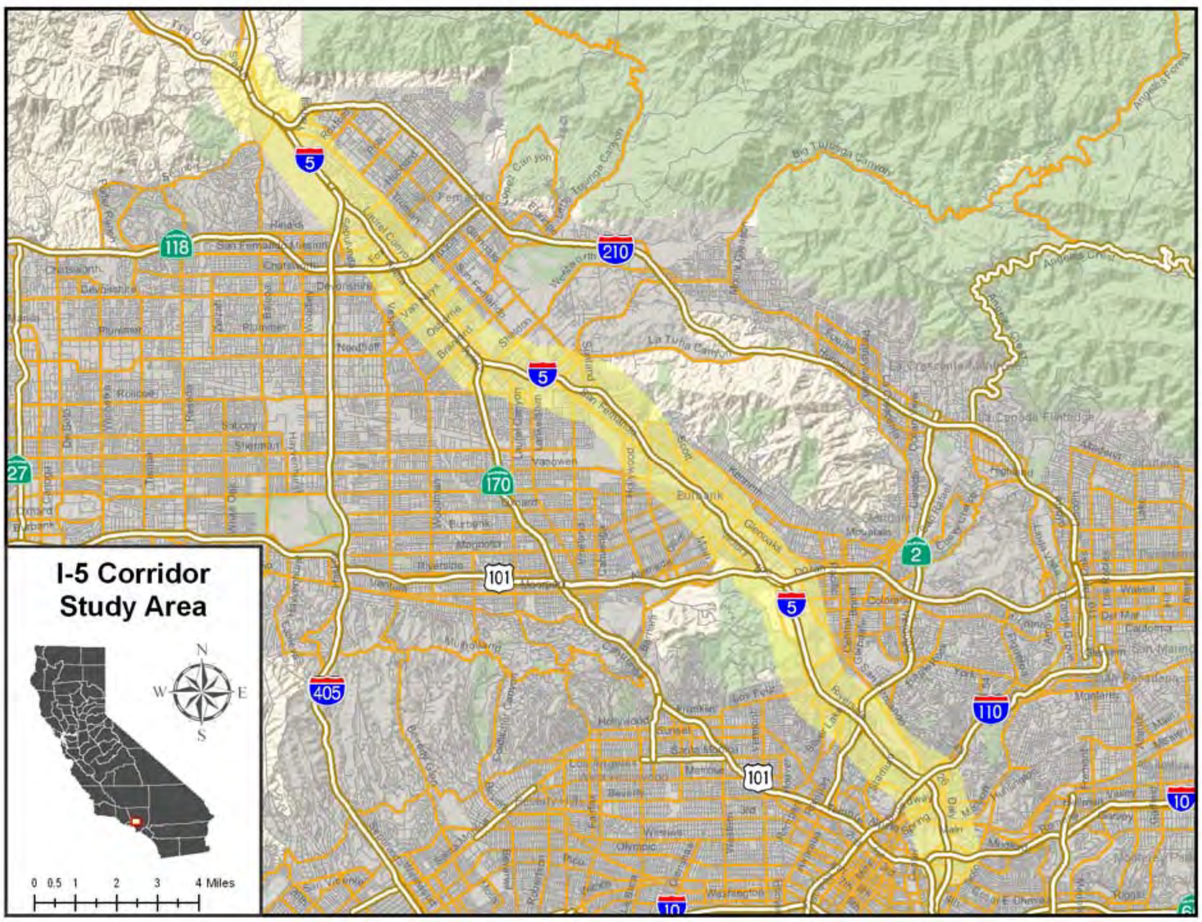
NOTE: The next page is intentionally left blank so that Caltrans can insert updates to the detection analysis results presented in the last four exhibits (Exhibits 1-3 through 1-6) and discuss the ramifications of its findings (e.g., have the gaps been filled, is detector reliability improving or diminishing, etc.). Similar place holder pages have been inserted throughout the document for future updates.

Page Intentionally Left Blank for Future Updates on Detection Coverage

2. CORRIDOR DESCRIPTION

The Golden State Freeway (I-5) study corridor begins at the I-10 (San Bernardino Freeway) interchange and runs northwest to the I-210 (Foothill Freeway) interchange. The study corridor, as defined by Caltrans District 7, extends approximately 26 miles from the I-10 interchange at Post Mile (PM) 18.452 to the I-210 interchange at PM 44.014. It traverses the cities of Los Angeles, Glendale, Burbank, and San Fernando.

Exhibit 2-1: Map of I-5 Study Area



Corridor Roadway Facility

The study corridor crosses through Los Angeles County and includes the following eight major freeway-to-freeway interchanges:

- San Bernardino Freeway (I-10) runs from east to west connecting San Bernardino County to Los Angeles County cities. It provides access to the areas surrounding downtown Los Angeles.

- Pasadena Freeway (SR-110) runs from north to south connecting the San Gabriel Valley cities of Pasadena and South Pasadena to downtown Los Angeles and the Port of Los Angeles.

- Glendale Freeway (SR-2) runs from north to south connecting downtown Los Angeles to the Foothill cities of Glendale, Montrose, and La Canada Flintridge.

- Ventura Freeway (SR-134) runs from east to west providing connection between the US-101 freeway and the I-210 freeway. It provides access to the neighboring cities of Glendale and Burbank.

- North Hollywood Freeway (SR-170) runs from north to south connecting the SR-134 and I-5 freeways. It provides access to the cities of Panorama City, Pacoima, and other surrounding communities.

- Ronald Reagan Freeway (SR-118) runs from east to west connecting Ventura County to the San Fernando Valley.

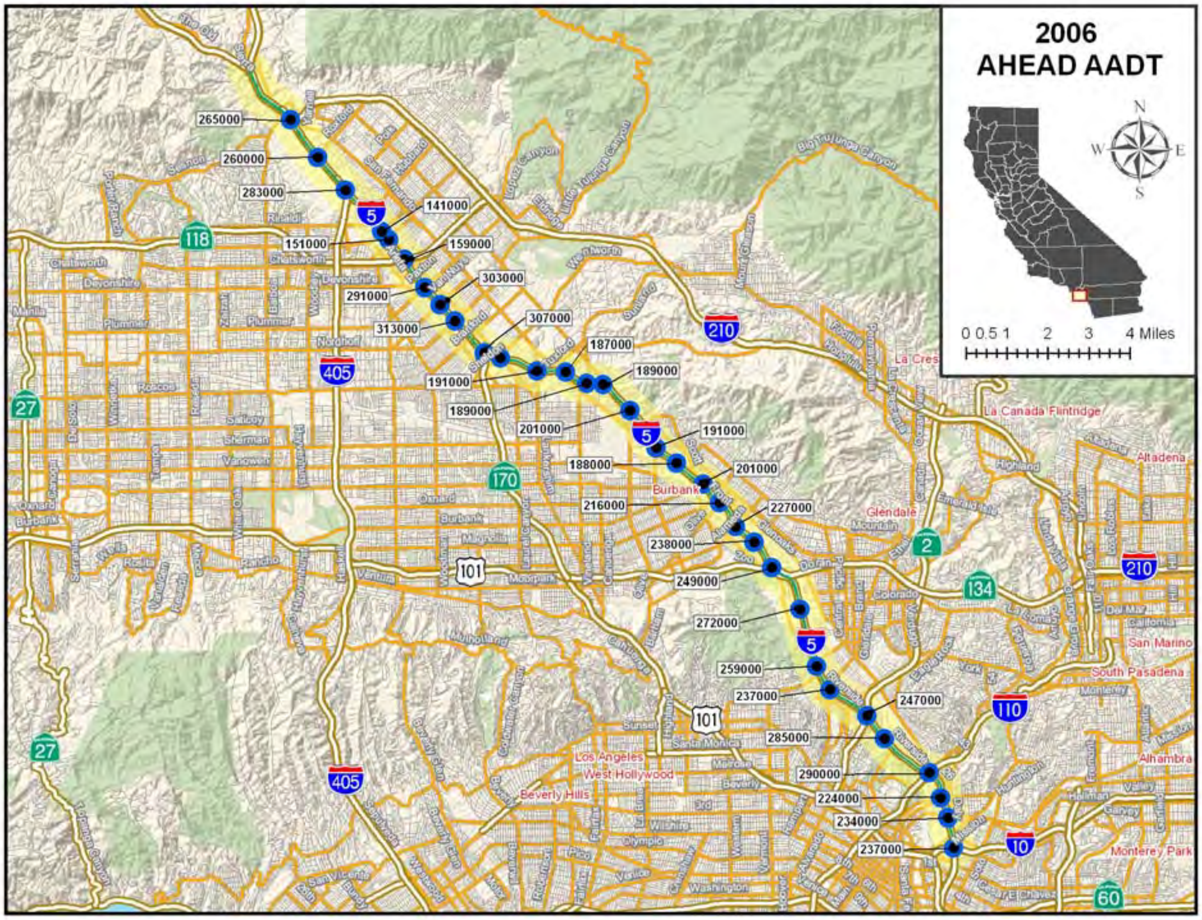
- San Diego Freeway (I-405) runs from north to south connecting Orange County to Los Angeles County. I-405 terminates at this interchange providing access to cities in the San Fernando Valley.

- Foothill Freeway (I-210) freeway starts at the I-5/I-210 interchange providing a connection between north Los Angeles County and the San Gabriel Valley.

According to annual traffic reports from the Caltrans Traffic and Vehicle Data Systems Unit, the I-5 Corridor carries between 141,000 and 313,000 annual average daily traffic (AADT)[1] as shown in Exhibit 2-2. The highest traffic occurs just north of the SR-170 junction at the Osborne Street interchange.

[1] AADT is the total annual volume of vehicles counted divided by 365 days.

Exhibit 2-2: Major Interchanges and AADT on the I-5 Corridor



Source: AADT is from the Caltrans Traffic and Vehicle Data Systems Unit[2]

As indicated in Exhibit 2-3, the I-5 Corridor is a Surface Transportation Assistance Act (STAA) route, which permits large trucks to operate on them. According to the latest validated truck volumes from the 2006 Caltrans Annual Average Daily Truck Traffic data, trucks comprise between 7.3 and 10.5 percent of the total daily traffic along the corridor with the highest percentage at the Olive Avenue interchange in the City of Burbank.

The current Traffic System Network (TSN) records and latest available aerial photos and photologs indicate that the I-5 has three to five lanes in each direction of travel. Exhibit 2-4 shows the lane configurations on the corridor according to the latest available aerial photos.

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

Exhibit 2-3: Los Angeles County Truck Network on California State Highways

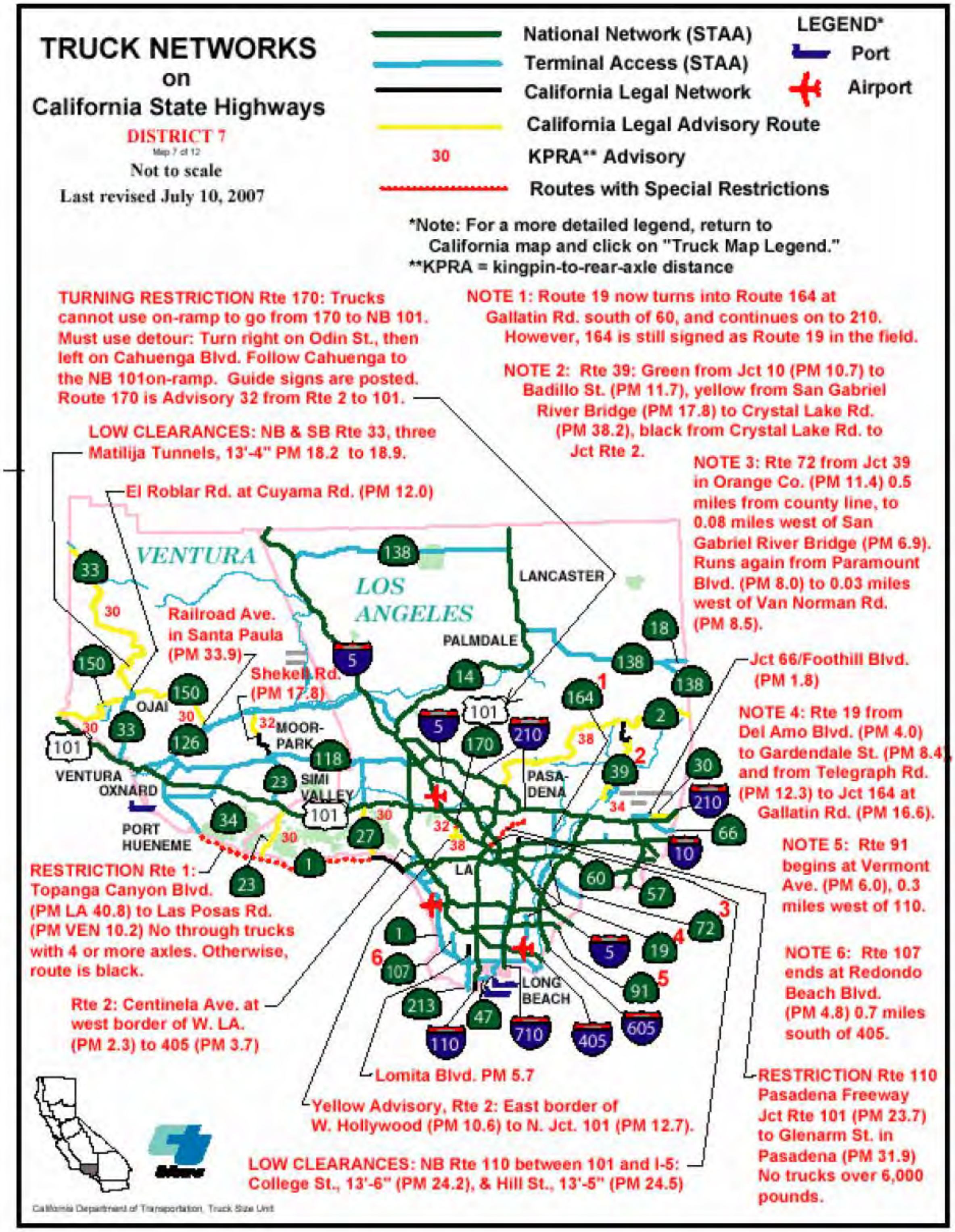
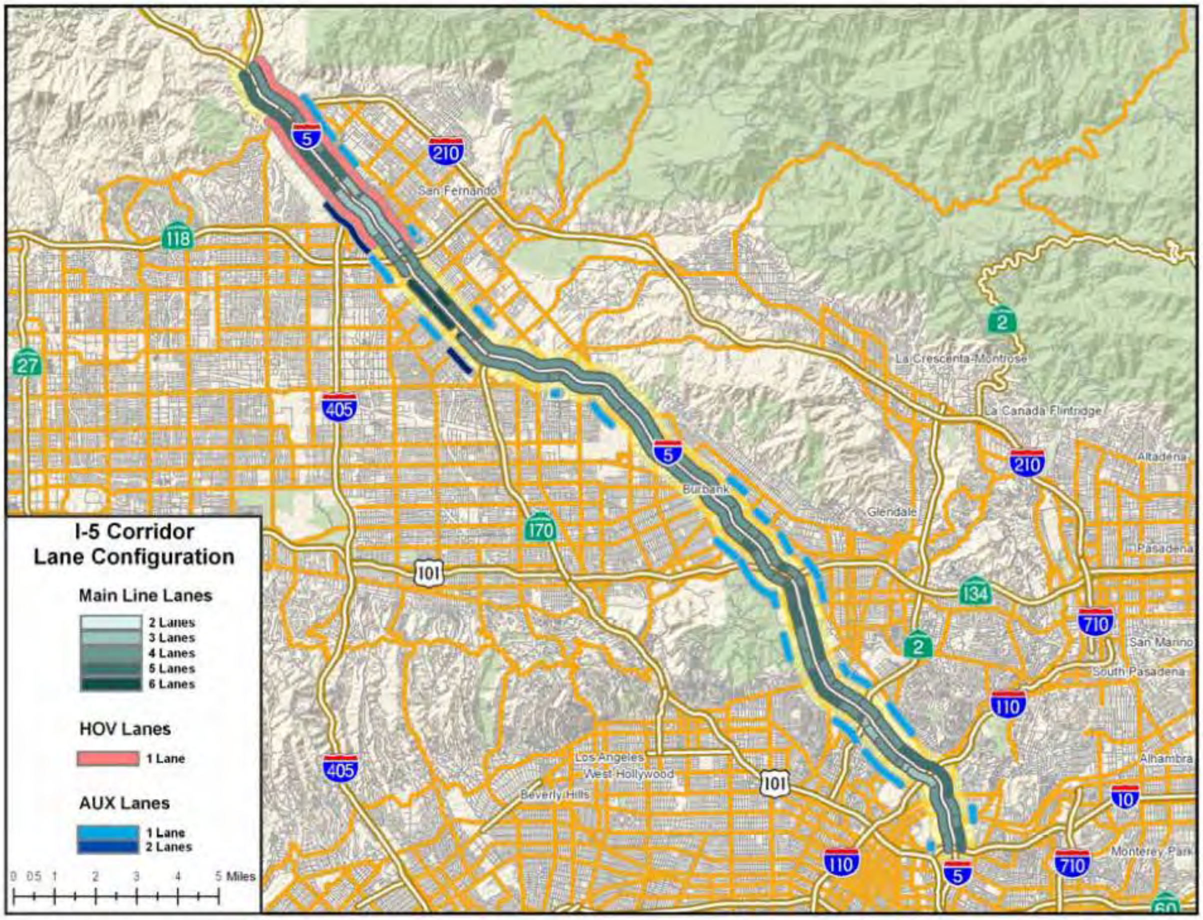


Exhibit 2-4: Lane Configurations on the I-5 Corridor



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Recent Roadway Improvements

The first HOV lane on I-5 in Los Angeles County from the Simi Valley Freeway (SR-118) to the Antelope Valley Freeway (SR-14) opened in spring 2008. This project added 6.2 miles of HOV lane in each direction from SR-118 to SR-14.

Caltrans began the I-5 Repavement Project in winter 2005. This project involves pavement grinding and the replacement of damaged concrete pavement on I-5 from the SR-60 to the cities of Glendale and Burbank. It also includes guardrail replacement work. The project is expected to be completed in winter 2010.

Corridor Transit Services

The following major public transportation operators provide service near the I-5 CSMP corridor:

- Southern California Regional Rail Authority (SCCRA) - Metrolink
- Amtrak
- Los Angeles County Metropolitan Transportation Authority (Metro)
- Santa Clarita Transit (SC)
- Antelope Valley Transit (AV)
- Los Angeles Department of Transportation (LADOT).

As of early 2007, overall Metrolink weekday ridership was slightly above 44,000 per day. This reflects a growth of 4 percent from 2006 boardings. The Antelope Valley Line operates service parallel to the I-5 Corridor along San Fernando Road. It connects Lancaster to the downtown Los Angeles and carries an average weekday ridership of 7,302. The Ventura County Line also operates along San Fernando Road from the SR-134 interchange connecting Ventura County to the downtown Los Angeles area with an average weekday ridership of 4,317.

Amtrak offers the Coast Starlight and Pacific Surfliner rail services that operate parallel to the I-5 study corridor. The Coast Starlight offers daily service from Los Angeles to Oakland and Seattle. The Pacific Surfliner provides high-frequency service from San Diego to San Luis Obispo, via Los Angeles. The Pacific Surfliner is the second busiest corridor in the country with 2,898,859 riders in FY08. According to the Fiscal Year 2008 Amtrak Fact Sheet on the State of California, California has the highest Amtrak usage of any state in the country.

Metro services 1,433 square miles in Los Angeles County with over 190 bus lines and an average weekday passenger boarding of 1.2 million. Some of the Metro parallel bus routes include: Route 224 runs along Lankershim Boulevard; Routes 90, 91, 94, and

394 run along San Fernando Road; Route 230 runs along Laurel Canyon Boulevard; Route 292 runs along Glenoaks Boulevard; and Route 96 runs along Riverside Drive.

According to the Santa Clarita Transportation Development Plan 2006-2015, Santa Clarita Transit Express bus ridership was 314,000 for fiscal year 2005-2006. Express service frequency increased from 18 buses in 1996 to 28 buses in 2006. Several Santa Clarita Transit Express buses operate on the I-5 Corridor and provide access from the Santa Clarita Valley to the downtown Los Angeles area: SC784, SC788, SC794, and SC799.

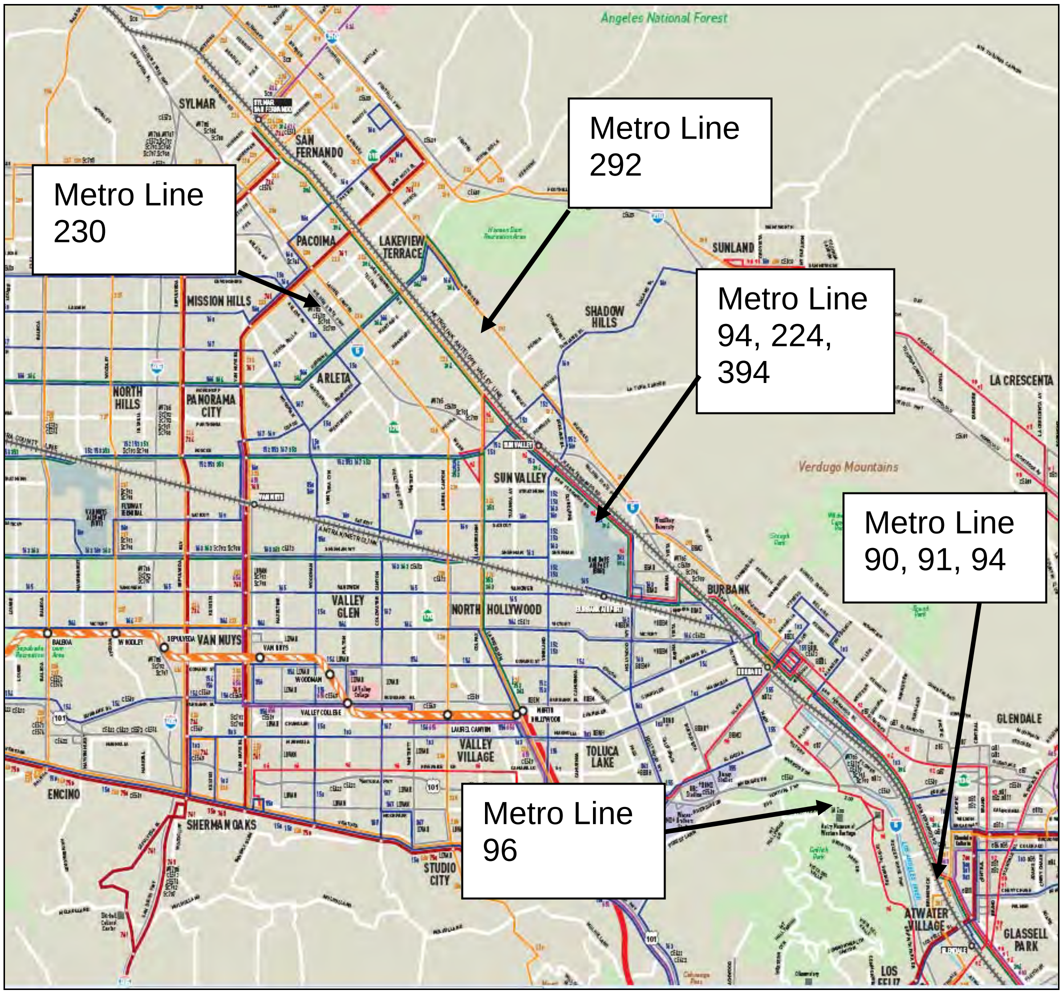
Antelope Valley Transit Authority operates a fleet of 25 commuter coaches from Antelope Valley to Los Angeles and San Fernando Valley Monday through Friday. Ridership has tripled over the last decade of operation. Antelope Valley Transit currently operates AV785 and AV786 commuter coaches from the Antelope Valley to the San Fernando Valley and downtown Los Angeles area.

The City of Los Angeles Department of Transportation (LADOT) also operates Commuter Express (CE) buses that run on or adjacent to the I-5 Corridor. These routes include CE413 and CE419.

Exhibit 2-5 shows the Metrolink system map for Southern California. Exhibit 2-6 shows Metro service in the vicinity of the I-5 Corridor.

Exhibit 2-5: Metrolink System Map

Exhibit 2-6: Metro Service in the Vicinity of the I-5 CSMP Corridor



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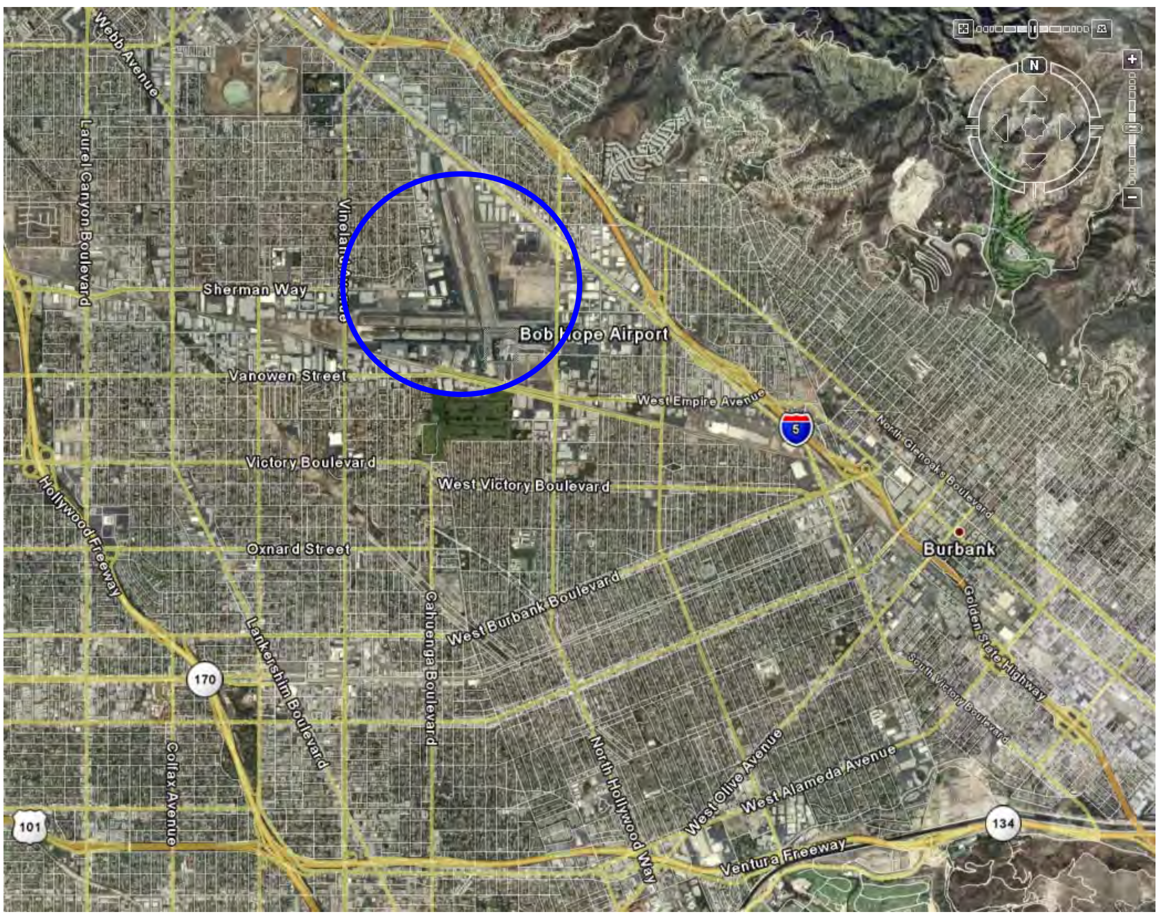
Intermodal Facilities

Bob Hope Airport is located in the City of Burbank and can be accessed by several freeways including I-5, SR-134, and SR-170. Exhibit 2-6 provides a satellite image of the facility and the surrounding area. Alaska, American, Delta, JetBlue, Skybus, Southwest, United, and US Airways operate out of Bob Hope Airport with frequent schedules along the West Coast as well as direct and connecting flights across the country. Other scheduled and charter or contract carriers include Federal Express, Champion Air Lines, Horizon Air, Mesa Airlines, United Parcel Service, AirNet Express, and Ameriflight. Total passengers deplaned and enplaned was 484,989 in September 2007, which reflects an increase of 4.9 percent from September 2006.

Exhibit 2-7: Bob Hope Airport



Whiteman Airport is located in the city of Pacoima off SR-118 in the San Fernando Valley, approximately one-mile east of I-5. No commercial airlines fly into this airport. Whiteman Airport is one of three weather monitoring sites for the National Weather Service in Los Angeles and is home to both Squadron 35 of the Civil Air Patrol and the Los Angeles County Fire Department Air Operations unit.

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Special Event Facilities/Trip Generators

There are various facilities and institutions located along I-5 that may generate significant trips on the corridor. Exhibit 2-9 shows the location of the most significant traffic generators.

The I-5 Corridor serves Dodger Stadium, which is adjacent to downtown Los Angeles, and northwest of the I-5/SR-110 interchange. Dodger Stadium is the home of the Los Angeles Dodgers Major League Baseball team. The stadium has a seating capacity of approximately 56,000. The Staples Center is another sports arena in Downtown Los Angeles. It is home to several professional sports franchises - the NBA's Los Angeles Lakers and Los Angeles Clippers, the NHL's Los Angeles Kings and the WNBA's Los Angeles Sparks. The arena is host to 250 events and nearly 4,000,000 visitors a year. It can seat up to 20,000 patrons for concerts and roughly 18,000 for sporting events. Staples Center is located approximately four miles west of the I-5/I-10 Interchange.

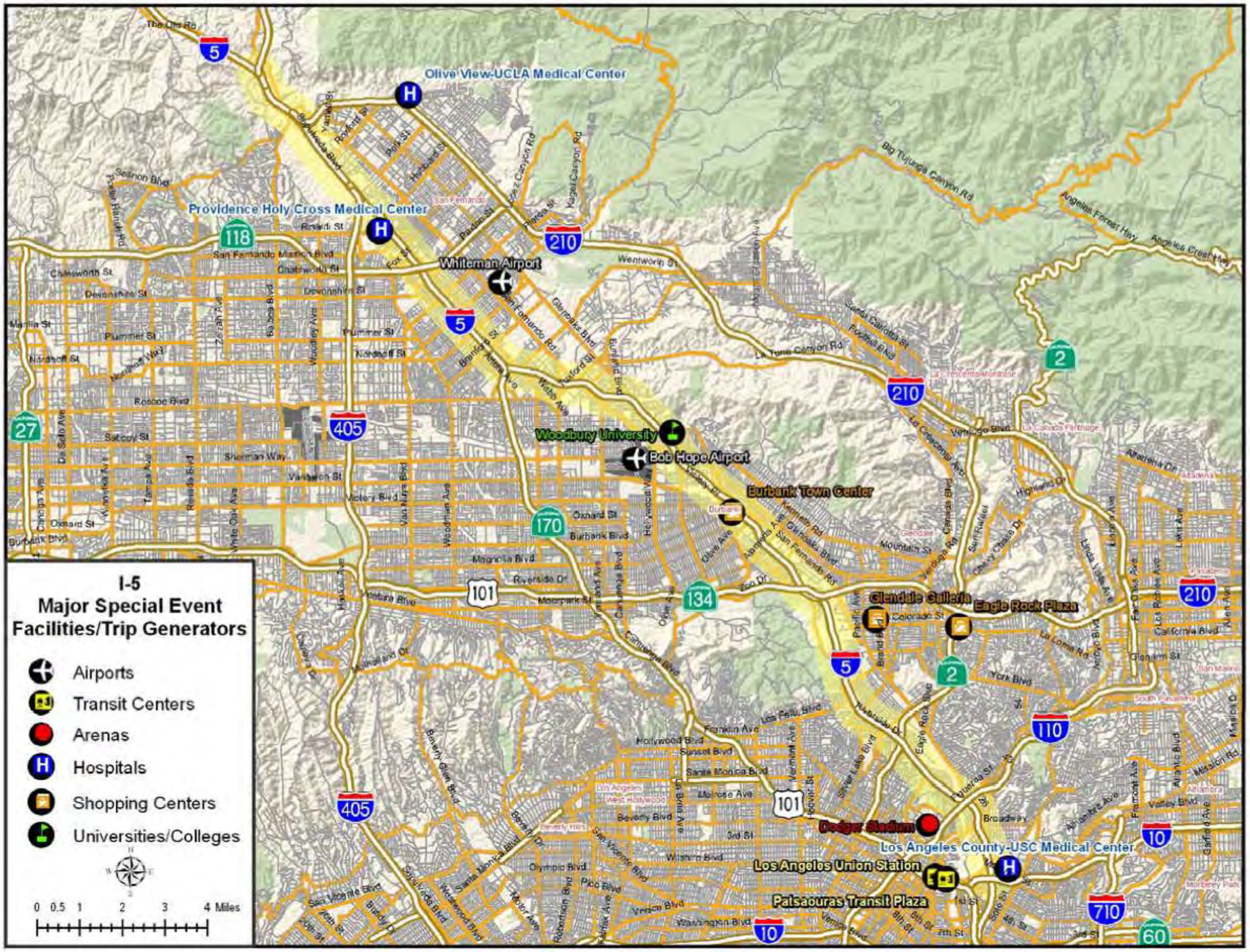
Woodbury University is located in the City of Burbank, just east of the I-5. The University offers Bachelors degrees in arts and sciences and Masters degree in Business Administration with a total enrollment of approximately 1,500 students. There are also several elementary, middle, and high schools near the I-5 Corridor that could contribute to morning and afternoon traffic.

Three major medical facilities are located close to the corridor. Providence Holy Cross Medical Center is a 254-bed facility in Mission Hills. Located west of I-5 in the northern portion of the corridor, the facility provides treatment through its cancer centers, heart center, orthopedics, neurosciences and rehabilitation services, as well as women's and children's services. Olive View-UCLA Medical Center is a 377-bed teaching hospital located north of I-210 and three-miles east of the I-5. Los Angeles County-USC Medical Center is one of the largest teaching hospitals in the country. The Medical Center is affiliated with the Keck School of Medicine and is located one-mile west of the I-5 between the SR-110 and I-10 within close proximity to downtown Los Angeles. The Medical Center is staffed with more than 450 full-time faculty and approximately 850 medical residents, who serve over 50,000 inpatients and 750,000 outpatients annually.

Other trip generators include Burbank Town Center, Glendale Galleria, The Americana, and Eagle Rock Plaza located within the southern portion of the I-5 Corridor.

In addition to the facilities listed above, Los Angeles Union Station, located in downtown Los Angeles approximately one mile west of the I-5, is the terminus for four long-distance Amtrak trains. Union Station serves as the hub for Metrolink’s passenger trains and provides connections to the Metro Red, Purple, and Gold light-rail lines. Patsaouras Transit Plaza is attached to Union Station. It provides many bus services including regular Metro and Metro Rapid bus lines, downtown DASH shuttles, FlyAway express service to Los Angeles World Airports, and several other municipal bus lines.

Exhibit 2-8: Major Special Event Facilities/Trip Generators



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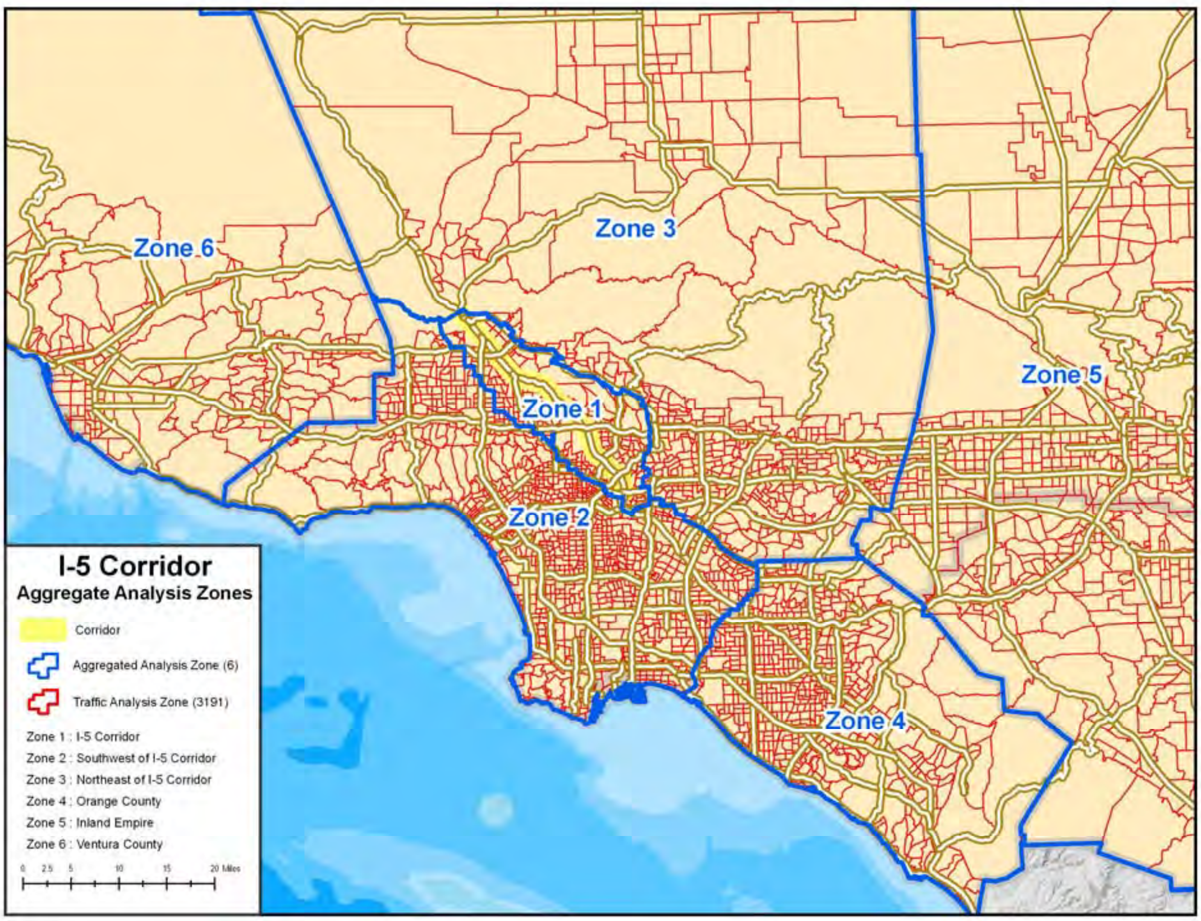
Demand Profiles

An analysis of origins and destinations was conducted to determine the travel pattern of trips made on the I-5 study corridor. Based on SCAG's 2000 travel demand model, this "select link analysis" isolated the I-5 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 six aggregate analysis zones as shown in Exhibit 2-9. These zones were determined by county line and proximity to the corridor.

Exhibit 2-9: 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 2-10 and 2-11 for the AM and PM peak periods. This analysis shows that a significant percentage of trips using the I-5 corridor represent inter-county trips. More than 60 percent of the trips either started or ended outside of Los Angeles County.

During the AM peak period from 6:00 AM to 9:00 AM, about 39 percent of all trips originate and terminate in Los Angeles County (Zones 1, 2, and 3). The remaining trips originate in Los Angeles County and terminate in another county (23 percent), originate outside the Los Angeles County and terminate in Los Angeles County (24 percent), or originate and terminate outside Los Angeles County (14 percent).

Exhibit 2-10: AM Peak Origin Destination by Aggregated Analysis Zone

		To Zone						
	AM Trips	I-5 North Corridor	Southwest of Corridor	Northeast of Corridor	Orange County	Inland Empire	Ventura County	Outsize Zones
From Zone	I-5 North Corridor	6,113	13,846	4,260	189	5,033	7,707	553
	Southwest Corridor	12,065	30,426	10,035	819	13,437	14,901	1,831
	Northeast of Corridor	3,640	10,950	3,108	189	4,061	5,085	768
	Orange County	138	752	175	121	223	333	691
	Inland Empire	5,328	14,663	4,464	308	5,729	7,178	993
	Ventura County	7,755	17,555	5,643	349	6,703	8,873	553
	Outsize Zones	221	760	554	240	430	222	1,179

~ 39%	Trips starting and ending in Los Angeles County
~ 23%	Trips starting in Los Angeles County and ending outside of Los Angeles County
~ 24%	Trips starting outside of Los Angeles County and ending in Los Angeles County
~ 14%	Trips starting and ending outside of Los Angeles County

During the PM peak period from 3:00 to 7:00 PM (which experiences nearly 35 percent more demand than the AM peak period), the picture is similar. Roughly 38 percent of trips originate and terminate in Los Angeles County. The remaining trips originate in Los Angeles County and terminate in another county (23 percent), or originate outside Los Angeles County and terminate in Los Angeles County (24 percent), or originate and terminate outside Los Angeles County (15 percent).

Exhibit 2-11: PM Peak Origin Destination by Aggregated Analysis Zone

		To Zone						
	PM Trips	I-5 North Corridor	Southwest of Corridor	Northeast of Corridor	Orange County	Inland Empire	Ventura County	Outsize Zones
From Zone	I-5 North Corridor	8,778	17,619	5,507	272	7,954	11,379	531
	Southwest Corridor	20,994	44,829	15,964	1,302	21,873	26,071	1,898
	Northeast of Corridor	6,423	15,262	4,782	259	6,658	8,816	778
	Orange County	329	1,392	323	212	482	585	784
	Inland Empire	7,762	19,958	6,187	456	8,645	10,475	971
	Ventura County	11,867	22,921	8,004	626	11,114	13,305	537
	Outsize Zones	1,306	4,066	2,054	1,554	2,245	1,250	2,233

~ 38%	Trips starting and ending in Los Angeles County
~ 24%	Trips starting in Los Angeles County and ending outside of Los Angeles County
~ 23%	Trips starting outside of Los Angeles County and ending in Los Angeles County
~ 15%	Trips starting and ending outside of Los Angeles County

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3. CORRIDORWIDE PERFORMANCE AND TRENDS

This section summarizes the analysis results of the performance measures used to evaluate the existing conditions of the I-5 Corridor. The primary objective of the measures is to provide a sound technical basis for describing traffic performance on the corridor. The base year for the analysis and modeling is 2007 for the I-5 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.

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:

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

In the formula above, the *Vehicles Affected per Hour* value depends on the methodology used. Some methods assume a fixed flow rate (e.g., 2000 vehicles per hour per lane), while others use a measured or estimated flow rate. The segment length is the distance under which the congested speed prevails. The duration is how long the congested period lasts (measured in hours), with the congested period being the amount of time spent below the threshold speed. The threshold speed is the speed under which congestion is considered to occur. Any speed can be used, but two commonly used threshold speeds are 35 mph and 60 mph.

Caltrans defines the threshold speed as 35 mph and assumes a fixed 2,000 vehicles per hour per lane are experiencing the delay to estimate severe delay for reporting congestion for the statewide Highway Congestion Monitoring Report (HICOMP).

In calculating total delay, PeMS uses the 60 mph threshold speed and the observed number of vehicles reported by detection systems. The congestion results of HICOMP and PeMS are difficult to compare due to these methodological differences, so they are discussed separately in this assessment.

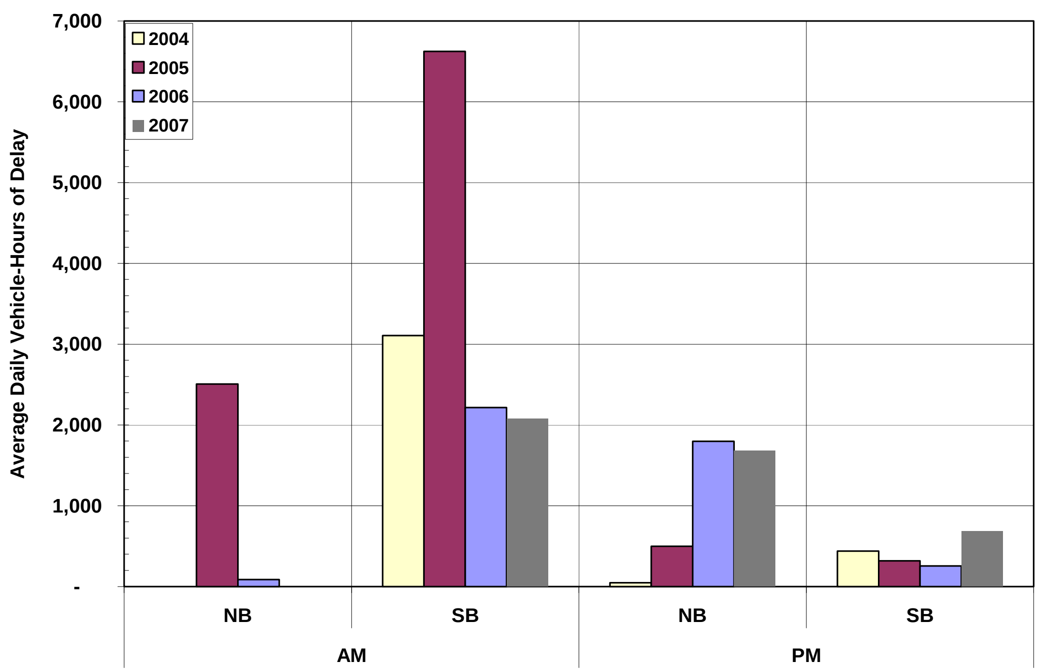
Caltrans HICOMP

The Caltrans Highway Congestion Monitoring Program (HICOMP) report has been published annually by Caltrans since 1987.[3] 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 only one to four days during the entire year for the mainline facility only. Ideally, two days of data collection in the spring and two in the fall of the year are desired, 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, the price of gasoline, and construction activities.

Exhibit 3-1 shows yearly delay from 2004 through 2007 for the two peak periods of the I-5 Corridor in both directions. The southbound direction generally experienced the most congestion during the AM peak period, while the northbound direction experienced the most delay during the PM peak.

Exhibit 3-1: Average Daily Vehicle-Hours of Delay (2004-2007)



[3] Located at <www.dot.ca.gov/hq/traffops/sysmgtpl/HICOMP/index.htm>

Exhibit 3-2 lists all of the congested segments shown in the last four HICOMP reports for the I-5 Corridor. As the exhibit illustrates, the lengths of the congested segments vary from one year to the next.

Exhibit 3-2: HICOMP Congested Segments (2004-2007)

Period	Dir	PM From/To	Generalized Congested Area	Generalized Area Congested Average Vehicle-Hours of Delay			
				2004	2005	2006	2007
AM	NB	18.0/22.5	Brooklyn Ave to SR-2		2,029		
		20.4/21.9	Avenue 26 to Riverside Dr/Eads			88	
		33.5/38.5	Sunland Bl to Van Nuys Bl		479		
	SB	40.0/32.5	Brand Bl to Hollywood Wy		921		
		40.0/24.0	Brand Bl to LA River Bridge/SR-134 Sep	1,093			
		37.9/34.9	Terra Bella St to Lankershim Bl			79	
		30.0/21.0	Burbank Bl to Elmgrove St		5,426		
		29.4/26.9	Magnolia Ave to SR-134			63	
		28.4/24.93	Alameda Ave to Cold Spring Dr				427
		27.0/17.0	LA River Bridge/SR-134 Sep to EB SR-60	2,013			
		26.4/21.4	SR-134 to SR-110/Riverside Dr			1,635	
		24.9/20.9	Cold Spring Dr to SR-110/Riverside Dr				1,635
		20.9/16.4	Duvall St to SR-60			438	
		20.0/17.0	Pasadena Ave to SR-60		278		
		19.9/17.9	SR-110 to I-10				24
AM PEAK PERIOD SUMMARY				3,106	9,133	2,305	2,086
PM	NB	16.9/19.4	7th St to n/o Main St				362
		17.9/21.9	Brooklyn Ave to Riverside Dr/Eads			431	
		19.0/22.5	Alhambra Ave to SR-2		212		
		24.9/26.9	n/o Los Feliz Rd to SR-134				258
		26.5/30.0	SR-130 Junction to Burbank Bl	47			
		26.9/28.9	Magnolia Ave to Verdugo Ave			649	566
		27.5/29.0	Sonora Ave to Olive Ave		49		
		31.9/34.9	s/o North Hollywood Way to Penrose St				282
		33.4/36.9	Roscoe Bl to Branford St			515	
		33.5/36.5	Sunland Bl to SR-170		178		
		34.4/36.9	Penrose St to Branford St				78
		36.5/38.5	SR-170 to Van Nuys Bl		57		
		36.9/38.9	Branford St to s/o Paxton St				140
		36.9/39.4	Branford St to Laurel Canyon Bl			204	
	SB	34.5/32.5	Penrose St to Hollywood Wy		116		
		32.9/29.4	s/o Sunland Blvd to Magnolia Ave				145
		30.5/27.0	San Fernando Bl to LA River Bridge/SR-134 Sep	440			
		30.0/26.5	Burbank Bl to SR-134		116		
		29.4/26.9	Magnolia Ave to SR-134			65	
		28.9/26.4	Verdugo Ave to SR-134				209
		26.4/22.4	SR-134 to SR-2				286
		25.4/22.4	Edenhurst to SR-2			188	
		23.5/21.5	Glendale Bl to Riverside Dr		85		
		19.9/17.9	Pasadena Ave To Cesar E Chavez Ave				51
PM PEAK PERIOD SUMMARY				487	815	2,052	2,377
TOTAL CORRIDOR CONGESTION				**3,593**	**9,948**	**4,357**	**4,463**

According to Exhibit 3-2, the most significant delay occurred in 2005 during the AM peak period in the southbound direction from Burbank Boulevard to Elmgrove Street. This segment falls within the project limits for both of the Caltrans construction projects that started in 2005. Traffic on the northbound segment between Brooklyn Avenue and SR-2 also experienced heavy delays in 2005. Total delay for the corridor decreased by over 55 percent from 2005 to 2006, and increased slightly from 2006 to 2007 by about 2.5 percent.

While delay during the PM peak period grew from year to year, Exhibit 3-2 shows that the variation in delay was not as significant as during the AM peak period, which experienced a decline of delay by 75 percent between 2005 and 2006. The higher than normal delay in 2005 is likely attributed to night-time construction that would have left the PM peak unaffected. Morning commute traffic may have experienced residual delay after traffic lanes opened from the previous night's activities. Detector data quality was lower in the first half of 2005 and may be another factor affecting the results.

Exhibits 3-3 and 3-4 present the congestion information on maps for the AM and PM peak commute periods in 2007. The approximate locations of the congested segments, the duration of that congestion, and the reported recurrent daily delay are also shown. More "generalized" congested segments were created so that segment comparisons can be made from one year to the next.

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

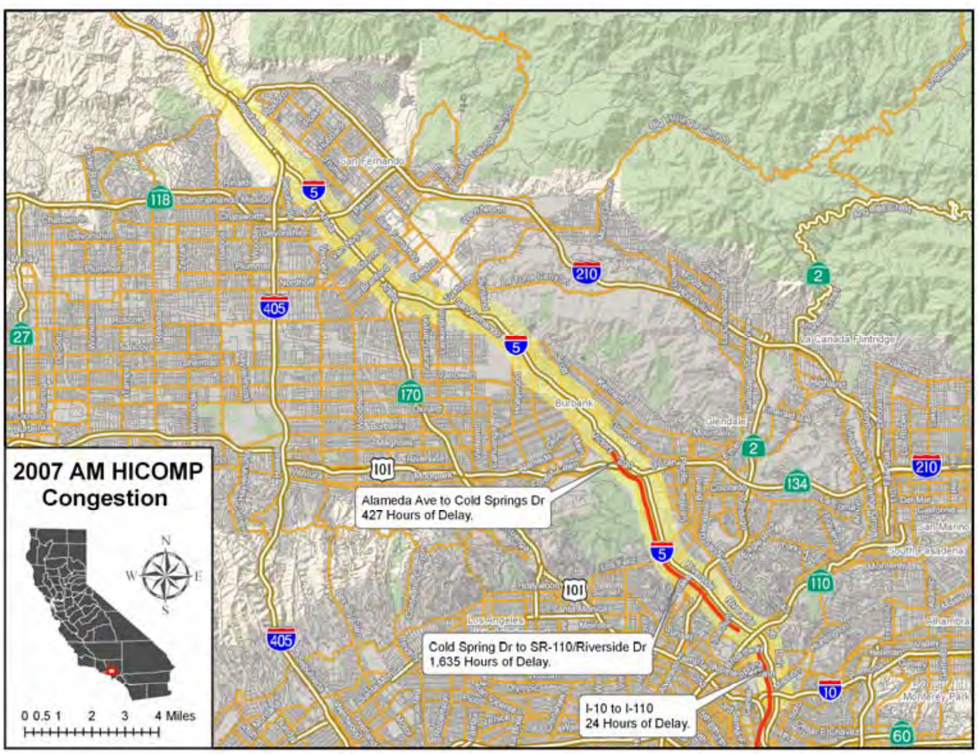
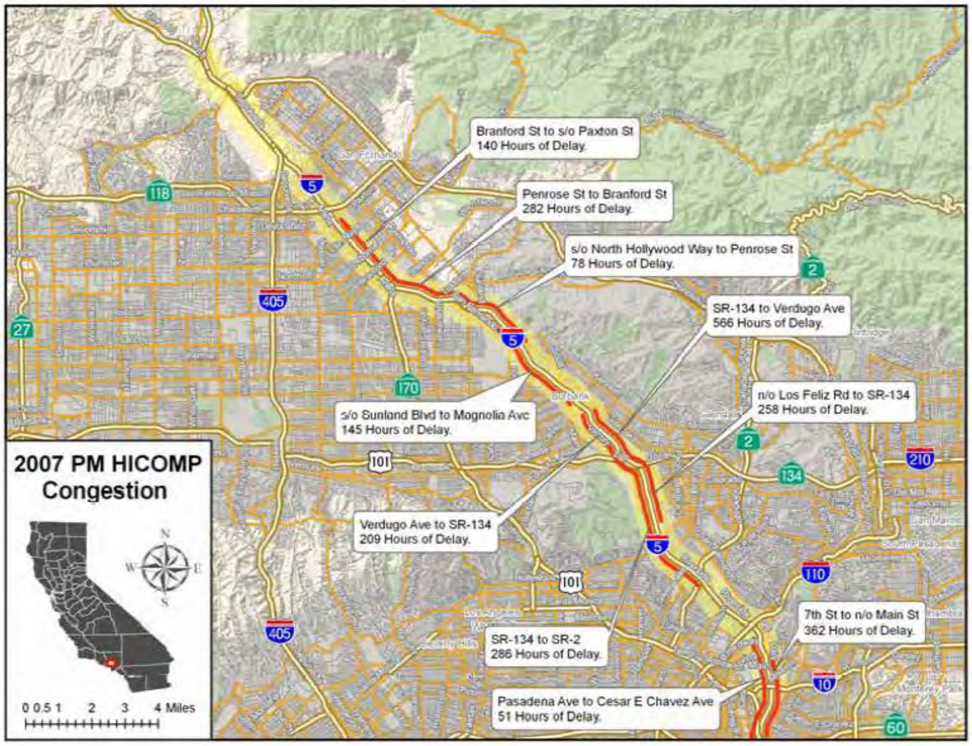


Exhibit 3-4: HICOMP Congested Segments Map - PM Peak Period (2007)



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Freeway Performance Measurement System (PeMS)

Using freeways detector data discussed in Section 1 and accessed via PeMS, delay is computed for every day and summarized in different ways, which is not possible when using probe vehicle data.

Performance assessments were initially conducted for the three-year period between 2005 and 2007. These assessments were recently updated through December 2008. The performance assessment includes four years of PeMS data. 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, delay presented in this section 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.

Exhibits 3-5 and 3-6 show the four-year trend in weekday (i.e., excluding weekends and holidays) delay for the entire corridor in the northbound and southbound 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 majority of delay in the northbound direction occurred during the PM peak period. Daily delay grew between 2005 and 2006, declined in 2007, gradually increased during the first half of 2008, but sharply declined in the summer of 2008 with variation in delay from one day to the next. Daily delay was lower in 2007 than in 2006 and more consistent from one day to the next, with the exception of a high-delay incident in the last quarter of 2007. In 2008, daily delay increased steadily until July when delay sharply declined.

Trends for the southbound direction differ from those for the northbound direction, reflecting the directional commute patterns toward downtown Los Angeles. As shown in Exhibit 3-6, the majority of delay in the southbound direction occurred during the AM peak period rather than the PM peak period. Like the northbound direction, the southbound direction experienced increases in daily delay during 2005 and the first quarter of 2006. Unlike the northbound direction, southbound daily delay started declining during the second quarter of 2006. The decline in the second quarter of 2006 continued through August 2007, when the trend reversed and daily delay started to increase until spring 2008.

Exhibit 3-5: Northbound Average Daily Delay by Time Period (2005-2008)

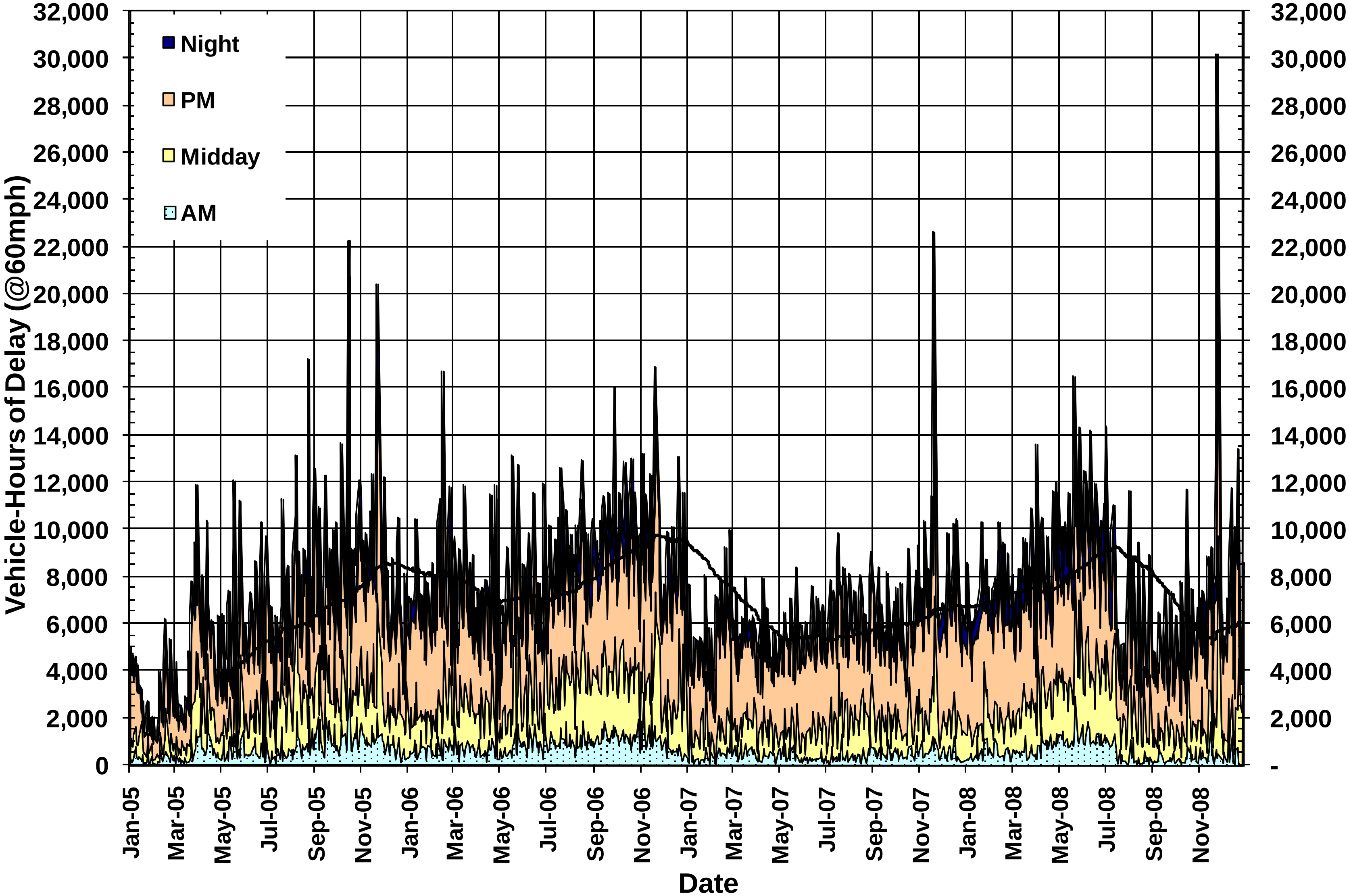


Exhibit 3-6: Southbound Average Daily Delay by Time Period (2005-2008)

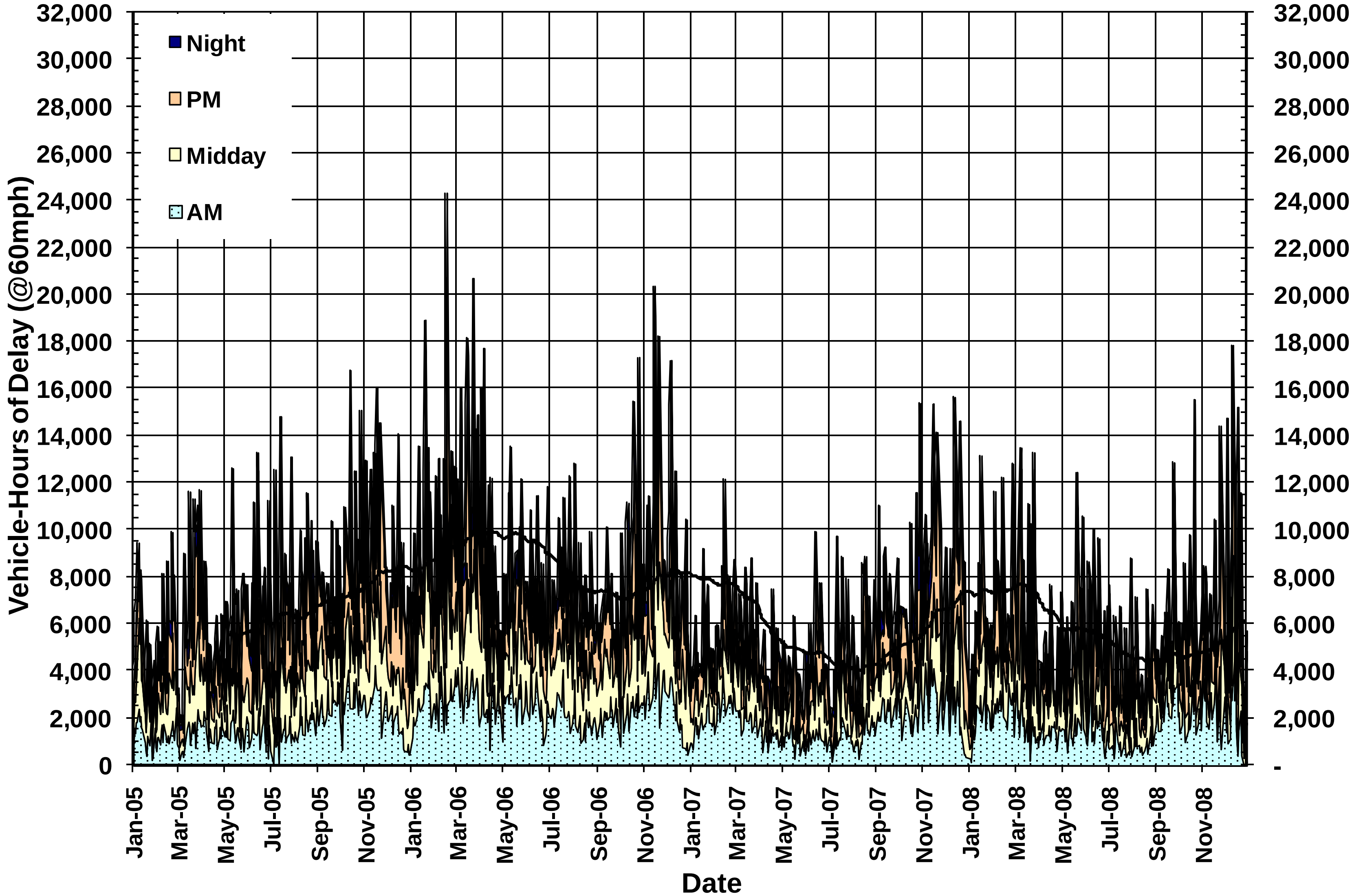
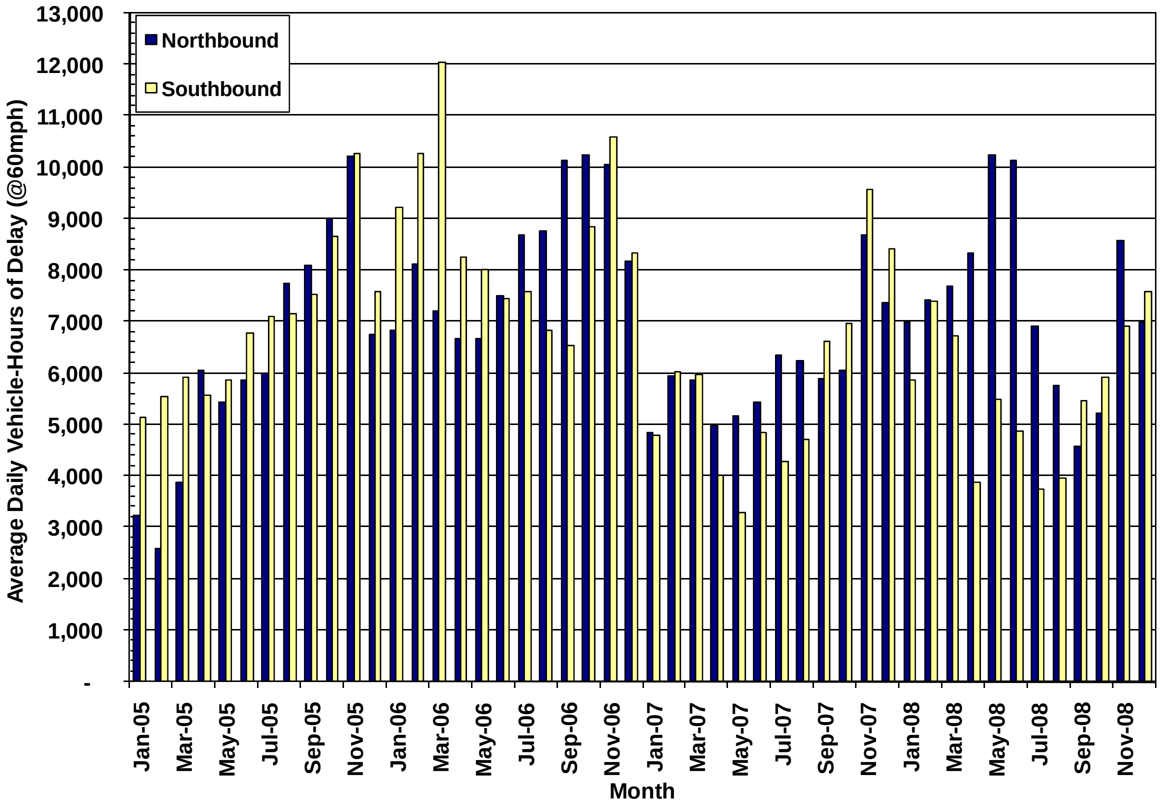


Exhibit 3-7 shows the average daily weekday delay for the I-5 Corridor by month and direction. This exhibit shows the general trend that delay was lower during the summer months and was highest in the year 2006. The exhibit also shows differing trends for the northbound and southbound directions. In the northbound direction, delay increased steadily from November 2007 to June 2008. However during the same period, the southbound direction experienced a gradual decline in delay. The monthly summaries in this exhibit also clarify the trends illustrated in Exhibits 3-5 and 3-6.

Exhibit 3-7: I-5 Average Weekday Delay by Month (2005-2008)

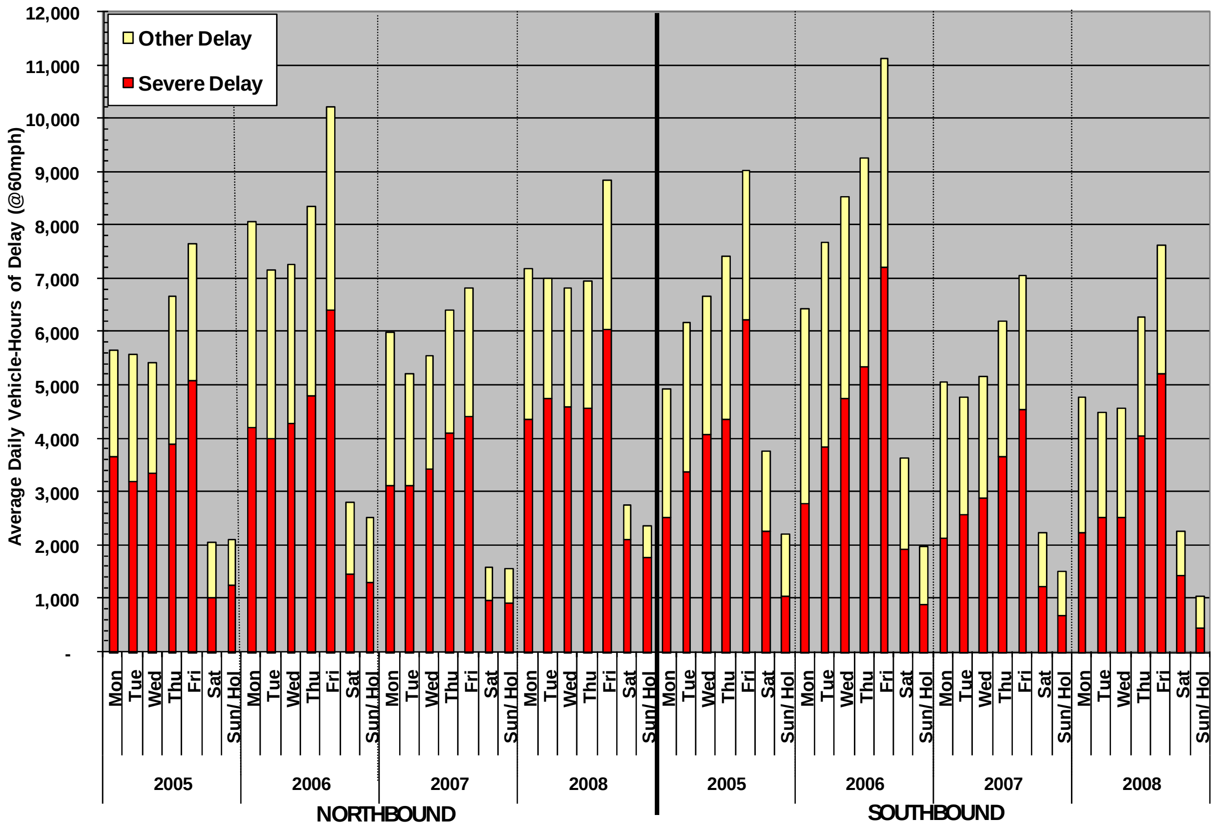


Delays presented to this point represent the difference in travel time between “actual” conditions and free-flow conditions at 60 miles per hour. This delay can be segmented into two components as shown in Exhibit 3-8:

- 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 magnitude of daily delay typically increased throughout the week with the highest delay occurring on Fridays. Delays were generally higher in 2006 and southbound delays tended to be greater in magnitude than northbound delays.

Exhibit 3-8: I-5 Average Delay by Day of Week by Severity (2005-2008)



Although combating congestion requires the focus on severe congestion, it is important to review "other" congestion and understand its trends. This could allow for proactive intervention before the "other" congestion turns into severe congestion.

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 delay for each year within the 2005-2008 period. 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-5 Corridor. The highest delay in the northbound direction occurred during the PM peak hour of 5:00 PM. At the 5:00 peak hour, delay was reported to be highest in 2006, followed by 2008 with about 1,200 average daily vehicle-hours. The lowest level of delay was reported in 2005 at about 1,000 vehicle-hours.

Exhibit 3-9: Northbound I-5 Average Weekday Hourly Delay (2005-2008)

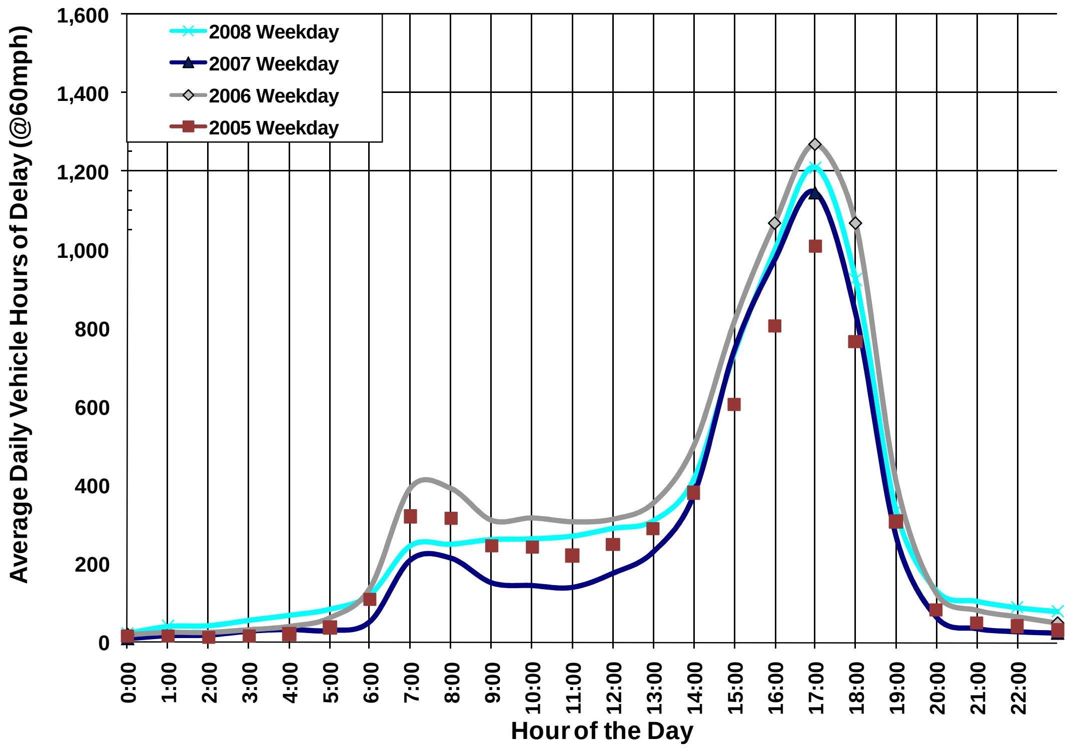
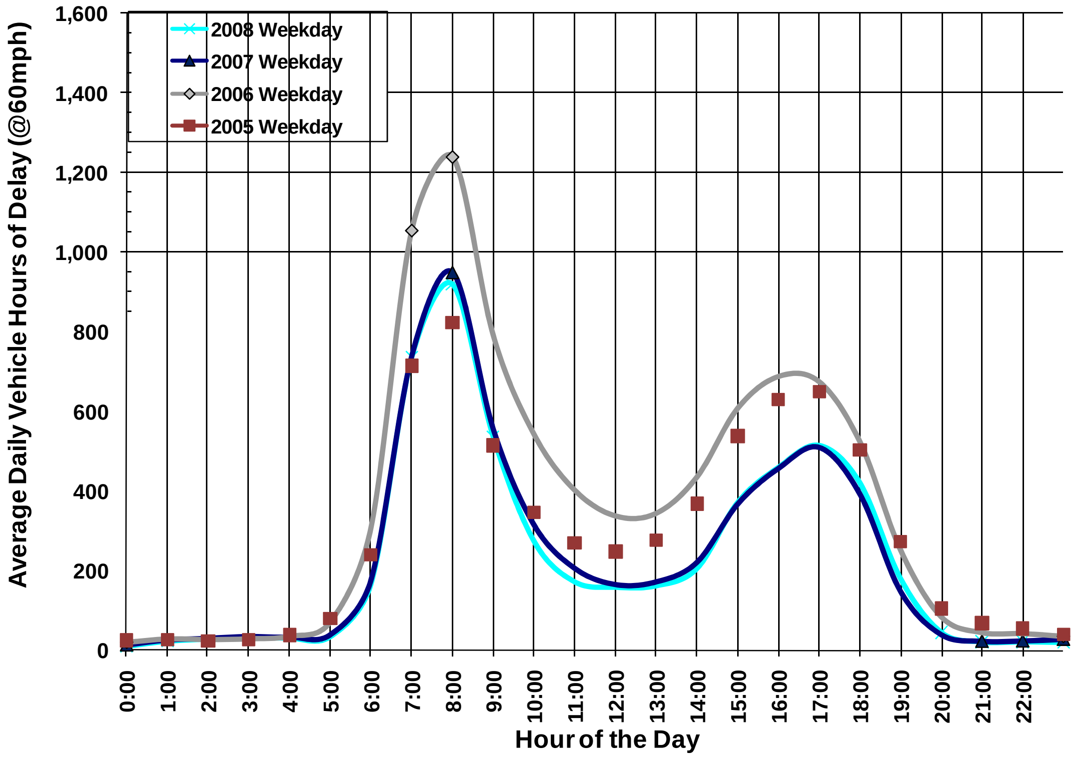


Exhibit 3-10 shows the hourly delay profile is the reverse for the southbound direction. The biggest delays occur during the AM peak hours centered on 8:00 AM. The PM peak hours also show sizeable delays from 2:00 PM to 7:00 PM (14:00 to 19:00). This probably reflects travel on this corridor in addition to traditional nine-to-five commuting. At the 8:00 AM peak hour, 2006 experienced the highest delay with over 2,500 vehicle-hours, while 2007 and 2008 experienced less delay with over 900 vehicle-hours.

Exhibit 3-10: Southbound I-5 Average Weekday Hourly Delay (2005-2008)



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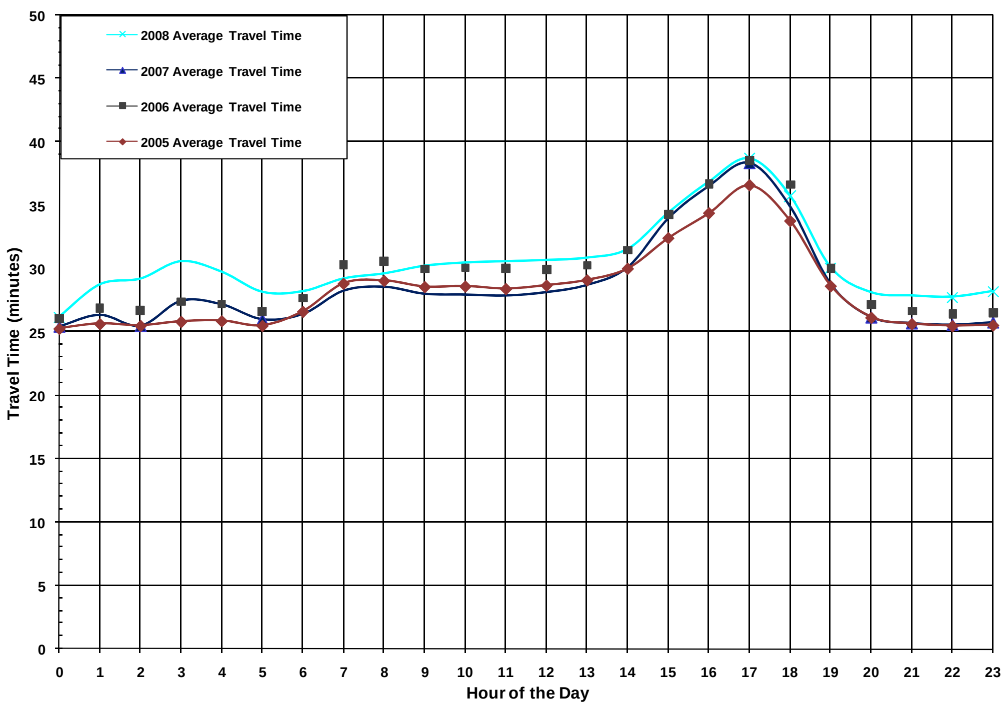
Travel Time

Travel time is reported as the amount of time it takes a vehicle to travel between two points on a corridor, as estimated using PeMS data in this analysis. In the case of the I-5 Corridor, the time it takes to travel 26 miles of the corridor from the I-10 to the I-210 interchange is 26 minutes traveling at 60 mph. Travel time on parallel arterials is not included in the analysis.

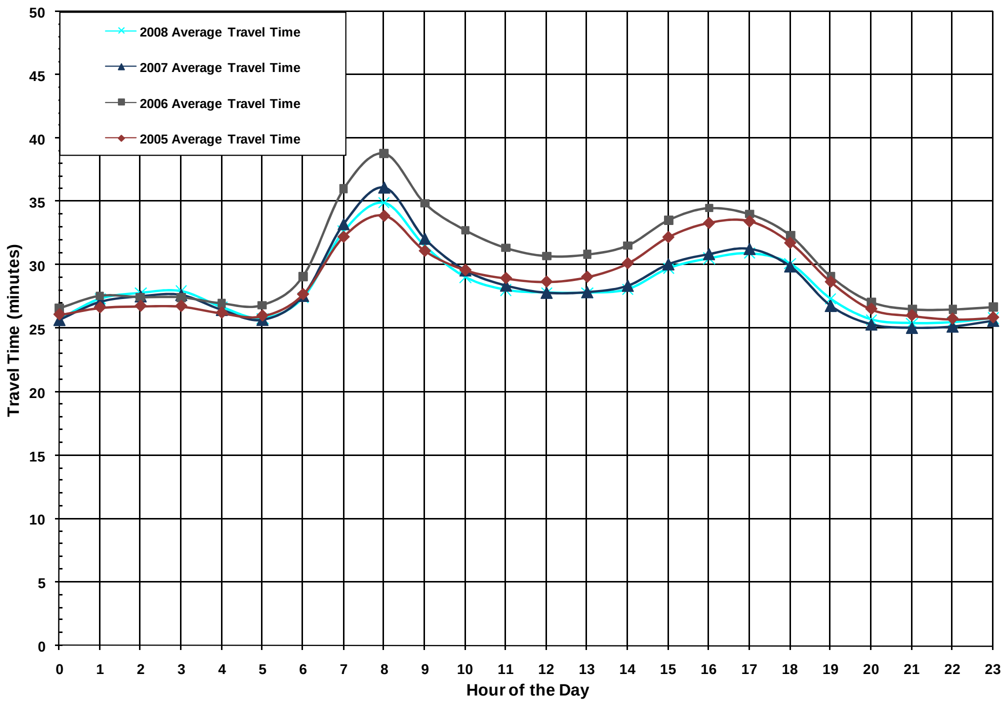
Exhibits 3-11 and 3-12 depict the travel times calculated for the I-5 Corridor. As shown, the northbound direction had typical travel times of approximately 36 to 39 minutes during the PM peak congested period. At the 5:00 PM hour, the highest travel times occurred in 2006 and 2008 at about 39 minutes. Overall, 2008 experienced the highest travel times of any previous year in the northbound direction.

Exhibit 3-11: Northbound I-5 Travel Time by Time of Day (2005-2008)



The southbound direction had travel times of approximately 34 to 39 minutes during the 8:00 AM peak hour. Unlike the northbound direction which showed that the highest travel times occurred in 2008, the southbound direction shows that travel times improved in 2008 compared to previous years. At the 8:00 AM peak hour, the travel time in 2008 was 35 minutes, which is a 4-minute improvement over the 39-minute travel time in 2006.

Exhibit 3-12: Southbound I-5 Travel Time by Time of Day (2005-2008)



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RELIABILITY

Reliability captures the relative predictability of 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 estimated travel time variability using PeMS data. The 95th percentile was chosen as a reasonable representation of the maximum peak travel time that could be experienced along the corridor. Severe incidents, such as fatal accidents, could cause travel times longer than the 95th percentile, but this statistic is a balance between extreme outliers and the "typical" travel day.

Exhibits 3-13 through 3-20 on the following pages illustrate the variability of travel time along the I-5 Corridor on weekdays for the years 2005, 2006, 2007, and 2008. Exhibits 3-13 through 3-16 present travel time variability for the northbound direction, and Exhibits 3-17 through 20 present travel time variability for the southbound direction.

In the northbound direction, the 5:00 PM peak hour was the most unreliable in addition to being the slowest hour. In 2005 (shown in Exhibit 3-13), motorists driving the entire length of the corridor had to add 9 minutes to an average travel time of 36 minutes (for a total travel time of 45 minutes) to ensure that they arrived on time 95 percent of the time. This is 18 minutes longer than the 27-minute travel time at 60 mph. In 2006 and 2007 (Exhibits 3-14 and 3-15), the time needed to arrive on time 95 percent of the time remained almost the same at 44 and 45 minutes, but increased slightly in 2008 to 47 minutes (Exhibit 3-16).

In the southbound direction, the most unreliable hour was 8:00 AM and 5:00 PM. Unlike the northbound direction which experienced the highest travel times during the PM peak period, the southbound direction experienced evenly high travel times between both AM and PM peak periods. In 2006 (Exhibit 3-17), the time needed to arrive on time 95 percent of the time was 42 minutes at 8:00 AM and 47 minutes at 5:00 PM. In 2006 (Exhibit 3-18), travel time variability increased to 47 minutes during both 8:00 AM and 5:00 PM hours. These variability in travel times decreased in 2007 (Exhibit 3-19) to 44 minutes at 8:00 AM and 41 minutes at 5:00 PM. In 2007 (Exhibit 3-20), travel times variability increased again to 46 minutes at 8:00 AM and 47 minutes at the 5:00 PM peak hour.

Exhibit 3-13: Northbound I-5 Travel Time Variation (2005)

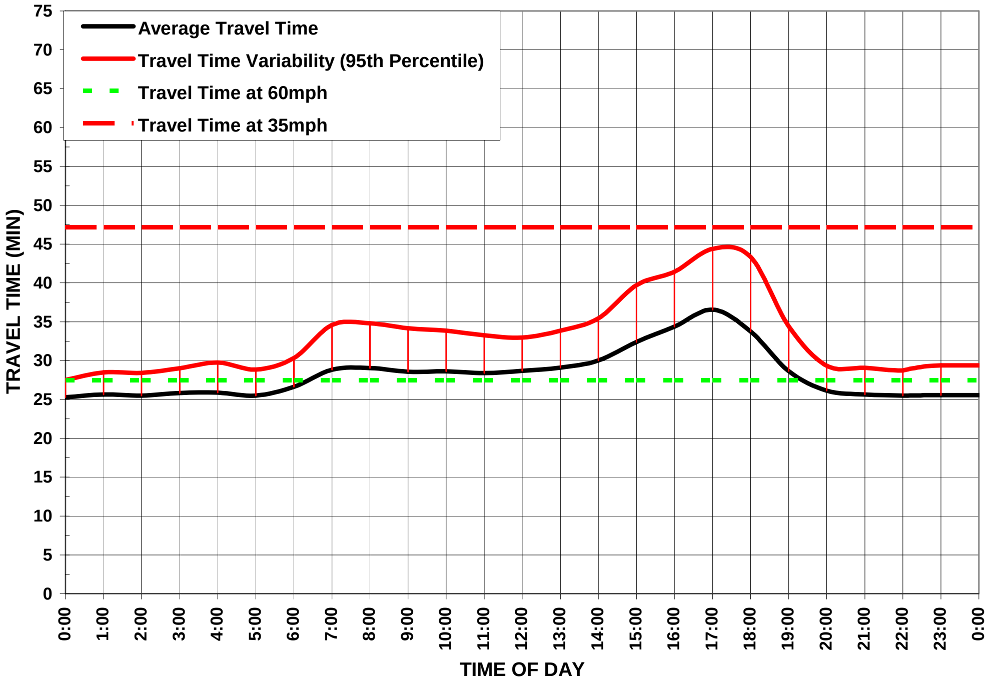


Exhibit 3-14: Northbound I-5 Travel Time Variation (2006)

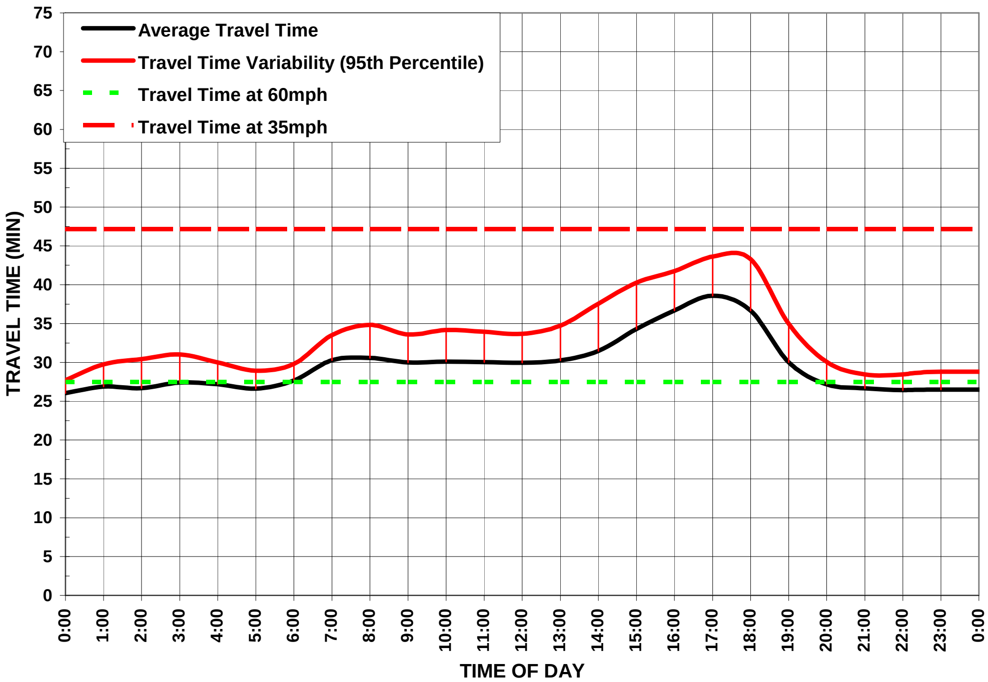


Exhibit 3-15: Northbound I-5 Travel Time Variation (2007)

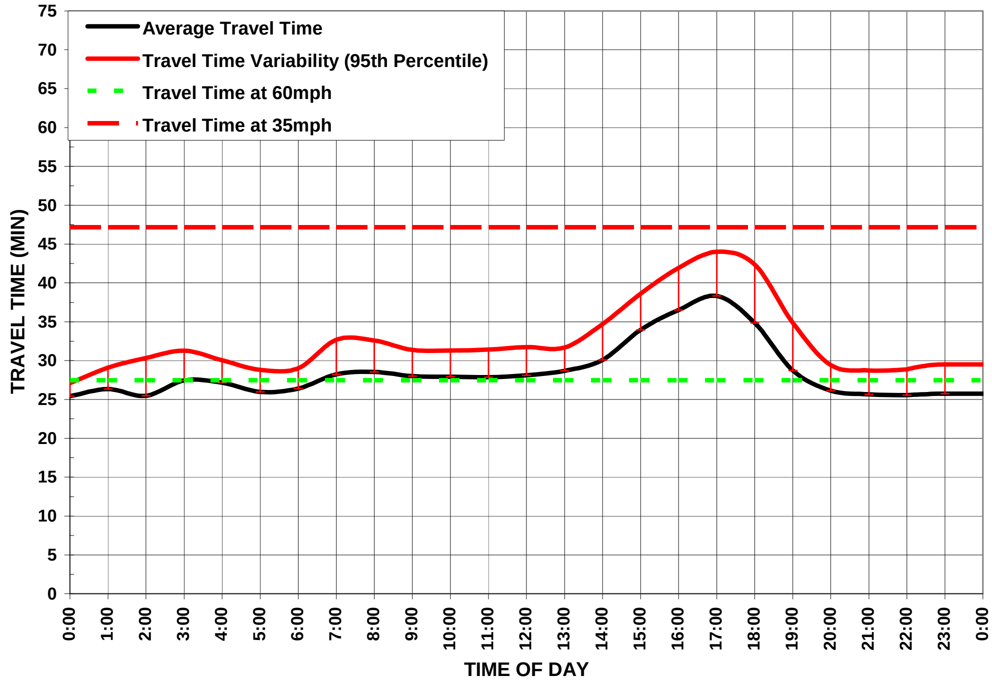


Exhibit 3-16: Northbound I-5 Travel Time Variation (2008)

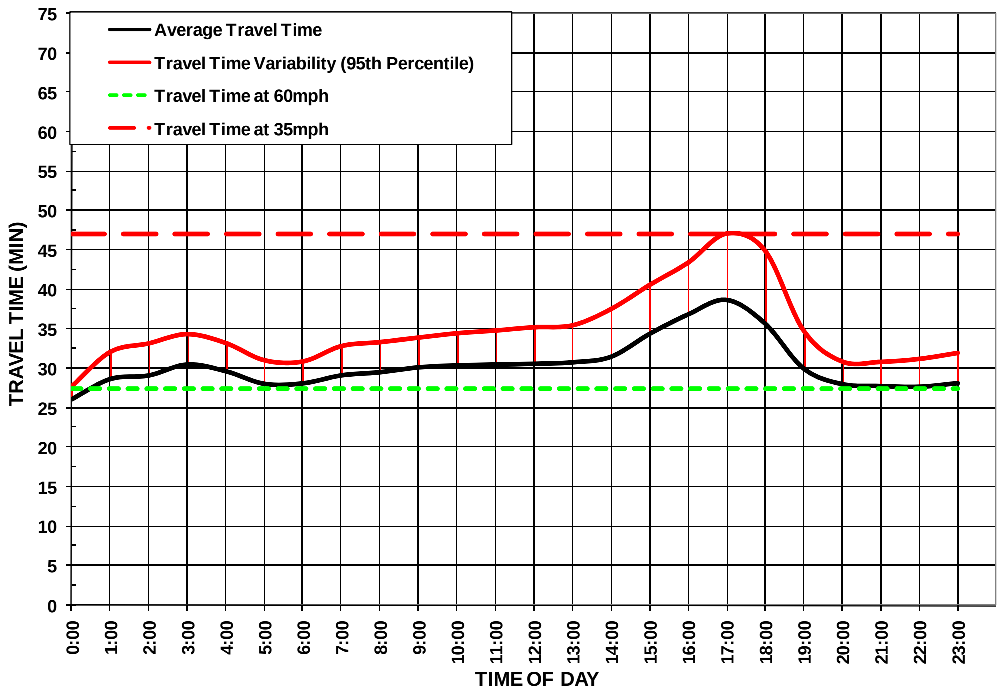


Exhibit 3-17: Southbound I-5 Travel Time Variation (2005)

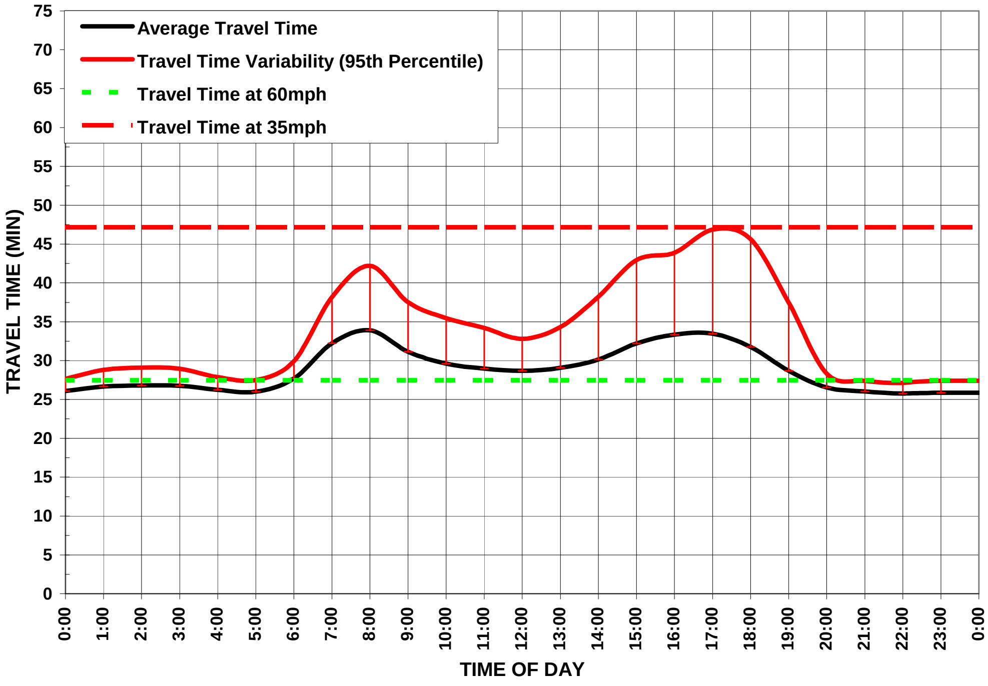


Exhibit 3-18: Southbound I-5 Travel Time Variation (2006)

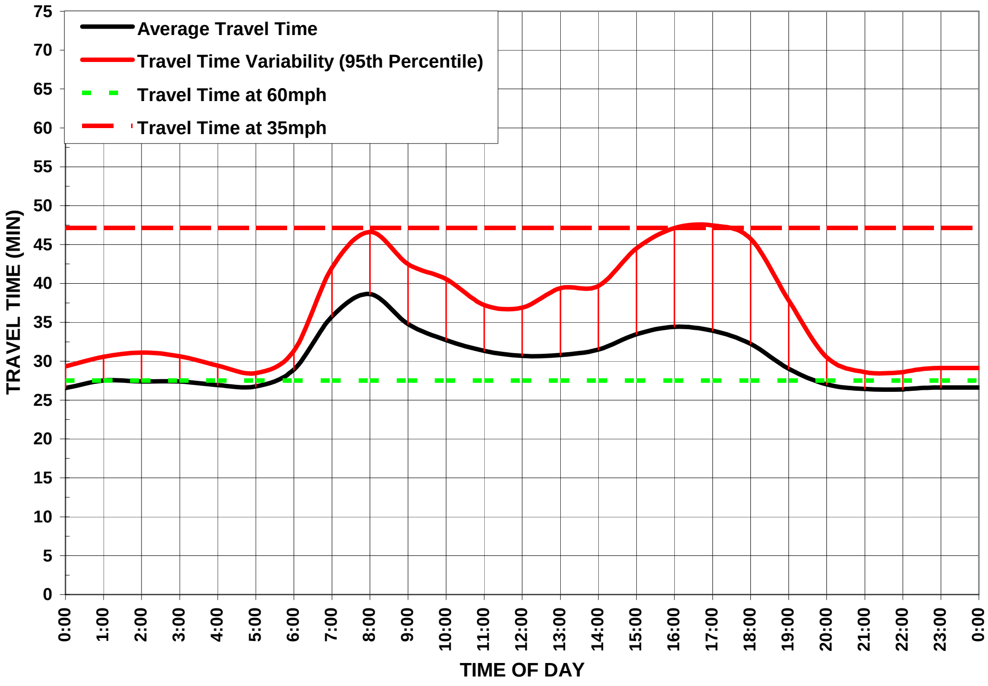


Exhibit 3-19: Southbound I-5 Travel Time Variation (2007)

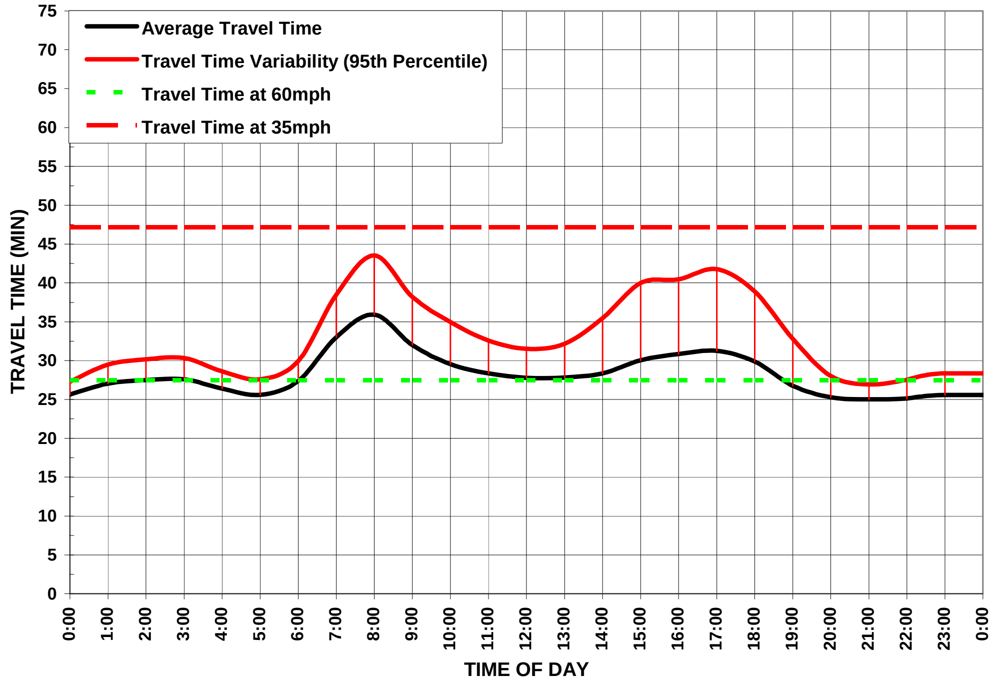
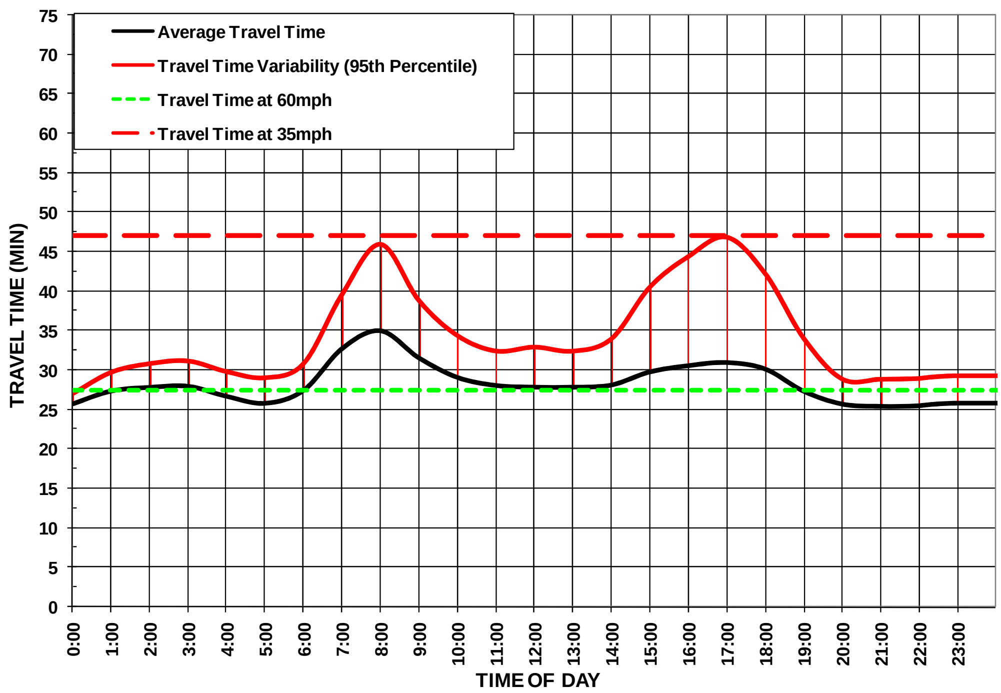


Exhibit 3-20: Southbound I-5 Travel Time Variation (2008)



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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 concentrations or patterns that are readily apparent. This report is not intended to supplant more detailed safety investigations routinely performed by Caltrans staff.

Exhibits 3-21 and 3-22 show the number of accidents experienced on I-5 for both directions of travel by month. 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.

Data quality was identified earlier as a possible cause of the 2007 delay reductions. Safety is another factor. As shown in Exhibit 3-21, the number of northbound incidents decreased from 2004 to 2006. This may have reduced incident-related delays. Southbound accident rates remained fairly steady over the three years, with typical monthly collisions ranging from 80 to 110.

Exhibit 3-21: Northbound Monthly Accidents (2004-2006)

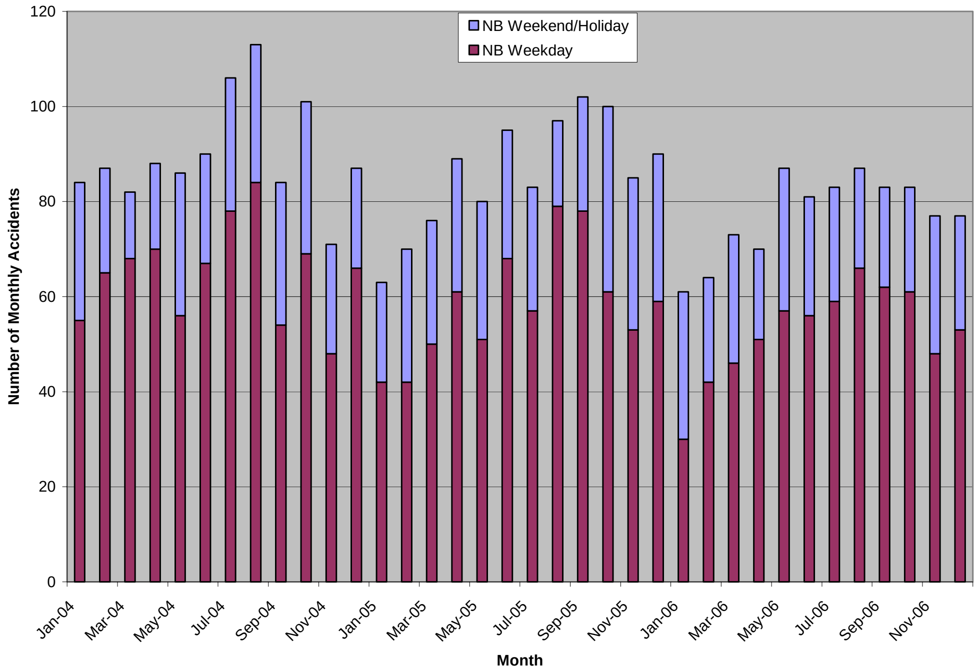
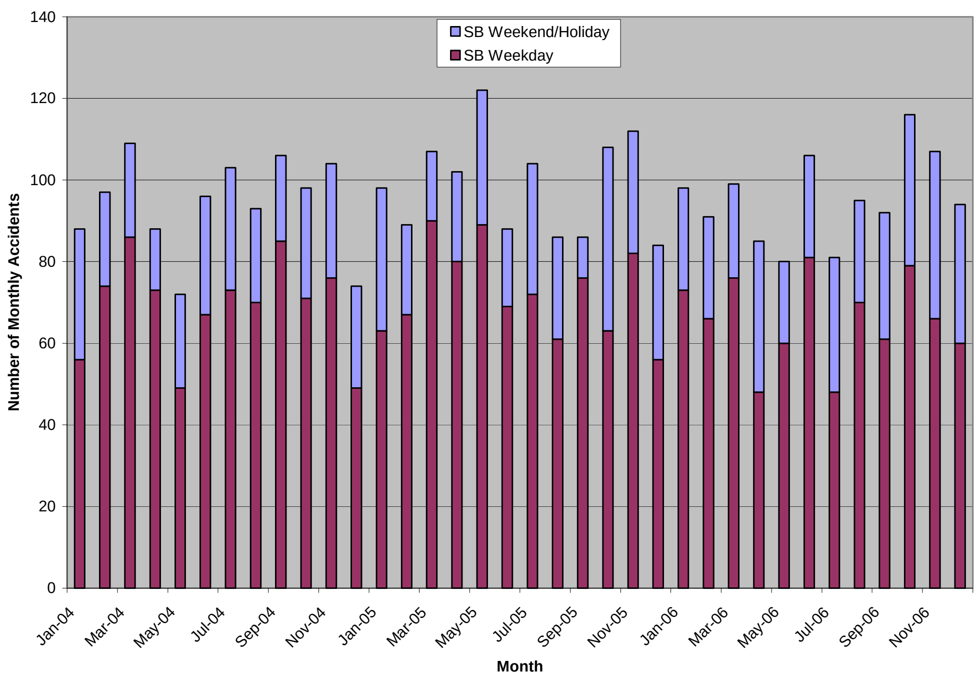


Exhibit 3-22: Southbound Monthly Accidents (2004-2006)



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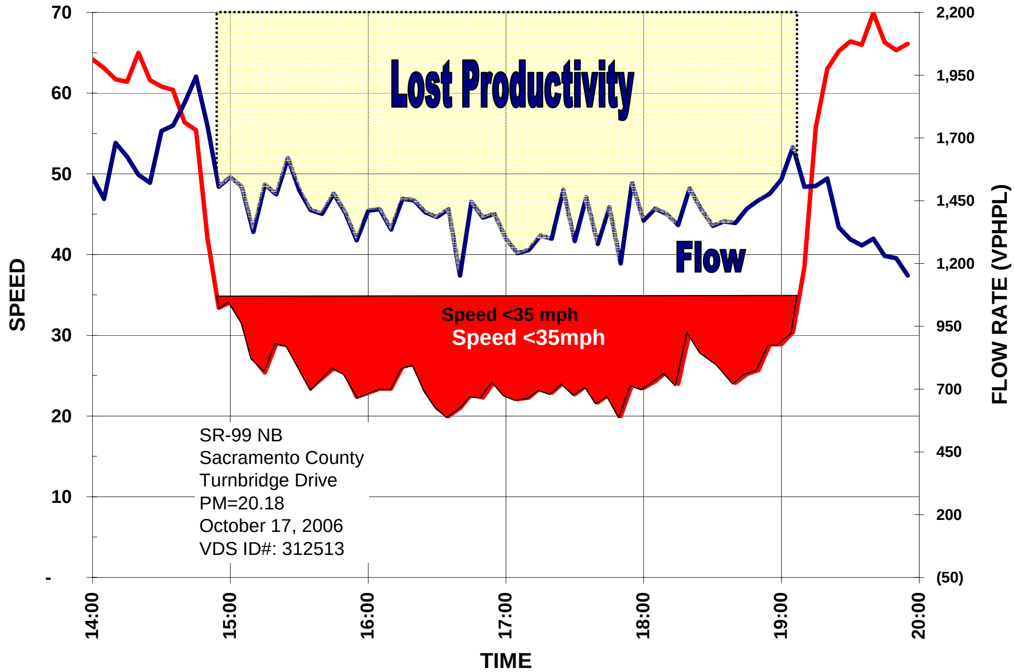
PRODUCTIVITY

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, productivity is the number of people served divided by the level of service provided. For highways, it is the number of vehicles compared to the capacity of the roadways.

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 generally do not project capacity loss for highways, but detailed micro-simulation tools can forecast productivity. For highways, productivity is particularly important because the lowest "production" from the transportation system occurs often when capacity is needed the most.

This loss in productivity example is illustrated in Exhibit 3-23. As traffic flows increase 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 is required to improve productivity.

Exhibit 3-23: Lost Productivity Illustrated



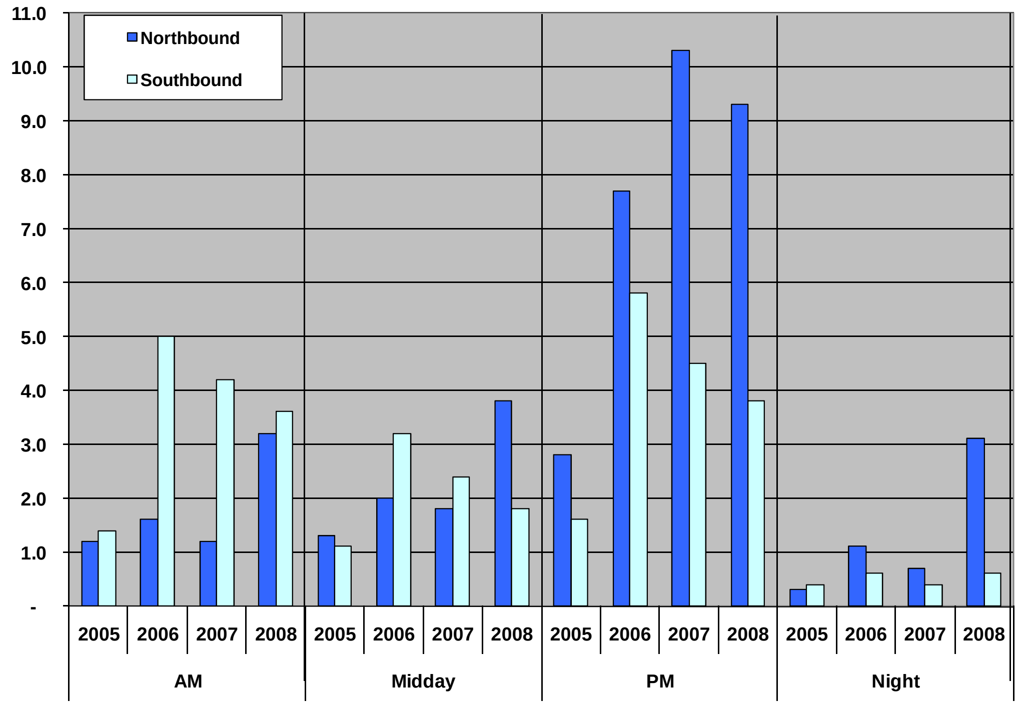
Equivalent lost lane-miles is computed as follows (for congested locations only):

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

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 3-24 summarizes the productivity losses on the I-5 Corridor from 2005 to 2008. The trends in the productivity losses are comparable to the delay trends. The largest productivity losses occurred in the PM peak hours in the northbound direction (as noted by the taller blue-colored bars), which is the time period and direction that experienced the most congestion, or delay. This exhibit also shows that the southbound direction was least productive during the AM and the northbound direction least productive during the PM peak.

Exhibit 3-24: Average Lost Lane-Miles by Direction, Time Period, and Year



Page Intentionally Left Blank for Future Updates on Detection Based Productivity

PAVEMENT CONDITION

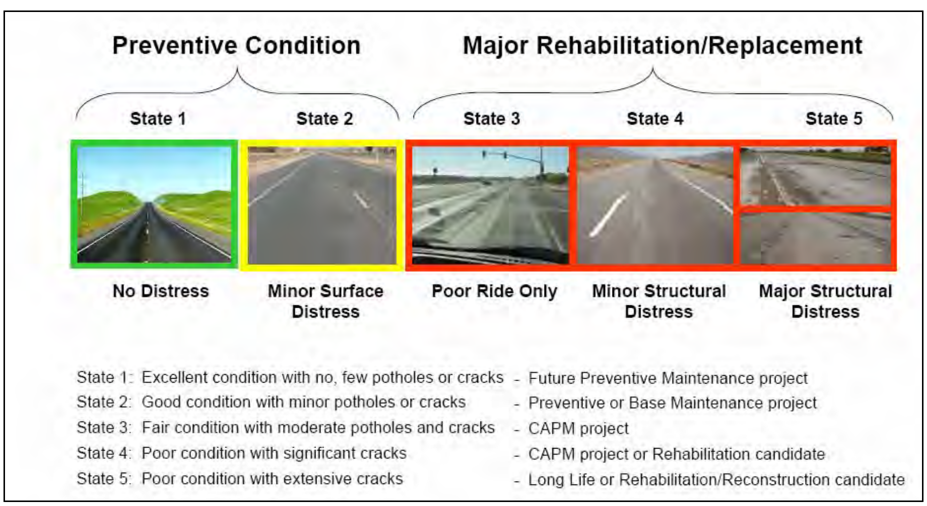
The condition of the roadway pavement (or ride quality) on the corridor can influence its traffic performance. Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor, whereas smooth pavement can have the opposite effect. Pavement preservation 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.

Pavement 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 3-25 provides an illustration of this distinction. The first two pavement conditions are considered roadways that provides adequate ride quality and is structurally adequate. The remaining three conditions are included in the calculation of distressed lane-miles.

Exhibit 3-25: Pavement Condition States



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 Conditions

The most recent pavement condition survey, completed in November 2007, identified 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.

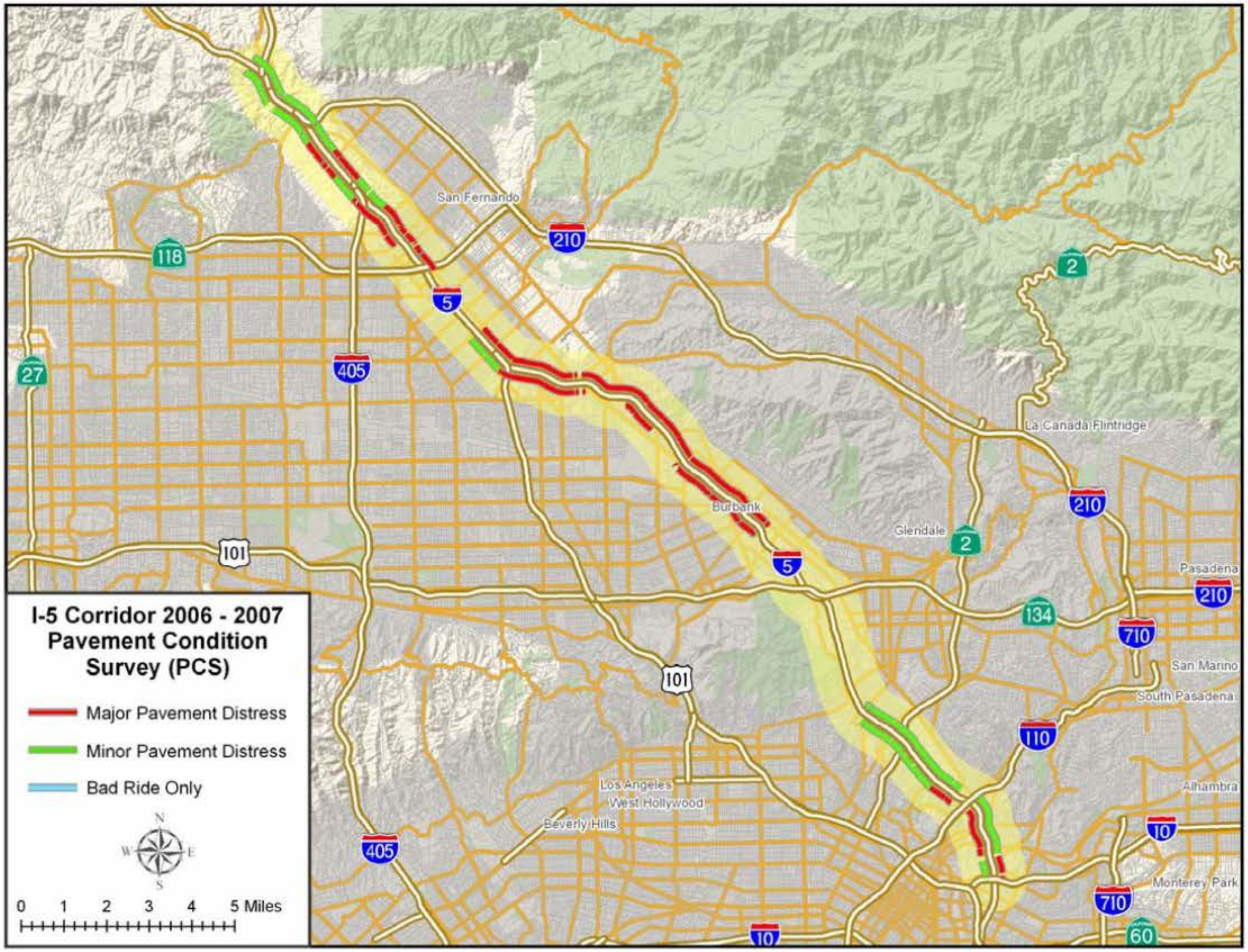
Exhibit 3-26 shows pavement distress along the I-5 Corridor according to the 2007 PCS data. The three categories shown in this exhibit represent the three distressed conditions that require major rehabilitation or replacement and were presented earlier in Exhibit 3-25.

The I-5 Corridor shows more pavement distress than does the typical freeway in District 7. Just over half of the corridor has at least one lane exhibiting major pavement distress. The major distress can be grouped into three subsections along the corridor. The first section includes about four centerline miles north of SR-118. The second section is longer and found between SR-118 and SR-134. The third section includes about two miles north of downtown Los Angeles near I-110. The distress along the rest of the corridor is minor and no sections exhibit only ride quality issues.

Exhibit 3-27 shows results from prior pavement condition surveys along the I-5 Corridor. The number of distressed lane-miles has generally increased since 2003. Most of the growth is due to an increase in major pavement distress. Ride quality only issues have not appeared since 2003 and have been replaced by minor pavement issues.

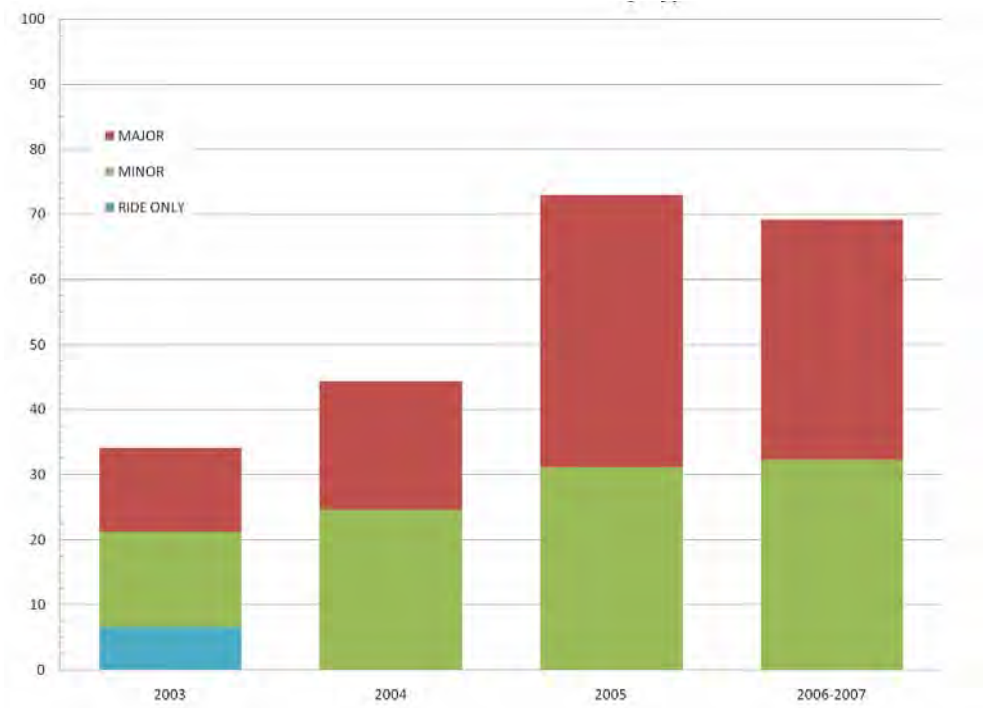
The change in the percent mix of distressed lane-miles is shown more clearly in Exhibit 3-28. As seen in the exhibit, distress is split roughly evenly between major and minor pavement issues.

Exhibit 3-26: Distressed Lane-Miles on I-5 Corridor (2006–2007)



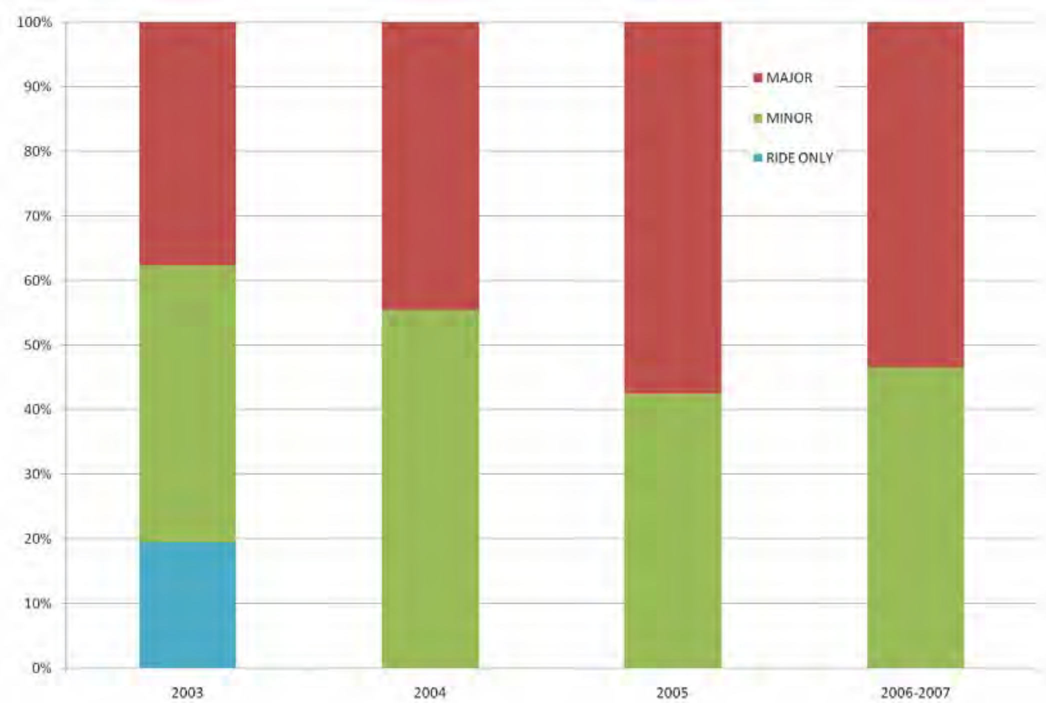
Source: SMG mapping of 2007 Pavement Condition Survey data

Exhibit 3-27: I-5 Distressed Lane-Miles Trends



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

Exhibit 3-28: I-5 Distressed Lane-Miles by Type



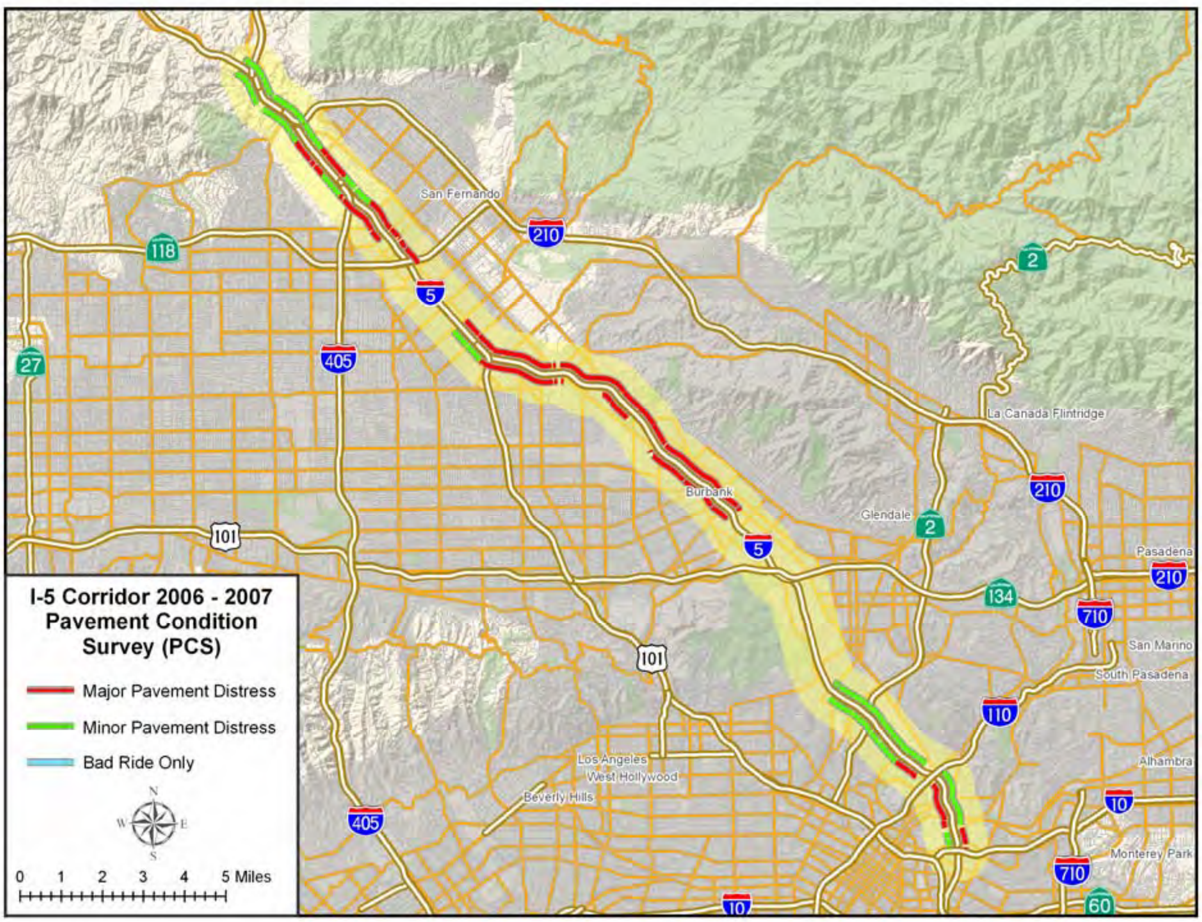
Source: SMG analysis of 2003 to 2007 Pavement Condition Survey data

Exhibit 3-29 shows IRI along the study corridor for the lane with the poorest pavement condition in each freeway segment. The poorest pavement conditions are shown in the exhibit because pavement investment decisions are made on this basis. As the exhibit shows, the entire corridor has ride quality issues (IRI greater than 170). Not all of these sections appear in Exhibit 3-26 due to algorithms and thresholds in the PSR.

When the conditions on all lanes are considered, the study corridor comprises roughly 221 lane-miles, of which:

- 101 lane-miles, or 46 percent, are considered to have good ride quality (IRI ≤ 95)
- 86 lane-miles, or 39 percent, are considered to have acceptable ride quality (95 < IRI ≤ 170)
- 34 lane-miles, or 15 percent, are considered to have unacceptable ride quality (IRI > 170)

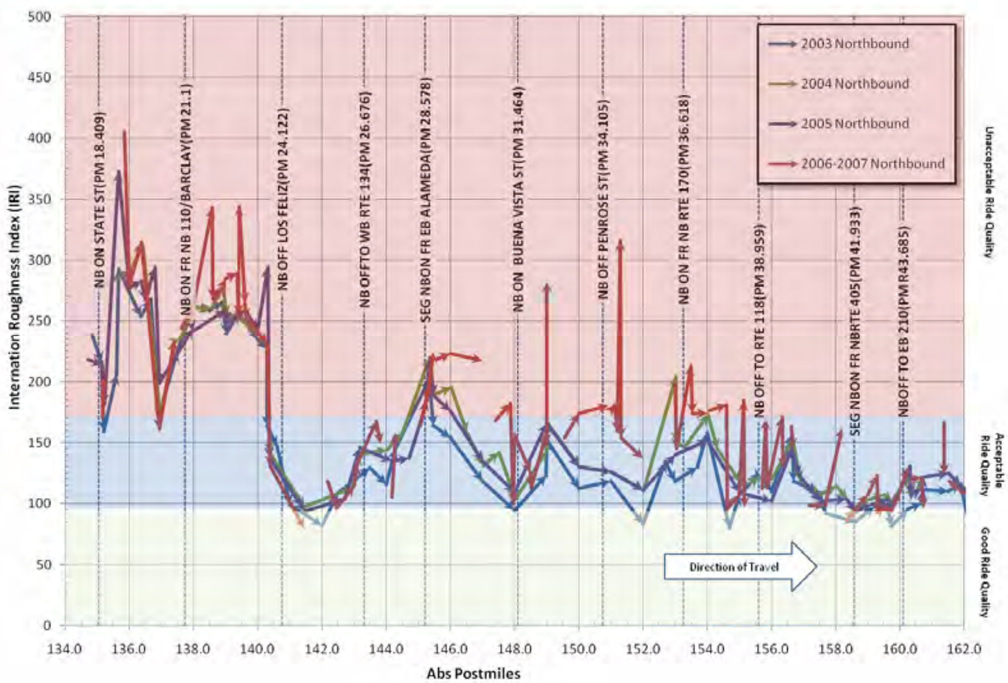
Exhibit 3-29: I-5 Road Roughness (2006-2007)



Source: SMG mapping of 2007 Pavement Condition Survey data

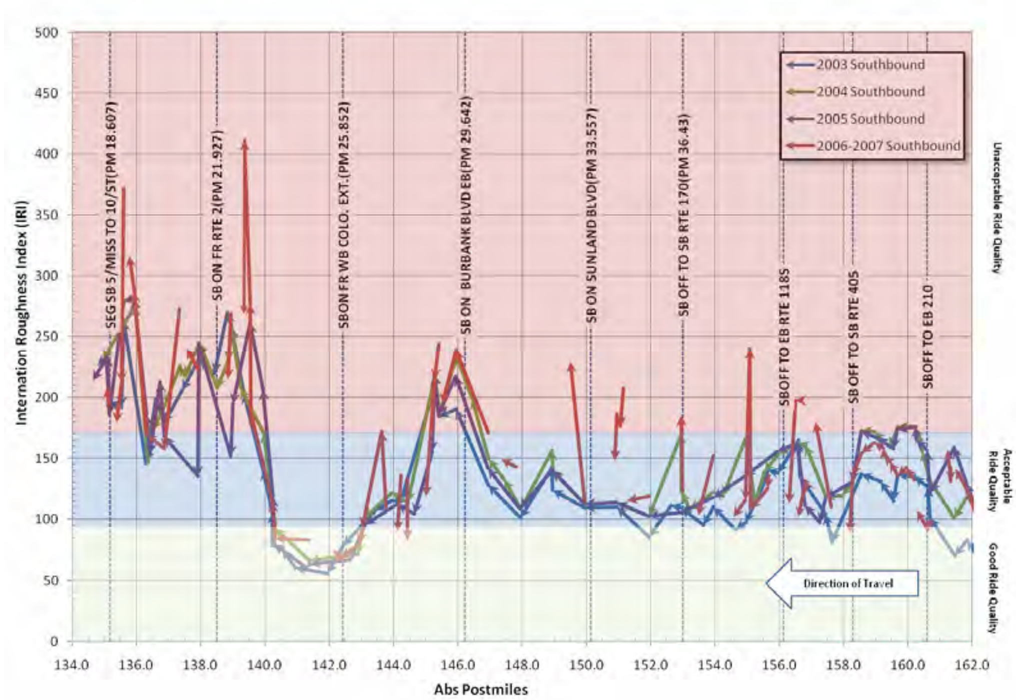
Exhibits 3-30 and 3-31 present ride conditions for the I-5 Corridor using IRI from the last four pavement surveys. The information is presented by Post Mile and direction. The exhibits include color-coded bands to indicate the three ride quality categories defined by Caltrans: good ride quality (green), 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 slightly 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) in the 2006-07 period.

Exhibit 3-30: Northbound I-5 Road Roughness (2003-2007)



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

Exhibit 3-31: Southbound I-5 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 May 2008. They were identified based on a variety of data sources, including HICOMP, probe vehicle runs, and PeMS. Limited field observations were also conducted at the time, but not enough to verify each bottleneck. Since the Preliminary Performance Assessment, significant field observations and additional analysis of PeMS data have been conducted. These efforts resulted in confirming consistent sets of bottlenecks for both directions of the freeway. These are presented below. The initial analysis from the Preliminary Performance Assessment is found in the Appendix.

NORTHBOUND BOTTLENECKS

Starting from I-10 and moving north, the following bottlenecks were identified:

- SR-110 On – This bottleneck is related to weaving from SR-110 within a short merge area.
- SR-134 On – This bottleneck occurs when capacity on the I-5 is limited and cannot accommodate additional traffic demand from SR-134.
- Alameda On – This bottleneck occurs when unmetered platoons of vehicles merge onto the mainline.
- Sheldon On – The uphill grade, roadway curvature compound poorly located ramp metering to contribute to this bottleneck location.
- Osborne Off – This bottleneck location relates to a left lane merging of vehicles at the SR-170 connector on-ramp and a right lane drop at the Osborne Street off-ramp.
- SR-118 Off – The reduction of lanes from seven to four mainline cannot accommodate the volume of demand resulting in the bottleneck condition.

SOUTHBOUND BOTTLENECKS

Starting from I-210 and moving south, the following bottlenecks were identified:

- SR-118 On – This bottleneck relates to vehicles merging from SR-118 followed by a lane exit to SR-170.
- SR-170 Off – This bottleneck occurs when the demand for the SR-170 is high, creating a backup on the I-5.
- SR-134 Off – This bottleneck occurs when traffic exiting to the SR-134 queues onto the I-5 mainline.
- SR-2 Off – The loss of a lane to the SR-2 connector off-ramp and another to Stadium Way results in this bottleneck location.

- SR-2 On – High demand from the SR-2 connector on-ramp, particularly during the AM peak hours, followed by an exit at I-110 results in this bottleneck location.
- SR-110 Off – This is the most significant bottleneck in the southbound direction and is caused by inadequate off-ramp capacity that results in queuing on the I-5.

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 such bottleneck areas, some performance statistics that were presented earlier for the entire corridor can be segmented by bottleneck area. This way, the relative contribution of each bottleneck area to the degradation of the corridor performance can be gauged. The performance statistics that lend themselves to such segmentation include:

- Delay
- Productivity
- Safety

The analysis of bottleneck areas is based on 2007 data (when available). Based on this segmentation approach, the study corridor comprises several bottleneck areas, which differ by direction. Exhibit 4-1 illustrates the general concept of bottleneck areas for the northbound direction of I-5. The red lines in the exhibit represent the bottleneck locations and the arrows represent the bottleneck areas.

Exhibit 4-1: Dividing a Corridor into Bottleneck Areas

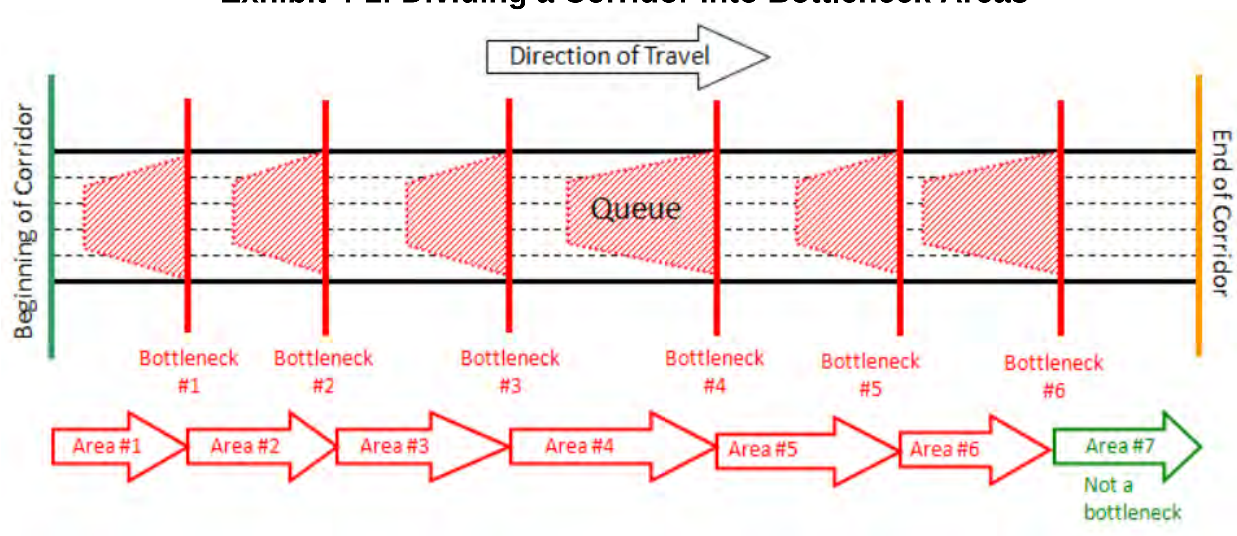
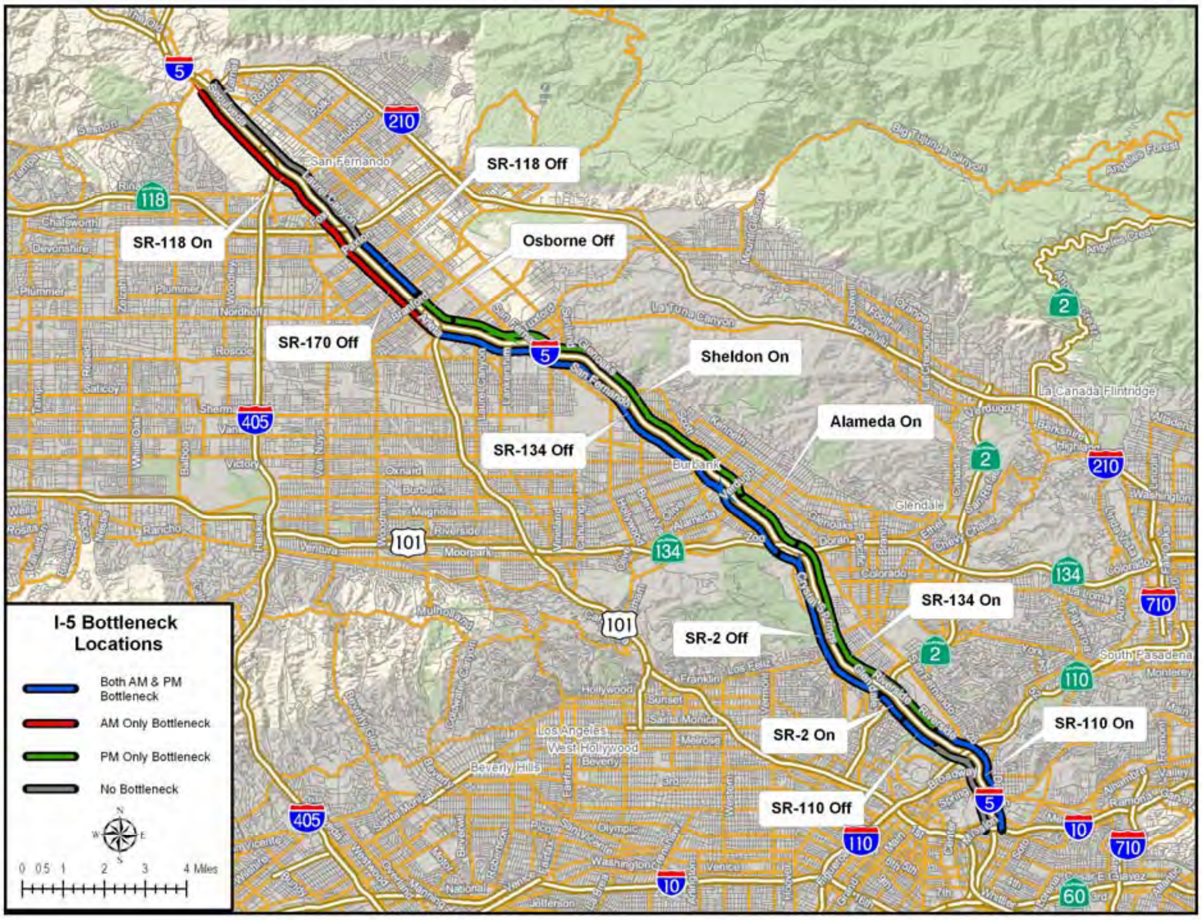


Exhibit 4-2 graphically illustrates the location of each of the bottleneck locations and areas for the I-5 Corridor.

Exhibit 4-2: I-5 Bottleneck Locations and Bottleneck 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, and productivity 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: Northbound I-5 Identified Bottleneck Areas

Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
SR-110 On	From I-10 to SR-110 On	✓	✓	135.0	18.4	138.0	21.3	3.0
SR-134 On	From SR-110 On to SR-134 On		✓	138.0	21.3	143.5	26.8	5.5
Alameda On	From SR-134 On to Alameda On		✓	143.5	26.8	145.2	28.6	1.7
Sheldon On	From Alameda On to Sheldon On		✓	145.2	28.6	152.7	36.1	7.5
Osborne Off	From Sheldon On to Osborne Off	✓	✓	152.7	36.1	153.9	37.2	1.2
SR-118 Off	From Osborne Off to SR-118 Off		✓	153.9	37.2	155.6	38.9	1.7
Not a bottleneck area	From SR-118 Off to I-210	N/A		155.6	38.9	162.5	44.0	6.9

Exhibit 4-4: Southbound I-5 Identified Bottleneck Areas

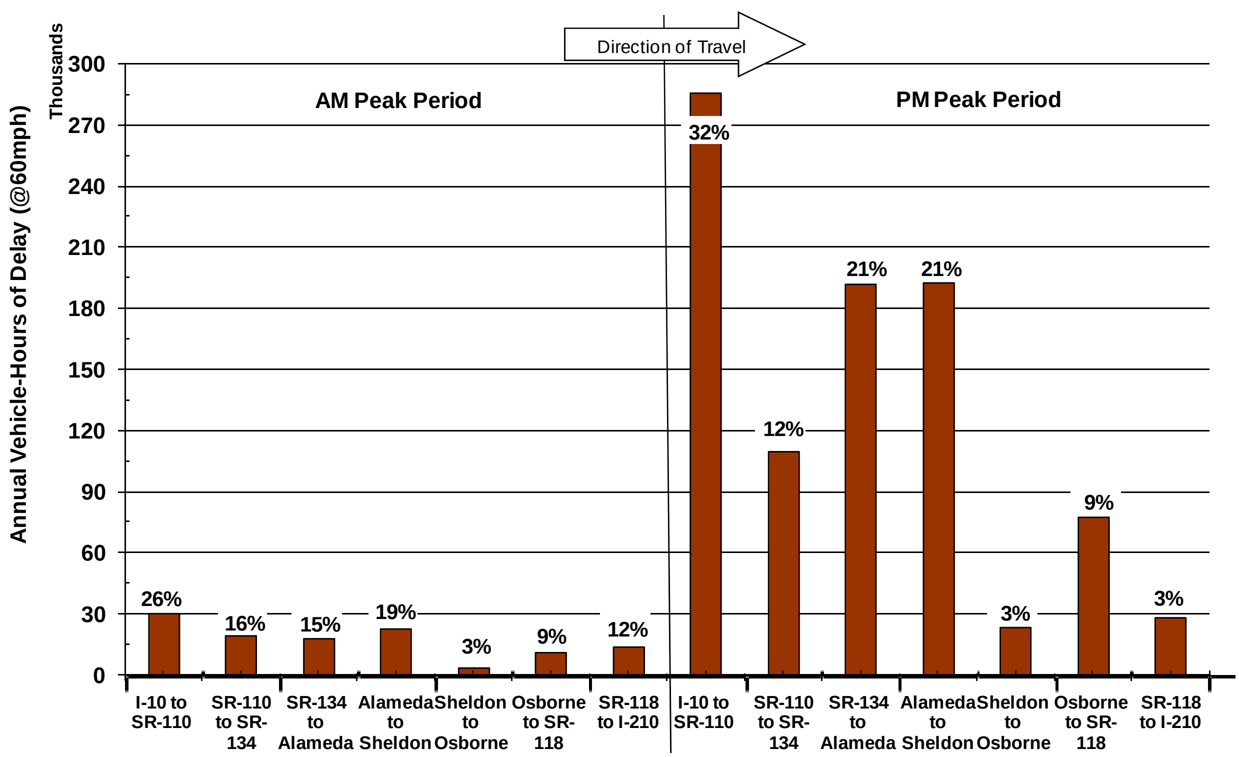
Bottleneck Location	Bottleneck Area	Active Period		From		To		Distance (miles)
		AM	PM	Abs	CA	Abs	CA	
SR-118 On	From I-210 to SR-118 On	✓		162.5	44.0	155.5	38.9	7.0
SR-170 Off	From SR-118 On to SR-170 Off	✓		155.5	38.9	153.0	36.4	2.5
SR-134 Off	From SR-170 Off to SR-134 Off		✓	153.0	36.4	143.5	26.9	9.5
SR-2 Off	From SR-134 Off to SR-2 Off	✓	✓	143.5	26.9	139.3	22.7	4.2
SR-2 On	From SR-2 Off to SR-2 On	✓	✓	139.3	22.7	138.5	21.9	0.8
I-110 Off	From SR-2 On to SR-110 Off	✓	✓	138.5	21.9	137.6	21.0	0.9
Not a bottleneck area	From SR-110 Off to I-10	N/A		137.6	21.0	135.0	18.4	2.6

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.

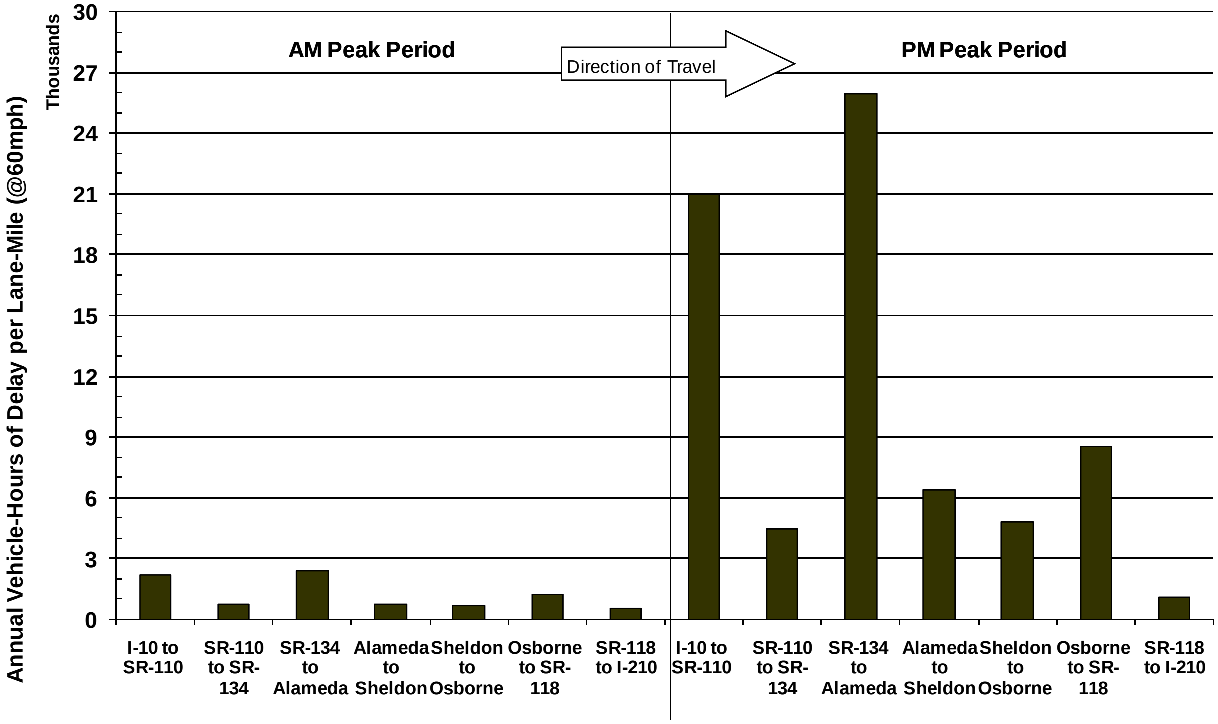
Exhibits 4-5 and 4-7 illustrate the vehicle-hours of delay experienced by each bottleneck area. As depicted in Exhibit 4-5, delay in the northbound direction is concentrated in the PM peak with almost eight times more total delay than the AM peak. The segment between the I-10 and SR-110 experienced the greatest delay during both AM and PM peaks with 32 and 26 percent of the delay on the corridor. During the PM peak, the segments from SR-134 to Alameda and Alameda to Sheldon also experienced high levels of delay at just under 200,000 annual vehicle-hours of delay each, or 21 percent of the delay on the corridor. Unlike the northbound direction, delay in the southbound direction is spread more evenly between peak periods. Exhibit 4-7 shows that the segment between SR-134 to SR-2 experienced the greatest delay with 36 and 39 percent of the delay on the corridor during the AM and PM peak periods.

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



Source: SMG analysis of PeMS data

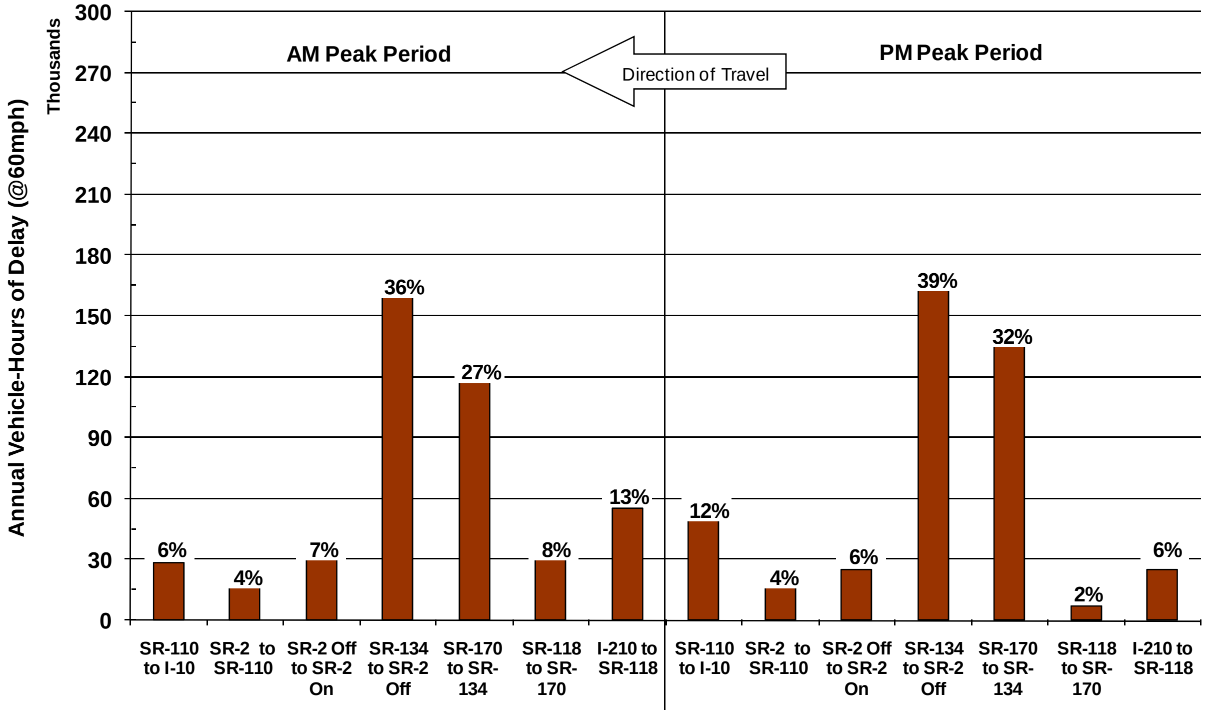
Exhibit 4-6: Northbound I-5 Delay per Lane-Mile (2007)



Source: SMG analysis of PeMS data

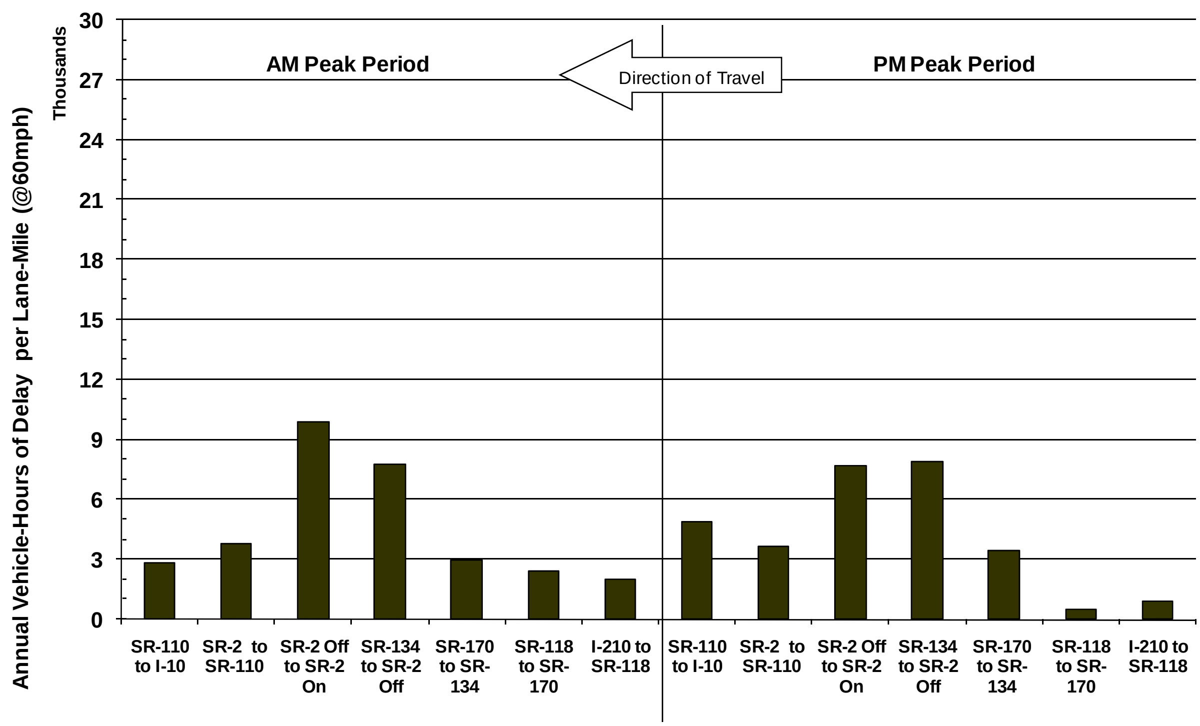
Exhibits 4-6 and 4-8 have been normalized to reflect delay per lane-mile. The delay calculated for each bottleneck area was divided by the total lane-miles for each bottleneck area to obtain delay per lane-mile. The results of these exhibits differ from Exhibits 4-5 and 4-7. In the northbound direction, the segment from SR-134 to Alameda experienced the highest delay per lane-mile during both peak periods. In the southbound direction, the segment from SR-2 Off to SR-2 On experienced the highest delay per lane-mile during the AM peak while the segment from SR-134 to SR-2 experienced the highest delay per lane-mile in the PM peak.

Exhibit 4-7: Southbound I-5 Annual Vehicle-Hours of Delay (2007)



Source: SMG analysis of PeMS data

Exhibit 4-8: Southbound I-5 Delay per Lane-Mile (2007)



Source: SMG analysis of PeMS data

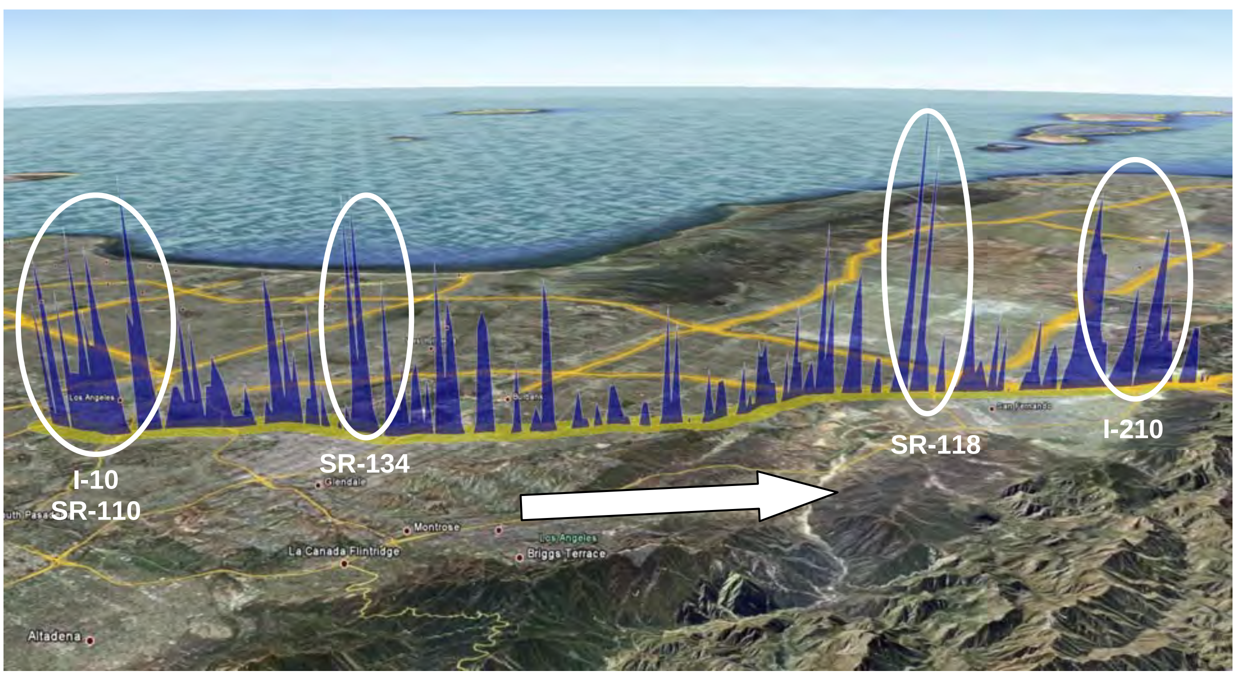
Safety by Bottleneck Area

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-5 Corridor in the northbound direction. The spikes show the total number of collisions (fatality, injury, and property damage only) occurring within 0.1 mile segments in 2006. The highest spike corresponds to roughly 20 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.

The magnitude of these spikes is less interesting than the concentration. As Exhibit 4-9 shows, a large group of collisions occurs at the southern portion of the study corridor, between I-10 and SR-110. Other groupings occurred near the SR-134 interchange, the SR-118 interchange, and the I-210 interchange. In many cases, a spike in the number of collisions occurs in the same location as a bottleneck. For example, a spike occurred at the SR-118 interchange, which is also a bottleneck location.

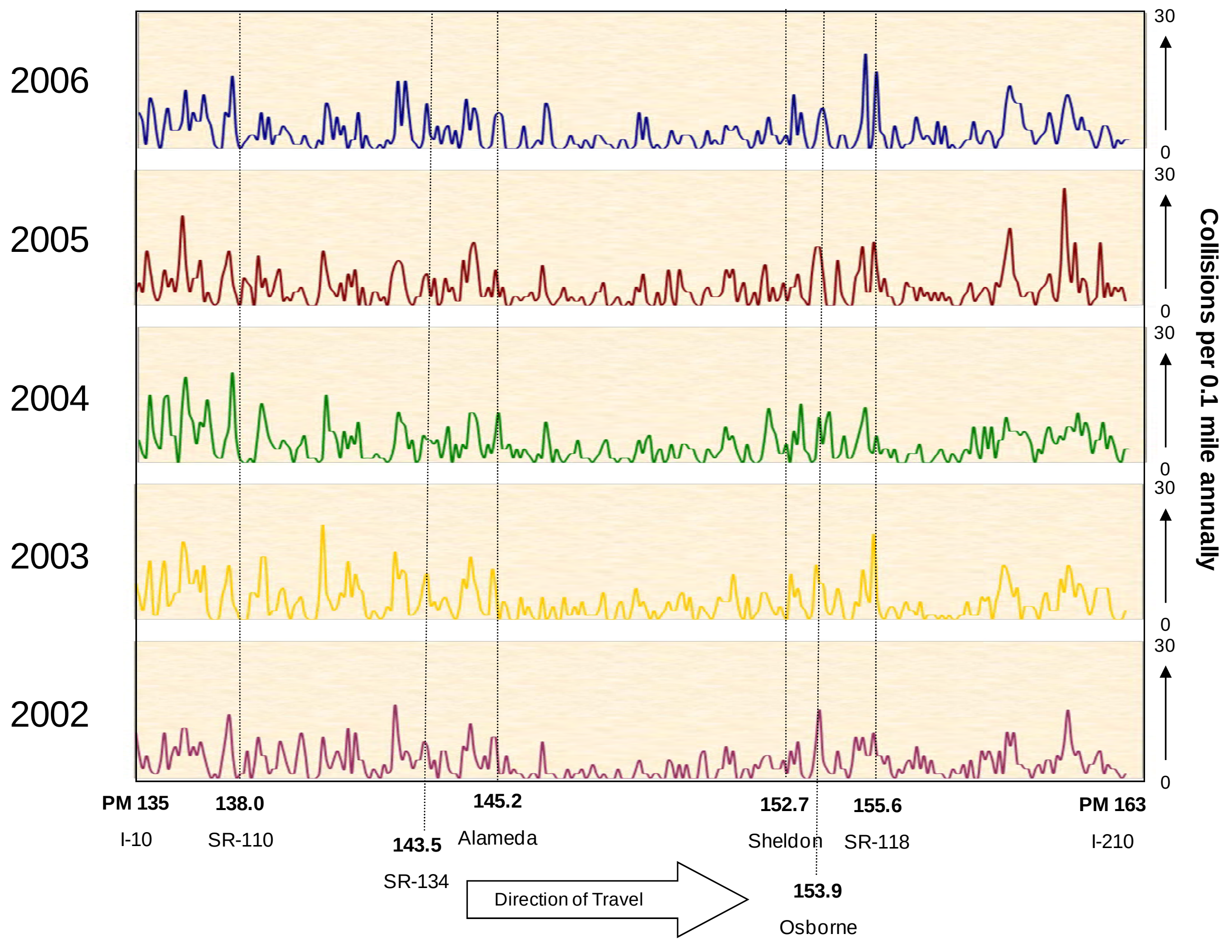
Exhibit 4-9: Northbound I-5 Collision Locations (2006)



Source: SMG analysis of TASAS data

Exhibit 4-10 illustrates the same data for the five-year period from 2002 to 2006. The vertical lines in the exhibit separate the corridor by bottleneck areas. As indicated in Exhibit 4-9, a concentration of collisions exist between the I-10 and SR-110, which corresponds to the bottleneck area depicted between PM 135.0 and PM138.0 in Exhibit 4-10. Exhibit 4-10 also shows that the pattern of collisions has stayed fairly consistent from one year to the next. However, the group of collisions near SR-118 (PM 155.6) has increased since 2002.

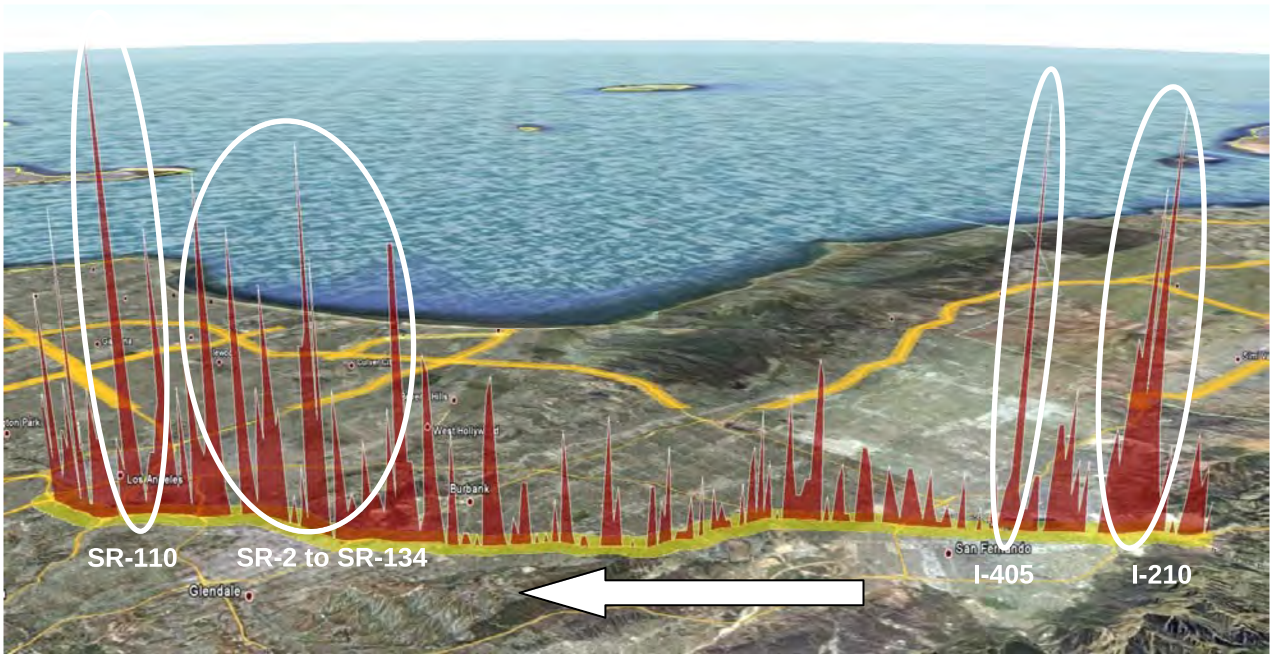
Exhibit 4-10: Northbound I-5 Location of Collisions (2002-2006)



Source: SMG analysis of TASAS data

Exhibit 4-11 shows the same 2006 collision data for the I-5 in the southbound direction. The largest spike in this exhibit corresponds roughly to 30 collisions per 0.1 miles. The pattern in the southbound direction is similar to that in the northbound direction but with greater intensity. Again, spikes are most notable near I-210, I-405, between SR-134 and SR-2, and at the SR-110 Interchange.

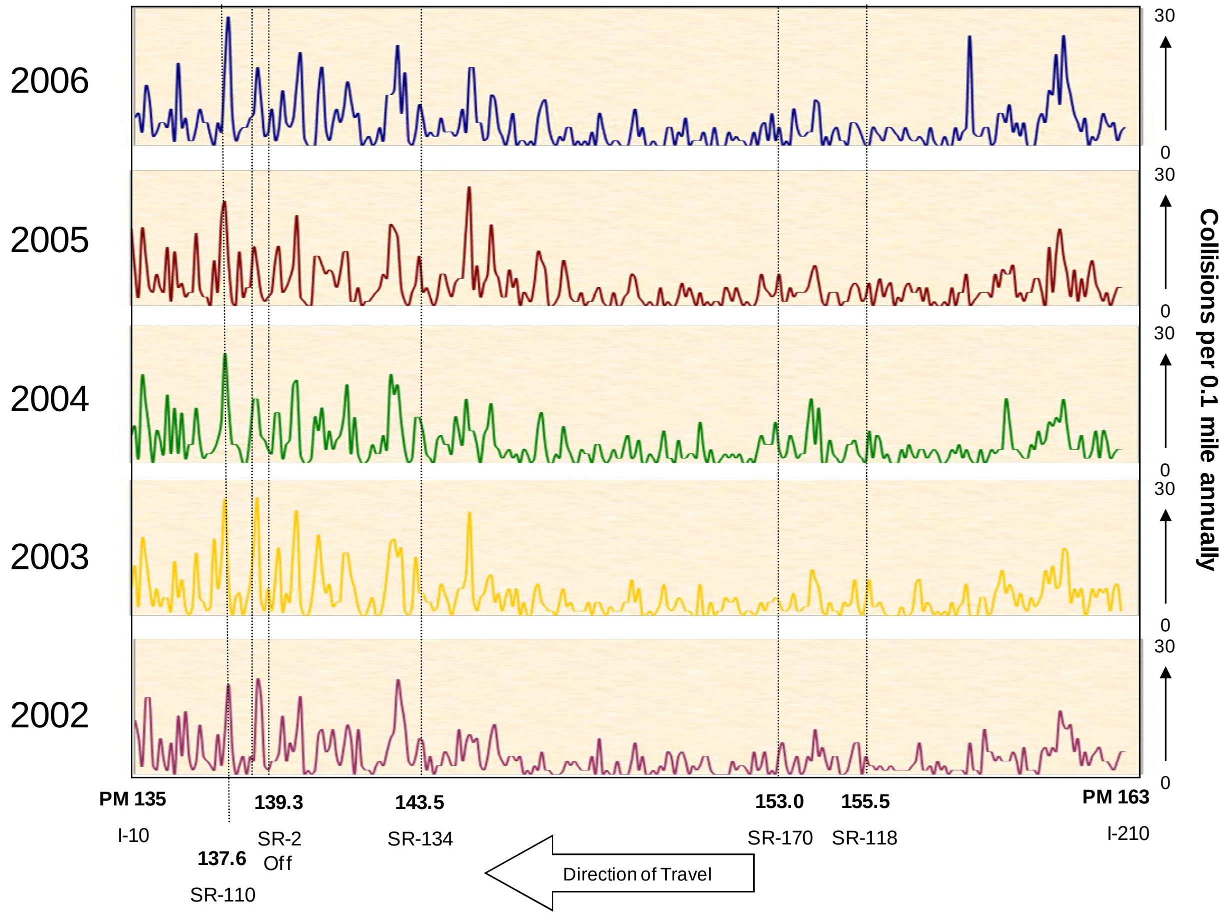
Exhibit 4-11: Southbound I-5 Collision Locations (2006)



Source: SMG analysis of TASAS data

Exhibit 4-12 shows the trend of collisions for the southbound direction from 2002 to 2006 period. As the exhibit shows, the pattern of collisions has been fairly steady from one year to the next. It also shows the high concentration that occurred in the south section of the corridor between SR-134 (PM 143.5) and I-10 (PM 135.0).

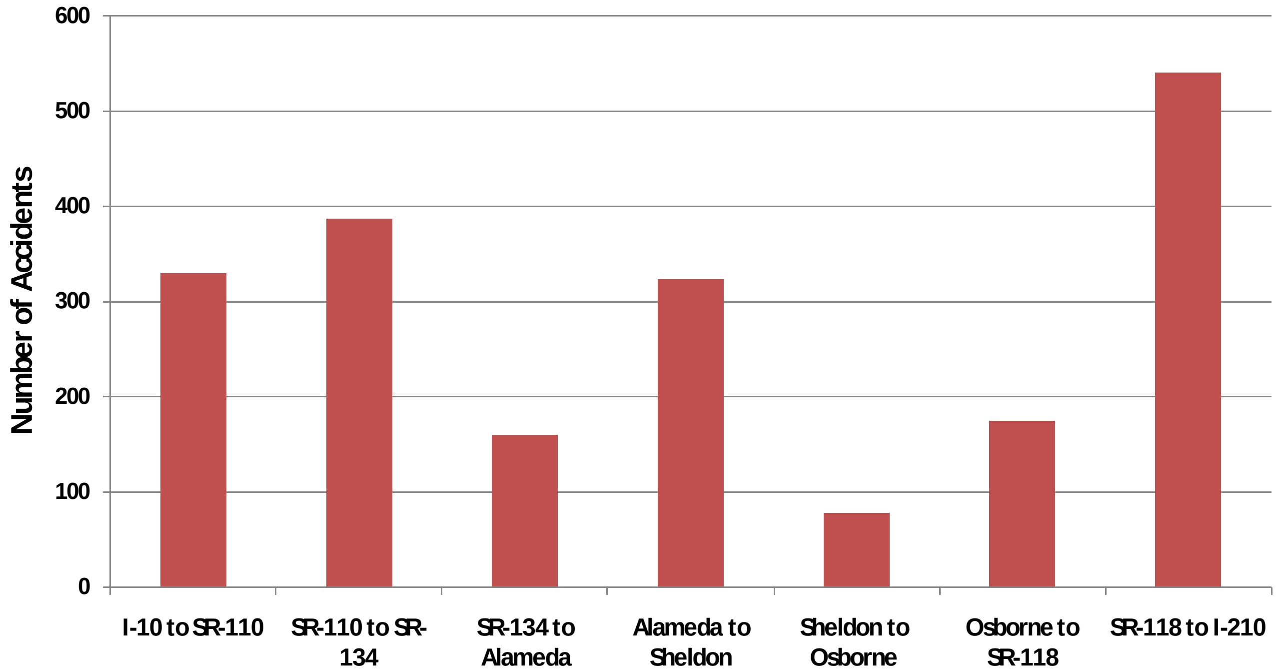
Exhibit 4-12: Southbound I-5 Collision Locations (2002-2006)



Source: SMG analysis of TASAS data

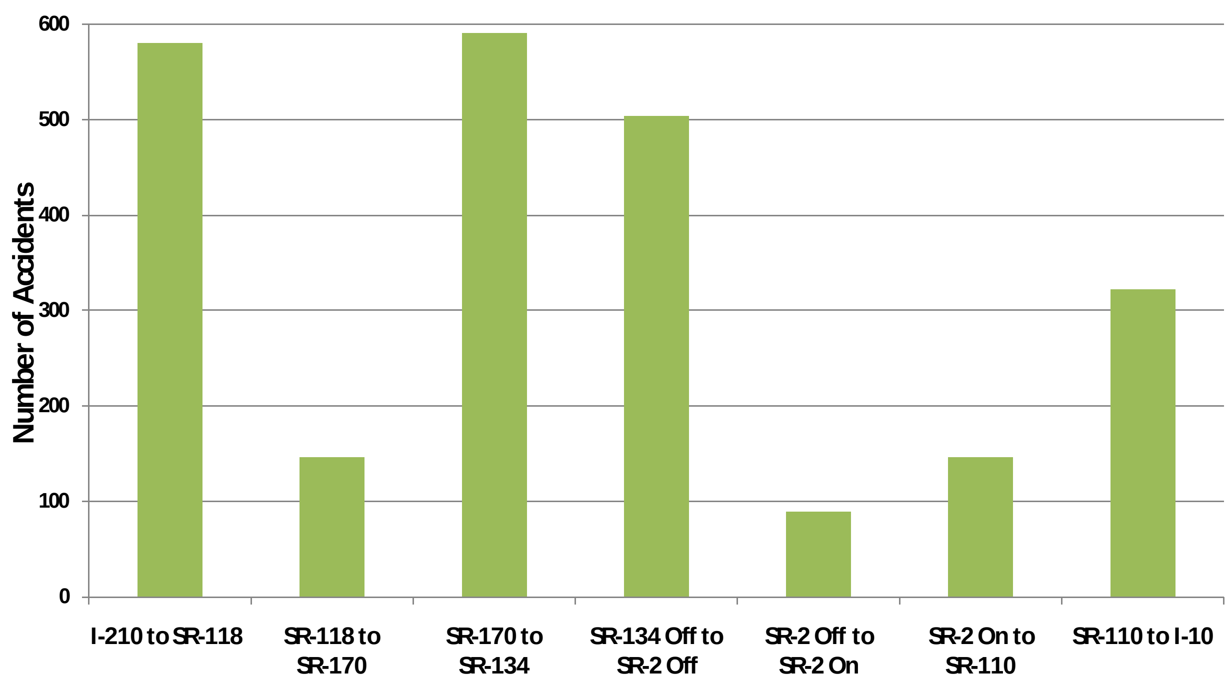
Exhibits 4-13 and 4-14 summarize the total number of accidents reported in TASAS by bottleneck area. The bars show the total number of accidents which occurred in 2005 and 2006 (the latest two years available in TASAS). In the northbound direction (Exhibit 4-13), the segment from SR-118 to I-210 experienced the most accidents with roughly 540. In the southbound direction (Exhibit 4-14), the segment from SR-170 to SR-134 experienced the most accidents at around 590, followed closely by the segment from I-210 to SR-118 with 580.

Exhibit 4-13: Northbound I-5 Total Accidents (2005-2006)



Source: SMG analysis of TASAS data

Exhibit 4-14: Southbound I-5 Total Accidents (2005-2006)



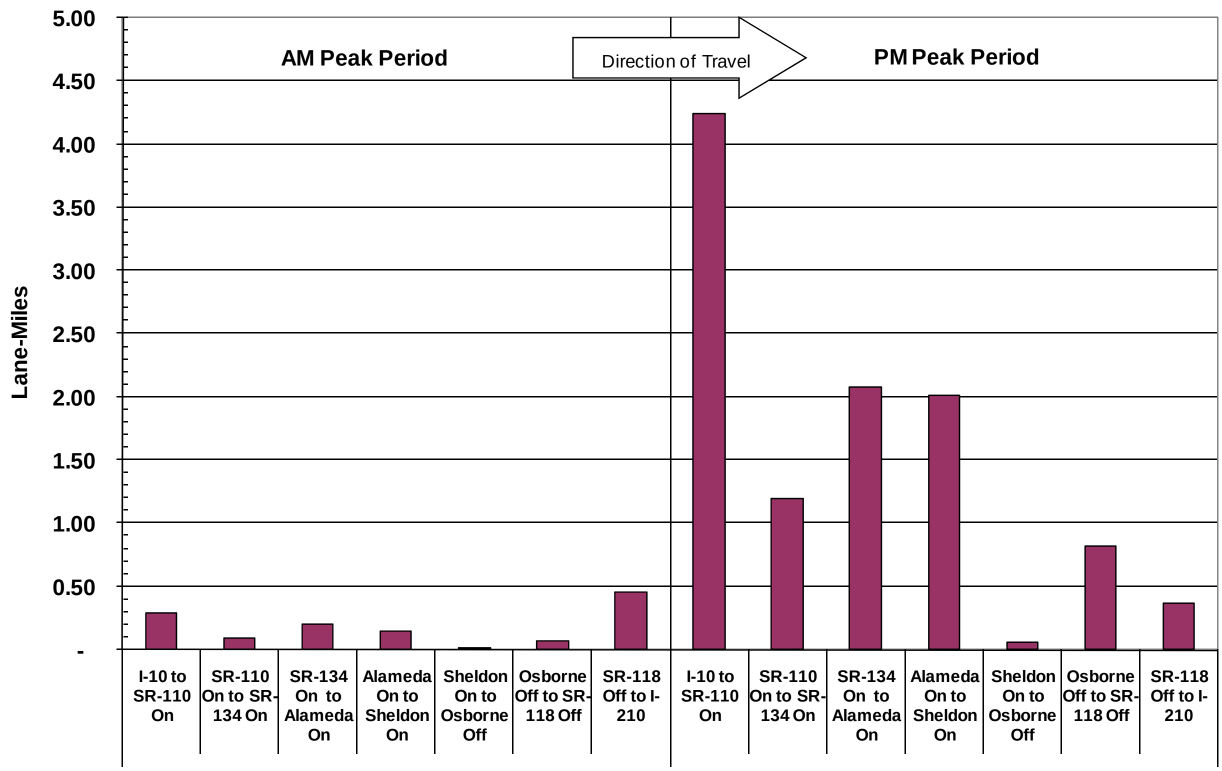
Source: SMG analysis of TASAS data

Productivity by Bottleneck Area

As previously discussed in Section 3, the productivity of a corridor is defined as the percent utilization of a facility or mode under peak conditions. Productivity is measured by calculating the lost productivity of the corridor and converting it into "lost lane-miles." These lost lane-miles represent a theoretical level of capacity that would have to be added in order to achieve maximum productivity.

Exhibits 4-15 and 4-16 show the productivity losses for both directions of the corridor.
In the northbound direction, the segment from I-10 to SR-110 had the worst productivity of any segment on the study corridor. It experienced a productivity loss of 4.2 lane-miles during the PM peak period. During the AM peak period, the northbound direction experienced relatively high productivity with all segments of the corridor experiencing less than a half-mile of productivity loss.

Exhibit 4-15: Northbound I-5 Lost Lane-Miles (2007)

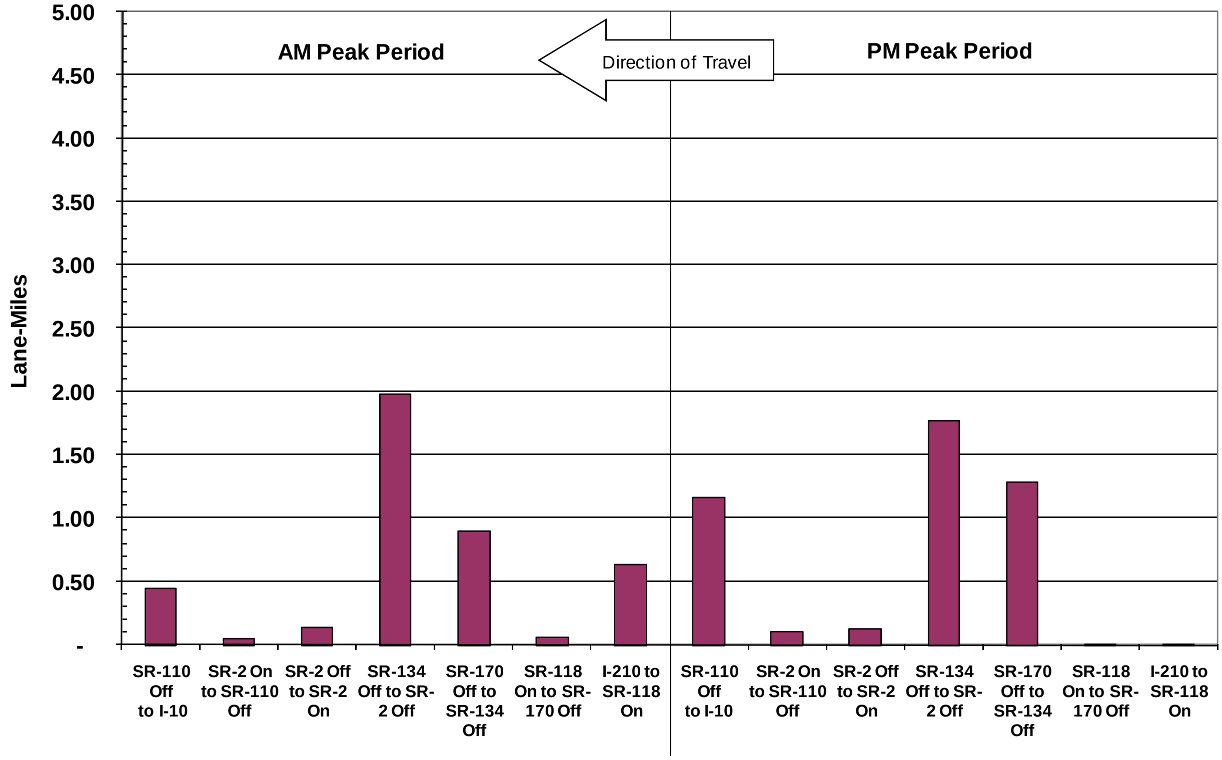


Source: SMG analysis of PeMS data

In the southbound direction, the segment from SR-134 to SR-2 Off experienced the greatest productivity loss during both peak periods with just under 2.0 lost lane-miles for each peak period.

The segments of the corridor with the highest productivity losses coincide with the segments that experience the greatest annual vehicle-hours of delay.

Exhibit 4-16: Southbound I-5 Lost Lane-Miles (2007)



Source: SMG analysis of PeMS data

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

5. CAUSALITY ANALYSIS

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 location of each major bottleneck should be verified by multiple field observations on separate days. The cause of each major bottleneck can also identified by field observations and additional traffic data analysis. For the I-5 Corridor, field observations were conducted by the project consultant team on multiple days (midweek) in September, October, and November 2008 during the AM and PM peak hours. The most recent field reviews were conducted during November 18 through 20, 2008.

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.

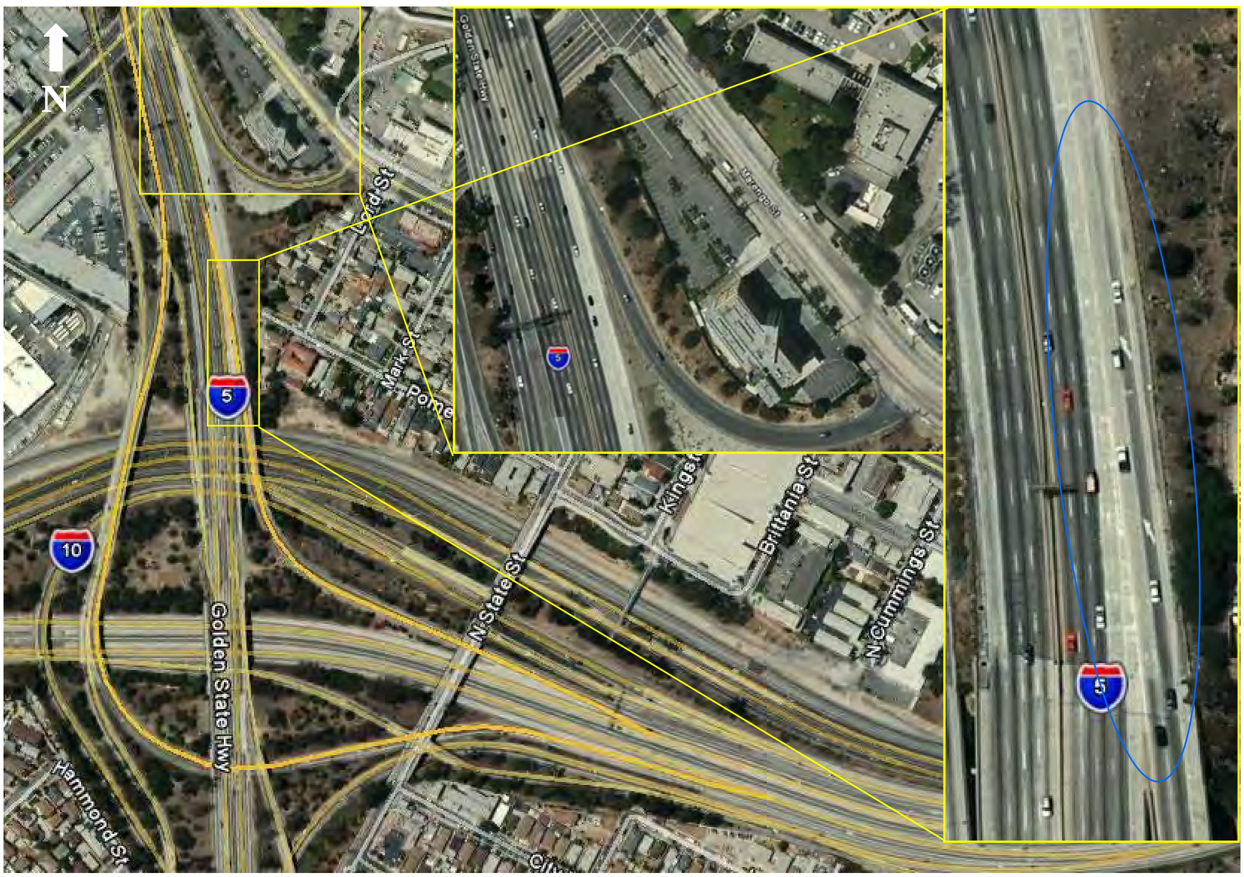
Northbound Bottlenecks and Causes

Major northbound bottlenecks and congestion often occurs during both AM and PM peak hours. The following is a summary of the northbound bottlenecks and the identified causes.

<u>I-10</u>

Exhibit 5-1 is an aerial photograph of the northbound I-5 mainline at the I-10 connector on-ramp, which is the beginning of the study corridor. During the PM peak hours, the volume of traffic from I-10 is heavy. The northbound I-5 cannot accommodate this additional demand and results in considerable congestion. Another on-ramp from Marengo Street adds to the I-10 merging traffic less than 1,000 feet away. Significant queuing results on the I-10 connector as well to the I-10 mainline.

Exhibit 5-1: Northbound I-5 at I-10 On



SR-110 On

Exhibit 5-2 is an aerial photograph of the northbound I-5 mainline at the SR-110 connector on-ramp. As shown in the exhibit, significant merging occurs from the connector on-ramp to the I-5 mainline, causing the traffic stream to breakdown, resulting in congestion. The mainline traffic cannot accommodate the additional demand from the connector ramp. The new connector lane is soon lost to the SR-2 exit and vehicles often try to merge quickly onto the I-5 mainline. In addition, the SR-110 connector ramp is a two-lane ramp that merges into one as it reaches the I-5 mainline; as a result, some of the traffic on the left connector lane tries to merge into the I-5 mainline before the two connector lanes merge. With slow-moving vehicles entering the fast-moving I-5 mainline, the mainline traffic is forced to slow down. This creates a ripple effect and a bottleneck.

Although this condition occurs mostly during the PM peak hours, it also frequently occurs during the AM peak hours. This location is likely to be a significant bottleneck in both the AM and PM peak hours in the future.

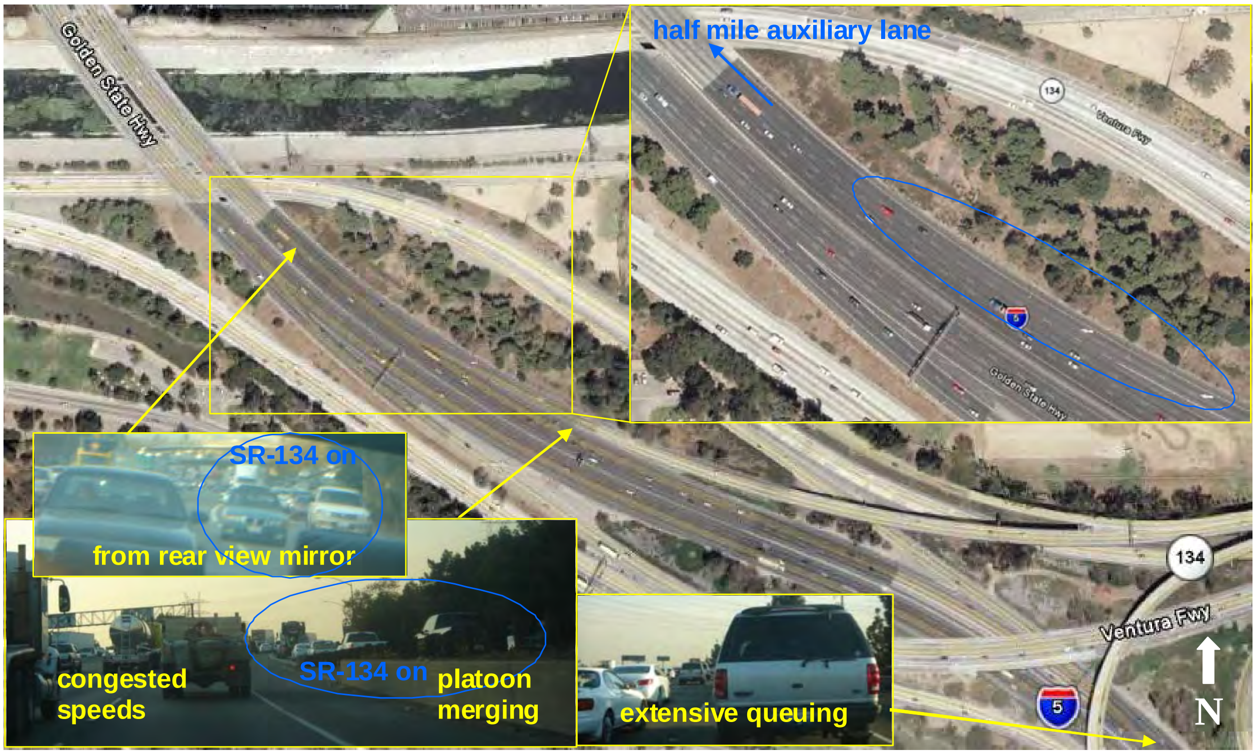
Exhibit 5-2: Northbound I-5 at I-110 On

<u>SR-134 On</u>

Exhibit 5-3 is an aerial photograph of the northbound I-5 mainline at the SR-134 connector on-ramp. As with the I-10 on-ramp and the SR-110 on-ramp, the I-5 mainline cannot accommodate the surge in demand from the SR-134 connector on-ramp. The lower right inset photograph shows significant stop-and-go congestion approaching this location. The other two photographs show the substantial platoon traffic from the SR-134 connector merging onto the I-5 mainline.

While the demand is above what the facility capacity can handle, the capacity is also likely to be impacted by an uphill grade and a roadway curve to the right while traffic merges to the left.

Exhibit 5-3: Northbound I-5 at SR-134 On



Alameda Avenue On

Exhibit 5-4 is an aerial photograph of the northbound I-5 at the Alameda Avenue interchange. The bottleneck condition at this location is caused by platoons of vehicles merging onto the freeway right as the mainline traffic makes the turn. The photograph illustrates the mainline queuing behind the merge point and free flow condition past it.

While the westbound Alameda Avenue on-ramp is metered, the eastbound Alameda Avenue on-ramp and the collector-distributor are not, which causes vehicles to platoon. This location is also impacted by the roadway curve to the right and uphill grade over San Fernando Road.

Exhibit 5-4: Northbound I-5 at Alameda Avenue On

<u>Sheldon Street On</u>

Exhibit 5-5 is an aerial photograph of the northbound I-5 at the Sheldon Street on-ramp. The bottleneck condition at this location is caused by the combination of uphill grade, roadway curvature, and traffic merging in from the Sheldon Street on-ramp. Sheldon Street traffic is metered, but too far back on the ramp to be effective. The location of the metering is illustrated by the blue circle in the exhibit. In addition, the collector-distributor traffic is not, which results in occasional platoons of merging vehicles.

Exhibit 5-5: Northbound I-5 at Sheldon Street On

<u>SR-170 On/Osborne Street Off</u>

Exhibit 5-6 is an aerial photograph of the northbound I-5 at the SR-170 on-ramp and Osborne Street off-ramp. As the exhibit illustrates, considerable merging (and cross weaving) occurs between the SR-170 connector on-ramp and the Osborne Street off-ramp. The outermost lane from the I-5 mainline is dropped at the Osborne Street interchange, forcing the mainline traffic to merge left, while at the same time, the SR-170 traffic enters the I-5 mainline from the left. Merges on both sides of the freeway cause the middle lanes to slow. This results in bottleneck conditions.

Exhibit 5-6: Northbound I-5 at SR-170 On/Osborne Street Off

SR-118 Off

Exhibit 5-7 is an aerial photograph of the northbound I-5 at the SR-118 off-ramp. As the exhibit illustrates, the seven lanes from the I-5 mainline is reduced to four as three lanes go to the SR-118 connector exit. When the mainline volumes are high, this reduction in lanes cannot accommodate the volume of demand resulting in the bottleneck condition.

Exhibit 5-7: Northbound I-5 at SR-118 Off

Southbound Bottlenecks and Causes

The southbound bottlenecks and congestion occur mostly in the AM peak hours, although evidence of some of the same bottlenecks to a lesser degree can be found in the PM peak hours. Below is a summary of the causes of the bottleneck locations.

<u>SR-118 On</u>

Exhibit 5-8 is an aerial photograph of the southbound I-5 mainline at the SR-118 connector on-ramp. Although this location was not identified as a major bottleneck, congestion caused by traffic entering from the SR-118 connector on-ramp was observed during numerous site visits. The SR-118 traffic enters on new lanes, but the traffic is forced to merge left when the right lanes exit to the SR-170 further downstream. This causes an occasional bottleneck at this location.

Exhibit 5-8: Southbound I-5 at I-710 On

<u>SR-170 Off</u>

Exhibit 5-9 is an aerial photograph of the southbound I-5 mainline at the SR-170 connector off-ramp. This is a major bottleneck location, shown in the inset photograph. Traffic demand for the SR-170 is very high, creating a backup onto the I-5 mainline. As a result, the I-5 mainline traffic shifts left to avoid the backup and creates further merging and queuing.

Exhibit 5-9: Southbound I-5 at SR-170 Off

<u>SR-134 Off</u>

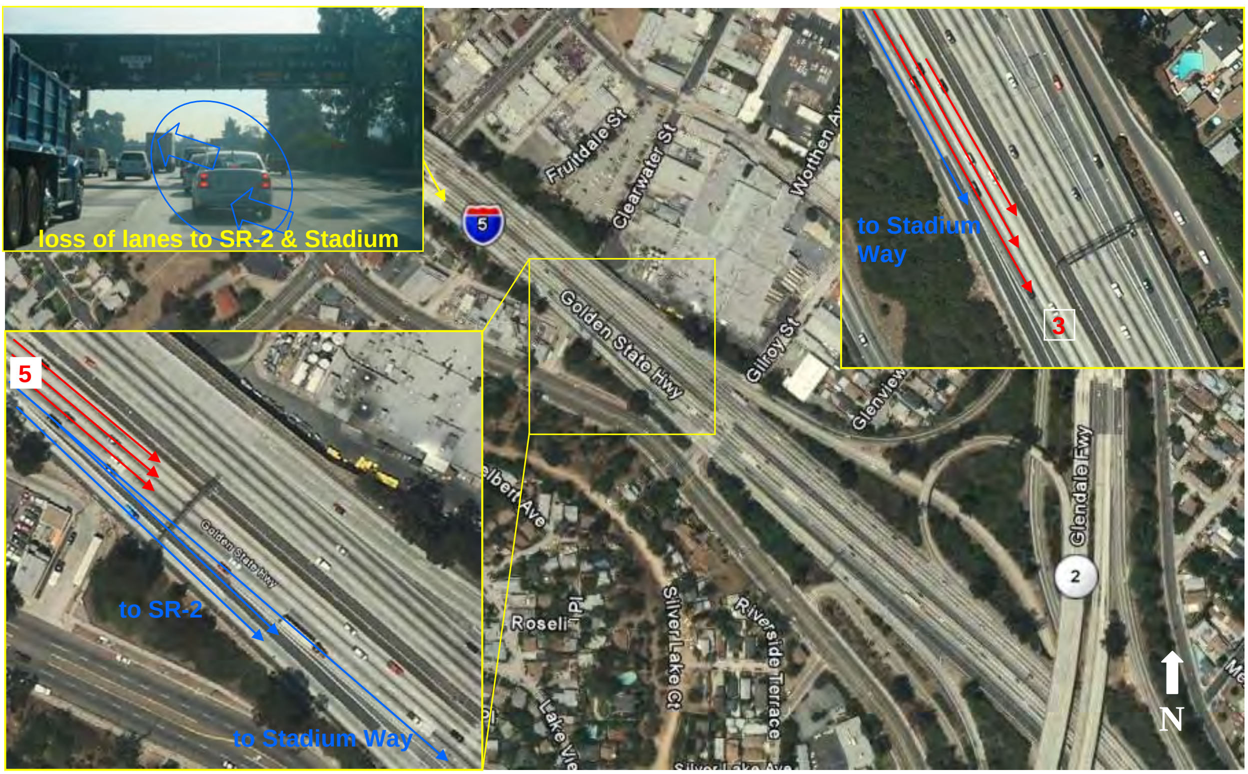
Exhibit 5-10 is an aerial photograph of the southbound I-5 at the SR-134 connector off-ramp. As the exhibit illustrates, traffic exiting to the SR-134 often queues onto the I-5 mainline, causing a bottleneck at this location. Congestion occurs mostly during PM peak hours (when demand for the SR-134 connector is high) and seldom during AM peak hours.

Exhibit 5-10: Southbound I-5 at SR-134 Off

<u>SR-2 Off</u>

Exhibit 5-11 is an aerial photograph of the southbound I-5 at SR-2 connector off-ramp. The mainline roadway loses one lane to the SR-2 exit, going from five lanes to four, and loses another lane at Stadium Way. As the inset photograph illustrates, the demand for the SR-2 is not significant. However, the two lane drops cause the traffic in those outer lanes to move left, causing a squeeze on those left lanes and resulting in the bottleneck condition.

Exhibit 5-11: Southbound I-5 at SR-2 Off



SR-2 On

Exhibit 5-12 is an aerial photograph of the southbound I-5 mainline at SR-2 connector on-ramp. As shown in the inset photograph, there is a surge of demand from the SR-2 connector on-ramp, particularly during the AM peak hours, resulting in a steady stream of platoon traffic merging onto the I-5 mainline freeway.

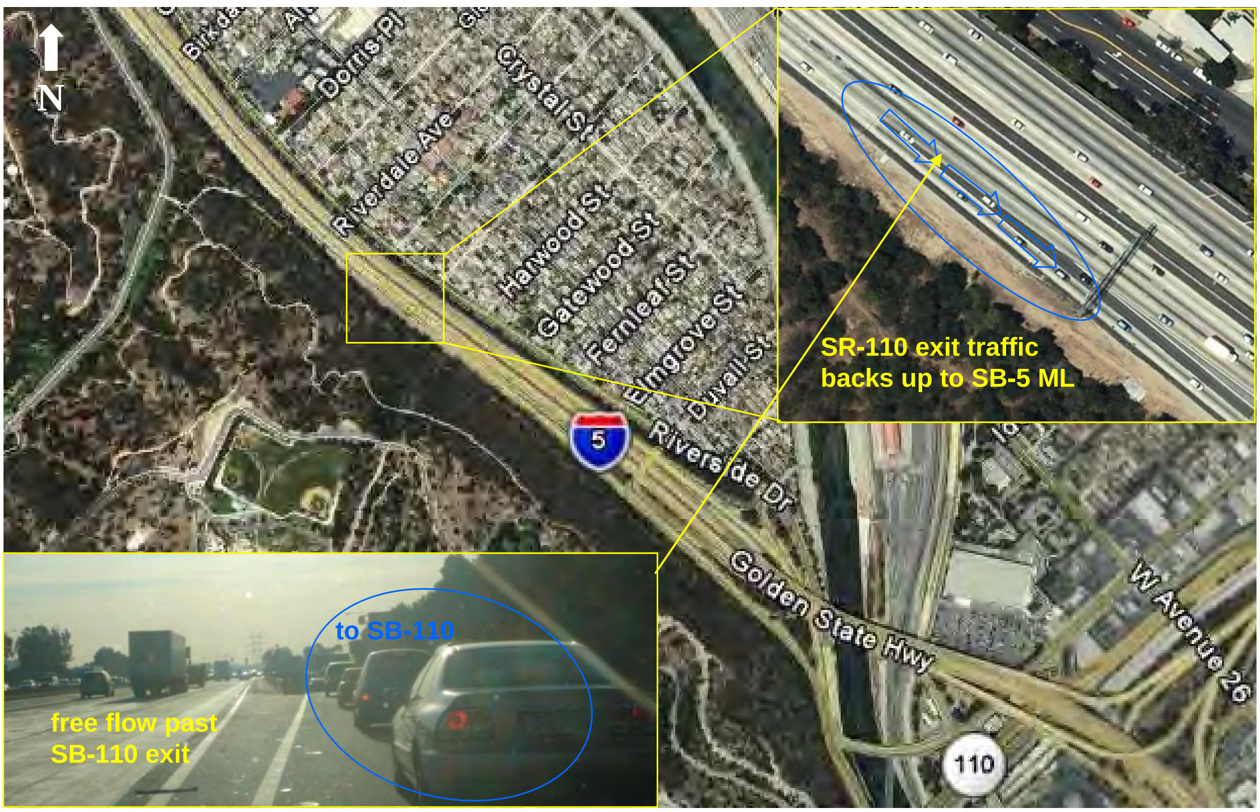
Although this on-ramp traffic enters into new lanes, they must move left to continue onto I-5. The outer lanes exit to the SR-110 exit further downstream.

Exhibit 5-12: Southbound I-5 at Carmenita Road IC

SR-110 Off

Exhibit 5-13 is an aerial photograph of the southbound I-5 mainline at the southbound SR-110 connector off-ramp. This is the most significant bottleneck in the southbound direction. This bottleneck and congestion occurs often from 7 AM to 7 PM. Traffic exiting to the southbound SR-110 connector is destined to or passing through the Los Angeles downtown area. The bottleneck condition is caused by the exit traffic backing onto the I-5 mainline blocking the I-5 through traffic lanes and the SR-2 connector on-ramp traffic merging to the left lanes. There is inadequate capacity to accommodate the demand due to the blockage of the through lanes by the exit traffic. As the inset photograph illustrates, free-flow conditions are restored just past this bottleneck location.

Exhibit 5-13: Southbound I-5 at SR-110 Off



Page Intentionally Left Blank for Future Updates on Bottleneck Causality

APPENDIX

This appendix is an exact copy of Section 4 of the Preliminary Performance Assessment document developed and submitted to Caltrans in April 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.

A. BOTTLENECK ANALYSIS

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

A variety of sources were used to identify bottlenecks:

- Caltrans Highway Congestion Monitoring Program (HICOMP) 2006 report
- Freeway Performance Measurement System (PeMS)
- Aerial photos (Google Earth) and Caltrans photologs.

HICOMP

Potential problem areas are initially identified by reviewing the Caltrans Highway Congestion Monitoring (HICOMP) Report. The results of the analysis are in Exhibits 4-1 and 4-2. The downstream end of congested segments indicate potential bottleneck areas, which are indicated by blue circles in the northbound direction and red circles in the southbound direction.

- In the **AM peak**, there are potentially three major bottlenecks in the <u>southbound</u> direction and one major bottleneck in the <u>northbound</u> direction, as identified in the 2006 HICOMP:
  - SR-110 (southbound)
  - Riverside Drive (northbound)
  - SR-134 (southbound)
  - Lankershim Boulevard/Tuxford (southbound).

- In the **PM peak**, there are potentially three major bottleneck in the <u>northbound</u> direction and two major bottlenecks in the <u>southbound</u> direction, as identified in the 2006 HICOMP:
  - Riverside Drive (northbound)
  - SR-2 (southbound)
  - SR-134 (southbound)
  - Verdugo Avenue (northbound)
  - Laurel Canyon Boulevard (northbound).

Further analysis is needed to determine their actual locations and other possible 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

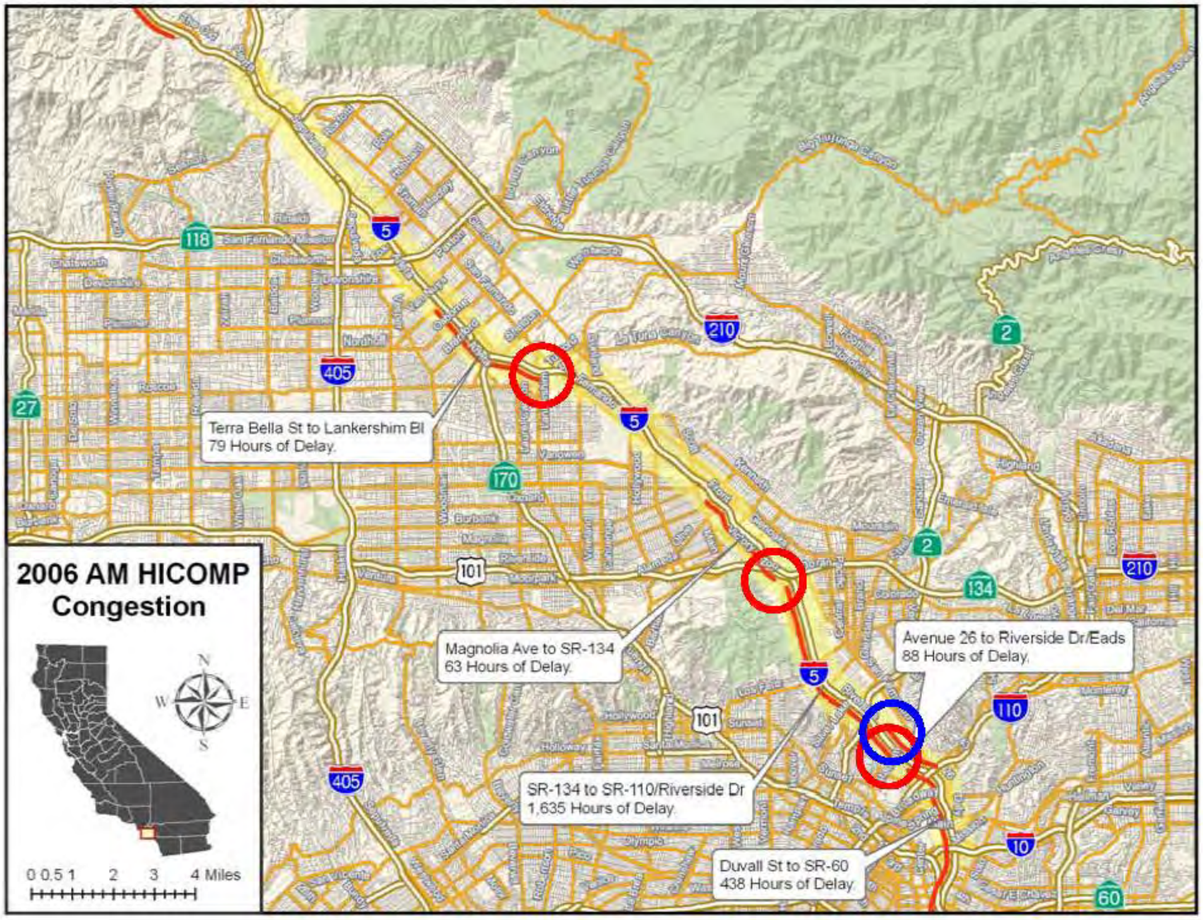
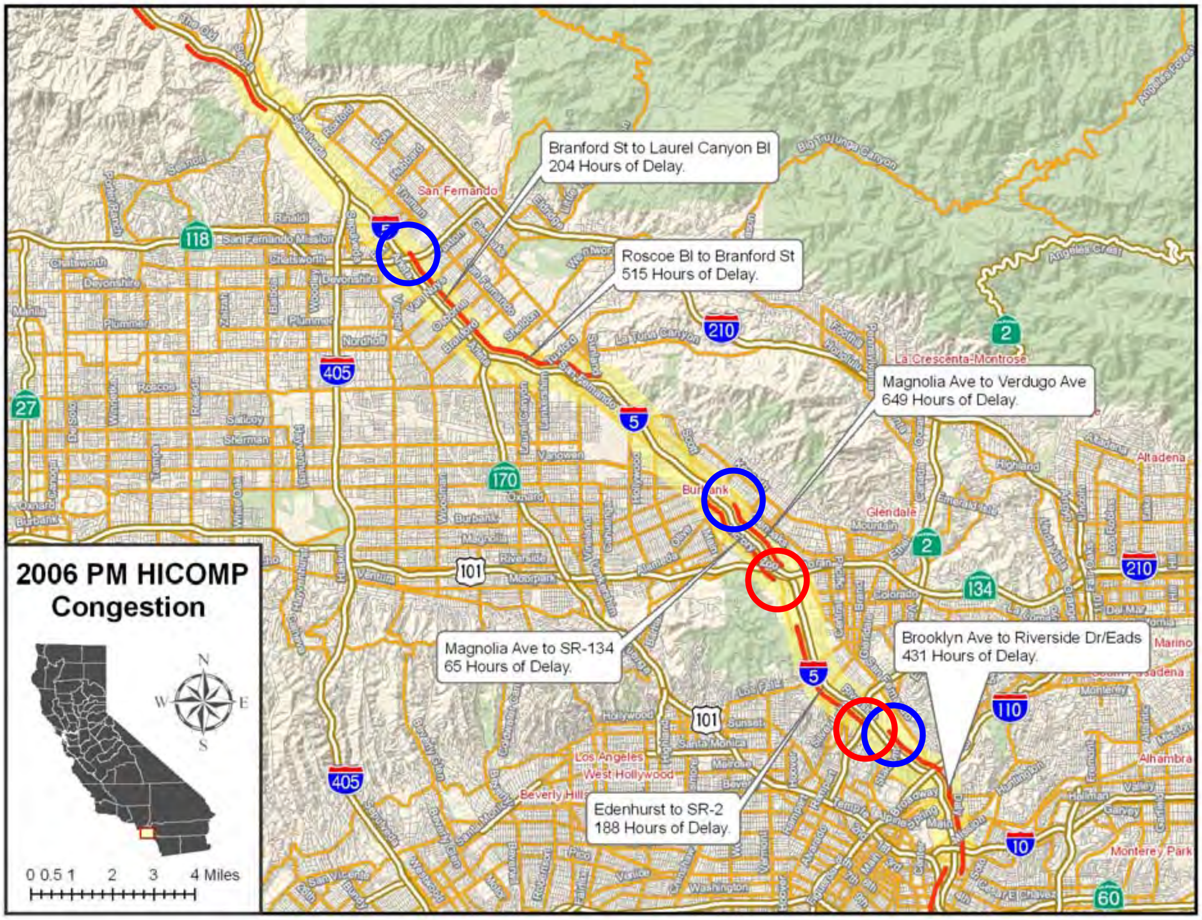


Exhibit A4-2: 2006 HICOMP PM Congestion Map with Potential Bottlenecks



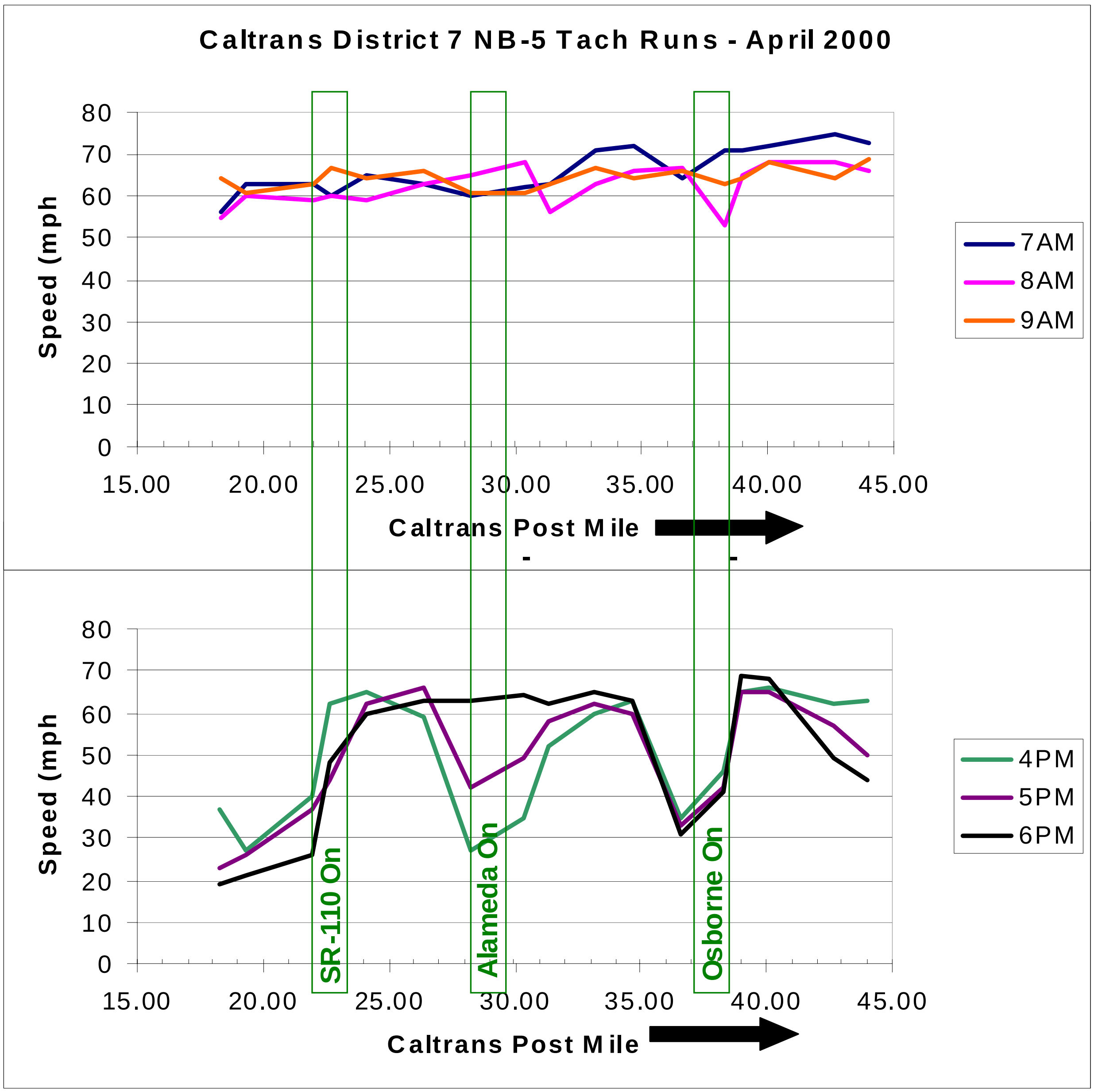
Probe Vehicle Runs

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, 20 to 30 minute intervals. Actual speeds are recorded as the vehicle traverses the corridor. Bottlenecks can be found at the end of congested segment, where speeds generally increase from about 30 miles per hour to 50 miles per hour.

Caltrans District 7 collected probe vehicle run data in April 2000 for the I-5 freeway from the Downtown Los Angeles to the I-210 interchange. The freeway corridor runs were broken into two separate segments from the I-10 to Buena Vista and Buena Vista to the I-210 interchange. For each segment, the runs were conducted from approximately 5:30 AM to 11:00 AM and from 2:30 PM to 7:30 PM. Exhibit 4-3 illustrates the I-5 northbound probe vehicle runs conducted on separate days in April 2000 at specific time intervals: run at 7:00 AM, 8:00 AM, 9:00 AM, 4:00 PM, 5:00 PM and 6:00 PM.

There are slow speeds (congestion) and bottleneck evident only in the PM peak hours in the northbound direction. However, these probe vehicle runs could be capturing entirely different condition than the PeMS data, since they were collected several years earlier.

Exhibit A4-3: Northbound I-5 Sample Probe Vehicle Runs (April 2000)



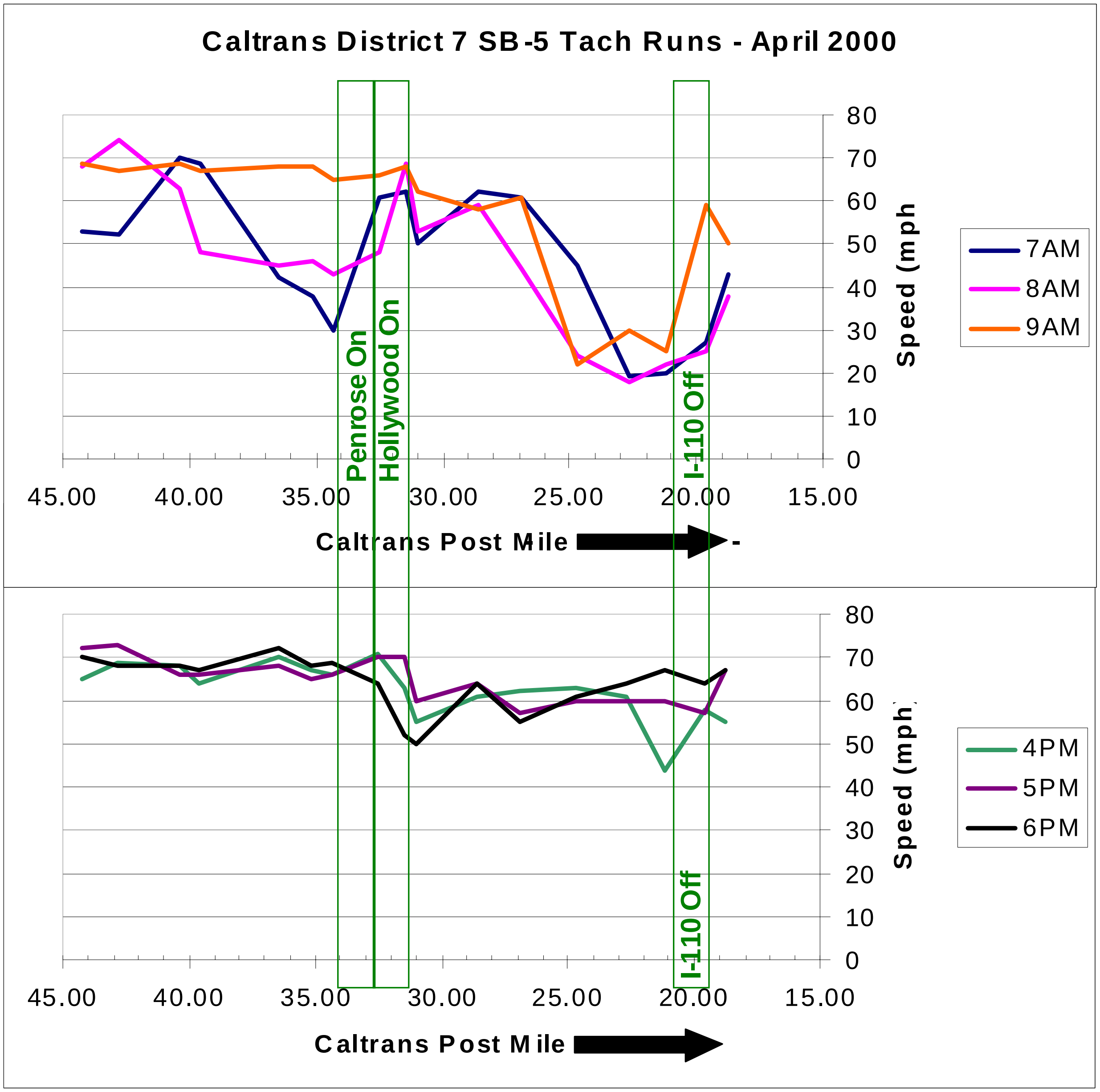
The major northbound bottlenecks identified from the probe vehicle runs occur at:

- SR-110 on (PM)

- Alameda on (PM)
- Osborne on (PM).

Exhibit 4-4 shows the I-5 southbound probe vehicle runs, which were conducted on separated days in April 2000, for six specific times: 7:00 AM, 8:00 AM, 9:00 AM, 4:00 PM, 5:00 PM, and 6:00 PM. Slow speeds (congestion) and bottlenecks evident primarily in the AM peak hours near the I-110 off-ramp.

Exhibit A4-4: Southbound I-5 Sample Probe Vehicle Runs (April 2000)



The major <u>southbound</u> bottlenecks identified from the probe vehicle runs occur at:

- Penrose on (AM)
- Hollywood on (AM)
- I-110 off (AM/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 graphs. Unlike the probe vehicle runs, each speed plot has the same time across the corridor. For example, an 8:00 AM plot includes the speed at one end of the corridor at 8:00 AM and the speed at the other end of the corridor also at 8:00 AM. 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, the two sets of graphs identify similar problem areas. These speed plots are then compiled at five minute intervals and presented in speed contour plots.

<u>NORTHBOUND</u>

Exhibit 4-5 shows the speed contour plots for Wednesday, October 24, 2007 and Thursday, October 25, 2007. The speed contour plots represent a typical weekday sample to illustrate the bottleneck locations and the resulting congestion. The sample days had observed or “good” detection data of less than 50 percent, providing less than desirable results with significant gaps. Still, some reasonable conclusions can be drawn from the results. Extensive field observation and/or additional data analysis will be needed for the comprehensive assessment to verify the bottleneck locations and their causes.

The speed contour plots are typical speed contour diagrams for the I-5 freeway in the northbound direction (traffic moving left to right on the plot). Along the vertical axis is the time period from 4:00 AM to 8:00 PM. Along the horizontal axis is the corridor segment from the I-10 to the I-210 interchange. The various colors indicate the average speeds corresponding to the color speed chart shown below the diagram. The dark blue blotches represent congested areas where speeds are reduced. The end of each dark blotch represents a bottleneck area, where speeds pickup after congestion, typically to 30 to 50 miles per hour in a relatively short distance. The horizontal length of each plot is the congested segment or queue lengths. The vertical length is the congested time period.

Exhibit A4-5: PeMS Northbound I-5 Speed Contour Plots (October 2007)

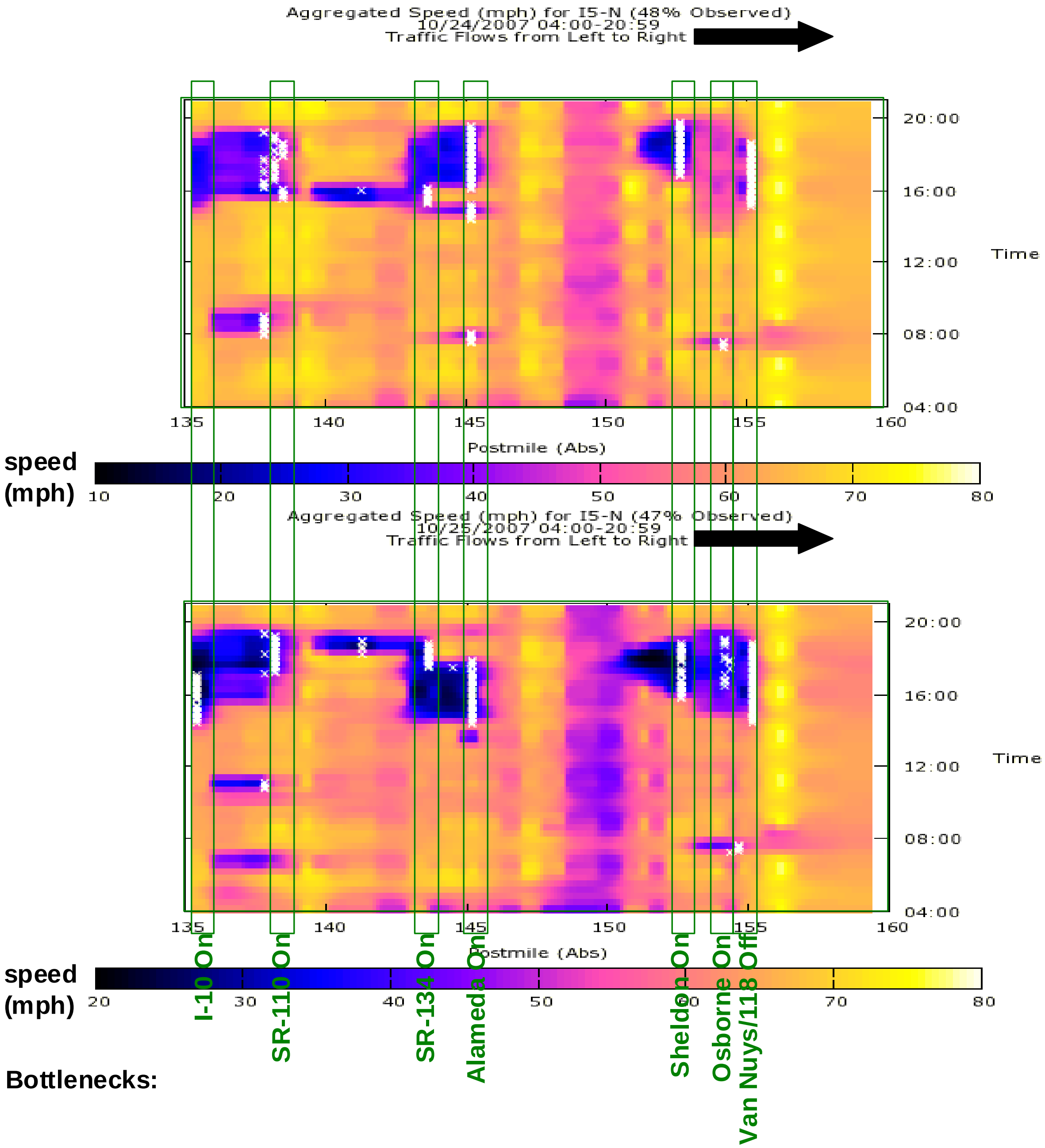
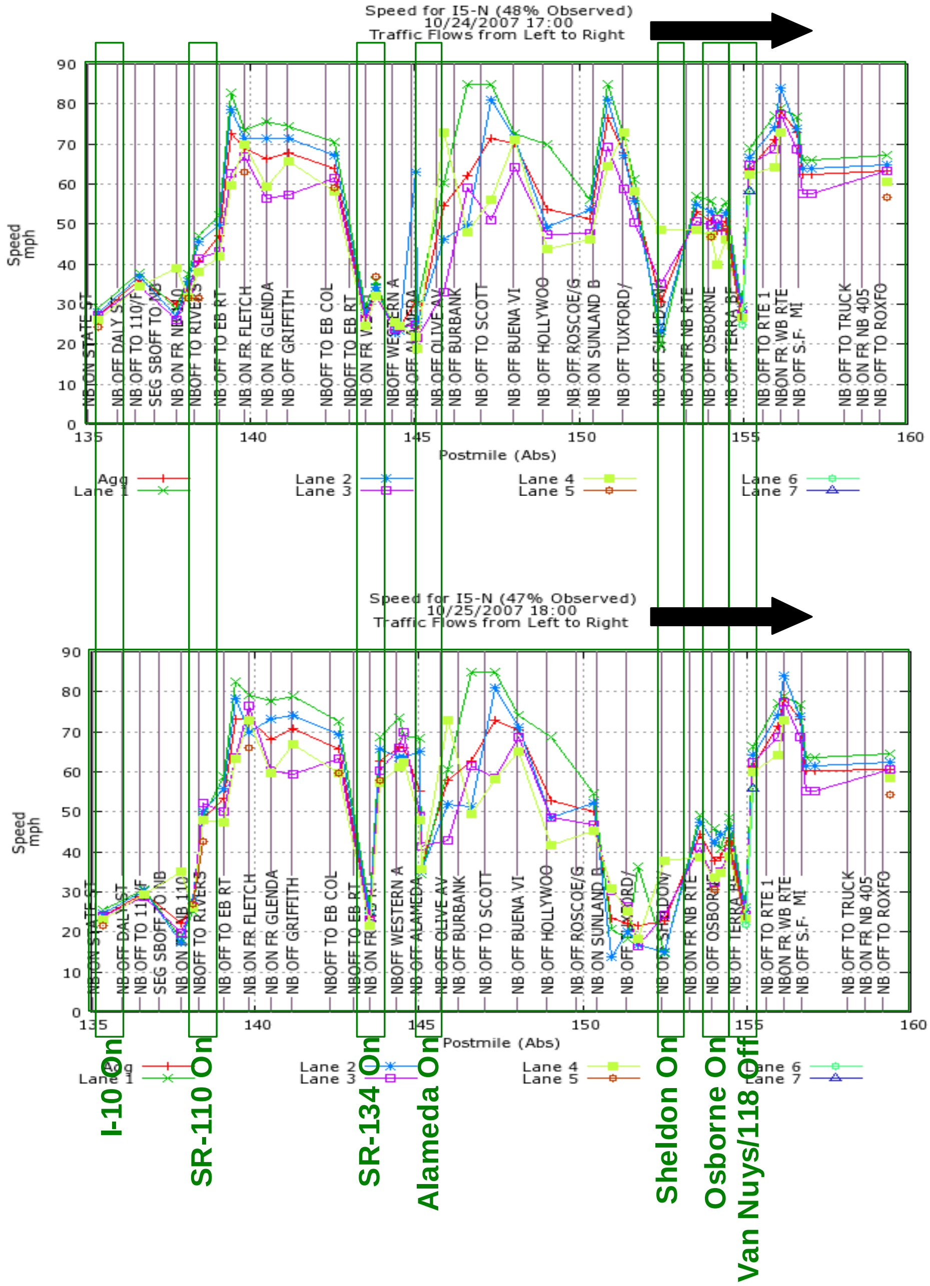


Exhibit 4-6 shows the speed profile plots for Wednesday, October 24, 2007 at 5:00 PM and Thursday, October 25, 2007 at 6:00 PM in the evening. The speed profile plots represent a typical weekday sample to illustrate the bottleneck locations and congestion formed from them at a particular time in the day, in this case at 5:00 PM and 6:00 PM. The speed profile plots illustrate the typical speed profile diagram for the I-5 freeway in the northbound direction (traffic moving left to right on the plot).

Exhibit A4-6: PeMS Northbound I-5 Speed Profile Plots (October 2007)



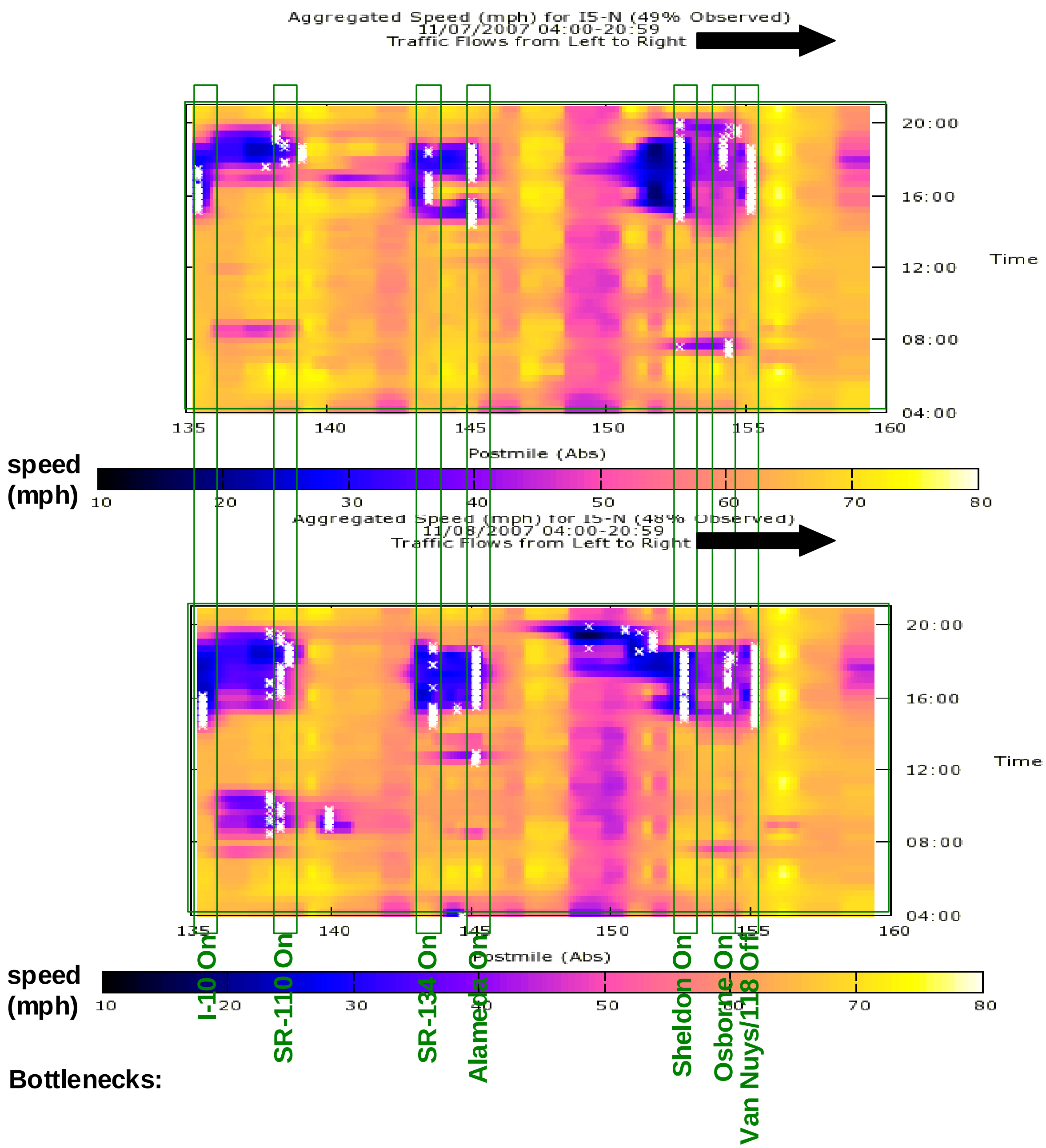
Based on the contour plots of a typical weekday sample in October 2007, the following bottlenecks were identified in the northbound direction:

- I-10 on (PM)
- I-110 on (AM/PM)

- SR-134 on (PM)
- Alameda on (PM)
- Sheldon on (PM)
- Osborne on (PM)
- SR-118 off (AM/PM).

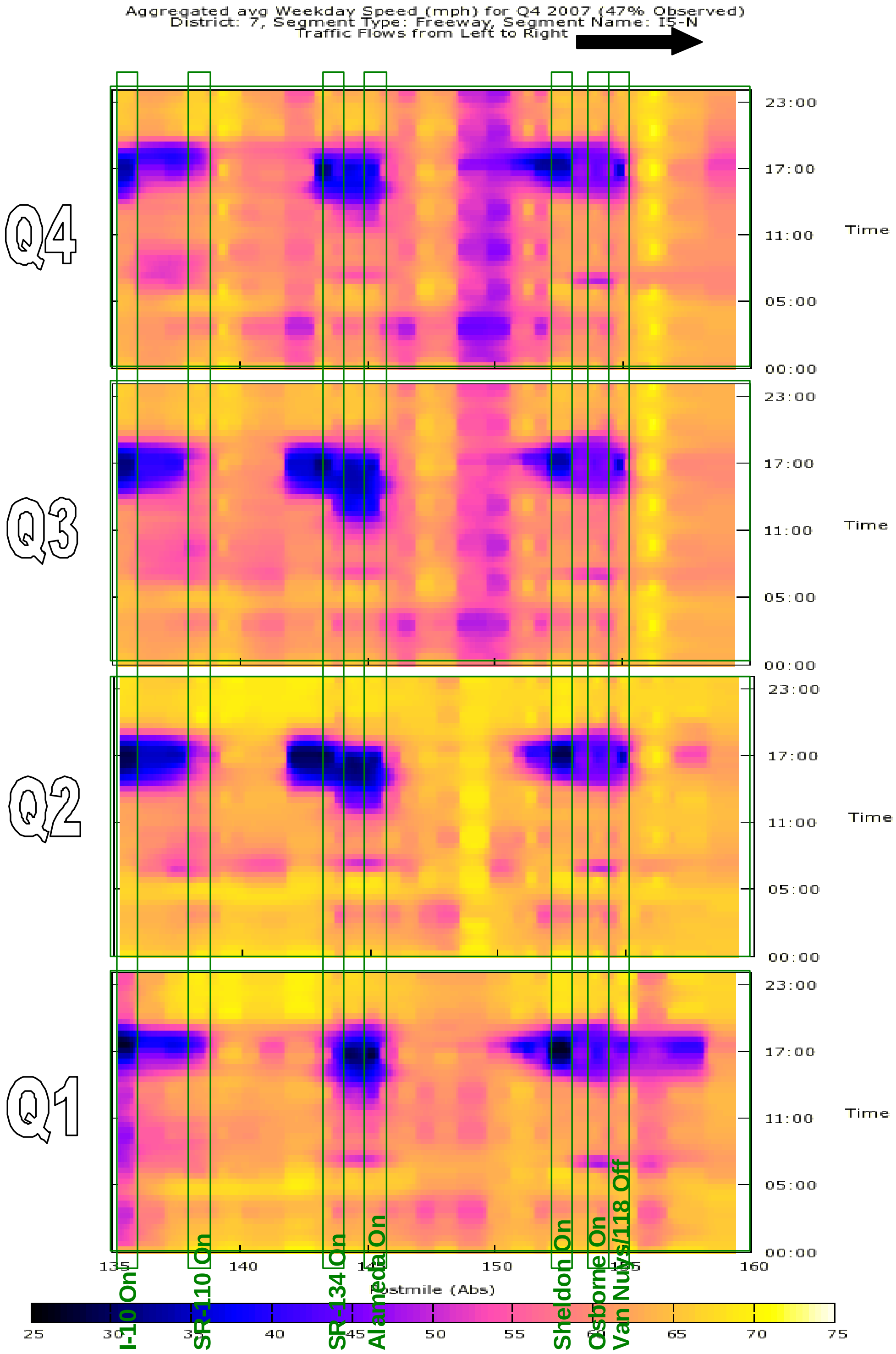
Other sample days were reviewed to validate the analysis. Exhibit 4-7 illustrates the speed contours of additional weekday samples in November 2007. The same bottleneck locations are identified on the new sample days, indicating a reoccurring pattern of the bottleneck locations.

Exhibit A4-7: PeMS Northbound I-5 Speed Contour Plots (November 2007)



In addition to multiple days, averages over longer periods were also considered. Exhibit 4-8 shows 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.

Exhibit A4-8: PeMS Northbound I-5 Long (Speed) Contours (2007 Avg. by Qtr.)



<u>SOUTHBOUND</u>

Similarly, speed contour and profile plots were analyzed in the southbound direction for probe vehicle sample days in October and November 2007. The results were validated by examining additional days in November 2007 and quarterly averages for 2007. Exhibits 4-9 to Exhibit 4-12 illustrate the speed contour and profile plots for the I-5 freeway corridor in the southbound direction (traffic moving left to right on the plot) for sample weekdays in October and November, additional typical weekdays in November, and 2007 quarterly weekday average long contours. Along the vertical axis is the time period from 4:00 AM to 8:00 PM. Along the horizontal axis is the corridor segment from the I-10 interchange to the I-210 interchange. Similar to the northbound PeMS speed contour analysis results, the PeMS southbound speed contour analysis results indicated reoccurring bottleneck locations across multiple weekdays and quarterly averages.

Exhibit A4-9: PeMS Southbound I-5 Speed Contour Plots (October 2007)

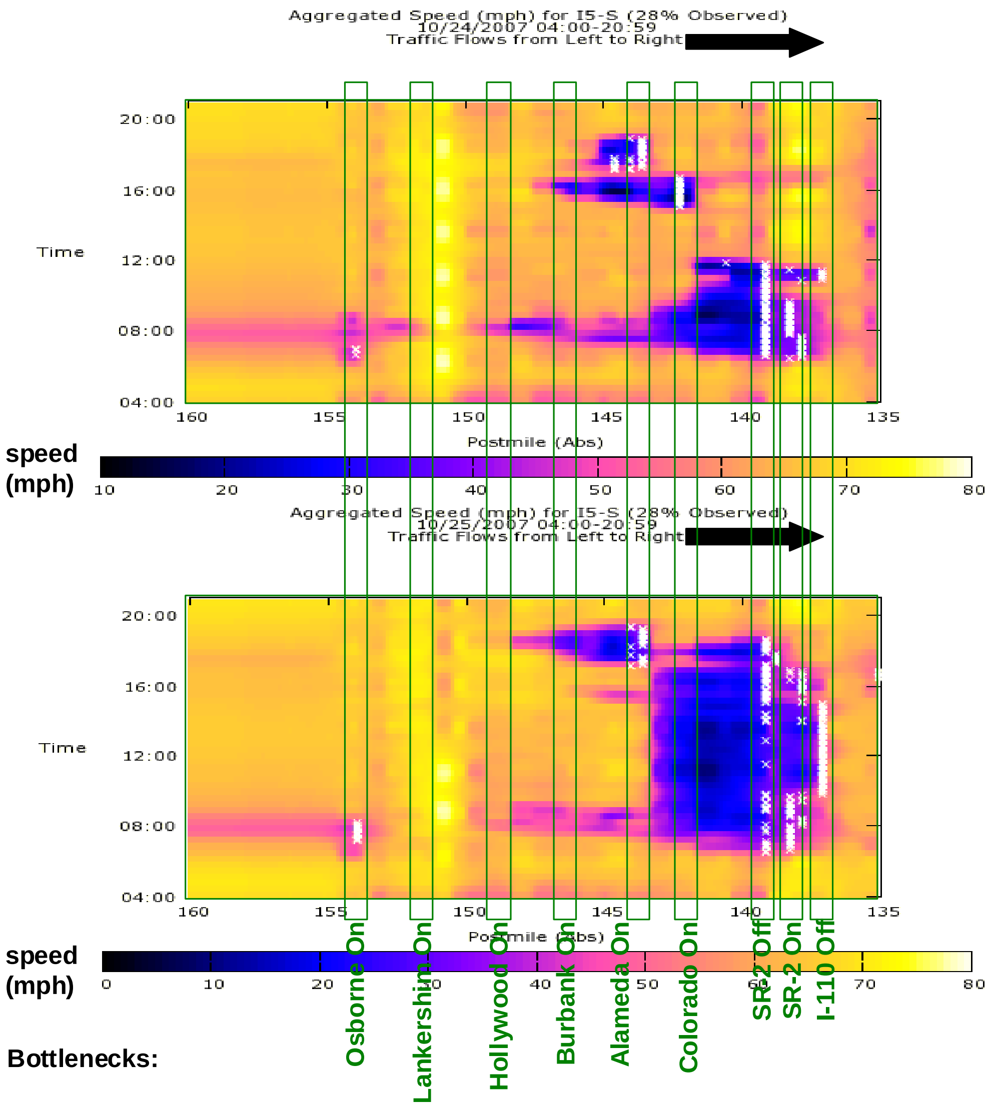


Exhibit A4-10: PeMS Southbound I-5 Speed Profile Plots (Oct/Nov 2007)

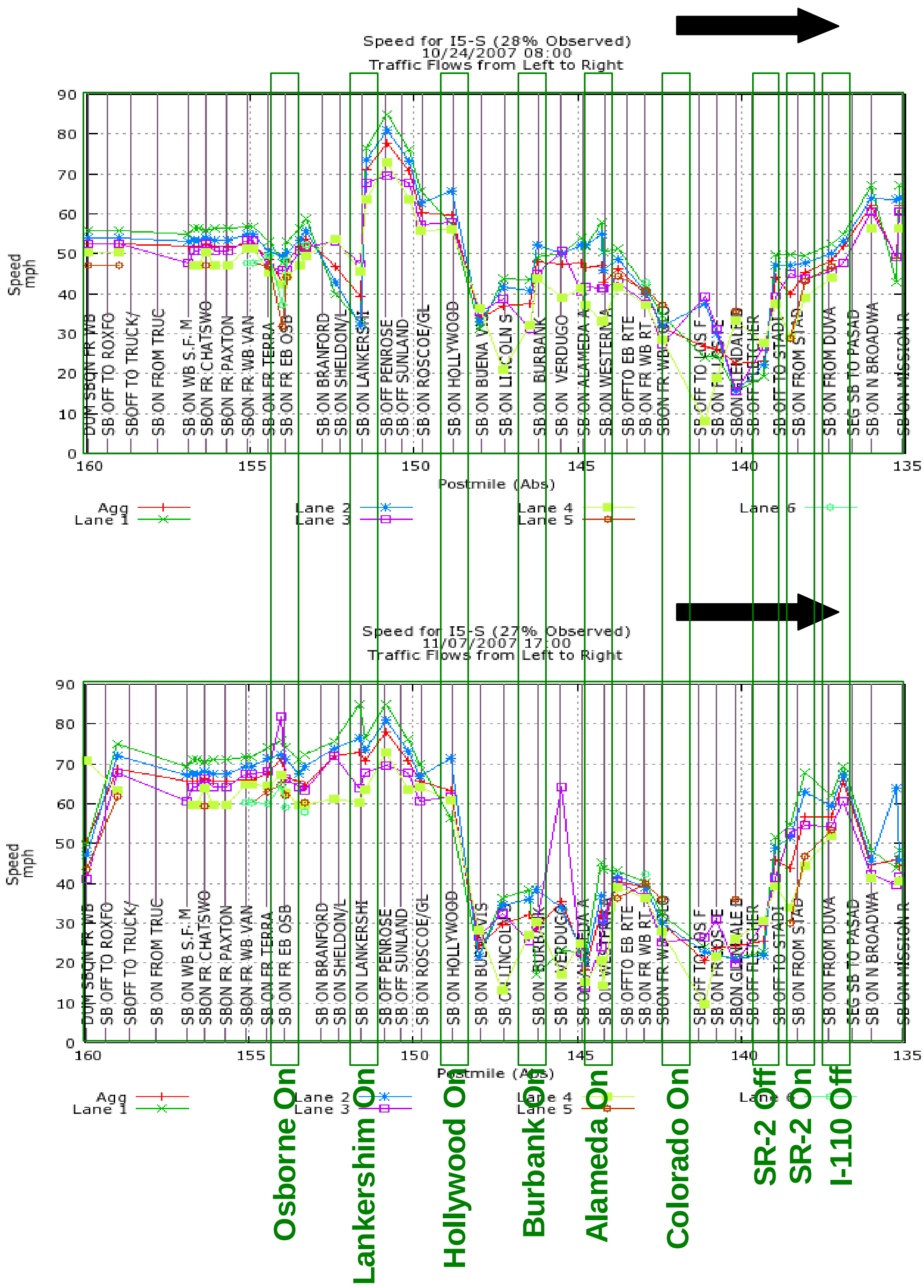


Exhibit A4-11: PeMS Southbound I-5 Speed Contour Plots (November 2007)

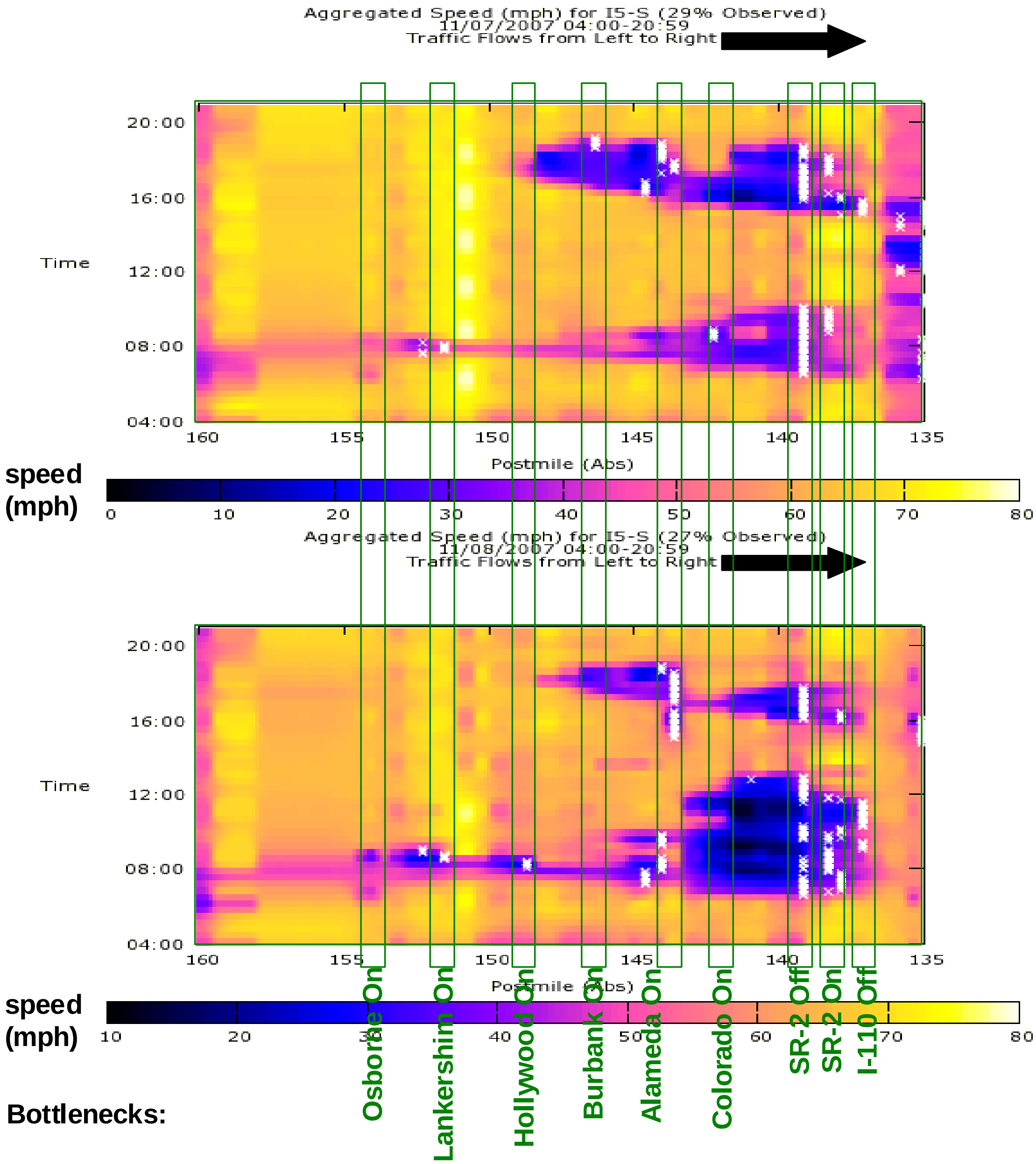
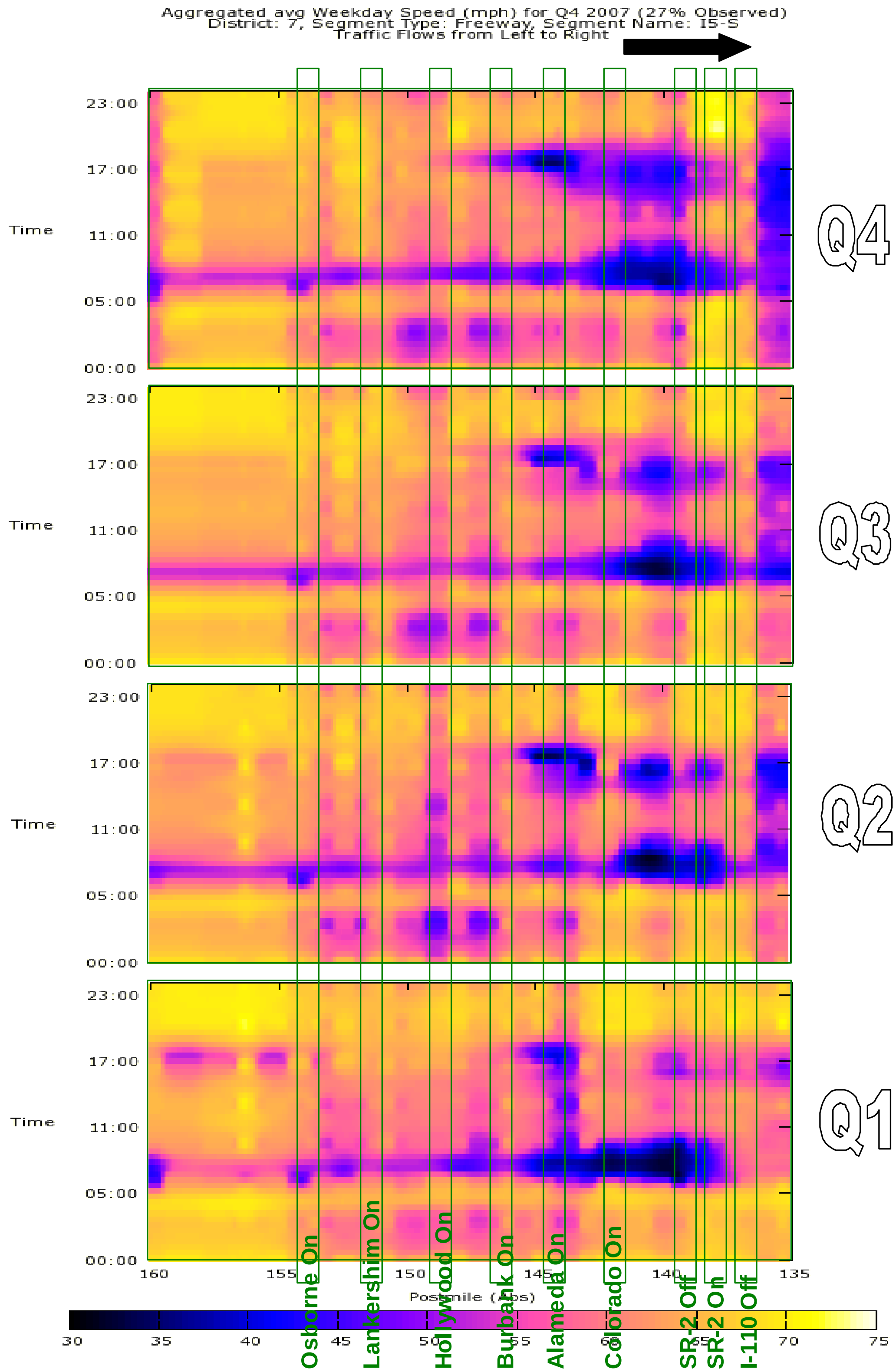


Exhibit A4-12: PeMS Southbound I-5 Long (Speed) Contours (2007 Avg. by Qtr.)



Based on these contour and profile plots of typical weekday samples, the following bottlenecks were identified in the southbound direction:

- Osborne on (AM)
- Lankershim on (AM)
- Hollywood on (AM)
- Burbank on (AM/PM)
- Alameda on (AM/PM)
- Colorado on (AM/PM)
- SR-2 off (AM/PM)
- SR-2 on (AM/PM)
- I-110 off (AM/PM).

Bottleneck Summary

Exhibit 4-13 provides a summary of the potential bottleneck locations based on the various sources: 2006 HICOMP report, Caltrans District 7 probe vehicle runs, and PeMS speed profile and speed contour plots. The rows in bold indicate bottlenecks identified in multiple sources. These are likely to be major reoccurring bottlenecks.

The 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 A4-13: I-5 Identified Bottlenecks Summary Table

BOTTLENECK LOCATION	Bottleneck Area Post Mile Range		HICOMP [a] Report		Caltrans [b] Probe Veh. Runs		PeMS [a] Speed Contours	
	Absolute	Caltrans	AM	PM	AM	PM	AM	PM
NORTHBOUND								
I-10 on	135.22	18.58	-	-	-	-	-	✓
I-110 on (Riverside Drive)	138.00	21.30	✓	✓	-	✓	✓	✓
SR-134 on	143.51	26.88	-	-	-	-	-	✓
Alameda on/Verdugo	145.29	28.65	-	✓	-	✓	-	✓
Sheldon on/Laurel Canyon	152.79	36.16	-	✓	-	-	-	✓
Osborne on	154.19	37.56	-	-	-	✓	-	✓
SR-118 off	155.59	38.96	-	-	-	-	✓	✓
SOUTHBOUND								
Osborne on	153.93	37.36	-	-	-	-	✓	-
Lankershim on	151.61	35.04	✓	-	-	-	✓	-
Penrose on	150.72	34.15	-	-	✓	-	-	-
Hollywood on	148.81	32.24	-	-	✓	-	✓	-
Burbank on	146.21	29.64	-	-	-	-	✓	✓
Alameda on	144.84	28.27	-	-	-	-	✓	✓
SR-134 off	143.51	26.94	✓	✓	-	-	-	-
Colorado on	142.42	25.85	-	-	-	-	✓	✓
SR-2 off	139.34	22.77	-	✓	-	-	✓	✓
SR-2 on	138.50	21.93	-	-	-	-	✓	✓
I-110 off	137.76	21.19	✓	-	✓	✓	✓	✓

NOTES:

[a] Based on 2006 HICOMP report.

[b] Based on Caltrans District 7 tach runs conducted on April 5 &13, 2000.

[c] Based on Performance Measurement System (PeMS) sample speed contours and profiles taken from October & November 2007 and 2007 quarterly weekday averages data.

na Data not available

\- No indication of bottleneck from this source.

✓ Bottleneck identified from this source.

bold Bottleneck identified from multiple sources.