Corridor System Management Plan (CSMP) Riverside and San Bernardino Counties I-15 Comprehensive Performance Assessment & Causality Report

September 2011

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Executive Summary

The purpose of this document is to analyze the existing conditions of Interstate 15 (I-15) corridor with the latest available data. It is the first phase of a two phase approach to evaluate the conditions of the corridor. The second phase will use microsimulation (through the urban areas) as a validation tool.

Corridor Description

The study corridor has a total length of 239 miles beginning at the Riverside/San Diego County Line and terminates at the California/Nevada State Line. The corridor passes through cities of Temecula, Murrieta, Wildomar, Lake Elsinore, Corona, Norco, and Eastvale in the County of Riverside. Within the County of San Bernardino, the corridor passes through cities of Ontario, Fontana, Rancho Cucamonga and through the high desert cities of Hesperia, Victorville, Apple Valley, and Barstow. The I-15 corridor varies from a six to eight-lane freeway facility in the urbanized areas and four to six-lane facility in rural areas. The corridor has nine major freeway-to-freeway interchanges at:

I-15 Freeway to Freeway Junctions

Route	Location
I-215	City of Murrieta
SR-91	City of Corona
SR-60	City of Ontario
I-10	City of Ontario
SR-210	City of Rancho Cucamonga
I-215	Devore
US-395	City of Hesperia
SR-58	City of Barstow
I-40	City of Barstow

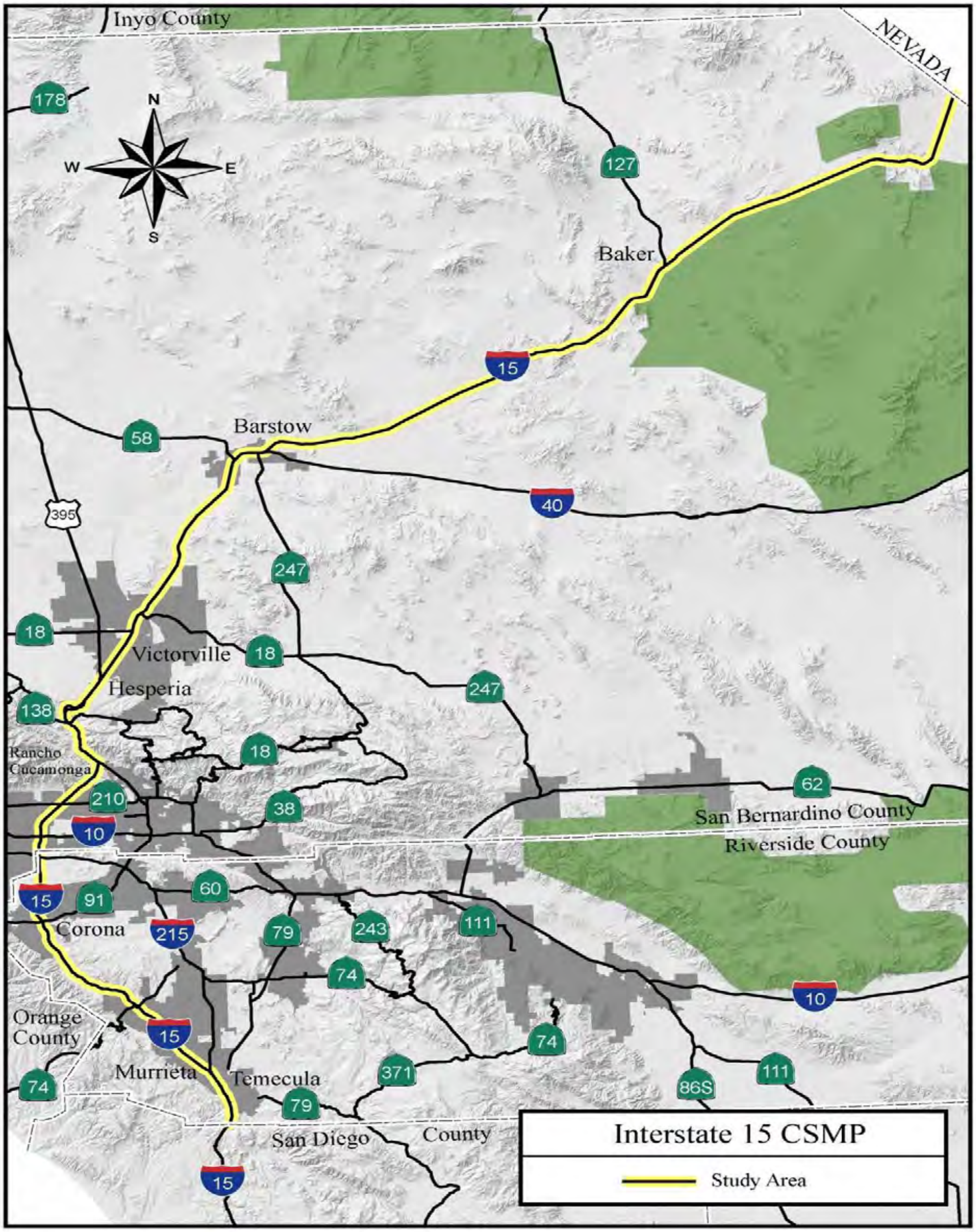
I-15 is part of the National Highway System (NHS), the Strategic Highway Corridor Network of National Defense (STRAHNET), and the Freeway and Expressway System (F&E).

The corridor is a primary link for the Inland Empire and the High Desert to major economics centers and geographic regions of the Greater Los Angeles area and San Diego. It is a significant goods movement corridor between the Ports of Los Angeles and Long Beach, Ontario and Southern California Logistics Airports, States to the east, and the border crossings with Mexico; it also serves as a conduit for recreation travel to San Diego, Las Vegas and other destinations.

In 2008, Average Daily Traffic ranged from nearly 214,000 vehicles near the Riverside/San Bernardino County Line to 37,000 near the California/Nevada State Line.

Traffic is forecasted to increase about 40 percent to approximately 299,000 at the Riverside/San Bernardino County Line, and about 86 percent to approximately 69,000 vehicles per day by 2035 near the California/Nevada State Line. The growing population and relatively affordable housing market in Riverside and San Bernardino Counties, along with increasing employment opportunities in the Greater Los Angeles, Orange County, and San Diego County areas, and increasing goods movement and recreational traffic have increased demand on the corridor in the last decade and are expected to continue into the future.

Exhibit ES-1: I-15 Study Corridor



Corridor-Wide Performance and Trends

In order to identify how well or poorly the corridor is performing, the existing conditions of the I-15 corridor were analyzed using the performance measures of mobility, reliability, productivity, and safety. These performance measures were based on data from 2008 to 2010 with a focus on the 2008 base model year. The following discussion briefly summarizes the results of each performance measure. The detailed discussion can be found in Section 3 of this document, *Comprehensive Performance Assessment*.

- Mobility –In Riverside County in 2010, northbound delay (554,000 vehicle-hours) exceeded southbound delay (369,000 vehicle-hours) by 33 percent. However, in San Bernardino County in 2010, southbound delay (831,000 vehicle-hours) was 5 percent greater than northbound delay (787,000 vehicle-hours). Travel times for the facility remained steady between 2008 and 2010.

- Reliability – this measure captures the degree of predictability in travel time and focuses on how travel time varies from day to day. The variability of peak hour travel time has remained steady between 2008 and 2010 on the facility. The variability is greater between south Corona (Cajalco Road) and Ontario (I-10) than on the rest of the route during weekdays.

- Productivity – this measure reflects the reduction in effective capacity due to merging and weaving activities in equivalent lost lane-miles. In Riverside County, productivity was unstable as lost lane-miles declined from 8.6 in 2008 to 5.7 in 2009, then increased to 9.5 in 2010. Similarly, in San Bernardino County, productivity was unstable as lost lane-miles declined from 6.6 in 2008 to 6.1 in 2009, then increased to 8.1 in 2010.

- Safety – reported accident data must be used for this measure and the latest year of available data is 2010. The number of accidents that occurred on the corridor declined in the northbound direction in both counties from 2008 to 2010 from about 2,000 in 2008 to 1,500 by 2010. In the southbound direction the number of accidents decreased from 2,000 in 2008 to 1,500 in 2009, but then increased in 2010 to 1,600. From 2008 to 2010, the rate of fatalities and injuries for this corridor is lower compared to other state highway facilities with similar operating characteristics. The accident rate for I-15 (0.48) is lower than the rate on similar facilities (0.95)

The following Exhibit ES-2 summarizes the current performance of the I-15 corridor.

Exhibit ES-2: I-15 Corridor-Wide Analysis

Riverside County										
Year	Mobility				Reliability		Safety		Productivity	
	Total Annual Delay (Vehicle Hours)[1]		Average Peak Hour Travel Time (Minutes)[2]		Peak Hour Travel Time Variability (Percent)[2]		Annual Accidents[3]		Average Daily Lost Productivity (Lane-Miles)[1]	
	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
2008	589,029	265,231	52	53	20%	9%	723	782	4.0	4.6
2009	538,875	289,294	52	51	15%	3%	568	547	1.9	3.8
2010	553,840	368,982	50	50	15%	7%	551	610	4.9	4.6

San Bernardino County										
Year	Mobility				Reliability		Safety		Productivity	
	Total Annual Delay (Vehicle Hours)[1]		Average Peak Hour Travel Time (Minutes)[2]		Peak Hour Travel Time Variability (Percent)[2]		Annual Accidents[3]		Average Daily Lost Productivity (Lane-Miles)[1]	
	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
2008	569,557	577,096	23	22	10%	5%	1,296	1,217	5.0	1.6
2009	379,917	510,816	23	22	5%	0%	1,036	976	4.6	1.5
2010	787,380	831,053	24	23	15%	2%	996	1,009	5.3	2.8

[1] Accounts for weekdays during peak and non-peak periods
[2] Accounts for weekdays only
[3] Accounts for weekdays and weekends

Bottleneck Identification and Causality Analysis

By definition (HCM2000), a bottleneck is where traffic demand exceeds the capacity of the roadway facility. In most cases, the cause of a bottleneck is related to a sudden reduction in capacity (such as lane drops, roadway geometry, heavy merging and weaving, and driver distractions) or a surge in demand (from ramps or connectors) that the facility cannot accommodate. The cause of each bottleneck along the corridor was identified through the Performance Measurement System (PeMS) and field observations in 2011. These causes are summarized in Exhibit ES-3. Speed contour data is used as well to validate the bottleneck locations.

Exhibit ES-3: Summary of I-15 2010 Bottleneck Causes[4]
Riverside County
Northbound Bottlenecks

Bottleneck Location	Active Period		Causality Summary
	AM	PM	
Rancho California On		X	Close proximity of two on ramps (E-N, W-N)
Winchester On		X	Close proximity of two on ramps (E-N, W-N)
Weirick On	X		High volume on ramp
2nd St. Lane Drop	X		Lane drop between 2nd St. off ramp and bridge
6th St. On	X		High volume on ramp and roadway geometry of horizontal and vertical alignment
Between Bellegrave OC and Cantu-Galleano Off		X	Roadway geometry of horizontal alignment
Riv/SBd County Line	X	X	Merging and weaving; Lane drop 0.5 mile south of Jurupa Ave.

[4] PeMS

Riverside County
Southbound Bottlenecks

Bottleneck Location	Active Period		Causality Summary
	AM	PM	
Cajalco On	X		High volume on ramp
0.5 mile north of Ontario Off		X	Roadway geometry of horizontal and vertical alignment
0.5 mile south of Magnolia On		X	Roadway geometry of horizontal and vertical alignment
Magnolia Off	X		Merging and Weaving from SR 91 connectors (E-S, W-S) to Magnolia off ramp

San Bernardino County
Southbound Bottlenecks

Bottleneck Location	Active Period		Causality Summary
	AM	PM	
Jurupa Off		X	Merging and Weaving from I-10 connectors (E-S, W-S) to Jurupa off ramp
Baseline Off	X		Lane drop between Baseline off ramp and bridge

San Bernardino County
Northbound Bottlenecks

Bottleneck Location	Active Period		Causality Summary
	AM	PM	
I-15/I-215 IC		X	Horizontal alignment and grade, high traffic volume, and decision point/ merge with I-215

Mobility and safety performance statistics were presented for each bottleneck area as well as for the entire corridor. This allows for the relative contribution of each bottleneck area to the degradation of the corridor to be gauged.

Mobility by Bottleneck Area – PeMS data was used to calculate delay for each bottleneck area. Section 4, Exhibits 4-7 through 4-10 shows the vehicle-hours of delay experienced by each bottleneck area during the peak periods in the each direction. The percentages assigned to each bottleneck area are the number of weekdays the bottleneck occurs. As depicted in Exhibit 4-7, the bottleneck at Weirick experienced the most delay with slightly over 100,000 vehicle-hours of delay.

Causality

By definition, a bottleneck is a condition where traffic demand exceeds the capacity of the roadway facility. In many cases, the cause of the bottlenecks is attributed to such conditions such as a sudden reduction in capacity, roadway geometry, heavy merging and weaving, or a surge in demand that the facility cannot accommodate. Some of the contributing causes of the bottleneck locations are related to:

- Cross weaving traffic at interchanges
- Heavy ramp volumes merging on to the mainline facility when mainline traffic is already heavy
- Platoon merging from the on-ramp
- Horizontal or vertical geometric changes in a roadway

A detailed description of the causality of each bottleneck location is provided in Section 5 of this report. The bottleneck locations identified in Exhibits ES-3 will be used for the I-15 micro-simulation model calibration process.

Planned Corridor System Management Strategies

As one of the major corridors in Southern California, I-15 has been the focus of many efforts to identify potential alternatives for improvement. Projects on the state highway system with funding are identified in the Southern California Association of Government's (SCAG's) Regional Transportation Improvement Program (RTIP) and in the State Highway Operations Protection Program (SHOPP).

In the table below, the first project is funded through the Project Approval and Environmental Document Phase (PA & ED) and the last two projects are fully funded. The focus of this a study is corridor-wide capacity increasing alternative; thus, local interchange projects are excluded from consideration because they tend to improve access more than mainline operations.

2008 Regional Transportation Improvement Program (RTIP) Projects

County	Post Miles	Location	Project
Riv	0.0-6.6	Temecula	Widen to 1 HOV/6 mixed-flow lanes each direction, I-215 to Winchester Rd. & 1 HOV/5 mixed-flow lanes each direction, Winchester Rd. to Riv/SD County Line
Riv	8.7-52.3	Temecula/ Murrieta/ Lake Elsinore/ Norco/ Corona	2 HOT lanes each direction from SBd County Line to SR-74 & 1 mixed-flow lane each direction from SBd/Riv County Line to SR-74 & 1 HOV lane each direction from SR-74 to I-15/215
SBd	14.0-16.4	Devore	Add 1 mixed-flow lane from Glen Helen Parkway to the 15/215 IC & add truck bypass lane/auxiliary lanes & improve Kenwood IC

Next Steps

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

1. INTRODUCTION

This document represents the fifth and sixth milestones of the Riverside/San Bernardino County Interstate 15 Corridor System Management Plan (CSMP). It is the initial step in the completion of the existing conditions comprehensive performance assessment. Once finalized, it will be a critical component of the CSMP.

These two milestones are the Comprehensive Performance Assessment and the Causality of Performance Degradation. They build upon previously developed milestone reports.

The main purpose of the Comprehensive Performance Assessment is to detail the performance of the corridor so that future investment decisions can be vetted and tested to ensure reasonable returns on investment for public funds. This report presents performance measurement findings, indentifies bottlenecks that lead to less than optimal performance, and diagnoses the cause for these bottlenecks. Following this report, alternative investment strategies will be modeled and evaluated to understand their relative benefits.

This report and the associated CSMP should be updated regularly since corridor performance can vary dramatically over time due to changes in demand patterns, economic conditions, and delivery of projects and strategies among other variables. 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.

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

- 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, non-motorized facilities, and special event facilities/trip generators. This section includes a subsection on corridor demand profiles.

- Corridor-wide Performance and Trends
  This section presents multiple years of performance data for the defined CSMP corridor. Statistics are included for the mobility, reliability, safety, and productivity performance measure. Wherever possible, this section has been expanded from the preliminary performance assessment by adding performance results through December 2010. A new section on pavement conditions on the freeways was also added.

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

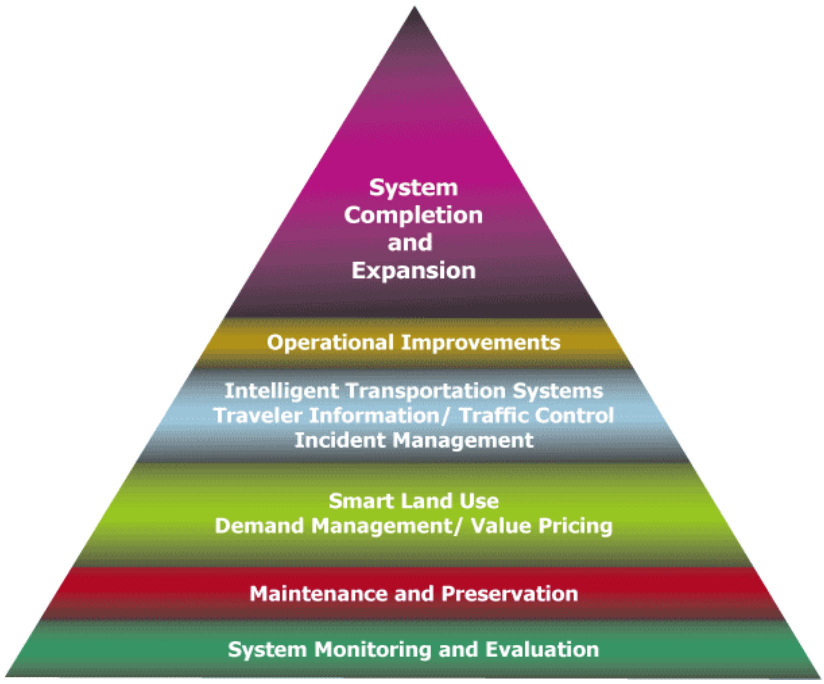
- <u>Causality Analysis</u>
  This section diagnoses the bottlenecks identified in Section 4 and identifies the cause of each bottleneck through additional data analysis and significant field observation. This section and the Bottleneck Identification and Analysis section provide valuable input to selecting projects to address the critical bottlenecks. Moreover, they provide the baseline against which micro-simulation models will be validated. Finally, this section represents the sixth milestone of the CSMP development process.

The remainder of this introduction provides some background on system management, a framework that eventually led to the CSMP requirement. It also includes a discussion on data sources and the state of detection on the I-15 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. System management aims to get the most of our transportation infrastructure through a variety of strategies, not just through the traditional and increasingly expensive expansion projects. It relies on extensive and continuous system monitoring and evaluation as the foundation of identifying problems, evaluating solutions (and combinations thereof), and eventually funding the most promising strategies. This report represents the first version of this foundation and should be updated on a regular basis as conditions on the corridor evolve.

Exhibit 1-1: System Management Pyramid



The base of the system management "pyramid" is "System Monitoring and Evaluation". It is the foundation of all other decisions, and it includes identifying problems, evaluating solutions, and eventually funding the most promising strategies. This document represents the first version of this foundation for the I-15 corridor.

Existing Data Sources

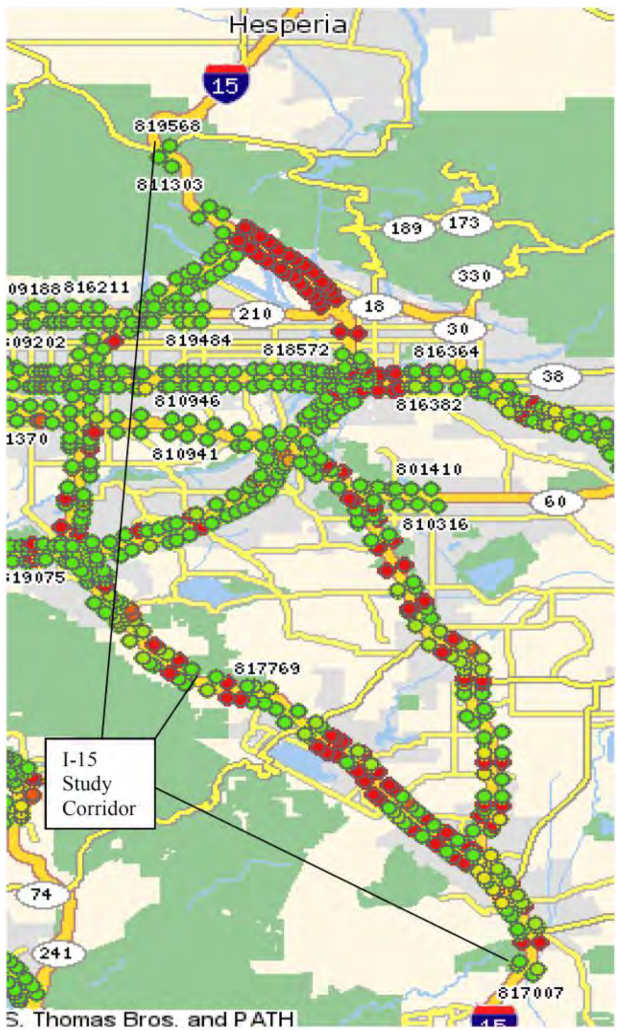
The available data analyzed for the comprehensive performance assessment includes the following sources:

- Mobility Performance Report (MPR) (2009)
- Caltrans Highway Congestion Monitoring Program (HICOMP) report and data files (2008)
- Caltrans Freeway Performance Measurement System (PeMS)
- Caltrans District 8 probe vehicle runs (electronic tachometer runs)
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS) from PeMS
- Various traffic study reports
- Aerial photographs (Microsoft Virtual Earth and Google Earth) and Caltrans photologs
- Internet (e.g., RTA, Omnitrans, and Metrolink transit websites).

Freeway Detection Status

There are a total of 421 detectors on northbound and 354 detectors on southbound I-15 refer to Appendix A for exact locations of existing detectors. Exhibit 1-2 depicts the I-15 freeway facility with the detectors in place as of April 2011. Exhibit 1-2 illustrates the availability of detection south of SR-138 and the absence of detection north of SR-138 to Nevada State line. Future detectors are planned north of SR-138 as referenced in Appendix B. As noted by the green color dots, the majority of existing detectors south of SR-138 were functioning well.

Exhibit 1-2: I-15 Sensor Status



Exhibits 1-3 and 1-4 illustrate the "good and bad" detectors by day, for the I-15 in Riverside and San Bernardino County. What is considered good detectors are those where useable data can be collected, and bad detectors are ones where useable data cannot be collected. Approximately 63 percent of those detectors are "good" and 37 percent are identified as "bad" detectors.

Exhibit 1-3: Percentage of Good & Bad Detection on Northbound I-15

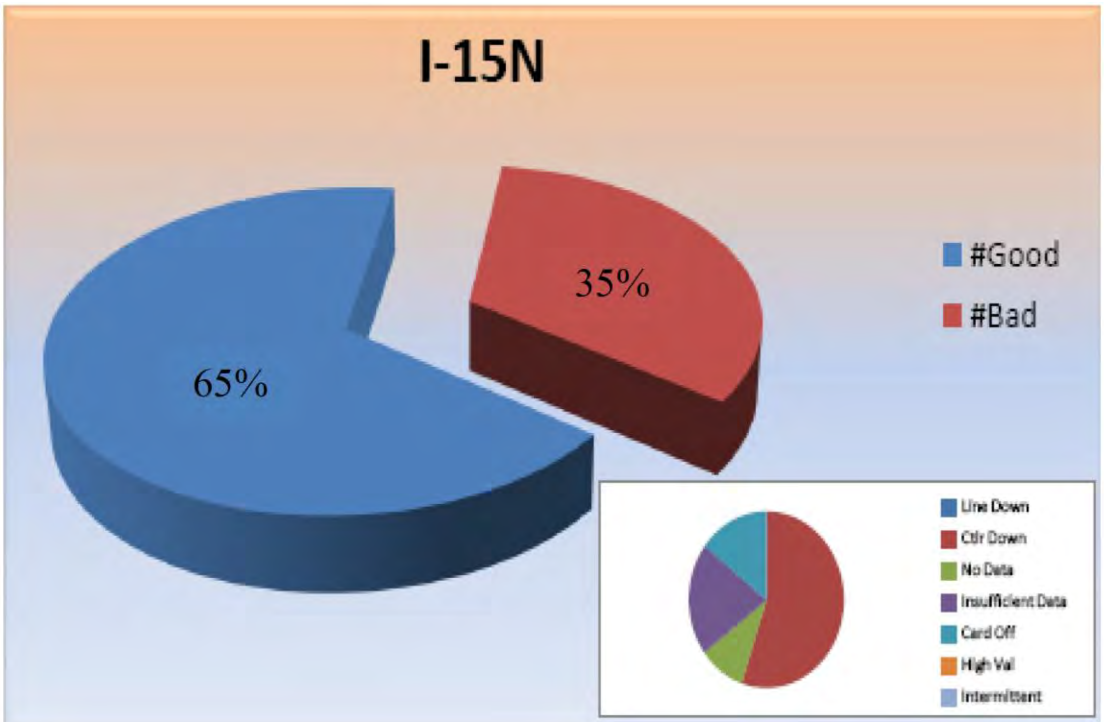
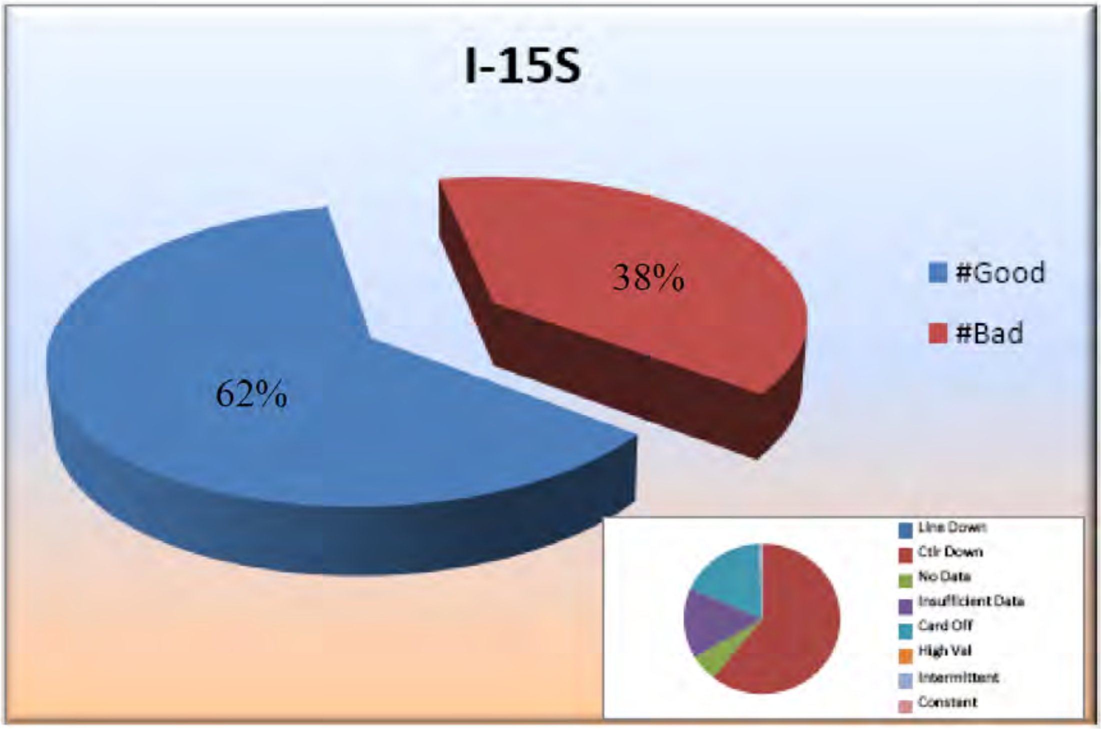


Exhibit 1-4: Percentage of Good & Bad Detection on Southbound I-15



Exhibits 1-5 and 1-6 provide the detectors health for the I-15 filtered by all collector-distributor, freeway to freeway, mainline, off-ramp, and on-ramp in Riverside and San Bernardino Counties. The y-axis shows the percent of total detectors and the x-axis shows the period from November 2010 to May 2011. The exhibits suggest reasons for the detectors bad health is insufficient data, controller down, no data, or the card was off. In late 2010, approximately 82 percent of the detectors were good. Today, this percentage has dropped to approximately 63 percent. The greatest change has been in the increase in the number of down controllers.

Exhibit 1-5: Percentage of Total Detectors on I-15 Northbound

Detector Health, filtered by All
Freeway I-15 N in D8
Wed 11/10/2010 00:00:00 to Mon 05/09/2011 23:59:59

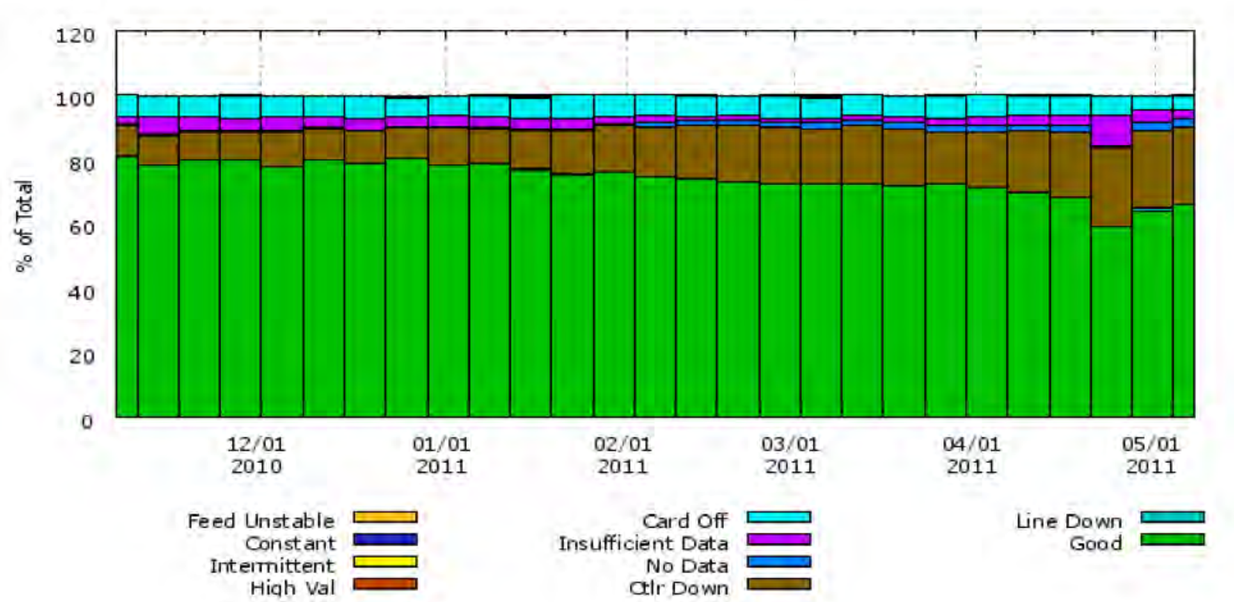


Exhibit 1-6: Percentage of Total Detectors on I-15 Southbound

Detector Health, filtered by All
Freeway I-15 S in D8
Wed 11/10/2010 00:00:00 to Mon 05/09/2011 23:59:59

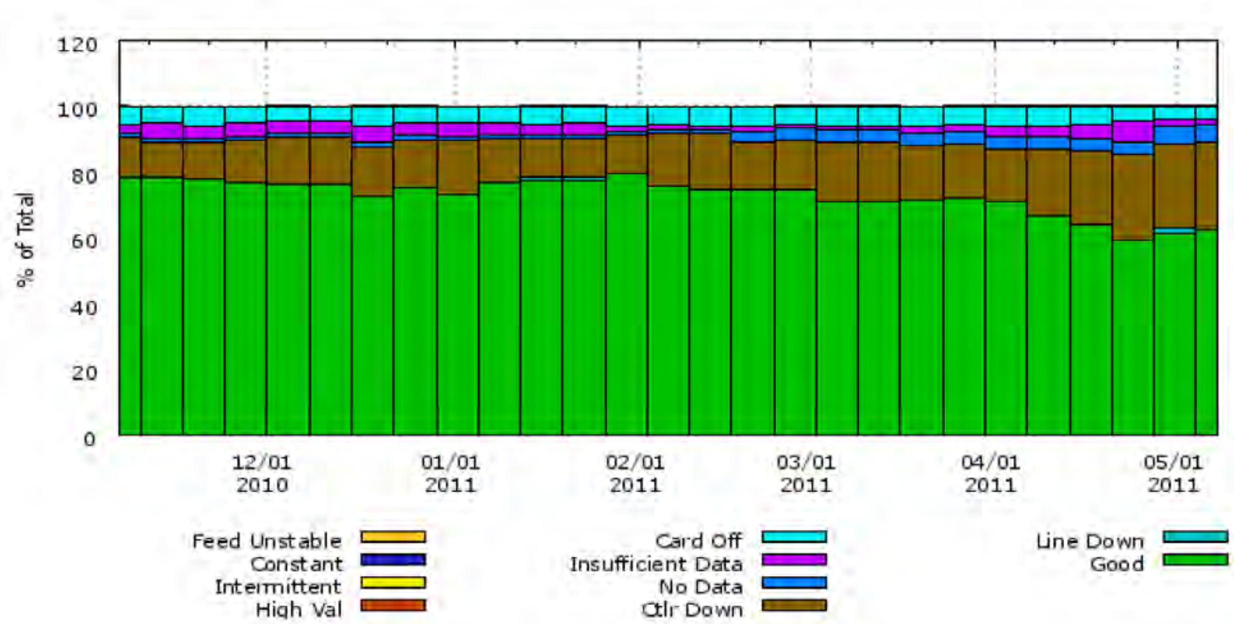


Exhibit 1-7 illustrates gaps in detection on the northbound and southbound I-15. It is standard practice to have detection placed approximately every half mile in urban areas. At times, detectors are placed closer depending on geometrics such as on-ramps, off-ramps and interchanges. Additional detectors are being considered north of SR-138 as shown in Appendix B.

Exhibit 1-7: Gaps in Detection on I-15

LOCATION		COUNTY	ABS PM		LENGTH (Miles)
FROM	TO		FROM	TO	
NORTHBOUND					
RAINBOW VALLEY BLVD	RAINBOW TR INSP STA	RIV	55.015	56.715	1.7
RAINBOW TR INSP STA	ROUTE 15/79 SEP.	RIV	56.715	57.715	1.0
ROUTE 79 NB ONR	RANCHO CALIFORNIA	RIV	58.015	59.215	1.2
RANCHO CALIFORNIA RD	RANCHO CALIF. N/O	RIV	59.615	60.215	0.6
RANCHO CALIF. N/O	WINCHESTER ROAD	RIV	60.215	61.115	0.9
WINCHESTER RD	WINCHESTER RD N/O	RIV	61.315	62.015	0.7
WINCHESTER RD N/O	ROUTE 15/215 SEP	RIV	62.015	62.915	0.9
ROUTE 15/215 SEP	MURRIETA HOT SPRINGS	RIV	62.915	63.915	1.0
MURRIETA HOT SPRINGS	CALIFORNIA OAKS RD	RIV	64.115	64.815	0.7
CALIFORNIA OAKS ROAD	NUTMEG ROAD S/O	RIV	65.315	66.115	0.8
NUTMEG ROAD S/O	NUTMEG ROAD N/O	RIV	66.115	67.015	0.9
NUTMEG ROAD N/O	CLINTON KEITH ROAD	RIV	67.015	67.815	0.8
BAXTER ROAD N/O	BUNDY CANYON ROAD	RIV	69.715	70.515	0.8
BUNDY CANYON ROAD	OLIVE STREET UC S/O	RIV	70.915	72.015	1.1
OLIVE STREET UC S/O	OLIVE ST. UC SB N/O	RIV	72.015	72.715	0.7
OLIVE ST. UC NB N/O	RAILROAD CANYON RD	RIV	72.716	73.515	0.8
RAILROAD CANYON RD	FRANKLIN STREET OC	RIV	73.815	74.715	0.9
MAIN STREET	CENTRAL AVE.	RIV	75.615	76.593	1.0
CENTRAL AVE.	NICHOLS ROAD	RIV	76.893	78.193	1.3
NICHOLS ROAD	GAVILAN WASH N/O	RIV	78.193	80.293	2.1
GAVILAN WASH N/O	LAKE STREET	RIV	80.293	81.093	0.8
LAKE STREET	TEMESCAL WASH	RIV	81.593	82.493	0.9
TEMESCAL WASH	HORSETHIEF WASH	RIV	82.493	83.493	1.0
HORSETHIEF WASH	INDIAN TRUCK TRAIL	RIV	83.493	84.793	1.3
INDIAN TRUCK TRAIL	TEMESCAL CANYON UC	RIV	85.093	85.893	0.8
TEMESCAL CANYON UC	MAYHEW WASH	RIV	85.893	86.793	0.9
MAYHEW WASH	TEMESCAL CANYON RD	RIV	86.793	87.493	0.7
TEMESCAL CANYON RD	BROWN CANYON WASH	RIV	87.893	88.993	1.1
BROWN CANYON WASH	WEIRICK ROAD	RIV	88.993	90.093	1.1
EL CERRITO ROAD	ONTARIO	RIV	92.293	93.419	1.1

MAGNOLIA N/B ON	.5 N/O MAGNOLIA	RIV	94.873	95.493	0.6
500 S/O PARKRIDGE	HIDDEN VALLEY	RIV	96.306	97.513	1.2
HIDDEN VALLEY	2nd St ONR	RIV	97.516	98.185	0.7
.02 N/O 4TH ST	M .18 N/O FIFTH ST	RIV	99.187	99.793	0.6
M 1.63 S/O LIMONITE	.75 S/O LIMEONITE	RIV	100.783	101.923	1.1
.75 S/O LIMEONITE	M .28 S/O LIMONITE	RIV	101.923	102.693	0.8
LIMEONITE NB ON	.25 N/O LIMEONITE	RIV	102.893	103.713	0.8
CANTU GALLEANO NB LP	.4 S/O 15/60 IC	RIV	104.593	105.334	0.7
.4 S/O 15/60 IC	M 1.2 S/O JURUPA ST	RIV	105.334	106.593	1.3
PHILADELPHIA UC	JURUPA	RIV	106.763	107.733	1.0
JURUPA	M .65 S/O I-10	SBD	108.003	108.574	0.6
AT AIRPORT DR	M 1.1 S/O FOOTHILL	SBD	108.774	110.774	2.0
15 N/O FOURTH ST	FOOTHILL NB	SBD	110.875	111.974	1.1
FOOTHILL NB	ETIWANDA/MILLER	SBD	111.974	112.774	0.8
ETIWANDA/MILLER	15 N/O BASELINE IDS	SBD	112.774	113.830	1.1
M 2.25 N/O FOOTHILL	S/O 15/210 IC	SBD	114.324	115.234	0.9
N/O 15/210 IC	SUMMIT S/O 15	SBD	115.424	116.194	0.8
DUNCAN CANYON	M 1.8 N/O SUMMIT AVE	SBD	117.274	118.174	0.9
M 1.8 N/O SUMMIT AVE	SIERRA NB ON	SBD	118.174	118.944	0.8
1.0 S/O GLEN HELEN	GLEN HELEN PKWY	SBD	119.774	120.444	0.7
N/O GLEN HELEN PKWY	M 1.5 S/O I-215	SBD	120.974	121.574	0.6
M 1.5 S/O I-215	M .16 S/O I-215	SBD	121.574	122.854	1.3
M .16 S/O I-215	M 2.25 N/O OAKIE FLT	SBD	122.854	124.329	1.5
M 2.25 N/O OAKIE FLT	M 1.65 S/O OAKIE FLT	SBD	124.329	125.292	1.0
M 1.65 S/O OAKIE FLT	M .3 S/O HWY 138	SBD	125.292	130.619	5.3
M .3 S/O HWY 138	NEVADA STATE LINE	SBD	130.619	283.590	153.0
	SOUTHBOUND				
RAINBOW VALLEY	RAINBOW TR INSP STA	RIV	55.005	56.705	1.7
RAINBOW TR INSP STA	ROUTE 15/79 SEP.	RIV	56.705	57.705	1.0
ROUTE 79 NB ONR	RANCHO CALIFORNIA	RIV	58.005	59.205	1.2
RANCHO CALIFORNIA RD	RANCHO CALIF. N/O	RIV	59.605	60.205	0.6
RANCHO CALIF. N/O	WINCHESTER ROAD	RIV	60.205	61.105	0.9
WINCHESTER RD	WINCHESTER RD N/O	RIV	61.305	62.005	0.7
WINCHESTER RD N/O	ROUTE 15/215 SEP	RIV	62.005	62.905	0.9
ROUTE 15/215 SEP	MURRIETA HOT SPRINGS	RIV	62.905	63.905	1.0
MURRIETA HOT SPRINGS	CALIFORNIA OAKS RD	RIV	64.105	64.805	0.7
CALIFORNIA OAKS ROAD	NUTMEG ROAD S/O	RIV	65.305	66.105	0.8
NUTMEG ROAD S/O	NUTMEG ROAD N/O	RIV	66.105	67.005	0.9
NUTMEG ROAD N/O	CLINTON KEITH ROAD	RIV	67.005	67.805	0.8
BAXTER ROAD N/O	BUNDY CANYON ROAD	RIV	69.705	70.505	0.8
BUNDY CANYON ROAD	OLIVE STREET UC S/O	RIV	70.905	72.005	1.1

OLIVE STREET UC S/O	OLIVE ST UC SB N/O	RIV	72.005	72.705	0.7
OLIVE ST. UC NB N/O	RAILROAD CANYON RD	RIV	72.706	73.505	0.8
RAILROAD CANYON RD	FRANKLIN STREET OC	RIV	73.805	74.705	0.9
MAIN STREET	CENTRAL AVE.	RIV	75.605	76.583	1.0
CENTRAL AVE.	NICHOLS ROAD	RIV	76.883	78.183	1.3
NICHOLS ROAD	GAVILAN WASH S/O	RIV	78.183	79.183	1.0
GAVILAN WASH S/O	GAVILAN WASH N/O	RIV	79.183	80.283	1.1
GAVILAN WASH N/O	LAKE STREET	RIV	80.283	81.083	0.8
LAKE STREET	TEMESCAL WASH	RIV	81.583	82.483	0.9
TEMESCAL WASH	HORSETHIEF WASH	RIV	82.483	83.483	1.0
HORSETHIEF WASH	INDIAN TRUCK TRAIL	RIV	83.483	84.783	1.3
INDIAN TRUCK TRAIL	TEMESCAL CANYON UC	RIV	85.083	85.883	0.8
TEMESCAL CANYON UC	MAYHEW WASH	RIV	85.883	86.783	0.9
TEMESCAL CANYON RD	BROWN CANYON WASH	RIV	87.483	88.983	1.5
BROWN CANYON WASH	WEIRICK ROAD	RIV	88.983	90.083	1.1
CAJALCO ROAD	EL CERRITO ROAD	RIV	91.583	92.283	0.7
EL CERRITO ROAD	0.4 N/O ONTARIO AVE.	RIV	92.283	93.722	1.4
MAGNOLIA N/B ON	.5 N/O MAGNOLIA	RIV	94.863	95.483	0.6
PARKRIDGE OC	HIDDEN VALLEY	RIV	95.941	97.217	1.3
YUMA	2ND	RIV	97.217	97.941	0.7
2ND	M .18 N/O FIFTH ST	RIV	97.960	99.783	1.8
6 TH ST SB	M 1.63 S/O LIMONITE	RIV	100.158	100.773	0.6
M 1.63 S/O LIMONITE	SB LIMENONITE ONR	RIV	100.773	102.563	1.8
M .28 S/O LIMONITE	M 2.04 S/O RIVERSIDE	RIV	102.683	104.003	1.3
CANTU GALLEANO SB LP	M 1.2 S/O JURUPA ST	RIV	104.683	106.583	1.9
M 1.2 S/O JURUPA ST	JURUPA	RIV	106.583	107.733	1.2
JURUPA	M .65 S/O I-10	SBD	107.733	108.564	0.8
M .65 S/O I-10	4TH ST SB LOOP ONR	SBD	108.564	109.764	1.2
4TH ST SB LOOP ONR	M 1.1 S/O FOOTHILL	SBD	109.764	110.764	1.0
M 1.1 S/O FOOTHILL	FOOTHILL SB	SBD	110.764	111.764	1.0
FOOTHILL LOOP SB	BASELINE SB	SBD	111.864	113.164	1.3
BASELINE SB	M 2.25 N/O FOOTHILL	SBD	113.164	114.354	1.2
M 2.25 N/O FOOTHILL	15@SUMMIT SB	SBD	114.354	116.415	2.1
M .46 N/O SUMMIT AVE	M 1.8 N/O SUMMIT AVE	SBD	116.864	118.164	1.3
M 1.8 N/O SUMMIT AVE	SIERRA	SBD	118.164	118.834	0.7
M .37 S/O SIERRA AVE	M 1.0 S/O GLEN HELEN	SBD	119.264	120.464	1.2
M 1.0 S/O GLEN HELEN	M .86 N/O I-215	SBD	120.464	121.274	0.8
M 1.5 S/O BARSTOW FW	M .16 S/O BARSTOW FW	SBD	121.564	122.844	1.3
M .16 S/O BARSTOW FW	M 1.65 S/O OAKIE FLT	SBD	122.844	125.282	2.4
M 1.65 S/O OAKIE FLT	M 2.25 N/O OAKIE FLT	SBD	125.282	129.528	4.2
M 2.25 N/O OAKIE FLT	M .3 S/O HWY 138	SBD	129.528	130.609	1.1
M .3 S/O HWY 138	SB OFF TO YATES WELL RD	SBD	130.609	289.360	158.8

2. CORRIDOR DESCRIPTION

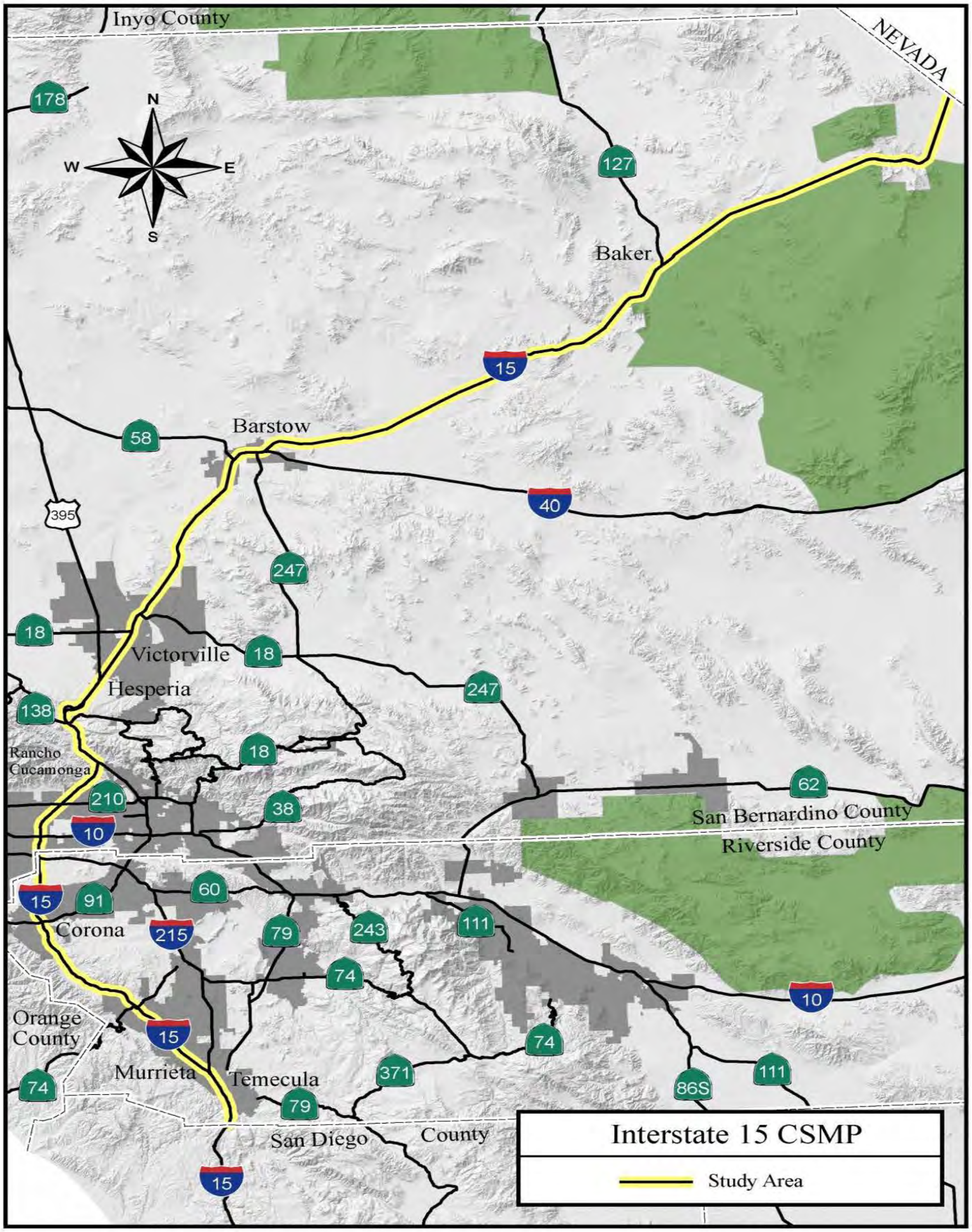
The I-15 study corridor (Exhibit 2-1) has a total length of 239 miles beginning at the San Diego/Riverside County Line and terminating at the California/Nevada State Line. The corridor passes through cities of Temecula, Murrieta, Wildomar, Lake Elsinore, Corona, Norco, Jurupa Valley, and Eastvale in the County of Riverside. Within the County of San Bernardino, the corridor traverses the cities of Ontario, Fontana, Rancho Cucamonga and passes through the high desert cities of Hesperia, Victorville, Apple Valley, and Barstow.

The corridor is a primary link for the Inland Empire and the High Desert to major economics centers and geographic regions of Orange and San Diego Counties and the Greater Los Angeles area. It is a significant goods movement corridor between the Ports of Los Angeles and Long Beach, border crossings with Mexico to destinations nationwide. It also serves as a conduit for recreation travel to Las Vegas, San Diego and other destinations.

In 2009, Average Daily Traffic ranged from nearly 214,000 vehicles near the Riverside/San Bernardino County Line to 37,000 near the California/Nevada State Line. Traffic is forecasted to increase about 40 percent to approximately 299,000 and about 86 percent to approximately 69,000 vehicles per day by 2035, respectively. The growing population and relatively affordable housing market in Riverside and San Bernardino Counties, along with increasing employment opportunities in the Greater Los Angeles, Orange, and San Diego County areas, and increasing goods movement and recreation traffic have increased demand on the corridor in the last decade and are expected to continue into the future. I-15 is part of the National Highway System (NHS), the Strategic Highway Corridor Network of National Defense (STRAHNET), and the Freeway and Expressway System (F&E).

The I-15 freeway varies from a six to eight-lane freeway facility in the urbanized areas and four to six-lanes in rural areas.

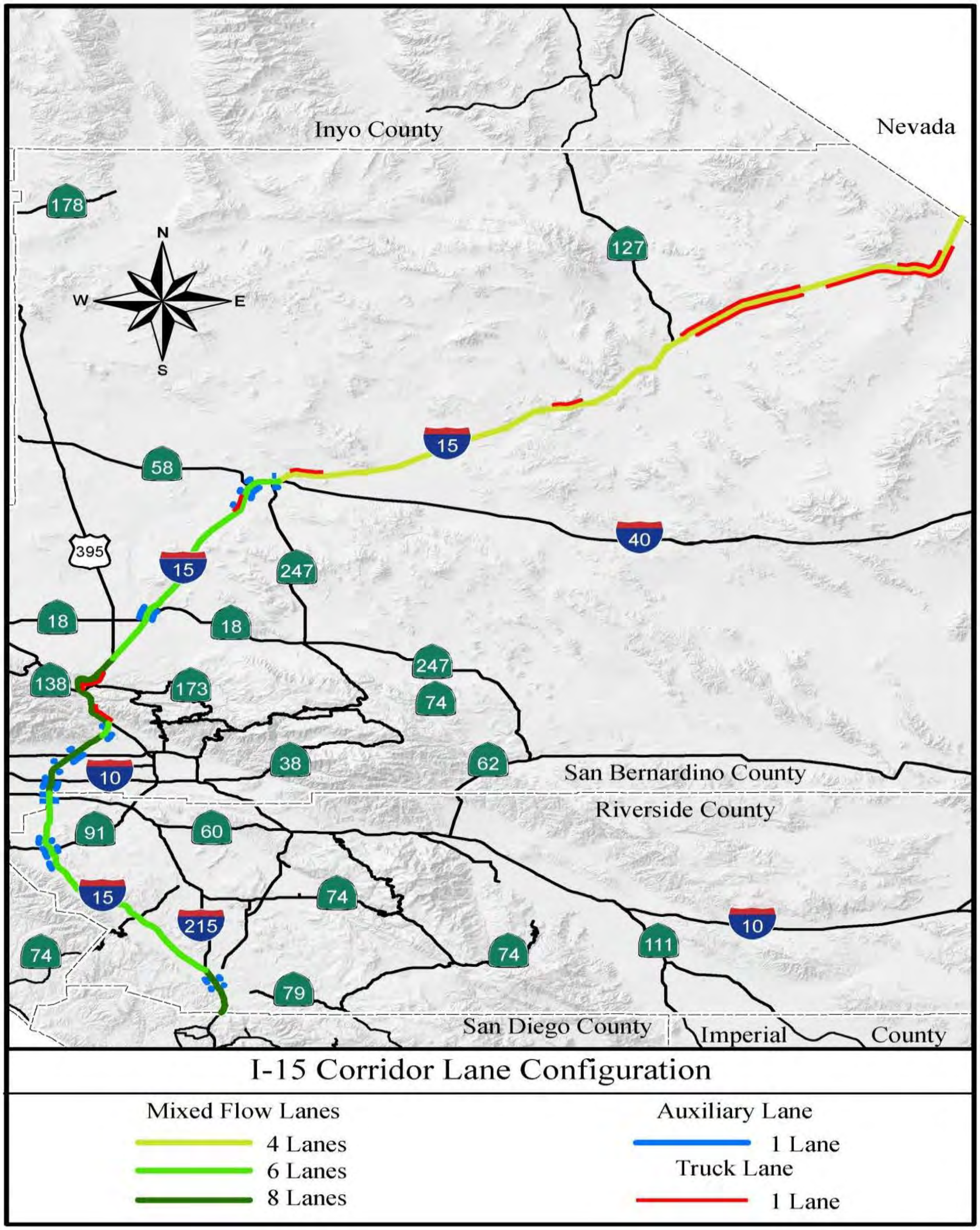
Exhibit 2-1: I-15 Study Corridor



Corridor Roadway Facility

As depicted in Exhibit 2-2, I-15 varies from a six to eight-lane freeway facility in the urbanized areas and four to six-lanes in rural areas with concrete median barrier that separates northbound and southbound traffic for most of the corridor. Note that the exhibit depicts lanes in each direction. There are auxiliary (aux) lanes along many sections of the corridor, but they are not continuous nor are they always available for both sides of the freeway. There are no continuous High Occupancy Vehicle (HOV) lanes on the corridor. Metered ramps for Single Occupancy Vehicle (SOV) and HOV lanes are present along the study corridor. In addition to the eight freeway-to-freeway interchanges, the corridor has seven interchanges with other state routes and 62 local road interchanges.

Exhibit 2-2: Corridor Lane Configuration



According to the 2008 Caltrans Annual Traffic Volumes Report, the I-15 corridor carries between 30,000 and 214,000 Annual Average Daily Traffic (AADT) as shown in Exhibit 2-3 and Exhibit 2-4 for the High Desert Region. The highest AADT was reported near the Riverside/San Bernardino County line area.

Exhibit 2-3: I-15 2008 AADT Riverside-San Bernardino Valley

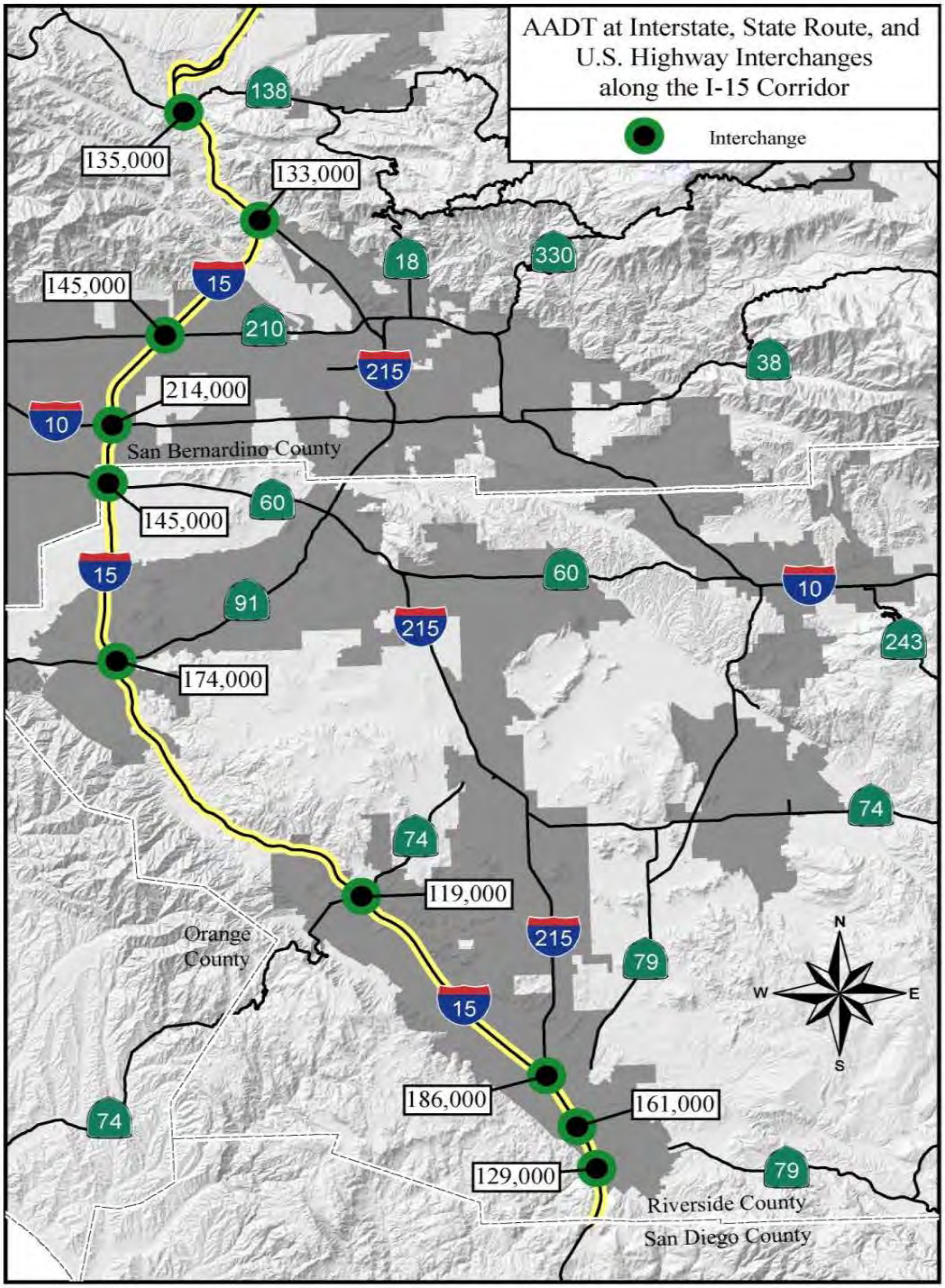
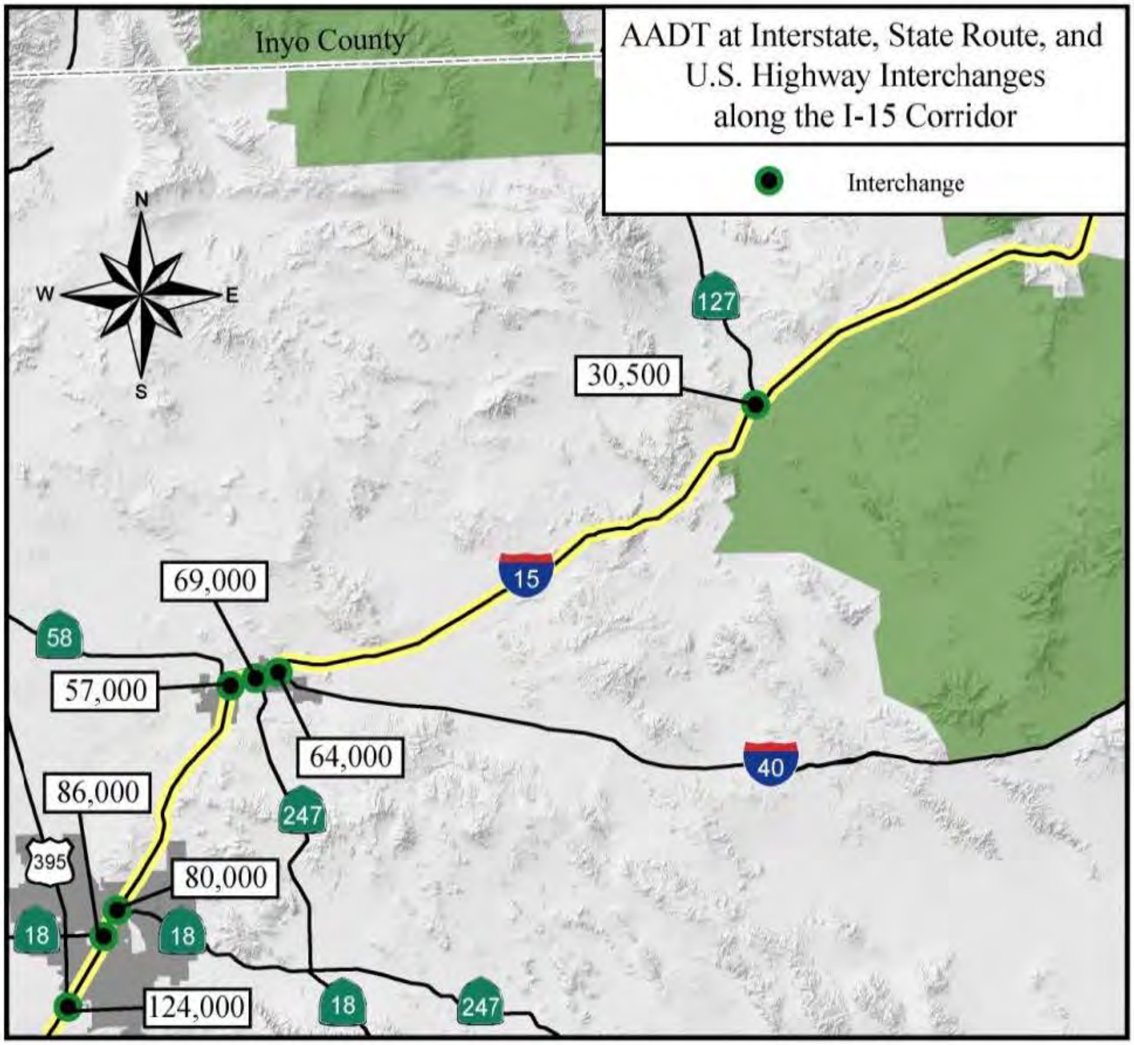


Exhibit 2-4: I-15 2008 AADT High Desert



As part of the Surface Transportation Assistance Act (STAA) route, trucks may operate along the corridor as shown in Exhibit 2-5. Exhibits 2-6 and 2-7, indentify trucks as a percentage of AADT (listed as total percentage). According to the 2008 Annual Average Daily Truck Traffic on the California State Highway System published by Caltrans in September 2009, this corridor's daily truck traffic ranges from 5.55 percent to 23.24 percent of the total daily traffic.

Exhibit 2-5: District 8 STAA Truck Routes

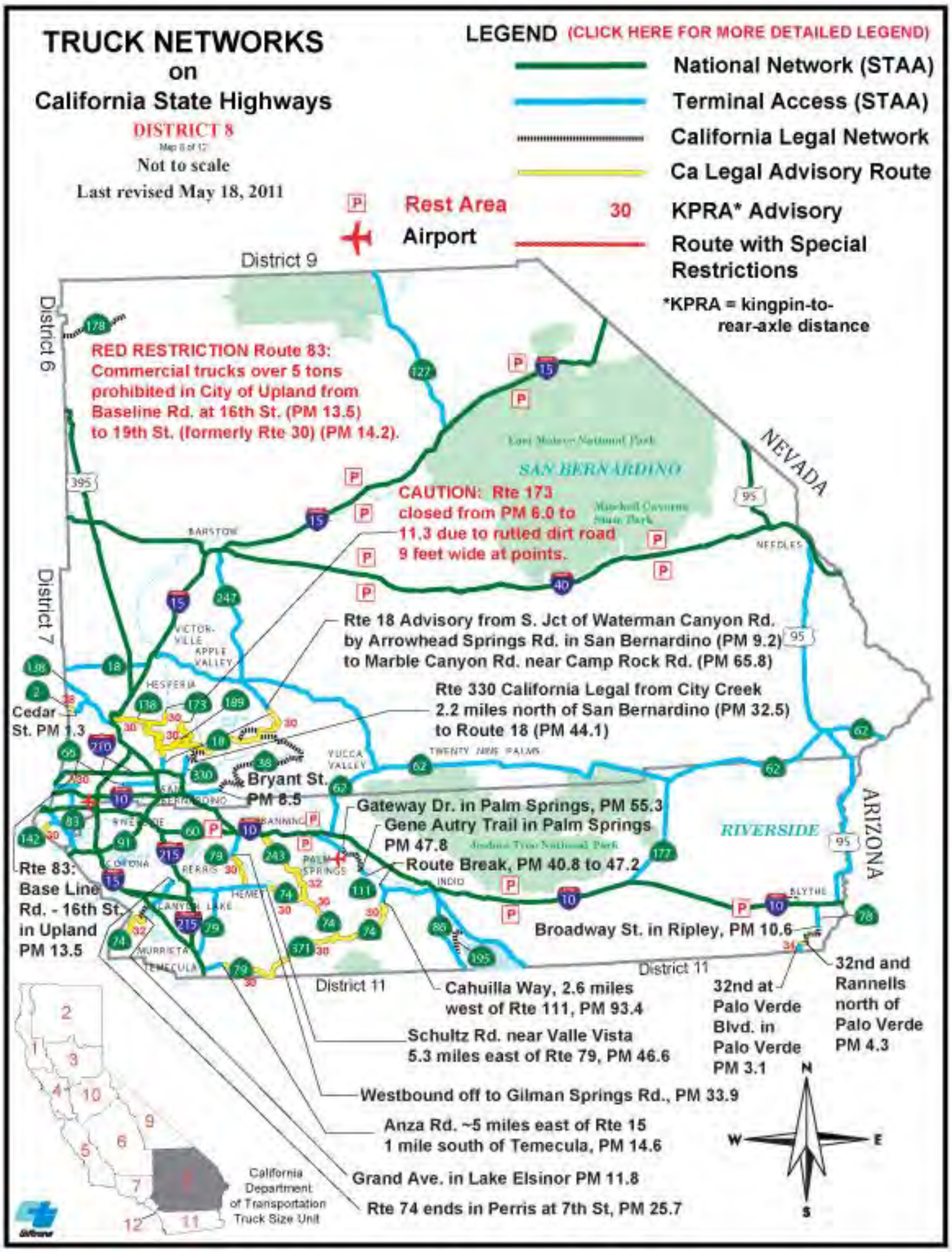


Exhibit 2-6: I-15 2008 Truck AADT – Riverside/San Bernardino Valley

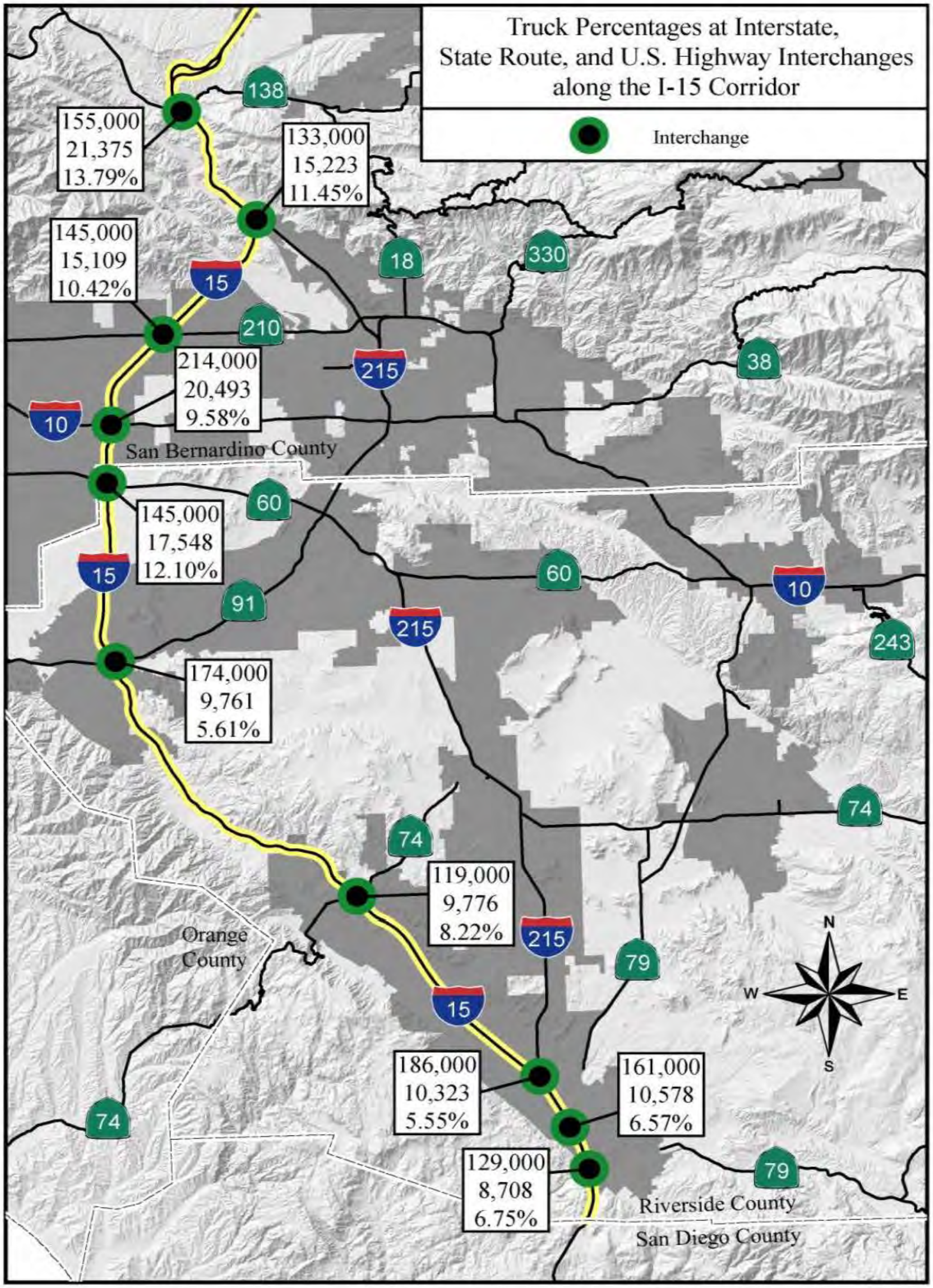
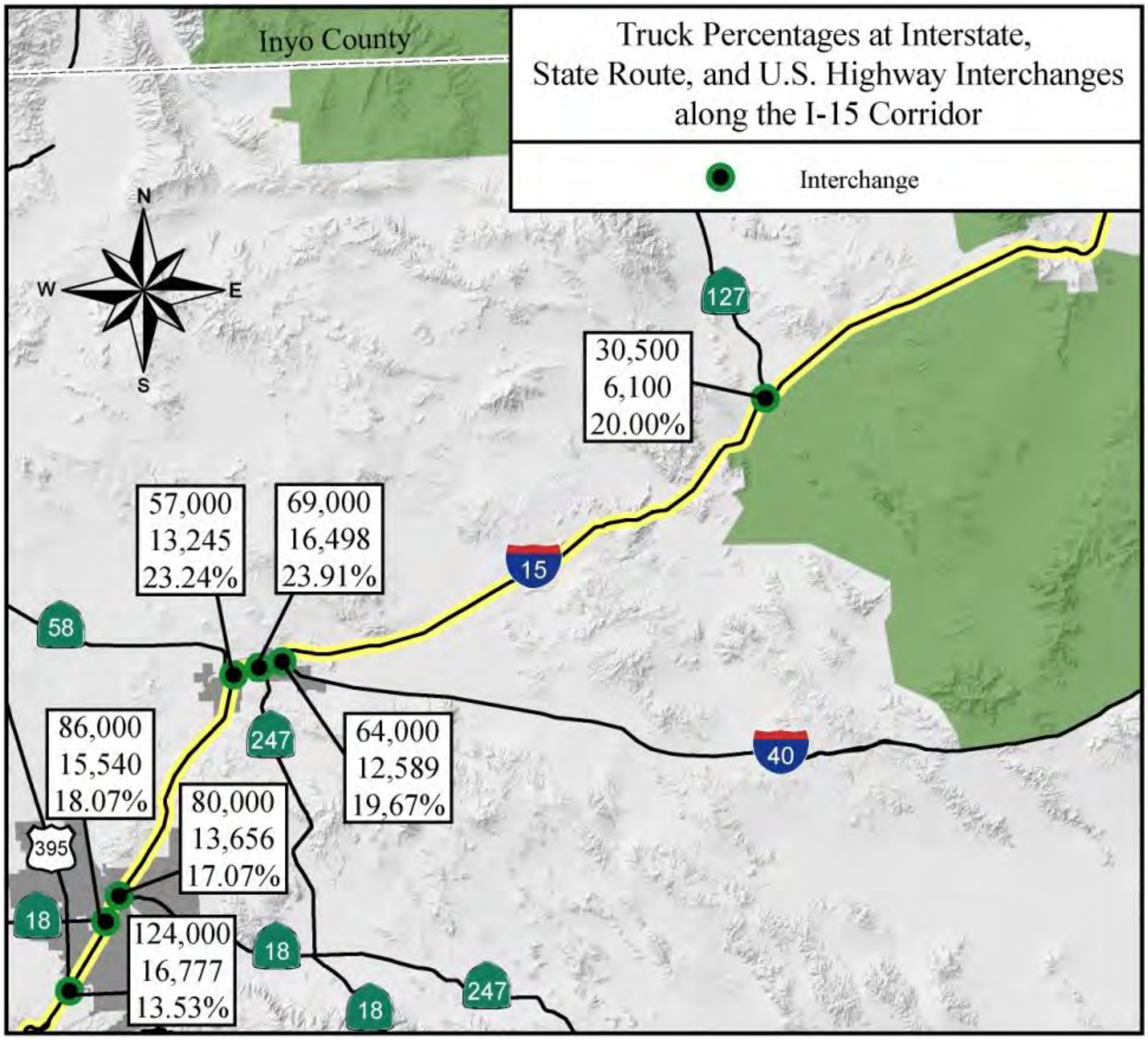


Exhibit 2-7: I-15 2008 Truck AADT - High Desert



Parallel Freeways and Expressways

Between the city of Temecula in Riverside County and the community of Devore in San Bernardino County, I-215 is the only major parallel freeway. In the city of Corona, SR-91 serves as a bypass for a short distance in the northwest section of the Riverside County.

Listed in Exhibit 2-8, below are other existing alternative parallel freeways/highways to I-15. During peak hours, the parallel routes are also congested/and or discontinuous and do not provide viable alternatives to the freeway.

Exhibit 2-8: Alternative Parallel Freeways-Highways to the I-15 Corridor

Parallel Routes		
Route	**County**	**Location**
I-215	Riv/SBd	East of and parallel to I-15 from the city of Temecula and the community of Devore in Riverside and San Bernardino Counties, respectively
SR-71	SBd	West of and parallel to I-15 in the Prado Dam Basin area
SR-83	SBd	West of and parallel to I-15 in southwest San Bernardino County, in the Ontario/Chino Valley area
I-40	SBd	East Barstow
US-395	SBd	West of and parallel to I-15 in High Desert
SR-247	SBd	East of and parallel to I-15 in High Desert

Major Parallel Local Arterials

In the event of a lane closure or high demand, parallel and intersecting local arterials that can accommodate trips or relieve congestion on I-15 are very limited. In the event of an I-15 closure, the southwest Riverside County arterial system does not provide adequate capacity to accommodate the additional traffic demand. There are no continuous local roads through Cajon Pass that can be used as an alternate. The urban area of Victor Valley does provide a series of parallel local streets but Barstow has limited alternate streets for the highly travelled I-15. Through the rural, undeveloped areas north of Barstow, alternate roads are very limited.

Major Intersecting Routes

Listed in Exhibit 2-9, below are intersecting freeways and conventional highways that connect to I-15.

Exhibit 2-9: Freeways/Conventional Highways Connecting to I-15

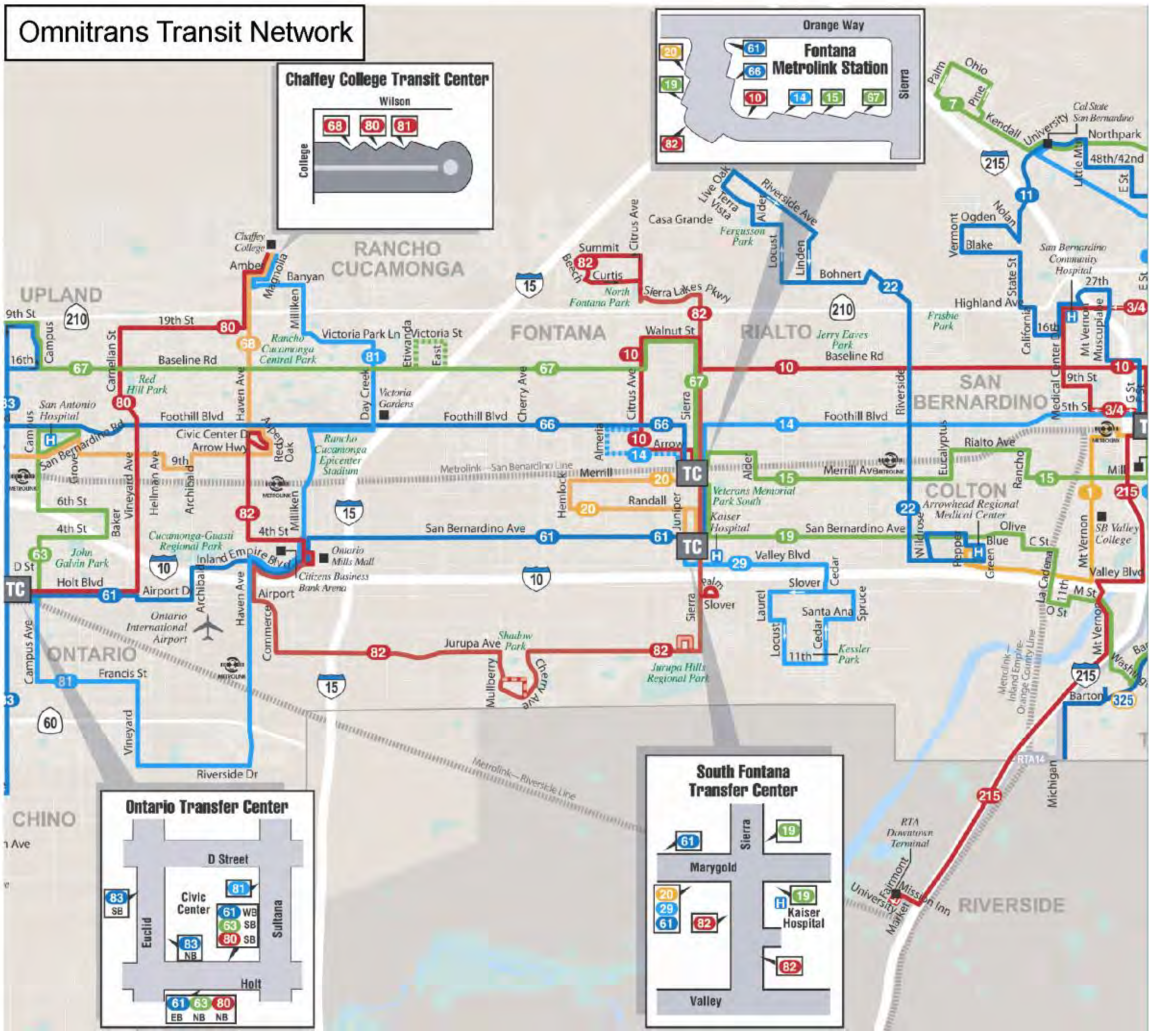
Route	Location
SR-79	City of Temecula
I-215	City of Murrieta
SR-74	City of Lake Elsinore
SR-91	City of Corona
SR-60	City of Ontario
I-10	City of Ontario
SR-210	City of Rancho Cucamonga
I-215	Devore
SR-138	Cajon Pass
US-395	City of Hesperia
SR-18	City of Victorville
SR-58	City of Barstow
SR-247	City of Barstow
I-40	City of Barstow
SR-127	Baker

Public Transit

Passenger Bus: Various local transit routes parallel different segments of I-15. Commuter bus service in Western Riverside County is provided by the Riverside Transit Agency (RTA), Exhibit 2-10. Omnitrans, a joint powers authority, provides public transportation (Exhibit 2-11) in the urbanized portion of the San Bernardino Valley including transit service that parallels Interstate 15. The Victor Valley Transit Authority provides local bus service in the urban areas of the High Desert. Central Barstow which is traversed by Interstate 15 is serviced by city busses. For longer commutes, Greyhound Line, Inc. provides scheduled bus service to and from Las Vegas, Nevada with stops in Barstow and Victorville with connections through the cities of San Bernardino, Riverside and Temecula. Amtrak also provides connecting bus service with stops in the community of Baker, and the cities of Barstow, Victorville and Ontario.

Exhibit 2-10: RTA Bus Service Map

Exhibit 2-11: Omnitrans Bus Service Map



Passenger Rail: The Amtrak Southwest Chief traveling between Los Angeles and Chicago uses the BNSF tracks which parallel I-15 from I-215 North junction at the foot of the Cajon Pass to the city of Barstow. Amtrak provides daily train and motor coach service (Exhibit 2-12) to and from the cities of San Bernardino and Riverside to destinations in Orange County and the city of Los Angeles.

Exhibit 2-12: Amtrak Map

Metrolink does not provide service along I-15. The 2008 SCAG RTP includes expanded service east of I-15, adjacent to the I-215 freeway with stops in the cities of Perris, Moreno Valley, Norco and Corona. The new service will provide access to the neighboring counties which include Los Angeles, Orange, and San Diego. Metrolink will be launching the new service by end of 2013.

Future High-Speed Passenger Rail Service: There are several planned or proposed high speed passenger rail services. They include:

- DesertXpress: This service is an interstate high-speed rail project that will provide non-stop service for the approximate 190 miles between Victorville, California and Las Vegas, Nevada. Running parallel to I-15 reaching speeds up to 150 mph; travel time will be approximately 80 minutes between the two cities. A future link between Victorville and Palmdale will connect Las Vegas and the voter–approved California High-Speed Rail (CHSR) network with planned Southern California stations in San Diego, Orange, Los Angeles, and San Bernardino Counties.[5]

- California-Nevada Interstate Maglev Train: The trains will use magnetic levitation technology providing passenger rail service for the 268 miles between Anaheim, California and Las Vegas, Nevada. Traveling at speeds up to 310 mph and with proposed stops to include the cities of Ontario, Victorville, and Barstow. Travel time is expected to be 87 minutes between Anaheim and Las Vegas.

- California High-Speed Rail (CHSR): This service is voter-approved, connecting Southern California with Northern California via high-speed passenger rail. The service would run from San Diego County traversing Orange County and the Los Angeles metropolitan area into the Central Valley with destinations in the San Francisco Bay area and Sacramento. A proposed south-eastern CHSR station would connect to the City of Ontario and its International Airport, and with a stop in the city of Palmdale, the CHSR service will be positioned for a proposed future connection with the DesertXpress service in Victorville.

Intermodal Facilities

Airports: Ontario International (ONT) is a medium-hub full service airport and a member of the Los Angeles World Airports system. It is the only commercial-passenger airport served by I-15 in San Bernardino and Riverside Counties. It is located near the southwest quadrant of the I-10/I-15 junction, approximately three miles from I-15. In 2010, the airport had a total of 94,030 operations serving a total of 4.8 million

[5] www.desertxpress.com

commercial airline passengers with a projected 30 million annual passengers (MAP) to be served by 2030.

The Southern California Logistics Airport (SCLA), formerly George Air Force Base, is being developed with the main purpose of facilitating goods movement. The airport is located in north Victorville and does not offer commercial passenger airline service at this time. The SCAG RTP shows that SCLA is expected to serve about 2 million MAP by 2035.

Listed in Exhibit 2-13 below and shown in Exhibits 2-14 to 2-25 are several private and municipal airports in the vicinity of I-15.

Exhibit 2-13: Private and Municipal Airports near the I-15 Corridor

Airport Name	Location	Description	Annual Flights Ops	Year
French Valley Airport	Temecula	4 miles northeast of I-15 via SR-79	98,185	2006
Skylark Field Airport	Lake Elsinore	2 miles west of I-15 via Bundy Cyn Rd.	-	-
Corona Municipal Airport	Corona	3 miles west of I-15 via SR-91	68,000	2004
Hesperia Airport	Hesperia	5 miles east of I-15 via Main St.	-	-
Apple Valley County Airport	Apple Valley	5 miles east of I-15 via SR-18	-	-
Osborne Airport	SBd Co.	Adjacent to I-15 via Stoddard Wells Rd.	-	-
Barstow-Daggett Airport	Daggett	4 miles south of I-15 via Minneola Rd.	36,500	2006
Baker Airport	Baker	2 miles northwest of I-15 via SR-127	500	2006

Exhibit 2-14: District 8 Airport Map, I-15 Corridor

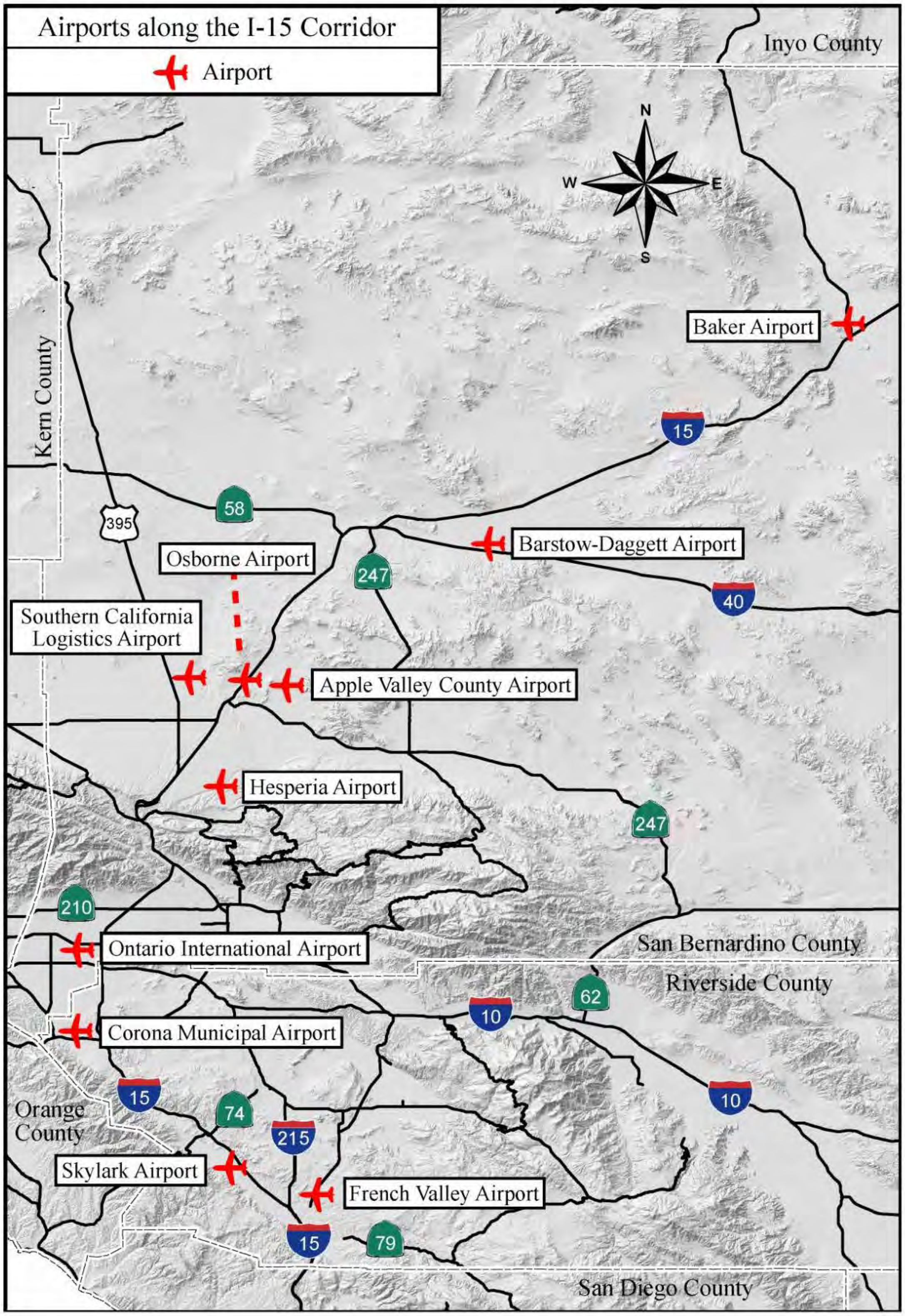


Exhibit 2-15: French Valley Airport

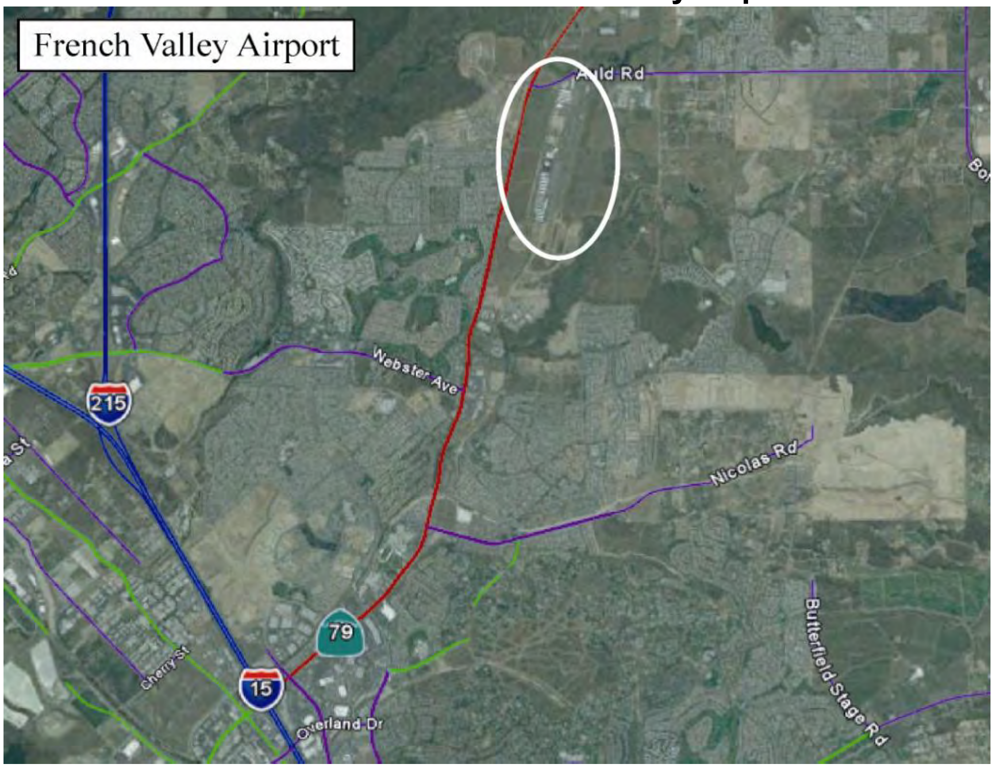


Exhibit 2-16: Skylark Field Airport

Exhibit 2-17: Corona Municipal Airport

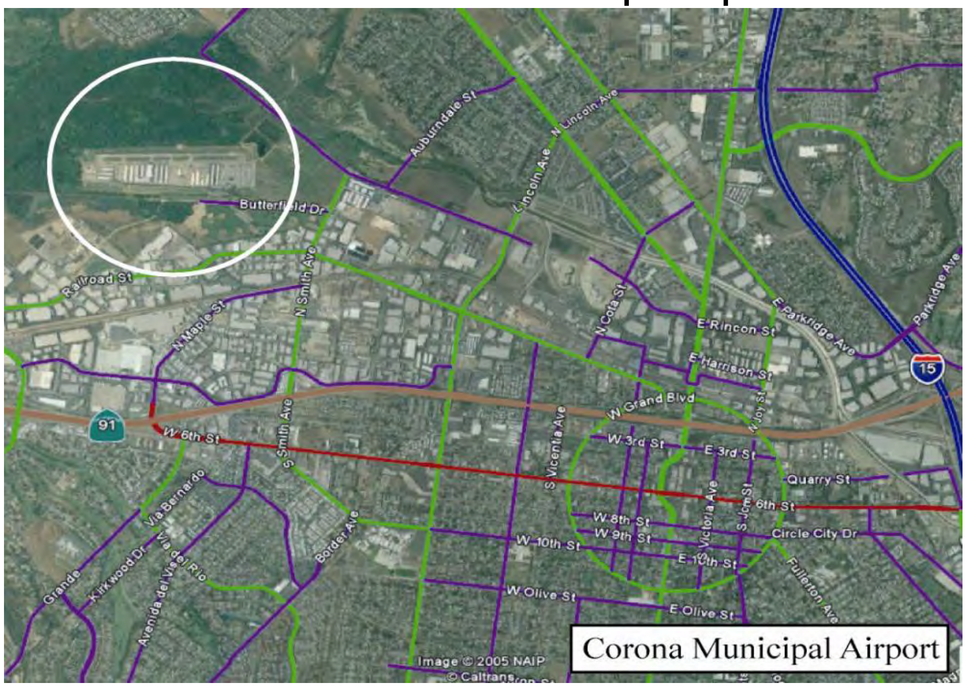


Exhibit 2-18: Ontario International Airport

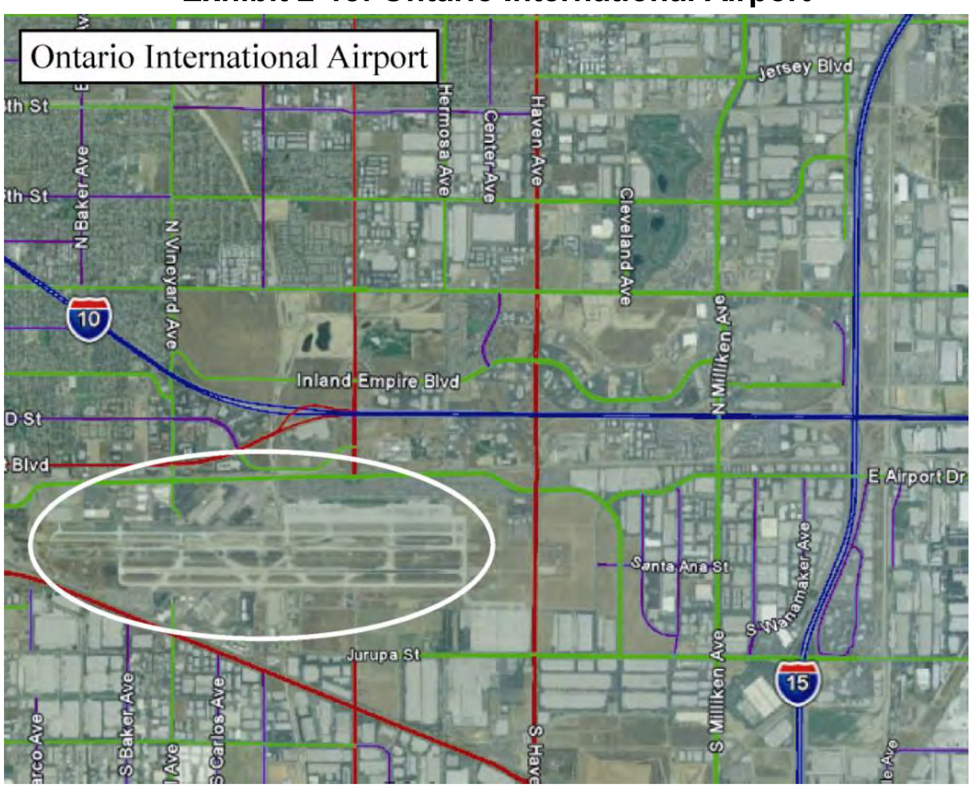


Exhibit 2-19: Hesperia Airport

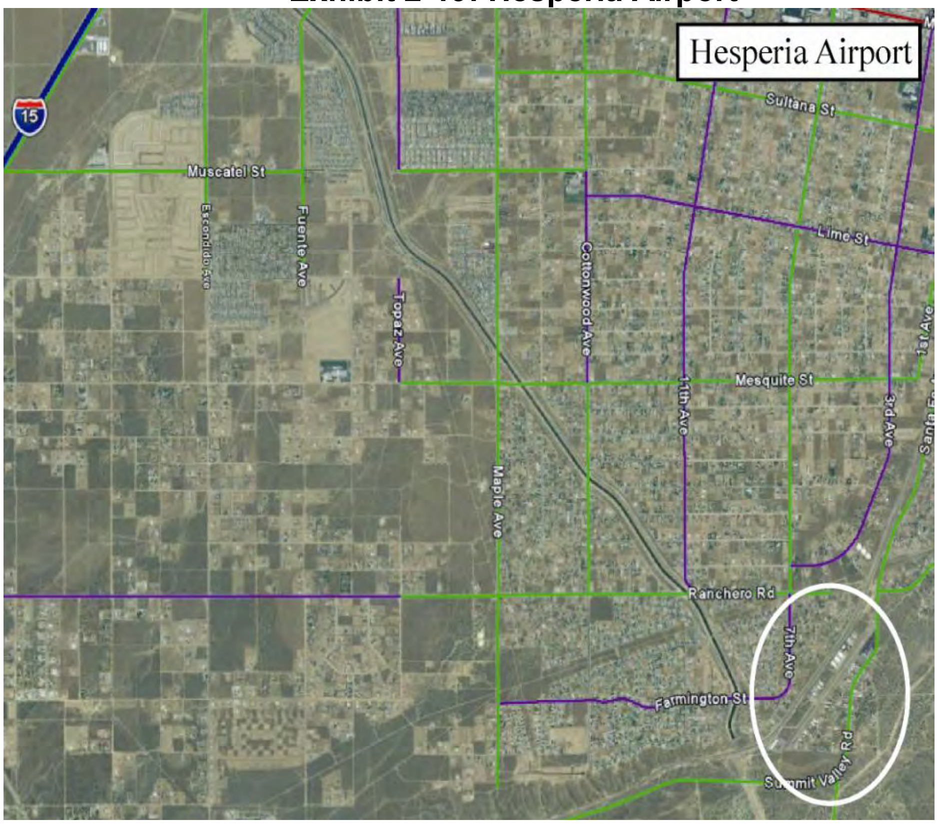


Exhibit 2-20: Southern California Logistics Airport

Exhibit 2-21: Apple Valley County Airport

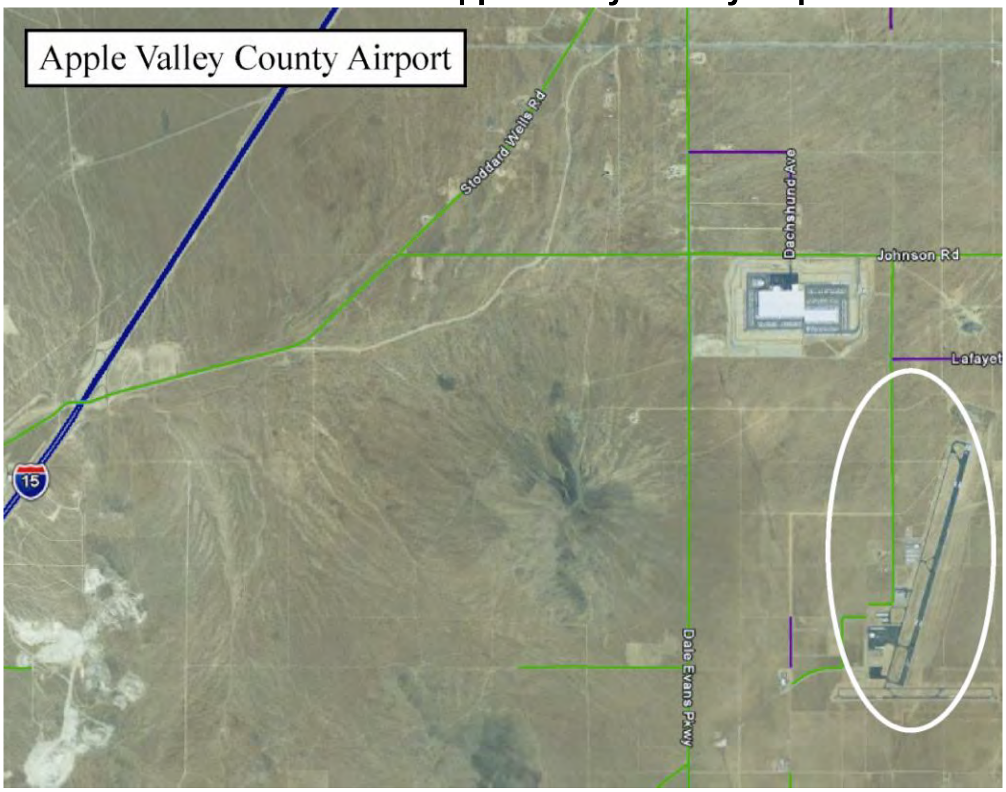


Exhibit 2-22: Osborne Airport

Exhibit 2-23: Barstow-Daggett Airport

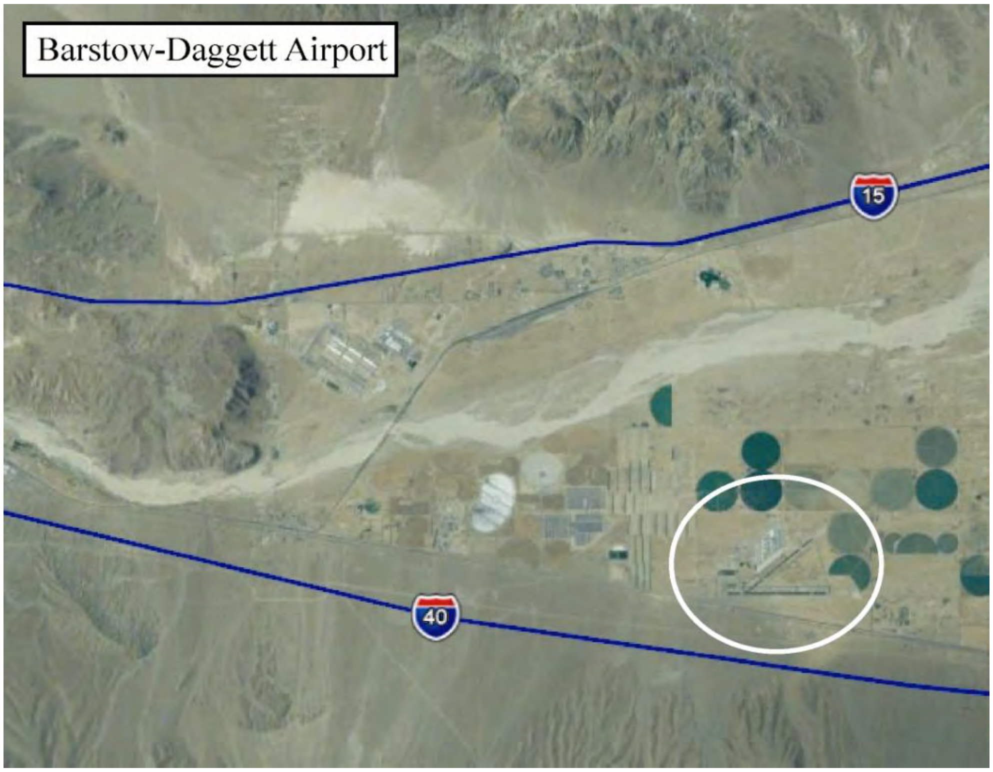


Exhibit 2-24: Baker Airport

Non-motorized Facilities

Of the 239 miles of the I-15 corridor, about 47 percent or 113 miles are accessible (Exhibit 2-25) for bicycles.

Exhibit 2-25: I-15 Bicycles Permitted

County	Post Miles	Description
SBd	R20.0-R28.6	Cleghorn Road to Oakhill Road
SBd	76.9-79.6	SR-58 to Fort Irwim Road
SBd	R81.8-R135.8	Ghost Town Road to South Baker Blvd.
SBd	R138.5-186.2	North Baker Blvd. to CA/NV State Line

In areas where bicycles are prohibited, bicylists can travel parallel to the I-15 corridor via local arterials.

Trip Generators

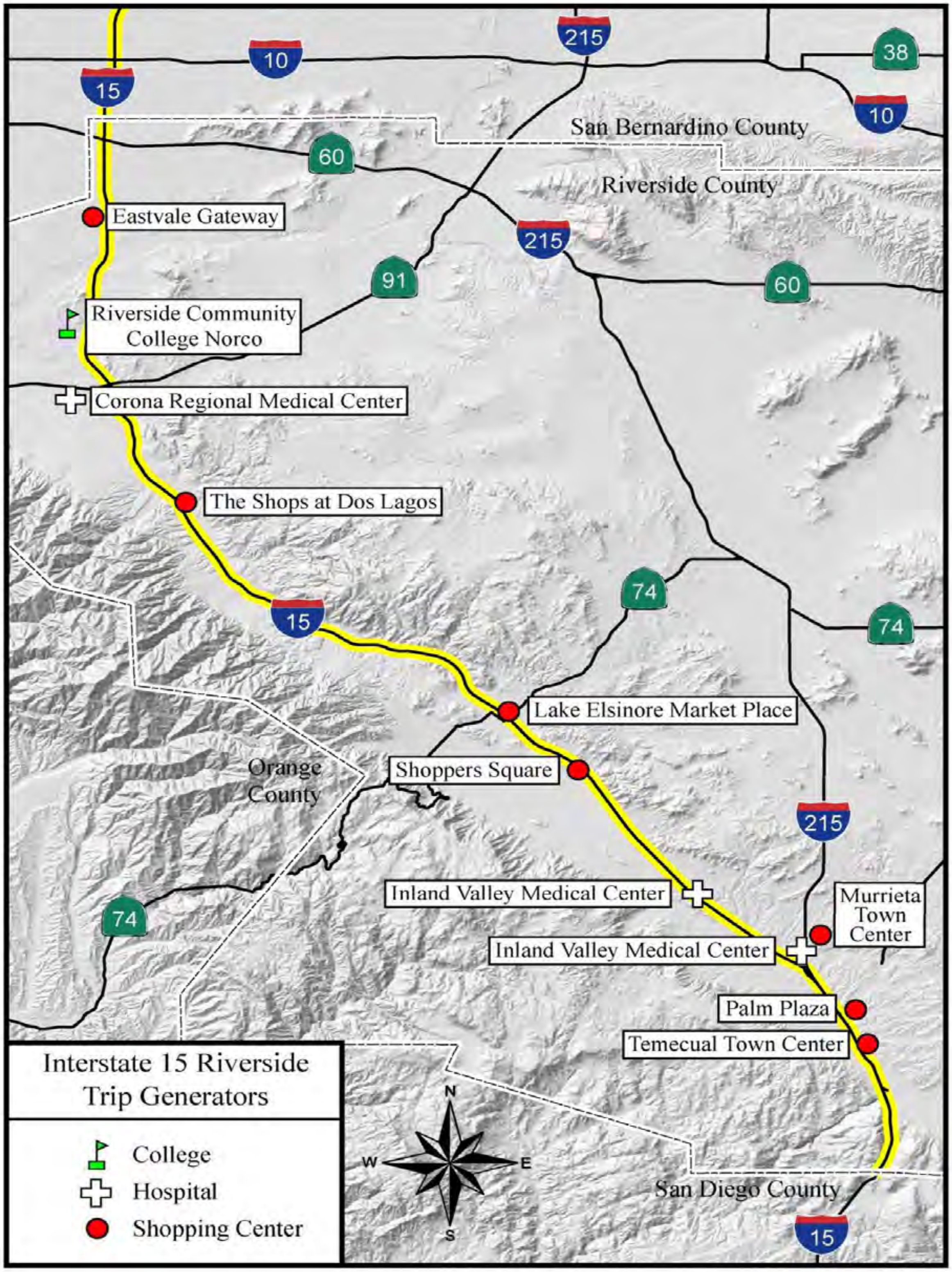
Major land use facilities such as educational institutions, medical centers, commercial/retail and entertainment centers can generate significant trips on the I-15 corridor. All educational institutions along the corridor are part of the California Community College System. Medical centers are comprised of regional and general Hospitals. Commercial/retail and entertainment centers can be a combination, in part or in all, major retail store (anchor store), retail store, general services store, movie theatre, sit-down dining, drive-through restaurant, etc. These facilities are listed in Exhibit 2-26 and displayed in map form, Exhibit 2-27.

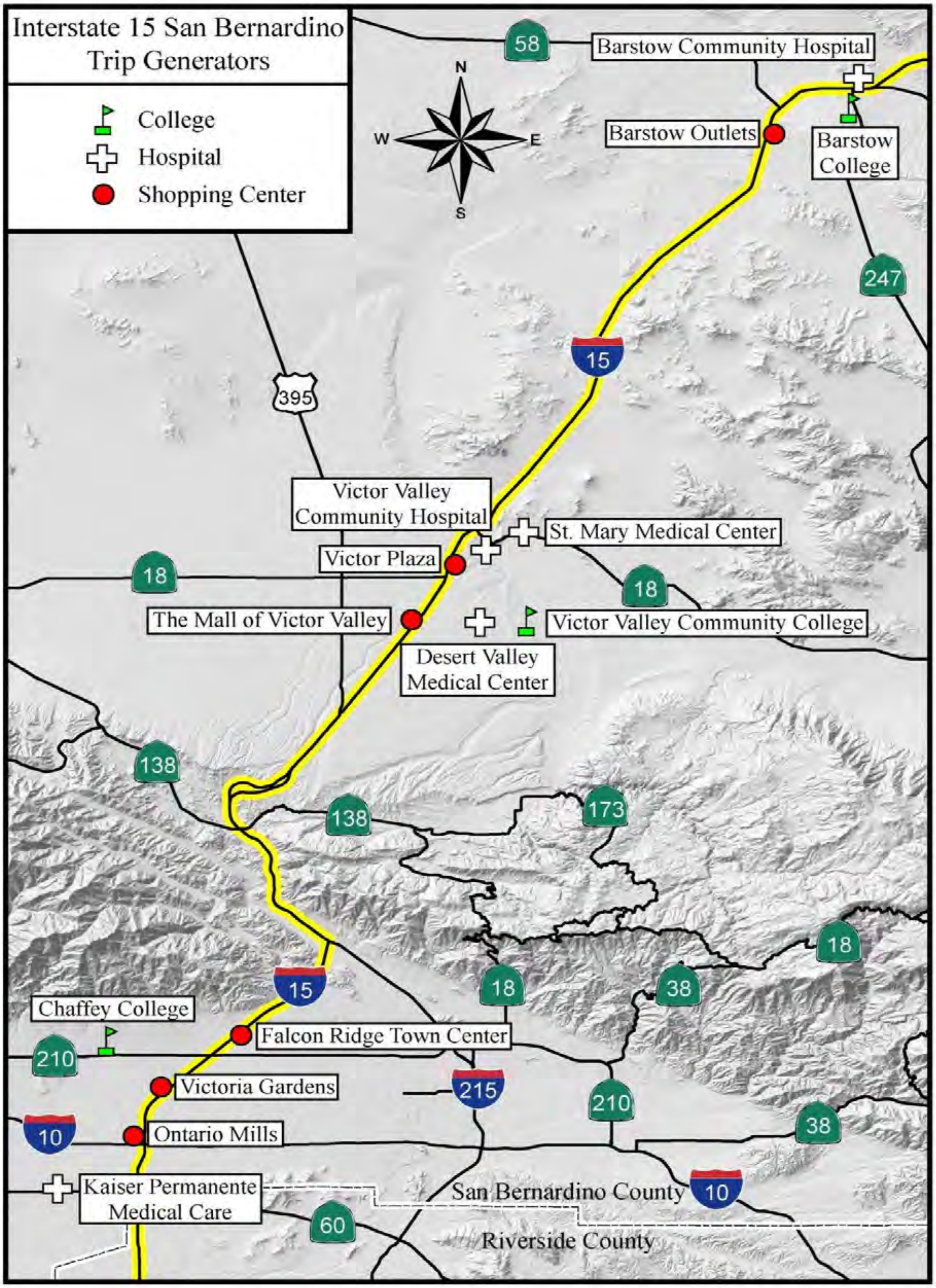
Exhibit 2-26: Trip Generators, I-15 Corridor

Land Use	Location	Description
Educational Institutions		
Riverside Community College	Norco	1 mile west of I-15 via Second St.
Chaffey College	Rancho Cucamonga	5 miles west of I-15 via SR-210
Victor Valley Community College	Victorville	5 miles east of I-15 via Bear Valley Rd.
Barstow College	Barstow	1 mile south of I-15 via SR-247
Medical Centers		
Rancho Springs Medical Center	Murrieta	1 east of I-15 via I-215
Inland Valley Medical Center	Murrieta	1 miles east of I-15 via Clinton Keith Rd.
Corona Regional Medical Center	Corona	1 mile west of I-15 via SR-91
Kaiser Permanente Medical Center	Ontario	3 miles west of I-15 via SR-60

Land Use	Location	Description
Desert Valley Medical Center	Victorville	3 miles east of I-15 via Bear Valley Rd.
Victor Valley Community Hospital	Victorville	1 mile east of I-15 via Mojave Dr.
St. Mary Medical Center	Apple Valley	3 miles east of I-15 via SR-18
Barstow Community Hospital	Barstow	1 mile north of I-15 via Barstow Rd.
Commercial/Retail and Entertainment Centers		
Temecula Town Center	Temecula	Adjacent to I-15 via Rancho California Rd.
Palm Plaza Shopping Center	Temecula	Adjacent to I-15 via SR-79 North
Murrieta Hot Springs Shopping Center	Murrieta	Adjacent to I-15 via Murrieta Hot Springs Rd.
Shoppers Square Shopping Center	Lake Elsinore	Adjacent to I-15 via Diamond Dr.
Lake Elsinore Market Place	Lake Elsinore	Adjacent to I-15 via Central Ave.
The Shops at Dos Lagos	Corona	Adjacent to I-15 via Cajalco Rd.
Eastvale Gateway	Eastvale	Adjacent to I-15 via Limonite Ave.
Ontario Mills	Ontario	Northwest quadrant of I-10/I-15
Victoria Gardens	Rancho Cucamonga	Adjacent to I-15 via Foothill Blvd.
Falcon Ridge Town Center	Fontana	Adjacent to I-15 via Summit Ave.
The Mall Victor Valley	Victorville	Adjacent to I-15 via Bear Valley Rd.
Valley Center Shopping Center	Victorville	Adjacent to I-15 via Roy Rogers Dr.
Barstow Outlet	Barstow	Adjacent to I-15 via Lenwood Rd.

Exhibit 2-27: Trip Generators Map, I-15 Corridor




Interstate 15 San Bernardino Trip Generators
College
Hospital
Shopping Center
N
W
E
S
58
Barstow Community Hospital
Barstow Outlets
Barstow College
247
15
395
Victor Valley Community Hospital
St. Mary Medical Center
Victor Plaza
18
18
The Mall of Victor Valley
Victor Valley Community College
Desert Valley Medical Center
138
138
173
18
15
18
38
Chaffey College
Falcon Ridge Town Center
210
Victoria Gardens
215
210
10
Ontario Mills
38
Kaiser Permanente Medical Care
San Bernardino County
10
60
Riverside County

Demand Profile

Demand for I-15 within the study area is described in terms of commute, recreational, and truck traffic. Exhibit 2-28 summarizes the current ADT and anticipated future traffic growth.

Commuter Traffic: Commuter traffic within the I-15 corridor is concentrated in three areas: 1) the urbanized portion of western Riverside County to San Diego County, 2) between San Bernardino and Riverside Counties, and 3) Victor Valley to western San Bernardino County and further westward toward Los Angeles. The traffic to San Diego County is projected to grow 101 percent from 2008 to 2040. The projected traffic volumes between San Bernardino and Riverside Counties increased 47 percent. The traffic between the Victor Valley and San Bernardino grew 77 percent south of US-395 and 100 percent north of I-215 in Devore.

Recreational Traffic: Much of the traffic headed northward on I-15 from southern California toward Nevada is recreational traffic bound for Las Vegas, the high desert, the Colorado River and beyond. The traffic volume north of the city of Barstow expected to increase 81 percent from 2008 to 2040.

Southbound I-15 traffic headed to San Diego/Mexico includes a recreational component bound for resorts, casinos, shopping centers, and theme parks. Traffic crossing from Riverside County into San Diego County is expected to increase 101 percent.

Truck Traffic: The projected volume of trucks headed north from San Diego into Riverside County grew 168 percent from 2008 to 2040. Continuing from Riverside into San Bernardino County, the truck traffic is projected to grow 66 percent. From San Bernardino on toward the Victor Valley, the volume of trucks is expected to grow 127 percent north of I-215 and 106 percent south of US-395. North of the city of Barstow toward Nevada, truck volumes increase 125 percent.

Exhibit 2-28: Traffic Demand Growth on I-15 within District 8

Description	2010 AADT	2010 Trucks	2010 Truck Volume	2040 AADT	2040 Trucks	2040 Truck Volume	Growth in AADT from 2010 to 2040	Growth in Trucks from 2010 to 2040
North of SD/Riv Co. Line	129,000	7%	8,708	259,500	9%	23,355	101%	168%
North of SB/Riv Co. Line	219,578	8%	17,548	323,044	9%	29,074	47%	66%
North of I-215 Devore	161,263	13%	21,237	321,895	15%	48,284	100%	127%
South of US-395	129,726	13%	16,777	230,052	15%	34,508	77%	106%
North of I-40	46,807	16%	7,515	84,704	20%	16,941	81%	125%

3. CORRIDOR-WIDE PERFORMANCE AND TRENDS

This section summarizes the analysis results of the performance measures used to evaluate the existing conditions of the I-15 Corridor. The primary objectives of the measures are to provide a sound technical basis for describing traffic performance on the corridor.

The performance measures focus on five key areas:

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

MOBILITY

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

Delay

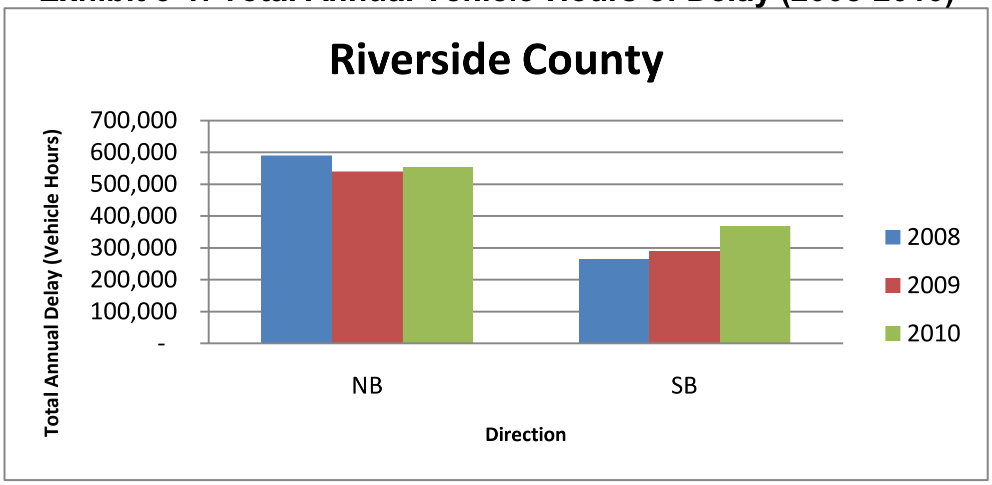
Delay is defined as the total observed travel time less the travel time under non-congested conditions, and is reported as vehicle-hours of delay. Delay can be computed for severe congested conditions using the following formula:

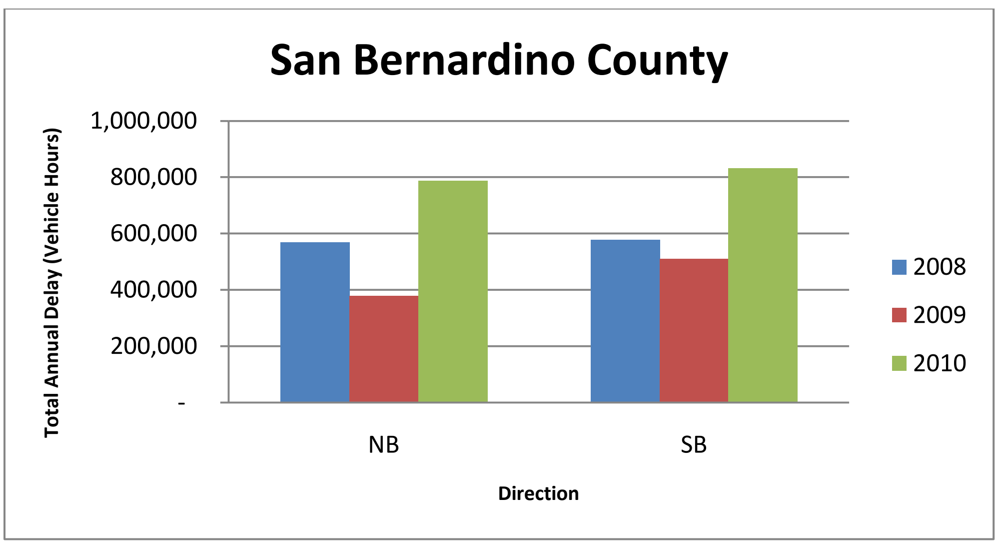
$$(\text{Vehicles Affected per Hour}) \times (\mathit{Distance}) \times (\mathit{Duration}) \times \left[\frac{1}{(\text{Congested Speed})} - \frac{1}{35\text{mph}} \right]$$

In the formula above, the *Vehicles Affected per Hour* value depends on the methodology used. Some methods assume a fixed flow rate (e.g., 2,000 vehicles per hour per lane), while others use a measured or estimated flow rate. The distance is the length under which the congested speed prevails and the duration is the hours of congestion experienced below the threshold speed. However, all delays can be computed by replacing the "35 mph" with "60 mph" in the previous formula.

Exhibit 3-1 shows the yearly delay trends from 2008 to 2010 for both directions along the I-15 corridor. As indicated, the northbound direction had the most significant congestion in Riverside County while the southbound direction experienced the most congestion in San Bernardino County.

Exhibit 3-1: Total Annual Vehicle-Hours of Delay (2008-2010)





Source: PeMS

Exhibit 3-2 shows the complete list of bottleneck locations reported by the Mobility Performance Report (MPR) for the I-15 corridor. A bottleneck is defined as a persistent and significant drop in speed between two locations on the freeway.[6] It is identified through the annual vehicle hours of delay (AVHD) below 60 miles per hour. Further analysis demonstrated these locations not to be areas of concern.

Exhibit 3-2: MPR Bottleneck Locations (2009)

County	Direction	Post Mile	Location	2009 AVHD (60 mph)
San Bernardino	NB	13.70	South of Glen Helen Pkwy.	151,000
Riverside	SB	39.24	North of Ontario	147,000
Riverside	NB	39.43	North of Temescal	77,000
Riverside	NB	52.27	Philadelphia	76,000
Riverside	SB	39.77	North of Orlando	63,000
San Bernardino	NB	109.97	4th St. NB On-Ramp	62,000

[6] Mobility Performance Report 2009

Freeway Performance Measurement System (PeMS)

Freeway detector data obtained from PeMS can be used to calculate daily delay, which is not possible through probe vehicle runs. The ability to capture it daily enables delay to be presented in different ways, such as by time period, month, day of the week, or time of day. For the I-15 study corridor, detector data was only available from the San Diego/Riverside County Line to State Route 138.

Delays identified using PeMS represent the difference in travel time between actual conditions and free-flow conditions at 60 miles per hour, applied to the actual output flow volume collected from a vehicle detector station.

Exhibits 3-3 and 3-4 show the typical weekly delay for the I-15 Corridor in each county by month and direction. As indicated in this exhibit, the typical weekday delay varies month to month, ranging from approximately 200 vehicle-hours to 5,000 vehicle-hours. December 2010 experienced the highest levels of congestion during the three-year period with over 5,000 vehicle-hours of delay in the northbound direction.

Exhibit 3-3: Riverside County I-15 Northbound Typical Weekday Delay by Month (2008)

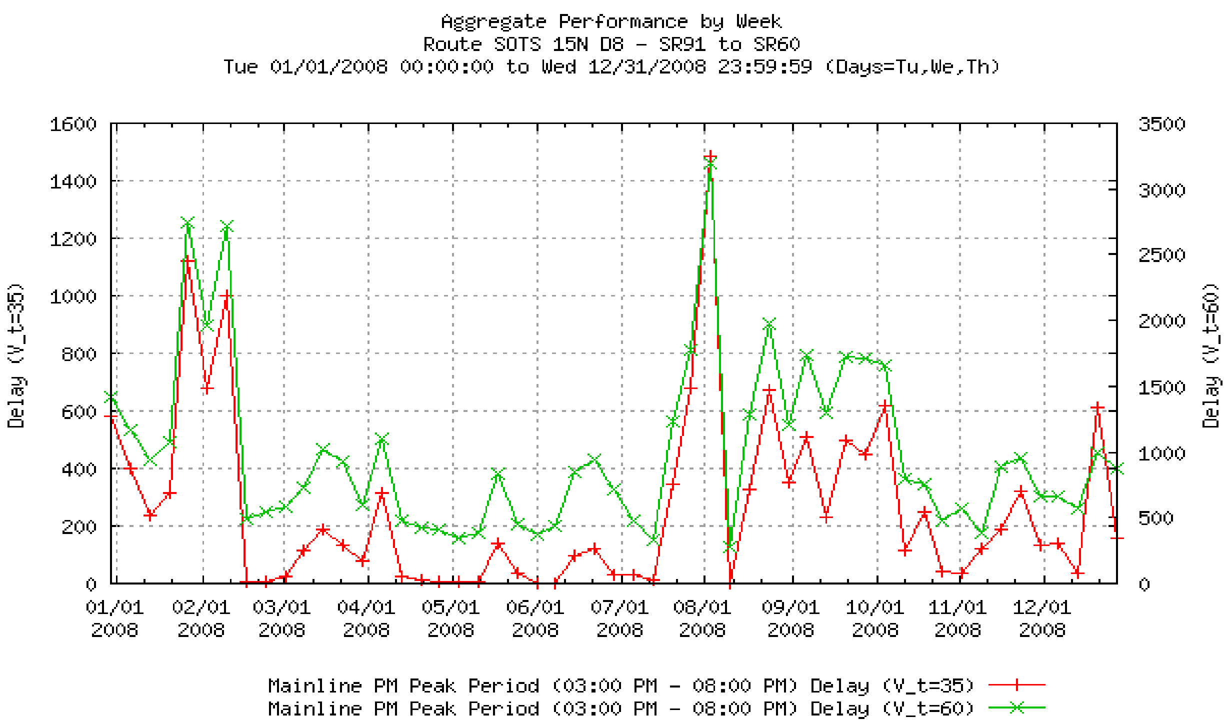


Exhibit 3-3: Riverside County I-15 Northbound Typical Weekday Delay by Month (2009)

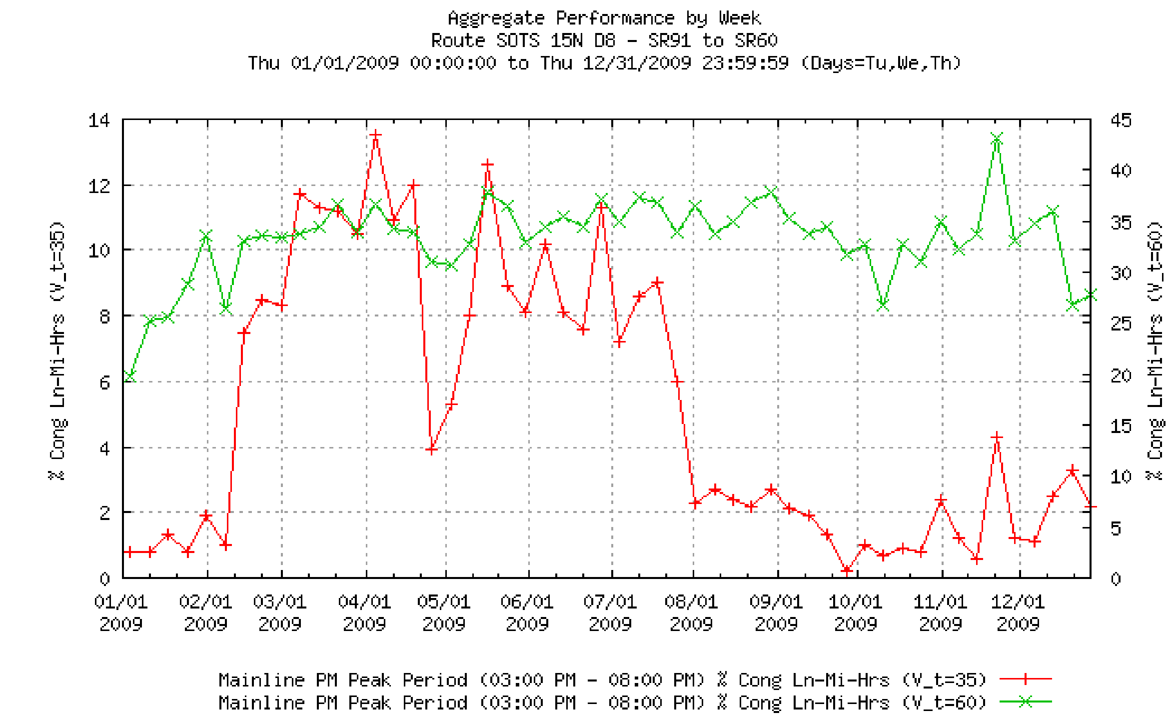
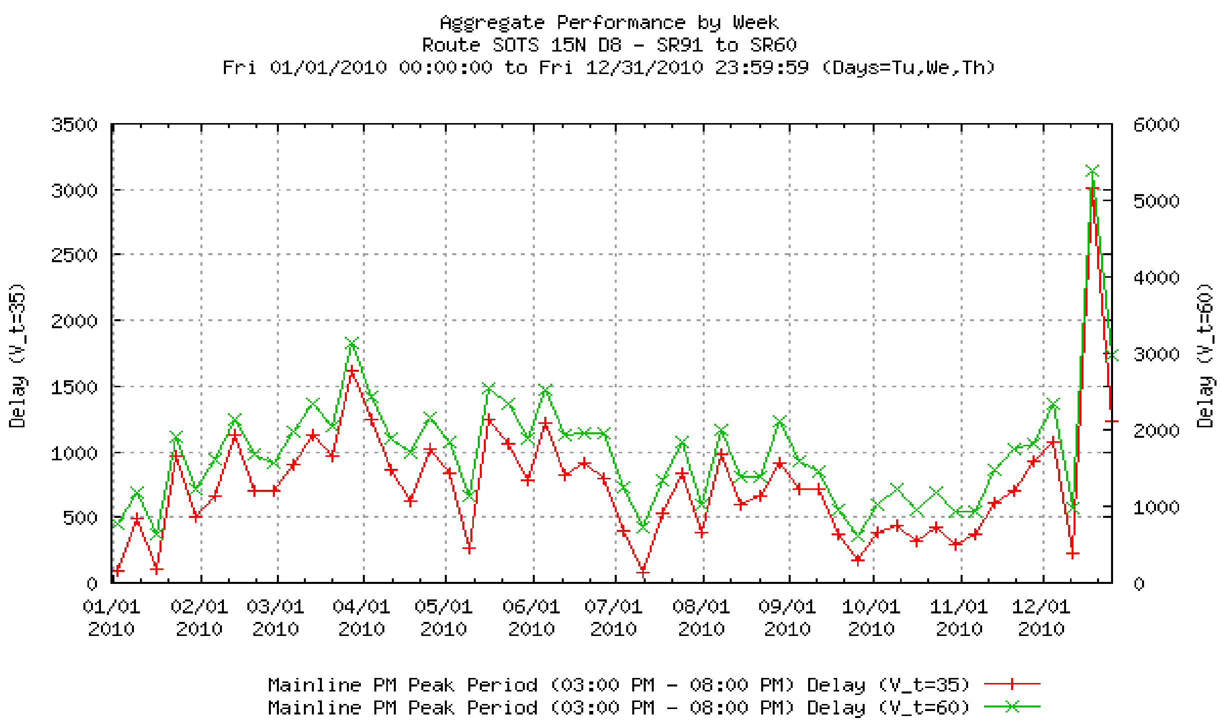


Exhibit 3-4: Riverside County I-15 Northbound Typical Weekday Delay by Month (2010)



Source: PeMS

Delay presented above represents the difference in travel time between "actual" conditions and free-flow conditions at 60 miles per hour. This delay can be segmented into two components as shown in Exhibits 3-3 and 3-4:

- 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.

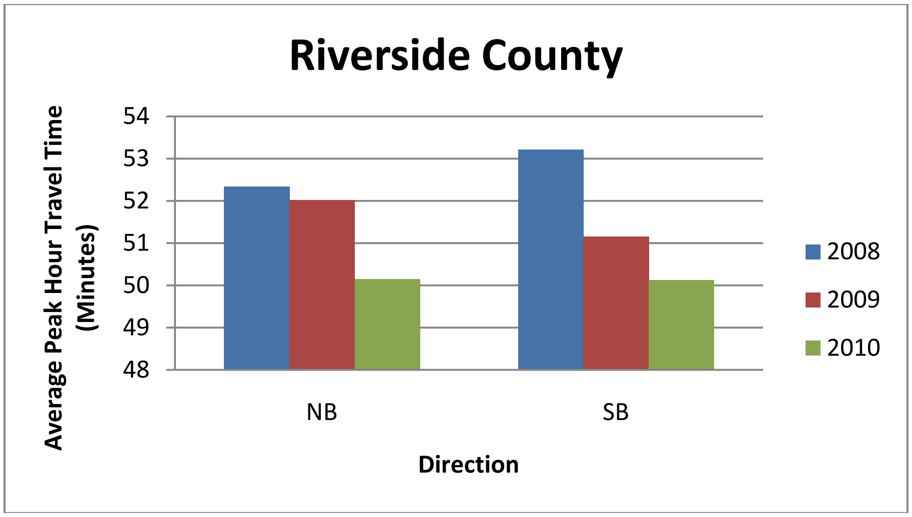
Severe delay represents *breakdown conditions* and is the focus of most congestion mitigation strategies. "Other" delay represents conditions approaching the breakdown congestion that are temporary slowdowns rather than widespread breakdowns.

Travel Time

Travel time is reported as the amount of time for a vehicle to traverse two points on a corridor. For the travel time analysis, PeMS data was analyzed for the corridor from the San Diego/Riverside County Line to State Route 138. The performance measure is reported in terms of time to travel from one end of the corridor to the other along the freeway. Travel time on parallel arterials is not included in the analysis.

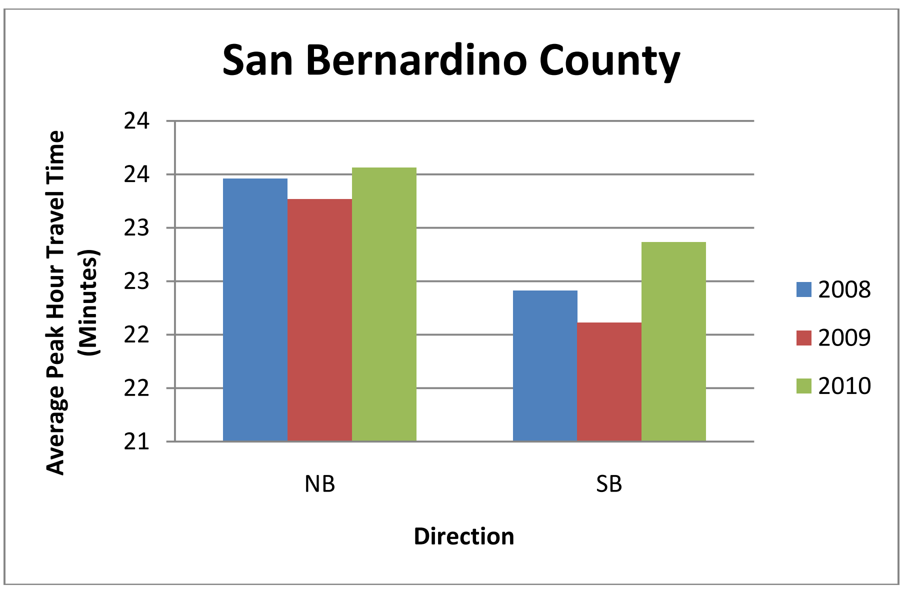
Exhibits 3-5 and 3-6 depict the travel times calculated for the I-15 Corridor in each county for 2008, 2009, and 2010. Both Exhibits 3-5 and 3-6 show that travel times remained consistent during 2008 to 2010.

Exhibit 3-5: I-15 Travel Time (2008-2010)



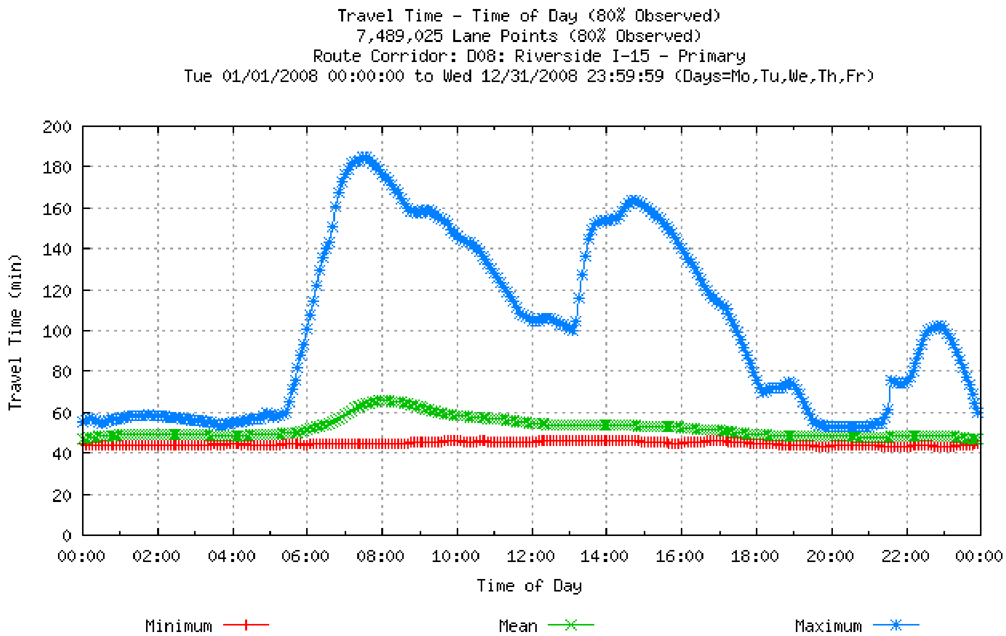
Source: PeMS

Exhibit 3-6: I-15 Travel Time (2008-2010)

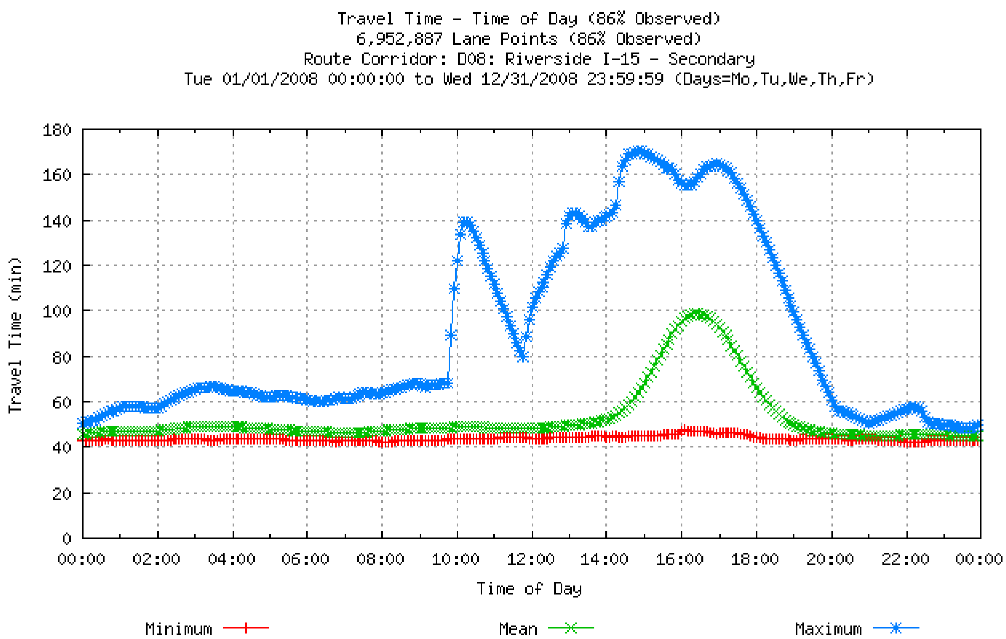


Source: PeMS

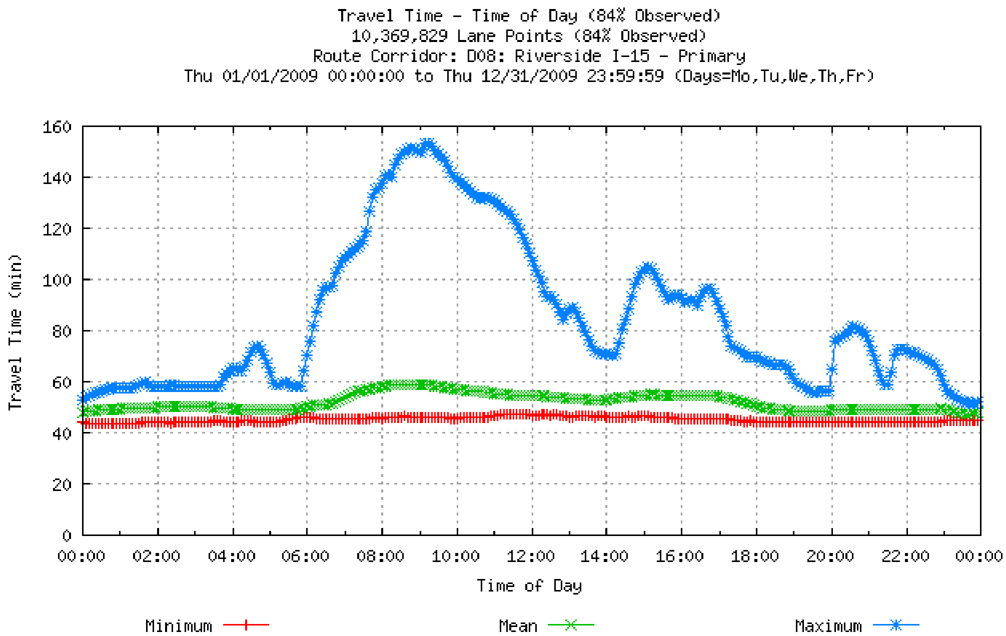
2008 Northbound – Riverside County



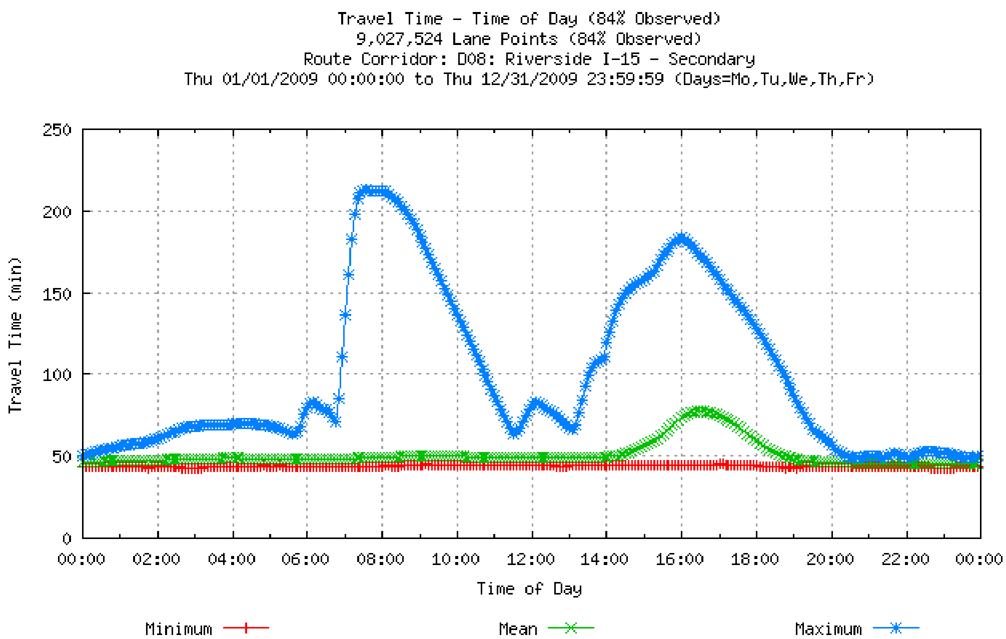
2008 Southbound – Riverside County



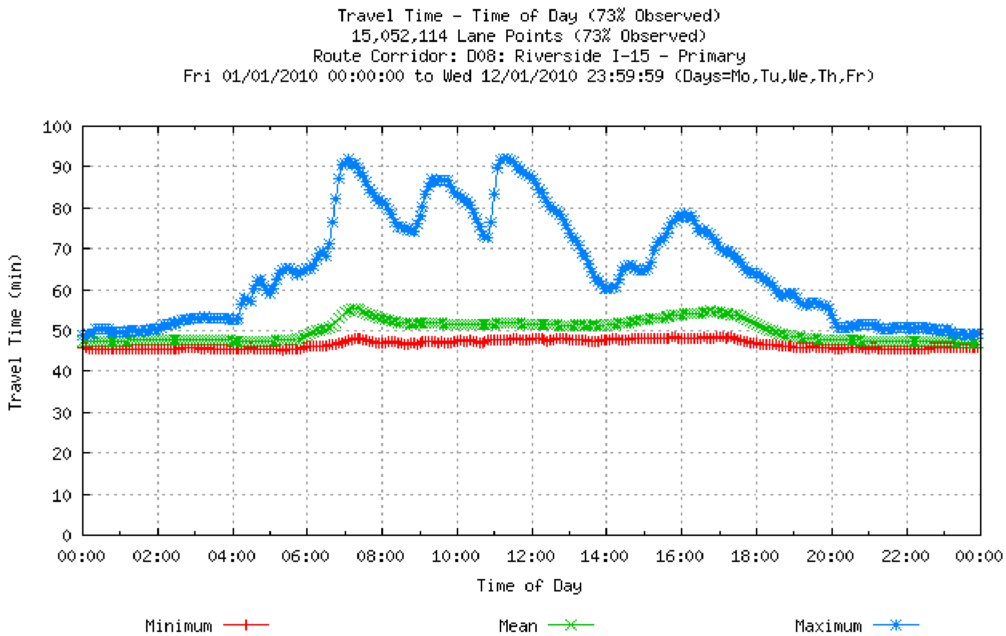
2009 Northbound – Riverside County



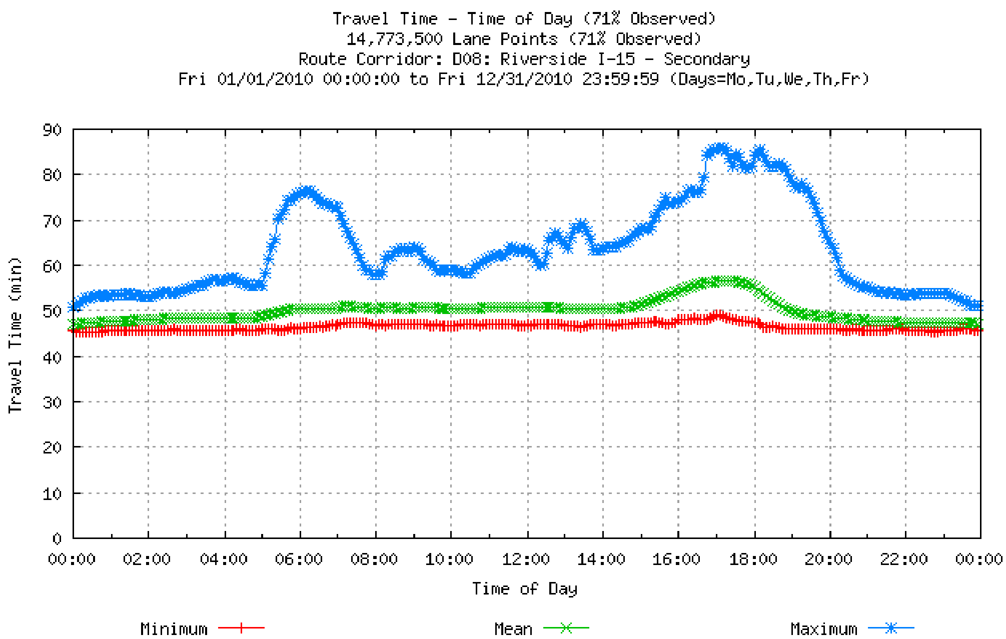
2009 Southbound – Riverside County



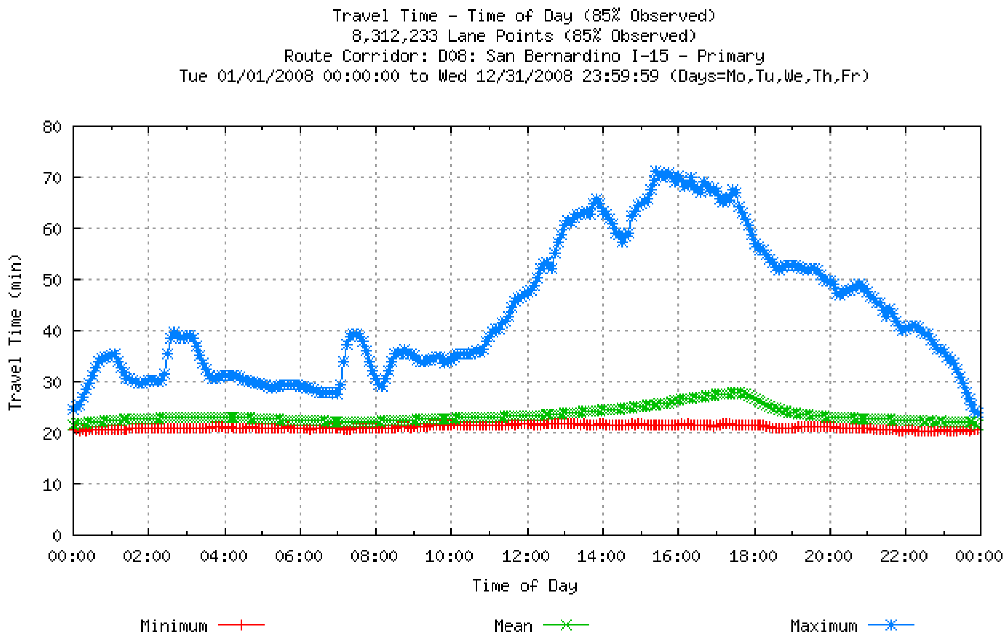
2010 Northbound – Riverside County



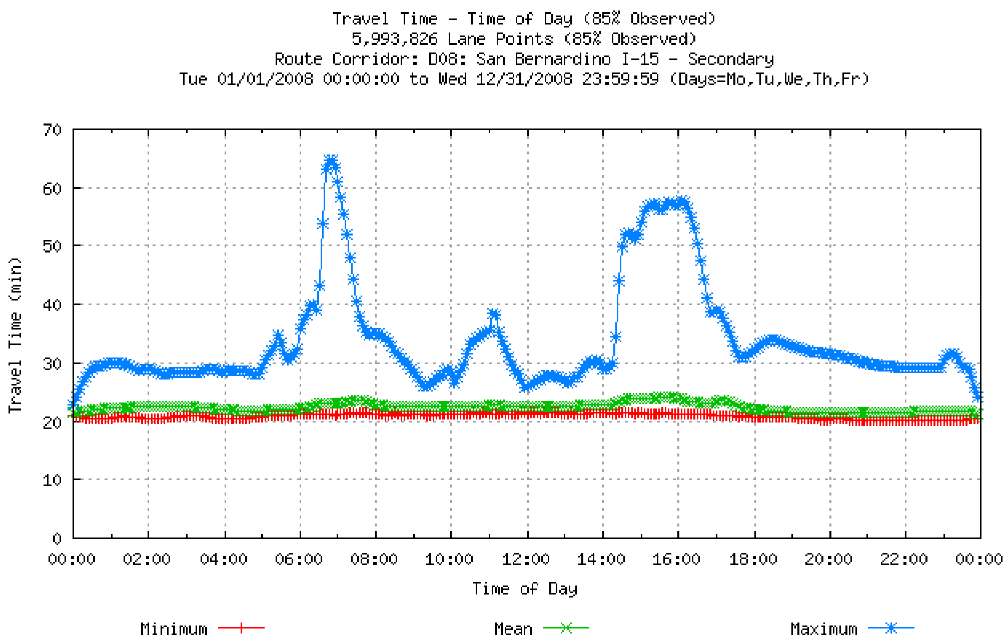
2010 Southbound – Riverside County



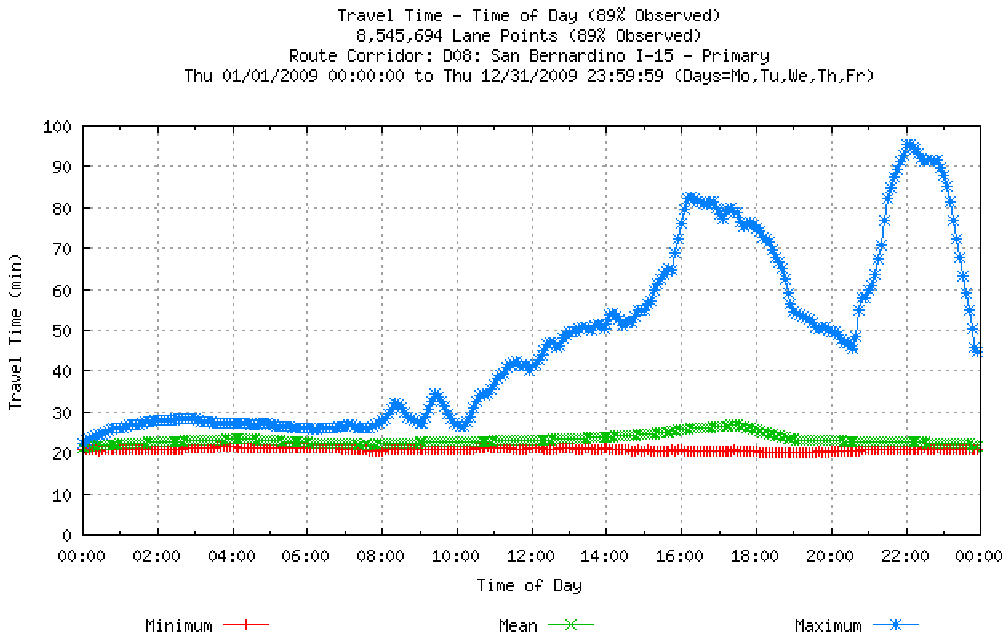
2008 Northbound – San Bernardino County



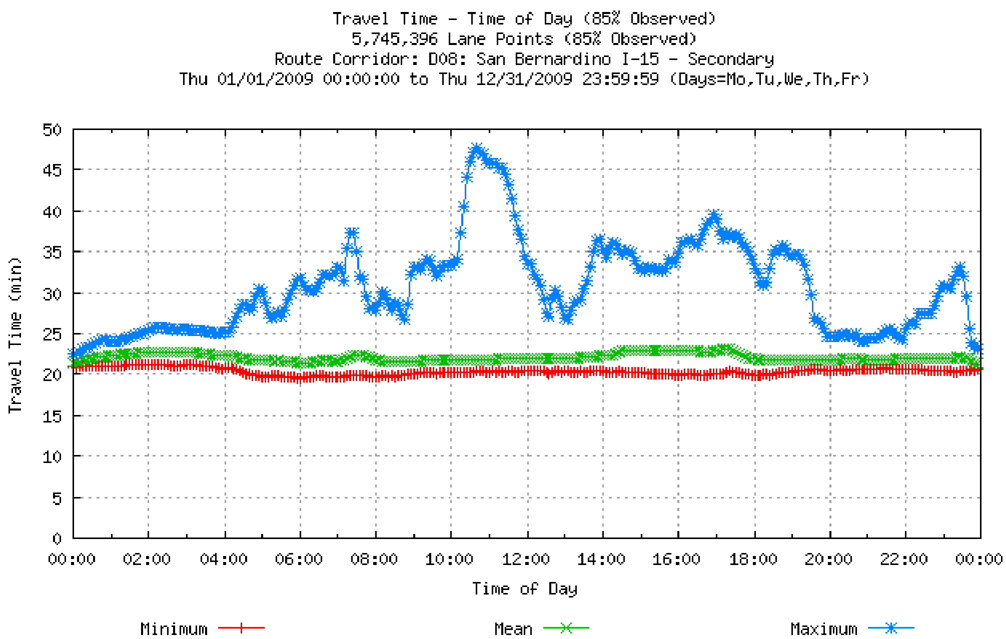
2008 Southbound – San Bernardino County



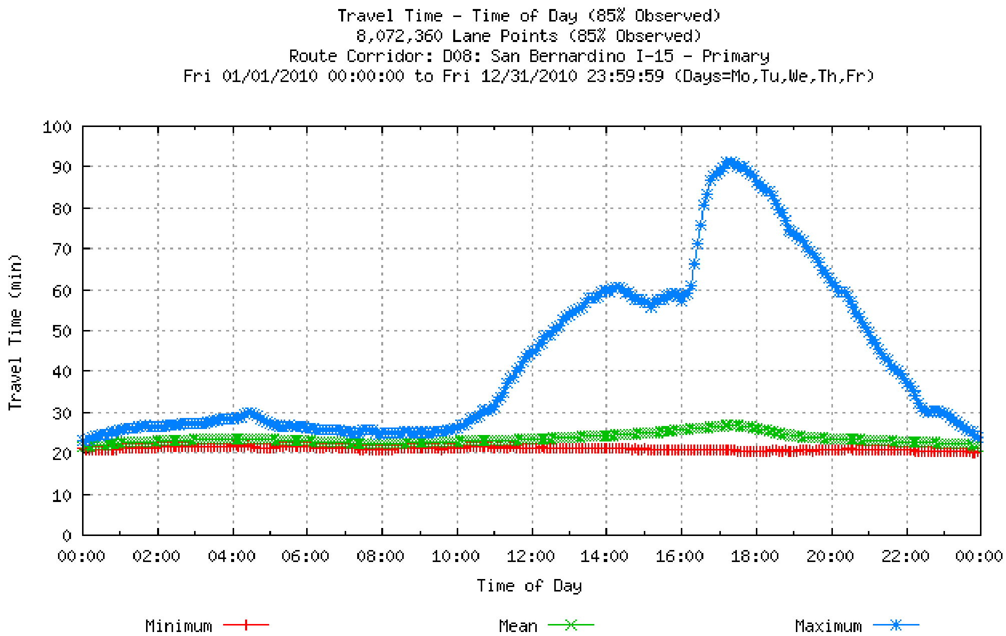
2009 Northbound – San Bernardino County



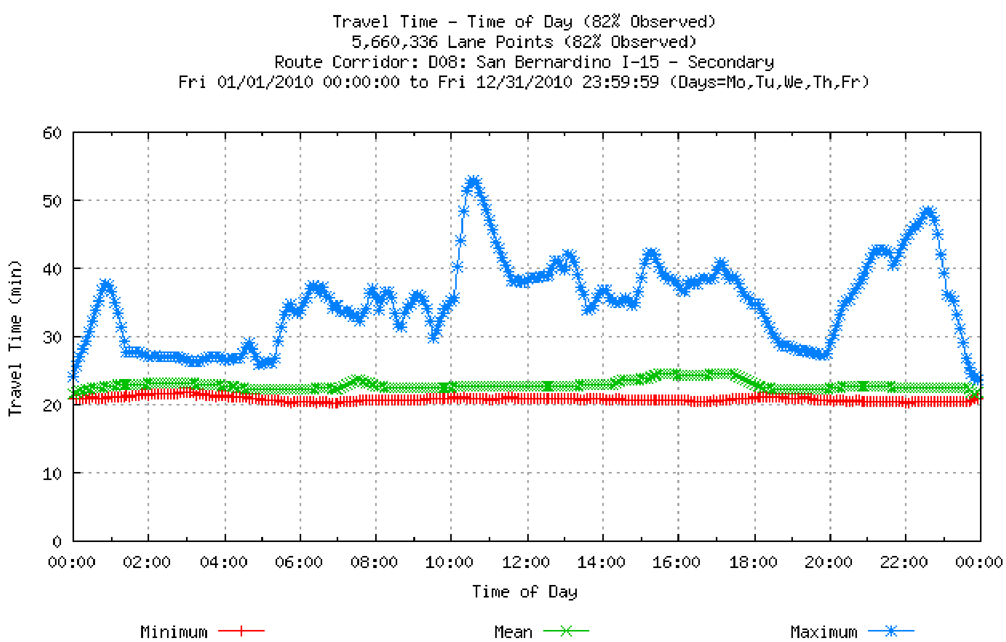
2009 Southbound – San Bernardino County



2010 Northbound – San Bernardino County



2010 Southbound – San Bernardino County



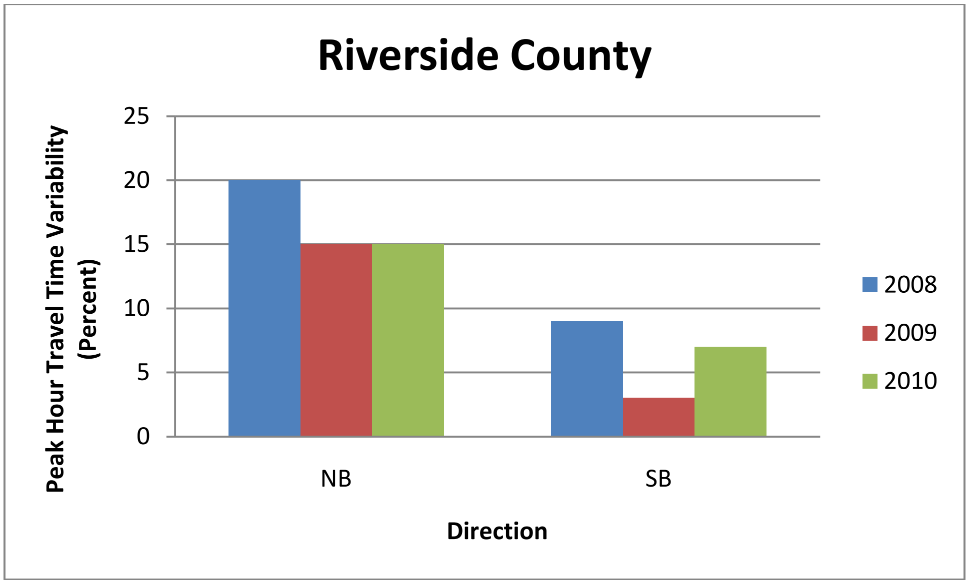
RELIABILITY

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

Exhibits 3-7 to 3-8 on the following page illustrate the variability of travel time along the I-15 corridor on weekday peak periods for 2008, 2009, and 2010 in both Riverside and San Bernardino Counties.

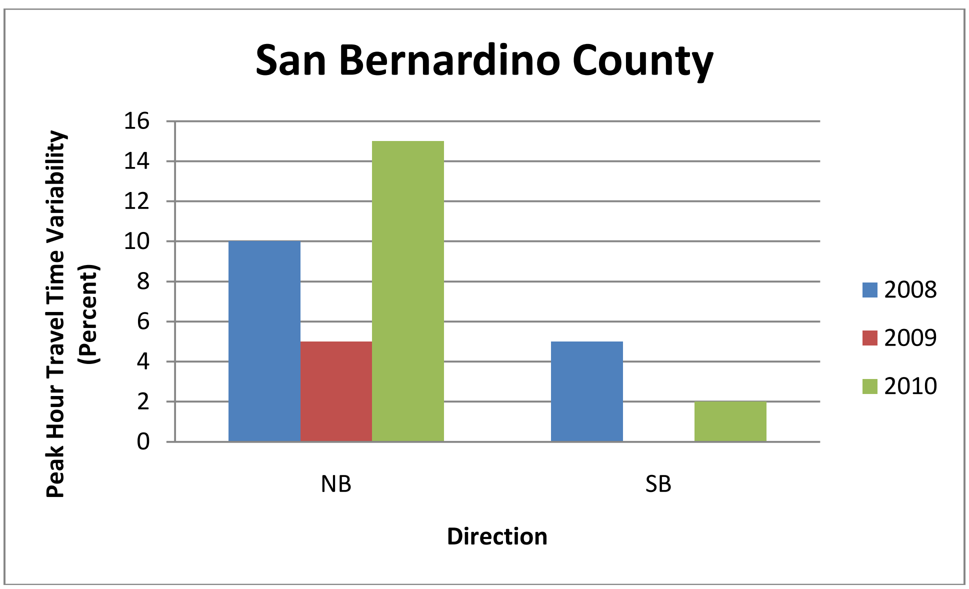
In Riverside County, the variability of travel time has declined slightly in recent years. In San Bernardino County, however, while the variability of travel time has declined slightly in the southbound direction, it has increased in the northbound direction. This may be due to marginal bottlenecks becoming more significant.

Exhibit 3-7: I-15 Travel Time Variation (2008-2010)



Source: PeMS

Exhibit 3-8: I-15 Travel Time Variation (2008-2010)



Source: PeMS

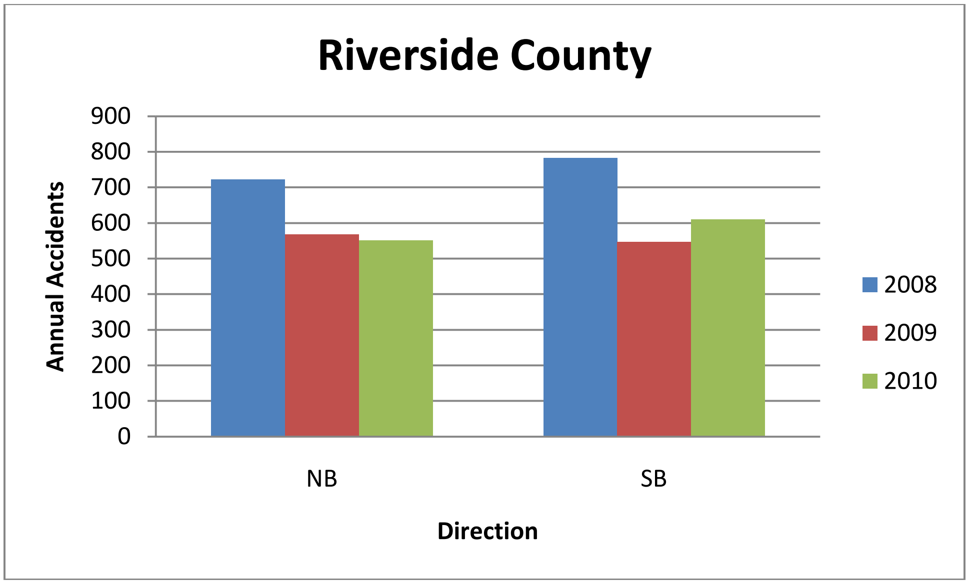
SAFETY

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

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

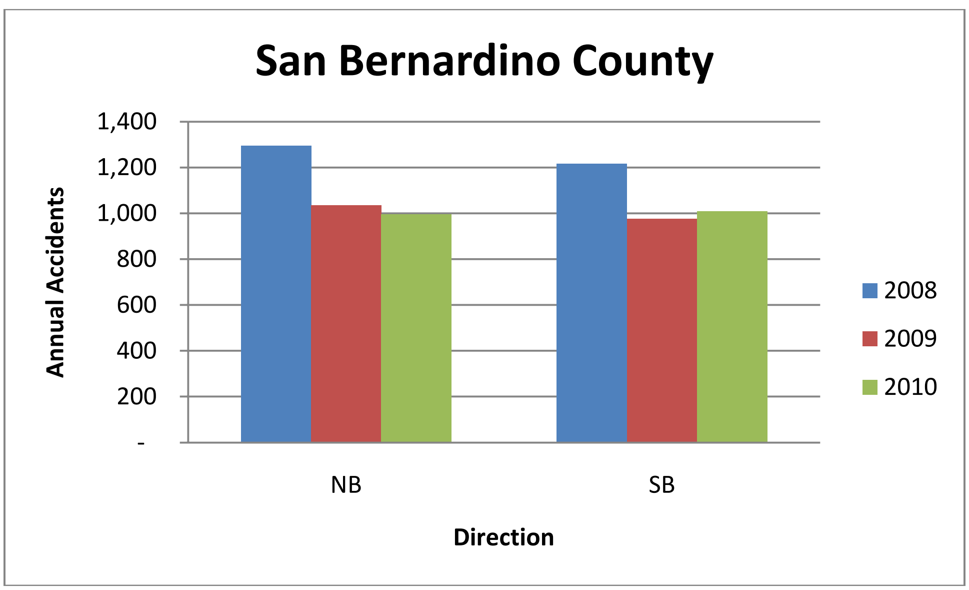
Exhibits 3-9 and 3-10 show the I-15 Corridor annual accidents by year in each direction. The annual accidents are broken down by weekdays and weekends. Typically the latest three-year safety data are analyzed, currently available only through March 31, 2010. Therefore, annual data for the three-year period from April 1, 2007 through March 31, 2010 were analyzed. As indicated, both the northbound and southbound corridor experienced similar total collisions for the combined three years. In addition, the northbound direction experienced slightly fewer collisions each year between 2008 and 2010, while the southbound direction had a slight increase in 2010 after declining in 2009.

Exhibit 3-9: I-15 Annual Accidents (2008-2010)



Source: PeMS

Exhibit 3-10: I-15 Annual Accidents (2008-2010)



Source: PeMS

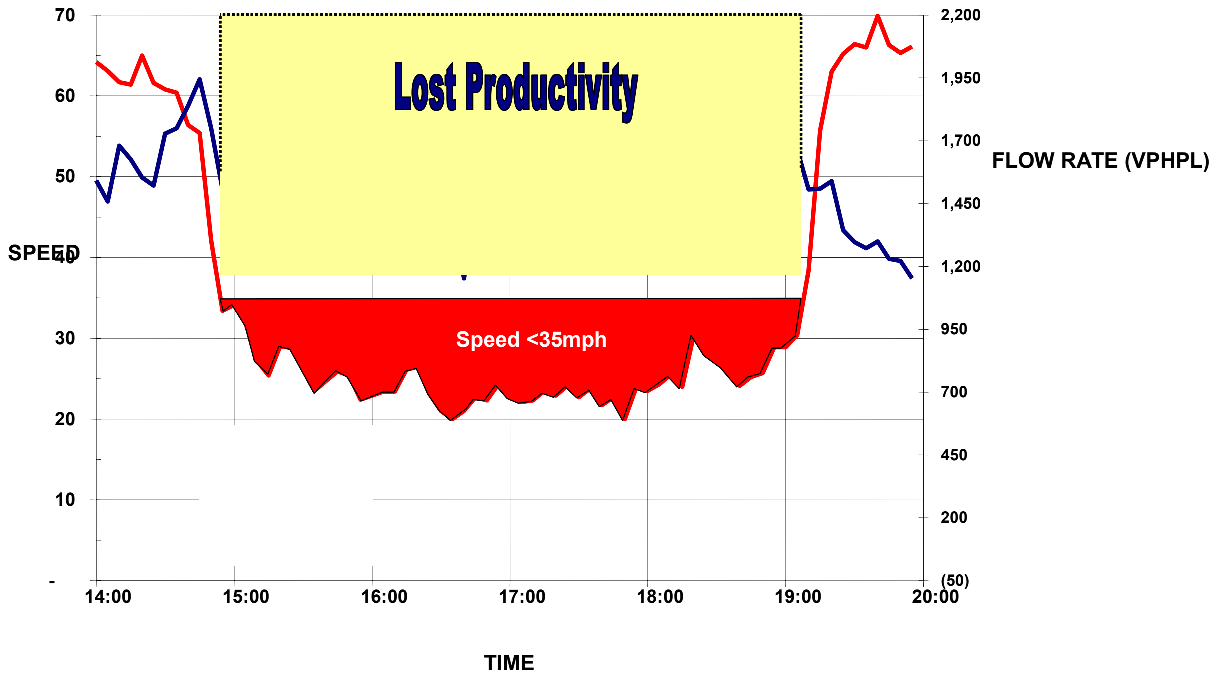
PRODUCTIVITY

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

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

This loss in productivity example is illustrated in Exhibit 3-11. As traffic flow increases close to the capacity limits of a roadway, speeds decline rapidly and throughput drops dramatically. This loss in throughput is the lost productivity of the system. There are a few ways to estimate productivity losses. Regardless of the approach, productivity calculations require good detection or significant field data collection at congested locations. One approach is to convert this lost productivity into "equivalent lost lane-miles." These lost lane-miles represent a theoretical level of capacity that would need to be added in order to achieve maximum productivity. For example, losing six lane-miles implies that adding a new lane along a six-mile section of freeway would be needed to improve productivity.

Exhibit 3-11: Lost Productivity Illustrated



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

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

Exhibits 3-12 and 3-13 summarize the productivity losses on the I-15 Corridor for the respective directions of travel. The trends in the productivity losses are comparable to the delay trends. Productivity during the AM and PM peak periods in both directions improved from 2008 to 2009, but then worsened in 2010.

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

Exhibit 3-12: I-15 Average Lost Lane-Miles by Direction and Year

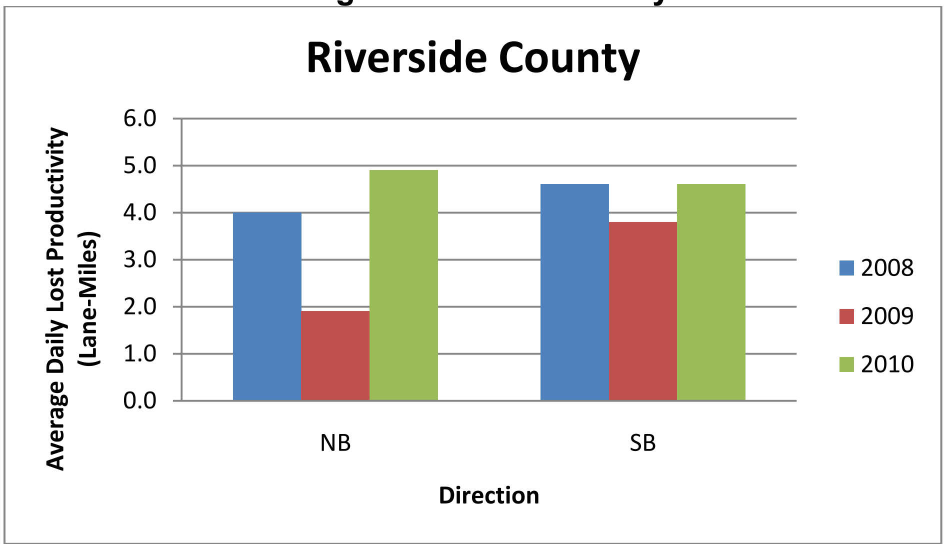
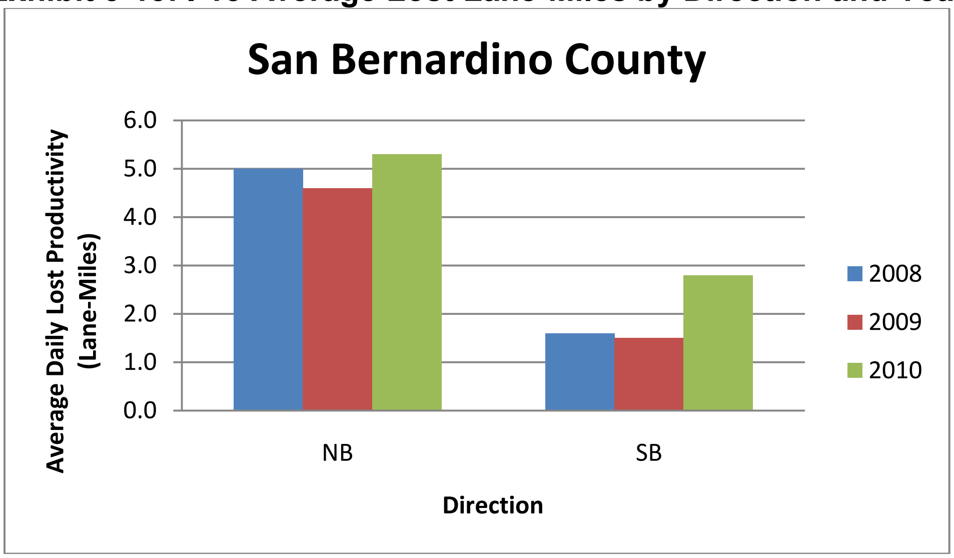


Exhibit 3-13: I-15 Average Lost Lane-Miles by Direction and Year



Source: PeMS

PAVEMENT CONDITION

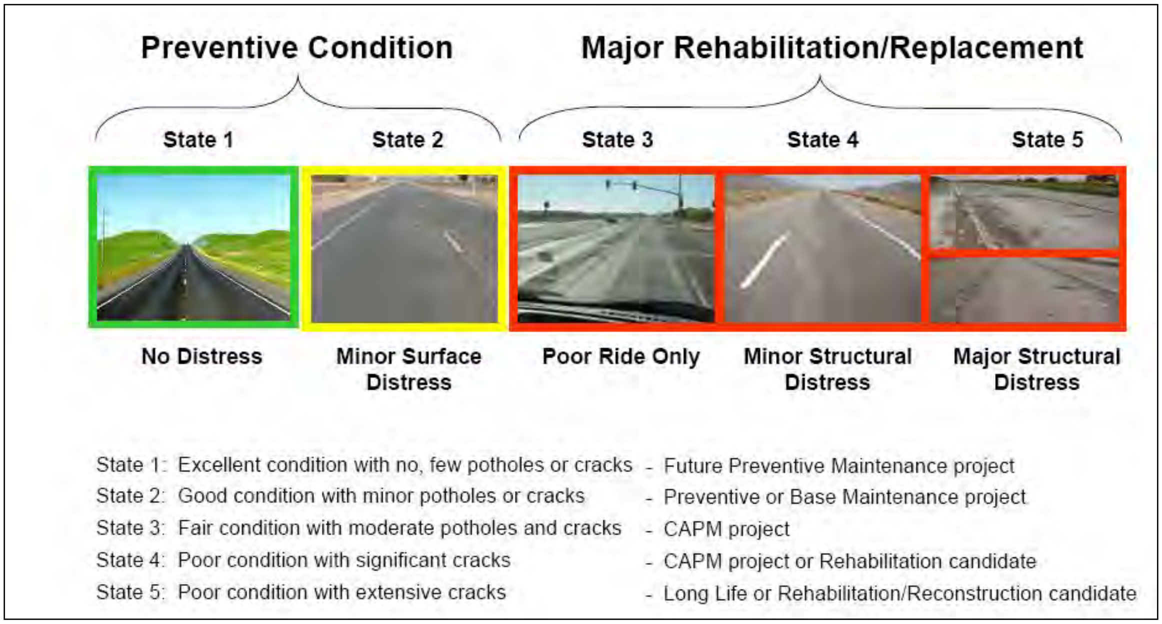
The condition of the roadway pavement (or ride quality) on the corridor can influence its traffic performance. Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor, whereas smooth pavement can have the opposite effect. Pavement preservation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

Performance Measures

The “smoothness” of pavement is measured using a standardized scale, called the International Ride Index (IRI). This is generally accepted as a worldwide pavement roughness measurement. The IRI measures a vehicle’s up and down movement over the pavement in inches per one mile of driving. On a smooth road, such as a recently completed pavement rehabilitation project, the up and down movements are low. The Federal Highway Administration (FHWA) *2002 Conditions and Performance Report* simplified the measurement of ride quality into two descriptive terms: “Good” or “Acceptable.” To be rated acceptable, pavement performance must have an IRI value of less than or equal to 170 inches per mile. According to the FHWA IRI rating scale, the IRI value must be less than or equal to 95 inches per mile to be rated good.

“Distressed lane-miles” distinguishes among pavement segments that require only preventive maintenance at relatively low cost and those segments that require major rehabilitation or replacement. Exhibit 3-14 provides an illustration of this distinction. The first two pavement conditions include roadway that provides adequate ride quality and is structurally adequate. The remaining three conditions are included in the calculation of distressed lane-miles.

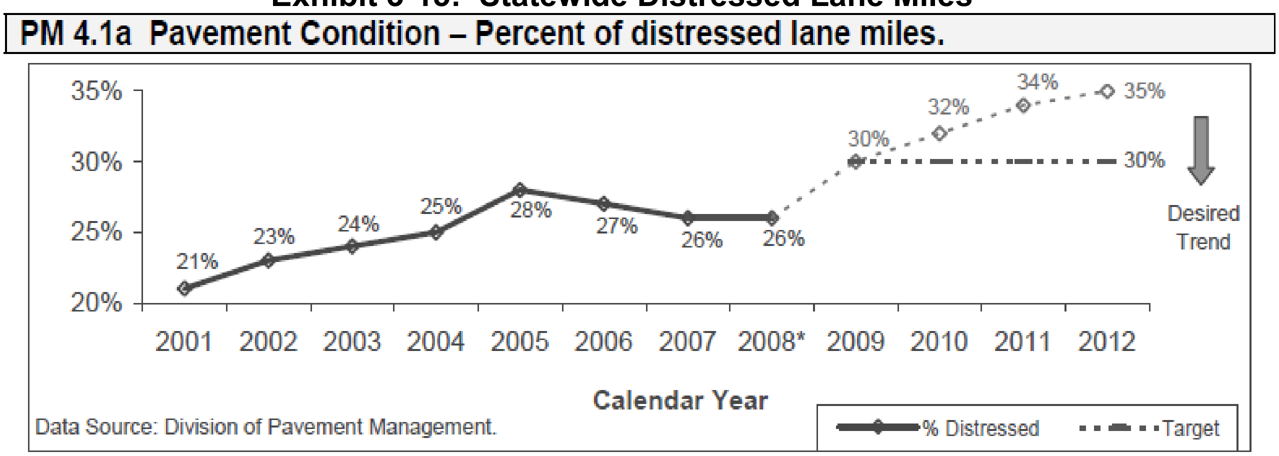
Exhibit 3-14: Pavement Condition States Illustrated



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

Exhibit 3-15 shows that in 2008 distressed lane-miles were 26 percent, statewide while the 2009 reporting cycle projects lane-miles to be 30+ percent distressed by 2012. However, the desired target is to maintain 30 percent distressed lane-miles.

Exhibit 3-15: Statewide Distressed Lane Miles



Notes

1. *The 2008 survey did not collect data for the entire system (only the NHS) and one of the distress types (faulting) was not collected. An estimate of the 2008 data can be made using the previous survey (2007), adding the distressed miles due to wear and aging of the pavement and subtracting the distressed miles eliminated due to construction.
2. Strategic Plan baseline for distressed lane miles is 28%, based on 2005 data.
3. 2006 pavement survey was delayed to 2007. The percentage shown for 2006 is interpolated.
4. Figures shown in red are forecast for pavement distress levels in 2008-2012, based on current State Highway Operation and Protection Program (SHOPP) funding for pavement projects. Meeting the stated target of 30% by 2012 will require a significant increase in SHOPP funding for pavement projects.

Existing Pavement Condition

The 2007 Pavement Condition Survey (PCS) included pavement field studies for a period longer than a year, due to an update in the data collection methodology. 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 Statewide 2007 PCS revealed that the majority of distressed pavement was on freeways and expressways (Class 1 roads). As a percentage of total lane-miles for each class, collectors and local roads (Class 3 roads) had the highest amount of distress.

During the 2009 PCS the following was found on I-15:

- From the San Diego County Line (PM R0.000) to north of Glen Eden Road (PM 30.0) in Riverside County, the route exhibited a fair pavement condition with ride quality remaining fairly constant with minor surface distress.

- From Lake Elsinore south of Temescal Canyon Road (PM 31.0) in Riverside County to the north of Sierra Avenue (PM 13.0) in San Bernardino County, the corridor exhibited a major rehabilitation pavement distress with rehabilitation projects in the preliminary stage.

- From north of the I-15/I-215 split (PM R17.4) to south of Victorville near the Bear Valley Overcrossing (PM 39.2) in San Bernardino County, the corridor exhibited a poor distressed condition that requires major rehabilitation and or replacement.

- From Victorville north bound near Bear Valley Overcrossing (PM 39.2) to the Nevada State Line (PM 179.4), after rehabilitation projects pavement condition were shown to exhibit good ride, which is an improvement from the 2007 Condition report that showed Poor-Ride only and Major Pavement Distress.

Exhibits 3-16 through 3-19 show the poorest pavement conditions in each freeway segment. The worst pavement quality is shown since pavement investment decisions are made on this basis. As seen in the exhibit, segments of this corridor has at least one lane with ride quality issues (IRI greater than 170), but it is important to keep in mind that some lanes have better quality than others within the same roadway section.

The corridor exhibits relatively good ride quality when the conditions on all lanes are considered. The study corridor is comprised of roughly 1,407 lane-miles, with a Total Distressed Pavement of 62 lane miles at 4.4 percent.

Exhibit 3-16: I-15 Pavement Condition
Riverside and San Bernardino Counties

I-15 Pavement Conditions	Lane-Miles	Percent
Major	27.30	1.9
Minor	3.74	0.3
Poor Ride	31.39	2.2
Total Distressed Pavement	62.43	4.4
Total Lane Miles	1,406.82	

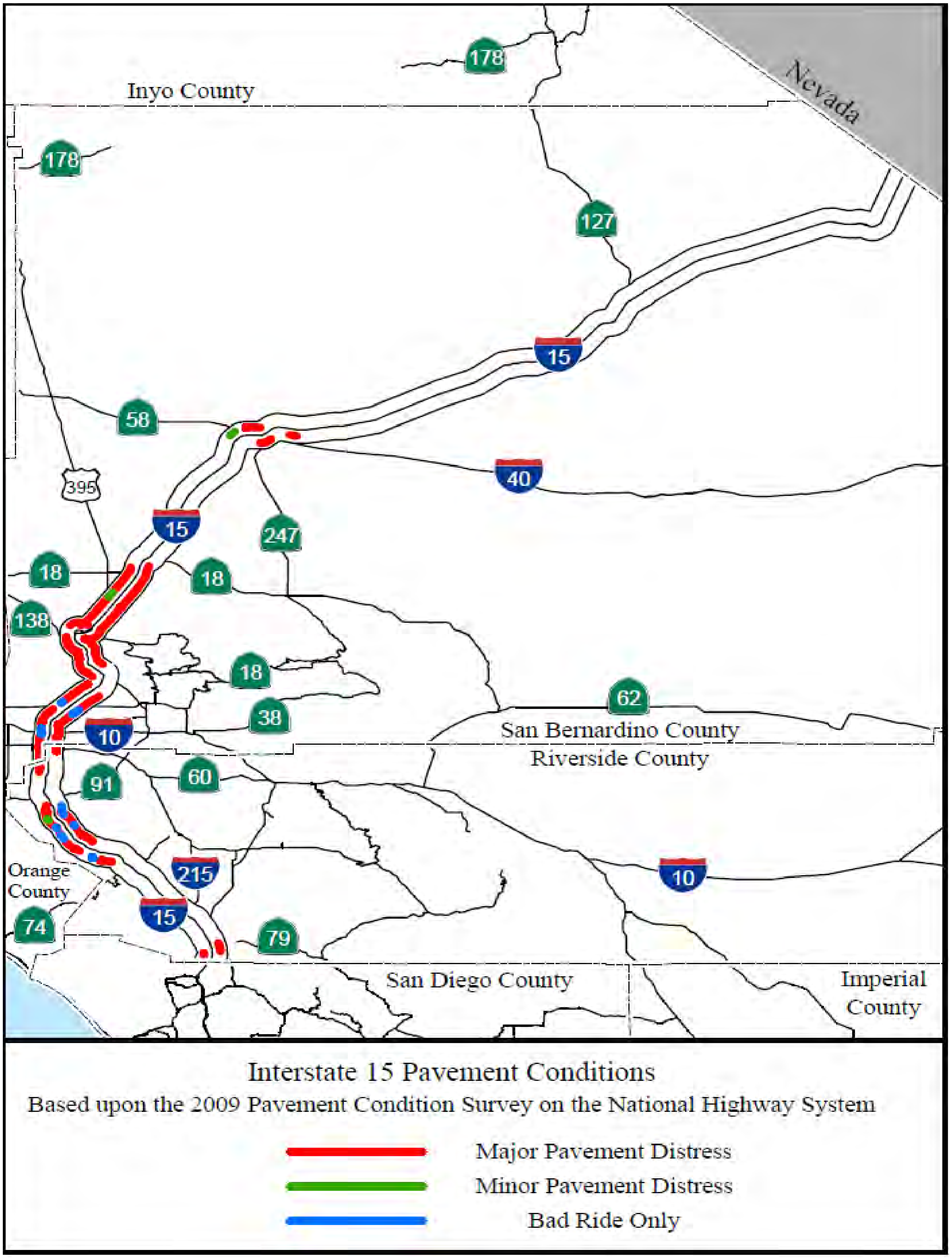
Exhibit 3-17: I-15 Riverside County Pavement Condition

Left Alignment Post Miles			Right Alignment Post Miles		
Poor Ride	Minor Distress	Major Distress	Poor Ride	Minor Distress	Major Distress
28.9-29.0	38.0-38.3	1.0-2.0	34.7-35.0		2.0-3.0
34.0-34.7		26.1-28.0	37.85-38.0		30.0-32.9
36.0-36.6		31.0-33.2	39.4-39.7		34.0-34.7
		34.7-35.0			35.0-37.8
		36.6-38.0			38.0-38.3
		38.3-40.0			51.0-52.28
		47.0-48.0			
		49.0-50.0			
		51.0-52.28			

Exhibit 3-18: I-15 San Bernardino County Pavement Condition

Left Alignment Post Miles			Right Alignment Post Miles		
Poor Ride	Minor Distress	Major Distress	Poor Ride	Minor Distress	Major Distress
2.0-3.0	34.0-35.0	0.0-2.0	8.0-9.0		0.0-8.0
7.6-8.0	70.0-71.0	3.0-6.0			9.0-12.8
		8.0-13.0			R15.0-R21.0
		R15.0-R22.8			R21.9-R26.2
		R23.9-R26.5			R28.9-R29.65
		R28.9-34			30.0-42.0
		35.0-41.0			74.0-75.0
		72.1-74.0			

Exhibit 3-19: I-15 Pavement Conditions
Riverside and San Bernardino Counties



4. BOTTLENECK IDENTIFICATION AND ANALYSIS

Potential bottlenecks were identified through PeMS. Field reviews were also conducted to verify PeMS data

Northbound Bottlenecks

Beginning at San Diego/Riverside County Line and moving northbound, the following bottlenecks were identified during the **AM** peak period:

- **Weirick Road On-ramp**: The northbound on-ramp joins the mainline with a short merge distance on an uphill grade. The high volume of traffic merging onto the mainline at this location is found to be the cause of this bottleneck.

- **2nd Street Lane Drop**: At the 2nd Street off-ramp, there are four mixed-flow lanes with an auxiliary lane ending at the 2nd Street off-ramp. The fourth lane is dropped within the interchange. A bottleneck occurs at the location of the lane drop.

- **6th Street On-ramp**: The on-ramp joins the mainline on an uphill grade. In addition there is a geometric curvature. The volumes on this ramp plus the vertical and horizontal geometry lends to the bottleneck.

The following bottlenecks were identified during the **PM** peak period only:

- **Rancho California Road On-ramps**: Successive on-ramps (loop and slip ramp) add high volumes of traffic from the ramps.

- **Winchester Road On-ramps**: Successive on-ramps (loop and slip ramp) add high volumes of traffic from the ramps.

- **Bellegrave Overcrossing to Cantu-Galleano Off-Ramp**: High volumes and the change in the horizontal alignment to the freeway create the bottleneck.

- **I-15/I-215 Connector**: Horizontal alignment and grade, high traffic volume, and decision point/ merge with I-215

The following bottlenecks were identified during the **AM** and **PM** peak periods:

- **Riverside/San Bernardino County Line (Philadelphia Undercrossing)**: North of the State Route 60 connectors, there is a lane drop. There is also significant merging and weaving traffic from the connectors to the mainline. A bottleneck occurs at the lane drop due to the loss of capacity.

Southbound Bottlenecks

The following bottlenecks were identified during the **AM** peak period:

- **Cajalco On-ramp**: The horizontal curvature of the mainline as well as a moderate upgrade creates a bottleneck south of the onramp.

- **Magnolia Avenue Off-ramp**: The significant merging and weaving between the State Route 91 connectors and the Magnolia off-ramp causes a bottleneck.

- **Baseline Road Off-ramp**: There are six mixed-flow lanes at the SR-210/15 Junction which reduce to four lanes past the off-ramp. There is also significant merging and weaving between connectors and the off-ramp. The lane drop compounded by the weaving condition causes a bottleneck.

The following bottlenecks were identified during the **PM** peak period only:

- **Ontario Avenue Off-ramp**: there are changes to the horizontal and vertical alignment of the roadway. Volumes and the alignment cause a bottleneck at this location 85 percent of the time in the southbound PM peak during weekdays.

- **Magnolia Avenue On-ramp**: there are changes to the horizontal and vertical alignment of the roadway. Volumes and the alignment cause a bottleneck at this location 82 percent of the time in the southbound PM peak during weekdays.

- **Jurupa Street Off-ramp**: Between the Interstate 10 connectors and the Jurupa Street off-ramp, there is significant merging and weaving that causes a bottleneck.

Exhibits 4-1 through 4-4 graphically illustrate the location of each of the bottleneck locations for the I-15 Corridor. The bottleneck locations are also listed in Exhibits 4-6.

Exhibit 4-1: I-15 Riverside County AM Bottleneck Locations

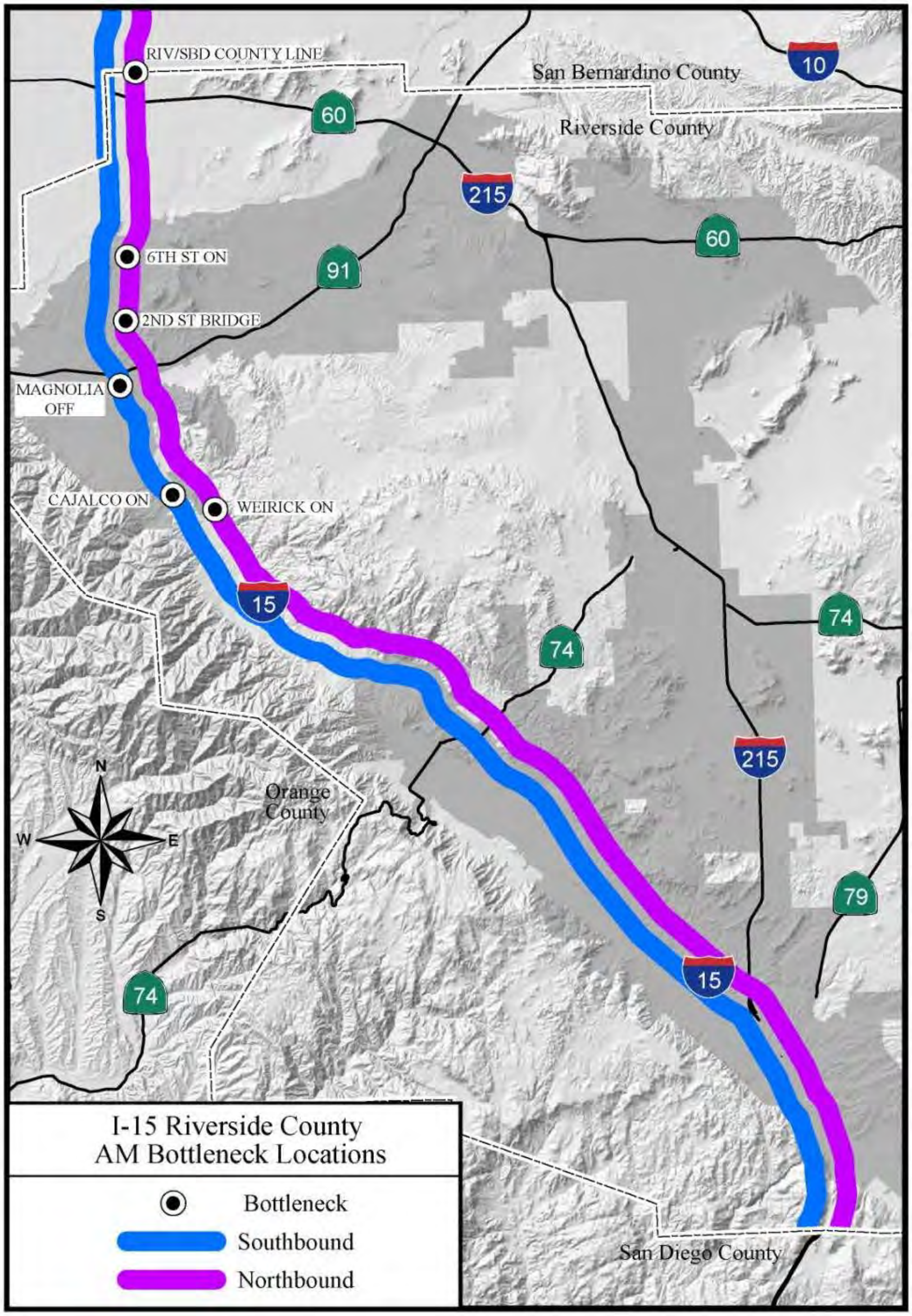


Exhibit 4-2: I-15 Riverside County PM Bottleneck Locations

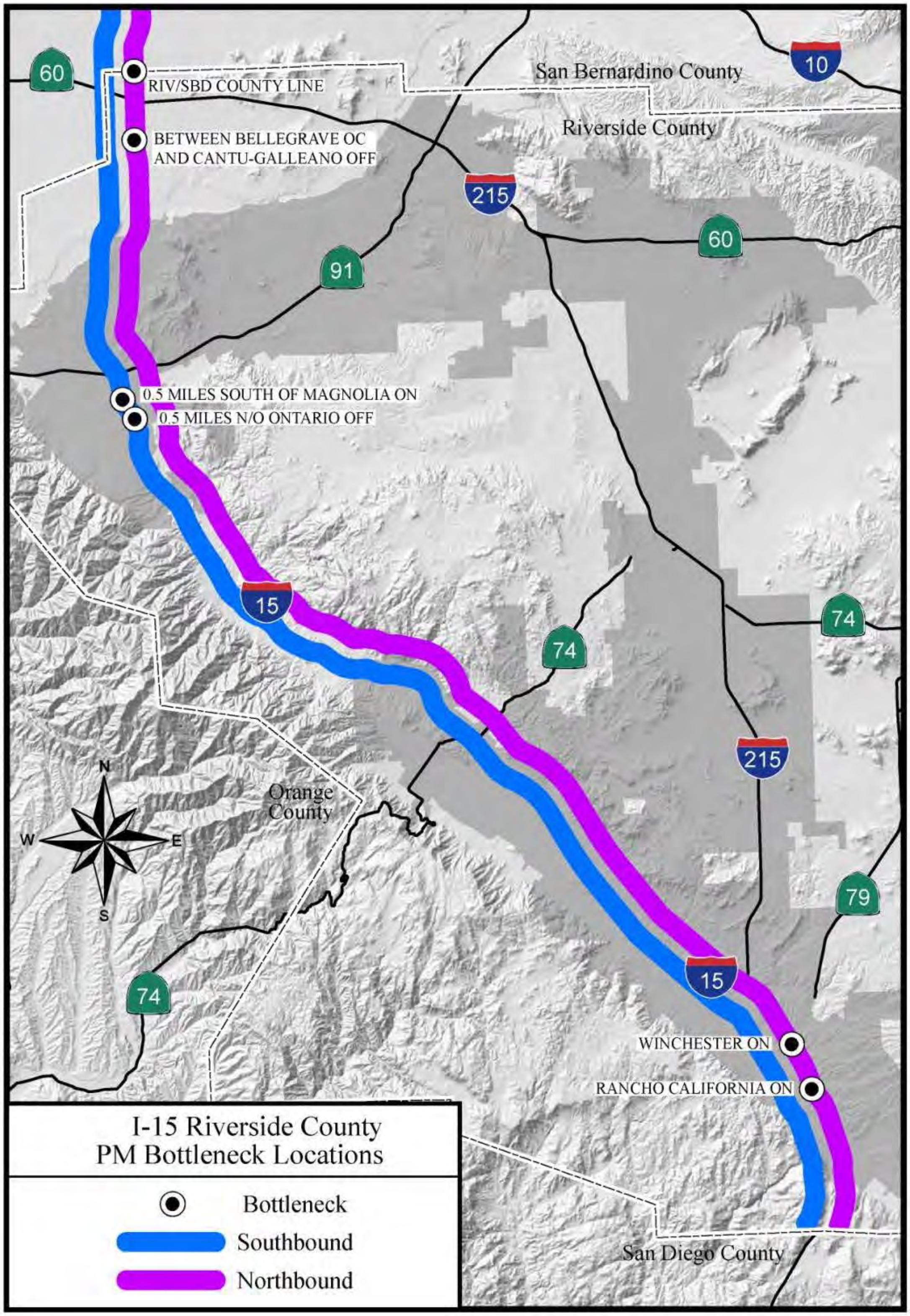


Exhibit 4-3: I-15 San Bernardino County AM Bottleneck Locations

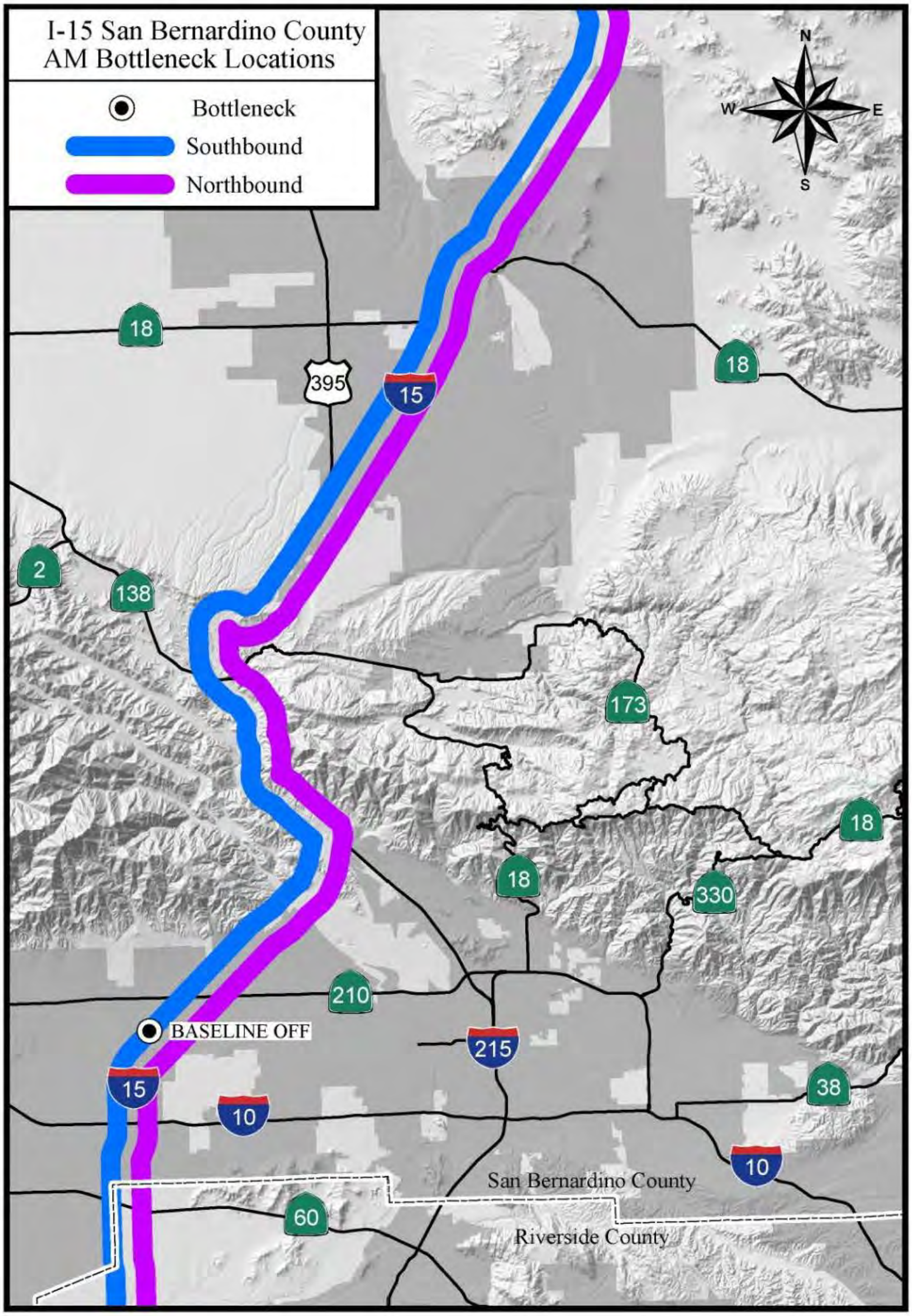
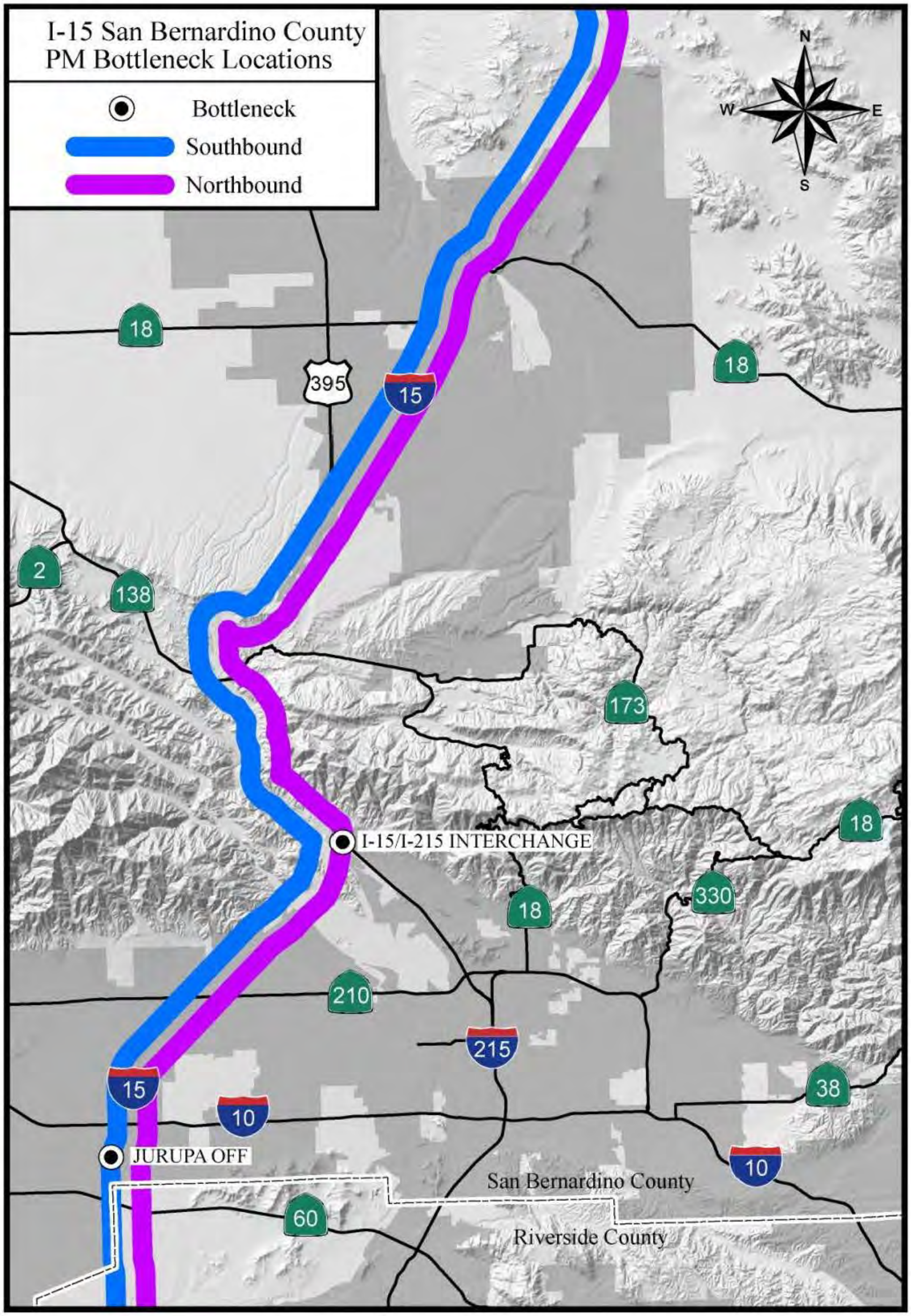


Exhibit 4-4: I-15 San Bernardino County PM Bottleneck Locations



ANALYSIS OF BOTTLENECK AREAS

Bottleneck areas represent segments that are defined by one major bottleneck (or a number of smaller ones). By segmenting the corridors into these bottleneck areas, the performance statistics that were presented for the entire corridor can then be broken down by bottleneck area. This way, the relative contribution of each bottleneck area to the degradation of the corridor performance can be gauged. The performance statistics that lend themselves to such segmentation include:

- Mobility
- Safety

Based on this approach, the study corridor comprises several bottleneck areas, which are different by direction. Exhibit 4-5 illustrates the *concept of bottleneck areas*. The red vertical lines represent the bottleneck locations, while the arrows identify the bottleneck areas.

Exhibit 4-5: Dividing a Corridor into Bottleneck Areas

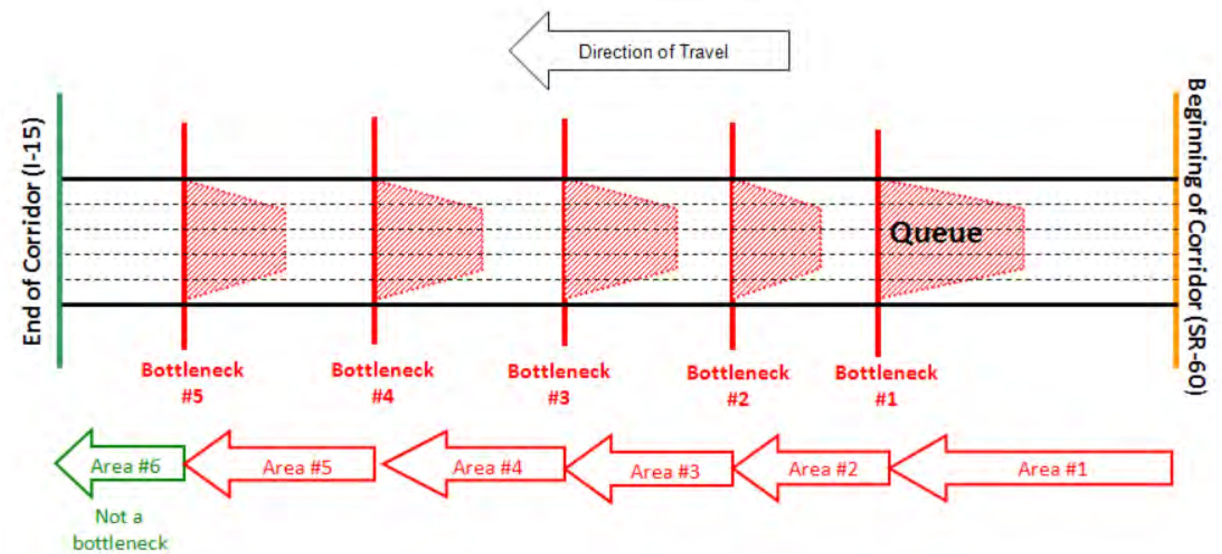


Exhibit 4-6: I-15 Identified Bottleneck Areas
Riverside County

Bottleneck Location	Active Period		Direction
	AM	PM	
Rancho California On		X	Northbound
Winchester On		X	Northbound
Weirick On	X		Northbound
2nd St. Lane Drop	X		Northbound
6th St. On	X		Northbound
Between Bellegrave OC and Cantu-Galleano Off		X	Northbound
Riverside/San Bernardino County Line	X	X	Northbound
Cajalco On	X		Southbound
0.5 mile north of Ontario Off		X	Southbound
0.5 mile south of Magnolia On		X	Southbound
Magnolia Off	X		Southbound

San Bernardino County

Bottleneck Location	Active Period		Direction
	AM	PM	
Jurupa Off		X	Southbound
Baseline Off	X		Southbound
I-15/I-215 Connector		X	Northbound

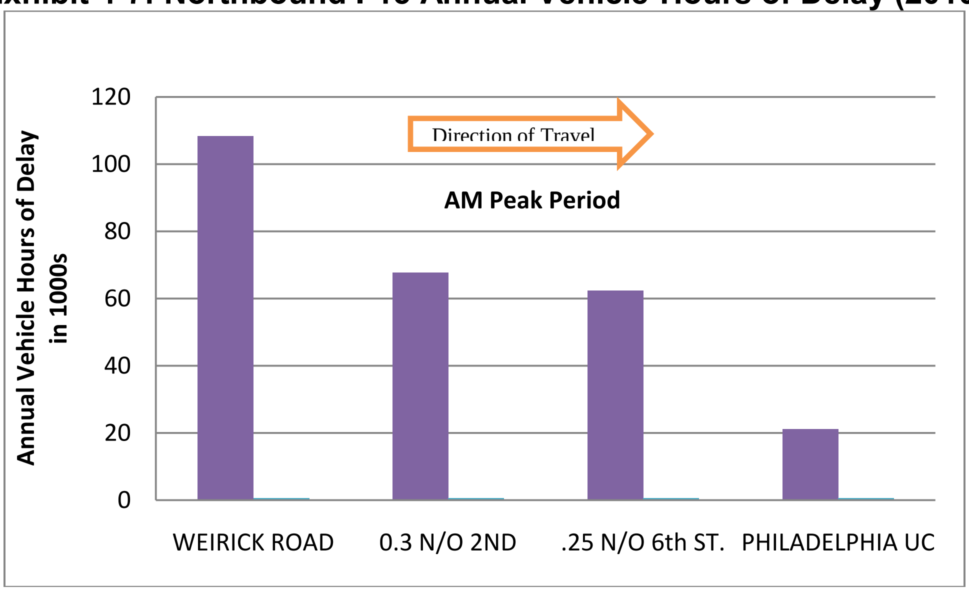
The following section uses the previously discussed performance measures of mobility, safety, productivity, and pavement condition to evaluate each bottleneck area. The results from this analysis reveals which segments of the corridor should be considered for improvement.

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. The source of data used to calculate delay for the corridor is PeMS. For each direction of travel, these charts express delay by illustrating the bottleneck areas where PeMS detection exists and is used to calculate delay.

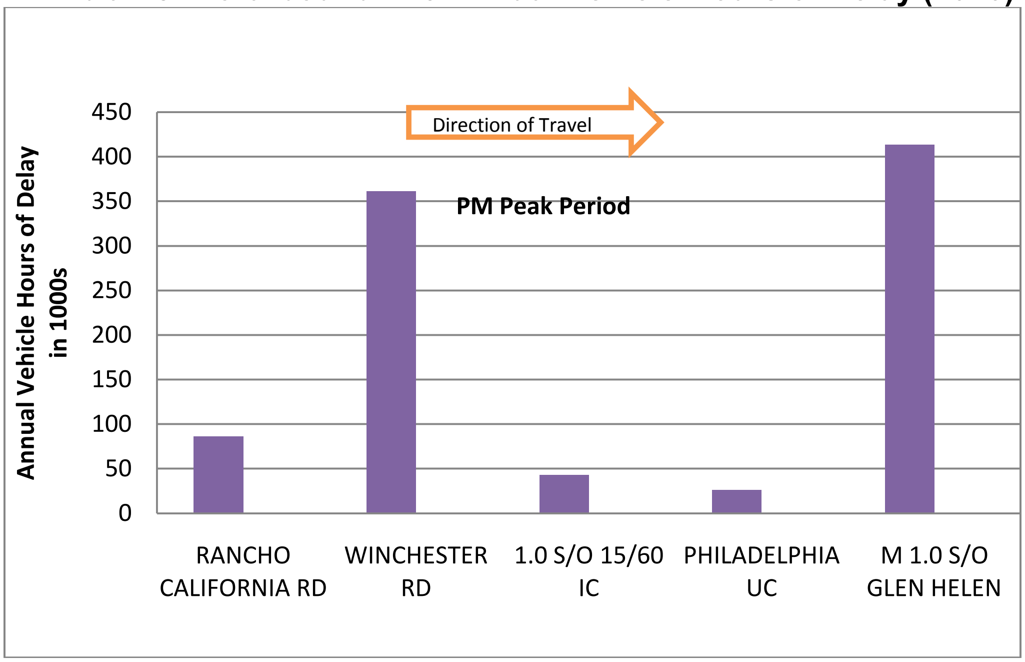
Exhibits 4-7 through 4-10 illustrate the vehicle-hours of delay experienced by each bottleneck area during the peak periods in each direction on I-15. The percentages assigned to each bottleneck area are the number of weekdays the bottleneck occurs. As depicted in Exhibit 4-7, the bottleneck at Weirick experienced the most delay with slightly over 100,000 vehicle-hours of delay.

Exhibit 4-7: Northbound I-15 Annual Vehicle-Hours of Delay (2010)



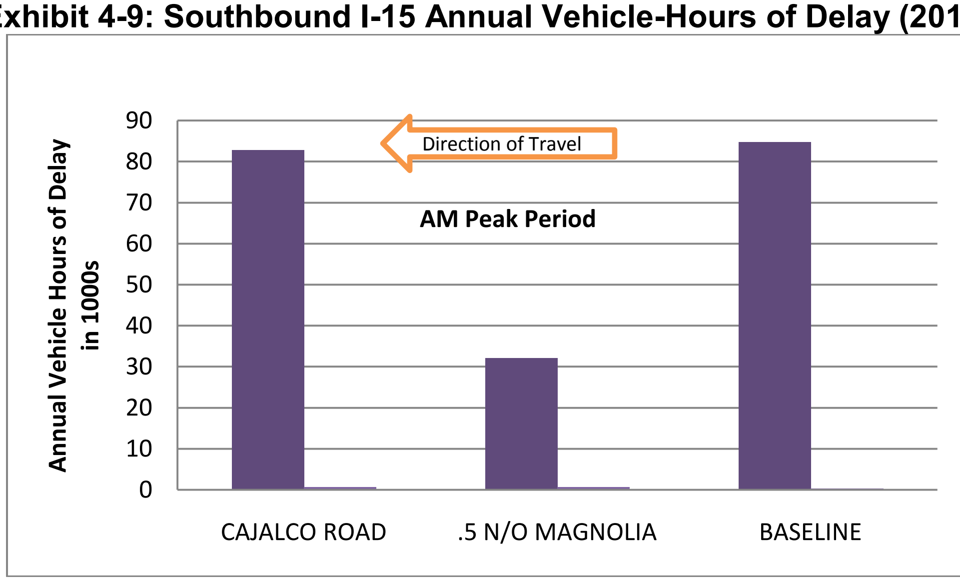
Source: PeMS

Exhibit 4-8: Northbound I-15 Annual Vehicle-Hours of Delay (2010)



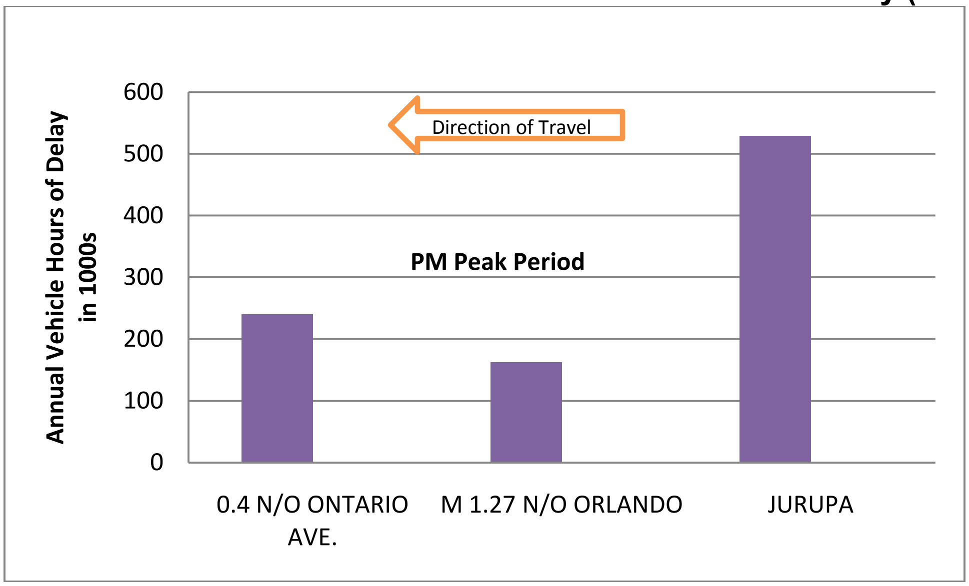
Source: PeMS

Exhibit 4-9: Southbound I-15 Annual Vehicle-Hours of Delay (2010)



Source: PeMS

Exhibit 4-10: Southbound I-15 Annual Vehicle-Hours of Delay (2010)



Source: PeMS

5. CAUSALITY

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

By definition, a bottleneck is a condition where traffic demand exceeds the capacity of the roadway facility. In most cases, the cause of the bottleneck is related to a sudden reduction in capacity, such as roadway geometry, heavy merging and weaving; 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

Congestion occurs in both the AM and PM peak hours.

The following is a summary of the northbound bottlenecks for the **AM** peak period and their identified causes.

Weirick On

Exhibit 5-1 is an aerial photograph of the of the Weirick Road interchange. The northbound on ramp joins the mainline with a short merge distance on an uphill grade. The high volume of traffic merging onto the mainline at this location is found to be the cause of this bottleneck.

Exhibit 5-1: Northbound I-15 at Weirick Road Interchange

2nd Street Overcrossing Lane Drop

Exhibit 5-2 is an aerial photograph of the 2nd Street interchange. At the 2nd Street off-ramp, there are four mixed-flow lanes with an auxiliary lane ending at the 2nd Street off-ramp. The fourth lane is dropped within the interchange. A bottleneck occurs at the location of the lane drop.

Exhibit 5-2: Northbound I-15 at 2nd Street Interchange

<u>6th Street On</u>

Exhibit 5-3 is an aerial photograph of the 6th Street on-ramp. The on-ramp joins the mainline on an uphill grade. In addition there is a horizontal curve. The volumes on this ramp plus the vertical and horizontal geometry lends to the bottleneck.

Exhibit 5-3: Northbound I-15 at 6th Street Interchange

Riverside/San Bernardino County Line (Philadelphia Undercrossing)

Exhibit 5-4 is an aerial photograph of the Philadelphia undercrossing at the Riverside/San Bernardino County Line. North of the State Route 60 connectors, there is a lane drop with significant weaving traffic from the connectors to the mainline. There is also significant merging and weaving traffic from the connectors to the mainline. A bottleneck occurs at the lane drop due to the loss of capacity.

Exhibit 5-4: Northbound I-15 at Philadelphia Undercrossing

The following is a summary of the northbound bottlenecks for the **PM** peak period and their identified causes.

<u>Rancho California On</u>

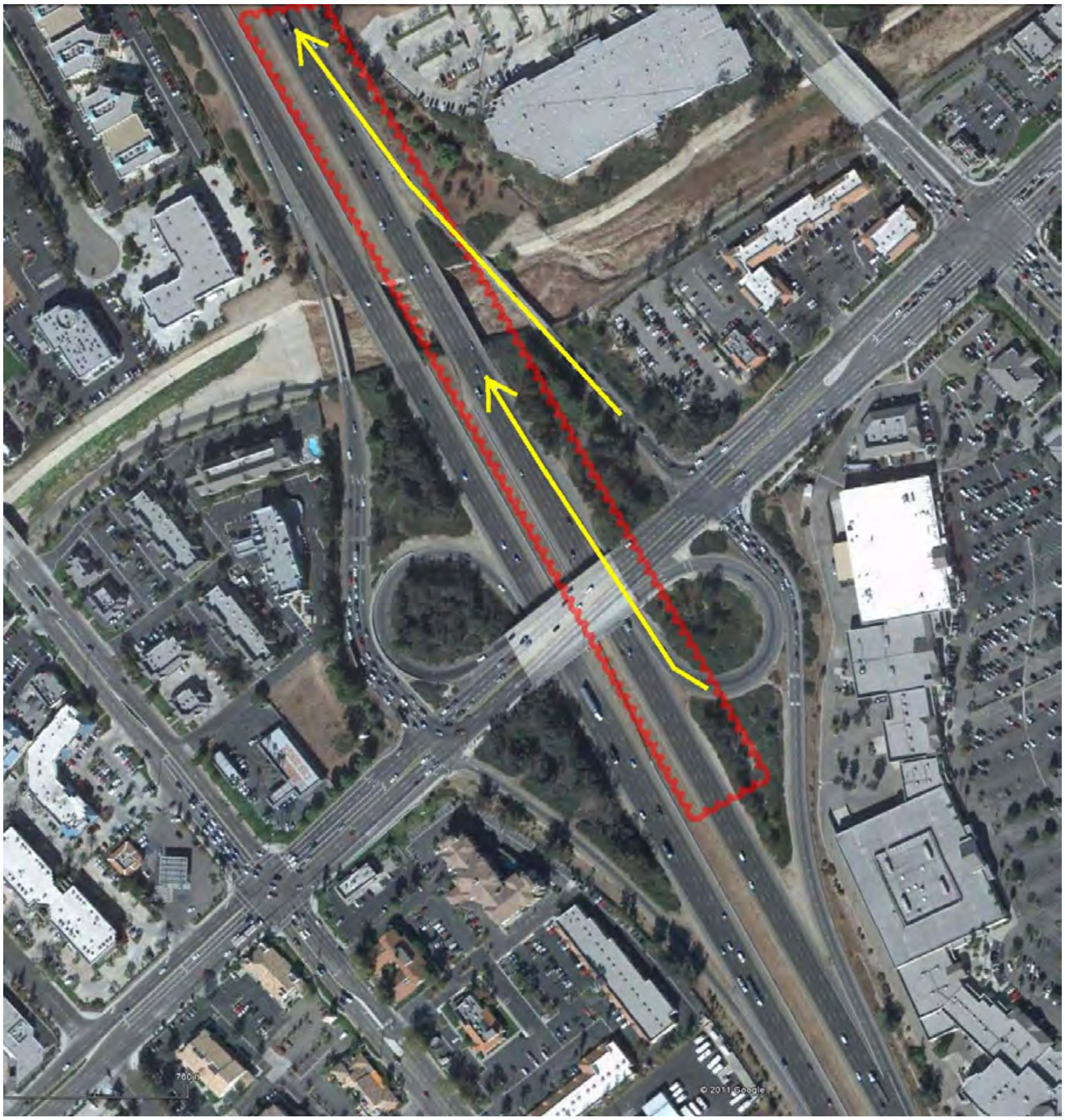
Exhibit 5-5 is an aerial photograph of the northbound I-15 at the Rancho California interchange. The bottleneck is due to successive on-ramps (loop and slip ramps) and high volumes of traffic from the ramps.

Exhibit 5-5: Northbound I-15 at Rancho California On

Winchester On

Exhibit 5-6 is an aerial photograph of the northbound I-15 at the Winchester Road interchange. The bottleneck is due to successive on-ramps (loop and slip ramps) and high volumes of traffic from the ramps.

Exhibit 5-6: Northbound I-15 at Winchester On



Bellegrave Overcrossing to Cantu-Galleano Off

Exhibit 5-7 is an aerial photograph of the northbound I-15 near the Bellegrave overcrossing. High traffic volumes and the change in the horizontal alignment create the bottleneck.

Exhibit 5-7: Northbound I-15 near the Bellegrave Overcrossing

I-15/I-215 Connector in Devore

Exhibit 5-8 is an aerial photograph of the northbound I-15 near the I-215 southbound connector. Horizontal alignment and grade, high traffic volume, and decision point/merge with I-215 create the bottleneck.

Exhibit 5-8: Northbound I-15 near I-215 Southbound Connector

Southbound Bottlenecks and Causes

Congestion occurs in both the **AM** and **PM** peak hours.

The following is a summary of the southbound bottlenecks for the **AM** peak period and their identified causes.

Cajalco On

Exhibit 5-9 is an aerial photograph of the Cajalco on-ramp. The horizontal curvature of the mainline combined with a moderate grade creates a bottleneck south of the on-ramp.

Exhibit 5-9: Southbound I-15 at Cajalco Road On

Magnolia Off

Exhibit 5-10 is an aerial photograph of the southbound I-15 at the Magnolia Avenue off-ramp. Significant merging and weaving between the State Route 91 connectors and the Magnolia Avenue off-ramp causes a bottleneck.

Exhibit 5-10: Southbound I-15 at Magnolia Avenue Off

<u>Baseline Off</u>

Exhibit 5-11 is an aerial photograph of the I-15 at the Baseline interchange. There are six mixed-flow lanes approaching the Baseline interchange which reduce to four lanes past the off-ramp. There is also significant merging and weaving between connectors and the off-ramp. The lane drop compounded by the weaving condition causes a bottleneck.

Exhibit 5-11: Southbound I-15 at Baseline Off

The following is a summary of the southbound bottlenecks for the **PM** peak period and their identified causes.

0.5 mile north of Ontario Off and 0.5 mile south of Magnolia On

Exhibit 5-12 is an aerial photograph of the southbound I-15 mainline between the Magnolia Avenue on-ramp and the Ontario Avenue off-ramp. There are changes to the horizontal and vertical alignment of the roadway. Volumes and the alignment cause a bottleneck.

Exhibit 5-12: Southbound I-15 between Magnolia On and Ontario Off

Jurupa Off

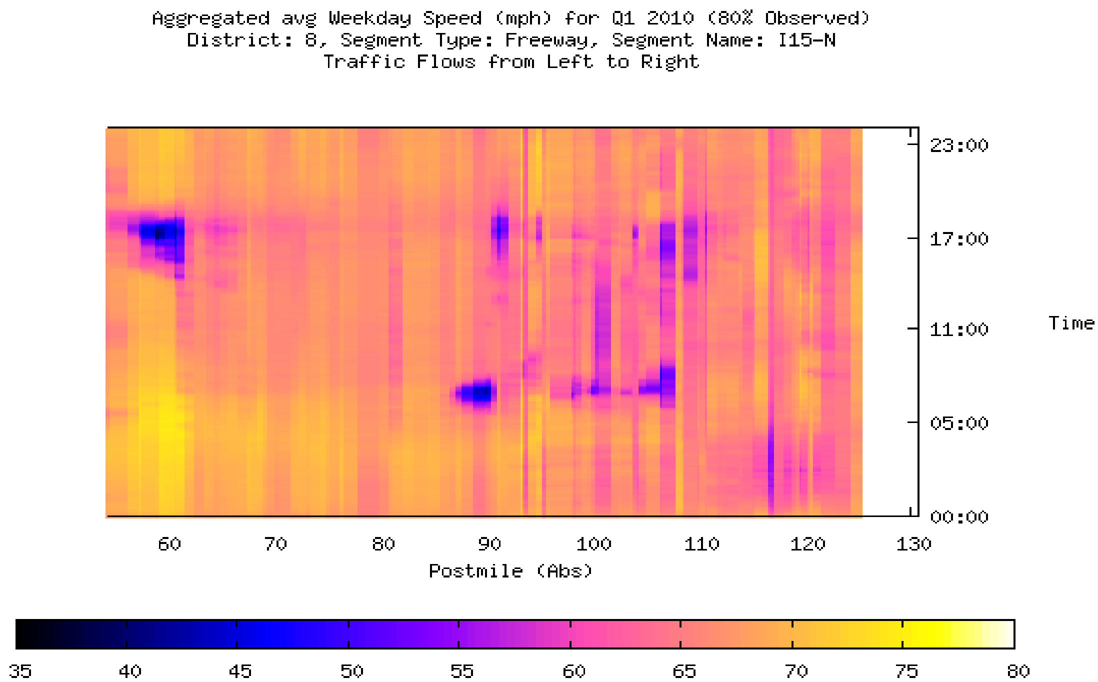
Exhibit 5-13 is an aerial photograph of southbound I-15 at the Jurupa Avenue off-ramp. Between the Interstate 10 connectors and the Jurupa off-ramp, there is significant merging and weaving that causes a bottleneck.

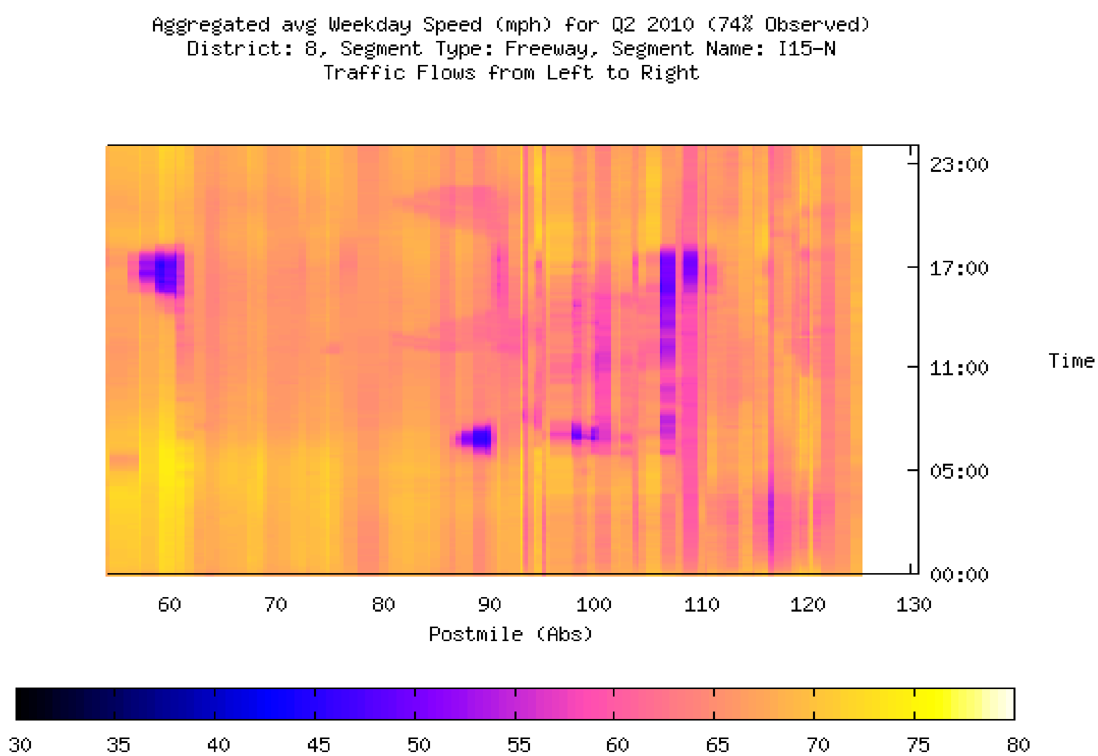
Exhibit 5-13: Southbound I-15 at Jurupa Avenue Off

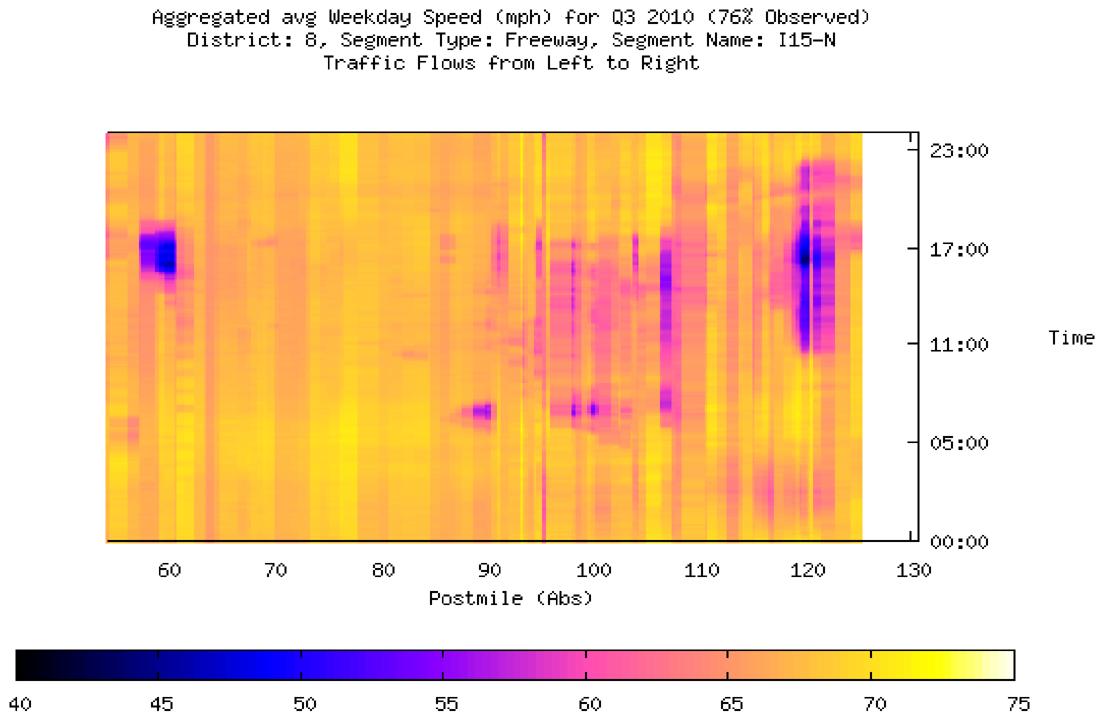
Speed Contours

Exhibits 5-14 and 5-15 show the speed contours along I-15 in the PM peak period for each quarter during 2010. The dark coloring represents areas of congestion.

Exhibit 5-14: Northbound I-15 Speed Contours (2010 Average by Quarter)






Aggregated avg Weekday Speed (mph) for Q3 2010 (76% Observed)
District: 8, Segment Type: Freeway, Segment Name: I15-N
Traffic Flows from Left to Right
23:00
17:00
11:00
05:00
00:00
Time
60
70
80
90
100
110
120
130
Postmile (Abs)
40
45
50
55
60
65
70
75

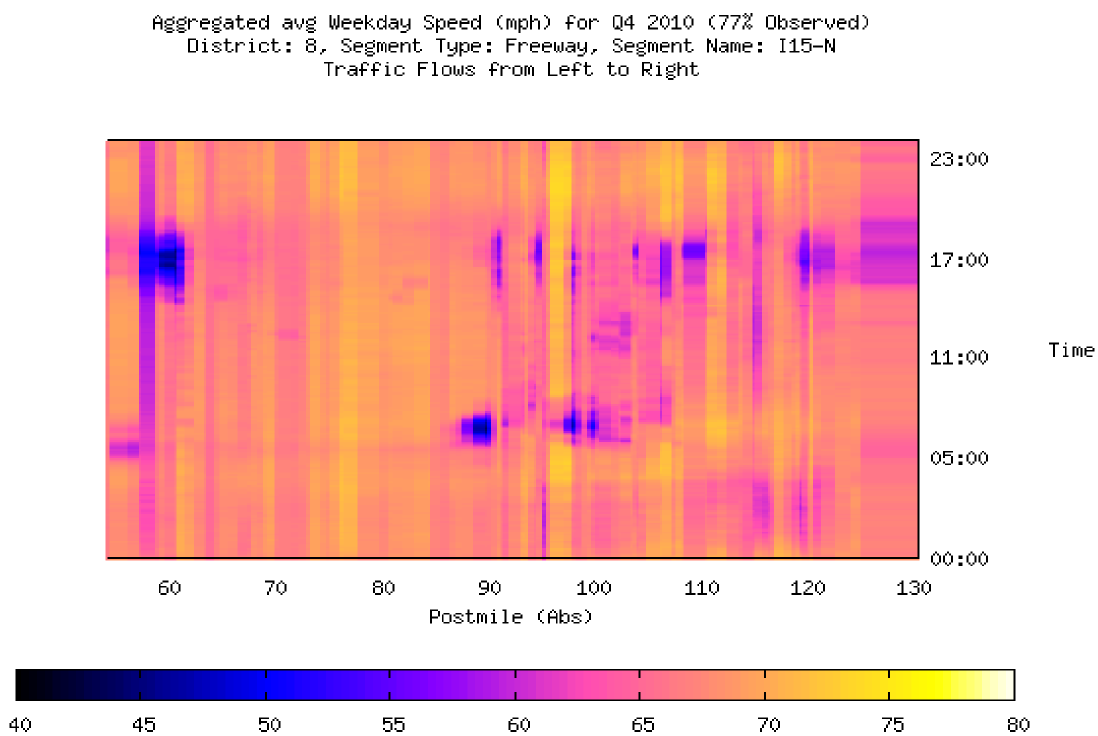
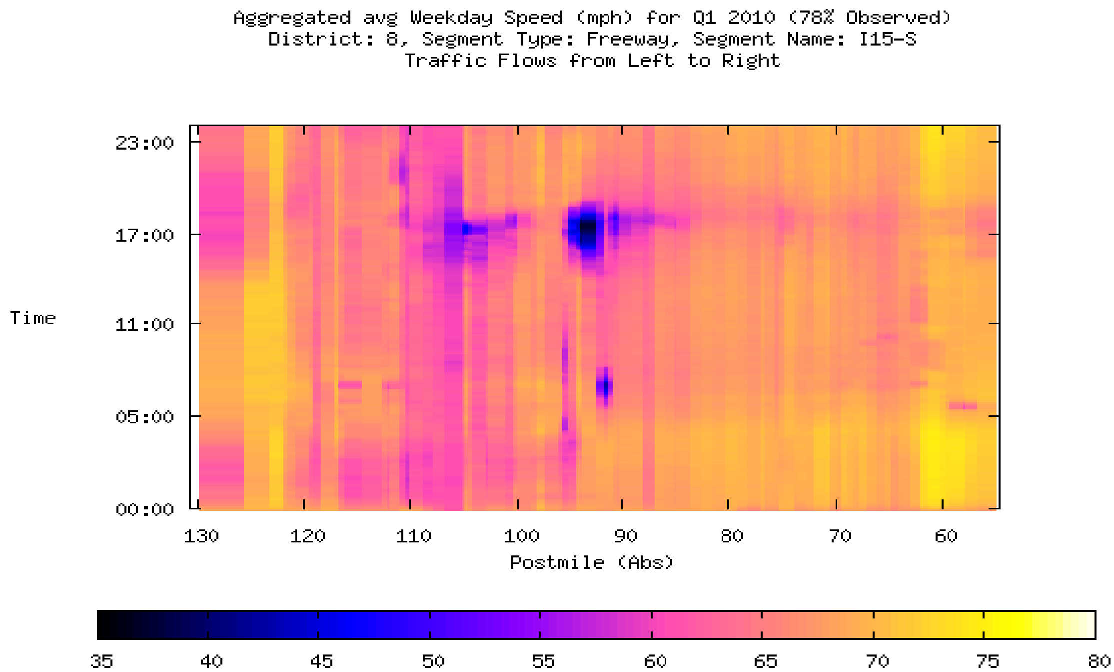
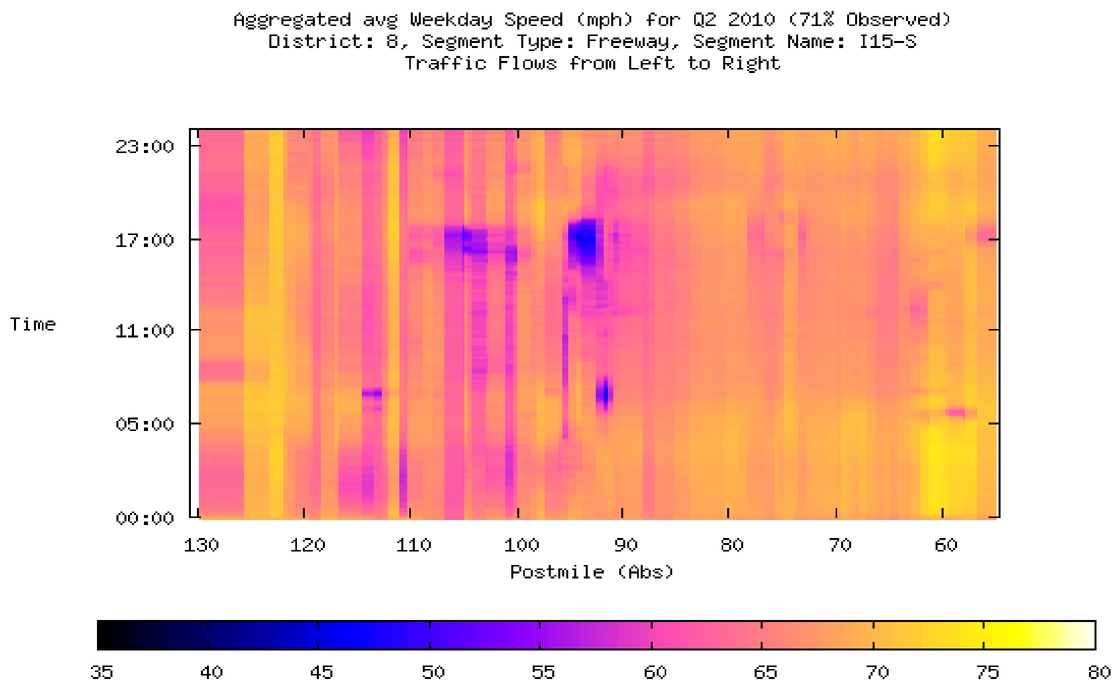
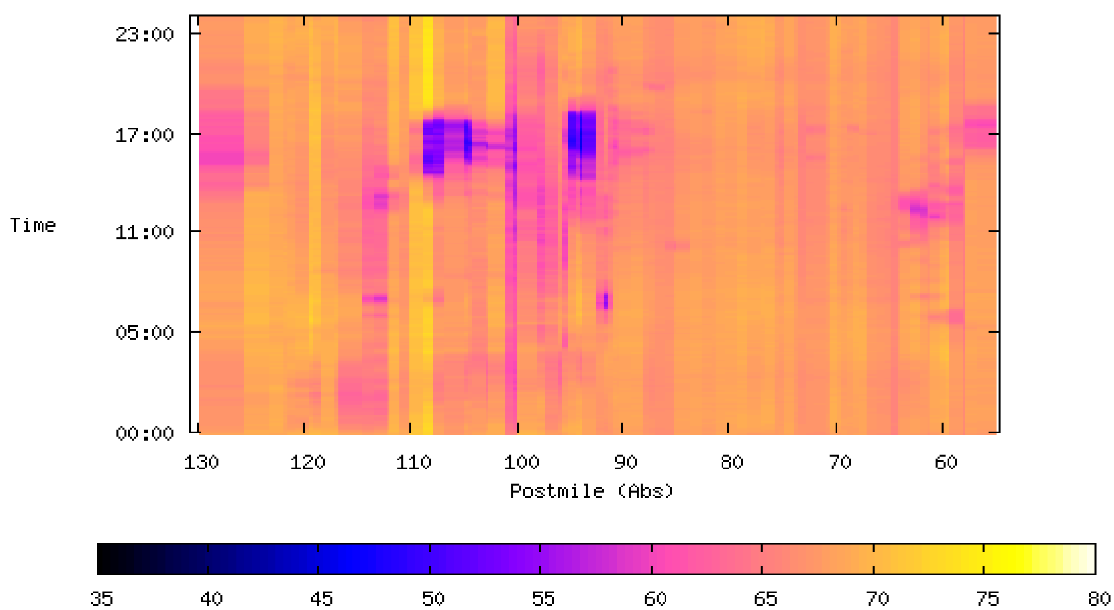

Aggregated avg Weekday Speed (mph) for Q4 2010 (77% Observed)
District: 8, Segment Type: Freeway, Segment Name: I15-N
Traffic Flows from Left to Right
23:00
17:00
11:00
05:00
00:00
Time
60
70
80
90
100
110
120
130
Postmile (Abs)
40
45
50
55
60
65
70
75
80

Exhibit 5-15: Southbound I-15 Speed Contours (2010 Average by Quarter)





Aggregated avg Weekday Speed (mph) for Q3 2010 (79% Observed)
District: 8, Segment Type: Freeway, Segment Name: I15-S
Traffic Flows from Left to Right



Aggregated avg Weekday Speed (mph) for Q4 2010 (77% Observed)
District: 8, Segment Type: Freeway, Segment Name: I15-S
Traffic Flows from Left to Right