Caltrans

System Metrics Group, Inc.

in association with

CLR Analytics, Inc.

Corridor System Management Plan (CSMP)

Orange County SR-57 Corridor

Final Report

August 2010

State Route 57

Corridor System Management Plan

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11-16-2010
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1. INTRODUCTION

This document represents the draft Final Report for the Orange County State Route 57 (SR-57) Corridor System Management Plan (CSMP) developed by the California Department of Transportation (Caltrans). The Orange County SR-57 study corridor runs in a north-south direction from the I-5/SR-22 Interchange (the "Orange Crush") at postmile 10.7 in the City of Orange to the Orange/Los Angeles County line at postmile R22.6.

This final report contains the results of a two-year study that included several key steps, including:

- Stakeholder Involvement (discussed below in this Section 1)
- Corridor Description and Performance Assessment (Sections 2 and 3)
- Bottleneck Identification and Performance (Section 4)
- Bottleneck Causality Analysis (Section 5)
- Scenario Development and Micro-Simulation (Section 6)
- Conclusions and Recommendations (Section 7).

This CSMP is the direct result of the November 2006 voter-approved Proposition 1B (The Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006). This ballot measure included a funding program deposited into a Corridor Mobility Improvement Account (CMIA). There are two CMIA-funded projects on the SR-57 Corridor:

- Lane addition on northbound SR-57 (from 0.4 mile north of SR-91 to 0.1 mile north of Lambert Road) - this project should be completed in 2014 at a total cost of approximately $182 million.
- Lane addition on northbound SR-57 (from 0.3 mile south of Katella Avenue to 0.3 mile north of Lincoln Avenue) - this project should be completed by 2018 or 2020 with a total cost of approximately $41 million.

To receive CMIA funds, the California Transportation Commission (CTC) guidelines required that project sponsors describe in a CSMP how mobility gains from CMIA-funded corridor improvements would be maintained over time. A CSMP therefore aims to define how corridors will be managed in the long term, focusing on operational strategies in addition to the already funded expansion projects. The goal is to get the most out of the existing system and maintain or improve corridor performance.

The SR-57 CSMP involved corridor stakeholders including representatives from cities bordering SR-57, Orange County Transportation Authority (OCTA), and the Southern California Association of Governments (SCAG). The stakeholders were briefed at critical milestones by the consulting team. Feedback from these stakeholders helped solidify the findings of the performance assessment, bottleneck identification, and causality analysis given their intimate knowledge of local conditions. Moreover, various stakeholders have provided support and insight, and shared valuable field and project data without which this study would not have been possible.

This report also presents a corridor performance assessment, identifies bottlenecks that lead to congestion, and diagnoses the causes for these bottlenecks. Alternative investment strategies were modeled using 2007 as the Base Year and 2020 as the Horizon Year.

This CSMP should be updated by Caltrans 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. Such changes could influence the conclusions of the current CSMP and the relative priorities in investments. Therefore, it is recommended that updates occur no less than every two to three years. To the extent possible, this document has been organized to facilitate such updates.

The report references locations on SR-57 using two types of postmiles: a California postmile (CA PM) and an absolute postmile (Abs PM). A California postmile is assigned to a geometric feature on the freeway when the freeway was built. The absolute postmile is the actual centerline distance down the freeway from the beginning of the route to the end of the route. Unless otherwise noted, all postmiles presented in this report are CA PM.

The following discussion provides background to the system management approach in general and CSMPs in particular.

What is a Corridor System Management Plan (CSMP)?

In November 2006, voters approved Proposition 1B (The Reduction, Air Quality, and Port Security Bond Act of 2006). This ballot measure included a funding program to be deposited into a Corridor Mobility Improvement Account (CMIA). For a project to be nominated by a Caltrans district or regional agency, California Transportation Commission (CTC) CMIA guidelines require that the project nomination describe how mobility gains of urban corridor capacity improvements would be maintained over time.

The guidelines also stipulate that the CTC will give priority to project nominations that include a CSMP. A CSMP is a comprehensive plan for maintaining the congestion reduction and productivity improvements achieved on a CMIA corridor. CSMPs incorporate all travel modes,including state highways and freeways, parallel and connecting roadways, public transit (bus, bus rapid transit, light rail, intercity rail), carpool/vanpool programs, and bikeways. CSMPs also include intelligent transportation technologies such as ramp metering, coordinated traffic signals, changeable message signs for traveler information, and improved incident management.

This CSMP is the first attempt to integrate the overall concept of system management into Caltrans' planning and decision-making processes for the SR-57 corridor. Traditional planning approaches identify localized freeway problem areas and then develop solutions to fix those problems, often by building expensive capital improvement projects. The SR-57 CSMP focuses on the system management approach with greater emphasis on using on-going performance assessments to identify operational strategies that yield higher congestion reduction and productivity benefits relative to the amount of money spent.

Caltrans develops integrated multimodal projects in balance with community goals, plans, and values. Caltrans seeks and tries to address the safety and mobility needs of bicyclists, pedestrians, and transit users in all projects, regardless of funding. Bicycle, pedestrian, and transit travel is facilitated by creating "complete streets" beginning early in system planning and continuing through project delivery, maintenance, and operations. Developing a network of complete streets requires collaboration among all Caltrans functional units and stakeholders. As the first generation CSMP, this report is more focused on reducing congestion and increasing mobility through capital and operational strategies. The future CSMP work will further address pedestrian, bicycle and transit components and seek to manage and improve the whole network as an interactive system.

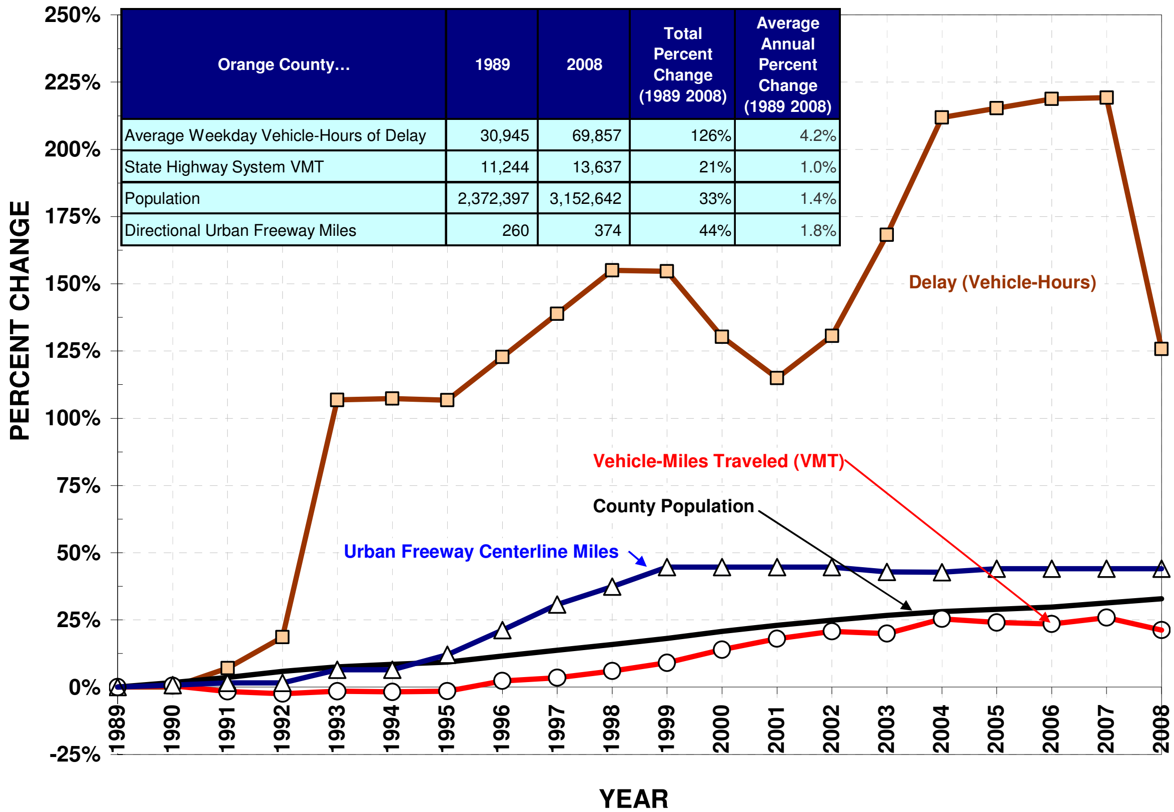
What is System Management?

With the rising cost and complexity of construction and right-of-way acquisition, the era of large-scale freeway construction is ending. Compared to the growth of vehicle-miles traveled (VMT) and population, congestion is growing at a much higher rate.

Exhibit 1-1 shows Orange County congestion (measured by average weekday vehicle-hours of recurring delay), VMT, population, and urban freeway mileage between 1989 and 2008. Over that 20-year period, congestion increased by more than 125 percent from 1989 levels (just over four percent per year). Over the same period, VMT and population rose by 21 percent and 33 percent, respectively. Between 1989 and 1999, urban freeway miles grew dramatically, but since then virtually no miles have been added.

Clearly, infrastructure expansion is not keeping pace with demographic and travel trends and is not likely to keep pace in the future. Therefore, if conditions are to improve, or at least not deteriorate as fast, a new approach to transportation decision making and investment is needed.

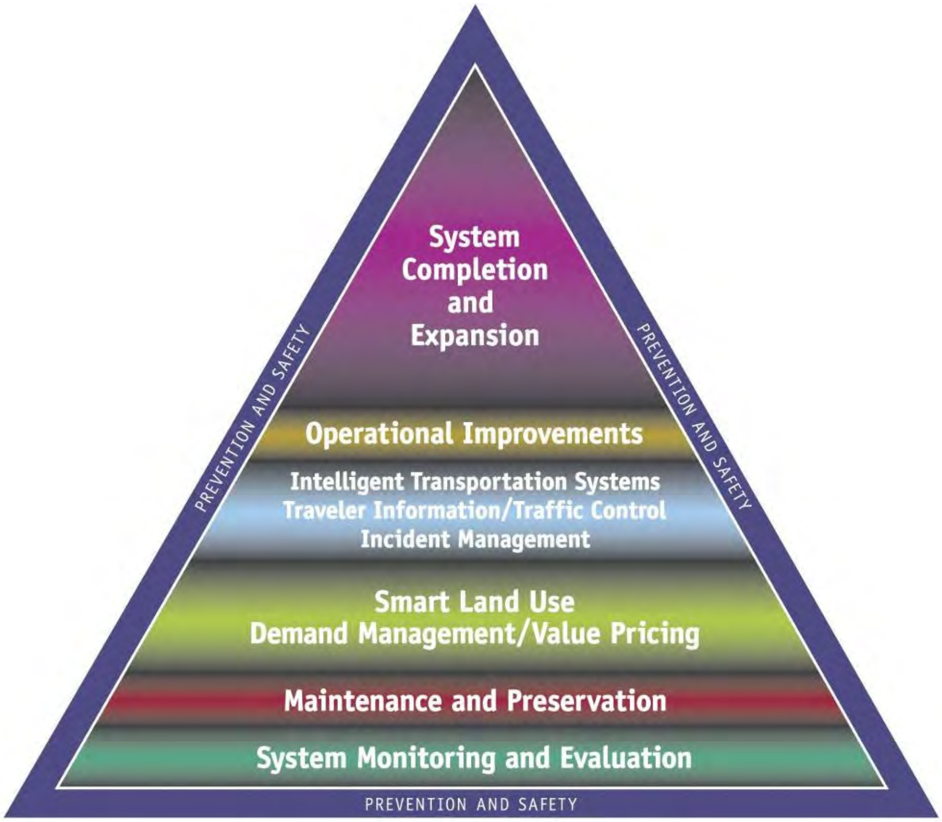
Exhibit 1-1: District 12 (Orange County) Growth Trends 1989-2008



Orange County...	1989	2008	Total Percent Change (1989 2008)	Average Annual Percent Change (1989 2008)
Average Weekday Vehicle-Hours of Delay	30,945	69,857	126%	4.2%
State Highway System VMT	11,244	13,637	21%	1.0%
Population	2,372,397	3,152,642	33%	1.4%
Directional Urban Freeway Miles	260	374	44%	1.8%

Caltrans recognizes this dilemma and has adopted a mission statement that embraces the concept of system management. This mission and its goals are supported by the system management approach illustrated in the System Management pyramid shown in Exhibit 1-2.

Exhibit 1-2: System Management Pyramid



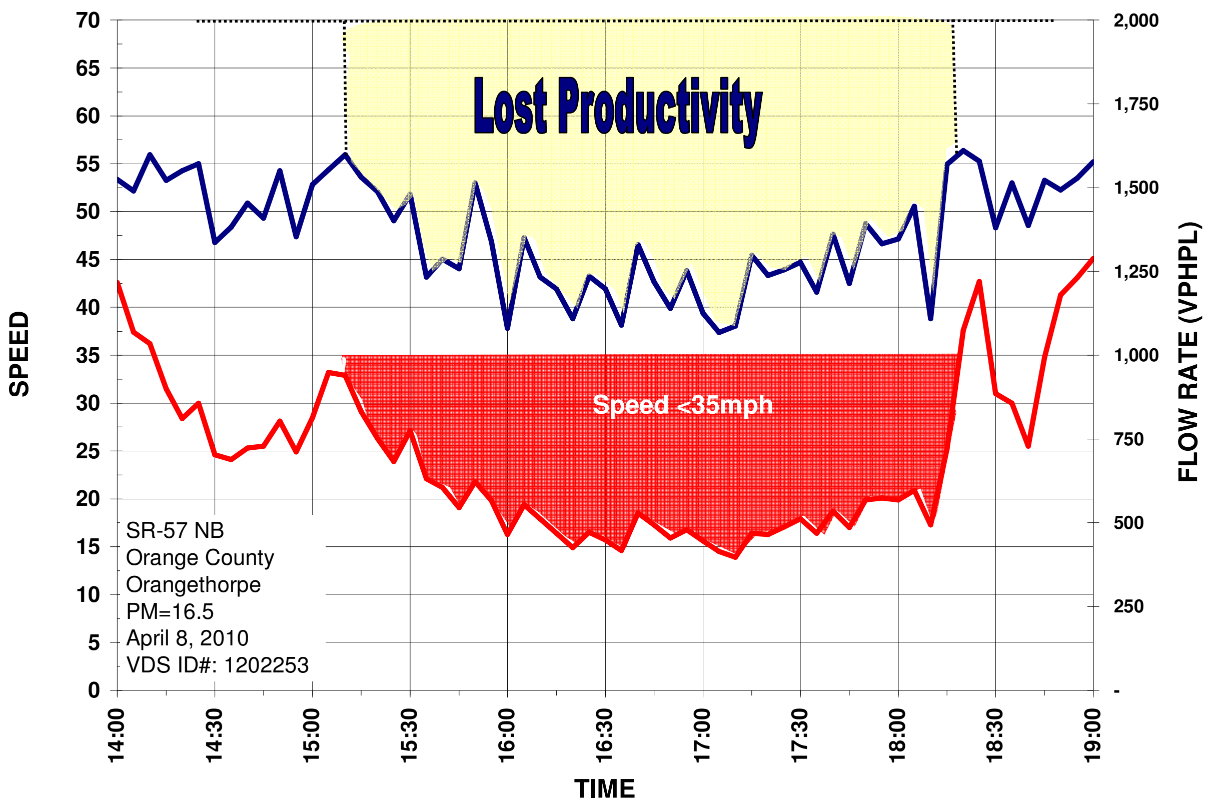
System Management is being touted at the federal, state, regional and local levels. It addresses both transportation demand and supply to get the best system performance possible. Ideally, Caltrans would develop a regional system management plan that addresses all components of the pyramid for an entire region comprehensively. However, because the system management approach is relatively new, it is prudent to apply it at the corridor level first.

The foundation of system management is monitoring and evaluation (shown as the base of the pyramid). This monitoring is done by comprehensive performance assessment and evaluation. Understanding how a corridor performs and why it performs the way it does is critical to crafting appropriate strategies. Section 3 is dedicated to performance assessment. It would be desirable for Caltrans to update this performance assessment every two or three years to ensure that future corridor issues can be identified and addressed before breakdown occurs on the corridor.

A critical goal of system management is to get the most out of the existing system, or maximize system productivity. One would think that a given freeway is most productive during peak commute times. Yet, this is not true for heavy commute corridors. In fact, for Orange County's urban freeways experiencing congestion, the opposite is true. When demand is the highest, the flow breaks down and productivity declines.

Exhibit 1-3 illustrates how congestion leads to lost productivity. The exhibit was created using observed SR-57 data from sensors for a typical spring 2010 afternoon peak period (Thursday, April 8, 2010). It shows speeds (in red) and flow rates (in blue) on northbound SR-57 at Orangethorpe Avenue just north of the SR-91 interchange, one of the most congested locations on this corridor.

Exhibit 1-3: Lost Productivity Illustrated



Flow rates (measured as vehicle-per-hour-per-lane or "vphpl") at Orangethorpe Avenue average slightly over 1,600 vphpl between 2:00 PM and 3:00 PM, which is slightly less than typical peak period maximum flow rate. Flow rates higher than approximately 2,000 vphpl cannot be sustained for a significant time.

Once volumes exceed this maximum rate, traffic becomes unstable. Any additional merging or weaving causes traffic to break down, and speeds can rapidly plummet to below 35 mph (miles per hour). In essence, every incremental merge takes up two spots on the freeway for a short time. However, since the volume is close to the capacity, these merges lead to queues. Moreover, rather than accommodating the same number of vehicles, flow rates also drop and vehicles back up, creating bottlenecks and associated congestion.

At the location shown in Exhibit 1-3, throughput drops by nearly 25 percent on average during the peak period (from over 1,600 to around 1,200 vphpl). This five-lane road therefore operates as if it were a four-lane road just when demand is at its highest. Stated differently, just when the corridor needed the most capacity, it performed in the least productive manner and effectively lost lanes.

This is lost productivity. Where there is sufficient automatic detection, this loss in throughput can be quantified and presented as “Lost Lane-Miles”. Discussed in more detail later in this report, the productivity losses on northbound SR-57 were over 5.0 lane-miles during the PM peak period in 2009. This means that several hundred million dollars of previous investments on SR-57 were idle when demand was at its highest. It is obvious that Caltrans needs to leverage these past investments to the extent possible. This can be done in large part by operational strategies.

Although still an important strategy, infrastructure expansion (at the top of the pyramid in Exhibit 1-2) cannot be the only strategy for addressing the mobility needs in Orange County. System management must be an important consideration as Caltrans and its partners evaluate the need for facility expansion investments. The system management philosophy begins by defining how the system is performing, understanding why it is performing that way, and then evaluating different strategies, including operations centric strategies, to address deficiencies. Various tools can be used to estimate potential benefits to determine if these benefits are worthy of the costs to implement the strategy.

Stakeholder Involvement

The SR-57 CSMP involved corridor stakeholders including representatives from cities bordering SR-57, the Orange County Transportation Authority (OCTA), and the Southern California Association of Governments (SCAG). Caltrans briefed these stakeholders at critical milestones. Feedback from the stakeholders helped solidify the findings of the performance assessment, bottleneck identification, and causality analysis given their intimate knowledge of local conditions. Moreover, various stakeholders have provided support and insight, and shared valuable field and project data without which this study would not have been possible.

The stakeholders included representatives from the following organizations:

- Orange County Transportation Authority
- Southern California Association of Governments
- City of Anaheim

- City of Brea
- City of Fullerton
- City of Orange
- City of Placentia.

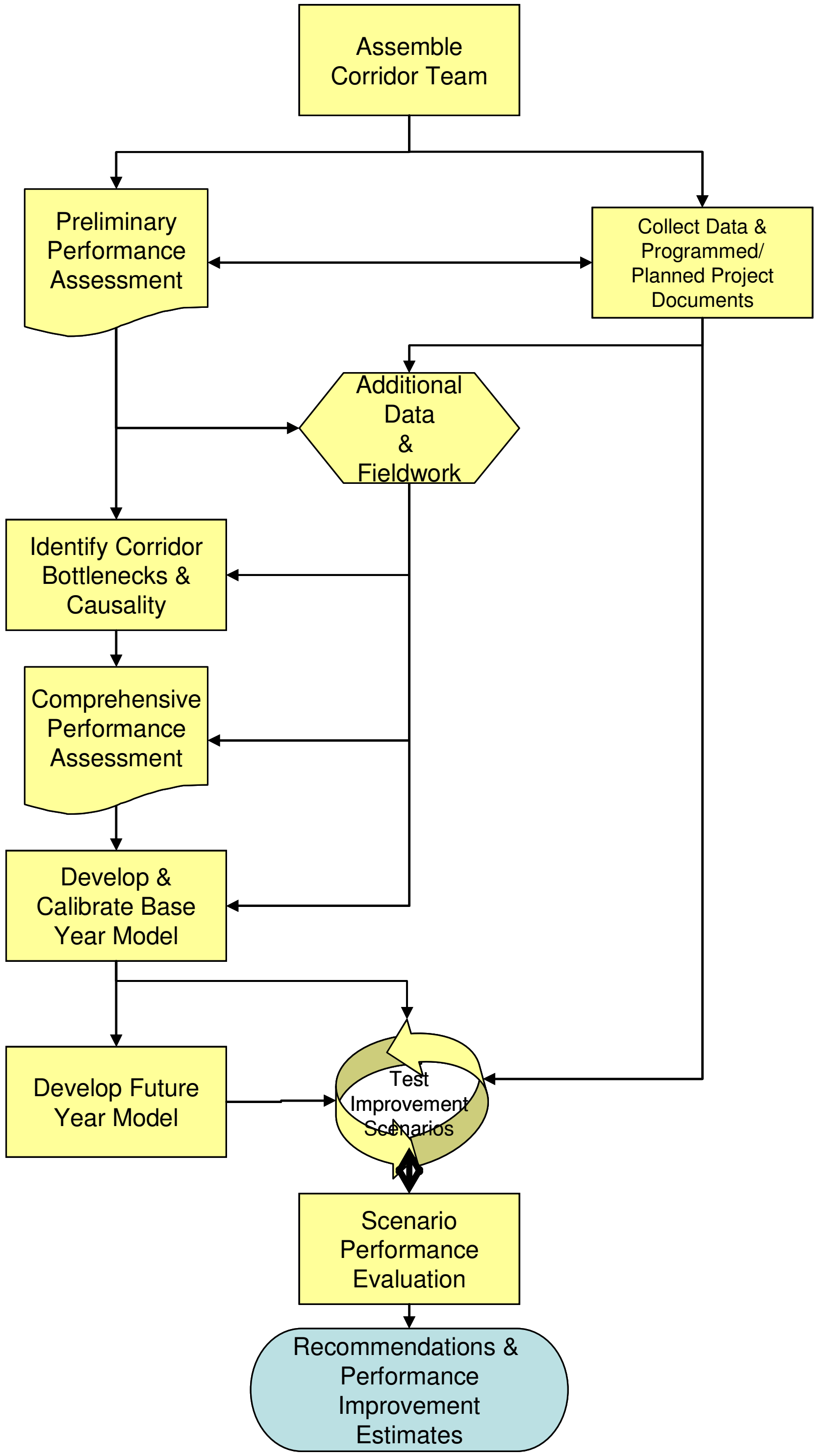
Caltrans would like to thank all of its partners for contributing to this CSMP development process. In addition, the CSMP development provided a venue for tighter coordination between Caltrans planning and operations professionals, which is critical to the success of the system management approach.

Study Approach

The SR-57 CSMP study approach follows system management principles by placing an emphasis on performance monitoring and evaluation (the base of the pyramid in Exhibit 1-2), and on using lower cost operational improvements to maintain system productivity.

Exhibit 1-4 is a flow chart that illustrates this approach. Each step of the approach is described following the chart.

Exhibit 1-4: Study Approach



Assemble Corridor Team

Caltrans District 12 assembled a CSMP Project Development Team, which consists of members from various divisions within Caltrans (Planning, Traffic Operations, Maintenance, and Modeling) as well as representatives from OCTA and SCAG. The CSMP team reviewed project progress and provided continuous feedback throughout the study. Additionally, Caltrans identified along the SR-57 CSMP corridor cities and other major stakeholders whose input would be needed at critical project junctures (e.g., performance assessments, scenario reviews, and final report). The stakeholders group met several times during the study period to receive local feedback on project status updates and agree on project milestones.

Preliminary Performance Assessment

The Preliminary Performance Assessment Report delivered in August 2008 presented a brief description of the corridor and existing projects along on or adjacent to SR-57. It included a corridor-wide performance assessment for four key performance areas: mobility, reliability, safety, and productivity up to 2007. The assessment also included a preliminary bottleneck location assessment based on readily available existing data and limited field observations.

The results of the Preliminary Performance Assessment were updated and included in the Comprehensive Performance Assessment described below. The results of these two assessments are presented in the Corridor Description and Corridor Performance sections–(Sections 2 and 3 of this final report).

For future SR-57 CSMP reporting, the Preliminary Performance Assessment should not be necessary since its main purpose is to identify data gaps – particularly detection gaps. It is anticipated that these gaps will be addressed with improved automatic detection. Future updates to CSMPs can be made to this final report.

Collect Data and Programmed/Planned Project Information

In conjunction with the Preliminary Performance Assessment, the study team reviewed existing studies, plans and other programming documents to assess additional data collection needs for modeling and scenario development. One of the key elements of this study was to identify projects that would be implemented in the short- and long-term time frames to be included in the Paramics micro-simulation model developed by the study team.

Details of the projects included in the scenario analysis are discussed in Section 6: Scenario Development and Evaluation.

Additional Data Collection and Fieldwork

The study team determined locations where additional manual traffic counts would be needed to calibrate the 2007 Base Year model and coordinated the collection of the traffic count data. Traffic data counts collected included peak period turning movement counts and 24-hour average daily traffic (ADT) counts. In addition, signal timing data were obtained from Caltrans and various cities for use in the model calibration.

The study team conducted several field visits in June, November, and December 2008 to observe field conditions during peak periods and videotape potential bottleneck locations. This fieldwork will be discussed in Sections 4 and 5: Bottleneck Identification and Causality.

Identify Corridor Bottlenecks and Causality

Building on the Preliminary Performance Assessment and the fieldwork, the study team identified major AM and PM peak period bottlenecks along the corridor. These bottlenecks will be discussed in detail in Section 4 of this report.

Comprehensive Performance Assessment

Once the bottlenecks were identified and the causality of the bottlenecks determined, the study team prepared the Comprehensive Performance Assessment, which was delivered to Caltrans in May 2009. This report built on the Preliminary Performance Assessment with a discussion of bottleneck causality findings – including performance results for each individual bottleneck area. It also included corridor-wide performance results updated to reflect 2009 conditions.

Develop and Calibrate Base Year Model

Using the bottleneck areas as the basis for calibration, the modeling team developed a calibrated 2007 Base Year model for the corridor. This model was calibrated against California and Federal Highway Administration (FHWA) guidelines for model calibration. In addition, the model was evaluated to ensure that each bottleneck area was represented in the model and that travel times and speeds were consistent with observed data. This process required several review iterations and an independent model peer reviewer.

Discussion of the calibrated 2007 Base Year model can be found in Section 6: Scenario Development and Evaluation.

Develop Future Year Model

Following the approval of the 2007 Base Year model, the modeling team developed a 2020 Horizon Year model to be used to test the impacts of short-term programmed projects as well as future operational improvements including the impacts of improved incident management on the corridor.

Discussion of the 2020 Horizon Year model can be found in Section 6: Scenario Development and Evaluation.

Test Improvement Scenarios

The study team developed 12 scenarios that were evaluated using the micro-simulation model. Short-term scenarios included programmed projects that would likely be completed typically within the next five years along with other operational improvements such as improved ramp metering. In addition to the short-term evaluations, short-term projects were tested using the 2020 Horizon Year model to assess their long-term impacts.

The study team also developed and tested other scenarios using only the 2020 model. These scenarios included programmed and planned projects that would not be completed within five years of 2007 and would likely only experience benefits in the long-term.

Scenario testing results are presented in Section 6: Scenario Development and Evaluation.

Scenario Performance Evaluations

Once scenarios were developed and fully tested, simulation results for each scenario were subjected to a benefit-cost evaluation to determine how much “bang for the buck” each scenario would deliver. The study team performed a detailed benefit-cost assessment using the California Benefit-Cost model (Cal-B/C).

The results of the Benefit-Cost analysis are presented in Section 6: Scenario Development and Evaluation.

Recommendations and Performance Improvement Estimates

The study team developed final recommendations for future operational improvements that could be reasonably expected to maintain the mobility gains achieved by existing programmed and planned projects. Section 7 summarizes these findings.

This report is organized into seven sections (Section 1 is this introduction):

2. *Corridor Description* describes the corridor, including the roadway facility, recent improvements, major interchanges and relative demands at these interchanges, relevant transit services serving freeway travelers, major intermodal facilities around the corridor, special event facilities/trip generators, and an SR-57 origin-destination demand profile from the SCAG regional model.

3. *Corridor Performance and Trends* presents multiple years (2005-2009) of performance data for the freeway portion of the SR-57 Corridor. Statistics are included for the mobility, reliability, safety, and productivity performance measures.

4. *Bottleneck Identification and Performance* identifies bottlenecks, or choke points on SR-57 using various sources. This section has performance results for delay, productivity, and safety by major bottleneck area, which allows for the relative prioritization of bottlenecks in terms of their contribution to corridor performance degradation.

5. *Bottleneck Causality Analysis* diagnoses the bottlenecks and identifies the causes of each location through additional data analysis and field observations. This analysis helps in selecting projects to address the critical bottlenecks, and they provide the baseline against which the micro-simulation models were validated.

6. *Scenario Development and Micro-Simulation* discusses the scenario development approach and summarizes the expected future performance based on the Paramics micro-simulation model developed by the modeling team for the corridor.

7. *Conclusions and Recommendations* describes the projects and scenarios that were evaluated and recommends a phased implementation of the most promising set of strategies.

The appendices provide project lists for the micro-simulation scenarios and detailed benefit-cost results.

2. CORRIDOR DESCRIPTION

The Orange County SR-57 study corridor, named the Orange Freeway, is a north-south route from the I-5/SR-22 Interchange (the “Orange Crush”) in the south to the Orange/Los Angeles County line in the north. The corridor extends approximately 12 miles from the I-5/SR-22 Interchange (Postmile 10.7) in Orange to the Orange/Los Angeles County line (Postmile R22.6).

Corridor Roadway Facility

As shown in Exhibit 2-1, the approximately 12-mile SR-57 Corridor passes through the cities of Orange, Anaheim, Fullerton, Placentia, and Brea, and includes two major freeway-to-freeway interchanges that involve three other state highways:

- I-5 is a north-south interstate serving California from Mexico to Oregon. Regionally, it connects Orange County to Los Angeles and San Diego.
- SR-22 is an east-west state highway intersecting most of the major north/south corridors in Orange County, including the I-405 and SR-55 corridors. SR-22 is a vital link for residents, businesses, employees and visitors.
- SR-91 is an east-west state highway connecting Riverside and San Bernardino counties to Orange County.

As depicted in Exhibit 2-2, SR-57 is an eight to ten-lane freeway with a concrete median barrier that separates northbound and southbound traffic for most of the corridor. There are auxiliary lanes along many sections of the corridor, but they are not always available on both directions of the freeway in a given highway section. There is one HOV lane in each direction of the study corridor, which operates as a 2+ facility, 24 hours a day. There is a direct HOV connector between the southbound SR-57 and westbound SR-91 and between SR-91 and northbound SR-57. There is also a direct HOV connector (transitway) from the northbound I-5 to northbound SR-57. Between SR-57 to I-5 the terrain is generally flat to rolling, with a long climbing grade in the northerly portion of the corridor. Exhibit 2-3 identifies the traffic operations and management systems that are part of the SR-57 Corridor. These include closed-circuit television (CCTV) cameras and fiber optic communications, changeable message signs (CMS), and vehicle detection stations.

Exhibit 2-1: Map of Study Area

Exhibit 2-2: SR-57 Corridor Lane Configuration

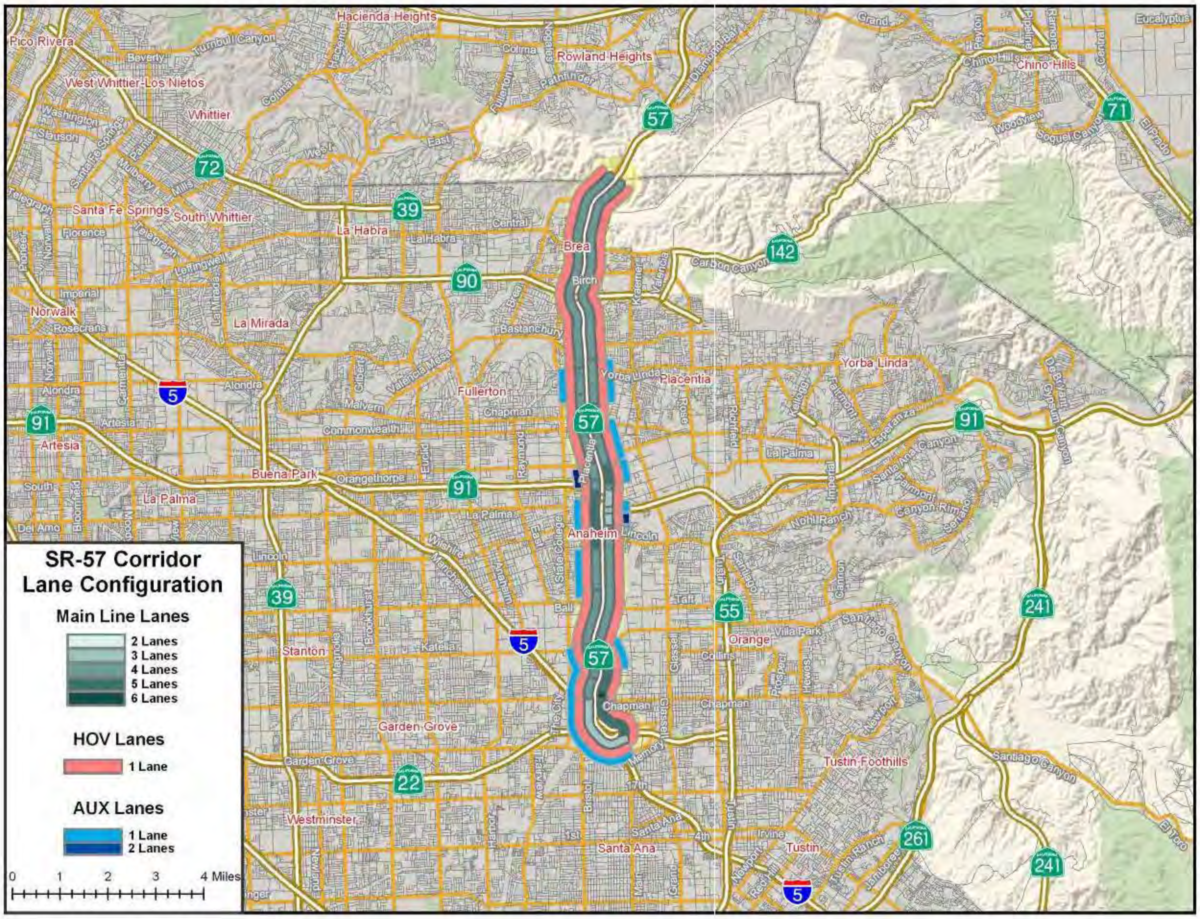
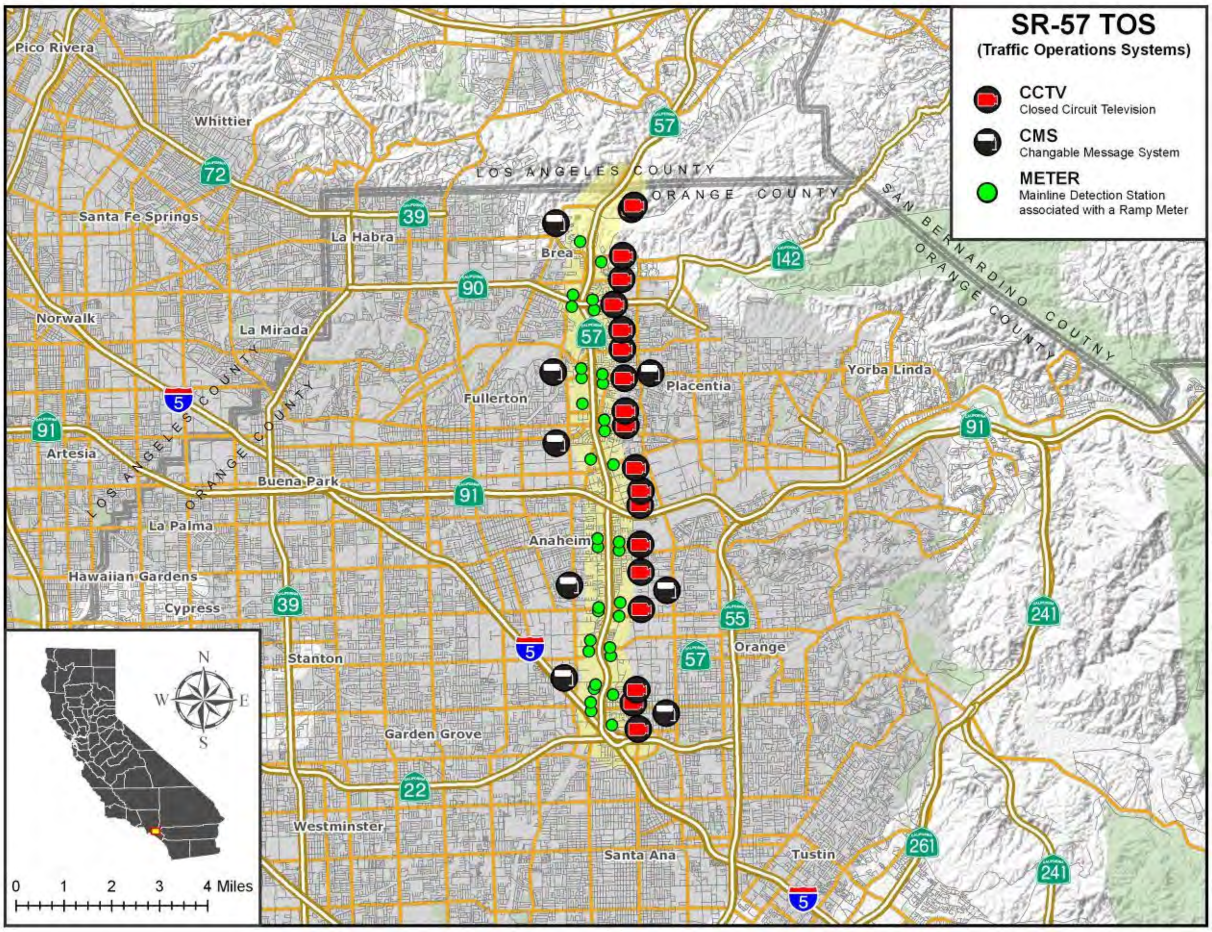


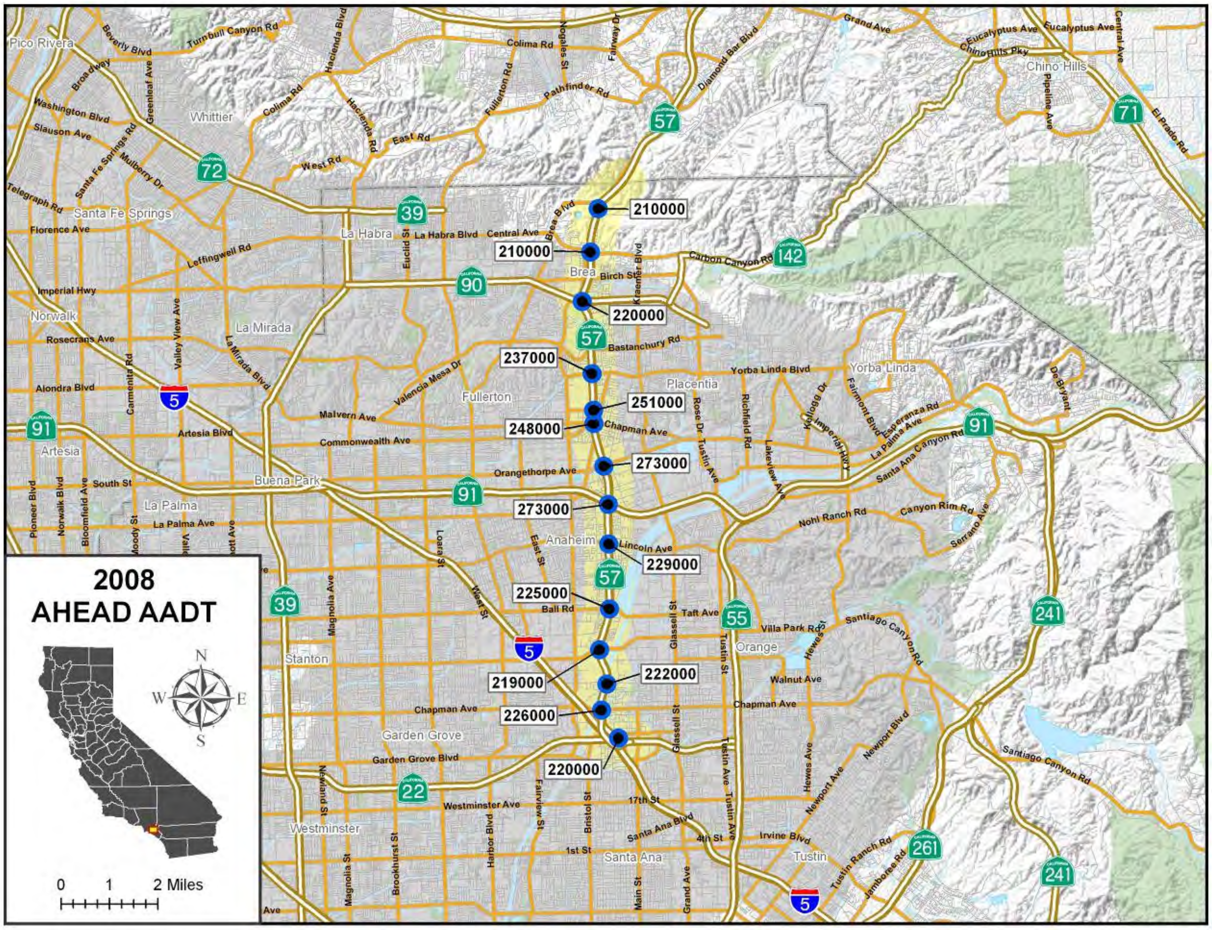
Exhibit 2-3: Traffic Operations and Management Systems



According to the Caltrans Traffic and Vehicle Data Systems annual traffic volumes report for 2008, SR-57 in Orange County carries between 210,000 and 273,000 annual average daily traffic (AADT) as shown in Exhibit 2-4. The highest average daily traffic volume on the corridor occurs between SR-91 and Orangethorpe Avenue and the lowest volume occurs between Lambert Road and Tonner Canyon Road.

SR-57 is a Surface Transportation Assistance Act (STAA) route, which means that trucks are allowed to operate on the corridor (see Exhibit 2-5). According to the latest truck volumes from the 2008 Caltrans Annual Average Daily Truck Traffic data, trucks comprise over six percent of total daily traffic along the corridor.

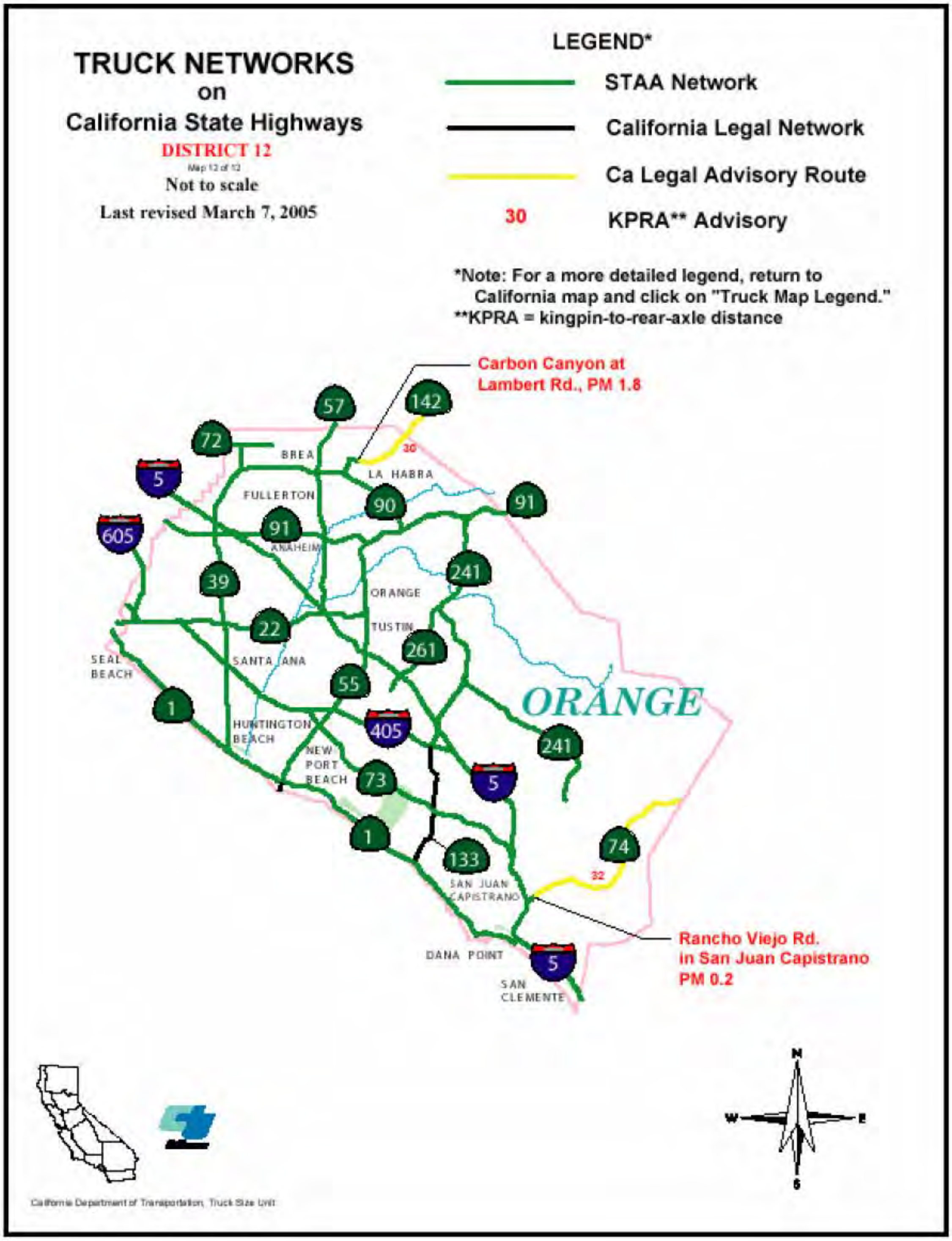
Exhibit 2-4: Major Interchanges and AADT along the SR-57 Corridor



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

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

Exhibit 2-5: Orange County Truck Network on California State Highways



Source: Caltrans

Corridor Transit Services

The following public transportation operators provide service on or near the SR-57 study corridor:

- Orange County Transportation Authority (OCTA)
- Foothill Transit
- Southern California Regional Rail Authority (SCRRA) – Metrolink
- Amtrak

<u>Orange County Transportation Authority (OCTA)</u>

Established in 1991, OCTA provides fixed-route bus and paratransit services throughout Orange County. In addition to several local and express routes that run in the vicinity of the SR-57 Corridor as shown in Exhibit 2-6, the following routes operate on or parallel to SR-57:

- *Route 53* operates parallel to SR-57, providing frequent service between the cities of Brea and Irvine via Associated Road, Placentia Avenue, and Sunkist Street. The route stops in the cities of Fullerton, Placentia, Anaheim, Orange, and Santa Ana.

- *Route 57* operates daily between the cities of Brea and Newport Beach via State College Boulevard. State College Boulevard is a four to six-lane arterial that runs parallel to SR-57 directly west of the corridor. The route begins at the Brea Mall and terminates at the Newport Transportation Center/Park-and-Ride facility, with various stops in the cities of Fullerton, Anaheim, Orange, Santa Ana, Costa Mesa, and Newport Beach.

- *Route 59* provides weekday service between the Brea Mall and the University of California at Irvine (UCI) with limited weekend service between the cities of Brea and Santa Ana. The route runs parallel to and less than a mile east of SR-57 on Kraemer Boulevard and Glassell Street. The arterial has two to three lanes in each direction and is known as Kraemer Boulevard north of SR-91 and Glassell Street south of SR-91.

- *Route 757* provides weekday express bus service between the City of Pomona in Los Angeles County, and the City of Santa Ana in Orange County, with a number of stops, including Brea Mall, Anaheim Stadium, the UCI Medical Center, and MainPlace Mall. This route operates on SR-57 between Imperial Highway and Katella Avenue, and northbound between Lambert Road and Tonner Canyon Road.

- *Route 758* provides weekday express service between the Cities of Irvine and Chino (San Bernardino County), with stops in Diamond Bar and Brea. The route operates on SR-57 between Lambert Road and Tonner Canyon Road.

Exhibit 2-6: OCTA Bus Services along the SR-57 Corridor

Source: Orange County Transportation Authority (OCTA).

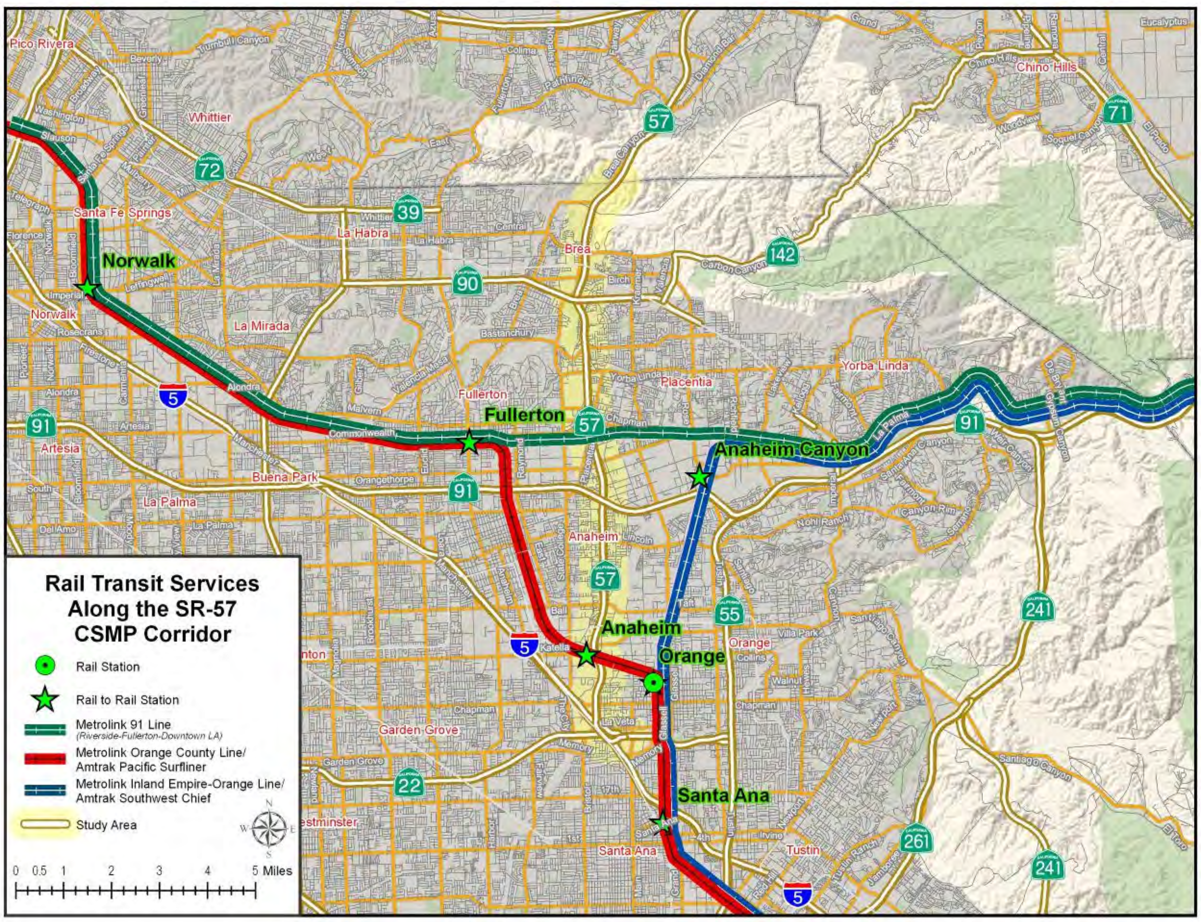
<u>Foothill Transit</u>

Foothill Transit has operated fixed-route bus public transit in the San Gabriel Valley since 1998. Foothill Transit *Route 286* operates directly on the study corridor. It provides daily inter-county service between the cities of Pomona in Los Angeles County and Brea in Orange County. The route operates on SR-57 between Brea Canyon Road and Lambert Road.

<u>Southern California Regional Rail Authority (SCRRA) – Metrolink</u>

SCCRA is a joint powers authority that operates the Metrolink regional rail service throughout Southern California. Metrolink commuter rail trains stop at 11 stations in Orange County. As shown in Exhibit 2-7 there are four stations near the SR-57 Corridor: Fullerton, Anaheim Canyon, Anaheim, and Orange. However, as the exhibit also shows, Metrolink service is available in only the southern portion of the corridor and does not provide a direct alternative to travel on SR-57.

Exhibit 2-7: Rail Services along the SR-57 Corridor



Three lines provide daily service to Orange County:

- Inland Empire–Orange County Line: service from San Bernardino to Oceanside

- 91 Line: service from Riverside to Los Angeles Union Station, via Fullerton and Buena Park
- Orange County Line: service from Los Angeles Union Station to Oceanside

Inland Empire-Orange County Line connects the City of San Bernardino in San Bernardino County to the City of Oceanside in San Diego County. This line can be accessed by two stations along the SR-57 Corridor. The first is the Anaheim Canyon Metrolink Station located at 1039 North Pacificenter Drive in Anaheim near the intersection of Tustin Avenue and La Palma Avenue (two miles east of SR-57). The second is the Orange Metrolink station located two miles east of SR-57 near Chapman Avenue at 100 North Atchison Street in the City of Orange. According to the latest ridership statistics provided by SCRRA, this line carries just under 4,800 weekday passengers with most AM peak period boardings occurring in Riverside County with destinations in Orange County. Ridership between 2006 and 2007 has grown by two percent. Over 90 percent of all riders are commuters.

The *91 Line* connects the City of Riverside to Union Station in downtown Los Angeles. The line does not offer service parallel to the SR-57 Corridor, but it has a station at the joint Amtrak/Metrolink station located in the Fullerton Transportation Center on 120 East Santa Fe Avenue. This station is less than three miles west of SR-57. According to the latest ridership statistics provided by SCRRA, this line carries just over 2,300 weekday passengers with most AM peak period boardings occurring in Riverside County. However, a significant percentage of passengers board in Fullerton. Ridership has declined by 14 percent between 2006 and 2007. Over 85 percent of riders are commuters.

The *Orange County Line* connects Oceanside to Union Station in downtown Los Angeles. Over 9,000 people ride the 19 trains that operate daily on this line. This line can be accessed at three stations near the SR-57 Corridor. The first is the Fullerton Transportation Center. The second is at the joint Anaheim Amtrak/Metrolink station located on 2150 East Katella Avenue, adjacent to the Angel Stadium parking lot. The station is less than a quarter mile west of SR-57 on Katella Avenue. The third is the Orange Metrolink station.

Amtrak

While Metrolink provides intra-regional service throughout Southern California, Amtrak provides interregional service. Two Amtrak trains use the same route as Metrolink's trains. Amtrak's Pacific Surfliner, which offers service from San Diego to San Luis Obispo, travels along the same route as Metrolink's Orange County Line; and Amtrak's Southwest Chief, which offers service from Los Angeles to Chicago, travels along the same route as Metrolink's Inland Empire-Orange County Line. Similarly, Amtrak shares station locations with Metrolink at the Fullerton, Santa Ana, Anaheim, and Orange stations.

Intermodal Facilities

There are various intermodal facilities throughout the SR-57 study area, including a large commercial airport, various park and ride lots, and several bike lane paths.

John Wayne Airport (SNA) lies approximately 10 miles south of the I-5/SR-22 Interchange and is linked to the SR-57 Corridor by I-5 and SR-55, as shown in Exhibit 2-8. SNA hosts air carrier, general aviation, air taxi, military, and air cargo services. Fourteen commercial and commuter air carriers operate from SNA.

As of 2006, SNA ranked 42nd in United States airports in terms of enplanements and is ranked seventh in California, just ahead of Ontario International Airport (ONT).[2] Exhibit 2-9 lists passenger boardings in recent years. Over the five-year period between 2002 and 2006, the number of passenger boardings grew from just under four million annually to nearly 4.8 million in 2006, with most of the growth occurring in the first two years. In one month alone (September 2007), SNA recorded 782,896 total passengers, including 388,735 enplanements and 394,161 deplanements. In the same month, the airport served 1,967 air cargo tons, including 1,838 tons carried by all-cargo carriers. Both FedEx and UPS serve SNA.[3]

Park and ride lots are also available along the SR-57 Corridor providing parking and access to local, regional and interregional transit. The park and ride lots within the surrounding SR-57 area are all illustrated in Exhibit 2-10.

Several major arterials adjacent to the SR-57 Corridor also provide bike lanes. Parallel to and west of SR-57, there are Class II lanes on Sunkist Avenue from Cerritos to Lincoln Avenue, and on Acacia Street from SR-91 to the California State University Fullerton (CSUF) campus at State College Boulevard and Nutwood Avenue. Classes I and II lanes exist from Commonwealth and Chapman Avenues (City of Fullerton) north to Central Avenue in Brea. East of SR-57, there is a network of Class III routes in Placentia as well as a Class II facility on Kraemer Boulevard between Yorba Linda Boulevard and Birch Street. Class II facilities exist at these freeway crossings: Bastanchury Road, Rolling Hills Road, and Associated Road in Fullerton; Birch Street and Lambert Road in Brea.

[2] "Passenger Boarding and All-Cargo Data." Federal Aviation Administration. May 2008. Air Carrier Activity Information System (ACAIS). <www.faa.gov/airports_airtraffic/airports/planning_capacity/passenger_allcargo_stats/passenger>.
[3] Wedge, Jenny. "John Wayne Airport Posts September Statistics (Revised)." *John Wayne Airport News and Facts*. October 11, 2007. John Wayne Airport. 15 May 2008 <www.ocair.com/newsandfacts/newsreleases/2007/NR-2007-10-11.html>.

Exhibit 2-8: John Wayne Airport

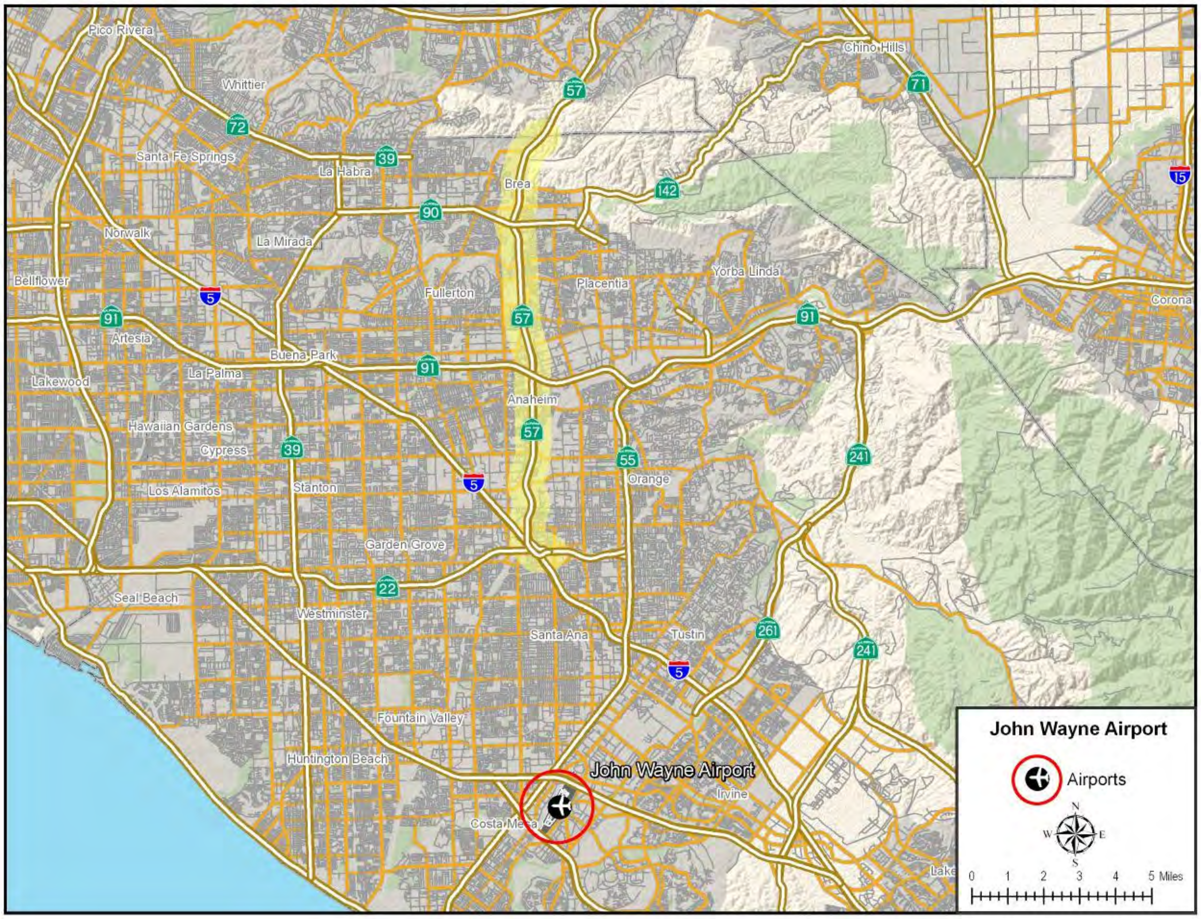
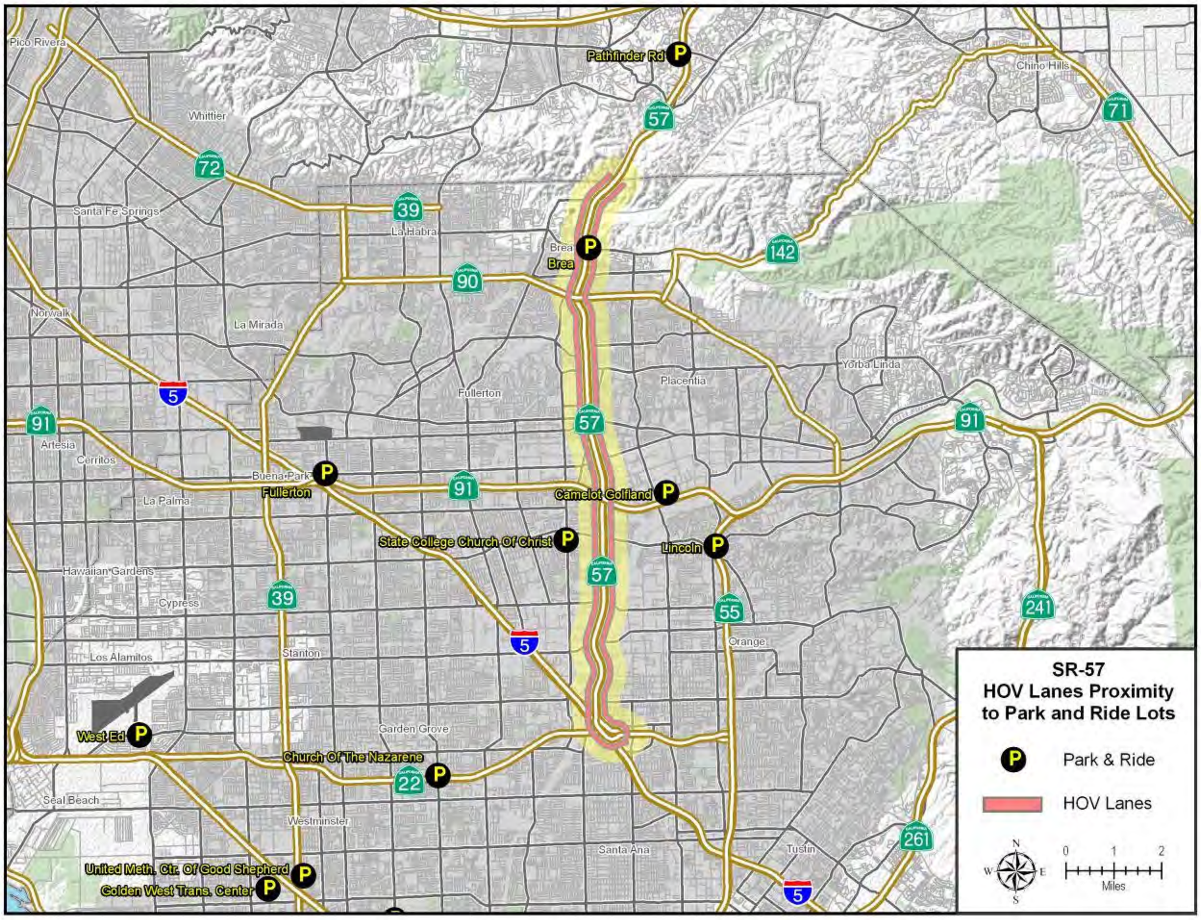


Exhibit 2-9: John Wayne Airport Passenger Boarding Statistics

	2002	2003	2004	2005	2006	2007
Passenger Boardings	3,968,978	4,266,083	4,621,107	4,791,786	4,777,896	4,948,846
Difference		297,105	355,024	170,679	(13,890)	170,950
Percent Difference		7.5%	8.3%	3.7%	-0.3%	3.6%

Source: Federal Aviation Administration (FAA) Air Carrier Activity Information System (ACAIS).

Exhibit 2-10: Park and Ride Lots



Special Event Facilities/Trip Generators

There are various facilities and institutions located along SR-57 that could generate significant trips on the corridor. Exhibit 2-11 shows the location of the most significant traffic generators.

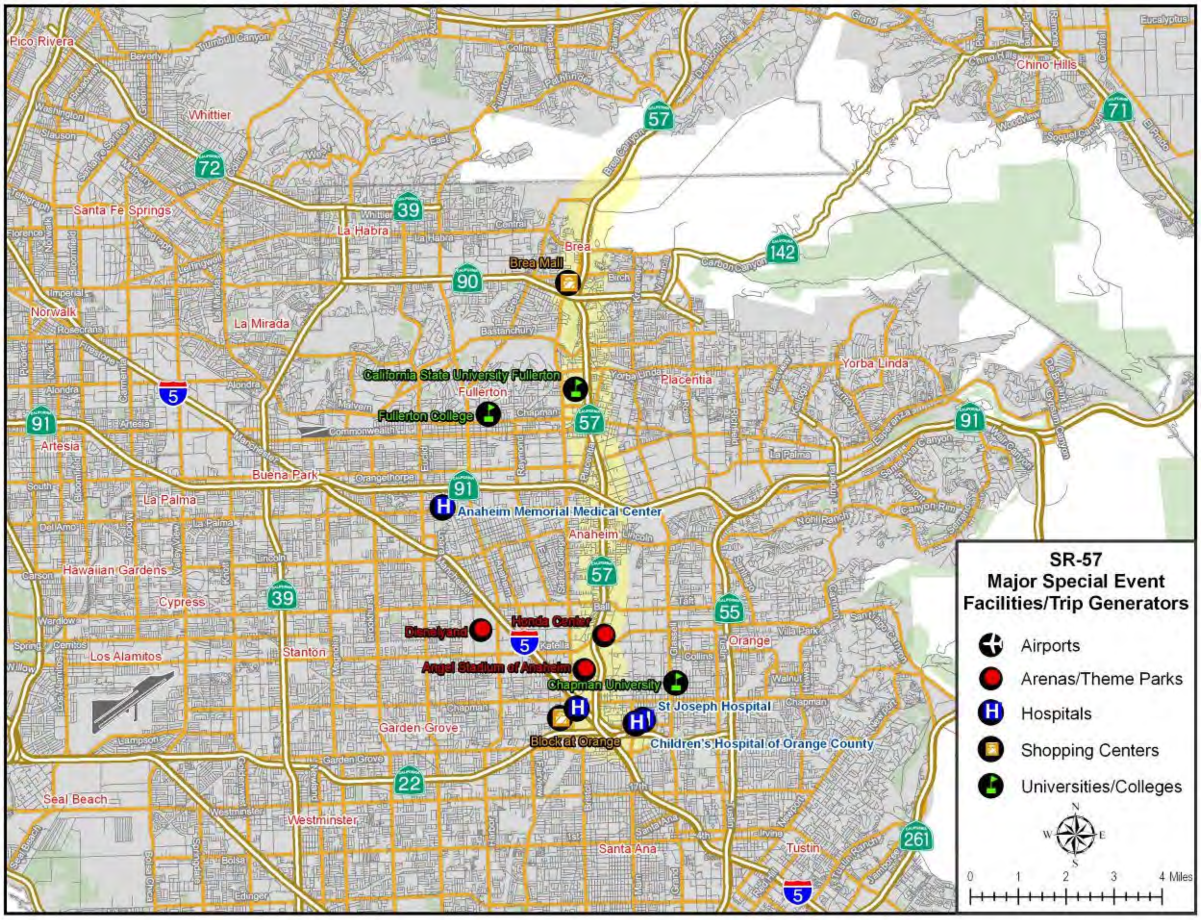
The special event facilities located within several miles of the SR-57 Corridor include Disneyland Resort and Theme Park, Angel Stadium, and the Honda Center. The Disneyland Resort and Theme Park is located three miles west of SR-57 on Katella Avenue and is the second busiest amusement park in the world, with an average daily attendance of nearly 40,000 patrons. The Disneyland Resort directly employs over 20,000 people, making it Orange County's largest employer and one of the largest single-site private employers in the state. Adjacent to SR-57 on Katella Avenue is the Angel Stadium of Anaheim, home of the Los Angeles professional baseball team the

Angels. Across the street from Angel Stadium on Katella Avenue and east of SR-57, is the Honda Center arena, home to the professional hockey team the Anaheim Ducks. Other events, such as concerts, rodeos, basketball tournaments, and other major performances, take place at the Honda Center. Angel Stadium seats over 45,000 people and the Honda Center can accommodate between 17,000 and 19,000 guests, depending on the event and seating configuration.

Two major universities and a college are located near the SR-57 Corridor. The two universities are California State University Fullerton (CSUF) and Chapman University. CSUF is situated directly west of SR-57 on Yorba Linda Boulevard and is a four-year public university offering Bachelor and Masters Degree programs to nearly 36,000 students. Chapman University, a private institution built around a liberal arts core with an enrollment of over 5,000 students, is located less than two miles east of SR-57 on Glassell Street in the City of Orange. Approximately two miles west from Cal State Fullerton on Chapman Avenue is Fullerton College, a two-year institution with an enrollment of almost 20,000 students. There are also several secondary, middle, and elementary schools within a few miles of the corridor.

There are four major medical facilities within a few miles of the SR-57 Corridor. The first is the Anaheim Memorial Medical Center. This facility has served North Orange County since 1958 and is ranked among the nation’s top 100 hospitals for heart attack, heart failure and pneumonia care. It is located about four miles west of SR-57 on La Palma Avenue. The second major medical facility is UCI Medical Center, which is located less than a mile west of SR-57 on Chapman Avenue in the City of Orange. This facility is the only university hospital in Orange County and boasts more than 400 specialty and primary care physicians who offer a full range of acute and general care services. The third and fourth major medical facilities are St. Joseph Hospital and Children’s Hospital of Orange County (CHOC), located in the City of Orange. St. Joseph Hospital is the largest and one of the highest-volume hospitals in the County, with a 1,000-member medical staff, and CHOC is the first hospital in Orange County to open an emergency room for children.

Exhibit 2-11: Major Special Event Facilities/Trip Generators

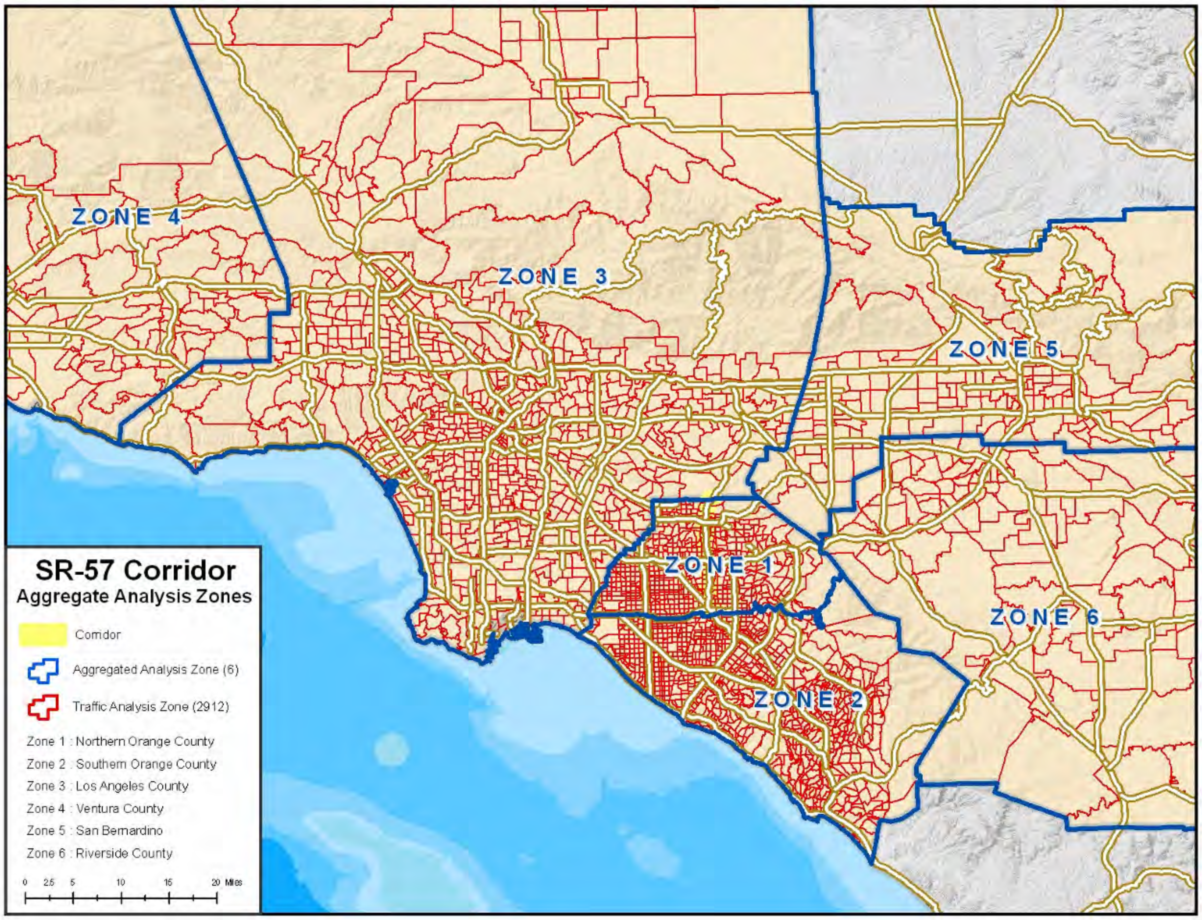


Two major shopping malls are located near the SR-57 Corridor. Brea Mall is directly west of SR-57 on Imperial Highway and State College Boulevard. It houses five major department stores and over 175 specialty shops and boutiques. The Block at Orange is located less than two miles west of SR-57 on Chapman Avenue and The City Drive in the City of Orange. The Block is an outdoor mall popular for its skateboarding facility and thriving nightlife.

Demand Profiles

An analysis of origins and destinations was conducted to determine the travel pattern of trips made on the SR-57 study corridor. Based on Caltrans' travel demand model, this "select link analysis" isolated the SR-57 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 shown in Exhibit 2-12.

Exhibit 2-12: Aggregate Analysis Zones for Demand Profile Analysis



Based on this aggregation, demand on the corridor was summarized by aggregated origin-destination zone as depicted in Exhibits 2-13 and 2-14 for the AM and PM peak periods. This analysis shows that the majority of trips using the SR-57 study corridor represent travel within Orange County. However, a significant number of trips also originated or terminated in Los Angeles County.

During the AM peak period, about 36 percent of all trips originate and terminate in Orange County (Zones 1, 2). The remaining trips originate in Orange County and terminate in another county (22 percent); originate outside Orange County and terminate in Orange County (33 percent); or originate and terminate outside Orange County (8 percent).

Exhibit 2-13: AM Peak Origin Destination by Aggregated Analysis Zone

AM Trips		TO ZONE: Northern Orange County	Southern Orange County	Los Angeles County	Ventura County	San Bernardino County	Riverside County	Outside Zones
FROM ZONE	Northern Orange County	12.2%	12.3%	9.3%	0.1%	0.5%	3.3%	0.1%
	Southern Orange County	10.4%	1.0%	6.4%	0.0%	0.2%	2.6%	0.0%
	Los Angeles County	13.6%	9.8%	4.3%	0.0%	0.2%	1.5%	0.0%
	Ventura County	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	San Bernardino County	0.8%	0.3%	0.2%	0.0%	0.0%	0.1%	0.0%
	Riverside County	4.7%	3.7%	1.3%	0.0%	0.1%	0.5%	0.0%
	Outside Zones	0.2%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%

35.8%	Trips starting and ending in Orange County
22.4%	Trips starting in Orange County and ending outside of Orange County
33.4%	Trips starting outside of Orange County and ending in Orange County
8.4%	Trips starting outside of Orange County and ending outside of Orange County

During the PM peak period (which experiences over 30 percent more demand for travel than the AM), the picture is similar. Roughly 35 percent of trips originate and terminate in Orange County. The remaining trips originate in Orange County and terminate in another county (31 percent); originate outside Orange County and terminate in Orange County (25 percent); or originate and terminate outside Orange County (9 percent).

Exhibit 2-14: PM Peak Origin Destination by Aggregated Analysis Zone

PM Trips		TO ZONE: Northern Orange County	Southern Orange County	Los Angeles County	Ventura County	San Bernardino County	Riverside County	Outside Zones
FROM ZONE	Northern Orange County	12.1%	10.7%	12.6%	0.1%	0.6%	4.5%	0.2%
	Southern Orange County	10.6%	1.1%	9.2%	0.1%	0.3%	3.6%	0.0%
	Los Angeles County	10.5%	7.3%	4.6%	0.0%	0.2%	1.4%	0.2%
	Ventura County	0.2%	0.2%	0.1%	0.0%	0.0%	0.0%	0.0%
	San Bernardino County	0.7%	0.3%	0.2%	0.0%	0.0%	0.1%	0.0%
	Riverside County	3.4%	2.7%	1.5%	0.0%	0.1%	0.4%	0.1%
	Outside Zones	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%

34.6%	Trips starting and ending in Orange County
31.2%	Trips starting in Orange County and ending outside of Orange County
25.3%	Trips starting outside of Orange County and ending in Orange County
8.9%	Trips starting outside of Orange County and ending outside of Orange County

Environmental Elements

Before pursuing any major project, many environmental factors are considered. Caltrans District 12 provided the following summary of environmental factors that may be impacted by the SR-57 widening projects.

Air Quality

The Clean Air Act is the comprehensive Federal law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the U.S. Environmental Protection Agency to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment.

Implementation of the project would involve federal approvals, which will necessitate demonstrating project conformance with the State Implementation Plan. The purpose of the Implementation Plan is to attain and maintain the National Ambient Air Quality Standards. Concerning Mobile Source Air Toxics (MSAT), when a NEPA document is required, a determination must be made as to whether the project will meaningfully increase emissions. If so, a qualitative analysis is required. If the project will create new or add substantial capacity to the route with traffic volumes where the Average Annual Daily Traffic (AADT) is projected to be in the range of 140,000 to 150,000 or greater, by the design year, a quantitative analysis is required.

SR-57 is located in the South Coast Air Basin (SCAB). Federal and State standards exist for lead, nitrogen dioxide, sulfur dioxide, and inhalable particulates labeled PM_{10} and $PM_{2.5}$. The SCAB is in a federal non-attainment status with regards to carbon monoxide, and for the ozone eight-hour standard.

Wetlands

The U.S. Army Corps of Engineers (the Corps) and the Environmental Protection Agency jointly define wetlands as “those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support…a prevalence of vegetation typically adapted for life in saturated soil conditions.” There is a potential for wetlands to exist at the following locations, although confirmation of wetlands requires formal delineation according to the protocol required by the Corps.

- Tonner Canyon Creek crosses SR-57 near the county line. Several blue-line (perennial) streams are found on both sides of the highway, which drain into Tonner Canyon Creek and have features essential to wetlands. The extent of these natural drains is unknown.
- Two blue-line streams located west of SR-57 and south of Tonner Canyon are found within one mile of SR-57. These streams may meet the definition of a wetland, although the extent of wetland is unknown.

- An oil field is located on the east of SR-57 and south of Tonner Canyon Creek. According to USGS maps, there are three unnamed streams running through the hillside into developed areas. Large sections of these streams may qualify as wetlands.
- Loftus Channel, east of SR-57, is tributary to Fullerton Creek, and may contain wetlands.
- Fullerton Creek crosses SR-57, and is fed by several unnamed streams. Portions of this creek and its tributaries may meet the definition of wetland.
- The large section of the Santa Ana River south of SR-57 is fully concrete-lined, and not expected to support vegetation. However, those sections of the river that are only partially modified have the potential to support wetlands, the extent of which is unknown.
- Santiago Creek, Collins Channel, and Bitterbrush Channel are partially improved blue-line streams and are tributaries to the Santa Ana River. These streams may meet the definition of wetland, dependent upon a full delineation study.
- Carbon Creek is entirely concrete-lined and is not expected to contain a wetland.

There are also small ponds in Craig and Centennial Regional Parks, which are used by migratory birds.

<u>Hazardous Materials</u>
There are no hazardous material disposal sites within one mile of SR-57 or the proposed extension.

<u>Visual</u>
SR-57 is located in north Orange County, which is heavily urbanized. North of Lambert Road in Brea, the terrain is rural; however, no alteration is proposed to SR-57 beyond that interchange. Views from the freeway would be slightly diminished in quality by the added lane northbound. Views to the freeway would also be minimally affected at right-of-way edges and community entrances. Overall changes in character are considered low to moderate.

<u>Construction Impacts</u>
Noise produced by construction equipment on the proposed widening projects would occur with varying intensities and duration during the phases of construction. These phases would occur over an estimated two year period. Because of phased construction, no single location would experience a long-term period of construction noise.

<u>Permits and Approvals</u>
The proposed extension of SR-57 to SR-1 along the bed of the Santa Ana River would affect waterways. Impacts to these waters would be identified, and appropriate

mitigation proposed, in the Environmental Document. Offsite mitigation would be required for the extension.

Permits and approvals would be required for construction of the two widening projects in the 2006 STIP. Exhibit 2-15 outlines the required permits and approvals.

Exhibit 2-15: Required Approvals for Northbound Widening on SR-57

AGENCY	APPROVAL REQUIRED
U.S. Fish and Wildlife Service	Consultation pursuant to Section 7 of the Endangered Species Act.
U.S. Army Corps of Engineers	Nationwide Permit per Section 404 of the Clean Water Act.
Regional Water Quality Control Board	Statewide NPDES permit per Section 402 of the Clean Water Act. Water Quality Certification per Section 401 of the Clean Water Act.
CA Dept. of Fish and Game	1601 Streambed Alteration Agreement per Section 1601 of the CA Fish and Game Code

3. CORRIDOR PERFORMANCE AND TRENDS

This section summarizes the performance measures used to evaluate the existing conditions of the SR-57 Corridor. The measures provide a technical basis to describe traffic performance on SR-57 and were used to calibrate the micro-simulation model. Data from mainline (ML) and high occupancy vehicle (HOV) facilities were analyzed separately.

Before discussing the performance measures, this section describes the quality of the data used in the analysis. This was done to ensure that the automatic sensor data used for the analysis was sufficiently reliable.

Following the data quality discussion, the following five key performance areas will be discussed in detail:

- *Mobility* describes how quickly people and freight move along the corridor.
- *Reliability* captures the relative predictability of travel time along the corridor.
- *Safety* provides an overview of collisions along the corridor.
- *Productivity* quantifies the degree to which traffic inefficiencies at bottlenecks or hot spots reduce flow rates along the corridor
- *Pavement Condition* describes the structural adequacy and ride quality of the pavement.

Data Sources and Detection

The existing available data analyzed for the SR-57 Corridor included the following sources:

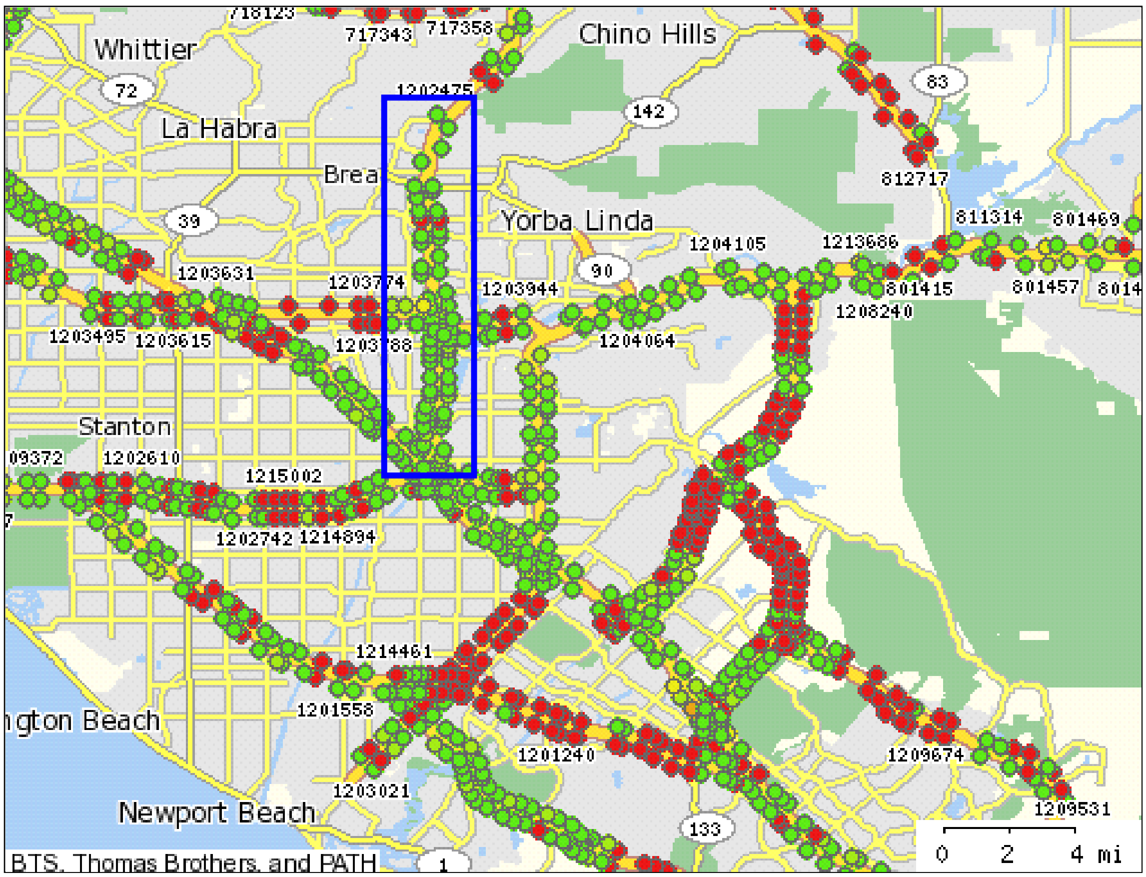
- Caltrans Highway Congestion Monitoring Program (HICOMP) report and data files (2006 – 2007)
- Caltrans Freeway detector data
- Caltrans District 12 probe vehicle runs (electronic tachometer runs)
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS)
- Signal Timing Plans from the Cities of Brea, Fullerton, Placentia, Anaheim, and Orange
- Various studies
- Aerial photographs (Google Earth) and Caltrans photologs
- Internet (i.e. OCTA website, Metrolink website, SCAG website, etc).

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

Freeway Detection Status

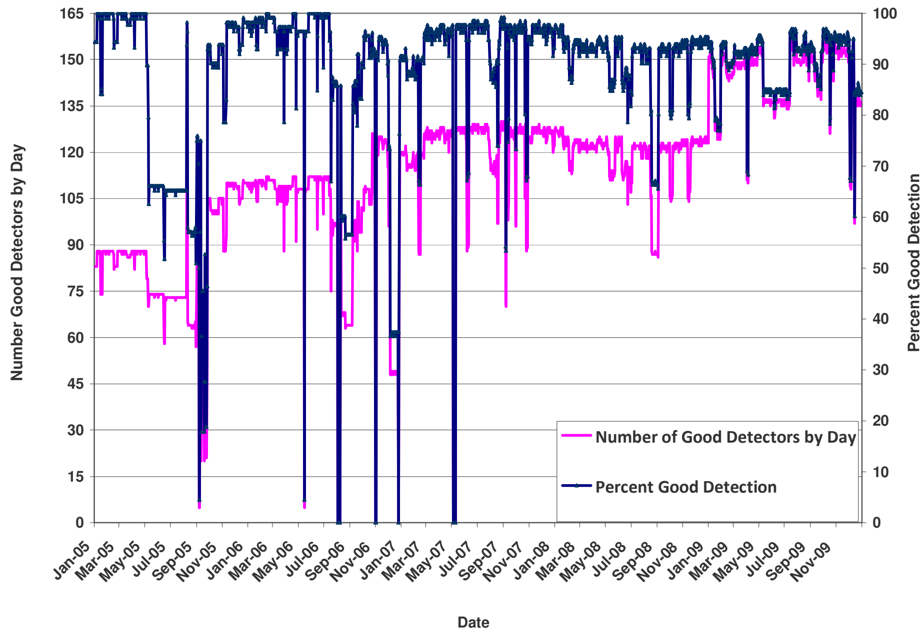
Exhibit 3-1 depicts the corridor freeway facility with the detectors in place as of May 30, 2008. This date was chosen randomly to provide a snapshot of the detection status. The exhibit shows that there are many detectors on the mainline, almost all functioning well on that date (based on the green color). Furthermore, it illustrates some seemingly small gaps between detectors at some locations.

Exhibit 3-1: SR-57 Detection Status for May 28, 2008



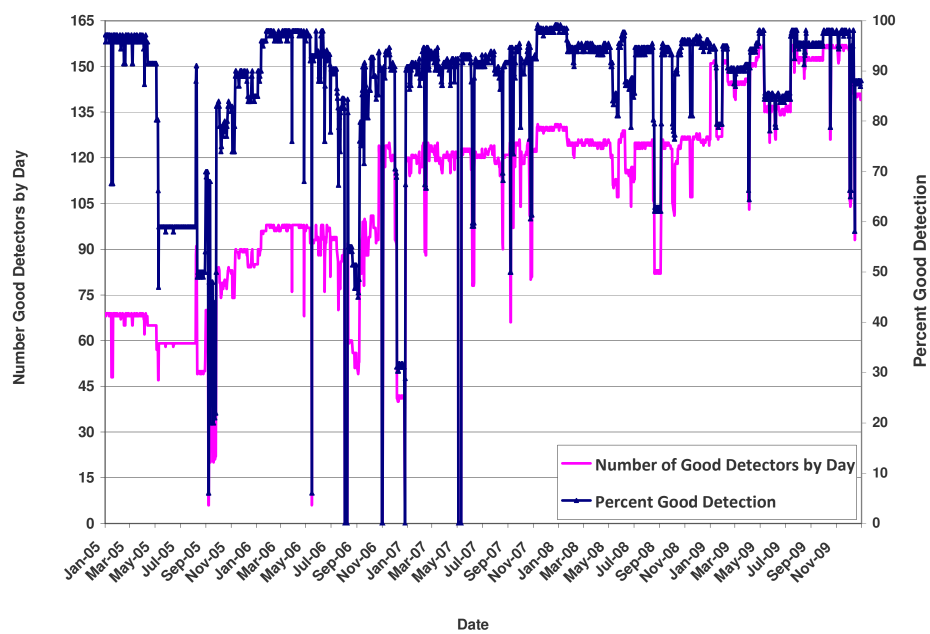
The following exhibits provide a better picture of how the detectors on the corridor performed over a longer period from January 2005 to December 2009. Exhibits 3-2 and 3-3 report the number and percentage of daily "good" detectors on the mainline facility of the SR-57 study corridor. Exhibits 3-4 and 3-5 report the same information for the HOV facility. 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 of good detectors. These exhibits suggest that detection on the mainline facility was solid with both directions reporting consistently over 90 percent of good data throughout most of the five-year period. In both directions of the mainline, it is clear that a large number of good detectors emerged in the fall of 2006, when the number of good detectors jumped from around 50-60 to over 120 by the end of the year. Exhibits 3-2 and 3-3 also indicate that additional "good" detectors were working in 2009.

Exhibit 3-2: Northbound SR-57 ML Number & Percentage of Daily Good Detectors



Source: Caltrans detector data

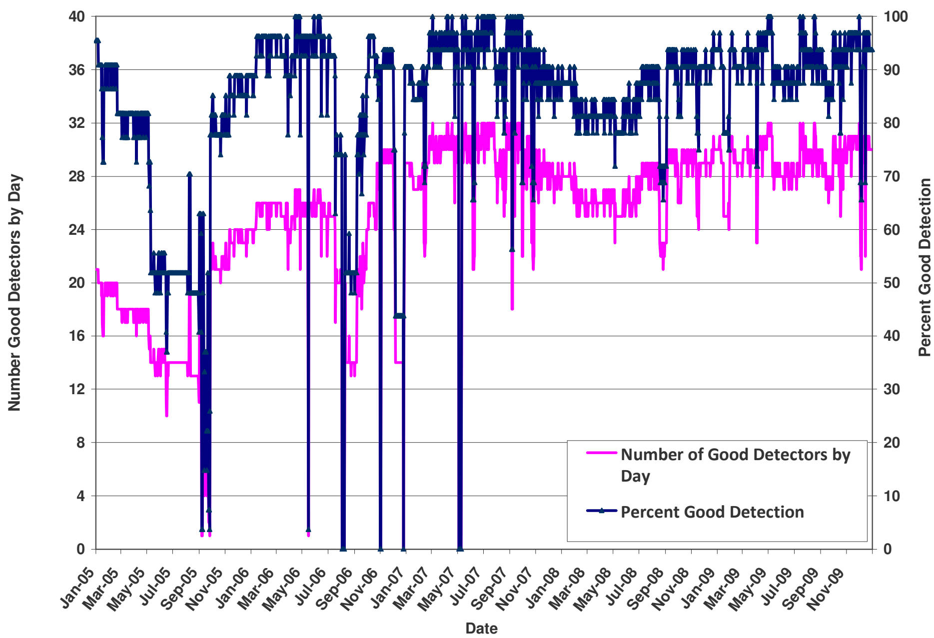
Exhibit 3-3: Southbound SR-57 ML Number & Percentage of Daily Good Detectors



Source: Caltrans detector data

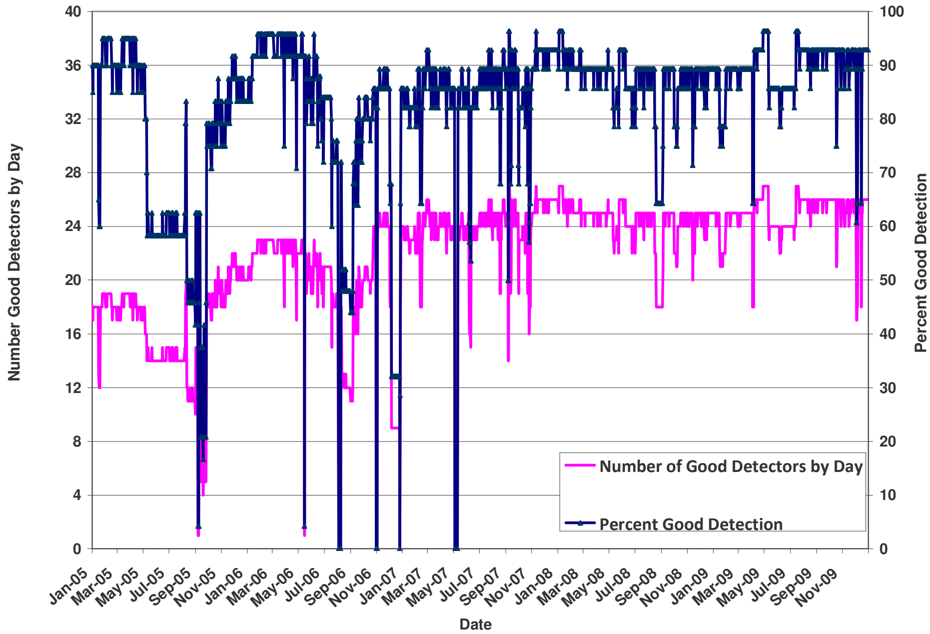
The quality of detection on the HOV facility was as almost as healthy as the mainline facility, as shown in Exhibits 3-4 and 3-5. In 2007 to 2009, the northbound HOV lane reported a greater number of good detectors (around 28-32) compared to the southbound HOV lane (around 24). Overall, detection on both directions of the HOV facility was healthy with both directions consistently reporting over 80 percent of good data, notably in 2007 through 2009.

Exhibit 3-4: Northbound SR-57 HOVL Number & Percentage of Daily Good Detectors



Source: Caltrans detector data

Exhibit 3-5: Southbound SR-57 HOVL Number & Percentage of Daily Good Detectors



Source: Caltrans detector data

A more detailed look at all the detectors along the corridor revealed that the latest detectors were placed in October 2006. Although no new detectors were added in 2007 to May 2010, the SR-57 Corridor generally has very good detector density and quality. Exhibit 3-6 shows an analysis of the gaps without detection. Note that there are several segments with lengths of over 0.75 miles without detection. These should be considered for deployment of additional detection when funding becomes available.

Exhibit 3-6: SR-57 Gaps Without Detection (May 2010)

Location	Abs PM		Length
	From	To	
NORTHBOUND			
Imperial Hwy to Lambert Rd	9.377	10.427	1.05
Lambert Rd to Tonner Canyon Rd	10.487	11.327	0.84
SOUTHBOUND			
Tonner Canyon Rd to Lambert Rd	11.458	10.158	1.30
Lambert Rd to Imperial Hwy	10.158	9.398	0.76
Yorba Linda Blvd to Nutwood Ave	7.638	6.868	0.77

Source: Caltrans detector data

Mobility

Mobility describes how well the corridor moves people and freight. The mobility performance measures are both measurable and straightforward for documenting current conditions. They can also be forecasted, which makes 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., 2,000 vehicles per hour per lane), while others use a measured or estimated flow rate. The distance is the length under which the congested speed prevails and the duration is the hours of congestion experience below the threshold speed.

The threshold speed can also vary. In general, the threshold speed represents free-flow or some other pre-defined speed. In this CSMP analysis, 60 mph is considered free-flow speed for the corridor, and will be used to calculate delay.

Different reports and studies use other threshold speeds, typically 35 mph (e.g., HICOMP), which is defined here as the “severe congestion” speed threshold, and 45 mph (Federal Highway Administration threshold to define HOV degradation).

The HICOMP annual report discussed in the following section uses the 35 mph threshold speed and assumes 2,000 vehicles per hour per lane as the throughput threshold. HICOMP therefore reports on severe delay, while the automatic detector data uses 60 mph and the reported number of vehicles reported by the detectors. Each of these two sources is discussed separately since their results are extremely difficult to compare because of methodological and data collection differences.

Caltrans HICOMP

The HICOMP report has been published annually by Caltrans since 1987.[4] Delay is presented as average daily vehicle-hours of delay (DVHD). The HICOMP report defines delay as travel time in excess of free flow travel time when speeds dip below 35 mph for 15 minutes or longer.

District 12 collects data for HICOMP using probe vehicle runs for two to four days during the year (ideally, two days of data collection in the spring and two in the fall, though resource constraints often affect the number of runs performed). As will be discussed later in this section when discussing the automatic detector data, congestion levels vary from day to day and depend on any number of factors including accidents, weather, special events, the price of gasoline, and construction activities.

Exhibit 3-7 shows the annual delay trends from 2006 to 2007 for the AM and PM peak travel period for both directions. As indicated in the exhibit, the most significant congestion occurs during the PM peak period in the northbound direction for both years. While the northbound delay showed an increase in the PM peak period, the southbound delay decreased significantly from 2006 to 2007 for both the AM and PM peak periods.

Exhibit 3-7: Average Daily Vehicle-Hours of Delay

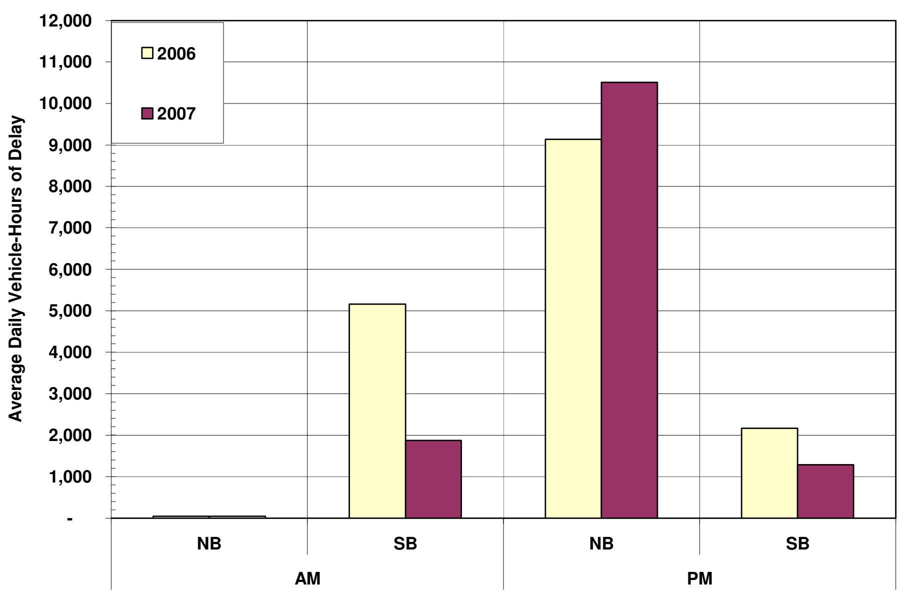


Exhibit 3-8 shows the complete list of congested segments reported by the HICOMP report for the corridor. "Generalized" congested segments are presented so that segment comparisons can be made from one year to the next since a given congested

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

segment may vary in distance or size from one year to the next as well as from day-to-day. However, it is important to reiterate that these trends are affected by the quality of the data available. As the exhibit and other measures presented throughout this report show, travel along the SR-57 Corridor exhibits directional demand. Congestion occurs during the AM and PM peak periods in the southbound direction and during the PM peak period in the northbound direction.

The maps in Exhibits 3-9 and 3-10 show the 2007 delays from Exhibit 3-8 during each of the two peak periods. The approximate locations of the congested segments, the duration of that congestion, and the reported recurrent daily delay are also shown on the maps.

The most congested segment on the corridor was in the northbound direction during the PM peak period between Chapman Avenue (City of Fullerton) and Tonner Canyon Road. Delay experienced in this segment increased from 9,138 hours in 2006 to 10,507 hours in 2007. Delay in the southbound direction decreased during both the AM and PM peak periods, thus the overall delay experienced on the corridor from 2006 to 2007 showed a decrease in total delay of 2,800 vehicle-hours, or approximately 17 percent.

Exhibit 3-8: HICOMP Hours of Delay for Congested Segments (2006-2007)

Period	Dir	Generalized Congested Area	Generalized Area Congested Average Vehicle Hours of Delay 2006	2007
AM	NB	Chapman Ave to s/o Orangewood Ave	5	
		Lincoln Ave to Orangethorpe Ave	39	47
	SB	Tonner Canyon Rd to Chapman Ave	5,157	1,874
		AM PEAK PERIOD SUMMARY	5,201	1,921
PM	NB	Chapman Ave to Tonner Canyon Rd	9,138	10,507
	SB	Tonner Canyon Rd to Chapman Ave	2,170	1,280
		PM PEAK PERIOD SUMMARY	11,308	11,787
		TOTAL CORRIDOR CONGESTION	**16,508**	**13,708**

Exhibit 3-9: 2007 AM Peak Period HICOMP Congested Segments Map

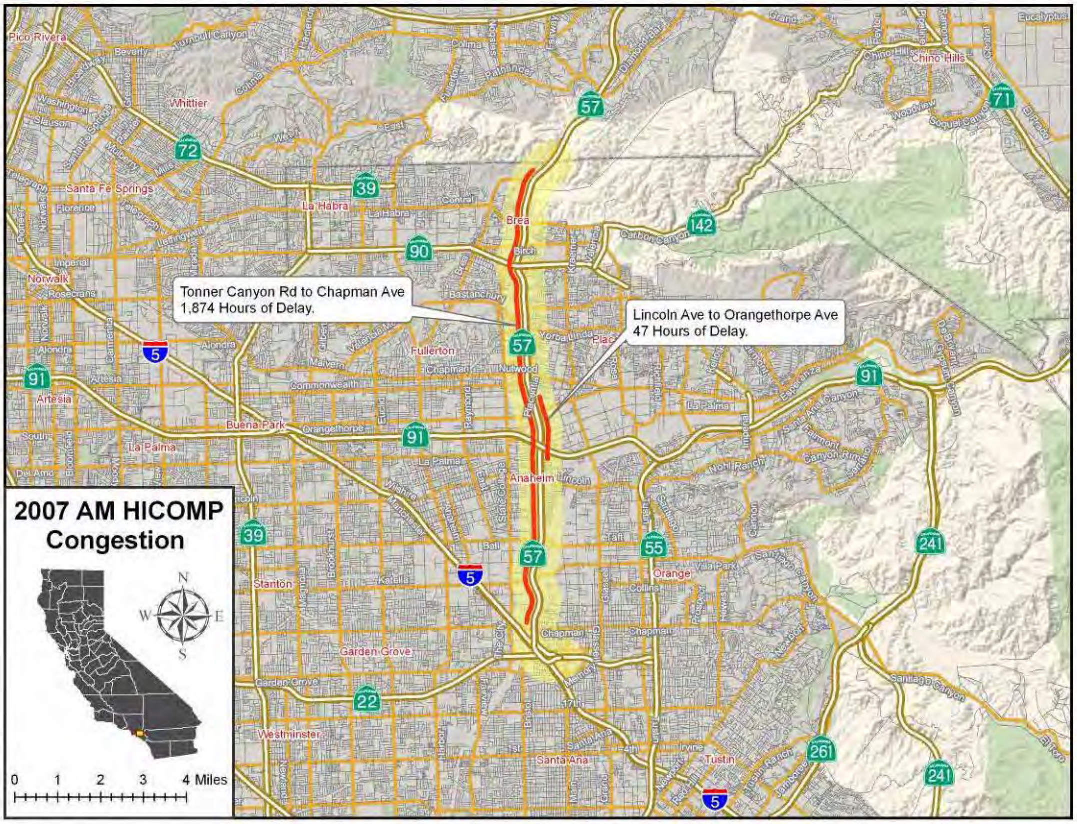
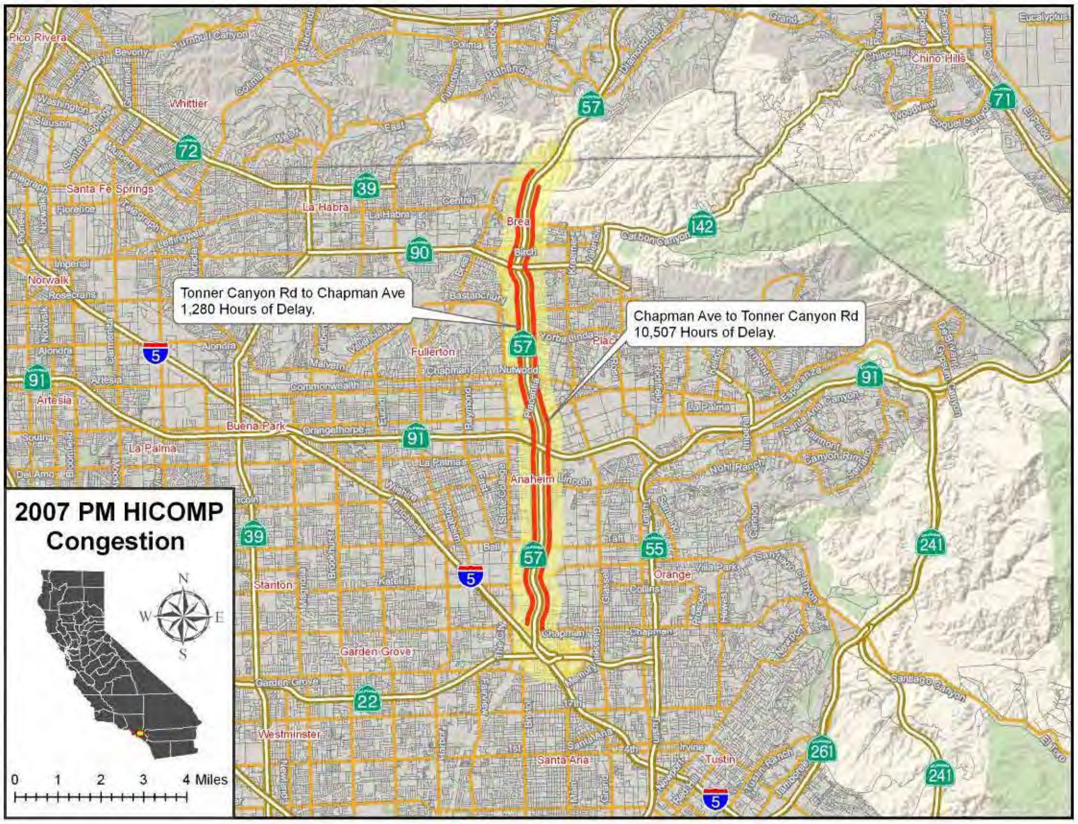


Exhibit 3-10: 2007 PM Peak Period HICOMP Congested Segments Map



Automatic Detector Data

Using freeway detector data in the previous section, delay is computed for every day and summarized in different ways, which is not possible when using probe vehicle data.

Performance assessments were conducted for the five-year period from 2005 to 2009. HICOMP only estimates delay when speeds drop below 35 mph, and it assumes a capacity volume of 2,000 vehicles per hour per lane.

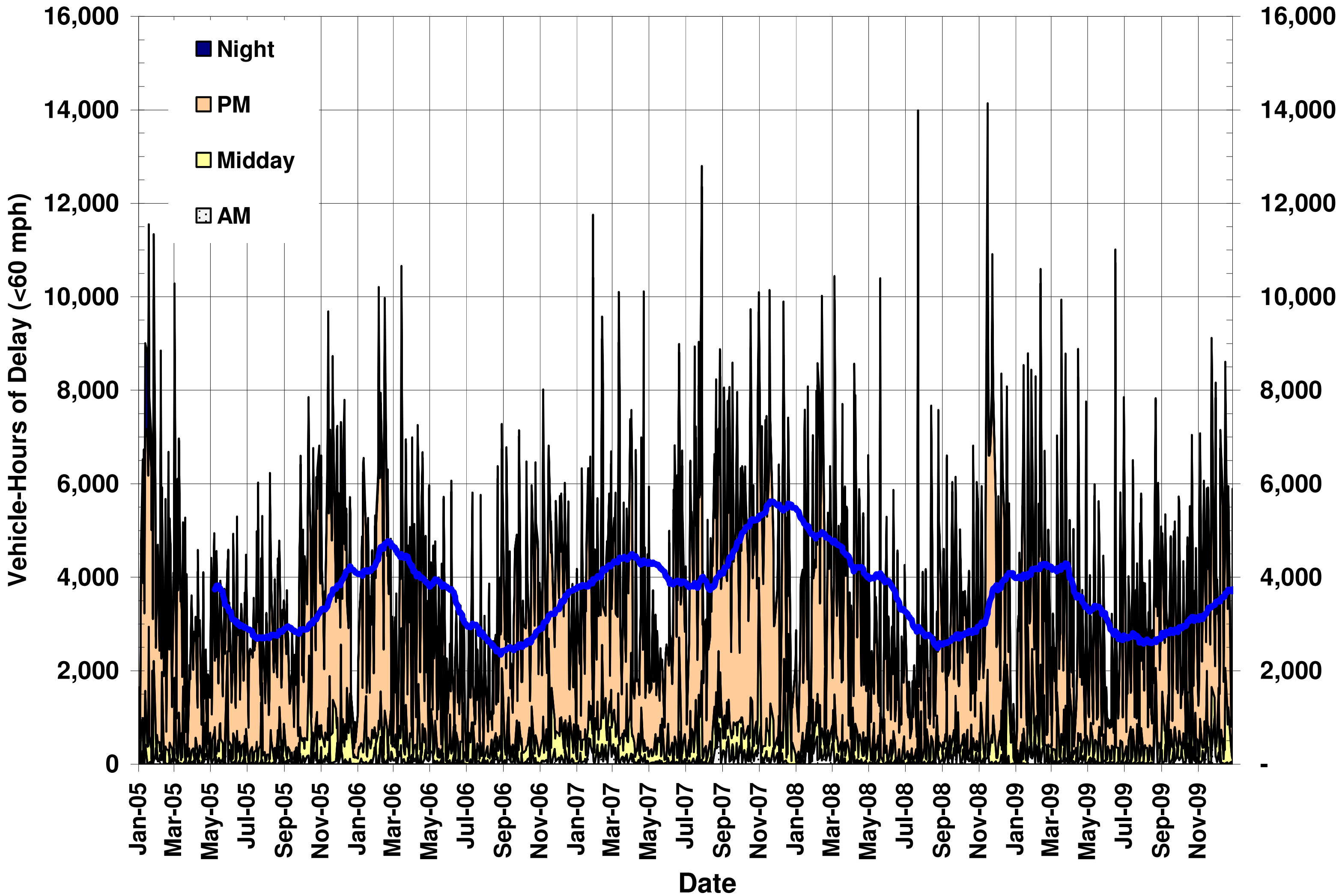
The automatically collected detector data presented here is based on the difference in travel time between reported conditions and the travel time at free-flow measured at 60 mph, applied to the actual output flow volume collected from a vehicle detector station. The total delay by period for SR-57 for each direction of the mainline and HOV facilities are shown in Exhibits 3-11 to 3-14.

Total delay along the study corridor was computed for four time periods: AM peak (6:00 AM to 9:00 AM), Midday (9:00 AM to 3:00 PM), PM peak (3:00 PM to 7:00 PM), and evening/early AM (7:00 PM to 6:00 AM).

Weekday delay for the mainline facility is presented in Exhibits 3-11 and 3-12 during the five-year period of 2005-2009. Within the exhibit, there is a 90-day moving average to smooth out the day-to-day variations and illustrate the seasonal and annual changes in congestion over time. Consistent with the HICOMP data, the highest daily congestion occurred during the PM peak period in the northbound direction (Exhibit 3-11). Total northbound delay fluctuated during this five-year period with the highest delay having occurred around December 2007. This was followed by a steep decline in delay from January to September 2008. This weekday delay trend further declined in 2009. The southbound direction is also consistent with the HICOMP data, which shows that the highest daily congestion occurred during the AM peak period (Exhibit 3-12). Similar to the northbound, delay in the southbound direction also fluctuated during the 2005-2009 period, but peaked around the last quarter of each year.

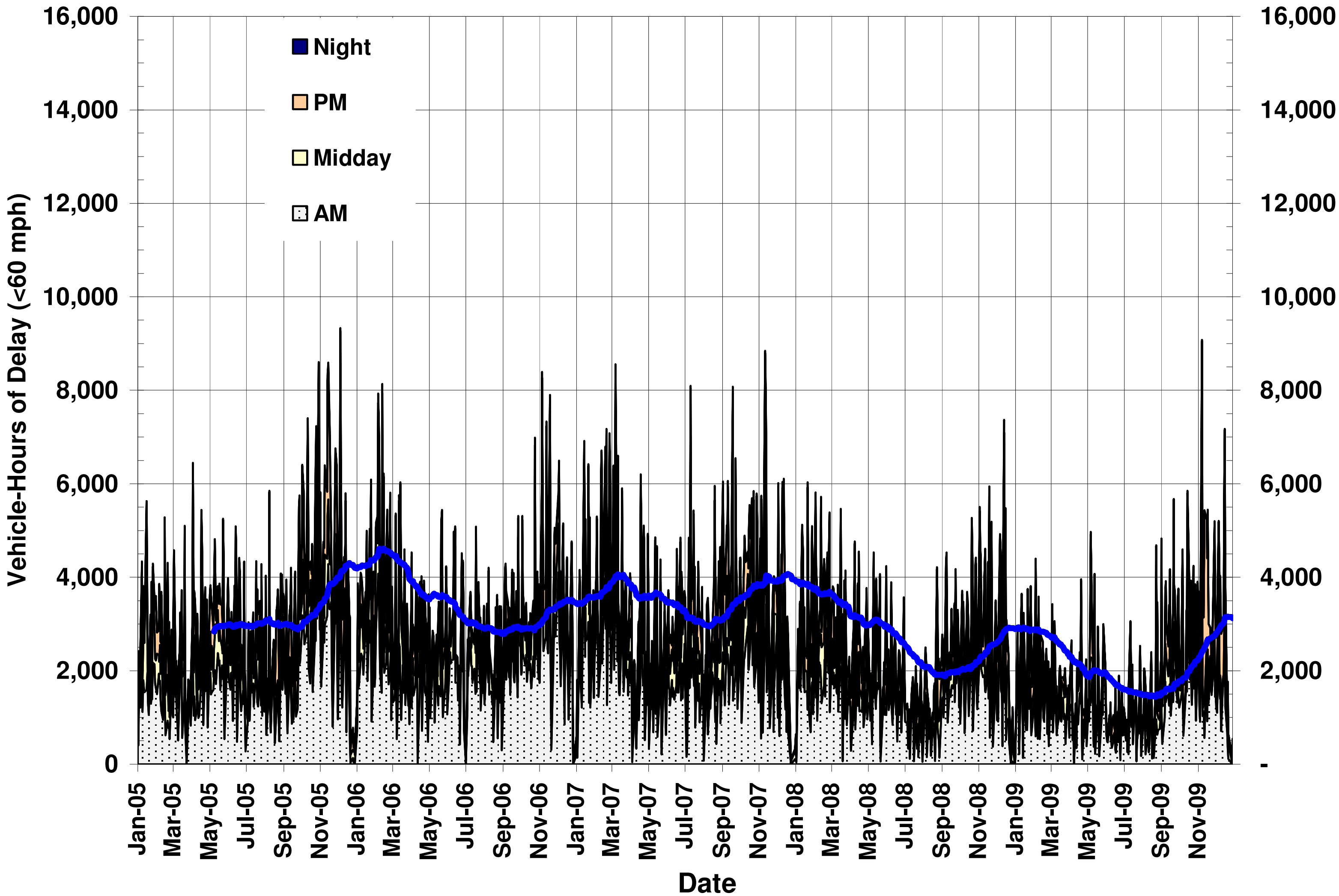
Exhibits 3-13 and 3-14 show that delay on the HOV facility followed the same pattern as the mainline facility with more congestion having occurred in the PM for the northbound direction and in the AM for the southbound direction. Similar to the mainline trend, the northbound HOV facility experienced significantly more delay than the southbound HOV.

Exhibit 3-11: Northbound SR-57 Mainline Average Daily Delay by Time Period (2005-2009)



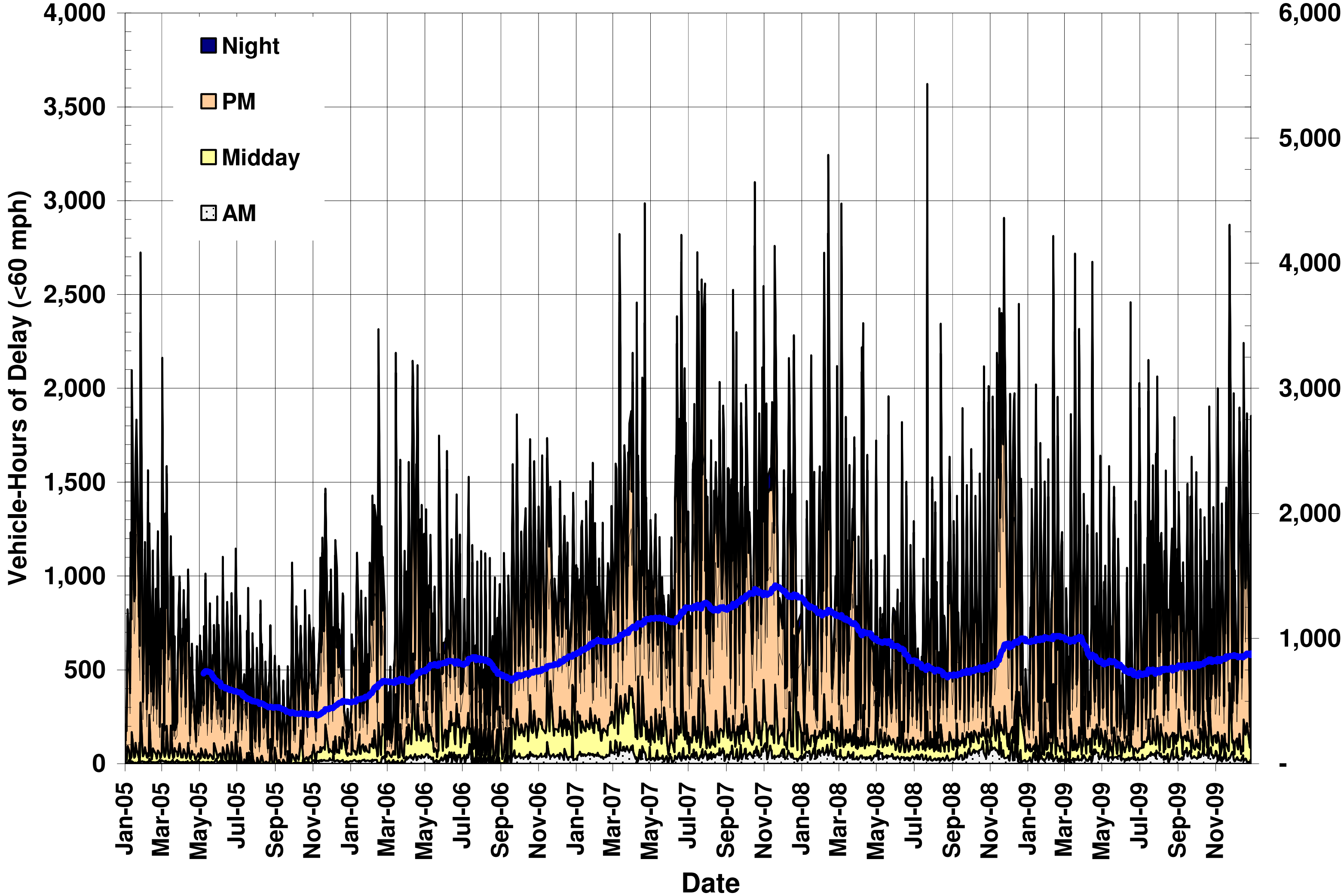
Source: Caltrans detector data

Exhibit 3-12: Southbound SR-57 Mainline Average Daily Delay by Time Period (2005-2009)



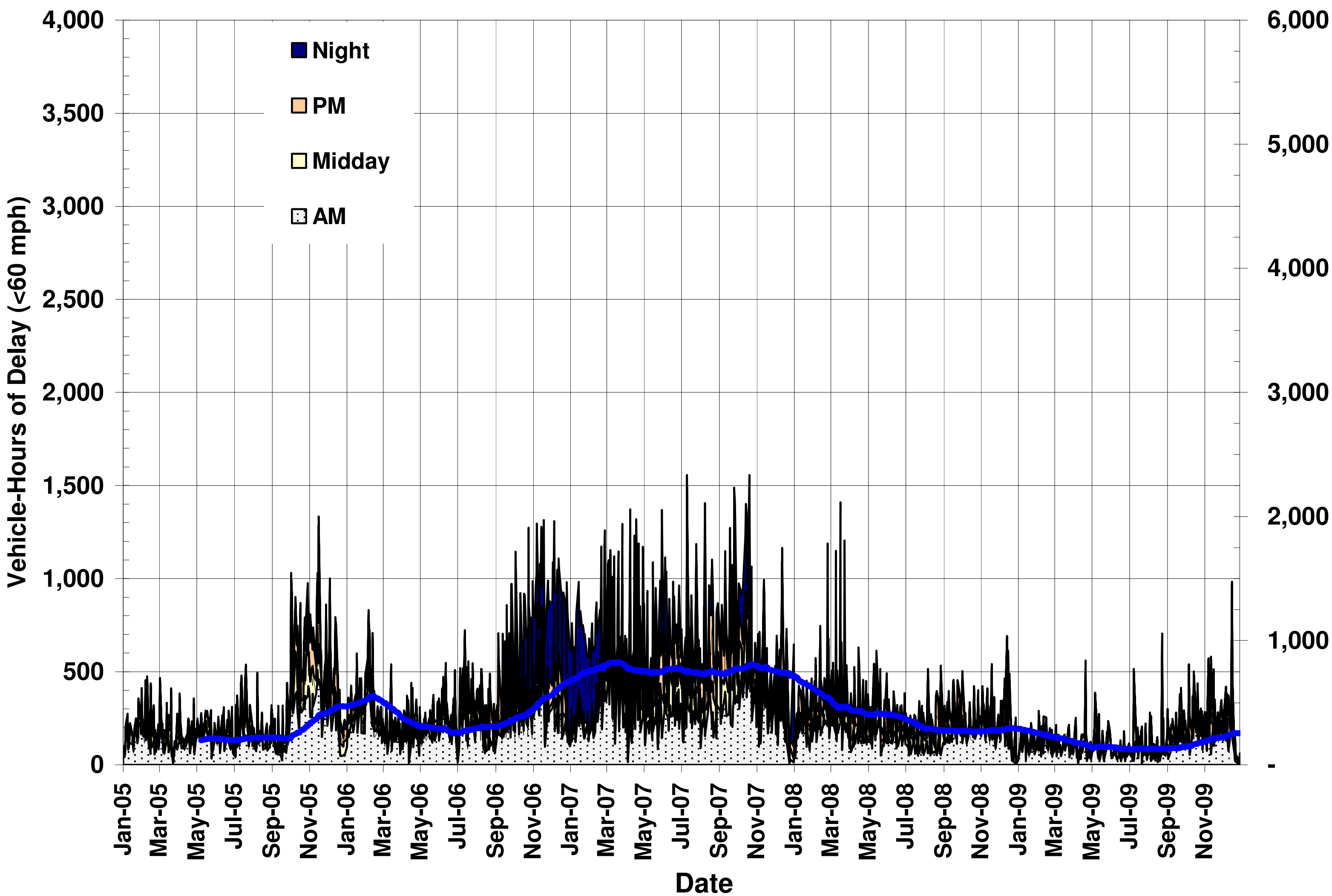
Source: Caltrans detector data

Exhibit 3-13: Northbound SR-57 HOV Average Daily Delay by Time Period (2005-2009)



Source: Caltrans detector data

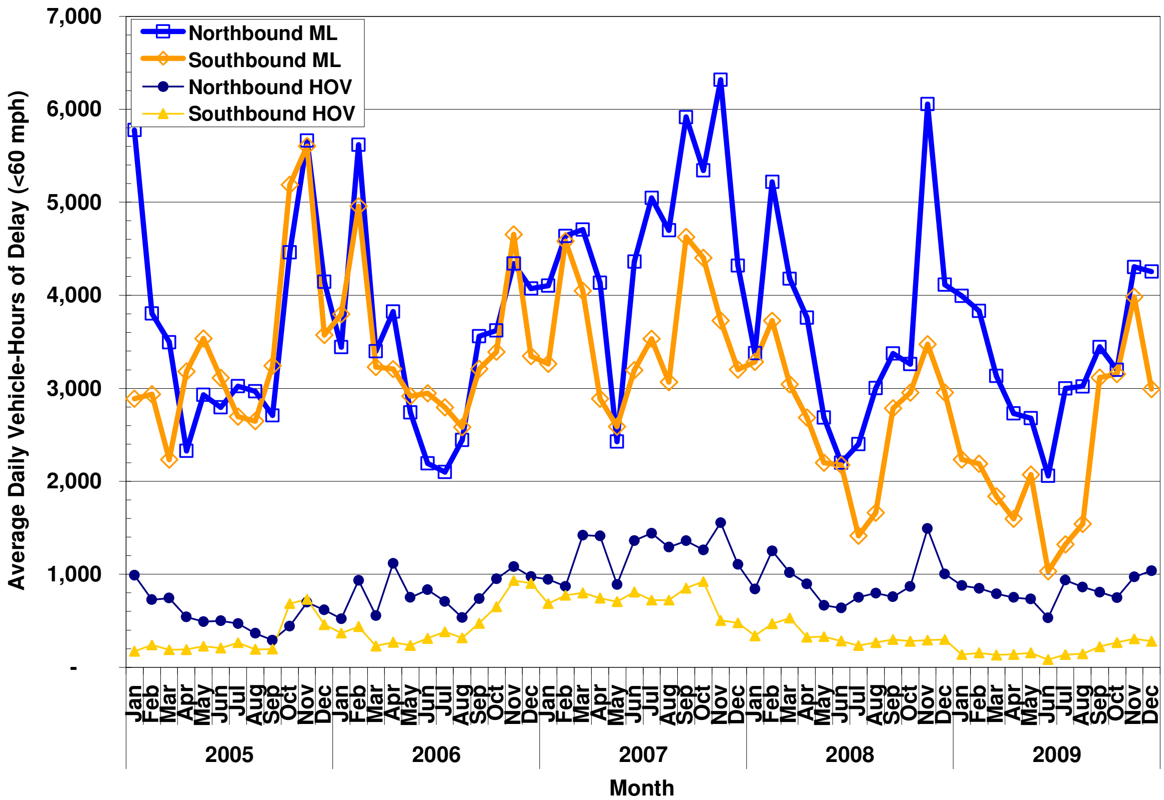
Exhibit 3-14: Southbound SR-57 HOV Average Daily Delay by Time Period (2005-2009)



Source: Caltrans detector data

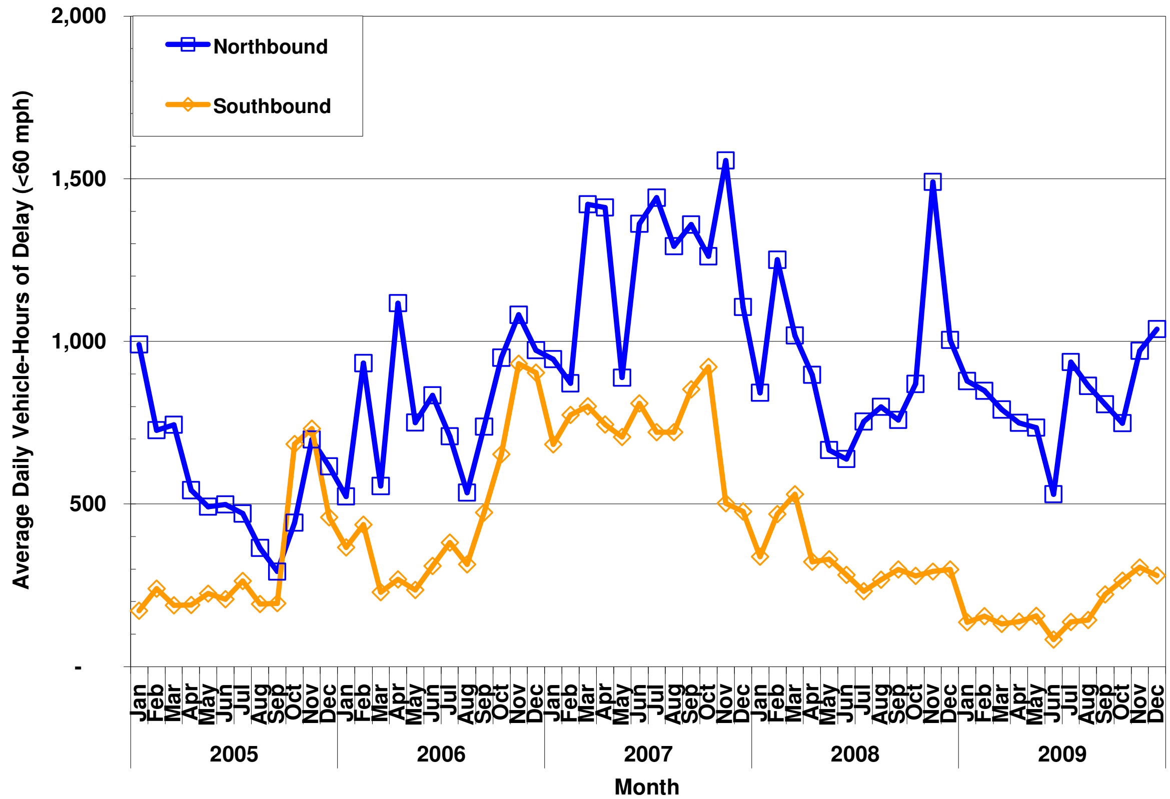
The average daily weekday delay by month for the mainline and HOV facilities are depicted in Exhibits 3-15 and 3-16. On the mainline facility, the average weekday delay ranged from approximately 2,000 to 6,000 vehicle-hours, in each direction. For the HOV facility, delay was significantly less, ranging from roughly 250 to 1,500 vehicle-hours (Exhibit 3-16). Overall, the northbound direction on both the mainline and HOV facilities experienced more congestion than the southbound during this five-year period. The northbound direction also experienced a wider variation in delays from month to month.

Exhibit 3-15: Mainline Average Weekday Delay by Month (2005-2009)



Source: Caltrans detector data

Exhibit 3-16: HOV Average Weekday Delay by Month (2005-2009)



Source: Caltrans detector data

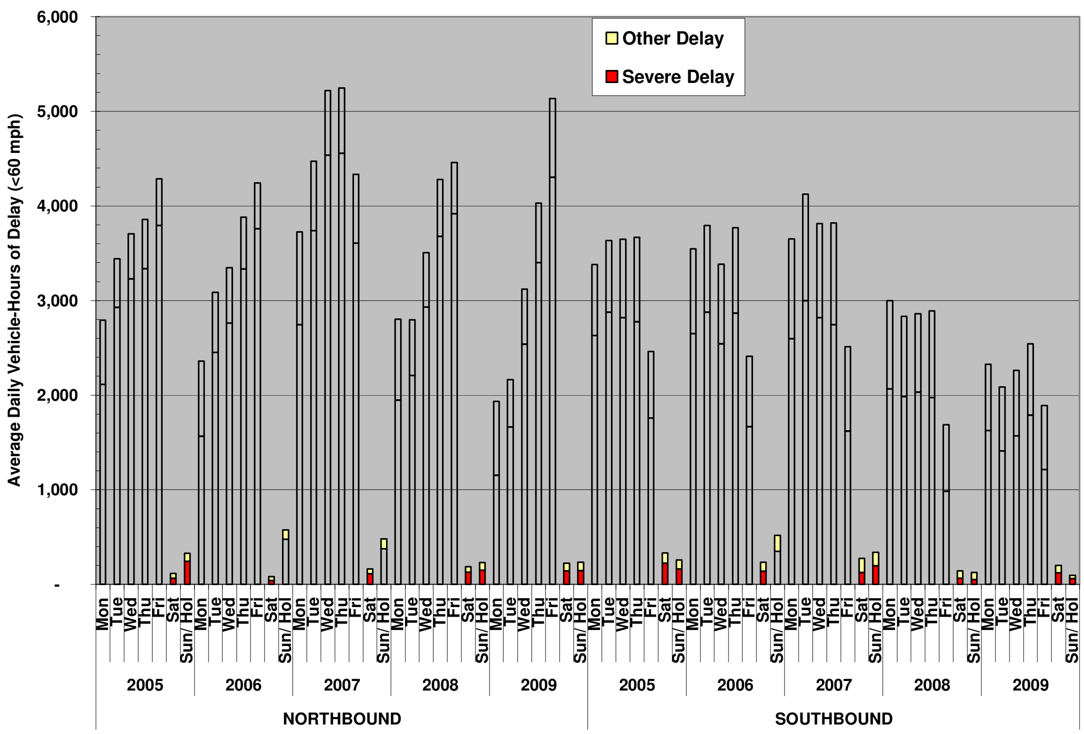
Delays presented to this point represent the difference in travel time between "actual" conditions and free flow conditions at 60 mph. This delay can be segmented into two components as shown in Exhibits 3-17 and 3-18:

- Severe delay – delay that occurs when speeds are below 35 mph; and
- Other delay – delay that occurs when speeds are between 35 mph and 60 mph

In Exhibits 3-17 and 3-18, severe delay represents breakdown conditions and is generally the focus of congestion mitigation strategies. "Other" delay represents conditions approaching the breakdown congestion, leaving the breakdown conditions, or areas that do not cause widespread breakdowns, but cause at least temporary slowdowns. 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.

As indicated in Exhibit 3-17, on the mainline lanes, severe delay makes up almost 90 percent of all weekday delay on the corridor in the northbound direction, and more than 70 percent in the southbound direction. This reflects the extreme congestion that faces corridor travelers during peak periods. In the northbound direction, the highest severe congestion generally occurred on Fridays, exceeding 4,000 vehicle hours of delay in 2007 and 2009. In the southbound direction, severe congestion occurred more or less evenly for Tuesdays through Fridays, ranging from a high of 3,000 vehicle hours of delay in 2007 to below 2,000 vehicle hours of delay in 2009. Peak Friday congestion in the northbound direction reached similar levels as in 2007, however, congestion in the southbound direction remains well below 2007 levels/

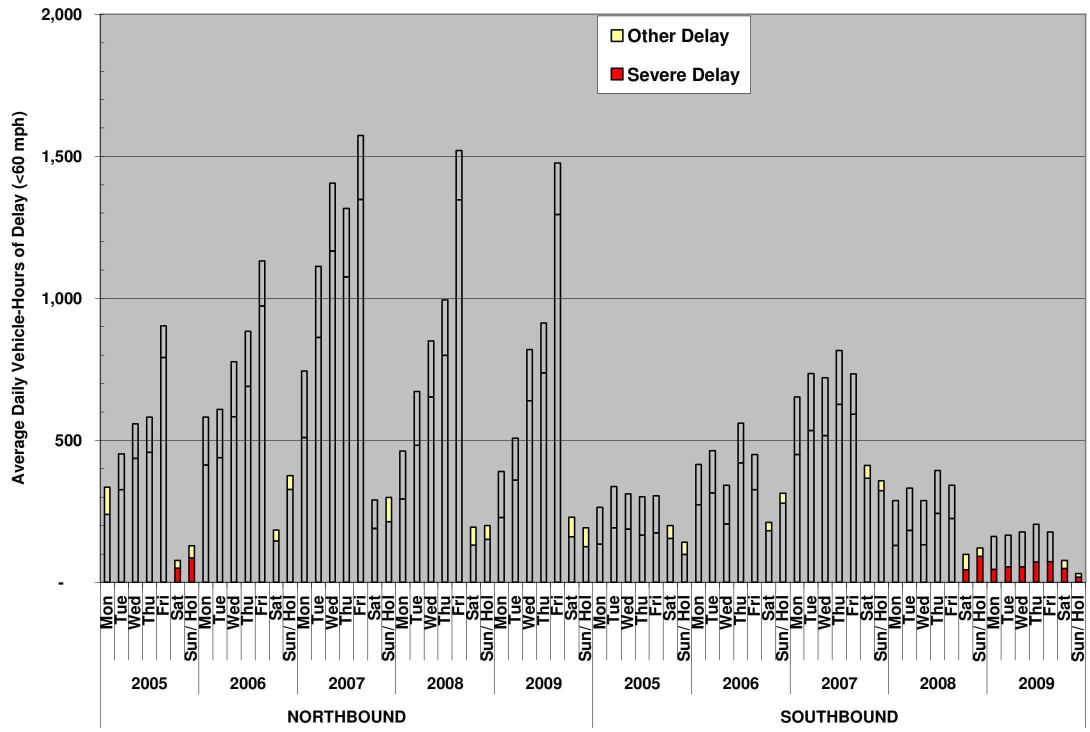
Exhibit 3-17: Mainline Average Delay by Day of Week by Severity (2005-2009)



Source: Caltrans detector data

On the HOV facility (Exhibit 3-18), "severe" delay was highest on Fridays in the northbound direction and Thursdays in the southbound direction. In 2007, the northbound HOV facility experienced about 1,300 vehicle-hours of "severe" delay on Fridays, and the southbound HOV facility experienced about 240 vehicle-hours of "severe" delay on Thursdays. HOV delays tend to average approximately 25 percent of the total delay for the northbound direction and approximately 15 percent of delay for the southbound direction.

Exhibit 3-18: HOV Average Delay by Day of Week by Severity (2005-2009)



Source: Caltrans detector data

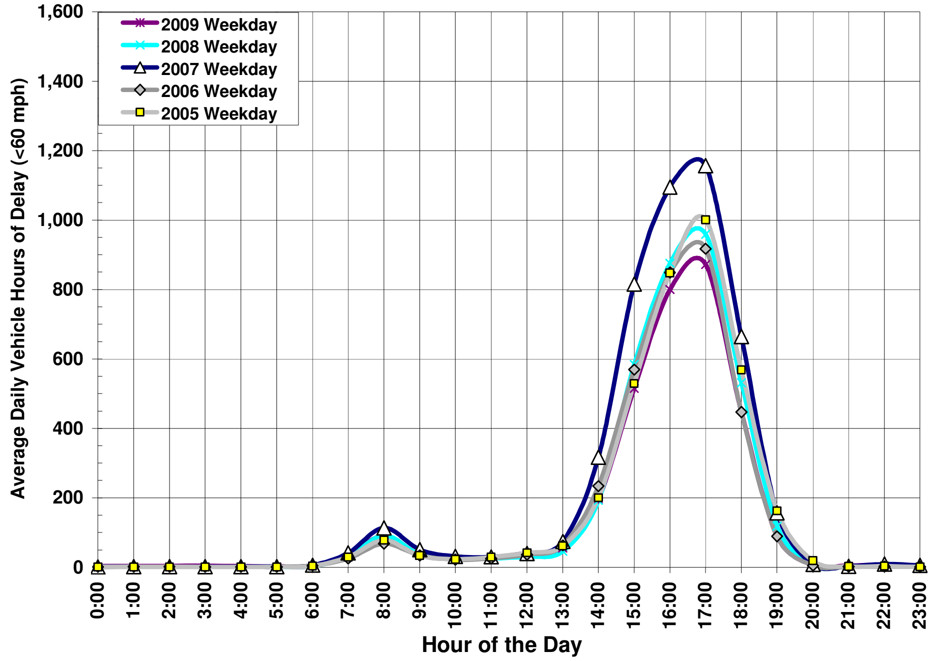
Another way to understand the characteristics of congestion and related delays is shown in Exhibits 3-19 and 3-20, which summarize average weekday hourly delays for the mainline, and Exhibits 3-21 and 3-22, which summarize average weekday hourly delay for HOV facility.

The exhibits highlight several trends on the mainline facility:

- Northbound delay peaked in 2007, almost reaching 1,200 hours between 5:00 PM and 6:00 PM. During 2007, congestion started at 2:00 PM and lasted to 7:00 PM. By 2009, peak hour delay was around 900 hours (a 25 percent decrease from 2007) but started and ended about the same time. In other words, the intensity of congestion decreased, but its duration remained more or less constant. Northbound peak hour delays were the lowest in 2009 for the five years analyzed.

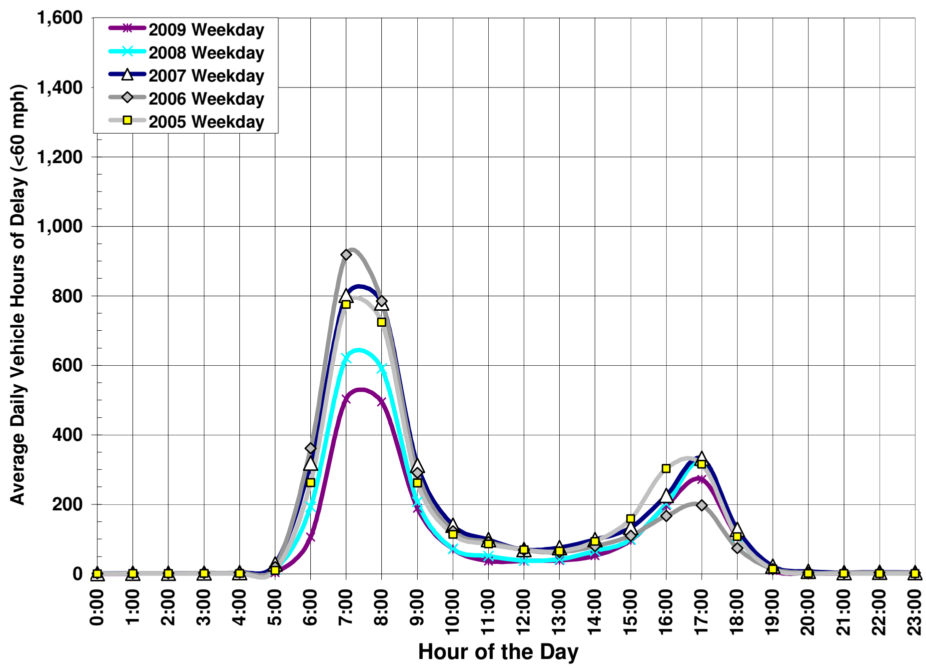
- Southbound delay peaked in 2006 at around 900 hours between 7:00 AM and 8:00 AM. During 2006, congested started at 6:00 AM and lasted until 9:00 AM. By 2009, peak delay was around 500 hours (more than a 40 percent decrease from 2007). Congestion duration decreased slightly. Again, southbound 2009 peak delays were the lowest in 2009 for the five years analyzed.

Exhibit 3-19: Northbound Mainline Average Weekday Hourly Delay (2005-2009)



Source: Caltrans detector data

Exhibit 3-20: Southbound Mainline Average Weekday Hourly Delay (2005-2009)

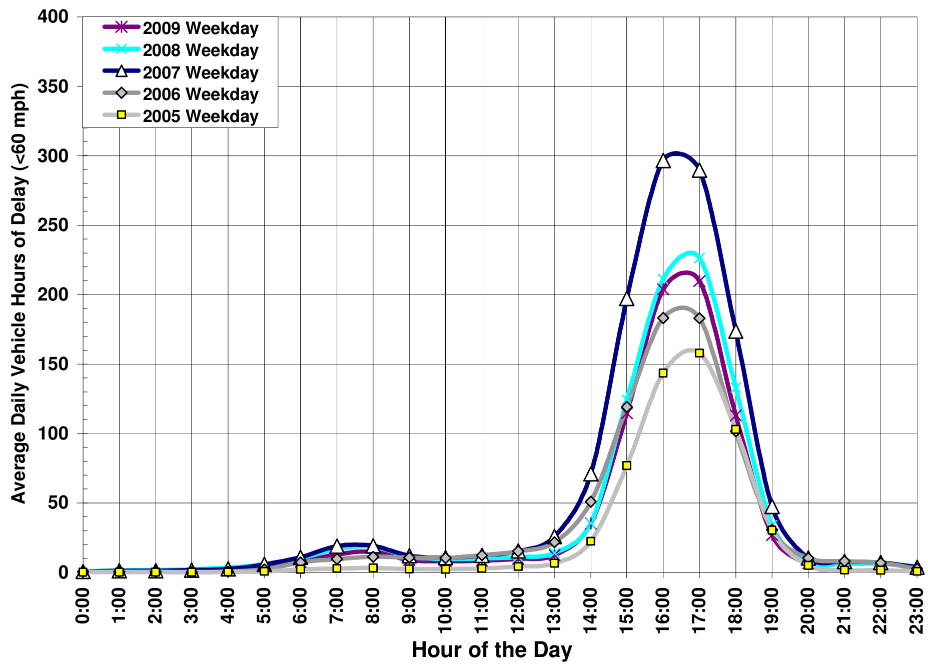


Source: Caltrans detector data

The following trends can be observed on the HOV facility (Exhibits 3-21 and 3-22):

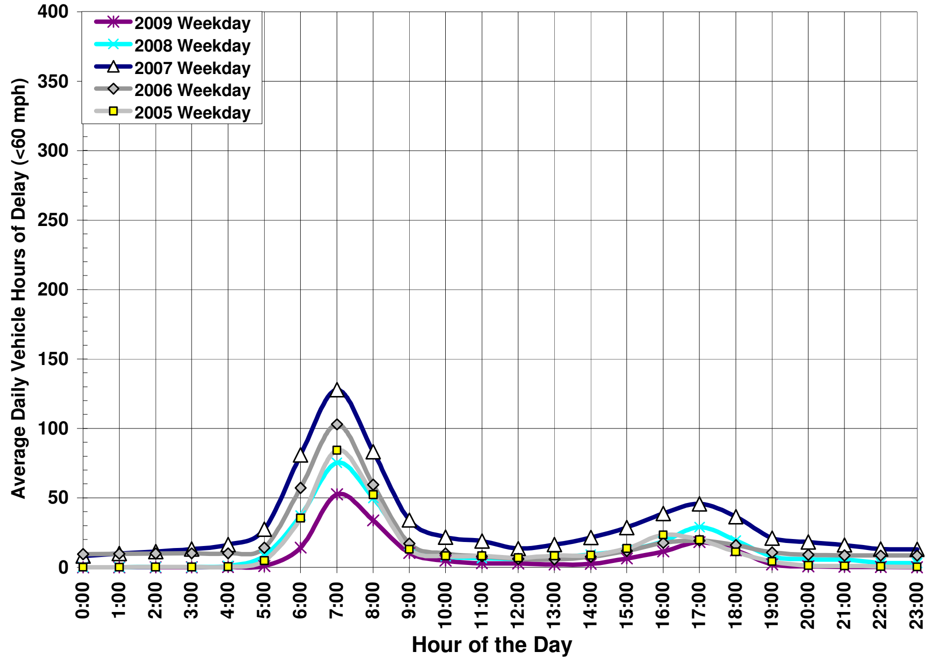
- Similar to the mainline trends, delay was highest in the northbound direction during the PM peak period, spanning from 3:00 PM to 6:00 PM.
- Delay was greatest in 2007 for both the northbound and southbound direction. It dropped significantly during the AM peak period in 2009 from 2007 conditions.
- The AM peak hour in the southbound direction is 7:00 AM.
- The PM peak hour in the northbound direction is at 5:00 PM.

Exhibit 3-21: Northbound HOV Average Weekday Hourly Delay (2005-2009)



Source: Caltrans detector data

Exhibit 3-22: Southbound HOV Average Weekday Hourly Delay (2005-2009)



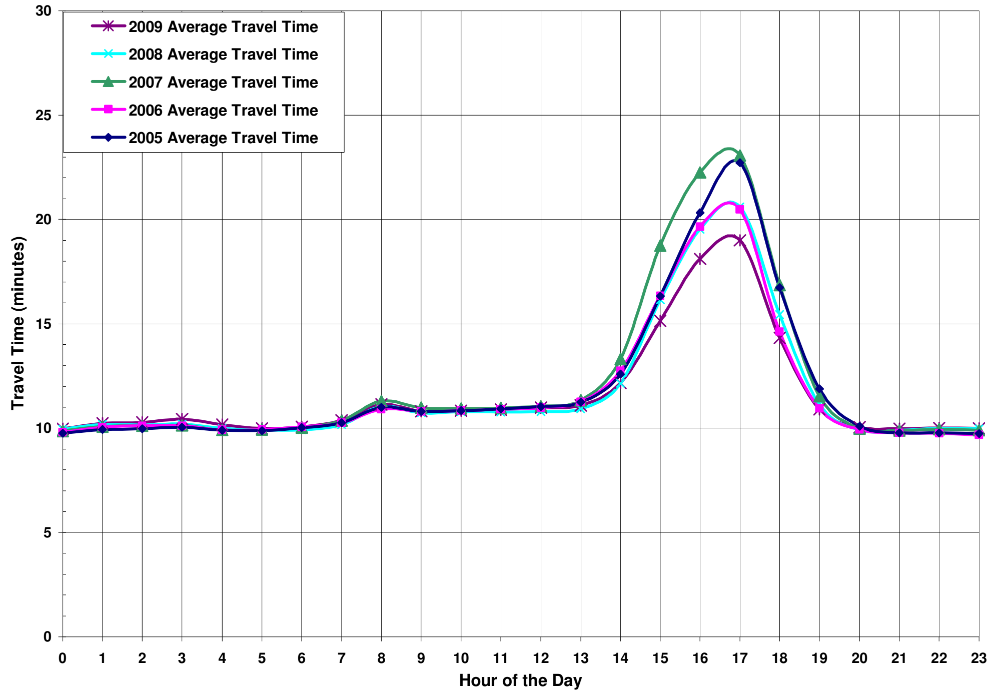
Source: Caltrans detector data

Travel Time

Travel time is reported as the amount of time it takes for a vehicle to travel between the I-5/SR-22 Interchange to the Orange/Los Angeles County line and vice versa (approximately 12 miles). Caltrans detection data was used to compute and analyze travel times.

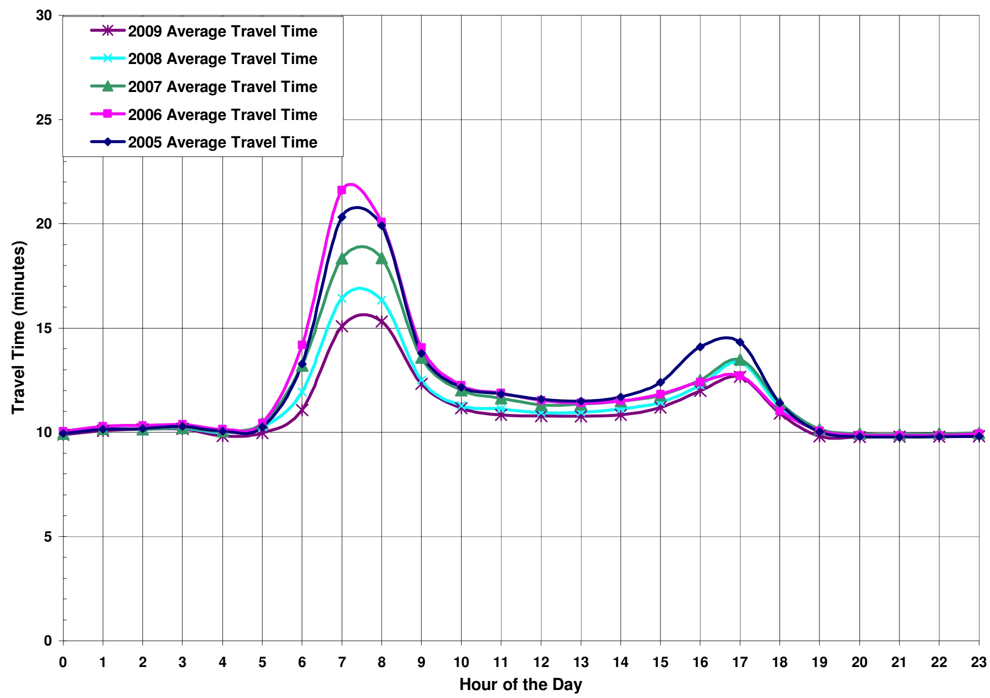
Exhibits 3-23 through 3-26 summarize the travel times estimated for the mainline and HOV facilities. As shown in Exhibits 3-23 and 3-24, travel along the mainline takes about 10 minutes in the off-peak periods. This corresponds to a speed of just over 60 mph. During the peak period in 2007, travel times were roughly double the free-flow travel times. The northbound mainline had an average travel time of approximately 22 minutes during the PM peak hour (5:00-6:00 PM) while the southbound mainline had an average travel time of approximately 19 minutes during the AM peak hour (6:30-7:30 AM). By 2009, peak hour travel times had diminished to 18 and 16 minutes for the northbound and southbound directions respectively. Once again, these statistics indicate the directionality of travel along the corridor – southbound in the morning and northbound in the afternoon.

Exhibit 3-23: Northbound Mainline Time by Time of Day (2005-2009)



Source: Caltrans detector data

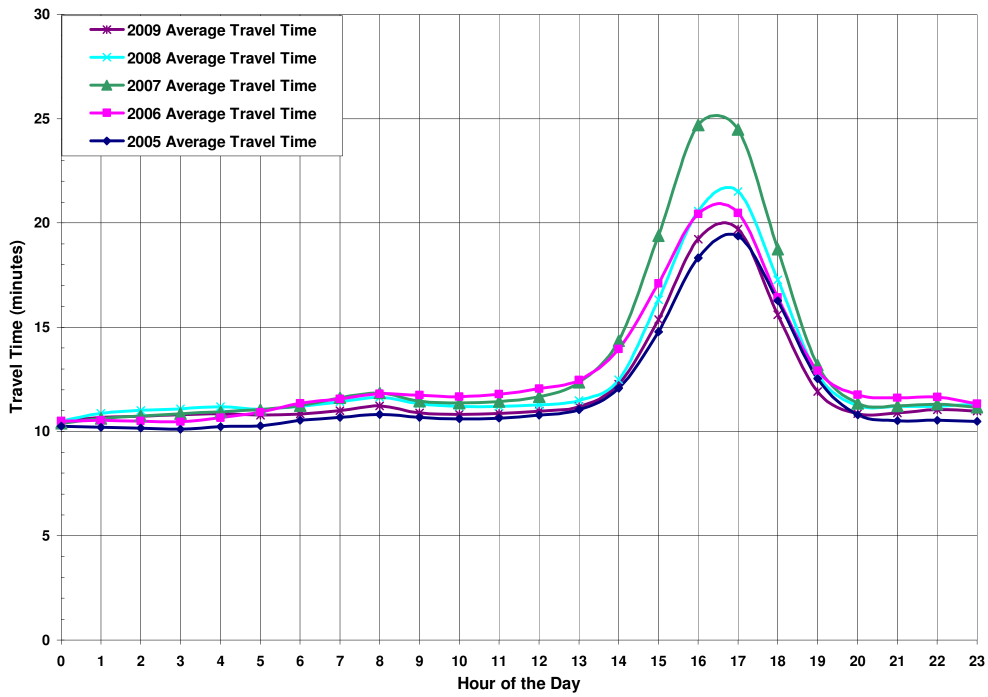
Exhibit 3-24: Southbound Mainline Travel Time by Time of Day (2005-2009)



Source: Caltrans detector data

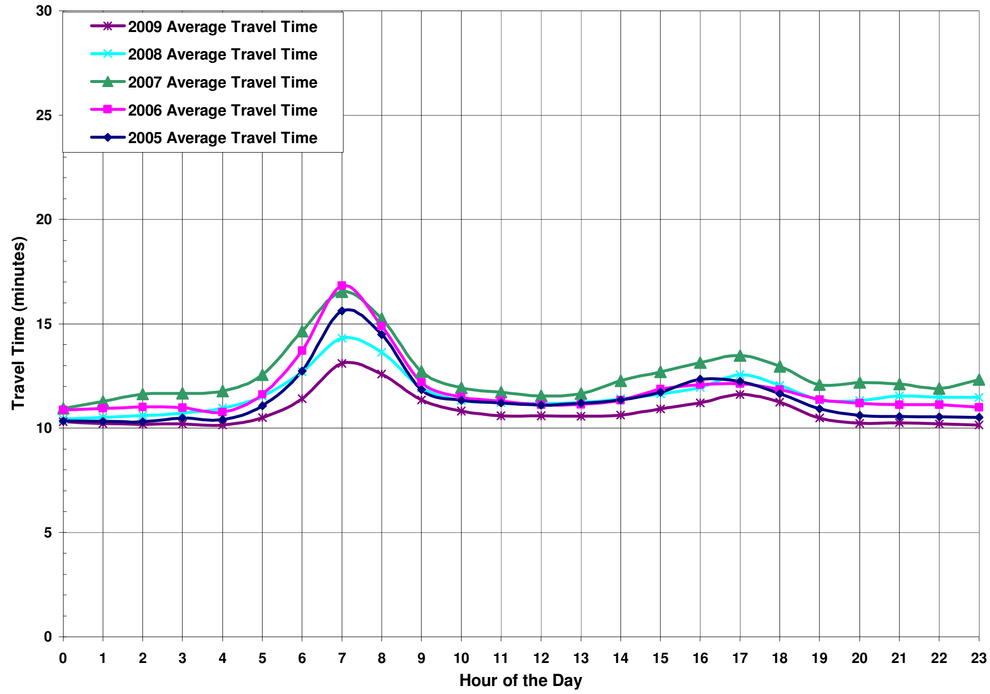
Exhibits 3-25 and 3-26 illustrate travel times on the HOV facility. These exhibits show a similar pattern of travel time compared to the mainline, with greater travel times in the northbound direction compared to the southbound. A notable difference between the mainline and the HOV facilities is that travel time on the HOV facility is less than the mainline in the southbound direction. In 2009, it took about 17 minutes to travel the southbound mainline compared to only 13 minutes on the southbound HOV facility at 7:00 AM.

Exhibit 3-25: Northbound HOVL Travel Time by Time of Day (2005-2009)



Source: Caltrans detector data

Exhibit 3-26: Southbound HOVL Travel Time by Time of Day (2005-2009)



Source: Caltrans detector data

Reliability

Reliability captures the relative predictability of the public's travel time. Unlike mobility, which measures average delays and travel times, the reliability measure focuses on how travel time varies from day to day.

To measure reliability, the study team used the "buffer index" metric, which reflects the additional time required (over and beyond the average) to ensure an on-time arrival 95 percent of the time (all but one day a month).

Exhibits 3-27 to 3-46 illustrate the variability of travel time along the SR-57 Corridor on weekdays for the years 2005 through 2009. Exhibits 3-27 through 3-36 present travel time variability for the mainline in the northbound direction followed by the southbound. Similarly, Exhibits 3-37 through 3-46 show travel time variability for the HOV facility beginning with the northbound and followed by the southbound direction.

For the mainline facility, the 5:00 PM peak hour was the most unpredictable, in addition to being the slowest hour in the northbound direction. In 2005 (shown in Exhibit 3-27), motorists driving the entire length of the corridor had to add 17 minutes to an average travel time of 23 minutes (for a total travel time of 40 minutes) to ensure that they arrived on time 95 percent of the time. This is 28 minutes longer than the 12-minute travel time at 60 mph. In 2006 (Exhibit 3-28), the time needed to arrive on time 95 percent of the time decreased to 34 minutes, but hovered at slightly above 35 minutes during the following two years (Exhibits 3-29 and 3-30). In 2009 (Exhibit 3-31), the total travel time decreased to 33 minutes. The variability in travel time during the northbound PM peak period is greater than the corresponding southbound AM peak period. This is consistent with the greater congestion and delay experienced in the northbound direction.

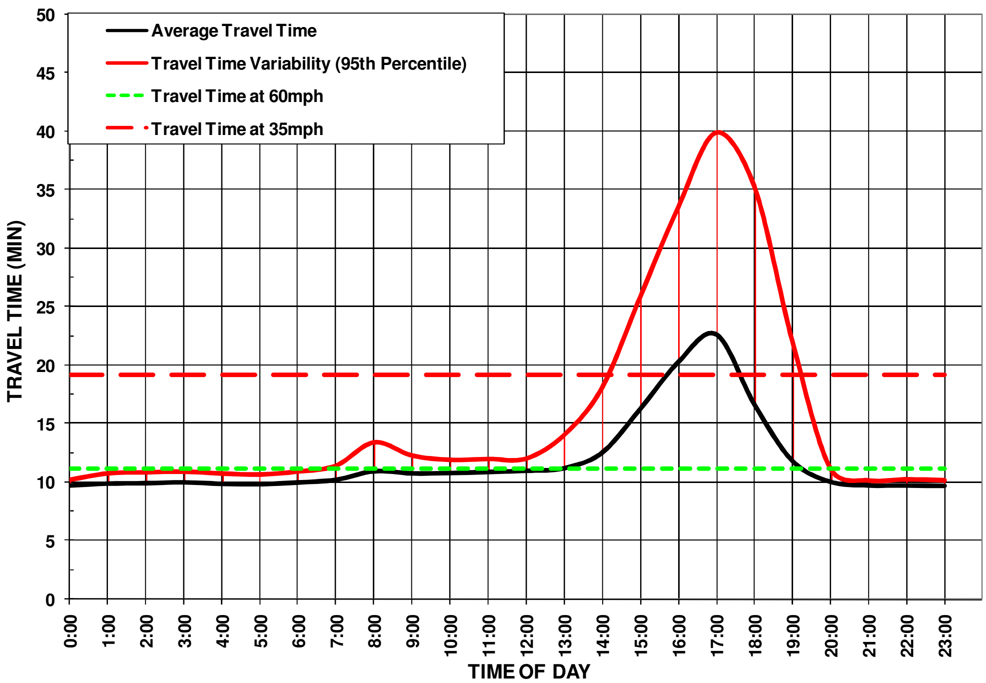
For the southbound direction, the 7:30 AM peak hour was the most unpredictable and slowest hour. As shown in Exhibit 3-32, motorists driving the entire length of the corridor in 2005 had to add nine minutes to an average travel time of 21 minutes (for a total travel time of 30 minutes) to ensure that they arrived on time 95 percent of the time. In 2006 (Exhibit 3-33), the time needed to arrive on time 95 percent of the time increased to 32 minutes but decreased to 28 minutes in 2007 and 2008 (Exhibits 3-34 and 3-35), and further decreased to 21 minutes in 2009 (Exhibit 3-36).

For the northbound HOV during the 5:00 PM peak hour (Exhibit 3-37), a driver needs to add 11 minutes to an average travel time of 23 minutes to ensure an on-time arrival 95 percent of the weekdays in 2005. This corresponds to a total travel time of 34 minutes. In 2006 (Exhibit 3-38), the time needed to arrive on time 95 percent of the time was also 34 minutes, but increased to almost 40 minutes in 2007 (Exhibit 3-39), and declined to 39 minutes in 2008 (Exhibit 3-40) and 35 minutes in 2009 (Exhibit 3-41).

For the southbound HOV, the AM peak hour at 7:30 AM was the most unpredictable and slowest hour. As shown in Exhibit 3-42, motorists must add six more minutes to an average travel time of 21 minutes to ensure an on-time arrival 95 percent of the time in 2005. In 2006 (Exhibit 3-43), the time needed to arrive on time 95 percent of the time increased to 28 minutes. However, it decreased therefore to 24 minutes for 2007 (Exhibit 3-44), 20 minutes in 2008 (Exhibit 3-45), and 16 minutes in 2009 (Exhibit 3-46).

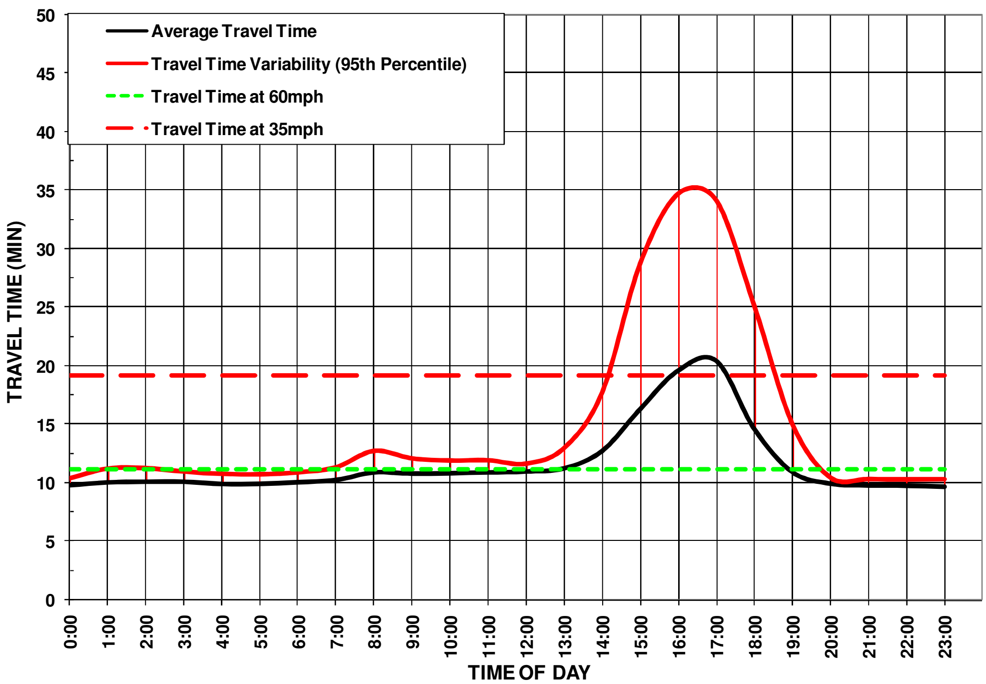
It is important to keep track of the reliability statistic, in part to evaluate incident management improvement strategies, and in part to gauge the effectiveness of safety projects delivered.

Exhibit 3-27: Northbound Mainline Travel Time Variability (2005)



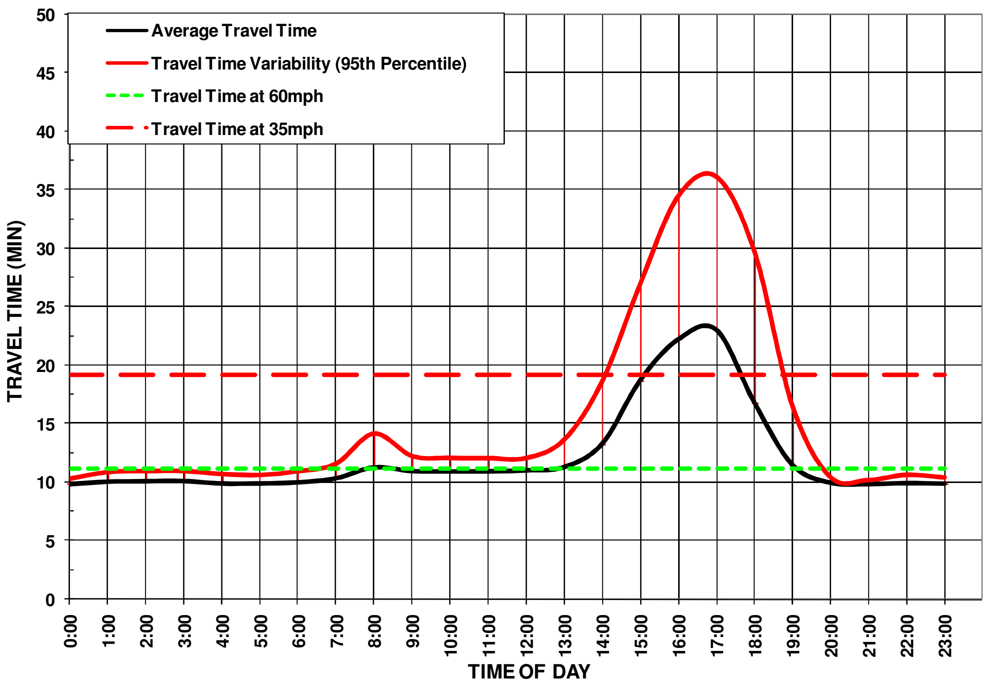
Source: Caltrans detector data

Exhibit 3-28: Northbound Mainline Travel Time Variability (2006)



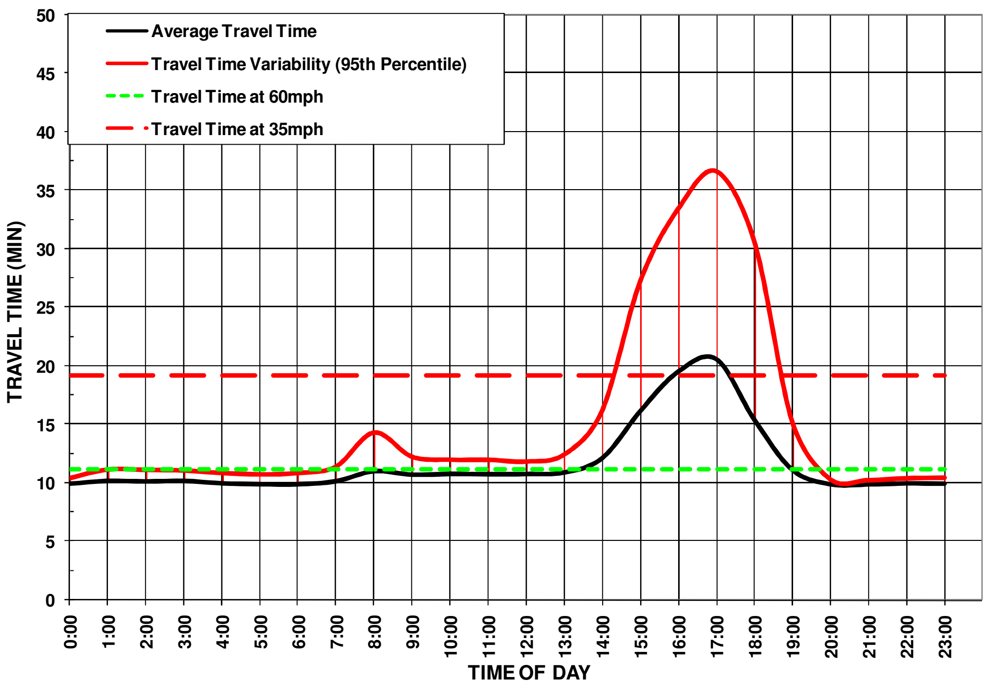
Source: Caltrans detector data

Exhibit 3-29: Northbound Mainline Travel Time Variability (2007)



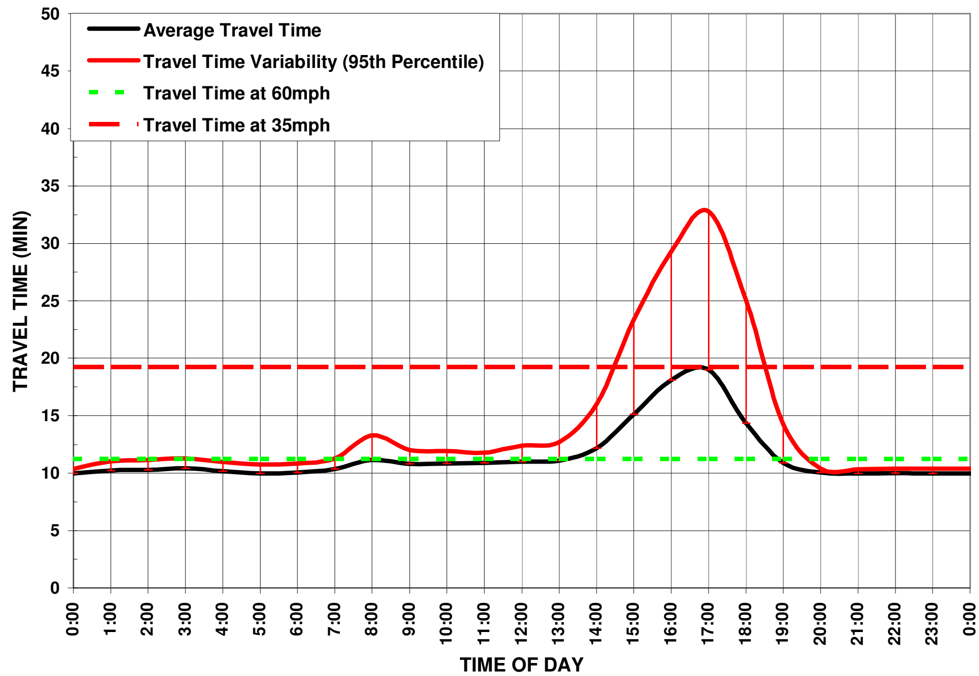
Source: Caltrans detector data

Exhibit 3-30: Northbound Mainline Travel Time Variability (2008)



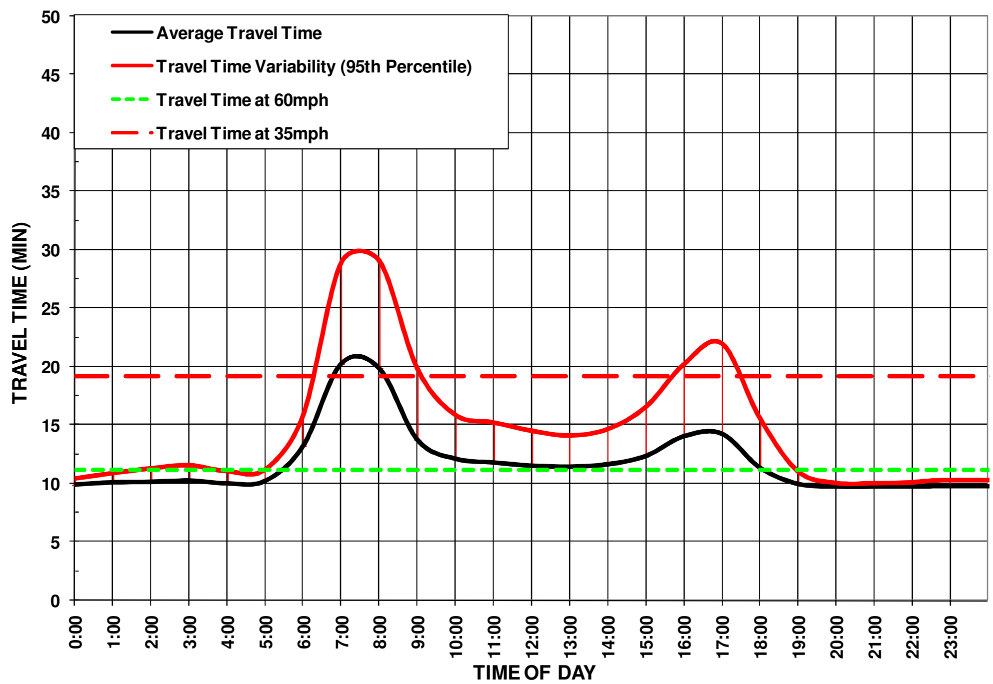
Source: Caltrans detector data

Exhibit 3-31: Northbound Mainline Travel Time Variability (2009)



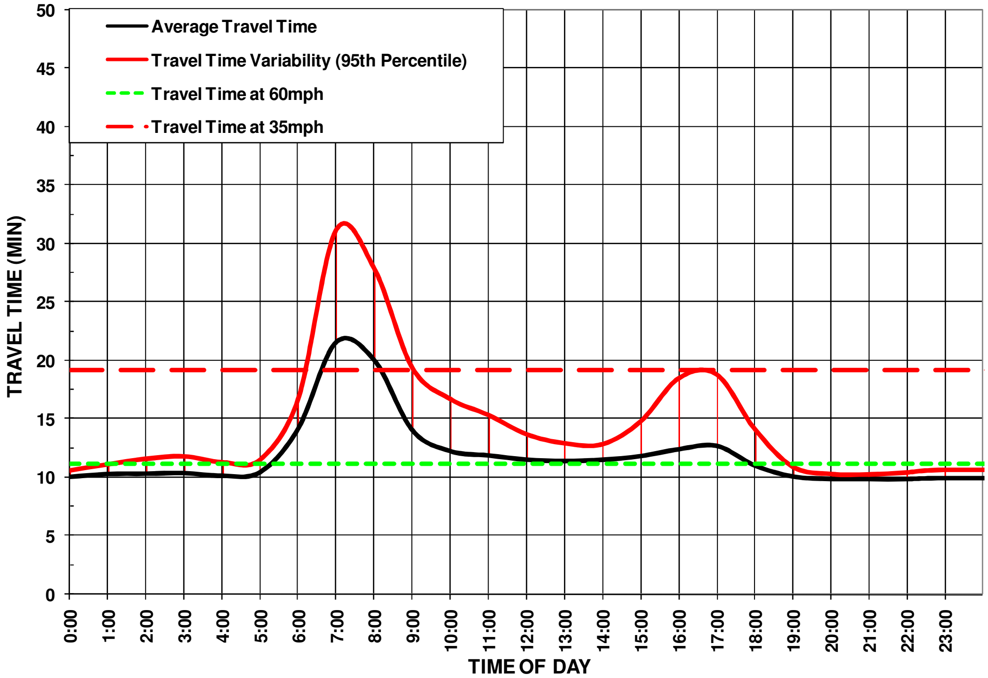
Source: Caltrans detector data

Exhibit 3-32: Southbound Mainline Travel Time Variability (2005)



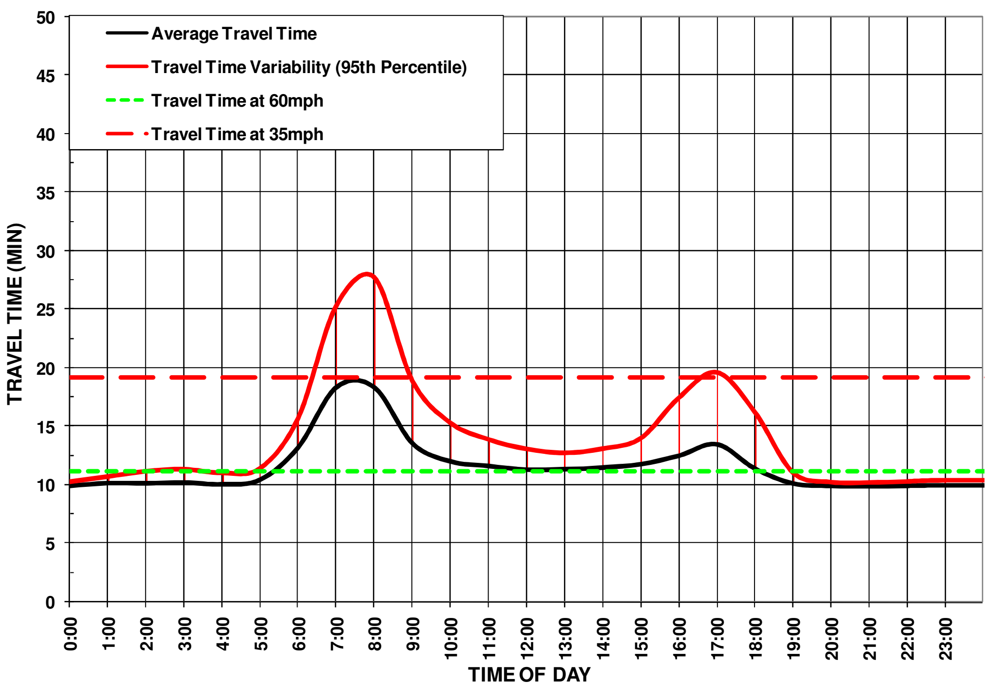
Source: Caltrans detector data

Exhibit 3-33: Southbound Mainline Travel Time Variability (2006)



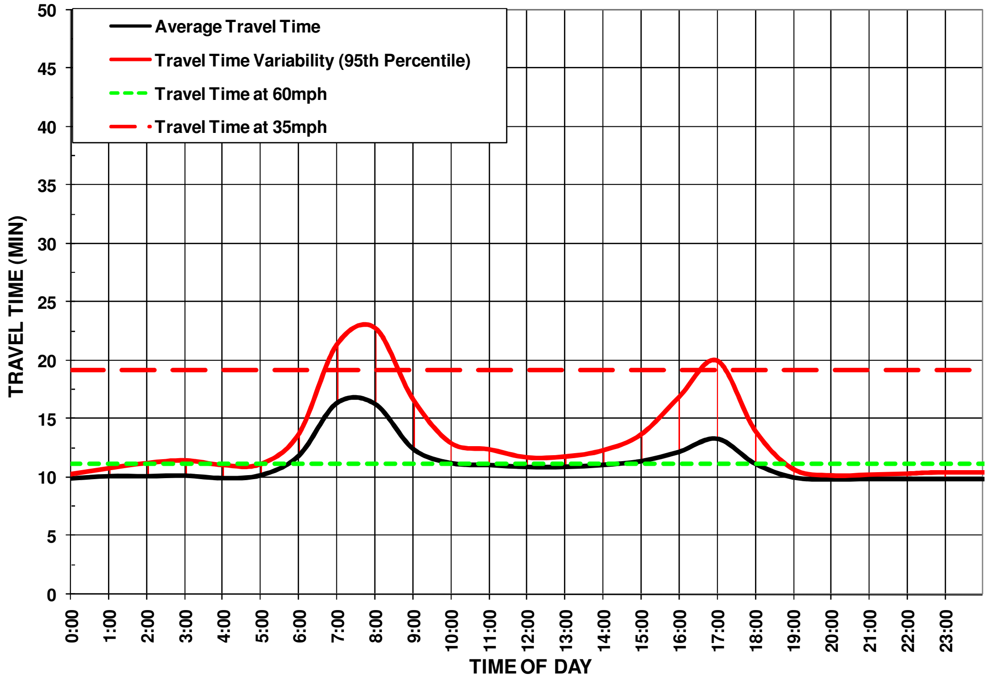
Source: Caltrans detector data

Exhibit 3-34: Southbound Mainline Travel Time Variability (2007)



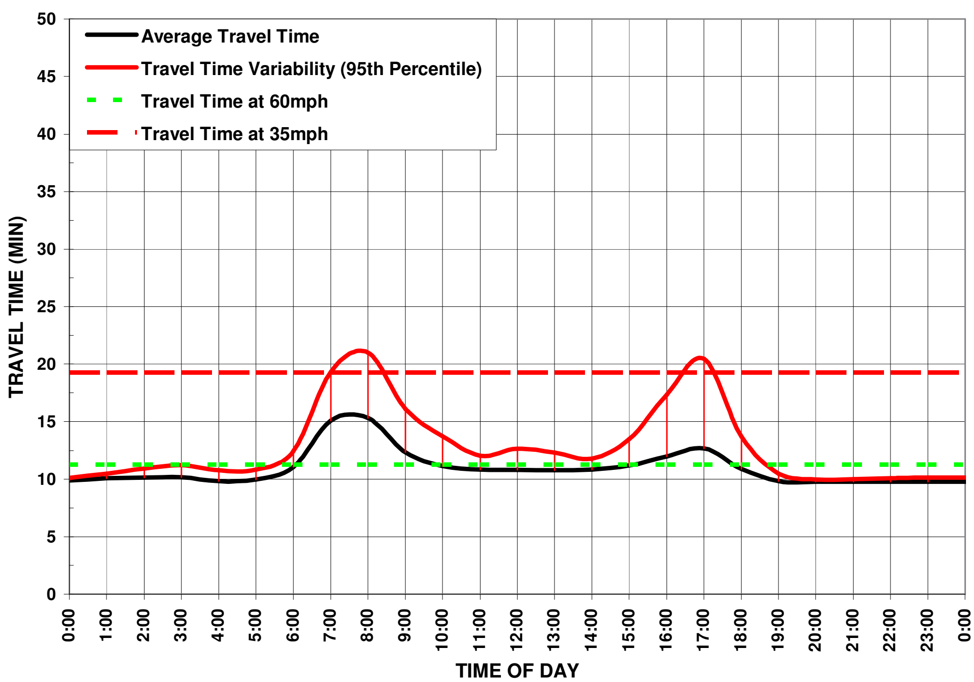
Source: Caltrans detector data

Exhibit 3-35: Southbound Mainline Travel Time Variability (2008)



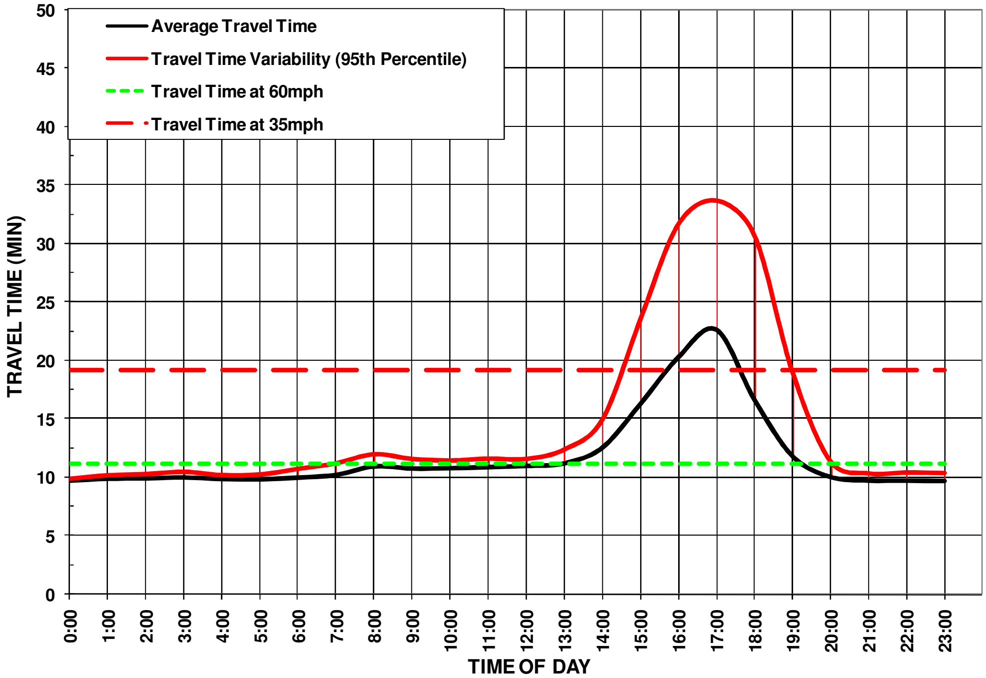
Source: Caltrans detector data

Exhibit 3-36: Southbound Mainline Travel Time Variability (2009)



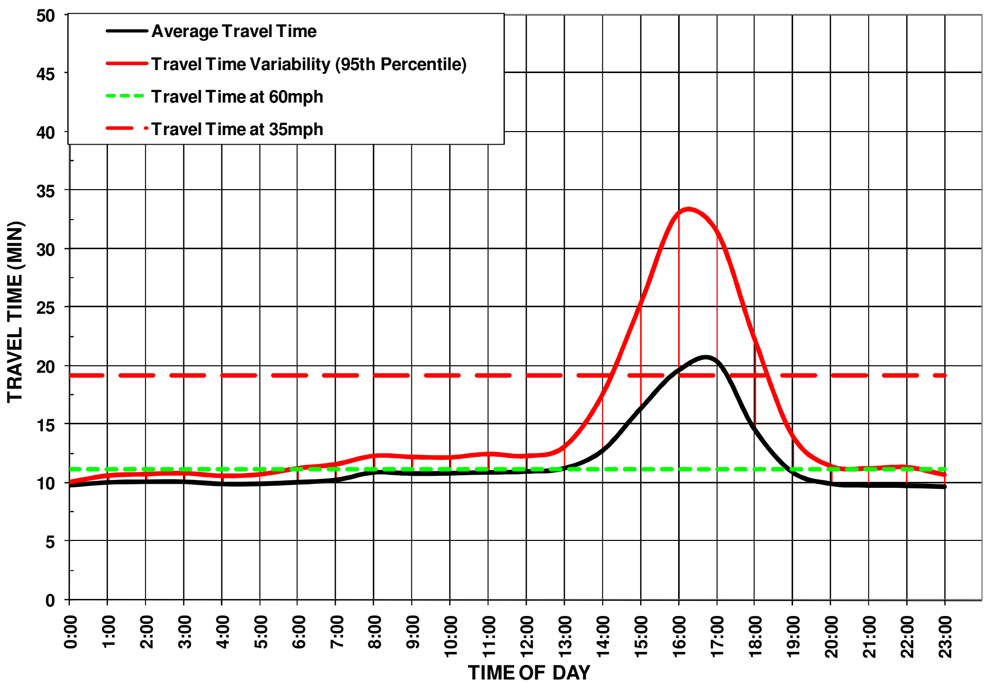
Source: Caltrans detector data

Exhibit 3-37: Northbound HOV Travel Time Variability (2005)



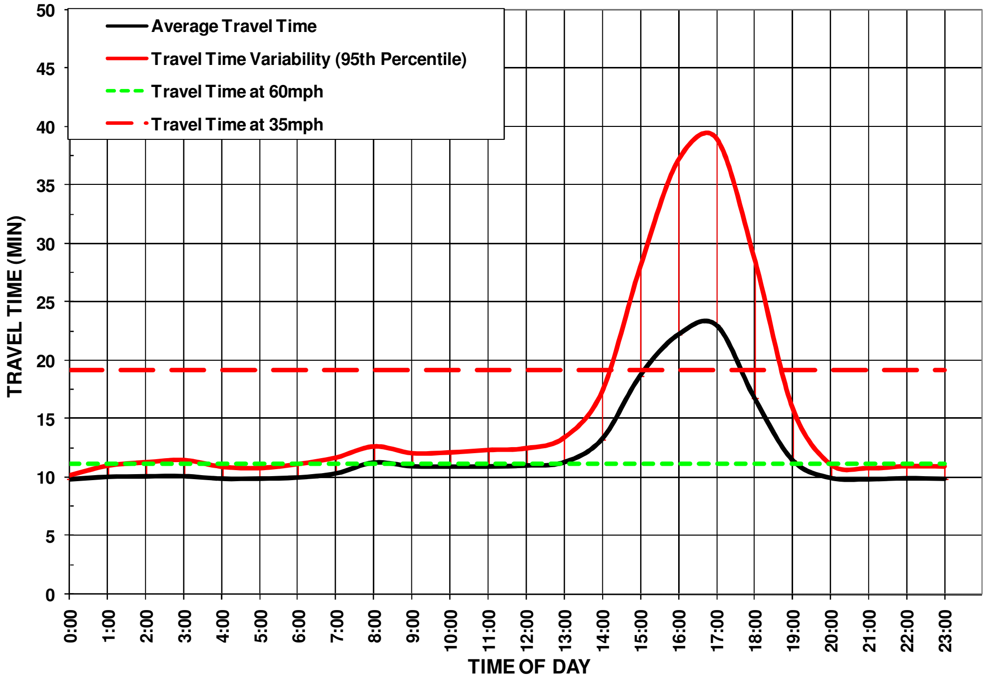
Source: Caltrans detector data

Exhibit 3-38: Northbound HOV Travel Time Variability (2006)



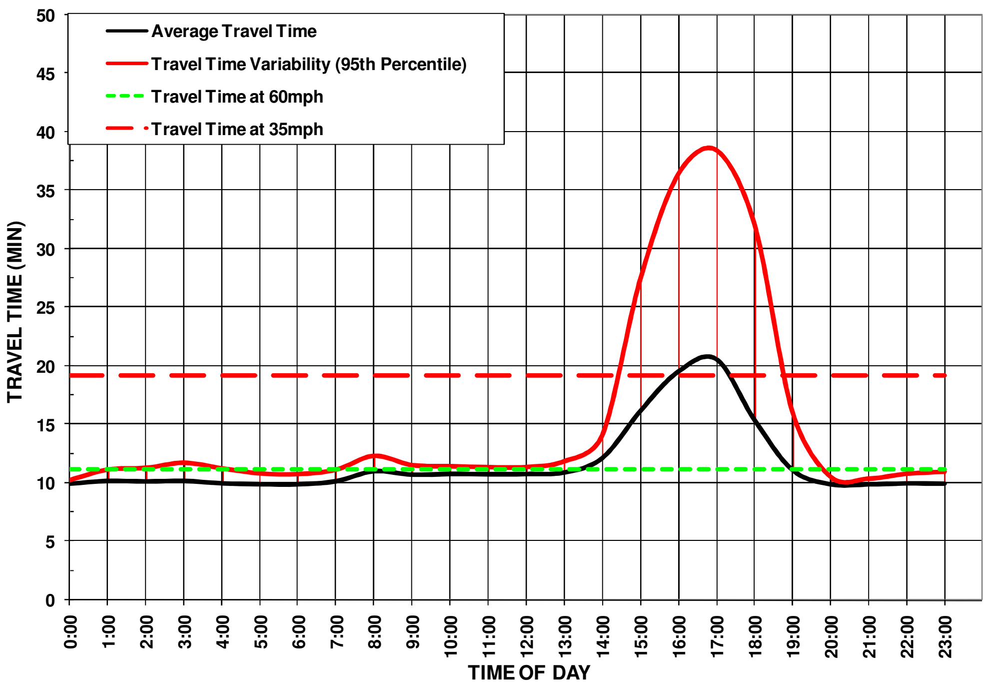
Source: Caltrans detector data

Exhibit 3-39: Northbound HOV Travel Time Variability (2007)



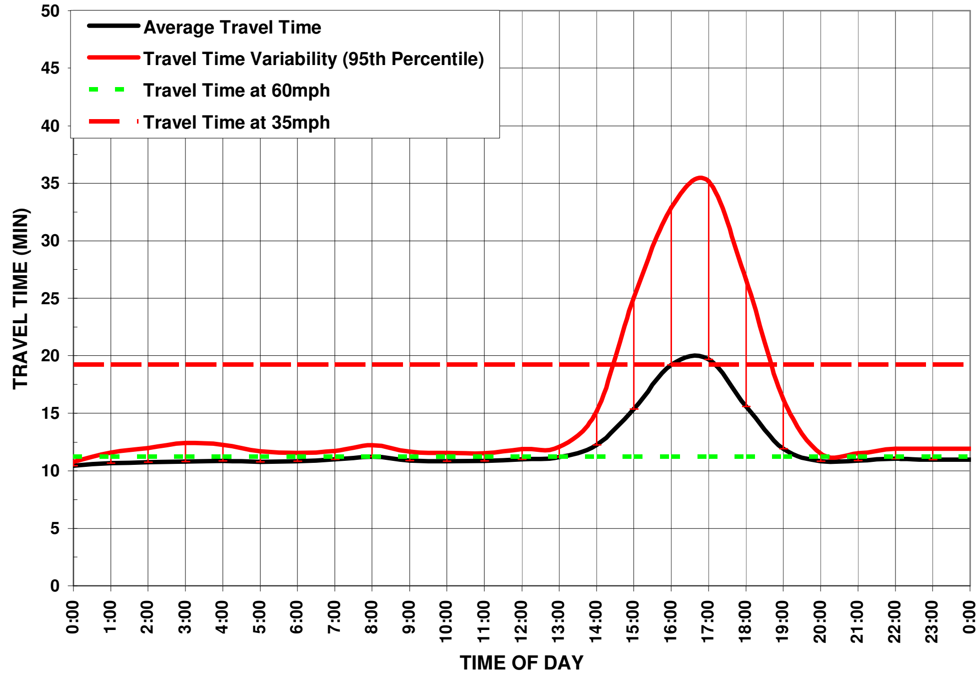
Source: Caltrans detector data

Exhibit 3-40: Northbound HOV Travel Time Variability (2008)



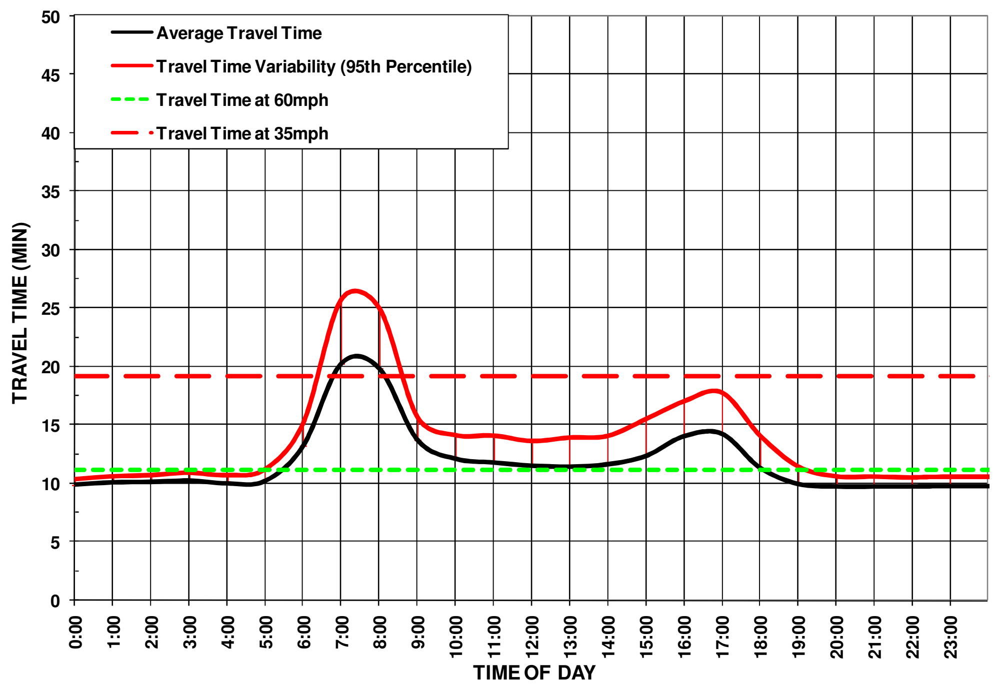
Source: Caltrans detector data

Exhibit 3-41: Northbound HOV Travel Time Variability (2009)



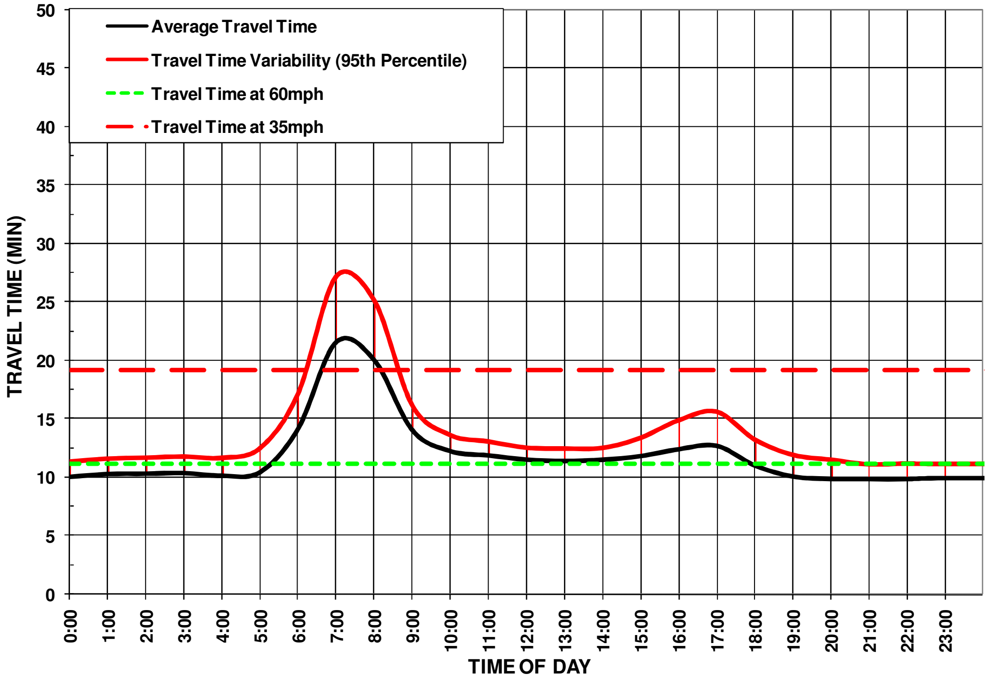
Source: Caltrans detector data

Exhibit 3-42: Southbound HOV Travel Time Variability (2005)



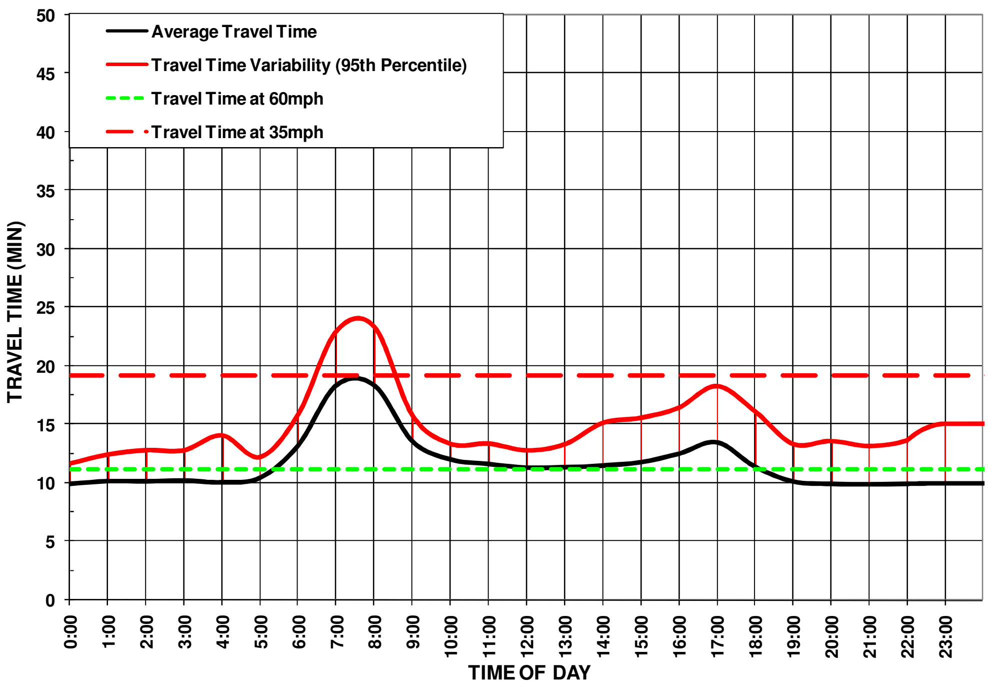
Source: Caltrans detector data

Exhibit 3-43: Southbound HOV Travel Time Variability (2006)



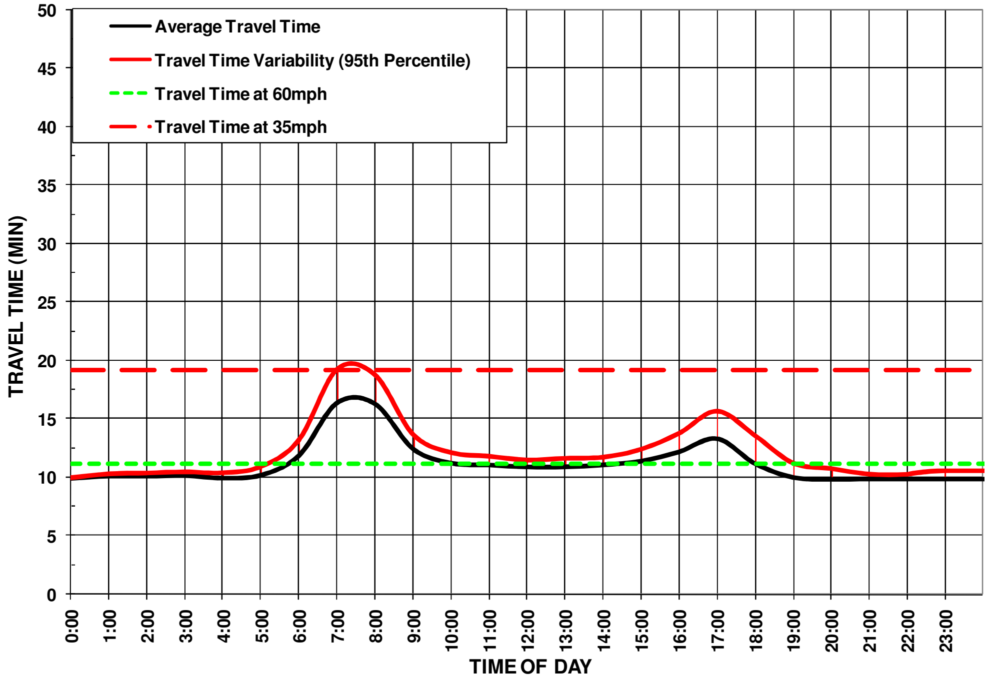
Source: Caltrans detector data

Exhibit 3-44: Southbound HOV Travel Time Variability (2007)



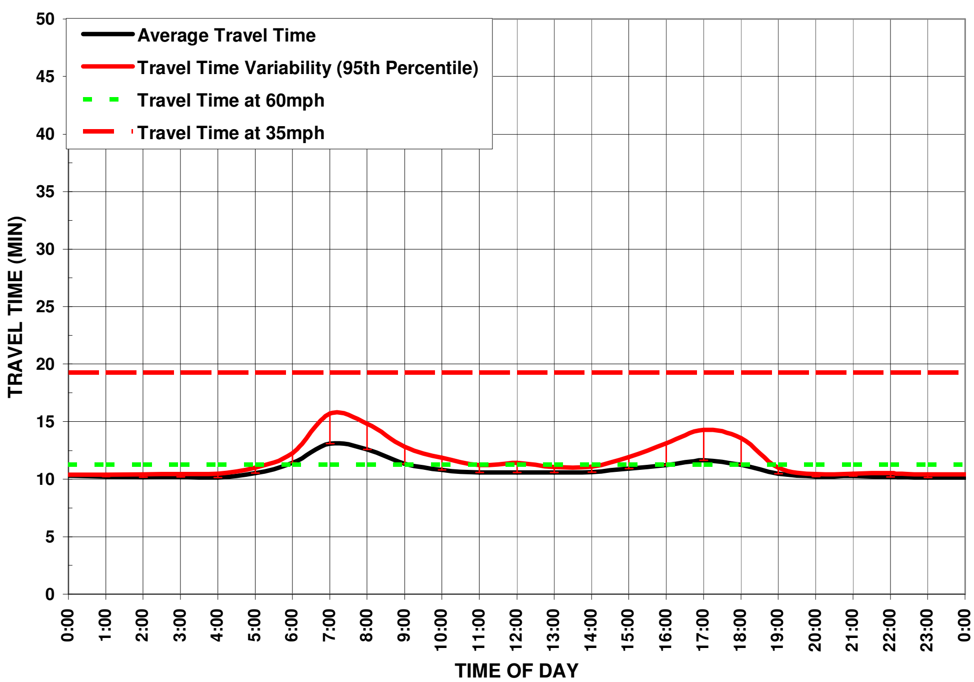
Source: Caltrans detector data

Exhibit 3-45: Southbound HOV Travel Time Variability (2008)



Source: Caltrans detector data

Exhibit 3-46: Southbound HOV Travel Time Variability (2009)



Source: Caltrans detector data

Safety

The adopted performance measures to assess safety include the number of accidents and accident rates computed from the Caltrans Traffic Accident Surveillance and Analysis System (TASAS). TASAS is a traffic records system containing an accident database linked to a highway database. The highway database contains descriptive 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 intends 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 does not intend to supplant more detailed safety investigations routinely performed by Caltrans staff.

Exhibit 3-47 shows TASAS Table B accident rates for the three-year period of 2005-2007. This exhibit shows that the SR-57 Corridor experienced 960 accidents, which include both fatalities and injuries. The rate of fatalities and injuries for this Corridor is similar to other state highway facilities with similar operating characteristics. However, the total accident rate for SR-57 (1.32) is higher than the rate on similar facilities (1.04), which reveals that there were a higher number of non-injury accidents on SR-57.

Exhibit 3-47: Total Number of Accidents by Type and Accident Rate (2005-2007)

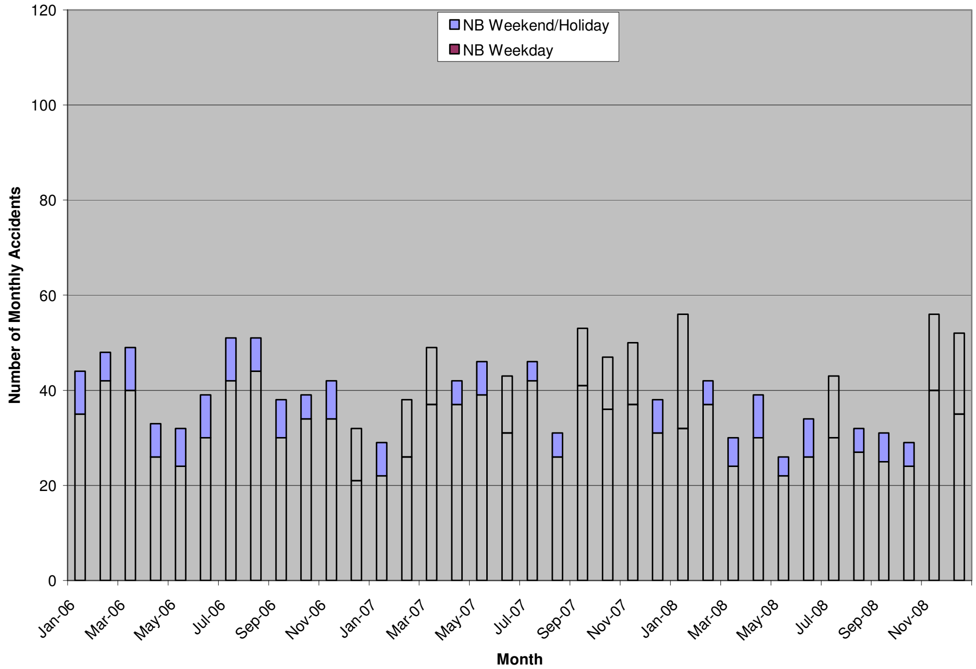
Number of Accidents on SR-57			Accident Rates					
			Actual Rates on SR-57			Average Rates on Similar Facilities		
Fat	Inj	F+I	Fat	F+I	Total	Fat	F+I	Total
9	951	960	0.003	0.31	1.32	0.005	0.32	1.04

Source: Caltrans Table B

Another way to analyze safety data is to look at when accidents occur. The latest available 3-year data from January 1, 2006 through December 31, 2008 were analyzed and summarized. Data that is more recent is not yet available. Note that these are comprehensive from TASAS and do not rely on automatic detection systems.

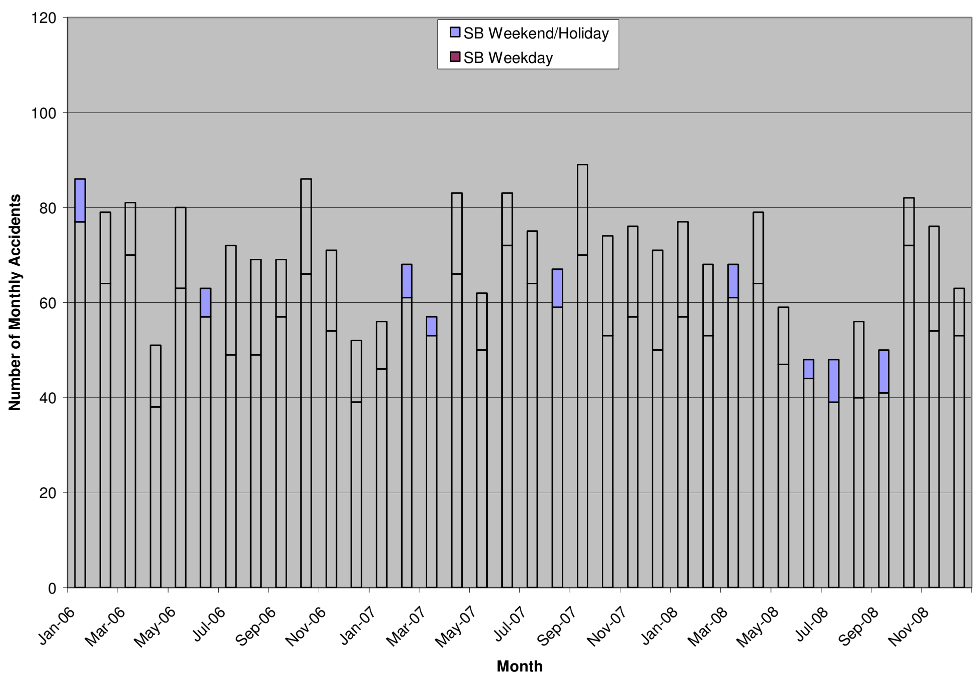
Exhibits 3-48 and 3-49 summarize the total number of weekday and weekend/holiday accidents by month in each direction from 2006 through 2008. The exhibits show that the southbound direction has the highest number of accidents during all three years. The total number of accidents for both the northbound and southbound directions decreased slightly in 2008. Note that the number of accidents are not separated by mainline or HOV facility.

Exhibit 3-48: Total Northbound SR-57 Accidents by Month (2006-2008)



Source: Caltrans TASAS

Exhibit 3-49: Total Southbound SR-57 Accidents by Month (2006-2008)



Source: Caltrans TASAS

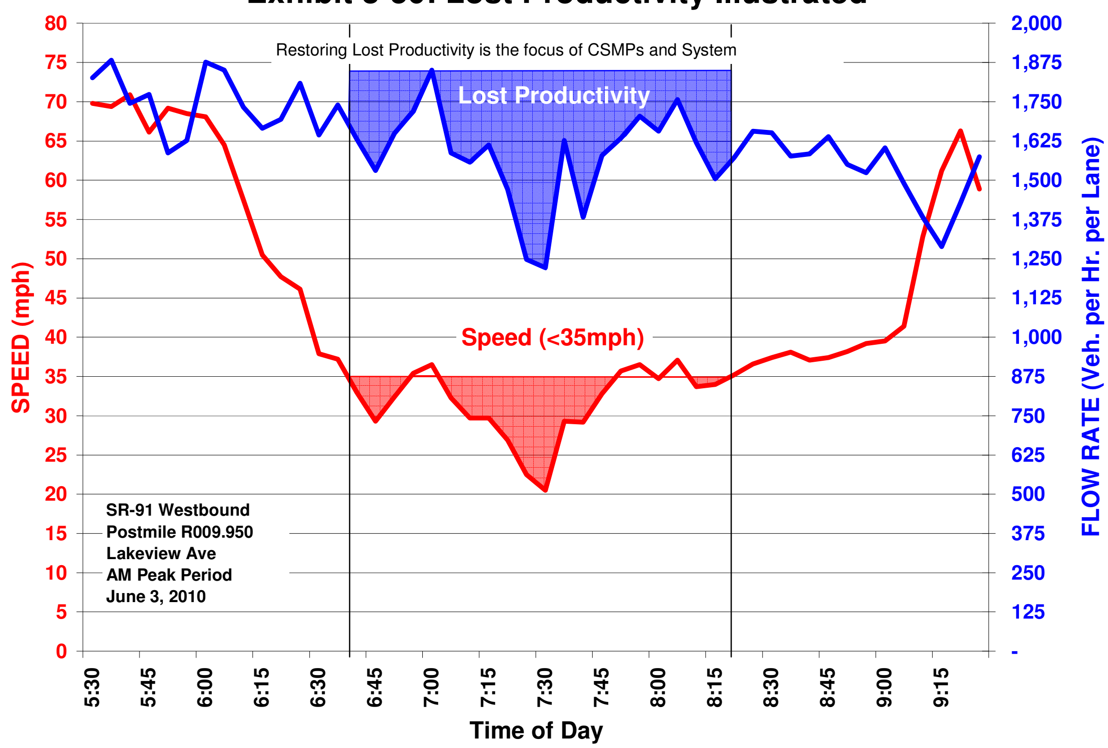
Productivity

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 number of people served divided by the level of service provided, or the percent utilization of a facility or mode under peak congested conditions.

For highways, the input to the system is the capacity of the roadway and the output is the number of people or vehicles that can pass through that roadway, and is calculated as the actual volume divided by the theoretical capacity of the highway. Highway 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 3-50, which is similar to the productivity chart presented in Section 1 of this final report. As traffic flow increases 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.

Exhibit 3-50: Lost Productivity Illustrated



There are a few ways to estimate productivity losses. Regardless of the approach, highway productivity calculations require good detection or significant field data collection at congested locations.

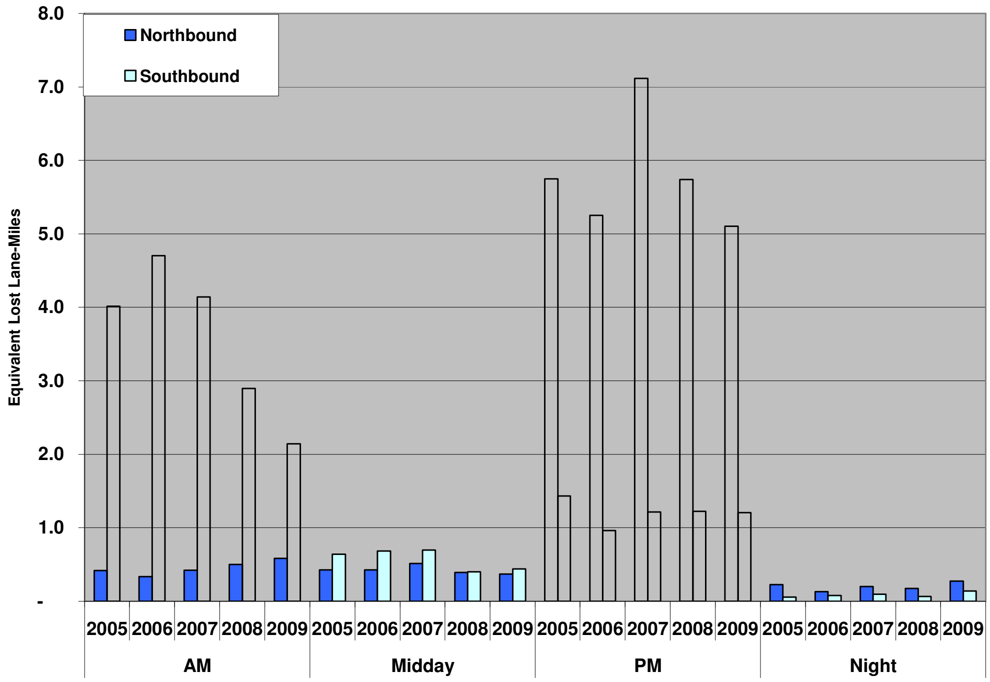
One approach is to convert this lost productivity into "equivalent lost lane-miles." These lost lane-miles represent a theoretical level of capacity that would have to be added in order to achieve maximum productivity. For example, losing six lane-miles implies that adding a new lane along a six-mile section of freeway would regain lost productivity. Equivalent lost lane-miles is computed as follows (for congested locations only):

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

Exhibits 3-51 and 3-52 summarize the productivity losses on the SR-57 mainline and HOV facilities during the 2005-2009 period. 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, which is the time period and direction that experienced the most congestion. In 2007, mainline lost productivity reached seven equivalent lane-miles. By 2009, that loss diminished to five equivalent lane-miles. In 2007, HOV lost productivity reached 1.5 equivalent lane-miles. By 2009, that loss diminished to less than one equivalent lane-mile.

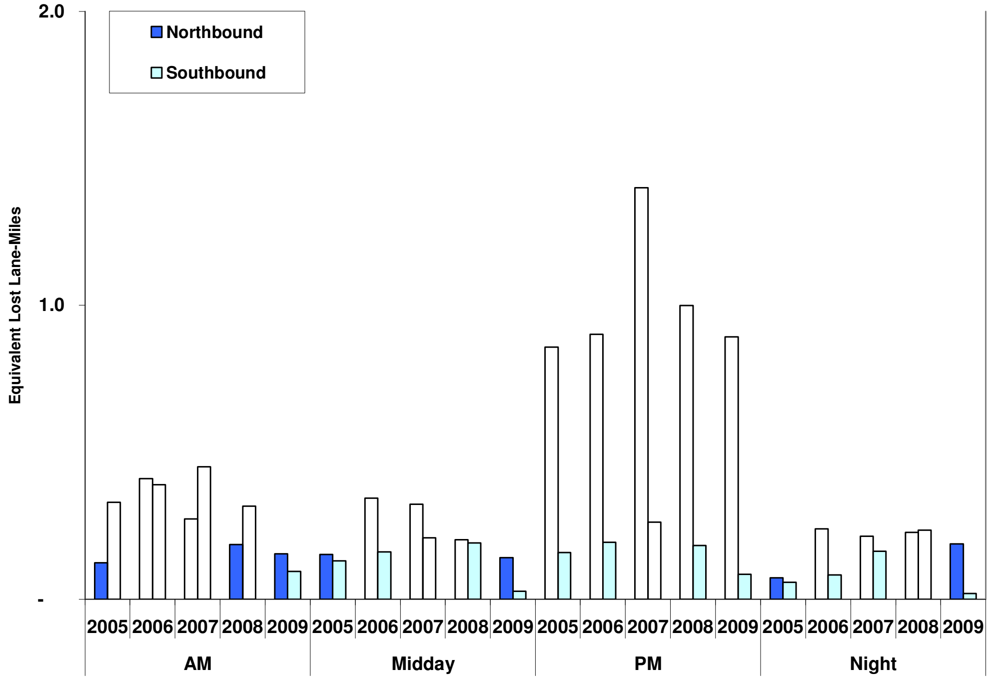
Strategies to combat such productivity losses are primarily related to operations and include building new or extending auxiliary lanes, developing more aggressive ramp metering strategies without negatively influencing the arterial network, and improvements in incident management.

Exhibit 3-51: Mainline Daily Equivalent Lost Lane-Miles by Direction and Time Period (2005-2009)



Source: Caltrans detector data

Exhibit 3-52: HOV Daily Equivalent Lost Lane-Miles by Direction and Time Period (2005-2009)



Source: Caltrans detector data

Pavement Condition

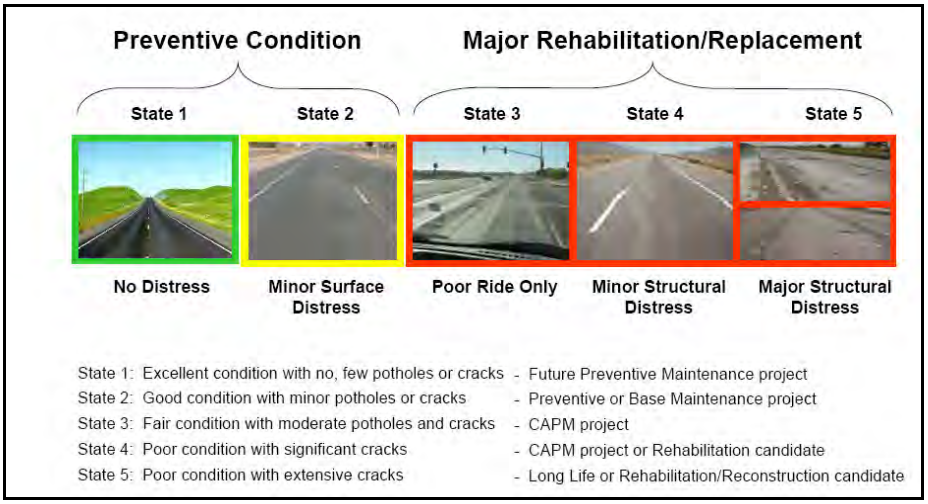
The condition of the roadway pavement (or ride quality) on the corridor can influence its traffic performance. Rough or poor pavement conditions can decrease the mobility, reliability, safety, and productivity of the corridor, whereas smooth pavement can have the opposite effect. Pavement preservation 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: 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 3-53 provides an illustration of this distinction. The first two pavement conditions are considered roadway that provides adequate ride quality and is structurally adequate. The remaining three conditions are included in the calculation of distressed lane-miles.

Exhibit 3-53: Illustrative 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 to be 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.

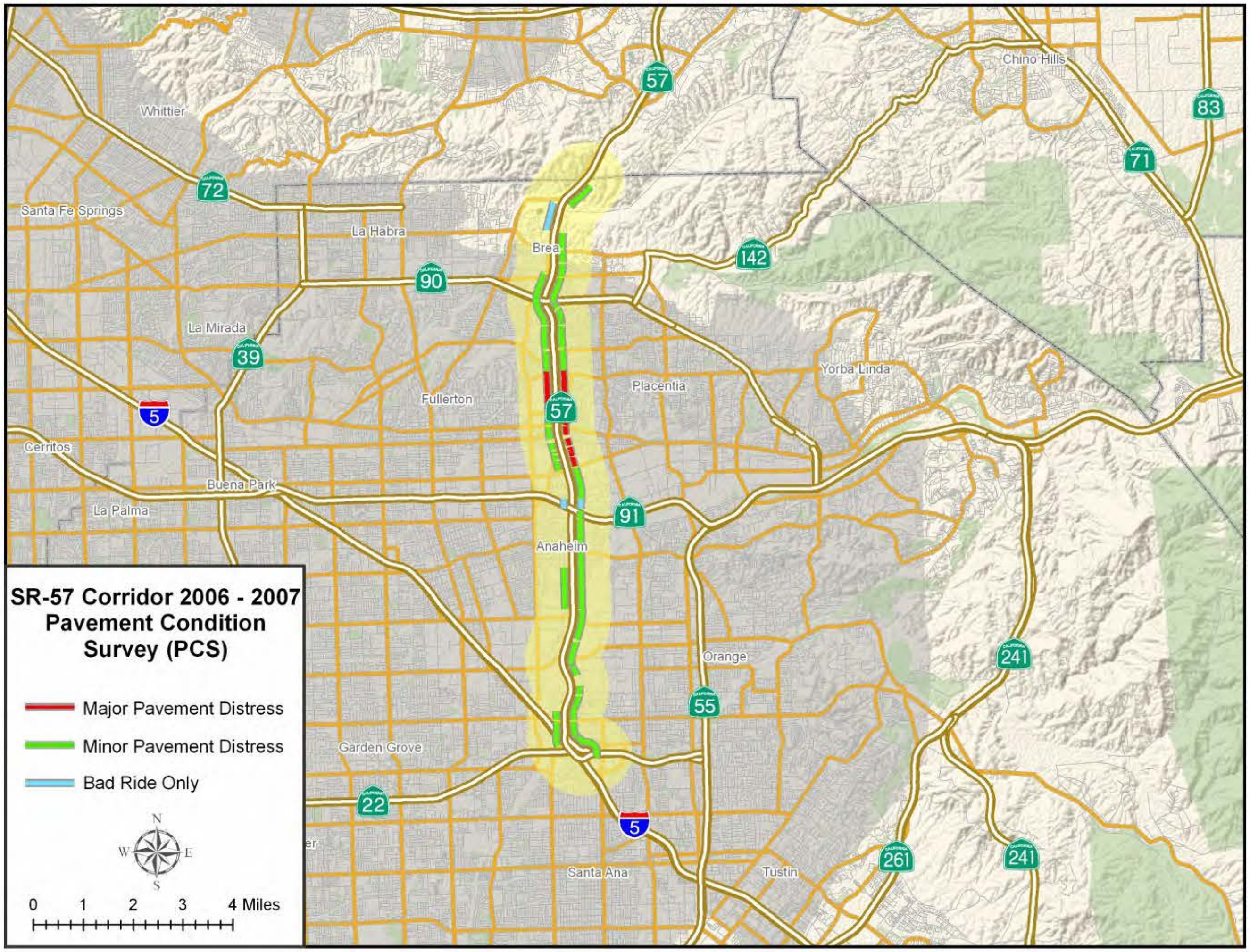
Existing Pavement Conditions

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 3-54 shows pavement distress along the SR-57 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 3-53.

Exhibit 3-54: Distressed Lane-Miles on SR-57 Corridor (2006-2007)



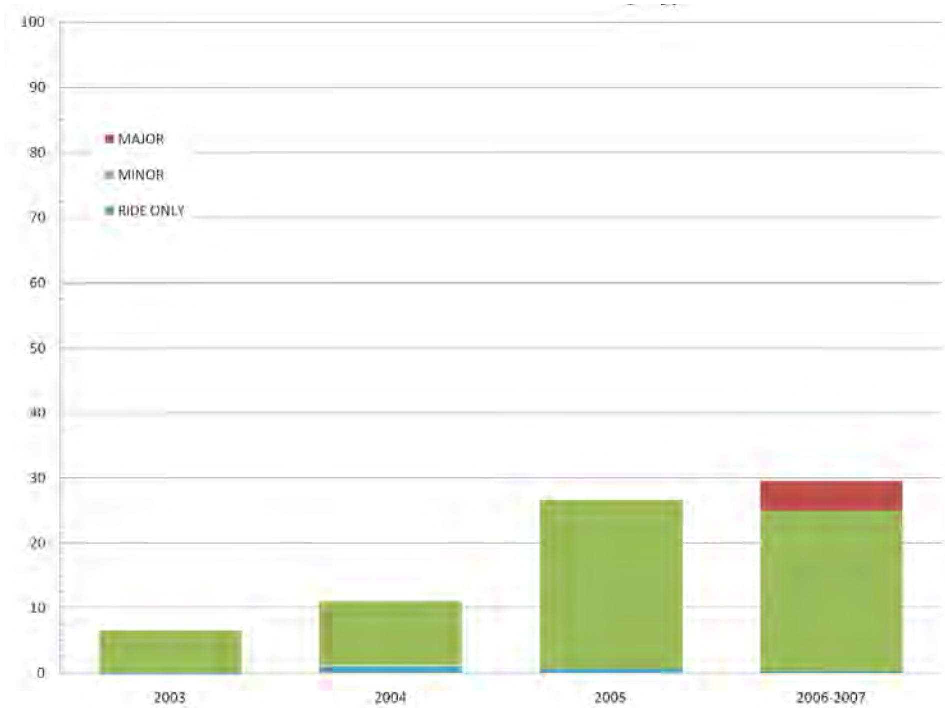
Source: Mapping of 2007 Pavement Condition Survey data

The SR-57 Corridor shows pavement distress equal to that of an average freeway in the northern, more urbanized part of Orange County. Much of the corridor has at least one lane exhibiting minor pavement distress. There is also a one to two mile section with major pavement distress in the middle of the corridor near Placentia and Fullerton. The rest of the corridor, mostly near Anaheim, exhibits no pavement distress or only ride quality issues.

Exhibit 3-55 compares results from prior pavement condition surveys along the SR-57 Corridor. The number of distressed lane-miles has increased since 2003. Most of the growth is due to an increase in minor pavement distress, although about four lane-miles of major pavement distress appeared in the 2007 PCS.

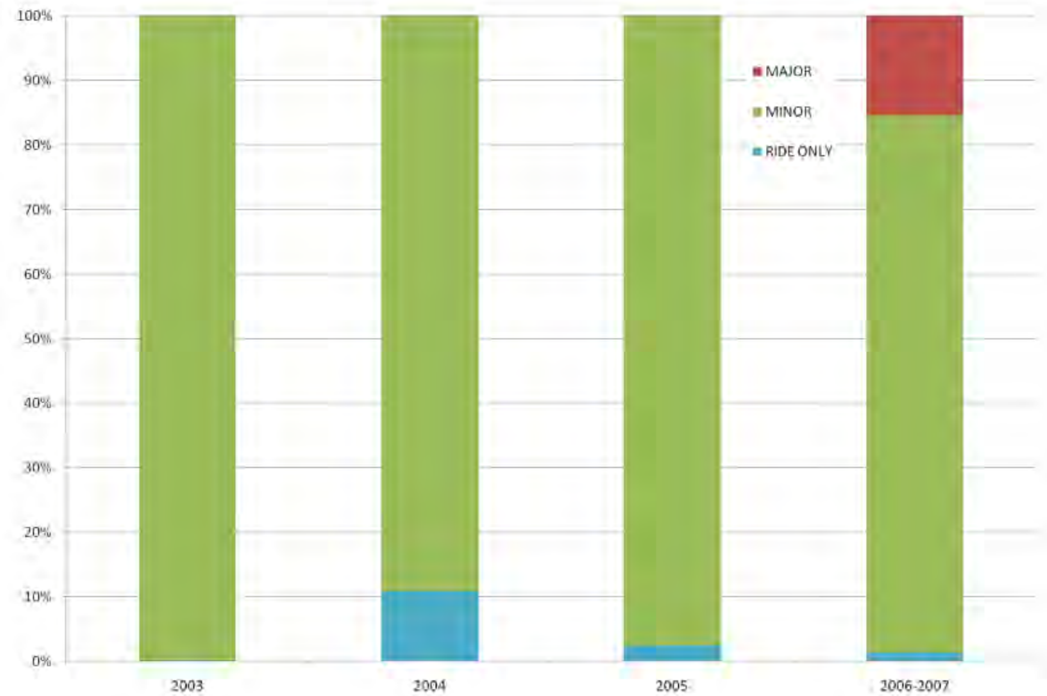
The change in the percent mix of distressed lane-miles is shown more clearly in Exhibit 3-56. As seen in the exhibit, minor distress represents over 80 percent of the pavement issues along the SR-57 Corridor. Some major distress appeared in the last PCS and it accounts for about 15 percent of the distressed lane-miles. Ride only issues have tended to be less than five percent of the distressed lane-miles and have been fully addressed in recent years.

Exhibit 3-55: SR-57 Distressed Lane-Miles Trends



Source: 2003 to 2007 Pavement Condition Survey data

Exhibit 3-56: SR-57 Distressed Lane-Miles by Type



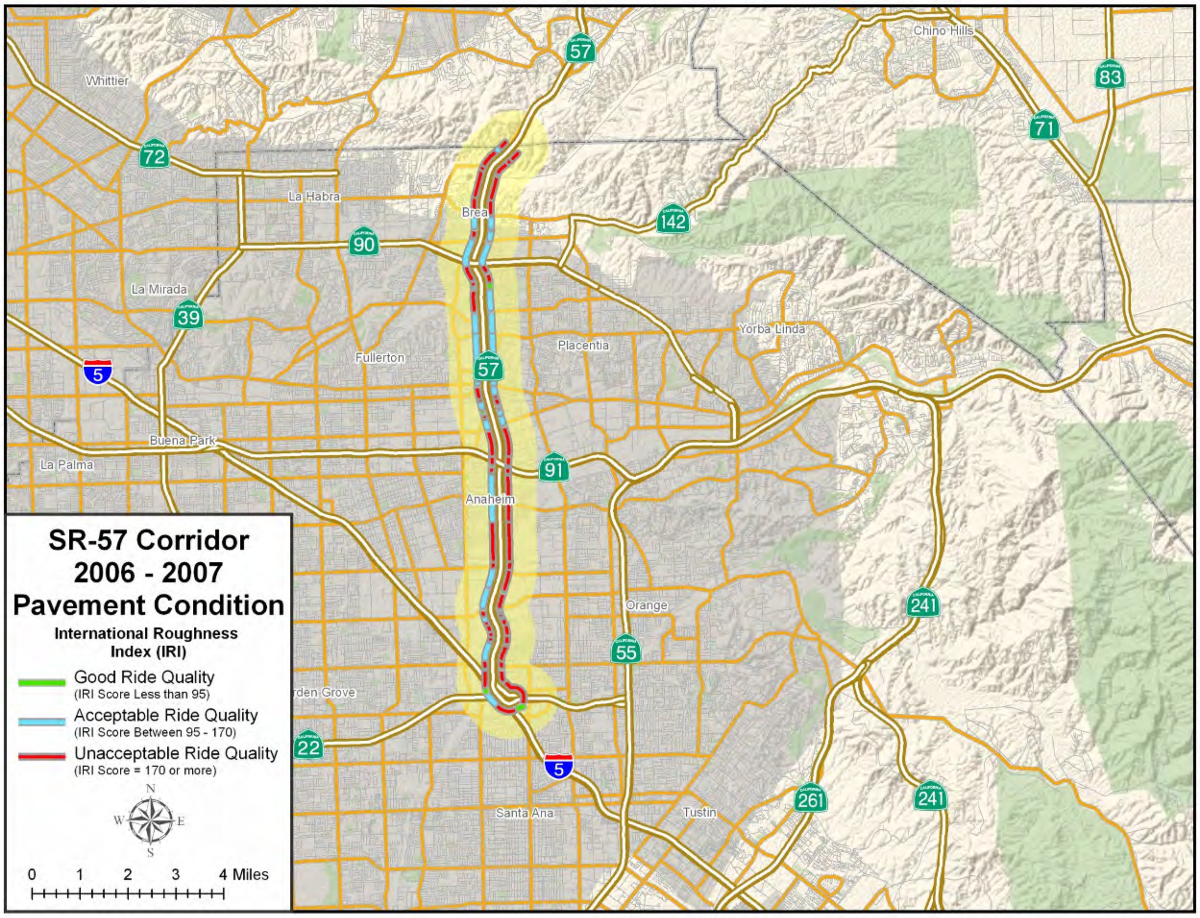
Source: 2003 to 2007 Pavement Condition Survey data

Exhibit 3-57 shows the IRI for the lane with the poorest pavement condition in each freeway segment. 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 3-54 due to algorithms and thresholds in the PCS.

The study corridor comprises roughly 116 lane-miles, when the conditions of all lanes are considered. Of these lanes:

- 31 lane-miles, or 27 percent, are considered to have good ride quality (IRI ≤ 95)
- 61 lane-miles, or 52 percent, are considered to have acceptable ride quality (95 < IRI ≤ 170)
- 25 lane-miles, or 21 percent, are considered to have unacceptable ride quality (IRI > 170)

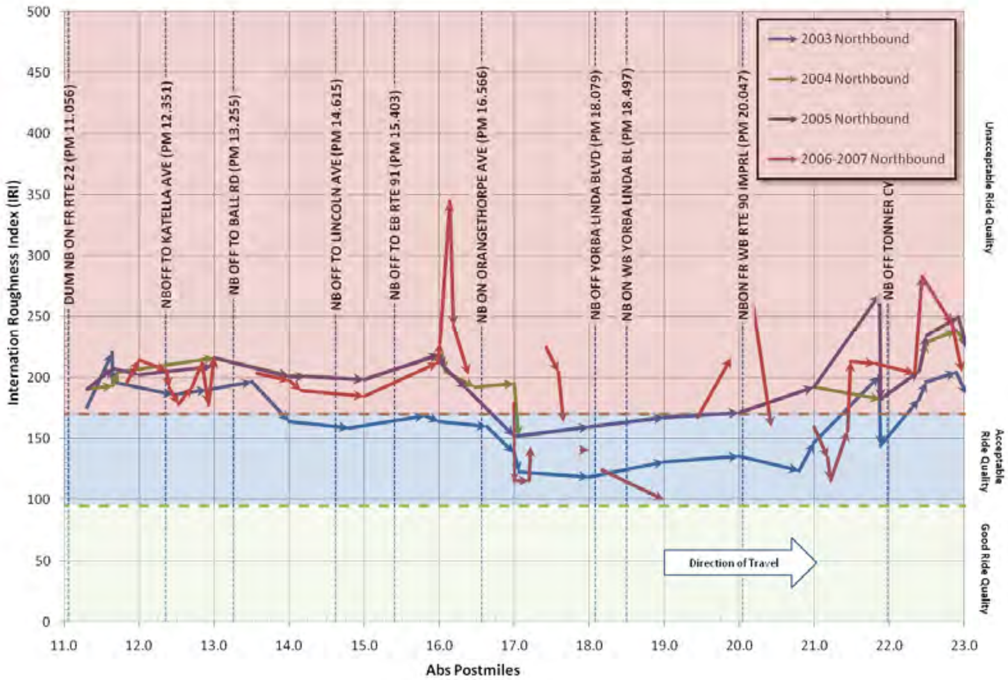
Exhibit 3-57: SR-57 Road Roughness (2006-2007)



Source: Mapping of 2007 Pavement Condition Survey data

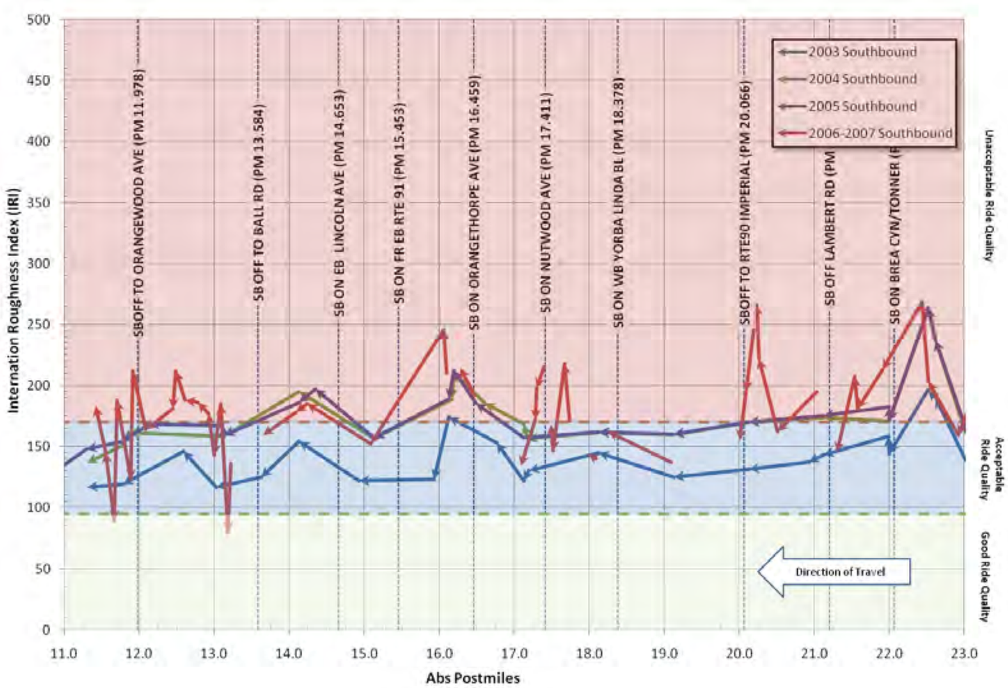
Exhibits 3-58 and 3-59 present ride conditions for the SR-57 Corridor using IRI from the last four pavement surveys. The information is presented by postmile and direction. The exhibits include color-coded bands to indicate the three ride quality categories defined by Caltrans: good ride quality (green), acceptable ride quality (blue), and unacceptable ride quality (red). The surveys show consistent patterns of good, acceptable, and unacceptable ride quality. Unlike many freeways in the state, SR-57 has had fairly steady ride quality over the last few surveys. 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 3-58: Northbound SR-57 Road Roughness (2003-2007)



Source: 2003 to 2007 Pavement Condition Survey data

Exhibit 3-59: Southbound SR-57 Road Roughness (2003-2007)



Source: 2003 to 2007 Pavement Condition Survey data

4. BOTTLENECK IDENTIFICATION AND PERFORMANCE

Orange County SR-57 Corridor bottlenecks were identified and verified during 2008 and 2009 based on a variety of data sources, including State Highway Congestion Monitoring Program (HICOMP) data, Caltrans District 12 probe vehicle runs, automatic detector data, and extensive consultant team field observations and video-taping.

Potential bottleneck locations were initially identified in the Preliminary Performance Assessment report delivered in August 2008. The Comprehensive Performance Assessment delivered in May 2009 presented the results of additional analysis and extensive field observations.

The study team conducted the field observations, videotaping major bottlenecks to document the locations and potential causes of the bottlenecks. These efforts resulted in confirming consistent sets of bottlenecks for both directions of the freeway. Exhibit 4-1 summarizes the bottleneck locations identified in this analysis and their associated delays. Exhibits 4-2 and 4-3 are maps showing these bottleneck locations for the AM and PM peak periods, respectively.

Exhibit 4-1: Orange County SR-57 Bottlenecks

Dir	Bottleneck Location	Active Period	
		AM	PM
NB	Tonner Canyon Rd		✓
NB	Lambert Rd On		✓
NB	Imperial Hwy On		✓
NB	Orangethorpe Ave On	✓	✓
Dir	**Bottleneck Location**	**Active Period**	
		AM	**PM**
SB	Imperial Hwy On	✓	
SB	Chapman Ave On	✓	✓
SB	Ball Rd On	✓	✓
SB	I-5 Off / SR-57 Terminus	✓	✓

Exhibit 4-2: Map of Major SR-57 AM Existing Bottlenecks

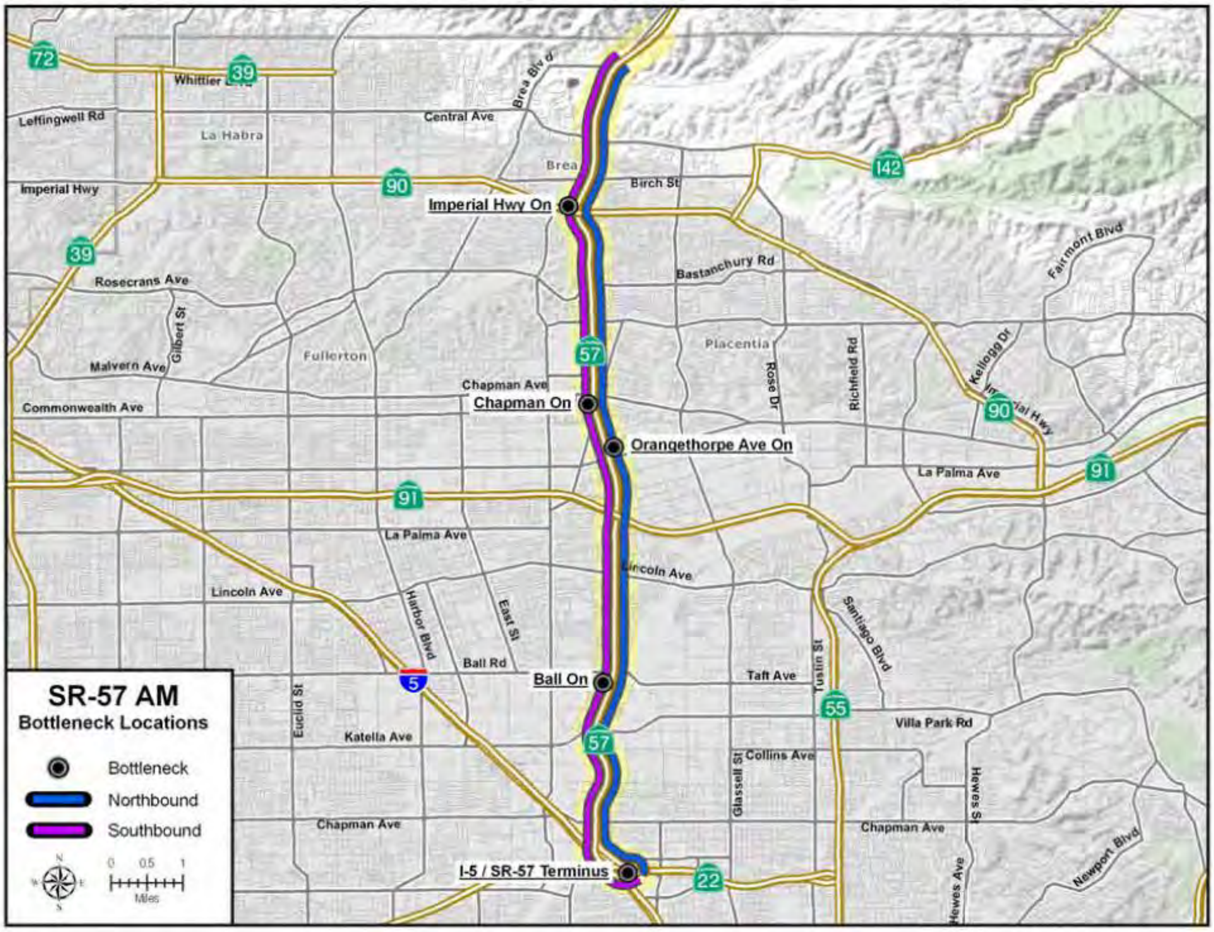
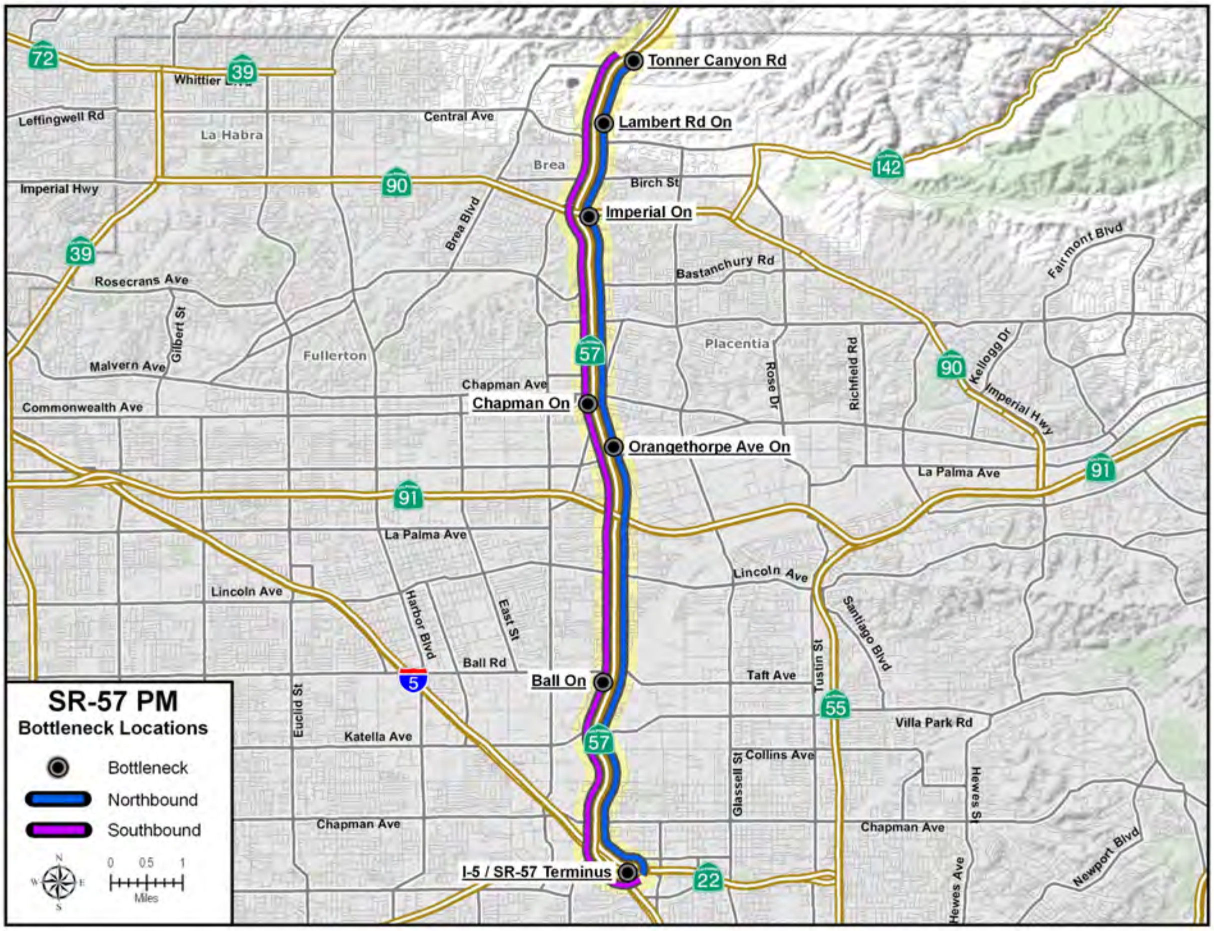


Exhibit 4-3: Map of Major SR-57 PM Existing Bottlenecks



Northbound Direction Bottlenecks

Starting from the I-5/SR-22 Interchange and moving northbound, the following bottlenecks were identified:

- Orangethorpe Avenue On-Ramp – This bottleneck occurs due to heavy weaving with high volumes on the on-ramp and mainlines.
- Imperial Highway On-Ramp – Back-to-back on-ramp merges, along with rolling terrain and horizontal curves, often create congested conditions at this bottleneck location.
- Lambert Road On-Ramp – Steady platooning of on-ramp traffic along with a short merge and uphill climb creates a bottleneck.

- Tonner Canyon Road – Uphill climb plus high demand often cause congestion at Tonner Canyon Road at the Orange/Los Angeles County line.

Southbound Direction Bottlenecks

Starting from the Orange/Los Angeles County line and moving southbound, the following bottlenecks were identified:

- Imperial Highway On-Ramp – Back-to-back on-ramp merges, along with rolling terrain and horizontal curves, often create congested conditions.
- Chapman Avenue On-Ramp – Back-to-back on-ramp merge with Nutwood Avenue on-ramp creates congested conditions.
- Ball Road On-Ramp – Back-to-back on-ramp merges often create congested conditions at this location.
- I-5 Off-Ramp/SR-57 Terminus – Back up from the I-5 connector on-ramp creates queuing that extends back to Ball Road.

Bottleneck Identification

This section of the SR-57 Corridor report presents the initial bottleneck identification analysis performed as part of the Preliminary Performance Assessment.

A variety of sources was used to identify bottlenecks. They include:

- Caltrans State Highway Congestion Monitoring Program (HICOMP) 2007 report
- Caltrans District 12 probe vehicle runs (electronic tachometer runs)
- Automatic freeway detector data
- Aerial photos (Google Earth) and Caltrans photologs.

State Highway Congestion Monitoring Program (HICOMP)

The Caltrans Highway Congestion Monitoring Program (HICOMP) annual report was the first tool used by the study team to identify problem areas. Published annually since 1987, HICOMP attempts to measure "typical" peak period, weekday, and recurring traffic congestion on urban area freeways. HICOMP does not include congestion on other state highways or local surface streets. Non-recurrent congestion such as holiday, maintenance, construction or special-event generated traffic congestion is also not included. HICOMP data is useful for finding general trends and making regional comparisons of freeway performance, but some estimates presented in the report are based on a limited number of observations. Furthermore, HICOMP does not attempt to capture bottleneck locations, but simply report on locations of likely recurrent congestion.

Using the 2007 HICOMP data, potential problem areas were initially identified. As illustrated in Exhibit 4-4 and 4-5, the downstream end of congested segments were initially considered bottleneck areas in the northbound direction (shown with blue circles) and in the southbound direction (shown with red circles).

Exhibit 4-4: 2007 HICOMP AM Congestion Map with Potential Bottlenecks

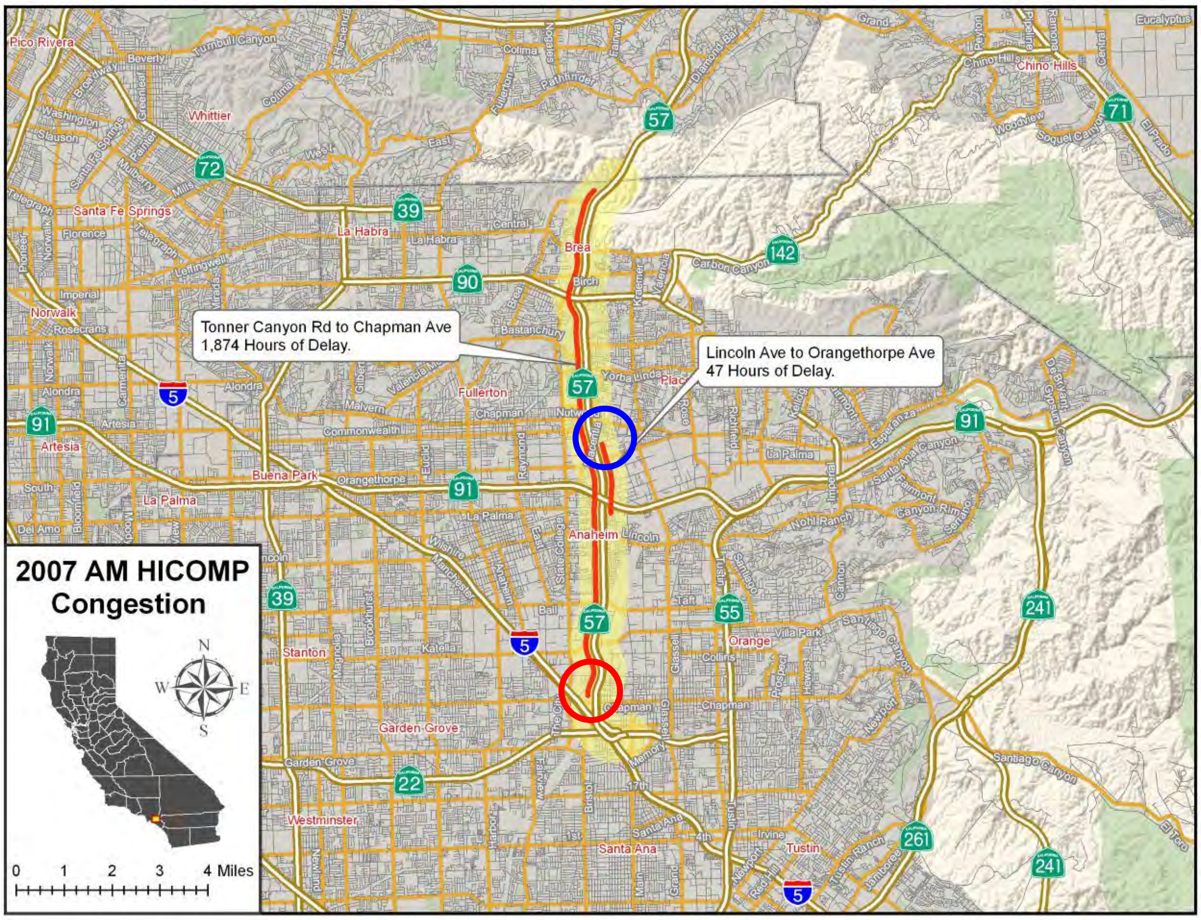
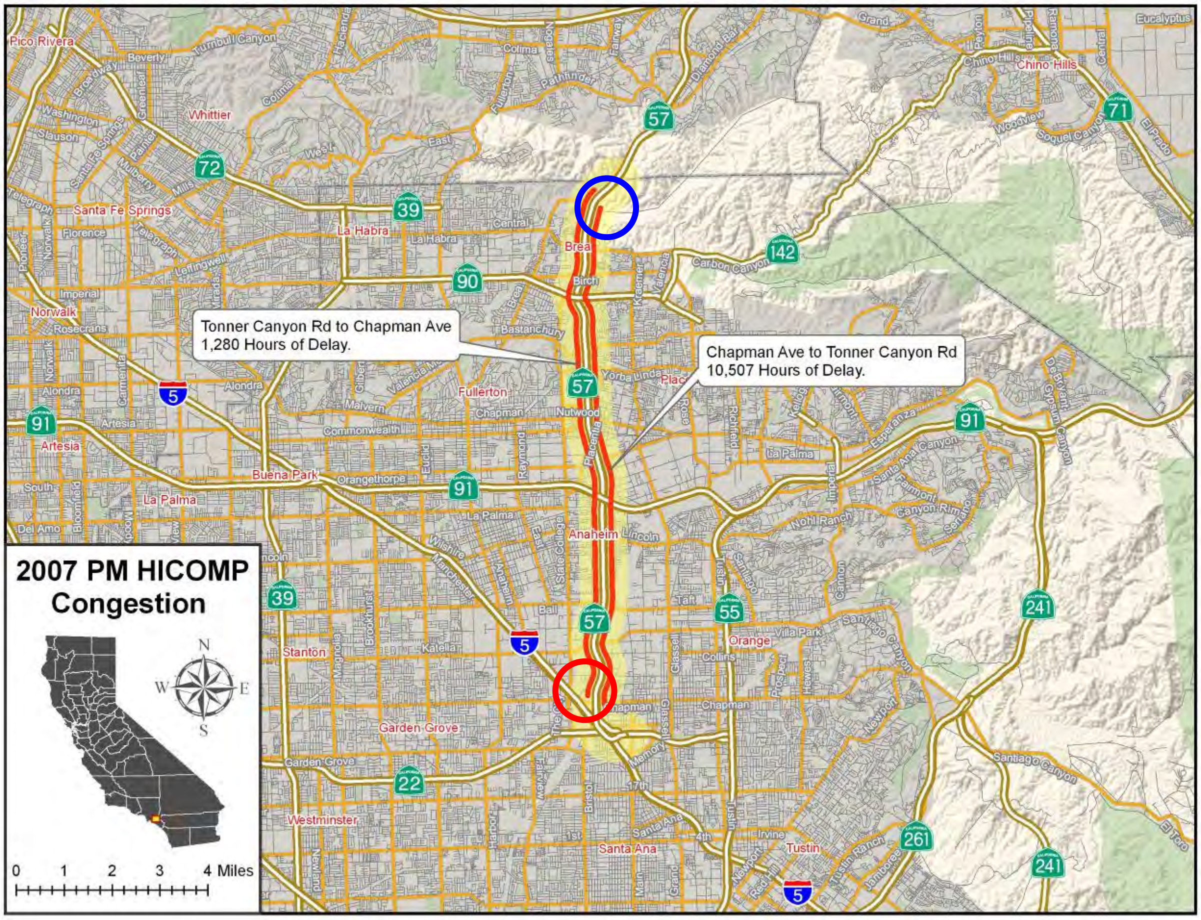


Exhibit 4-5: 2007 HICOMP PM Congestion Map with Potential Bottlenecks



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 tachograph) 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 length. Bottlenecks can be found at the end of a slow congested speed location where speeds pick up to 30 mph to 50 mph.

Caltrans District 12 collected probe vehicle run data on May 10, 2007 for the SR-57 freeway from the Orange/Los Angeles County line to the I-5/SR-22 Interchange. The freeway corridor runs were conducted from approximately 6:00 AM to 9:30 AM and from 3:00 PM to 7:30 PM.

Exhibit 4-6 illustrates the SR-57 northbound probe vehicle runs conducted on May 10, 2007 at 7:00 AM, 8:20 AM, 9:00 AM, 4:00 PM, 5:00 PM, and 6:20 PM. As indicated, there are slow speeds (congestion) and bottlenecks evident in both the AM and PM peak hours in the northbound direction. These potential bottleneck locations are highlighted in the exhibit.

Exhibit 4-7 illustrates the SR-57 southbound probe vehicle runs conducted on May 10, 2007 at 7:00 AM, 7:40 AM, 9:00 AM, 3:00 PM, 4:40 PM, and 6:00 PM. As indicated, there are slow speeds (congestion) and bottlenecks evident in both the AM and PM peak hours in the southbound direction as well.

Exhibit 4-6: Northbound Sample Probe Vehicle Runs (2007)

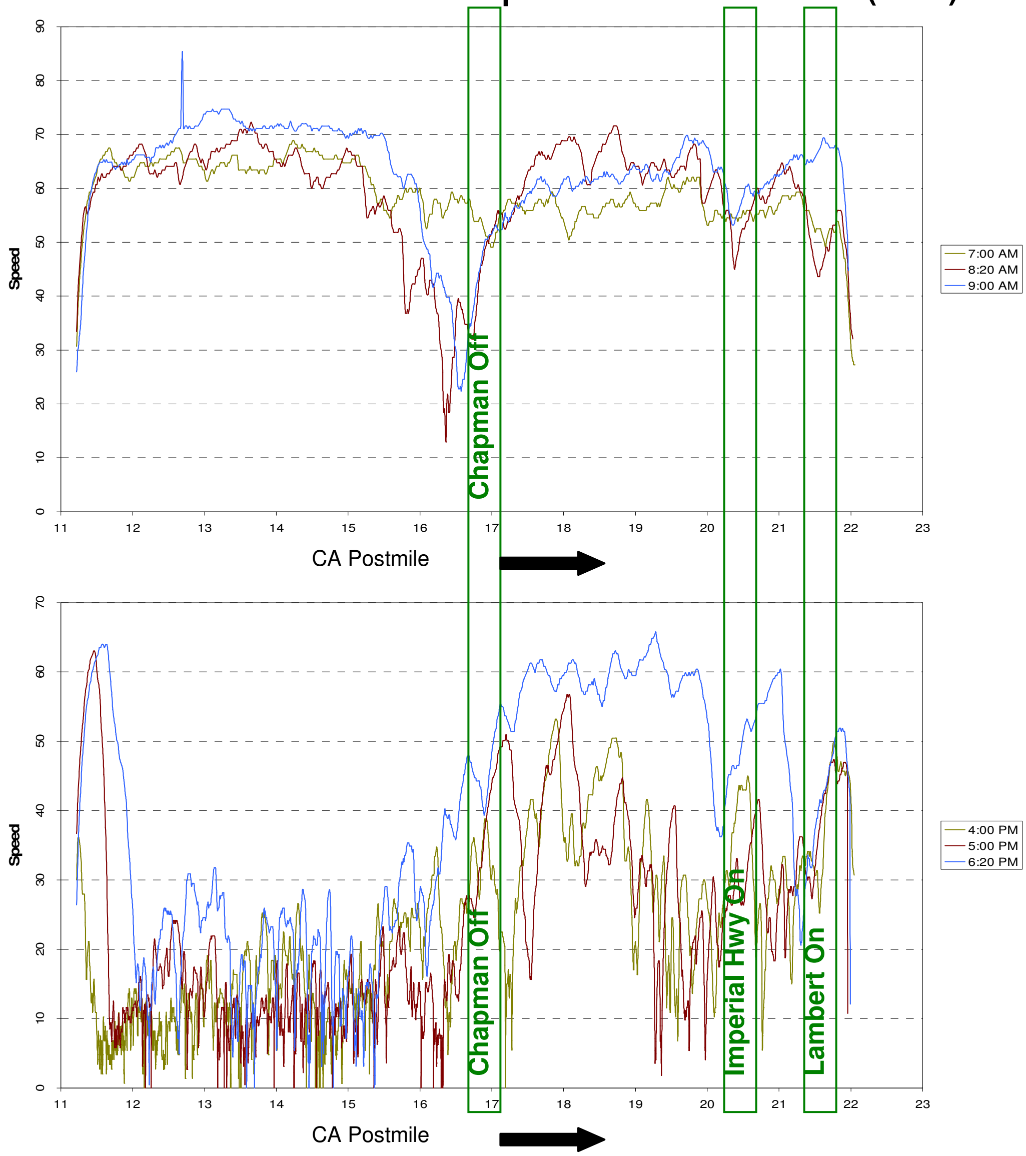
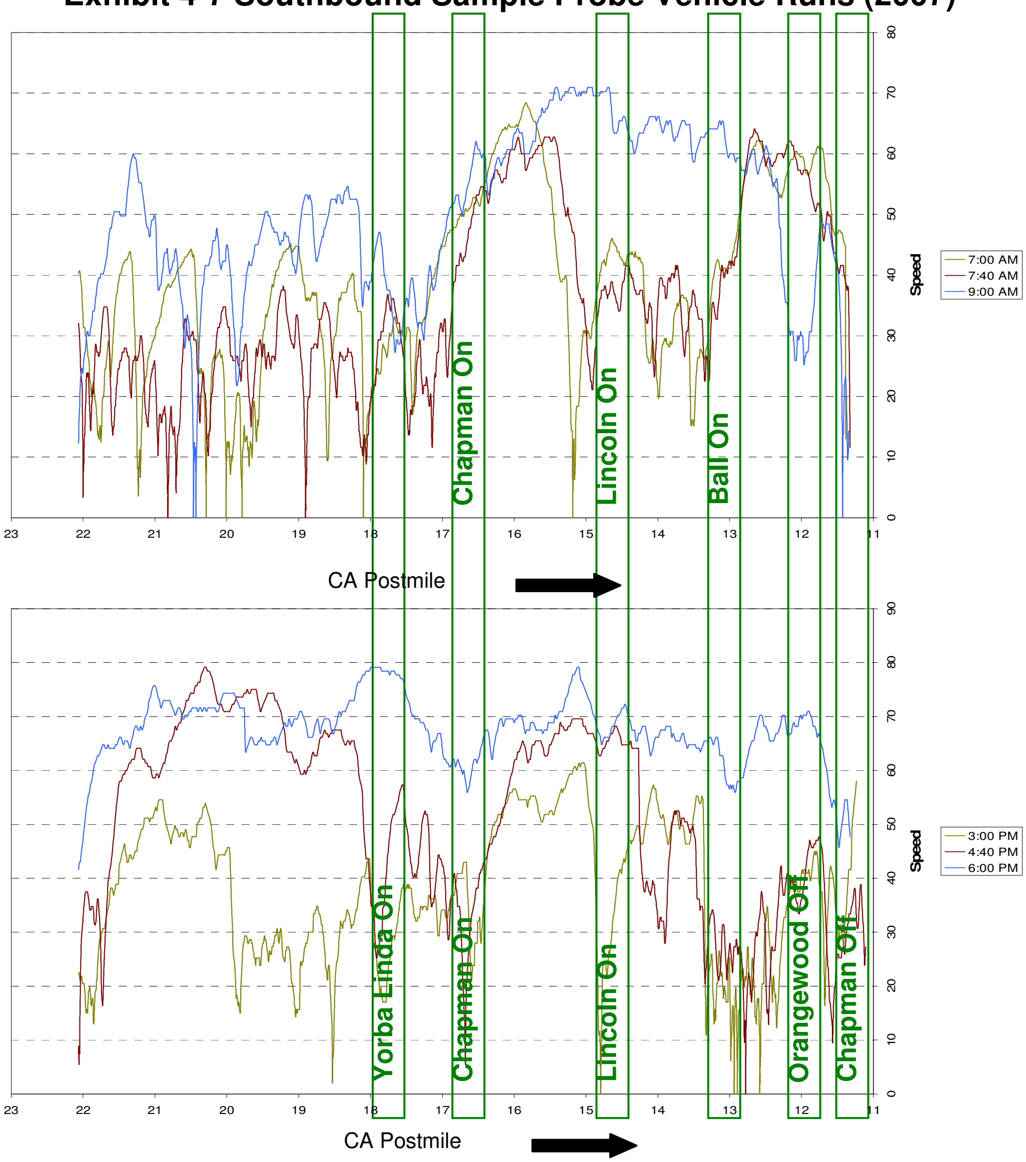


Exhibit 4-7 Southbound Sample Probe Vehicle Runs (2007)



Automatic Detector Data

The third source used to identify potential bottlenecks prior to the in-depth field visits was to review speed contour and speed profile plots from automatic detectors. The study team downloaded detector data from the Caltrans Performance Measurement System (PeMS)[5] to conduct this analysis.

[5] Developed and maintained by Caltrans and accessible at PeMS@dot.ca.gov

Speed contour plots show speeds for every detector location for every five-minute period throughout the day. The resulting plot shows the location, extent, and duration of congestion.

Speed profile plots are very similar to probe vehicle run graphs. Unlike the probe vehicle runs, however, each speed plot has universally the same time across the corridor. For example, an 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 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, they both identify similar problem areas. These speed plots are then compiled at every five minutes and presented in speed contour plots.

Northbound SR-57 Detector Analysis

Exhibit 4-8 shows illustrative speed contour plots for Tuesday, September 18, 2007 and Wednesday, September 19, 2007. The speed contour plots were selected to represent a typical weekday and highlight bottleneck locations and resulting congestion. The speed contour plots shown are typical for the SR-57 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-5/SR-22 Interchange to the Orange/Los Angeles County line. The various colors represent the average speeds corresponding to the color speed chart shown below the diagram. As shown, the dark blue blotches represent congested areas where speeds are reduced. The ends of each dark blotches represent bottleneck areas, where speeds pick up after congestion, typically to 30 to 50 mph. The horizontal length of each plot is the congested segment, queue lengths. The vertical length is the congested time period.

Exhibit 4-9 provides speed profile plots for Tuesday, September 18, 2007. The speed profile plots represent a typical weekday sample to illustrate the bottleneck locations and congestion formed from them at a particular time in the day, in this case at 8 AM in the morning and 5:00 PM in the evening. The speed profile plots were selected to represent a typical speed profile diagram for the SR-57 freeway in the northbound direction (traffic moving left to right on the plot).

The study team selected additional days to examine and confirm the trends identified in the September sample days. Exhibit 4-10 provides speed contours for weekday samples in April 2007. The same bottleneck locations are identified on each of the two different sample days, indicating a recurring pattern of the bottleneck locations.

In addition to multiple days, averages over longer time periods were also analyzed. Exhibit 4-11 illustrates the weekday averages by each quarter of 2007. Again, the same bottleneck locations are identified. From the long contours, the same bottlenecks are evident, further validating the reoccurring pattern of the bottleneck locations.

Exhibit 4-8: Northbound Speed Contour Plots (September 2007)

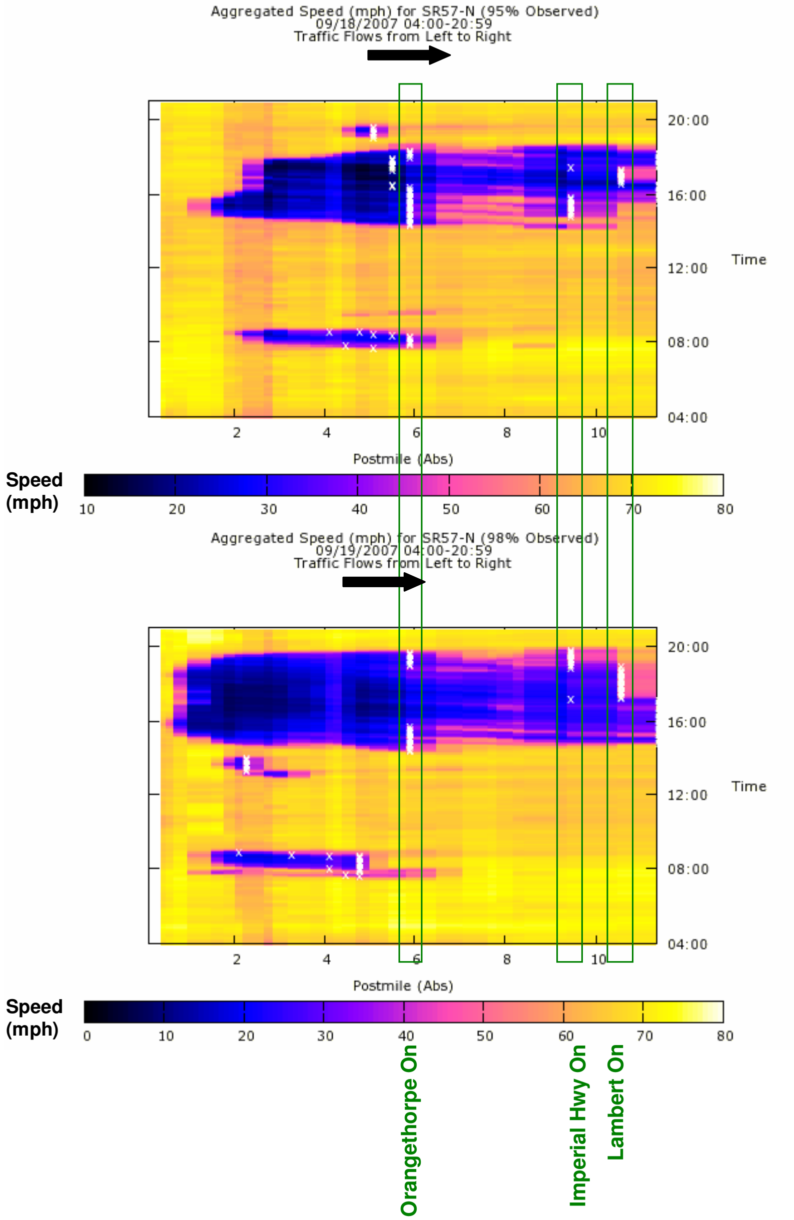


Exhibit 4-9: Northbound Speed Profile Plots (September 18, 2007)

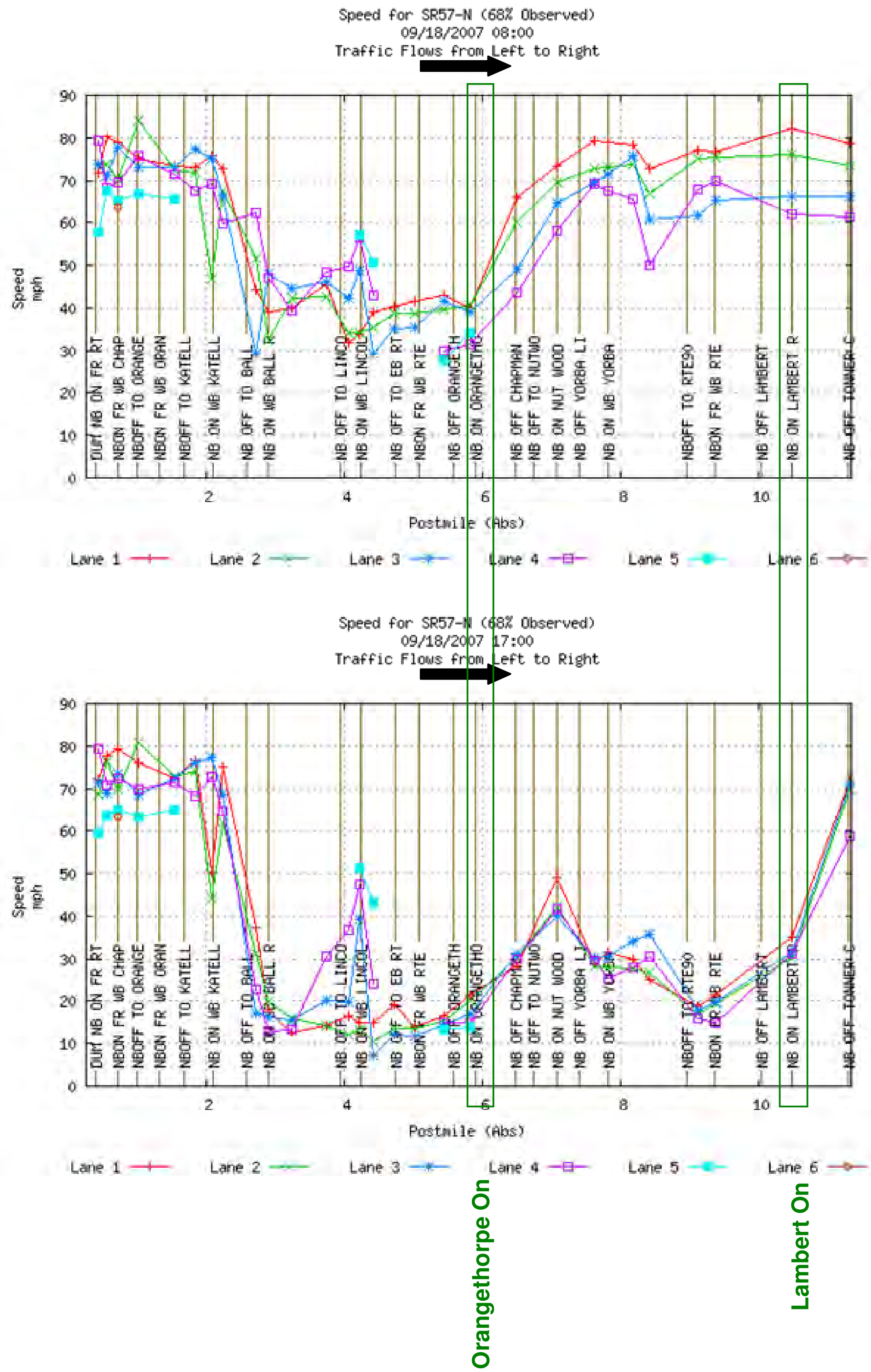


Exhibit 4-10: Northbound Speed Contour Plots (April 2007)

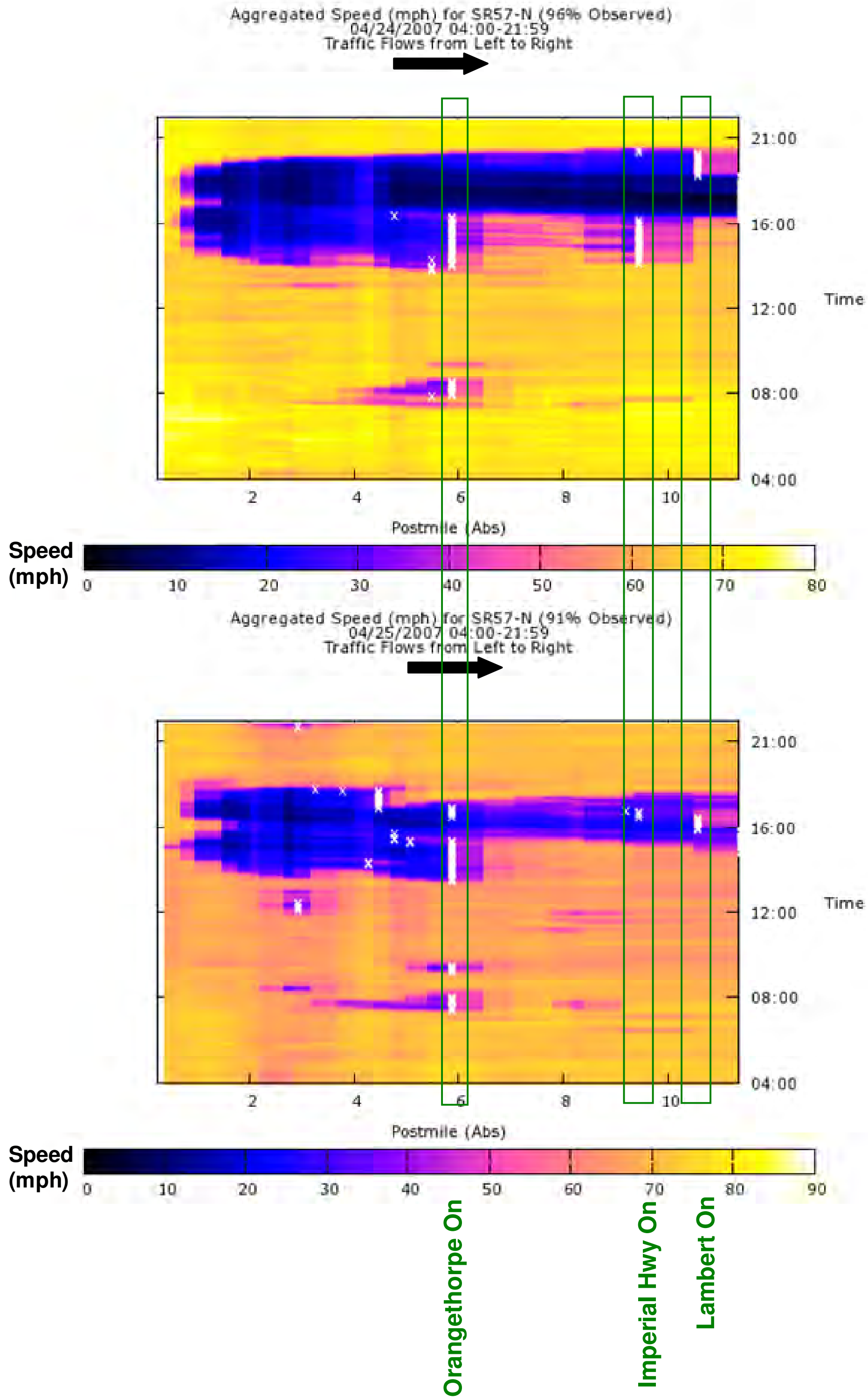
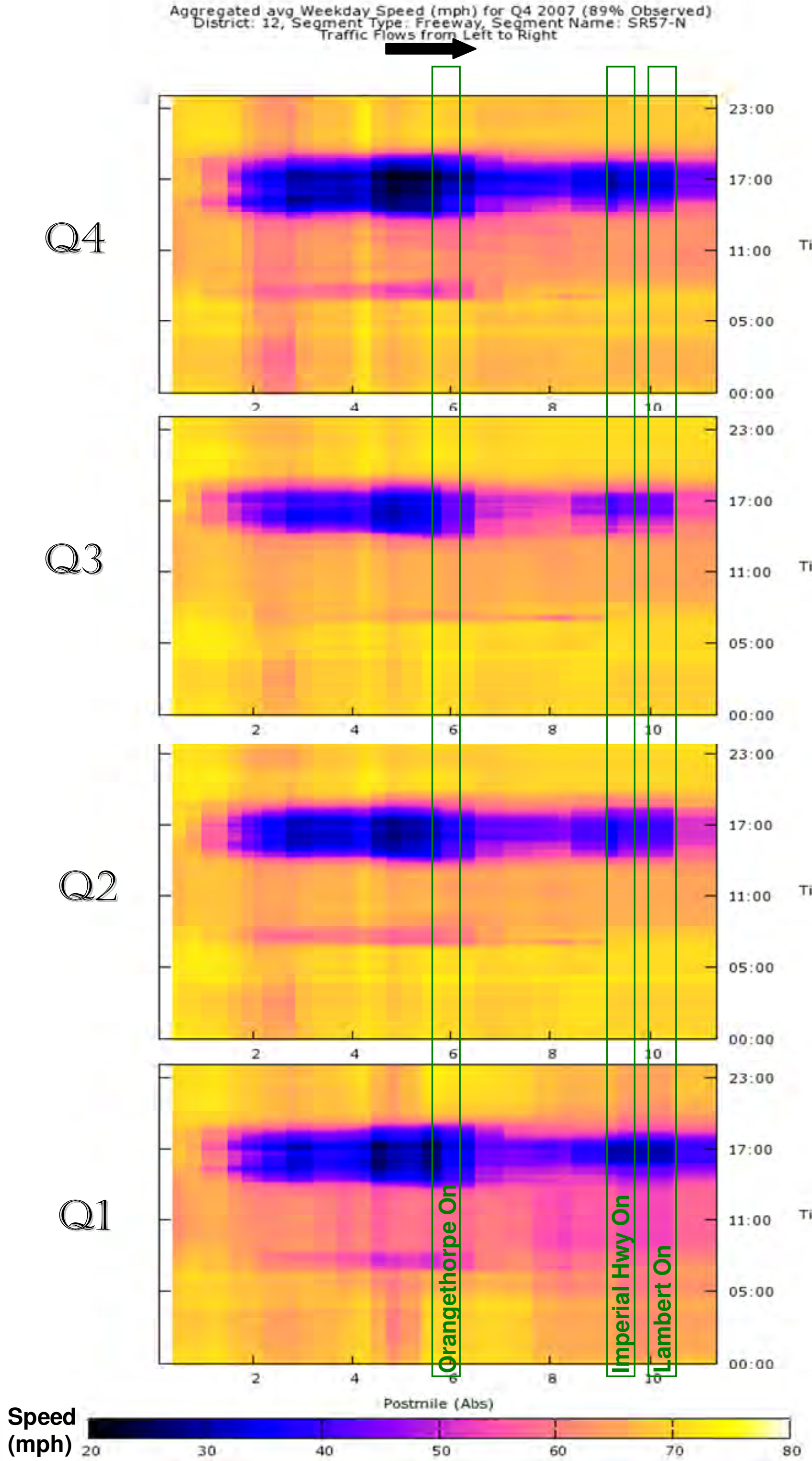


Exhibit 4-11: Northbound Speed Long Contours (2007 Quarterly Averages)



Southbound SR-57 Detector Analysis

Similarly, the study team analyzed speed contour and speed profile plots for sample days in September and April 2007 for the southbound direction. Exhibits 4-12 to Exhibit 4-15 illustrate the speed contour and profile plots for the SR-57 freeway corridor in the southbound 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 Orange/Los Angeles County line to the I-5/SR-22 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 4-12: Southbound Speed Contour Plots (September 2007)

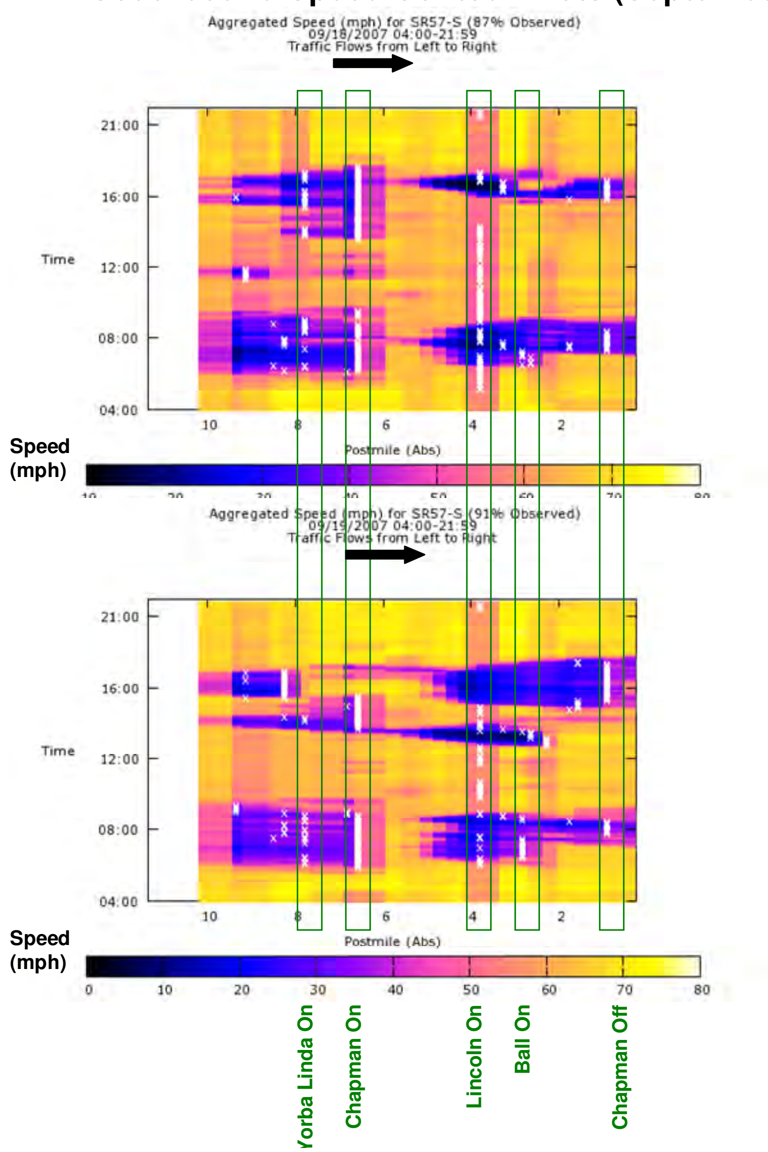


Exhibit 4-13: Southbound Speed Profile Plots (September 18, 2007)

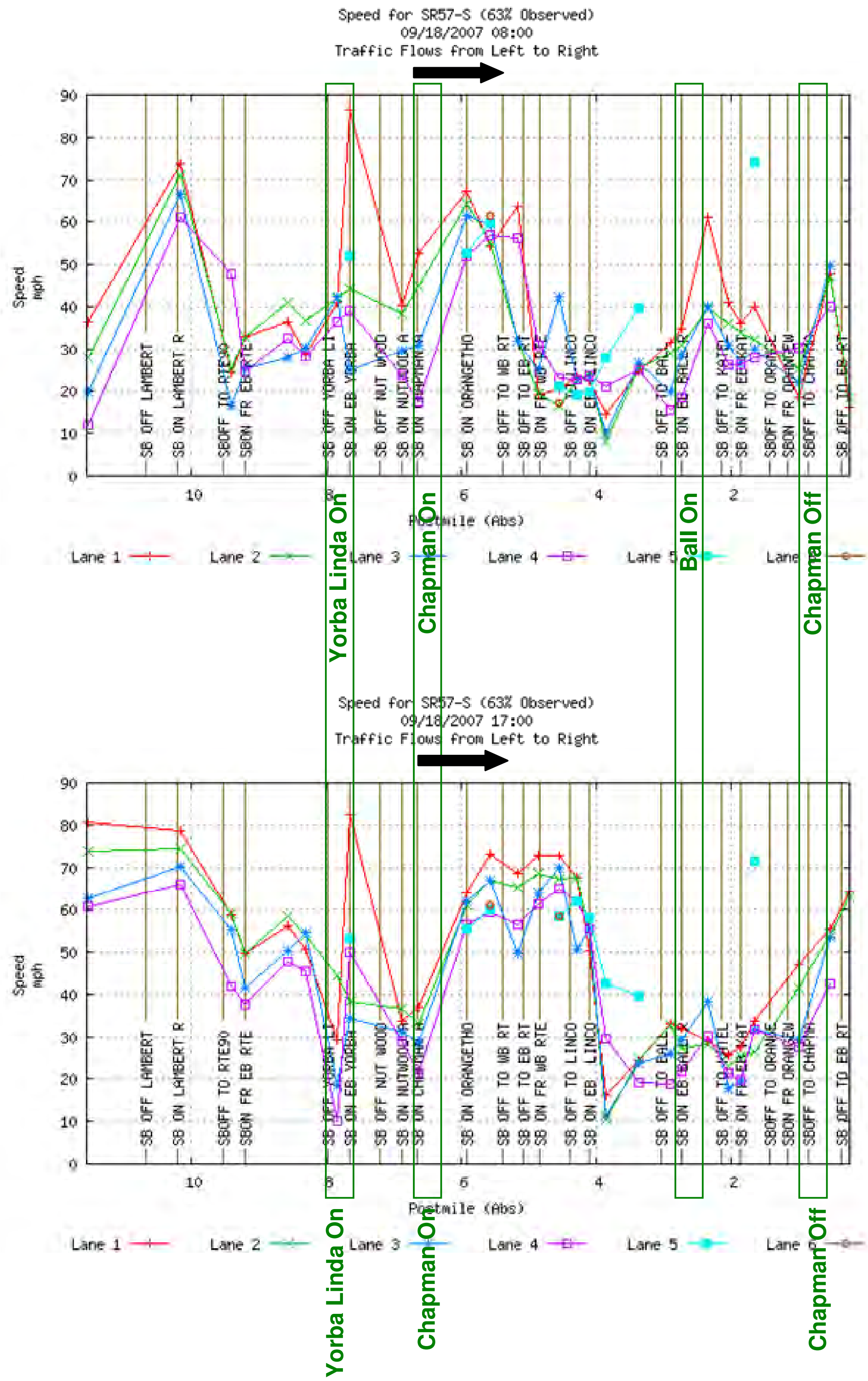


Exhibit 4-14: Southbound Speed Contour Plots (April 2007)

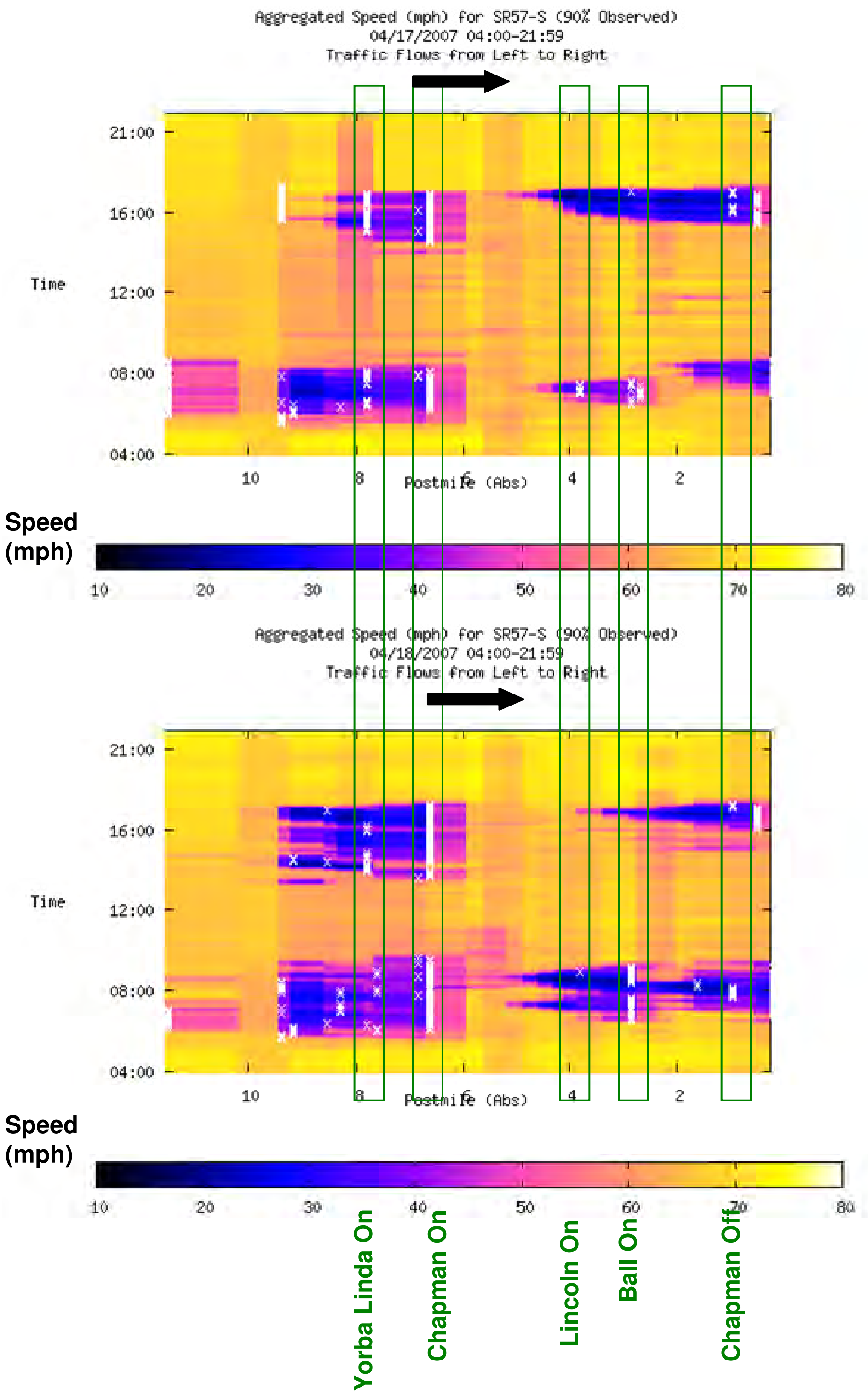
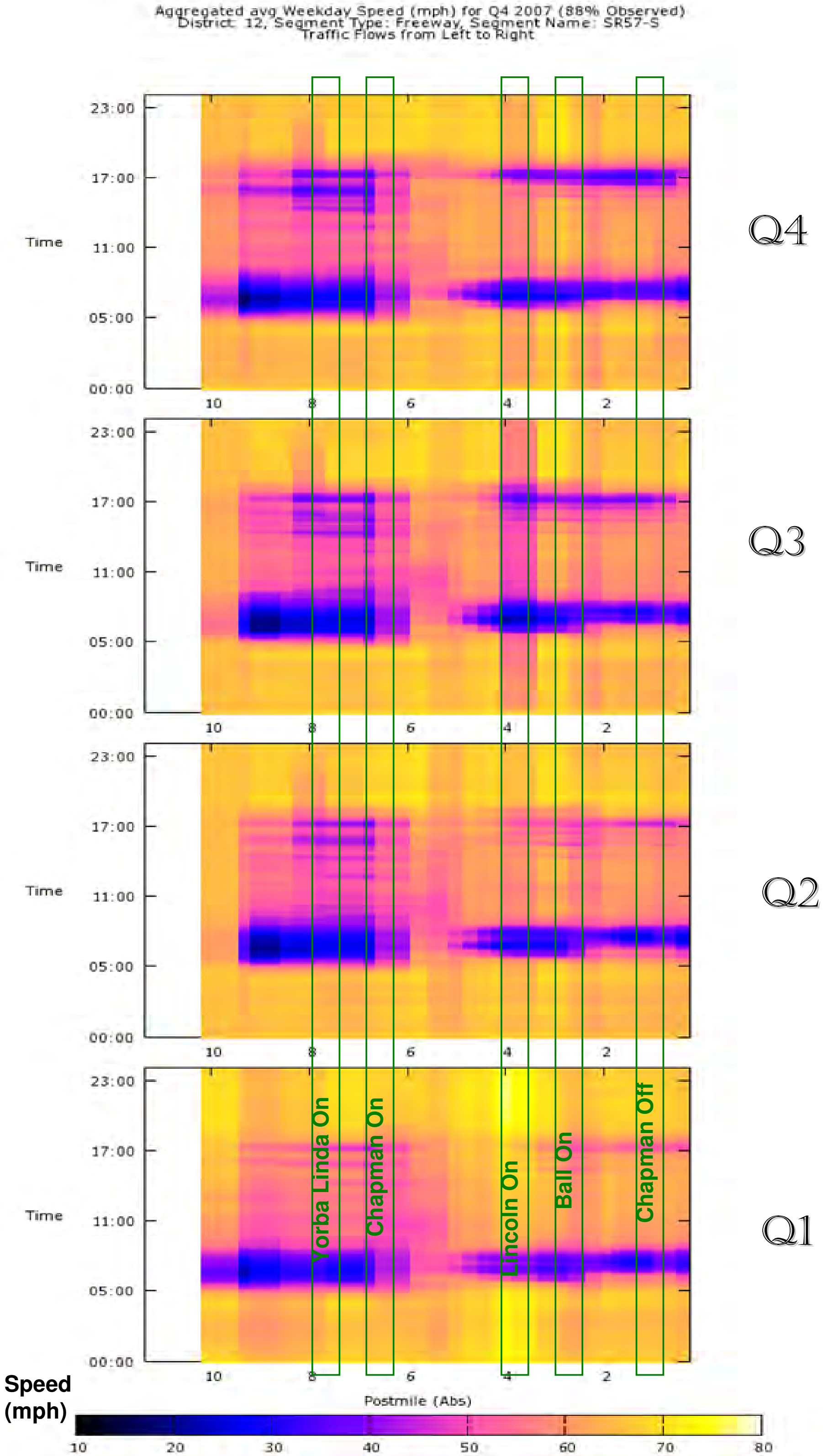


Exhibit 4-15: Southbound Speed Long Contours (2007 Quarterly Averages)



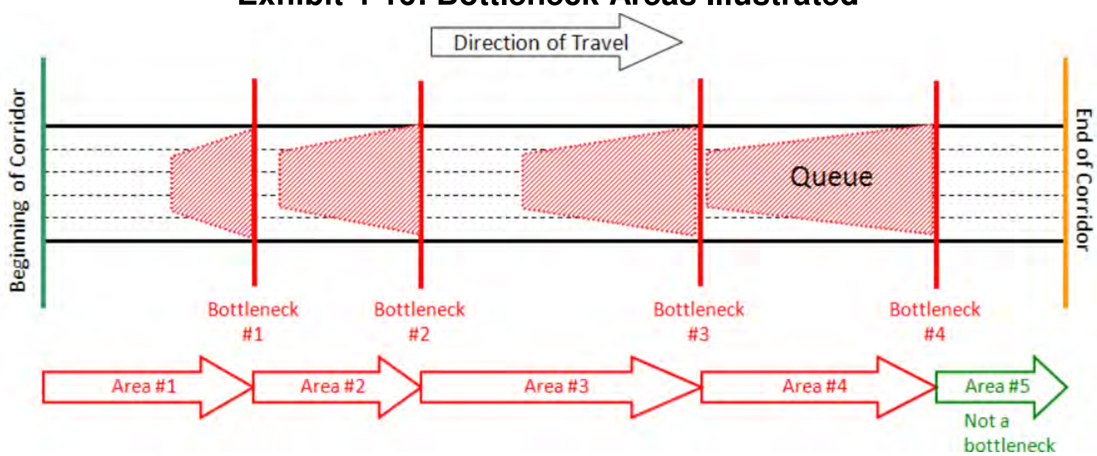
Bottleneck Area Analysis

Once the bottlenecks were identified, the corridor was divided into "bottleneck areas." Bottleneck areas represent segments that are defined by one major bottleneck (or a number of smaller ones). By segmenting the corridor into these bottleneck areas, the performance statistics presented earlier for the entire corridor in Section 3 of this report 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. Performance statistics that lend themselves to such segmentation include:

- Delay
- Productivity
- Safety.

The analysis of bottleneck areas is based on 2007 data (when available) and limited to the mainline facility due to the limited detection available on the HOV facility. Based on this approach, the study corridor comprises several bottleneck areas, which differ by direction. Exhibit 4-16 illustrates the general concept of bottleneck areas in one direction. The red lines in the exhibit represent the bottleneck locations and the arrows represent the bottleneck areas.

Exhibit 4-16: Bottleneck Areas Illustrated



Dividing the corridor into bottleneck areas makes it easier to compare the various segments of the freeway with each other. Based on the above, the bottlenecks previously identified in Exhibit 4-1 are shown again in Exhibit 4-17 with the associated bottleneck areas.

Exhibit 4-17: Orange County SR-57 Bottleneck Areas

Dir	Bottleneck Location	Bottleneck Area	Active Period		From		To	
			AM	PM	Abs	CA	Abs	CA
NB	Tonner Canyon Rd	Lambert Rd On to Tonner Canyon Rd		✓	10.43	21.10	11.35	22.06
NB	Lambert Rd On	Imperial Hwy On to Lambert Rd On		✓	9.13	19.80	10.43	21.10
NB	Imperial Hwy On	Orangethorpe Ave On to Imperial Hwy On		✓	5.83	16.56	9.13	19.80
NB	Orangethorpe Ave On	I-5/SR-22/SR-57 IC to Orangethorpe Ave On	✓	✓	0.12	10.70	5.83	16.50
Dir	**Bottleneck Location**	**Bottleneck Area**	**Active Period**		**From**		**To**	
			AM	**PM**	**Abs**	**CA**	**Abs**	**CA**
SB	Imperial Hwy On	South of Tonner Canyon Rd to Imperial Hwy On	✓		11.35	22.06	9.19	19.95
SB	Chapman Ave On	Imperial Hwy On to Chapman On	✓	✓	9.19	19.95	6.64	17.18
SB	Ball Rd On	Chapman On to Ball On	✓	✓	6.64	17.18	2.73	13.27
SB	I-5 Off / SR-57 Terminus	Ball on to I-5/SR-22/SR-57 IC	✓	✓	2.73	13.27	0.12	10.70

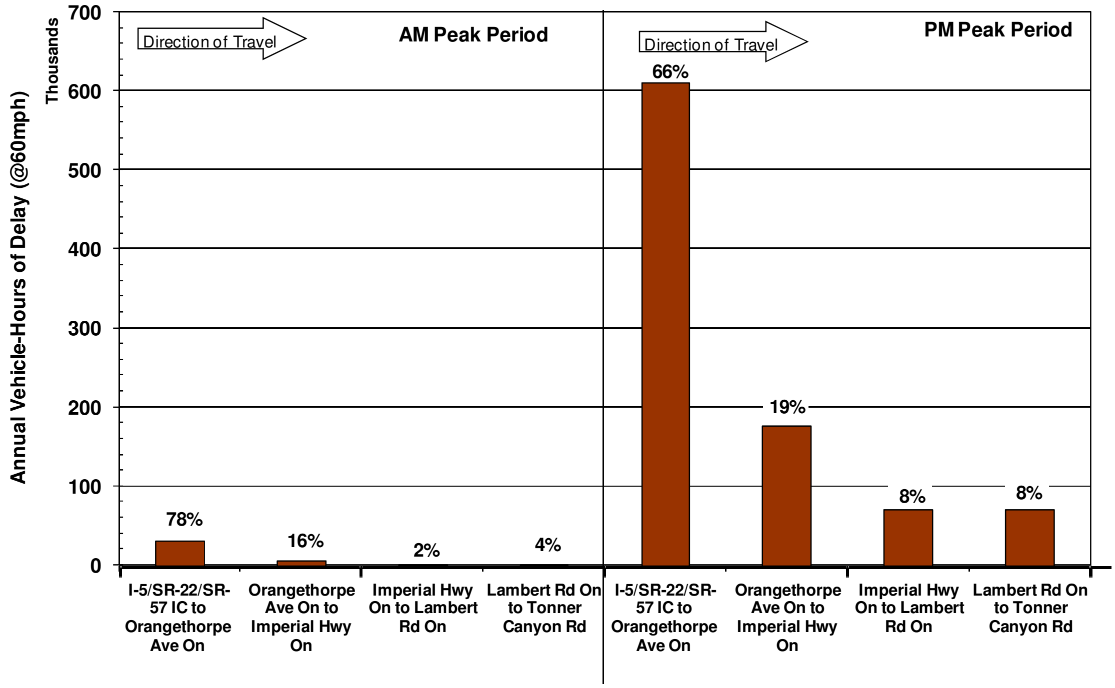
This section will use the previously discussed performance measures of mobility, safety, and productivity to evaluate each bottleneck area. The results from this bottleneck analysis will reveal which segments of the corridor should be prioritized for improvements.

Mobility by Bottleneck Area

Mobility describes how efficiently the corridor moves vehicles. Vehicle-hours of delay measured at 60 mph were calculated for each segment. The results reveal the areas of the corridor that experience the worst mobility.

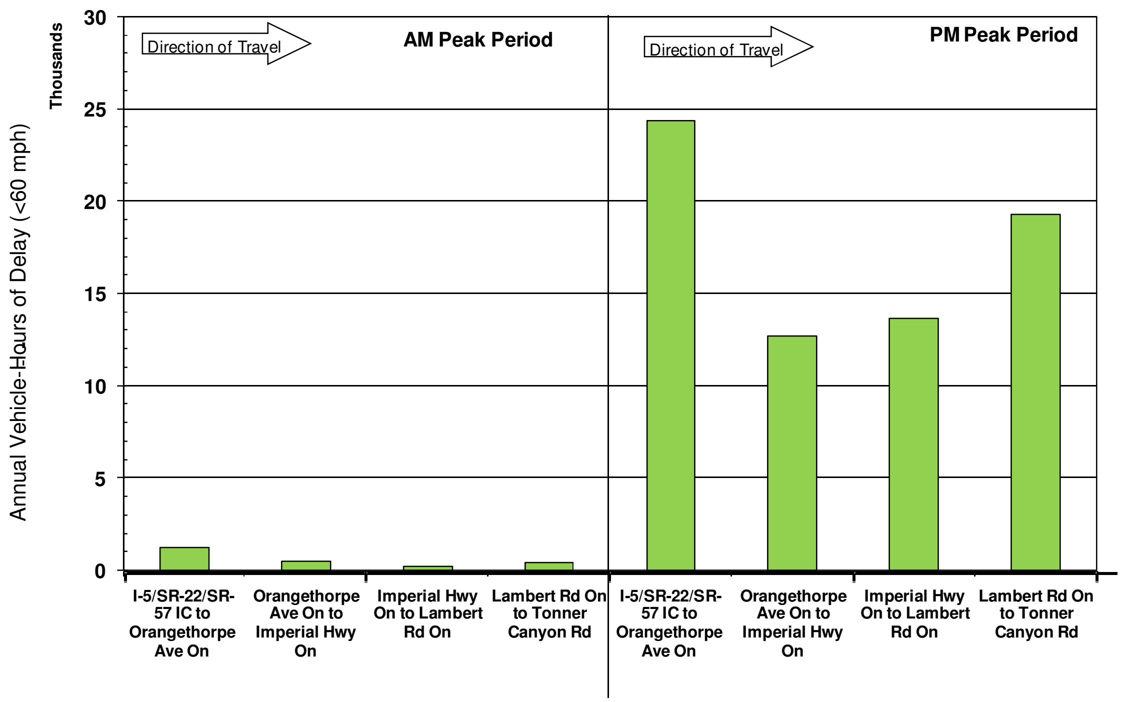
Exhibits 4-18 and 4-20 illustrate the vehicle-hours of delay experienced by each bottleneck area. In the northbound direction, the delay during the AM peak is noticeably less than the PM peak with all segments of the corridor having experienced less than 100,000 annual vehicle-hours of delay during the AM peak. However, during the PM peak, the single segment between the I-5/SR-22 Interchange and Orangethorpe Avenue experienced over 600,000 vehicle-hours of delay (66 percent of the corridor's delay during the PM peak), making it the most congested segment on the corridor. Delay in the southbound direction illustrates a reversed pattern of travel from the northbound direction with greater delay during the AM peak than the PM peak. The segment from Imperial Highway to Chapman Avenue (City of Fullerton) experienced the most AM delay with over 160,000 hours (37 percent), while the segment from Chapman Avenue (City of Fullerton) to Ball Road experienced the most PM delay with under 74,000 (37 percent).

Exhibit 4-18: Northbound Annual Vehicle-Hours of Delay (2007)



Source: Caltrans detector data

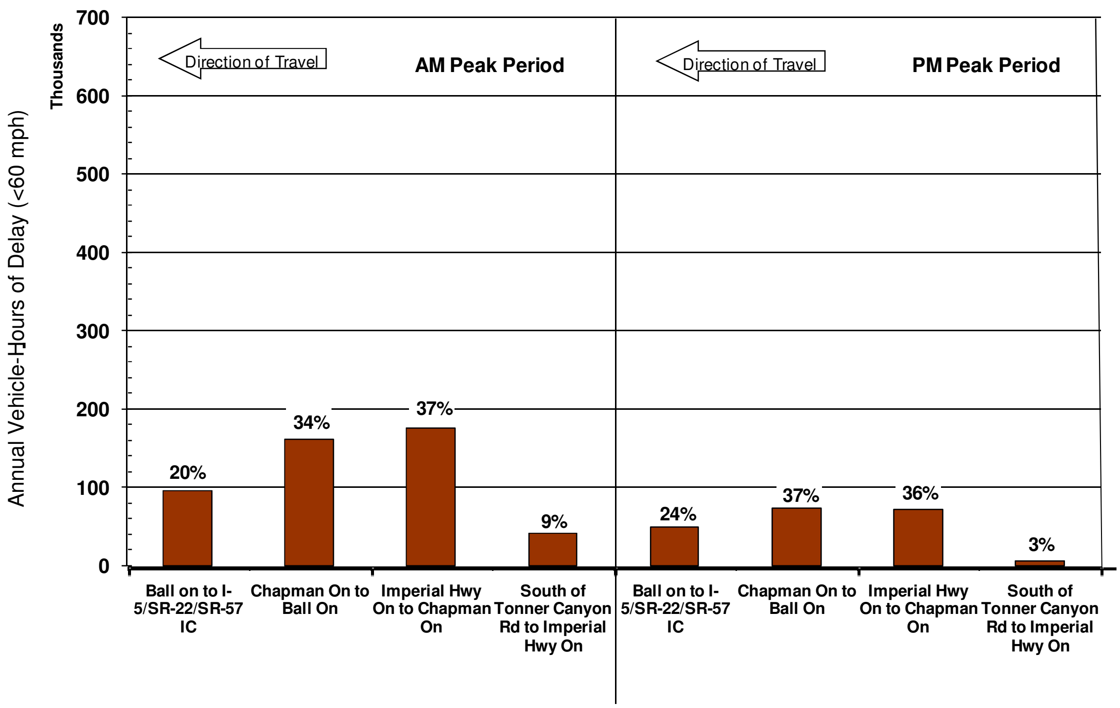
Exhibit 4-19: Northbound Delay per Lane-Mile (2007)



Source: Caltrans detector data

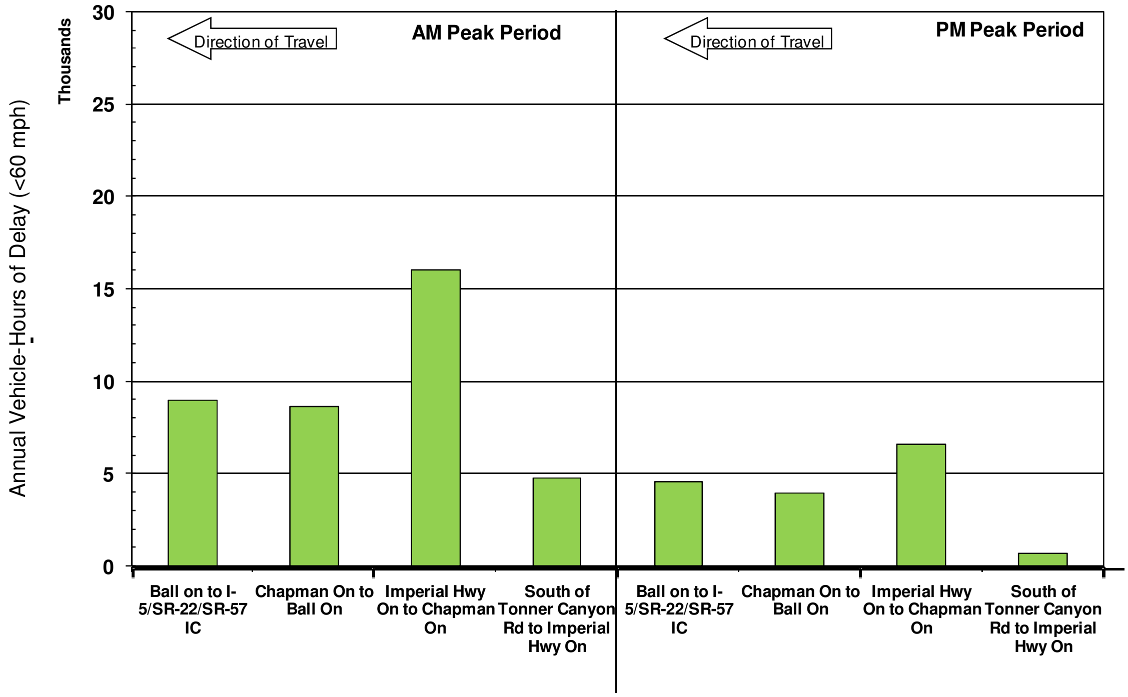
Exhibits 4-19 and 4-21 normalize delay to reflect delay per lane-mile. The delay calculated for each bottleneck area was divided by the total lane-miles for each bottleneck area to obtain delay per lane-mile. The results of these exhibits indicate a similar pattern to Exhibits 4-18 and 4-20. Exhibit 4-18 illustrates a greater contrast between delay in the AM and PM peaks in the northbound direction with the PM peak having experienced considerably more delay per lane-mile in each bottleneck area than the AM peak. Exhibit 4-21 remained consistent with Exhibit 4-20, showing the same pattern of delay and the same segment with the greatest delay, from Imperial Highway to Chapman Avenue (City of Fullerton) during both AM and PM peak periods.

Exhibit 4-20: Southbound Annual Vehicle-Hours of Delay (2007)



Source: Caltrans detector data

Exhibit 4-21: Southbound Delay per Lane-Mile (2007)



Source: Caltrans detector 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. Concentrated highway collisions may be indicative of safety issues. TASAS produces a "Table C" that reports collision concentrations. It counts the total number of collisions for three, six, 12, 24, and 36-month periods. Locations with four or more collisions and significance in the three, six, or 12-month period are flagged as requiring investigation. The northbound direction did not yield any Table C locations. However, there were several Table C locations in the southbound direction. Exhibit 4-22 shows the number of Table C collisions by bottleneck area during three different 12-month periods. In the southbound direction, the bottleneck area from Ball Road to the I-5/SR-22 Interchange experienced the most Table C collisions with 170 during the July 2004-June 2007 period. This bottleneck area also experienced high levels of delay during both peak periods with roughly a quarter of the corridor's delay during both AM and PM peaks.

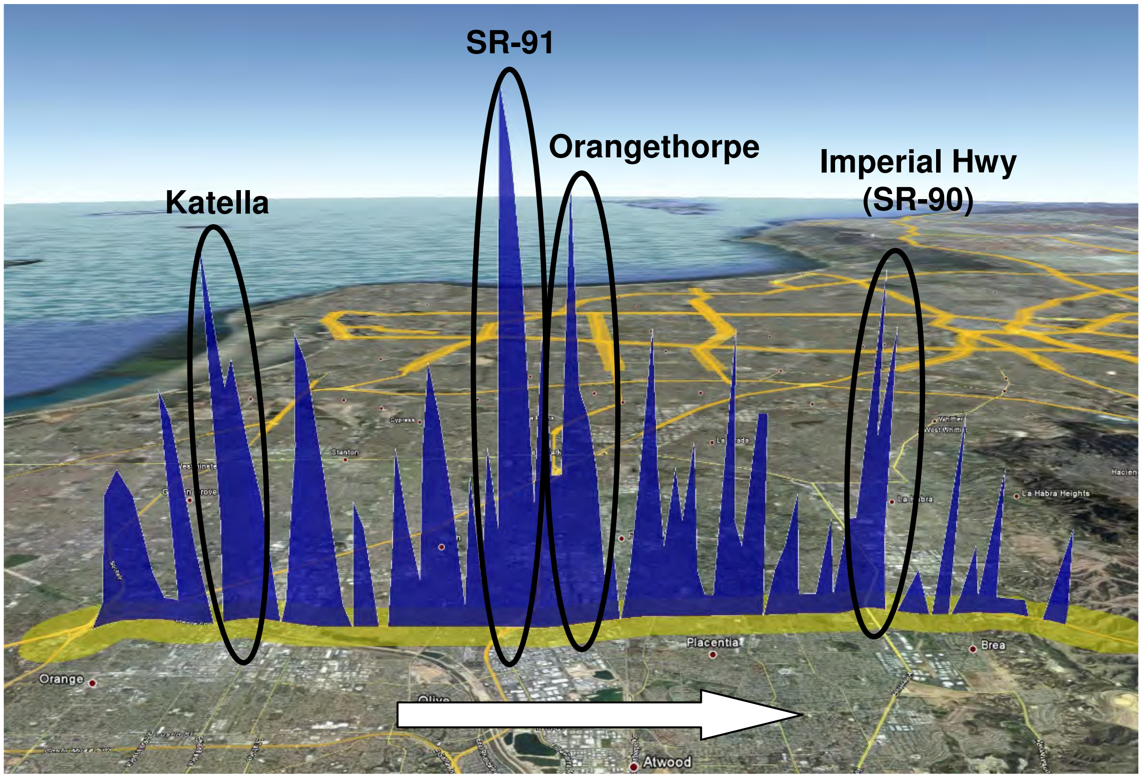
Exhibit 4-22: Southbound Table C Locations and Collisions

From		To		Bottleneck Area	Number of Table C Accidents[1]			
Abs	CA	Abs	CA		July 04-June 05	July 05-June 06	July 06-June 07	36 Mo Total
11.35	22.06	9.19	19.95	South of Tonner Canyon Rd to Imperial Hwy On	50	36	43	129
9.19	19.95	6.64	17.18	Imperial Hwy On to Chapman On	43	60	60	163
6.64	17.18	2.73	13.27	Chapman On to Ball On	Not a Table C Location			
2.73	13.27	0.12	10.70	Ball on to I-5/SR-22/SR-57 IC	51	61	58	170
				Southbound Total	144	157	161	462

Exhibit 4-23 shows the location of all collisions (Table C and other) plotted along the SR-57 Corridor in the northbound direction. The spikes show the total number of collisions (fatality, injury, and property damage only) that occurred within a 0.1 mile segment during 2007. 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.

In the northbound direction, a large number of collisions occurred around Katella Avenue, at the SR-91 Interchange, near Orangethorpe Avenue, and at Imperial Highway (SR-90). It is common for a high collision location to correspond to a bottleneck location. For example, a high spike of collisions occurred at Orangethorpe Avenue, which is also a bottleneck location.

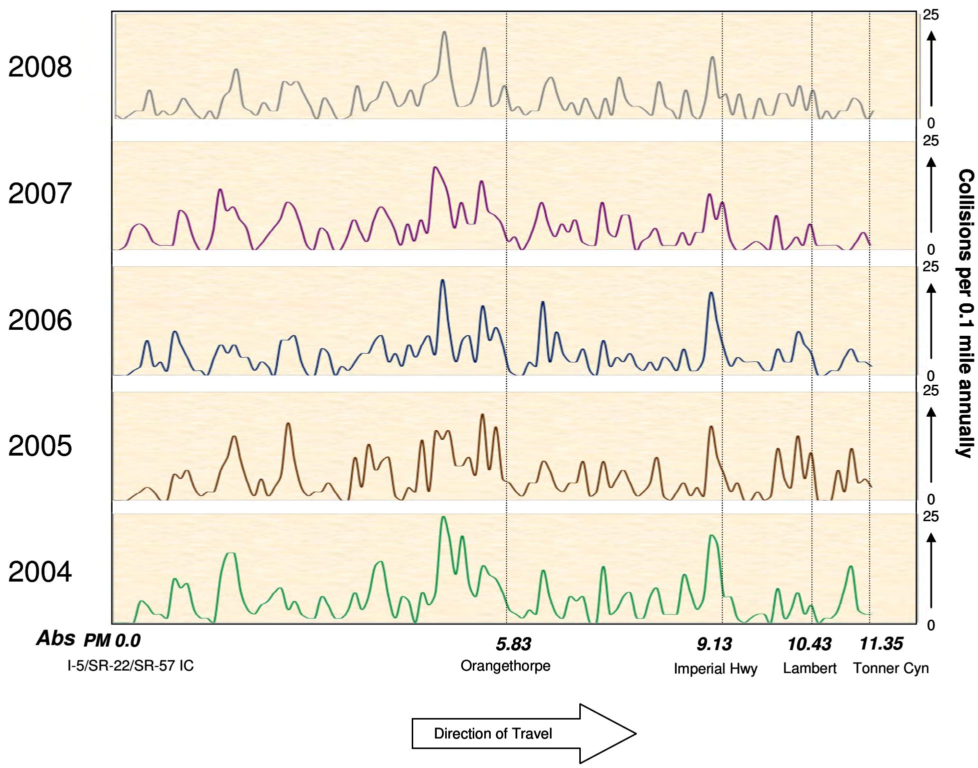
Exhibit 4-23: Northbound Location of Collisions (2007)



Source: TASAS data

Exhibit 4-24 provides a comparison of collision data between 2003 and 2007 by bottleneck area. Similar to Exhibit 4-23, the largest spike corresponds to roughly 22 collisions over 0.1 miles. Exhibit 4-24 demonstrates that the pattern of collisions has remained fairly consistent from one year to the next. Most notably, the group of collisions between Ball Road (Abs PM 2.7) and Orangethorpe Avenue (Abs PM 5.8) has continuously experienced the greatest concentration of accidents since 2003. The number of collisions occurring at the other two locations has appeared to decline slightly during this five-year period.

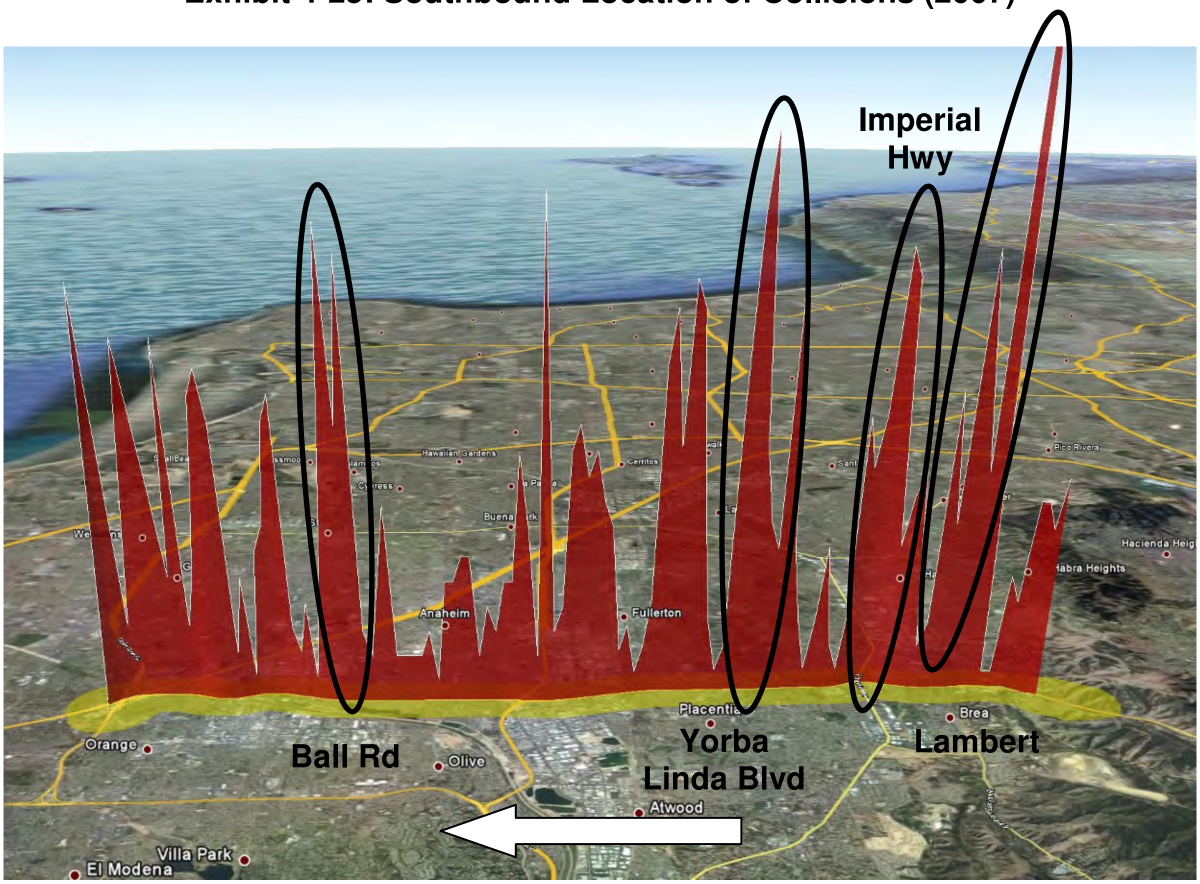
Exhibit 4-24: Northbound Location of Collisions (2004-2008)



Source: TASAS data

Exhibit 4-25 illustrates similar data for SR-57 in the southbound direction during 2007. The largest spike corresponds roughly to 34 collisions per 0.1 miles. The pattern in the southbound direction is similar to the northbound direction but with increased intensity, reflecting a greater number of accidents in the southbound direction compared to the northbound. Moving southbound, high collision locations can be found at Lambert Road, Imperial Highway (SR-90), Yorba Linda Boulevard, and Ball Road. Imperial Highway and Ball Road are also identified bottleneck locations in the southbound direction.

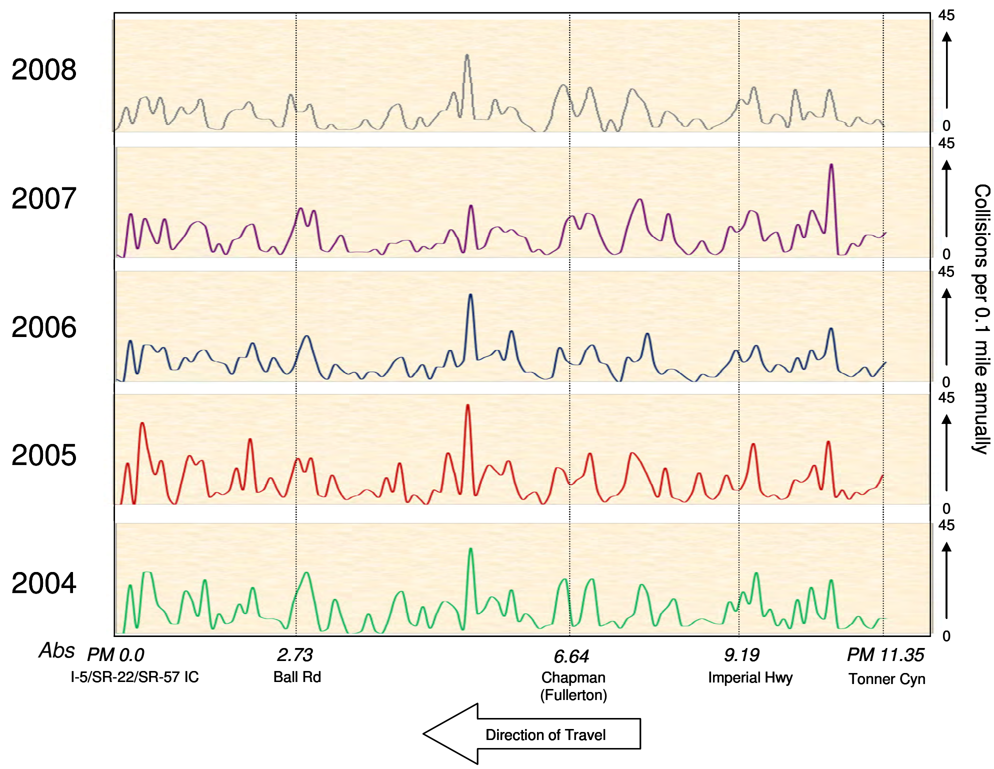
Exhibit 4-25: Southbound Location of Collisions (2007)



Source: TASAS data

Exhibit 4-26 provides a comparison of collision data for the southbound direction between 2003 and 2008. As the exhibit shows, the pattern of collisions has been fairly steady from one year to the next. Since 2003, the southbound direction experienced a slight decrease in the number of collisions between the I-5/SR-22 Interchange and Ball Road. Additionally, the spike near SR-91 (Abs PM 5.2) consistently experienced the highest number of collisions, but decreased significantly between 2006 and 2007.

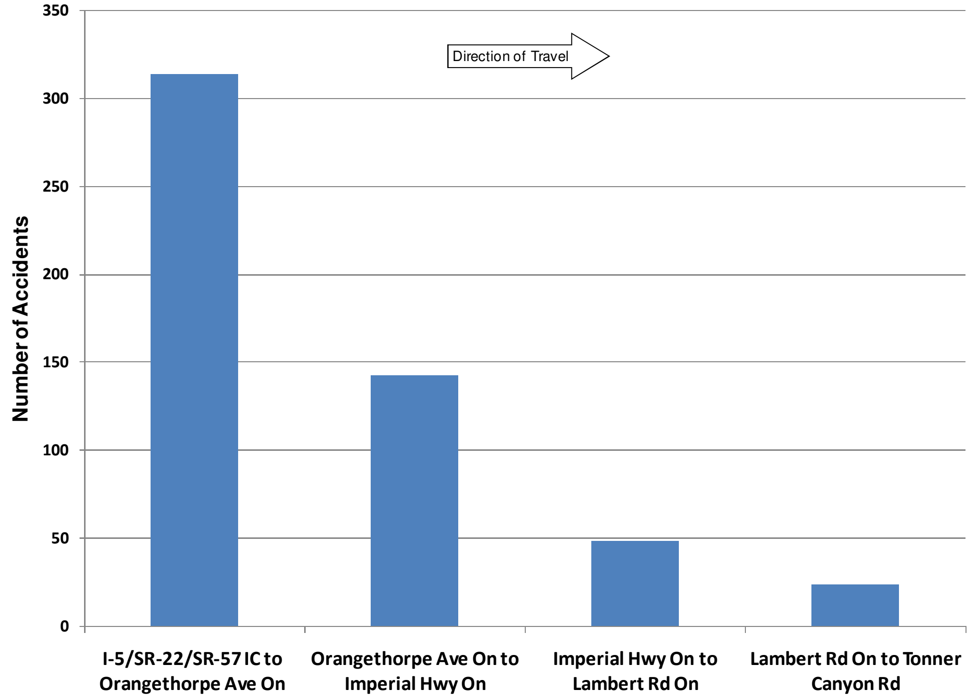
Exhibit 4-26: Southbound Location of Collisions (2004-2008)



Source: TASAS data

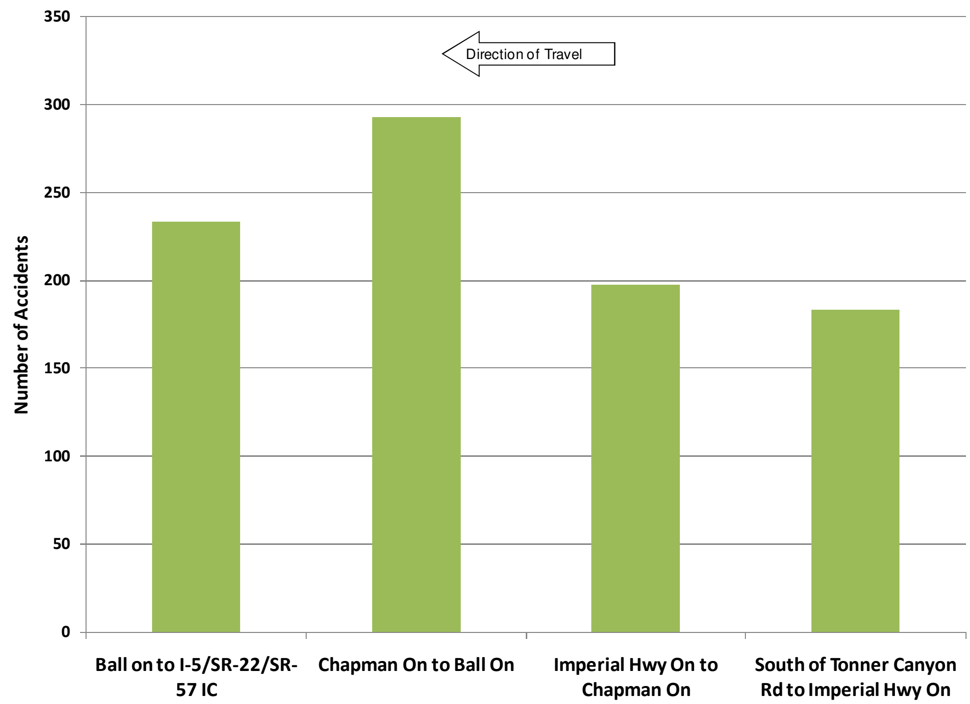
Exhibits 4-27 and 4-28 summarize the average annual accidents reported in TASAS by bottleneck area. The bars show the average annual accidents that occurred in 2005, 2006, and 2007. The exhibits show that the bottleneck areas with the greatest number of accidents (I-5/SR-22 to Orangethorpe Avenue in the northbound and Chapman Avenue (City of Fullerton) to Ball Road in the southbound direction) were also the segments that cover the longest distances. The segment from I-5/SR-22 to Orangethorpe Avenue experienced an average 310 annual accidents (Exhibit 4-27), and the segment from Chapman Avenue to Ball Road experienced an average 290 annual accidents (Exhibit 4-28).

Exhibit 4-27: Northbound Average Annual Accidents (2005-2007)



Source: TASAS data

Exhibit 4-28: Southbound Average Annual Accidents (2005-2007)



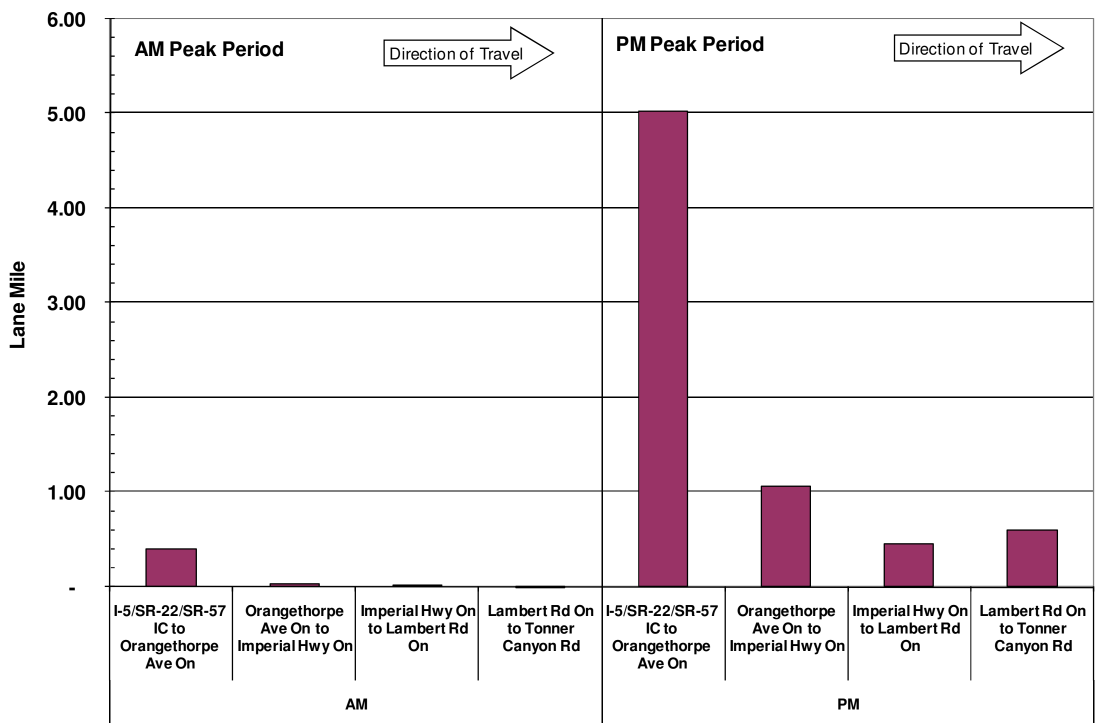
Source: TASAS data

<u>Productivity by Bottleneck Area</u>

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 utilization 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 4-29 and 4-30 show the productivity losses for both directions of the corridor. In the northbound direction, the segment from the I-5/SR-22 Interchange to Orangethorpe Avenue had the worst productivity of any segment on the study corridor. It experienced a productivity loss of over 5.0 lane-miles during the PM peak. During the AM peak, the northbound direction experienced relatively high productivity with all segments of the corridor experiencing less than a half-mile of productivity loss.

Exhibit 4-29: Northbound Lost Lane-Miles (2007)

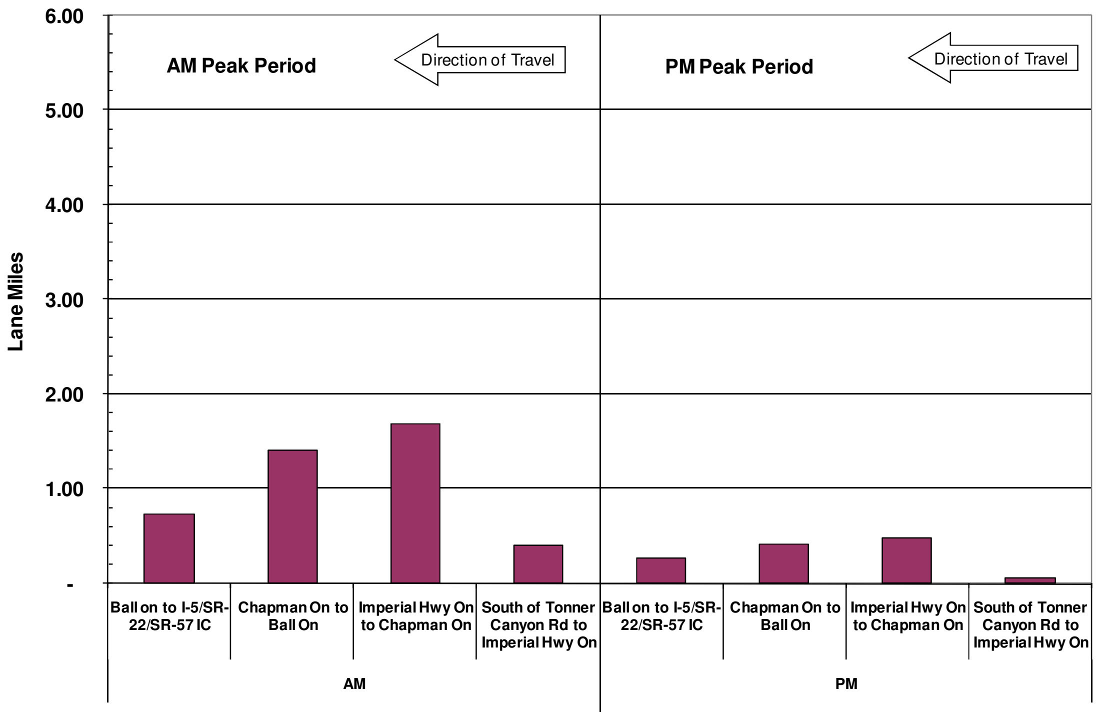


Source: Caltrans detector data

In the southbound direction, the segment from Imperial Highway to Chapman Avenue (City of Fullerton) experienced the greatest productivity loss during the AM peak (1.7 mile), and the PM peak (0.5 mile).

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

Exhibit 4-30: Southbound Lost Lane-Miles (2007)



Source: Caltrans detector data

5. BOTTLENECK CAUSALITY ANALYSIS

This section details the causes of the major bottlenecks identified in Section 4 of this report.

Major bottlenecks are the primary cause of traffic congestion and lost productivity. It is important to verify the precise location and causes of each major bottleneck to develop appropriate, low capital cost operational improvements to maintain corridor mobility.

The location of each major bottleneck was verified by multiple field observations on separate days as discussed in Section 4 of this final report. The cause(s) of each major bottleneck is also identified by field observations and additional traffic data analysis. For the SR-57 study corridor, field observations were conducted by the study team in June, November, and December 2008 during the AM and PM peak hours. The most recent field reviews were conducted on December 3, 5, and 10, 2008.

By definition, a bottleneck is a condition where traffic demand exceeds the capacity of the roadway facility. The cause of a bottleneck is typically related to a sudden reduction in capacity, such as a physical loss when a lane drop occurs or when heavy merging and weaving take place at major on- and off-ramps. Other variables that can cause reductions in capacity include weather or driver distractions. On the demand side, surges in demand can be larger than a roadway can accommodate. In many cases, it is a combination of increased demand and capacity reductions.

Mainline Facility

Northbound Bottleneck Causality

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

From Section 4, the following northbound bottlenecks were identified:

- Orangethorpe Avenue On-Ramp
- Imperial Highway On-Ramp
- Lambert Road On-Ramp
- Tonner Canyon Road

The following is a summary of the northbound bottlenecks and the identified causes.

<u>Katella Avenue On-Ramp</u>

Exhibit 5-1 is an aerial photograph of the northbound SR-57 mainline at the Katella Avenue interchange. As indicated in the exhibit, back-to-back merging from each of the Katella Avenue on-ramps adds about 700 vehicles per hour (vph) to the mainline traffic demand. When the mainline traffic demand is high (i.e., 7,000 vph), a bottleneck condition and traffic congestion typically forms. This non-recurrent bottleneck is included within the Orangethorpe Avenue On-ramp bottleneck area. An example of this bottleneck is shown in the inset photograph below.

Exhibit 5-1: Northbound SR-57 at Katella Avenue On-Ramp

Ball Road On-Ramp

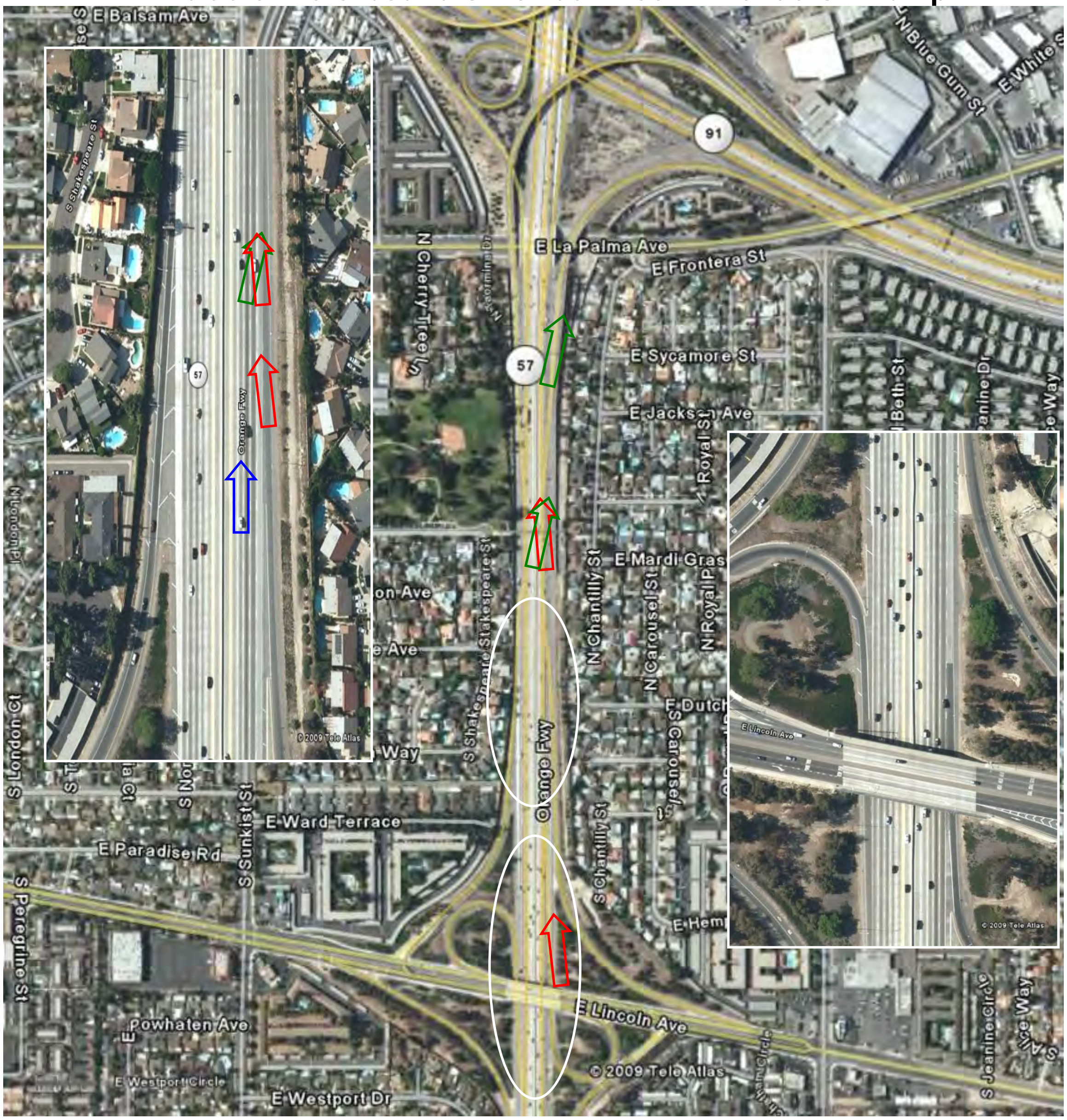
Exhibit 5-2 is an aerial photograph of the northbound SR-57 mainline at the Ball Road interchange. During the PM peak hours, the mainline traffic is at about 6,000 vph in four lanes, or 1,500 vph per lane (vphpl). As indicated in the exhibit, back-to-back merging from each of the Ball Road on-ramps adds about 1,100 vph to the mainline traffic demand. This results in a fairly heavy mainline traffic demand of nearly 1,800 vphpl and significant merging activity; the combination of which often creates a bottleneck condition and traffic congestion. This bottleneck is included in the Orangethorpe Avenue On-ramp bottleneck area.

Exhibit 5-2: Northbound SR-57 at Ball Road On-Ramp

Lincoln Avenue On-Ramp

Exhibit 5-3 is an aerial photograph of the northbound SR-57 mainline at the Lincoln Avenue interchange. During the PM peak hours, the mainline traffic can reach 6,000 vph with four lanes. An additional through-lane is available for the 450 vph of on-coming traffic from the first Lincoln Avenue on-ramp. The second Lincoln Avenue on-ramp must merge with the mainline and the first Lincoln Avenue on-ramp traffic, which combined, can carry up to 6,500 vph in five lanes. Just north of the second Lincoln Avenue on-ramp merge, the mainline traffic loses two through-lanes as one lane becomes an auxiliary lane exiting off to eastbound SR-91, and the other lane becomes an auxiliary lane exiting off to westbound SR-91. As a result, much of the connector off-ramp traffic must weave right, while the mainline traffic and on-ramp traffic must weave left to travel on the three lanes available to through-traffic. This active weaving causes the mainline traffic to breakdown, creating bottleneck conditions and resulting in traffic congestion. This bottleneck is included in the Orangethorpe Avenue On-ramp bottleneck area.

Exhibit 5-3: Northbound SR-57 at Lincoln Avenue On-Ramp



Caltrans

SR-91 On-Ramp /Lane Drop/Orangethorpe Avenue Off-Ramp (Lane Drop)

Exhibit 5-4 is an aerial photograph of the northbound SR-57 mainline at the SR-91 on-ramps and the Orangethorpe Avenue off-ramp interchange. A variety of merging and weaving activities occur at this interchange as a result of the SR-91 eastbound and westbound on-ramp traffic, the mainline lane drop, and the SR-57 traffic exiting Orangethorpe Avenue. As shown in the inset aerial photograph and field photograph below, mainline traffic at the westbound SR-91 on-ramp can reach 5,500 vph in three lanes, with an added lane for the on-ramp traffic carrying about 1,800 vph. Just north of this are two on-coming lanes from the eastbound SR-91, with traffic reaching 2,500 vph merging onto the SR-57 mainlines. Immediately north of the SR-91 connector, one mainline lane is dropped and becomes an auxiliary lane exiting off Orangethorpe Avenue, which requires on-coming SR-91 traffic to weave left, while mainline traffic destined for Orangethorpe Avenue must weave right. As a result of this heavy cross-weaving and the high traffic demand at this location, a bottleneck condition and congestion occurs, as is evident in the inset field photograph. This bottleneck is immediately upstream of and part of the Orangethorpe Avenue bottleneck area.

Exhibit 5-4: Northbound SR-57 at SR-91 On-Ramp /Orangethorpe Avenue Off-Ramp

Orangethorpe Avenue On-Ramp

Exhibit 5-5 is an aerial photograph of the northbound SR-57 mainline at the Orangethorpe Avenue on-ramp. During the PM peak hours, mainline traffic can reach 8,000 vph with five lanes. About 700 vph of Orangethorpe Avenue on-ramp traffic must merge with the mainline traffic and weave left since the outside lane becomes an auxiliary lane. This merging and weaving activity results in a bottleneck condition. This bottleneck and congestion clears just north of the on-ramp and the mainline traffic merges.

Exhibit 5-5: Northbound SR-57 at Orangethorpe Avenue On-Ramp

<u>Yorba Linda Boulevard On-Ramp</u>

Exhibit 5-6 is an aerial photograph of the northbound SR-57 mainline at the Yorba Linda Boulevard interchange. During the PM peak hours, the mainline traffic can reach 7,000 vehicles per hour (vph) with four lanes. Back-to-back ramp merges from Yorba Linda Boulevard add approximately 750 vph (350 vph from the first on-ramp, 400 vph from the second on-ramp) to the mainline traffic. The four lanes cannot accommodate this amount of traffic thus resulting in a bottleneck and congestion that occurs at this location. This bottleneck is included within the Imperial Highway On-ramp bottleneck area.

Exhibit 5-6: Northbound SR-57 at Yorba Linda Boulevard On-Ramp

Imperial Highway On-Ramp

Exhibit 5-7 is an aerial photograph of the northbound SR-57 mainline at the Imperial Highway interchange. During the PM peak hours, the mainline traffic can reach 6,000 vehicles per hour (vph) with four lanes. The two on-ramps merge back to back within a quarter-mile of each other adding up to 1,000 vph for the two on-ramps, resulting in a bottleneck and congestion in this location. This interchange location also has rolling terrain and reverse horizontal curves starting from south of the off-ramp to just north of the on-ramp, which compounds the congestion by causing vehicles to brake and slow down.

Exhibit 5-7: Northbound SR-57 at Imperial Highway On-Ramp

Lambert Road On-Ramp

Exhibit 5-8 is an aerial photograph of the northbound SR-57 mainline at the Lambert Road on-ramp. During the PM peak hours, the mainline traffic can reach 5,500 vehicles per hour (vph) with four lanes. This location only forms a bottleneck during the PM peak hour periods with the added demand of the on-ramp traffic of about 1,000 vph. Although this ramp is metered, platoons of vehicles form and must merge with the freeway mainline traffic, causing mainline traffic flow to break down. This, along with a short merge and steep grade, creates bottleneck conditions and traffic congestion. Throughout the PM peak period, the steady stream of vehicles (platoons) merges on the freeway, as shown in the inset photographs.

Exhibit 5-8: Northbound SR-57 at Lambert Road On-Ramp

Southbound Bottleneck Causality

Major southbound bottlenecks and congestion also occur during both the AM and PM peak hours.

From Section 4, the following southbound bottlenecks were identified:

- Imperial Highway On-Ramp
- Chapman Avenue On-Ramp
- Ball Road On-Ramp
- I-5/SR-57 Terminus

The following is a summary of the southbound mainline major and minor bottlenecks and the identified causes.

Imperial Highway On-Ramp

Exhibit 5-9 is an aerial photograph of the southbound SR-57 mainline at the Imperial Highway interchange. During the AM peak hours, the mainline traffic can reach 6,000 vph with four lanes. As indicated in the exhibit, the two on-ramps merge back to back within less than a quarter-mile of each other adding a total of 1,050 vph (350 vph from the first on-ramp, 700 from the second on-ramp). The combined freeway traffic flow is nearly 1,800 vphpl, which is near the capacity threshold level. This interchange location also has rolling terrain and reverse horizontal curves starting from north of the off-ramp to south of the on-ramp which also impacts the traffic flow creating more congestion.

Exhibit 5-9: Southbound SR-57 at Imperial Highway On-Ramp

<u>Nutwood Avenue-Chapman Avenue On-Ramp</u>

Exhibit 5-10 is an aerial photograph of the southbound SR-57 mainline at the Nutwood Avenue-Chapman Avenue (City of Fullerton) on-ramps. Mainline traffic can reach 7,000 vph, which includes 450 vph from Nutwood Avenue on-ramp. An additional 750 vph from the Chapman Avenue on-ramp contributes to a total freeway flow of over 1,900 vphpl, which is near the capacity threshold level. The Nutwood Avenue and Chapman Avenue on-ramps are back-to-back ramps spaced approximately a quarter-mile of each other. Traffic merging from the Nutwood Avenue on-ramp does not have adequate time and distance to merge with mainline traffic before traffic merging from the Chapman Avenue on-ramp. The back-to-back short merges from the two ramps and the high demand results in creating bottleneck conditions and congestion at this location during both the AM and PM peak hours.

Exhibit 5-10: Southbound SR-57 at Nutwood Avenue-Chapman Avenue On-Ramp

Ball Road On-Ramp

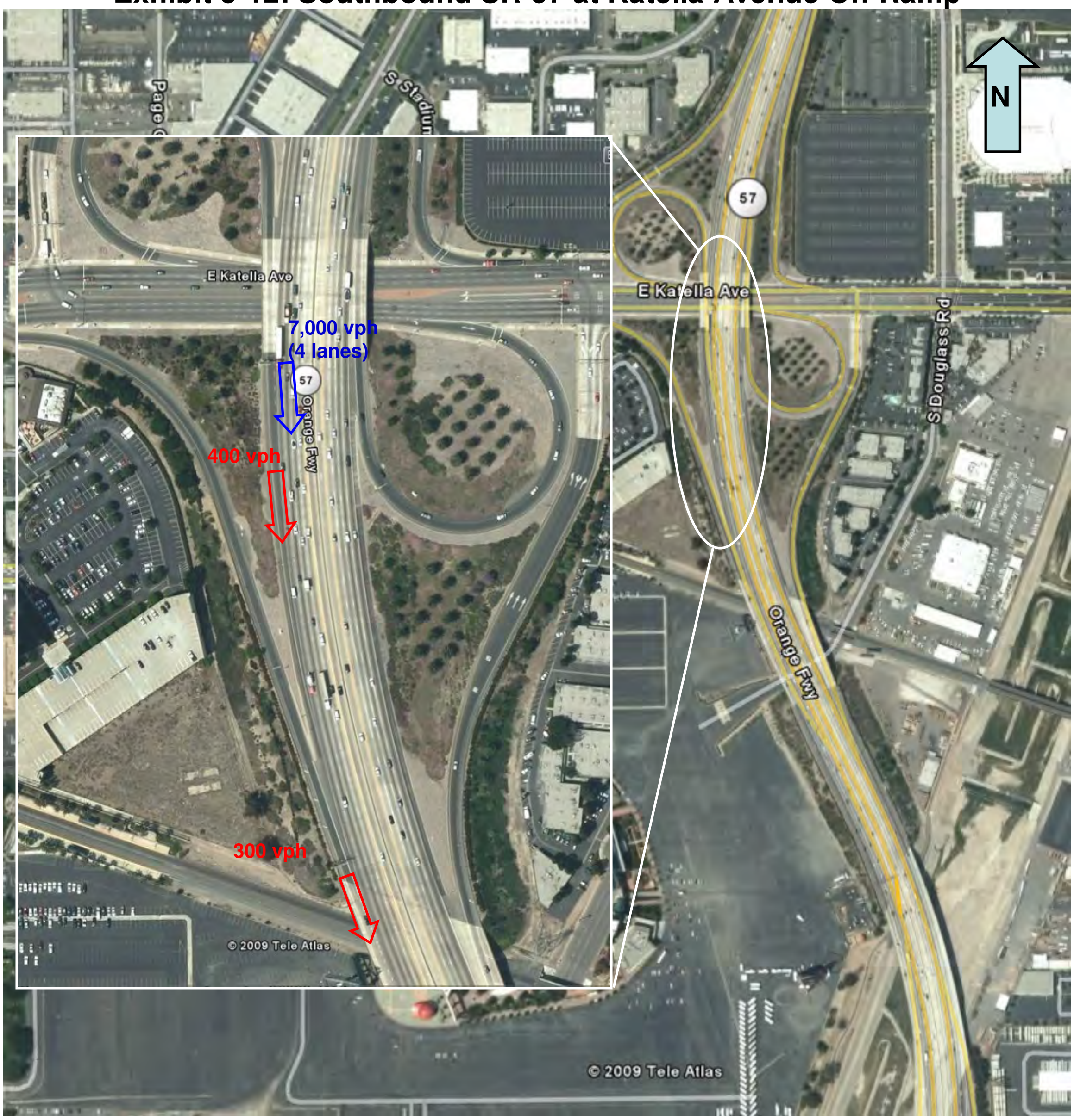
Exhibit 5-11 is an aerial photograph of the southbound SR-57 mainline at the Ball Road interchange. The combined freeway traffic reaches 7,500 vph with four lanes, which includes 300 vph from the first on-ramp and 500 vph from the second on-ramp. The two Ball Road on-ramps are spaced less than a quarter-mile of each other. The close spacing of merging traffic does not allow for the first Ball Road on-ramp traffic to merge completely with mainline traffic before having to merge again with the second Ball Road on-ramp traffic. The back-to-back merge coupled with the high demand of almost 1,900 vphpl results in creating bottleneck conditions and congestion. An example of this is illustrated in the two inset photographs.

Exhibit 5-11: Southbound SR-57 at Ball Road On-Ramp

Katella Avenue On-Ramp

Exhibit 5-12 is an aerial photograph of the southbound SR-57 mainline at the Katella Avenue interchange. The combined freeway traffic can reach 7,700 vph with four lanes, which includes 400 vph from the first on-ramp and 300 vph from the second on-ramp. The two Katella Avenue on-ramps are spaced less than a quarter-mile of each other. These back-to-back merges coupled with the high traffic demand often results in creating bottleneck locations and congestion. This bottleneck is included within the I-5/SR-57 Terminus bottleneck area.

Exhibit 5-12: Southbound SR-57 at Katella Avenue On-Ramp



<u>I-5 Off-Ramp at the SR-57 Terminus</u>

Exhibit 5-13 is an aerial photograph of the southbound SR-57 terminus to the I-5/SR-22 off-ramps. SR-57 ends with two lanes exiting to the southbound I-5 and three lanes exiting to the eastbound and westbound SR-22. The I-5 off-ramp carries up to 3,400 vph. As indicated in the inset photo, vehicles are queued on the left two lanes exiting to I-5, while traffic exiting to SR-22 eastbound and westbound (right three lanes) travel unimpeded. The bottleneck causing the congestion is from the I-5 mainline causing the connector ramp traffic to back up onto the SR-57 mainline.

Exhibit 5-13: Southbound SR-57 at I-5 Off-Ramp

High-Occupancy Vehicle (HOV) Facility

Bottleneck and causality analyses were also conducted for the HOV facilities on SR-57. The bottleneck locations on the HOV facility were initially determined based on detector data analysis and later verified by field reviews that confirmed the actual bottleneck locations and identified the causes. The HOV facility along SR-57 operates on a full-time basis with a vehicle occupancy requirement of two plus in both directions, but is buffer-separated from the mainline facility with varying widths. The proceeding section describes the bottleneck locations and the causes for the bottlenecks that were verified on the SR-57 HOV facilities.

Northbound SR-57 HOV Facility Bottleneck Causality

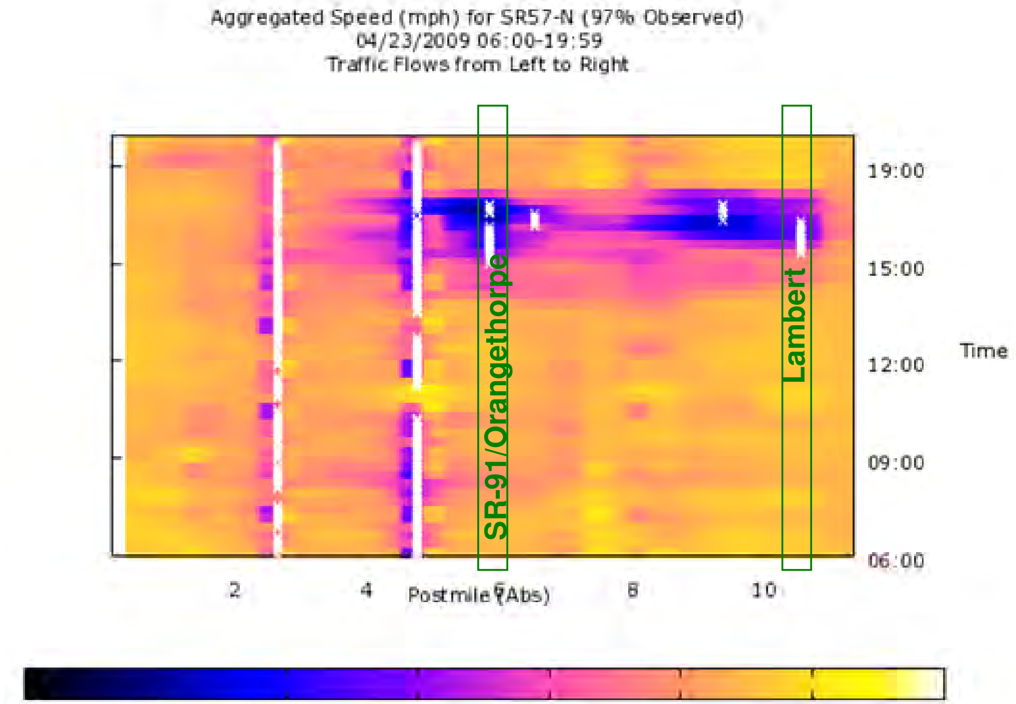
Automatic detector data analysis and field reviews conducted April and May 2009 during the weekday peak period confirm two major bottlenecks in the northbound direction at the following locations:

- SR-91 HOV direct connector and Orangethorpe Avenue
- Lambert Road

The SR-91 HOV direct connector and Orangethorpe Avenue bottleneck is caused by the high demand of HOV traffic at this location while the Lambert Road HOV bottleneck is caused by the steep vertical curve of the road. Exhibit 5-14 presents the speed contour diagram of the northbound SR-57 HOV lane for a sample day in April 2009 and for an average of all weekdays in the month of March 2009.

Exhibit 5-15 is an aerial photograph of the SR-91 HOV direct connector and Orangethorpe Avenue. The SR-57 mainline HOV facility cannot handle the additional surge in demand and merge from the SR-91 HOV direct connector and results in this bottleneck condition. Although there is no ingress/egress at this location, on a typical day, as much as 1,500 vph from the HOV lane must merge with 500 vph coming from the SR-91 HOV direct connector combined, exceeding the available capacity of the facility. This bottleneck has been observed during multiple field visits and is illustrated in the inset field photographs.

Exhibit 5-14: Northbound HOV Lane Speed Contour Plots (2009)



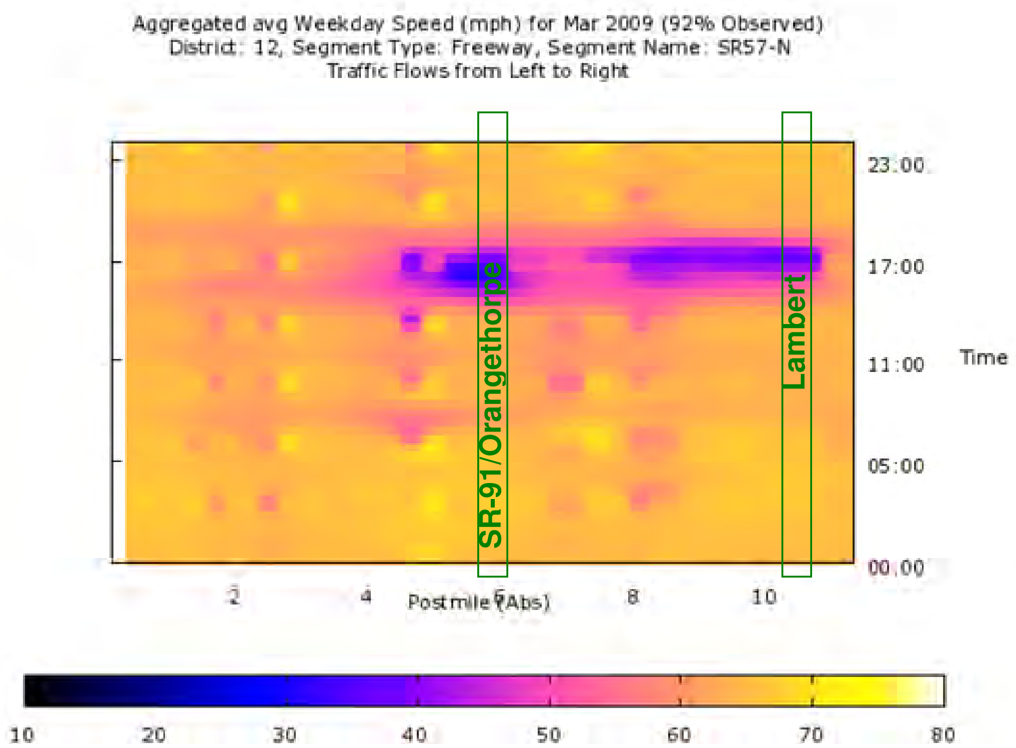


Exhibit 5-15: Northbound SR-57 between SR-91 HOV Direct Connector and Orangethorpe

Exhibit 5-16 is an aerial photograph of the HOV lane bottleneck area for the Lambert Road location. HOV traffic must climb a steep vertical curve at this location, which causes a bottleneck to form upstream that queues back over two miles. Once traffic passes the peak of the vertical curve, the bottleneck clears, as illustrated in the exhibit.

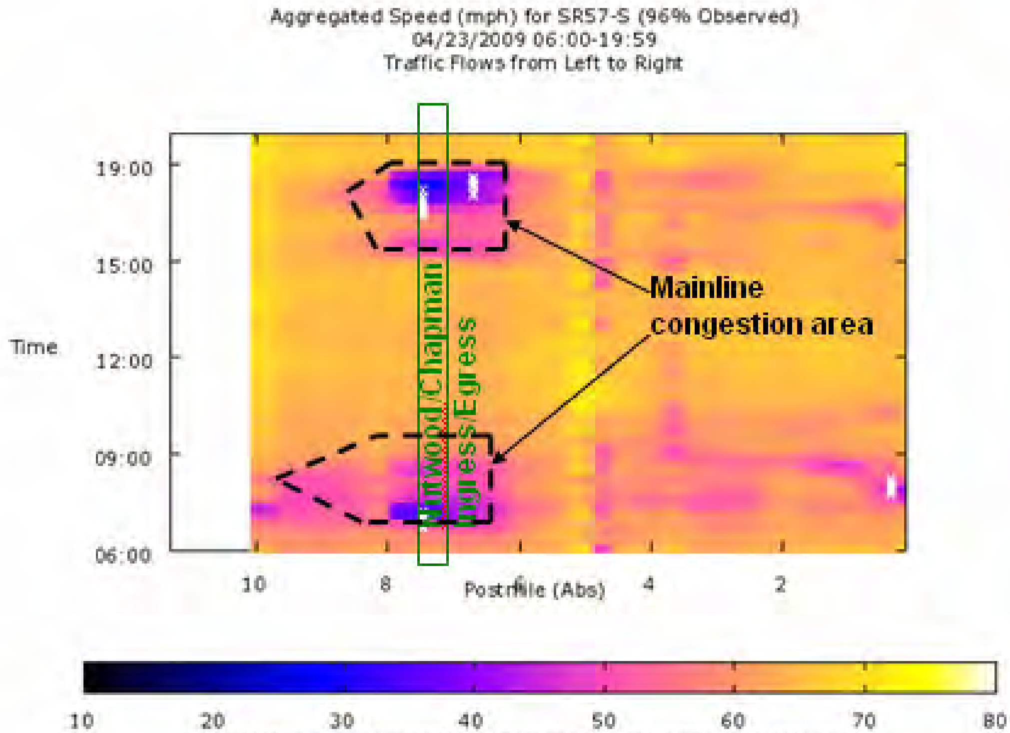
Exhibit 5-16: Northbound HOV Lane at Lambert Road

Southbound SR-57 HOV Facility Bottleneck Causality

Automatic detector data analysis and field reviews conducted in April and May 2009 during the weekday peak period confirm one major bottleneck in the southbound direction at the Nutwood Avenue and Chapman Avenue ingress/egress.

This bottleneck location is caused by weaving traffic entering and exiting at the HOV lane ingress/egress area during the peak hours. Exhibit 5-17 presents the speed contour diagram of the southbound SR-57 HOV lane for a sample day in April 2009 and for an average of all weekdays in the month of March 2009. As indicated in the exhibit, this bottleneck location is within the mainline congestion area. As a result, the vehicles on the HOV lane that intend to exit the corridor must stop to squeeze into the mainline congested traffic stream. Similarly, the vehicles on the mainline that intend to enter the HOV lane must do so from a very low speed, disrupting the HOV lane flow.

Exhibit 5-17: Southbound HOV Lane Speed Contour Plots (2009)



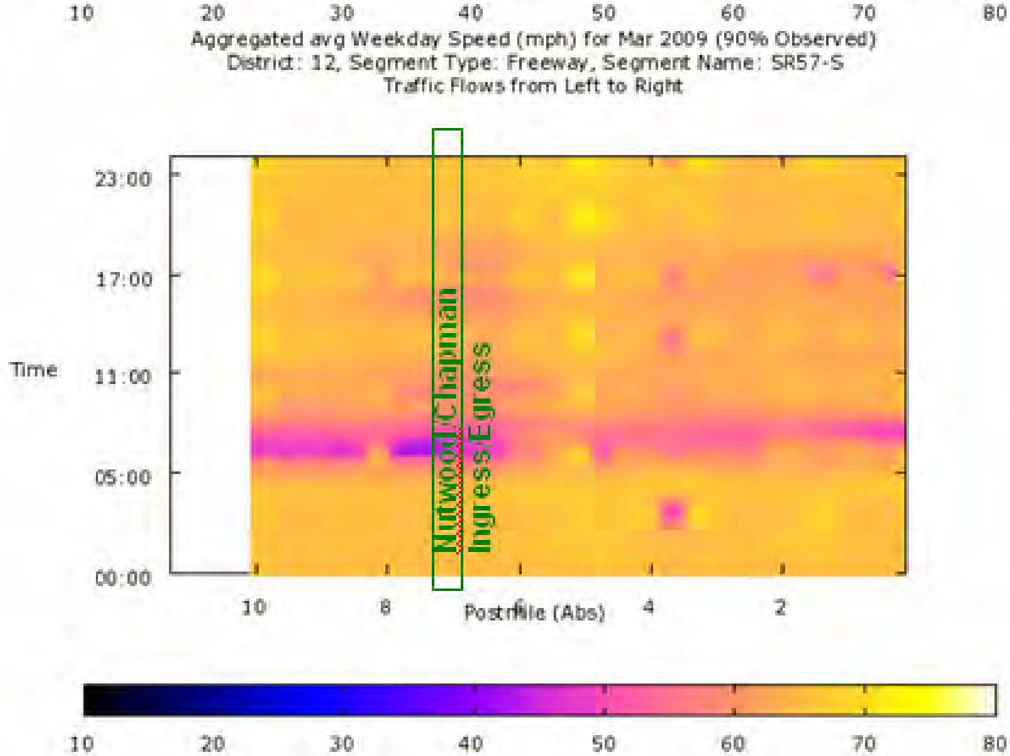


Exhibit 5-18 is the aerial photograph of the bottleneck location of the HOV lane ingress/egress area at Nutwood Avenue and Chapman Avenue. When the mainline freeway is congested, vehicles have a difficult time entering and exiting the HOV lane. As a result, bottleneck conditions occur and vehicles queue behind this area. The HOV volume at this location can reach 1,700 vph, which is near the threshold capacity level of 1,800 vph

Exhibit 5-18: Southbound HOV Ingress/Egress at Nutwood Avenue and Chapman Avenue

Caltrans

6. SCENARIO DEVELOPMENT AND MICRO-SIMULATION

The previous sections presented the diagnostic part of the CSMP effort. They describe the corridor, examine its performance trends, and pinpoint its bottlenecks and related causes. This section describes the improvement evaluation component of the CSMP effort. It describes the logic behind developing the scenarios to be evaluated and presents the mobility results estimated by using the Paramics micro-simulation model. It also summarizes the overall benefit cost analysis results conducted to compare costs to benefits. The following steps are discussed in more detail below:

- Developing a traffic model based on current and medium-term demands
- Combining projects in a logical manner into "scenarios" for modeling and testing
- Evaluating model scenario outputs and summarizing results
- Conducting a benefit cost assessment of scenarios

Traffic Model Development

In order to evaluate the effectiveness of any proposed project or set of projects, an SR-57 traffic model was developed by the modeling team using the Paramics micro-simulation software.

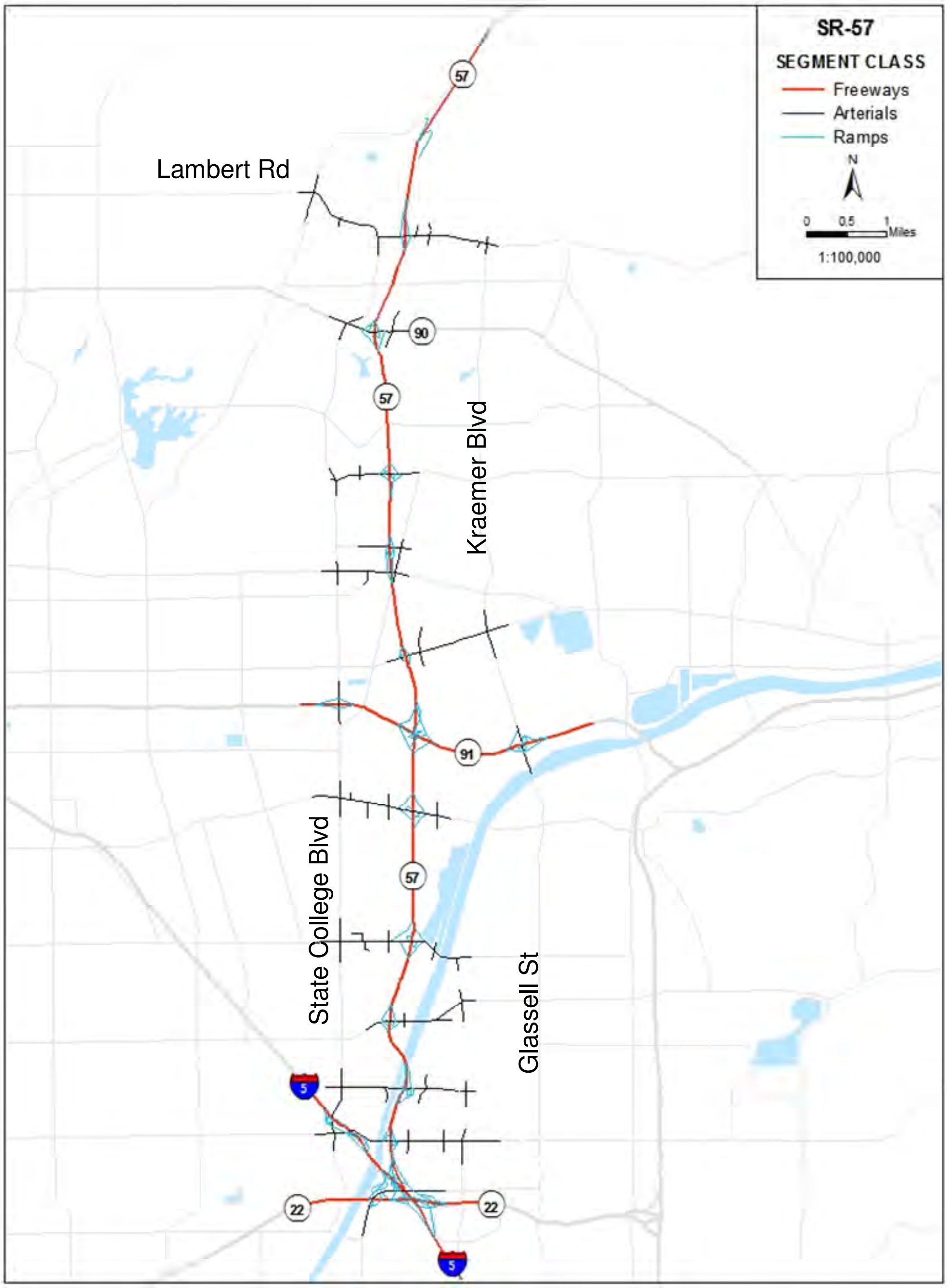
It is important to note that micro-simulation models are complex to develop and calibrate for large congested urban corridors such as the SR-57 Corridor. However, it is one of the only tools capable of providing a reasonable approximation of bottleneck formation and queue development. Such tools help quantify the impacts of operational strategies, which traditional travel demand models cannot.

Exhibit 6-1 shows the roadway network included in the SR-57 model. The model includes all freeway interchanges, arterial sections leading to these interchanges, and on- and off-ramps.

The model was calibrated against 2007 conditions. This was a resource intensive effort, requiring several review cycles until the model reasonably matched bottleneck locations and relative severity. Once the calibrated 2007 base year model was approved, a 2020 model was developed based on the Orange County Transportation Authority's (OCTA) travel demand model demand projections. Caltrans and the study team agreed to 2020 as the Horizon Year since micro-simulation modeling captures operational strategies, but is typically suited for the short- to medium-term forecasting. Note that latent demand over and beyond the OCTA forecast demand was not accounted for in the analysis.

These two models were then used to evaluate different scenarios (combinations of projects) to quantify the associated congestion relief benefits and to compare total benefits from each scenario to the associated project costs.

Exhibit 6-1: SR-57 Micro-Simulation Model Network



Scenario Development Framework

The study team developed a framework for combining projects into scenarios. It would be desirable to evaluate every possible combination of projects. However, this would have entailed thousands of model runs. Instead, the team combined projects based on a number of factors, including:

- Projects that were fully programmed and funded were combined separately from projects that were not.
- Short-term projects (typically delivered by 2014) were used to develop scenarios to be tested with the both the 2007 and 2020 models.
- Long-term projects (delivered after 2014, but before or by 2020) were used to develop scenarios to be tested with the 2020 model only.

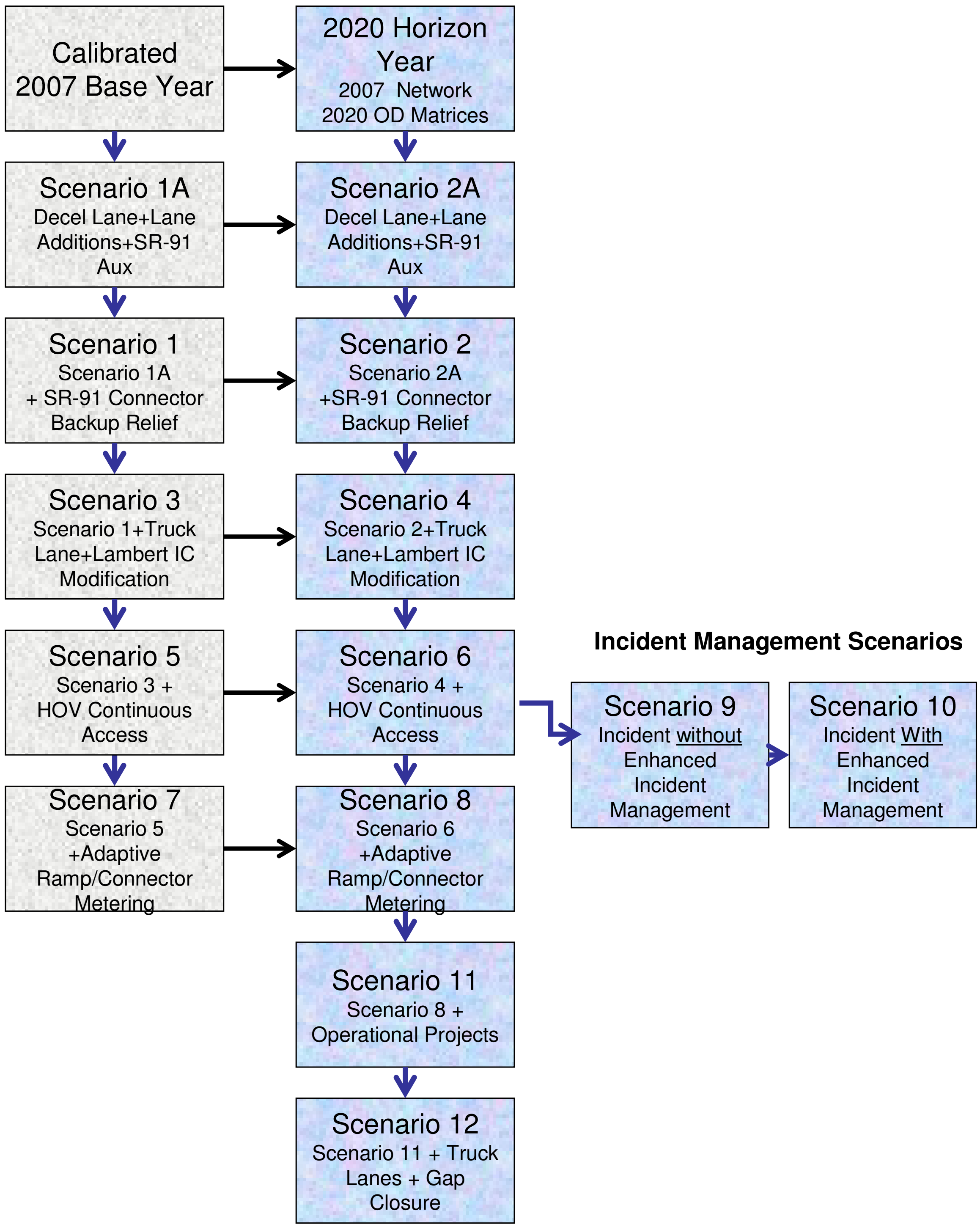
The study assumes that projects developed before 2014 could reasonably be evaluated using the 2007 base year model. The 2020 forecast year for the SR-57 Corridor was extrapolated from the OCTA regional travel demand model origin-destination matrices. When OCTA updates its travel demand model and when the Southern California Association of Governments (SCAG) updates the Regional Transportation Plan (RTP), Caltrans may wish to update the micro-simulation model with revised demand projections.

Project lists used to develop scenarios were obtained from the Regional Transportation Improvement Program (RTIP), the Regional Transportation Plan (RTP), Measure M2, SR-91 Implementation Plan, Transportation Corridor Agencies (TCA) improvements, and Riverside County Transportation Commission (RCTC) improvements, and other sources (e.g., special studies). Projects that do not directly affect mobility were eliminated. For instance, sound wall, landscaping, or minor arterial improvement projects were not evaluated since micro-simulation models cannot evaluate them.

Scenario testing performed for the SR-57 CSMP differs from traditional alternatives evaluations or Environmental Impact Reports (EIRs). Traditional alternatives evaluations or EIRs focus on identifying alternative solutions to address current or projected corridor problems, so each alternative is evaluated separately and results among competing alternatives are compared, resulting in a locally preferred alternative. In contrast, for the SR-57 CSMP, scenarios build on each other in that a scenario contains the projects from the previous scenario plus one or more projects as long as the incremental scenario results showed an acceptable level of performance improvement. This incremental scenario evaluation approach is important since CSMPs are new and are often confused with alternatives studies.

Exhibit 6-2 summarizes the SR-57 modeling approach and the scenarios tested. It also provides a general description of the projects included in the 2007 and 2020 micro-simulation runs. Appendix A provides the detailed project list included in each scenario.

Exhibit 6-2: Micro-Simulation Modeling Approach



Scenario Evaluation Results

Exhibits 6-3 and 6-4 show the delay results by facility type and peak period for all the scenarios evaluated using the 2007 base year model. Exhibits 6-5 and 6-6 show the results for the scenarios that evaluated using the 2020 horizon year model. The percentages shown in the exhibits indicate the difference in delay between the current scenario and the previous scenario (e.g., Percent Change = (Current Scenario/Previous Scenario)/Previous Scenario). Impacts of strategies differ based on a number of factors such as traffic flow conditions, ramp storage, bottleneck locations, and levels of congestion.

For each scenario, the modeling team produced results by facility type (i.e., mainline, HOV, arterials, and ramps) and vehicle type (SOV, HOV, trucks) as well as speed contour diagrams (discussed in more detail in the full technical CSMP). The study team scrutinized these results to ensure that they were consistent with general traffic engineering principles.

A traffic report with all the model output details is available under separate cover.

Exhibit 6-3: 2007 AM Peak Micro-Simulation Delay Results by Scenario

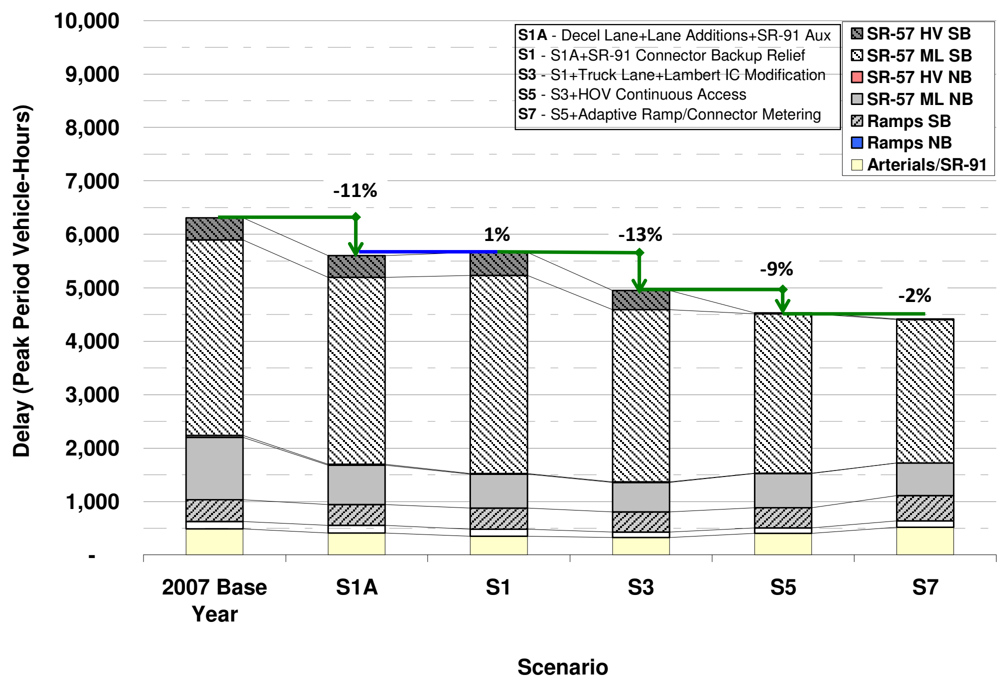


Exhibit 6-4: 2007 PM Peak Micro-Simulation Delay Results by Scenario

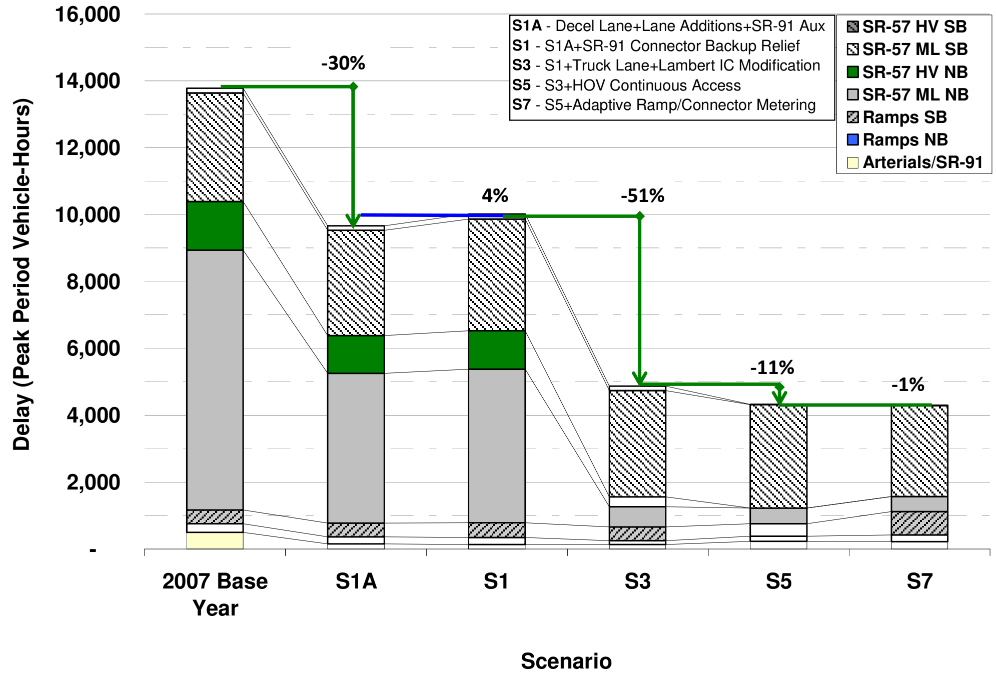


Exhibit 6-5: 2020 AM Peak Micro-Simulation Delay Results by Scenario

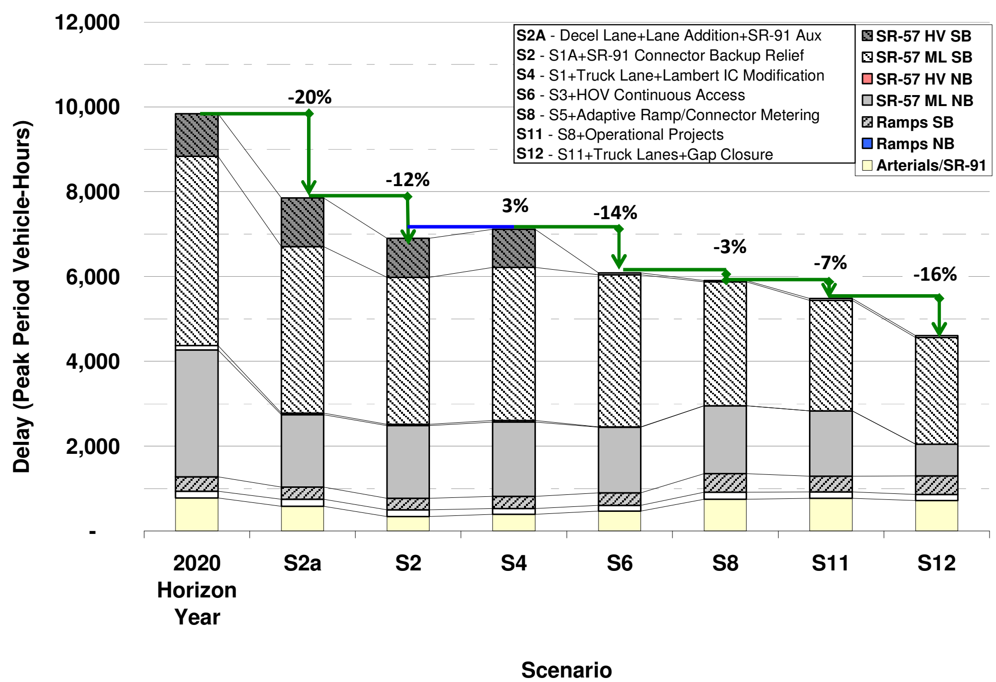
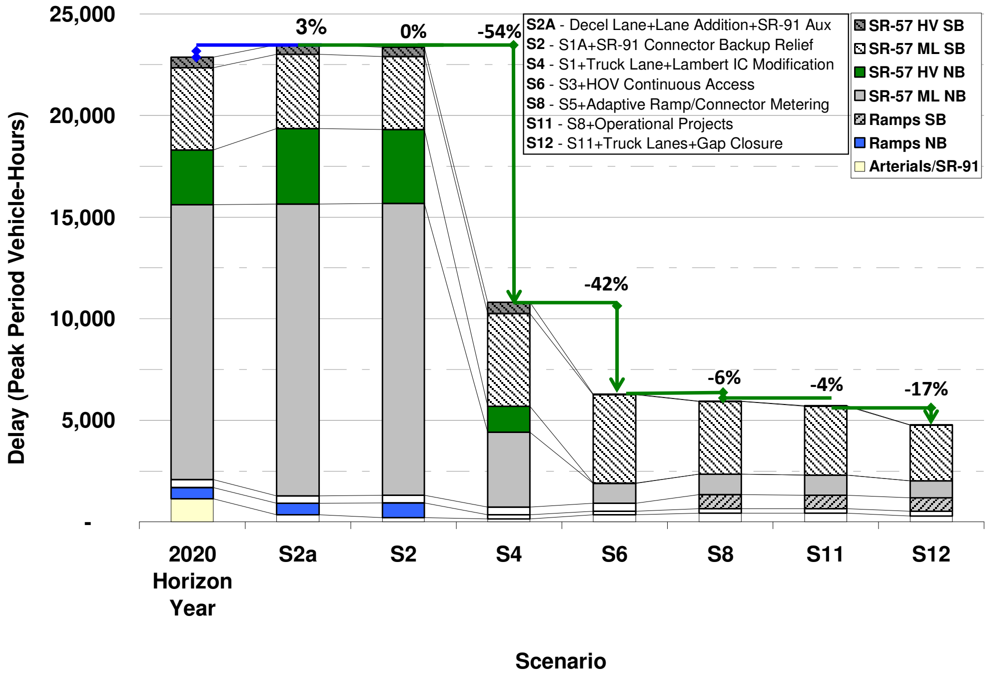


Exhibit 6-6: 2020 PM Peak Micro-Simulation Delay Results by Scenario



Exhibits 6-7 through 6-10 summarize the delay results of the 2007 base year model by bottleneck area for the northbound and southbound directions and for each peak period. Exhibits 6-11 through 6-14 report the delay results of the 2020 horizon year model.

Exhibit 6-7: 2007 Northbound AM Delay by Scenario and Bottleneck Area

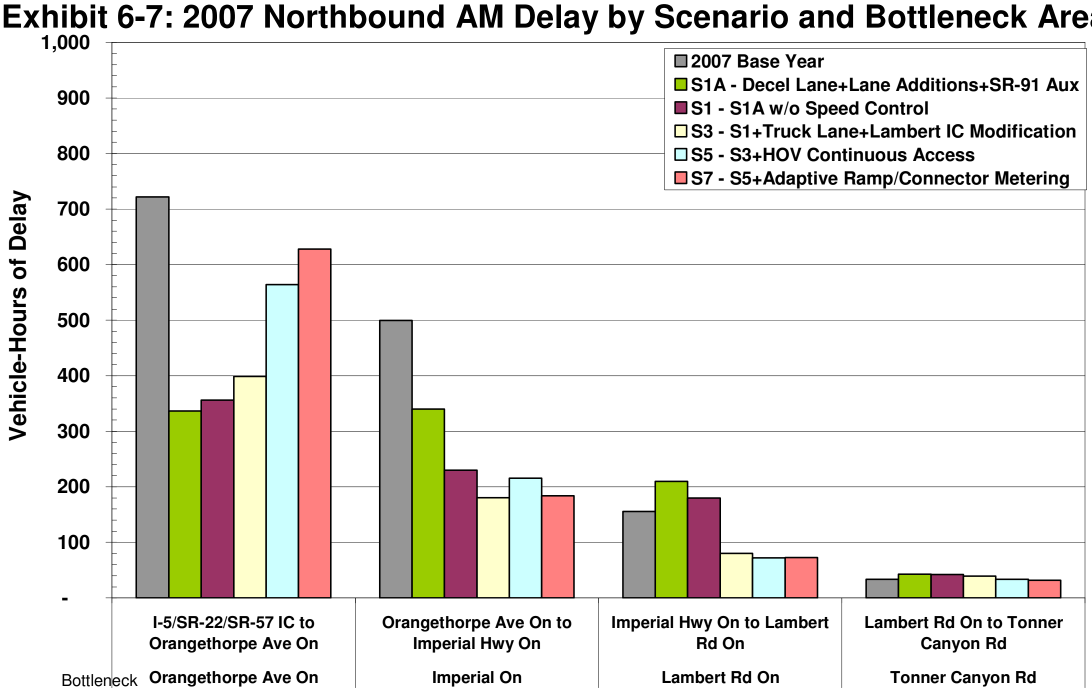


Exhibit 6-8: 2007 Northbound PM Delay by Scenario and Bottleneck Area

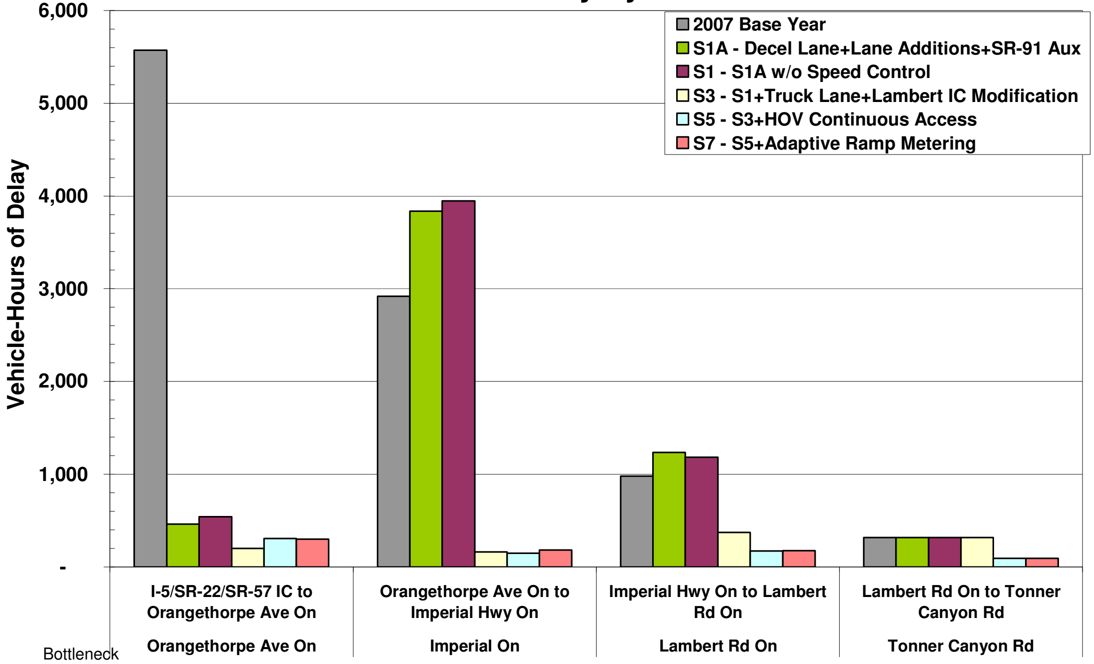


Exhibit 6-9: 2007 Southbound AM Delay by Scenario and Bottleneck Area

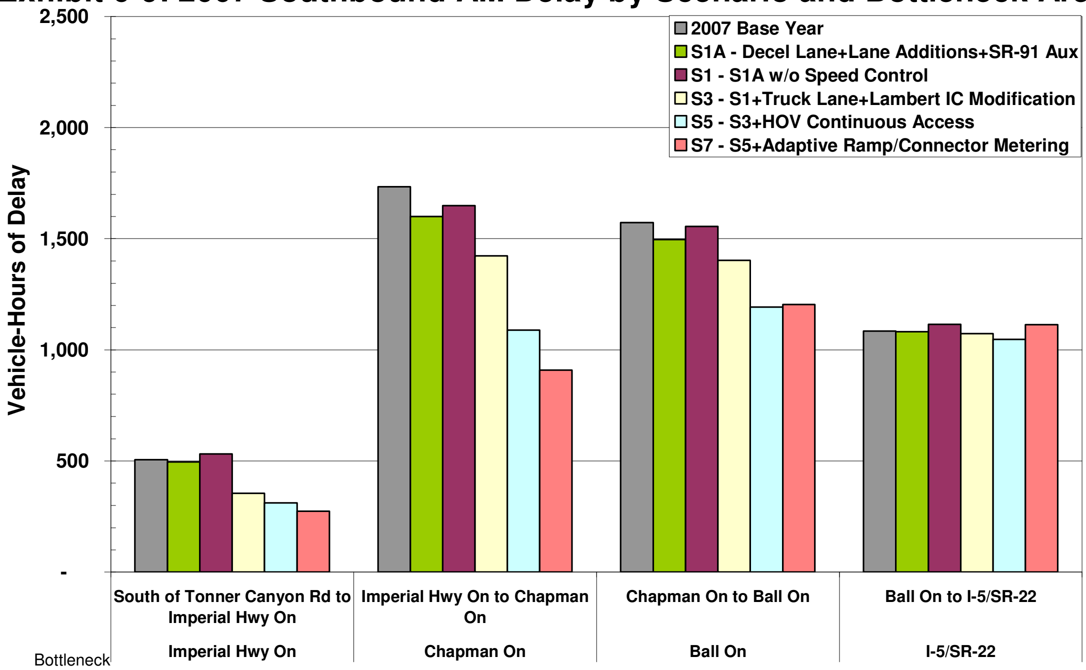


Exhibit 6-10: 2007 Southbound PM Delay by Scenario and Bottleneck Area

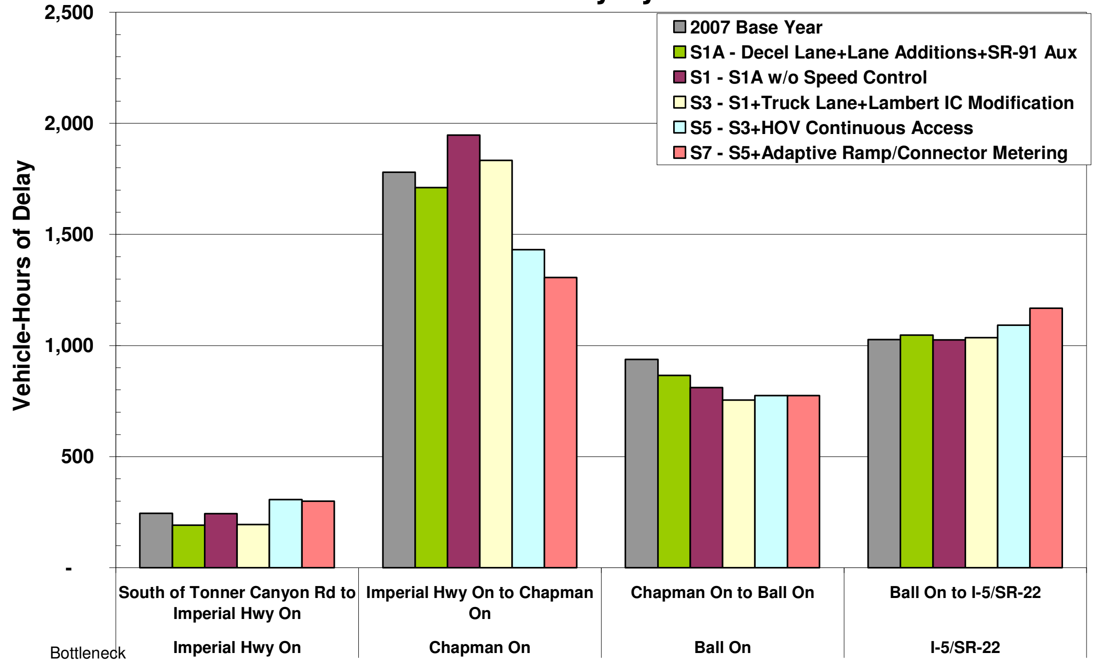
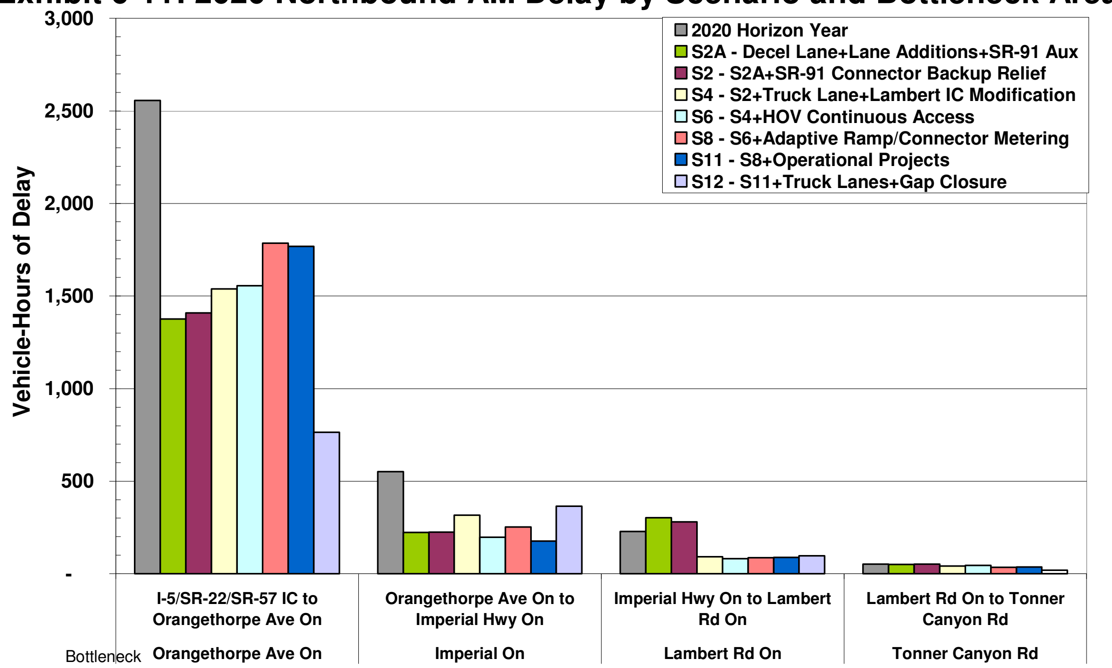


Exhibit 6-11: 2020 Northbound AM Delay by Scenario and Bottleneck Area



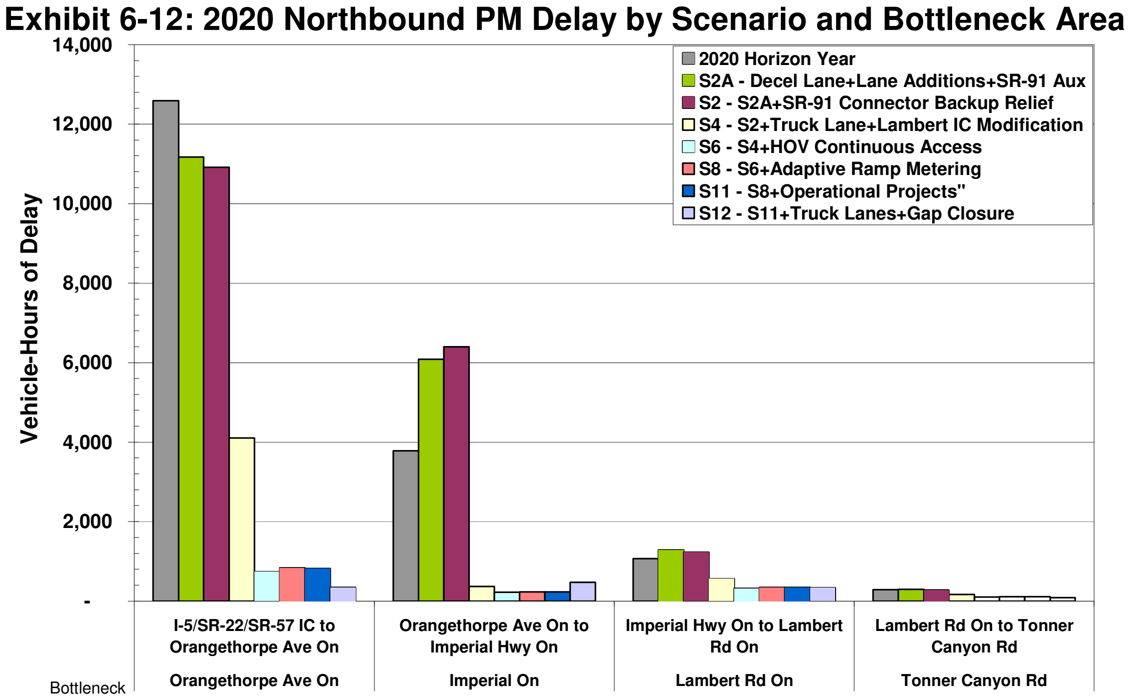


Exhibit 6-12: 2020 Northbound PM Delay by Scenario and Bottleneck Area
Vehicle-Hours of Delay
14,000
12,000
10,000
8,000
6,000
4,000
2,000
-
2020 Horizon Year
S2A - Decel Lane+Lane Additions+SR-91 Aux
S2 - S2A+SR-91 Connector Backup Relief
S4 - S2+Truck Lane+Lambert IC Modification
S6 - S4+HOV Continuous Access
S8 - S6+Adaptive Ramp Metering
S11 - S8+Operational Projects"
S12 - S11+Truck Lanes+Gap Closure
I-5/SR-22/SR-57 IC to Orangethorpe Ave On
Orangethorpe Ave On to Imperial Hwy On
Imperial Hwy On to Lambert Rd On
Lambert Rd On to Tonner Canyon Rd
Bottleneck
Orangethorpe Ave On
Imperial On
Lambert Rd On
Tonner Canyon Rd

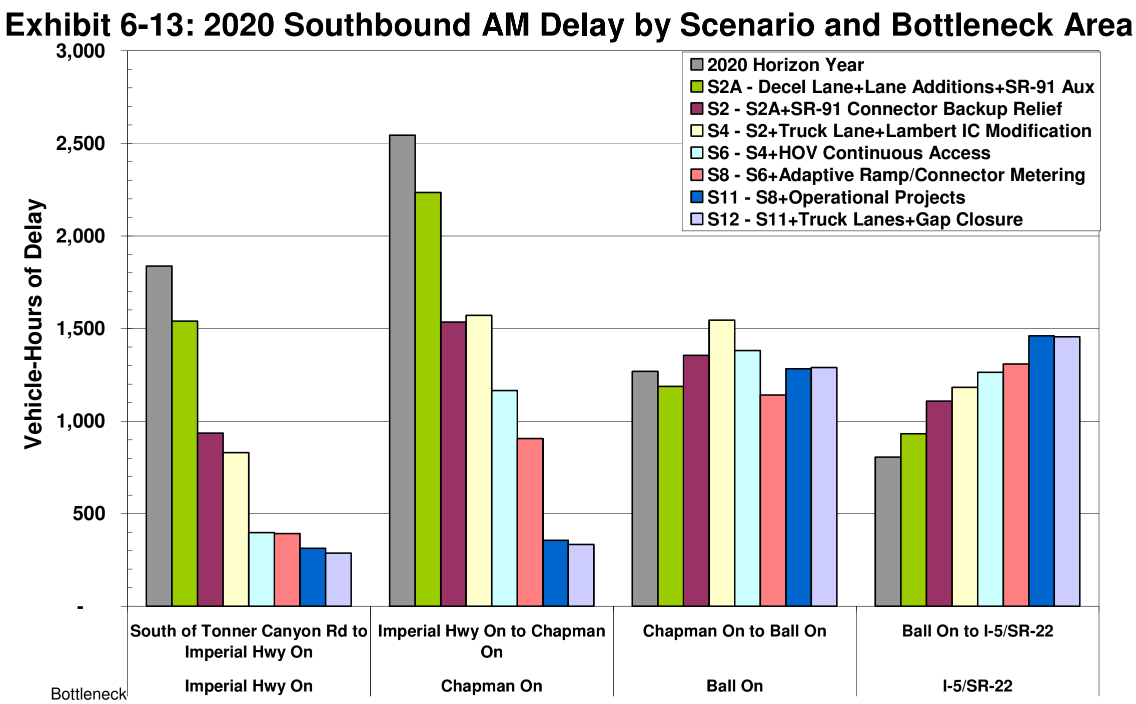
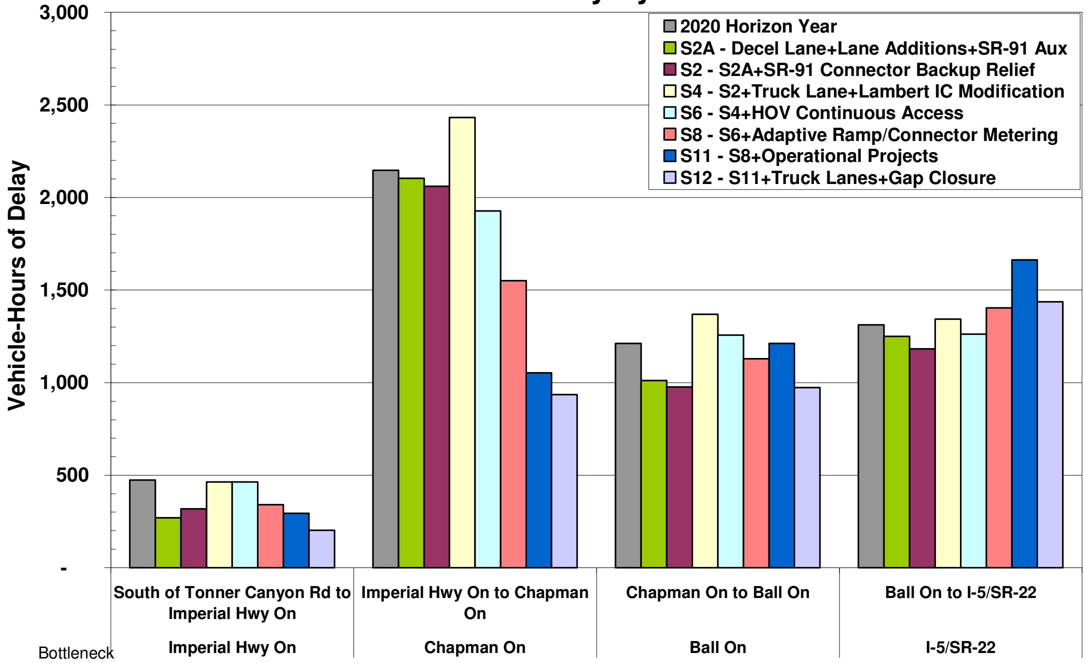


Exhibit 6-13: 2020 Southbound AM Delay by Scenario and Bottleneck Area
Vehicle-Hours of Delay
3,000
2,500
2,000
1,500
1,000
500
-
2020 Horizon Year
S2A - Decel Lane+Lane Additions+SR-91 Aux
S2 - S2A+SR-91 Connector Backup Relief
S4 - S2+Truck Lane+Lambert IC Modification
S6 - S4+HOV Continuous Access
S8 - S6+Adaptive Ramp/Connector Metering
S11 - S8+Operational Projects
S12 - S11+Truck Lanes+Gap Closure
South of Tonner Canyon Rd to Imperial Hwy On
Imperial Hwy On to Chapman On
Chapman On to Ball On
Ball On to I-5/SR-22
Bottleneck
Imperial Hwy On
Chapman On
Ball On
I-5/SR-22

Exhibit 6-14: 2020 Southbound PM Delay by Scenario and Bottleneck Area



The following describes the findings for each scenario tested and reviewed by the study team:

Base Year and "Do Minimum" Horizon Year

Absent any physical improvements, the modeling team estimates that by 2020, total delay (mainline, HOV, ramps, and arterials) will increase by more than 60 percent compared to 2007 (from a total of around 20,000 hours daily to more than 34,000 hours) in the AM and PM peak hours. Demand may continue to increase beyond 2020 and may require further study. As described below, the short-term programmed projects lead to significant decreases and improved mobility on the corridor.

Scenarios 1A/1 and 2A/2 (Deceleration Lane, Lane Additions, SR-91 Aux Lane)

The first four scenarios include both expansion and operations-related, fully funded programmed projects slated for completion by 2014, except for the Katella Avenue to Lincoln Avenue widening project, which is slated for completion by 2018 or 2020. These projects include:

- A southbound deceleration lane from Lambert Road to Imperial Highway (SR-90)
- Widening the northbound SR-57 by adding one lane from 0.4 miles north of SR-91 to 0.1 mile north of Lambert Road
- Widening the northbound SR-57 by adding one lane from 0.3 miles south of Katella Avenue to Lincoln Avenue
- Connect existing auxiliary lanes on westbound SR-91 from SR-57 to I-5. This would provide additional capacity to SR-57.

During the early stages of testing, the study team realized that improvements on SR-57 led to mobility benefits on SR-91 and vice versa. The team needed to isolate such benefits and assign them to the correct corridor.

For instance, improvements on SR-91 will reduce backups on the connector from southbound SR-57 to westbound SR-91. These delay benefits do not relate to improvements on SR-57. Conversely, improvements on SR-57 also lead to delay reductions on SR-91.

In order to correctly assign benefits to the associated projects, the team evaluated two sets of scenarios related to the short term projects listed above. The first set relieved the backups on the connectors from southbound SR-57 to westbound SR-91. The second set maintained these backups. The difference between the two benefits belongs to SR-91 projects. The team used the same approach on the SR-91 model (developed for the SR-91 CSMP) to delineate the benefits associated with the improvements on SR-57.

The 2007 model estimates that the projects included in the first scenario (S1A) will reduce delay on the corridor by approximately 11 percent in the AM peak period and by 30 percent in the PM peak period. In total, this scenario estimates a reduction of around 5,000 hours of daily delay. The majority of the delay reduction occurs in the northbound direction during the PM peak period where the corridor experiences the highest amount of congestion. There is a slight increase in delay from S1A to S1 as the congestion at the SR-91 connector clears up, and traffic throughput and speed from upstream increases causing slight additional delays further downstream.

The 2020 model estimates that the same set of projects will reduce delay on the corridor by approximately 20 percent in the AM peak period but increase delay slightly (by 3 percent) in the PM peak period, primarily on the HOV facility. When demand increases in 2020, the lane drop at Lambert (at the end of the lane addition) intensifies the Lambert bottleneck and leads to very long queues. This in turn makes it harder for HOV vehicles to enter and exit the HOV facility at the current egress and ingress access points, and leads to delay increases. A similar increase in delay also occurs from S2A to S2 as the congestion at the SR-91 connector clears up, traffic throughput and speed from upstream increases causing slight additional delays further downstream.

In summary, the first set of projects significantly reduces 2007 congestion by 5,000 hours. By 2020, the same projects reduce 2020 congestion by less than 2,000 hours. The diminishing benefits suggest that complementary improvements to address the Lambert bottleneck are needed.

Scenarios 3 and 4 (Truck Climbing Lane and Lambert Interchange Improvement)

Scenarios 3 and 4 build on Scenarios 1 and 2 by adding operations-related projects in the northern section of the corridor. One project would add a truck climbing/auxiliary lane from Lambert Road to the Orange/Los Angeles County line and the other project would reconfigure the Lambert Road interchange to provide additional storage capacity at the ramps. The two projects are programmed in the 2008 Regional Transportation Improvement Program (RTIP).

These improvements target the aforementioned Lambert bottleneck. Providing a separate lane for trucks relieves the other lanes significantly. The 2007 model estimates that S3 will reduce delay on the corridor by approximately 13 percent in the AM peak period and by around 51 percent in the PM peak period. Much of the delay reduction occurs at the Imperial Highway and Lambert Road bottleneck areas. In total, S3 reduces daily vehicle-hours of delay by more than 5,000 hours in addition to the benefits from S1. Together, the models estimate that the first two sets of projects combined reduce congestion by more than 50 percent.

The 2020 model estimates that S4 will decrease delay by approximately 54 percent in the PM peak period or almost 13,000 hours of daily delay. The largest delay reduction in the PM peak period occurs in the northbound direction. As the bottleneck at Lambert Road clears up, traffic throughput and speed increases upstream of the bottleneck, thereby reducing delay significantly. Together, the models project that the first two sets of projects will have a reduction of more than 14,000 daily vehicle-hours of delay. Caltrans has noted that prior studies have shown that extending the truck climbing lane even further beyond the Orange/Los Angeles County line to SR-60 would reduce delay even further.

Scenarios 5 and 6 (Continuous Access HOV)

Scenarios 5 and 6 test the conversion of the existing buffer-separated HOV and limited access HOV to a full-time continuous access HOV facility with both 2007 and 2020 demand, respectively. Caltrans may revisit the modeling once the full details of the continuous access design are finalized.

The 2007 model estimates that S5 will produce a delay reduction of 9 percent in the AM peak period and 11 percent in the PM peak period over and beyond S4 benefits. This translates into a bit less than 1,000 hours of daily delay.

The 2020 model estimates that S6 will produce an even higher delay reduction of 14 percent in the AM peak period and 42 percent in the PM peak period. Standard HOV continuous access conversion would not normally produce such high reduction in delays. However, for SR-57, much of the delay reduction occurs at the HOV access location near the SR-91 interchange. Currently, HOV traffic must exit just south of SR-91 to exit to Orangethorpe Avenue, Chapman Avenue, and Nutwood Avenue. With continuous access, HOV traffic desiring to exit off Chapman Avenue and Nutwood Avenue can continue using the HOV lane until further downstream. This allows the HOV lane to have a higher throughput/capacity, and it reduces the weaving at the Orangethorpe Avenue bottleneck area.

In summary, the model estimates that the first three sets of projects provide compelling mobility benefits to the corridor. Delivery of these projects would reduce congestion on the corridor by around 11,000 hours or 55 percent of total congestion in the near term, and by almost 22,000 hours by 2020, representing more than 60 percent of total projected congestion.

Scenarios 7 and 8 (Advanced Ramp Metering, Connector Metering)

Scenarios 7 and 8 show the impacts of the following proposed projects:

- Implementing an advanced ramp metering with queue control
- Metering the eastbound SR-91 to northbound SR-57 connector ramp and metering the westbound SR-91 to southbound SR-57 connector ramp

- Metering and widening the eastbound SR-91 to southbound SR-57 connector ramp and metering and widening the westbound SR-91 to northbound SR-57 connector ramp.

Note that there are several advanced ramp metering systems deployed around the world, and for modeling purposes, we used one called Asservissement Lineaire d'Entrée Autoroutiere (ALINEA). This algorithm has been deployed in Europe and Asia and the software was readily available for modeling. However, it is used as a proxy and is not specifically recommended. Caltrans should evaluate different algorithms and implement the one it deems most beneficial.

The 2007 model indicates that the projects will improve delay slightly in the AM peak by two percent and PM peak by one percent. The 2020 model shows that the projects will improve delays modestly in both the AM and PM peaks by three and six percent, respectively. Although the mainline facility experienced an improvement in delay during both the AM and PM peak hours, the ramps and connector ramps experienced an overall delay increase, thereby resulting in only a small improvement for the overall corridor. Overall, the two models estimate that advanced ramp and connector metering would reduce congestion along the corridor by more than 650 vehicle-hours of delay.

Scenarios 9 and 10 (Enhanced Incident Management)

Two incident scenarios were tested upon Scenario 6 to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. In the first scenario, Scenario 9, one collision incident with one outside lane closure was simulated in the southbound direction in the AM peak period model and in the northbound direction in the PM peak period model. The incident simulation location and duration was selected based on review of the 2010 actual incident data, at one of the high frequency locations. The following are the Scenario details:

- Southbound AM peak period starting at 8:00 AM, close outermost mainline lane for 40 minutes at postmile 15.38 (at westbound SR-91 on-ramp)
- Northbound PM peak period starting at 5:00 PM, close outermost mainline lane for 30 minutes at postmile 19.45 (at Imperial Highway)

This scenario represents a typical, moderate incident at one location during each peak direction period. Data suggest that incidents vary significantly in terms of impact and duration. Some incidents last hundreds of minutes, some close multiple lanes, and some occur at multiple locations simultaneously. There are also numerous minor incidents lasting only a few minutes without lane closures, yet still resulting in congestion. In addition, there are many incidents occurring during off-peak hours.

Based on actual Caltrans incident management data, it is estimated that an enhanced incident management system could reduce a 35-minute incident by about 10 minutes. An enhanced incident management system would entail upgrading or enhancing the current Caltrans incident management system to include deployment of intelligent transportation system (ITS) field devices, central control/communications software, communications medium (i.e. fiber optic lines), advanced traveler information system, and/or freeway service patrol (FSP) program to reduce incident detection, verification, response, and clearance times.

In the second scenario, Scenario 10, the same collision incident was simulated with a reduction in duration by 10 minutes in the southbound direction and eight minutes in the northbound direction to determine the benefits of an enhanced incident management system.

Exhibits 6-15 and 6-16 show the delay results by facility type and peak period for the enhanced incident management scenarios that were evaluated using the 2020 base year model. Without enhanced incident management, the first scenario produced a four percent increase in congestion in the AM and a six percent increase in the PM over Scenario 6 —an increase of almost 400 hours of vehicle delay. The model results indicate enhanced incident management could eliminate approximately 85 vehicle-hours of delay in the southbound direction and 50 vehicle-hours of delay in the northbound direction using 2020 demand. These results reflect benefits realized during the peak direction period. Additional benefits would be realized during off-peak hours and in the off-peak direction.

Exhibit 6-15: 2020 AM Delay Results for Enhanced Incident Management

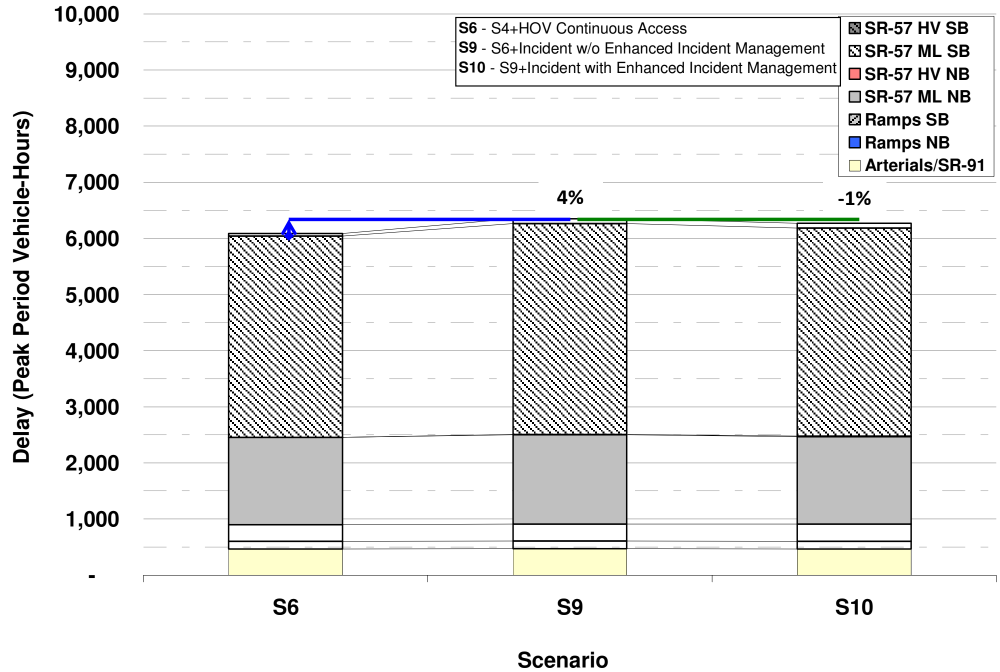
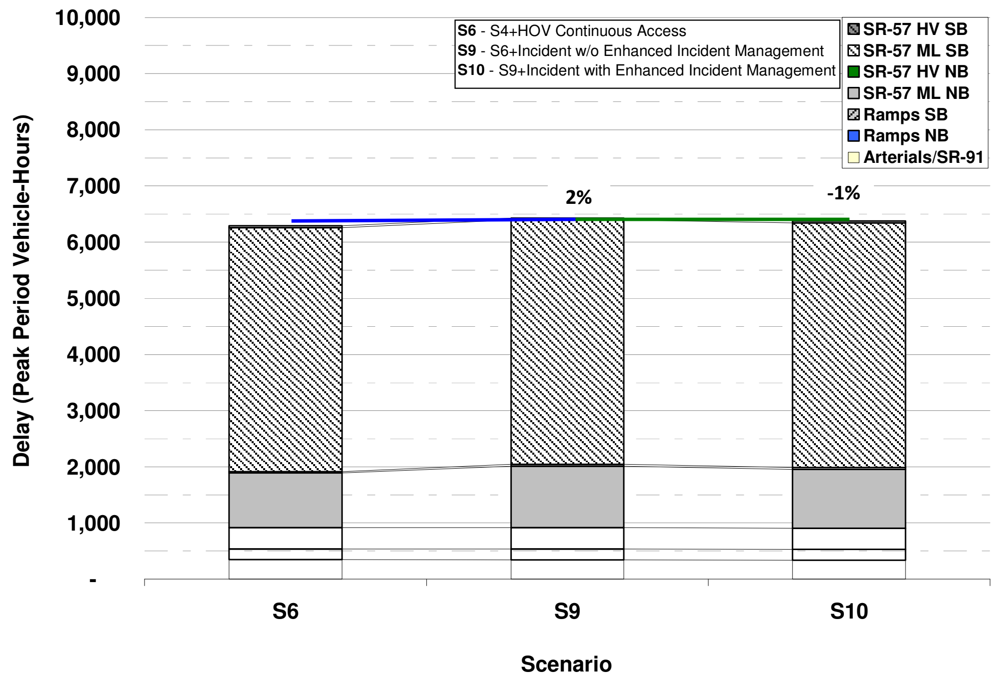


Exhibit 6-16: 2020 PM Delay Results for Enhanced Incident Management



Scenario 11 (Operational Projects)

Scenario 11 tests the following projects proposed by the study team and Caltrans:

- Extend eastbound Imperial Highway on-ramp merge further downstream with an acceleration lane on southbound SR-57.
- Add an acceleration lane from Nutwood Avenue to downstream of Placentia Avenue on southbound SR-57.
- Merge Ball Road loop on-ramp with slip on-ramp further downstream with an acceleration lane on southbound SR-57.
- Merge Katella Avenue loop on-ramp with slip on-ramp further downstream and merge with auxiliary lane to Orangewood Avenue on southbound SR-57.
- Add northbound lane from Orangewood Avenue to Katella Avenue.

The 2020 model shows that the combination of these projects will produce a seven percent reduction in delay in the AM peak period and a four percent reduction in delay in the PM peak period. While the first two projects improved congestion, this allowed more traffic to build up on the downstream end of the corridor. Without the Ball and Katella on-ramp projects, delay might increase further. Total congestion on the corridor incrementally decreased by almost 650 vehicle-hours.

Scenarios 12 (Truck Climbing Lanes, Gap Closure)

Scenario 12 tests the following long-term projects proposed by Caltrans on the 2020 model:

- Add a second northbound truck climbing lane from Lambert Road to Orange/Los Angeles County line.
- Add a southbound truck climbing lane from north of the Orange/Los Angeles County line to Lambert Road.
- Construct northbound gap closure between north of Lincoln and north of SR-91 (add one lane and modify interchanges).

The 2020 model shows that these three projects will produce a 16 percent reduction in delay in the AM and 17 percent reduction in delay in the PM peak periods. These delay improvements are mostly due to the addition of the southbound truck lane and the gap closure project. The addition of the second northbound truck climbing lane does not seem to improve conditions. With these three projects, the corridor is expected to experience a 16 percent delay reduction of over 1,800 vehicle-hours incrementally.

Post Scenario 12 Conditions

By 2020, with the inclusion of projects from Scenarios 1 to 12, the model reveals some residual congestion that remains to be addressed with future improvements. The total remaining delay for the corridor as according to the model results is less than 10,000 daily vehicle-hours of delay.

Benefit-Cost Analysis

Following an in-depth review of model results, the study team performed a benefit-cost analysis (BCA) for each scenario. The benefit cost results represent the incremental benefits over the incremental costs of a given scenario.

The study team used the California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) developed by Caltrans to estimate benefits in three key areas: travel time savings, vehicle operating cost savings, and emission reduction savings. The results are conservative since this analysis does not capture the benefits after the 20-year lifecycle or other benefits, such as the reduction in congestion beyond the peak periods and improvement in transit travel times.

Project costs were obtained from various sources, including the RTIP, OCTA's Long Range Plan (LRP), and Caltrans project planning. Costs for the advanced ramp and connector metering include widening to accommodate the connector meters within the State's right-of-way, but not the acquisition of new right-of-way. A B/C greater than 1.0 means that a scenario's projects return greater benefits than they cost to construct or implement. It is important to consider the total benefits that a project brings. For example, a large capital expansion project such as adding a northbound lane from Katella to Lincoln has a high capital construction cost, which reduces the B/C ratio, but brings much higher absolute benefits to SR-57 users. Exhibit 6-17 illustrates typical benefit-cost ratios for different project types.

The benefit-cost analysis for the SR-57 corridor is summarized in Exhibit 6-18.

Exhibit 6-17: Benefit-Cost Ratios for Typical Projects

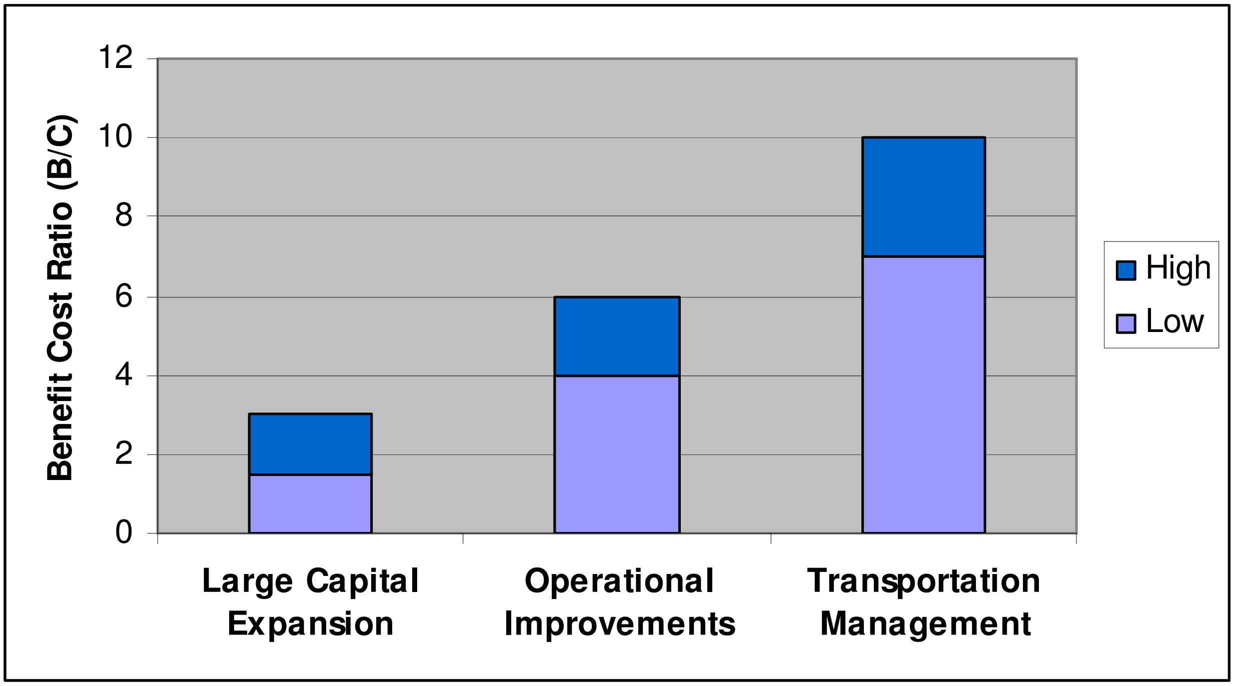
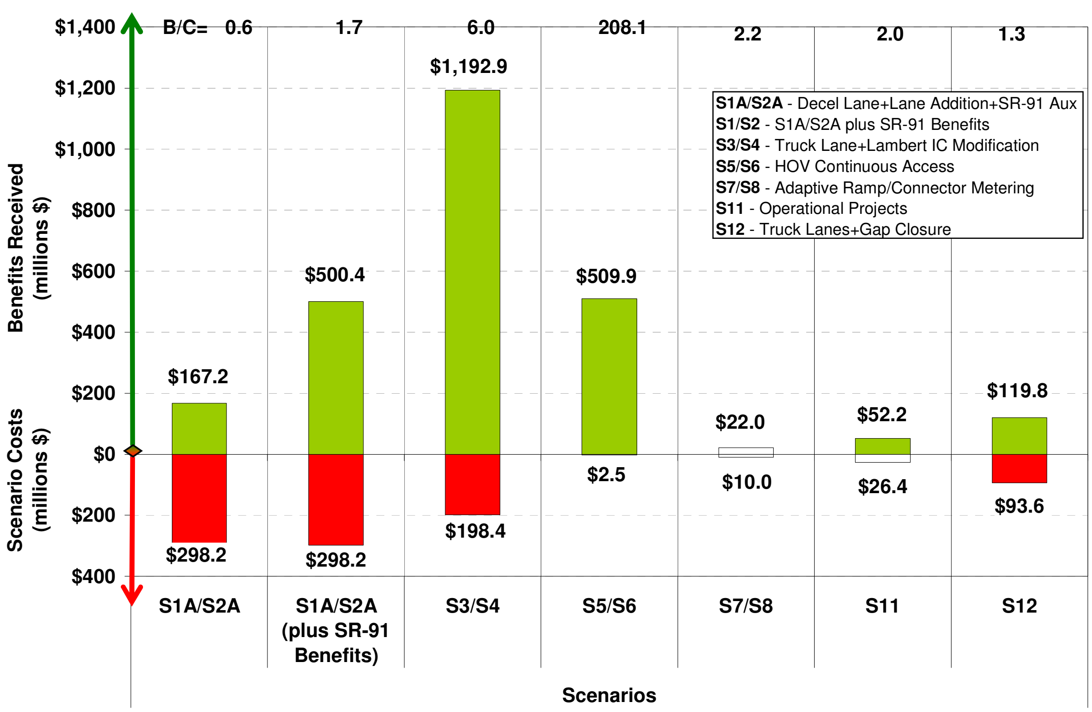


Exhibit 6-18: Scenario Benefit/Cost (B/C) Results



The benefit-cost findings for each scenario are as follows:

- Scenario 1A and Scenario 2A (deceleration lane, lane additions, SR-91 auxiliary lane) produces a medium BC ratio of less than 2:1. This ratio takes into account SR-91 benefits (computed with the SR-91 model).
- Scenario 3 and Scenario 4 (truck climbing lane and Lambert Road interchange modification) produce a high benefit cost ratio of over 5:1, reflecting the significant delay reductions.
- Scenarios 5 and 6 (continuous access for HOV) produce a very high benefit cost ratio of over 10.
- Scenarios 7 and 8 (advanced ramp metering and connector metering) produce a medium to high ratio of over 2:1.
- Scenario 11 (operational projects) produces a ratio of medium to high ratio of over 2:1.
- Scenario 12 (truck climbing lane, gap closure) produced a medium BC ratio of less than 2:1. While the southbound truck climbing lane produced some delay reductions, the northbound gap closure project produced the biggest benefits. The addition of the second northbound truck climbing lane does not seem to make a significant difference.
- The benefit cost ratio of the all the scenarios combined is almost 4:1 which is compelling. If all the projects are delivered at current cost estimates, the public will get four dollars of benefits for each dollar expended. In current dollars, costs add up to around $630 million whereas the benefits are estimated to be almost $2.4 billion.
- Finally, the projects also alleviate greenhouse gas emissions by over 1.1 million over 20 years, averaging more than 50,000 tons or reductions per year. The emissions are estimated in Cal-B/C using data from the California Air Resources Board (CARB) EMFAC model.

Detailed benefit-cost results can be found in Appendix B.

7. CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the conclusions and recommendations based on the analysis discussed so far. It is important to note that many of these conclusions are based primarily on the micro-simulation model results. The model was developed based on the best data available at the time. The study team believes that both the calibration and the scenario results are reasonable. However, caution should always be used when making decisions based on modeling alone, especially complex models such as this one. Project decisions are based on a combination of regional and inter-regional plans and needs, regional and local acceptance for the project, availability of funding, planning and engineering requirements.

Based on the results, the study team offers the following conclusions and recommendations:

- Due to the high capital cost of the two expansion projects in Scenarios 1A/1 and 2A/2, the overall benefit cost is a modest 1.7. However, the long-term relief in congestion provided by the combination of all four projects, particularly in the most heavily congested location in the corridor, is needed to improve both the short-term and long-term mobility of the mainline, ramps, and arterials.

- The addition of a northbound truck climbing lane from Lambert Road to the Orange/Los Angeles County line and the Lambert Road interchange modification project provides significant operational benefits to the mainline by removing heavy truck traffic from the mainline. It complements the aforementioned expansion projects and significantly reduces overall congestion further. These projects are critical for improving the mobility of the corridor. In fact, without them, the Lambert bottleneck will worsen over time and its queue will extend to several miles south of Lambert.

- The addition of a second northbound truck climbing lane does not seem to make a significant improvement in operations of the corridor. However, Caltrans should consider extending the truck climbing lane further north beyond the Orange/Los Angeles County line to provide for continuous flow into and within the Los Angeles section of the freeway, which also experiences high levels of congestion.

- The benefits of the HOV conversion to a continuous access facility are compelling. Even if the model is overestimating them, this project will certainly improve mobility on the corridor.

- Operational projects such as adaptive ramp metering with queue control and construction of acceleration lanes, auxiliary lanes, and ramp reconfigurations in the southbound corridor should be considered and evaluated further.

- The northbound auxiliary lane from Orangewood to Katella however may not be worth funding as its cost is over $13 million, and it does not lead to any noticeable change in congestion in the project area within the model year 2020. Longer term 2030 and beyond may yield different results.

- The addition of the southbound truck climbing lane and the northbound gap closure (lane addition and interchange modifications from north of Lincoln Avenue to SR-91) would provide congestion relief in the areas that have not previously been addressed. The two northbound expansion projects tested in Scenarios 1A/1 and 2A/2 provided much needed congestion relief in the northbound direction, however, left a gap between Lincoln Avenue and SR-91. It may be worth considering funding the gap closure project closer to the same time as the other two expansion projects so that it would provide better continuity for construction as well as improved operations.

- Enhanced incident management shows promise. The SR-57 experiences up to 1,600 collisions per year. With an average delay savings of nearly 70 vehicle-hours per incident, that would translate to a total annual delay savings of over 110,000 vehicle-hours for the corridor.

- Exhibits 7-1 and 7-2 show the speed contour maps for the 2020 “do minimum” horizon year with the growth in congestion before any improvements. Exhibits 7-3 and 7-4 illustrate the speed contour maps produced by the model at the conclusion of Scenario 12, the final scenario tested. Exhibits 7-3 and 7-4 show the last remaining residual congestion and bottleneck locations. There is very little noticeable congestion by year 2020 for the northbound model after all of the scenarios are implemented. For the southbound model, three small areas of congestion still remain during both the AM and PM peak periods at Chapman Avenue (City of Fullerton), Katella Avenue, and the I-5/SR-22 interchange (SR-57 terminus).

This is the first generation CSMP for the SR-57 Corridor. It is important to stress that CSMPs should be updated on a regular basis. This is particularly important since traffic conditions and patterns can differ from current projections. After projects are delivered, it is also useful to compare actual results with estimated ones in this document so that models can be further improved as appropriate.

CSMPs, or a variation thereof, should become the normal course of business that is based on detailed performance assessments, an in-depth understanding of the reasons for performance deterioration, and an analytical framework that allows for evaluating complementary operational strategies that maximize the productivity of the current system. A traffic report with all the speed contours is available under separate cover.

Exhibit 7-1: 2020 Northbound PM Peak Model Speed Contours Before Improvements

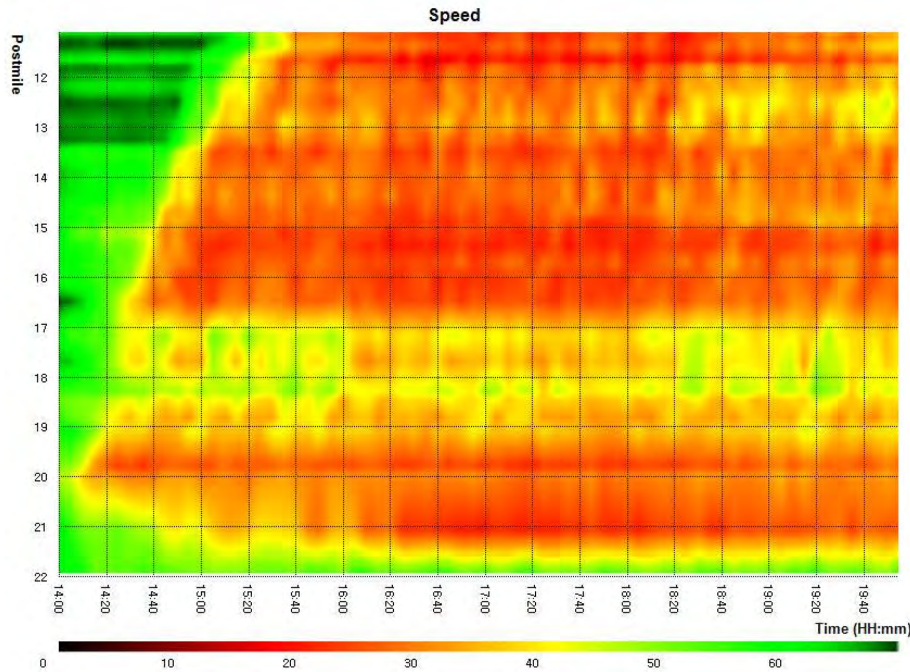


Exhibit 7-2: 2020 Southbound AM Peak Model Speed Contours Before Improvements

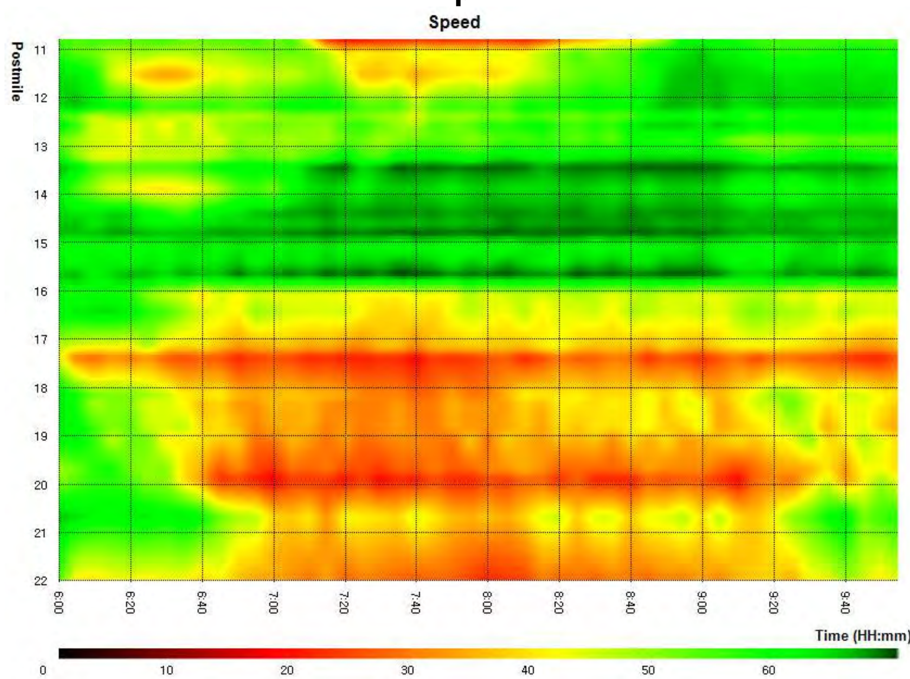


Exhibit 7-3: 2020 Northbound PM Peak Model Speed Contours After Improvements

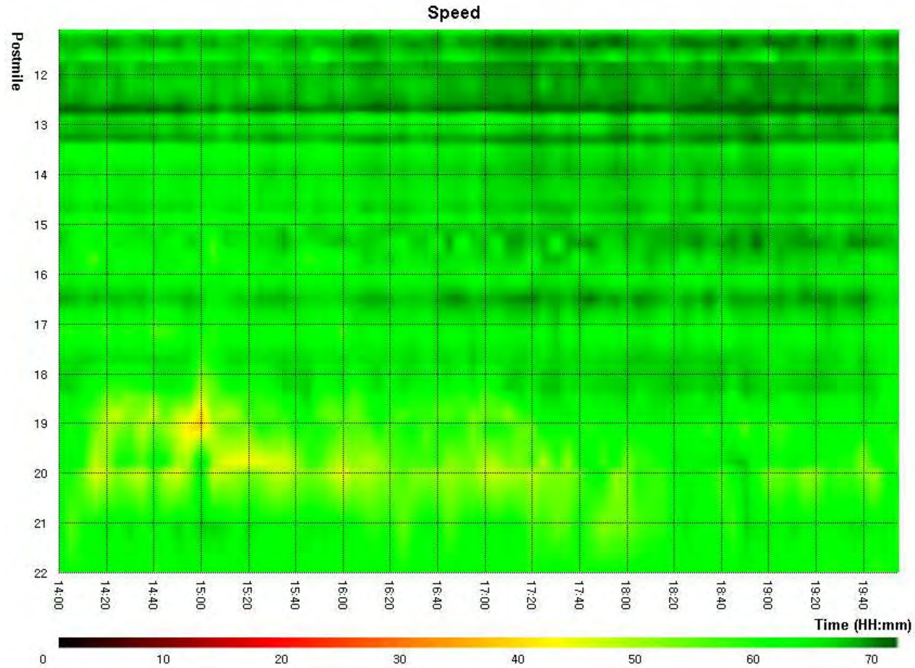
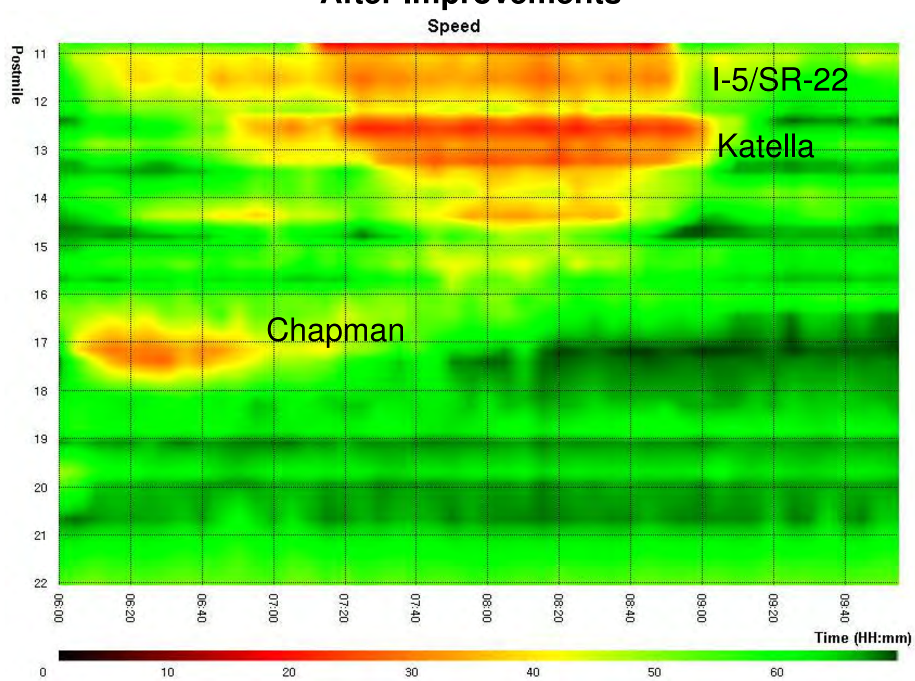


Exhibit 7-4: 2020 Southbound AM Peak Model Speed Contours After Improvements



Appendix A: SR-57 Detailed Scenario Descriptions

This appendix describes the scenarios and the projects from the Regional Transportation Improvement Program (RTIP), Regional Transportation Plan (RTP), and other plans (e.g., State Highway Operations and Preservation Program or SHOPP) that are used to build the scenarios to be tested using the Paramics micro-simulation model.

Exhibit A-1 shows the scenarios for both the 2007 Base Year and 2020 Horizon Year forecast.

Exhibit A-1: Project Lists for Micro-Simulation Scenarios

Scenarios	Proj ID	Improvement	Lead Agency	Expected Compl Date	Source	Est Total Proj Cost (in 1,000s)
1A (2007-1A) 2A (2020-1A)	EA 0H018	SR-57 In Brea: Southbound at Route 90 - construct freeway deceleration lane	CALTRANS	Completed 3/2008	2006/2007 SHOPP	$ 1,986
	ORA120332 ORA081901 EA 0F0311	Add one GP lane on NB SR-57 from 0.4 mi n/o SR-91 to 0.1 mi n/o Lambert Rd (5.1 miles)	CALTRANS	2014	06 & 08 TIP CMIA	$ 181,730
	ORA120333 EA 0F0401	Exist 4 GP NB; widen to 5 GP lanes NB from 0.3 mi s/o Katella to 0.3 mi n/o Lincoln (2.9 miles)	CALTRANS	2018/2020 (CT)	06 & 08 TIP CMIA	$ 41,086
	ORA000822 EA 0C5700	On SR-91: Connect existing auxiliary lane through interchanges on WB SR-91 between SR-57 and I-5 with its elements. (Provides additional capacity on SB-57 connector)	OCTA	2014	06 & 08 TIP CMIA	$ 73,400
1 (2007-1) 2 (2020-1)		Same as Scenarios 1 and 2 WITH speed control to properly assign benefits to SR-91				
3 (2007-2) 4 (2020-2)	ORA000820 EA 0C120	SR-57 NB truck climbing aux lane from Lambert to LA County line. (Alternative 1 preferred)	CALTRANS	2014 (TIP) 2020 (CT)	06 & 08 TIP	$ 161,191
	ORA120320	SR-57/Lambert Rd IC improvements - Reconfig existing diamond interchange to loop ramp, add SB LN on offramp. Widen Lambert on-ramp from 2 to 3 lanes	BREA	2010/2014 (CT)	06 & 08 TIP	$ 37,216
5 (2007-3) 6 (2020-3)	EA 0J420K	Convert existing buffer-separated and limited access HOV to full time contiguous access.	CALTRANS		PSR	$2,451 (2007 PSR)
7 (2007-4) 8 (2020-4)	Proposed (SMG)	Adaptive ramp metering with queue control				$ 10,000
	Proposed (SMG)	Meter EB and WB SR-91 connector ramps to NB and SB SR-57. Widen EB SR-91 to SB SR-57 to 2 lanes and WB SR-91 to NB SR-57 to 3 lanes.				
9 (2020-5) 10 (2020-6)	Proposed (SMG)	**Enhanced Incident Management System** - incident clearance time reduction from current and with improvements (2020 Model Only)				$ 10,000
11 (2020-7)	Proposed (SMG)	SB-57: Extend EB Imperial Hwy on-ramp merge further down stream and build accel lane				$ 2,500
	Proposed (SMG)	SB-57: Construct accel lane from Nutwood to downstream of Placentia Ave, before the R/R crossing (about 2,400 feet)				$ 4,500
	Proposed (SMG)	SB-57: Reconfigure Ball loop on-ramp to merge with tangent on-ramp before merging with mainline. Extend merge point downstream with separate acceleration lane to Katella Ave				$ 3,000
	Proposed (SMG)	SB-57: Reconfigure Katella loop on-ramp to merge with tangent on-ramp and auxiliary lane at Katella Ave and join aux lane to Orangewood Ave				$ 3,000
	2M0735A	Exist 4 GP NB; Add 1 NB Aux lanes from Orangewood to Katella	OCTA	2018/2020 (CT)	2008 RTP	$ 13,439
12 (2020-8)	EA 0C120 (Alt 2)	Second NB truck climbing aux lane from Lambert to LA Co. line	CALTRANS	2020+	PSR	$14,260 (2001 PSR)
	Proposed (CT)	Southbound SR-57: Truck lane from n/o LA Co line to Lambert				$ 40,000
	2M0735B	Exist 4 GP NB; Add 1 GP NB from Lincoln to Orangethorpe & IC improvements at SR-91	OCTA	2020 (CT)	2008 RTP	$ 39,318

* Total cost includes construction and support costs in current dollars

Appendix B: Benefit-Cost Analysis Results

This appendix provides more detailed Benefit-Cost Analysis (BCA) results than found in Section 6 of the SR-57 Corridor System Management Plan (CSMP) Final Report. The BCA results for this CSMP were estimated by using the *California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) Version 4.0* developed for the California Department of Transportation (Caltrans) by System Metrics Group, Inc. (SMG).

Caltrans uses Cal-B/C to conduct investment analyses of projects proposed for the interregional portion of the State Transportation Improvement Program (STIP), the State Highway Operations and Protection Program (SHOPP), and other ad hoc analyses requiring BCA. Cal-B/C is a spreadsheet-based tool that can prepare analyses of highway, transit, and passenger rail projects. Users input data defining the type, scope, and cost of projects. The model calculates life-cycle costs, net present values, benefit-cost ratios, internal rates of return, payback periods, annual benefits, and life-cycle benefits. Cal-B/C can be used to evaluate capacity expansion projects, transportation management systems (TMS), and operational improvements.

Cal-B/C measures, in constant dollars, four categories of benefits:

- Travel time savings (reduced travel time and new trips)
- Vehicle operating cost savings (fuel and non-fuel operating cost reductions)
- Accident cost savings (safety benefits)
- Emission reductions (air quality and greenhouse gas benefits).

Each of these benefits was estimated for the peak period for the following categories:

- **Life-Cycle Costs** - present values of all net project costs, including initial and subsequent costs in real current dollars.
- **Life-Cycle Benefits** - sum of the present value benefits for the project.
- **Net Present Value** - life-cycle benefits minus the life-cycle costs. The value of benefits exceeds the value of costs for a project with a positive net present value.
- **Benefit/Cost Ratio** - benefits relative to the costs of a project. A project with a benefit-cost ratio greater than one has a positive economic value.
- **Rate of Return on Investment** - discount rate at which benefits and costs are equal. For a project with a rate of return greater than the discount rate, the benefits are greater than costs and the project has a positive economic value. The user can use rate of return to compare projects with different costs and different benefit flows over different time periods. This is particularly useful for project staging.

- **Payback Period** - number of years it takes for the net benefits (life-cycle benefits minus life-cycle costs) to equal the initial construction costs. For a project with a payback period longer than the life-cycle of the project, initial construction costs are not recovered. The payback period varies inversely with the benefit-cost ratio. A shorter payback period yields a higher benefit-cost ratio.

The model calculates these results over a standard 20-year project life-cycle, itemizes each user benefit, and displays the annualized and life-cycle user benefits. Below the itemized project benefits, Cal-B/C displays three additional benefit measures:

- **Person-Hours of Time Saved** - reduction in person-hours of travel time due to the project. A positive value indicates a net benefit.
- **Additional CO2 Emissions (tons)** -additional CO2 emissions that occur because of the project. The emissions are estimated using average speed categories using data from the California Air Resources Board (CARB) EMFAC model. This is a gross calculation because the emissions factors do not take into account changes in speed cycling or driver behavior. A negative value indicates a project benefit. Projects in areas with severe congestion will generally lower CO2 emissions.
- **Additional CO2 Emissions (in millions of dollars)** - valued CO2 emissions using a recent economic valuing methodology.

A copy of Cal-B/C v4.0, the User's Guide, and detailed technical documentation can be found at the Caltrans' Division of Transportation Planning, Office of Transportation Economics website at http://www.dot.ca.gov/hq/tpp/offices/ote/benefit.html.

The exhibits in this appendix are listed as follows:

- Exhibit B-1: BCA Results - S1A/S2A - Decel Lane+Lane Addition+SR-91 Aux
- Exhibit B-2: BCA Results - S1/S2 - S1A/S2A Plus SR-91
- Exhibit B-3: BCA Results - S3/S4 - S1/S2+Truck Lane+Lambert IC Modification
- Exhibit B-4: BCA Results - S5/S6 - S3/S4+HOV Continuous Access
- Exhibit B-5: BCA Results - S7/S8 - S5/S6+Adaptive Ramp/Connector Metering
- Exhibit B-6: BCA Results - S11 - S8+Operational Projects
- Exhibit B-7: BCA Results - S12 - S11+Truck Lanes+Gap Closure
- Exhibit B-8: Cumulative BCA Results.

Exhibit B-1: BCA Results - S1A/S2A - Decel Lane+Lane Addition+SR-91 Aux

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$298.2
Life-Cycle Benefits (mil. $)	$167.2
Net Present Value (mil. $)	-$131.0
Benefit / Cost Ratio:	0.6
Rate of Return on Investment:	#NUM!
Payback Period:	20+ years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$6.6	$132.4
Veh. Op. Cost Savings	$1.2	$24.3
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.5	$10.5
TOTAL BENEFITS	$8.4	$167.2
Person-Hours of Time Saved	597,457	11,949,143
Additional CO_2 Emissions (tons)	-4,405	-88,099
Additional CO_2 Emissions (mil. $	-$0.2	-$3.0

Incremental Costs (mil. $)	$298.2
Incremental Benefits (mil. $)	$167.2
Incremental Benefit / Cost Ratio	0.6

Exhibit B-2: BCA Results - S1/S2 - S1A/S2A Plus SR-91 Benefits

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$298.2
Life-Cycle Benefits (mil. $)	$500.4
Net Present Value (mil. $)	$202.2
Benefit / Cost Ratio:	1.7
Rate of Return on Investment:	n/a
Payback Period:	n/a

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$21.8	$436.9
Veh. Op. Cost Savings	$2.2	$44.3
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$1.0	$19.2
TOTAL BENEFITS	$25.0	$500.4
Person-Hours of Time Saved	2,599,414	51,988,275
Additional CO_2 Emissions (tons)	-10,453	-209,058
Additional CO_2 Emissions (mil. $	-$0.3	-$6.3

Exhibit B-3: BCA Results - S3/S4 - S1/S2+Truck Lane+Lambert IC Modification

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$496.6
Life-Cycle Benefits (mil. $)	$1,473.7
Net Present Value (mil. $)	$977.1
Benefit / Cost Ratio:	3.0
Rate of Return on Investment:	19.0%
Payback Period:	6 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$57.2	$1,143.9
Veh. Op. Cost Savings	$11.9	$238.8
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$4.5	$91.0
TOTAL BENEFITS	$73.7	$1,473.7
Person-Hours of Time Saved	7,085,363	141,707,251
Additional CO_2 Emissions (tons)	-57,755	-1,155,108
Additional CO_2 Emissions (mil. $	-$1.7	-$34.3

Incremental Costs (mil. $)	$198.4
Incremental Benefits (mil. $)	$1,192.9
Incremental Benefit / Cost Ratio	6.0

Exhibit B-4: BCA Results - S5/S6 - S3/S4+HOV Continuous Access

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$499.1
Life-Cycle Benefits (mil. $)	$1,983.6
Net Present Value (mil. $)	$1,484.6
Benefit / Cost Ratio:	4.0
Rate of Return on Investment:	23.8%
Payback Period:	5 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$83.5	$1,669.5
Veh. Op. Cost Savings	$11.3	$225.5
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$4.4	$88.6
TOTAL BENEFITS	$99.2	$1,983.6
Person-Hours of Time Saved	10,628,179	212,563,578
Additional CO_2 Emissions (tons)	-56,229	-1,124,587
Additional CO_2 Emissions (mil. $	-$1.6	-$32.9

Incremental Costs (mil. $)	$2.5
Incremental Benefits (mil. $)	$509.9
Incremental Benefit / Cost Ratio	208.0

Exhibit B-5: BCA Results - S7/S8 - S5/S6+Adaptive Ramp/Connector Metering

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$509.1
Life-Cycle Benefits (mil. $)	$2,005.7
Net Present Value (mil. $)	$1,496.6
Benefit / Cost Ratio:	3.9
Rate of Return on Investment:	23.5%
Payback Period:	5 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$84.6	$1,692.7
Veh. Op. Cost Savings	$11.3	$225.1
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$4.4	$87.8
TOTAL BENEFITS	$100.3	$2,005.7
Person-Hours of Time Saved	10,783,976	215,679,524
Additional CO_2 Emissions (tons)	-56,325	-1,126,500
Additional CO_2 Emissions (mil. $)	-$1.6	-$32.9

Incremental Costs (mil. $)	$10.0
Incremental Benefits (mil. $)	$22.0
Incremental Benefit / Cost Ratio	2.2

Exhibit B-6: BCA Results - S11 - S8+Operational Projects

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$26.4
Life-Cycle Benefits (mil. $)	$52.2
Net Present Value (mil. $)	$25.7
Benefit / Cost Ratio:	2.0
Rate of Return on Investment:	13.5%
Payback Period:	7 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$2.3	$46.7
Veh. Op. Cost Savings	$0.1	$2.5
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.2	$3.0
TOTAL BENEFITS	$2.6	$52.2
Person-Hours of Time Saved	240,449	4,808,972
Additional CO_2 Emissions (tons)	-623	-12,456
Additional CO_2 Emissions (mil. $)	-$0.0	-$0.4

Exhibit B-7: BCA Results - S12 - S11+Truck Lanes+Gap Closure

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$93.6
Life-Cycle Benefits (mil. $)	$119.8
Net Present Value (mil. $)	$26.2
Benefit / Cost Ratio:	1.3
Rate of Return on Investment:	7.0%
Payback Period:	11 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$6.2	$123.6
Veh. Op. Cost Savings	-$0.2	-$3.1
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	-$0.0	-$0.7
TOTAL BENEFITS	$6.0	$119.8
Person-Hours of Time Saved	707,343	14,146,862
Additional CO_2 Emissions (tons)	517	10,341
Additional CO_2 Emissions (mil. $)	$0.0	$0.3

Exhibit B-8: Cumulative BCA Results

3

INVESTMENT ANALYSIS
SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$629.1
Life-Cycle Benefits (mil. $)	$2,397.2
Net Present Value (mil. $)	$1,768.1
Benefit / Cost Ratio:	3.8
Rate of Return on Investment:	n/a
Payback Period:	n/a

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$103.9	$2,079.0
Veh. Op. Cost Savings	$11.2	$223.9
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$4.7	$94.3
TOTAL BENEFITS	$119.9	$2,397.2
Person-Hours of Time Saved	13,086,015	261,720,305
Additional CO_2 Emissions (tons)	-56,786	-1,135,728
Additional CO_2 Emissions (mil. $)	-$1.7	-$33.0

Note: Benefits on SR-91 removed (Scenarios 1 & 2) and benefits of SR-57 projects on SR-91 added.

District 12 CSMP Team Organization Chart