Corridor System Management Plan (CSMP)

Los Angeles I-5 South Corridor

From Orange County Line to I-710

Final Report

Executive Summary

September 2010

I approve this Corridor System Management Plan (CSMP) for the I-5 South Corridor in Caltrans District 7 as the overall Policy Statement and Strategic Plan that will guide transportation decisions and investment for the I-5 Corridor from the Orange County Line to I-710 in Los Angeles County.

Approval

for MICHAEL MILES 5/4/11
District 7 Director Date

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List of Exhibits

This document represents the Executive Summary for the Los Angeles Interstate 5 (I-5) South Corridor System Management Plan (CSMP) developed on behalf of the California Department of Transportation (Caltrans) by System Metrics Group (SMG). A more detailed technical CSMP is available upon request.

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). CMIA money is partially funding one project on the southern section of I-5. The project will construct high occupancy vehicle (HOV) lanes in the median of I-5 from the Orange County Line to I-605, a distance of about seven miles. Approximately $387 million in CMIA funds have been adopted by the CTC for this project.

To receive CMIA funds, the California Transportation Commission (CTC) guidelines required that project nominations describe in a CSMP how mobility gains from funded corridor improvements would be maintained over time. Therefore, a CSMP aims to define how corridors will be managed over time, 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.

This Executive Summary and the technical CSMP represent the results of a study that included several key steps:

- Stakeholder Involvement
- Corridor Performance Assessment
- Bottleneck Identification and Causality Analysis
- Scenario Development and Analysis
- Conclusions and Recommendations.

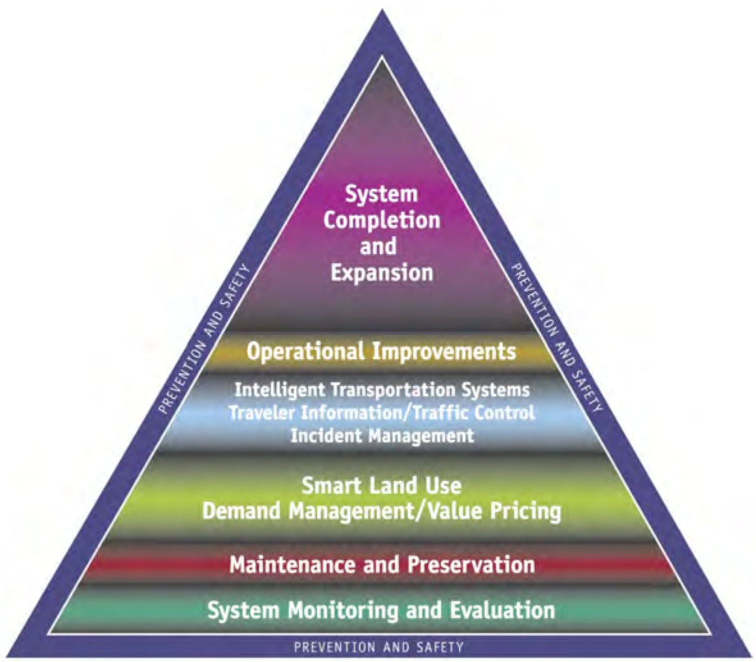
Highlights of each of these steps are included in later sections of this summary.

BACKGROUND

Los Angeles County's transportation system faces numerous challenges — the demand for transportation keeps rising, congestion is increasing, and infrastructure is aging. At the same time, traditional transportation finance mechanisms are not able to provide adequate funding to keep expanding the infrastructure to keep up with demand. Caltrans recognized that infrastructure expansion cannot keep pace with demand, and adopted a system management philosophy to address current and future transportation needs in a comprehensive manner.

Exhibit ES-1 illustrates the concept of system management as a pyramid. The exhibit shows that transportation decision makers and practitioners at all jurisdictions must expand their "tool box" to include many complementary strategies, including smart land use, demand management, and an increased focus on operational investments (shown in the middle part of the pyramid) to complement the traditional system expansion investments. All of these strategies build on a strong foundation of system monitoring and evaluation.

Exhibit ES-1: System Management Pyramid



This CSMP defines how Caltrans and its stakeholders will manage the I-5 South Corridor over time, focusing on operational strategies in addition to already funded expansion projects. The CSMP fully respects previous decisions (including land use, pricing, and demand management) and complements them with additional promising investment suggestions, where appropriate. The CSMP development effort relies on complex analytical tools, including micro-simulation models, to isolate deficiencies and quantify improvements for even relatively small operational investments.

Caltrans develops integrated multimodal projects in balance with community goals, plans, and values. Caltrans seeks 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 focuses more on reducing congestion and increasing mobility through capital and operational strategies. Future CSMP work will further address pedestrian, bicycle and transit components and seek to manage and improve the whole network as an interactive system.

STAKEHOLDER INVOLVEMENT

The I-5 South Corridor CSMP involved corridor stakeholders including representatives from cities bordering I-5, the Southern California Association of Governments (SCAG), and the Los Angeles County Metropolitan Transportation Authority (Metro). Caltrans briefed 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:

- Southern California Association of Governments (SCAG)
- Los Angeles County Metropolitan Transportation Authority (Metro)
- I-5 Consortium Cities Joint Powers Authority (JPA)
- Gateway Cities Council of Governments
- City of Norwalk
- City of Downey
- City of La Mirada
- City of Santa Fe Springs.

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

CORRIDOR PERFORMANCE ASSESSMENT

This section briefly describes the I-5 South Corridor and summarizes the results of the comprehensive corridor performance assessment.

Corridor Description

Exhibit ES-2 is a map showing the Los Angeles I-5 South CSMP Corridor. The study corridor extends approximately 14 miles from the Orange County line at Post Mile (PM) 0.0 to the I-710 interchange at PM 13.8. It traverses the cities of La Mirada, Norwalk, Santa Fe Springs, Downey, Pico Rivera, Bell Gardens, and Commerce. It connects with two major freeways, the San Gabriel Freeway (I-605) and the Long Beach Freeway (I-710).

I-5 is a six 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 with some only available on one side of the freeway.

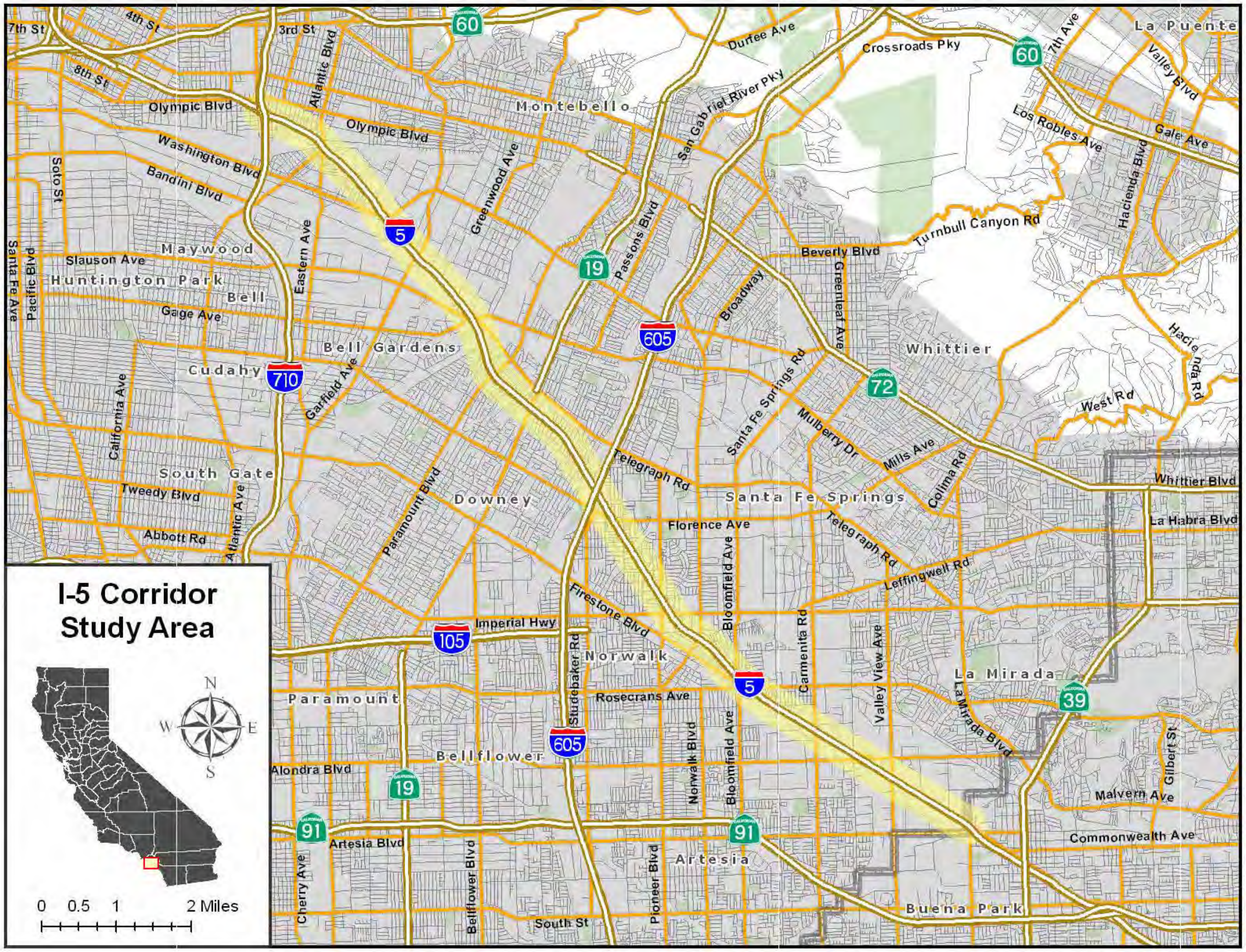
According to 2008 traffic volumes from Caltrans, I-5 carries between 163,000 and 246,000 annual average daily traffic (AADT) depending on location. The highest AADT occurs at the I-710 Interchange, while the lowest occurs just north of Artesia Boulevard.

I-5 is a Surface Transportation Assistance Act (STAA) truck route. According to 2008 Caltrans truck traffic estimates, trucks make up about 7 to 10 percent of total daily traffic along the study corridor, with the highest percentage (9.5 percent) occurring at the Orange/Los Angeles County Line. These percentages are high and indicative of the corridor being a truck route. Some of these trucks may be destined for Hobart Railyard, which is the largest intermodal railyard in the country and located at the north end of the study corridor near the I-5/I-710 Interchange on Washington Boulevard in the City of Commerce. The railyard includes intermodal facilities and handles the distribution of international containers to out-of-state places, such as Chicago and Memphis.

There are several operators that provide transit service near the corridor. Metro operates Line 62, which runs parallel to the study corridor on Telegraph Road. Metrolink operates the Orange County Line and the 91 Line, which offer rail service from downtown Los Angeles to Orange County. The Orange County Line terminates in Oceanside in San Diego County with an average weekday ridership of 2,315, while the 91 Line terminates in downtown Riverside.

Amtrak offers the Coast Starlight and Pacific Surfliner rail services parallel to the I-5 South Corridor. The Coast Starlight provides daily service from Los Angeles to Oakland and Seattle. The Pacific Surfliner provides high-frequency service from San Diego to San Luis Obispo via Los Angeles. The Pacific Surfliner is the second busiest corridor in the country with 2,898,859 riders in fiscal year (FY) 2008.

Exhibit ES-2: Los Angeles I-5 South CSMP Corridor Map



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

Few bicycle facilities exist near the study corridor. Class I bike paths (paved with an exclusive right-of-way) run parallel to Valley View Street, I-605, and I-710, which intersect I-5. There are also various Class III bike paths in the City of Santa Fe Springs, just south of I-605. However, no bike path runs parallel to the study corridor.

There are special event facilities that generate significant trips along the I-5 corridor, including Dodger Stadium, which is adjacent to downtown Los Angeles and northwest of the I-5/SR-110 interchange. Dodger Stadium is the home of the Los Angeles Dodgers Major League Baseball team. The stadium has a seating capacity of approximately 56,000. The Staples Center is another sports arena in Downtown Los Angeles. It is home to several professional sports franchises - the Los Angeles Lakers, the Los Angeles Clippers, the Los Angeles Kings, and the Los Angeles Sparks. Other trip generators include the Citadel Outlet in the City of Commerce and Stonewood Shopping Center in the City of Downey.

Corridor Performance Assessment

The I-5 South CSMP focuses on four categories of performance measures:

- *Mobility* describes how quickly people and freight move along the corridor
- *Reliability* captures the relative predictability of travel 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.

Mobility

Two primary measures were used to quantify mobility: delay and travel time. Each can be estimated from field automatic detection data and forecasted using macro or micro models. The Performance Measurement System (PeMS)[1] provides access to the historical freeway detection data needed to estimate the two mobility measures. PeMS collects detector volume and vehicle occupancy data on the freeway, which are used to estimate speed, delay and travel time.

Delay

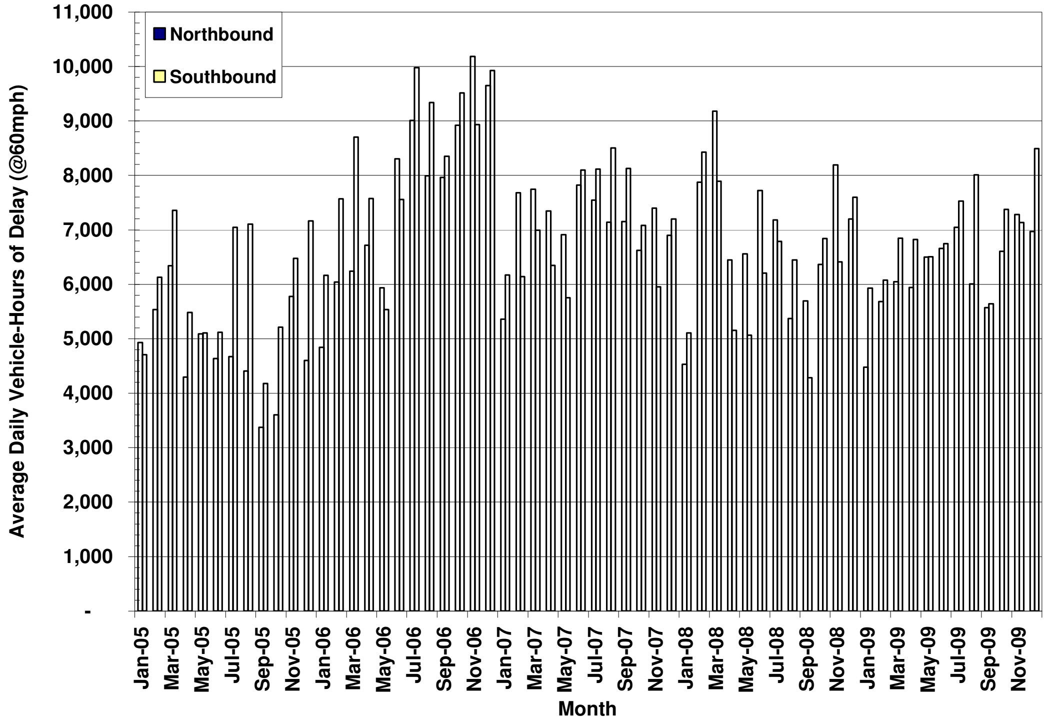
Delay is defined as the observed travel time minus the travel time during free-flow conditions (assumed to be 60 miles per hour). It is reported as vehicle-hours of delay.

Exhibit ES-3 shows the <u>average weekday daily vehicle-hours of delay for each month</u> between 2005 and 2009 for the I-5 South Corridor. These figures exclude weekends and holidays. This exhibit reveals the following delay trends:

- ♦ Congestion on the corridor increased from 2005 to 2006, which was probably due to economic growth in the region and the country. In 2007, however, delay decreased and leveled off, most likely due to the global financial meltdown and the associated recession. By the end of 2009, congestion levels still had not reached 2006 levels.
- ♦ Delay was lower during the winter months and was highest in 2006.
- ♦ In 2005 and 2006, southbound delay was worse than northbound delay almost every month. However, starting in 2007, northbound delay reached the southbound levels.

[1] Developed and maintained by Caltrans and accessible at http://pems.dot.ca.gov.

Exhibit ES-3: I-5 Average Weekday Delay by Month (2005-2009)

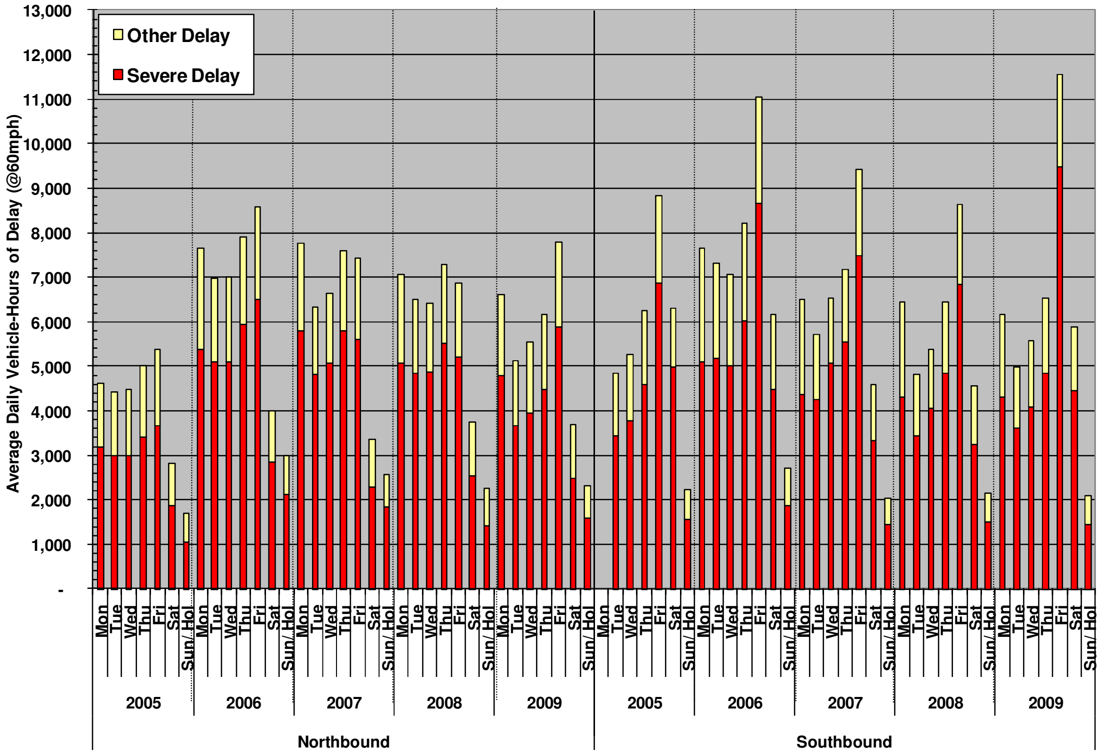


The CSMP further separates delay into two components: severe delay and other delay. *Severe delay* occurs when speeds are below 35 mph and *other delay* occurs when speeds are between 35 and 60 mph. Severe delay represents breakdown conditions. "Other" delay represents conditions approaching or leaving breakdown congestion, or areas that experience temporary slowdowns. However, it can also be a leading indicator of future, severe delay.

Exhibit ES-4 shows average severe and other daily vehicle-hours of delay by day of the week. A few notes related to this exhibit:

- Severe delay makes up about 70 percent of all weekday delay on the corridor in either the northbound or the southbound directions.
- Fridays in the southbound direction generally experience the highest delays, probably due to weekend travel. The second highest delays generally occur on Thursdays.
- Delay was highest in 2006 when southbound delay tended to be greater in magnitude than northbound delay.

Exhibit ES-4: I-5 Delay by Day of Week by Severity (2005-2009)



Exhibits ES-5 and ES-6 summarize average annual weekday delay by hour of the day over the five-year period for both directions of the corridor. These exhibits allow planners and decision makers to understand the trend in peak period delay spiking (greater variance/differences) and peak period spreading (longer duration) by comparing the intensity and duration of the peak period congestion. A few notes on these exhibits:

- The corridor is highly directional with the northbound freeway experiencing significant delay during the AM peak and the southbound freeway experiencing significant delay during the PM peak.
- The delay spike for the AM peak period occurs between 7:00 AM and 8:00 AM, while the delay spike for the PM peak period occurs between 5:00 PM and 6:00 PM. This is typical for an urban corridor serving a large number of peak work trips.
- In 2009, northbound PM peak period congestion was over 45 percent less than it was in 2006 (from an estimated high of over 600 vehicle-hours in 2006 to around 320 vehicle-hours in 2009). The same trend occurred during the southbound AM with 2006 delay levels at about twice 2009 levels (from 400 vehicle-hours in 2006 to 200 vehicle-hours in 2009.
- Midday congestion is present on both directions of the corridor and ranges from about 200 to 400 vehicle-hours.

Exhibit ES-5: Northbound I-5 Hourly Delay (2005-2009)

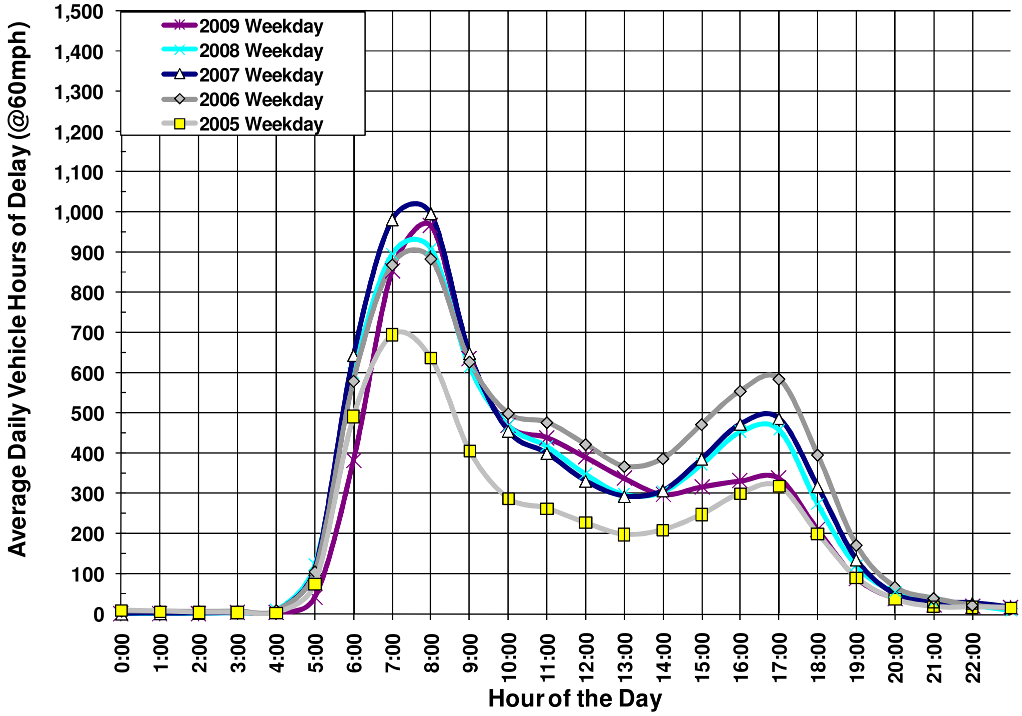
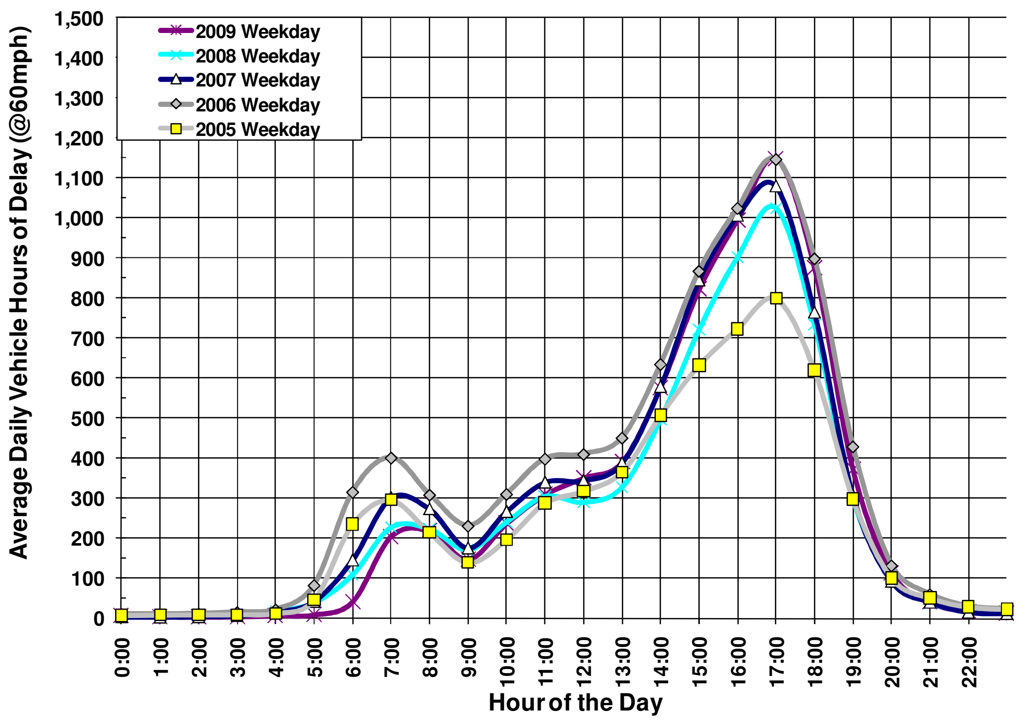


Exhibit ES-6: Southbound I-5 Hourly Delay (2005-2009)



Travel Time

The travel time performance measure for the I-5 South Corridor represents the average time it takes for a vehicle to travel between the Orange County Line and the I-710 Interchange.

Exhibits ES-7 and ES-8 summarize average annual travel times estimated for the corridor by hour of day for the years 2005 through 2009. Similar to delay, travel times were highest in the northbound direction during the AM peak and in the southbound direction during the PM peak. The AM peak period travel time in the northbound direction was greatest in 2007 at 27 minutes, followed by 2009 at 26 minutes. In the southbound direction, PM peak period travel times were the same in 2006 and 2009 at 29 minutes.

Exhibit ES-7: Northbound I-5 Travel Time by Hour (2005-2009)

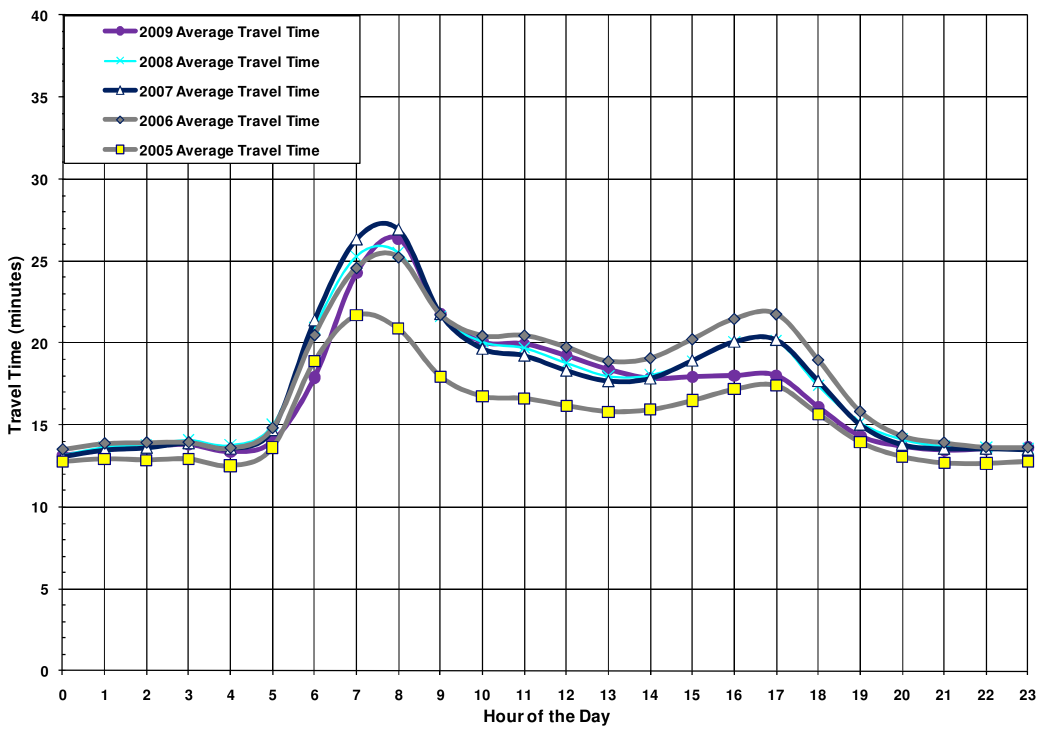
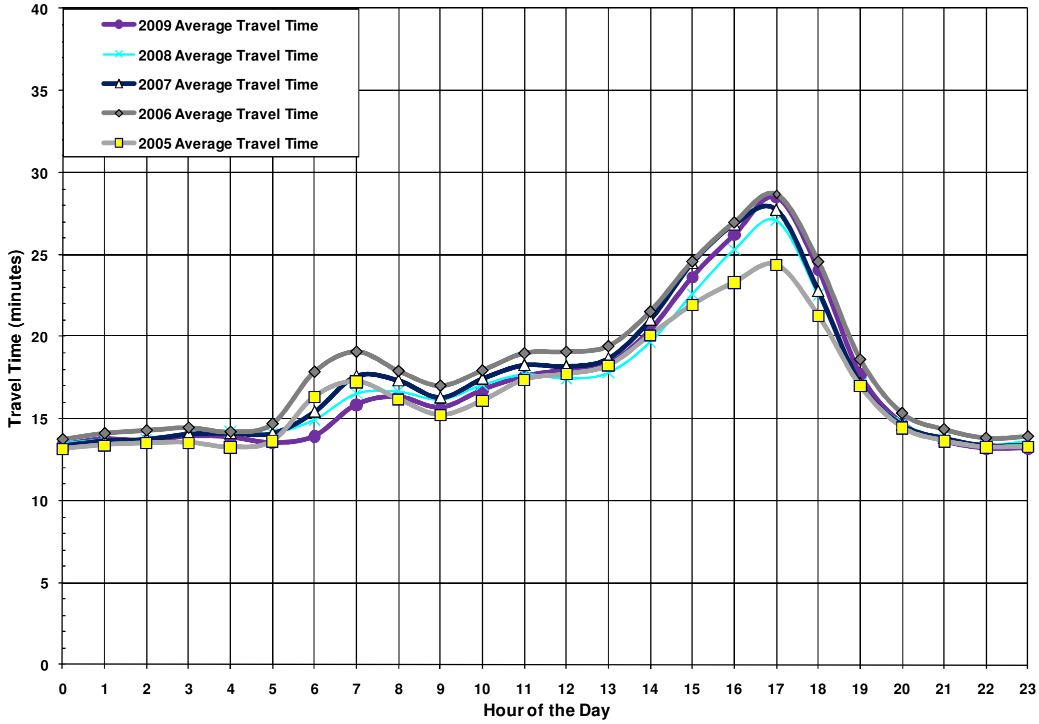


Exhibit ES-8: Southbound I-5 Travel Time by Hour (2005-2009)



Reliability

Reliability captures the degree of predictability in travel time. Reliability focuses on how travel time varies from day to day and reflects the impacts of accidents, incidents, weather, and special events. Improving reliability is an important goal for transportation agencies and efforts to accomplish this include incident management, traveler information, and special event planning.

To measure reliability, the CSMP used the "buffer index", which reflects the additional time required (over and beyond the average) to ensure an on-time arrival 95 percent of the time. In other words, if a person must be on time 95 days out of 100 (or 19 out of 20 workdays per month), then that person must add additional time to their average expected travel time to ensure an on-time arrival. That additional time is the buffer time. Severe events, such as collisions, could cause longer travel times, but the 95th percentile represents a balance between days with extreme events (e.g., major accidents) and other, more "typical" travel days.

Exhibits ES-9 and ES-10 illustrate travel time variability along I-5 on non-holiday weekdays for 2007. The full technical CSMP shows the buffer index for the years 2005 to 2009, but this Executive Summary reports only the data for the mainline freeway in 2007 since that year was used as the base year for modeling.

The following observations on the reliability results are worth noting:

- In 2007, the northbound direction had the highest estimated average travel time at 8:00 AM, when the travel time was approximately 27 minutes with an estimated buffer index time of 10 minutes for a buffer index of 37 percent. In other words, to arrive on time 95 percent of the time, a commuter would need to leave for work 37 minutes before the start time (add a safety margin of 37 percent) to travel the entire length of the I-5 South Corridor.
- The southbound direction at 5:00 PM had an estimated average travel time of 28 minutes in 2007 with a buffer time of 7 minutes for a buffer index of 25 percent.

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

Exhibit ES-9: Northbound I-5 Travel Time Variability (2007)

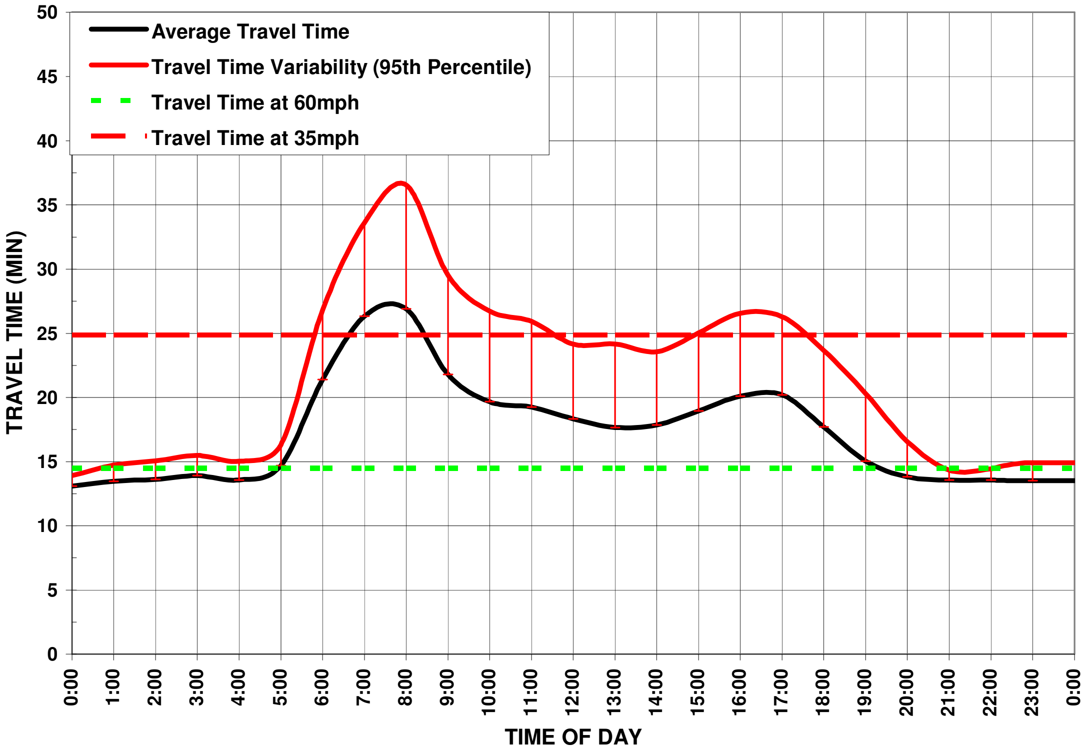
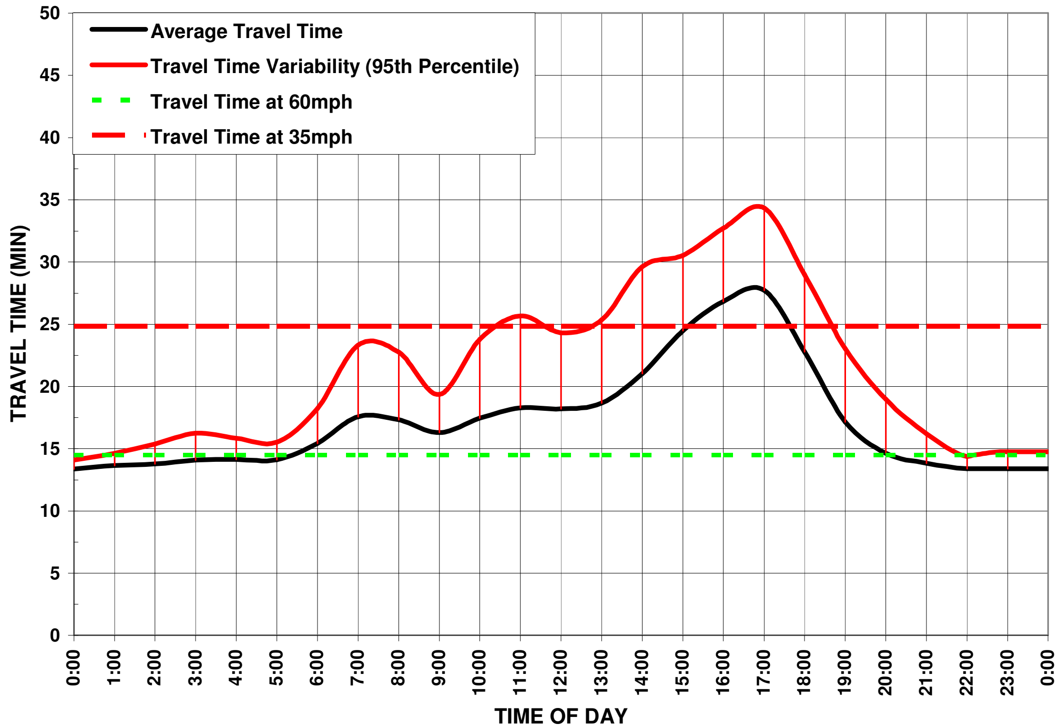


Exhibit ES-10: Southbound I-5 Travel Time Variability (2007)



Safety

The adopted performance measures to assess safety involve 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.

Exhibits ES-11 and ES-12 show the total number of collisions by month on northbound and southbound I-5 respectively within the corridor area. The exhibits summarize the latest available, three-year data from January 1, 2006 through December 31, 2008. Weekday accidents comprised typically over 60 percent of total accidents. Total monthly accidents in the northbound direction increased from 890 in 2006 to 910 in 2007 and decreased to 850 in 2008. In the southbound direction, total monthly accidents decreased annually from 2006 to 2008. The average monthly number of collisions during the three-year period was greater in the northbound direction (75 collisions) than the southbound direction (65 collisions).

Exhibit ES-11: Northbound I-5 Monthly Collisions (2006-2008)

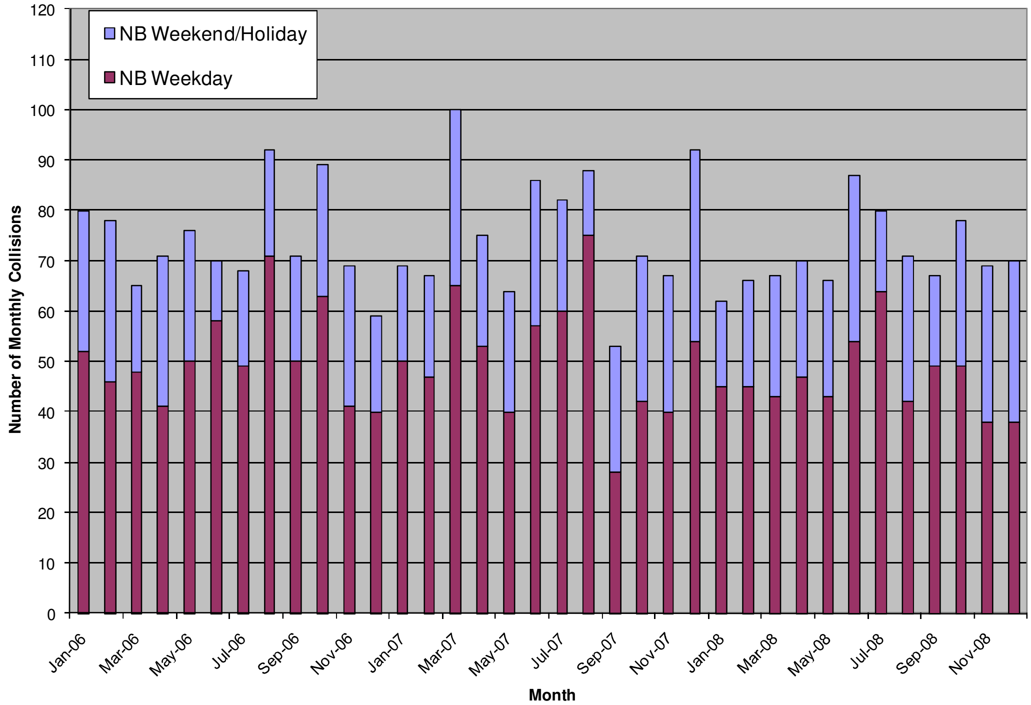
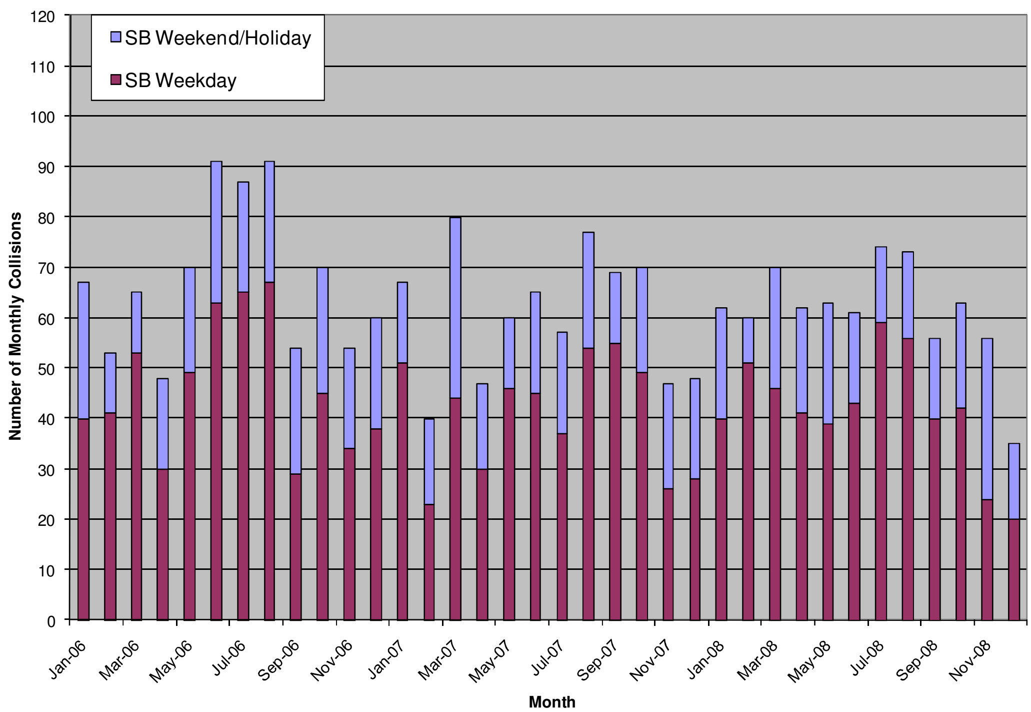


Exhibit ES-12: Southbound I-5 Monthly Collisions (2006-2008)



Productivity

Productivity is a system efficiency measure used to analyze the throughput of the corridor during congested conditions. Restoring lost productivity is a focus of CSMPs.

Exhibit ES-13 illustrates how congestion leads to lost productivity. The exhibit uses observed data from I-5 sensors for a typical autumn 2009 afternoon peak period (October 5, 2009). It shows speeds (in red) and flow rates (in blue) on southbound I-5 at Carmenita Avenue, one of the most congested locations on the corridor.

Flow rates (measured as vehicle-per-hour-per-lane or “vphpl”) at Carmenita Avenue averaged slightly over 1,600 vphpl between 2:30 PM and 3:00 PM, which is slightly less than a typical peak period maximum flow rate. Generally, freeway flow rates over 2,000 vehicles per hour per lane cannot be sustained over a long period.

Once volumes approach this maximum rate, traffic becomes unstable. With any additional merging or weaving, traffic breaks down and speeds can rapidly plummet to below 35 mph. In essence, every incremental merge takes up two spots on the freeway for a short time. However, since the volume is close to capacity, these merges lead to queues. 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 ES-13, throughput drops by nearly 20 percent on average during the peak period (from over 1,600 to around 1,200 vphpl). This three-lane road therefore operates with 20 percent less capacity when demand is at its highest. Just when the corridor needed the most capacity, it performed in the least productive manner and effectively lost lanes. This loss in throughput can be aggregated and presented as “Equivalent Lost-Lane-Miles”.

Exhibit ES-13: Lost Productivity Illustrated

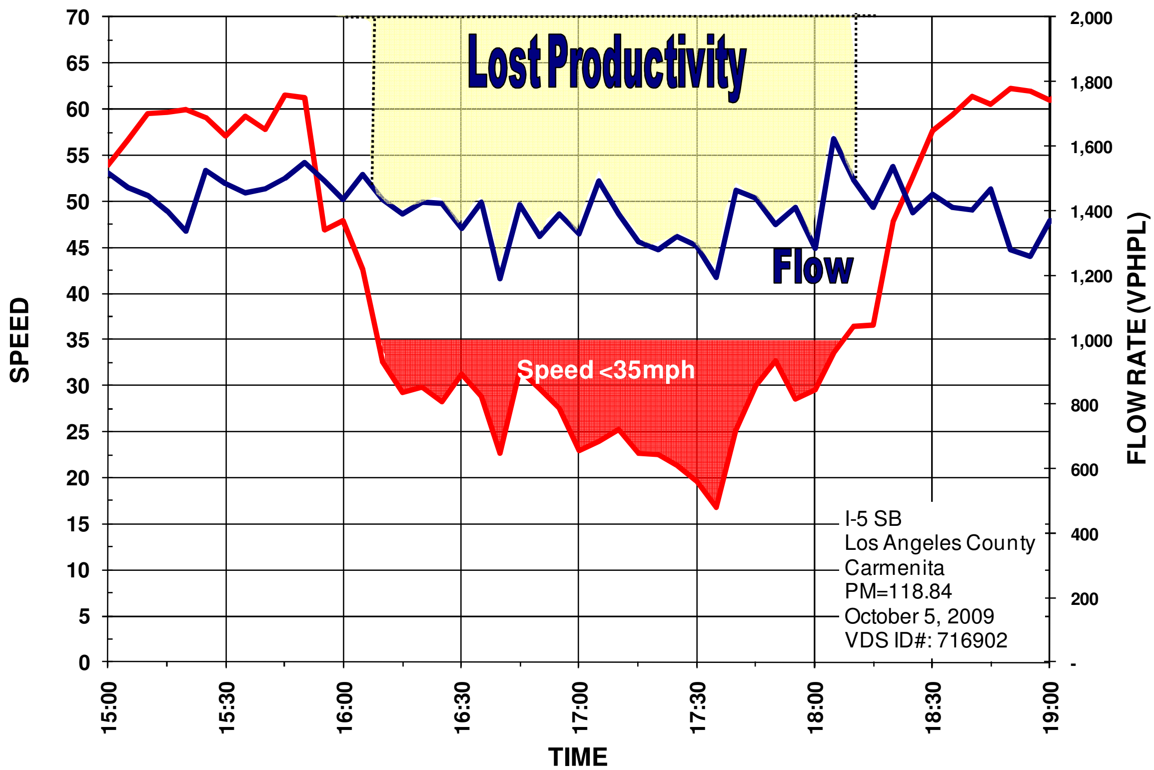
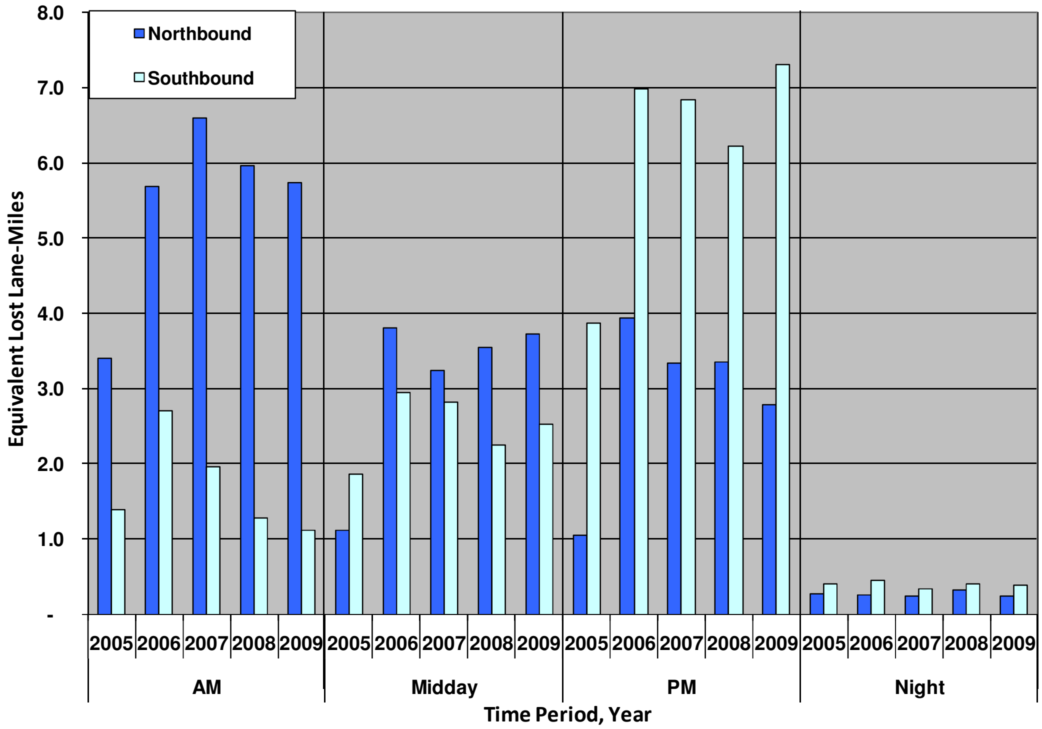


Exhibit ES-14 shows the estimated average weekday (non-holiday) equivalent lost lane-miles by period and year on the I-5 South Corridor. A few notes on this exhibit:

- The largest productivity losses occurred in the PM peak hours in the southbound direction. Productivity during the PM peak in both directions improved from 2006 to 2008, but declined in 2009 with lost lane-miles peaking at over 7.0.
- Productivity during the AM improved annually in the northbound direction from 2007 to 2009 as lost lane-miles declined from 6.7 in 2007 to 6.0 in 2008 and 5.8 in 2009.

Operational strategies are critical to recovering such productivity losses. These strategies include building new or extending auxiliary lanes, developing more aggressive ramp metering strategies without negatively influencing the arterial network, and improving incident clearance times.

Exhibit ES-14: I-5 Average Daily Equivalent Lost Lane-Miles by Direction, Time Period, and Year (2005-2009)



BOTTLENECK IDENTIFICATION AND CAUSALITY ANALYSIS

Major bottlenecks are the primary cause of congestion and lost productivity. By definition, a bottleneck is a location where traffic demand exceeds the effective carrying capacity of the roadway. In most cases, the cause of a bottleneck relates to a sudden reduction in capacity, such as a lane drop, merging and weaving, driver distractions, a surge in demand, or a combination of factors.

Exhibit ES-15 summarizes the northbound and southbound bottleneck locations, the time period that these bottlenecks are active, and the causes of the bottlenecks. Exhibits ES-16 and ES-17 are maps of the corridor showing the bottleneck locations for the AM and PM peak periods, respectively.

The specific location and causality of each major I-5 South Corridor bottleneck was verified by multiple field observations on separate weekdays. Many bottleneck locations were videotaped to validate specific locations and causes, and to assist in micro-simulation model calibration.

The detailed final report explains in detail the process and results of the bottleneck identification and causality analysis.

Exhibit ES-15: Los Angeles I-5 South Corridor Bottleneck Locations and Causality

Northbound

Abs	CA	Bottleneck Location	Active Period		Causality Summary
			AM	PM	
119.1	2.5	Carmenita IC	✓	✓	Merging traffic from the off- and on-ramps; lack of ramp storage capacity
121.9	5.2	Pioneer On	✓	✓	Short merge taper; vertical grade
123.6	7.0	I-605 On	✓		Two consecutive ramp merges
125.5	8.8	Paramount On	✓		Heavy ramp merge; roadway curve
126.5	9.8	Telegraph Off	✓		Uphill grade; roadway curve
130.5	13.7	I-710 On	✓	✓	Cross-weaving with I-710 traffic

Southbound

Abs	CA	Bottleneck Location	Active Period		Causality Summary
			AM	PM	
128.0	11.5	Washington On		✓	On-ramp merge beyond the crest of a vertical grade
125.5	8.9	Paramount On		✓	Queuing to Slauson; roadway curve
123.6	7.0	I-605 Off	✓	✓	Queuing of the I-605 off-ramp traffic
118.8	2.3	Carmenita IC	✓	✓	Poor geometric configuration of interchange
117.6	1.0	Valley View IC		✓	Poor geometric configuration of interchange
116.0	0.0	OC/LA County Line	✓	✓	Reduced capacity; construction

Exhibit ES-16: Map of Major Existing AM Bottlenecks on I-5 South Corridor

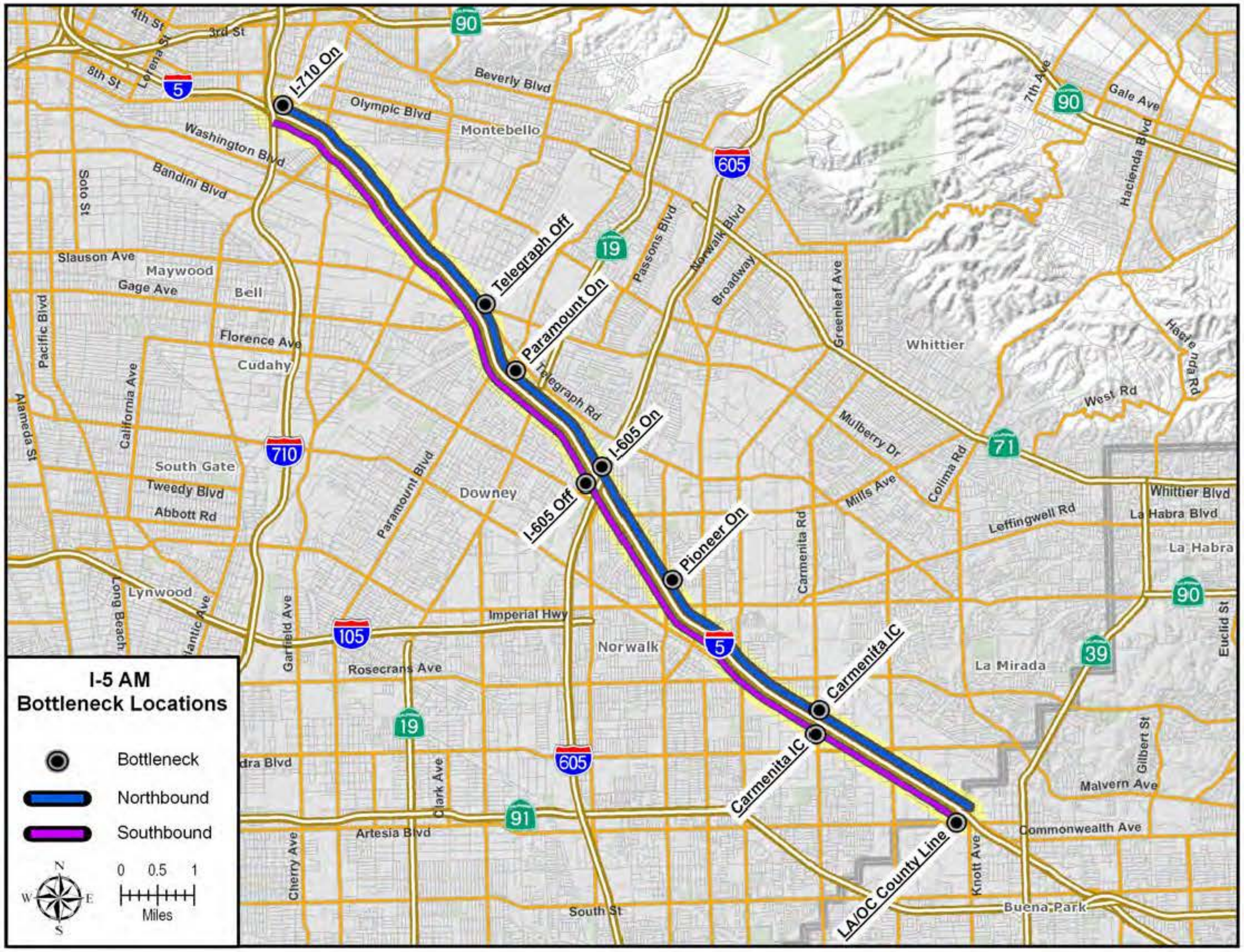
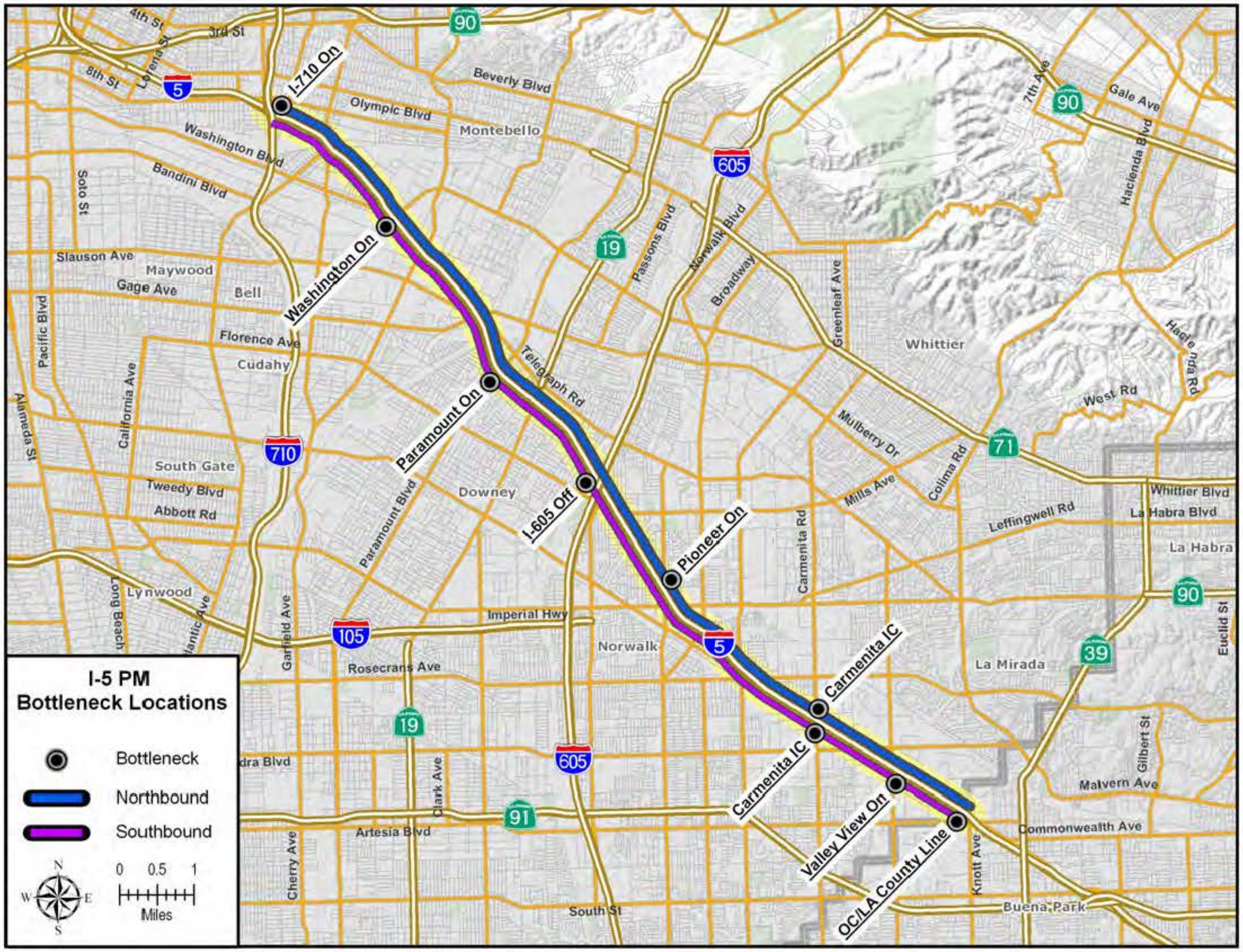


Exhibit ES-17: Map of Major Existing PM Bottlenecks on I-5 South Corridor



SCENARIO DEVELOPMENT AND ANALYSIS

Fully understanding how a corridor performs and why it performs that way sets the foundation for evaluating potential solutions. Several steps were required to develop and evaluate improvement projects, including:

- Developing traffic models for 2007 base year and 2020 long-term demand
- Combining projects in a logical manner for modeling and testing
- Evaluating model outputs and summarizing results
- Conducting a benefit cost assessment of scenarios.

Traffic Model Development

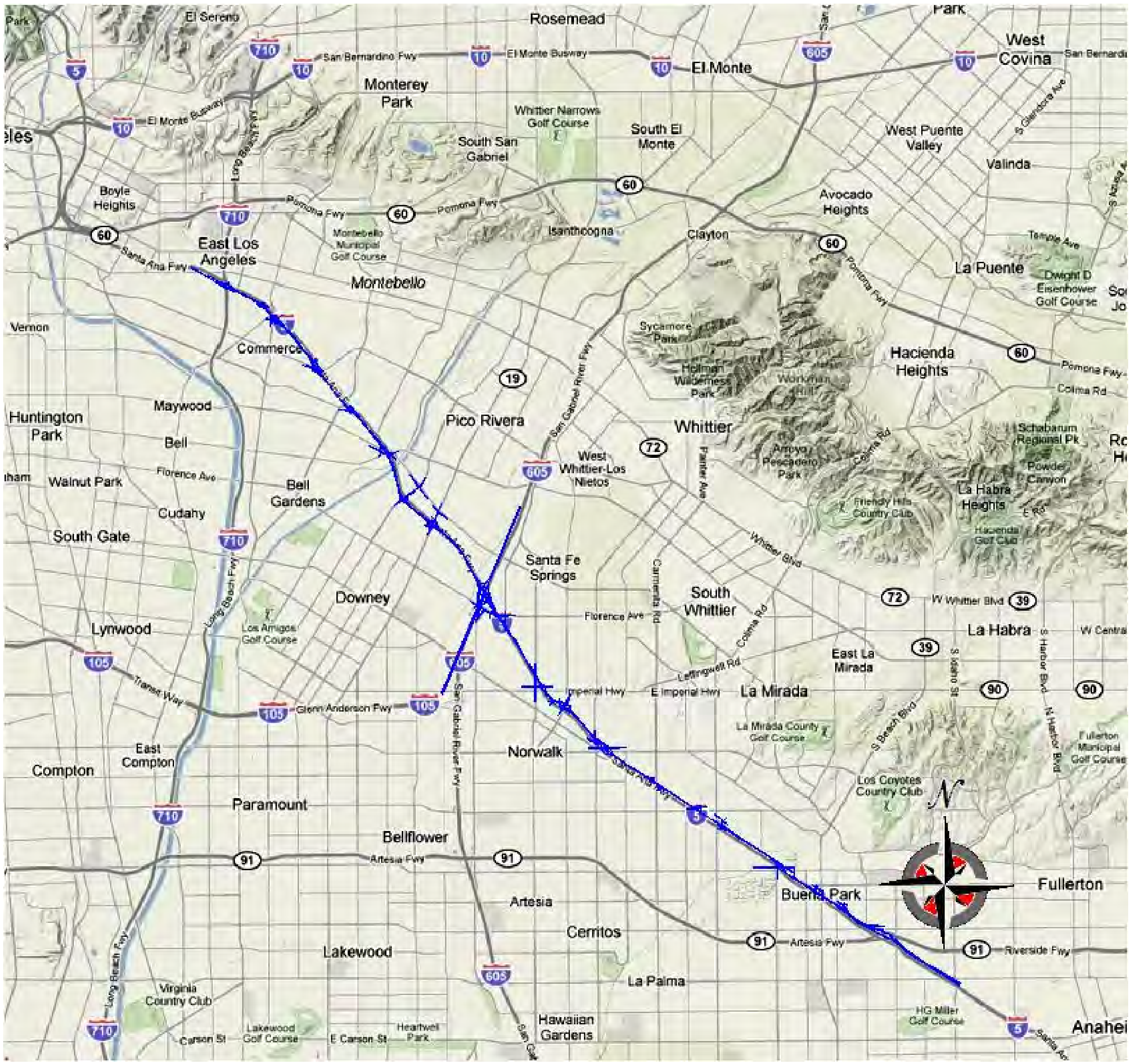
The study team developed a traffic model using the VISSIM micro-simulation software. It is important to note that micro-simulation models are complex to develop and calibrate for a large urban corridor. However, it is one of the only tools capable of providing a reasonable approximation of bottleneck formation and queue development. Therefore, such tools help quantify the impacts of operational strategies, which traditional travel demand models cannot.

The model was calibrated against 2007 conditions. This was a resource-intensive effort, requiring several submittal and review cycles until the model reasonably matched bottleneck locations and relative severity. Once calibration was approved, a 2020 model was also developed based on SCAG's travel demand model demand projections.

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

Exhibit ES-18 depicts the network included in the model. There are no parallel arterials in the model with the exception of arterials at interchanges. All freeway interchanges were included as well as on-ramps and off-ramps.

Exhibit ES-18: I-5 South 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, but this would have entailed thousands of model runs. Instead, the team combined projects based on a number of factors, including:

- Projects fully programmed and funded were combined separately from projects that were not and tested with both the 2007 and 2020 models.

- Short and medium range operational projects were grouped into scenarios and tested with the both the 2007 and 2020 models.
- Longer range projects to be delivered by 2020 and beyond were used to develop scenarios to be tested with the 2020 model only.

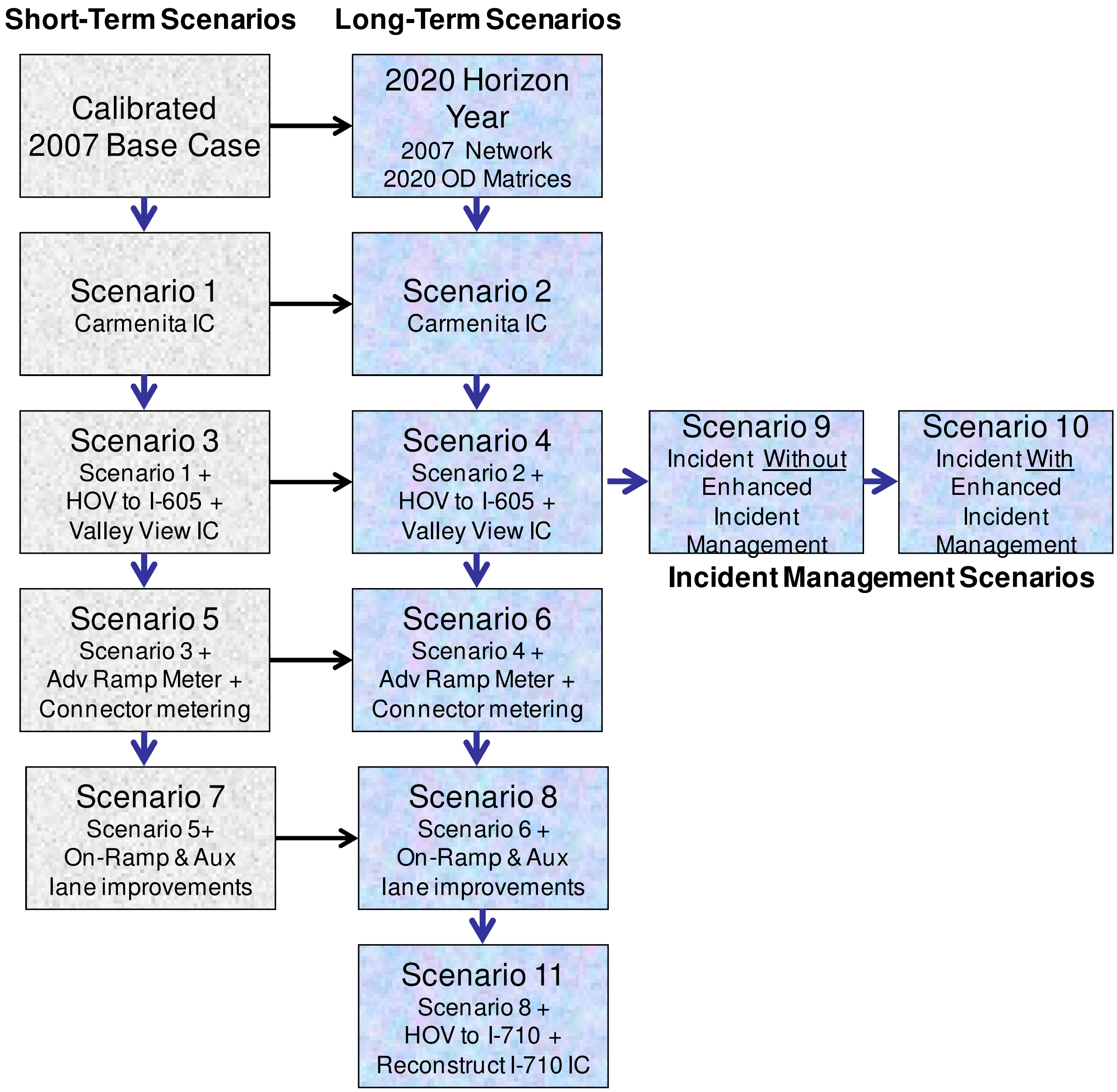
The study team assumed that projects delivered before 2016 could reasonably be evaluated using the 2007 base year model. The 2020 forecast year for the I-5 South Corridor was consistent with the SCAG 2020 regional travel demand model origin-destination matrices used to develop the 2008 Regional Transportation Plan (RTP). When SCAG updates its travel demand model and the RTP, it may wish to update the micro-simulation model with revised demand projections.

Project lists used to develop scenarios were from the Regional Transportation Improvement Program (RTIP), the RTP, and other sources (e.g., special studies). The study team eliminated projects that do not directly affect mobility. For instance, sound wall, landscaping, or minor arterial improvement projects were eliminated since micro-simulation models cannot evaluate them.

Scenario testing for the I-5 South CSMP differs from the traditional "alternatives evaluations" for Major Investment Studies (MIS) or Environmental Impact Reports (EIRs). An MIS or EIR focuses on identifying alternative solutions to address current or projected corridor problems. Each alternative is evaluated separately and results among competing alternatives are compared resulting in a locally preferred alternative. In contrast, for the I-5 CSMP, scenarios build on each other. Each scenario contains the projects from the previous scenario plus additional projects as long as the incremental scenario results showed an acceptable level of performance improvement. This incremental scenario evaluation approach is important to understand since CSMPs are new and often compared with alternatives studies.

Exhibit ES-19 summarizes the approach used and scenarios tested. It also provides a general description of the projects included in the 2007 and 2020 micro-simulation runs. As can be seen in the exhibit, most projects were tested in both the short-term and long-term and built upon prior scenarios. Enhanced incident management was tested in Scenarios 9 and 10 by comparing congestion with and without enhanced incident management. These scenarios assume that the prior scenario projects were built in the horizon year model and are expected for the longer term and were not tested using the short-term model.

Exhibit ES-19: Micro-Simulation Modeling Approach



Scenario Evaluation Results

Exhibits ES-20 and ES-21 show the delay results for all the 2007 scenarios evaluated for the AM and PM peak periods, respectively. Exhibits ES-22 and ES-23 show similar results for scenarios evaluated using the 2020 horizon year model.

For each scenario, the modeling team coded the proposed improvements, conducted multiple runs, and produced composite results by facility type (i.e., mainline, HOV, arterials, and ramps) and vehicle type (SOV, HOV, and trucks) as well as speed contour diagrams (discussed in more detail in the full technical CSMP). The study team reviewed incremental steps in detail for each modeling analysis to ensure they were consistent with general traffic engineering principles.

Exhibit ES-20: AM Peak Micro-Simulation Delay Results by Scenario (2007)

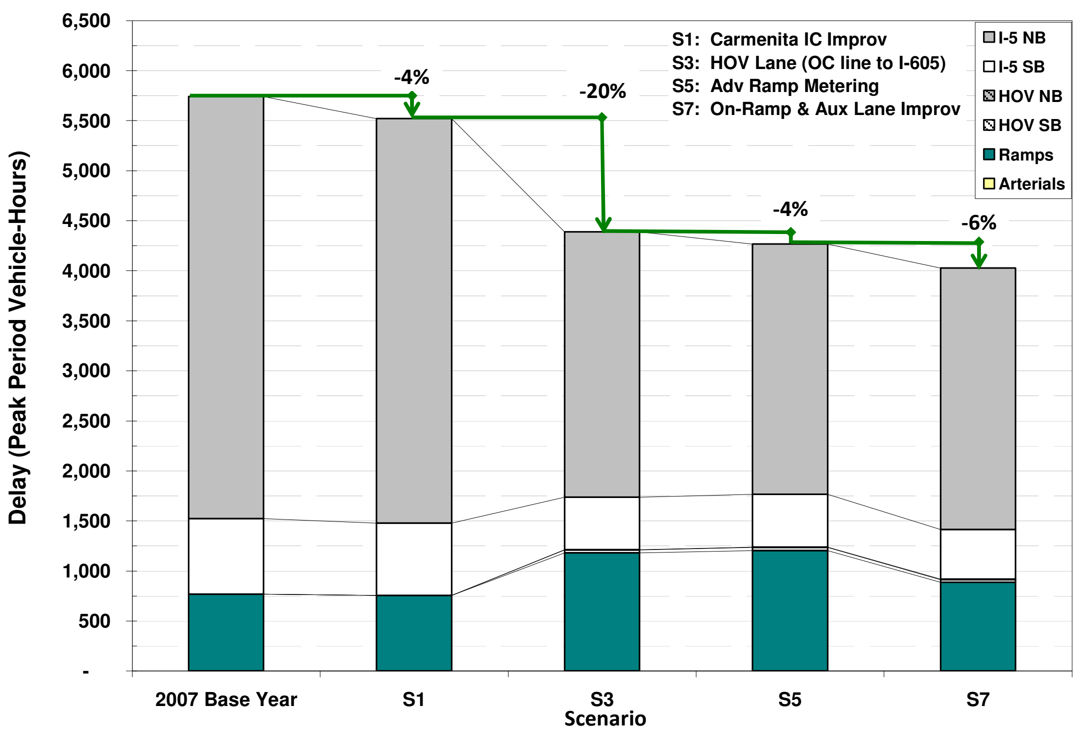


Exhibit ES-21: PM Peak Micro-Simulation Delay Results by Scenario (2007)

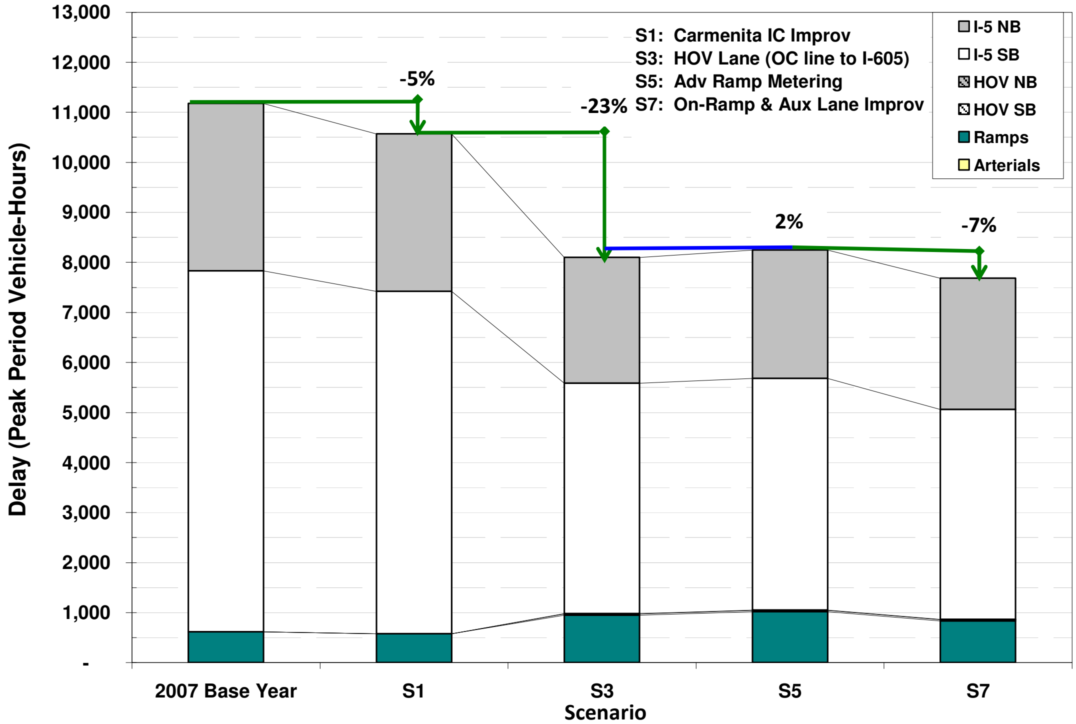


Exhibit ES-22: AM Peak Micro-Simulation Delay by Scenario (2020)

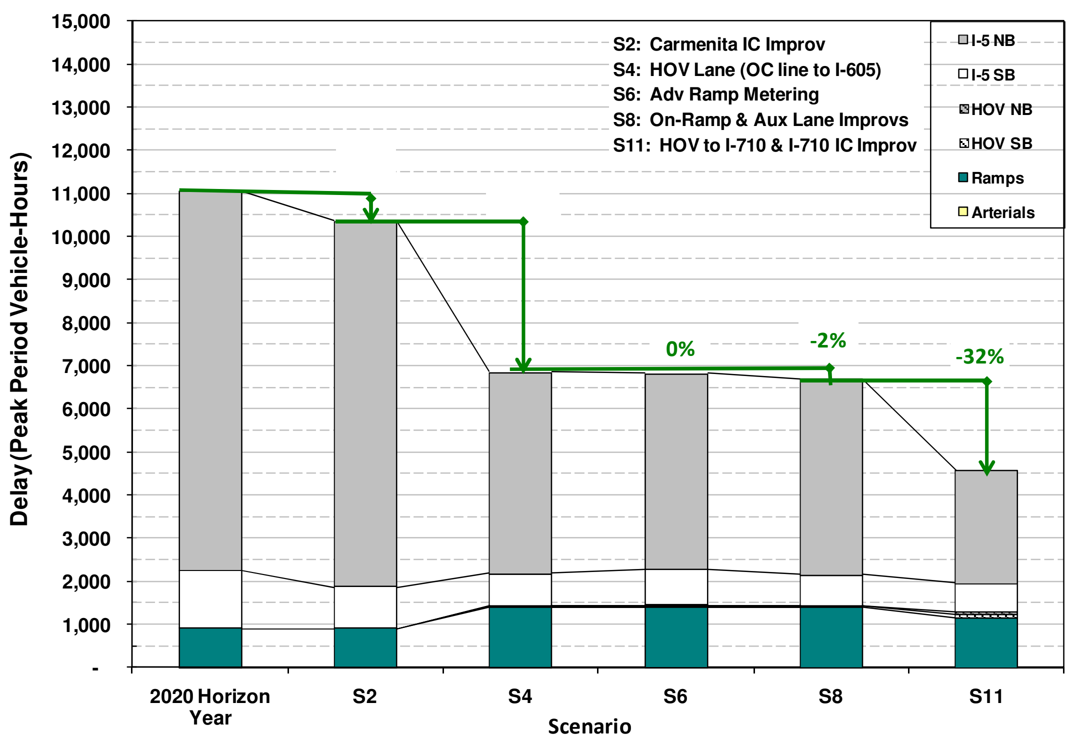
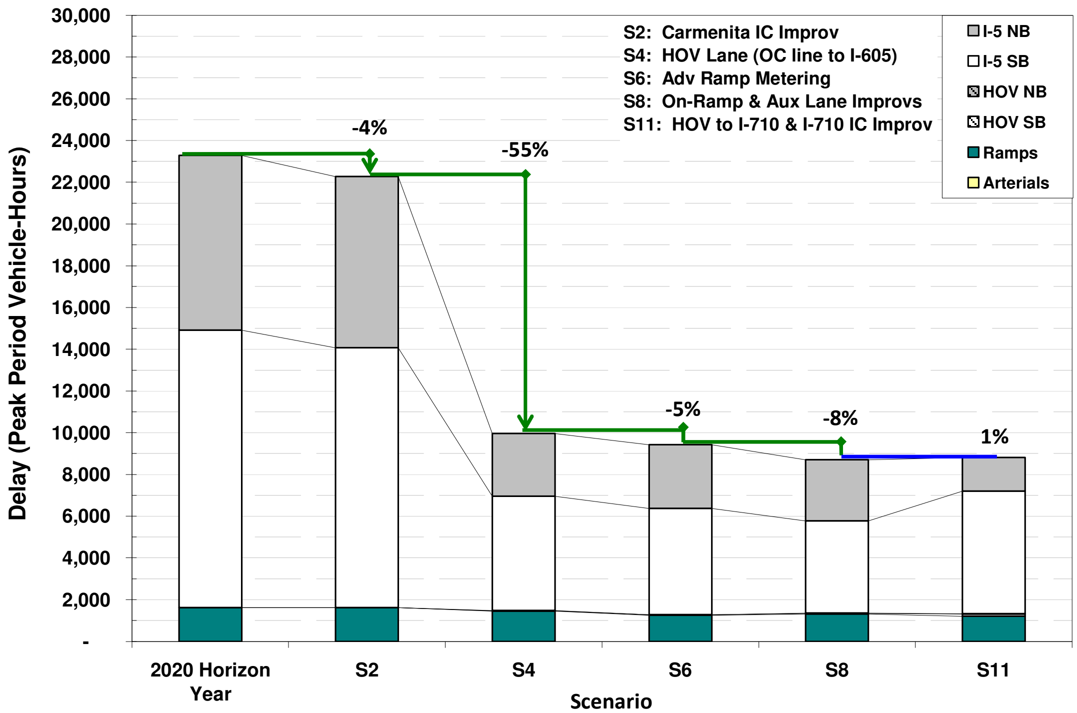


Exhibit ES-23: PM Peak Micro-Simulation Delay by Scenario (2020)



The following sections summarize findings for each scenario tested and reviewed by the study team.

2007 Base Year and 2020 Do Minimum Horizon Year

Absent any physical improvements, the modeling team estimates that by 2020, total delay (on mainline, HOV, ramps, and arterials) will double compared to 2007 (from a total of around 17,000 vehicle-hours daily to just fewer than 35,000 vehicle-hours) in the combined AM and PM peak.

Scenarios 1 and 2 (Carmenita Interchange)

Scenarios 1 and 2 test one of the two projects fully funded on the corridor. The Carmenita Interchange Improvement removes an existing two-lane steel structure and replaces it with a new eight-lane concrete structure with tight diamond ramps. It also elevates the interchange and arterial above an existing at-grade railroad crossing. The existing crossing causes traffic at the southbound off-ramp to back onto the corridor during the morning and afternoon peak hours. This project is expected to be completed in 2013.

The 2007 model estimates that Scenario 1 would reduce overall delay on the corridor by about 4 to 5 percent (800 vehicle-hours) over the base model during the AM and PM peak periods. Likewise, the 2020 model estimates that Scenario 2 would reduce overall delay on the corridor by about 4 percent (over 1,500 vehicle-hours) compared to the Do Minimum Horizon Year base during the AM and PM peak periods.

Scenarios 3 and 4 (HOV and General Purpose Widening)

Scenarios 3 and 4 build on Scenarios 1 and 2, and test an HOV widening project funded partially by the CMIA. The project involves constructing one HOV lane and one general- purpose (GP) lane in each direction between the Orange/Los Angeles County Line and I-605. The project also reconstructs the Valley View Interchange and upgrades the 6.7-mile segment to conform to current highway design. The expected completion of this project is 2016.

The 2007 model estimates that Scenario 3 will reduce delay by 20 percent in the AM peak and 23 percent in the PM peak, for a total delay reduction of 3,600 daily vehicle-hours compared to Scenario 1. The 2020 model estimates that Scenario 4 will reduce overall delay on the corridor by about 34 to 55 percent over the Scenario 2 results during both the AM and PM peak periods. This reduction is substantial at over 15,000 vehicle-hours and improves mobility from the Orange County line to the I-605 interchange, particularly in the southbound direction. These improvements are expected to allow more northbound traffic to flow downstream of I-605 and increase congestion in this section.

Scenarios 5 and 6 (Advanced Ramp Metering)

Scenarios 5 and 6 build on Scenarios 3 and 4 by adding an advanced ramp metering system, such as dynamic or adaptive ramp metering. Although connector metering at the I-605 and I-710 interchanges would significantly add to advanced ramp metering operations along this corridor, the existing configurations do not support effective implementation without substantial and costly interchange modifications.

The 2007 model estimates that advanced ramp metering reduces delay by 3 percent in the AM peak (or 120 daily vehicle-hours) and slightly increases delay in the PM peak. The 2020 model estimates greater gains with a total delay reduction of almost 600 daily vehicle-hours.

There are various types of advanced ramp metering systems deployed around the world, including the System-wide Adaptive Ramp Metering System (SWARM) tested on Los Angeles I-210 freeway corridor. For modeling on the I-5 South Corridor, the ALINEA system was tested as proxy for any advanced ramp metering system, since its algorithm for the model was readily available (and the algorithm for SWARM was not). However, the study team is not necessarily recommending ALINEA be deployed on I-5, but rather some type of advanced ramp metering system that would produce similar or better results.

Scenarios 7 and 8 (Operational Improvements)

Scenarios 7 and 8 add low-cost operational improvements (that could be implemented by 2016) to the improvements tested in the previous scenarios:

- Adding a northbound auxiliary lane from Rosecrans to San Antonio
- Adding a northbound auxiliary lane from Imperial Highway to the Pioneer on-ramp
- Moving the Florence on-ramp metering downstream and closer to the I-5 merge, while reducing the metering rate.
- Restriping the southbound I-710 on-ramp to a solid white line 1,000 feet past the merge
- Adding an auxiliary lane from Paramount to the Lakewood on-ramp, converging the Lakewood on-ramps into a single auxiliary lane, and moving the Lakewood on-ramp merge further downstream
- Adding a third storage lane on the I-605 connector off-ramp and widening the bridge
- Widening the Rosecrans on-ramp for more storage and reducing the metering rate.

The 2007 model estimates that Scenario 7 reduces delay by six percent in the AM peak and seven percent in the PM peak, for a total delay reduction of about 800 daily vehicle-hours. The 2020 model estimates that Scenario 8 by two percent in the AM peak and eight percent in the PM peak, or a total delay reduction of just over 800 vehicle-hours.

Scenarios 9 and 10 (Enhanced Incident Management)

The study team tested two incident scenarios built upon the Scenario 4 network to evaluate the non-recurrent delay reductions resulting from enhanced incident management strategies. The proposed enhanced incident management strategies would entail upgrading or enhancing the current Caltrans incident management system that includes 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 first scenario (Scenario 9), a collision incident with one outside lane closure was simulated in the northbound direction in the AM peak period model and in the southbound direction in the PM peak period model. The incident simulation location and duration were selected based on review of the 2010 actual incident data at one of the high-frequency incident locations. The following are the scenario details:

- Northbound AM peak period starting at 7:00 AM, close outermost mainline lane for 35 minutes at absolute post mile 126.3 (south of Slauson)
- Southbound PM peak period starting at 4:00 PM, close outermost mainline lane for 35 minutes at absolute post mile 123.1 (south of I-605).

In the second scenario (Scenario 10), the same collision incident was simulated with a 10-minute reduction in duration in both the northbound and southbound directions. 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.

These scenarios represent a typical moderate incident at one location during the peak period direction. 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 without lane closures that last only a few minutes that also result in congestion. There are also many incidents that occur during off-peak periods.

Without enhanced incident management, Scenario 9 produces a 46 percent increase in congestion in the AM peak and a 35 percent increase in the PM over Scenario 4, an increase of over 6,000 hours of vehicle delay. With enhanced incident management, Scenario 10 evaluation resulted in delay decrease by 19 percent in the AM peak and 11 percent in the PM peak against Scenario 9 results, a reduction of over 3,200 vehicle-hours for improving the incident detection, verification, response, and clearance time of one moderate level incident for both of the peak periods.

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.

Scenario 11 (HOV Widening to I-710 and I-710 IC Improvement)

Scenario 11 tests two capital expansion projects using the 2020 horizon year model. The scenario builds on Scenario 8 and includes the following improvements:

- Adding an HOV lane in each direction from the Florence Avenue Overcrossing to south of Eastern Avenue (length of 6.6 miles)
- Reconstructing the I-710/I-5 Interchange to support widening the I-5 freeway and new freeway-to-freeway connections.

Since the designs for these projects are very preliminary, the final configurations could differ significantly from what was modeled in Scenario 11. As a result the conceptual design elements included in Scenario 11 may not capture the full mobility improvements once the designs are finalized. However, the model results provide some insight into the potential benefits of the projects.

The 2020 model estimates that Scenario 11 will reduce delay as much as a 32 percent in the AM peak period (or over 2,100 daily vehicle-hours), mostly on the northbound mainline facility (which experienced a reduction of 1,900 vehicle-hours). However, the PM peak experienced a slight increase in congestion with gains achieved in the northbound direction being offset by increases in delay in the southbound direction. The study team suggests that design changes in the southbound direction may be necessary to improve operational performance.

Benefit-Cost Analysis

Following an in-depth review of the model results, the study team developed a benefit-cost analysis 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 Benefit-Cost 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 other benefits, such as reductions in congestion from deploying bus rapid transit.

Project costs were developed from SCAG and Caltrans project planning and programming documents. These costs include construction and support costs in current dollars. The study team estimated costs for projects that did not have cost estimates by reviewing similar completed projects. A B/C ratio greater than one 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 can cost a great deal and have a low B/C ratio, but brings much higher absolute benefits to I-5 users.

Exhibit ES-24 shows B/C results for the major scenarios tested in the I-5 South Corridor. The results are classified from low (with a B/C of less than one) to high (with a B/C between 5 and 10).

Exhibit ES-24: Scenario Benefit/Cost (B/C) Results

Scenario	Scenario Description	Benefit/Cost Ranges			
		Low	Medium	Medium-High	High
		<1	1 to 2	2 to 5	> 5
1/2	Carmenita Interchange	★			
3/4	HOV Lane (OC Line to I-605)		★★		
5/6	Advanced Ramp Metering			★★★	
7/8	On-ramp & Aux Lane Improvs		★★		
11	HOV to I-710 & I-710 IC Improv	★			

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

- Scenarios 1 and 2 (Carmenita Interchange) produce a benefit-cost ratio of less than one. This is low compared to a typical interchange improvement and is due to a high project cost of nearly $400 million. The elimination of an at-grade rail crossing contributes to this high cost. Typical interchange modifications cost under $30 million, even with right-of-way acquisitions. However, the mobility benefits are significant at over $160 million. If the Carmenita Interchange had a more typical cost (about $30 million), the benefit-cost ratio would be greater than 5, which is consistent with similar projects.
- The Camenita Interchange addresses several operational deficiencies that cannot be captured in the micro-simulation model, which captures only the benefits of the freeway components. The model captures neither the benefits in arterial circulation nor the elimination of the railroad crossing. Total benefits (including the grade separation, arterial circulation and off-peak hours) are likely to be significantly higher, so the true benefit-cost ratio may exceed one.
- Scenarios 3 and 4 (HOV Lane Widening from Orange County Line to I-605) produce a benefit-cost ratio of just over one. Although this is less than a typical capital expansion project, the mobility benefits are substantial at over $1.3 billion. The high density of the surrounding communities, the diagonal alignment of the corridor, and the age of the freeway are likely what cause high roadway improvement costs (particularly right-of-way) of over $1.2 billion along this corridor.
- Scenarios 5 and 6 (Advanced Ramp Metering) produce a benefit-cost ratio of about three. While high compared to other scenarios, this benefit-cost ratio is low compared to some transportation management strategies. This is likely due to the limited effect of the advanced ramp metering strategy, which does not include connector metering. The benefit-cost ratio would likely be higher if connector metering were included at the I-605 and I-710 interchanges.
- Scenarios 7 and 8 (Operational Improvements) produce a benefit-cost ratio of a little over two. As with the other scenarios, this result is low relative to typical

projects (benefit-cost ratios of about 4 to 6 are expected for operational improvements).

- Scenario 11 (HOV Lane Widening from I-605 to I-710 and I-710 IC Modification) produces a relatively low benefit-cost ratio of below one, but the analysis assumes a very high cost at $1.2 billion. The designs are very preliminary and there is no official cost estimate for the project. As such, the estimated benefit-cost ratio should be taken as a rough approximation of the concept.
- The benefit-cost ratio of all scenarios combined is less than one. Several of the tested projects have extremely high costs such as the programmed HOV widening on I-605 (over $1.2 billion) and the Carmenita Interchange improvement (almost $400 million) as well as the conservatively high estimate ($1.2 billion) for the Scenario 11 HOV lane widening. In addition, the simulation modeling does not capture all benefits (i.e., arterial and grade crossing benefits) at Carmenita. In current dollars, total costs are around $2.9 billion whereas the benefits are estimated at just under $1.8 billion.
- The projects alleviate greenhouse gas (GHG) emissions by about 1.3 million tons over 20 years, averaging a reduction of nearly 64,000 tons per year.

CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the conclusions and recommendations based on the analysis presented. Many of these conclusions are based on the micro-simulation model results. After thorough and careful review of each incremental step and analysis, the study team believes that both the calibration and the scenario results are reasonable and allow for more informed decision-making. Caution is advised in making decisions based on modeling alone. There are engineering and professional judgment and experience, among other technical factors to take into consideration in making the most effective project decisions that affect millions, if not billions, of dollars in investment.

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

- The combination of all scenarios significantly reduces overall congestion on the corridor. Projected 2020 congestion after implementation of all scenarios is below 2007 levels in both the AM and PM peak period. In the AM peak period, the model projects total delay in 2020 after delivering all projects to be around 4,500 vehicle-hours compared to the 2007 base year delay of over 5,700 vehicle-hours. This represents a reduction of 25 percent. In the PM peak period, the model projects total delay in 2020 after delivering all projects to be just under 9,000 vehicle-hours compared to the 2007 base year delay of 11,000 hours. This represents a reduction of over 20 percent. Clearly, the scenarios deliver significant mobility benefits to the corridor. Despite the growth in demand, future 2020 congestion will be less than experienced in 2007.

- The programmed Carmenita Interchange modification and the CMIA project, which constructs the HOV lanes from the Orange County Line to I-605, are expected to produce substantial mobility benefits of nearly $1.5 billion that could potentially reduce delay by as much as 20,000 vehicle-hours each day. This could improve mobility by well over 50 percent over current and projected conditions.
- Advanced ramp metering results in only modest mobility improvements on this corridor, likely due to lack of controlled connector metering at a major freeway-to-freeway interchange.
- Operational improvements, such as auxiliary lanes and ramp improvements, combined with advanced ramp metering could leverage on the programmed capital expansion projects by making the corridor more efficient and productive and result in additional mobility benefits of nearly $100 million.
- Model analysis of the very preliminary design elements of planned I-710 interchange modifications and HOV lane extension from I-605 to I-710 indicated only modest results with gains in the northbound direction that are offset by worsening conditions in the southbound direction. The study team suggests possible design changes, particularly in the southbound direction to optimize the beneficial results.
- An enhanced incident management system associated with Scenarios 9 and 10 to address non-recurrent congestion proved to be effective with a delay reduction of over 1,600 vehicle-hours for one modest level incident with a typical duration of 35 minutes reduced to 25 minutes. With the I-5 South corridor experiencing up to 1,500 collisions per year, this translates to total annual delay savings of over 2,400,000 vehicle-hours for the study corridor.

This is the first-generation CSMP for the I-5 South Corridor. It is important to emphasize that CSMPs should be updated, on a regular basis, if possible. 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 some variation, should become the normal course of business that includes 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 system productivity.