PARTNERS FOR ADVANCED TRANSPORTATION TECHNOLOGY
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

Connected Corridors: I-210 Pilot Integrated Corridor Management System

Corridor Description, System Inventory and Needs Assessment

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Partners for Advanced Transportation Technology works with researchers, practitioners, and industry to implement transportation research and innovation, including products and services that improve the efficiency, safety, and security of the transportation system.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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1. INTRODUCTION

This document provides a high-level description of the transportation corridor that has been selected as part of the Connected Corridors program led by the California Department of Transportation (Caltrans) and the Partners for Advanced Transportation Technology (PATH) at the University of California, Berkeley for the pilot deployment of an Integrated Corridor Management (ICM) system. As will be outlined later, this corridor is centered on a section of the I-210 freeway in Los Angeles County crossing the cities of Pasadena, Arcadia, Duarte and Monrovia. It further includes both the freeway and arterials running parallel to the facility.

Prior to presenting the networks, facilities and assets of the corridor, this section provides some general background information on the pilot project, referred to hereafter as the “I-210 Pilot”. Specific elements presented in this section include:

- Project motivation
- General project definition
- Document content

1.1. PROJECT MOTIVATION

Southern California has the second-worst traffic in the country, behind Washington, D.C. Recent statistics compiled by the Texas Transportation Institute indicate that commuters in the Los Angeles area spent on average 61 hours per year stuck in traffic in 2012, compared to 37 hours in 1982. This time is estimated to carry an annual cost of about $1,300 in both wasted time and wasted fuel. The region is also second behind Washington, D.C. in the unreliability of its freeways. Incidents often have significant impacts on the time that travelers may need to travel to a given destination. As population and car ownership continue to grow, more time is spent in gridlock, more money is lost on wasted energy, and more air pollution is generated. This trend is expected to continue if nothing is done to address the problem.

In the past, government agencies across the country would have addressed the problem of urban congestion by widening highways; building new roads, tunnels, and bridges; and providing multimodal options where feasible, particularly for shorter urban trips. However, due to both financial and space constraints the emphasis has now shifted from building new infrastructure to efficiently using what has already been built.

Except in very select situations, safety, mobility, and environmental improvements can no longer be achieved through expensive capital improvements alone. Nor do they need to be, as new technologies and improved organizational cooperation can deliver a better traveler experience with minimal infrastructure modifications. Similar to the same way the manufacturing sector has raised efficiency through better software, hardware, and supply integration, the transportation sector can use technology to improve the performance of existing infrastructure. Several studies have indicated that technological advances may be used to improve the operations of freeways, arterials, and other transportation systems at a much lower cost than the traditional infrastructure-based approach. While it can be expected that notable gains can be obtained regarding the operations of specific roadway facilities or transportation systems, the greatest potential gains in operational performance, and travelers’ quality of life, are likely associated with multi-facility, multi-modal, and multi-jurisdiction solutions considering the overall transportation needs of a corridor rather than the needs of specific elements.

1.2. PROJECT DEFINITION

The general objective of the I-210 Pilot is to reduce congestion and improve mobility within a section of the I-210 corridor in the San Gabriel Valley north of Los Angeles through the coordinated management of the I-210 freeway, key surrounding arterials, supporting local transit services, and other relevant transportation components. Operational improvements within the corridor will be achieved through the design, development, implementation, and evaluation of a prototype Integrated Corridor Management (ICM) system designed to assist transportation system managers in their decision-making tasks. The overall goal of this system is to achieve performance gains by enabling transportation systems managers, transportation control systems, vehicles, and travelers within a corridor to work together in a highly coordinated manner.

At the heart of the proposed ICM system is a Decision Support System (DSS) that will use information gathered from monitoring systems to estimate the current operational performance of systems being managed, simulation and analytical tools to forecast near-future operational conditions under alternative scenarios, and imbedded decision algorithms to recommend courses of action to address specific problems being observed. It is expected that the deployed system will more specifically:

- Improve real-time monitoring of travel conditions within the corridor
- Enable operators to better characterize travel patterns within the corridor and across systems
- Provide predictive traffic and system performance capabilities
- Evaluate alternative system management strategies and recommend desired courses of action in response to incidents, events, and even daily recurring congestion
- Improve decision-making from transportation system managers
- Improve collaboration among agencies operating transportation systems within the corridor
- Improve the utilization of existing infrastructure and systems
- Provide corridor capacity increases through operational improvements
- Reduce delays and travel times along freeways and arterials
- Improve travel time reliability
- Help reduce the number of accidents occurring along the corridor
- Reduce incident clearance times
- Reduce greenhouse gas emissions
- Generate higher traveler satisfaction rates
- Increase the overall livability of communities in and around the I-210 corridor

A preliminary project scope for the I-210 Pilot includes the design, development, installation, testing, and operation components of the proposed ICM system, including the development of interfaces with existing monitoring systems. However, given the experimental nature of the project, Caltrans has already indicated that the system will not be permitted to interact directly with its existing traffic management systems. Additional agencies may opt to do the same. In such cases, interactions with these systems will need to consider how system operators may effectively communicate the desired control interventions to the various targeted systems.

While development of the proposed ICM system is under the sponsorship of Caltrans Headquarters and Caltrans District 7, the system will be developed in collaboration with local transportation agencies and other stakeholders. In addition to considering the needs of individual stakeholders, the system will also be based on the experiences and lessons learned that have been identified through other recent successful ICM projects, both in the United States and abroad. It is expected that the deployed system will be an important element of Caltrans' strategic response to the State of California's objectives of improving the performance of transportation systems and enhancing the livability, sustainability, and economic performance of the state.

1.3. DOCUMENT CONTENT

This document provides a description of the corridor that has been selected for the development of the I-210 Integrated Corridor Management pilot system. Specific elements presented in this document include:

- Corridor boundaries
- Jurisdictional environment
- Existing transportation systems
- Major trip generators within the corridor
- Existing transportation management assets within the corridor
- Current operational conditions
- Justification for operational changes

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2. CORRIDOR BOUNDARIES

Figure 1 locates the study corridor relative to downtown Los Angeles. The central element of the corridor is a 25-mile section of the I-210 freeway (Foothill Freeway) extending from Pasadena in the west to La Verne in the east. More specifically, the section of interest extends from the Arroyo Boulevard interchange in Pasadena (Exit 22B) approximately 2 miles north of the I-210/SR-134 interchange, to the Foothill Boulevard/SR-66 interchange in La Verne (Exit 47) approximately 2 miles east of theI-210/SR-57 interchange. The section of I-210 west of the I-605 freeway (San Gabriel River Freeway) will be the focus of the first phase of the system deployment, while the management of the section east of the I-605 will added in a second project phase.

Figure 1 – I-210 ICM Corridor Study Area

As illustrated, the I-210 freeway provides a vital link between various communities in the northern end of the Los Angeles metropolitan area. From the Sylmar district at the north end of the city of Los Angeles, the freeway links the city of Pasadena, communities in the San Gabriel Valley and Pomona Valley and, finally, communities in the San Bernardino area. This corridor runs through a predominantly urban environment and includes the most frequently and heavily congested sections of the freeway.

South of the I-210, the study area extends to the I-10 freeway. While the proposed Integrated Corridor Management System explicitly aims to improve operations along I-210, the close proximity of the I-10 creates some operational interdependencies between the two freeways. Depending on the location along I-210, the I-10 is only 4 to 5 miles to the south of I-210. In this context, incidents or events significantly affecting operations along the I-10 are likely to affect operations along the I-210, and vice versa. This interdependency thus creates a need to consider what may be happening on I-10 when developing operational strategies for the I-210 freeway.

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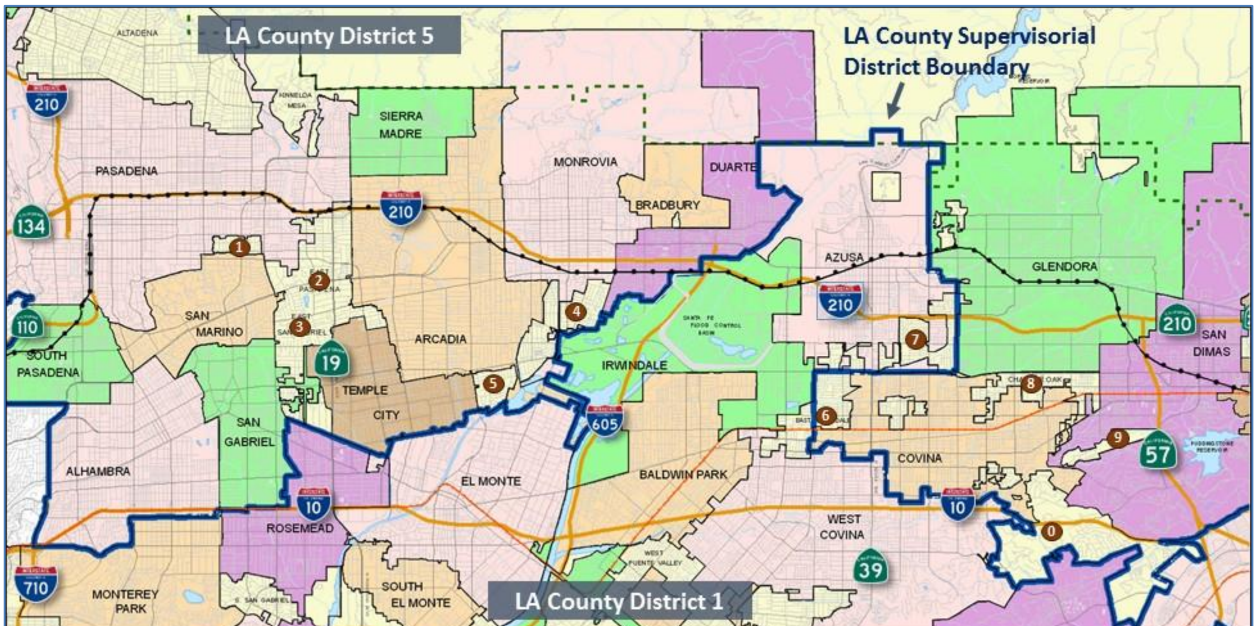
3. JURISDICTIONAL ENVIRONMENT

Figure 2 maps the cities and unincorporated county areas located within the study corridor. As can be observed, cities crossed by the I-210 include Pasadena, Arcadia, Monrovia, Duarte, Irwindale, Azusa, Glendora, San Dimas and La Verne. The freeway also crosses two unincorporated areas under administration from Los Angeles County: the East Pasadena area between the cities of Pasadena and Arcadia, and the Citrus area between the cities of Azusa, Covina and Glendora.

To help assess the relative size of each jurisdiction, the map also lists the population of each jurisdiction or unincorporated area. The map also shows the Los Angeles County Supervisioral boundaries. Jurisdictions north of the boundary are part of the Supervisioral District 5, while jurisdictions on the south are part of District 1.



Cities (Population)

Pasadena (137,122)
El Monte (116,249)
West Covina (106,870)
Alhambra (85,961)
Baldwin Park (75,940)
Arcadia (56,769)
Rosemead (54,154)
Covina (50,954)
Glendora (50,435)
Azusa (46,678)
San Gabriel (40,005)
Monrovia (36,857)
Temple City (35,816)
San Dimas (35,064)
South Pasadena (25,806)
Duarte (21,486)
San Marino (13,241)
Sierra Madre (10,996)
Irwindale (1,472)
Bradbury (1,268)

Unincorporated LA County Areas

1 *San Pasqual (2,082)*
2 *East Pasadena (6,144)*
3 *East San Gabriel (14,874)*
4 *Mayflower Village (11,649)*
5 *North El Monte (3,723)*
6 *Vincent (15,922)*
7 *Citrus (11,964)*
8 *Charter Oak (9,310)*
9 *West San Dimas (309)*
0 *Ramona (4,053)*

Figure 2 – Jurisdictional Boundaries

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4. EXISTING TRANSPORTATION SYSTEMS

This section describes the various transportation systems that currently exist within the I-210 corridor. These systems include:

- A network of interconnected freeways
- A network of urban arterials running predominantly parallel or perpendicular to the freeways
- Various public transit systems, including commuter rail service, a light-rail system, a transitway bus service, commuter express buses, regular surface bus transit, and dial-a-ride transit services;
- Park-and-ride facilities operated by various public transportation agencies
- Parking structures and surface lots supporting local retail, commercial and business activities
- A network of bike routes

4.1. FREEWAYS

As was illustrated in Figure 1, the proposed ICM system seeks to improve the management of a 25-mile section of the **I-210/SR-210 freeway (Foothill Freeway)**. The section of interest extends from the Arroyo Boulevard interchange in Pasadena (Exit 22B) approximately 2 miles north of the SR-134/I-210 interchange, to the Foothill Boulevard interchange in La Verne (Exit 47) approximately 2 miles east of the SR-57 interchange. The focus of the first phase of the project is on the section of the freeway west of the I-605, while the second phase will add the portion of the freeway east of the I-605.

As shown in Figure 3, the I-210 freeway typically provides four general-purpose traffic lanes, with additional auxiliary lanes between some interchanges. Sections west of SR-57 generally only offer three traffic lanes. In Pasadena, the I-210/SR-134 interchange further provides a break in the continuity of the freeway. At this interchange, the main east-west crossing at this interchange takes traffic from the I-210 freeway to the SR-134 freeway. The main north-south crossing takes traffic from the I-210 freeway to a

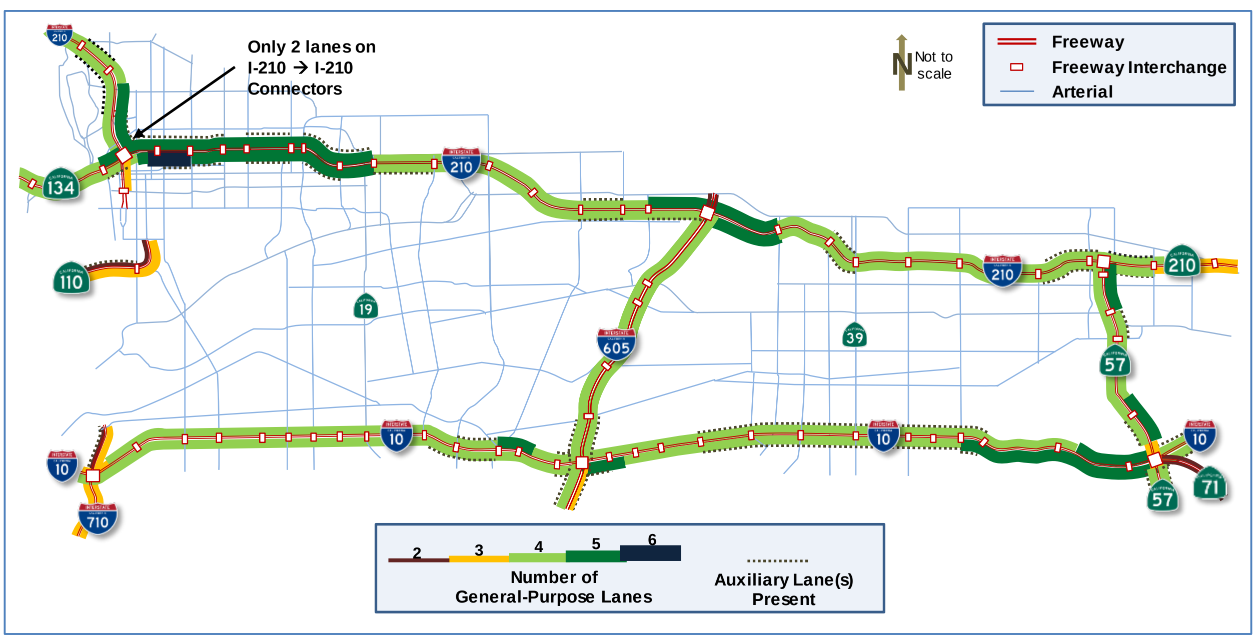

Figure 3 – General-Purpose Freeway Lane Configuration

short section of I-710 running on the west side of downtown Pasadena. In each direction, motorists wishing to continue traveling along I-210 must do so by traveling through a two-lane freeway connector.

South the I-210/SR-210 freeway, the **I-10 freeway (San Bernardino Freeway)** provides an alternate route to downtown Los Angles from the communities in the San Gabriel Valley and San Bernardino area. As shown in Figure 3, this facility typically provides four general-purpose traffic lanes per direction within the study area, while some sections feature five traffic lanes or auxiliary lanes. Within the area of interest, the I-10 is a good alternative to the I-210 as it runs parallel to it, only four to five miles to the south.

Within the study corridor, two north-south freeways may be used to travel between the I-210/SR-210 and I-10 freeways:

- **I-605 (San Gabriel River Freeway) –** This freeway connects the I-210 freeway near Irwindale with the I-10, SR-60, I-5, I-105, SR-91 and I-405 freeways to the south. It terminates near Seal Beach.
- **SR-57 (Orange Freeway) –** This freeway connects the I-210/SR-210 freeway near San Dimas with the I-5 and SR-22 freeways near downtown Orange to the south.

Other freeways further provide connections between the I-210 study corridor and other areas of the metropolitan Los Angeles region:

- **SR-134 (Ventura Freeway)** – East-west freeway linking Pasadena to the southern San Fernando Valley and Ventura.
- **SR-110 (Arroyo Seco Parkway)/I-110 (Harbor Freeway)** – North-south freeway linking Pasadena to downtown Los Angeles, South Los Angeles, Carson and the Port of Los Angeles.
- **I-710 (Long Beach Freeway)** – North-south freeway linking Alhambra to East Los Angeles and Long Beach. While this freeway currently ends at the boundary between the cities of Los Angeles and Alhambra, just north of the I-10 freeway, studies are currently exploring the possibility of extending it through South Pasadena to the I-210/SR-134 interchange.
- **SR-71 (Chino Valley Freeway)** – Freeway linking the I-10 freeway, from the I-10/SR-57 interchange, to the SR-60 and SR-91 freeways to the southeast.

4.2. HOV/HOT FACILITIES

As indicated in Figure 4 both east-west freeways crossing the study corridor have HOV lanes:

- **I-210/SR-210 Freeway** – A single HOV lane runs in direction between the SR-134 freeway in Pasadena and the I-215 freeway in San Bernardino. At the SR-134 interchange, the HOV lanes continue uninterrupted along SR-134 and extend past the I-5 interchange up to the US-101 northeast of downtown Los Angeles. Similar to other freeways in the region, HOV restrictions are in effect 24 hours a day, seven days a week. The lanes are further separated from the general-purpose lanes by a solid double yellow line, with designed ingress/egress points. As shown in Figure 4, 11 ingress/egress points are provided between the SR-134 and Foothill Boulevard interchanges for vehicles traveling east, while 12 are provided for vehicles traveling west.
- **I-10 Freeway** – A continuous single HOV lane runs from the I-5 interchange, near downtown Los Angeles, to just west of the I-605 freeway. West of El Monte, the lane runs along the El Monte

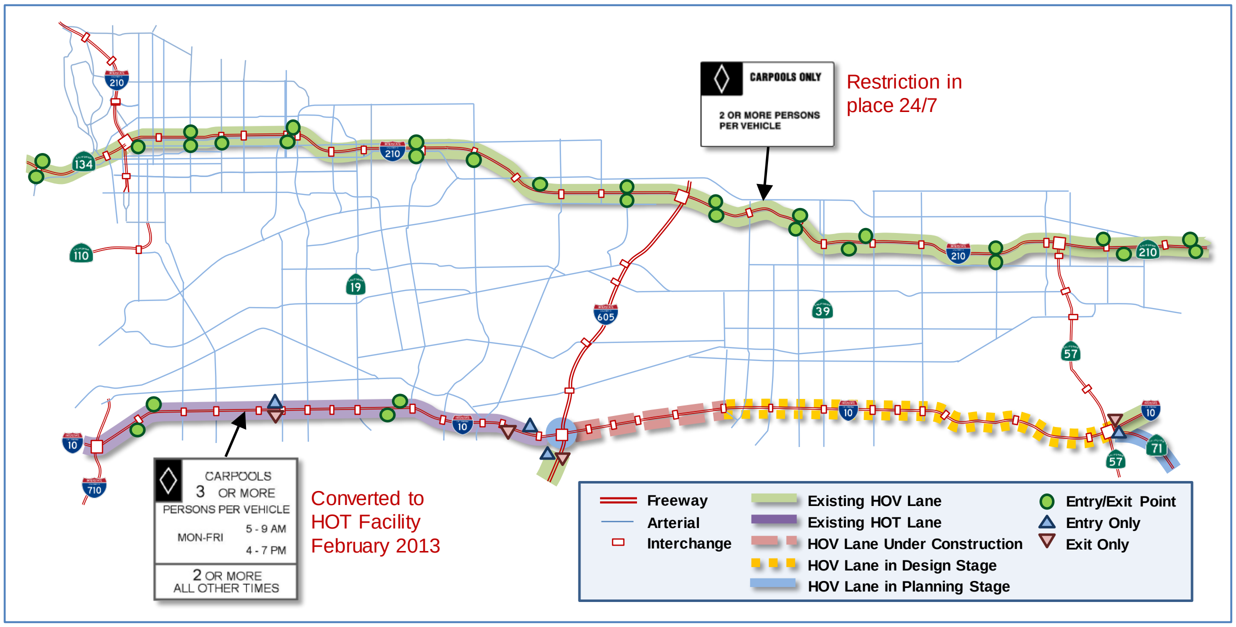

Figure 4 – HOV/HOT Facilities

Busway. While no continuous HOV lanes currently exist between I-605 and SR-57, there are plans to close this gap to provide HOV lanes up to the I-15 freeway in the east. Between the I-710 and I-605 interchanges, eastbound traffic has three ingress and four egress points, while westbound traffic has four ingress and three egress points. This HOV lane has stricter access restriction than other Southern California freeways. During peak hours, only vehicles with three occupants or more can access it. Off peak, any vehicle with two occupants can access it. On February 2013, the HOV lanes west of the I-605 interchange were converted to High-Occupancy Toll (HOT) lanes with dynamic pricing. This change now enables vehicles that do not meet the HOV lane requirement to use the facility, but for a fee. It also resulted in a requirement that all vehicles using the facility have a valid transponder, whether or not they would be subject to a toll.

There is currently no HOV lane on freeways crossing the corridor in a north-south alignment. While HOV lanes exist along I-605, these lanes terminate just south of the I-10 interchange.

4.3. SUPPORTING ARTERIALS

As shown in Figure 5, arterials providing alternate routes parallel to the I-210 freeway within the study area include the following:

- **East Orange Grove Boulevard** – Four-lane roadway running through the northern part of Pasadena, from Fair Oaks Avenue to the Sierra Madre Villa Avenue / Rosemead Boulevard intersection, predominantly through residential neighborhoods except for a small commercial district near Los Robles Ave.
- **Walnut Street / Foothill Boulevard –** Succession of four-lane roadways parallel to I-210 across Pasadena, Arcadia and Monrovia, often within less than a ¼ mile from the freeway. Within Pasadena, the arterials predominantly run through commercial areas. Within Arcadia and Monrovia, long sections of Foothill Boulevard run through residential neighborhoods.

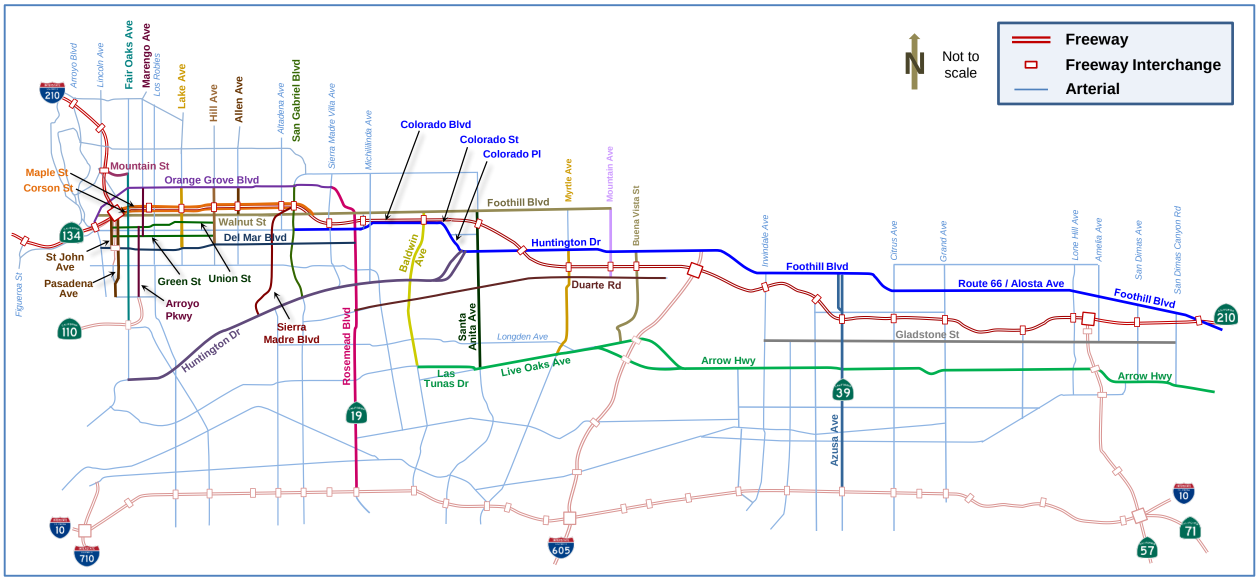

Figure 5 – Key Arterials

- **Maple Street and Corson Street** – Pair of two-lane, one-way roads running on each side of I-210 through Pasadena. Corson St is located south of I-210 and runs eastward from Fair Oaks Avenue to Sierra Madre Villa Boulevard, while Maple Street is located on the north side of I-210 and runs westward from Foothill Boulevard to Fair Oaks Avenue.
- **Colorado Boulevard / Colorado Street / Colorado Place –** Succession of four-lane roadways through downtown Pasadena approximately ½ mile south of I-210, and then adjacent to I-210 through the northwest portion of Arcadia. Within Pasadena, Colorado Boulevard is in a high-density commercial area with active parking activities and high pedestrian traffic. For this reason, only the section east of San Gabriel Boulevard is considered a viable supporting arterial.
- **Green Street / Union Street –** Pair of three-lane, one-way streets on each side of Colorado Boulevard between Hill Avenue and Saint John Avenue and used as travel alternatives to Colorado Boulevard. Green Street carries traffic eastbound, while Union Street carries traffic westbound.
- **Del Mar Boulevard –** Four-lane roadway running ¾ mile south of I-210, from the west end of downtown Pasadena to Rosemead Boulevard in Arcadia, mainly through residential areas.
- **Huntington Drive –** Six-to-eight lane arterial running predominantly through residential areas in South Pasadena, San Marino, the East Pasadena unincorporated areas of Los Angeles County, and Arcadia, up to the Santa Anita Park.
- **Huntington Drive / Foothill Boulevard / Route 66 / Alcosta Avenue –** Succession of four-lane roadways north of I-210, from the Santa Anita Park area through Arcadia, Monrovia, Duarte, Irwindale, Azusa, Glendora, San Dimas, and La Verne. Despite various name changes when crossing city boundaries, this is a continuous road mainly running through commercial areas.
- **Duarte Road –** Two-to-four lane roadway south of I-210, extending from San Gabriel Boulevard in the East San Gabriel unincorporated area of Los Angeles County through Arcadia and Monrovia. While this road runs predominantly through residential areas, the section of the road closest to I-210 within Duarte mainly runs through a commercial and industrial area.

- **Las Tunas Drive / Live Oak Avenue / Arrow Highway –** Succession of four-lane roadways 1 to 1½ miles south of I-210 providing continuous travel opportunity from Baldwin Avenue to SR-57. This set of arterials provides the closest continuous travel opportunity across I-605 south of I-210. It includes segments within or along the boundaries of Arcadia, Irwindale, Baldwin Park, Covina, Glendora, and San Dimas, as well as the unincorporated areas of Mayflower Village, Vincent, Citrus and Charter Oak. While Las Tunas Drive extends to Rosemead Boulevard through Temple City, this section is not considered a viable route as it runs through downtown Temple City and as the city has indicated a desired to reduce the number of lanes on the arterial in a near future.
- **Gladstone Street** – Four-lane roadway less than ½ mile south of I-210 crossing through the predominantly residential areas of Irwindale, Azusa, Glendora and San Dimas.

In addition to the I-605 and SR-57 freeways, several north-south arterials may be used to reach the parallel roads listed above from the I-210, and possibly I-10:

- **Saint John Avenue and Pasadena Avenue –** Pair of two-to-three lanes one-way roads running on each side of the I-210 extension in Pasadena. Saint John Avenue carries traffic southbound and extends from Walnut Street, where it can be viewed as a continuation of Maple Street, to Del Mar Boulevard. Another section also runs from California Boulevard to Bellefontaine Street. Pasadena Avenue carries traffic northbound and runs continuously from Columbia Street, near the end of the SR-110 freeway to Walnut Street, where it continues as Corson St.
- **Fair Oaks Avenue –** Four-lane roadway connecting Altadena, Pasadena and South Pasadena.
- **Arroyo Parkway –** Four-lane roadway extending from the end of the Arroyo Seco Parkway (SR-110 freeway) to Colorado Boulevard in downtown Pasadena.
- **Marengo Avenue –** Two-to-five lane roadway east of Arroyo Parkway and extending north past Orange Grove Boulevard. The section of interest is the one extending from Green St to Maple Street, as this section can be used as a continuation route to I-210 for the Arroyo Parkway traffic.
- **Lake Avenue –** Four-to-seven lane roadway traversing downtown Pasadena west of the Caltech and Pasadena City College campuses.
- **San Gabriel Boulevard –** Four-lane roadway linking the I-210, I-10, and SR-60 freeways
- **Rosemead Boulevard (SR-19) –** Four-to-six lane roadway running south from the Sierra Madre Villa Boulevard/Orange Grove Boulevard intersection. This arterial runs through the East Pasadena and East San Gabriel unincorporated areas of Los Angeles County, Temple City, and Rosemead, and extends up to the SR-60 and I-5 freeways south of the study area.
- **Baldwin Avenue** – Four-to-five lane roadway through Arcadia, Temple City, and El Monte and providing direct access from the I-210 to the Santa Anita Racetrack, Westfield Mall, the Los Angeles Arboretum, various commercial retail areas south of the mall, and the I-10 freeway.
- **Santa Anita Avenue –** Four-lane roadway through Arcadia, Pasadena, and El Monte up to the I-10 and SR-60 freeways, predominantly through residential areas, except between Foothill Boulevard and Huntington Drive to the north where it runs through a commercial area.
- **Azusa Avenue (SR-39) –** Roadway traversing Azusa, Covina and West Covina. South of I-210, it is a four-to-five lane avenue. Between I-210 and Foothill Boulevard, it is a northbound one-way avenue with two to three lanes. Along this section, southbound traffic runs on San Gabriel Avenue, a two-to-four one-way road two blocks the west.

4.4. TRUCK ROUTES

Figure 6 maps the existing truck routes within the I-210 corridor as currently defined in city plans and regulations. As can be observed by comparing the figure with the map to the map of key arterial shown in Figure 5 the vast majority of truck routes correspond to arterials that have been selected as potential candidates for inclusion on the proposed ICM system.

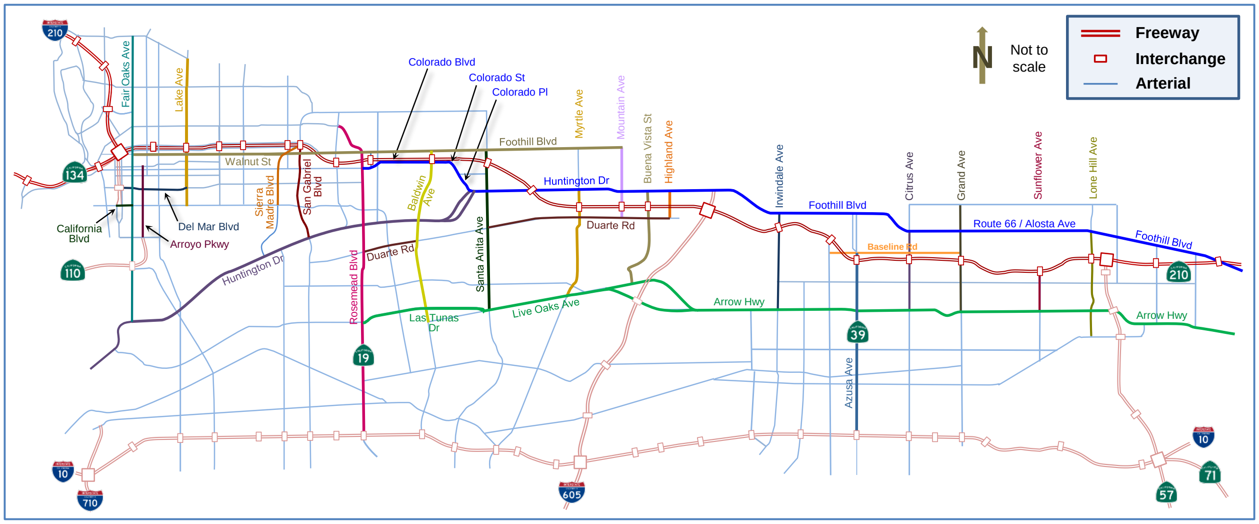

Figure 6 – Truck Routes

Figure 7 further shows the arterial segments comprised in LA Metro's Countywide Significant Truck Arterial Network (CSTAN). This network was developed to assist cities in identifying truck arterial system needs and connectivity gaps, support the development of the Federal National and Primary Freight Networks, help prioritize freight-related funding to projects showing the greatest needs and system-wide benefits, minimize conflicts between trucks and pedestrians and bikes, and assist the trucking industry in identifying designed truck routes. In most cases, the CSTAN segments corresponds to segment already identified as truck routes by local jurisdictions.

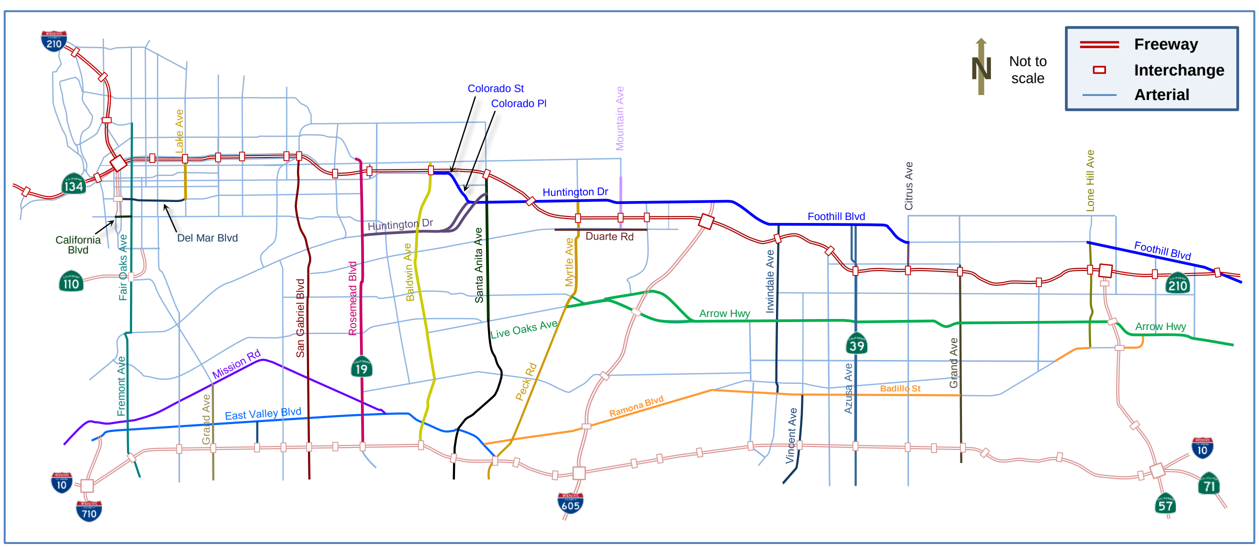

Figure 7 – Countywide Significant Truck Arterial Network (CSTAN)

4.5. PUBLIC TRANSIT SERVICE

This section provides information about public transportation services offered to travelers within the I-210 corridor. These services include:

- Commuter rail
- Light-rail transit
- Transitway buses
- Commuter express and rapid buses
- Regional bus networks
- Local bus services
- Dial-a-Ride services

4.5.1.1. Commuter Rail

Metrolink operates seven commuter rail lines within the metropolitan Los Angeles area. As shown by the dotted line in Figure 8, one Metrolink line runs through the corridor. This is the San Bernardino linem which links downtown Los Angeles with San Bernadino. West of the El Monte station, this rail line runs in the median of the I-10. East of the I-605, it runs midway between the I-210 and I-10. This line runs all day, seven days a week, with the exception of some holidays, and has the highest service frequency in the Metrolink system. Trains typically run every 20-30 minutes during peak hour in the peak direction, and every one to two hours during off-peak periods. Within the corridor, stops are currently made at Cal State Los Angeles, El Monte, Baldwin Park, and Covina. Recently, proposals have also been floated to add a new station in San Dimas, south of the planned Metro Gold Line San Dimas station.

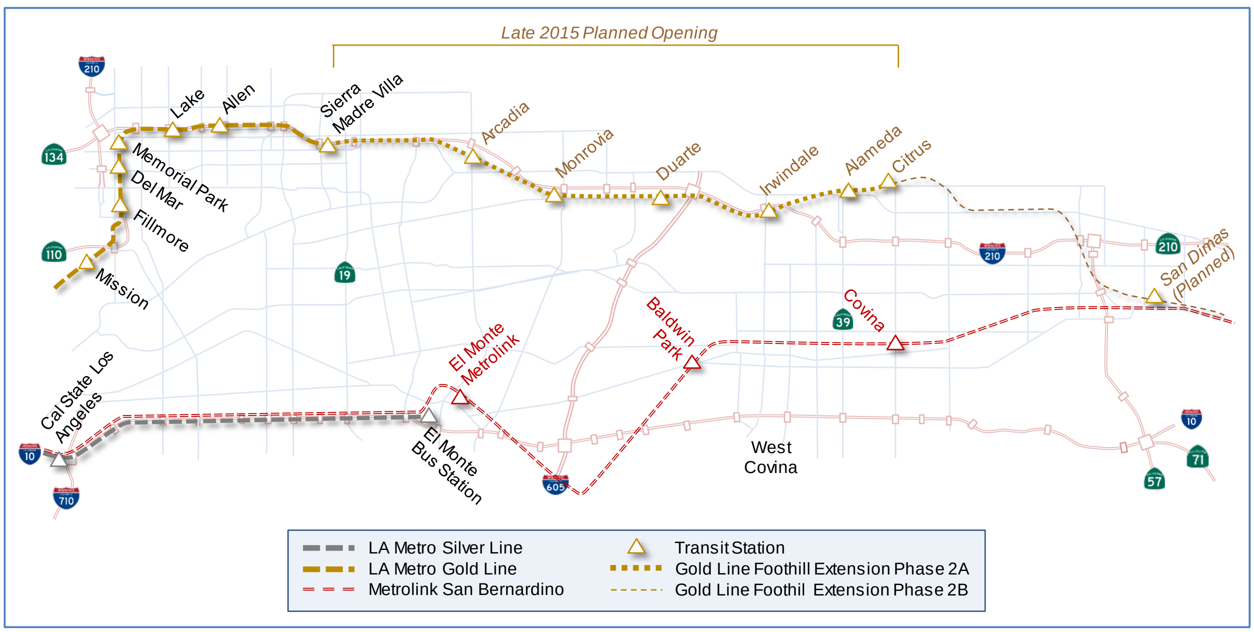

Figure 8 – Commuter Rail, Light Rail, Bus Rapid Transit Services

4.5.1.2. Light Rail Transit

The western portion of the I-210 corridor is currently served by LA Metro's Gold Line. This light-rail line was opened in 2003 and links downtown Pasadena with downtown Los Angeles and East Los Angeles. Its location within the I-210 corridor is shown in the upper portion of Figure 8. Under normal operating conditions, trains operate from 4 AM to 1 AM, with service approximately every 6 minutes during peak periods and weekends, 12 minutes during midday, and 20 minutes during other periods. Gold Line trains typically have two cars, except in the evening and weekends, when one-car trains are used. Each car can seat 76 passengers and can carry up to 144 passengers, including standing passengers. This results in a nominal carrying capacity of 2,880 passengers per hour per direction when considering a peak service interval of 6 minutes and the use of two-car trains.

While the line currently ends at the eastern end of Pasadena, a project seeking to extend the line in phases by another 24 miles is currently underway. The first phase will extend the line by 11.5 miles from its current terminal at the Sierra Madre Villa station to a new terminus at the eastern end of the City of Azusa. Construction began in 2011 and has an expected completion date in late 2015. The second phase, which is currently under study, proposes to extend the line by an addition 12.3 miles to Montclair.

4.5.1.3. Transitway Rapid Buses

Busway, a shared-used transitway and high-occupancy vehicle facility running along I-10 between the Los Angeles Union Station and the El Monte bus terminal. Both these services are mapped in the bottom half of Figure 8:

- **Metro Silver Lane** – Service running every 4 to 8 minutes during peak hours, every 15 minutes during the midday, 20 minutes on Saturdays, 30 minutes on Sundays and holidays, and every 30 to 40 minutes during evenings.
- **Foothill Transit Silver Streak** – Express bus service between the Montclair Transportation Center and downtown Los Angeles via I-10 using high-capacity, 60-foot long articulated buses during peak hours and 42-foot long single-body buses during off peak periods. Buses on this line typically operate with a 8-minute frequency during peak hours, a 20-minute frequency during weekday off-peak periods, and a 30-minute frequency during weekends.

4.5.1.4. Commuter Express and Rapid Buses

Figure 9 maps the commuter express bus routes operated by LA Metro, Foothill Transit and the Los Angeles Department of Transportation (LADOT) within or close proximity of the I-210 corridor. There are seven routes linking the corridor to downtown Los Angeles:

- **Foothill Transit 481** – Weekday express service between the El Monte Metrolink station and downtown Los Angeles via I-10, with buses running every 10 or 20 minutes depending on the time of day.
- **Foothill Transit Route 498** – Weekday express service between Citrus College in Azusa and downtown Los Angeles via I-10, with buses running every 5-10 minutes during peak periods.
- **Foothill Transit Route 499** – Weekday express service between the park-and-ride lot along South San Dimas Avenue in San Dimas and downtown Los Angeles via Covina and I-10, with buses running every 10 to 15 minutes depending on the time of day.

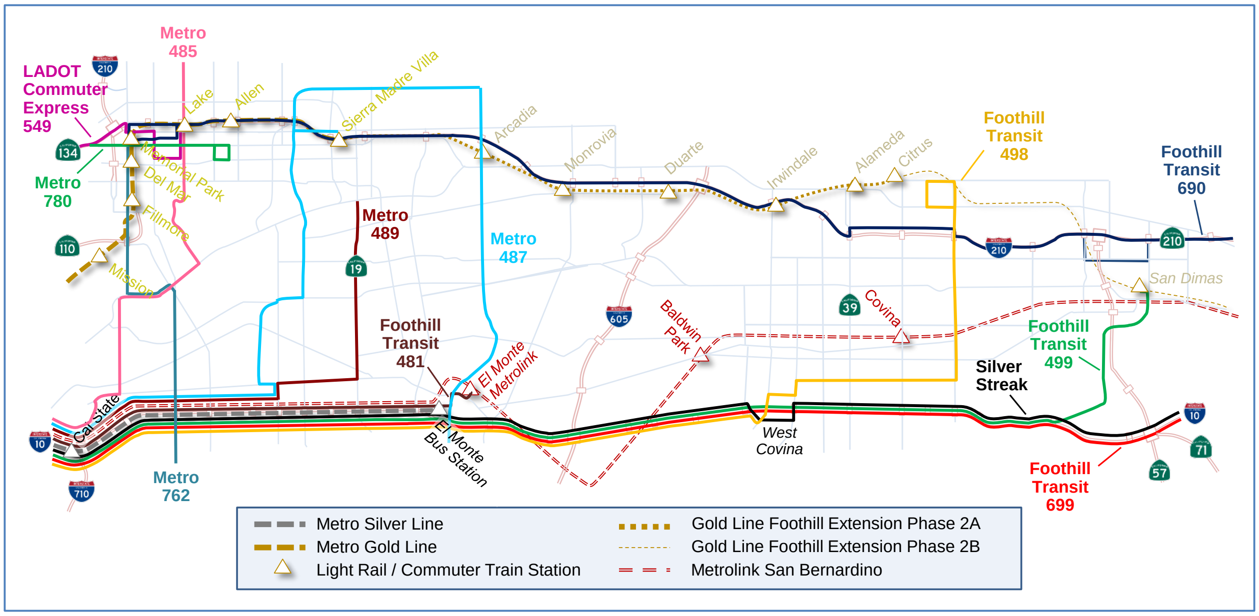

Figure 9 – Express Bus Services

- **Foothill Transit Route 699** – Weekday express service between the Montclair Transportation Center and downtown Los Angeles via I-10, with buses typically running every 5 to 15 minutes depending on the time of day.
- **LA Metro 485** – Weekday express service between downtown Pasadena and downtown Los Angeles via I-710 and I-10, with buses running approximately every 40 to 50 minutes.
- **LA Metro 487** – Express service between the Sierra Madre Villa light rail station, El Monte Bus Station and downtown Los Angeles via I-10, with buses running every 20 to 30 minutes on weekdays, depending on the direction and time of day, and every 60 minutes on weekends.
- **LA Metro 489** – Weekday express service between Arcadia and downtown Los Angeles via Rosemead Boulevard and I-10, with buses running every 20 to 30 minutes only in the peak travel direction during the peak period.

Four additional routes further link downtown Pasadena to other communities:

- **Foothill Transit Route 690** – Weekday service between downtown Pasadena and the Montclair Transportation Center in Montclair via I-210/SR-210, with buses running every 10 to 30 minutes depending on the time of day.
- **LADOT Commuter Express 549** – Weekday express service between downtown Pasadena and Burbank via the SR-134 freeway, with service intervals varying between 25 to 35 minutes depending on the time of day.
- **LA Metro 762** – Weekday rapid bus service between downtown Pasadena and Compton primarily along Atlantic Boulevard, with service intervals varying between 15 and 30 minutes depending on the time of day.
- **La Metro Rapid 780** – Weekday rapid bus service between downtown Pasadena and Hollywood with service intervals varying between 20 and 30 minutes depending on the time of day.

To reduce travel times, many of the express bus routes include some freeway travel, primarily along I-10, and a limited number of stops on select off-freeway segments. With the exception of the Silver Streak, all of the express routes only operate during weekday peak hours in the peak travel direction.

4.5.1.5. Transit Bus Networks

Two major transit agencies service communities within the I-210 corridor:

- **Foothill Transit** - Foothill Transit is the primary transit service provider for the San Gabriel and Pomona Valley area. The agency, which includes 22 member cities and the County of Los Angeles, operates 29 bus lines within the area in addition to the six commuter express bus lines mentioned earlier. Figure 10 illustrates the current service map of the agency over the I-210 corridor.
- **LA Metro** - LA Metro operates over 190 bus lines over a 1,433 square mile area in Los Angeles County. As shown in Figure 11, the agency operates a few bus lines in the western end of the corridor.

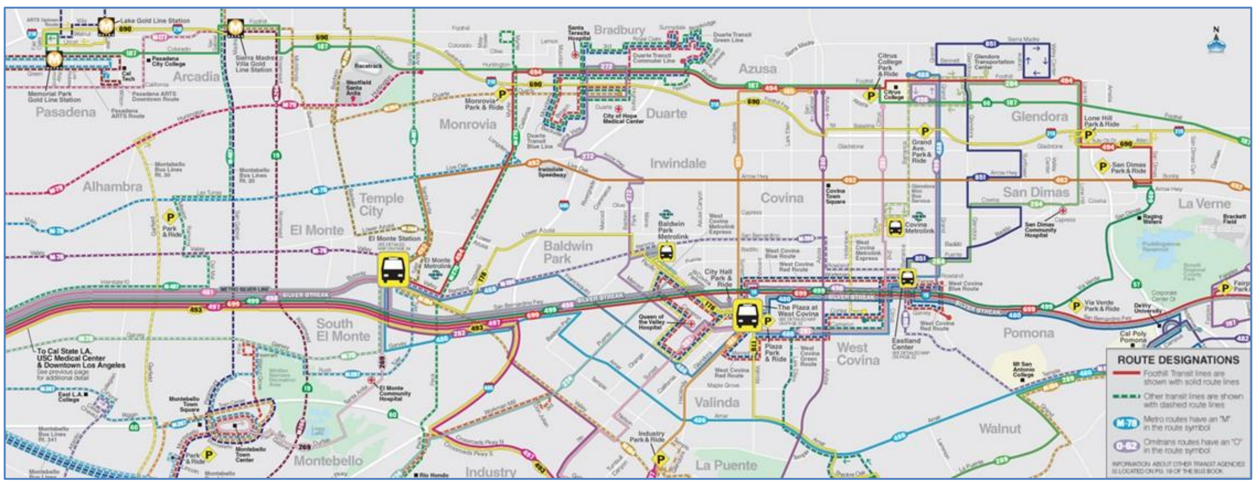

Figure 10 – Foothill Transit System Map

Figure 11 – LA Metro System Map

4.5.1.6. Local Fixed Bus Services

In addition to the regional transit services provided by Foothill Transit and LA Metro, several cities within the I-210 corridor also provide local fixed transit services to their residents. Table 1 provides a summary of the transit services provided. Many of the routes offered are designed to allow city residents to access key city services or main commercial areas, or to facilitate access to regional transit services.

Table 1 – Fixed Local Bus Transit Services

Name	Operator	Routes	Weekday Service	Saturday Service	Sunday Service	Service Map
Pasadena Area Rapid Transit System (ARTS)	City of Pasadena	8	6:00 AM to 8:00 PM	11:00 AM to 8:00 PM	None	Figure 12
Duarte Transit	City of Duarte	3	7:00 AM to 7:00 PM	None	None	Figure 13
Gateway Coach Round-A-Bout	City of Sierra Madre	1	11:30 AM to 1:30 PM	None	None	Figure 14
Alhambra Community Transit (ACT)	City of Alhambra	2	8:00 AM to 5:00 PM	8:00 AM to 4:30 PM	8:00 AM to 4:30 PM	Figure 15
El Monte Transit	City of El Monte	5	6:00 AM to 7:00 PM	9:40 AM to 7:00 PM	None	--
Baldwin Park Transit	City of Baldwin Park	2	6:00 AM to 7:00 PM	8:00 AM to 5:00 PM	9:00 AM to 4:00 PM	Figure 17
Rosemead Explorer	City of Rosemead	2	5:00 AM to 8:00 PM	10:00 AM to 5:00 PM	10:00 AM to 5:00 PM	Figure 15

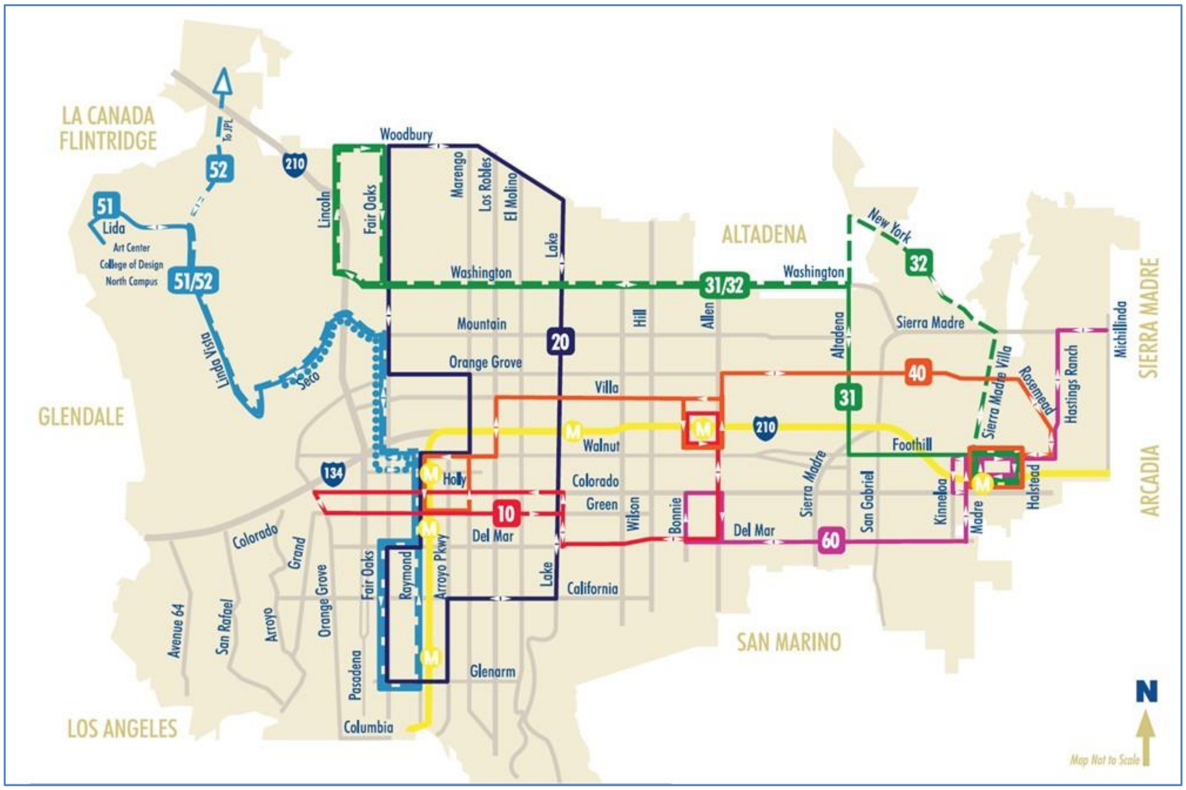

Figure 12 – Pasadena Area Rapid Transit System (ARTS) System Map

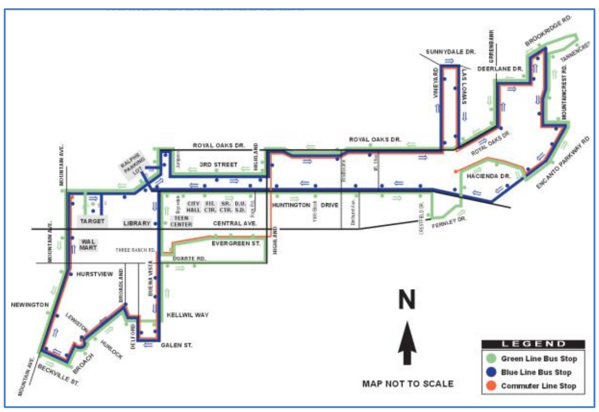

Figure 13 – Duarte Transit System

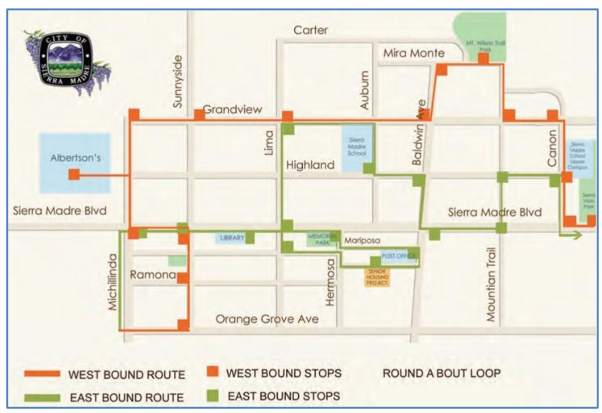

Figure 14 – Sierra Madre Transit System

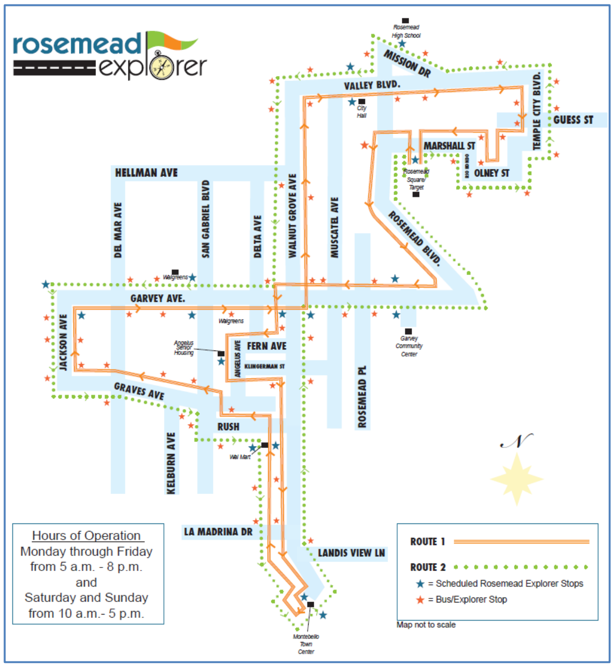

Figure 15 – Rosemead Explorer

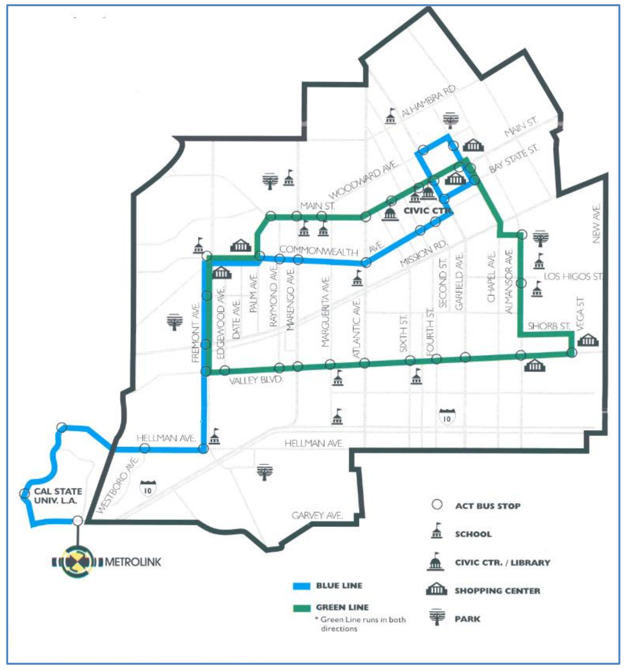

Figure 16 – Alhambra Community Transit

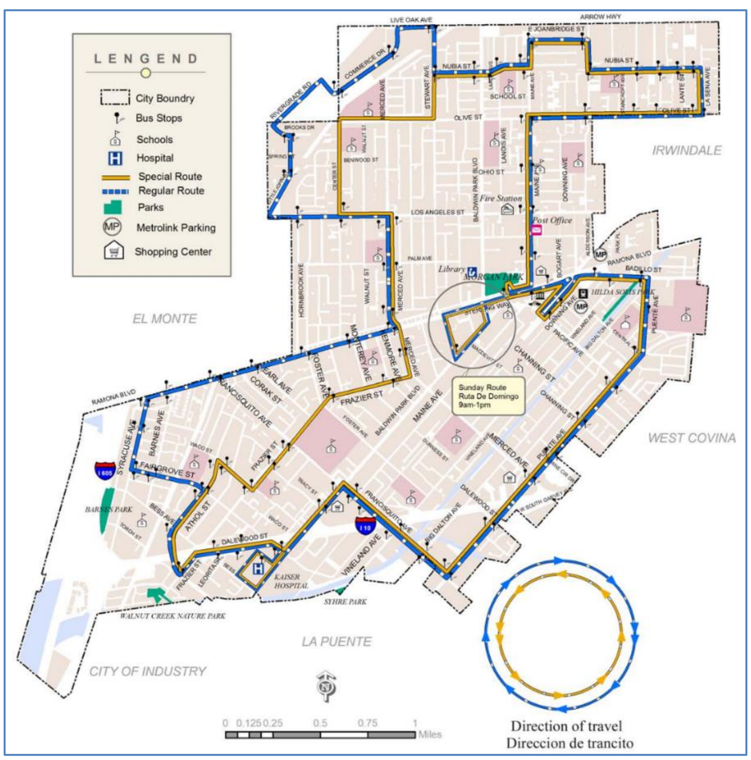

Figure 17 – Baldwin Transit System

4.5.1.7. Dial-a-Ride Services

Many cities provide curb-to-curb transportation services that typically do not follow fixed routes or fixed schedules. Similar to taxi or airport shuttle services, customers are asked to phone a call center and make a reservation for a ride in advance. Reservations can typically be made for travel within a defined geographical area. While many cities restrict these services to seniors and persons with disabilities, others allow any individual residing within a given area to use the service. Agencies currently offering Dial-a-Ride services within the I-210 corridor include:

- City of Pasadena (serving the cities of Pasadena, San Marino and Altadena)
- City of South Pasadena
- City of Arcadia
- City of Sierra Madre
- City of Monrovia
- City of Azusa
- City of Glendora (*Mini Bus* service)
- City of Temple City
- City of Alhambra (*Senior Ride* program)
- City of San Gabriel
- City of Baldwin Park
- City of Covina
- City of West Covina
- Pomona Valley Transportation Authority (*Get About* service for San Dimas and LaVerne)
- Los Angeles County Access Services

4.6. PARK-AND-RIDE FACILITIES

Figure 18 maps the park-and-ride facilities currently in operation or under construction within the corridor. Thirty-three facilities are shown, distributed among the following operators:

- Facilities operated by LA Metro along the existing Gold Line
- Facilities under construction along the Metro Gold Line extension to be operated by LA Metro
- Facilities near Metrolink commuter rail stations respectively operated by the cities of El Monte, Baldwin Park and Covina
- Facilities operated by Caltrans along the I-210 and SR-57 freeway
- A facility operated by the County of Los Angeles along I-10 near west of the SR-57 interchange
- Various facilities operated by cities or by private entities (e.g., colleges, malls, churches) through cooperative agreements with public transportation agencies

Parking at most park-and-ride facilities is on a first-come, first-served basis. The only exceptions are for a few facilities along the Metro Gold Line, where a small number of spaces can be reserved prior to arriving at the facility. These facilities are indicated by a red "R" sign in Figure 18.

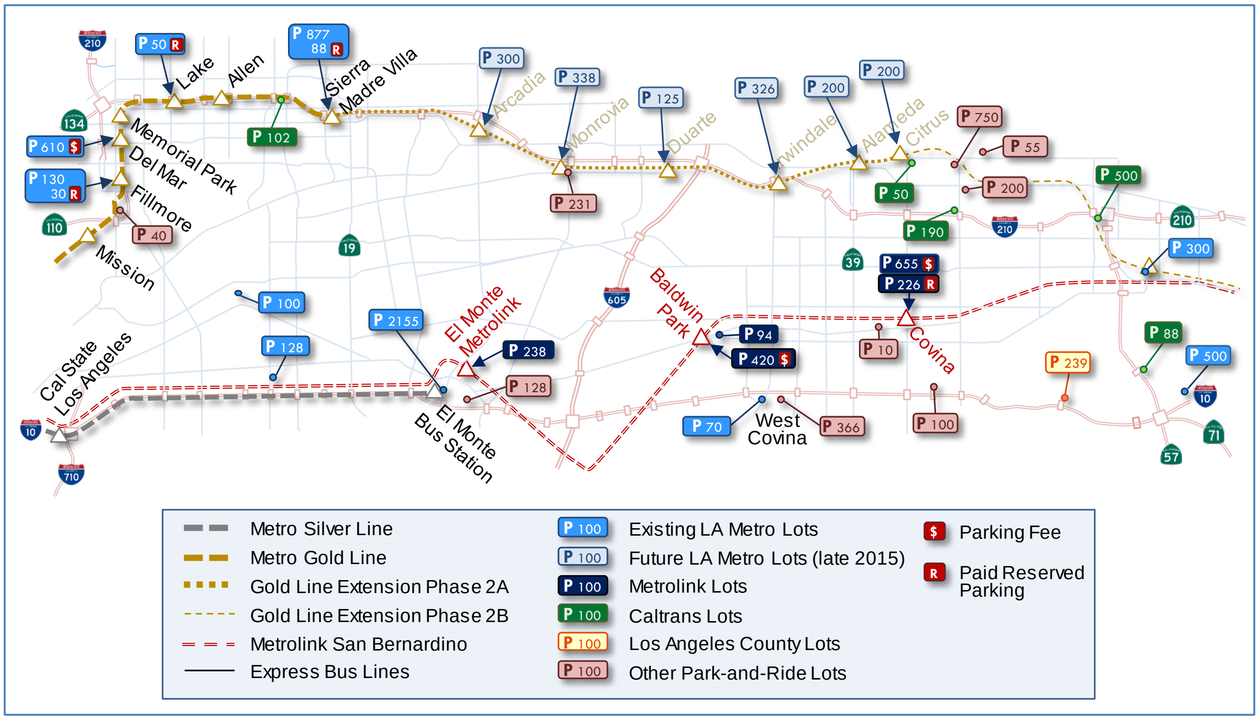

Figure 18 – Park-and-Ride Facilities

Parking is free of charge at most facilities. Table 2 identifies the facilities that charge a fee. These facilities are also indicated by a red dollar sign or R symbol in Figure 18. Where daily parking on a first-come, first served is allowed, motorists can park for a flat daily fee of $2 or $3. At a few Gold Line stations, motorists may similarly reserve a parking space for a single day, if a space is available, for $3. Along the Gold Line, a monthly parking permit guaranteeing the availability of a parking space before 10:30 AM currently costs $28 or $29, depending on the station. At the Metrolink facilities, frequent park-and-ride users can purchase a monthly parking pass for $10 to $45, depending on the location of the parking facility and residency status of the person requesting the pass.

Table 2 – Daily and Monthly Fees Charged at Park-and-Ride Facilities with Paid Parking

Station	Type of Space	Parking Spaces	Weekday Daily Use Fee	Monthly Permit
Metro Gold Line Stations				
Filmore	Reserved parking	30	$3	$29
Del Mar	First-come, first served	610	$3	---
Lake	Reserved Parking	50	$3	$28
Sierra Madre Villa	Reserved parking	88	$3	$29
Metrolink Stations				
Covina	First-come, first served	226	---	$20 residents / $45 non-residents
	First-come, first served	655	$2	$10 residents / $20 non-residents
Baldwin Park	First-come, first served	236	$3	$10 residents / $30 non-residents

4.7. GENERAL PARKING FACILITIES

General parking facilities include city-operated and private off-street facilities that motorists may use to park their vehicle near business, commercial, retail, and educational areas. As shown in Figure 19, most of these facilities are found around downtown Pasadena. A few additional facilities are sprinkled throughout the corridor around major event venues, regional commercial centers, and local commercial and business areas.

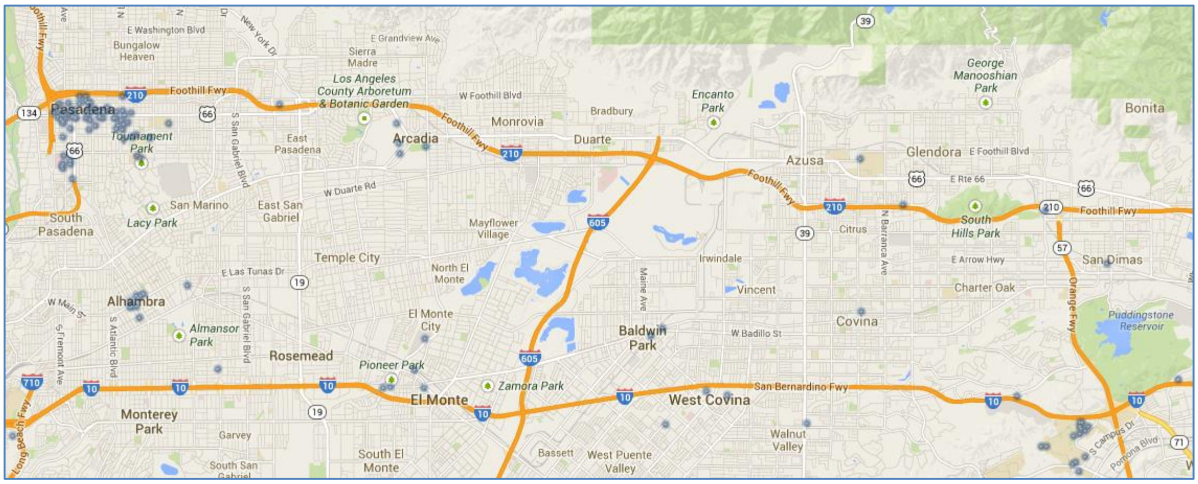

Figure 19 – Parking Structures and Surface Lots

In downtown Pasadena, many of the garages are fully utilized by employees of adjacent businesses holding monthly parking permits and only operate from Monday through Friday. However, several facilities also operate as public parking on nights and weekends. Many of the parking garages further sell monthly permits for residents who do not have off-street parking, while some garages offer preferential parking for City employees, emergency services, or electric vehicles.

Most of the mapped facilities charge an hourly fee for parking. Public parking facilities generally offer lower rates than private facilities and offer free parking for the first 60 to 90 minutes. Across all types of facilities, hourly fees vary from $1 to $10. Many facilities also have a fixed daily rate or a maximum daily fee. Depending on the location and the operator, daily parking fees are typically capped between $5 and $10. Only a few private facilities have daily maximum fees exceeding $10.

While many cities own parking facilities, they are often operated by a private operator. For instance, while the City of Pasadena owns several parking garages, their operation is contracted out to private firms on five-year contracts. These private operators are responsible for staffing the parking payment booths during the hours of operations of each garage.

4.8. BIKE PATHS

Figure 20 maps the bike paths within the I-210 corridor. The maps distinguish several types of bike paths:

- Class I – Paved path within an exclusive right-of-way.
- Class II – Signed and striped lanes within a street right-of-way.
- Class III – Preferred routes on existing streets identified by signs only.

The majority of bike paths within the corridor are Class III facilities, with most of the established paths found in the cities of Pasadena, Monrovia, Duarte, Glendora and San Dimas. Several Class II bike paths can be found along select arterial sections. All Class I bike paths are off-street facilities that were developed along former railroad right-of-way or along regional park trails.

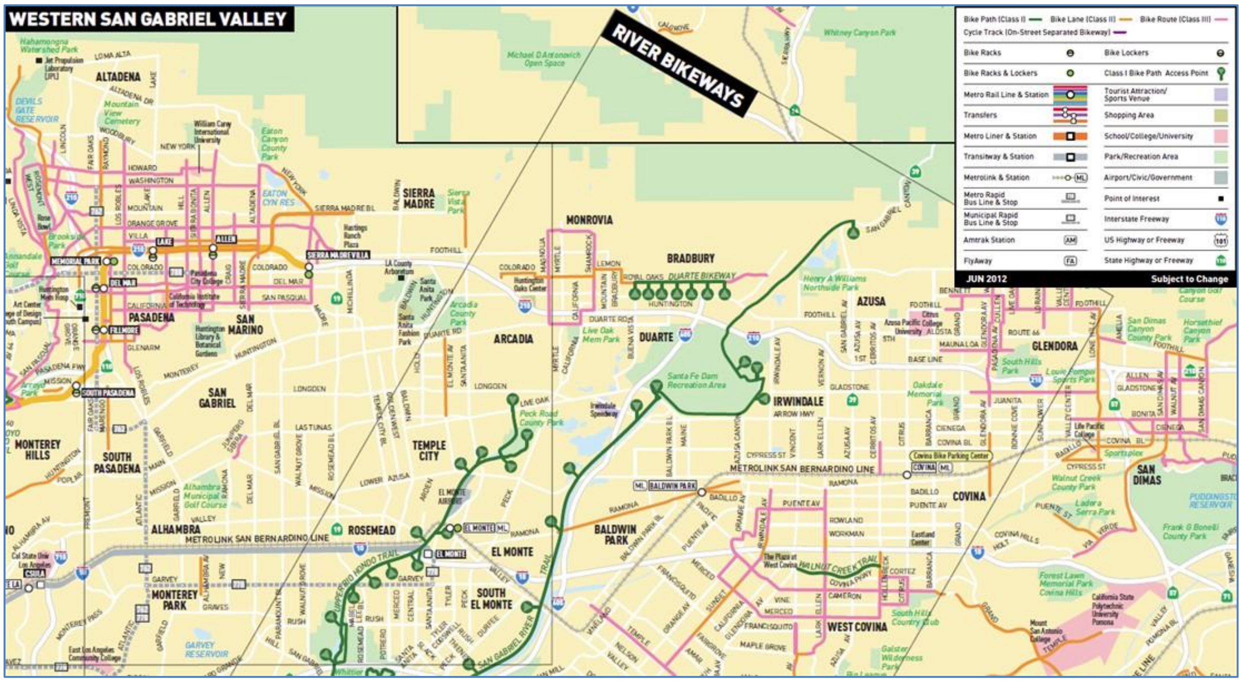

Figure 20 – Bike Paths

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5. TRIP GENERATORS

Recurring and periodic trip patterns within corridor are strongly influenced by the institutions, businesses centers and facilities located within the corridor. Key trip generators within the corridor include:

- Commercial areas
- Industrial areas
- Educational institutions
- Medical centers
- Event venues

5.1. COMMERCIAL AREAS

Figure 21 maps the main commercial and industrial areas within the corridor. Here, commercial areas include areas with retail activities and areas where professional office buildings are located. As can be observed, commercial areas are spread throughout the corridor, with local clusters in or near the downtown area of each city. However, downtown Pasadena is generally viewed as a major regional employment and commercial center.

Areas with a high concentration of retail stores are important for the development of traffic management strategies, as these areas will often generate a high concentration of trips during weeknights, weekday days, and around holidays. Many traffic engineers have indicated that traffic patterns during December can be significantly different from other months due to holiday shopping activities.

Major regional shopping malls labeled in Figure 21 include:

- **Westfield Santa Anita Mall –** Major regional shopping mall with 1.3-million-square-foot of retail space hosting 282 stores.

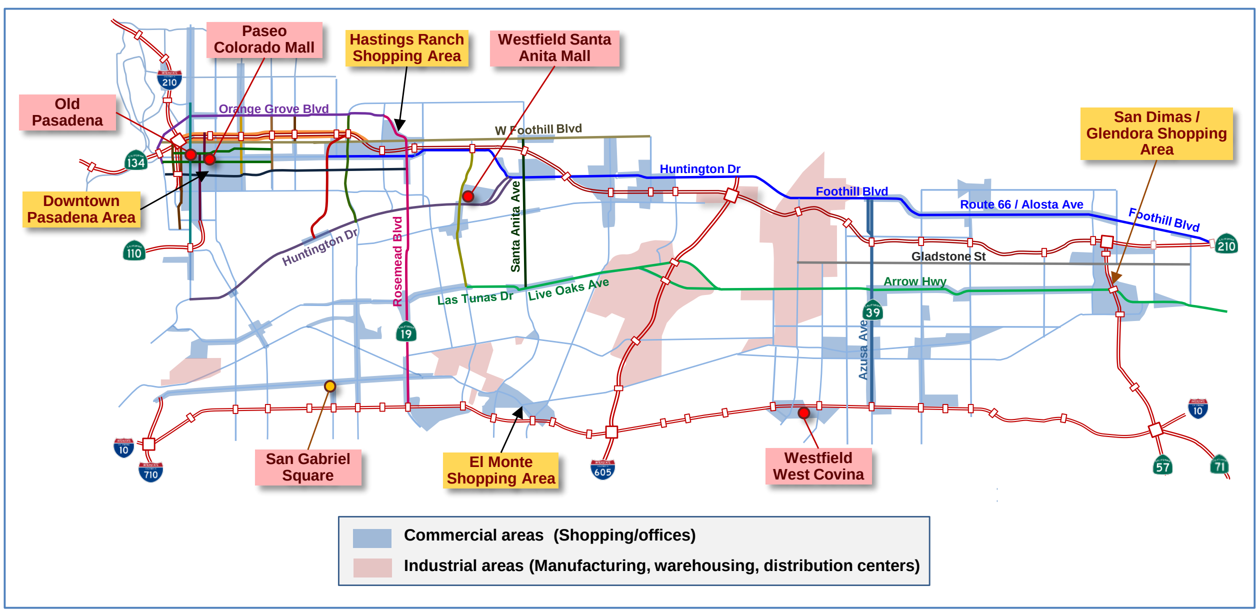

Figure 21 – Commercial Areas

- **Westfield West Covina –** Major regional shopping mall, with 1.2-million-square-foot of retail spaces hosting 208 shops, stores, and restaurants.
- **Old Pasadena** – Area of downtown Pasadena featuring over 200 specialty boutiques and over 100 restaurants, as well as a very active nightlife. These features make the district a popular attraction for locals and out-of-towners alike.
- **Paseo Colorado Mall** – Upscale outdoor mall in Pasadena covering three city blocks with 566,000 square foot of shops, office space, restaurants, and a movie theater. 400 loft-style condominiums are also located above the shopping areas.
- **San Gabriel Square** - 219,000 square feet commercial complex in San Gabriel featuring a wide array of Asian stores.

Other notable shopping areas shown in the figure include:

- **Hastings Ranch Shopping Area** – Area along Foothill Boulevard at the boundary between the cities of Pasadena and Arcadia where numerous big-box stores are located.
- **San Dimas / Glendora shopping area** – Area with a large concentration of retail stores west of SR-57 along Arrow Highway and Lone Hill Avenue predominantly within the City of San Dimas but with some sections in the City of Glendora.
- **El Monte Shopping –** Area along Valley Mall and Valley Boulevard in El Monte.

5.2. INDUSTRIAL AREAS

Figure 22 maps the areas where several warehouses and distribution centers are located. Because of their nature, these areas likely act as origin or destination points for trips made by a significant portion of heavy and light-weight distribution trucks traveling within the corridor. Five specific areas with a high number of warehouses and distribution centers are:

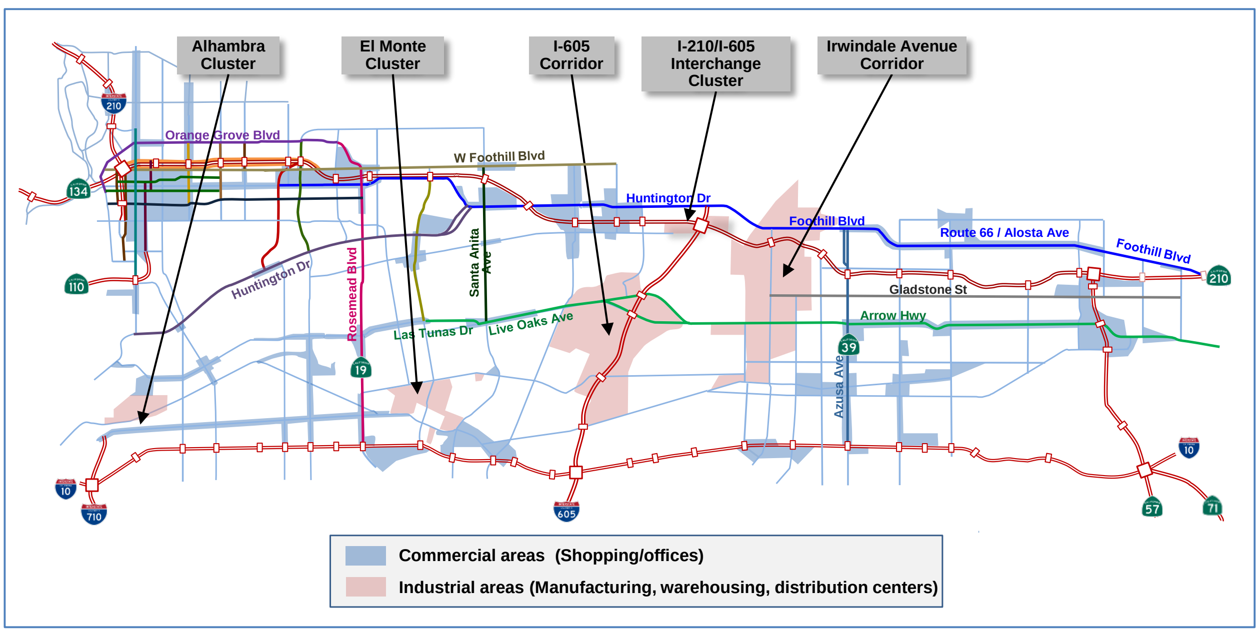

Figure 22 – Industrial / Warehouse Areas

- Corridor along Irwindale Avenue in the cities of Irwindale and Azusa, south of I-210 and east of the I-605 interchange
- Area along the I-605 freeway, predominantly along Arrow Highway and Live Oak Avenue within the City of Irwindale
- Small cluster around the I-210/I-605 interchange, along Duarte Road in the city of Duarte and the eastern end of Central Avenue in the City of Irwindale
- Small cluster in the City of El Monte to the south of I-210 and west of the I-605 freeways
- Small cluster in the City of Alhambra, north of the I-10 freeway

Outside these five areas, general trucking companies, both commercial and private, are dispersed more evenly throughout the corridor, with most of the companies being located along Foothill Boulevard north of I-210 and along Arrow Highway/Live Oak Avenue south of I-210.

Typical commodities hauled by trucking companies operating within the corridor include food, paper products, general merchandise, plastic products, apparel/textiles, furniture, hazardous waste/materials, aggregates and building materials, metal products, and agricultural products.

5.3. EDUCATIONAL INSTITUTIONS

Universities and colleges can generate significant traffic to and from their campuses, particularly early in the morning and early evening, when multiple classes often start at the same time, and late afternoon and late evening, when classes end. Figure 23 maps the universities and community colleges that are located within the corridor or in close proximity. The mapped institutions include:

- **Mount San Antonio College** – Community college located approximately five miles south of the I-210 in the City of Walnut. It is the largest public two-year community college in the nation with an enrollment of approximately 43,000 students.

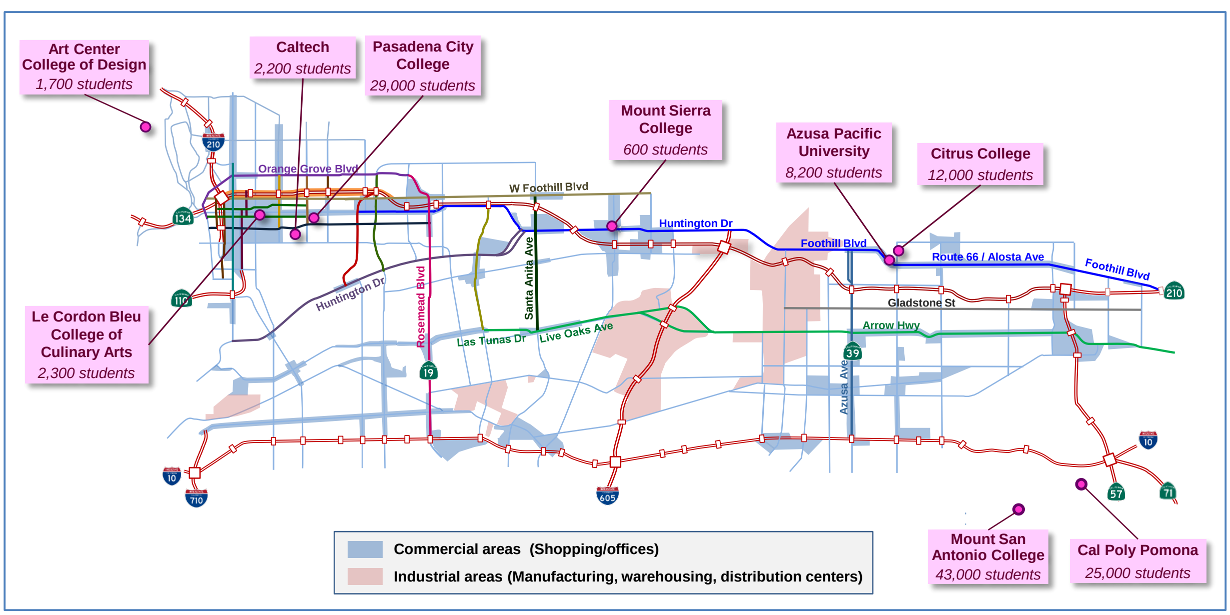

Figure 23 – Universities and Colleges

- **Pasadena City College** – Two-year public community college located one mile south of the I-210 in Pasadena, with approximately 29,000 students.
- **California State Polytechnic University, Pomona** – Public university located south of the I-10 and west of the SR-57 interchange, with approximately 25,000 students.
- **Citrus College** – Two-year public community college located one mile north of the I-210 in Glendora with an estimated enrollment of 12,000 students.
- **Azusa Pacific University** – Four-year private college located one mile north of the I-210 in Azusa with approximately 10,000 undergraduate and graduate students.
- **Le Cordon Bleu College of Culinary Arts** – Educational institution offering certificate, associate and bachelor's degrees in culinary arts, with an estimated full-time enrollment of 2,300 students.
- **California Institute of Technology (Caltech)** – Private research university located in Pasadena, south of the I-210 enrolling approximately 2,200 undergraduate and graduate students and employing over 5,000 individuals.
- **Art Center College of Design** –Private college located in Pasadena, northwest of the I-210/SR-134 interchange with an estimated enrollment of 1,700 students.
- **Mount Sierra College** – Private, four-year college located north of the I-210, along Huntington Drive in Monrovia, preparing students for careers in the fields of business, media arts and technology and typically enrolling less than 1000 students.

Figure 24 further maps the public and private elementary, middle and high schools within the study area. While large educational institutions can account for a significant portion of trips within the corridor, elementary, middle and high schools also generate a certain amount of trips. While the number of trips generated is smaller than large institutions, these trips tend to all occur at the same time, i.e., when school starts and ends. Depending on local conditions, such a sudden surge in traffic, couple with crossing guards periodically stopping traffic to let students cross arterials, schools may significantly affect traffic operations on streets and arterials near each school.

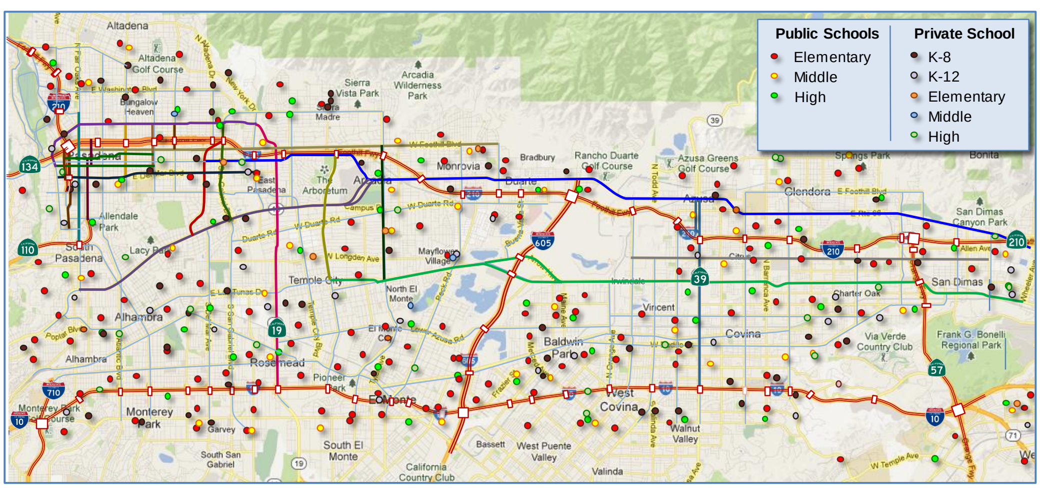

Figure 24 – Public and Private Elementary, Middle, and High Schools

5.4. MEDICAL CENTERS

While medical centers do not typically generate a large rush of traffic, the coming and going of patients and visitors may generate noticeable traffic, particularly around the larger centers. Ambulances equipped with devices enabling them to preempt traffic signals may also cause significant disruptions to traffic patterns. As shown in Figure 25, major medical centers within the I-210 corridor include the following:

- **Huntington Memorial Hospital** – Nonprofit hospital located in Pasadena about a mile south of the I-210/SR-134 junction. This 558-bed hospital serves as the regional trauma center for the San Gabriel Valley area and nearby communities.
- **Citrus Valley Medical Center – Inter-Community Campus** – Nonprofit medical center with 518 beds located two miles south of I-210 in Covina.
- **Methodist Hospital** – Nonprofit hospital across from the Santa Anita Park in Arcadia. This 395-bed hospital provides comprehensive acute care including surgical, pediatric, and intensive care units as well as specialty services such as cardiology, oncology, neurology, and orthopedics.
- **City of Hope National Medical Center** - Nonprofit clinical research center, hospital, and graduate medical school located in Duarte, just south of I-210. This 185-bed center includes a cancer treatment center and a biomedical research facility known as the Beckman Research Institute.
- **San Gabriel Valley Medical Center** – General medical and surgical hospital located in San Gabriel, south of the I-210 and close to the I-10 freeway, with 269 beds.
- **Foothill Presbyterian Hospital** – Nonprofit hospital located in Glendora, one mile north of I-210, west of the SR-57 interchange. This 105-bed medical center provides general acute care services, 24-hour emergency room services, and medical/surgical services.

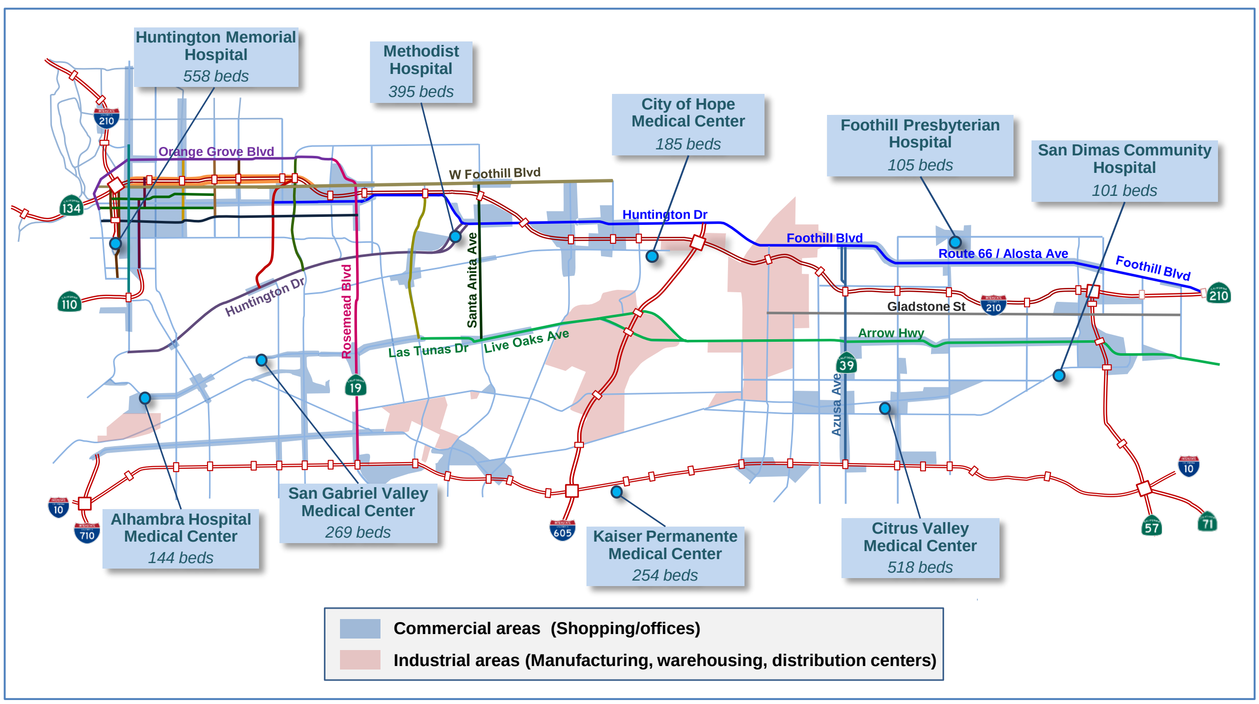

Figure 25 – Major Medical Centers

- **Kaiser Permanente Baldwin Park Medical Center** – Medical center located in Baldwin Park, south if I-10 just east of the I-605 interchange, with 254 beds.
- **Alhambra Hospital Medical Center** – General medical and surgical hospital located in Alhambra, south of the I-210 and close to the I-10 freeway, with 144 beds.
- **San Dimas Community Hospital** – Acute care hospital along West Covina Boulevard, west of the SR-57 freeway between the I-210 and I-10 freeways, with 101 beds.

5.5. EVENT VENUES

Figure 26 maps major event centers and facilities that can on occasion generate unusual traffic or large traffic surges. The mapped facilities include:

- **Rose Bowl Stadium** – 90,000 seat stadium located northwest of the I-210/SR-134 interchange. This stadium is the home of the Tournament of Roses Football Game, UCLA Bruin Football, Fourth of July celebrations, concerts, religious services, filming, and the World's Largest Flea Market. Its parking lots are also available for a wide variety of rental uses.
- **Rose Bowl Aquatic Center –** Olympic-size pool located south of the Rose Bowl Stadium periodically hosting regional, statewide and national swimming competitions.
- **Santa Anita Park** – Thoroughbred racetrack hosting some of the prominent racing events in the United States during the winter and spring. The facility includes a 1,100-foot long grandstand that can seats 26,000 guests. The track infield area, which resembles a park, can accommodate an additional 50,000 guests.
- **Pasadena Convention Center –** Multi-purpose facility including a divisible 55,000 square foot exhibit hall, a divisible 25,000-square-foot ballroom, 29 meeting rooms, and a 3,000-seat multi-purpose auditorium located in downtown Pasadena.
- **Irwindale Event Center** – Motorsport facility with 1/2-mile and 1/3-mile oval racetracks, in addition to a 1/8-mile drag strip, offering fixed seating accommodations for 6,500 spectators.

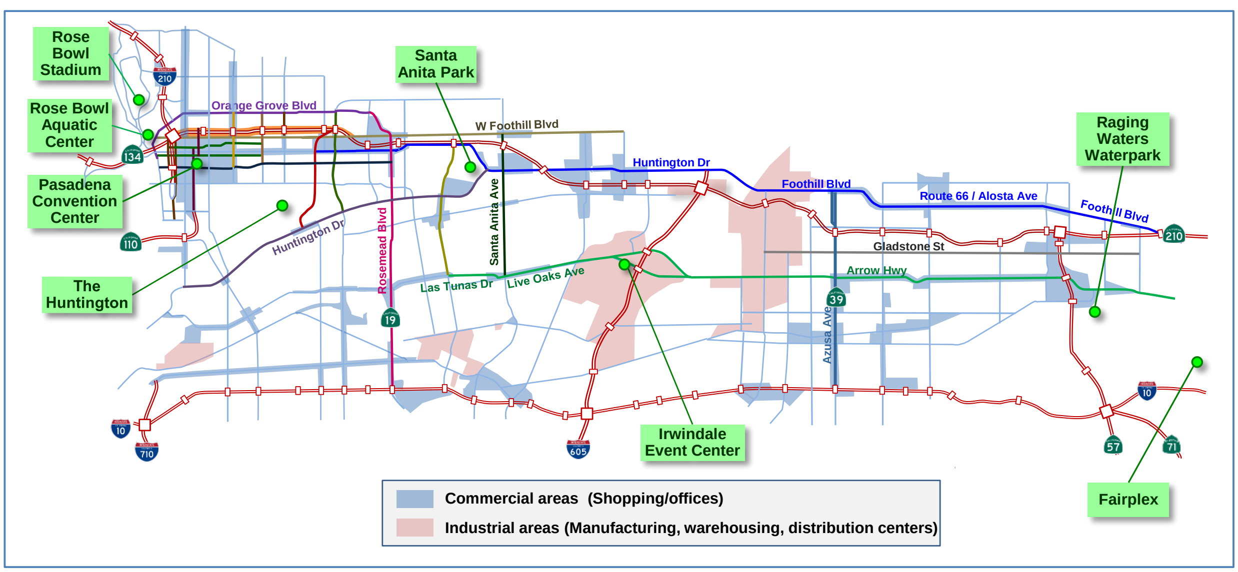

Figure 26 – Event Venues

- **Raging Waters Water Park** – 23-acre amusement park located on the north end of the Bonelli Regional Park, about three miles south of the I-210/SR-57 junction. It is the largest water park in California.
- **The Huntington** – Private nonprofit institution located three miles south of I-210 in San Marino with a research library, an art gallery, and a botanical garden.
- **Los Angeles County Arboretum and Botanical Garden** – 127-acre arboretum, botanical garden, and historical site located in Arcadia, near the Santa Anita Park.
- **Fairplex** – 543 acres facility with 325,000 square feet of indoor exhibit space and a 30,000-vehicle parking capacity owned by Los Angeles County and used year-round to host a variety of educational, commercial, and entertainment events, including the annual Los Angeles County Fair held each September.

In addition to the above facilities, various local events may generate additional trips within the corridor or cause significant disruptions to normal traffic patterns. Among the most notable events are:

- **Tournament of Roses Parade –** Parade held each year on New Year’s Day on Colorado Boulevard in downtown Pasadena. Attendance figures for the parade have oscillated around 700,000 individuals since 2009.
- **Pasadena Marathon** – Marathon and bike race held annually within the city of Pasadena in June, with a free festival held on the day of the race on the campus of the Pasadena City College.
- **Art Night** – Night during which several museums within Pasadena offer free admission. Art nights typically happen twice a year, one in March and the other in October.

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6. TRANSPORTATION MANAGEMENT ASSETS

This section describes existing transportation management assets and Intelligent Transportation Systems (ITS) assets supporting the operation of transportation systems and management of transportation activities within the study corridor. Elements reviewed in this section include:

- Traffic management centers
- Traffic monitoring systems
- Freeway traffic management systems
- Arterial traffic management systems
- Incident/event management systems
- Transit management systems
- Parking management systems
- Traveler information systems
- Information exchange networks

6.1. TRAFFIC MANAGEMENT CENTERS

Several traffic management centers current support the management of traffic operations within the I-210 corridor:

- Los Angeles Regional Transportation Management Center (LARTMC)
- Los Angeles County Traffic Management Center
- Pasadena Traffic Management Center
- Arcadia Traffic Management Center
- Upcoming county-hosted centralized signal control for Duarte and Monrovia

6.1.1. LOS ANGELES REGIONAL TRANSPORTATION MANAGEMENT CENTER (LARTMC)

Figure 27 – Los Angeles Regional Transportation Management Center

The Los Angeles Regional Transportation Management Center (LARTMC) is a facility jointly operated by Caltrans and the California Highway Patrol. Located next to the SR-2/SR-134 interchange and staffed 24 hours a day, seven days a week, this center was designed to help Caltrans staff manage traffic within the highly congested Los Angeles and Ventura County regions.

At the heart of the TMC is an Advanced Traffic Management System (ATMS) that was developed by Delcan. This system enables TMC operators to monitor traffic conditions on regional freeways and to control various traffic management devices through a high-level, graphical user interface. Key functionalities supported by the LARTMC ATMS include:

- Collection and processing of traffic data from over 10,000 inductive loop detectors spread across 1280 traffic detection stations along 525 miles of freeway

- Ability to display traffic sensor data on electronic video map displays
- Access to video feeds from 350 CCTV cameras
- Management of messages displayed on 109 changeable message signs
- Management of messages broadcasted on 15 highway advisory radio stations
- Operational control of 960 ramp meters
- Link to Caltrans' lane closure tracking system
- Direct access to the CHP's Computer-Aided Dispatch (CAD) system
- Automated incident detection system
- Event response decision support system
- Access to a traffic data archive covering at least five years
- Access to real-time data portals with other regional agencies
- Automated report generation functions

6.1.2. LOS ANGELES COUNTY TRAFFIC MANAGEMENT CENTER (LACTMC)

The Los Angeles County Traffic Management Center, located in Alhambra, started operations in 2005 and houses the staff and equipment needed to operate, manage, and maintain traffic signals along the major arterials in Los Angeles County. Key functionalities of this TMC include:

Figure 28 – Los Angeles County Traffic Management Center

- Ability to monitor and control remotely the operation of traffic signals connected to the Kimley-Horn Integrated Transportation System (KITS) server. This system, which was initially deployed in 2004 and gradually expanded since then, now enable county staff to manage over 700 signalized intersections across county areas and within cities for which a maintenance agreement has been made with the County. Within the I-210 corridor, this includes the cities of El Monte, San Gabriel and Temple City. For the future, it is envisioned that over 900 signals will eventually be connected to the system.
- Hosting the Information Exchange Network (IEN), which enables participants to monitor traffic signal operations in adjacent jurisdictions. Within the I-210 corridor, this network currently enables County staff to monitor traffic signal operations within the cities of Pasadena, Arcadia, and Alhambra.
- Access to video feeds from more than 30 CCTV cameras.

Two or three individuals from the Traffic and Traffic Systems sections of LA County are normally assigned to the TMC. The facility is typically staffed from 7:00 AM to 9:30 AM and from 2:00 PM to 5:15 PM during weekdays, as well during special events.

6.1.3. CITY OF PASADENA TRAFFIC MANAGEMENT CENTER

The City of Pasadena Traffic Management Center is located in the city's administrative. Launched in 1992, this center allows city staff to:

- Monitor and control in real time over 300 traffic signals operated under the city's i2tms, QuicNet Pro, Transcore Series 2000, and SCATS traffic signal control systems.
- Control a network of 10 CCTV cameras
- Post messages on 11 changeable message signs installed along key arterial segments.

Figure 29 – Pasadena Traffic Management Center

Three individuals from the Traffic Operations Division are normally assigned full-time to the TMC. They staff the TMC from 7:30 AM to 6:30 PM on weekdays, as well as during special events. While on duty, they are tasked to operate and dynamically adjust, when necessary, the signal timings at individual intersections to improve traffic flow. This is done through workstations connecting the TMC to the various controlled intersections.

While the TMC has been predominantly used to support traditional traffic signal operations, there has been growing interest in enhancing its ability, including developing abilities to support more adaptive signal operations and to provide information to travelers.

6.1.4. CITY OF ARCADIA TRAFFIC MANAGEMENT CENTER

The City of Arcadia Traffic Management Center is located in the city's administrative. This center consists of a workstation connected to large display monitors mounted on the wall. This workstation is used by city staff to:

- Monitor and control signalized intersections connected to the city's centralized TransSuite traffic control system
- Access and manage video feeds from a network of 18 CCTV cameras
- Track travel times between key intersections through data collected by a network of 15 Bluetooth reading devices scattered throughout the city
- Access historical traffic and signal timing data archived by the TransSuite traffic control system

This center does not have staff specifically dedicated to its operation. It is predominantly used by city staff during special events and during major incidents to monitor and manage traffic on city streets.

6.1.1. COUNTY-HOSTED CENTRALIZED CONTROL FOR MONROVIA AMD DUARTE

In addition to the facilities described above, the cities of Monrovia and Duarte have each signed an agreement with LA County to have some of their signals operated by LA County's KITS traffic control system. In both cases, the signal control software will be run from LA County's TMC, but each city will remain in control of the operation of their signals through a remote KITS workstation installed in city offices.

6.2. TRAFFIC MONITORING SYSTEMS

This section provides a summary of systems that have been deployed along the I-210 corridor to monitor traffic demand and roadway conditions. These systems include:

- Freeway traffic detectors
- Arterial traffic detectors
- Closed-circuit television (CCTV) cameras
- Pasadena SMART Signal System
- Performance Measurement System (PeMS)

6.2.1. FREEWAY TRAFFIC SENSING

Caltrans currently maintain an extensive network of traffic detectors on freeways. The following summarizes deployed field elements within the I-210 corridor:

- **Freeway mainline detectors** – Figure 30 maps the mainline detection stations maintained by Caltrans on the I-210 and freeways near the I-210. Along I-210, Caltrans maintains 42 detection stations between the SR-134 and Foothill Boulevard interchanges in the eastbound direction and 46 stations in the westbound direction. In each direction, about half of the detectors are located west of the I-605 interchange and half on the east. As shown in Figure 31, mainline detection stations are typically located just upstream of an on-ramp. Spacing between successive mainline detection stations varies between 300 feet to 1.3 mile, with an average of 0.5 mile. Single-loop in-pavement detectors are used at all detection stations. No dual loops capable of directly measuring speeds are used along the I-210 corridor. Consequently, all traffic detection stations only directly measure vehicle counts and loop occupancy. While speed measurements are provided for all mainline detectors, these measurements are derived from the vehicle counts and loop occupancy data.

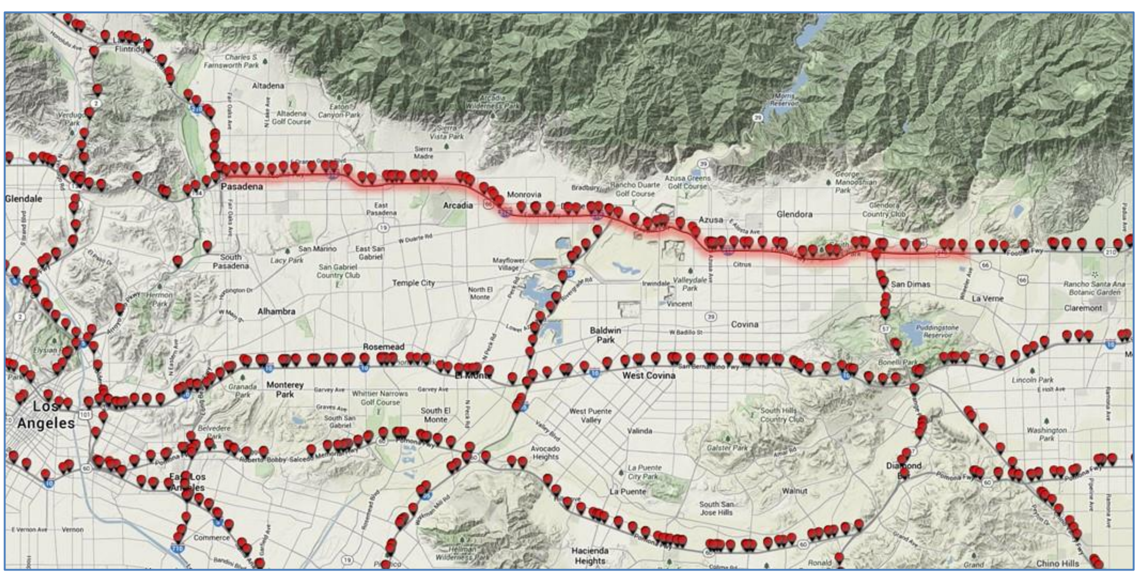

Figure 30 – Caltrans Mainline Freeway Traffic Detection Stations

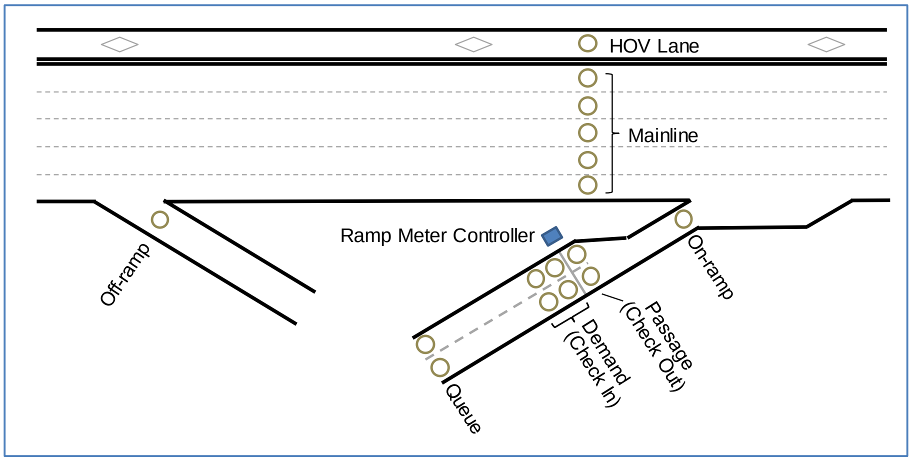

Figure 31 – Typical Sensor Layout along Freeways

- **HOV lane detectors –** In each direction, traffic detectors are deployed along the existing HOV lane at the same locations as along the freeway mainline. Similar to the mainline detectors, these devices are used to obtain vehicle counts, loop occupancy data, and vehicle speed estimates.
- **On-ramp detectors** – All on-ramps along I-210 are equipped with traffic detectors. As shown in Figure 31, four types of detectors are typically used to monitor traffic on each on-ramp. At the downstream end of each ramp, a sensor is first installed on each traffic lane entering the freeway mainline to count the number of vehicles entering the facility. Since these are typically single-loop detectors, they only provide vehicle counts and loop occupancy information. Vehicle speeds are not estimated. Near the metering stop line, demand and passage detectors are used to support ramp-metering operations. The demand detectors are used to detect the presence of a vehicle upstream of the stop line and call for a green signal, while the passage detectors are used to return the signal to red. Finally, at the upstream end of the ramp, a single-loop detector is typically installed to detect queues of vehicles threatening to spill onto the nearby surface streets.
- **Off-ramp detectors** – Most of the off-ramps along I-210 are equipped with traffic detectors. These are typically single-loops providing vehicle flow and loop occupancy data. They are primarily used to count the number of vehicles taking the ramps. The collected occupancy data may also be used to assess traffic conditions on the ramps. However, since the detectors are not currently linked to the traffic signals that may control traffic at the bottom of a ramp, the information they provide cannot currently be used to manage queues of vehicles that may threaten to spill onto the freeway mainline. Similar to the on-ramps, vehicle speeds are not estimated for these detectors.

6.2.2. ARTERIAL TRAFFIC SENSING

To support vehicle-actuated functionalities, most signalized intersections have traffic detectors installed on some or all of their approaches. Figure 32 identifies the intersections for which traffic detectors are known to be present, and the type of technology used for detecting vehicles. At a majority of intersections, traditional inductive loop detectors place within the pavement are used to sense traffic. However, a growing number of intersections are being equipped with video detection systems.

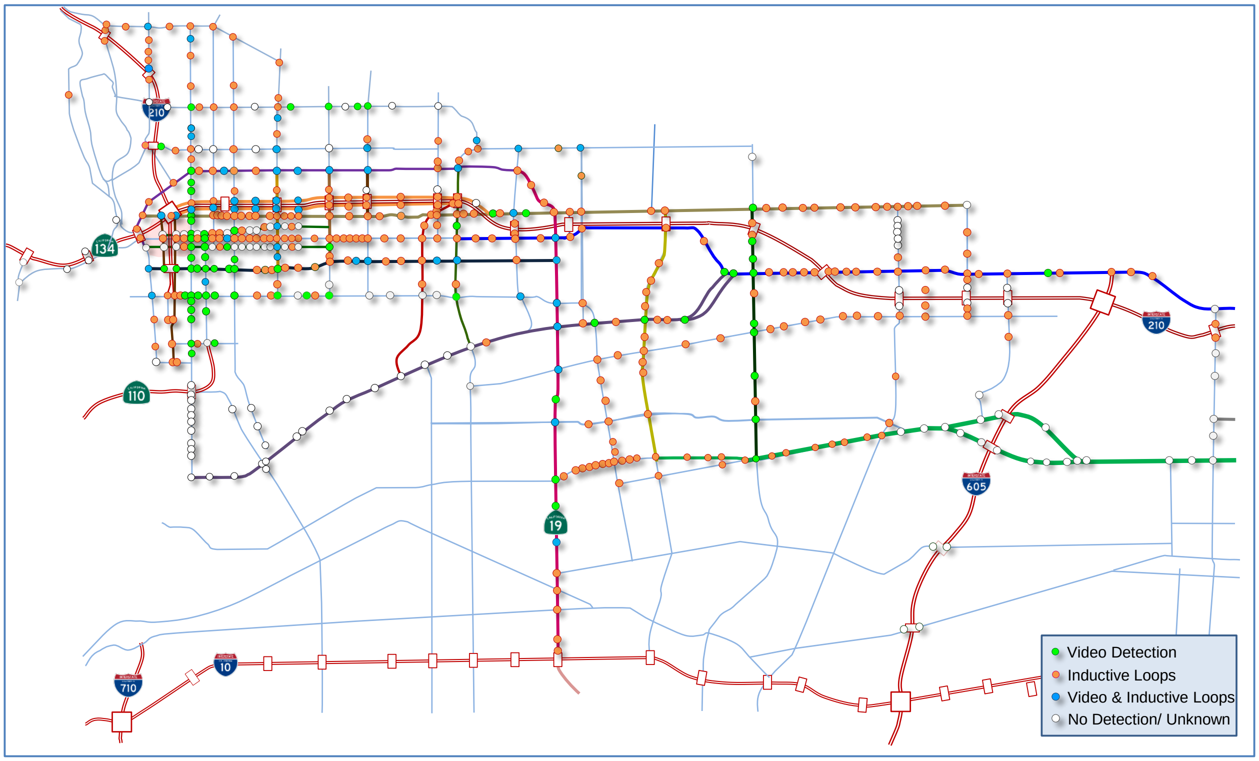

Figure 32 – Traffic Detection Technologies used by Jurisdictions West of I-605

Depending on the location, one or two of the following types of detectors may be present on the intersection approaches:

- **Stop line detectors** – Detectors used to sense the presence of vehicles near the intersection stop line. Use of these detectors depends on their operational setting. When set in the "presence" mode, these detectors are used to place calls to the signal controller for the display of a specific green phase whenever a vehicle is in the zone of detectors. When set in "passage" or "gap" time, they are used to monitor the interval between successive vehicles and to determine when to terminate an active green phase.
- **Advanced passage detectors** – Detectors located some distance upstream of the stop line to sense approaching vehicles. These detectors are typically placed at a distance of three to five seconds behind the stop line and are used in actuated systems to place calls for an extension of the green signal each time a new vehicle is sensed to pass through the detection zone.

Figure 33 provides several examples of detector placements. The most frequent combination is the one featuring advanced detectors on all approach lanes and stop line detectors on exclusive left turn and right-turn lanes (Example 3). This configuration allows monitoring the total traffic demand placed on an intersection and the proportion of left-turning vehicle within the total demand. However, it does not allow distinguishing right-turning vehicles from the through traffic. Depending on the approach, variance in the placement of the advance detectors may also result in some detection leaks. This may be the case where advanced detectors are placed downstream of the start of a left-turn or right-turn bay, as shown in Example 4 as such a placement may allow vehicles to pass besides the detectors.

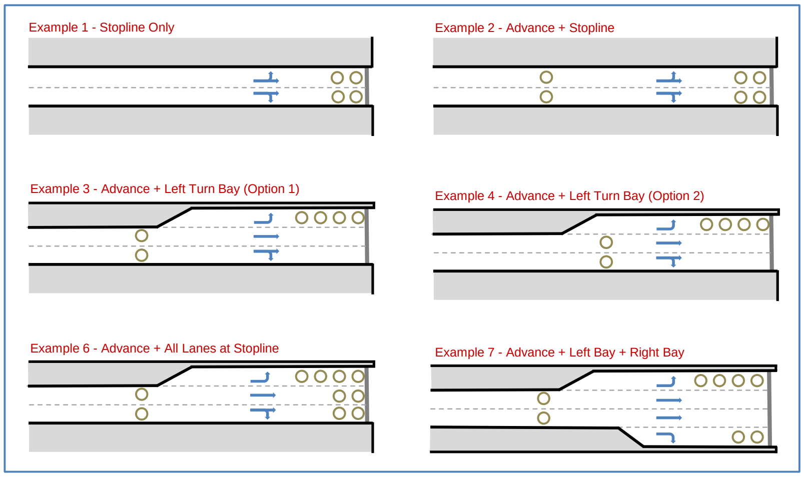

Figure 33 – Examples of Intersection Approach Detector Layouts

While most intersections are equipped with detectors, the availability of sensor data to conduct operational analyses depends on whether the generated data is forwarded to a central location. Depending on the system setup, individual detectors may be defined as local or system detectors. Local detectors strictly send their data to the local signal controller, whereas system detectors are also set to send information to a central traffic control system. In the former case, the collected data is typically dumped by the signal controller after use. In the latter, data may be available for retrieval from a central database. Figure 34 summarily identifies the extent of traffic flow information that may be available from a central location for each intersection within the corridor. For each intersection, the figure identifies whether information is currently obtained from all approaches, some approaches, or no approach at all.

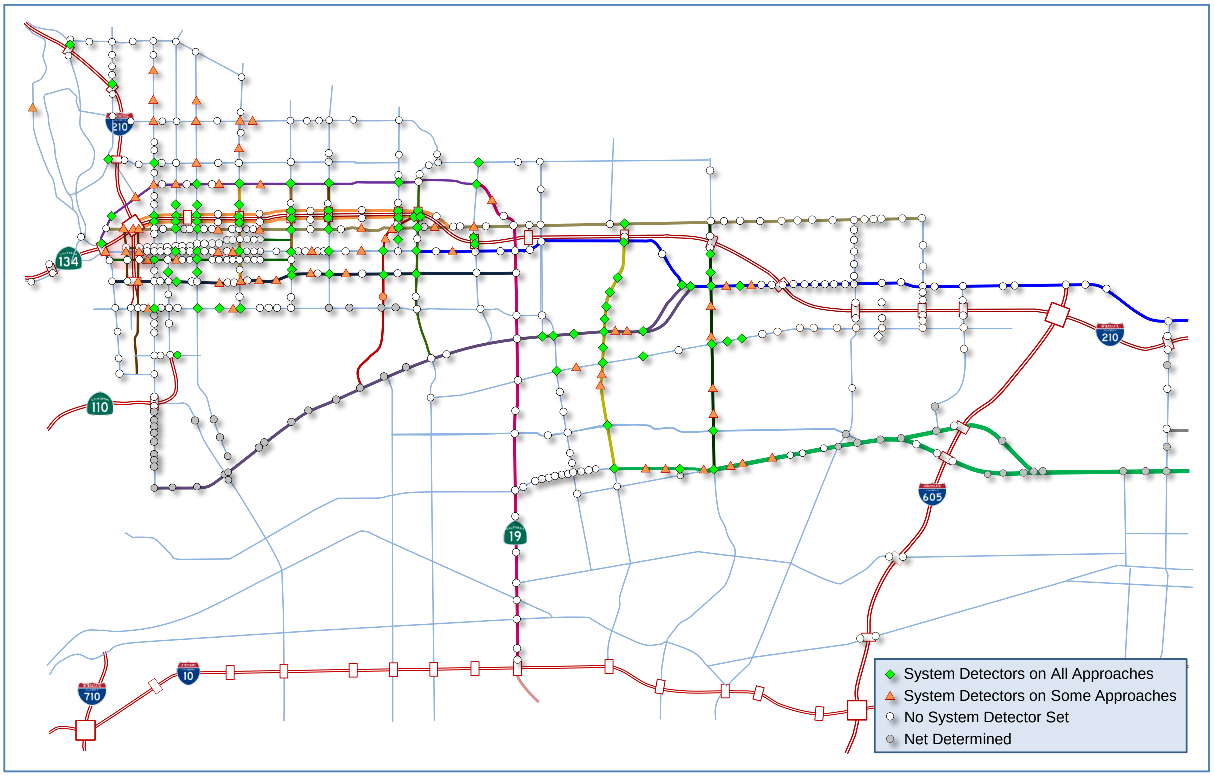

Figure 34 – Monitoring of Intersection Approach Volumes

The following provides a summary of the traffic flow data currently being collected by each agency:

- **Caltrans** – Caltrans-operated intersections typically have detectors on most of their approaches to support actuated signal control. This includes both advanced and stop line detectors. Unfortunately, the information collected by these detectors is not currently forwarded to the regional TMC. However, an exception exists for Caltrans intersections operated by the City of Pasadena. Historical data for these intersections may be available through the Transcore Series 2000 and McCain QuicNet Pro Traffic Control Systems. While a TranSuite traffic control system is currently being procured to support uniform statewide traffic signal operations, there is uncertainty as to when the intersections within the I-210 corridor will be connected to system to be installed at the LARTMC.
- **Los Angeles County Department of Public Works** – While most of the intersections along arterials of interest are equipped with traffic detectors, the generated detector data is not currently forward to the KITS system. The data is strictly used in a local control capacity.
- **City of Pasadena** – 271 of the 323 signalized intersections within the city boundaries have some type of vehicle detection. Of these intersections, 84 are currently set up with system detectors capable of measuring volumes and speeds on some or all the approaches. Only data generated by intersections connected to the i2tms traffic signal control system are currently archived. Fifteen-minute aggregated data is retrieved once a day during the night. While there are plans to develop real-time data feeds, these have not yet been completed. In addition to the data provided by the i2tms system, traffic flow data may also be retrieved from the recently installed real-time SCATS traffic signal control system. Intersections equipped with a video detection system also generate cycle-by-cycle data. However, this data can only be retrieved by physically connecting a data collection device directly to the signal controller.
- **City of Arcadia** – Most of the 51 signalized intersections operated by the city are equipped with traffic detectors. The city's TranSuite traffic signal control system further provides real-time 5-minute traffic count data for 46 of the 51 intersections. Depending on the location, data may be provided from all installed detectors or from specific detectors on specific approaches.
- **City of Monrovia** – Most of the intersections along arterials of interest within the city are equipped with traffic detectors. However, generated detector data is not currently forwarded to a central location. The data is strictly used in a local control capacity.
- **City of Duarte** – Most of the intersections along arterials of interest within Duarte are equipped with traffic detectors. However, generated detector data is not currently forwarded to a central location. The data is strictly used in a local control capacity.

6.2.3. TRAVEL TIME MONITORING SYSTEMS

Two agencies within the I-210 corridor have installed Bluetooth devices to measure travel times between specific points within their local road networks. Figure 35 maps the location of the devices operated by the cities of Pasadena and Arcadia. More information about these devices is provided below.

- **City of Pasadena –** As part of a pilot project, Bluetooth devices have been installed in the Linda Vista Annandale neighborhood to track travel times and travel patterns on roads servicing the Rose Bowl during events. The locations of these devices are shown in the upper left corner of Figure 35.

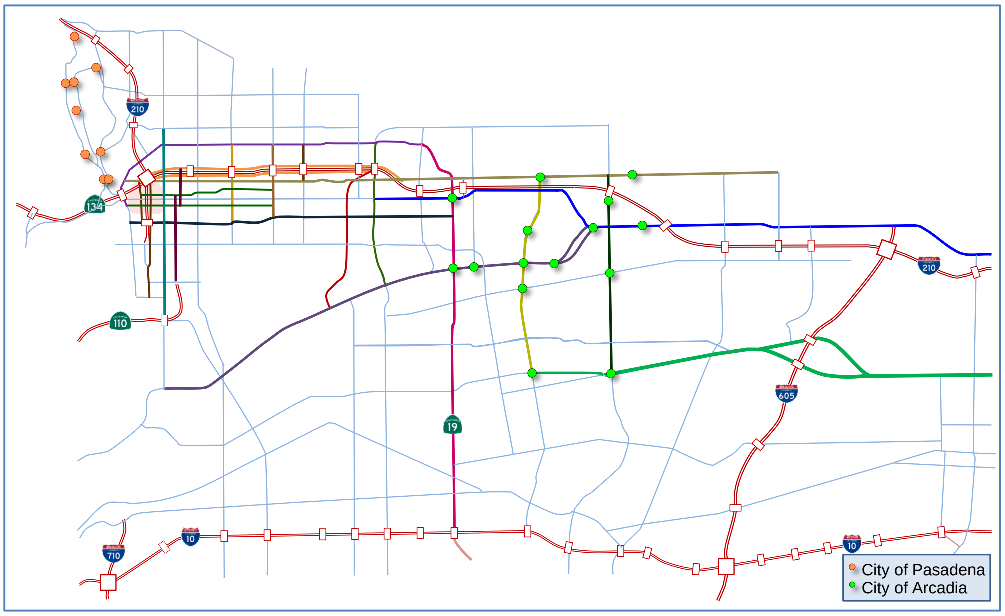

Figure 35 – Bluetooth Devices Operated by the Local Jurisdictions West of I-605

- **City of Arcadia –** To help monitor travel times and travel patterns within the city's road network, 13 permanent Bluetooth detection stations were installed at strategic intersections throughout the city in 2012. With the help of LA County, two additional detectors were further installed in early 2014 at two intersections along Rosemead Boulevard to extend the coverage provided by the system. Installation of these detectors typically involved installing field-processing units in existing traffic signal cabinets and establishing Ethernet communication lines with a host data processing software residing on a city-owned server. No additional communication infrastructure or poles were required. This system currently supplies raw detection pings and observed travel times between detection stations on a minute-by-minute basis.

6.2.4. PASADENA SMART SIGNAL SYSTEM

In May 2011, the City of Pasadena implemented an experimental arterial traffic monitoring system developed at the University of Minnesota known as SMART (System Monitoring of Arterial Road Traffic) along Orange Grove Boulevard. This system, implemented at six signalized intersections between Lake Avenue and Sierra Madre Boulevard, collects traffic data from traffic sensor and traffic signal controllers to help traffic engineers monitor, evaluate, forecast and optimize arterial traffic flows. More specifically, it is designed to generate real-time intersection queue length and arterial travel time estimates using collected traffic flow and signal operation data, including all vehicle actuation calls. Queue lengths are predicted using traffic shockwave concepts, which allow queue estimates to be produced when queues of vehicles extends beyond the farthest upstream detector. Travel times are further estimated by simulating the movements of virtual probe vehicles along the monitored arterial.

6.2.5. CLOSED-CIRCUIT TELEVISION (CCTV) CAMERAS

Figure 36 maps the CCTV cameras currently operated by Caltrans between the SR-134 and Foothill Boulevard interchanges along the I-210 freeway, as well as along the I-605, SR-57 and I-10 freeways in

Figure 36 – Caltrans CCTV Camera Locations

proximity of the I-210 freeway. The figure distinguishes two types of cameras: those used exclusively by Caltrans (shown in red) and those with a feed accessible on public website or shared with information service providers (shown in green). As indicated, existing cameras provide a relatively good coverage of the freeway. While Caltrans staff has access to 25 cameras, the public and information service providers are granted access to feeds from nine cameras positioned near major freeway-to-freeway interchanges.

Figure 37 shows a typical CCTV camera installation. Each camera has pan, tilt, and zoom capabilities and can be operated remotely from the LARTMC. All the video feeds are normally available for viewing by Caltrans TMC staff. Outside the TMC, some of the video feeds are also made available for use by information service providers, such as news broadcasts.

Figure 37 – CCTV Camera along I-210 West at SR-57 Interchange

In addition to the Caltrans-operated cameras, local jurisdictions also operate CCTV cameras to support their traffic management tasks. Figure 38 map the location of the city-operated cameras in the western half of the I-210 corridor. The following networks are depicted:

- **City of Pasadena** – The City of Pasadena currently operates 30 CCTV cameras within the area of interest to the I-210 corridor. Plans have been approved to install at least 10 more. Figure 39 illustrates an installation on top of a mast supporting traffic signals at the corner of Colorado Boulevard and Los Robles Avenue. Video feeds from deployed cameras are available for display in the city’s TMC. Proprietary software provided by the camera vendors further allows panning, tilting, and zooming each camera.

- **City of Arcadia** – The city of Arcadia currently operates 18 CCTV camera to monitor traffic along key arterials. Twelve of the cameras provide a digital video feed, while the remaining six provide an analog signal. For all locations, the video feed can be accessed directly from the city's traffic management center.
- **City of Monrovia** – The city of Monrovia currently operates 2 CCTV cameras along Huntington Drive, one at the intersection of 5th Avenue and the other at the intersection with Mayflower
- **LA County –** The LA County Department of Public Works has been operating a CCTV camera at the intersection of Huntington and Rosemead. In addition to this site, the County has just completed the installation of CCTV cameras at several other locations within the San Gabriel Valley.

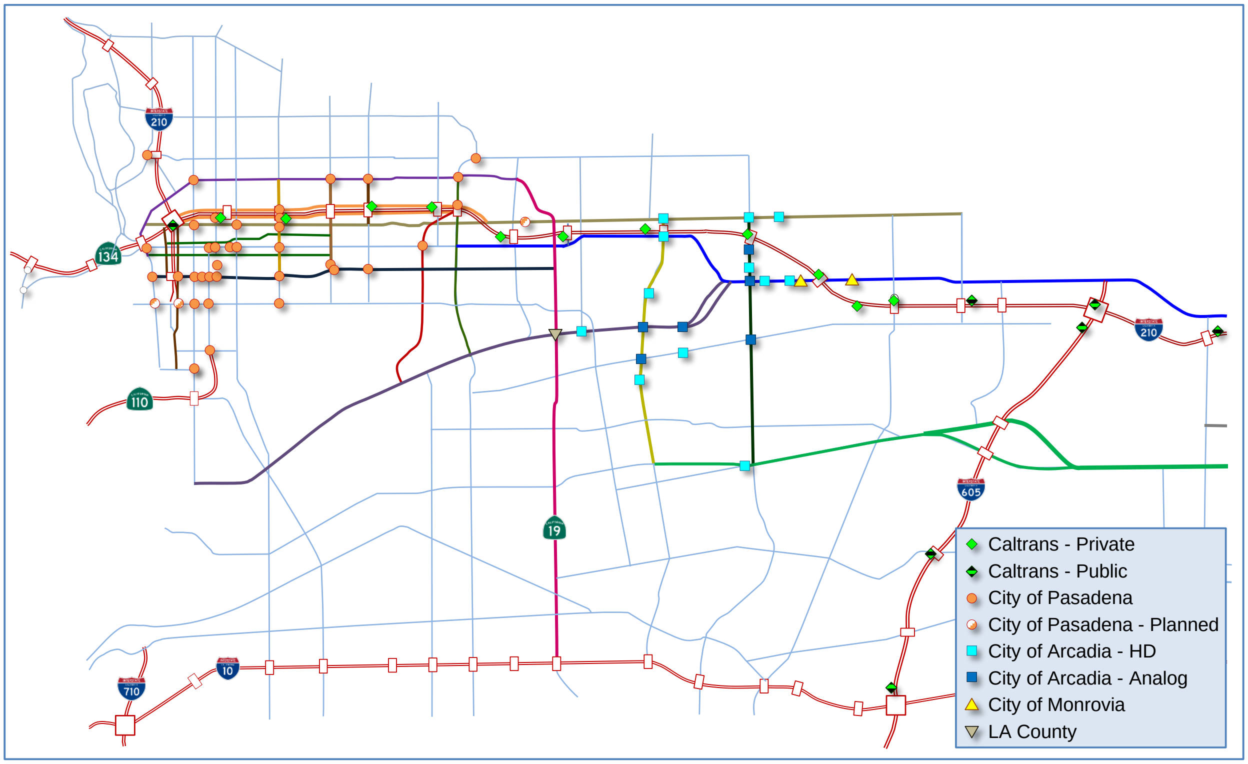

Figure 38 – CCTV Cameras Operated by the Local Jurisdictions West of I-605

Figure 39 – CCTV Cameras at Colorado/Los Robles Intersection in Pasadena

6.2.6. PERFORMANCE MEASUREMENT SYSTEM (PEMS)

The Freeway Performance Measurement System (PeMS) is a web-based tool that was developed by Caltrans and the University of California, Berkeley to retrieve, process, analyze and store data collected by traffic monitoring systems. A screenshot is shown in Figure 40. In operation since 1999, the system currently allows users to retrieve and analyze data from the following sources:

- Traffic detectors operated by Caltrans on freeway mainlines and ramps
- Caltrans' Lane Closure System
- Incident reports logged by the California Highway Patrol (CHP)
- Accident records contained in the Traffic Accident Surveillance and Analysis System (TASAS)

Figure 40 – PeMS Information System

In addition to providing access to real-time traffic sensor data, PeMS provides access to over ten years of historical data. The data analysis tools within PeMS further allow users to perform a wide range of investigations related to freeway operations. Among other things, the system may be used to retrieve information about the quality of data collected from traffic detectors; compile performance measures such as vehicle-miles traveled or delays for specific roadway segments, geographical areas, or periods; or develop regional aggregated traffic performance trends.

6.3. FREEWAY RAMP METERING SYSTEM

Ramp metering uses traffic signals at freeway entrances and freeway-to-freeway connectors to regulate the volume of traffic entering a freeway, as well as the spacing between entering vehicles. From an operational standpoint, ramp-metering systems typically attempt to ensure that the total traffic entering a freeway segment remains below its capacity. A long operational history has demonstrated that ramp metering has the potential to prevent freeway congestion, or at least delay its onset and reduce its severity, by eliminating problems associated with the entry of large groups of vehicles at freeway on-ramps. The result is increased freeway throughput, increased operating speeds, reduced delays and improved overall operations. Ramp metering also initiates smoother and safer merging operations, which, in turn, improves safety by reducing rear-end and sideswipe collisions.

As shown in Figure 41, all on-ramps along the I-210 freeway from Pasadena to La Verne are currently equipped with ramp meters. This includes the freeway-to-freeway connectors bringing traffic from the I-605 and SR-57 freeways, where metering started in March 2008. The only non-metered interchange is the SR-134/I-210 interchange in Pasadena. As further illustrated, most on-ramps along nearby freeways are also metered. This includes ramps on the I-10 freeway running parallel to I-210, as well as along the sections of the I-605 and SR-57 freeways connecting I-10 to the I-210, with the exception of the freeway connectors at the I-10/I-605 and I-10/SR-57 interchanges.

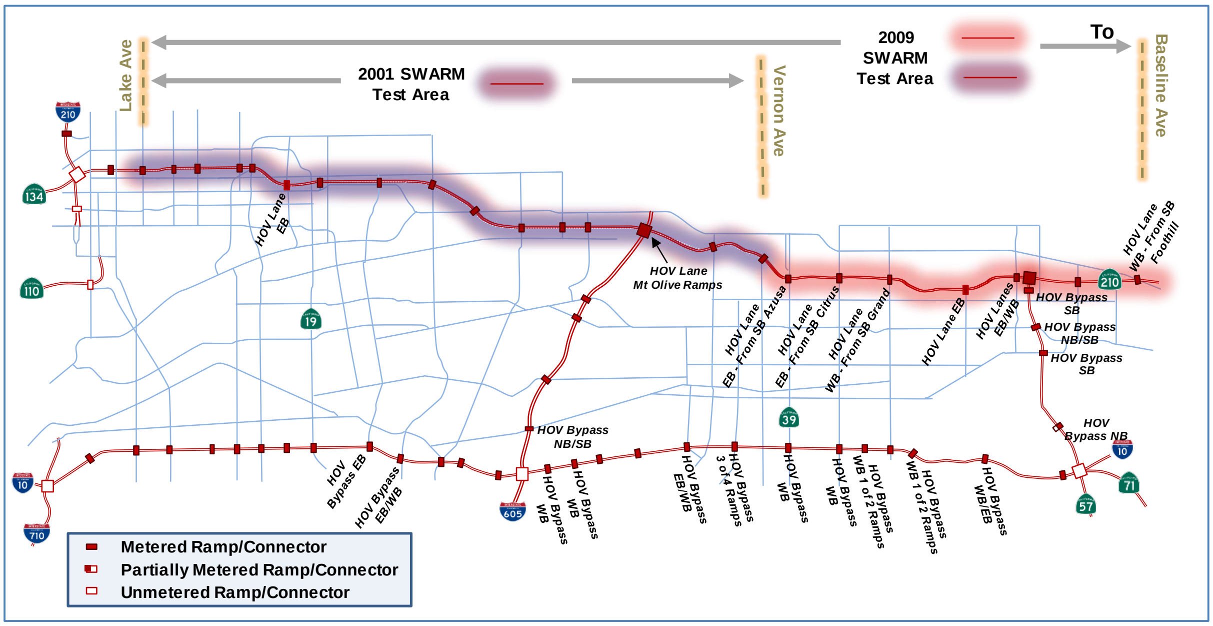

Figure 41 – Deployed Ramp Meters

Several ramps along I-210, particularly in the westbound direction, are equipped with metered HOV lanes. An example is shown in Figure 42. These lanes allow vehicles with two or more passengers to queue separately from the general traffic at the metering lights. Unlike other locations, such as along the I-605, SR-57, and I-10 freeways, these lanes do not allow the HOV vehicles to bypass the ramp meters completely. Most of the metered HOV lanes on ramps along I-210 freeway were previously HOV bypass lanes that were converted as HOV metered lanes in 2008 as part of the I-210 Congestion Relief Project.

Figure 42 – Examples of HOV Bypass and HOV Metered Lanes on Freeway Ramps

Three primary types of ramp metering are currently deployed within Caltrans District 7:

- **Fixed-Time / Time-of-Day (TOD)** – This is the simplest form of ramp metering. Its primary purpose is to break up platoons of vehicles entering the freeway. The ramp meters are simply turned on and off at specific times during the day and the rates with which vehicles are allow to pass adjusted based on a preset schedule. Operational parameters are typically developed to reflect historical average traffic conditions. There is no adjustment to actual traffic conditions.
- **Local Mainline Responsive (LMR)** – This strategy sets the metering rate on each ramp proportional to traffic conditions reported by the mainline freeway detectors placed immediately upstream of the ramp. When the traffic volume or loop occupancy is above the preset thresholds, traffic on each on-ramp is metered according to a predetermined table indicating which metering rate (typically out of a set of 16 rates) to apply based on the prevailing mainline traffic conditions. If the volume and occupancy drop below the defined thresholds, the ramp meter controller is then provided with the authority to override the preset metering rates to allow more vehicles on the freeway, up to the point of turning the ramp meters to a constant green light.
- **System-Wide Adaptive Ramp Meter (SWARM)** – Strategy seeking to optimize traffic flow on the freeway by responding to actual and forecasted traffic conditions. This strategy is actually comprised of three separate algorithms: SWARM-1, SWARM-2a and SWARM 2b. The SWARM-1 algorithm is based on the principles illustrated in Figure 43. At the start of each control interval, recent traffic flow information is used to identify the location of bottlenecks along the freeway and to forecasts traffic density at the bottlenecks over the next 7 to 10 minutes. Metering rates at individual ramps between each pair of bottlenecks are then set to try to maintain the flow density at the downstream bottleneck below a given threshold. Calculations also take into account congestion that may propagate from downstream freeway sections where metering constraints may still allow more vehicle to enter the freeway than desired. The SWARM-2a and 2b algorithms focus instead on traffic conditions around each on-ramp. SWARM-2a determines the metering rate at each ramp needed to attain an ideal headway between vehicles that would maximize flow rate, while SWARM-2b tries to maintain a level of service D or better as long as possible by considering the number of vehicles that can be stored between two successive mainline detection stations. At the end of the calculations, the more restrictive metering rate from the three algorithms is applied, subject to minimum and maximum metering constraints.

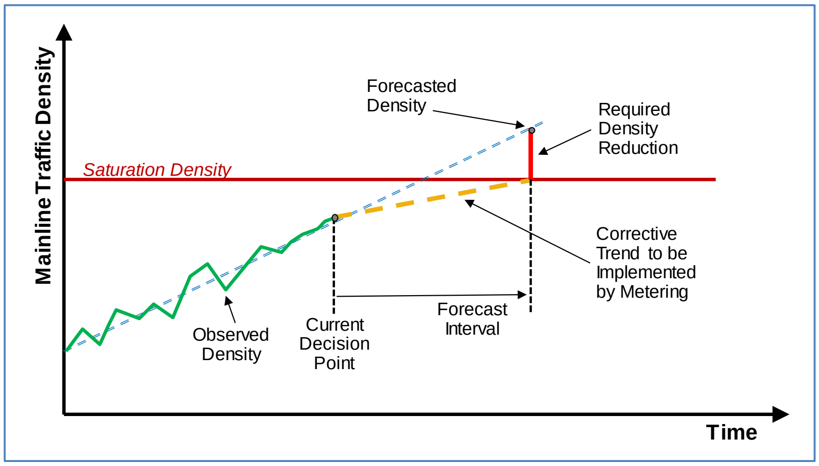

Figure 43 – SWARM Control Objective

Ramp meters along I-210 currently use the Local Mainline Responsive (LMR) algorithm. Fixed-time or simple Time-of-Day control is not normally used due to its insensitivity to traffic conditions. These approaches are only used when mainline detectors are down or during construction. While SWARM has been implemented along the corridor and field-tested twice, first in 2001 and again in 2008/2009, it is not currently used. While both tests have indicated that SWARM could effectively manage traffic, the obtained benefits were deemed not sufficient to justify replacing the existing LMR strategy.

On ramps where a single car is allowed to pass per green signal, the ramp meters can be programmed to allow between 180 and 900 vehicles/hour/lane. Where two or three vehicles are allowed per green signal (platoon metering), between 600 and 1320 vehicles/hour/lane can be allowed to enter the freeway mainline. On ramps equipped with queue detectors at the entrance, the ramp meter is further normally programmed to automatically increase the metering rate to the maximum rate possible (900 or 1320 vehicles/hour/lane) when stopped vehicles are present over the queue detector in order to prevent the ramp queues from spilling onto the nearby streets.

6.4. ARTERIAL TRAFFIC MANAGEMENT SYSTEMS

Figure 44 maps the location and operational ownership of the signalized intersections along key arterials within the I-210 corridor. Few stop-controlled intersections are also mapped to help assess constraints to traffic management options. The map indicates a relatively high density of signalized intersections (10 to 12 signals per mile) around downtown Pasadena at the western end of the corridor, medium densities on arterials running east of Pasadena and west of the I-605 freeway, and the lowest densities on arterial running east of the I-605 freeway. Throughout the corridor, local clusters of signalized intersections are further found near the historical downtown of various cities or significant commercial areas.

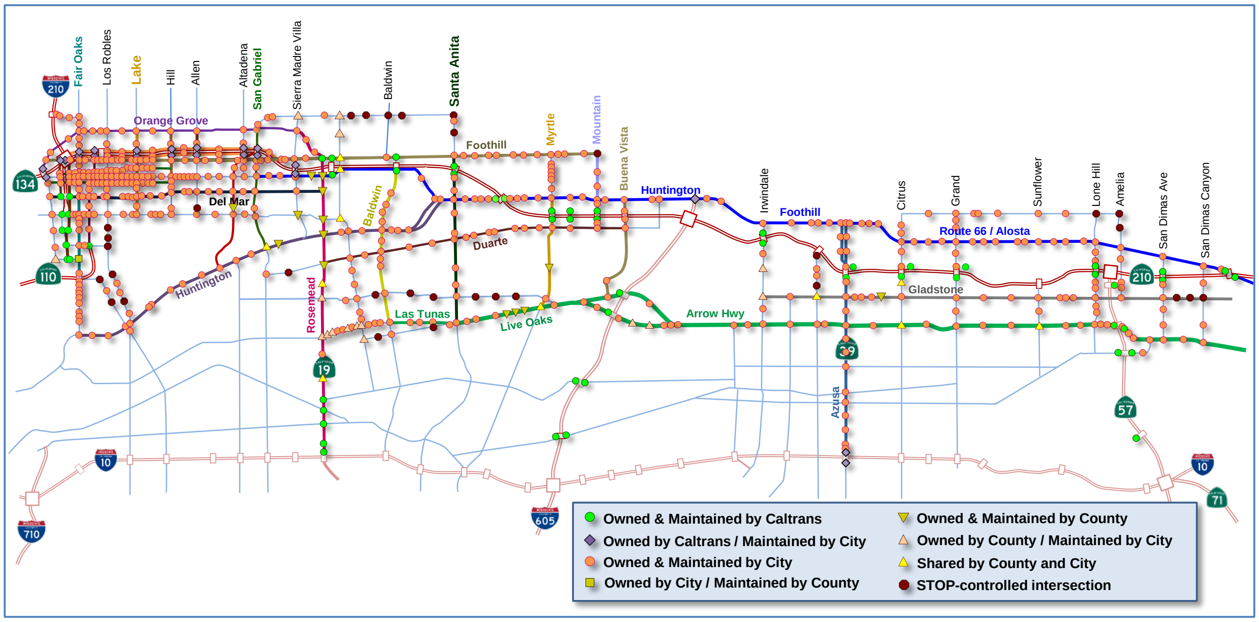

Figure 44 – Intersection Control along Key Arterials

To understand fully the operational context of the I-210, it is not sufficient to know simply where traffic signals are located. It is equally important to understand how these signals are operated and what the capabilities are. To answer these questions, the following aspects of traffic signal control are discussed in more details in the subsections that follow:

- Types of traffic signal control
- Signal synchronization groups
- Types of signal control equipment used
- Traffic detection support
- Centralized control capabilities

6.4.1. TYPE OF TRAFFIC SIGNAL CONTROL

Depending on the location, time of day and operating agency, individual traffic signals within the I-210 corridor may be operated according to one or more of the following modes:

- **Fixed-time or pre-time control** – Mode of operation in which the signals cycle through the green, yellow and red indications following a predetermined sequence, without adjustment of the duration of each signal indication to the actual traffic demand in each cycle. Average historical traffic conditions are typically used to determine each signal duration.

- **Fully actuated control** – Control using vehicle detections to trigger the display or determine the duration of specific phases. In this case, all approaches to an intersection are typically equipped with traffic detectors, either at the stop line, at some distance upstream from the stop line to provide detection 3 to 5 seconds before arrival, or at both the stop line and upstream location. The green signal is passed from one movement to next based on received detection calls, subject to maximum green constraints. Since phases without demand can be skipped, the phase sequence and phase duration can be entirely determined by the traffic demand.

- **Semi-actuated control** – Type of actuated control using vehicle detection only for the minor movements. In typical setups, detectors may only be installed on the minor cross street and left-turn bays along the major street. The green signal is then programmed to dwell on the main traffic movement and is only transferred to a minor movement after a call for service is received. This again results in an operation in which the cycle length is variable.

- **Coordinated-actuated control** - Variation of semi-actuated control in which a fixed cycle and a coordination reference point (offset) is imposed on the signal operation to promote synchronized operation with adjacent intersections. Similar to semi-actuated control, the duration of phases serving minor traffic movements is based on detection calls received. However, any unused green within the allotted time to minor phases is in this case transferred to the main phase.

- **Traffic-responsive control** – Mode of operation in which the fixed-time plans to implement within a control period is determined based on traffic flow data collected from traffic detectors. Plan selection may be based on measured traffic volumes, observed traffic speeds, the directional distribution of traffic, time of day, special detection, and/or other inputs.

- **Traffic adaptive / real-time control** – Mode of operation within which the signal timing parameters are adjusted every cycle or every few minutes to match the observed traffic demand. Predefined timing plans are not necessarily used. The signal timings continuously evolve with observed changes in traffic conditions.

Along the corridor, coordinated-actuated is the dominant mode of operation during peak periods. Most of the intersections along major arterials are equipped with detectors allowing the signal controllers to adjust the duration of each phase to the actual traffic demand. During periods of low demand, the signals typically cycle through a set of phases without any defined cycle length. However, to enable synchronized operations with other signals, a specific cycle and offset is typically imposed at key intersections during peak periods. Only a few intersections may still operate in a fully actuated mode during this period.

Adaptive systems are currently used, or planned to be used, at a very small number of intersections along the corridor. Systems currently in operation or under development include:

- **Fair Oaks SCATS Corridor** – A SCAT real-time control system has recently been implemented by the City of Pasadena along a 12-intersection segment along Fair Oaks Avenue between the I-210 and SR-110 freeways. This system has been implemented to resolve traffic problems created by frequent signal preemption along the Metro Gold Line and to better handle the frequent surges of traffic that occur along this arterial. It uses stop line detectors to monitor how each green signal is used and to determine which of the predefined control plan contained in a library should be used to manage traffic along the arterial, as well as what local, temporary modifications could be made to the selected plan at each intersection to improve local operations.
- **Pasadena Light-Rail At-Grade Crossing System** – Several intersections along LA Metro's Gold light-rail line have been equipped with a treatment implementing a flashing yellow to allow to reduce the amount of preemption needed to clear roadways prior to the passage of a train.
- **Arcadia Adaptive Signal Control System** – The City of Arcadia is currently working with KLD Associated to implement an adaptive traffic signal control system along some of the city arterials. This system will enable the signal timing parameters at intersections controlled by the system to be updated as quickly every 30 minutes based on detected traffic conditions.

6.4.2. MULTI-INTERSECTION SIGNAL SYNCHRONIZATION

To facilitate smooth progression across successive intersections, groups of signals along arterials often have their operation synchronized. This practice typically results in the imposition of a common cycle length to all intersections in the group, and in the establishment of fixed time points, or offsets, at which a reference phase must start at each intersection.

Figure 45 maps the arterial segments that have been synchronized through LA County's Traffic Signal Synchronization Program since 1988 or for which synchronization is currently being planned. The map indicates several key arterials within the I-210 corridor that have already had their signals synchronized. In addition to the development of new signal timings, these projects have also installed new traffic detectors and upgraded traffic signal controllers where existing instrumentation was deemed insufficient.

Not shown in Figure 45 are arterial segments that may have been coordinated by individual agencies within their jurisdiction. Information obtained from the City of Pasadena indicates, for instance, that 34 signal coordination groups are currently defined within the city. While some of these groups correspond to segments that were coordinated through the LA County programs, several others correspond to segments not shown in Figure 45. Several coordination groups also exist within the City of Arcadia, notably along Baldwin Avenue, Santa Anita Avenue, and Duarte Road.

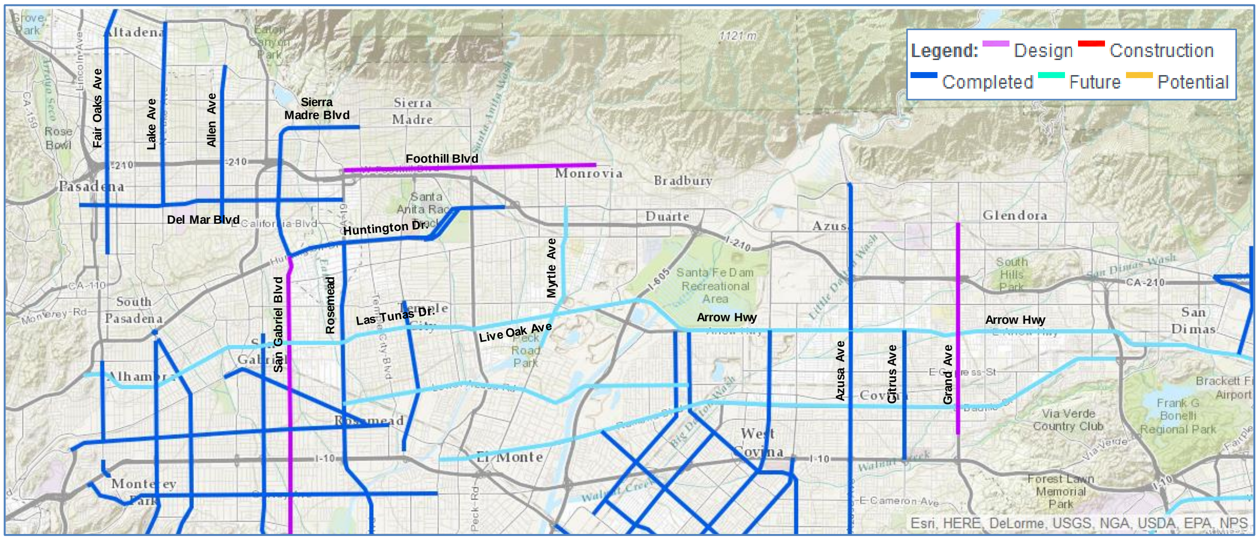

Figure 45 – Completed and Planned Traffic Signal Synchronization Projects from LA County

While efforts have been devoted to coordinate traffic signals along key arterials, significant breaks in synchronization still exist, particularly around Caltrans-operated intersections. Except for the intersections along Maple Street, Corson Street and a few other locations within Pasadena for which control has been passed to the city, Caltrans typically operates its signals independently from nearby city-controlled signals. Since most of these are operated in a vehicle-actuated mode throughout the day, they may not always operate with the same cycle as nearby signals. However, while no formal synchronization may exist, some indirect synchronization may still result from the implementation of signal timings designed to accommodate the cyclic traffic patterns that are normally produced by the nearby signals.

6.4.3. SIGNAL CONTROLLERS

Figure 46 indicates that the dominant type of signal controllers used in the western half of the I-210 corridor is the Type 170. More advanced Type 2070 controllers are currently mostly found along Colorado Boulevard and Del Mar Boulevard in Pasadena, as well as various other isolated locations, typically where complex traffic patterns or control problems resulted in poor operation of Type 170 controllers.

While two types of controllers equip the vast majority of intersections, there is significantly more variation in the firmware used to operate the devices, as evidenced by the data of Table 3. Among these, the LACO firmware developed by the Los Angeles County Department of Public Works is the most common. This firmware equips controllers operated by Los Angeles County and the cities of Arcadia, Duarte, Monrovia and several other cities within the county. Proprietary software is also used by Caltrans to operate the intersections under its direct control. On the other hand, the City of Pasadena generally relies on firmware provided by commercial vendors. Use of commercial firmware has also recently been favored by the City of Arcadia, which has started to replace some of its LACO-operated 170 controllers with 2070 controllers running on firmware provided by two vendors.

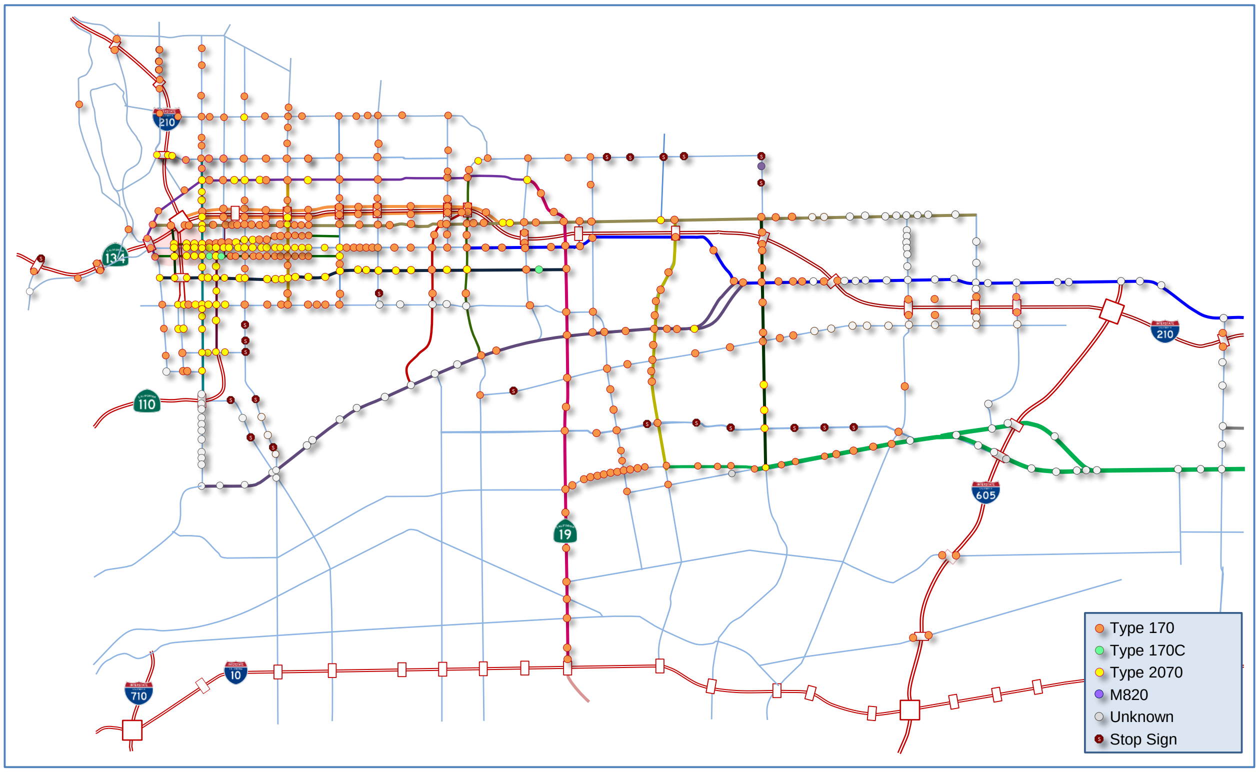

Figure 46 – Signal Controller Types in Use in Western Section of Corridor

Table 3 – Signal Controller Firmware in Use in Western Section of Corridor

Developer	Controller Type	Firmware	Versions	Users
Los Angeles County Department of Public Works	170	LACO	LACO-4 LACO-4E LACO-1R LACO-1H LACO-1HC	Los Angeles County, Arcadia, Monrovia, Duarte
Caltrans	170	C7 Program		Caltrans
	170	C8 Program	Version 3 (C8V3) Version 4 (C8V4)	Caltrans
	2070	TSCP	2.12	Caltrans
McCain	170	Program 222P		Pasadena
	170	Program 233		Pasadena
	2070	Program 2033		Pasadena
	2070	Omni-eX	--	Arcadia
Fourth Dimension Traffic	2070	D4	--	Arcadia
Road and Traffic Authority of New South Wales, Australia	2070	SCATS	--	Pasadena

6.4.4. TRAFFIC DETECTION SUPPORT

To support vehicle-actuated functionalities, most signalized intersections have traffic detectors installed on some or all of their approaches. Signal operation may be support by one or two of the following types of detectors:

- **Stop line detectors** – Detectors used to sense the presence of vehicles near the intersection stop line. Use of these detectors depends on their operational setting. When set in the "presence" mode, these detectors are used to place calls to the signal controller for the display of a specific green phase whenever a vehicle is in the zone of detectors. When set in "passage" or "gap" time, they are used to monitor the interval between successive vehicles and to determine when to terminate an active green phase.
- **Advanced passage detectors** – Detectors located some distance upstream from the stop line to sense vehicles approaching an intersection. These detectors are typically placed at a distance of three to five seconds behind the stop line and are used to place calls for green signal extension each time a new vehicle is sensed to pass through the detection zone.

Figure 33 in Section 6.2.2 illustrated several examples of detector placements. As indicated, the most frequent combination within the I-210 corridor is the one in which intersection approaches are equipped with advanced detectors on all approach lanes and stop line detectors on exclusive left turn and right-turn lanes.

6.4.5. CENTRALIZED CONTROL AND MONITORING CAPABILITIES

Table 4 inventories the traffic management systems currently used by individual jurisdictions to control the traffic signals under their jurisdiction. Figure 47 further indicates for the western half of the corridor the system that each intersection uses. The following key observations can be made from the data:

- A variety of commercial traffic control systems are used to support traffic signal operations. Systems in operation currently include systems developed by Kimley-Horn (KITS), TransCore (TransSuite), McCain (QuicNet), Siemens (i2), Econolite (Centrac), and the Road and Traffic Authority of New South Wales in Australia (SCATS).
- Most of the systems currently in operation provide agencies with second-by-second signal status information and enable them to alter signal operations from a remote workstation.
- Not all systems are currently set up to forward traffic detection data to the associated traffic management center. Systems currently archiving traffic flow data include the TransSuite system used by Arcadia (data provided in real-time at 5-minute intervals), the i2 system used by Pasadena (flow data downloaded once a day) and Pasadena's SCAT system (real-time flow data processing).
- The most commonly used control system within the I-210 corridor is KITS. This system was procured by LA County from Kimley-Horn in 2004 to operate signals in unincorporated county areas. Since then, signals within the cities of Temple City, San Gabriel, El Monte, Baldwin Park, and Covina have also been connected to the County KITS, while San Dimas has procured its own version of the system. It is anticipated that 10 signals within Monrovia and 5 within Duarte, mainly along Huntington Drive, will be connected by the end of January 2015. Future deployment is also being planned for signals within San Marino.

- In cities using KITS, the county system is typically only used as a host. While the signals are physically connected to the system installed in LA County's Traffic Management Center in Alhambra, each city remains in charge of managing the signals within its jurisdiction. An exception is for the city of Temple City, where LA County has been tasked by agreement to manage and to operate the signals on behalf of each city. In these cases, the cities only retained the right to determine how their signals should be operated.
- While individual cities typically rely on a single traffic signal control system, Pasadena has relied for many years on four systems. Of the city's 341 signalized intersections, 215 have been supervised by a Siemens i2 system. This is a legacy system that the city is considering upgrading or replacing. A McCain QuicNet/Pro system supervises an additional 62 intersections, mostly at intersections near at-grade crossings along the Metro Gold Line light-rail and at intersections along planned bus rapid transit routes. Deployment of this system at these locations is based on its abilities to provide priority to light rail vehicles and buses while attempting to sustain signal coordination along the crossing arterials. A Transcore Series 2000 system further controlled 35 intersections for which operation is shared with Caltrans or Los Angeles County. However, control of these intersections was to be migrated to the i2 system by December 2014. Finally, a SCAT real-time traffic signal system has recently been implemented at 12 intersections along Fair Oaks Avenue to address complex signal coordination and light-rail priority issues along that arterial.

Table 4 – Traffic Signal Control Systems

Jurisdiction	Kimley-Horn KITS	Siemens i2tms	McCain QuickNet Pro	Econolie Centracs	TransCore Series 2000	TransCore TransSuite	SCATS
Caltrans						●	
LA County	●						
Pasadena		●	●		●		●
Arcadia						●	
Monrovia	Planned [1]						
Duarte	Planned [1]						
Irwindale						●	
Azusa	*System to be selected in the future*						
Glendora				●			
San Dimas	●						
La Verne				●			
Alhambra						●	
San Marino	Planned [1]						
San Gabriel	● [1]						
Temple City	● [2]						
El Monte	● [1]						
Baldwin Park	● [1]						
Covina	● [1]						
West Covina						●	

[1] Signal operations to be hosted by KITS at the Los Angeles County Traffic Management Center, but management of signal timing plans to remain under local jurisdiction control

[2] Signals maintained and operated by the Los Angeles County Department of Public Works, with the city retaining control over signal operation

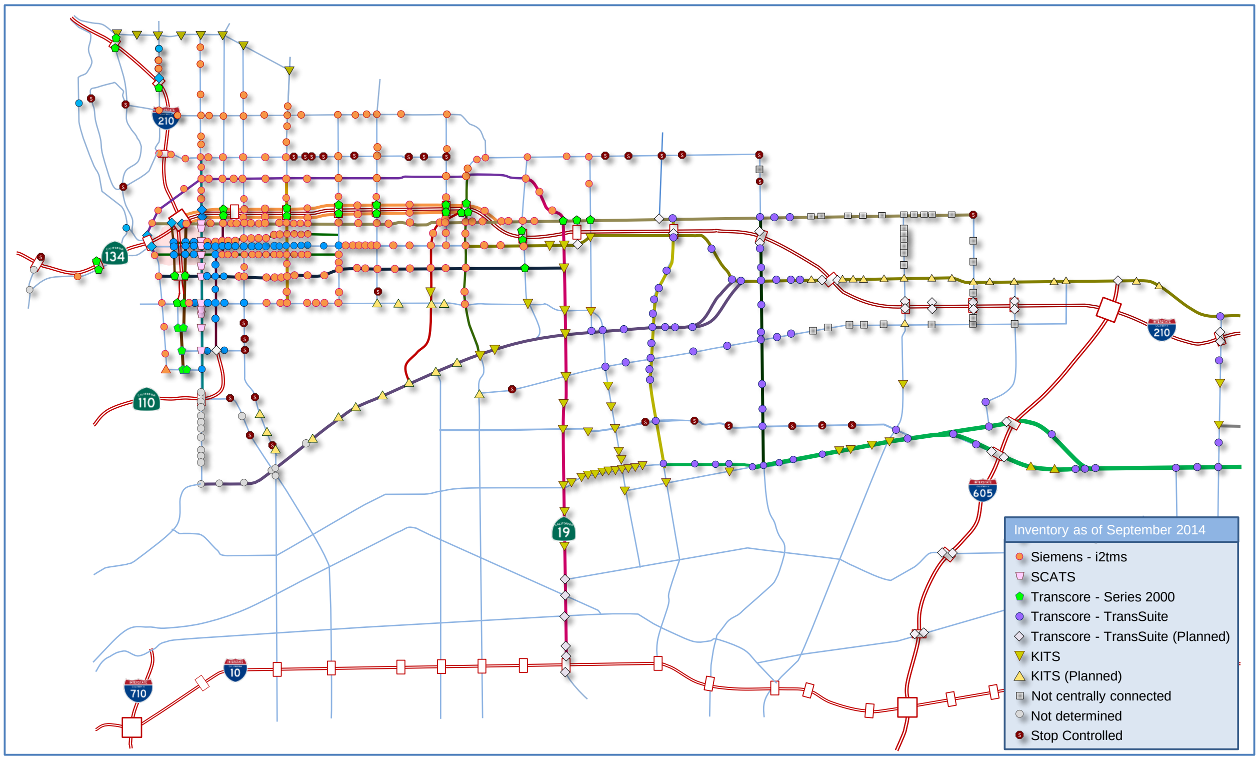

Figure 47 – Traffic Control System Deployments

- While Caltrans does not currently operate a centralized traffic signal control system, the agency has recently procured a TransSuite system from TransCore for the monitoring and management of at all traffic signals operated by the agency within California. While the system is currently operational at the LARTMC, it is still unknown when all Caltrans-operated intersections within the I-210 corridor will be connected to the centralized system.
- After installing a TransSuite system, Arcadia is currently working with KLD Associates to develop an add-on capability that will enable the TransSuite system to adapt signal responses to actual traffic flows.

6.5. INCIDENT/EVENT MANAGEMENT SYSTEMS

Assets used to assist with the management of incidents and events within the I-210 corridor include:

- Caltrans Planned Lane Closures System
- California Highway Patrol Computer-Aided Dispatch (CAD) system
- Caltrans District 7 Event Management System
- Freeway Service Patrol
- Caltrans Transportation Management Team

6.5.1. CALTRANS PLANNED LANE CLOSURE SYSTEM

Caltrans' Lane Closure System (LCS) allows Caltrans traffic managers to track lane, ramp, and road closures due to incidents, construction, and maintenance. This statewide system tracks active closures as well as.

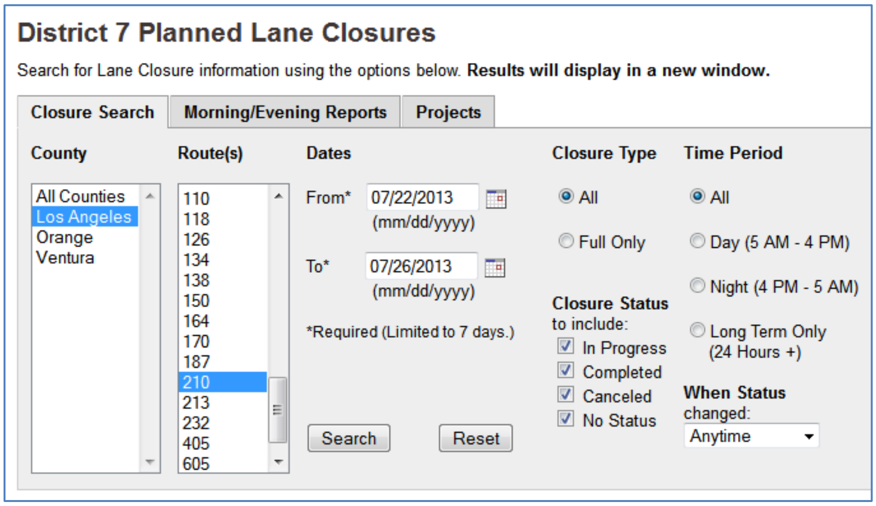

Figure 48 – Caltrans Planned Lane Closure System

all planned closures for the next seven days from any given day. District TMCs can utilize this information to monitor both their own closures as well as those planned on highways in adjacent districts, as well as to coordinate closures with neighboring districts

6.5.2. CALIFORNIA HIGHWAY PATROL (CHP) COMPUTER-AIDED DISPATCH SYSTEM

CHP's Computer-Aided Dispatch (CAD) system is a secure system used by the CHP to support dispatch and response functions. It links all dispatcher workstations, provides reliable and accurate incident information, and both standardizes operational procedures and decreases incident response times by eliminating previously used manual processes. Although not a Caltrans system nor originally intended for Caltrans use, this system has become one of the primary methods for disseminating incident information within TMCs as it is often the point of first notification for an incident and because it provides regular updates as a situation progresses.

6.5.3. CALTRANS AUTOMATED INCIDENT DETECTION SYSTEM

In addition to accessing the CHP CAD system, Caltrans District 7 uses the All-Purpose Incident Detection (APID) algorithm to assist with the detection of incidents. This algorithm scans flow, speed and loop occupancy data collected from individual traffic detection stations to assess whether sudden changes in traffic conditions have occurred over time or whether unusual data patterns exist across successive stations. Alert messages are sent to TMC operators following the detection of unusual data patterns. Following the reception of an alert message, TMC operators are then responsible for assessing whether the observed changes in traffic conditions or unusual data patterns are due to the presence of an incident.

6.5.4. CALTRANS DISTRICT 7 EVENT MANAGEMENT SYSTEM

Another important element of the LARTMC is an event management system designed to provide operators with responses to incidents, emergency closures, and major scheduled events. This system, which was developed by Delcan, develops a standardized response plan for each incident by relying on information characterizing an incident, such as location, time, type, and number of vehicles involved, as well as rules formulated by experts in freeway management. Response plan elements include items such as which changeable message sign and highway advisory radios to use, which messages to post, whether operators should request a Sig Alert (incident notification) to be generated, who should be contacted regarding the incident, etc.

6.5.5. FREEWAY SERVICE PATROL (FSP)

Within Los Angeles County, the Freeway Service Patrol (FSP) is a joint program provided by the California Department of Transportation (Caltrans), the California Highway Patrol (CHP) and LA Metro. It consists of privately owned tow trucks that patrol designated routes on congested urban California freeways and offer free help to stranded motorists. FSP services include changing flat tires, jump-starting dead batteries, refilling radiators and temporarily repairing leaking hoses, or providing a gallon of fuel. If the FSP cannot get a stranded car running within ten minutes, it will tow the vehicle to a safe location off the freeway. The FSP also assists emergency responders in clearing traffic accidents. The goal of the FSP is to maximize the effectiveness of the freeway transportation system by promptly removing disabled/stranded vehicles from the freeway.

Typically, the FSP operates Monday through Friday during peak commute hours, and all day in pre-designated freeway construction zones. In heavily congested freeway corridors, it is also becoming more commonplace for the FSP to operate during the midday and on weekends/holidays in addition to the weekday peak-period service.

Services are provided to motorists at no cost. State and local public funds allocations support the program. State funding is apportioned to each FSP program through a formula considering population, miles of freeway in the region, and congestion measurements. Local transportation agencies typically match the state funding allocation with a minimum of 25 percent of local funds.

6.5.6. TRANSPORTATION MANAGEMENT TEAMS (TMT)

Transportation Management Teams is a team of Caltrans employees that can be dispatched from the LARTMC at any time, day or night, to assist the CHP with emergency lane closures and freeway closures following an accident or emergency incidents such as spilled cargo or natural disasters that may obstruct the roadways. The TMT assists with by monitoring freeway back-ups, performing traffic analyses, providing detour recommendations, helping with the cleanup of incident scenes. The team also communicates vital information to the LARTMC and may use portable changeable signs to provide recommend detour information to motorists or inform them of expected delays.

6.6. TRANSIT MANAGEMENT SYSTEMS

This section provides a summary of the transit management systems currently deployed within the I-210 corridor. These systems include:

- Automated vehicle location (AVL) systems
- Automated passenger counting (APC) systems
- Transit signal priority (TSP) systems

6.6.1. AUTOMATED VEHICLE LOCATION (AVL) SYSTEMS

Several transit agencies within the I-210 corridor have deployed systems enabling them to track in real-time or near real-time the location of individual transit vehicles. These systems are generally used by operators to aid dispatchers with identifying the location of vehicles, tracking route adherence, assessing performance, and facilitating the resolution of incidents. These systems are also increasingly being used to support the provision of real-time next arrival information to transit riders.

The following is a brief description of the AVL systems in operation within the corridor:

- **LA Metro Buses and Trains** – All buses and light-rail trains operated by LA Metro are equipped with a system allowing transit operators to track their position. This is a time-point based system. The position of each vehicle is not tracked centrally on a second-by-second basis but rather at periodic intervals. While a GPS link is used by the onboard equipment to track the position of a vehicle, the transit management center only obtains vehicle location data when the system communicates witch a vehicle via a radio link, typically once every 3 to 5 minutes.
- **Foothill Transit Buses** – As part of its SMARTBus System deployment in 2007, Foothill Transit equipped all its buses with a GPS-based vehicle location system. This system is similar to the one used by LA Metro. While onboard equipment continuously tracks the location of each vehicle through a GPS link, the vehicle location is only forwarded to the transit management center when the AVL system establishes radio communication with the vehicle to retrieve the location data. The agency is currently seeking to replace this system with a newer system leveraging recent technological advances to provide added functionalities.
- **Pasadena ARTS Buses** – As part of its proposed Transit Vehicle Arrival Information System, Pasadena ARTS is currently planning the deployment of an AVL system for its entire fleet of buses. There is no specific information on when this system would become operational.

Other agencies can access the vehicle location data generated by LA Metro's and Foothill Transit's AVL systems through dedicated XML data feeds on the RIITS network. Access to this data is only available to public agencies involved in transportation and is subject to approval by the RIITS Administrator.

6.6.2. AUTOMATED PASSENGER COUNTING (APC) SYSTEMS

All LA Metro and Foothill Transit buses currently have automated passenger counting (APC) devices installed onboard the vehicles. These devices allow each agency to track the number of passengers boarding and alighting at each stop. This information is typically used to estimate ridership, assess route segment utilization, assess the level of utilization of individual service stops, etc. Sensing is typically done using infrared detectors mounted above a vehicle's doors. Whether passengers are boarding or alighting is determined by using detectors capable of determining direction of movement.

The following is a brief description of the APC systems in operation within the corridor:

- **LA Metro Buses** – All buses operated by LA Metro have automated passenger-counting devices installed onboard. Similar devices are not installed on light-rail train cars, mainly due to the difficulty of accurately counting the number of persons passing through the train's wide doors. Similar to the vehicle's location, information about the number of passengers present onboard a vehicle is not continuously sent back to the transit management center. Data is typically retrieved from the onboard system when a vehicle returns to its garage.

- **Foothill Transit Buses** – Foothill Transit buses typically have automated passenger-counting devices installed onboard each vehicle. The system used for counting passengers is similar to the one used by LA Metro.
- **Pasadena ARTS Buses** – Pasadena ARTS buses are not currently equipped with automated passenger counters. Buses are only equipped with manual counters that must be operated by the bus driver. These counters are used to track the number of persons boarding the bus, by passenger type and fare type.

Unlike vehicle location data, passenger count data collected by individual transit agencies is typically not sent to systems outside the agency such as RIITS.

6.6.3. TRANSIT SIGNAL PRIORITY (TSP) SYSTEMS

In 1998, Metro initiated the Countywide Bus Signal Priority Pilot Project as part of an effort to design, develop, implement, and evaluate a multi-jurisdictional bus priority system for Los Angeles County. This effort brought together multiple jurisdictions and transit operators and led to the development of a wireless signal priority standard for the county. This standard enables buses approaching an intersection to obtain a green extension or early green recall of 8 to 10 seconds, as long as this change does not exceed 10% of the cycle length and no priority has been granted to another bus in the previous cycle. To minimize traffic disruptions, priority requests cannot also be granted to different buses on back-to-back cycles.

Upon the success of the initial pilot, which reduced bus travel times by 4% to 9% and average delays to red signals by 12% to 23%, Metro initiated the Countywide Metro Rapid Signal Priority Expansion Project in 2005. This project first resulted in the implementation of signal priority along four Metro Rapid corridors south of downtown Los Angeles. A second phase, initiated in 2008, added three more corridors by January 2013. One of these corridors, illustrated in red in Figure 49, covers a section of Fair Oaks Avenue in Pasadena served by Metro Rapid Route 762.

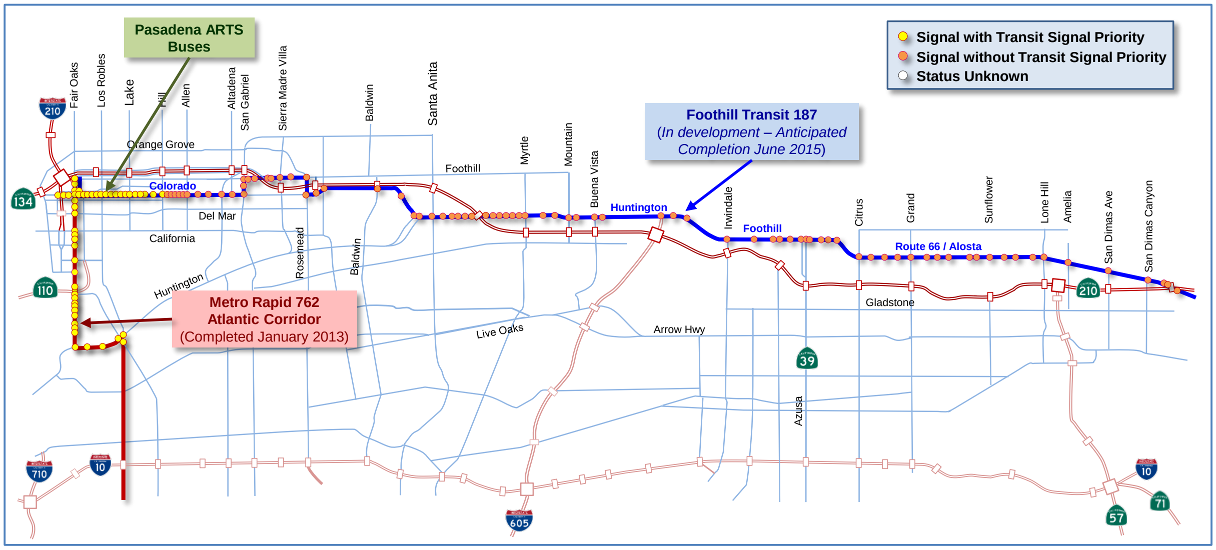

Figure 49 – Existing and Projected Transit Signal Priority Corridors

LA Metro is further collaborating with Foothill Transit to demonstrate signal priority capabilities along the Foothill Transit Route 187 using LA Metro's Countywide Signal Priority Standard. This route is illustrated in blue in Figure 49. As of December 2014, equipment for this corridor has already been procured and installed on buses, and city approval and permits were being sought for the installation of equipment on traffic signals. The anticipated completion data for this project was June 2015.

Other systems outside of the two corridors illustrated in Figure 49 may also become operational in the future. While the City of Pasadena has deployed in the past a priority system using the LADOT standards for the city-operated ARTS buses, this system is believed to be no longer in operation or supported. To replace this system, the deployment of a transit signal priority using Metro's Countywide Signal Priority standard has been actively considered. This new system would include new on-board equipment for the entire ARTS fleet, and signal priority equipment for 42 intersections. However, because of a lack of funding, design of this system is not currently scheduled to start before 2018.

6.7. PARKING MANAGEMENT SYSTEMS

This section provides a summary of the parking management systems currently deployed within the I-210 corridor. These systems include:

- Real-time parking occupancy tracking
- Guidance to parking facilities

6.7.1. REAL-TIME PARKING OCCUPANCY TRACKING

Park-and-ride operators within the I-210 corridor do not track the occupancy of the facilities they manage in real time. When required, occupancy data is obtained by sending agency staff to manually survey the number of parking stalls occupied at a given time within a given facility. While some agencies have investigated the potential procurement of systems to track parking occupancy, these efforts have not yet resulted in significant system deployments.

A somewhat different situation exists for general parking facilities operated by cities or private operators. Since most facilities charge a daily use fee, there is a need to assess facility occupancy. Occupancy is commonly determined by using systems counting the number of vehicles entering and exiting the facility. Detectors placed in front of and behind the entry and exit gates to control their operation are used to derive facility occupancy. At facilities without gates where users are required to pay for parking at a kiosk, occupancy can instead be determined by tracking the number of spaces with registered vehicles..

While occupancy may be tracked at some parking facilities for the benefit of the parking operator, the collected occupancy information is not typically made available to information service providers or the traveling public within the I-210 corridor. This may change in the near future if the City of Pasadena completes the planned deployment of a traveler information system to provide motorists with parking availability information within nine of the city-owned parking structures.

6.7.2. ROUTE GUIDANCE TO PARKING FACILITIES

Route guidance to parking facilities within the I-210 corridor primarily consists of static roadside signs installed at key locations to inform motorists which direction to travel to find parking. Aside from the static signs, travelers may also locate parking garages by looking at information on the web or by using specialized parking finder application, such as Park Me. Travelers unfamiliar with the road network may also use mobile navigation applications to obtain directions to a particular parking garage.

No system or application specifically directing travelers to parking facilities with open spaces currently exists within the corridor. Again, this situation will change if the City of Pasadena completes a planned implementation of a dynamic parking guidance system that has been considered for several years for the city's central district. As part of this deployment, informational signs would be installed at the entrance of nine city-owned off-street parking facilities to display the total number of parking stalls available within, and where relevant, on each floor. Additional signs installed at key decisions points throughout the downtown area would further provide occupancy information for several nearby facilities, thus enabling motorists to make an informed decision regarding parking.

6.8. TRAVELER INFORMATION SYSTEMS

Information systems currently in operation along the I-210 corridor include the following:

- Changeable message signs
- Highway advisory radios (HARs)
- NextTrip bus/train tracking information
- Go511 traveler information services
- Blue Commute personalized traveler information application

6.8.1. CHANGEABLE MESSAGE SIGNS (CMS)

Changeable message signs are used by Caltrans TMC operators to inform motorists about traffic advisories, delays, and emergency conditions. Some CMSs are also used to display estimated travel times to specific locations along the current freeway, as well as comparative travel times to a specific destination along the current freeway and an alternate freeway.

Figure 50 maps the location of Caltrans CMSs near the I-210 corridor. Only six signs are located along the study section of I-210. One eastbound sign and one westbound sign are located between the SR-134 and I-605 interchanges. Two westbound and one eastbound signs are located between the I-605 and SR-57 interchange. One westbound sign is located just downstream of the Foothill Boulevard interchange in La

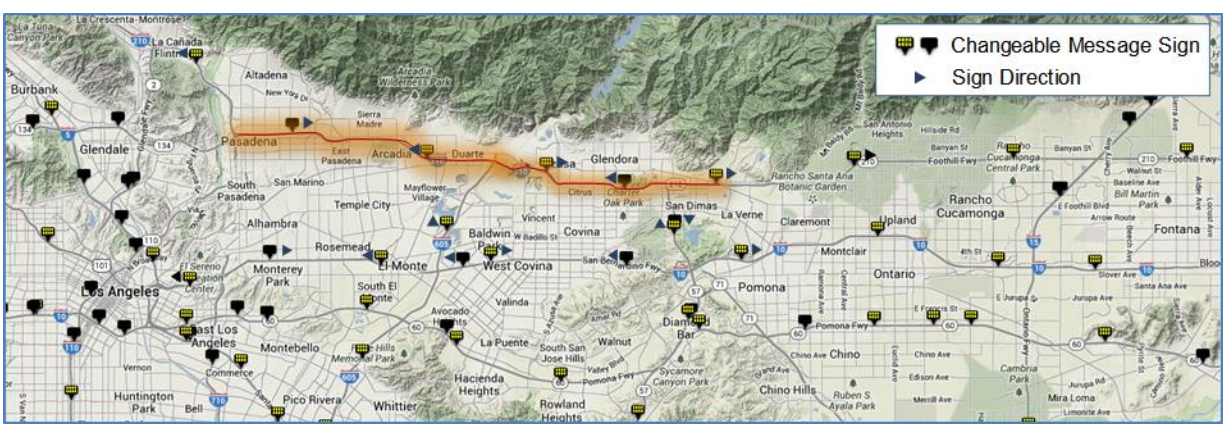

Figure 50 – Caltrans Changeable Message Signs

Verne. Outside the I-210 corridor, several CMSs can also be used to provide advanced information to motorists traveling towards the I-210 freeway, particularly along the I-605, SR-57, and I-10 freeways.

As shown in Figure 51, most of the CMSs used by Caltrans are capable of displaying up to three lines of text, with each containing up to 16 characters. There is also a possibility to display messages on alternating screens. However, this option is not always favored as it increases the time required to read the displayed message.

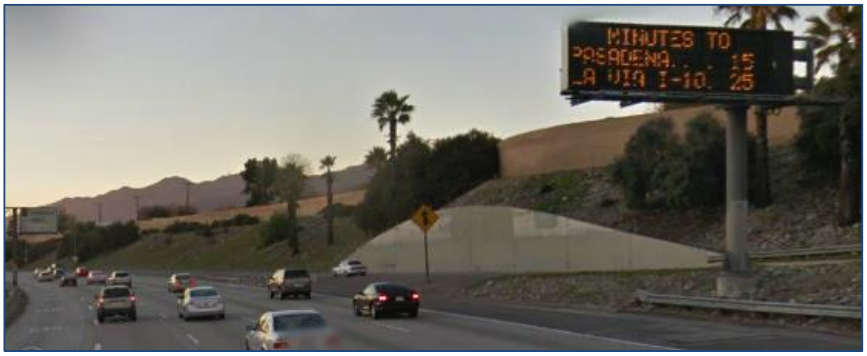

Figure 51 – Typical Freeway Changeable Message Sign

Within District 7, individual CMSs are controlled through the ATMS application installed at the Los Angeles Regional Traffic Management Center (LARTMC). This application allows the operator to use a map-based display to view which signs have been activated and what messages are currently being displayed. Additionally, automated CMS systems are utilized on various routes in both northern and southern California to provide estimated travel times to commuters.

In addition to the Caltrans CMSs, the City of Pasadena has deployed 11 fixed CMSs at key locations within its local street network. Figure 52 maps the location of the devices, while Figure 53 illustrates a typical installation. As of October 2014, only five of these existing CMSs were operational. The remaining six

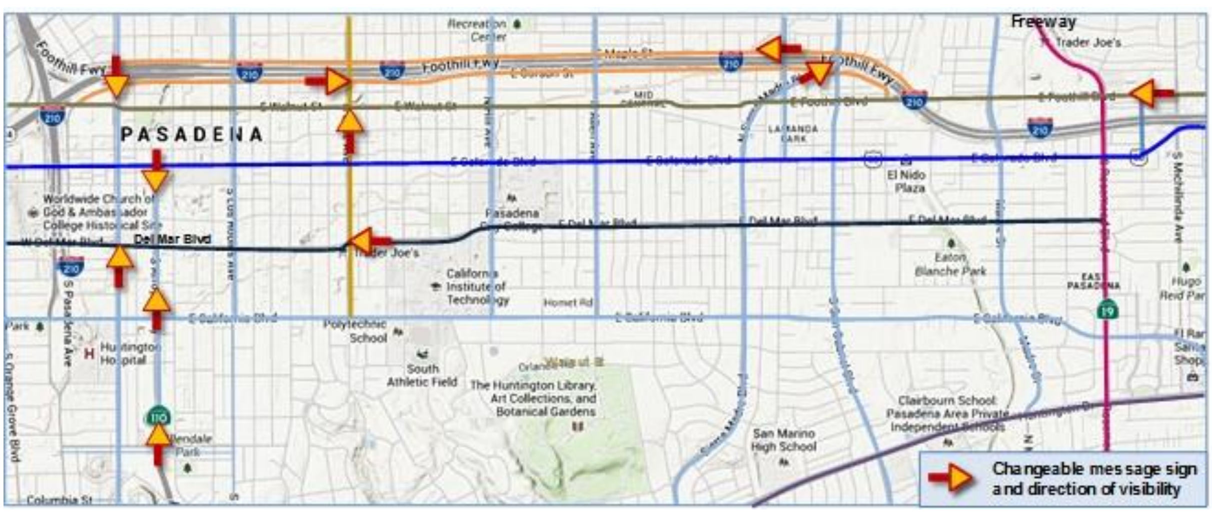

Figure 52 – Location of Changeable Message Signs Operated by the City of Pasadena

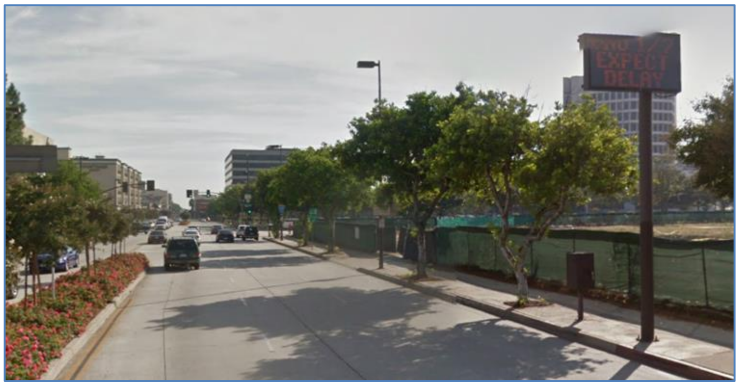

Figure 53 – Example of Changeable Message Signs Operated by the City of Pasadena

were legacy devices no longer operational and in need of replacement. Replacement of the non-operational devices was expected to occur in the near future. While the city-operated CMSs are smaller than those operated by Caltrans, these devices allow up to three lines of text to be displayed, with up to eight characters per line.

6.8.2. HIGHWAY ADVISORY RADIO (HAR)

Figure 54 maps the Highway Advisory Radio (HAR) transmitters operated by Caltrans within the Los Angeles County area in June 2013. These are low-powered AM radio stations capable of broadcasting pre-recorded traffic information bulletins in a range of 4 to 6 miles. The map shows 17 fixed-location HAR transmitters, and 2 portable transmitters being used to support construction activities along I-405. A single station is located along I-210, near the I-605 interchange. Other nearby station include two stations along I-10, one near the I-605 interchange and one east of the SR-57 interchange, as well as an additional station near the I-5/SR-2 interchange.

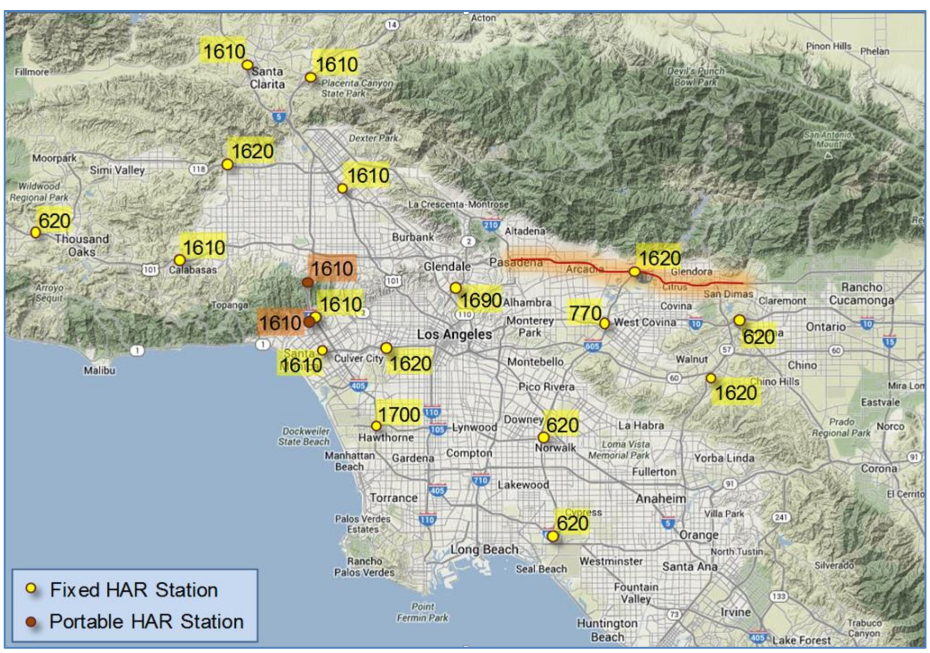

Figure 54 – Location and Broadcast Frequency of Highway Advisory Radios in Caltrans District 7

While HAR stations are frequently used in rural areas to inform motorists of traffic-related situations, they are rarely used within the metropolitan Los Angeles area. This is due to the many commercial radios within the area broadcasting traffic bulletins every few minutes, particularly during the morning and afternoon peak periods. Since traffic information is already being propagated on mediums accessible by a large proportion of travelers, Caltrans has found little value in using the existing HAR stations to broadcast messages that would not enable travelers to gain more information than what is currently available. In addition, there were some difficulties in determining whether recorded messages were being broadcast as planned, and whether the flashing lights installed on the roadside signs to inform travelers of a message being broadcast were operating correctly. Another detriment to using the HAR stations was the fact that the solar panels used to power the flashing lights were on occasion vandalized or stolen. This occurred for instance for the roadway signals along I-210 and I-605, thus preventing them to be effectively used to inform motorists of a message broadcast.

6.8.3. NEXTTRIP

Real-time vehicle location and projected stop arrival/departure information are available for LA Metro's buses and trains through an application developed by NextBus, Inc. (now part of Cubic Transportation Systems). Figure 55 illustrates the information available for the Metro Gold Line. Similar information is available for all Metro buses. For each transit stop, travelers are provided with the estimated departure times for the next three vehicles along each transit route scheduled to service the stop. In addition to being able to display the information on a map, travelers can also query departure times for a particular bus stop using their cellular phones or SMS (Short Message Service) text messages.

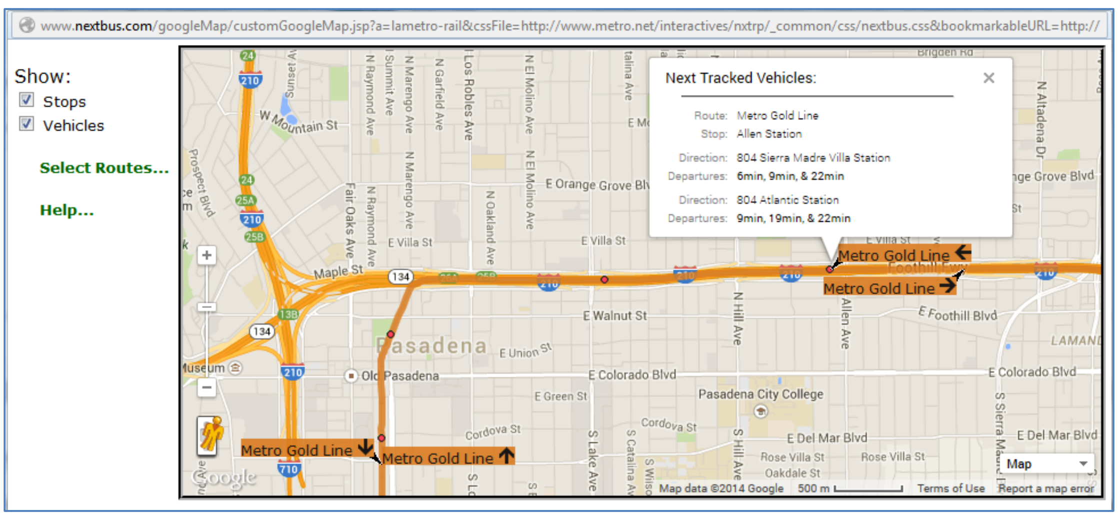

Figure 55 – LA Metro's NextTrip Application

6.8.4. GO511

The Southern California Go511 service provides multi-modal traveler information through a 511 interactive voice response (IVR) system and the Go511.com web portal illustrated in Figure 56. Go511 is operated by the Los Angeles County Service Authority for Freeway Emergencies (LA SAFE) in partnership with LA Metro, the Orange County Transportation Authority, the Ventura County Transportation Commission, the California Highway Patrol (CHP), and Caltrans Districts 7, 8 and 12.

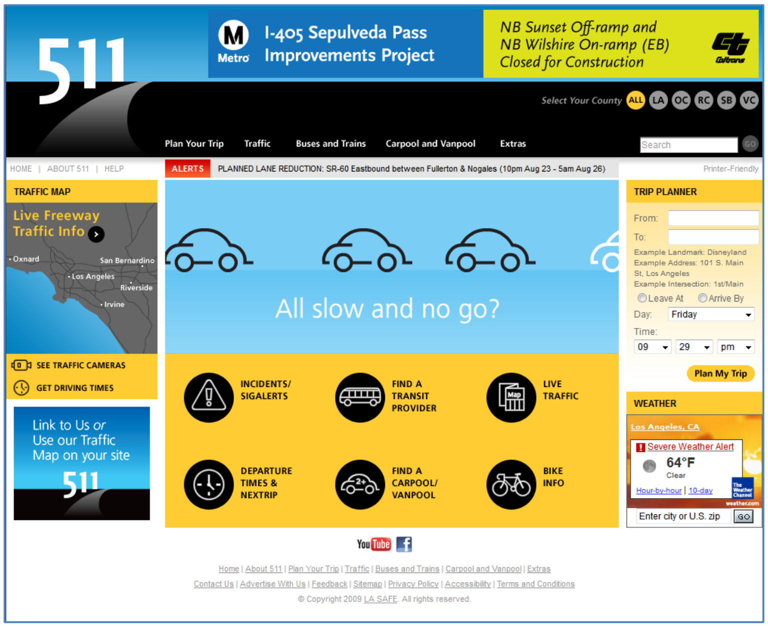

Figure 56 – Go511 Application

Go511 provides traffic information for the Los Angeles, Orange, Riverside, San Bernardino and Ventura counties. Currently available traveler information services include:

- Real-time traffic speeds along area freeways
- Road construction, lane closures, road closure notices, and incidents
- Access to live video feeds from CCTV cameras operated by Caltrans
- Real time transit departure times
- Bus and train schedules
- Transit trip planner
- General information about toll roads and carpool lanes
- Carpool/vanpool matching application
- Information about regional park-and-ride facilities
- How to obtain roadside assistance

Real-time traffic comes from information collected by traffic detectors embedded into the freeways operated by Caltrans. Planned road and freeway closures for maintenance and construction are also sent by Caltrans. Accidents, incidents and road conditions that affect freeways, such as Sig Alerts, icy roads or flooding, are delivered by the California Highway Patrol as soon as they are reported. Metro real-time bus arrival information comes from the Nextrip application.

6.8.5. BLUE COMMUTE

Blue Commute is a personalized, $9.99-a-month subscription based travel information application that was developed by Iteris in partnership with LA County Department of Public Works, with additional financial support from LA Metro, the Federal Highway Administration, the San Bernardino Associated Governments, the Riverside County Transportation Commission, and other agencies. A screenshot of the application's main page is shown in Figure 57. It allows travelers to obtain real-time traffic reports via phone and internet on computers, laptops, smartphones, and tablet devices for routes identified by them. Information provided includes:

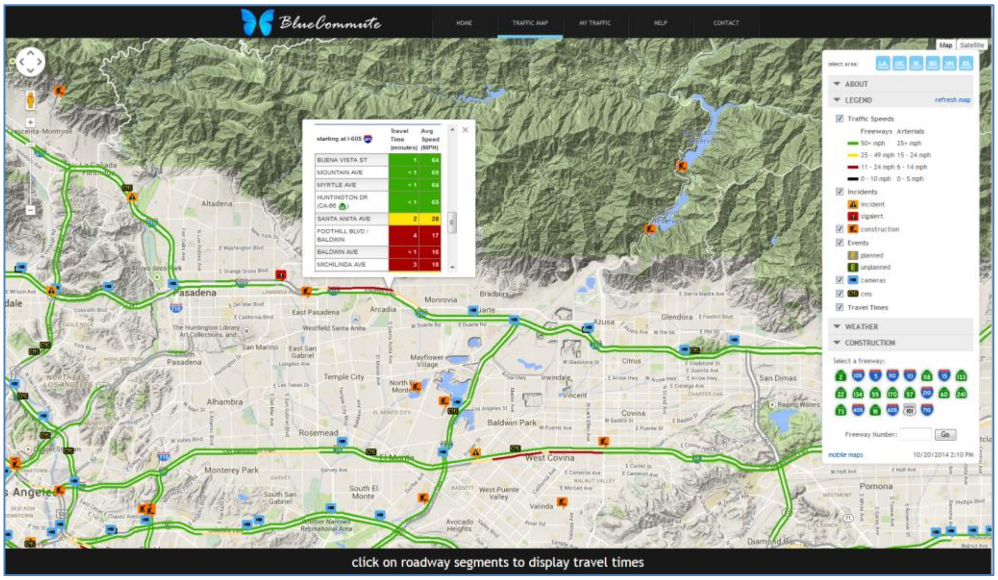

Figure 57 – Blue Commute Application

- Congestion information on freeways and arterial roads
- Speeds and travel times on user-selected routes
- Incident notices and construction events along user-selected routes
- Schedule notices pertaining to user-selected routes
- Travel time comparisons for possible routes from point A to point B
- Messages displayed on changeable message signs
- Access to video feeds from CCTV cameras operated by Caltrans
- Call-in service

6.9. INFORMATION EXCHANGE NETWORKS

The following two systems currently enable corridor stakeholders to obtain and/or exchange information about the operations of transportation systems within the I-210 corridor:

- Regional Integration of Intelligent Transportation Systems (RIITS)
- Information Exchange Network (IEN)

6.9.1. REGIONAL INTEGRATION OF INTELLIGENT TRANSPORTATION SYSTEMS (RIITS)

The Regional Integration of Intelligent Transportation Systems (RIITS) network was developed under sponsorship from Metro to provide a platform supporting real-time information exchange among freeway, traffic, transit and emergency service agencies. RIITS' central mission is to support the core business needs of public agencies by creating a one-stop shop for real-time transportation data. It is designed to combine real-time data from various Intelligent Transportation Systems and agencies across Los Angeles County and to provide in return value-added information on the operation of multimodal transportation systems (including freeway, arterial, and transit systems) to partnering agencies, information service providers, and the public. The system is currently the primary provider of Los Angeles County data to the Southern California 511 system.

Figure 58 provides an overview of the RIITS architecture. Information provided to the system includes data from the following agencies:

- Los Angeles Metropolitan Transportation Authority (Metro) bus and rail operations
- City of Los Angeles Department of Transportation (LADOT)
- Caltrans Districts 7, District 8 and District 12
- California Highway Patrol
- Long Beach Transit
- Foothill Transit
- Agencies supplying information to the IEN Network

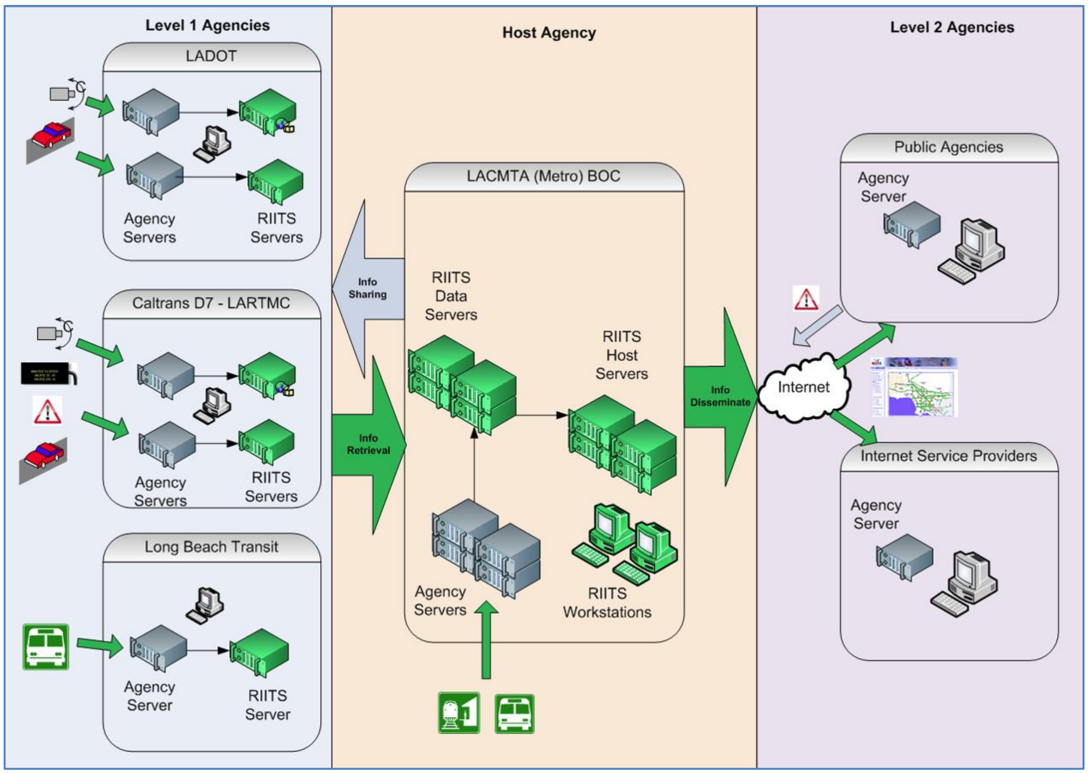

Figure 58 – RIITS Architecture

Within RIITS, partnering agencies have access to the full set of data collected via a secure web-based interface, while information service providers and the public have access to limited data sets through data feeds and a public information website. Partnering agencies have access to freeway and arterial detector data, freeway travel time estimates, changeable message sign data, CCTV data, arterial signal timing data, incident reports from the CHP, events and lane closure data from Caltrans, and transit vehicle location and route data. Data provided to information providers and the public is limited to freeway congestion and travel time data, CCTV video snapshots, and changeable message sign content.

Underlying the interfaces and overall architecture is a communications network linking the various servers. This network includes two fiber optic lines connecting servers at the Los Angeles Regional TMC supporting Caltrans and CHP operations with the LADOT servers, and two lines connecting the LADOT and Metro servers. To enhance communication speed and provide added data exchange capacity, which is currently limited to 2GB per second, plans are being made to place RIITS on Metro's virtual private network (VPN). Data communications are further supported by a series of published standards for data formats and data feeds using the widely adopted XML format and the Traffic Management Data Dictionary (TMDD) V2.1 standard from the Institute of Transportation Engineers (ITE).

While RIITS has been successful in providing baseline transit, traffic, and incident data to its users, the following issues were identified in RIITS' 2010 ten-year strategic development plan:

- The absence of data archival prevents historical data analyses
- Current network speed/capacity is not enough to handle additional enhanced functionality such as filtered data feeds and database queries
- Since the system does not currently store any data, it does not facilitate the review of transportation conditions over time
- While sufficient for current needs, network security needs to be upgraded in order to ensure the privacy of future data contributors

Table 5 – RIITS Data

Data Source	**Data**	**Update Rate**	**Availability**	
			Agency Feed	**ISP Feed**
Caltrans District 7	Freeway detector inventory data	Daily (midnight)	●	
	Arterial detector inventory data	Quarterly	●	
	Freeway travel times	1 minute	●	●
	Arterial travel times	1 minute	●	●
	CMS inventory data	Daily (midnight)	●	
	CMS messages	1 minute	●	●
	CCTV inventory data	Quarterly	●	
	CCTV snapshots	1 minute	●	●
	Freeway closure data (next 24 hours)	1 minute	●	
City of Los Angeles Department of Transportation (LADOT)	Arterial detector inventory	Daily (midnight)	●	
	Arterial travel times	1 minute	●	
CHP - Los Angeles	Incident reports	1 minute	●	
Metro Bus Operations	Route inventory	Quarterly	●	
	Vehicle location data	2 minutes	●	
Metro Rail Operations	Route inventory	Quarterly	●	
	Vehicle location data	1 minute	●	
Long Beach Transit	Route inventory	*Unknown*	●	
	Vehicle location data	1 minute	●	
Foothill Transit	Route inventory	*Unknown*	●	
	Vehicle location data	1 minute	●	

Table 5 identifies the data feeds available through RIITS. The table distinguishes two types of data feeds: a data feed that can only be accessed by transportation agencies connected to the system, and a feed providing limited data to information service providers. If should also be noted that the listed data types may not be available from all devices or systems operated by an agency. Data availability depends on whether data-supplying devices are connected to RIITS and have been configured within the system.

Data latency between when a piece of information is collected from a source agency to the time it is available on the RIITS system outputs generally varies from roughly 1 to 2 minutes. RIITS is further dependent on source systems for information and is subject to the limitations of those source systems in terms of accuracy and timeliness of data.

6.9.2. INFORMATION EXCHANGE NETWORK (IEN)

The Information Exchange Network (IEN) is an information-sharing network that was developed by TransCore for the Los Angeles County Department of Public Works in the early 2000s. It was established to enable the sharing of traffic signal control information, and eventually traffic signal control itself, across the various systems used within the county. Unlike many other information-sharing systems, its primary focus is on traffic signal control rather than freeway management. Key features of the IEN include:

- Use of a common system interface definition language (IDL) to enable heterogeneous traffic control systems to be connected onto the IEN backbone
- Ability to process second-by-second intersection data to support real-time intersection displays, section displays, and arterial coordination
- Ability for agency operators to change the plan/mode of signalized intersections through pop-up control windows
- Ability for smaller agencies to relinquish control and monitoring of devices to another agency for off-hours support and maintenance
- Ability to collect data from PeMS and RIITS, thus enabling the system to report freeway congestion status, incidents, and lane closures
- Ability for participating agencies to share incident, planned event and construction activities information through an incident and planned events tracking system
- Ability to establish multi-agency incident response with a scenario manager

Figure 59 illustrates the basic system architecture. As illustrated, the IEN is a multi-tiered, hierarchical system with site, regional, and external interface components. Site components typically include:

- A site server to manage the distribution of data between local workstations, local traffic control systems, and the regional server
- One or more workstations to run the IEN user interfaces
- Command/data interface software connecting the IEN site server to a traffic control system
- A network firewall to enforce secure connections between the IEN and agency networks

Regional IEN components are located at the Los Angeles County Department of Public Works and provide the central servers for the IEN System. These components include:

- One or more regional servers to manage the distribution of data between sites
- A database server to maintain system configuration information and historical status, event management, and alarm data
- Utility servers providing supporting services, such as active directory, domain name system, and time synchronization
- Terminal services servers to provide access to the IEN Workstation software for remote users that connect to LA County's Virtual Private Network (VPN)

As of December 2014, agencies within the I-210 corridor connected to the IEN network include:

- Los Angeles County Department of Public Works
- City of Pasadena
- City of Arcadia
- City of Alhambra
- City of West Covina
- Caltrans (via RIITS)

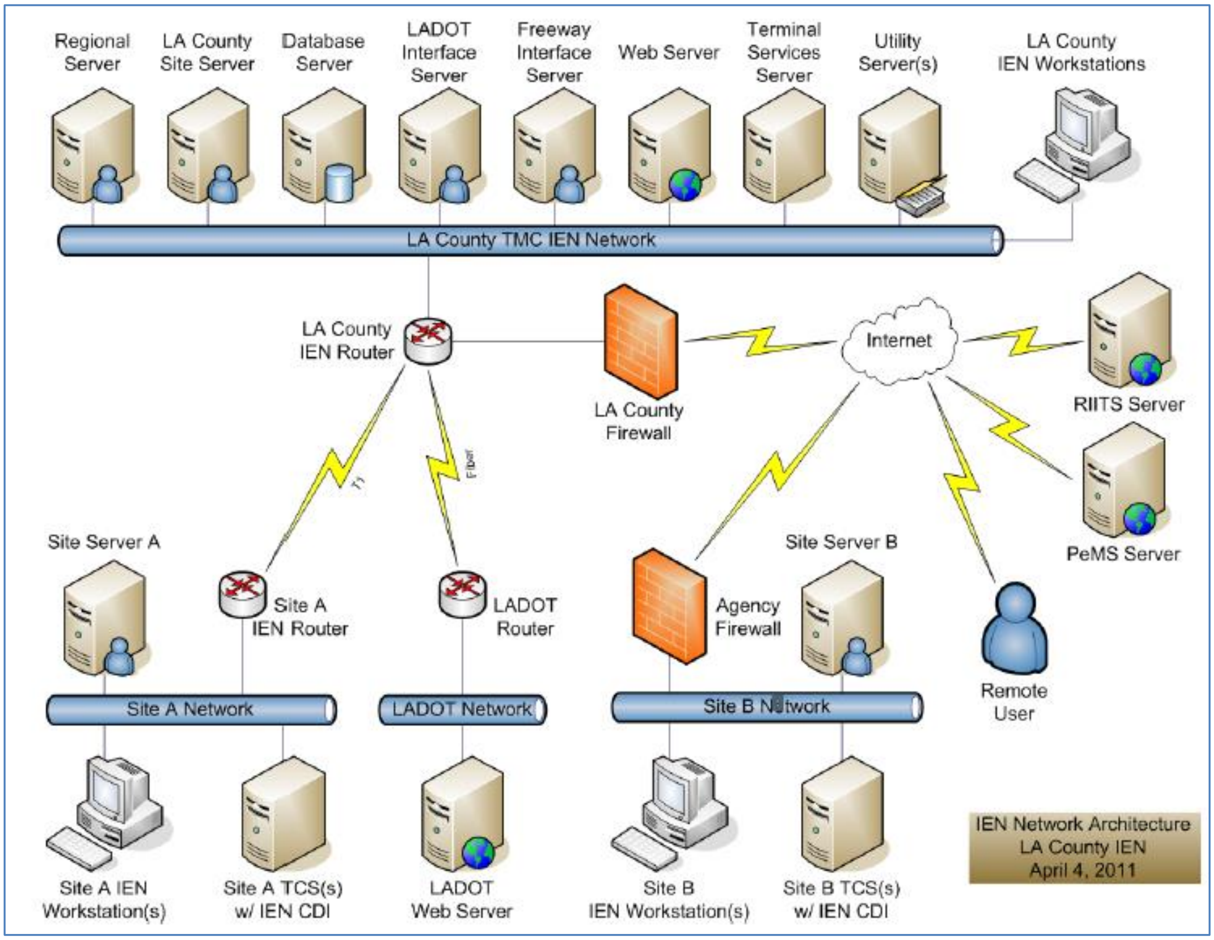

Figure 59 – IEN System Architecture

In addition to the above connections, the LA County Department of Public Works is currently developing an interface that will allow any jurisdiction using the KITS signal control system to communicate with the IEN. For the I-210 corridor, this will enable to communicate data from signals operated by the cities of Duarte and Monrovia in addition to data from County-operated intersections.

The IEN is designed to collect continuously intersection controller and arterial system detector data from the various traffic control systems connected to it. The IEN polls each device once every minute for a full set of summary status data and simply for status updates during the remaining 59 seconds. To avoid overwhelming traffic control systems with data requests, full data are only polled from 1/60 of all devices are polled each second, thus enabling all devices to be polled in one minute.

Table 6 lists the data collected by the IEN system. It is important to note that while a traffic control system may be capable of supporting a particular type of data, data may not be available for a given device because it has not been configured within the traffic control system. For example, detector direction and road name are usually optional fields within traffic control systems that many agencies have not entered and therefore are not available to the IEN. The availability of data depends on the combined status and capabilities of the device, traffic control system, field-to-central communications, and command/data interface. As an example, devices connected to McCain's QuicNet systems only report actual offset and planned phase max green times for controllers running McCain's 233RV2 firmware, in addition to communicating at a minimum baud rate of 9600.

Table 6 – IEN Data

Data	McCain QuicNet	TransCore Series 2000	Siemens i2tms	TransCore TransSuite
Traffic Control System Data				
Description	●	●	●	●
Signal type	●	●	●	●
Latitude/Longitude	●	●	●	●
Main street			●	
Cross street			●	
Communication state	●	●	●	●
Timing plan	●	●	●	●
Desired cycle length	●	●	●	●
Desired offset	●	●	●	●
Actual offset	●	●	●	●
Signal control mode	●	●	●	●
Signal state	●	●	●	●
Last cycle length	●	●	●	●
Last cycle phase green times	●	●	●	●
Planned phase maximum green times	●	●	●	●
Traffic Detector Data				
Associated intersection number	○	○	○	○
Averaging period	●	●	●	●
Road name				●
Cross street name	○	○	○	○
Travel direction	●		●	●
Description text	○	○	○	○
Detector state	●	●	●	●
Traffic volume	●	●	●	●
Detector occupancy	●	●	●	●
Traffic speed		●	●	●
Average traffic volume	●	●	●	●
Average detector occupancy	●	●	●	●
Average traffic speed	●	●	●	●

● Currently available ○ Planned to be added at RIITS's request

The IEN, the participating traffic control systems, and the Internet are interconnected distributed systems with inherent and variable data transfer latencies. The data that the IEN receives from traffic control systems can therefore be several seconds old. Data will age further by the time it reaches an external system through the IEN Web Server

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7. CURRENT OPERATIONAL STATUS

This section provides an assessment of the current operational situation along the corridor. The objective of this assessment is to identify operational gaps, constraints and problems affecting systems operations. Operational elements of the I-210 corridor reviewed herein include:

- Travel demand
- Freeway operations
- Arterial operations
- Transit operations
- Parking management
- Inter-jurisdictional collaboration

7.1. TRAVEL DEMAND

This section characterizes the traffic demand for the I-210 freeway and surrounding arterials. Elements covered in this section include:

- Profile of trips originating, destined, or passing through the I-210 corridor
- Demand for travel along the I-210 freeway
- Demand for travel along key corridor arterials

7.1.1. CORRIDOR TRIP PROFILE

Information about trip patterns along the I-210 corridor presented in this section is extracted from the facility's Corridor System Management Plan (CSMP) that was released in September 2010. This characterization, which was completed in 2008, was developed using Caltrans' version of the Southern California Association of Governments (SCAG) Regional Travel Demand Model for the year 2000. This was the latest model available at the time of the evaluation (the 2003 model was released in January 2008, and the 2008 model subsequently released in January 2012). The CSMP analysis identified the origin and destination of trips made along the I-210 corridor using the aggregate zonal system shown in Figure 60.

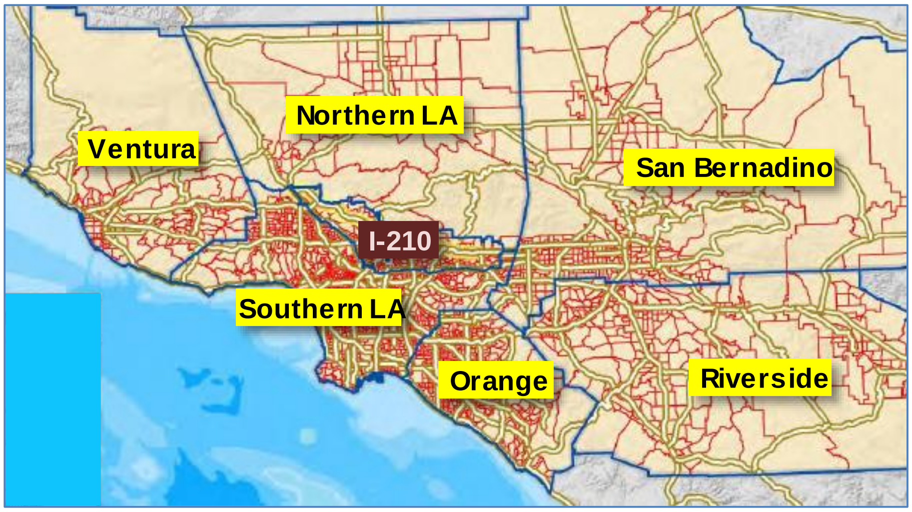


Figure 60 – 2010 CSMP Travel Demand Analysis Zones

Reflective of the CSMP objectives, the I-210 corridor defined in this analysis extends from the I-5 interchange in San Fernando to the Los Angeles County / San Bernardino County boundary, approximately 7 miles east of the SR-57 interchange in San Dimas. While this is longer than the corridor under consideration, it includes in its entirety the section of I-210 being evaluated.

Table 7 – AM Peak Travel Patterns

	I-210	Southern LA	Northern LA	Orange County	Riverside	San Bernardino	Ventura	Outside Zone	Total Origin
I-210	83,477	49,842	3,872	3,230	622	3,431	2,886	483	**147,843**
Southern LA	37,275	2,703	504	31	129	518	154	225	**4,301**
Northern LA	7,780	1,766	76	61	29	95	76	14	**9,897**
Orange County	2,852	45	12	0	0	0	13	74	**2,996**
Riverside	1,678	286	9	0	0	0	23	113	**2,109**
San Bernardino	7,932	1,652	71	3	0	0	105	99	**9.862**
Ventura	2,006	103	50	10	45	109	0	33	**2,356**
Outside Zones	280	180	9	21	85	90	10	336	**1,011**
Total Dest.	**106,042**	**56,577**	**4.603**	**3,356**	**910**	**4,243**	**3,267**	**1,377**	**180,375**

Table 8 – PM Peak Travel Patterns

	I-210	Southern LA	Northern LA	Orange County	Riverside	San Bernardino	Ventura	Outside Zone	Total Origin
I-210	122,552	58,306	10,380	4,747	2,271	11,035	2,886	597	**212,774**
Southern LA	74,797	2,809	1,617	122	409	2,048	154	363	**82.319**
Northern LA	7,297	1,092	133	53	43	155	76	16	**8,865**
Orange County	5,735	55	96	0	0	1	13	111	**6.011**
Riverside	1,306	248	27	0	0	0	23	135	**1,739**
San Bernardino	7,103	1,275	167	3	0	0	105	125	**8.778**
Ventura	2,056	103	55	14	46	134	0	46	**2,454**
Outside Zones	1,062	546	23	284	341	278	15	1,164	**3,713**
Total Dest.	**221,908**	**64,434**	**12,498**	**5,223**	**3,110**	**13,651**	**3,272**	**2,557**	**326,653**

Table 7 and Table 8 show the result of the trip pattern analysis for the AM and PM periods respectively. For the AM peak, Table 7 shows that 87% of trips made along the I-210 corridor are entirely contained within Los Angeles County, i.e., have both an origin and destination within the county. The data notably suggests that a large percentage of AM peak traffic uses the I-210 freeway to connect to other freeways heading south to southern Los Angeles County. A more detailed analysis further reveals that:

- 39% of trips made along the corridor have both an origin and destination within the corridor
- 41% of trips are originating from or destined to southern Los Angeles County, which includes downtown Los Angeles and the urban core of the region
- 7% of trips represent travel to other sections of Los Angeles County
- 8% originate outside Los Angeles County and terminate within the county
- 5% of trips originate from Los Angeles County and terminate in other counties
- 1% of trips start and terminate outside Los Angeles County

For the PM peak period, the data of Table 8 indicates a much higher travel demand. For this period, the analysis indicates a 52% higher travel demand than from the AM peak period. The analysis also indicated that the traffic patterns observed during the morning repeat in the afternoon, with 85% of trips entirely contained within Los Angeles County. More specifically, the analyses suggest that:

- 38% of trips made along the corridor have both an origin and destination within the corridor
- 41% of trips are originating from or destined to southern Los Angeles County, which include downtown Los Angeles and the urban core of the region

- 6% of trips represent travel to other sections of Los Angeles County
- 8% originate outside Los Angeles County and terminate within the county
- 6% of trips originate from Los Angeles County and terminate in other counties
- 1% of trips start and terminate outside Los Angeles County

7.1.2. I-210 TRAVEL DEMAND

This section characterizes the demand for travel along the I-210 freeway. This characterization is performed through the following analyses:

- Average daily traffic (ADT) volumes along various sections of I-210
- Average daily vehicle-miles traveled (VMT) along the portion of I-210 extending from the SR-134 interchange through the SR-57 interchange
- Truck movements within the I-210 corridor
- Weekday variability of vehicle-miles traveled along the freeway

7.1.2.1. Average Daily Traffic (ADT) Volumes

Figure 61 presents the average number of vehicles that have been observed to travel daily along various sections of the freeway between May 2013 and April 2014 for each travel direction. These statistics

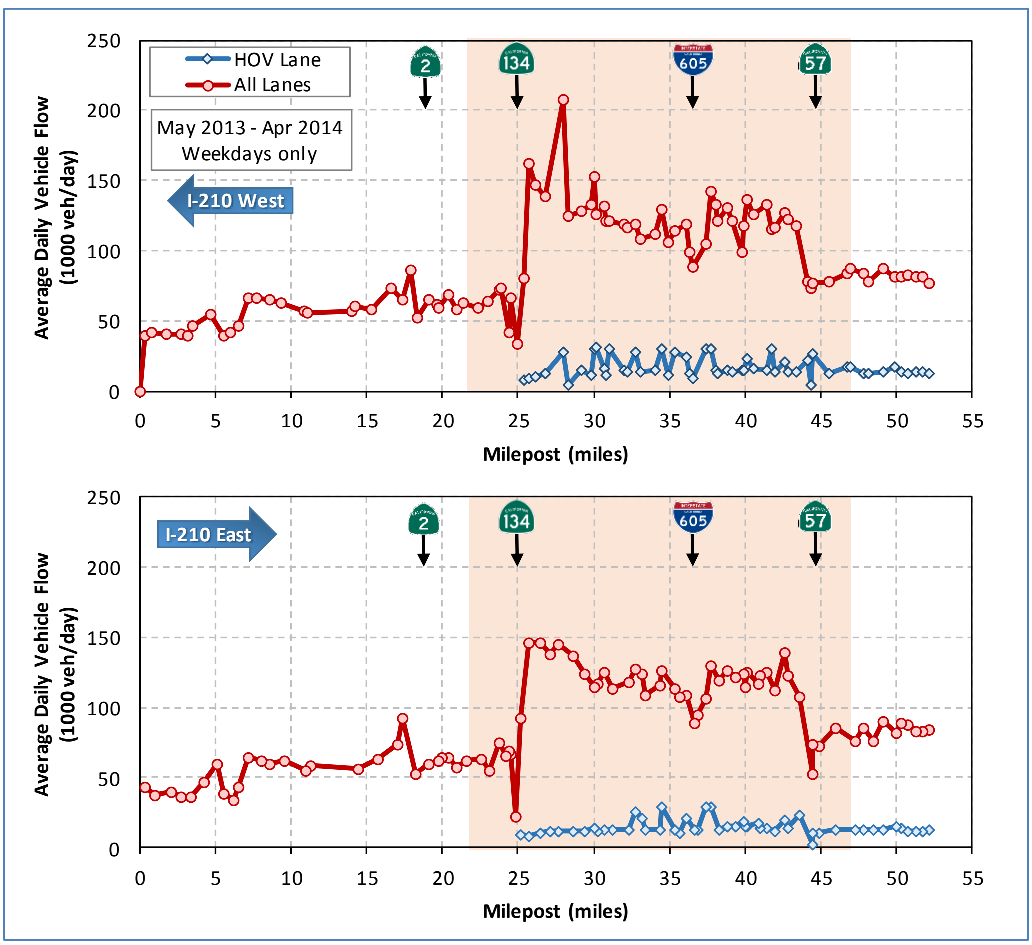


Figure 61 – Average Daily Weekday Traffic Flow at Various Locations along I-210

were retrieved from PeMS in May 2014 and are derived from vehicle count data generated by traffic detectors operated by Caltrans along the freeway mainline. Each graph shows the total average daily traffic over all traffic lanes and the portion of the total traffic that traveled on the facility's HOV lane east of the SR-134 interchange. The shaded area in the middle of the graphs further represents the section of I-210 that is of primary interest for the development of the pilot ICM system. As can be expected, traffic along I-210 is heaviest between the SR-134 and SR-57 interchanges, with the peak traffic just east of the SR-134 interchange near downtown Pasadena. Within this segment, between 100,000 and 150,000 vehicles are observed to travel daily along I-210 in both the eastbound and westbound directions, with slightly higher traffic volumes observed in the westbound direction. In both directions, the HOV lane is observed to carry between 10,000 and 30,000 vehicles per day depending on the section considered, with the highest volumes again observed in the westbound direction.

At the SR-134 interchange, the significant change in observed traffic volume is associated with the geometry of the interchange. As shown in Figure 62, the main freeway lanes along I-210 east of the interchange directly connect with the SR-134 freeway Traffic destined to or coming from the I-210 freeway north of Pasadena has to take a two-lane connector to transfer between the two sections of the I-210 freeway. The flow drop observed in the graphs of Figure 61 reflect both the constrained capacity of the connector and the fact that a significant portion of the I-210 traffic east of the interchange either comes from SR-134 or is destined to this freeway.

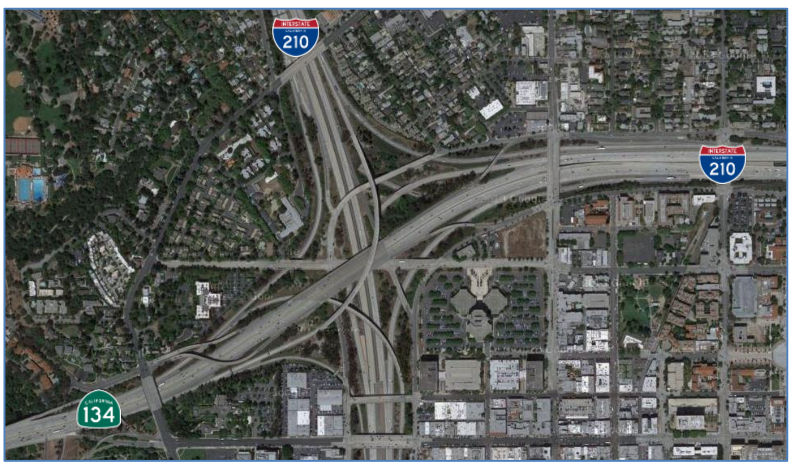


Figure 62 – I-210/SR-134 Interchange

The flow drops observed at the I-605 and SR-57 interchanges are similarly reflective of a large proportion of vehicles entering or exiting the I-210 freeway at these locations. At each interchange, the data point with the smaller volume corresponds to a detection station located between the ramp carrying the traffic exiting the I-210 freeway and the ramp bringing traffic onto I-210 from the intersecting freeway. These data points thus represent the proportion of traffic along I-210 that does not enter or leave the freeway at these locations.

7.1.2.2. Average Vehicle Miles Traveled (VMT)

Figure 63 presents another measure of travel demand. The graphs shown in the figure track the total vehicle-miles traveled for each travel direction along I-210 between the SR-134 interchange in Pasadena and the Foothill Boulevard interchange in La Verne during non-holiday weekdays between January 2008 and April 2014. In each graph, the vertical bars illustrate the average daily VMT for each month that was

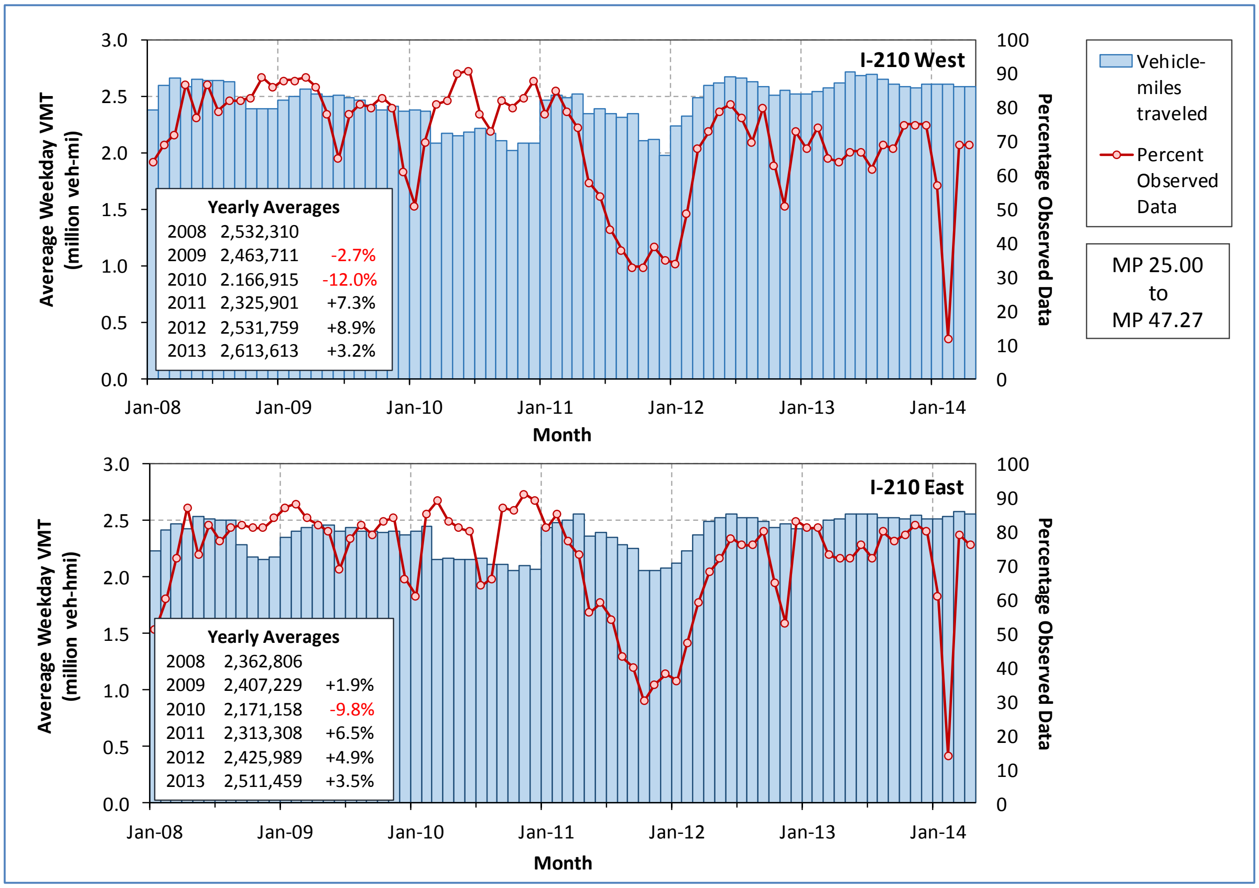


Figure 63 – Average Daily VMT between Mileposts 25.00 and 47.27, by Month

estimated by PeMS from traffic counts along the freeway mainline, while the table on the lower left corner shows the average daily VMT for each full year covered within the analysis period. To help assess data quality, the red line further presents the percentage of the vehicle counts at the base of the VMT estimates that were obtained from direct sensor measurements, i.e., that have not been subject to imputation by PeMS using data from nearby detectors or other sources.

The graphs of Figure 63 first indicate that approximately 2.5 million vehicle-miles are traveled each month in each direction of I-210, with a slightly higher number of traveled miles in the westbound direction. The graphs also indicate that following reductions in 2009 and 2010, vehicle miles traveled along the I-210 are 3 to 6 percent higher than in 2008, the year that was used as a reference to develop the 2010 Corridor System Management Plan (CSMP) for the I-210. As can be observed, this growth was preceded by a period of significant fluctuations in VMT. Various factors can explain these fluctuations. The drop observed at the end of 2008 can first be attributed to the financial crisis that hit in the fall of 2008. The second significant drop observed to occur in March 2010 and to last until December 2010 is in turn likely the result of shifted travel patterns due to road construction that occurred along the freeway at that time. Finally, the concordance between the drop in VMT and drop in the percentage of observed data between January 2011 and June 2012 suggests that the likely cause of the observed drop in VMT during this period can be attributed to sensor problems.

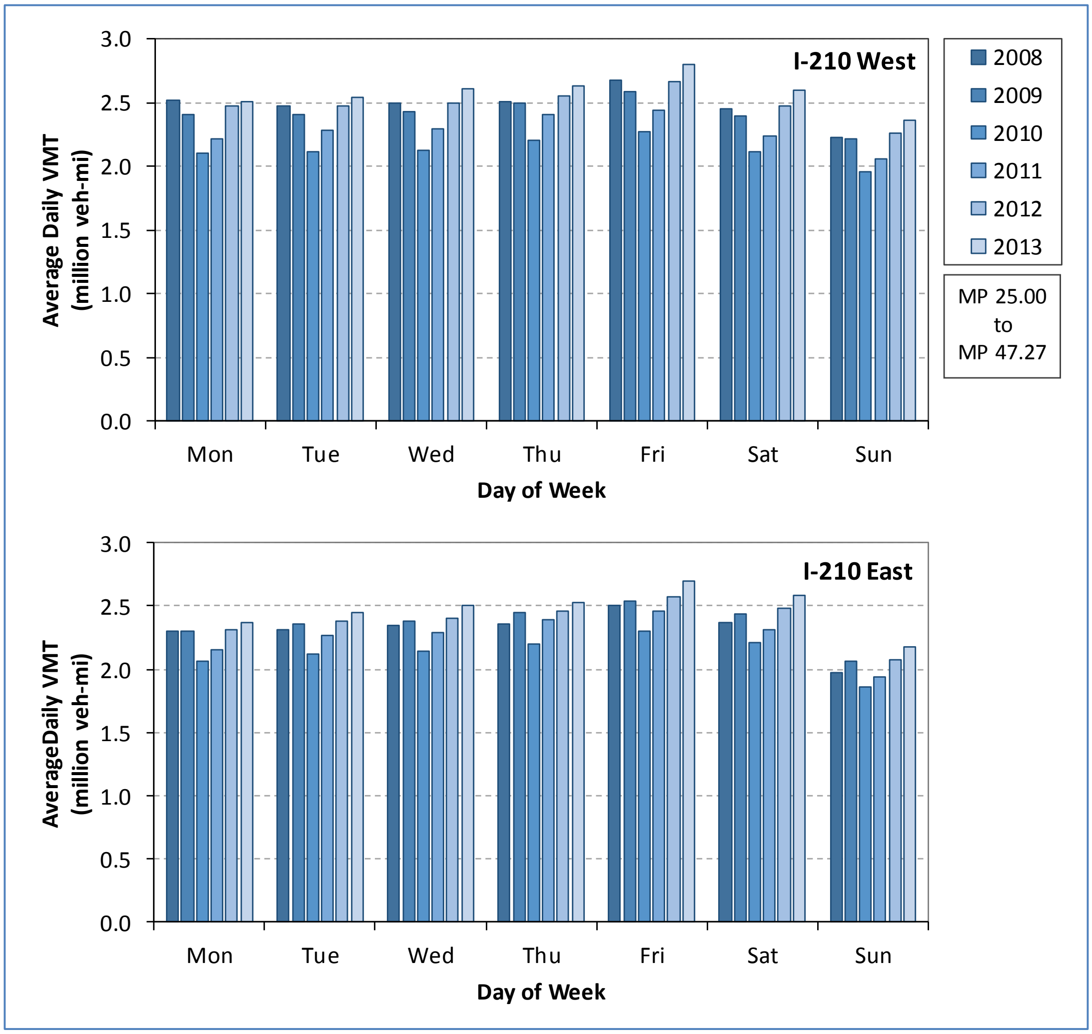


Figure 64 – Average Daily VMT between Mileposts 25.00 and 47.27, by Day of Week

Figure 64 further compares the average daily VMT in each travel direction for each day of the week. For both directions, traffic demand is found to be lowest on Monday and to increase gradually as the week progresses, reaching a peak on Friday. In the westbound direction, the data indicates an average increase of 8% from Monday to Friday. In the eastbound direction, the average increase is 11%. These trends are relatively consistent across the years. A relatively high traffic demand is also commonly observed on Saturday, with VMT values similar or exceeding those associated with some of the early weekdays. Finally, as expected, the lowest traffic demand typically occurs on Sunday.

7.1.2.3. Truck Operations

This section provides an assessment of current truck operations along the I-210 corridor. This assessment is based on a truck origin-destination survey that was commissioned from Minagar & Associates by LA Metro in March 2011 and released in January 2012 and which specifically covered the 20-mile section of I-210 extending from the SR-134 to the SR-57 interchanges. This study assessed truck movements based on vehicle classification, origin-destination, vehicle commodity type, route selection, and turning counts; video data collected near the I-605 and I-210 freeways; and a survey of truck drivers.

The following is a summary of the key findings of the study regarding the proportion of trucks traveling on I-210:

- 55% of trucks traveling on I-210 are large, heavy-duty trucks with 3 or more axles and having a minimum weight of 13 tons (26,000 lbs). The remaining 45% are commercial vehicles having a lighter weight or fewer axle-tire combinations, such as two-axle service/delivery trucks and recreational vehicles.
- As shown in Table 9, trucks accounted for 6.2% of the total I-210 traffic in 2011, with heavy-duty trucks accounting for 4.4% of the total traffic.

Table 9 – Proportion of Trucks on I-210 and Surrounding Freeways (2011 Data)

Freeway	Section	Heavy Duty Trucks	Light-Duty Trucks	All Truck Types
I-210	SR-134 to SR-57	4.4%	1.8%	6.2%
SR-134	West of I-210	1.3%	1.2%	2.5%
I-605	SR-60 to I-210	5.1%	3.5%	8.6%
SR-57	SR-60 to I-210	5.1%	2.6%	7.7%

- On a section-by-section basis, in 2011 trucks accounted between 3.4 and 7.8% of the I-210 mainline traffic, with the highest proportions typically observed just west of the I-605 interchange. When considering only heavy-duty trucks, the proportion of trucks varied between 2.3% and 5.2% (see Figure 65).
- On most on-ramps and off-ramps, heavy-duty trucks typically account for less than 1% of the total ramp traffic. A significant exception is for the Irwindale interchange, where heavy-duty trucks represent 9% of the AM peak and 13% of the midday traffic in 2010, with proportions on specific ramps reaching up to 19%.

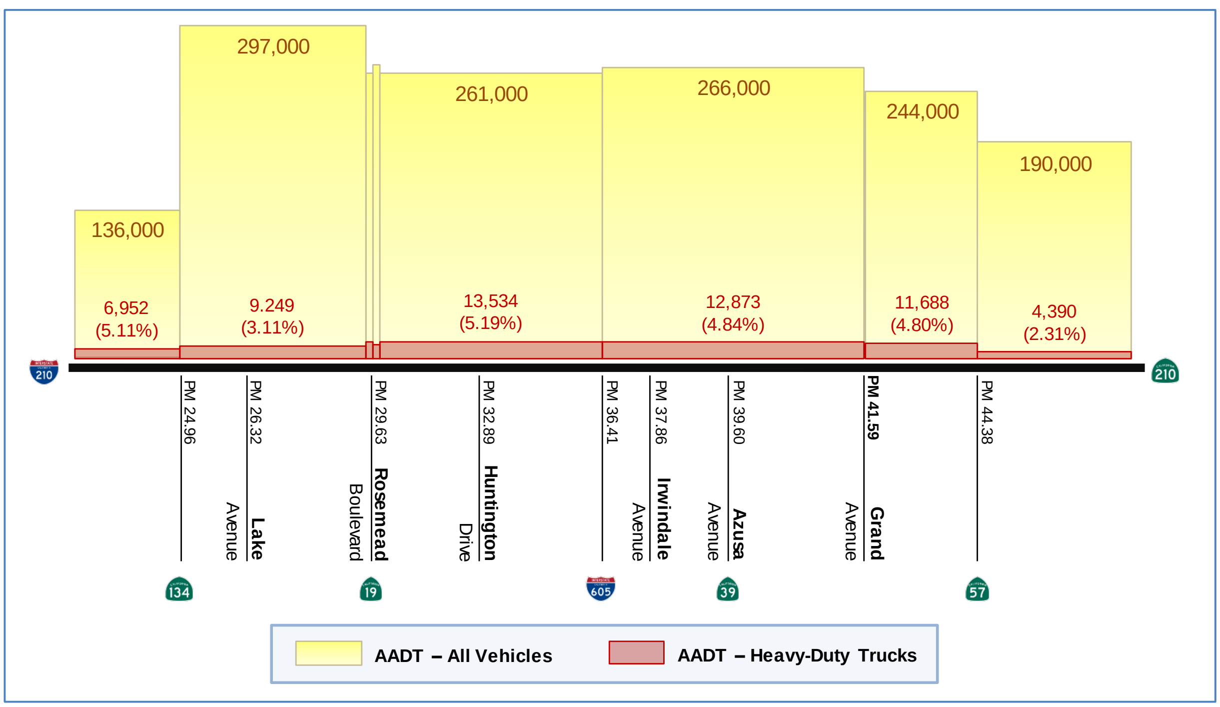


Figure 65 – Proportion of Trucks along I-210 Sections (2011 Data)

Key findings regarding the demand profile for truck traffic along the freeway corridor are as follows:

- The peak period for heavy-duty truck traffic is between 9:00 AM and 1:00 PM
- Eastbound heavy-duty truck volumes are typically 28% higher than westbound volumes
- Contrary to a commonly held view, heavy-duty truck traffic on arterials is highest on Fridays, not on Mondays or Tuesdays
- Approximately 20% of local freight operators experience seasonal activity peaks. Depending on the operator, this peak occurs either during the summer months or during the winter months

Finally, key findings regarding the origins and destinations of truck traffic along the corridor are as follows:

- Throughout the day, the I-210 Continuation at the west end of the corridor and SR-57 freeways at the east end are the two main heavy-duty truck entry and exit points. Significant proportions of trucks enter and exit using the I-605 freeway and I-210 freeway at the east end of the corridor. Relatively few trucks use the SR-134 freeway, except during the PM peak period when a large proportion of trucks is often observed exiting the corridor towards Burbank and Los Angeles via SR-134 (see Figure 66)
- According to the survey of truck drivers conducted by Minagar & Associates, many truck drivers choose to travel along I-210 as an alternate route to other congested freeways
- As illustrated in Figure 67, 45.5% of truck traffic on I-210 originates from locations within the San Gabriel Valley. An additional 36.5% of trips originate from other areas of Los Angeles County
- As illustrated in Figure 68, 48.9% of trips made by heavy-duty trucks along I-210 are destined to a location within the San Gabriel Valley. An additional 32% of trips are destined to locations elsewhere in Los Angeles County

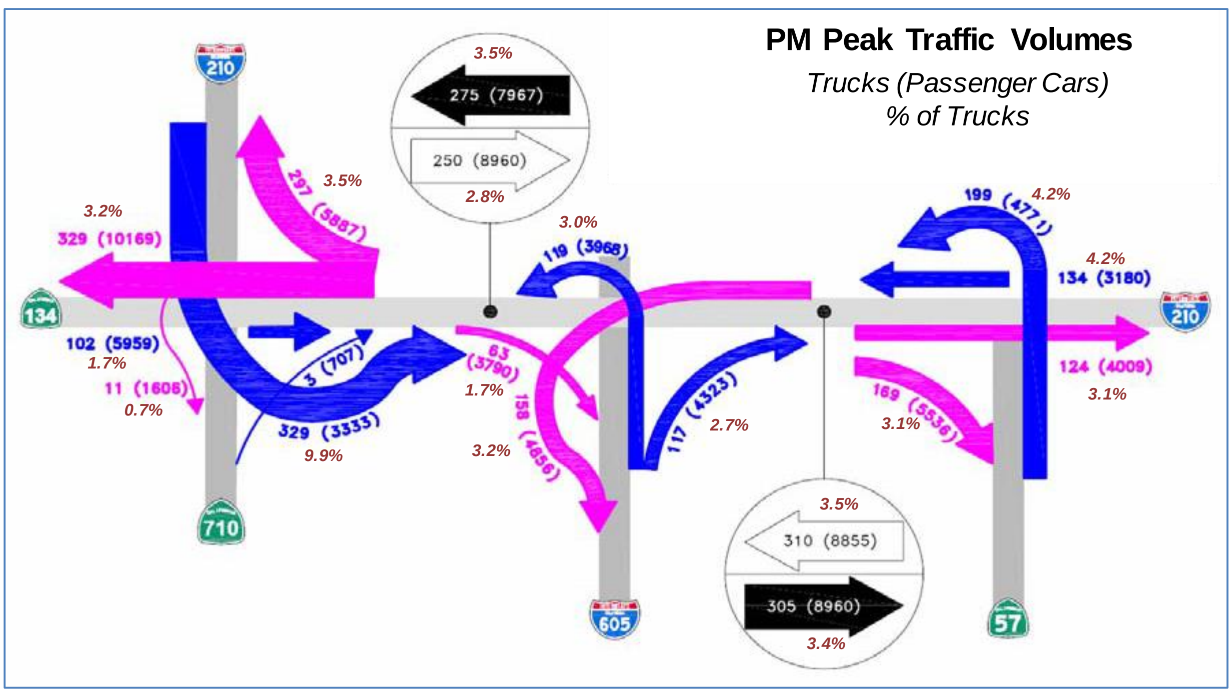


Figure 66 – PM Peak Main Truck Entry and Exit Points along I-210 (2010 Data)

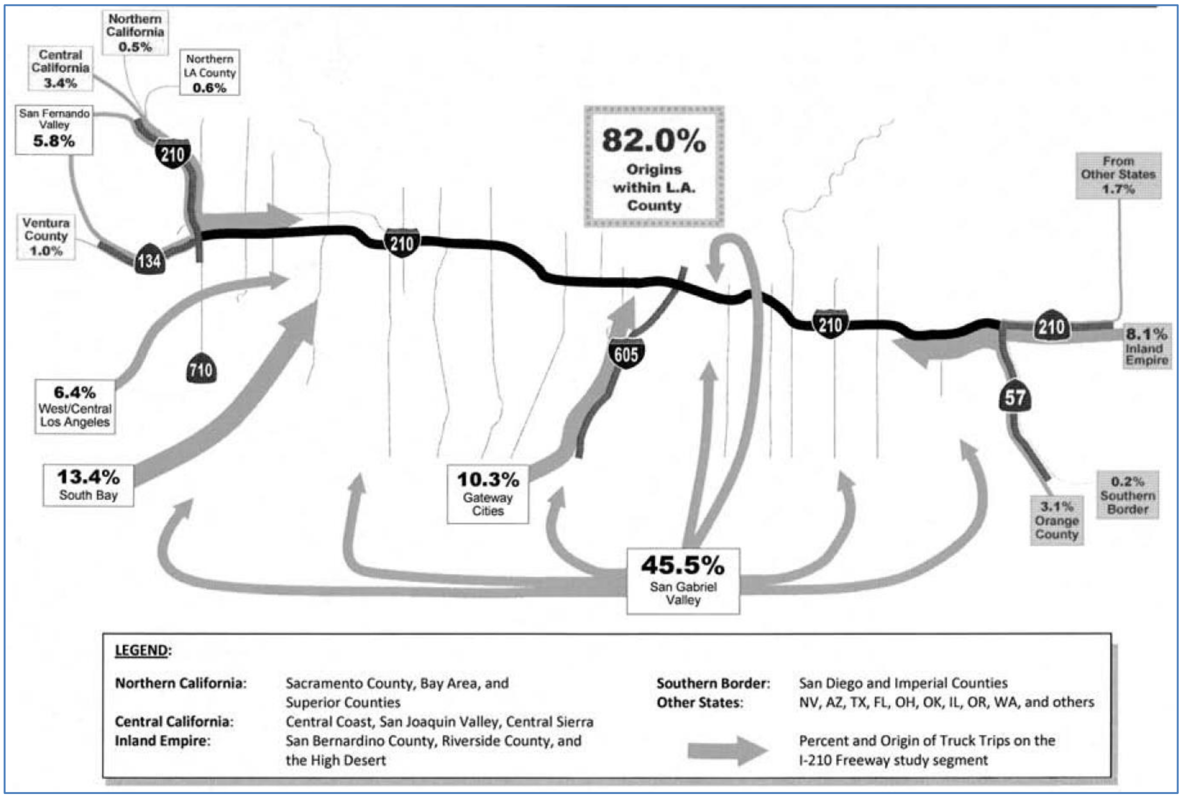


Figure 67 – I-210 Truck Traffic Origins

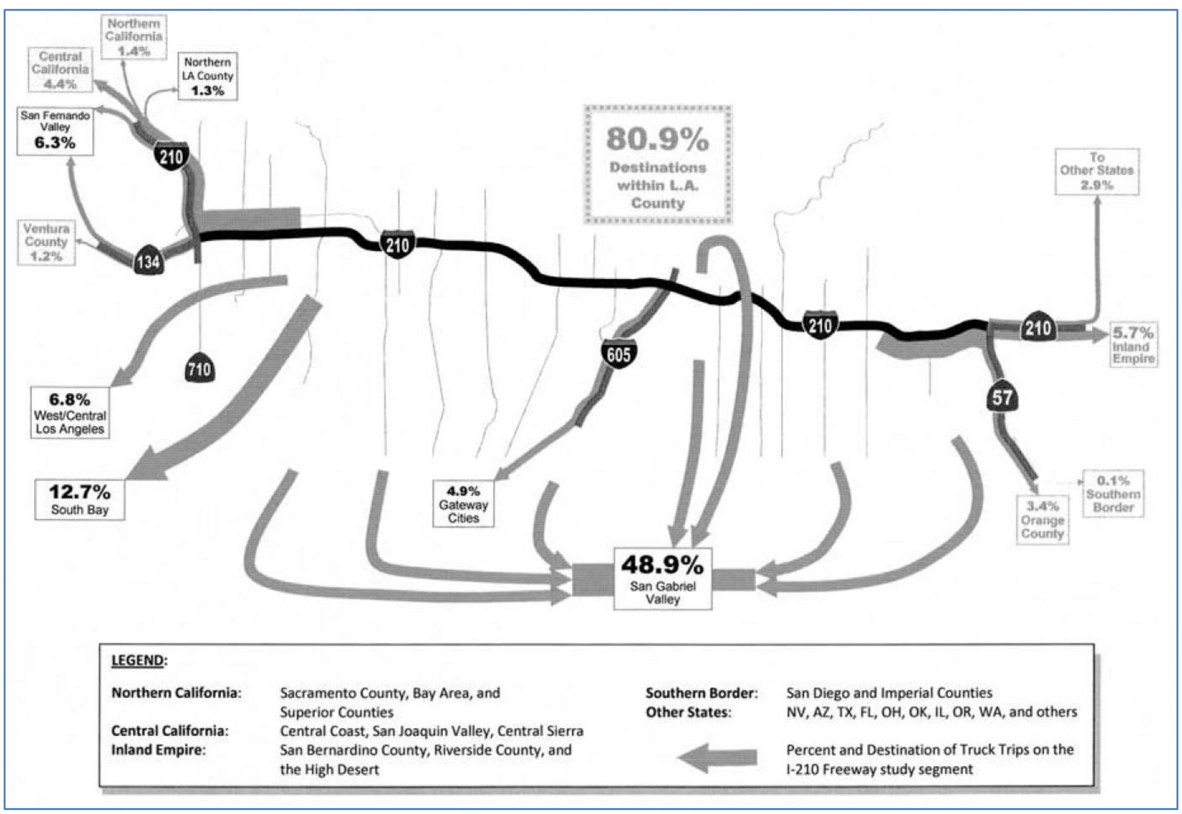


Figure 68 – I-210 Truck Traffic Destinations

7.1.2.4. Travel Demand Variability

Figure 69 characterizes the variability of traffic demand along the I-210 freeway by illustrating the variability of vehicle-miles traveled (VMT) along the freeway on a specific weekday and hour of the day. For each travel direction and weekday, the figure illustrates the average VMT, as well as values corresponding to the average plus or minus one standard deviation and values corresponding to the 5^{th} and 95^{th} percentile of observations based on vehicle count data collected by freeway mainline traffic detectors. The data sample used in this analysis include data from all I-210 mainline traffic sensors from the Arroyo Boulevard interchange in Pasadena (Exit 22B) to the Foothill Boulevard interchange in La Verne (Exit 47) that were collected by PeMS between September 4 and November 16, 2013. In the westbound direction, this data set include on average 77% of direct observations and 23% of imputed data from historical data or data from nearby detectors. In the eastbound direction, it includes 73% of observed data and 27% of imputed data. The interval bounded by one standard deviation illustrates the range of hourly VMT estimates that includes 68% of observed values if it is assumed that VMT follows a normal statistical distribution. The 5^{th} and 95^{th} percentiles represent extreme demand values that may on occasion be observed. While VMT values can exceed the 5^{th} and 95th percentile boundaries on occasion, such values can be assumed to represent highly unusual traffic conditions and thus, values that could not reasonably be expected to be observed during typical day-to-day operations.

Analysis of the data of Figure 69 leads to the following general observations:

- As expected, traffic demand fluctuates quite significantly within each weekday.
- In each direction, traffic patterns on Monday, Tuesday, Wednesday and Friday are relatively similar. Each day feature a morning and an afternoon peak period, with the two periods bridged by a period of relatively high demand.
- Traffic patterns on Saturday and Sunday are relatively similar and significantly different from other weekdays. On both days, traffic tend to increase until mid-afternoon, at which point it gradually starts to decrease before reaching a minimum early in the night.
- For each weekday, there is a relatively small variability in traffic demand from one week to the next when, particularly when compared to the variability across the hours of a day.
- Between 6:00 AM and 8:00 PM on weekdays, the VMT typically vary by less than 5% around the estimated average from one week to the next over the observation period, with the largest fluctuations reaching approximately 10%.
- While a significant portion of the observed variability can be attributed to normal fluctuations in travel demand, such as motorists deciding to start a trip earlier or later, some of the larger fluctuations may be attributed shifts in traffic patterns due to events and incidents. Such events may either entice motorists to take an alternate route away from I-210, or push traffic from other freeways or arterials onto the I-210.

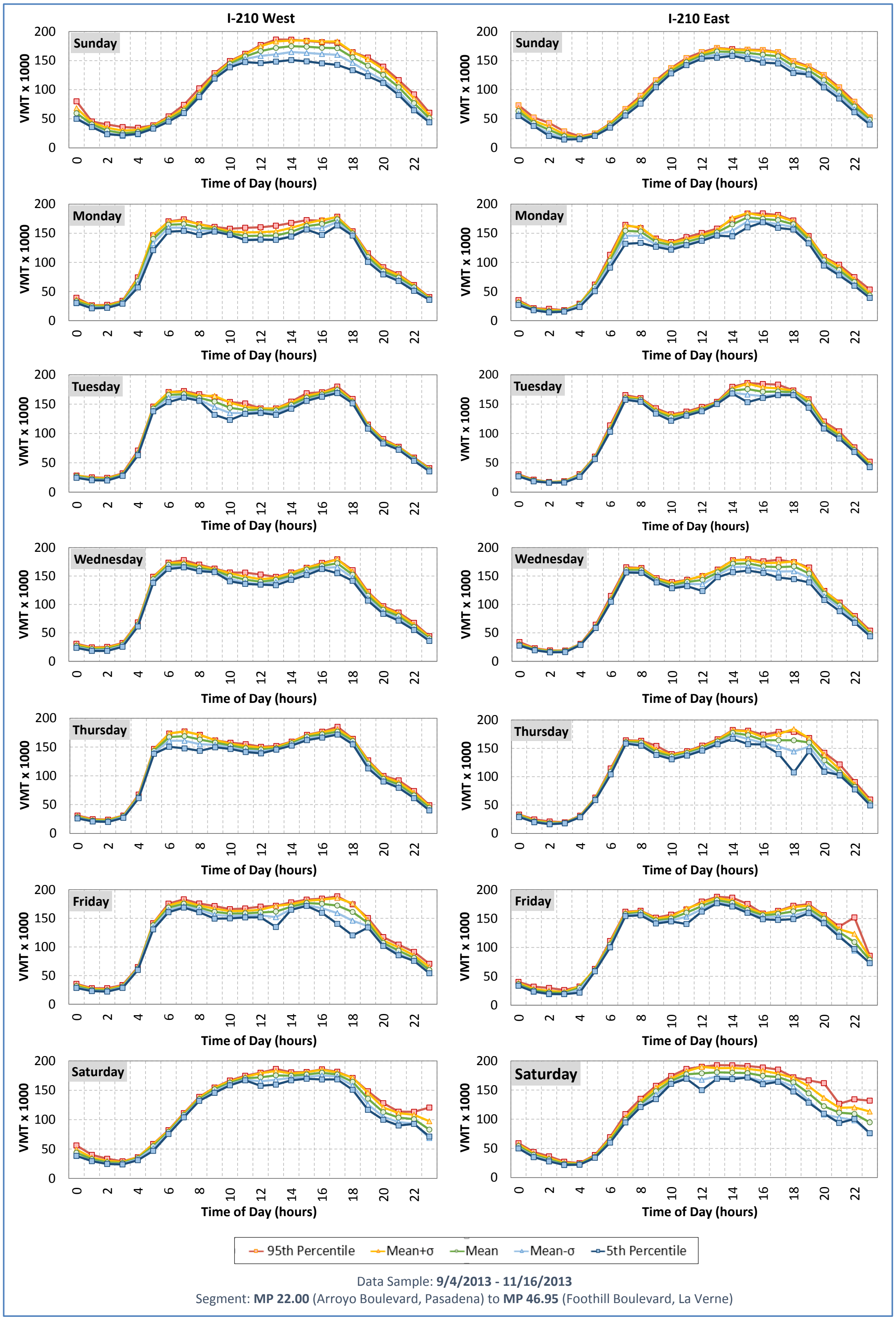


Figure 69 – I-210 Mainline VMT Variability between Arroyo Boulevard and Foothill Boulevard

7.1.3. ARTERIAL TRAVEL DEMAND

This section characterizes the current demand for travel on the corridor arterials. This characterization is primarily achieved through a compilation of mid-block traffic counts that have been executed over the past several years by the various jurisdictions in the corridor for transportation planning purposes or in support of traffic impact studies associated with specific development projects. While relatively limited, a summary of available information about truck movements on corridor arterials is also provided.

7.1.3.1. *Arterial Traffic Volumes*

Figure 70, Figure 71, and Figure 72 present the average daily traffic volumes that have been derived from traffic counts for various arterial roadway links across the I-210 corridor by various local jurisdictions. Each graph presents the total number of vehicles that have been counted on the given roadway links, in both travel directions, over a 24-hour period on a normal weekday. The following are key observations that can be derived from the statistics:

- **Pasadena (**Figure 70**)** – Within Pasadena, the highest traffic volumes are typically observed on Lake Avenue between Colorado Boulevard and Washington Boulevard, as well as on sections of Fair Oaks Avenue and Arroyo Parkway south of California Boulevard. On a normal weekday, these arterial segments carry between 30,000 and 40,000 vehicles. 24-hour volumes exceeding 20,000 vehicles are also observed on sections of Colorado Boulevard, Del Mar Boulevard, California Boulevard, Orange Grove Boulevard, Allen Avenue, Altadena Drive, San Gabriel Boulevard, Sierra Madre Boulevard, and Foothill Boulevard.
- **Arcadia (**Figure 71**)** – Within Arcadia, the busiest arterials are Huntington Drive, Foothill Boulevard, Baldwin Avenue, Santa Anita Avenue, and Live Oak Avenue. These facilities all feature segments carrying over 25,000 vehicles per day. Within the group, the busiest section is Huntington Drive west of Holly Avenue, with a 24-hour traffic volume oscillating between 31,000 and 35,000 vehicles. Daily traffic volumes exceeding 20,000 vehicles are also observed on sections of Duarte Road, Sunset Boulevard, and Las Tunas Drive.
- **Monrovia** – No count data were found for the City of Monrovia. Since both Huntington Drive and the section of Myrtle Avenue south of Huntington Drive are designed as primary arterials, it can be assumed that these two arterials would normally carry the highest traffic volumes within the city. Similarly, since Duarte Road, Foothill Boulevard, Mountain Avenue, California Avenue south of Huntington Drive are all designed as secondary arterials, it can further be assumed that notable traffic volumes may exist on these facilities.
- **Duarte (**Figure 72**)** – The busiest arterials within Duarte are Huntington Drive and Mountain Avenue near the I-210. In 2005, which represents the latest data available, Huntington Drive was estimated to carry between 24,000 and 29,000 vehicles per day within the city limits, while the sections of Mountain Avenue immediately north and south of the I-210 carried 24,500 and 31,000 vehicles respectively. Other arterials typically had 24-hour volumes of less than 15,000 vehicles, except for a section of Buena Vista close to the I-210 with a daily volume of nearly 19,000 vehicles.
- **Jurisdictions east of I-605 (**Figure 72**)** – East of the I-605, the two primary east-west arterial corridors are Foothill Boulevard / Alosta Avenue and Arrow Highway. Both corridors typically carry between 20,000 and 25,000 vehicles day. The three primary north-south arterials are Irwindale Avenue, Grand Avenue, and Lone Hill Avenue. The three arterials all feature sections carrying over 30,000 vehicles per day. Azusa Road and Citrus Avenue are two additional relatively busy arterials.

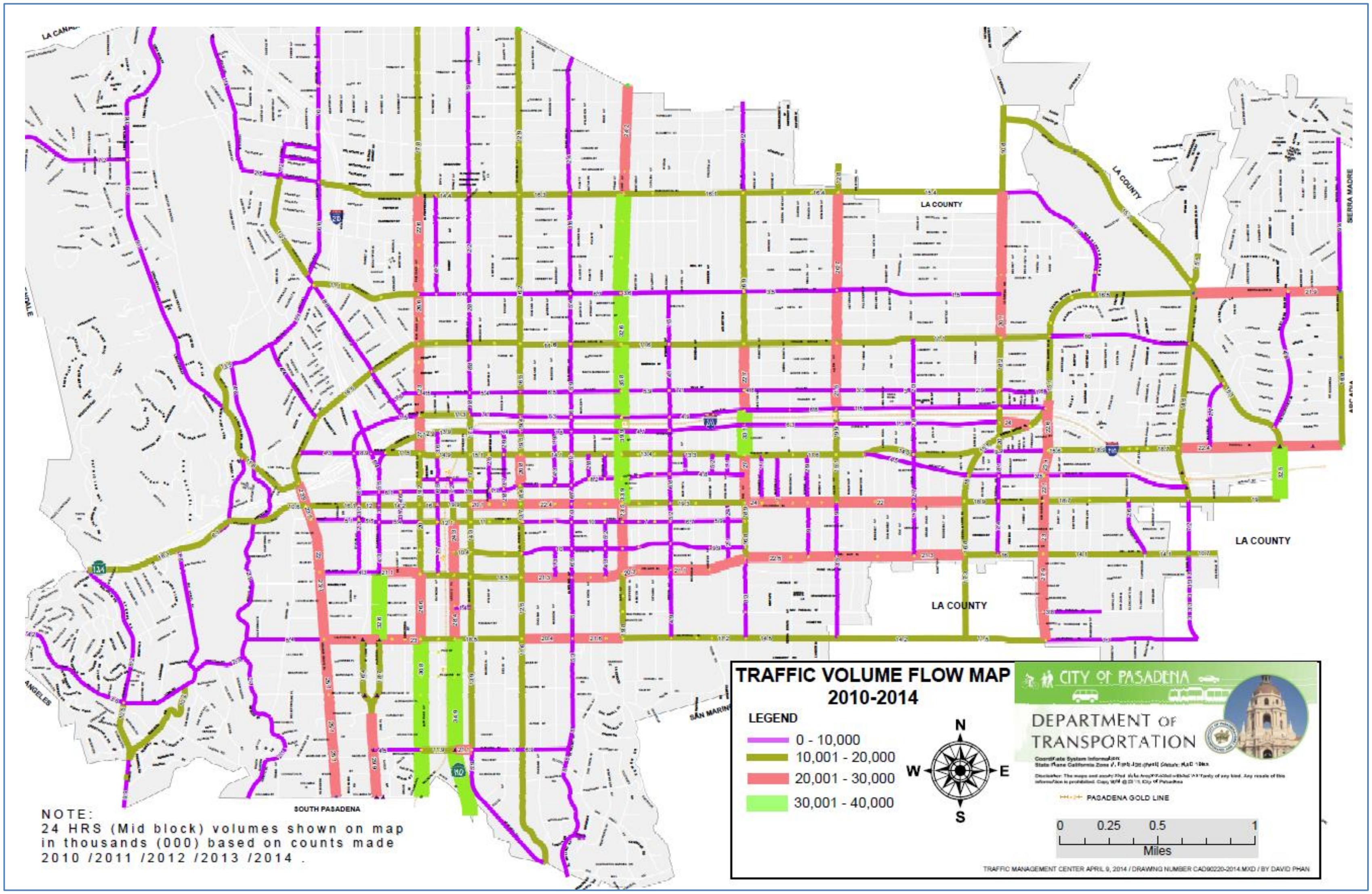


Figure 70 – 24-Hour Arterial Traffic Volumes, Pasadena (2010-2014)

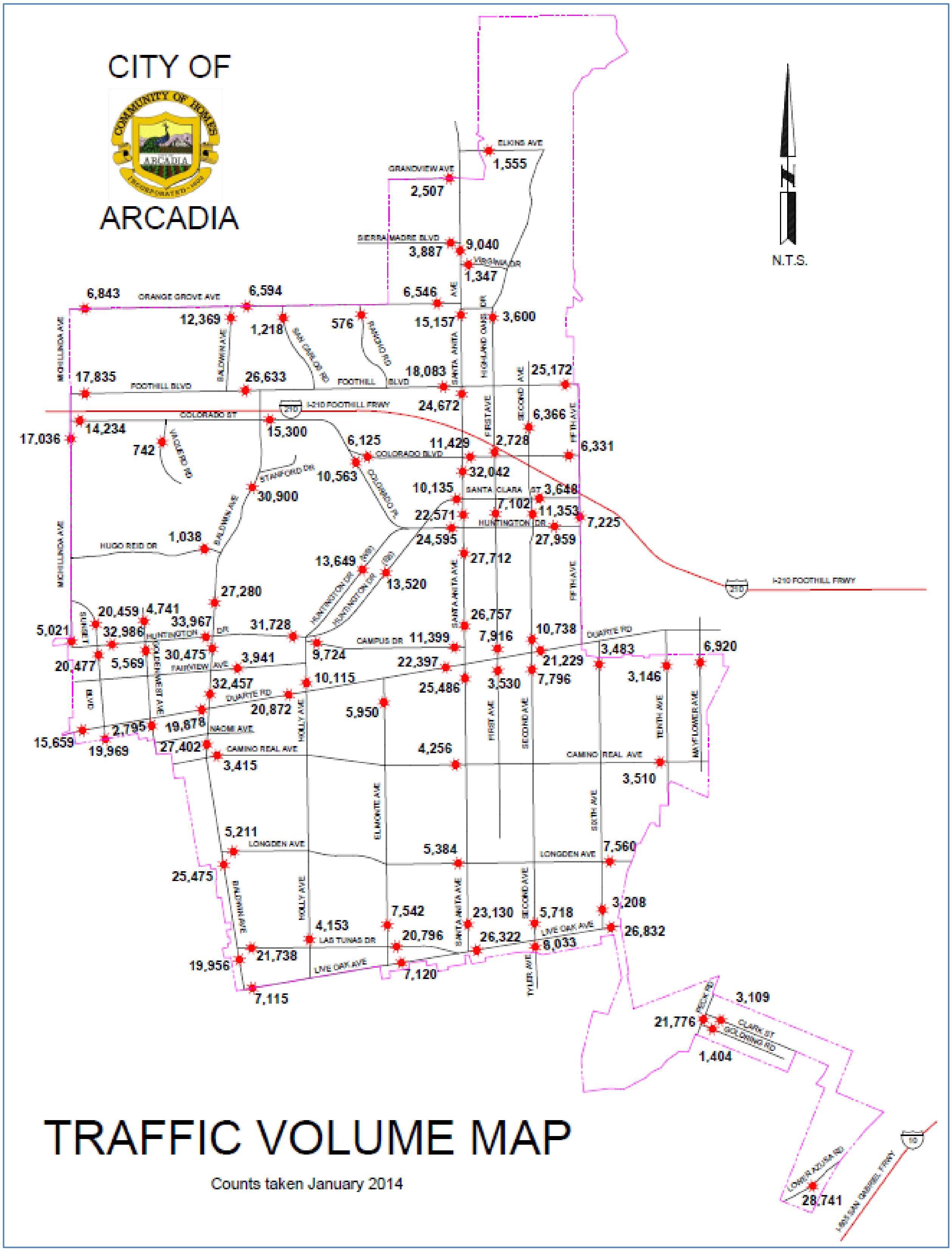


Figure 71 – 24-Hour Arterial Traffic Volumes, Arcadia (2014)

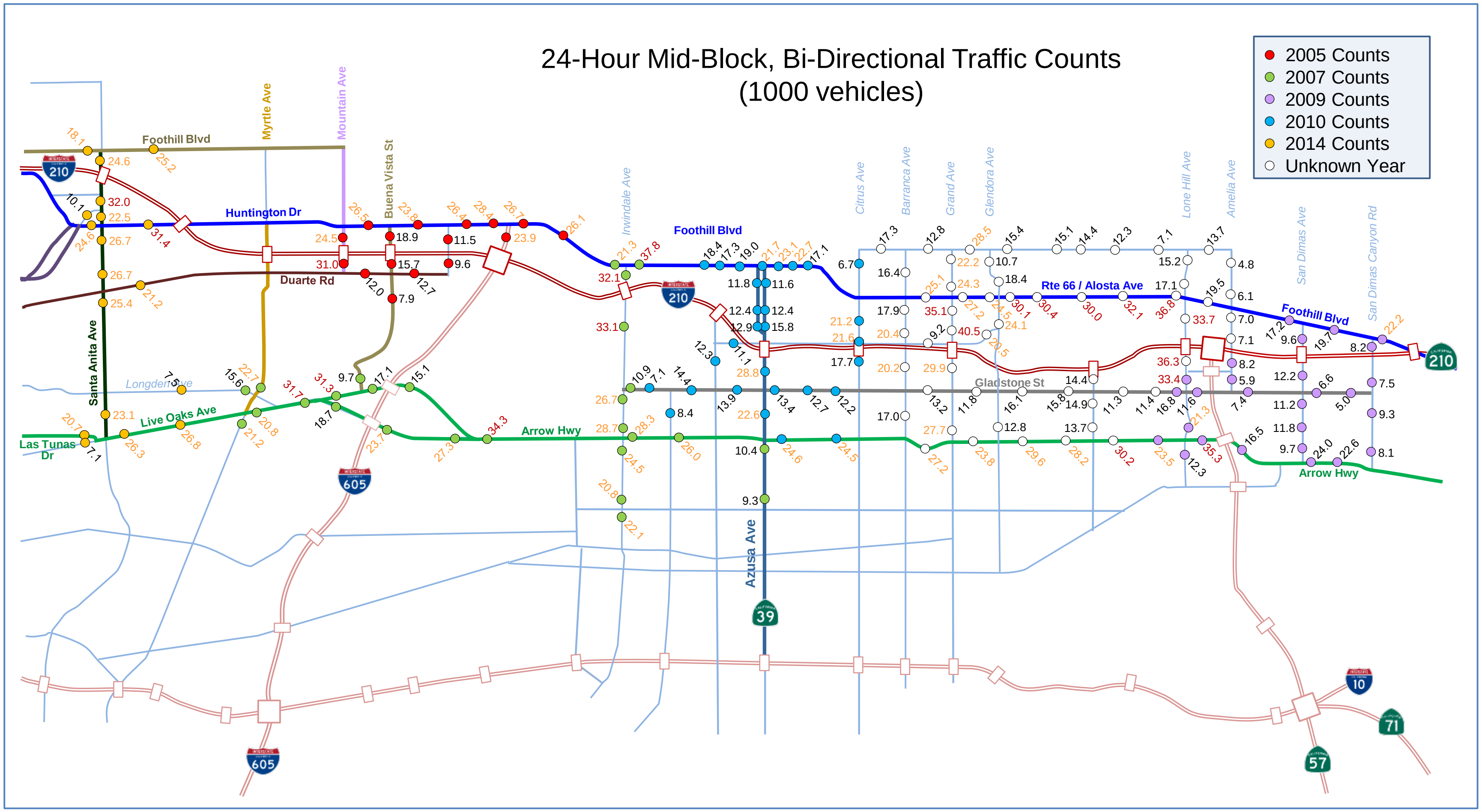


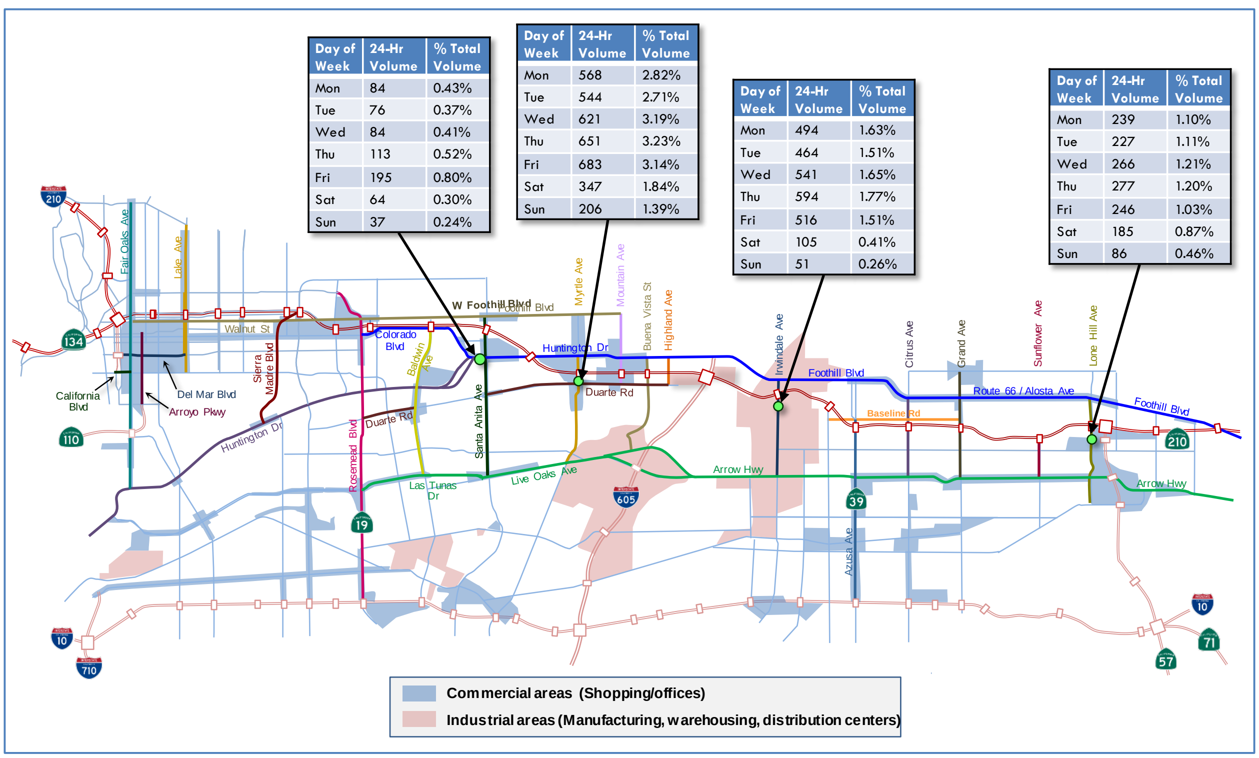
Figure 72 – 24-Hour Arterial Traffic Volumes, East End of Corridor (2005-2010)

7.1.3.2. Arterial Truck Volumes

Relatively little recent information exists about truck movements on arterials surrounding the I-210. The primary source of information is a 2010 study on truck movements that was commissioned by LA Metro to analyze truck movements on the I-210, I-605 and SR-57 freeways. Figure 73 maps the results of the vehicle classification counts that were conducted as part of the study. The arterial segments mapped with a bold line represent the designed as truck routes within the corridor, while the shaded areas indicate commercial and industrial areas.

The following are key observations that can be made from the study and existing truck movement regulations:

- No significant truck traffic is expected to occur on arterial segments not designed as part of a truck route as law enforcement agencies can give citations to truckers these arterial segments without a permit or valid reason.
- Reflective of business cycles, the proportion of trucks on arterials is highest during weekdays, typically reaching a peak on Wednesdays or Thursdays.
- On segments that are part of a truck route, the proportion of heavy trucks remains relatively small, typically below 4%, and often below 1%.
- The largest proportions of trucks were observed on Myrtle Avenue and Irwindale Avenue. This can be expected, as these two arterials connect the I-210 freeway with the large industrial areas along the I-605 freeway and Irwindale Avenue. On Myrtle Avenue, trucks were observed to comprise between 2.8 and 3.2% of the total weekday traffic. On Irwindale Avenue, the proportion of trucks oscillates between 1.5 and 1.8%.



Day of Week	24-Hr Volume	% Total Volume
Mon	84	0.43%
Tue	76	0.37%
Wed	84	0.41%
Thu	113	0.52%
Fri	195	0.80%
Sat	64	0.30%
Sun	37	0.24%

Day of Week	24-Hr Volume	% Total Volume
Mon	568	2.82%
Tue	544	2.71%
Wed	621	3.19%
Thu	651	3.23%
Fri	683	3.14%
Sat	347	1.84%
Sun	206	1.39%

Day of Week	24-Hr Volume	% Total Volume
Mon	494	1.63%
Tue	464	1.51%
Wed	541	1.65%
Thu	594	1.77%
Fri	516	1.51%
Sat	105	0.41%
Sun	51	0.26%

Day of Week	24-Hr Volume	% Total Volume
Mon	239	1.10%
Tue	227	1.11%
Wed	266	1.21%
Thu	277	1.20%
Fri	246	1.03%
Sat	185	0.87%
Sun	86	0.46%

Figure 73 – Observed Arterial Truck Volumes

7.2. FREEWAY OPERATIONS

This section describes key aspects of current traffic operations along the I-210 freeway. Elements characterized herein include:

- Location and cause of recurring bottlenecks
- Observed vehicle delays
- Current travel time profiles
- Current travel time reliability
- Location of safety hotspots

7.2.1. RECURRING BOTTLENECKS

Figure 74 and Figure 75 identify the main recurring bottlenecks associated with the AM and PM peak travel periods along the I-210 freeway. These bottlenecks were identified and verified during the winter of 2007 and spring of 2008 by the team that developed the I-210 Corridor System Management Plan (CSMP). The bottlenecks were identified based on data from Caltrans' 2006 State Highway Congestion Monitoring Program (HICOMP) Annual Data Compilation report, probe vehicle runs, Caltrans freeway detector data, aerial photos, field reviews, and other data sources. As indicated, most of the bottlenecks along the freeway are associated with locations with significant weaving traffic, either by traffic entering or exiting the freeway, and in some cases compounded by roadway geometry factors, such as sharp curves or lane drops.

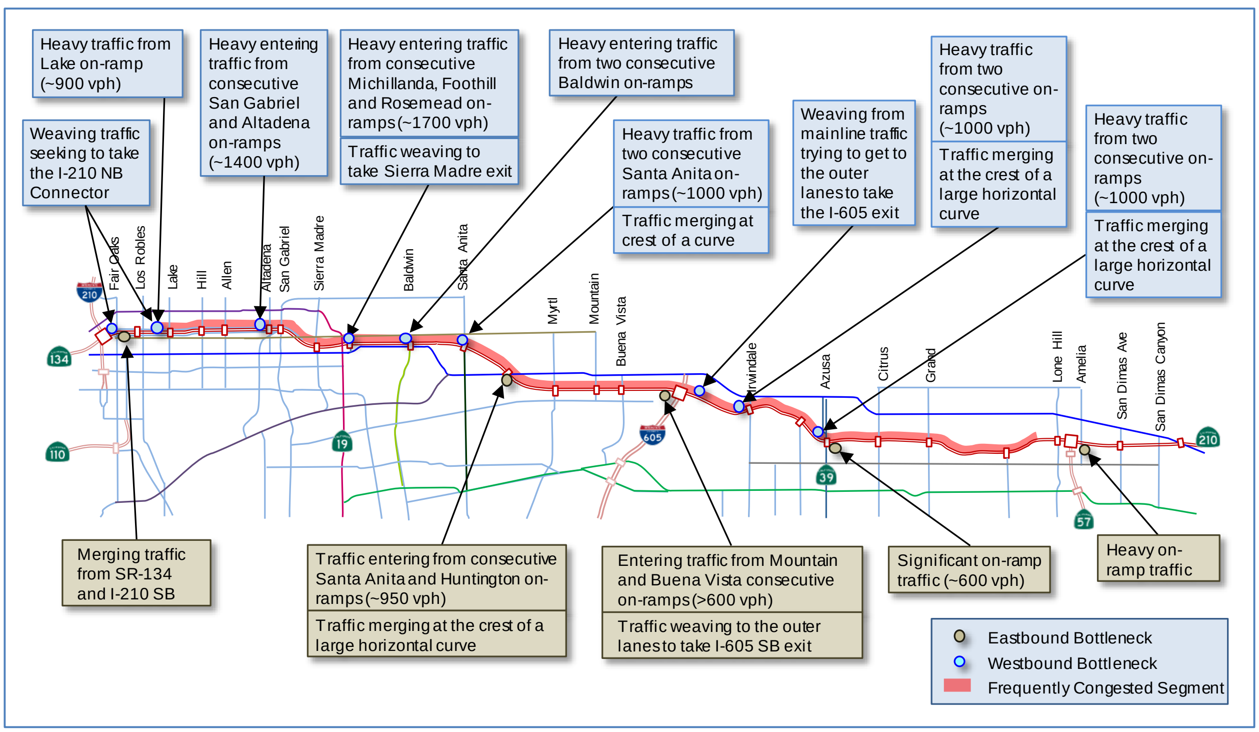


Figure 74 – Main Freeway Bottlenecks – AM Peak

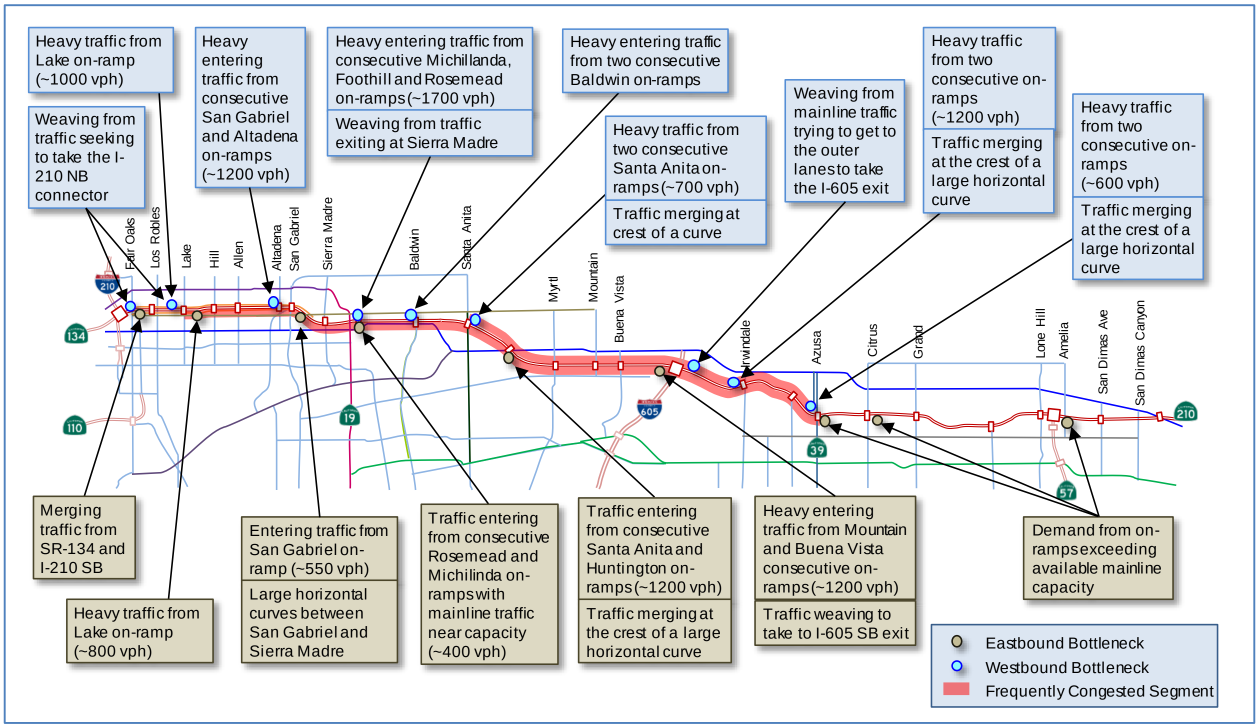


Figure 75 – Main Freeway Bottlenecks – PM Peak

In each direction, the bottlenecks on the HOV lane typically occur at the same location as the bottlenecks on the freeway mainline. This is primarily due to the close proximity of the HOV lane to the mainline traffic lanes. Along the I-210, the HOV lane is separated from the mainline lanes by a simple double yellow-and-white stripe separation about two feet in width. The HOV-lane also has little to no inside shoulder. When stop and go traffic occurs on the mainline, traffic on HOV lane also slows down, primary out of caution, thus resulting in a flow breakdown, particularly near the HOV lane ingress/egress locations and at roadway curves.

7.2.2. AVERAGE DAILY TRAVEL TIME PROFILES

Figure 76 illustrates the estimated average travel time along I-210 between the SR-134 and Foothill Boulevard interchanges on each weekday and for each travel direction in October and November 2013. These estimations are based on 5-minute speed data that were estimated by PeMS from detector occupancy and count data obtained from the freeway mainline traffic detectors. At a constant speed of 65 mph, 20.25 minutes is needed to travel the section of freeway under evaluation. Considering this reference, the following observations can be made from the data:

- Westbound travelers typically experience increased travel time along the I-210 freeway on each weekday between 6:00 AM and 11:00 AM, as well as between 4:00 and 8:00 PM. In the morning, the average travel time typically peaks between 7:00 and 9:00 AM, at around 47 minutes on Monday, between 48 and 50 minutes on Tuesday, Wednesday and Thursday, and at around 37 minutes on Friday. In the afternoon, the average travel time only exceeds 30 minutes between 5:00 PM and 7:00 PM on Fridays.

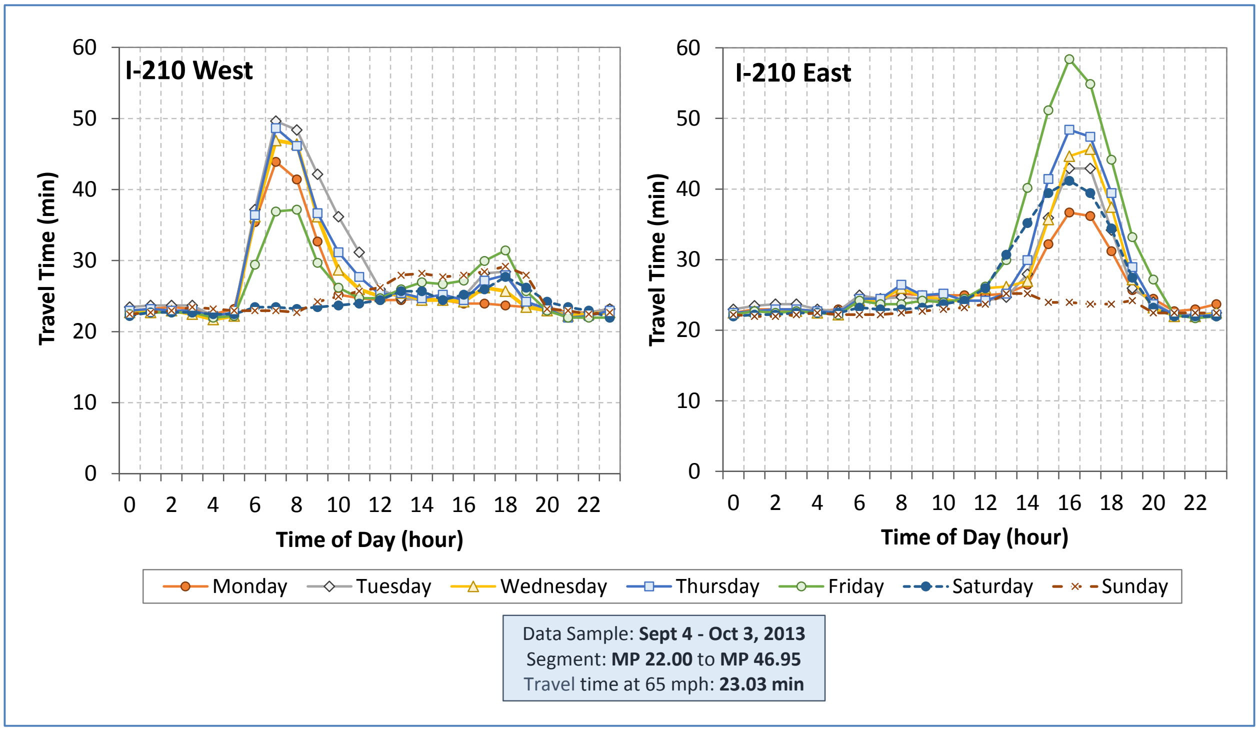


Figure 76 – Average Travel Times on I-210 between Arroyo Boulevard and Foothill Boulevard by Time of Day, Day of Week, and Direction

- Eastbound travelers only experience significantly longer travel times during the afternoon peak, usually between 2:00 PM and 8:00 PM, with peaks occurring between 4:00 PM and 6:00 PM. On Fridays, however, travel times often start to increase as early as 1:00 PM and do not return to free-flow levels before 9:00 PM. In this direction, peak travel times vary significantly across all weekdays. On Mondays, the average travel time peaks at 37 minutes. On Tuesdays, Wednesdays and Thursdays, it peaks between 42 and 48 minutes. On Fridays, it can finally take up to 59 on average minutes to travel the corridor eastward between 4:00 PM and 5:00 PM

- Increased travel times are also observed on Saturday afternoons in both travel directions. In the westbound direction, an average peak travel time of 28 minute is observed between 6:00 PM and 7:00 PM. In the eastbound direction, the peak travel time reaches 41 minutes between 4:00 PM and 5:00 PM.

- On Sunday, average travel times between 28 and minutes are observed almost continuously from 1:00 PM to 8:00 PM in the westbound direction, while travel times remain near free-flow conditions in the opposing direction.

7.2.3. DAILY TRAVEL TIME RELIABILITY

Figure 77 characterizes the daily variability of travel times along the I-210 freeway for each weekday. Similar to Figure 76, this characterization is based on estimated traffic speed data at freeway mainline traffic detectors between September 4 and October 3, 2013. For each weekday and travel direction, the figure illustrates the average estimated travel time for each one-hour interval, the range of travel times corresponding to one standard deviation, and the travel times corresponding to the 5th and 95th

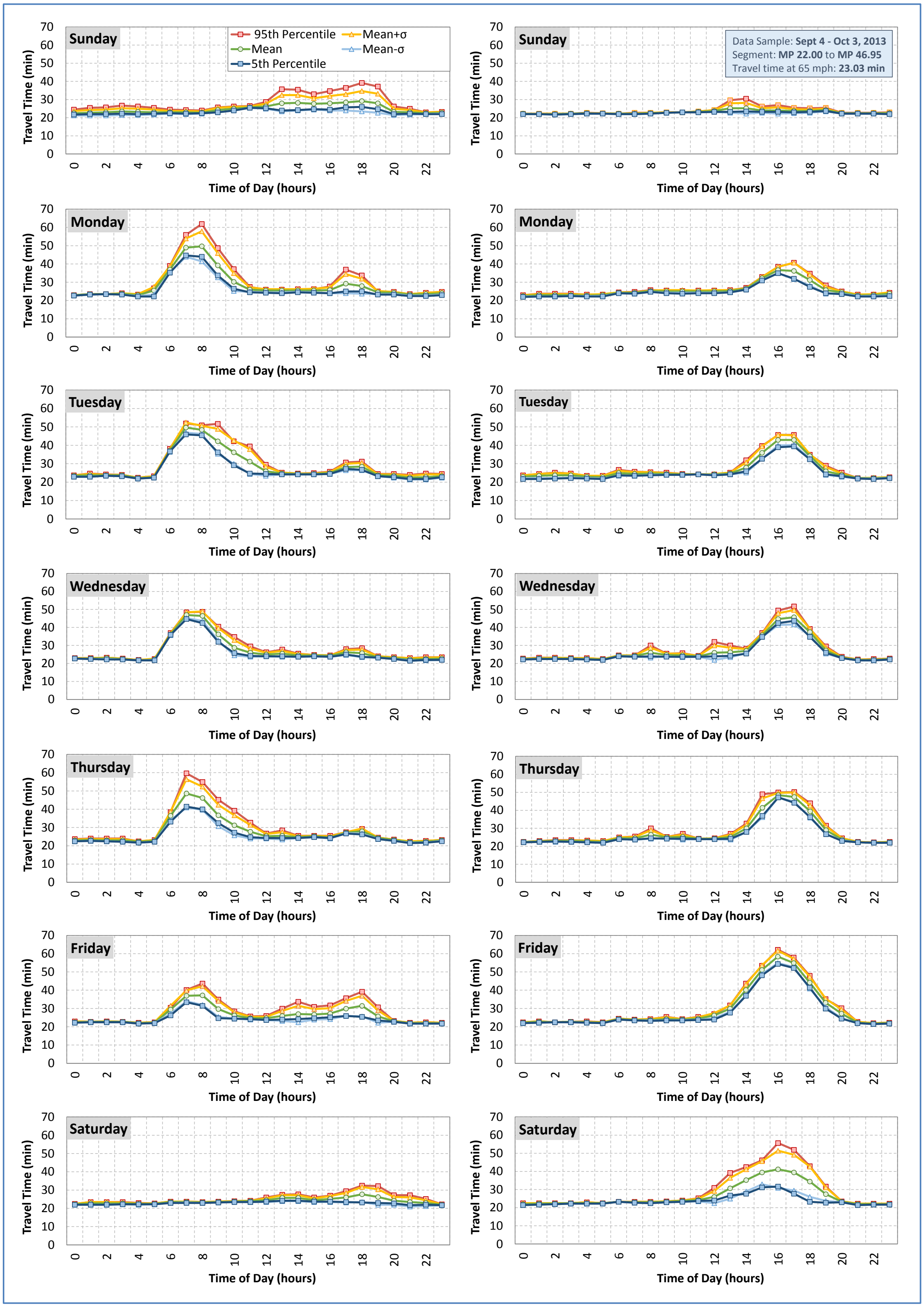


Figure 77 – Variability of Travel Times on I-210 between Arroyo Boulevard and Foothill Boulevard, by Time of Day, Day of Week, and Direction

percentiles. The one standard deviation range illustrates the shortest and fastest travel times that would include 68% of observations if it is assumed that travel time observations are normally distributed. The 5^{th} and 95^{th} percentiles represent extreme values that may be observed on occasion. While longer travel times are possible, the 5^{th} and 95^{th} percentile boundaries are thought to represent a reasonable balance between extreme traffic conditions and conditions that can be expected to occur during typical operations.

As shown in each of the graphs, travel times along the corridor exhibit significant variability within each day and across days. The following are key observations that can be made regarding the illustrated data:

- While many factors may be contributors, the observed variations are likely primarily influenced by the number, duration and magnitude of incidents occurring within each day, as well as normal fluctuations in traffic demand from one week to the next. No holidays are included in the analysis period.
- In the westbound direction, the start of the AM peak period generally occurs at the same time across weekdays, in the 6:00 to 7:00 AM interval. In the eastbound direction, the afternoon peak period starts in either the 1:00 to 2:00 PM, 2:00 to 3:00 PM interval, or 3:00 to 4:00 PM interval.
- Across weekdays, there are significant variations in the magnitude of the traffic congestion associated with the AM or PM peak period. As an example, the average travel time reaches 37 minutes during the Monday afternoon peak travel period, but 43 minutes on Tuesday, 46 minutes on Wednesday, 48 minutes on Thursday, and 58 minutes on Friday. This is a range of 21 minutes. For the AM peak period, peak travel times in the westbound direction vary between 37 and 50 minutes, for a range of 13 minutes.
- For a given time period on a given weekday, there can be significant variations in travel times from one week to the next, particularly during peak periods. As an example, the calculated 5^{th} and 95^{th} percentile values indicate that Thursday morning westbound travel times can vary between 40 and 60 minutes. This is a 20-minute range. While smaller variations are generally observed for other days, several periods still feature near 10-minute ranges between the 5^{th} and 95^{th} percentile travel times.
- Travel time fluctuations during peak periods result in a travel time index of approximately 0.34 for each travel direction. In the off-peak period, the index generally oscillates between 0.01 and 0.20, with an average of 0.05. The travel time index represents the additional time that must be budgeted above the reported average travel time to ensure an on-time arrival 95% of the time. As an example, an index of 0.35 associated to a 40-minute average travel time period indicates that a motorist should plan for an additional 14 minutes of travel, or a potential total travel time of 54 minutes, to ensure an on-time arrival 95% of the time.
- Travel times in the westbound direction appear to experience more fluctuations that travel times in the eastbound direction.
- Over the weekend, travel times are highly variable in the eastbound direction on Saturday afternoon and the westbound direction on Sunday afternoon.
- In addition to the magnitude of the congestion, the duration of the peak period on a given weekday can vary noticeably from one weekday to the next.

7.2.4. INCURRED DELAYS

Figure 78 illustrates the average weekday delay incurred by vehicles traveling along different sections of I-210. For each travel direction, the figure illustrates the average daily total vehicle delay for non-holiday weekdays over a 12-month period extending from May 2013 to April 2014. The delays were calculated by PeMS based on vehicle counts and speed estimates from traffic detectors along the freeway mainline and HOV lanes using a reference free-flow speed of 60 mph. Reflective of the higher local traffic levels, most of the delays are incurred on the section of I-210 between the SR-134 and SR-57 interchanges, with the highest delays observed around mileposts 28 and 29, around the interchanges with San Gabriel Boulevard, Sierra Madre Villa Avenue, and Rosemead Boulevard. Outside of this section, notable delays are also observed in the eastbound direction upstream of the SR-2 interchange. Significant variability further exists from one detection station to the next as traffic moves from one bottleneck to the next.

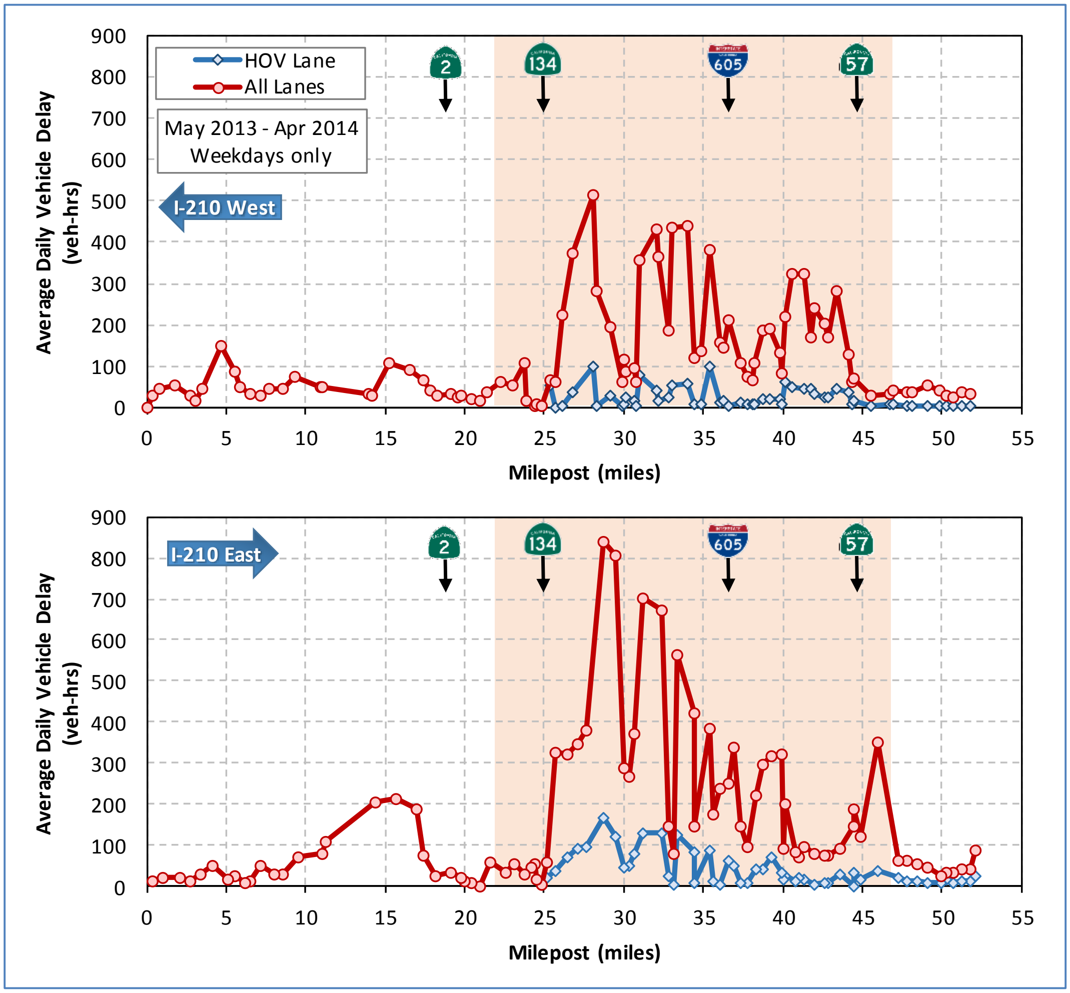


Figure 78 – Average Weekday Vehicle Delay at Various Locations along I-210

Figure 79 tracks the changes in average weekday delay from January 2008 to April 2014. Following significant fluctuations, average weekday delays in the westbound direction are 9% higher in 2013 than in 2008, while the eastbound delays are 23% higher, indicating an increase in congestion. Various factors may explain the significant fluctuations observed between 2008 and 2013. The financial crisis of late 2008

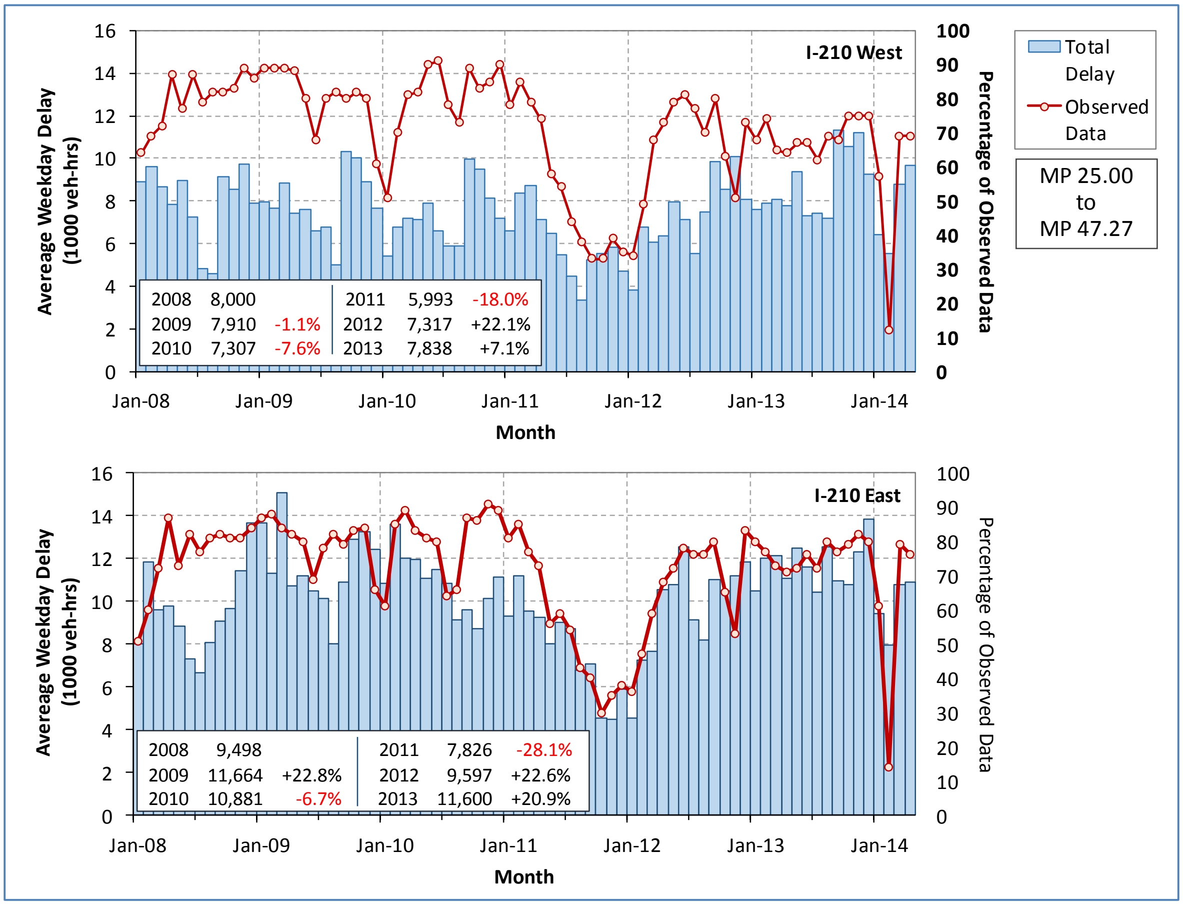


Figure 79 – Average Weekday Vehicle Delay between MP 25.00 and MP 46.94, by Month

and subsequent economic recession provide some explanations. Construction projects, along either I-210 or neighboring freeways, may have also influenced travel demand, as suggested in the VMT analysis of Figure 63. Infrastructure and operational improvements, such as the activation of freeway-to-freeway connector metering and the addition of ramps meters at non-metered ramps and on HOV bypass lanes on metered ramps in early 2008 as part of the I-210 Congestion Relief Project, are likely additional influencing events. Finally, some fluctuations such as the large observed drop in estimated delay in late 2011/early 2012 or the short-term drop observed in January/February 2012 may be explained by data quality issue, as the dips in estimated delays appear linked with a dip in the percentage of observed data.

Figure 80, finally, compares the average incurred delay in each direction of travel for each day of the week. For the eastbound direction, the lowest delays are typically observed on Monday and noticeably increase with each passing day until a peak is reached on Friday. This trend reflects the trend of increasing VMT from one weekday to the next that was presented in Figure 64. For the westbound direction, the data indicates that traffic experiences relatively constant congestion levels from Monday through Thursday, and lower congestion on Fridays. This is somewhat counterintuitive with the data of Figure 64 that shows an increase in VMT as the week progresses. This may be the result of a slightly lower overall traffic demand in the eastbound direction.

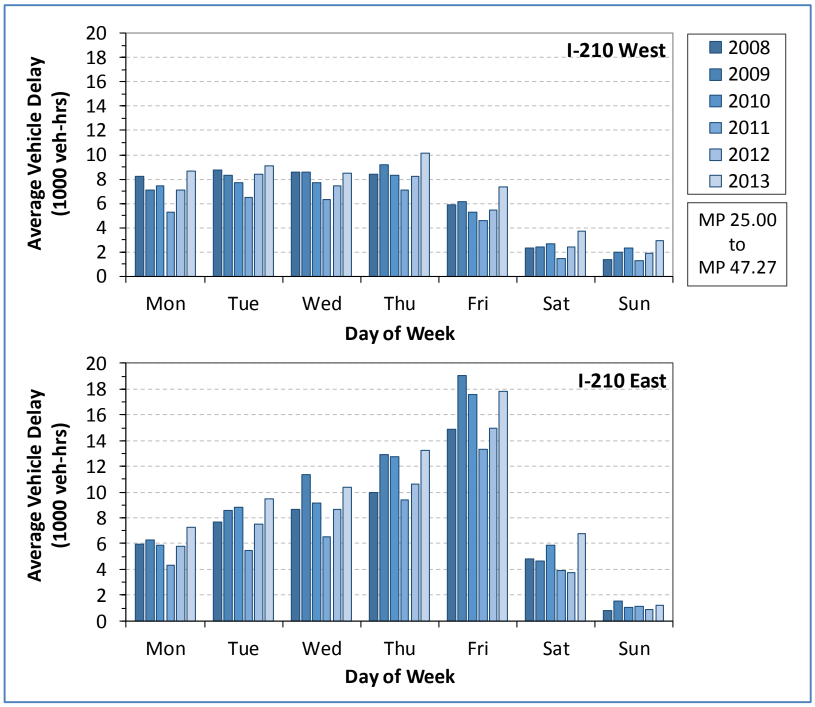


Figure 80 – Average Daily Vehicle Delay between MP 25.00 and MP 46.94, by Day of Week

7.2.5. TRAFFIC SAFETY

This section presents a general safety assessment of the I-210 corridor. This assessment aims to characterize general accident trends along the corridor and to highlight locations with notable accident concentrations and readily apparent patterns. It is not intended to supplant more detailed safety investigations routinely performed by Caltrans staff.

Table 10 begins by presenting general statistics on incidents that have been logged by the CHP along various sections of I-210 within Los Angeles County throughout 2011, based on information available in PeMS. The statistics cover both injury and non-injury data (excluding fatal accidents), as well as incidents ranging in duration from less than one minute to several hours. Data from 2011 are presented since this is the most recent year for which a complete set of incident records was available. The top part of the table presents average statistics for normal weekdays while the bottom section presents statistics for weekend days and weekdays falling on a holiday.

The data further indicate that over 40 incidents were logged on average every weekday throughout 2011 along the section of I-210 traveling through Los Angeles County, and that 22 incidents were logged daily on weekends and holidays. When considering only the section extending from SR-134 to SR-57, approximately 24 incidents were logged daily on average during weekdays, and 12 incidents during weekends or holidays. These frequencies indicate that days without incidents are rare.

When considering the rate of incidents relative to traffic demand, Table 10 further indicates that 4.9 incidents per million miles traveled were logged on average during weekdays throughout 2011, and that 4.0 incidents per million miles traveled were logged on average over weekend days and holidays. These statistics are for the entire section of I-210 within Los Angeles County. When analyzing data on a section-by-section basis, the portion of I-210 between Rosemead Boulevard and the I-605 freeway is observed to

Table 10 – Frequency and Rate of Incidents on I-210 in 2011

Corridor Section			I-210 W				I-210 E			
Segment	Mileposts	Length	Number of Incidents	Vehicle-miles traveled (VMT)	Incidents/ Day	Incidents/ million VMT	Number of Incidents	Vehicle-miles traveled (VMT)	Incidents/ day	Incidents/ million VMT
Weekdays										
I-5 to SR-134	0.0 – 25.0	25.0	1,835	339,578,943	7.3	5.4	1,762	324,338,666	7.0	5.4
SR-134 to Rosemead	25.0 – 30.0	5.0	729	166,269,804	2.9	4.4	637	175,010,107	2.6	3.6
Rosemead to I-605	30.0 – 36.6	6.6	1,076	166,158,455	4.3	6.5	961	167,657,426	3.8	5.7
I-605 to SR-57	36.6 – 45.0	8.4	1,385	218,635,400	5.5	6.3	1,294	231,871,070	5.2	5.6
SR-57 to Foothill	45.0 – 47.3	2.3	93	43,758,903	0.4	2.1	110	25,030,549	0.4	4.4
Foothill to County Line	47.3 – 52.5	5.2	223	91,213,575	0.9	2.5	325	120,708,649	1.3	2.7
Freeway	***0.0 – 52.5***	***52.3***	***5,349***	***1,025,615,08***	**21.4**	***5.2***	***5,089***	***1,044,616,470***	**20.4**	***4.9***
Weekends and Holidays										
I-5 to SR-134	0.0 – 25.0	25.0	689	118,633,140	4.6	5.8	629	116,207,283	4.2	5.4
SR-134 to Rosemead	25.0 – 30.0	5.0	248	66,396,295	1.7	3.7	173	70,969,312	1.2	2.4
Rosemead to I-605	30.0 – 36.6	6.6	300	70,636,813	2.0	4.2	313	69,956,648	2.1	4.5
I-605 to SR-57	36.6 – 45.0	8.4	412	93,418,639	2.8	4.4	379	98,754,346	2.5	3.8
SR-57 to Foothill	45.0 – 47.3	2.3	21	19,902,723	0.1	1.0	42	11,295,046	0.3	3.7
Foothill to County Line	47.3 – 52.5	5.2	76	40,664,034	0.5	1.9	148	53,017,030	1.0	2.8
Freeway	***0.0 – 52.5***	***52.5***	***1,746***	***409,651,646***	**11.6**	***4.3***	***1,684***	***420,199,667***	**11.2**	***4.0***

Source: All Non-injury and injury accidents reported by PeMS from CHP incidents data

have the highest incident rates, with rates varying between 5.7 to 6.5 incidents per million miles traveled compared to rates of 2.5 to 5.4 incidents on surrounding sections. This is not surprising given that this section features high traffic demand and several bottlenecks. On a directional basis, a higher incident rate also appears to be associated with the westbound traffic between the SR-134 and SR-57 interchanges.

Figure 81 maps in more detail the location of incidents along I-210. The figure compiles the number of incidents that have been reported for each travel direction on the freeway mainline and ramps throughout 2011 over successive, non-overlapping 0.25-mile sections. As can be observed, the freeway sections with the highest occurrence of incidents are predominantly located between the SR-134 and SR-57 interchanges. High-incident sections are more specifically associated with the Sierra Madre Boulevard/San Gabriel Boulevard (PM 28.25-28.50), Baldwin Avenue (PM 31.25-31.50), Huntington Drive (PM 32.75-33.25), Myrtle Avenue (PM 34.00-34.25), I-605 (PM 36.25-36.75), Irwindale Avenue (PM 37.50-38.00), Azusa Avenue (PM 39.50-39.75), and SR-57 (PM 40.25-40.75) interchanges. Many of these sections are also closely linked to freeway bottlenecks (see Figure 74 and Figure 75 in Section 7.2.1). While some variations exist in the number of reported incidents from year to year, a multi-year data analysis further reveals a relative consistency in the location of the high-incident sections.

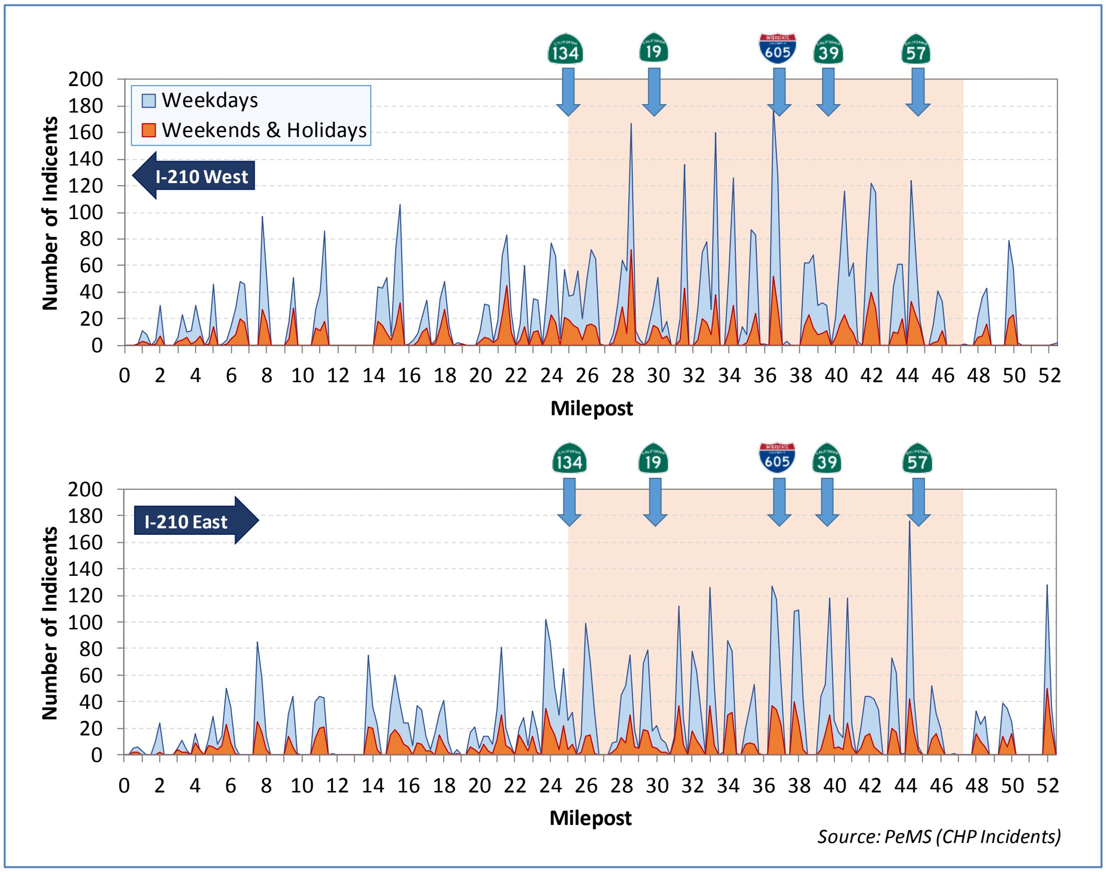


Figure 81 – Location of CHP Reported Incidents along I-210 in 2011

Figure 82 presents contour plots illustrating when and where incidents tend to occur along I-210 between SR-134 and SR-57. The locations with the highest incident frequencies are associated with major interchanges. As further expected, peak frequencies are associated with peak travel periods and directions. For weekdays, peak incident frequencies are associated with the morning peak westbound traffic and afternoon peak eastbound traffic. Less noticeable peaks are observed for weekend days and holidays due to the lower traffic demand that prevails on those days. In this case, the highest incident frequencies are associated with the late morning or afternoon period, when traffic demand normally reaches its maximum level.

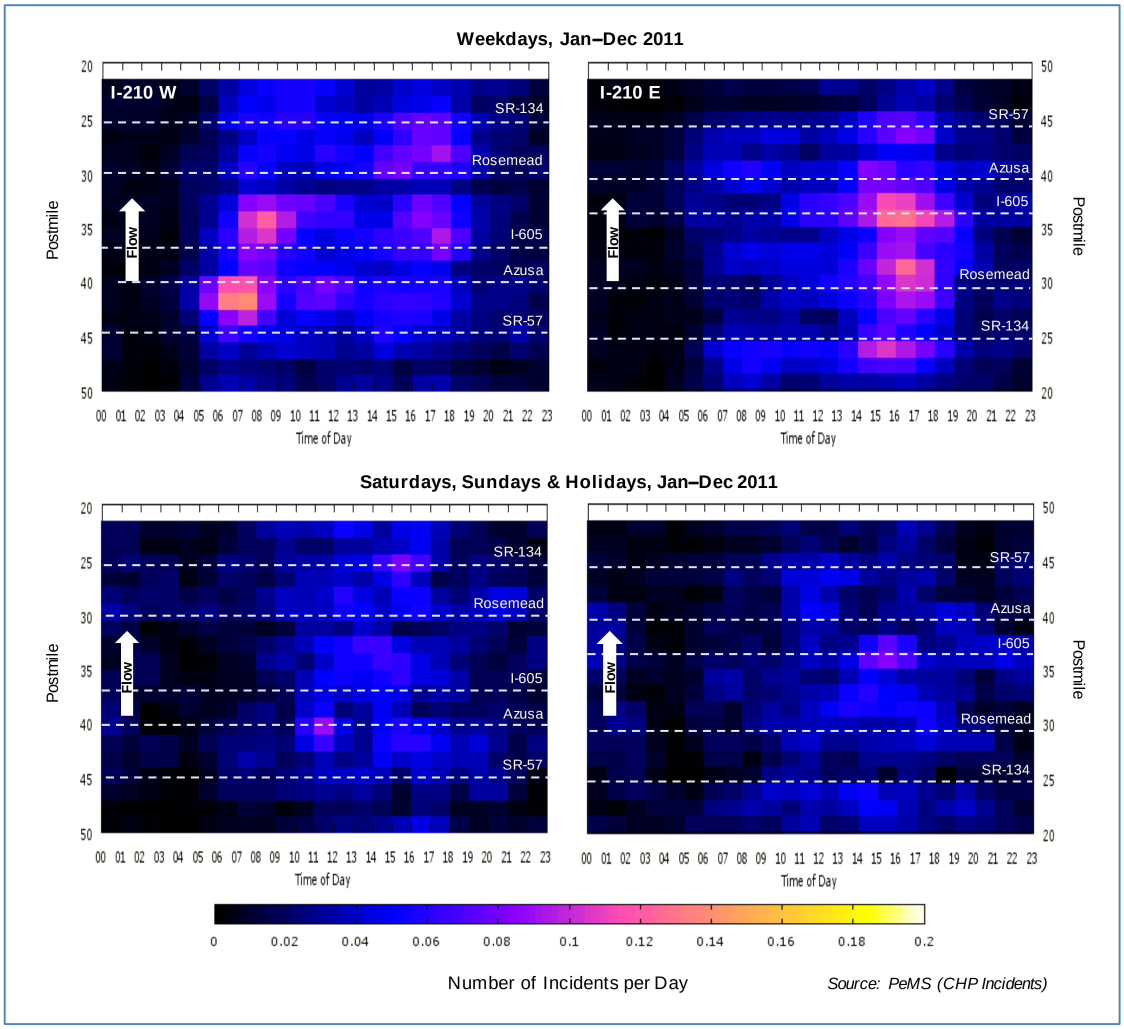


Figure 82 – Frequency of Incidents along I-210 According to Time of Day in 2011

Figure 83 looks at the duration of events between SR-134 and Foothill Boulevard. These events are the same as those mapped in Figure 82. It should be noted that the actual duration of events is in many cases likely to have been longer than reported. Many of the CHP incident records that were used to perform the compilation have a duration that corresponds to the time it took to notify the CHP or for a vehicle to arrive at the scene, not the time to clear the event. The records also provide no information about the extent to which traffic was affected on the freeway, such as how many lanes were closed and for how long. The compilation nevertheless shows the frequency of incidents with noticeable impacts on local traffic. For instance, 491 events lasting one hour or more were recorded throughout 2011, with 136 of these events lasting more than 2 hours. 371 of these events occurred during weekdays and 120 during weekends or holidays. These statistics convert to 1.48 events lasting one hour or more occurring every weekday on average, and 1.04 events occurring every weekend or holiday day.

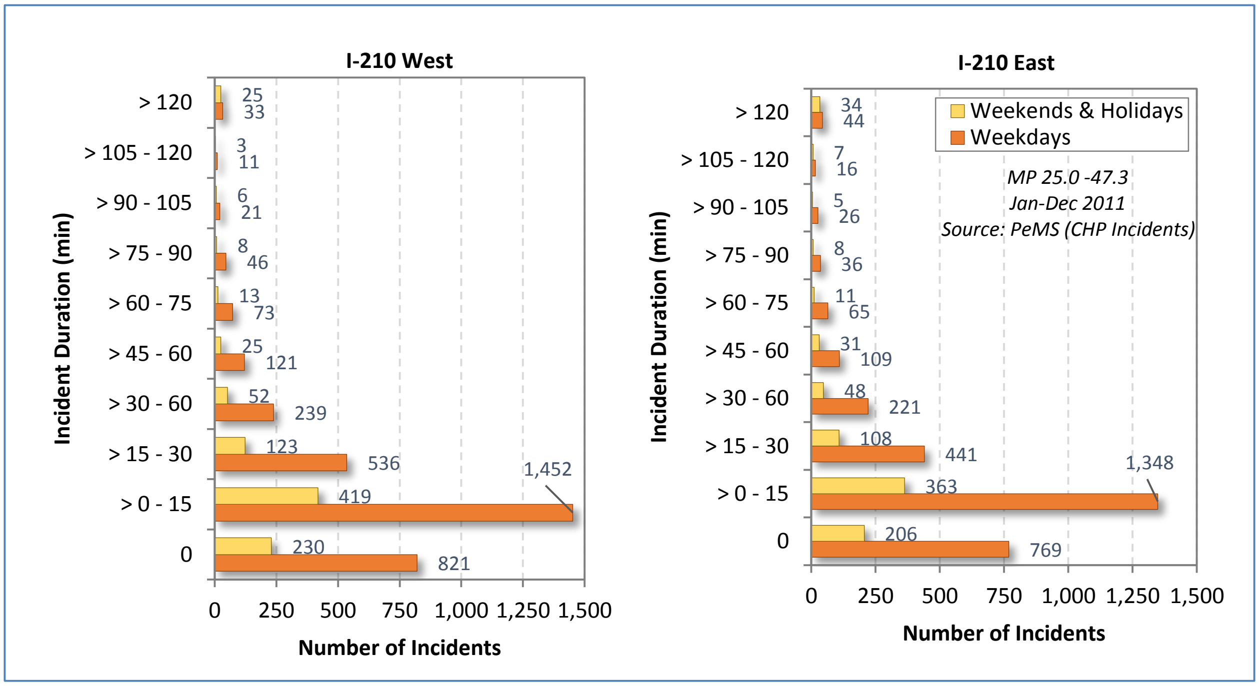


Figure 83 – Incident Durations along I-210 between SR-134 and Foothill Boulevard in 2011

Among the incidents compiled in Figure 83, 10 resulted in the deployment of Caltrans' Traffic Management Team (TMT). As indicated in Section 6.5.6, the TMT is dispatched to assist the CHP with emergency lane and freeway closures following an accident or emergency incident expected to last 2 hours or more. Table 11 details the events throughout 2011 for which the TMT was deployed. They include events ranging in duration from 0.8 to 5.9 hours. Between 2009 and 2012, the team was deployed 48 times on I-210 between the SR-134 and Foothill Boulevard interchanges, for an average of 12 deployments per year. Events ranged in duration from 0.8 to 13.5 hours, with an average of 5.4 hours.

Table 11 – 2011 Incidents with Caltrans Transportation Management Team Dispatch in 2011

Date	Day	Direction	Location	City	Postmile	Event	Duration
01/22	Sat	210 West	I-605	Irwindale	36.3	Emergency bridge rail repair	3.8
01/29	Sat	210 East	Buena Vista	Duarte	35.5	Fatal accident	3.5
04/27	Wed	210 East	Irwindale	Irwindale	37.5	Fatal accident	4.5
05/05	Thu	210 East	Vernon	Azusa	38.4	Overturned big rig & diesel spill	5.0
06/03	Fri	210 East	Buena Vista	Duarte	35.0	Fatal jumper	3.1
07/21	Thu	210 East	SR-134	Pasadena	25.2	Emergency water line repair	5.6
07/28	Thu	210 East	Grand	Glendora	42.1	Diesel spill	3.8
09/23	Fri	210 West	I-605	Irwindale	36.5	Jackknifed big rig	0.8
10/05	Wed	210 West	SR-134	Pasadena	25.2	Overturned big rig & diesel spill	3.8
10/30	Sun	210 West	SR-134	Pasadena	25.5	Emergency tree removal	5.9

Figure 84 and Figure 85, finally, compile the collision type and primary collision factor associated with all incidents that have occurred along I-210 between milepost 25.21 (Pasadena) and milepost 52.12 (County Border) throughout 2011. This analysis is based on information contained in Caltrans' Traffic Accident Surveillance and Analysis System (TASAS). This analysis period covers 597 incidents. Figure 84 indicates that 53% of accidents that occurred were rear-end collisions, i.e., collisions strongly related to the presence of congestion. If accidents associated with lane changing behavior are added to the statistics, such as sideswipe and broadside accidents, nearly 80% of all recorded accidents could be linked to either congestion or traffic behavior. Figure 85 indicates that a large majority of incidents were caused by driver-related factors, such as speeding (55%), unsafe lane change (17%), and improper turn movements (11%). These statistics indicate that a strong potential exists along I-210 to reduce accident occurrences through improvements to congestion, lane-changing maneuvers, or other unsafe behavior.

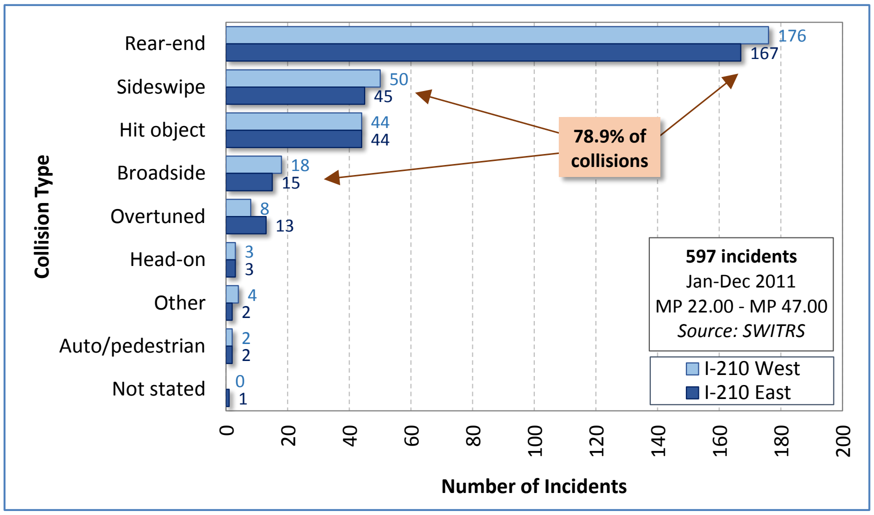


Figure 84 – Type of Injury and Fatal Collisions along I-210 in 2011

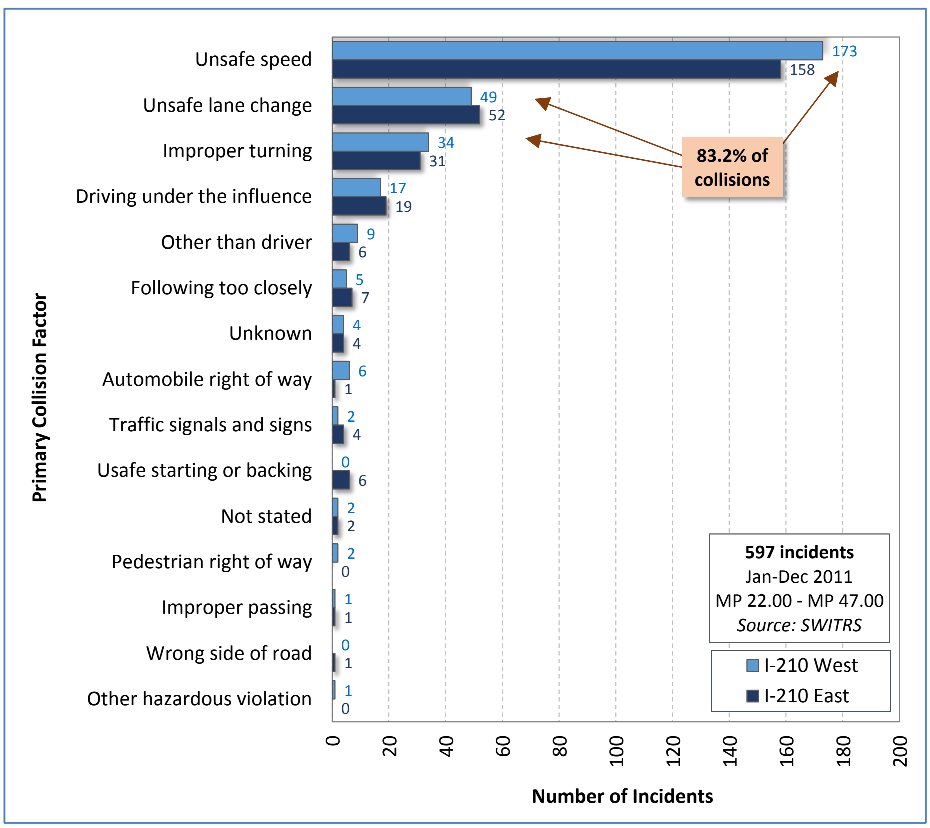


Figure 85 – Primary Cause of Injury and Fatal Collisions along I-210 in 2011

7.3. ARTERIAL OPERATIONS

This section characterizes the following elements regarding the operations of key arterials within the I-210 corridor:

- Available capacity at key signalized intersections
- Traffic safety

7.3.1. AVAILABLE INTERSECTION CAPACITY

This section presents an assessment of the degree to which available traffic capacity at individual signalized intersections within the corridor is used to accommodate recurrent traffic during the AM and PM peak travel periods. This assessment has been done by compiling the volume-to-capacity (v/c) ratio or equivalent Intersection Capacity Utilization (ICU) ratio that have been estimated by various consulting firms over the past 8 years for various groups of intersections as part of traffic signal retiming projects or traffic impact studies. The following lists the various sources from which information was compiled:

- **LA Metro**
    - *Metro Gold Line Foothill Extension – Azusa to Montclair Draft Environmental Impact Report*. Report prepared by LA Metro, August 2012.
- **City of Pasadena**
    - Pasadena citywide Synchro model that had been developed by Iteris in 2013 to support some signal retiming projects.
    - *All Saints Church Master Development Plan*. Report prepared by the City of Pasadena with the assistance of Rincon Consultants, Inc., June 2010.
    - *Crown City Medical Center Environmental Impact Report*. Report prepared by The Planning Center/DC&E for the City of Pasadena, October 2012.
    - *Temporary Use of the Rose Bowl Stadium by the National Football League (NFL)*. Report prepared by Impact Science, Inc. for the City of Pasadena, November 2012.
    - *Lincoln Avenue Specific Plan Environmental Impact Report*. Report prepared by the City of Pasadena, October 2013.
- **City of Arcadia**
    - *The Shops at Santa Anita Parks Specific Plan.* Report prepared by EIP Associates for the City of Arcadia, October 2006.
    - *Huntington Capacity Improvement Project*. Memo prepared by KOA Corporation for the City of Arcadia, May 2014.
- **City of Duarte**
    - *Duarte Station Specific Plan Environmental Impact Report.* Report prepared by RBF Consulting for the City of Duarte, September 2013.
- **City of Glendora**
    - *Glendora Wal-Mart Expansion, Glendora, CA.* Report prepared by Mountain Pacific, Inc. for Applied Planning, Inc., April 2010.

- **City of Irwindale**
    - *Athens-Irwindale Materials Recovery Facility and Transit Station Traffic Impact Analysis*. Report prepared by Urban Crossroads for the City of Irwindale, August 2013.
    - *Olive Pit Mining and Reclamation Project Traffic Impact Analysis*. Report prepared by Urban Crossroads for the City of Irwindale, June 2014.

Figure 86 and Figure 87 present the results of the compilation for the AM Peak and PM Peak periods respectively. The dates shown within each figure represent the dates of the studies behind the information shown from each section of the corridor. Since the studies are spread in time, with the oldest presenting operational analyses from 2006, the result of the assessment presented in this section should only be viewed as a rough assessment of available traffic capacity at individual intersections. On one hand, changes made to the geometry or the traffic signal operating parameters since the respective studies have been made may have noticeably improved their performance. On the other hand, changes in traffic patterns may have further increased or decreased traffic demand at individual intersections and thus, resulted in either increase or deterioration in performance.

In each figure, the available capacity to accommodate traffic flow surges would be the difference between the illustrated factor and 1.00. An intersection with a factor of 0.85 would mean that 15% of the existing overall capacity of the intersection would theoretically be available to accommodate traffic surge, assuming that nothing would prevent shifting unused capacity from one approach or a specific movement to another. In interpreting the results, it should also be noted that the presented statistics assess the operational performance of each intersection during the peak hour of the intersection within the peak period. The statistics thus represent the worse performance over a one-hour period. Performance during other hours of the peak period may be slightly of noticeably better, depending on how traffic demand rises and drops at each intersection. Across intersections, the peak hour within the peak period may also fluctuate depending on local traffic patterns. One intersection may for instance have its peak hour between 4:30 and 5:30 PM, while another may have its peak hour between 5:00 and 6:00 PM.

As can be expected, constrained capacities are found primarily at intersections along the busiest arterials. Intersections with limited available capacity and which may command particular attention when implementing detours around incidents or events are listed in Table 12. Some of these intersections are problematic only during the AM or PM peak period, while other have limited spare capacity during both periods. The intersections to pay particular attention are those having less than 10% available capacity, shown in light gray in the table, and more particularly those with a utilization ratio of 1.00 or above, shown in black. The latter represent intersections for which demand reach or exceed capacity during the peak hour and for which there would be no capacity to accommodate demand surges under the geometry and signal timings in operation at the time of the study.

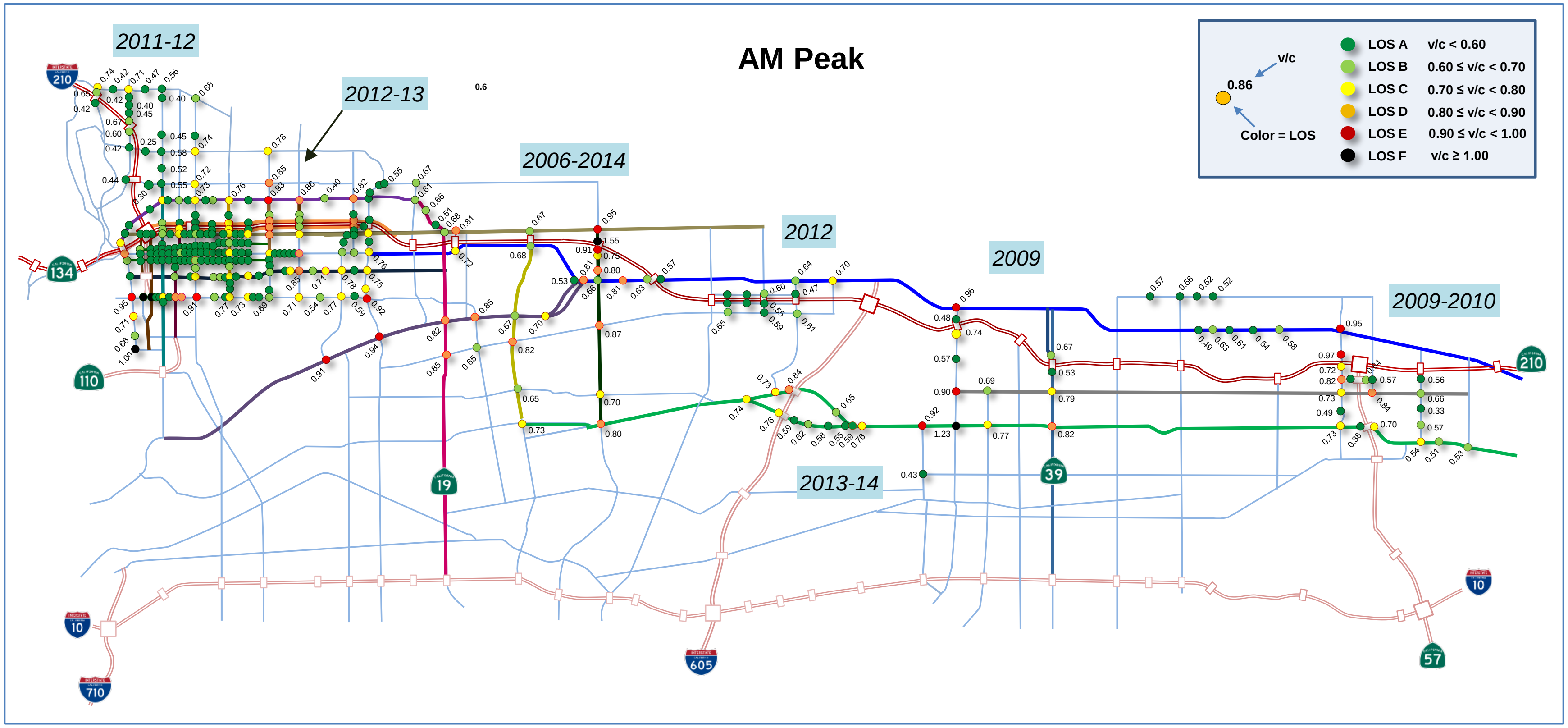


Figure 86 – Volume-to-Capacity Ratio at Signalized Intersections – AM Peak

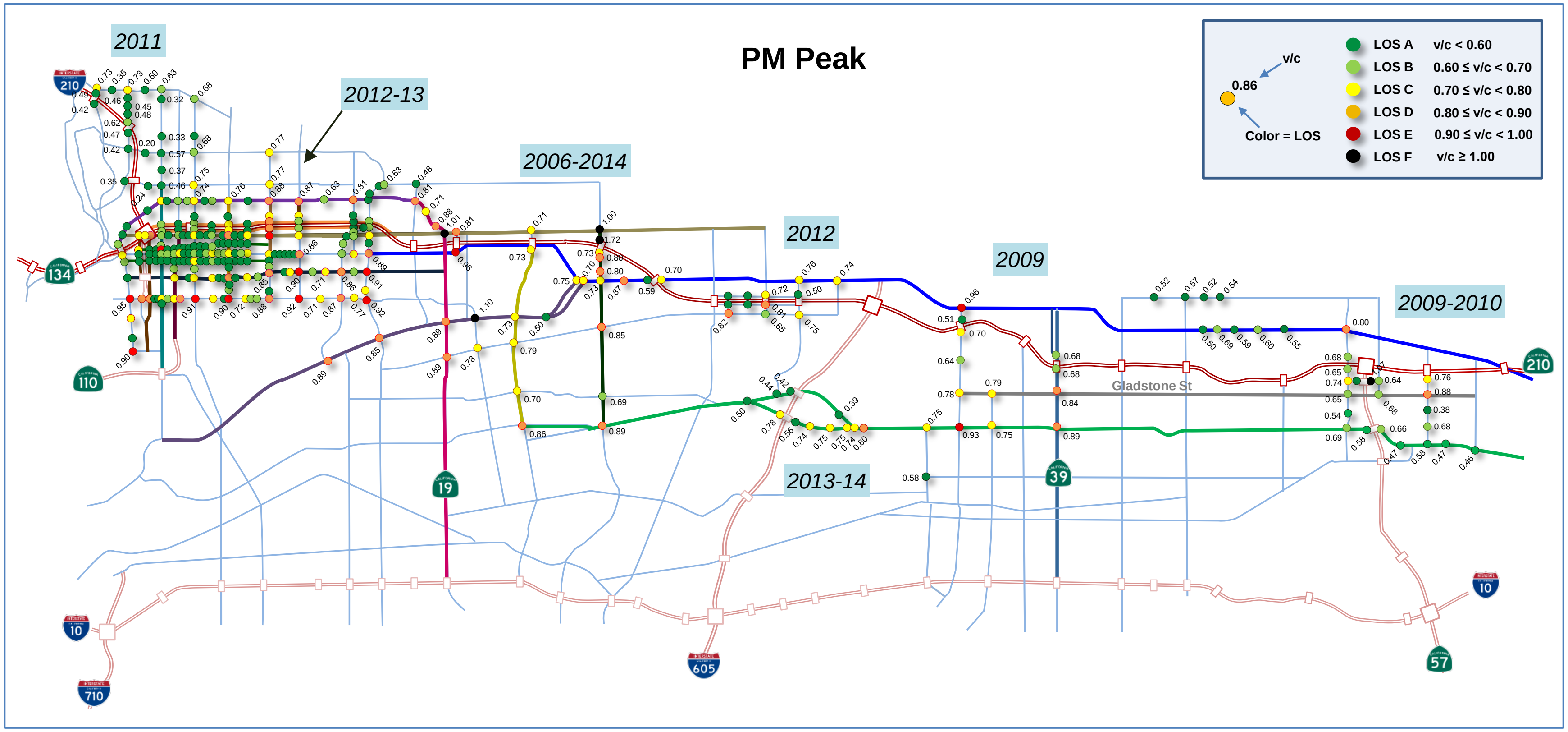


Figure 87 – Volume-to-Capacity Ratio at Signalized Intersections – PM Peak

Table 12 – Intersections with Potentially Limited Spare Capacity

Intersection	Jurisdiction	AM Peak Capacity Utilization	PM Peak Capacity Utilization	Date of evaluation
California Boulevard & Orange Grove Boulevard	Pasadena	0.95	0.95	2013
California Boulevard & Saint John Avenue	Pasadena	1.21	0.90	2013
California Boulevard & Pasadena Avenue	Pasadena	1.21	0.90	2013
California Boulevard & Los Robles Avenue	Pasadena	0.91	0.91	2013
California Boulevard & Lake Avenue	Pasadena	0.77	0.90	2013
California Boulevard & Allen Avenue	Pasadena	0.71	0.92	2013
California Boulevard & San Gabriel Boulevard	Pasadena	0.92	0.92	2013
Colorado Boulevard & I-210 Eastbound Ramps	Caltrans	0.72	0.96	2006
Del Mar Boulevard & Allen Avenue	Pasadena	0.85	0.90	2013
Del Mar Boulevard & San Gabriel Boulevard	Pasadena	0.75	0.91	2013
Foothill Boulevard & Rosemead	Caltrans	0.68	1.02	2013
Foothill Boulevard & Santa Anita	Arcadia	0.95	1.00	2006
Huntington Drive & Santa Anita	Arcadia	0.91	0.86	2006
Huntington Drive & Sunset Boulevard	Arcadia	0.85	1.10	2006
Huntington Drive & Sierra Madre Boulevard	San Marino	0.91	0.89	2006
Huntington Drive & San Gabriel Boulevard	San Marino	0.94	0.85	2006
Irwindale Avenue & Foothill Boulevard	Irwindale	0.96	0.96	2009
Irwindale Avenue & Gladstone Avenue	LA County	0.90	0.78	2009
Irwindale Avenue & Arrow Highway	Irwindale	1.23	0.93	2009
Lone Hill Avenue & Route 66	Glendora	0.95	0.80	2009
Lone Hill Avenue & I-210 Westbound Ramps	Caltrans	0.97	0.68	2009
Orange Grove Boulevard & Columbia Avenue	Pasadena	1.00	0.91	2013
Orange Grove Boulevard & Hill Avenue	Pasadena	0.91	0.73	2013
Santa Anita & I-210 East Ramps	Arcadia	0.93	0.88	2012
Santa Anita & I-210 West Ramps	Arcadia	1.56	1.72	2012
Walnut Street & Allen Avenue	Pasadena	0.73	0.91	2013
SR-57 Northbound Off Ramp & Auto Center Drive	Caltrans	0.64	1.07	2009

7.3.2. TRAFFIC SAFETY

Figure 88 maps the number of accidents that have been recorded near key signalized intersections within the western half of the I-210 corridor throughout 2012 and 2013. This assessment is based on data from the SWITRS database and the City of Pasadena. Approximately only 1,900 accidents of the reported 5,587 accidents are mapped. Accidents that have occurred at minor intersections or between two intersections are not shown. While accidents are shown to occur throughout the corridor, a few intersections present significantly higher frequencies of accidents. These are shown with a reddish circle in Figure 88 and identified in Table 13. Most of them are intersections carrying relatively high traffic volumes.

Figure 89 and Figure 90 further compile the collision type and primary collision factor associated with all the incidents that have occurred in 2012 and 2013 within the cities of Pasadena, Arcadia, Duarte, and Monrovia, as well as the surrounding unincorporated county areas. This analysis is based on the same data that was used to develop the map in Figure 88 and includes all 5,587 recorded incidents for the period. Figure 89 indicates that 28% of accidents that occurred around signalized intersections were rear-end collisions, i.e., collisions strongly related to the presence of congestion. If accidents associated with lane changing behavior are added to the statistics, such as sideswipe and broadside accidents, nearly 78%

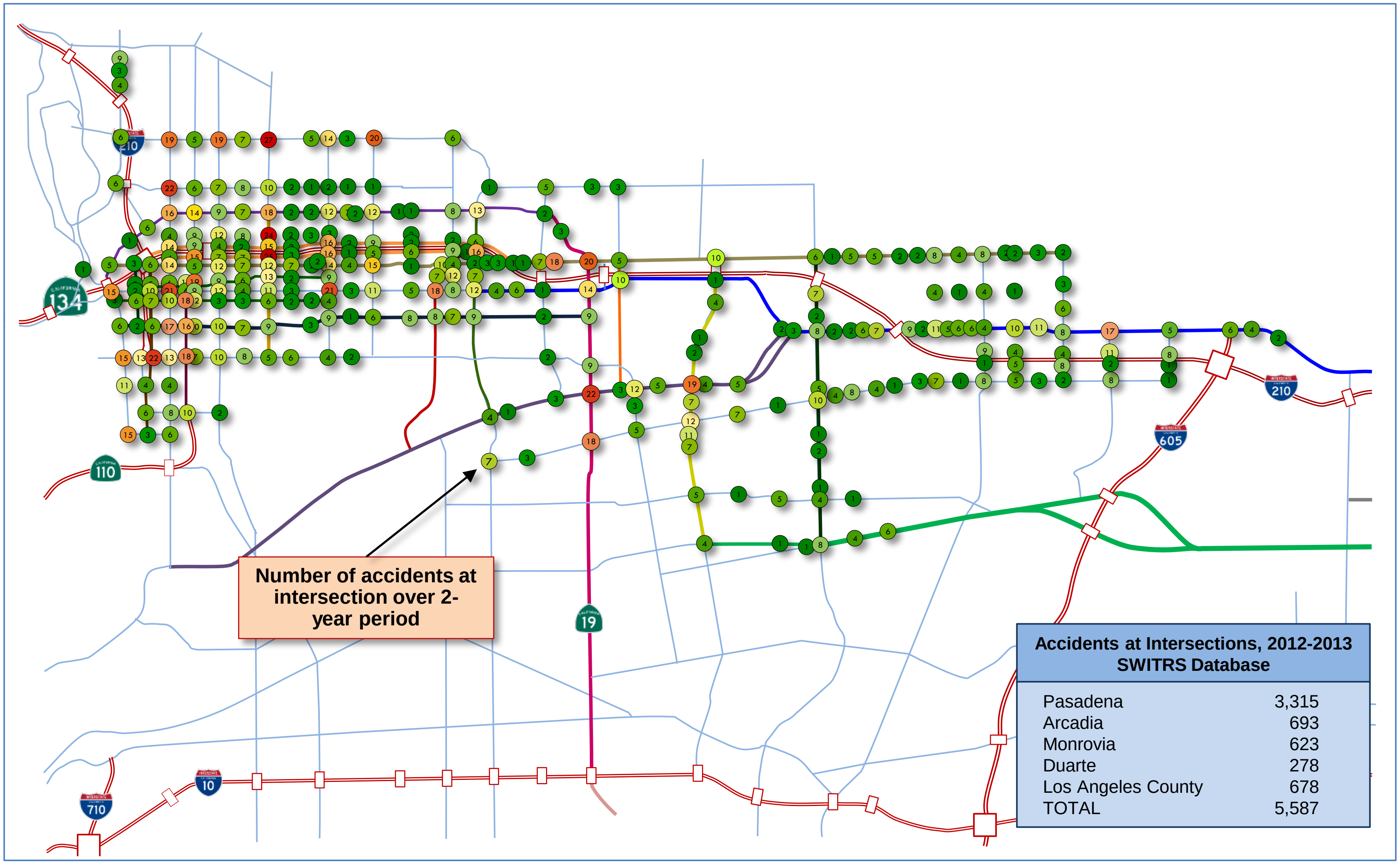


Figure 88 – Number of Accidents at Key Corridor Intersections in 2012-2013

Table 13 – Signalized Intersections with Highest Number of Accidents in 2012-2013

Jurisdiction	Intersesction	Number of Accidents
Pasadena	Washington Boulevard / Lake Avenue	25
Pasadena	Corson Street / Lake Avenue	25
Pasadena	Villa Street / Lake Avenue	24
LA County	Huntington Drive / Rosemead Boulevard	22
Pasadena	Colorado Boulevard / Fair Oaks Ave	21
Pasadena	Colorado Boulevard / Hill Avenue	21
Pasadena	Mountain Street / Fair Oaks Avenue	21
Pasadena	Foothill Boulevard / Rosemead Boulevard	20
Pasadena	Washington Boulevard / Allen Avenue	20
Pasadena	Union Street / Marengo Avenue	19
Pasadena	Foothill Boulevard / Sierra Madre Ville Avenue	19
Arcadia	Huntington Drive / Baldwin Ave	19
Pasadena	Washington Boulevard / Fair Oaks Avenue	19
Pasadena	Washington Boulevard / Los Robles Avenue	19
Pasadena	Green Street / Arroyo Parkway	18
Pasadena	Colorado Boulevard / Sierra Madre Boulevard	18
Pasadena	Orange Grove Boulevard / Lake Ave	18
Pasadena	Del Mar Boulevard / Fair Oaks Avenue	17
Duarte	Huntington Drive / Buena Vista Ave	17
Pasadena	Del Mar Boulevard / Arroyo Parkway	16
Pasadena	Maple Street / Hill Ave	16
Pasadena	Corson Street / Hill Ave	16
Pasadena	Orange Grove Boulevard / Fair Oaks Avenue	16

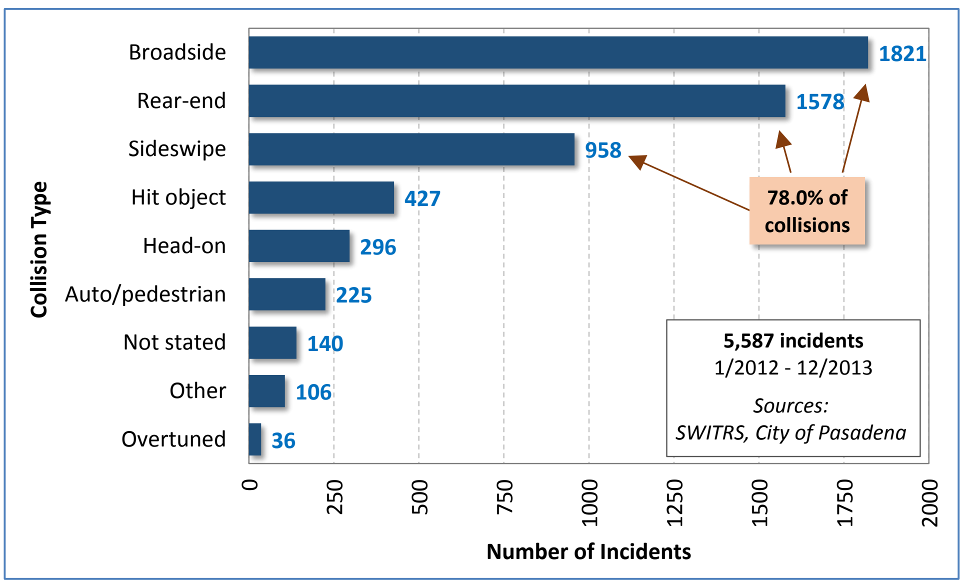


Figure 89 –Collision Types along Corridor Arterials in 2012-2013

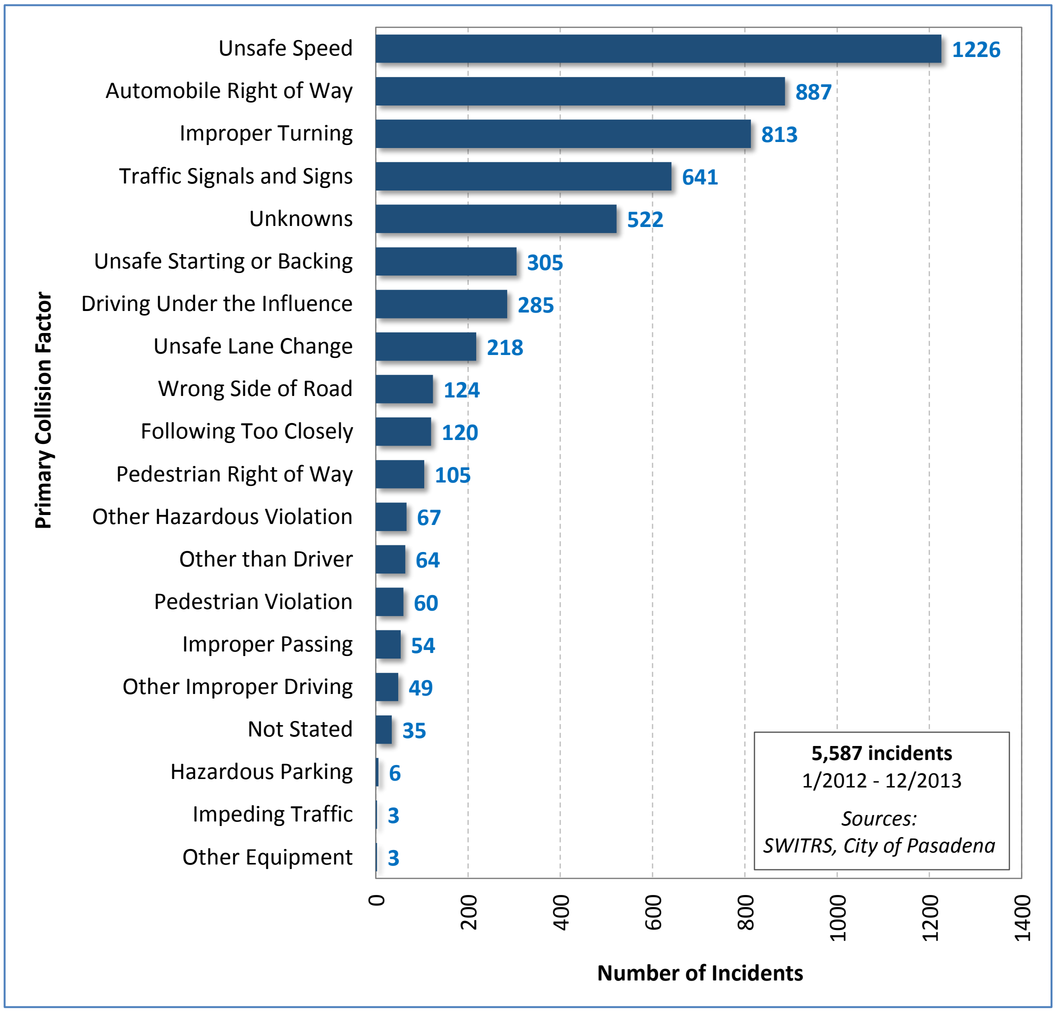


Figure 90 – Primary Causes of Collisions along Corridor Arterials in 2012-2013

of all recorded accidents could be linked to either congestion or traffic behavior. Figure 90 further indicates that a large majority of incidents were caused by vehicles being driven at unsafe speed (22% of accidents), or by drivers failing to respect right-of-way (16%), making improper turns (15%), or failing to respect traffic signs and signals (12%). These four factors account for nearly 64% of all recorded accidents. These statistics indicate that a strong potential exists along the I-210 to reduce accident occurrences through improvements to congestion, lane-changing maneuvers, or other unsafe behavior.

7.4. TRANSIT OPERATIONS

This section presents summary statistics about the on-time performance of transit services within the I-210 corridor. Other commonly cited statistics in transit performance reports, such as total ridership, miles traveled, or fare revenues are not presented, as these statistics would have little incidence on the needs assessment of an ICM system. While ridership is an important measure of overall demand, a metric of greater importance is vehicle occupancy, as this metrics allows determining how much additional demand could be accommodated. However, vehicle occupancy is often not readily available. Where it is, only an average occupancy may be available while an occupancy for specific route segments is needed.

For fixed transit routes, on-time performance is generally defined as a vehicle departing from a given time point within 0 to 5 minutes from the time identified on the published route schedules. Below are the most recent on-time performance evaluations that could be retrieved:

- **LA Metro Bus –** The latest customer survey, conducted in May 2012, had 76% of 20,730 bus riders indicating that the bus they had taken arrived within 5 minutes of its scheduled time.
- **LA Metro Rail –** Results from the latest customer survey, conducted in May 2012 had 85% of 1143 respondents indicating that the train they took arrived within 5 minutes of its scheduled time.
- **Foothill Transit –** At its August 2013 performance evaluation, Foothill Transit evaluated that its fixed-route buses were on-time 73.0% of the time. The commuter express service was further assessed to have an overall on-time performance of 77%. Road construction along major roads within the service area is noted to have caused some service delay and to have affected on-time performance. An increase in arterial traffic associated with the beginning of the school year is also cited as having an impact on on-time performance.
- **Pasadena ARTS –** At the mid-2014 fiscal year evaluation, buses operated by the City of Pasadena were reported to have an 80.49% on-time performance. This was consistent with the standard industry standard of achieving 80% on-time performance. For fiscal year 2015, a higher 85% on-time performance is being sought by the agency.
- **Metrolink Commuter Rail –** For the second half of 2010, Metrolink reported monthly average on-time performance varying between 93% and 96%, and between 94% and 97%, when removing from consideration external factors such as trespasser incidents and extreme weather events.

7.5. PARKING OPERATIONS

Available information on park-and-ride facilities within the I-210 corridor suggests a very high-level of utilization during the day. As shown in Figure 91, recent occupancy surveys indicate that many facilities exceed 90% occupancy on average during the day. This is particularly true for parking facilities along the Metro Gold Line where parking is free of charge, as well as several park-and-ride lots along I-210. Such a high level of occupancy indicates that limited excess parking capacity currently exists throughout the corridor.

Occupancy levels of general parking facilities depend on their location and time of day. Anecdotal evidence suggests that many of the privately operated facilities around downtown Pasadena are fully utilized during the day by employees of adjacent businesses. Facilities catering primarily to retail business customers, such as city-owned facilities, may have some space capacity.

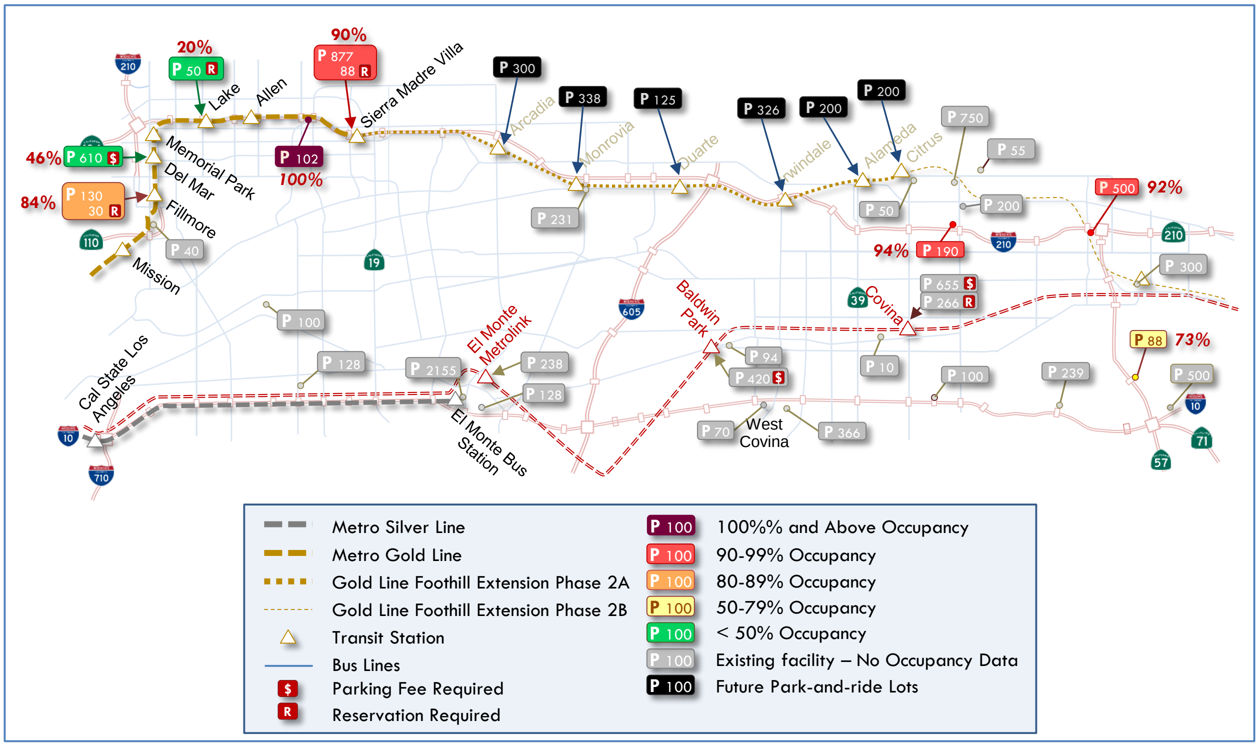


Figure 91 – Park-and-Ride Occupancy Rates

8. JUSTIFICATION FOR CHANGES

This section presents a summary of the needed changes to improve corridor operations. Elements presented include:

- Operational, informational, and institutional gaps in current corridor operations
- Environmental and financial influencing factors
- Desired operational changes
- Priorities among desired changes

8.1. OPERATIONAL, INFORMATIONAL, AND INSTITUTIONAL GAPS

The following operational, informational, and institutional gaps currently affect the ability to manage and operate the I-210 corridor to its full potential:

- **Transportation system monitoring capability**
    - Limited ability to monitor traffic conditions in real time on corridor arterials. While most signalized intersections are equipped with traffic detectors, only a small fraction of signal controllers are currently set up to forward the data they collect to the associated TMC in real time. This results in a limited ability to track changes in traffic conditions as they occur for large portions of the corridor.
    - Predominant reliance on estimated travel patterns. Corridor travel patterns are typically derived from regional travel demand models or techniques developing origin-destination flow matrices based on observed traffic counts. There are very few direct observations of routing decisions made by travelers. This limits the ability of traffic managers to assess the effectiveness of implemented strategies aiming to affect routing decisions.
    - Travel forecasts used by traffic managers remain largely based on historical data analyses. No agency within the corridor uses algorithms attempting to forecast in real-time the travel times that may be experienced by travelers. Travel time estimates are typically compiled by adding up the travel times on individual sections corresponding to the speeds currently observed everywhere.
    - While emerging crowd-sourcing applications increasingly attempt to forecast travel times that travelers may actually experience based on extrapolations of historical and current traffic data, they do not usually have access to operational data (for instance, signal timing data). This can significantly degrade the accuracy of the forecasts and undermine acceptance of the application by travelers.
    - Limited real-time information about transit capacity utilization. Due to the difficulty of doing so, passenger boarding and alighting are not compiled on a day-to-day basis for light-rail trains operated by Metro. While onboard passenger counters automatically compile this information for buses operated by Metro and Foothill Transit, the collected data is typically only retrieved when a vehicle returns to its garage. This lag prevents tracking transit capacity utilization in real time and assessing how transit services may be affected by an incident.

  - Limited real-time information about parking availability, both at publicly and privately operated facilities. Very few facilities within the corridor have systems counting the number of vehicles present. This results in an inability to assess whether a lack of parking may be an impediment to the promotion of transit alternatives or transit use in general.

- **Operational performance assessment**
  - While PeMS can be used to assess the effectiveness of freeway operations in near-real time, no similar tool exists for assessing arterial performance. While third-party information tools such as Google Maps are increasingly being used to visualize traffic speeds on main arterials and locate congestion hotspots, these tools do not provide many of the performance metrics of interest to roadway managers, such as incurred delays, volume-to-capacity ratios, etc.
  - Different agencies use different metrics for assessing the operational performance of roadway elements. This is often the result of different traffic management policies. While one agency may focus on travel times and delays, another may focus instead on reliability. A need thus exists to define a set of performance metrics adequately capturing both local and corridor-wide control objectives.

- **Traffic signal control capability**
  - While the vast majority of traffic signals within the corridor are connected to a TMC, some key signals remain unconnected. This is the case for most of Caltrans' signals at the end of freeway ramps, as well as some signals in Monrovia and Duarte. The inability to communicate with these signals from a central location prevents the implementation of unscheduled changes in traffic operations, as changes must be entered directly into the signal controller by personnel.

- **Information sharing capability**
  - No direct communication links currently exist between the various TMCs operating within the corridor.
  - While both the IEN and RIITS communication networks were developed to facilitate data exchanges among agencies, both still provide constrained communication capabilities. While the IEN was developed to support the exchange of signal timing data, it does not currently support the exchange of traffic flow data collected from roadway detectors. On the other hand, while RIITS can circulate both signal and traffic flow data, very few agencies within the I-210 corridor have developed interfaces with this system.
  - Where data sharing is possible, different data-gathering and recording practices often make sharing cumbersome or difficult. For instance, while Arcadia's TransSuite system records the duration of each traffic signal phase on a cycle-by-cycle basis, Pasadena's i2 system records when a particular signal indication changes from green to yellow, yellow to red, or red to green. Comparing data collected by the two systems thus requires some processing to convert the data to a common reference framework.

- **Collaboration among agencies managing transportation systems within the corridor**
    - Limited collaboration exists between Caltrans and local jurisdictions. Freeway and arterials are managed as independent systems, each with their own objectives. This occasionally results in Caltrans making decisions regarding freeway operations that may have detrimental effects on local arterials, or in local agencies making traffic management decisions that may negatively affect freeway operations.
    - Local agencies typically manage their road network independently of surrounding networks, sometimes with different objectives. While some regional signal synchronization projects have promoted inter-agency coordination along specific arterial corridors, arterials signals are for the most part independently set up by the agency having jurisdiction over them based on criteria, communication capabilities, and priorities set up by the agency. This has often resulted in coordination breaks at jurisdictional boundaries.
    - Limited coordination between roadway and transit operators. Traffic signals along the arterials are primarily set up based on general traffic flow needs. Apart from a few locations where the signals have been equipped with a transit signal priority system, transit-specific mobility needs are typically not considered by roadway agencies when developing arterial mobility plans. While transit agencies often develop schedules reflecting congestion, this is often only an attempt to reflect actual expected service performance.
    - Transit agencies operating within the corridor typically set their service schedules independently of each other. While some service coordination may exist at some intermodal stations, such coordination is often the result of customer requests and not necessarily the result of a continuous agency collaborative process.

- **Incident response management**
    - While significant efforts have been made to develop efficient incident management responses, traffic management decisions made by law enforcement officers remain generally based on local operational and safety situational assessments. Greater coordination between law enforcement officers, first responders, traffic managers, and transit operators is needed to ensure that efficient detours around incidents are implemented, particularly for incidents occurring during peak travel periods.

- **Traveler information systems**
    - Existing traveler information systems typically estimate the time needed for a given trip based on current conditions or historical data. This results in travel time estimates not necessarily corresponding to the experienced travel time. By the time a traveler reaches a certain location, a congestion hotspot that previously existed may have dissipated. No traveler application yet attempts to forecast the travel times that travelers may actually experience based on the conditions they are likely to encounter along each segment of their trip when they actually reach each segment.
    - While various existing routing applications can already provide detour recommendations around incidents, these applications do not necessarily have an accurate view of operating conditions in the network. In addition, they do not track how many travelers

adjust their travel plans based on the information provided. As a result, these applications can cause too many vehicles to reroute through the same arterials and creating new congestion problems.

- Trip planning tools remain mainly informational in nature. In most cases, tool users are left with the task of comparing trips by themselves. The potential for suggesting trip alternatives or incentivizing travel behavioral changes is not fully used.

The various gaps identified prevent many transportation elements from being used to their full potential, thus resulting in unused or inefficiently used transportation capacity. The problems are associated with both the supply side and demand side of the transportation system:

- On the supply side, better system awareness, operational tools, and coordination among various transportation system operators can increase the efficiency with which existing systems are being managed and operated.
- On the demand side, enhancing information dissemination may enable travelers to make informed decisions that may lead to a more efficient distribution of trips across time and modes. While travelers often make decisions based on their experience, they do not always have comprehensive or accurate knowledge of the alternative travel options that are available to them. As a result, travelers often reject alternative travel options based on inaccurately perceived difficulties. In this case, better information would help alleviate these problems.

8.2. ENVIRONMENTAL AND FINANCIAL INFLUENCING FACTORS

Several additional environmental and financial factors reinforce the need to make a more efficient use of existing transportation systems:

- **Limited available right-of-way**
  - Limited land availability, particularly in core urban areas, makes it difficult to consider road-widening projects to alleviate operational problems. Along many corridor arterials, widening roads would require land purchases, building demolition, and a lot of funding. Since such options are likely to be highly unpopular, this increases the need for solutions that can be implemented within the existing right-of-ways.
- **Limited funds for large-scale capital infrastructure investments**
  - Many agencies are now operating with limited budgets. This makes it difficult to justify expensive infrastructure projects and leads to a need to find solutions that can be implemented within the existing infrastructure or with minimal changes.
- **Limited funds for operations and maintenance support**
  - Funding sources for corridor improvements often exclude operations and maintenance as eligible expenses. This leaves each agency responsible for finding the funds required for the operations and maintenance of newly deployed equipment. Projects proposing significant deployment of new equipment will often have to compete with existing systems for fund allocation.

8.3. DESIRED CHANGES

This section identifies key desired changes that would help address the gaps identified in Section 8.1 and improve overall corridor operations:

- **Enhance communication capabilities with field devices**
    - Provide fast, reliable communication lines with field devices
    - Enable real-time or near-real-time communication with relevant field devices

- **Expand traffic and travel monitoring capabilities**
    - Increase the number of arterial detectors providing traffic volumes and turning counts
    - Increase the ability to monitor travel times between specific locations
    - Enable traffic and travel monitoring systems to provide data in real time
    - Increase the ability to track vehicle routing patterns
    - Increase the ability to visually assess conditions on managed roadways and systems
    - Produce performance-based metrics supporting various operational and reporting needs

- **Improve the ability to respond quickly to changes in travel demand, congestion, or operating conditions**
    - Provide tools allowing system operators to assess quickly the potential operational impacts of the control and management strategies being considered
    - Enable all relevant traffic management devices to be centrally controlled from the associated TMC
    - Improve communication between the various transportation management centers operating in the corridor
    - Improve communication between transportation management centers and transit operation centers managing services within the corridor

- **Provide system managers with integrated, multi-system decision-support tools**
    - Develop integrated processes for gathering, validating, analyzing and distributing data
    - Implement standardized system interfaces and data communication protocols
    - Develop integrated tools for planning, design, and evaluation
    - Develop optimization tools considering the needs and capabilities of all transportation elements and system users within a corridor
    - Develop interagency agreements promoting integrated operations and management

- **Improve coordination among transportation systems**
    - Increase data sharing capabilities among agencies operating within a corridor
    - Enhance coordination between freeway and arterial traffic management operations
    - Enhance coordination between roadway and transit operators
    - Enhance coordination operations among transit agencies
    - Enhance coordination among law enforcement agencies, first responders, freeway operators, and arterial operators during incidents

- **Improve the dissemination of real-time travel information to motorists, transit riders, and other travelers**
    - Provide comprehensive incident/event information to corridor travelers
    - Improve information dissemination to en-route travelers, particularly hands-free delivery capabilities to motorists
    - Provide reliable travel time forecasts based on current and projected transportation system conditions
    - Provide real-time parking availability at park-and-ride facilities to travelers

- **Improve the ability to proactively influence travel demand and promote route, mode and/or time-of-day shifts**
    - Improve the ability to communicate en-route information to travelers
    - Provide effective dynamic route guidance around problem areas in response to incidents, planned events, or unusual situations
    - Improve the ability for travelers to obtain and compare information about trips based on various alternative transportation modes
    - Improve the ability for traffic managers to influence travel mode and itinerary choices through targeted traffic control actions and information dissemination

The end goal is to develop a corridor-based transportation management system providing:

- Enhanced real-time control capabilities
- Reliable information about current and projected travel conditions within the corridor
- Performance-based metrics supporting operations and reporting needs
- Coordinated operations across various transportation systems and modes
- Improved corridor-wide travel performance within individual and across multiple modes
- Greater partnership opportunities between regional transportation agencies, local agencies, and private sector entities.

8.4. PRIORITIES AMONG DESIRED CHANGES

This section presents a prioritization of the desired changes to improve the operations and management of the I-210 corridor that have been identified in Section 8.3. The need for this prioritization is based on the recognition that not all identified changes carry the same operational impact factors. Some changes may also easier to implement than others, particularly when considering the current constrained fiscal environment. For instance, changes requiring significant instrumentation deployments or infrastructure modifications are less likely to obtain approval from stakeholders if adequate funding is not already secured. Operational changes relying on innovative applications of technologies may also require more development time than changes replying on small procedural changes or the use of infrastructure that is largely already in place. An effective implementation strategy would be one that focuses first on the implementation of changes yielding high benefits for a low deployment cost. The success of these early applications could then be used to support the development and implementation of more complex or resource-intensive changes.

Table 14 – Priority among Desired Changes

Desired Change	Priority
Enhance communication with field devices	1
Expand traffic and travel monitoring capabilities	1
Improve the ability to respond in real time to observed changes in travel demand, congestion or operating conditions	1
Improve coordination of operations among transportation systems elements	1
Provide system managers with integrated, multi-system decision-support tools	1
Improve the dissemination of real-time travel information to motorists, transit riders, and other travelers	2
Improve the ability to influence travel demand within a corridor to promote route, mode, and/or time-of-day shifts	3

In the above context, Table 14 identifies the priority level of the various categories of desired changes listed in Section 8.2. Each desired change is assigned a value between 1 (highest priority) and 3 (lowest priority). It is anticipated that changes with a high priority will be strong candidates for short-term implementation, while changes with low priority may be considered over a long-term horizon or fully removed from consideration.

The rationale for the various assigned priorities is based on the following factors:

- The ability to monitor in real time changes in operational conditions is of paramount importance. Without information characterizing travel conditions within the corridor, the proposed ICM system could not conduct operational evaluations and assess whether changes in management strategies are desired. This has led to the attribution of a Priority 1 level to the first three items.
- Coordination of operations is a foundational element of the proposed ICM system. The system aims to bring together various systems that are currently typically operated independently from each other. For this reason, the fourth item was also assigned a Priority 1 level.
- The development of integrated, multi-modal operational tools is important to facilitate data processing and development of objective processes to assess operational benefits across modes and jurisdictions. This includes the development of the proposed Decisions Support System and all associated data processes. For this reason, changes under this category were assigned a Priority 1 level.
- Some operational improvements can be achieved without supporting information dissemination. For instance, simply changing traffic signal plans or ramp metering rate may be sufficient in various cases to implement efficient detours around incidents. In addition, improvements in the dissemination of information cannot be achieved before adequate monitoring and evaluation systems are in place. For these reasons, a Priority 2 level was assigned to changes focusing on improving information dissemination.
- The implementation of strategies aiming to change travel behavior is finally seen as a more long-term goal. These changes also cannot be effectively realized until adequate travel monitoring and information dissemination are in place. Because of these considerations, a Priority 3 level was assigned to the last category of desired changes.

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APPENDIX A - ACRONYMS

The following acronyms and abbreviations are used in this document.

ADT	Average Daily Traffic
APC	Automated Passenger Counter
APID	All-Purpose Incident Detection
ATMS	Advanced Traffic Management System
AVL	Automated Vehicle Location
CAD	Computer-Aided Dispatch
Caltrans	California Department of Transportation
CCTV	Closed-Circuit Television
CDI	Command/Data Interface
CHP	California Highway Patrol
CMS	Changeable Message Sign
CSMP	Corridor System Management Plan
DSS	Decision Support System
FSP	Freeway Service Patrol
GPS	Global Positional System
HAR	Highway Advisory Radio
HICOMP	Highway Congestion Monitoring Program
HOT	High-Occupancy Toll
HOV	High-Occupancy Vehicle
ICM	Integrated Corridor Management
IDL	Interface Definition Language
IEN	Information Exchange Network
ITE	Institute of Transportation Engineers
IVR	Interactive Voice Response
KITS	Kimley-Horn Integrated Transportation System
LA DOT	City of Los Angeles Department of Transportation
LA Metro	Los Angeles County Metropolitan Transportation Authority
LA SAFE	Los Angeles County Service Authority for Freeway Emergencies
LACDPW	Los Angeles County Department of Public Works
LACTMC	Los Angeles County Traffic Management Center
LACO	Los Angeles County
LARTMC	Los Angeles Regional Transportation Management Center
LCS	Lane Closure System
LMR	Local Mainline Responsive Metering
Pasadena ARTS	Pasadena Area Rapid Transit System
PATH	Partners for Advanced Transportation Technology
PeMS	Performance Measurement System
PM	Post Mile
RIITS	Regional Integration of Intelligent Transportation Systems
SCAG	Southern California Association of Governments
SCATS	Sydney Coordinated Adaptive Traffic System
SR	State Route

SWARM	System-Wide Adaptive Ramp Meter
TASAS	Traffic Accident Surveillance and Analysis System
TMC	Traffic Management Center
TMDD	Traffic Management Data Dictionary
TMT	Traffic Management Team
TOD	Time of Day
TSP	Transit Signal Priority
TSSP	Traffic Signal Synchronization Program
VMT	Vehicle-Miles Traveled
VPN	Virtual Public Network
XML	Extensible Markup Language