BEACH BOULEVARD CORRIDOR STUDY

FINAL REPORT

FEBRUARY 2020

Beach Boulevard Corridor Study Final Report

OCTA Project Number: 8-1683

Kittelson Project Number: 22820

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EXECUTIVE SUMMARY

Beach Boulevard (State Route 39, or SR 39) is the longest continuous north-south arterial in Orange County. The corridor extends through nine cities (Huntington Beach, Westminster, Garden Grove, Stanton, Anaheim, Buena Park, Fullerton, La Mirada, and La Habra) as well as through unincorporated Orange County, and is primarily under the jurisdiction of the California Department of Transportation (Caltrans).

In October 2018, the Beach Boulevard Corridor Study (Project) was initiated to develop a comprehensive multimodal transportation vision for the corridor. This 14-month study identified constraints and opportunities to improve and enhance local and regional mobility. The study evaluates existing conditions, forecasts future growth, and develops solutions ranging from enhanced pedestrian, bicycle, and transit facilities to improved signal synchronization. Ultimately this study will provide local agencies along Beach Boulevard with transportation options to help guide and enhance local planning initiatives.

The Project Corridor is defined as Beach Boulevard from State Route 1 (SR 1, also known as Pacific Coast Highway or PCH) in Huntington Beach and continues for about 21 miles north to State Route 72 (SR 72, also known as Whittier Boulevard) in La Habra. Given the configuration of the roadway network and that modifications may affect parallel facilities, the Study Area has been defined as a 1.25-mile buffer around the Project Corridor.

To support the development of the Project, OCTA, Caltrans and the consultant team convened a Technical Working Group (TWG), comprised of representatives from each city and jurisdiction along the corridor.

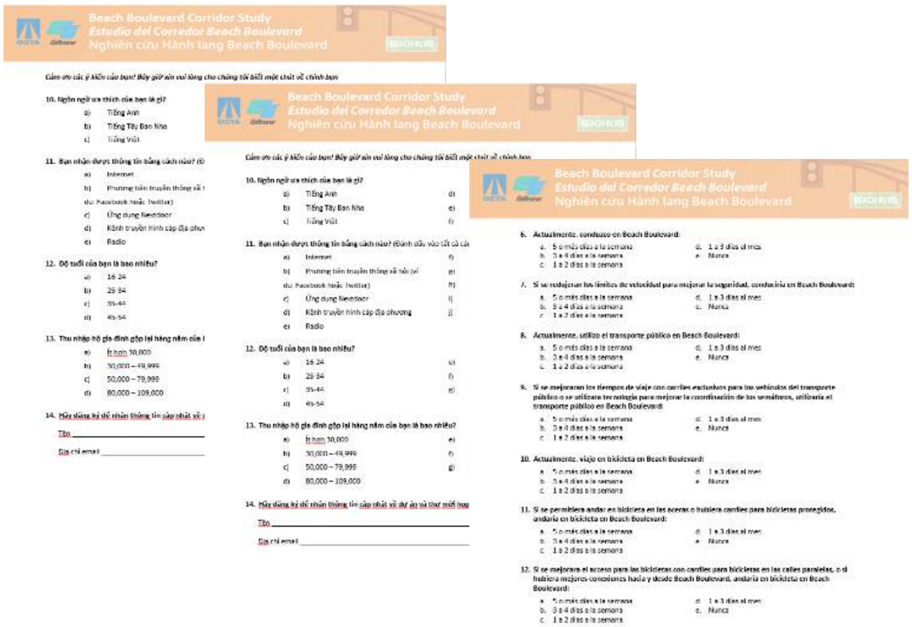
The following is an overview of key findings for the final report.

Baseline Conditions

This Baseline Conditions Report presents data and analysis for the current circulation, travel market, land use, and infrastructure conditions across the Project Corridor and Study Area. In addition, future (year 2040) developments, areawide growth and transportation network changes were identified. The data and analysis in this report were used to identify existing and future opportunities and constraints along the Project Corridor and support subsequent study recommendations. Key findings of the Baseline Conditions Report were as follows:

- **Demographics, Land Use, and Mode Split.** Generally, population and employment in the Study Area are projected to grow by 7 percent and 18 percent, respectively, between 2012 and 2040. In addition, the dominant mode of travel in the Study Area are trips by auto modes (drive alone plus rideshare).

- **Roadway Infrastructure.** Caltrans has jurisdiction over the Project Corridor except for portions of the roadway within the City of Buena Park. The Project Corridor has six or eight lanes (three to four lanes in each direction), plus left-turn pockets at intersections, with curb-to-curb widths from 110 feet to 125 feet. Traffic signal systems are also interconnected to the Caltrans District 12 Traffic Management Center (TMC) and have the latest controller types.
- **Vehicular Traffic Circulation.** Existing daily traffic volumes range from about 29,400 near SR 1 to nearly 83,600 at Interstate 405 (I-405) and are projected to grow by 6 percent on average. Generally, half of the trips along the Project Corridor originate or terminate in the Study Area (the remaining half effectively use the corridor as a pass through), with up to 14 percent of trips along the Project Corridor attributed to highway to highway connection. For certain segments, almost half of the trips travel 5 miles or less along the Project Corridor, and less than 10 percent of trips travel 15 miles along the Project Corridor. Less than 1 percent of trips travel the entire length of the Project Corridor. Peak period travel speeds along the Project Corridor do not show any significant sections operating at speeds classified as Level of Service (LOS) D or worse.
- **Transit Circulation.** The Orange County Transportation Authority (OCTA) is the primary transit provider in the Study Area, with transportation hubs at SR 1/First Street, Goldenwest Transportation Center, Fullerton Park-and-Ride, and the Buena Park Metrolink Station. OCTA Route 29 runs the entire extent of the Project Corridor, with headways of approximately 20 minutes during peak and off-peak periods. Bravo! 529 route runs between Edinger Avenue and Orangethorpe Avenue, with headways of 12 minutes during peak periods and 18 minutes during off-peak periods. Boardings at key Route 29 stops are generally above 100 riders per day.
- **Bicycle and Pedestrian Facilities**. No bicycle facilities are provided along the Project Corridor. The existing network of bicycle facilities within the Study Area is most comprehensive towards the southern end with many gaps in the northern end. Sidewalks are provided along much of the project corridor with a few noted gaps. The highest bicyclist volumes are in the City of Huntington Beach, and the highest volumes of pedestrians are in the cities of Huntington Beach and Buena Park.
- **Opportunity Areas.** Along the Project Corridor, there is a higher concentration of collisions for all collision types in the cities of Huntington Beach, Anaheim, and Buena Park, with a higher concentration of collisions for bicyclists in the cities of Huntington Beach and Westminster and for pedestrians in the cities of Huntington Beach, Westminster, Anaheim, and Buena Park.


Beach Boulevard Corridor Study
Estudio del Corredor Beach Boulevard
Nghiên cứu Hành lang Beach Boulevard

Outreach

Public engagement has been a key component to the study and helps OCTA establish and maintain the trust, support and confidence of the public and other stakeholders. In addition, the information gained in the outreach activities provide a foundation for future stages of development. Three primary outreach activities were conducted throughout the duration of the study:

- **Survey.** In order to gather public feedback, the primary outreach effort for both public engagement phases were the promotion and distribution of an online survey. Two surveys were conducted: the first to assess the corridor's existing conditions and the second to ascertain opinions of specific improvements. Combined, 2,360 surveys were collected over the course of the study. Both surveys were conducted in English, Spanish, and Vietnamese.
- **Local Jurisdiction Interviews.** The Project team conducted individual interviews with jurisdictions along the Study Corridor to gain insight about the Project and to identify recommendations that may provide support for project implementation. Discussion topics included the balance between auto and non-auto modes, coordination with Caltrans, funding and implementation, and local versus regional needs.
- **Other Outreach.** A variety of methods were employed to reach out to the public, stakeholders, local jurisdictions and elected officials. Survey participation was promoted via local events, briefings, presentations, print and electronic notices, and social media platforms. The team engaged a diverse mix of groups to ensure the improvements considered the various needs and concerns of the

greater corridor community. Briefings were provided to key stakeholder groups and elected officials to provide communication on the study goals and progress updates on the process and results. Corridor jurisdictions were represented on the technical working group and, along with OCTA and Caltrans, provided updates to local elected officials.

This information was used to help identify improvement needs and opportunities to coordinate project improvements with ongoing or proposed infrastructure activities.

Goals and Objectives

The goals and objectives of the Project are as follows:

- **Purpose and Need.** The purpose of the Beach Boulevard Corridor Study is to identify and recommend feasible multimodal transportation improvements to facilitate mobility and connectivity for travelers of all modes along the Project Corridor. The Project is needed to address existing and anticipated future demands for local and regional travel along the Project Corridor, including vehicular throughput, active transportation connectivity and transit operations, and to complement local land use types.
- **Goals and Objectives.** The following goals and objectives have been developed to address the purpose and need:

  1) Improve travel time, reliability and convenience of transit

  2) Reduce impediments to walking and biking along and across corridor

  3) Maintain vehicular throughput and access to and from regional freeways network

  4) Provide a safe and accessible environment for all user groups

  5) Support local land use planning with improved mobility options

Toolbox Development

To address the purpose and need for the study, a series of multimodal toolbox elements were identified, screened and refined. These elements represent potential improvements that could be implemented along segments of the Project Corridor.

The following describes the toolbox development process.

- **Initial Toolbox Elements.** An initial list of toolbox elements was prepared to address the goals and objectives of the Project. Elements were developed for each mode of travel and for each goal. Given that the improvements could benefit or negatively affect one or more modes of travel, it was also noted if they would have secondary effects on other modes.

- **Toolbox Elements Screening.** Based on initial screening with Project stakeholders, several initial toolbox elements were eliminated or modified. Preliminary cost ranges, associated risk factors, and coordination needed to implement each element were developed. In addition, a tier system was developed to classify each element. This was based on ease of implementation, cost, and risk factors as well as whether the element would require local or regional implementation.
- **Refined Toolbox Elements.** Based on the data from the toolbox elements screening process, a final refined list of toolbox elements was developed for further evaluation:
  - **Transit Toolbox Elements**
    - Bus Stop and Station Amenities
    - First/Last Mile Improvements at Major Stops
    - Transit Signal Priority Treatments
    - Dedicated Transit Lanes [for Bus Rapid Transit (BRT)]
  - **Pedestrian Toolbox Elements**
    - Close Gaps in Sidewalk Network
    - High-Visibility Crosswalks
    - Realigned Crosswalks at Freeway Ramps
    - Pedestrian Countdown Signal Heads
    - Sidewalk Amenities
    - Remove Sidewalk Obstructions
    - Pedestrian Scrambles
    - Pedestrian Refuge Islands
    - Corner or Sidewalk Bulbs
    - Mid-block Signalized Pedestrian Crossing
    - On-Street Parking or Loading Zones
  - **Bicycle Toolbox Elements**
    - Bike on Sidewalk Treatments
    - Close Gaps in Bicycle Network (on parallel streets)
    - Bike Preferential Treatments
    - Protected Bike Lanes (on Beach Boulevard)

- **Vehicle Toolbox Elements**
  - On-Street Parking or Loading Zones Removal
  - Advanced Traffic Signal Timing or Intelligent Transportation Systems
  - Consolidate Mid-block Unsignalized Intersections
  - Access Management
  - Active Traffic Management
  - Pedestrian Bridges
  - Adjust Interchange Ramp Locations and/or Configurations
  - Alternative Intersection Configurations

Evaluation of Toolbox Elements

A detailed evaluation was conducted for the final list of potential improvements for consideration for the Project Corridor. Included in this evaluation was the research and guidelines for each toolbox element as well as the benefits and implementation concerns.

Toolbox

Reference sheets for each toolbox element were prepared to summarize the following information:

- The name of the toolbox element.
- Whether it would be a local/city-specific project or one that would need to be studied and implemented across multiple cities or along the entire corridor as a regional project.
- The mode of travel the toolbox element applies to.
- Photos or diagrams showing applications of the toolbox element.
- Description of the toolbox element and the potential strategies and benefits of applying the toolbox element.
- Location key map showing which of the six segments the toolbox element could be applied in.
- Discussion of how the toolbox element addresses each of the Project goals.
- Design considerations to document plans and guidelines and implementation issues to consider for the toolbox element.
- Information on where each toolbox element could be applied.
- Cost range to quality the typical cost for each toolbox element.

- Identification of coordination needed to implement each toolbox element.

The information in these summaries serve as a tool for agencies to help determine the types of improvements available for the Project Corridor.

Case Studies

Case studies were developed to illustrate how toolbox elements could be applied to locations throughout the Project Corridor. The case study location types were chosen to represent typical intersection and roadway segment characteristics found throughout the Project Corridor and present opportunities for implementation of different toolbox elements. Five case studies were prepared at the following types of location along the Project Corridor:

- A major intersection
- A minor intersection
- A freeway ramp intersection
- A 6-lane roadway segment
- An 8-lane roadway segment

Implementation Approach

Based on the findings of the baseline conditions analyses, the following are the next steps for the Project in developing improvements to be advanced for implementation:

- Coordination will be needed between Caltrans and local cities for the planning, design and implementation of toolbox elements. Depending on the type of project and the level of potential effects, additional regional support may be needed. In addition, projects should follow the Caltrans standard project development processes (PDPM).
- A review of potential funding sources should be undertaken to determine if the proposed toolbox elements would be eligible for various federal, state, regional, or local funding programs.
- Detailed cost estimates will be required for each toolbox element. Given that the majority of the Project Corridor is under Caltrans jurisdiction, it is recommended that the Caltrans standard cost estimation process be followed, and cost data be checked with information from local cities or recent projects within Orange County.
- To assist in the implementation of the toolbox elements, opportunities to include components should be explored through development projects and area/specific plans. In particular, the best practices as documented should be incorporated into the planning of these

projects. In addition, when transportation network projects are proposed along the Study Corridor, efforts should be made to incorporate low-cost toolbox elements.

To help guide the future of the Study Corridor, this Long-Term Vision should be further enhanced to address recent and upcoming trends in transportation planning and mobility services, including: mobility hubs, connected corridors, autonomous vehicles, microtransit, and micromobility.

Section 1
INTRODUCTION

1.1 PROJECT OVERVIEW

Beach Boulevard (State Route 39, or SR 39) is the longest continuous north-south arterial in Orange County. The corridor extends through nine cities (Huntington Beach, Westminster, Garden Grove, Stanton, Anaheim, Buena Park, Fullerton, La Mirada, and La Habra) as well through unincorporated Orange County. In addition, the majority of Beach Boulevard is a State facility under Caltrans jurisdiction. The corridor provides connections to and is crossed by four freeways (Interstate 405, State Route 22, State Route 91, and Interstate 5). The Project Corridor begins to the south at State Route 1 (SR 1, also known as Pacific Coast Highway or PCH) in Huntington Beach and continues for approximately 21 miles north to State Route 72 (SR 72, also known as Whittier Boulevard) in La Habra.

The purpose of this Beach Boulevard Corridor Study (Project) is to develop a comprehensive multimodal transportation vision for the corridor. As part of this effort, the Project identified constraints and opportunities to improve and enhance local and regional mobility.

The Project was initiated in October 2018 and completed in February 2020.

Given that the Project Corridor is located within a dense network of parallel north/south arterials, a Study Area was defined as the area within 1.25 miles of the Project Corridor, as shown on Figure 1-1.

To support the development of the Project, the Project team (e.g., OCTA, Caltrans and the consultant team) formed a Technical Working Group (TWG), comprised of representatives from each city and jurisdiction along the corridor, plus agency staff.

1.2 HISTORY OF PROJECT CORRIDOR

The following is the history of the Project Corridor, as summarized from Caltrans's State Route 39 Route Concept Report (June 2000).

> *Over the years SR 39 has had many names. These include: La Habra Road, Grand Avenue, Hampshire Street, Huntington Beach Boulevard, Route 62, and Route 171. In 1933, State*

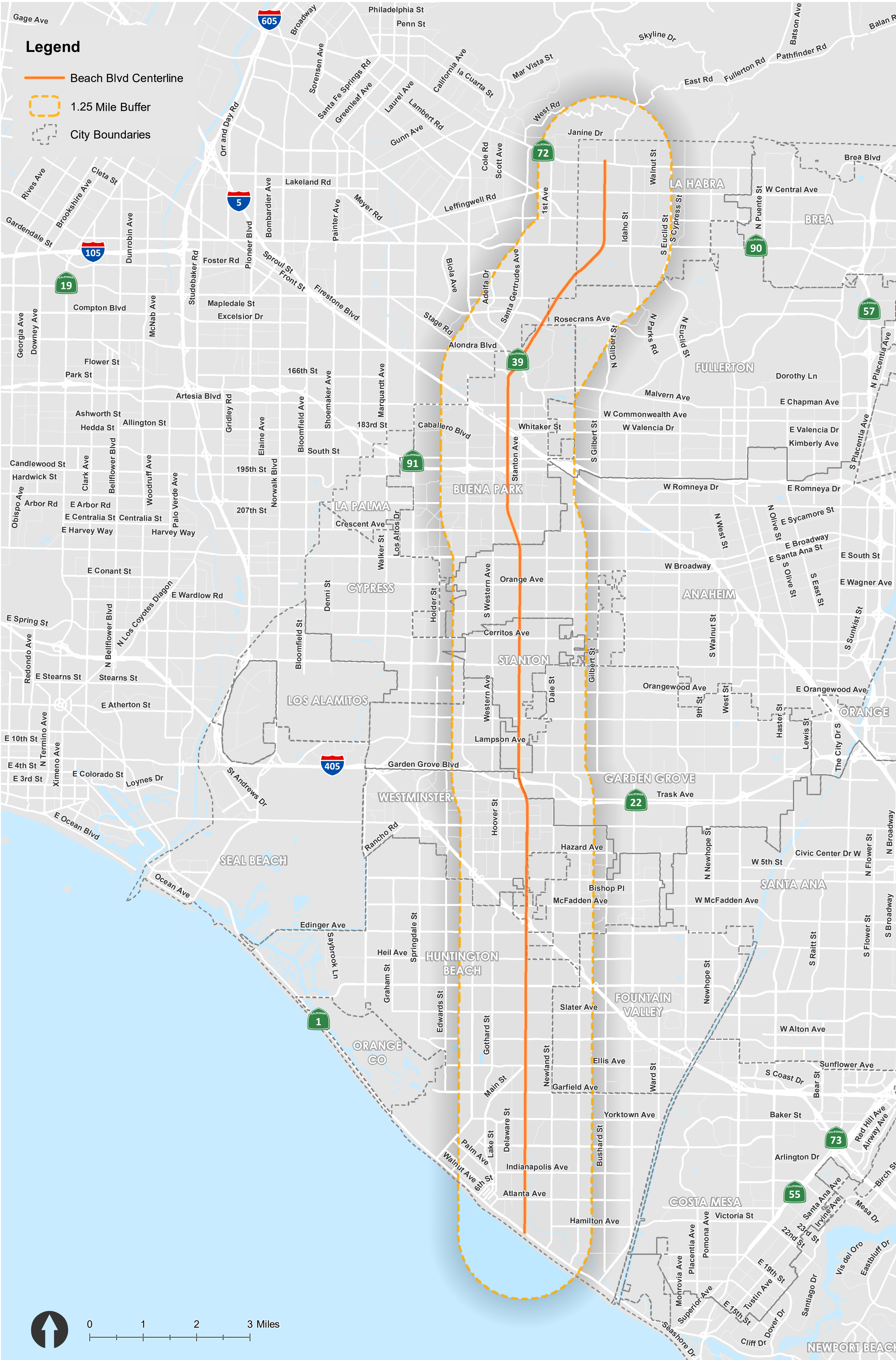
officials, seeing the unified nature of the road designated the entire route as SR 39. In 1960, an Orange County street naming committee decided to name the entire route Beach Boulevard in honor of the "Road to Summer." It is the only north-south conventional route that provides direct access from inland Orange County to the coastal areas.

SR 39 was first adopted as a State Highway – Conventional Route between Northern Station (rail station) and Ocean Avenue in November of 1935. The section(s) from Coast Boulevard to Ocean Avenue was added in June of 1937; from 22nd Street to Lampson Avenue in August of 1939; and from Lincoln Avenue to La Palma Avenue in December of 1941.

A freeway portion of the route was adopted between Route 1 and Lampson Avenue in October of 1968, but later rescinded by the California Highway Commission in March of 1975.

1.3 PURPOSE OF THIS REPORT

This report synthesizes the entire Project process, from the determination of baseline conditions, through the community workshops, to the identification of the toolbox of potential improvements. The technical documents prepared as part of the Project are summarized in this report along with additional documentation discussing the detailed evaluation of each toolbox element. The report also provides guidance for implementation of toolbox elements, including major project elements such as city and Caltrans approval processes, estimated costs for implementation, and potential funding sources.



Study Area
Beach Boulevard Corridor Study

Figure
1-1

1.4 REPORT ORGANIZATION

The Final Report is organized as follows:

Section 2, Baseline Conditions: This section presents data and analysis for transportation circulation, travel markets, land uses, and infrastructure conditions across the Project Corridor and Study Area. The report documents key findings for existing and planned future conditions that was used to identify issues and opportunities and develop mobility improvement concepts.

Section 3, Outreach: This section summarizes the outreach activities conducted throughout the duration of the Project. This input gathered from the outreach informed the development of the purpose and need, goals and objectives, evaluations and results of the Project.

Section 4, Goals and Objectives: This section presents the purpose and need, and goals and objectives for the Project.

Section 5, Toolbox Development and Evaluation Elements: This section describes the toolbox of potential toolbox elements for consideration for the Project Corridor. This includes the preliminary evaluation conducted to refine the list of toolbox elements and identifies the final list to be analyzed in detail.

Section 6, Evaluation of Toolbox Elements: This section documents the detailed evaluation for the final list of potential improvements for consideration for the Project Corridor. In addition, the section presents research and guidelines for each toolbox element, as well as the benefits and implementation concerns.

Section 7, Toolbox: This section presents the reference sheets for each toolbox element. This section is intended to serve as a tool for agencies along the corridor to help determine the types of improvements available and applicable for the Project Corridor.

Section 8, Case Studies: This section documents case studies where various toolbox elements are applied at several types of locations throughout the Project Corridor.

Section 9, Implementation Approach: This section provides guidance on the implementation of the various toolbox elements, including major project elements such as approval processes, estimated costs for implementation, and potential funding sources. In addition, information on land use and corridorwide planning, plus potential elements for a long-term corridor vision, are included

Section 2
BASELINE CONDITIONS

The Baseline Conditions Report[1] presents data and analysis for the current and future transportation circulation, travel markets, land uses, and infrastructure conditions across the Project Corridor and Study Area. The data and analysis in this report is used to identify opportunities and constraints along the Project Corridor and support subsequent study recommendations.

The following is an overview of key findings for the baseline conditions analysis.

2.1 DEMOGRAPHICS, LAND USE, AND MODE SPLIT

Existing and future conditions related to population, employment, and modes of travel shape transportation demands to, from, and within the Study Area. Key findings regarding the Study Area's demographic, land use, and mode split context are as follows:

- **Near-Term and Long-Term Development Activity.** Near-term development projects totaling approximately 250,000 square feet of office, one million square feet of commercial and entertainment space, 300 hotel rooms, and about 1,400 residential units are expected to be constructed along the Project Corridor within generally the next five years. In addition, several cities have identified long-term development potential through specific plans and similar efforts.
- **Population Growth.** Total population in the Study Area is projected to grow by 7 percent between 2012 and 2040, about half the rate for Orange County as a whole (13 percent).
- **Employment Growth.** Total employment in the Study Area is projected to grow by 18 percent between 2012 and 2040, which is 6 percent lower than that of Orange County as a whole (24 percent).
- **Land Uses.** The predominant forecasted land use in the Study Area is residential, with approximately 14,000 acres of new

[1] The Baseline Conditions Report is available on the Project webpage: https://www.octa.net/Projects-and-Programs/Plans-and-Studies/Beach-Boulevard-Corridor-Study/?frm=11189#!Resources

residential space forecasted by 2040. Mixed land use has the second largest growth with 2,700 acres.

- **Mode Split.** Trips by auto modes (drive alone plus rideshare) for all trip purposes that start and end in the Study Area comprise 82 percent of Study Area trips, as compared to approximately 90 percent for Orange County as a whole. The share of transit trips within the Study Area is also higher than for Orange County as a whole, for all trip purposes and work trips.

The demographics and land use analysis findings were used to inform near-term and long-term demand for multimodal improvements in the Study Area.

2.2 ROADWAY INFRASTRUCTURE

Roadway infrastructure conditions form the framework under which potential improvements are implemented. Key findings regarding roadway infrastructure are as follows:

- **Curb-to-Curb Widths.** Generally, curb-to-curb widths vary across the Project Corridor from 110 feet to 125 feet, with the exception of about one mile within the City of Buena Park where the roadway narrows to 85 feet from curb to curb.
- **Roadway Jurisdiction.** Caltrans has jurisdiction over the Project Corridor except for portions of the roadway within the City of Buena Park. Potential relinquishment of the roadway is currently being explored within the City of Anaheim. The largely unified maintenance responsibility for the Project Corridor will simplify the coordination activities required to implement proposed improvements.
- **Traffic Signal Systems.** All signals have been updated to the latest controller type and interconnected to the Caltrans District 12 Traffic Management Center (TMC) through either fiber or copper. Potential improvements to traffic signal systems can provide benefits to auto, pedestrian, bicycle, and transit circulation in the Study Area.

- **Programmed and Proposed Roadway Projects.** No near-term roadway or right-of-way improvement projects are expected along the Project Corridor at this time. Several ongoing and upcoming freeway improvement projects or large developments may affect traffic signal installations and/or streetscapes.

This information was used in subsequent project tasks to identify improvement needs and opportunities to coordinate project improvements with ongoing or proposed infrastructure activities.

2.3 VEHICULAR TRAFFIC CIRCULATION

Travel by auto is the most widely used mode of transportation along the Project Corridor and thus is a key element of analysis. Key findings regarding vehicular traffic circulation are as follows:

- **Existing Traffic Volumes.** Existing daily traffic volumes for the Project Corridor range from a low of 29,400 near SR 1 to a high of nearly 83,600 near I-405. Traffic volumes generally are highest in the middle of the corridor and reduced in the northern and southern portions.
- **Existing Intersection Operations.** Of the intersections along the Project Corridor with performance data available, most operate at LOS D or better during peak hours.
- **Existing Travel Speeds.** Posted speed limits along the Project Corridor vary between 35 mph and 55 mph. Peak period travel speeds along the Project Corridor do not show any significant sections operating at speeds classified as LOS D or worse. A seasonality review shows that speeds are generally higher during the summer season during both the weekday and weekend peak periods.
- **Traffic Volume Forecasts.** Forecasted traffic volumes for the Project Corridor show a median growth of about 4 percent and an average growth of about 6 percent. The highest growth is projected in the City of La Habra (24 percent near SR 72).
- **Trip Patterns.** Generally, half of the trips along the Project Corridor originate or terminate in the Study Area. Between 0.1 and 14 percent of trips along the Project Corridor are attributed to highway to highway connections, with higher percentages observed at closely spaced highway facilities. As high as 43 percent of trips travel 5 miles or less along the Project Corridor for certain segments, and as high as 7 percent of trips travel 15 miles along the Project Corridor for certain segments. Less than 1 percent of trips travel the entire length of the Project Corridor.
- **On-Street Parking and Loading.** On-street parking is provided along the Project Corridor in the southern and northern portions for a total of approximately 5.5 miles or 25 percent of the length of the Project Corridor. Loading zones are only

provided on the northern end of the Project Corridor within the on-street parking area. However, on-street loading has been noted along the Huntington Beach auto dealership and in the Buena Park Entertainment Zone.

- **Goods Movement.** Heavy vehicle percentages of 1 to 5 percent were calculated along the Project Corridor with the highest reported in the City of La Habra.

As multimodal improvements are identified for the Project Corridor, this data was used to inform potential benefits to vehicular traffic circulation as well as potential tradeoffs.

2.4 TRANSIT CIRCULATION

Based on the data and analysis presented in this section, the key findings for transit along the corridor are as follows:

- **Transit Coverage.** OCTA is the primary provider in terms of geographic coverage and hours of operation. Other transit providers include Metrolink and LA Metro. As project improvements are developed for the Study Area, coordination among transit providers will allow for seamless connections between services.
- **OCTA Bus Service and Ridership.** Bus service frequencies vary widely for bus service in the study area. OCTA Route 29 runs the entire extent of the Project Corridor from SR 1 to the south to SR 72 to the north, with headways of approximately 20 minutes during both peak and off-peak periods. Bravo! 529 route runs between Edinger Avenue and Orangethorpe Avenue, with headways of 12 minutes during peak periods and 18 minutes during off-peak periods. For other regular bus service in the Study Area, peak period headways range from 15 minutes to 75 minutes. Boardings at key Route 29 stops are generally above 100 riders per day. Transit rider amenities at typical bus stops generally include benches and trash cans, but bus shelters are not consistently provided. In addition, most stops do not have bus pullouts (buses must stop within travel lanes).

- **Multimodal Transportation Hubs.** Transportation hubs in the Study Area consist of the Buena Park Metrolink Station, Goldenwest Transportation Center/Park-and-Ride, SR 1/First Street, and Fullerton Park-and-Ride. These hubs provide connectivity for OCTA bus service, LA Metro bus service, Metrolink rail service, OC Flex on-demand shuttle service, and park-and-ride users. However, there are opportunities for increasing multimodal amenities, such as secure bicycle storage, at these locations.

The transit analysis findings were used to define projects that improve bus travel time along the Project Corridor and improve connectivity to multimodal transportation hubs. As these projects are being developed, coordination among transit providers will allow for seamless connections between services.

2.5 BICYCLE AND PEDESTRIAN CIRCULATION

Based on the data and analysis presented in this section, the key findings for bicycle and pedestrian circulation along the Project Corridor are as follows:

- **Existing Bicycle Facilities.** The existing network of bicycle facilities is most comprehensive towards the southern end of the Project Corridor, such as within the City of Huntington Beach. Towards the northern portion of the Study Area, parallel and perpendicular routes to the Project Corridor have many gaps and provide largely local circulation within neighboring cities.
- **Existing Pedestrian Facilities**. Sidewalks are provided along much of the Project Corridor with a few noted gaps. The sidewalks are wider than 3 feet along the corridor, although these can be subject to obstructions. Crossing opportunities are largely limited to major intersections.
- **Bicyclist and Pedestrian Volumes.** Active transportation activity levels vary along the Project Corridor and depend greatly on the land use context. Overall, Huntington Beach and Buena Park currently see the greatest amount of pedestrian activity, with about 300-350 pedestrians at an intersection in a peak period. Huntington Beach also experiences the highest amount of bicyclist activity, with 60 bicyclists

observed in a peak period; Garden Grove experiences the second highest at 30 bicyclists.

- **Relevant Plans and Projects.** These include numerous city-led and OCTA-prepared studies on mobility along the Project Corridor, as well as relevant citywide plans for circulation throughout the Study Area.

The bicycle and pedestrian analysis findings were used to define projects that address existing facility gaps, improve connectivity to transit and other Study Area destinations, and improve the safety and comfort of bicyclists and pedestrians.

2.6 OPPORTUNITY AREAS

Safety for all transportation users is a critical element in the Study Area's multimodal network. The opportunity areas along the Project Corridor are based on a detailed assessment of collision data. Key findings are as follows:

- **High Collision Locations.** Along the Project Corridor, there is a higher concentration of collisions for all collision types in the cities of Huntington Beach, Anaheim, and Buena Park. The highest number of collisions occur along the Edinger Avenue to Heil Avenue roadway segment which experiences some of the highest traffic volumes along the Project Corridor.

- **Bicyclist High-Injury Areas.** Along the Project Corridor, there is a higher concentration of collisions for bicyclists in the cities of Huntington Beach and Westminster. The highest number of bicycle collisions occur between Yorktown Avenue and Adams Avenue. This portion of the Project Corridor provides on-street parking which could influence the bicycle collision rates. In addition, bike lanes are not provided along the Project Corridor; however, east-west connector roads do have bike lanes. The highest number of bicyclists are also reported in this area.

- **Pedestrian High-Injury Areas.** Along the Project Corridor, there is a higher concentration of collisions for pedestrians in the cities of Huntington Beach, Westminster, Anaheim, and Buena Park. The highest number of pedestrian collisions occur along the SR 91 Eastbound Ramps to La Palma Avenue segment. This segment is located in a high pedestrian activity area within the Buena Park Entertainment Zone, which may relate to the rates.

- **Opportunity Areas.** Based on the high collision and high injury bicyclist/pedestrian locations, there are opportunities for safety-related enhancements at key locations within Huntington Beach, Westminster, Anaheim, and Buena Park. Contra-flow bicycle travel, negligence of right-of-way rules, illegal pedestrian behavior, and turning movements are the primary areas for potential improvements.

The safety analysis findings were used to define locations along the Project Corridor that support safety improvements, and to identify potential safety countermeasures that address collision risk factors and patterns.

Section 3
OUTREACH

The purpose of this section is to summarize the outreach activities conducted throughout the Project duration. This input gathered from the outreach informed the development of the Study purpose and need, goals and objections, and evaluations and results of the Project.

3.1 PUBLIC ENGAGEMENT

Public engagement was a key component to the Study and helps OCTA establish and maintain the trust, support and confidence of the public and other stakeholders as well as provide a foundation for future stages of development.

The Project webpage (https://www.octa.net/beachstudy) provides an overview of the Project, details on outreach materials, and presents the various documents developed throughout the study.

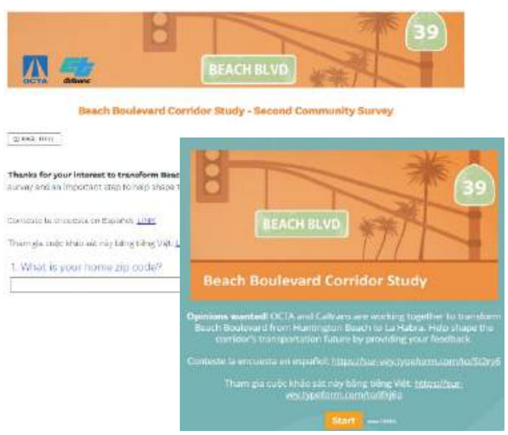
The first outreach phase of the Study took place in the spring of 2019 to inform and educate key stakeholders and the general public about the purpose and goals of the Study and to identify improvement opportunities. The second phase took place in fall of

2019 to determine participants travel patterns and usage and to rank their impression of the improvement strategies.

In order to gather public feedback, the primary outreach effort for both public engagement phases was the promotion and distribution of an online survey. Following is a summary of the survey process, highlights and outreach tactics performed during the Study. The complete survey reports for Phase 1 and Phase 2 are in the appendix.

3.1.1 Survey Process

Two surveys were conducted in the course of the Study to assess the corridor's existing conditions and specific improvements. Survey findings were used to guide and enhance the development of the Study.



Phase 1 and Phase 2 survey highlights:

- 2,360 surveys were collected during the course of the Study.
- Both surveys were conducted in English, Spanish, and Vietnamese.
- Surveys were shared online and in written format at events.

Both surveys' research utilized a nonprobability sample, which means that results cannot be considered representative of the total population of interest. However, these research methods are useful to explore a group's opinions and views, allowing for the collection of a variety of data. This data can reveal information that may warrant further study and is often a cornerstone for the generation of new ideas.

3.1.1.1 Phase 1 Survey Results Summary

The first survey was available for public participation from May 1 to June 1, 2019 and sought to assess the community's current travel patterns and uses of the Project Corridor as well as the community's perspective on needed improvements.

The 15-question survey was conducted using an online survey tool. Print versions of the survey were also created as handouts and presentation boards for use at eight (8) local pop-up/community events. Surveys were also conducted by OCTA staff during three (3) onboard bus outreach efforts.

The survey questions were designed to:

- Establish participant habits and use,
- Assess perceived challenges,
- Identify opportunities for improvement,
- Gather respondent demographics, and,
- Inform future outreach initiatives and receive new contact information.

A total of 1,133 surveys were collected (1,076 English, 29 Spanish, 28 Vietnamese). Based on the demographic information collected, respondents were comprised of a diverse mix of age, income, ethnicity, geography, and habits.

The survey findings highlighted the complexity of the corridor and offer insight into the challenges facing OCTA, Caltrans and each of the local jurisdictions. In particular, survey respondents recognize the need for improvements on the Project Corridor and generally wanted to see:

- Reduction in congestion,
- Improvement in circulation, and,
- Overall safer conditions for all modes of travel.

The top two improvements for each mode of travel was:

- **Vehicles:** Optimize traffic signals; extend turn pockets
- **Transit:** Enhance bus stop amenities; build a high-capacity transit system
- **Bike:** Provide barrier-separated bike lanes; add bike lanes on parallel streets
- **Walk:** Add sidewalks where there are gaps; add pedestrian bridges

The complete Survey 1 report is provided on the Project webpage, and summarized in Figure 3-1.

Beach Boulevard Corridor Study Outreach and Survey Results

Corridor Survey Results

Why do you travel on Beach Boulevard? (Check all that apply)

- Shopping 73%
- Entertainment 57%
- Beach 49%
- Business or Service 45%
- Employment 44%
- School 10%
- Other 9%

How do you currently travel on Beach Boulevard? (Check all that apply)

- 83% Drive solo
- 22% Bus
- 21% Rideshare (Carpool, Uber, etc.)
- 13% Bike
- 9% Walk

What challenges do you experience while traveling on Beach Boulevard? (Select up to 3)

- 83% Congestion
- 59% Long waits at traffic signals
- 55% Delays from turning vehicles
- 16% Lack of bike space
- 13% Limited bus routes
- 13% Long distance between crosswalks
- 10% Lack of bus stop amenities
- 6% Lack of sidewalks

What would you do to enhance travel conditions on Beach Boulevard? (Select up to 3)

- Make infrastructure adjustment to better drive time 77%
- Add high-capacity transit 43%
- Improve pedestrian access and safety 34%
- Improve existing transit service 32%
- Improve bicycle infrastructure 28%
- Add community shuttles 25%

What would you do to improve:

Driving on Beach Blvd (Select up to 5)

Optimize traffic signals	83%
Extend turn pockets	61%
Add pedestrian bridges	47%
Improve access to freeways	42%
Add more locations for left turns	36%
Add more travel lanes	35%
Provide more space for bicyclists	31%
Limit the number of driveways	27%
Provide pick-up/drop-off areas	26%

Transit service on Beach Blvd (Select up to 5)

Enhance bus stop amenities	49%
Build a high-capacity transit system	46%
Provide more frequent buses	45%
Improve access to bus stops	39%
Provide bus-only lanes	38%
Operate buses earlier/later	36%
Enhance bus amenities	36%
Add signal priority timing for buses	34%
Add bus stops and transfer points	29%

Bicycling on Beach Blvd (Select up to 5)

Provide barrier-separated bike lanes	51%
Add bike lanes on parallel streets	48%
Add bike lanes	47%
Add pedestrian bridges	41%
Remove on-street parking	40%
Increase bike racks on buses	32%
Widen sidewalks	26%
Add more safe/secure bike parking	26%
Limit the number of driveways	25%
Provide bike-sharing/e-bike/scooters	24%
Lower vehicle speed limits	10%

Walking on Beach Blvd (Select up to 5)

Add sidewalks where there are gaps	64%
Add pedestrian bridges	53%
Improve sidewalk experiences	50%
Add safety features for crossing	49%
Move obstructions outside sidewalk	33%
Add missing accessible ramps	33%
Widen sidewalks	31%
Provide mid-block crosswalks	25%
Provide more right turn pockets	22%
Limit number of driveways	17%
Provide more bike lanes	14%

What is the age range of respondents?

16-24	25-34	35-44	45-54	55-64	65-74	75+
6%	17%	19%	18%	24%	12%	4%

What is the combined annual household income?

Less than $30,000	14%
$30,000-$49,000	10%
$50,000-$79,000	16%
$80,000-$109,000	15%
$110,000-$169,000	15%
More than $170,000	11%
Preferred not to say	19%

Beach Boulevard Corridor Study Outreach and Survey Results

First Steps to Transforming Beach Boulevard

Hosted **8** pop-up/community events, attracting **350** participants

Mailed **453** postcards and E-mailed **16,000+** bus riders and stakeholders

Distributed flyers to **45** libraries, city halls, and senior and communty centers

Shared e-communication tool-kits with **9** corridor cities and **18** public committees/stakeholder organizations

Advertised in **1** Spanish and **1** Vietnamese newspaper

Shared **100's** of fact sheets and frequently asked questions

Conducted bus surveying on-board **3** buses

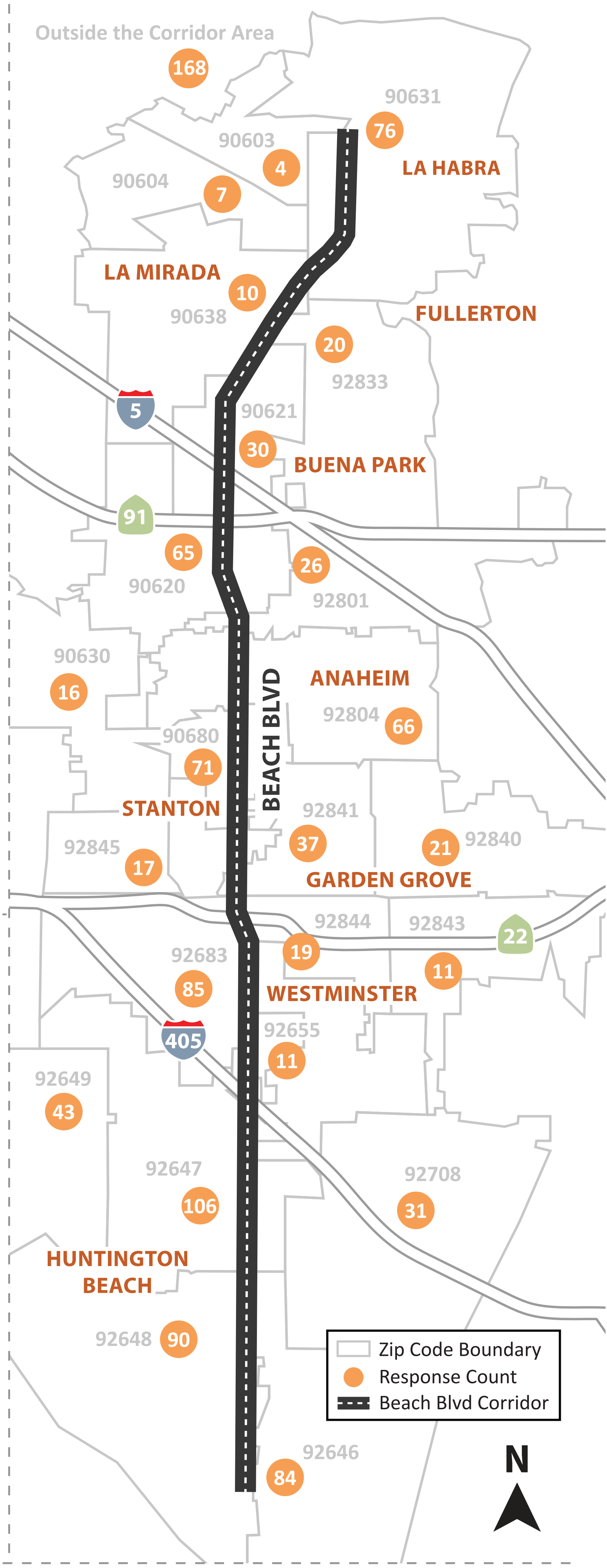
Promoted the project and survey with **2** Facebook ad boosts, **4** OCTA Facebook posts, and **1** OCTA Twitter post

Announced the project through OCTA On-the Move blog and the press resulting in **5** additional news articles

Collected **1,133** completed surveys from May 1 - June 1, 2019

All materials were shared in English, Spanish, and Vietnamese

Where are the responses coming from?



What is being said about the study?

Stay Connected

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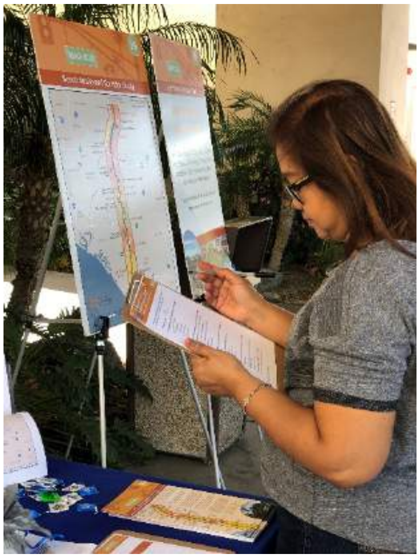
OCTA Caltrans

As of June 2019

3.1.1.2 Phase 2 Survey Results Summary

The second survey was available from September 19, 2019 to November 3, 2019.



The 20-question survey was conducted using an online survey tool. Print versions of the survey were also created as handouts for use at nine (9) local pop-up/community events. Surveys were also conducted by OCTA staff during two (2) onboard bus outreach efforts.

The survey questions were designed to:

- Rank opportunities for improvement,
- Determine participant's travel characteristics and use of the corridor and their potential opportunities for change,
- Gather respondent demographics, and,
- Inform future outreach initiatives and receive new contact information.

The survey gathered input from 1,227 respondents (1,187 English, 26 Spanish, and 14 Vietnamese). Based on the demographic information collected, respondents were comprised of a diverse mix of age, income, ethnicity, geography, and habits.

The Phase 2 survey questions focused on evaluating the effectiveness of specific Project Corridor improvements, including the effect of reduced speeds, dedicated transit lanes, and potential changes to bike and pedestrian rights-of-way.

Survey findings illustrated how the survey respondents may react to potential changes to the transportation conditions. The results suggest that possible reductions to the speed limits along the Project Corridor would likely result in driver's decreased use, rerouting vehicles from Beach Boulevard to parallel north-south arterials.

In contrast, the survey indicated usage may increase with all of the following:

- If transit travel time improved using transit-only lanes or technology to enhance traffic signal timing
- If biking on sidewalks was allowed or protected bikeways were provided
- If bike lanes were added to parallel streets or connections to and from Beach Boulevard were improved
- If walking was improved with better lighting or wider sidewalks
- If street crossings were improved with enhanced crosswalks, more frequent crossings or shorter crossing distances by extending sidewalks or curbs

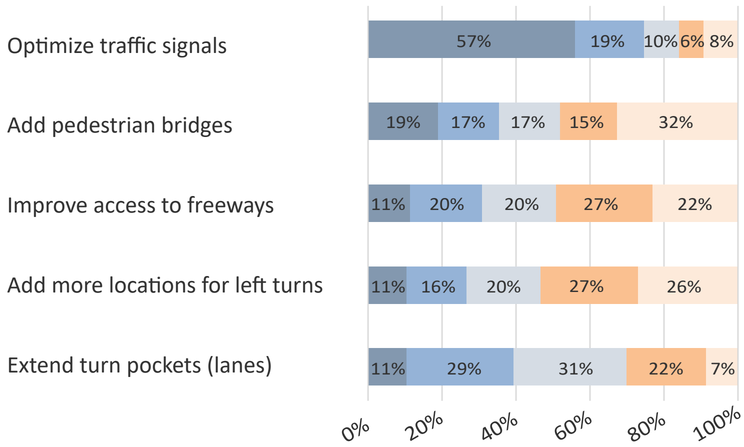
Follow-up corridor improvement questions were asked during the survey with very similar results as the Phase 1 survey.

The complete Survey 2 report is provided on the Project webpage and summarized in Figure 3-2.

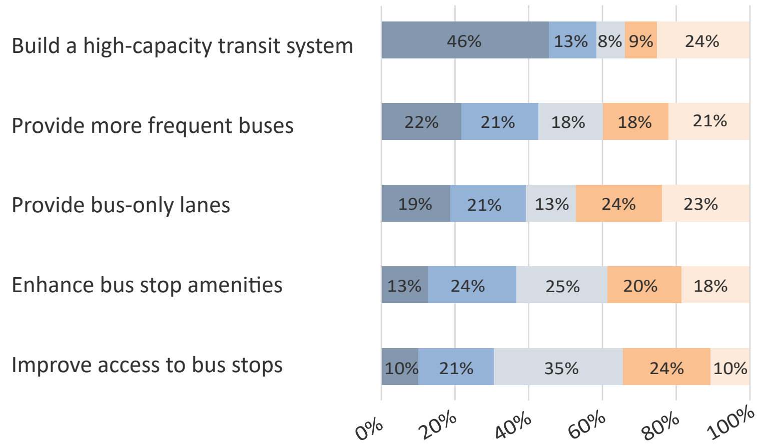
What would you do to improve:

Rank 1 | Rank 2 | Rank 3 | Rank 4 | Rank 5

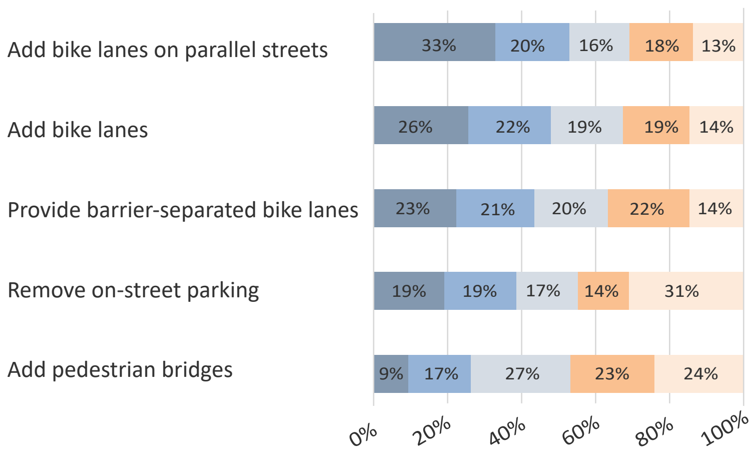
Driving on Beach Blvd
(Rank 1-5 with 1 as top pick)



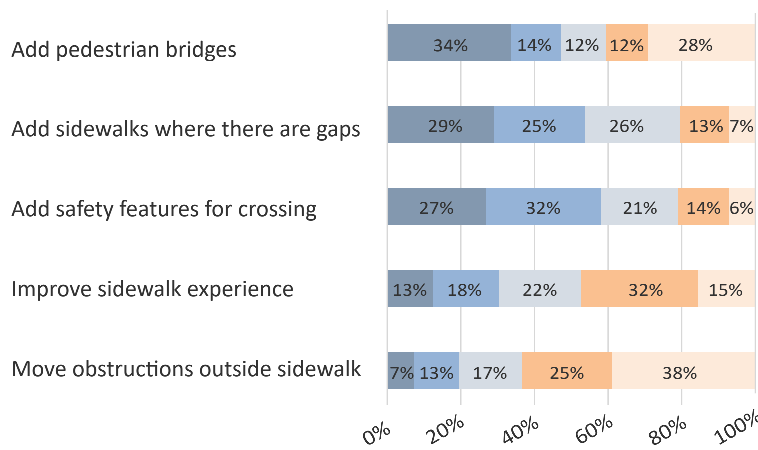
Transit service on Beach Blvd
(Rank 1-5 with 1 as top pick)



Bicycling on Beach Blvd
(Rank 1-5 with 1 as top pick)



Walking on Beach Blvd
(Rank 1-5 with 1 as top pick)



Use & Opportunities

	5+ Days a Week	3 - 4 Days a Week	1 - 2 Days a Week	1 - 3 Days a Month	Never
Currently I drive on Beach Boulevard:	36%	22%	21%	14%	7%
If driving speed limits were reduced to enhance safety, I would drive on Beach Boulevard:	24%	17%	20%	18%	21%
Currently, I use transit on Beach Boulevard:	8%	6%	6%	12%	68%
If transit travel time was improved using transit-only lanes or technology to enhance traffic signal timing, I would use transit on Beach Boulevard:	21%	15%	12%	19%	33%
Currently, I ride a bike on Beach Boulevard:	1%	2%	4%	9%	84%
If biking on sidewalks were allowed or protected bikeways were provided, I would bike on Beach Boulevard:	7%	8%	12%	21%	52%
If bike access was improved by having bicycle lanes on parallel streets or better connections to and from Beach Boulevard, I would bike on Beach Boulevard:	8%	9%	11%	22%	50%
Currently, I walk along Beach Boulevard:	6%	5%	8%	23%	58%
If walking conditions on sidewalks were improved with better lighting or wider sidewalks, I would walk along Beach Boulevard:	10%	11%	14%	27%	38%
If street crossings were improved with enhanced crosswalks, more frequent crossings or shorter crossing distances by extending sidewalks or curbs, I would walk on Beach Boulevard:	10%	11%	15%	28%	36%

What is the age range of respondents?

16-24	25-34	35-44	45-54	55-64	65-74	75+
6%	15%	15%	16%	27%	15%	6%

What is the combined annual household income?

Less than $30,000	11%
$30,000-$49,000	12%
$50,000-$79,000	15%
$80,000-$109,000	15%
$110,000-$169,000	15%
More than $170,000	9%
Preferred not to say	23%

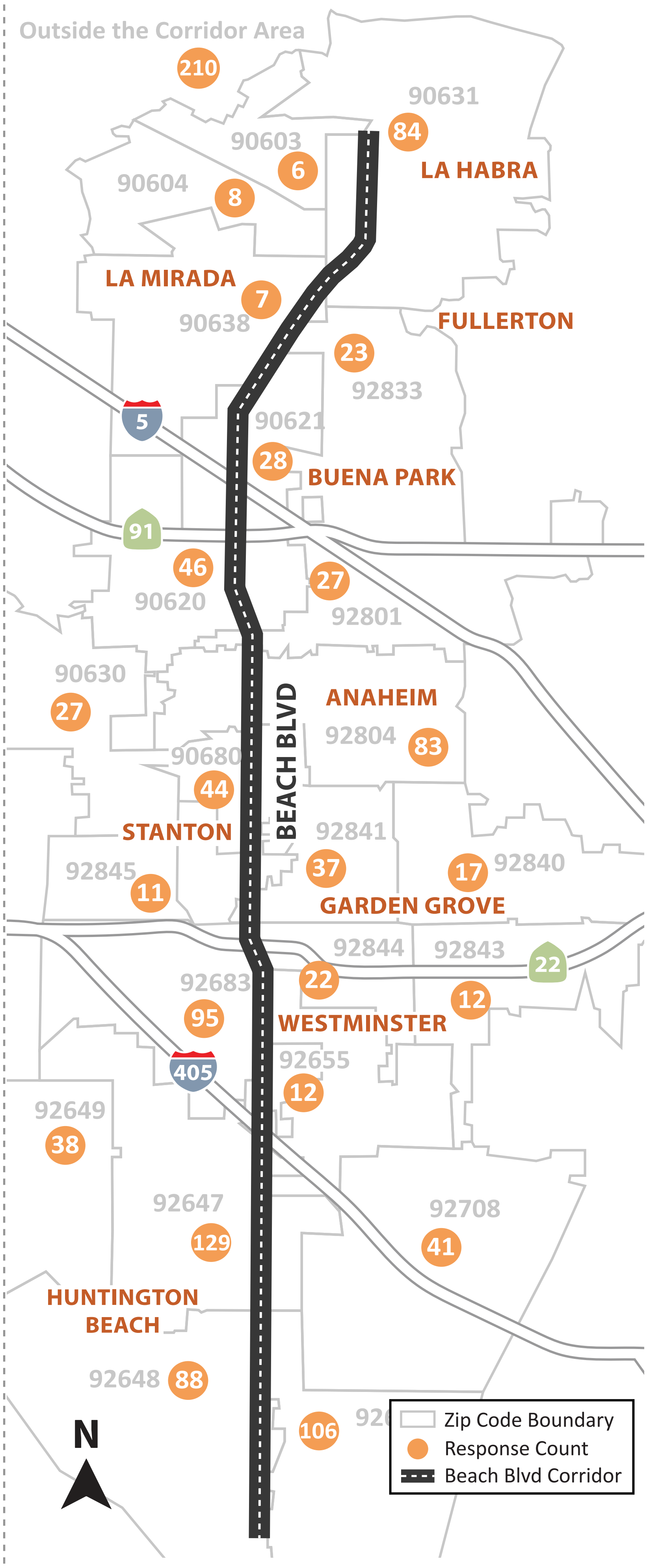
Which race/ethnicity best describes you?

American Indian or Alaska Native	1%
Asian or Asian American	8%
Black or African American	2%
Hispanic or Latino	18%
Native Hawaiian or other Pacific Islander	1%
White or Caucasian	55%
Another race	2%
Prefer not to say	13%

Community Engagement to Transform Beach Blvd

- Hosted 9 pop-up/community events, attracting 400+ participants
- Mailed and delivered 2,375+ postcards and e-mailed 17,375+ bus riders and stakeholders
- Distributed flyers to 54 libraries, city halls, chambers of commerce, and senior and community centers
- Shared e-communication tool-kits with 9 corridor cities and 18 public committees/stakeholder organizations
- Shared 100+ fact sheets and frequently asked questions
- Conducted on-board bus surveying, reaching 100+ riders
- Promoted the project and survey with 3 OCTA Twitter posts, 3 OCTA Facebook posts, and 3 Facebook ads with 119,830 views
- Announced the project through OCTA On-the Move blog, reaching 9,000 subscribers
- Collected 1,227 completed surveys from September 19 - November 3, 2019
- All materials were shared in English, Spanish, and Vietnamese

Where are the responses coming from?



Stay Connected

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OCTA Caltrans

As of December 2019

3.2 LOCAL JURISDICTION INTERVIEWS

As part of the Project, individual interviews were conducted with the TWG to gain insight about the Project and to identify recommendations that may provide support for project implementation. Of the ten TWG agencies along the Project Corridor, the following participated in the interview process: Huntington Beach, Westminster, Garden Grove, Stanton, Anaheim, Buena Park, La Mirada, Fullerton, La Habra, and the County of Orange.

Interviews were conducted at each respective agency from October 8 to 11, 2019 with a panel consisting of city staff, Project team. The interview format was an open-ended discussion about the Project Corridor, and covered several key subjects, such as Caltrans, multi-jurisdiction coordination, agency staffing, funding, and OCTA. As part of the interview process, a survey with respect to the project goals was also distributed.

3.2.1 Common Interview Themes

Throughout the agency interviews, several common themes emerged (these were identified when an issue was mentioned multiple times). The following common themes are noted in alphabetical order:

- **Alternatives:** Different alternatives could be supported if data supports roadway capacity and LOS needs
- **Caltrans Right of Way (ROW):** Issues of jurisdiction with the Project Corridor as a Caltrans ROW
- **Caltrans Cost:** Cost sharing between agencies and Caltrans may not be considered equitable
- **Caltrans Processes:** Roles that OCTA can do to streamline or assist Caltrans reviews and permit process
- **Economic Development:** Land use development can impact transportation
- **Freeway Access:** Access and route to freeways is a major consideration for the street
- **Funding:** Financial resources of the responsible agencies are critical to implementation
- **Liability:** Cities inherit liability of Caltrans right-of-way if the roadway is relinquished
- **Mobility Modes:** Roadway currently has an auto-centric priority with some multimodal considerations

- **Open Streets:** SCAG open streets event will enliven the corridor
- **Political Influence:** Political decisions can affect the ability to implement projects
- **Regional Relinquishment:** OCTA lead and fund a study for Caltrans relinquishment along the corridor
- **Regional and Local Uses:** The roadway has both regional and local needs that both need to be considered
- **Signal Timing:** Signal coordination is a good example of a regional project that requires Caltrans coordination

As shown above, one of the common themes was specific to working with Caltrans, since the majority of the corridor is a Caltrans facility. There was also a focus on auto-centric priority, throughput, and access to freeways. Discussions also focused on how the roadway is used as a local or regional street, as well as the types of modes that use it. Concerns were raised about how development, specifically housing projects, could impact traffic on the Project Corridor. In addition, it was noted that implementation of improvements along the Project Corridor would depend on funding and political influence. A summary of the survey results is provided on the Project webpage.

3.2.2 TWG Ranking Survey Result

In addition to the discussion of the overall issues and opportunities along the Project Corridor as part of the interviews, agencies were also asked to rank their relative importance of the Project goals. The results of these ranking were considered when making the project recommendations and are presented in **Table 3-1** below.

Table 3-1. TWG Rankings Survey

Ranking	Transit	Active Modes	Vehicular Travel	Safety	Mobility/ Connectivity
Totals	18	33	29	14	33
Weighted	1.8	3.3	2.9	1.4	3.3
Rank	2	4	3	1	4

3.3 OTHER OUTREACH EFFORTS

A variety of methods were employed to reach out to the public and encourage survey participation for both phases of outreach, including local events as well as print and electronic notices. The Project team engaged a diverse mix of stakeholder groups to ensure the improvements accounted for the various needs and concerns of the greater corridor community.

3.3.1 Technical Working Group (TWG)

A Technical Working Group (TWG) was formed in late 2018, and eight TWG meetings took place between November 2018 and February 2020. A 12-agency group was composed of a mix of agency department representatives from the corridor jurisdictions.

The TWG was essential in achieving the Study's goal of developing and presenting meaningful alternatives that would be used to guide future development efforts along the Project Corridor. Members provided insight to the existing conditions and challenges within each community as well as jurisdictional plans for future development. They also worked collaboratively with the Project team to develop the alternatives and shape the final reporting objectives into a format that would suit their future use.

These agencies also supported the outreach notification process, facilitated event coordination, and posted survey invitations on social media and through the use of public counters.

3.3.2 Elected Officials and City Councils

While the TWG served as the primary interface with each of the corridor jurisdictions, OCTA and Caltrans maintained contact with staff of local-elected official offices to keep them apprised of the Study's progress. In addition, OCTA and Caltrans presented to two city councils during their regular meetings. Briefings were available upon request throughout the duration of the study.

3.3.3 Stakeholder Groups

Briefings were also provided to key stakeholder groups to provide communication on the study goals and progress updates on the process and results. These stakeholder engagements also provided an opportunity to promote Study awareness and survey participation to the broader stakeholder organizations. OCTA and Caltrans communicated with 11 stakeholder groups, in the form of: two agency focused briefings, four OCTA advisory groups and business organizations, four community organization briefings, four neighborhood association briefings, the Beach Boulevard Coalition, and three other stakeholder group briefings.

3.3.4 Local Events

Local events served as the primary in-person method of engagement to support the survey goal to involve participants with the greatest diversity of geographic and demographic representation. The events for both surveys consisted of three formats: scheduled community events, pop-up table events, and onboard bus outreach efforts.

At these events, staff educated interested parties on the Study, building public awareness on the purpose and need for this collaborative work. They also provided collateral fact sheets, frequently asked questions (FAQ), and surveys to all interested parties. In addition, OCTA conducted onboard bus surveying on five occasions on routes 29 and Bravo! 529.

In total, the Study was shared at 22 events located in seven of the local jurisdictions, which engaged with more than 900 members of the public.

In addition, OCTA participated at the Meet on Beach event, hosted by SCAG on November 17, 2019.

3.3.5 Notifications

In addition to the events, the online survey was also shared through a number of notification methods to engage communities in the Study Area, as well as individuals who travel along the corridor. Electronic noticing was a key component in the survey notification process, including linking the survey on the Project webpage, pushing the survey through social media ads and posts on Facebook and Twitter, sharing posts on the OCTA blog, and by distributing to bus riders and key project stakeholders via e-blasts. The corridor cities also help distribute the survey by way of a communications toolkit, which offered a variety of programmed messaging for agencies to share with their various communities. In addition, the survey was promoted through traditional means, including a direct mail postcard, flyers posted at public counters, and through ads in Spanish and Vietnamese newspapers. Complete details of all outreach efforts are provided on the Project webpage.

Section 4
GOALS AND OBJECTIVES

The purpose of this section is to present the goals and objectives for the Project Corridor.

4.1 PURPOSE AND NEED

Based on the information developed during the baseline conditions study and feedback from the TWG, the purpose and need of the Study were developed.

4.1.1 Purpose

The purpose of the Beach Boulevard Corridor Study is to identify and recommend feasible multimodal transportation improvements to facilitate mobility and connectivity for travelers of all modes along the Project Corridor.

4.1.2 Need

The Project is needed to address existing and anticipated future demands for local and regional travel along the Project Corridor, including vehicular throughput, active transportation connectivity and transit operations, and to complement local land use types. These issues are outlined below:

Transit: In addition to vehicular travel, roadway congestion and delays also reduce the operating speeds of transit, including the new Bravo! 529 service. First/last mile connections can also be improved to facilitate access to bus stops, and bus stop amenities can be enhanced at key transfer locations to further increase the comfort of and convenience for riders.

Active Transportation: A continuous north-south bicycle connection (i.e., bicycle path or lane) is not provided for the entire length of the Project Corridor (i.e., on Beach Boulevard and along parallel facilities), nor is one proposed as part of any future city or regional bicycle plans. Similarly, there are gaps in the sidewalk network that potentially constrains the ability to walk continuously along the

Project Corridor. In addition, the pedestrian environment is not conducive for walking, with narrow sidewalk widths, obstructions, and a lack of amenities.

Vehicular Travel: Congestion, based on a reduction in travel speeds, occurs along the Project Corridor in the vicinity of the freeway interchanges (e.g., I-405, SR 22, I-5, and SR 91) during peak periods. This can result from volumes destined to on-ramps which causes the formation of queues, plus traffic signal signalization plans that are needed to clear off-ramp queues. In addition, localized congestion occurs in the vicinity of major intersections, primarily a result of activities at driveways, buses at bus stops and the turning speeds of large trucks, plus at mid-block locations due to vehicles stopping at the curb and parking maneuvers.

Safety: As a result of the size of the intersections and the volumes of traffic, there are long crossing distances for pedestrians and a lack of bicycle lanes that extend to and through the Project Corridor. This contributes to varying levels of exposure for pedestrians and bicyclists crossing the corridor. In addition, the speed of vehicular traffic, in conjunction with the localized congestion due to queuing and driveway blockages, leads to vehicle-to-vehicle collisions along the corridor.

Mobility: Given the spacing of the roadway grid, crosswalks are typically provided about 0.5 miles along the Project Corridor, which limits the ability for pedestrians to connect easily between nearby land uses. The vehicular travel speeds, lack of buffers between the travel lanes, and relatively narrow sidewalks also reduce the attractiveness for walking. In addition, there are limited on-street parking and loading spaces (including for rideshare pick-up and drop-off) or locations that provide shared mobility services (such as car-, bike- or scooter-share), thereby limiting the usage of alternative travel modes.

Projected Traffic Volumes: Traffic volume for the Project Corridor were projected for the year 2040 using the latest version of OCTAM[2]. These projections are used to identify vehicular traffic circulation deficiencies in the future.

4.2 GOALS AND OBJECTIVES

The following goals and objectives have been developed to address the problems discussed in the purpose and need statement, as shown in Table 4-1. These goals were used to inform the development of toolbox elements for the Project.

[2] Orange County Transportation Analysis Model version 4.0.

Table 4-1. Project Goals and Objectives

Goals	Objectives
1) Improve travel time, reliability and convenience of transit	1.1 Minimize delays to bus operations 1.2 Enhance transit stops and improve first/last mile connections
2) Reduce impediments to walking and biking along and across the Project Corridor	2.1 Establish continuous north/south routes 2.2 Enhance the walking and biking environment
3) Maintain vehicular throughput and access to and from regional freeways network	3.1 Reduce congestion associated with freeway on- and off-ramps 3.2 Minimize localized delays
4) Provide a safe and accessible environment for all user groups	4.1 Improve pedestrian and bicyclist crossings of corridor 4.2 Reduce vehicular incidents
5) Support local land use planning with improved mobility options	5.1 Encourage use of alternative modes of travel 5.2 Facilitate connections between nearby land uses

Section 5
TOOLBOX ELEMENTS DEVELOPMENT AND EVALUATION

The purpose of this section is to present a toolbox of potential improvements for consideration for the Project Corridor. The section presents the preliminary evaluation conducted to refine the initial list of toolbox elements and to determine the final list to be analyzed in detail.

5.1 INITIAL TOOLBOX ELEMENTS

The initial list of multimodal improvements has been identified to address the purpose and need for the study. From this toolbox, a series of project alternatives was developed and evaluated as part of subsequent tasks. However, it should be noted that the purpose of this initial list is to inform the project alternatives and to guide future analysis, and thus is not an comprehensive listing of all possible improvements and does not include improvements that are inconsistent with the context and physical conditions of the Project Corridor (i.e., within the current right-of-way).

5.1.1 Improvement Toolbox

Toolbox elements were identified to enhance the transportation conditions associated with each of the main issues along the Study Corridor, as outlined below. Note that each element was identified with an ID, which indicated the transportation condition addressed.

Transit (T)

- Roadway congestion and delays reduce the operating speeds of transit.
- Lack of first/last mile connections and bus stop amenities limits access to bus stops and does not support the comfort of and convenience for riders.

Active Transportation (A)

- Continuous north-south bicycle connection is not provided or proposed.
- Gaps in the sidewalk network and narrow sidewalks/ obstructions limit pedestrian travel.

Vehicular Travel (V)

- Congestion in the vicinity of the freeway interchanges

- Localized congestion near major intersections, due to bus stops, pedestrians and driveways

Safety (S)

- Varying levels of exposure for pedestrians and bicyclists due to long crossing distances and lack of continuous facilities
- High levels of vehicle-to-vehicle collisions along corridor

Mobility/Connectivity (C)

- Lack of east-west connectivity due to large block lengths (about 0.5 miles)
- Attractiveness for walking negatively affected by non-friendly pedestrian environment
- Limited on-street parking and loading for shared mobility services

The toolbox includes improvements that generally stay within the overall right-of-way (back-of-sidewalk to back-of-sidewalk) along the Project Corridor, incorporate best practices for each of the modes, and reflect issues and opportunities directly observed in the Study Area. Table 5-1 provides the list of initial toolbox elements and notations on which Project objective is supported by the element.

It should be noted that many of the proposed improvements may benefit multiple modes of travel and thus support several of the Project's objectives. As such, the primary (**X**) and secondary (x) goals have been identified for each element. For example, the provision of pedestrian bridges would primarily benefit vehicular travel by removing conflicts at intersections and would secondarily benefit pedestrian safety.

Table 5-1. Initial Toolbox Elements

ID	Toolbox Element	Transit	Active Modes	Vehicular Travel	Safety	Mobility/ Connec-tivity
T1	Bus stops/ stations amenities	**X**	x		x	x
T2	Transit signal priority treatments	**X**				
T3	Transit preferential treatments	**X**				
T4	Streetcar (mixed-flow)	**X**				

ID	Toolbox Element	Transit	Active Modes	Vehicular Travel	Safety	Mobility/ Connec-tivity
T5	Bus rapid transit (mixed-flow)	**X**				
T6	Dedicated transit lanes (for BRT or streetcar)	**X**				
T7	First/last mile improvements at major stops	**X**	x		x	x
A1	Close gaps in sidewalk network		**X**		x	x
A2	Remove sidewalk obstructions		**X**		x	x
A3	Sidewalk amenities		**X**		x	
A4	Painted bike lanes		**X**		x	x
A5	Pedestrian scramble		**X**		x	x
V1	Advanced traffic signal timing/ ITS	x		**X**	x	
V2	Active traffic management		x	**X**	x	
V3	Access management	x	x	**X**	x	
V4	On-street parking/ loading zones removal	x	x	**X**		

ID	Toolbox Element	Transit	Active Modes	Vehicular Travel	Safety	Mobility/ Connec-tivity
V5	Consolidate mid-block median breaks	x		**X**	x	
V6	Pedestrian bridges	x	x	**X**	x	
V7	Adjust interchange ramp locations/ configurations			**X**	x	
V8	Displaced left-turn at intersections			**X**	x	
S1	Pedestrian refuge islands		x	x	**X**	
S2	Protected bike lanes (on Beach Boulevard)		x		**X**	x
S3	Close gaps in bicycle network (on parallel streets)		x		**X**	x
S4	Bicycle preferential treatments (e.g., detection, signal phases, bike boxes)		x		**X**	x
S5	Bike on sidewalk treatments		x		**X**	x
S6	Countdown pedestrian signal heads		x	x	**X**	
S7	High-visibility crosswalks		x		**X**	

ID	Toolbox Element	Transit	Active Modes	Vehicular Travel	Safety	Mobility/ Connec-tivity
S8	Realigned crosswalks at freeway ramps		x		**X**	
C1	Corner/ sidewalk bulbs		x		x	**X**
C2	Signalized mid-block pedestrian crossings	x	x		x	**X**
C3	Reduced speed limits		x		x	**X**
C4	Landscaped sidewalk buffer		x		x	**X**
C5	On-street parking/ loading zones				x	**X**

5.2 TOOLBOX ELEMENTS SCREENING

5.2.1 Initial Screening with Stakeholders

Based on discussions with Project stakeholders, the following elements were eliminated from future consideration:

- **Transit: Streetcar (mixed flow) (T4)**. This element was inconsistent with the OCTA Transit Vision Plan.
- **Transit: Bus rapid transit (mixed flow) (T5)**. OCTA would only consider this element in conjunction with an exclusive transit only lane; as such, it would not be considered as a standalone element.
- **Bicycles: Painted bike lanes (A4).** There is inadequate curb-to-curb width to create bike lanes without narrowing travel lanes to less than required minimum standard widths.
- **Connectivity: Reduced speed limits (C3)**. These could only be applied within Caltrans-defined Business Districts.

- **Connectivity: Landscaped sidewalk buffer (C4).** This would be considered with protected bike lanes or on-street parking/loading zones and would not be implemented as a standalone element.

In addition, the following elements were modified to address stakeholder input:

- **Transit: Dedicated transit lanes (for BRT or streetcar) (T6).** This element was modified to only include BRT, as streetcars would be inconsistent with the OCTA Transit Vision Plan.
- **Vehicles: Displaced left-turn at intersections (V8).** This was modified to include all alternative intersection configurations, not just displaced left-turns.

5.2.2 Review of Cost and Risk Factors

Preliminary cost ranges were developed per mile or per location for the refined list of toolbox elements to provide a relative comparison of the typical cost factors, such as design and construction (note that these counts do not account for right-of-way). The costs were divided into the following ranges:

- $ - low cost ($0 to $750,000)
- $$ - medium cost ($750,000 to $1,500,000)
- $$$ - high cost (> $1,500,000)

In addition, risk factors associated with implementing each element were developed related to environmental effects, constructability, right-of-way needs, agency coordination (in addition to Caltrans where the roadway is under its jurisdiction), and operations and maintenance.

Both the cost ranges and the risk factors for each element are presented in Table 5-2 below.

Table 5-2. Preliminary Cost and Risk Factors

ID	Toolbox Element	Cost Range	Risk Factors
T1	Bus stops/ stations amenities	$	Right-of-Way - may need to widen sidewalk or reduce path of travel Agency - requires coordination with OCTA and other transit operators Constructability - may require power and connectivity O&M - may require additional upkeep from OCTA staff

ID	Toolbox Element	Cost Range	Risk Factors
T2	Transit signal priority treatments	$	Environmental - may reduce traffic capacity at intersections Constructability - ability to provide signal infrastructure and bus detection Agency - would need to be implemented as part of a corridor-long system
T3	Transit preferential treatments	$$	Right-of-Way - may require additional street width Environmental - may reduce traffic capacity of street Agency - would need to be implemented as part of a corridor-long system
T6	Dedicated transit lanes (for BRT)	$$$	Right-of-Way - additional width needed for dedicated lane and stations (need to reduce # of travel lanes) Constructability - may effect drainage and utilities Environmental - may reduce traffic capacity of intersections and street Agency - would need to be implemented as part of a corridor-long system
T7	First/last mile improvement s at major stops	$	Right-of-Way - may need to widen sidewalks or reduce path of travel
A1	Close gaps in sidewalk network	$-$$	Right-of-Way - may require additional width, agreements with adjacent property owners Constructability - may require utility relocation
A2	Remove sidewalk obstructions	$	Right-of-Way - may require additional width Constructability - may affect utilities
A3	Sidewalk amenities	$	Constructability - may require power Right-of-Way - may require additional sidewalk width O&M - may require additional maintenance from cities
A5	Pedestrian scramble	$$	Constructability - may require new signals and timing plans

ID	Toolbox Element	Cost Range	Risk Factors
V1	Advanced traffic signal timing/ ITS	$$	Constructability - ability to run interconnects to upstream and downstream intersections Agency - would need to be implemented as part of a corridor-long system
V2	Active traffic management	$$	Constructability - requires active management; ability to provide communication to signals Agency - would need to be implemented as part of a corridor-long system
V3	Access management	$	Environmental - potential impacts to businesses
V4	On-street parking/ loading zones removal	$	Environmental - potential impacts to businesses
V5	Consolidate mid-block median breaks	$	Environmental - may lead to additional traffic due to restricted access Agency - must be done in conjunction with C2
V6	Pedestrian bridges	$$	Right-of-Way - may need additional space for bridge landings Environmental - potential visual impacts Agency - requires coordination with Caltrans
V7	Adjust interchange ramp locations / configura-tions	$$$	Right-of-Way - required for reconfiguration Environmental - potential impacts to drainage, ESA, utilities Constructability - restrictive conditions such as bridge structure or high-risk utility Agency - requires approvals/coordination with Caltrans; would need to be implemented within the context of the adjacent segments
V8	Alternative intersection configura-tions	$$	Right-of-Way - may require additional width Agency - would need to be implemented as part of a corridor-long system
S1	Pedestrian refuge islands	$	Right-of-Way - may need to narrow lanes or sidewalk

ID	Toolbox Element	Cost Range	Risk Factors
S2	Protected bike lanes (on Beach Boulevard)	$	Right-of-Way - need to reduce # of travel lanes on Beach Boulevard Environmental - may require reduction in travel lanes, on-street parking/loading O&M - additional costs may be required for paint and bollard maintenance Agency - would need to be implemented as part of a corridor-long system
S3	Close gaps in bicycle network (on parallel streets)	$	Right-of-Way - may require additional street widths Environmental - may require reduction in travel lanes, on-street parking/loading
S4	Bicycle preferential treatments (e.g., detection, signal phases, bike boxes)	$	Constructability - ensure that signal controllers can accommodate Environmental - may reduce traffic capacity at intersections
S5	Bike on sidewalk treatments	$	Agency - requires local policies and approvals Right-of-Way - may require additional sidewalk space
S6	Countdown pedestrian signal heads	$	Constructability - ensure that signal poles and controllers can accommodate
S7	High-visibility crosswalks	$	O&M - additional costs may be required for upkeep
S8	Realigned crosswalks at freeway ramps	$	Agency - requires Caltrans approvals/coordination; would need to be implemented within the context of the adjacent segment Constructability - may need to realign ramps or relocate utilities to implement
C1	Corner/ sidewalk bulbs	$$	Environmental - may reduce traffic capacity at intersections Constructability - may affect drainage and utilities
C2	Signalized mid-block pedestrian crossings	$	Constructability - ability to run interconnects to upstream and downstream intersections Agency - must be done in conjunction with V5

ID	Toolbox Element	Cost Range	Risk Factors
C5	On-street parking/ loading zones	$	Right-of-Way - need to reduce # of travel lanes on Beach Boulevard Agency - would need to be implemented as part of a corridor-long system

5.2.3 Identification of Coordination Needs

Each toolbox element would require certain steps and coordination with various agencies to implement. Table 5-3 below outlines the coordination needed for implementation. It should be noted that implementation of toolbox elements within Caltrans jurisdiction will require coordination and approvals from Caltrans. In addition, given Beach Boulevard is a Principal/Major arterial in OCTA's Master Plan of Arterials and Highways (MPAH), any changes to the capacity of the roadway would need to be reviewed and approved by OCTA through its MPAH amendment process.

Table 5-3. Steps/Coordination Needed for Implementation

ID	Toolbox Element	Implementation Steps/Coordination Required (all elements would require Caltrans approval)
T1	Bus stops/ stations amenities	OCTA to determine elements and requirements; coordination with cities for implementation
T2	Transit signal priority treatments	Coordination with affected cities
T3	Transit preferential treatments	Coordination with affected cities
T6	Dedicated transit lanes (for BRT)	Coordination with affected cities; OCTA to determine operational plan
T7	First/last mile improvement s at major stops	Coordination with affected cities; ensure consistency with city and OCTA bicycle plans
A1	Close gaps in sidewalk network	Coordination between cities, Caltrans, and adjacent property owners
A2	Remove sidewalk obstructions	Coordination between cities, Caltrans, utilities, and adjacent property owners

ID	Toolbox Element	Implementation Steps/Coordination Required (all elements would require Caltrans approval)
A3	Sidewalk amenities	Coordination between cities, Caltrans, and adjacent property owners
A5	Pedestrian scramble	Coordination with cities; additional operational/timing studies required
V1	Advanced traffic signal timing/ ITS	Coordination with cities
V2	Active traffic management	Coordination with cities
V3	Access management	Coordination between OCTA, affected cities, and adjacent property owners/businesses
V4	On-street parking/ loading zones removal	Coordination between OCTA, affected cities, and adjacent property owners/businesses
V5	Consolidate mid-block median breaks	Coordination with affected cities; coordination may be required with affected neighborhoods or businesses / Done in conjunction with C2
V6	Pedestrian bridges	Coordination between cities, Caltrans, and adjacent property owners; coordination may be required with affected neighborhoods or businesses
V7	Adjust interchange ramp locations/ configurations	Coordination with cities, utilities, and flood control district; additional operational studies required
V8	Alternative intersection configurations	Coordination with affected cities; additional operational studies required
S1	Pedestrian refuge islands	Coordination with cities

ID	Toolbox Element	Implementation Steps/Coordination Required (all elements would require Caltrans approval)
S2	Protected bike lanes (on Beach Boulevard)	Coordination with cities; ensure consistency with city and OCTA bicycle plans
S3	Close gaps in bicycle network (on parallel streets)	Approval and coordination with cities; ensure consistency with city and OCTA bicycle plans
S4	Bicycle preferential treatments (e.g., detection, signal phases, bike boxes)	Coordination with cities; ensure consistency with city and OCTA bicycle plans
S5	Bike on sidewalk treatments	Coordination with cities
S6	Countdown pedestrian signal heads	Coordination with cities
S7	High-visibility crosswalks	Coordination with cities
S8	Realigned crosswalks at freeway ramps	Coordination with affected cities; additional operational studies required
C1	Corner/ sidewalk bulbs	Coordination between OCTA, affected cities, utilities, and adjacent property owners/businesses
C2	Signalized mid-block pedestrian [illegible]	Coordination between OCTA and affected cities / Done in conjunction with V5
C5	On-street parking/ loading zones	Coordination between OCTA, affected cities, and adjacent property owners/businesses

5.2.4 Element Classification

Based on the information provided above, each element was classified into four tiers based on the ease of implementation, cost, and risk factors:

- TSM/Tier 0[3] Tier are elements that can easily be implemented, have very low cost, and have minimal secondary effects.
- Tier 1 includes elements that have low costs, could be implemented in the short term, and/or have no significant secondary effects.
- Tier 2 includes elements that have medium costs, could be implemented in the mid-term, and/or have risks that would need to be addressed.
- Tier 3 includes elements that have high costs, could be implemented under the long term, and/or have significant risk factors.

It should be noted that certain toolbox elements cannot be implemented by a single agency or could have affects that span multiple jurisdictions. As such, these elements would need to be studied as corridor-wide treatments, and implemented on corridor-long basis. As such, toolbox elements were separated into Local elements (things that can be done independently and within a single jurisdiction) and Regional elements (things that would need to be evaluated and implemented throughout the corridor).

Both the Tier and Local-versus-Regional classifications for each element are presented in Table 5-4 below.

Table 5-4. Classification of Toolbox Elements

ID	Toolbox Element	Tier	Local or Regional Element
T1	Bus stops/ stations amenities	1	Local
T2	Transit signal priority treatments	2	Regional
T3	Transit preferential treatments	2	Regional
T6	Dedicated transit lanes (for BRT)	3	Regional

[3] Transportation System Management (TSM)/Transportation Demand Management (TDM)

ID	Toolbox Element	Tier	Local or Regional Element
T7	First/last mile improvements at major stops	1	Local
A1	Close gaps in sidewalk network (locations where parallel sidewalks are provided, but connections to/from Beach Boulevard are needed)	TSM	Local
A1	Close gaps in sidewalk network (locations where no parallel sidewalks exist; new facilities would need to be added)	2	Local
A2	Remove sidewalk obstructions	2	Local
A3	Sidewalk amenities	1	Local
A5	Pedestrian scramble	2	Local
V1	Advanced traffic signal timing/ ITS	2	Regional
V2	Active traffic management	3	Regional
V3	Access management	2	Local
V4	On-street parking/ loading zones removal	1	Local
V5	Consolidate mid-block median breaks	2	Local
V6	Pedestrian bridges	3	Local
V7	Adjust interchange ramp locations/ configurations	3	Regional
V8	Alternative intersection configurations	3	Regional
S1	Pedestrian refuge islands	2	Local
S2	Protected bike lanes (on Beach Boulevard)	3	Regional
S3	Close gaps in bicycle network (on parallel streets)	TSM	Local
S4	Bicycle preferential treatments (e.g., detection, signal phases, bike boxes)	1	Local
S5	Bike on sidewalk treatments	TSM	Local

ID	Toolbox Element	Tier	Local or Regional Element
S6	Countdown pedestrian signal heads	1	Local
S7	High-visibility crosswalks	TSM	Local
S8	Realigned crosswalks at freeway ramps	1	Regional
C1	Corner/ sidewalk bulbs	2	Local
C2	Signalized mid-block pedestrian crossings	2	Local
C5	On-street parking/ loading zones	3	Regional

5.3 FINAL TOOLBOX ELEMENTS

The final list of toolbox elements was refined and grouped per mode and per the tiers identified above in order to organize the elements from easiest to hardest to implement. Table 5-5 shows the groupings which were used in subsequent study steps. In addition to the preliminary cost estimates that informed the refinements, detailed cost estimates were prepared for each of the refined toolbox elements and are provided in Section 9 of this document.

Table 5-5. Final List of Toolbox Elements

Mode	Toolbox Element	Tier	Local or Regional Element
Transit	Bus stops/ stations amenities	1	Local
	First/last mile improvements at major stops	1	Local
	Transit signal priority treatments	2	Regional
	Transit preferential treatments	2	Regional
	Dedicated transit lanes (for BRT)	3	Regional
	Close gaps in sidewalk network (locations where parallel sidewalks are provided, but connections to/from Beach Boulevard are needed)	TSM	Local

Mode	Toolbox Element	Tier	Local or Regional Element
Pedestrians	High-visibility crosswalks	TSM	Local
	Realigned crosswalks at freeway ramps	1	Regional
	Countdown pedestrian signal heads	1	Local
	Sidewalk amenities	1	Local
	Close gaps in sidewalk network (locations where no parallel sidewalks exist; new facilities would need to be added)	2	Local
	Remove sidewalk obstructions	2	Local
	Pedestrian scrambles	2	Local
	Pedestrian refuge islands	2	Local
	Corner/sidewalk bulbs	2	Local
	Mid-block signalized pedestrian crossings	2	Local
	On-street parking/loading zones	3	Regional
Bicycles	Bike on sidewalk treatments	TSM	Local
	Close gaps in bicycle network (on parallel streets)	TSM	Local
	Bicycle preferential treatments	1	Local
	Protected bike lanes (on Beach Boulevard)	3	Regional
Vehicles	On-street parking/loading zones removal	1	Local
	Advanced traffic signal timing/ ITS	2	Regional
	Consolidate mid-block unsignalized intersections	2	Local
	Access management (remove driveways)	2	Local
	Active traffic management	3	Regional
	Pedestrian bridges	3	Local
	Adjust interchange ramp locations/ configurations	3	Regional

Mode	Toolbox Element	Tier	Local or Regional Element
	Alternative intersection configurations	3	Regional

Section 6
EVALUATION OF TOOLBOX ELEMENTS

The purpose of this section is to present the detailed evaluation for the final list of potential improvements for consideration for the Project Corridor. The section includes the research and guidelines for each toolbox element as well as the benefits and implementation concerns.

6.1 TRANSIT

The following are the details on the five transit-specific toolbox elements.

6.1.1 Bus Stop and Station Amenities

The *Bus Rapid Transit Practitioner's Guide (Transit Cooperative Research Program Report 118)*,[4] prepared by the Transportation Research Board (TRB) and sponsored by the Federal Transit Administration (FTA), provides information on the costs and effectiveness of implementing various bus rapid transit (BRT) components and their effectiveness.

The *Bus Rapid Transit Practitioner's Guide* provides the following types of station amenities as those that most affect ridership:

- A unique or attractively designed shelter, which stands out in comparison to a standard/conventional shelter which generally should not be used for BRT service. This can involve incorporating branding or public art into the station design.
- Illumination in and around the station
- Telephones and/or security phones that are accessible at all times
- Climate- or temperature-controlled waiting area for passengers
- General passenger amenities, such as seating, trash containers, drinking fountains, restrooms, and public address/automated passenger information systems

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[4] *Bus Rapid Transit Practitioner's Guide*. Transit Cooperative Research Program (TCRP), 2007. https://nacto.org/docs/usdg/tcrp118brt_practitioners_kittleson.pdf. Accessed December 2019.

- Passenger services, such as vending machines, newsstands, shops, and special services (e.g., dry cleaners)

The report provides guidance on the appropriateness of each station feature based on the type of stop. For example, features such as restrooms, special services, and shops are more appropriate for major intermodal centers. Station features such as telephones/ security phones, seating, trash containers, public address/ automated passenger information systems, vending machines, and newsstands are more appropriate for major curbside bus stops and intermodal stations. Unique/attractively designed shelters and illumination are appropriate for all BRT station types.

Information from the *Bus Rapid Transit Practitioner's Guide* for different station features, including the estimated effects on ridership, is provided in Table 6-1 below.

Table 6-1. State, Regional, and Local Pedestrian Network Goals

Component	Description	Ridership Increase
Unique/ attractively designed shelter	These differ from standard or conventional shelters and are differentiated with features such as branding, unique designs, or public art. Unique shelters are appropriate for all BRT stations.	+0.50%
Illumination	Illumination for passengers is important both within and around the station. Illumination is appropriate for all BRT stations.	+0.50%
Telephones/ security phones	Phones can be provided for both general convenience and security during all hours of the day or during all hours of transit operation. These phones are appropriate for major curbside bus stops or intermodal stations.	+0.75%

Component	Description	Ridership Increase
Climate-controlled waiting area	An enclosed temperature-controlled waiting area can increase passenger comfort during boarding, alighting, and while waiting for bus arrivals. This component is more appropriate for stations along busways or median arterial busways (as opposed to curbside stops).	+0.75%
Passenger amenities	General passenger amenities can include (but are not limited to) comfortable seating, trash containers, drinking fountains, accessible restrooms, and public address/automated passenger information systems. These amenities are appropriate for major curbside bus stops or intermodal stations.	+0.75%
Passenger services	Passenger services are defined by the unique needs of those using the transit station and often also include vending machines, newsstands, small shops, and specialized services, such as a dry cleaner. These services are more appropriate for major intermodal centers; however, vending machines may also be appropriate at some major curbside	+0.50%

6.1.1.1 Key Findings

In general, the benefits of bus stop and station amenities include:

- Increased ridership for routes that undergo stop/station improvements
- Generally higher perception of transit user comfort and safety
- Safety and comfort benefits of some amenities (e.g., illumination, security phones, and drinking fountains) for other roadway users, such as bicyclists and pedestrians

Some issues of implementation include:

- The cost to provide and maintain amenities, especially along an entire bus line or for a transit system
- Right-of-way and physical constraints around the bus stop or station

6.1.2 First/Last Mile Improvements at Major Stops

Traditionally, transit service features, such as frequency and reliability, have been the primary determinants as to whether people will use bus and rail. However, transit agencies and local jurisdictions have come to understand that a transit user's first and last mile experience is also a key determinant. The first and last mile of a transit user's trip is the portion of the trip to and from the transit stop or station that they must complete on their own, whether on foot, by bicycle, or another mode.

Transit agencies in Southern California and elsewhere have developed guidelines and strategic plans for local jurisdictions to implement to enhance access to and from transit stops and stations. Locally, these include OCTA's Nonmotorized Metrolink Accessibility Strategy (2013)[5] and LA Metro's First Last Mile Strategic Plan & Planning Guidelines (2014).[6] Improvements recommended by these two agencies fall into the following categories:

- Improvements that enhance the bicyclist experience, such as different types of bikeways, bike boxes at intersections, bike signal detection, dedicated bike signals, bike parking, and bike share facilities
- Improvements that enhance the pedestrian experience, such as bulb-outs and curb extensions, pedestrian refuge islands, improved crosswalks, scramble crosswalks, street furniture and mid-block crosswalks with Rectangular Rapid Flashing Beacons (RRFBs) or Pedestrian Hybrid Beacons (PHBs). For example, sidewalks should be continuous and can be widened and enhanced with paving or paint. Intersection signals can also be improved with a leading pedestrian crossing interval (LPI), pedestrian countdown heads, and right-turn-on-red prohibitions.

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[5] *Nonmotorized Metrolink Accessibility Strategy*. Orange County Transportation Authority (OCTA), 2013. http://www.scag.ca.gov/Documents/OCTAMetrolinkStation%20Access_Final_report.pdf. Accessed December 2019.

[6] *First Last Mile Strategic Plan & Planning Guidelines*. Los Angeles County Metropolitan Transportation Authority (LA Metro), 2014. http://media.metro.net/docs/sustainability_path_design_guidelines.pdf. Accessed December 2019.

- Improvements that can enhance both the bicyclist and pedestrian experience, such as enhanced/improved bus waiting area, improved lighting, landscaping and shade, and time-to-station signage and other wayfinding signage. Traffic calming techniques (e.g., landscaped medians, narrow vehicle lanes, reduced curb radii, reduced speeds, reverse angled on-street parking, and traffic circles/roundabouts) can also improve this experience.
- Improvements for transit users accessing the station or stop by vehicle. These improvements can include carshare spaces, pick-up/drop-off areas, and vanpool loading/ unloading areas.

There is limited data available on the effects of different first and last mile strategies on transit ridership. However, the Utah Transit Authority (UTA) prepared an analysis for its First/Last Mile Strategies Study (April 2015)[7], which assessed a number of strategies based on effectiveness in potentially adding riders to the transit system. The level of effectiveness was categorized from high (positive and significant correlation between strategy and ridership) to medium (positive but not significant correlation between strategy and ridership) to low (no effect or effect is undefined). Generally, the most effective strategies were dedicated bikeways, RRFBs/PHBs, and on-site wayfinding and signage.

First/last mile improvements strategies recommended in the OCTA and LA Metro guidance documents, as well as their approximate ridership effect, if available, are provided in Table 6-2.

Table 6-2. First and Last Mile Improvements

Improvement	Effectiveness in Adding Ridership
Bike lanes (including standard, buffered, and protected/ separated bike lanes)	High
Off-street shared-use bicycle and pedestrian paths	High
Mid-block crosswalks with Rectangular Rapid Flashing Beacons (RRFBs) or Pedestrian Hybrid Beacons (PHBs)	High

[7] *First/Last Mile Strategies Study*. Utah Transit Authority (UTA), 2015. http://www2.rideuta.com/-/media/Files/About-UTA/Tiger-VIII/UTAFirst_LastMileFINALCOMP1.ashx?la=en. Accessed December 2019.

Improvement	Effectiveness in Adding Ridership
On-site wayfinding, signage, and maps	High
Bike racks/parking	Medium
Bikeshare and stations	Medium
Sidewalk improvements (e.g., continuity, widening, and enhanced paving and surface)	Medium
Crosswalk improvements (e.g., enhanced/painted crosswalks, raised crosswalks, scramble crosswalks, refuge islands, and bulb-outs/curb extensions)	Medium
Wayfinding to the bus stop/station, including time-to-station signage	Medium
Carshare spaces	Medium
Enhanced/improved waiting area	Low
Pedestrian-oriented traffic signal improvements (e.g., LPI, pedestrian countdown, and right-turn-on-red prohibitions)	N/A
Pedestrian- and bicycle-oriented lighting, landscaping, shade, and furniture	N/A
Bike routes (including sharrows and bike boulevards)	N/A
Bike boxes at intersections	N/A
Bike signal detection and/or dedicated bike signals	N/A
Traffic calming strategies (e.g., landscaped medians, narrow vehicle lanes, reduced curb radii, reduced speeds, reverse angled on-street parking, and traffic circles/roundabouts)	N/A
Rideshare and vanpool pick-up/drop-off areas	N/A

6.1.2.1 Key Findings

In general, the benefits of first/last mile improvements at major transit stops include:

- Increased ridership due to improvements in accessing and connecting to the stop
- Improvements to the overall active transportation network, with better conditions for all bicyclists and pedestrians, including those who do not use transit, in areas with first/last mile improvements
- Increased carpooling and vanpooling to access transit as opposed to single-occupancy vehicles

Some issues of implementation include:

- The cost to implement more expensive improvements, such as PHBs
- Right-of-way constraints both at the station and areas leading to stations that would undergo first/last mile treatments
- Potential need for cross-jurisdictional or cross-agency coordination to implement improvements

6.1.3 Transit Signal Priority Treatments

Transit Signal Priority (TSP) systems give transit vehicles priority over other vehicles at signalized intersections. Typical TSP strategies extend traffic signal green time, or turn the traffic signal green earlier than scheduled, to provide priority passage through the intersection to the transit vehicle. The TSP system consists of, but is not limited to, the following main components:

- Traffic signal hardware
- Traffic signal controller with TSP functionality
- Priority request server (implemented within the controller firmware or external)
- Transit vehicle on-board hardware and software with TSP functionality
- Communication system

There are various configurations or architectures in which TSP is typically deployed. The two main types are a Distributed TSP Concept and a Centrally Directed TSP Concept. In the Distributed Concept, the transit vehicle makes the decision to request priority, and the priority request server at the intersection makes the decision to grant priority. In the Centrally Directed Concept, many of the TSP functions are performed by a computer at a central location, such as a traffic management center or a transit operations center. The Distributed Concept is generally a more simplified configuration to design and deploy.

There are four distinct Transit Signal Priority (TSP) measures that can be implemented at signalized intersections: Passive TSP, Active TSP, Real-Time TSP and Pre-emption. Of these TSP strategies, Active TSP and Real-Time TSP are more effective. Active TSP strategies adjust signal timing after detecting the arrival of a transit vehicle and can be either conditional or unconditional in nature. Real time TSP strategies use systems that provide continuous communication between the transit vehicle making the priority request and the server handling the priority request. Arrival times of transit vehicles can be estimated and integrated with other information inputted into the system from signalized intersections to make decisions on granting TSP. According to the Institute of Transportation Engineers (ITE) Application Supplement to the NACTO Guide, Active TSP can reduce transit delay significantly, up to 10 percent for overall route travel times and up to 50 percent at specific problem intersections, particularly those with far-side stops.

Per OCTA's Beach Boulevard Transit Signal Priority Implementation Plan, the typical benefits derived from TSP implementation include the following:

- Improved schedule reliability and on-time performance
- Improved transit vehicle productivity and mobility
- Increased transit vehicle and transit passenger throughput
- Reduced transit vehicle fuel usage
- Transit patrons experience a smoother and more comfortable ride
- Transit vehicle operator workloads are reduced as a result of fewer signal-related stops

TSP implementations by various agencies throughout the United States show significant reductions in bus delays and journey times. The Los Angeles Department of Transportation and Los Angeles County Metro have indicated that TSP implementations reduced journey times by 22 to 27 percent. King County Department of Transportation achieved a 34 percent reduction in bus delay with the implementation of TSP. King County was also able to reduce bus travel time variability by 35 percent. New York Transit reduced travel times by approximately 17 percent with TSP implementations.[8]

The OCTA Beach Boulevard Transit Signal Priority Implementation Plan identifies the following key recommendations for TSP implementation on the Project Corridor:

On-board Transit Management System:

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[8] *Beach Boulevard Transit Signal Priority Implementation Plan – Technology Recommendations and Cost-Benefit Information Memorandum*. Iteris, 2019.

- Upgrade OCTA's Integrated Transportation Management System (ITMS) on-board systems with a Priority Request Generator module to implement conditional TSP functionality, with an interface to OCTA's Automated Vehicle Locator system to enable conditional TSP based on route schedule adherence, or bus headways, or bus passenger occupancy
- An on-board emitter/transmitter to effect communications between the bus and the signalized intersection

Traffic Signal System(s):

- Upgrade the traffic signal controller software on Beach Boulevard to enable TSP functionality. The controller software in existing Model 2070 traffic signal controllers on Beach Boulevard needs to be upgraded to Traffic Signal Control Program (TSCP) version 2.21 for TSP functionality.
- Procure and install Priority Request Server hardware and/or software into the traffic signal controller cabinet
- Procure and install an appropriate receiver, optical or Radio Frequency (RF) based, depending on the TSP system selected, to receive priority from the transit vehicle

Institutional:

- Engage the Orange County Fire Authority and city fire departments to begin coordination of TSP implementation with existing Emergency Vehicle Pre-emption system
- Engage the traffic management personnel from each of the corridor agencies to inform and coordinate TSP implementation efforts
- It is recommended that OCTA and Caltrans District 12 develop and formalize a Project Charter for TSP deployment activities.

Long-term Communications Planning:

- Install fiber optic communications along Beach Boulevard and connect all traffic signals to Caltrans Traffic Management Center
- Plan for a communications link between Caltrans District 12 and OCTA for the purposes of logging and sharing TSP event data from each of their respective systems

OCTA Transit Management System (Central System):

- Perform required upgrades to OCTA's ITMS central system software and hardware to implement TSP

Caltrans Central System Recommendations:

- Deploy TransSuite central traffic signal control software to enable more robust communications capabilities between the intersections along Beach Boulevard and the Caltrans TMC. TransSuite has the capability to log TSP events on the controller, depending on the hardware and software configuration in the traffic signal controller cabinet.

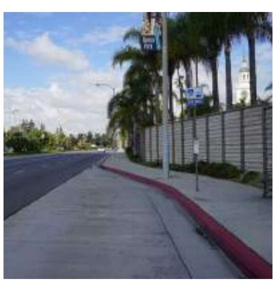
6.1.3.1 Key Findings

In general, the benefits of transit signal priority systems include:

- Improved schedule reliability and on-time performance
- Improved transit vehicle productivity and mobility
- Increased transit vehicle and transit passenger throughput
- Reduced transit vehicle fuel usage
- Transit patrons experience a smoother and more comfortable ride.
- Reduced transit vehicle operator workloads as a result of fewer signal related stops

Some issues of implementation include:

- The cost to implement transit signal priority treatments
- Corridor wide improvement in order to see significant operational benefits
- Institutional challenges when implemented in a multi-jurisdictional setting
- Trip times for other vehicles (non-transit) may be negatively impacted due to preferential treatments for transit



6.1.4 Transit Preferential Treatments

Successful transit is reliable and efficient; slow and inconsistent service discourages riders and jeopardizes benefits provided by transit. Removing sources of delay have proven to be more effective than increasing transit vehicle travel speeds. Common sources of delay include traffic and intersection delay, dwell time, acceleration, merging and route divergence, passenger access and wait time, and operational efficiencies. Reducing sources of transit delay shortens trip times and decreases the time and cost expenditures for each transit vehicle, allowing for shorter headways and more frequent service using the same number of vehicles. Per OCTA's Beach Boulevard Transit Signal Priority Implementation Plan, traffic signal delay accounted for at least 18 percent of total trip time during the peak hours on Beach Boulevard between Center Street, in the City of Huntington Beach to Orangethorpe Avenue, in the City of Buena Park.

Relative to transit preferential treatments, the Project Corridor presents its own set of design opportunities and challenges, with infrastructure options affected by the existing built environment and the type of transit vehicles chosen. The Bus Rapid Transit Practitioners Guide (BRTPG)[9] notes that many arterial streets have the potential to serve as critical thoroughfares for high-frequency and high-quality transit. Redesigning the Project Corridor to prioritize transit and pedestrians alongside vehicular traffic can be accomplished through a variety of design tactics to reduce trip time and increase reliability and efficiency. The design strategies could include stop design factors, stop configurations, station and stop elements, transit lanes, and intersection and signal operations and design. Far-side in-lane stops provide the highest level of priority for transit operations.

The physical design of intersections affects the efficiency and safety of transit operations. One improvement, queue jump lanes, uses a combination of short dedicated transit facilities and active TSP or a leading bus signal interval to allow transit vehicles to pass other vehicles queued at an intersection and re-enter traffic in a priority position. For queue jumps to work effectively, it is critical that buses have access to the lane and can reach the front of the queue at the start of a signal cycle. Separate signals must be used for transit and private vehicles. The OCTA Beach Boulevard Transit Signal Priority Implementation Plan identified the following locations as possible candidates for queue jumps on the Project Corridor

- Beach Boulevard southbound at Hazard Avenue
- Beach Boulevard northbound at Garden Grove Boulevard
- Beach Boulevard northbound and southbound at Anacapa Way
- Beach Boulevard southbound at Crescent Avenue
- Beach Boulevard northbound at north entrance to Medieval Times
- Beach Boulevard southbound at eastbound SR-91 off-ramp to Beach Boulevard
- Beach Boulevard northbound at westbound SR-91 off-ramp to Beach Boulevard
- Beach Boulevard northbound at Orangethorpe Avenue

[9] Bus Rapid Transit Practitioners Guide (TCRP Report 118. Transportation Research Board, 2007. https://nacto.org/docs/usdg/tcrp118brt_practitioners_kittleson.pdf. Access November 2019.

6.1.4.1 Key Findings

In general, the benefits of transit preferential treatments include:

- Reduced transit trip time
- Improved transit trip reliability

Some issues of implementation include:

- Features such as queue jumps may require additional right-of-way
- Trip times for other vehicles (non-transit) may be negatively impacted due to preferential treatments for transit.
- The cost to implement transit preferential treatments

6.1.5 Dedicated Transit Lanes (for BRT)

The Bus Rapid Transit Practitioners Guide (BRTPG) states that, on average, conversion of a regular bus route to a BRT line will result in a 25 percent increase in ridership beyond what could be predicted using ridership elasticities. Of the total 25 percent increase in ridership, 5% would be realized with exclusive running way with the remainder of the 20% attributed to improved stations, improved vehicles, limited stop service, ITS applications, specialized branding, and BRT packaging.

As shown above, the exclusive running way (dedicated transit lane) component is estimated to increase ridership by 5 percent due to its effects on transit speed, reliability, identity/image, safety/security (of vehicles), and capacity.

To test the effect of dedicated BRT lanes along the Project Corridor, OCTAM was used to determine the effects on transit ridership with an exclusive running way. The model was modified to provide a transit only lane for two conditions. The first model run provided a transit only lane from Talbert Avenue to the Fullerton Park and Ride Facility (following the current Bravo! 529 route and extending it about 2 miles south) and the second provided the transit only lane further south to SR-1 which is consistent with the OC Transit Vision report. Both model runs showed a minimal increase (<5%) in ridership to the existing Bravo! 529 service. Note, however, that the model can only access the effects of the transit only lane and not the other BRT components listed above.

The OC Transit Vision's Transit Opportunities Corridors Report[10] ranked the Project Corridor high as a Transit Opportunity Corridor (TOC) based on projected demand, network connectivity, and available

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[10] OC Transit Vision, OCTA. https://www.octa.net/Projects-and-Programs/Plans-and-Studies/Transit-Master-Plan/. Accessed November 2019.

right-of-way. As part of potential next steps, the report suggests updating Bravo! service with near-term improvements (e.g., off-board fare payment, all-door boarding, transit signal priority) and long-term improvements (e.g., queue jumps, improved shelters, priority transit lanes) to continue to improve the system and increase ridership.

6.1.5.1 Key Findings

In general, the benefits of dedicated transit lanes for BRT include:

- Reduced bus travel times and delays
- Improved transit service reliability
- Reduced conflicts between buses and other vehicles
- Improved bus boarding and alighting, if buses no longer need to enter and exit general traffic lanes

Some issues of implementation include:

- Potential need for right-of-way acquisition and related costs
- Potential increase in delay and congestion for passenger vehicles with lane reduction
- Driveway and access conflicts for businesses and other properties along the bus lane
- Coordination with multiple jurisdictions and agencies along the length of the Project Corridor
- Potential need to update and maintain corridor signal timing plans to incorporate bus-only lanes

6.2 PEDESTRIANS

Details on the 11 pedestrian-focused toolbox elements are presented below.

6.2.1 Close Gaps in Sidewalk Network

The presence of sidewalks is a basic element of pedestrian mobility. As part of the Baseline Conditions Report, a sidewalk inventory was conducted along the Project Corridor and identified several gaps in the sidewalk network along the Project Corridor as shown in Figure 6-1 below.

The National Association of City Transportation Officials (NACTO) defines the following as 'critical' for best practice sidewalk design:

Ensure that sidewalks are without major gaps or deformities that would make them non-traversable for wheelchairs and other mobility devices.

Guo and Gandavarapu (2010)[11] estimate that completing the sidewalk network in a typical U.S. town would increase average per capita active travel by 16 percent (from 0.6 to 0.7 miles per day) and reduce vehicular travel by 5 percent (from 22.0 to 20.9 vehicle-miles), or about 10 miles of reduced VMT for each mile of increased walking. Research collated by the Victoria Transport Policy Institute (July 2019) finds that the strategy to improve walking and cycling facilities improves active conditions significantly, increases non-motorized travel significantly, and moderately reduces vehicular travel. In this context, 'significant' is considered as 5 percent, and 'moderate' as 1 to 5 percent.

According to United States Department of Transportation PEDSAFE[12] research, the provision of continuous walkways and the reduction of any significant obstacles to walking, such as extended gaps in the pedestrian network, are key to reducing pedestrian crashes. Extended gaps in sidewalks can contribute to pedestrians walking along the side of the carriageway, which can lead to road collisions. Roadways without sidewalks are more than twice as likely to have pedestrian crashes as sites with sidewalks on both sides of the street. By providing sidewalks on both sides of the street, numerous mid-block crossing crashes can be eliminated. One study found that the likelihood of a site with a paved sidewalk being a crash site is 88 percent lower than a site without a sidewalk after accounting for traffic volume and speed limits [McMahon et al., 2002][13].

A similar corridor project in the State of Washington implemented pedestrian improvements with significant reduction in collisions. The

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[11] Guo, Jessica Y. and Sasanka Gandavarapu. *An economic evaluation of health-promotive built environment changes*. Preventive medicine. 50 Suppl 1 (2010): S44-9. https://doi.org/10.1016/j.ypmed.2009.08.019. Accessed November 2019.

[12] Pedestrian Safety Guide and Countermeasure Selection System. Federal Highway Administration, Office of Safety, 2013. http://www.pedbikesafe.org/PEDSAFE/authors.cfm. Accessed November 2019.

[13] McMahon, P. J., C. V. Zegeer, C. Duncan, R. L. Knoblauch, J. R.Stewart, and A. J. Khattak. 2002. *An Analysis of Factors Contributing to 'Walking along Roadway' Crashes: ResearchStudy and Guidelines for Sidewalks and Walkways* (FHWA-RD-01-101). Federal Highway Administration, 1999. https://doi.org/10.3141%2F1674-06. Access November 2019.

Aurora Avenue Corridor Project in the City of Shoreline[14] initially presented some similar characteristics to the Project Corridor: State Highway facility, lack of pedestrian crossing islands, and several non-signalized vehicle entry and exit points to the highway. Continuous curbs, sidewalks, and better lighting were added along a 3-mile stretch to encourage pedestrian use and define driveways, resulting in a 60 percent reduction in roadside collisions (the highway stretch previously had the state's high collision hotspots) and significant increase in transit boardings along the corridor stops.

State, regional, and local goals and policy quoted in Table 6-3 below show that providing a completed pedestrian sidewalk network is key to the goals of the entity.

Table 6-3. State, Regional, and Local Pedestrian Network Related Policy

Source	Document	Content
State of California	Complete Streets Act of 2008	"upon any substantive revision of the circulation element of the general plan, modify the circulation element to plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways, defined to include motorists, pedestrians, bicyclists, children, persons with disabilities, seniors, movers of commercial goods, and users of public transportation, in a manner that is suitable to the rural, suburban, or urban context of the general plan."
Caltrans	Deputy Directive-64-R2	"The Department provides for the needs of travelers of all ages and abilities in all planning, programming, design, construction, operations, and maintenance activities and products on the State Highway System."

[14] *SR-99 - Shoreline Aurora Ave - N Corridor Transit/HOV Lanes*. Washington State Department of Transportation, 2013. https://fortress.wa.gov/ecy/publications/documents/1310024.pdf. Accessed November 2019.

Source	Document	Content
OCCOG	Complete Streets Design Guidelines	"Streets need to cater to all users, especially those who are vulnerable: young and old, disabled persons, and those without vehicles. This requires an environment where people walking or bicycling are not intimidated by vehicles, especially on routes to schools, hospitals, and other community facilities." "Sidewalks should be uninterrupted, of suitable width and on both sides of all streets."
Anaheim	General Plan	"Pedestrian facilities provide a vital link between many other modes of travel and can make up a considerable portion of short-range trips made in the community. Where such facilities exist, people will be much more likely to make shorter trips by walking rather than by automobile." "Pedestrian circulation is accommodated by the provision of sidewalks within streets rights-of-way" "Maintain and rehabilitate all components of the circulation system, including roadways, sidewalks, bicycle facilities, pedestrian facilities, Intelligent Transportation systems and traffic signals"

Source	Document	Content
Buena Park	General Plan	"Complete streets are designed and operated to enable safe access for all users—not just vehicles. Pedestrians, bicyclists, motorists and transit riders of all ages and abilities must be able to safely move along and across a complete street." "Sidewalks are provided on all arterial roadways and on the majority of residential streets. The City's circulation system has been designed to ensure that adequate facilities are provided for pedestrian circulation… It is the City's goal to construct new sidewalks/wheelchair ramps as well as modify existing sidewalks/wheelchair ramps to comply with the American with Disabilities Act (ADA). When streets do not have sufficient right-of-way for ADA compliant sidewalks and wheelchair ramps, the City will acquire easements as dedications from land owners through a private development process." "Encourage the development of a citywide pedestrian network, including both on-street (sidewalks) and off-street (trails or paths) facilities, to connect neighborhoods, schools, open space, and major destinations, where feasible."
Huntington Beach	General Plan	"Making a street more complete could include installing or improving sidewalks" "Maintain and repair bicycle lanes and sidewalks as necessary to expand use and safety"

Source	Document	Content
La Habra	General Plan	"Maintain sidewalks or other means of pedestrian and bicycle connections to neighborhood commercial centers, parks, schools, work places, and other community activity centers" "Link commercial districts to adjoining residential neighborhoods and other districts by well-designed and attractive pedestrian sidewalks and corridors, where appropriate." "The City's roadway network is planned in consideration of complete streets principles for streets to be designed to enable safe and convenient travel by all users… Incorporation of the complete street concept will result in a balanced circulation system coordinated with land uses to ensure the safe, efficient, and environmentally sound movement of people and goods freely in the community."
Garden Grove	General Plan	"The existing City of Garden Grove General Plan includes a policy to require new construction, including subdivisions, to provide sidewalks. It is the objective of the City to provide a system of sidewalks in all areas of the City" "The major sidewalk program has been the voter approved sidewalks installation program. These sidewalks can be installed only on arterial streets within the City"
Garden Grove	Active Streets Master Plan	"Close sidewalk gaps in school zones" "A lack of sidewalks presents issues for pedestrian access throughout the city" "Sidewalks are missing on some corridors…these sidewalks should be filled in as redevelopment allows"

Source	Document	Content
Stanton	Municipal Code	"Sidewalks shall be designed in accordance with the standard plans adopted by the city council and located as follows: Along both sides of arterial highways; Along all commercial and industrial frontage; Along both sides of collector streets; Along residential frontage where the required minimum building site area is less than fifteen thousand square feet and the lots have access to the street, except in those instances where an alternate pedestrian circulation system is proposed; Along all streets leading directly to a school, a designated school bus stop, or a park; Where the sidewalk will provide a continuation or link between other sidewalks. Additional pedestrian ways not abutting a street shall be provided when necessary for access to schools, recreation, and other public areas. These pedestrian ways shall not be less than six feet in width. (Ord. 780 § 2, 1996)"
Stanton	General Plan	"Not all sidewalks are presently ADA accessible, which limits mobility for some people; however, the city is implementing a program to improve accessibility."

In addition to the above documented standards and goals, the Americans with Disabilities Act (ADA) provides standards for pedestrian facilities. The 2010 ADA Standards for Accessible Design compliance are required for new construction and alterations under Titles II and III. These statutes prohibit public agencies from discriminating against persons with disabilities by excluding them from services, programs, or activities, meaning that agencies must provide pedestrian access for persons with disabilities to the agency's streets and sidewalks, wherever a pedestrian facility exists. These requirements are implemented by imposing standards for accessible features, such as curb cuts, ramps, continuous sidewalks, and detectable warnings. However, ADA does not require a public agency to provide a pedestrian facility; only when a pedestrian facility is provided by a public agency must it be "accessible to persons with disabilities to the extent technically feasible."

Under this interpretation, sidewalk gaps do not in themselves constitute ADA non-compliance. However, any facilities provided to address sidewalk gaps must be ADA compliant. In the spirit of ADA, the lack of sidewalks effectively excludes persons with disabilities in free and safe movement and closing sidewalk gaps would demonstrate a commitment to improving pedestrian environment for those with disabilities.

Though the lack of a sidewalk may in itself not be non-compliant, some linkages where sidewalks are missing have non-compliant features, as seen in Exhibit 6-1 below.

Exhibit 6-1 Beach Boulevard at Durango Drive[15]

6.2.1.1 Key Findings

In general, the benefits of closing gaps in the sidewalk network include:

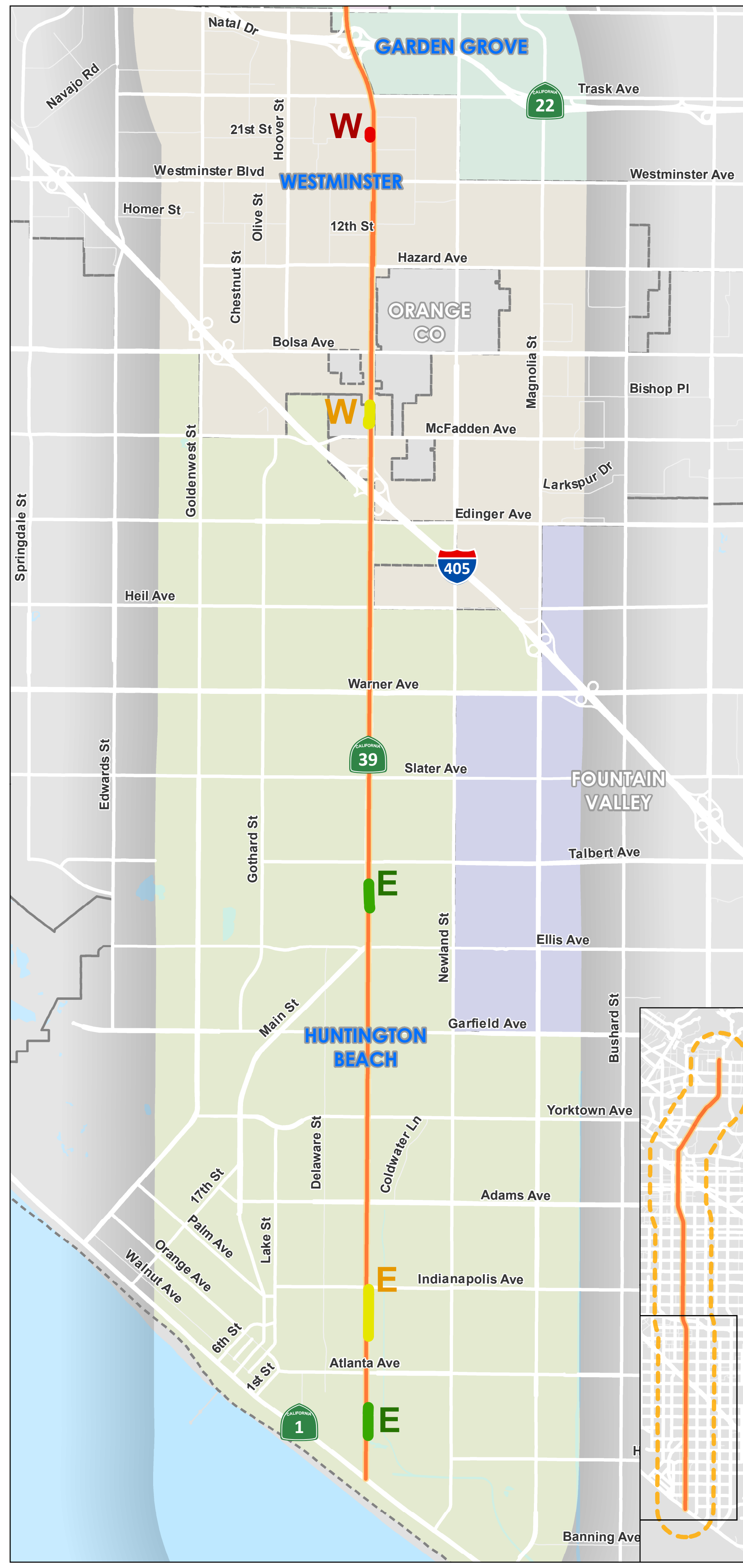
- More consistency with regional and local policies
- Addressed ADA access concerns
- Reduced roadside collisions
- Increased active travel and reduced vehicular travel

Some issues of implementation include:

- Availability of right-of-way

[15] Google Streetview December 2017. https://www.google.com/maps/. Accessed November 2019.

- Coordination with property owners
- The cost to add facilities
- Required design to provide ADA access



Legend

- Beach Blvd Centerline
- Facility exists on frontage road with connections (No improvements needed)
- Facility exists on frontage road but connections needed (TSM/Tier 0)
- No adjacent facility exists (Tier 2)

OCTA

Missing Sidewalks
Beach Boulevard Corridor Study

Figure
6-1

Coordinate System: NAD 1983 StatePlane California VI FIPS 0406 Feet
Data Source: Delete if there isn't one.

6.2.2 High-Visibility Crosswalks

A high-visibility crosswalk is much easier for an approaching driver to see and improves yielding behavior by drivers, and as a result, improves pedestrian safety while crossing. High-visibility ladder and zebra markings are preferable to parallel or dashed markings. High visibility is particularly important for crosswalks at mid-block locations, where drivers may not otherwise expect pedestrians to be crossing. In addition, these treatments can be paired with other measures to further enhance visibility[16].

The FHWA[17] recommends that high-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs should always occur in conjunction with other identified countermeasures on four or more lane roadways with AADT over 9,000. FHWA also recommends that advance Yield Here To (or Stop Here For) pedestrian signs and yield (stop) lines, pedestrian refuge islands, and Pedestrian Hybrid Beacons should always be considered (but based on engineering judgment) at a marked uncontrolled crossing location of the roadway characteristics mentioned above. Curb extensions and road diets can also be candidate treatments; however, raised crosswalks and in-street pedestrian crossing signs are generally not appropriate for of the roadway characteristics mentioned above.

Installing a marked high-visibility crosswalk alone should be considered a high priority for locations with a minimum of 20 pedestrian crossings (or 15 or more elderly or child pedestrians) per peak hour. Additional crossing measures (e.g., reduced speeds, shortened crossing distance, enhancing driver awareness of crossing or active warning or crosswalk use presence) are recommended at uncontrolled locations where the speed limit is 40+ mph and either:

- The roadway has four or more lanes of travel without a raised crossing island and an ADT of 12,000 vehicles per day or greater; or
- The roadway has four or more lanes of travel with a raised crossing island (either existing or planned) and an ADT of 15,000 vehicles per day or greater.

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[16] *Global Street Design Guide*. NACTO. https://nacto.org/global-street-design-guide-gsdg/. Accessed December 2019.

Designing Walkable Urban Thoroughfares. ITE, 2010. https://www.ite.org/pub/?id=E1CFF43C-2354-D714-51D9-D82B39D4DBAD. Accessed December 2019.

[17] *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations*. FHWA (FHWA-SA-17-072), 2018. https://safety.fhwa.dot.gov/ped_bike/step/docs/STEP_Guide_for_Improving_Ped_Safety_at_Unsig_Loc_3-2018_07_17-508compliant.pdf. Accessed December 2019.

Research has shown that high-visibility crosswalks can have a positive effect on pedestrian and driver behavior at crossing locations.[18]

6.2.2.1 Key Findings

In general, the benefits of high-visibility crosswalks include:

- Better visibility for drivers of crosswalks and improved yielding behavior
- Improved pedestrian safety

Some issues of implementation include:

- If not adequately visible, pedestrians may feel a sense of security from non-yielding drivers and may cross unsafely.
- The cost to maintain high-visibility crosswalks

6.2.3 Realigned Crosswalks at Freeway Ramps

In areas with freeway interchanges, pedestrian crossing at crosswalks may conflict with high-speed turning drivers entering or exiting a freeway ramp. Providing safe pedestrian crossing infrastructure is particularly important at these locations.

Factors that need to be considered when assessing crossings include type of ramp, turning angles, signalization, visibility, pedestrian crossing distance, and directness of route.

The best configurations for pedestrians are those where the ramp intersects the crosswalk at a 90-degree angle, and where it is controlled by a stop or signal. The Caltrans Complete Intersections[19] guidance recommends the following:

- Design or reconstruct intersections and interchanges so that roads and ramps meet at a 90-degree angle.
- Use striped crosswalks so they cross traffic lanes at a 90-degree angle, unless this placement does not follow the pedestrian's natural path.
- Design or reconstruct intersections to allow maximum motor vehicle turning movement speeds of 20 mph through

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[18] *Main Street. California - A Guide for Improving Community and Transportation Vitality*. Caltrans, 2013. https://dot.ca.gov/-/media/dot-media/programs/design/documents/main-street-3rd-edition-a11y.pdf.

[19] Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrian. Caltrans, 2010. https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/f0018151-intersection-guide-bicycles-pedestrians-a11y.pdf. Accessed January 2020.

reducing turning radii and bringing intersections close to a 90-degree angle.

- Reduce turning radii for motorists.
- Reconstruct skewed intersections to meet at a 90–degree angle.
- Provide ample sight distance in advance of crossings.

Conversely, it is most difficult for pedestrians to cross free-flow movements and locations where the ramp connects at a narrow angle.

Project Corridor crossings at freeway on- and off-ramps should be assessed on a case-by-case basis to identify what improvements, if any, can be made for safe pedestrian crossings. The Project Corridor has a mix of freeway ramp types, including both signalized pedestrian crossings across ramp entrances/exits and unsignalized crossings over free-flow ramps. Where there are free-flow ramps, the crosswalk should be placed where it is visible, and wherever possible, measures to call attention to the pedestrian crossing and increase its visibility should be implemented.

In some cases, it might not be possible to place crosswalks at a location that provides pedestrians with the most direct route and/or shorter crossing distances and mitigates danger from drivers turning quickly or speeding up on the ramp. A recommended compromise would be to place a crosswalk midway after a gradual turn in order to minimize crossing distances and ensure that pedestrians are not directly in conflict with turning vehicles, without putting the crosswalk too far up the ramp (which reduces visibility and coincides with motor vehicles speeding up to merge).

Reconfiguring ramps to reduce speed and improve crossing distances is the most preferred approach for improving pedestrian safety. A flat angle results in wide crossings and high-speed turns, whereas a tight angle can result in shorter crossings and slower-speed turns. Additionally, designing interchanges to look like intersections can help prepare drivers to expect the presence of pedestrians.

6.2.3.1 Key Findings

In general, the benefits of reconfiguring crosswalks at freeway ramps include:

- Improved motor vehicle awareness of pedestrian crossing
- Reduction in pedestrian-vehicle collisions at ramps
- Increased safety and ease for pedestrians with limited mobility to safely navigate freeway ramp crossings

Some issues of implementation include:

- The cost to improve crossing facilities
- The cost to reconfigure freeway ramp to be safer for pedestrians
- Potential delays for vehicles entering and exiting the freeway

6.2.4 Pedestrian Countdown Signal Heads

The pedestrian countdown signal device provides a numeric countdown display that indicates the number of seconds remaining for a pedestrian to complete their crossing of a street. The California Manual on Uniform Traffic Control Devices (CA MUTCD) standard states that all pedestrian signal heads used at crosswalks where the pedestrian change interval is more than 7 seconds should include a pedestrian change interval countdown display in order to inform pedestrians of the number of seconds remaining in the pedestrian change interval.[20]

With the majority of the curb-to-curb distances of 110 feet to 125 feet, signals across the Project Corridor would typically require a pedestrian change interval of more than 7 seconds and thus would fall under the recommendations from Caltrans to provide countdown pedestrian signal heads.

A 2008 Federal Highway Administration (FHWA) Pedestrian Safety Report to Congress stated that San Francisco's pedestrian countdown signals have been associated with a 52 percent reduction in pedestrian injury collisions at pilot locations; in addition, about 92 percent of post-installation interviewees explicitly said the countdown signals were "more helpful" than conventional pedestrian signals, primarily because they showed the time remaining to cross. This is consistent with recent FHWA research that showed that pedestrians strongly preferred the countdown signal to actual and theoretical versions of pedestrian signals, and that the countdown version was "most easily understood."[21]

Though the pilot study looked at a small number of locations, the results indicated a positive improvement in pedestrian safety after the installation of pedestrian countdown signal heads as well as a high preference for this device by the public.

A review of the existing pedestrian signals determined that all existing pedestrian signals along the six segments of the Project Corridor can be retrofitted to accommodate the countdown

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[20] California Manual on Uniform Traffic Control Devices. Caltrans, 2014.

[21] *Pedestrian Safety – Report to Congress*. Federal Highway Administration (FHWA), 2008. https://safety.fhwa.dot.gov/ped_bike/legis_guide/rpts_cngs/pedrpt_0808/chap_3.cfm. Access November 2019.

signals. Currently, two projects are identified to provide this improvement at 18 intersections along the corridor. The first project is Caltrans Project ID No. 1200020177, which provides pedestrian countdown signals at twelve intersections between Lincoln Avenue and Rosecrans Avenue. The second project is Caltrans Project ID No. 1212000096, which provides pedestrian countdown signals at six intersections between Atlanta Avenue and Cypress Street.

6.2.4.1 Key Findings

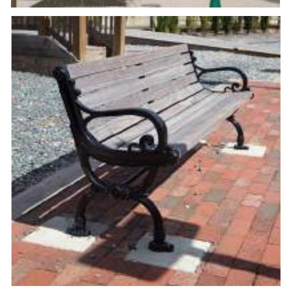
In general, the benefits of pedestrian countdown signal heads include:

- Reduced pedestrian injury collisions
- Better pedestrian reception compared to those for conventional pedestrian signals

Some issues of implementation include:

- The cost to install or replace conventional signal heads with pedestrian countdown signal heads

6.2.5 Sidewalk Amenities



The NACTO Sidewalk Buffer Zone[22] document on ideal clear sidewalk widths recommends the following as a 'critical' part of sidewalk design:

> *Where a sidewalk is directly adjacent to moving traffic, the desired minimum is 8 feet, providing a minimum 2-foot buffer for street furniture and utilities.*

NACTO also lists the following as a critical design element:

> *Sidewalk design should go beyond the bare minimums in both width and amenities. Pedestrians and businesses thrive where sidewalks have been designed at an appropriate scale, with considerations are especially important sufficient lighting, shade, and street-level activity. These for streets with higher traffic speeds and volumes, where pedestrians may otherwise feel unsafe and avoid walking.*

NACTO recommended design measures and information on appropriate locations to place such amenities include:

- Lighting scaled to the pedestrian realm in addition to overhead lighting for vehicles

[22] Urban Street Design Guide. NACTO, 2013. https://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/. Accessed November 2019.

- Benches and other seating platforms designed into the structure itself or placed within the frontage zone
- Incentives to provide awnings, sidewalk cafes, and other elements that improve the comfort and appearance of the sidewalk
- Where security concerns are present, use of permeable, rather than closed, metal shutters on storefronts at night
- Provision of adequate lighting beneath scaffolding and other construction sites

There is limited guidance regarding the threshold of pedestrian volumes to quantify the provision of the street furniture types. The general concept is that street furniture should be provided where it can improve the experience for pedestrians, and other road users, moving through a particular environment. Such requirements may be associated with:

- Space constraints;
- Real or perceived threat to personal safety (e.g., poor lighting, areas for concealment, etc.);
- Area frequently used by elderly pedestrians, mobility-impaired users, or those with pushchairs;
- Proximity to local amenities like ground-use commercial units requiring bicycle parking facilities for general public;
- Open space providing limited coverage from weather elements; or,
- Lack of clear pedestrian sightlines.

Case studies provide a measure of the effects of sidewalk amenities. Two recent case studies with facilities similar to those with the Project Corridor were identified and summarized below

PEDSAFE highlights the Allen and Pike Streets Corridor Improvements case study in Manhattan's Lower East Side, which faced high speeds along the roads, and were seeking the opportunity to turn the corridor into a pedestrian boulevard. Through simple, inexpensive street furniture, including planters and fixed seating, which places pedestrians further away from traffic, the pedestrian and cyclist connectivity increased. Data compiled following the installation of the protected bike paths and pedestrian improvements showed a 35 percent decrease in both motor vehicle and bike crashes involving injuries, and 12 percent decrease in injuries for pedestrians, cyclists, and drivers from Houston Street to South Street. Bike ridership increased by 23 percent to 43 percent and more people actively used the space as a meeting point.

NACTO outlines the case study for Bell Street in City of Seattle. In 2013, the section between 1st and 5th Avenues experienced a transformation and sought to improve the neighborhood which experienced high volumes of traffic across all modes. The design introduced tables, chairs, bicycle parking, public art installations, and programming to further activate the street. The project also brought energy-efficient LED lights and pedestrian-scale fixtures to improve ambient lighting while reducing light pollution.

Information and guidance on specific sidewalk amenities are provided in Table 6-4 below[23,24].

Table 6-4. Sidewalk Amenities

Amenity	Benefit
Lighting	In purely functional terms, should enable the safe and secure use of streets in areas that are poorly lit by natural light, and in all areas outside of daylight hours. Pedestrian-focused lighting should be installed in streets with high levels of pedestrian activity, or streets where pedestrian activity should be better provided for. • Most arterial streets in Orange County contain streetlight poles that are 30 feet tall and illuminate both the roadway and the sidewalk. Pedestrian-scale lighting fixtures are typically 12 to 15 feet high. This should be provided in areas of high pedestrian activity.
Seating	Should be located where people are likely to congregate or wait, and also at regular intervals to provide rest points. The seat should be situated under shade, where people can comfortably rest. Should be oriented toward points of interest. This may be overlooking a vista, street activity, or towards another seating area to encourage socializing. On streets with ground-floor commercial uses and medium to high pedestrian volumes, seating for 3 (e.g., one 6-foot-long bench) should be provided at least every 200 feet (the pedestrian volumes for 'medium to high' scenario are not defined within the guidance).

[23] *OC Complete Streets Initiative Design Handbook*. Orange County Council of Governments, 2016. https://static1.squarespace.com/static/587121d0ebbd1ae2e3a080b3/t/58e2726cb8a79b14751cd0da/1491235470685/OC_Complete_Streets_Design_Handbook.pdf. Accessed November 2019.

[24] *Complete Streets Guide*. City of Los Angeles, 2017. https://planning.lacity.org/odocument/c9596f05-0f3a-4ada-93aa-e70bbde68b0b/Complete_Street_Design_Guide.pdf. Accessed November 2019.

Amenity	Benefit
Trash cans and recycling bins	Should be situated in the street furniture zone of a sidewalk in areas where there is high activity (e.g., street corners, transit stops, public/event spaces). They should be clearly visible and identifiable as trash cans/recycling bins. They should be provided at regular intervals to ensure use. Along streets in retail commercial districts, there should be a maximum of one trash receptacle every 200 feet. Additional trash receptacles should be provided only if a private sponsor provides continued maintenance.
Bollards	Should be used sparingly, and only where absolutely necessary to separate pedestrians and other nonmotorized traffic from vehicles, or to define pedestrian spaces. If used to define pedestrian spaces, consideration should be given to alternative design solutions, such as strategic positioning of planters or street furniture to prevent vehicle incursion.
Handrails and railings	Are used primarily for safety and to assist mobility and therefore should comply with Section 505 of the ADA Standards. Should be coherent across a street furniture scheme and be used where necessary for safety in balance with keeping the pedestrian space free of clutter.
Bicycle parking	Bicycle racks are critical in facilitating bicycling. It should be as easy, or easier, to park a bicycle as a car. While the majority of bicycle racks should be provided in off-street parking facilities and in bicycle corrals in the curbside parking lane (where applicable), convenient parking should also be provided along the sidewalk. Racks should be located within the furniture zone as close to the entrance of a destination as possible. This means there may be several smaller bicycle parking zones along one length of road increasing the opportunities for cyclists. Number of racks should relate to projected demand for bicycle parking. Public bicycle parking racks should be located 5 feet clear of other street furniture.

Amenity	Benefit
Way-finding	Assists in aiding people to navigate unfamiliar environments, helping them find their way to key destinations, and explore the local area. A successful wayfinding system can encourage more active lifestyles, help people feel more confident in navigating when walking and using bicycles, and in turn, support local businesses with additional foot traffic. A wayfinding system is usually communicated through the development of a signage and information system that includes mapping. Pedestrian-oriented signage is most appropriate in areas with high pedestrian volumes, including commercial districts, tourist-oriented locations, historic districts, and cultural districts. Wayfinding programs can be used to provide signage to enhance pedestrian mobility throughout the city; they can deliver directional information to guide pedestrians to special destinations, such as parks, historic buildings, cultural amenities, bus stops and train stations. Normally, greater emphasis is on this where there is a high frequency of first-time visitors. For example, in Atlanta Avenue/Beach Boulevard in Huntington Beach, a large majority of pedestrians are first-time visitors seeking directions to the beach area or the main town center.

6.2.5.1 Key Findings

In general, the benefits of sidewalk amenities include:

- Benefits to adjacent businesses in addition to pedestrians
- Improved safety in pedestrian environment by separating pedestrians from fast moving traffic and providing amenities, such as adequate lighting
- Reduced number of collisions and injuries
- Increased walking and active trips
- Cleaner street environment (provision of trash/recycling receptacles)

Some issues of implementation include:

- Insufficient sidewalk widths
- Land uses that displaces activity from the street (e.g., strip malls or barriers from parking lots)
- The cost to add sidewalk amenities

6.2.6 Remove Sidewalk Obstructions

Most pedestrians use sidewalks as access routes. Sidewalks should provide a continuous path that connects pedestrians to accessible elements, spaces, and facilities. Minimum sidewalk clear widths should be kept free of all obstructions including utilities, furniture, signs, and other impediments. The Caltrans Highway Design Manual provides minimum horizontal clearances for objects on or adjacent to sidewalks:

- The minimum width of a sidewalk should be 8 feet between a curb and a building when in urban and rural main street place types.
- For all other locations the minimum width of sidewalk should be 6 feet when contiguous to a curb or 5 feet when separated by a planting strip.
- Note that street furniture, buildings, utility poles, light fixtures and platoon generators, such as window displays and bus stops, can reduce the effective width of sidewalks and likewise the LOS of the walkway.

According to FHWA guidelines[25], those designing or building sidewalks should ensure that they do not create movement barriers or should eliminate or minimize movement barriers that do occur.

Particularly for narrow sidewalks, eliminating any removable obstacles (e.g., trash cans, newspaper stands, etc.) should be the top priority. Protruding tree branches, overgrown shrubs, and others should also be removed from the pedestrian thoroughfare. Wherever possible, permanent obstacles (such as utilization boxes, signs or light poles) should be removed from the pedestrian zone.

Designing sidewalks for pedestrians means planning for users with limited mobility and those who are most vulnerable. Keeping in mind the ability for those with wheelchair or pushing strollers ability to safely navigate sidewalks should be a key priority.

6.2.6.1 Key Findings

In general, the benefits of removing sidewalk obstructions include:

- Improved pedestrian experience
- Addressing the needs of users with limited mobility or users who are most vulnerable
- ADA compliance

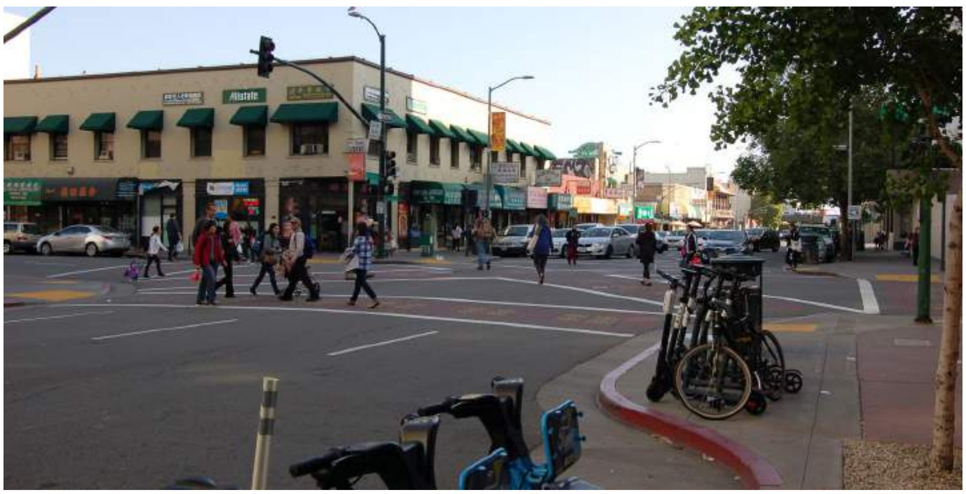
[25] Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide. Federal Highway Administration (FHWA), 2001. https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa09027/resources/Designing%20Sidewalks%20and%20Trails%20for%20Access.pdf. Accessed December 2019.

Some issues of implementation include:

- Continuous sidewalk maintenance
- The cost to move or remove permanent obstructions obstacles (e.g., utility boxes)
- Right-of-way availability to relocate obstructions
- Coordination with affected utilities or agencies

6.2.7 Pedestrian Scrambles

A pedestrian scramble crossing gives pedestrians an exclusive signal phase at an intersection during which all vehicle approaches are stopped. All crossing directions (sometimes including diagonally) are permitted during the pedestrian scramble phase which eliminates all possible pedestrian-vehicle conflicts (enforced by "no right turn on red" signage.)



Published evaluations suggest that[26]:

- Increased pedestrian safety is achieved so long as vehicles and pedestrians are compliant with the signals.
- Both pedestrians and vehicles experience increased delays due to an increased cycle length, and green ratio (length of green indication divided by cycle length) is decreased.

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[26] Reviewed the following: Chen, L., C. Chen, R. Ewing, C. McKnight, R. Srinivasan, and M. Roe. *Safety Countermeasures and Crash Reduction in New York City—Experience and Lessons Learned*. Accident Analysis and Prevention. Vol. 50, January 2013, p. 312-322. http://dx.doi.org/10.1016/j.aap.2012.05.009. Accessed November 2019.

Bechtel, A. K, MacLeod, K. E, & Ragland, D. R. (2003). *Oakland Chinatown Pedestrian Scramble: An Evaluation*. UC Berkeley: Safe Transportation Research & Education Center. https://escholarship.org/uc/item/3fh5q4dk. Accessed November 2019.

- Some of the increased safety gains may be negated due to pedestrian non-compliance, which is more likely if delays become excessive.

Table 6-5 below provides findings from three case studies with similar conditions as with along the Project Corridor. The published evaluations have found that scrambles have generally been effective in reducing crashes and traffic conflicts and are especially effective where high pedestrian volumes conflict with high volume vehicle turning movements.

Table 6-5. Pedestrian Scramble Case Studies

Case Studies	Content
Pre/post implementation study of 72 scramble intersections in New York City[27]	Average pedestrian crash rate decreased by 44.9% at treatment sites, compared to 11.5% at control comparison sites (ANCOVA-adjusted to 48% reduction, significant at the 0.05 level)
Pre/post implementation study of high-volume pedestrian locations in Beverly Hills, CA[28]	Found a 66% reduction in pedestrian-vehicles incidents at high-volume pedestrian locations in Beverly Hills, CA Prior to implementation, turning vehicles unable to complete movements due to high pedestrian volumes on the crossing

[27] Chen, L., C. Chen, R. Ewing, C. McKnight, R. Srinivasan, and M. Roe. *Safety Countermeasures and Crash Reduction in New York City—Experience and Lessons Learned*. Accident Analysis and Prevention. Vol. 50, January 2013, p. 312-322. http://dx.doi.org/10.1016/j.aap.2012.05.009

[28] Vaziri, B. *Exclusive pedestrian phase for the business district signals in Beverly Hills: 10 years later*. Institute of Transportation Engineers. District 6 Meeting (1998 : San Diego, CA), compendium of technical papers, 1998.

<table>
<tr><th>Case Studies</th><th>Content</th></tr>
<tr><td>Oakland, CA ped scramble evaluation[29]</td><td>Found that implementing the scramble crossing reduced the green ratio, and thus the capacity of each approach which does not minimize user delay, nor does it maximize vehicle capacity

While pedestrian delay increases on average by varying degrees, it reduces the distance that pedestrians must travel – another measure of convenience.
- A New Zealand study that estimated 5-7% reduction in distance travelled by pedestrians
- Study found to reduce pedestrian crossing distance by 13% on average at one location

Results of pedestrian-vehicle conflict analysis found reduced conflict incidence rate by nearly 50% during for the observation time period effect.

The analysis of pedestrian violations demonstrates that more violations occurred after introduction of the pedestrian scramble.

Public acceptance was assessed via intercept survey.
- Majority understood changes and were not confused on intersection operation.
- Most noticed that they tended to wait longer.
- Most reported feeling safer crossing with the scramble arrangement.
- Some raised concern noting that some pedestrians crossed on vehicle green phase.</td></tr>
</table>

6.2.7.1 Key Findings

In general, the benefits of pedestrian scramble phases include:

- Multi-direction crossing for pedestrians to cross in any direction, negating the need to cross twice to reach

[29] Bechtel, A. K, MacLeod, K. E, & Ragland, D. R. (2003). *Oakland Chinatown Pedestrian Scramble: An Evaluation*. UC Berkeley: Safe Transportation Research & Education Center. https://escholarship.org/uc/item/3fh5q4dk. Accessed November 2019/

destinations diagonally across the intersection (when diagonal crossings are employed)

- Reduced conflicts between drivers and pedestrians by isolating movements for each to occur during separate signal cycles

Some issues of implementation include:

- Potential increase in pedestrian violations (pedestrians crossing on "do not walk" symbol)
- Increased wait times for all intersection users
- Potential confusion for visually impaired pedestrians who rely on traffic sounds to decide when and where to cross
- Potential effect to the ability to synchronize timing at adjacent traffic signals

6.2.8 Pedestrian Refuge Islands

Refuge islands provide pedestrians and bicyclists a dedicated area within intersection and mid-block crossings. On wide thoroughfares or where pedestrians with reduced mobility need to cross, these features provide a safe area for pedestrians to wait partially through their crossing.

In addition, refuge islands can help pedestrians cross streets more safely with less exposure to vehicles. At unsignalized intersection and mid-block crossings, refuges help pedestrians split their crossing into two phases so that they only have to concentrate on crossing one direction of the roadway at a time.

The CA MUTCD does not provide guidance on when pedestrian refuge islands should be used, but states: "raised islands or medians of sufficient width that are placed in the center area of a street or highway can serve as a place of refuge for pedestrians who are attempting to cross at a mid-block or intersection location. Center islands or medians allow pedestrians to find an adequate gap in one direction of traffic at a time."

According to NACTO's Urban Street Design Guide, pedestrian refuge islands are generally applied at locations where speeds and volumes make crossings prohibitive, or where three or more lanes of traffic make pedestrians feel exposed or unsafe in the intersection. The Guide also outlines the following critical and recommended guidelines for refuge islands:

- Critical: Islands should be at least 6 feet wide but have a preferred width of 8–10 feet. Where a 6-foot-wide median cannot be attained, a narrower raised median is still preferable to nothing. The minimum protected width of 6 feet is based on the length of a bicycle or a person pushing a stroller. The refuge is at a minimum 20 feet long feet long.

- Critical: The cut-through or ramp width should equal the width of the crosswalk. Where this cannot be achieved, crosswalks should be striped wider than the cut-through area.
- Recommended: All medians at intersections should have a "nose" which extends past the crosswalk. The nose protects people waiting on the median and slows turning drivers.
- Recommended: Safety islands should include curbs, bollards, or other features to protect people waiting.
- Recommended: It is preferable to have the crosswalk "cut-through" the median. Where the median is wider than 17 feet, ramps are preferred. This dimension is based on a 6-inch-high curb, two 1:12 ramps, and a 5-foot-wide level landing in the center.

According to FWHA's Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, this countermeasure is highly desirable for mid-block pedestrian crossings on roads with four or more lanes and should be considered for undivided crossings of four or more lanes with speed limits of 35 mph or greater and/or AADTs of 9,000 or greater. Consideration should be given to creating a two-stage crossing with the island to encourage pedestrians to cross one direction of traffic at a time and look towards oncoming traffic before completing the second part of the crossing.

Caltrans Main Street, California: A Guide for Improving Community and Transportation Vitality[30] states: "Pedestrian refuge islands or pedestrian crossing islands are raised islands that separate crossing pedestrians from traffic at intersections or mid-block locations. They allow pedestrians a sheltered place to stop at the midpoint of the roadway before crossing the rest of the street. They provide pedestrians a better view of oncoming traffic and increase the visibility of pedestrians to drivers. Where raised medians would otherwise hinder access to desirable pedestrian routes, a crossing island can help preserve pedestrian circulation."

According to Caltrans' Highway Design Manual, at unsignalized intersections in rural city/town centers (rural main streets), suburban, or urban areas, a pedestrian refuge should be provided between opposing traffic where pedestrians are allowed to cross two or more through-traffic lanes in one direction of travel, at marked or unmarked crosswalks. Pedestrian islands at signalized crosswalks

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[30] Main Street, California – A Guide for Improving Community and Transportation Vitality. Caltrans, November 2013. https://dot.ca.gov/-/media/dot-media/programs/design/documents/main-street-3rd-edition-a11y.pdf. Accessed November 2019.

should be considered, taking into account crossing distance and pedestrian activity.

6.2.8.1 Key Findings

In general, the benefits of pedestrian refuge islands include:

- Positive safety and crossing outcomes for pedestrians with reduced mobility across wide and busy roads
- Improved safety for pedestrians crossing at unsignalized intersections
- The crossing journey is split into two which can make it more manageable and safer for those crossing

Some issues of implementation include:

- Right-of-way for minimum refuge island width of 6 feet
- For signalized intersections, a pedestrian button on the refuge island may be necessary
- The cost to install and maintain pedestrian refuge islands

6.2.9 Corner or Sidewalk Bulbs

Curb extensions extend the line of the curb into the roadway, reducing the width of the street, and typically are used at pedestrian crossing locations. They most often occur at intersections but can be used at mid-block locations as well. Curb extensions help to manage conflict between vehicles and pedestrians, improve visibility, and slow down driver speed. They can increase safety, efficiency, and attractiveness.

Benefits of curb extensions identified in ITE's Walkable Urban Thoroughfares include:

- Reduced pedestrian crossing distance and traffic exposure

- Improved driver and pedestrian visibility at intersections
- Separation between vehicles parking and vehicles turning at the intersection
- Narrower roadway (both physically and visually) to slow drivers down
- Greater likelihood of pedestrians crossing at preferred locations
- Prevent drivers from parking too close to or blocking the crosswalk
- Wider waiting areas at crosswalks and bus stops
- Slower vehicle turning because of reduced curb radius
- Level landing and more space for pedestrian facilities, such as beg buttons or detectable warnings
- More space for streetscape elements

The Global Street Design Guide (NACTO) lists the following guidance on curb extensions:

- Bulb-outs are extensions of the sidewalk into the parking lane. They should be installed whenever on-street parking is present to increase visibility, reduce the crossing distance, provide extra waiting space, and allow for seating or landscaping.
- The length of a bulb-out should at least be equal to the width of the pedestrian crossing, but should preferably extend to the stop bar
- In advance of a full reconstruction, gateways can be designed using striping or signage that communicates the entrance to a slow zone.

6.2.9.1 Key Findings

In general, the benefits of bulb-outs include:

- Improved visibility of pedestrians
- Reduced crossing distances
- Improved safety and reduction of pedestrian-involved collisions
- Reduced vehicle speeds

Some issues of implementation include:

- Availability of right-of-way
- The cost to install bulb-outs

- Coordination with underground utilities and roadway drainage

6.2.10 Mid-Block Signalized Pedestrian Crossing

Pedestrians tend to take the most direct route possible unless there is a far superior crossing that is out of their way. Mid-block traffic crossings enable pedestrians to legally cross at non-intersections without endangering themselves or drivers.

Mid-block traffic crossings enable pedestrians to safely cross the street in the middle of a block, rather than traveling out of their way (sometimes significantly) to the nearest intersection. Mid-block signals are typically flashing lights that stop traffic and enable pedestrians to safely cross.

Mid-block crosswalks provide pedestrians (as well as bicyclists) a safer and more visible way to cross a street than crossing at random and often dangerous locations when protected crossings at signalized intersections are widely spaced apart. Signalized mid-block crossings are most valuable in suburban contexts on multilane arterial streets with high traffic volumes and speeds, where the major street system creates "superblocks" with as long as one quarter to one half mile between traffic signals.

While the use of signalized mid-block crossings is important to connect significant pedestrian generators located on long blocks (such as connecting high density housing and parking facilities to large parks, entertainment venues, major retail centers, major transit centers, and schools/universities), their use should also be considered in less visible, but equally important environments that will improve the quality of life for many people, such as near senior centers and assisted living facilities or connecting an apartment complex to a city park across the street.

The "Proven Ability to Enhance Pedestrian Safety" Study was conducted in the early 1990s and involved several states.[31] It showed that mid-block events were the second major grouping of pedestrian crash types and accounted for 26.5 percent of all pedestrian crashes. Among this group, the most common crash type (1/3 of all) was the "mid-block dash" where a pedestrian would run into the street, and the driver's view was not obstructed.

Mid-block crossings typically require traffic control such as hybrid beacons or traffic signals. To justify the installation of a pedestrian hybrid beacon or traffic signal, the CA MUTCD, has warrants based primarily on pedestrian volumes and vehicle volumes. The applicable warrant for using a traffic signal at a mid-block location is Warrant 4, Pedestrian Volume. The pedestrian volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

6.2.10.1 Key Findings

In general, the benefits of mid-block signalized crossings include:

- Improved pedestrian connectivity
- Reduced pedestrian crashes
- Reduced instances of jaywalking

Some issues of implementation include:

- Determining which mid-block locations meet signal warrants (by either pedestrian volume, distance between signalized crossings, or with land use destinations)
- Ensuring that drivers stop for flashing lights as they would for a red light
- The cost to implement signalization
- Need to design a highly visible facility to ensure pedestrian safety
- Potential reduction in coordination of upstream and downstream signals

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[31] Hunter, W. Stutts, J. Pein, W, Cox, C. *Pedestrian and Bicycle Crash Types of the Early 1990's*. Federal Highway Administration (FHWA) (FHWA-RD-95-163), 1996. https://rosap.ntl.bts.gov/view/dot/38569. Accessed November 2019.

6.2.11 On-Street Parking or Loading Zones

In some cases, the addition of on-street parking can be used to improve the street pedestrian environment. Parking strips narrow the travel right-of-way, which can slow down traffic as well as reduce crossing distances for pedestrians. On-street parking can also act as a buffer between traffic and pedestrians on the sidewalk.

In areas with retail, especially street-front shops, street parking can be good for local businesses and help customers access stores and commercial establishments. Stores that rely on street parking for their customers also tend to be more pedestrian friendly. Other uses such as high-density housing can also benefit from short-term on-street parking.

Conversely, on-street parking can create a visual barrier between pedestrians and oncoming traffic. Adding parking can also take away from road space that could be dedicated to transit or used for bicycle facilities. Once on-street parking has been added, it can be difficult to remove without incurring backlash from people and businesses who rely on its presence.

The Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (FWHA) provides the following guidance on on-street parking as related to pedestrians:

- Limit parking on the crosswalk approach so there is adequate sight distance for drivers on the approaches to the crossings and ample sight distance for pedestrians attempting to cross
- The minimum setback between intersection and parking is 20 feet where speeds are 25 mph or less, and 30 feet between 26 mph and 35 mph.
- If this cannot be done, the curbs should be “bulbed out” to allow the pedestrian to see past the parked vehicle along the street.

In addition to vehicular parking, on-street parking areas can also be used for passenger loading zones (typically white curbs) and commercial loading zones (typically yellow curbs). Passenger loading zones can accommodate drop-off and pick-up activities, such as from rideshare services. By providing space for these maneuvers at the curb, double-parking can be reduced. Commercial loading zones should be considered to minimize some of the risk from truck loading operations, which can result in double-parking or blocking of bike lanes. Commercial loading zones should be provided within the parking strip and can be time-restricted to encourage off-peak delivery.

6.2.11.1 Key Findings

In general, the benefits of designing on-street parking or loading zones with pedestrians in mind include:

- Added buffer between pedestrians and traffic
- Slower traffic speeds and shorter crossing distances
- Street parking can be good for businesses and improve neighborhood connectivity
- Increased efficiency for passenger loading and commercial deliveries
- Reduction in conflicts between commercial trucks and bicyclists

Some issues of implementation include:

- Reduction of a travel lane
- Potential visual barrier between pedestrians and oncoming traffic during crossing which may require additional features, such as curb extensions

6.3 BICYCLES

Details on the four bicycle toolbox treatments are provided below.

6.3.1 Bike on Sidewalk Treatments

By allowing cyclists to legally ride on the sidewalk, vehicle right-of-way can be maintained on the road while also reducing conflict and the likelihood of collision between people cycling and vehicles. However, placing cyclists on a sidewalk with no separation from pedestrians increases the likelihood of collision between people cycling and people walking. Accordingly, if cyclists are to use what would otherwise be pedestrian-oriented sidewalk space, it is important that there be some form of indication or separation of where people cycling travel and where people walking travel.

Adapting an existing sidewalk for use as a multi-use path to accommodate bicyclists in addition to pedestrians is generally considered an undesirable practice. However, despite being prohibited in some jurisdictions, it is unlikely to eliminate use of sidewalks by bicycles where cyclists do not feel safe riding on the road.

AASHTO[32] and the NYS DOT[33] manual identify circumstances when it may be desirable to accommodate bicyclists on sidewalks, including:

- To provide bikeway continuity along high speed or heavily traveled roadways with inadequate space for bicyclists, uninterrupted by driveways and intersections for long distances
- On long narrow bridges

Typical bike on sidewalk treatments include:

- Removing unnecessary obstacles
- Providing additional sidewalk width
- Adding curb cuts at location where bicyclists are directed from the roadway onto the sidewalk
- Providing bikeway yield or stop signs at uncontrolled intersections

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[32] *Guide for the development of bicycle facilities*. AASHTO, 1999. http://www.aashto.org/aashto/home.nsf/FrontPage. Accessed December 2019.

[33] *Highway Design Manual Chapter 18 Pedestrian Facility Design.* NYS DOT, 2017. https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_18.pdf. Accessed December 2019.

- Additional pavement striping and signing to alert drivers and pedestrians to the presence of bicycles
- Correcting areas of impaired sight distance

It should be noted that it is considered inappropriate to sign a sidewalk as a bicycle path in order to discourage bicycles from using the roadway.

Table 6-6 below provides a summary of state and local regulations pertaining to bicycle riding on sidewalks within the Study Area. Currently, by law[34], bicyclists in Orange County must not ride on the sidewalk with a willful disregard for safety. Pedestrians have the right-of-way on walkways. If a rider must ride on sidewalks, they must do so at a walking pace. Riders must slow down and look very carefully for traffic at driveways or intersections.

Table 6-6. Bicycle Riding on Sidewalks Regulations Within the Study Area

Jurisdiction	Applicable Laws	Interpretation
State of California	There is no statewide California law prohibiting the operation of a bicycle on a sidewalk; however, California Vehicle Code Section 21206 allows local (county, city, etc.) governments to regulate operation of bicycles on pedestrian facilities.	Allowance of bicycles on sidewalks is left to the local jurisdiction's municipal code.
City of Huntington Beach	10.84.160 Riding on Sidewalk No person shall ride a bicycle upon a sidewalk within any business district, or upon the sidewalk adjacent to any public school building, church, recreation center, playground or over any pedestrian overcrossing, or within any crosswalk. (22-8/09, 322-1/29, 1784-12/72, 1913-5/74, 2270-3/78) 10.84.170 Yielding Right-of-Way Whenever any person is riding a bicycle upon a sidewalk, such person shall yield the right-of-way to any	Riding bicycles on sidewalks is prohibited on certain facilities, in certain districts, and adjacent to certain uses. However, in areas not identified in 10.84.160, bicycles appear to be allowed on sidewalks.

[34] Safety Awareness. Orange County Transportation Authority (OCTA). https://www.octa.net/Bike/Safety-Awareness/. Accessed December 2019.

Jurisdiction	Applicable Laws	Interpretation
	pedestrian, and when overtaking and passing a pedestrian shall give an audible signal. A person riding a bicycle off a sidewalk and onto a roadway shall yield to all traffic on the roadway. (22-8/09, 1784-12/72, 1913-5/74) 10.84.260 Walking Bicycles Bicycles may be walked subject to all provisions of law applicable to pedestrians. (1913-5/74) 10.72.040 Riding or Driving on a Sidewalk No person shall ride, drive, propel or cause to be propelled any vehicle or animal across or upon any sidewalk excepting over permanently constructed driveways and excepting when it is necessary for any temporary purpose to drive a loaded vehicle across a sidewalk; provided further, that the sidewalk area be substantially protected by wooden planks two inches thick, and written permission be previously obtained from the Director of Public Works. Such wooden planks shall not be permitted to remain upon such sidewalk area during the hours from 6:00 p.m. to 6:00 a.m. (322-1/29, 1157-9/65) 10.20.020 Vehicles on Sidewalks The operator of any vehicle except those vehicles regulated by Chapter 10.88, shall not drive within any sidewalk area except to a permanent or temporary drive. (322-1/29, 1003-10/63) 8.44.030 Prohibited Areas of Operation A. No person shall operate a vehicle, motorcycle or motor-	

Jurisdiction	Applicable Laws	Interpretation
	driven cycle other than a publicly-owned vehicle, motorcycle or motor-driven cycle, upon a public sidewalk, walkway, parkway or in any public park or recreational area or upon any other publicly-owned property, except highways, within the City. This shall not be construed to prohibit the operation of a vehicle, motorcycle or motor-driven cycle having a valid California vehicle registration by any person possessing a valid California operator's license upon the public highways in the City. B. No person shall operate a vehicle, motorcycle or motor-driven cycle, other than a publicly-owned vehicle, motorcycle or motor-driven cycle, upon any unimproved private property within the City, except as set forth in Section 8.44.040. (1587-6/70, 1926-8/74)	
City of Westminster	10.84.230 Riding on sidewalks—Restrictions. A. No person shall ride a bicycle upon a sidewalk within any business district, or upon the sidewalk adjacent to any public-school building, church, recreation center or playground. Peace officers shall be exempt from these provisions while in the discharge of their duties. (Ord. 2210 § 1, 1993; Ord. No. 2128 § 1, 1990; Ord. 1874 § 1, 1979; prior code § 3440.22) B. Whenever any person is riding a bicycle upon a sidewalk, such person shall yield the right-of-way to any pedestrian or to any vehicle exiting or	Riding bicycles on sidewalks is prohibited on certain facilities, in certain districts, and adjacent to certain uses. However, in areas not identified in 10.84.230, bicycles appear to be allowed on sidewalks.

Jurisdiction	Applicable Laws	Interpretation
	entering any private driveway or alley. (Ord. 2128 § 1990; Ord. 1874 § 1, 1979; prior code § 3440.22) C. It is unlawful to ride a bicycle or state board on any sidewalk within the civic center complex. Peace officers shall be exempt from these provisions while in the discharge of their duties. (Ord. 2210 § 1, 1993; Ord. 1966 § 1, 1983) 10.36.030 Riding or driving on sidewalk prohibited Exceptions. No person shall ride, drive, propel, or cause to be propelled any vehicle or animal across or upon any sidewalk excepting over permanently constructed driveways and excepting when it is necessary for any temporary purpose to drive a loaded vehicle across a sidewalk; provided, that said sidewalk area is substantially protected by wooden planks two inches thick, and written permission is previously obtained from the city traffic engineer. Such wooden planks shall not be permitted to remain upon such sidewalk area during the hours from six p.m. to six a.m. (Prior code § 3410 § 8.3)	
City of Garden Grove	10.28.030 Driving on Sidewalk The driver of a vehicle shall not drive within any sidewalk area or any parkway except at a permanent or temporary driveway. (2804 § 1, 2011; prior code § 3135) 10.16.050 Application to Bicycle or Animal Riders Every person riding a bicycle, or riding, or driving an animal upon a highway shall be granted all of the	Code 10.28.030 appears to prohibit driving any vehicle within a sidewalk area except to cross a driveway. Code 10.16.050 defines a bicycle as a vehicle and subject to code 10.28.030.

Jurisdiction	Applicable Laws	Interpretation
	rights and shall be subject to all of the duties applicable to the driver of a vehicle by this title, except those provisions that by their very nature can have no application. (2804 § 1, 2011; prior code § 3111)	
City of Stanton	No regulations found.	
City of Anaheim	No regulations found.	
City of Buena Park	10.20.020 Riding or driving animals or vehicles on sidewalk. No person shall ride, drive, propel or cause to be propelled any vehicle or animal across or upon any sidewalk excepting over permanently constructed driveways, and excepting when it is necessary for any temporary purpose to drive a loaded vehicle across a sidewalk; provided, further, that such sidewalk area be substantially protected by wooden planks two inches thick, and written permission be previously obtained from the city traffic engineer. Such wooden planks shall not be permitted to remain upon such sidewalk area during the hours from six p.m. to six a m. (Prior code § 17-57)	Appears to restrict any vehicle to be propelled across or upon a sidewalk except on a driveway. A bicycle is considered a vehicle per the CVC.
City of La Mirada	10.25.060 (d) No person shall ride or operate a bicycle on a roadway or sidewalk adjacent to which or upon which bicycle lanes have been designated, except within such bicycle lane or except as otherwise permitted by the provisions of this chapter. No person shall ride or operate a bicycle upon a roadway adjacent to which there is a bicycle path which parallels	Restricts bicycles on operating on sidewalks if bicycle lanes are provided along the corridor.

Jurisdiction	Applicable Laws	Interpretation
	the roadway and which bicycle path when measured from the edge of the roadway to the edge of the bicycle path nearest the roadway is no more than seventy-five feet distant, except within such bicycle path or except as otherwise permitted by the provisions of this chapter.	
City of Fullerton	No regulations found.	
City of La Habra	10.40.020 Required. No person residing in the city shall ride or propel any bicycle upon any public street, sidewalk, alley, bicycle lane or path, or any other public property, or have in his/her possession any bicycle which has not been licensed and for which the appropriate license fee has not been paid or which does not bear a bicycle plate as required by the provisions of this chapter. (Ord. 944 § 3, 1976)	Bicycle license is required to ride on any public road facility. Does not appear to restrict riding on sidewalks.

Given the general difficulty in cycling along Beach Boulevard and the lack of space within the right-of-way to provide on-street bicycle facilities, the allowance of cyclists on the sidewalk may help encourage bicycle usage along the Project Corridor.

6.3.1.1 Key Findings

In general, the benefits of allowing bicycles on sidewalks include:

- Reduced potential for conflict between bikes and drivers traveling at speed
- Bicyclists may feel safer riding on the sidewalk than on the street, as fear of riding in the street may be a barrier to their bicycle use

Some issues of implementation include:

- Currently, by law, Orange County bicyclists are not allowed on sidewalks
- More potential for pedestrian-bicyclist collisions

- Increased danger from vehicles at driveways and limited visibility
- Sidewalks may need modifications and improvements to be suitable for bicycle use

6.3.2 Close Gaps in Bicycle Network (on parallel streets)

Connected and consistent networks for bicycles enable a comfortable and direct trip for those traveling by bike and can encourage bicycling as a primary mode of travel. Bicyclists need safe, clear and, direct routes which take them to destinations without stopping short at difficult intersections or obstacles. Well delineated and designed facilities for bicyclists can reduce conflicts with pedestrians and motor vehicles. To accomplish good bicycle connectivity within the Study Area, improvements can be implemented on parallel, lower-traffic streets, where disconnected street networks, barriers, dangerous intersections, and difficult mid-block crossings should be addressed.

Figure 6-2 shows a potential alternative bicycle route running parallel to the Project Corridor. Highlighted streets include those that are continuous, have an existing or planned bikeway, and are close to the Project Corridor, so as not to remove riders too far from desired destinations in the corridor. Key segments have been identified where there are no existing or planned bikeways. Bicycle infrastructure within this alternative route may be able to be prioritized by cities for completion, and integrated wayfinding should be implemented along the route to help bicyclists follow with changing streets or navigate their way back to the Project Corridor at activity centers. Ensuring that the route has crossing facilities across large roadways will also be key to achieving meaningful connectivity and establishing a viable alternative to biking on the Project Corridor.

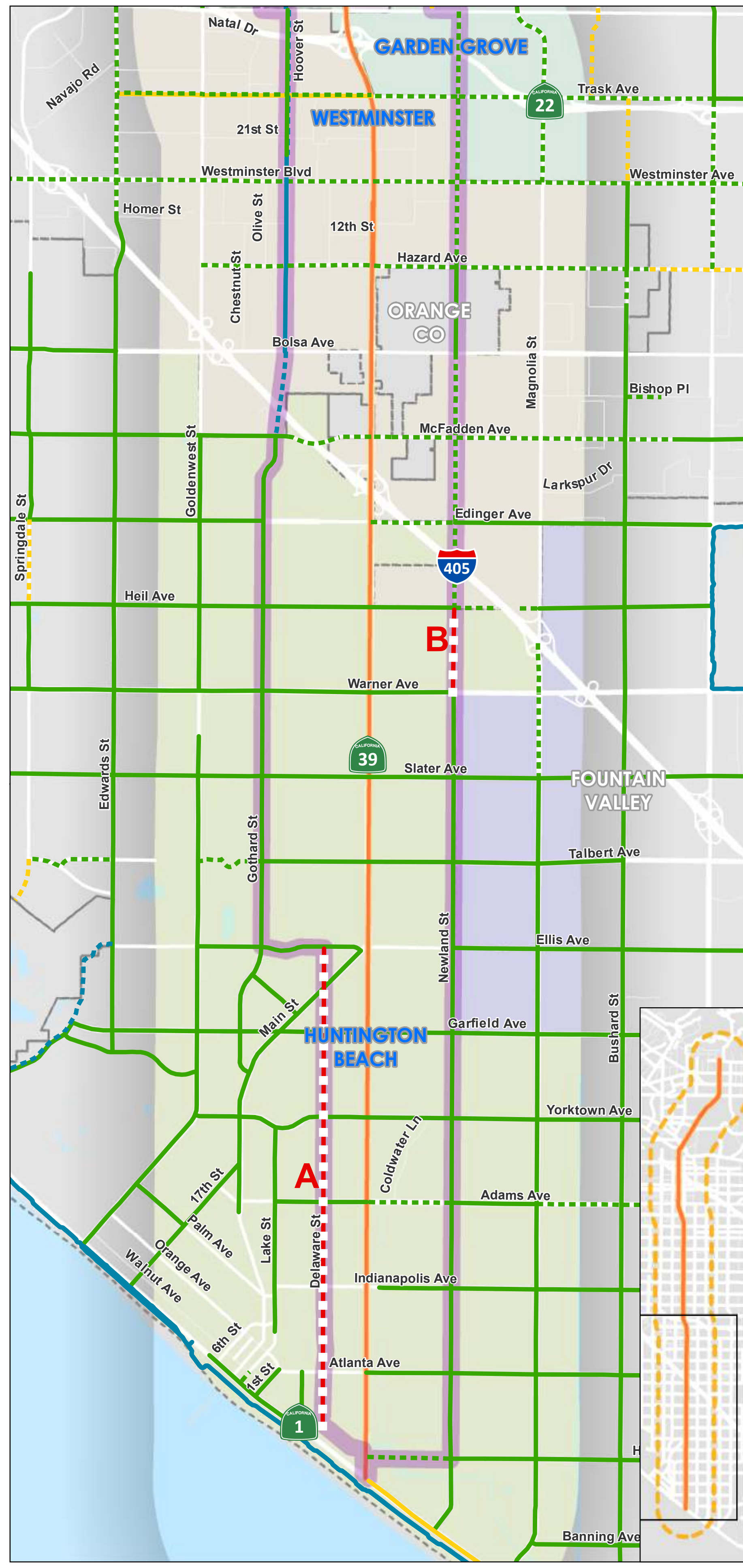
6.3.2.1 Key Findings

In general, the benefits of closing gaps in bicycle network (on parallel streets) include:

- Safer and continuous bicycle routes parallel to the Project Corridor
- Lower costs compared to implementing separated bike lanes on Beach Boulevard
- Alignment with some existing or planned bikeways in different cities

Some issues of implementation include:

- Selection of bikeways facility type
- Wayfinding along route that runs along different streets
- Bicycle connections from parallel routes back to Beach Boulevard for access to destinations
- Coordination across local jurisdictions



Legend

- Beach Blvd Centerline
- Class I Existing
- Class II Existing
- Class III Existing
- Class I Proposed
- Class II Proposed
- Class III Proposed
- Segments without planned bikeways
- Beach Blvd Bike Route Alternative

City	Segment	Facility Type Recommendation
Huntington Beach	A	Class II Bike Lane
Huntington Beach	B	Class II Bike Lane
Buena Park	C	Class II Bike Lane
Buena Park	D	Class III Bikeway
Buena Park	E	Class II Bike Lane

OCTA

Study Area Parallel Facility Bicycle Route
Beach Boulevard Corridor Study

Figure
6-2

Coordinate System: NAD 1983 StatePlane California VI FIPS 0406 Feet

6.3.3 Bike Preferential Treatments

Generally, bicyclist-oriented improvements consist of implementing or improving bikeways along roads, whether they are bike lanes, protected bike lanes, bike route, bike boulevards, or other bikeway classes. However, treatments to improve bicyclist safety at and around intersections is also critical. NACTO has published resources for loc al and regional agencies to implement bike preferential treatments to augment bikeways, such as the Urban Bikeway Design Guide (2014) and Don't Give Up at the Intersection: Designing All Ages and Abilities Bicycle Crossings (2019). NACTO provides the following statistics and guidance pertaining to bicyclists at intersections:

- Intersections are where the most vehicle-bike conflicts occur. In 2017, 43 percent of urban bicyclist fatalities occurred at intersections.
- Designs for intersections with bicycle facilities should reduce conflict between bicyclists (and other vulnerable road users) and vehicles by heightening the level of visibility, denoting a clear right-of-way, and facilitating eye contact and awareness with competing modes.
- The configuration of a safe intersection for bicyclists may include elements such as color, signage, medians, signal detection, and pavement markings.

Bike preferential treatments for navigating intersections can fall into several categories:

- Utilizing paint or physical facilities to help bicyclists safely position themselves at an intersection. These can include bike boxes, bend-in crossings, and bend-out crossings.
- Utilizing paint and other markings to help bicyclists safely navigate through intersections. These can include bicyclist crossing markings through the intersection and two-stage left-turn queue boxes.
- Treatments at the intersection approach to reduce conflicts between bicyclists and right-turning vehicles. These can include through bike lanes (also known as pocket bike lanes) and combined bike/turn lanes.
- Changes to or augmentation of traffic signals to accommodate bicyclists. These can include bicycle detection and actuation, protected bicycle signals, and leading bike interval (LBI).
- Physical treatments to decrease the speed of right-turning vehicles, such as corner islands, corner wedges and speed bumps, and delineator posts.

Bicyclist preferential treatments can help improve bicyclist comfort and safety and encourage bicycling for all ages and abilities. These treatments build upon traditional bikeway improvements, allowing bicyclists to navigate stressful intersections and avoid conflicts with bicyclists. They can be used in combination, including with pedestrian-oriented treatments or as part of protected intersections.

NACTO also provides information and guidance on specific treatments, shown in Table 6-7 below.

Table 6-7. Standard Bike Preferential Treatments

Treatment	Description/Benefit
Bike box	A bike box is a green-painted designated area for bicyclists to queue at the head of a traffic lane at a signalized intersection. It provides bicyclists with a safe and visible way to get ahead of queuing traffic during a red signal phase. Benefits of bike boxes include increased bicyclist visibility, reduced delay for bicyclists, and greater prevention of right-hook conflicts with turning vehicles.
Bend-in crossing	At a bend-in crossing, a curb extension or painted buffer is used to bend-in a bikeway toward the roadway to promote visibility of bicyclists in advance of an intersection. Benefits of bend-in crossings include increased driver awareness of bicyclists, especially for right-turning vehicles approaching an intersection.
Bend-out crossing	At a bend-out crossing, a bikeway bends away from the vehicle lanes and toward the sidewalk. In addition, the vehicle stop bar is set back, so that bicyclists stop ahead of and in plain view of vehicles. Similar to bend-in crossings, bend-out crossings increase the visibility of bicyclists at an intersection due their position relative to vehicles.

Treatment	Description/Benefit
Intersection crossing markings	Bicycle intersection crossing markings indicate the intended path of bicyclists through an intersection. Intersection crossing markings can take several forms, including dotted lines, chevrons, shared lane markings (sharrows), and green paint. They serve multiple benefits, including providing bicyclists with a clear and delineated path through the intersection, providing a boundary between vehicle and bicyclist paths to reduce conflicts, and increasing driver awareness of bicyclists crossing the intersection to the right of moving vehicles.
Two-stage left-turn queue box	It can often be difficult for bicyclists to navigate multiple vehicle lanes to turn left at a signalized intersection. A two-stage turn queue box provides bicyclists a safe way to make left turns from the right side of an intersection. Benefits of two-stage turn queue boxes include improved bicyclist comfort at intersections and reduced conflicts between bicycles, vehicles, and pedestrians.
Through bike lane	The approach to an intersection can be challenging, especially if a bike lane drops or if the bicyclist must travel along a dedicated vehicle right-turn lane. A through bike lane, or pocket bike lane, provides bicyclists with an opportunity to correctly position themselves to avoid conflicts with right-turning vehicles. This treatment consists of a through bicycle lane along the left side of the vehicle right-turn lane. Benefits of through bike lanes include reduced conflicts between bikes and right-turning vehicles, increased bicyclist comfort at the intersection approach, and reduced bicyclist and driver confusion or unpredictability.
Combined bike/turn lane	Similar to a through bike lane, a combined bike lane/turn lane provides a delineated path for bicyclists along a right-turn lane to reduce conflicts. Also known as a mixing zone, a combined bike/turn lane places a suggested bike lane within the inside left portion of a right-turn lane with shared lane markings or conventional bicycle stencils. Benefits of mixing zones include maintaining bicyclist guidance in the absence of a bike through lane, encouraging bicyclists to travel in right-turn lanes (with slower vehicle traffic than on through lanes), and increasing driver awareness of the presence of bicyclists at the intersection approach.

Treatment	Description/Benefit
Bicycle detection and actuation	Standard forms of traffic signal actuation at intersections lack the sensitivity to detect bicyclists, causing bicyclist delay. Bicycle detection (through the use of push-buttons, in-pavement loops, video, or other means) alerts the signal controller of bike crossing demand on a particular approach. Benefits include reduced bicyclist delay, improved bicyclist convenience and safety, and discouraging bicyclists from running red lights or using the pedestrian crosswalk.
Protected bike signal	A protected bike signal is an augmentation to an existing conventional traffic signal or hybrid beacon. A protected bike signal includes unique signal heads for bicyclists and provides them with a dedicated signal phase during which all motor vehicles have a red light. Benefits of protected bike signals include separating bicycle movements from conflicting motor vehicle or pedestrian movements, protecting bicyclists at intersections, and improving intersection operations for bicyclists.
Leading bike interval (LBI)	An LBI includes the addition of bike signal heads on standard traffic signals but does not provide bicyclists a dedicated signal phase. Rather, an LBI gives bicyclists a head start to enter the intersection before vehicles, similar to how a leading pedestrian interval (LPI) provides pedestrians with a few seconds' head start before vehicles. Benefits of LBI include reducing conflicts between bicyclists and right-turning vehicles and increasing bicyclist visibility at intersections.
Decreasing right-turn speeds	Drivers yield more frequently to people biking and walking when speeds are low, making it safer for bikes and pedestrians to pass in front of turning vehicles. There are several methods to reduce vehicle turning speeds, including reduced turning radii, corner islands, corner wedges and speed bumps, and delineator posts. Benefits of lower turning speeds include increasing levels of drivers yielding to bicyclists and reducing the likelihood of fatal or severe injury crashes.

Depending upon the location, one or more of these improvements may be appropriate to address the safety, operation, and accessibility of bicyclists within the Study Area.

6.3.3.1 Key Findings

In general, the benefits of bike preferential treatments include:

- Reduced conflict points between bicyclists and other modes (vehicles, pedestrians)
- Improved bicyclist safety and comfort when approaching and navigating intersections
- Increased bicycle ridership
- Increased utilization of bike facilities along roads such as bike lanes

Some issues of implementation include:

- Potential need for right-of-way or property (primarily for treatments that require additional right-of-way, such as bend-out crossings)
- Updates to signal timing to incorporate protected bike signal and/or LBIs
- Potential for longer vehicular delay
- Costs for maintenance

6.3.4 Protected Bike Lanes (on Beach Boulevard)

Protected bike lanes are facilities exclusively for bicyclists that are within or directly adjacent to the roadway but have an element of physical separation from vehicle traffic. By separating bicyclists from traffic, bikeways become low-stress and safer for bicyclists. In addition, these facilities have the potential to improve traffic safety for all street users and can encourage bicycling. The FHWA[35] highlights the benefits of separated bike lanes as:

- Providing a more comfortable experience for less-skilled riders
- Improving access to community destinations
- Enhancing access to public transportation
- Improving employment opportunities, especially for those without access to a vehicle
- Providing linkages for regional trail systems

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[35] Separated Bike Lane Planning and Design Guide. FHWA, 2016. https://nacto.org/wp-content/uploads/2016/05/2-4_FHWA-Separated-Bike-Lane-Guide-ch-5_2014.pdf. Accessed December 2019.

The National Institute for Transportation and Communities[36] found that 96 percent of users feel safer as a result of separation. There have not been sufficient studies to fully understand the real safety impact of separated bike lanes; however, preliminary studies have found that the addition of separated bike lanes were generally associated with a decrease in total crashes and an increase in total bicycle-related crashes. Accounting for increase in bicycle riders caused by presence of facility, the per capita bicycle crash rate did decrease, while more bicycle-related collisions for facilities with separated bike lanes occurred at intersections, highlighting the need to focus not only on bike lane separation but also on safety for bicycles at intersections where a facility is present.

FHWA outlines the following key considerations, as shown in Table 6-8, and provides more in-depth guidance in the Separated Bike Lane Planning and Design Guide.[37]

Table 6-8. Key Considerations for Protected Bike Lanes

Category	Consideration
Planning Considerations	• Consistency within the network • Safety benefits • Design flexibility • Existing and potential users • Local support • Equity
Contextual Considerations	• Roadway capacity effects • Pedestrian and other street user safety effects • Transit corridors • Loading and unloading • Accessibility • Parking
Installation Opportunities	• Pilot projects • Street retrofits • New construction or reconstruction

[36] Monsere, Dill, McNeil, Clifton, Foster, Goddard, Berkow, Gilpin, Voros, van Hengel, Parks. Lessons from the Green Lanes: Evaluating Protected Bike Lanes in the U.S. Portland State University Transportation Research and Education Center. (TREC)https://pdfs.semanticscholar.org/d83a/36ad68e27c1c9e06e390b4f54648e9c7b102.pdf and. Access November 2019

[37] Separated Bike Lane Planning and Design Guide. Federal Highway Administration (FHWA), 2015. https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/separated_bikelane_pdg/separatedbikelane_pdg.pdf. Accessed December 2019.

Category	Consideration
Issues to Consider	• Cost • Funding • Maintenance • Outreach • Agency Coordination
Project Evaluation	• Holistic evaluation • Data collection

Decision making on the appropriate form of bicycle lane separation should be based on factors such as presence of parking, street and buffer width, costs, durability, traffic speeds and other factors. Different types of separation can include bollards, planters, parking stops, concrete barriers or raised medians. Type of separation can also depend on whether separated bike lane is added in as a temporary pilot or as a permanent fixture of the roadway.

Bikeway width should be determined based on street characteristics and anticipated demand. Preferred width ranges from 7 feet for one-way bike lanes to 12 feet for two-way bike lanes.

Separated bike lanes are mostly a geometric design rather than a traffic control device, so their use is not restricted by the Manual on Uniform Traffic Control Devices (MUTCD)[38]. However, any traffic control devices that are used for separated bike lanes must comply with MUTCD. Interim approvals (IAs) have been issued by the FHWA for green colored pavement (IA-14) and bicycle signal faces (IA-17), so these methods will require requesting specific approval from FHWA.

6.3.4.1 Key Findings

In general, the benefits of protected bike lanes include:

- Improvements to perceived safety for bicyclists, may also result in real improved safety outcomes
- Increase in bicycling
- Improving access to community destinations, transit, and system connectivity

Some issues of implementation include:

- Building community support
- Designing for bicycle safety at intersections

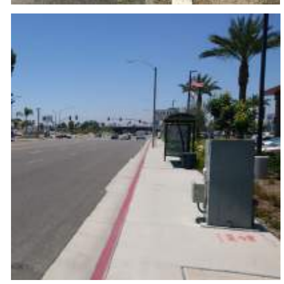
[38] Manual of Traffic Control Devices. FHWA, 2012. https://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm. Accessed December 2019.

- The cost to implement and maintain
- Coordination across local jurisdictions
- Potential right-of-way constraints

6.4 VEHICLES

The eight toolbox elements related to vehicular activity are discussed below.

6.4.1 On-Street Parking or Loading Zones Removal



A roadway's primary function is to move people, goods, and services rather than to store stationary vehicles. The majority of studies conducted to assess the possible removal of on-street parking state that "safety and capacity are improved."[39] Conversely, on-street parking can create a buffer zone between pedestrians on a sidewalk and vehicle traffic on the adjacent roadway. In addition, the presence of on-street parking may reduce vehicle speeds, further enhancing pedestrian safety and comfort.

The estimated speed reduction caused by the addition of on-street parking can fluctuate between 15 to 44 percent. On-street parking is also associated with increased congestion along major arterials, as there can be increases in traffic volumes due to vehicles circling looking for parking and vehicles attempting to enter or exit a space can block the adjacent travel lane. It was observed that when parking maneuvers increased, traffic volume decreased noticeably. In fact, increasing parking maneuvers by 35 percent can reduce arterial capacity up to 35 percent.[40]

In addition, according to *Effects of On-Street Parking in Urban Context: A Critical Review*, 93 percent more crashes take place on major streets due to the presence of on-street parking. Therefore, the removal of on-street parking would be justifiable at least for major streets as negative trade-offs outweigh its benefits.

Loading zones are not specifically provided along the Study Corridor, with the exception of within the City of La Habra. In the section of Beach Boulevard between Hillsborough Drive and SR 72, truck parking is prohibited, but loading and unloading are permitted. In addition, commercial in-street loading activities were observed at

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[39] Federal Highway Administration. Bicycle and Pedestrian Planning, Program, and Project Development. 2019.

[40] Biswas, Subhadip. "Effects of On-Street Parking in Urban Context: A Critical Review." ResearchGate, 2017, www.researchgate.net/publication/315729734_Effects_of_On-Street_Parking_In_Urban_Context_A_Critical_Review. Accessed November 2019.

the auto dealerships located in the City of Huntington Beach between Yorktown Avenue and Talbert Avenue. On-street passenger loading activities were also observed in the City of Buena Park in the Buena Park Entertainment Zone, where vehicles were observed to drop-off or pick-up passengers along the curb, although no stopping is permitted on the streets in this area.

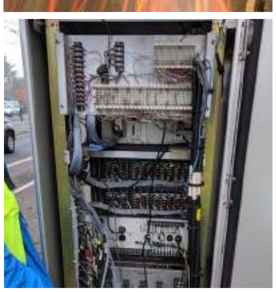
6.4.1.1 Key Findings

In general, the benefits of removing on-street parking and loading zones include:

- Increased safety for bicyclists if curb travel lanes are not narrowed by parked vehicles (door zone)
- Increased safety for pedestrians, especially children who cannot be seen between parked vehicles
- Possibility of wider sidewalks being constructed for pedestrians
- Increased sight distance for transit entering traffic stream

Some issues of implementation include:

- Elimination of convenient parking and loading spaces for business patrons
- Consistency with city, regional and state agency policies and requirements.
- Parking space elimination is usually opposed by adjacent business owners.
- Removal of buffer between travel lanes and pedestrians
- Loss of city revenue with metered parking removal



6.4.2 Advanced Traffic Signal Timing or Intelligent Transportation Systems

Studies and projects over the years have demonstrated that synchronizing traffic signals can substantially improve traffic flow along major streets. The FHWA Signalized Intersections: An Informational Guide states that one objective of signal coordination is smooth flow of traffic along an arterial, street or a highway to improve mobility, safety, and fuel consumption[41]. OCTA's Orange County Traffic Signal Coordination Program, Final Report, states that "coordination of traffic signals results in the reduction of vehicle stops, delays, travel times and emissions, and provides relief to

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[41] Federal Highway Administration (FHWA): "Signalized Intersections: An Informational Guide", Safety, Chapter 8 "System-wide Treatments".

congested corridors by capitalizing and building on existing arterial transportation infrastructure."[42]

Traffic signal synchronization coupled with implementation of Intelligent Transportation Systems (ITS) by OCTA on Beach Boulevard in 2010[43] resulted in 13.5 percent reduction in travel time, 29.6 percent reduction in number of stops, and 33.1 percent reduction in total delay. In addition to the operational benefits, signal coordination can reduce vehicle conflicts, particularly rear-end collisions, as vehicles tend to move more in platoons from intersection to intersection. Updating the signal synchronization plans for current field conditions and periodically for future traffic volumes changes can see similar improvements.

6.4.2.1 Key Findings

In general, the benefits of advanced traffic signal timing and intelligent transportation systems include:

- Reduced travel times, delays and number of stops
- Reduced number of rear-end collisions
- Reduced fuel consumption and air pollution
- Reduced queuing

Some issues of implementation include:

- Potential for longer pedestrian and side-street delays due to longer cycle lengths
- Required periodical signal timing plan updates
- The cost to implement advanced traffic signal timing and ITS elements
- Need to implement across long distances to achieve effectiveness

6.4.3 Consolidate Mid-block Unsignalized Intersections

Along the Project Corridor, there are over 60 non-signalized full access points (driveways or public streets) between signalized intersections. Exhibit 6-2 below shows a typical intersection broken out into the physical area (typically represents the space confined within the corners of the intersection) and the function area (area

[42] OCTA: Orange County Traffic Signal Coordination Program, Final Report, Albert Grover & Associates, 2006.

[43] OCTA: Beach Boulevard Traffic Light Synchronization Project, Final Report, Advantec Consulting Engineers, 2010.

beyond the physical intersection that comprises decision and maneuvering distance, plus any required vehicle storage length). Access points outside of the function area of an intersection would likely perform best from a safety perspective if restricted to right-in, right-out operation. However, in urban areas, two signalized intersections may be so close together that any access would encroach within the functional area of the intersections. These situations are likely candidates for either partial or full access restriction. As a general guideline, the functional area of an intersection is more critical along corridors with high speeds (45 mph or greater) and whose primary purpose is mobility.

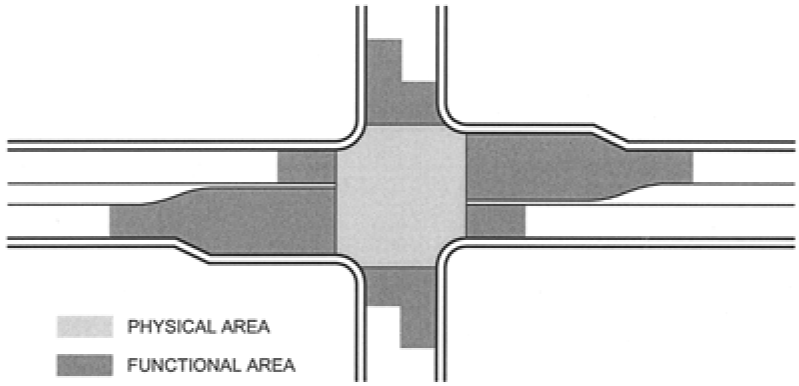

Exhibit 6-2 Comparison of Physical and Functional Areas of an Intersection

Improvements to the access to properties adjacent to an intersection area can be implemented by restricting turning movements through median treatments, driveway treatments, and/or signing.

According to the FHWA, research suggests that approximately 72 percent of collisions at a driveway involve a left-turning vehicle. Approximately 34 percent of those collisions are because an outbound vehicle is turning left across through traffic; 28 percent are because an inbound, left-turning vehicle is conflicting with opposing traffic; and 10 percent are because of outbound, left-turning movements incorrectly merging into traffic. Therefore, by eliminating left-turn movements, safety can be enhanced along an arterial. Below is a graphic from the FHWA to demonstrate the movements of vehicles that cause these types of collisions.[44]

[44] *Access Management in the Vicinity of Intersections*. Federal Highway Administration (FHWA), 2013. https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa10002/. Accessed November 2019.

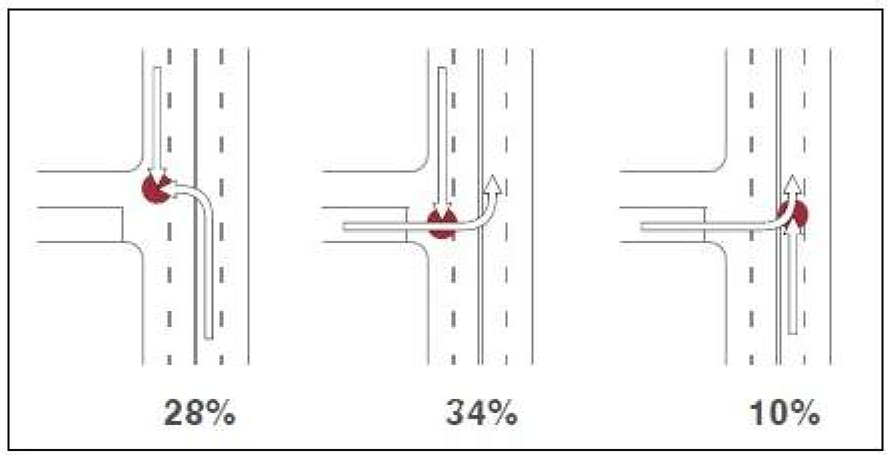

Exhibit 6-3 Driveway Collision Types

If access were restricted, traffic would need to be redirected to access driveways or local streets. Two of the more typical options include:

- Requiring drivers to make a U-turn at a downstream, signalized intersection (Exhibit 6-4). This requires adequate cross-section width to allow the U-turn and sufficient distance to the downstream intersection to weave across the through-travel lanes.

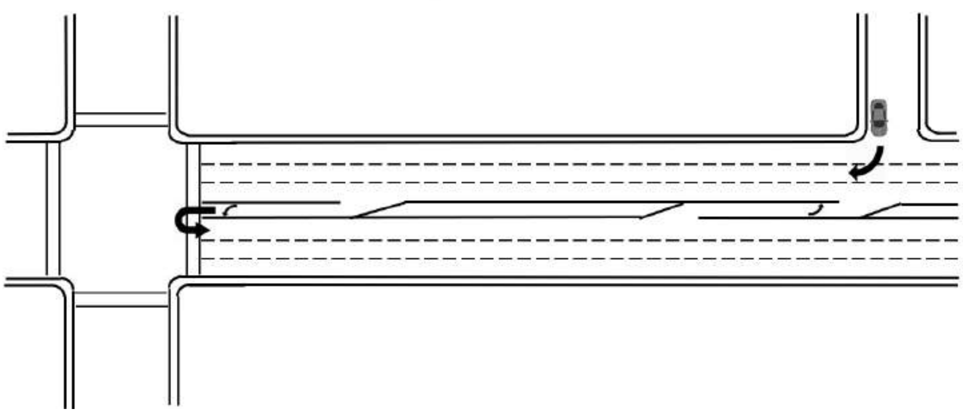

Exhibit 6-4 Access Management with Downstream U-turns

- Creating a mid-block opportunity for drivers to make an unsignalized U-turn maneuver via a directional median opening (Exhibit 6-5). The FHWA Informational Guide noted the safety effect of these directional median openings on six-lane divided arterials with large traffic volumes, high speeds, and high driveway/side-street access volumes. This study found a statistically significant reduction in the total crash rate of 26.4 percent as compared with direct left turns.[45]

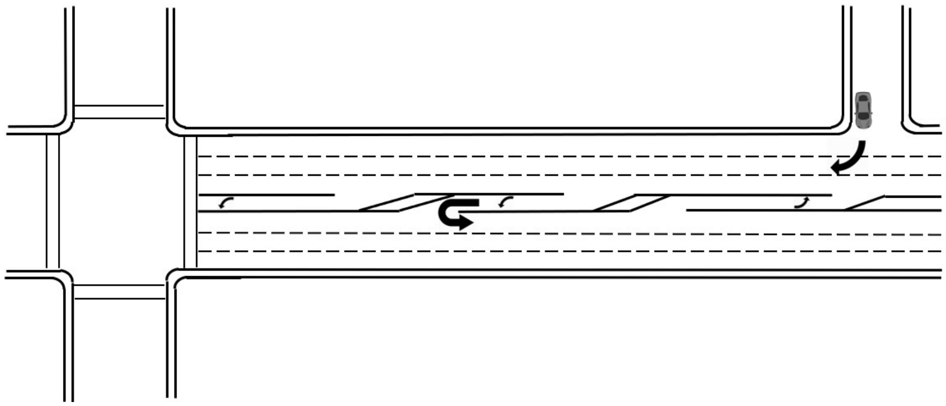

Exhibit 6-5 Access Management with Median U-turns

6.4.3.1 Key Findings

In general, the benefits of consolidating mid-block unsignalized intersections include:

- Reduced collision rates at non-signalized intersections or driveways
- Reduced congestion along roadway segments by reducing conflicting vehicle movements
- Safer environment for pedestrians and bicyclists crossing unsignalized driveways or public streets
- Better access at driveways and reduced delays due to eliminating left turns out of driveways

Some issues of implementation include:

- Increase in U-turn movements at signalized intersections or other unsignalized location which can increase delay and increase the potential for left-turn crashes at the location of the U-turn
- Increase in arterial weaving
- Potential for increased demand for left turns at other driveways serving the same property

[45] "Chapter 8. System-Wide Treatments". *Signalized Intersections: An Informational Guide – Safety*. Federal Highway Administration (FHWA), 2014. https://safety.fhwa.dot.gov/intersection/conventional/signalized/fhwasa13027/ch8.cfm. Accessed November 2019.

6.4.4 Access Management

Access management is the proactive management of vehicular access points to land parcels adjacent to roadways and intersections. Good access management promotes safe and efficient use of the transportation network and encompasses a set of techniques that state and local governments can use to control access to highways, major arterials, and other roadways. FHWA lists the following access management techniques that may be applicable to the Project Corridor[46]:

- Driveway Spacing: Fewer driveways spaced further apart allows for more orderly merging of traffic and presents fewer challenges to drivers.
- Safe Turning Lanes: Dedicated left and right turns, indirect left turns and U-turns, and roundabouts keep through-traffic flowing. Roundabouts represent an opportunity to modify an intersection with many conflict points or a severe crash history (T-bone crashes) to one that operates with fewer conflict points and less severe crashes (sideswipes) if they occur.
- Median Treatments: Two-way left-turn lanes (TWLTL) and non-traversable, raised medians are examples of some of the most effective means to regulate access and reduce crashes.

Exhibit 6-6 below demonstrates how the functional areas of nearby signalized intersections affect the location and extent of feasible access. In particular, access should be limited in the intersection influence area to minimize the disruption to intersection operations (e.g., pedestrian crossings, bus stops, bicyclist crossings). Full access could be accommodated in between signalized intersections; however, most signalized intersections are located too close to each other, so the upstream functional area of one intersection partially or completely overlaps with the upstream functional area of the other. Access driveway should be managed based on the feasible access between two signalized intersections.

[46] What is *Active Traffic Management*. Federal Highway Administration (FHWA), 2017. https://ops.fhwa.dot.gov/access_mgmt/what_is_accsmgmt.htm. Accessed November 2019.

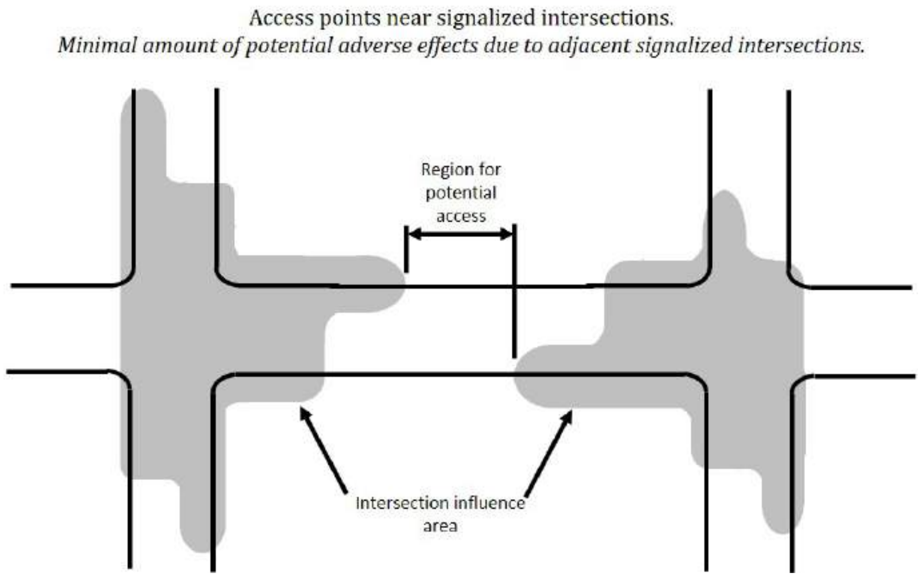

Exhibit 6-6 Access Locations Near Signalized Intersections[47]

Based on a document from FHWA, a research study showed that roadway speeds decrease by 2.5 mph for every 10 access points per mile on a major arterial similar to the Project Corridor. This reduction in speed disrupts traffic flow through the arterial, and this disruption in speed could increase collisions along the arterial. Additionally, based on an examination across seven states, a direct correlation between the number of collisions and the number of driveways was made, showing that if driveways are increased, the number of collisions also increases.[48]

According to FHWA, effective access management along a corridor can reduce collisions along an urban arterial road by 25 to 31 percent. Although property owners generally do not like the idea of access management, as they view it will limit customer access to their business, FHWA insists that increased traffic flow and a safer corridor will increase the number of potential customers who pass the property and will provide a better experience for customers. FHWA states that "'before and after' studies of businesses in Florida, Iowa, Minnesota, and Texas along highways where access has been managed found that the vast majority of businesses do as well or better after the access management projects are completed." According to this study, 53 percent of business noticed no change

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[47] "Chapter 8. System-Wide Treatments". *Signalized Intersections: An Informational Guide – Safety*. Federal Highway Administration (FHWA), 2014. https://safety.fhwa.dot.gov/intersection/conventional/signalized/fhwasa13027/ch8.cfm. Accessed November 2019.

[48] *Methods and Practices for Setting Speed Limits: An Information Report*. Federal Highway Administration (FHWA), 2019. https://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12004/. Accessed November 2019.

in sales, while only 5 percent of businesses noticed a decrease in sales.[49]

6.4.4.1 Key Findings

In general, the benefits of access management include:

- Reduced congestion and better overall traffic flow
- Reduced crash potential due to fewer conflict points between vehicles and other vehicles, pedestrians, bicycles and transit
- Added roadway capacity, which could reduce the number of lanes needed
- Increased travel times for all road users

Some issues of implementation include:

- Not acceptable to property owners
- Limited property frontage may require combined/shared access points

6.4.5 Active Traffic Management

Active traffic management (ATM) is the ability to dynamically manage recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions. ATM tools help to maximize the effectiveness and efficiency of the facility and enhance trip reliability. According to FWHA[50], ATM provides for increased throughput and safety through the use of integrated systems with new technology. This includes the automation of dynamic deployment to optimize performance quickly and without the delay that occurs when operators must deploy operational strategies manually.

ATM approaches focus on influencing travel behavior with respect to lane/facility choices and operations. Various ATM strategies can be deployed concurrently to meet systemwide needs of congestion management, traveler information, and safety, resulting in synergistic performance gains. ATM strategies have been widely implemented along freeways and expressways, as well as have their applicability along major roadways, such as State Highways. ATM approaches include dynamic speed limits, queue warning, dynamic routing, adaptive signal control, and transit signal priority.

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[49] *Safety: Corridor Access Management*. Federal Highway Administration (FHWA), 2019. https://safety.fhwa.dot.gov/intersection/other_topics/corridor/. Accessed November 2019.

[50] *Active Traffic Management*. Federal Highway Administration (FHWA), 2019. https://ops.fhwa.dot.gov/atdm/approaches/atm.htm. Accessed November 2019.

The Washington State Department of Transportation conducted a six-year "before and after" review of collision trends within the I-5 Active Traffic Management corridor and found a reduction in collisions of 4.1 percent in the ATM enabled roadway section.[51]

6.4.5.1 Key Findings

In general, the benefits of active traffic management include:

- Maximized efficiency of the facility
- Improved trip reliability
- Increased throughput
- Reduced number of collisions

Some issues of implementation include:

- Cost to implement
- Coordination between agencies
- Potential for secondary effects to parallel roadways

6.4.6 Pedestrian Bridges

Pedestrian bridges have typically been constructed as a result of traffic-engineering outcomes (i.e., removing pedestrians at intersections to increase traffic volumes and speeds), rather than as a result of pedestrian-focused outcomes (i.e., accommodating high pedestrian volumes). Those cases related to the latter are located in major tourism locations such as Las Vegas, theme parks such as Disneyland, or major shopping centers/districts such as Mall of

[51] *Corridor Capacity Report – Smarter Highway Operations*. Washington State Department of Transportation, 2014. https://wsdot.wa.gov/publications/fulltext/graynotebook/ccr14.pdf. Access November 2019.

America; or are provided to cross barriers such as rivers, freeways and railway tracks.

The majority of the research and literature on pedestrian bridges highlight that convenience is a significant factor to the effectiveness of the facility. If the bridge cannot be built in a way that makes it convenient for pedestrians, they will not use it and will put themselves in more dangerous conflict situations. Most pedestrian bridges span a significantly longer distance than the straight path at grade. It should be noted that metrics relating to the volume of pedestrians required to necessitate a pedestrian bridge are not readily available.

Table 6-9 lists recommendations from various resources on pedestrian bridges. In addition, Table 6-10 provides standards used by the agencies sourced.

Table 6-9. Pedestrian Bridge Recommendations

Source	Content
NACTO: Urban Street Design Guide	"Pedestrian crossings should be at grade except in instances where they are crossing limited access highways. Pedestrian overpasses and underpasses pose security risks from crime and are frequently avoided for a more direct (if less safe) crossing."
Transport for London: Streetscape Guidance	"Grade-separated crossings should only be considered in exceptional circumstances where high vehicle speeds and traffic capacity need to be maintained and where there is evidence that road safety risks would not support at-grade facilities. This should be prioritized where designated bicycle routes meet a barrier in the form of a [freeway] or topographic constraint, such as a river, and the route needs to continue."
City of Los Angeles: Complete Streets Design Guide	"Bicycle/pedestrian undercrossings and overcrossings provide critical bicycle path links by separating the path from conflicts with motor vehicles. These structures are designed to provide safe crossings for bicyclists where they previously did not exist."

Source	Content
City of Minneapolis: Design Guidelines for Street and Sidewalks	"Grade separated crossings (above via bridge or beneath via underpass) are often located across freeways, parkways, and rail lines, and often represent the only option to cross a significant barrier. These are more expensive than at-grade crossings due to the cost of the structure and/or excavation. The designer should recognize that they often make pedestrians walk farther, which discourages pedestrians from using them at all. To be well designed and functional, grade-separated crossings should pay special attention to accessibility, user comfort and personal safety, including preserving good sight lines."

Table 6-10. Pedestrian Bridge Standards

Characteristic	Transport for London	City of Los Angeles	City of Minneapolis
Minimum width	Pedestrian only: 2000mm (6.5') Shared use with cyclists: 4000mm (13')	12 feet minimum width 14 feet preferred If overcrossing has any scenic vistas additional width or belvederes should be provided to allow for stopped path users. A separate 5-foot pedestrian area be provided for facilities anticipated to have high bicycle and pedestrian use.	Width of approaching trail plus 2 feet or 12 feet, whichever is greater
Optimum ramp grade	1:20 (5%)	ADA requirements/Caltrans HDM: Ramps should not exceed 5% grade with landings at 400 feet intervals or 8.33% with landings at 30 feet intervals.	Maximum of 5%

Characteristic	Transport for London	City of Los Angeles	City of Minneapolis
Maximum number of steps in a flight	12 steps	-	Stairs should be avoided along paths and trails. When unavoidable, an alternative accessible route shall be provided. Handrails shall be provided along stairways per ADA guidelines.
Vertical clearance	-	Local road: 17 feet Freeway: 18.5 feet Rail line: 23 feet	-
Ramp approaches	-	At least 400 feet of approach at either side	-

6.4.6.1 Key Findings

Documented quantifiable benefits of pedestrian bridges were unavailable. In general, benefits include:

- Improved connectivity between neighborhoods severed by a physical barrier
- Continuity for bicycle and pedestrian routes, particularly bicycle routes where demand or connectivity would increase as a result
- Wide land bridges can provide additional amenity and green infrastructure value.
- Inspired designs act as icons within the community, making it a place in its own right.

Some issues of implementation include:

- Cost to construct and maintain pedestrian bridges
- Need to be designed to provide convenient access to ensure usage (e.g., not situated appropriately on a desire line) and to not require negotiating a large number of steps or ramps

- Required additional space for constructing a landing point and approach ramp
- Potential security risks if not well-lit or has inadequate surveillance
- Potential issues with vandalism and maintenance

6.4.7 Adjust Interchange Ramp Locations and or Configurations

The primary purpose of freeway interchanges is to efficiently carry vehicles to and from freeways and limited-access highways. They can be broadly classified into two functional categories: system interchanges connect two or more freeways and generally provide free-flowing traffic movements; service interchanges connect a freeway to a non-freeway facility such as an arterial and they generally have some form of traffic control (e.g., traffic signal, stop signs, or yield signs). The location, type, and ramp spacing of these service interchanges can affect operations and flow along intersecting arterials. Examples of these effects can include:

- The effect of through-traffic controls on arterial operations
- The effect of on-ramp traffic and potential queues due to metering
- The effects of off-ramp traffic and how vehicles enter or merge onto the arterial

FHWA provides information and design guidance for interchanges through several resources such as the *Model Inventory of Roadway Elements* (2017),[52] *Alternative Intersections/Interchanges: Informational Report* (2010),[53] and *Design Discipline Support Tool*.[54]

Generally, interchange types include the following:

- Diamond Interchange – The most common type of service interchange configuration, a diamond interchange has one-way diagonal ramps in each quadrant. Benefits of this interchange include driver familiarity and the fact that turning movements at the ramps are true to the intended

[52] *Model Inventory of Roadway Elements*. Federal Highway Administration (FHWA), 2017. https://safety.fhwa.dot.gov/rsdp/downloads/fhwasa17048.pdf. Accessed December 2019.

[53] *Alternative Intersections/Interchanges: Informational Report (AIIR)*. Federal Highway Administration (FHWA), 2010. https://www.fhwa.dot.gov/publications/research/safety/09060/09060.pdf. Accessed December 2019.

[54] *Federal Highway Administration Design Discipline Support Tool*. Federal Highway Administration (FHWA), 2019. https://www.fhwa.dot.gov/modiv/programs/intersta/idp.cfm. Accessed December 2019.

change in direction of travel. Diamond interchanges can vary in ramp separation distance and traffic controls.

- Tight Urban Diamond Interchange (TUDI) – A type of compressed diamond interchange, a TUDI consists of two closely spaced signalized intersections at the crossings of the ramp terminals and the arterial. TUDIs require signal coordination so that arterial through-traffic can pass through both ramp intersections with one stop.
- Double Crossover Diamond Interchange (DCD) – Also known as a diverging diamond, a DCD is a more recent interchange design that better accommodates left-turning movements. The highway is connected to the arterial by two on-ramps and two off-ramps; on the arterial, traffic moves to the left side of the roadway between the ramp terminals, so that left-turning vehicles do not conflict with opposing through-traffic.
- Single Point Urban Interchange (SPUI) – Also known as a single-point interchange or single-point diamond interchange, a SPUI consolidates all left-turn movements to and from on- and off-ramps into a single intersection at the center of the interchange. All four left-turning movements are controlled by a single multiphase traffic signal; right-turning movements are often free rights.
- Displaced Left-Turn (DLT) Interchange – Also known as a continuous flow interchange, a DLT interchange includes left-turn crossovers that are present on the cross-street approaches. Left-turning traffic is relocated several hundred feet upstream of the first ramp terminal, crossing over the opposing through lanes, and then travels situated between opposing through lanes and right-turning traffic from the ramps, before making a left turn onto the ramp.
- Full Cloverleaf Interchange – A cloverleaf interchange uses loops to accommodate some movements; a full cloverleaf interchange has loops in all four quadrants. With a full cloverleaf interchange, there are no intersections along the intersecting arterial since all left-turn movements are made via loops.
- Partial Cloverleaf Interchange – Unlike a full cloverleaf interchange, a partial cloverleaf interchange uses one, two, or three loops to handle certain movements (such as heavier left-turn movements). A partial cloverleaf interchange can take multiple forms based on the location and number of loops.

Of these service interchange types, most (except for traditional diamond interchanges) are beneficial for improving arterial throughput and reducing delay, as outlined below:

- Tight Urban Diamond Interchange (TUDI) – With coordination, this interchange type reduces the number of through-traffic stops between the two ramp terminals.
- Double Crossover Diamond Interchange (DCD) – This interchange type can accommodate high left-turn and through movements that may have high delays. It reduces the number of signal phases, allowing movements to proceed concurrently.
- Single Point Urban Interchange (SPUI) – With this type of interchange, arterial traffic would only need to pass through a single intersection, so operations would be improved and delay would be reduced. It can accommodate more vehicles than a traditional diamond interchange.
- Displaced Left-Turn (DLT) Interchange – This intersection type could potentially reduce delays due to the reduced number of phases at the two ramp terminals; however, arterial through vehicles must still pass through two distinct ramp terminal intersections.
- Full Cloverleaf Interchange – Since there are no intersections along the arterial, this interchange type reduces arterial through-traffic delay. All entering and exiting movements are free/uncontrolled.
- Partial Cloverleaf Interchange – While this interchange type still maintains two intersections at the ramp terminals, the reduced number of conflicting movements would result in less arterial through-traffic delay.

While several of these service interchange types are beneficial for arterial delay and flow, not all of them are applicable to an urban environment, primarily due to right-of-way requirements and weaving movements between ramps. Tight urban diamond interchanges, double crossover diamond interchanges, single point urban interchanges, and partial cloverleaf interchanges are beneficial for arterials and are also applicable in an urban environment. Diagrams of these four interchange types are provided below (Exhibits 6-7 to 6-10).

A tight urban diamond interchange is applicable in an urban environment since it has shorter ramp terminal spacing and an overall smaller footprint, requiring less right-of-way.

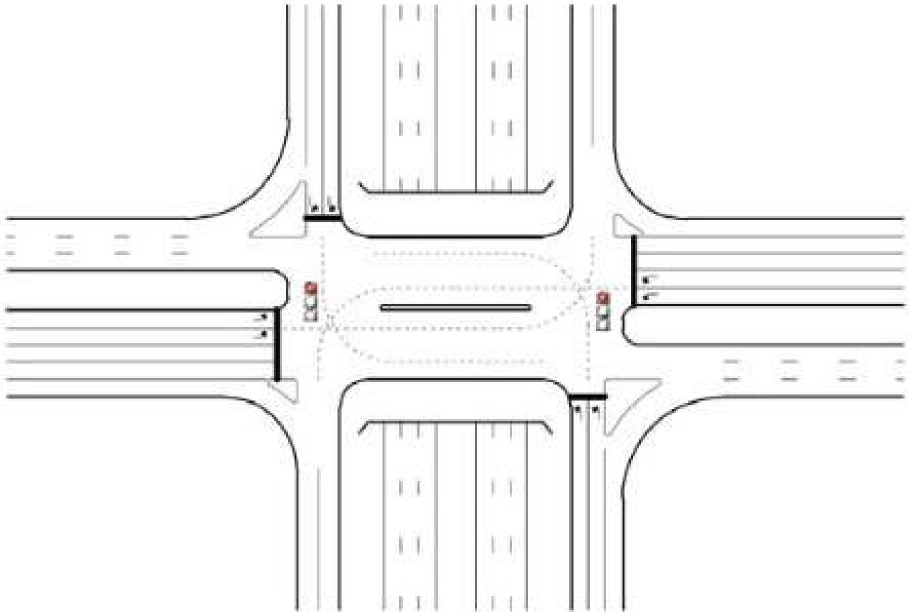

Exhibit 6-7 Tight Urban Diamond Interchange Layout

A double crossover diamond interchange is applicable in an urban environment since it combines lane assignments for left-turn and through movements, thus requiring a narrower bridge.

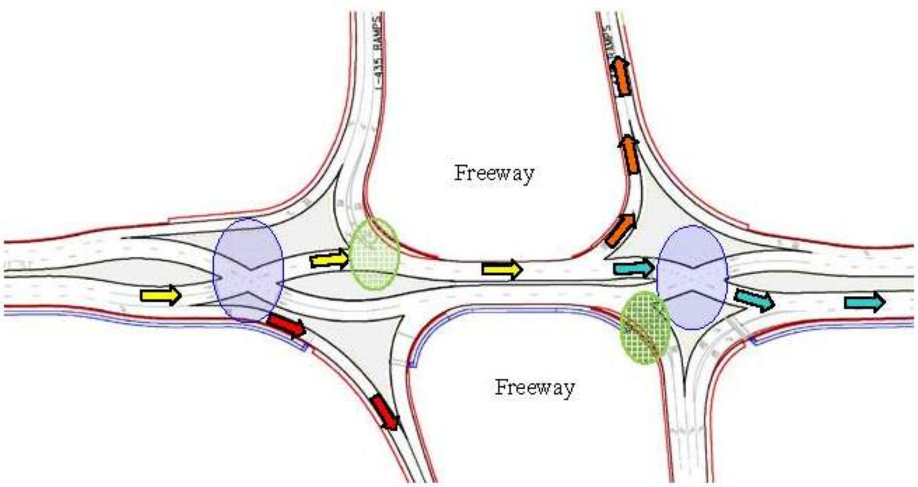

Exhibit 6-8 Double Crossover Diamond Interchange Layout

A single point urban interchange is applicable in an urban environment since it requires less right-of-way.

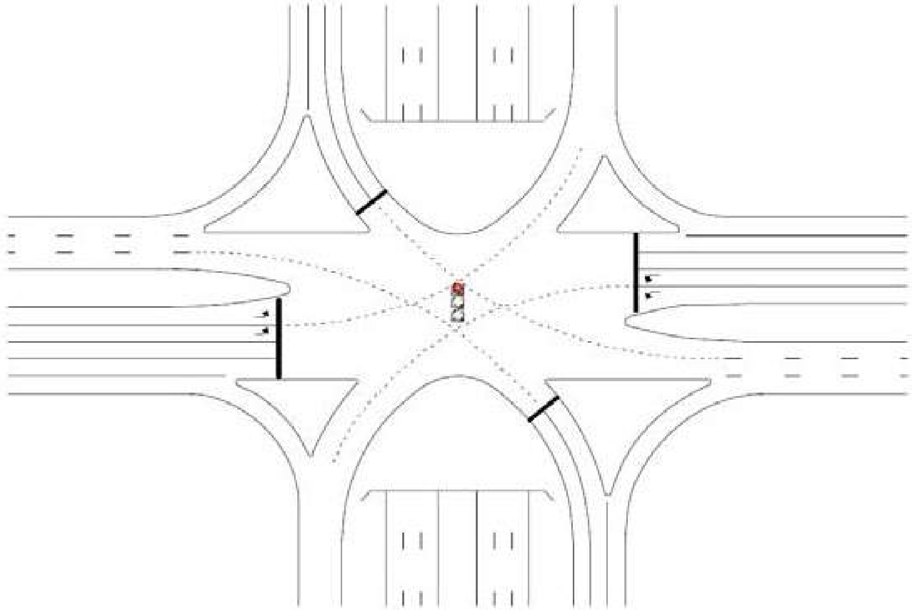

Exhibit 6-9 Single Point Urban Interchange Layout

A partial cloverleaf interchange is applicable in an urban environment since unlike a full cloverleaf interchange, this interchange type can avoid quadrants that have right-of-way restrictions.

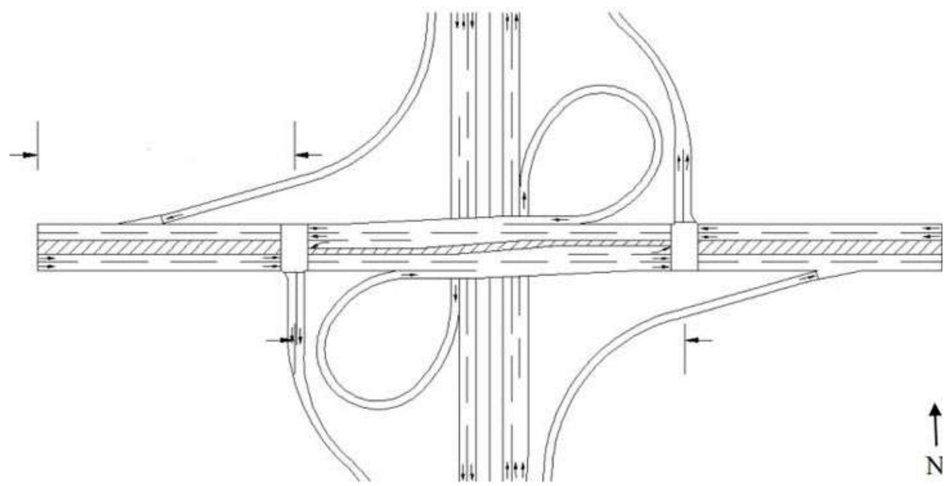

Exhibit 6-10 Partial Cloverleaf Interchange Layout [55]

Freeway mainline, on- and off-ramp, and adjacent arterial volumes typically dictate the design and configuration of an interchange. In addition, availability of right-of-way and the surrounding land uses and local street network need to be considered. At locations along

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[55] Galletebeitia, Borja. Comparative Analysis Between the Diverging Diamond Interchange and Partial Cloverleaf Interchange Using Microsimulation Modeling. Florida Atlantic University, December 2011.http://fau.digital.flvc.org/islandora/object/fau%3A3779. Accessed December 2019.

the Project Corridor, different interchange configurations may improve safety local access and circulation (accounting for pedestrian volumes, presence of nearby intersections, and land use patterns).

6.4.7.1 Key Findings

In general, the benefits of reconfiguring interchanges and relocating ramps include:

- Improved arterial delay and flow
- Improved safety due to reduced number of conflict points for vehicles entering and exiting the freeway
- Lower right-of-way requirements

Some issues of implementation include:

- The cost to reconfigure interchanges
- Potential higher right-of-way requirements
- Some configurations require more complicated signalization that would need to be maintained.
- Driver unfamiliarity with newer or non-traditional interchange designs

6.4.8 Alternative Intersection Configurations

While the number of lanes along a corridor and its functional classification (including the presence of a median) affect its overall capacity and flow, a roadway is also affected by the spacing and type of intersections along the corridor. Intersection capacities and operations generally determine the overall roadway capacities along a corridor. This can largely be the result of delays due to turning and cross traffic as well as queues and backups at intersections due to capacity and/or signal timing.

Traditionally, improving capacity at intersections has involved widenings and lane additions. However, alternative intersection types offer the potential to reduce delay (with other benefits, such as improved safety) at a lower cost and with fewer impacts than traditional intersection solutions. FHWA provides information and design guidance for intersections through several alternative intersection design resources as well as the *Alternative Intersections/Interchanges: Informational Report* (2010).[56]

Generally, alternative intersection types include the following types:

- Roundabout[57] – A roundabout is a type of intersection where turning movements are separated by a physical central island, and traffic moves along the travel lanes surrounding the central island and exits the roundabout by turning right at the appropriate leg. Traffic does not stop but must yield if needed when entering the roundabout. There is the potential for multiple lanes around the roundabout and channelized right turns.
- Displaced Left-Turn (DLT) Intersection[58] – Also known as a continuous flow intersection, a DLT intersection has left-turning vehicles cross to the other side of opposing through traffic before turning. Left turns and opposing through traffic move at the same time.
- Median U-Turn (MUT) Intersection[59] – At an MUT intersection, left-turning vehicles make U-turns at dedicated median openings downstream of the intersection before making a right turn. Through and right-turning vehicles are unaffected.
- Restricted Crossing U-Turn (RCUT) Intersection[60] – At an RCUT intersection, all side-street movements begin with a right turn.

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[56] *Alternative Intersections/Interchanges: Informational Report (AIIR)*. Federal Highway Administration (FHWA), 2010. https://www.fhwa.dot.gov/publications/research/safety/09060/09060.pdf. Accessed December 2019.

[57] *Roundabouts: An Informational Guide*. Federal Highway Administration (FHWA), 2000. https://www.fhwa.dot.gov/publications/research/safety/00067/00067.pdf. Accessed December 2019.

[58] *Displaced Let Turn Intersection Informational Guide*. Federal Highway Administration (FHWA), 2014. https://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14068_dlt_infoguide.pdf. Accessed December 2019.

[59] *Median U-Turn Intersection Informational Guide*. Federal Highway Administration (FHWA), 2014. https://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14069_mut_infoguide.pdf. Accessed December 2019.

[60] *Restricted Crossing U-Turn Intersection Informational Guide*. Federal Highway Administration (FHWA), 2014. https://safety.fhwa.dot.gov/intersection/alter_design/pdf/fhwasa14070_rcut_infoguide.pdf. Accessed December 2019.

These vehicles then use dedicated U-turns at downstream median openings for all through movements and left turns.

- Quadrant Roadway (QR) Intersection – At a QR intersection, all four left-turn movements at a conventional four-legged intersection are rerouted using a connector roadway in one quadrant. Left turns from all approaches are prohibited at the main intersection.
- Jughandle Intersection – At a jughandle intersection, an at-grade ramp is provided at or between intersections to permit vehicles to make indirect left turns and/or U-turns.
- Hamburger or Through-About Intersection – This intersection type is a variant of a signalized roundabout. The primary arterial through movements continue through the intersection, but all other movements follow a circulatory movement around islands at the main intersection.
- Synchronized Split-Phasing Intersection – Also known as a double crossover intersection, the through and left-turn movements along an arterial cross over before the intersection. At the intersection, through traffic and opposing lefts can move concurrently.
- Offset T-Intersection – At an offset T-intersection, the minor street approaches are offset by a distance. This lateral separation causes through movements along the minor street to be diverted to a right-turn movement followed by a left-turn movement.
- Continuous Green T-Intersection – This is a type of T-intersection in which the left-turn movement from the minor street is channelized to the main arterial through movement can continue uninterrupted, without stopping for the conflicting left turns.
- Parallel Flow Intersection – This is a variant of the DLT intersection in which left-turning traffic crossings over opposing through lanes and travels on a bypass lane before merging onto the intersecting road.

Of these different types of alternative intersection configurations, four are most typical for urban at-grade intersections: roundabout, displaced left-turn (DLT) intersection, median U-turn (MUT) intersection, and restricted crossing U-turn (RCUT) intersection. The features and benefits of these four alternative intersection configurations, along with diagrams (Exhibit's 6-11 to 6-14), are provided below.

At a roundabout, traffic entering the circle does not need to stop, but must yield, if needed, when entering the roundabout if conflicting traffic is present. Often, a complete stop is not necessary when deceleration is sufficient to avoid a conflict. Thus, roundabouts typically have lower delays than other intersection types. Even when there are queues, these tend to be moving queues. In addition, roundabouts tend to perform better during off-peak periods than other intersection types. Roundabouts tend to be more appropriate for the intersection of two arterial streets, as opposed to an intersection of an arterial and a collector or local street; this is because at a roundabout, all intersection movements have equal priority. In an urban area, a roundabout may require less right-of-way than a standard intersection, since less queuing space is required at the intersection approaches. In addition, roundabouts eliminate the costs associated with installation and maintenance of traffic signals.

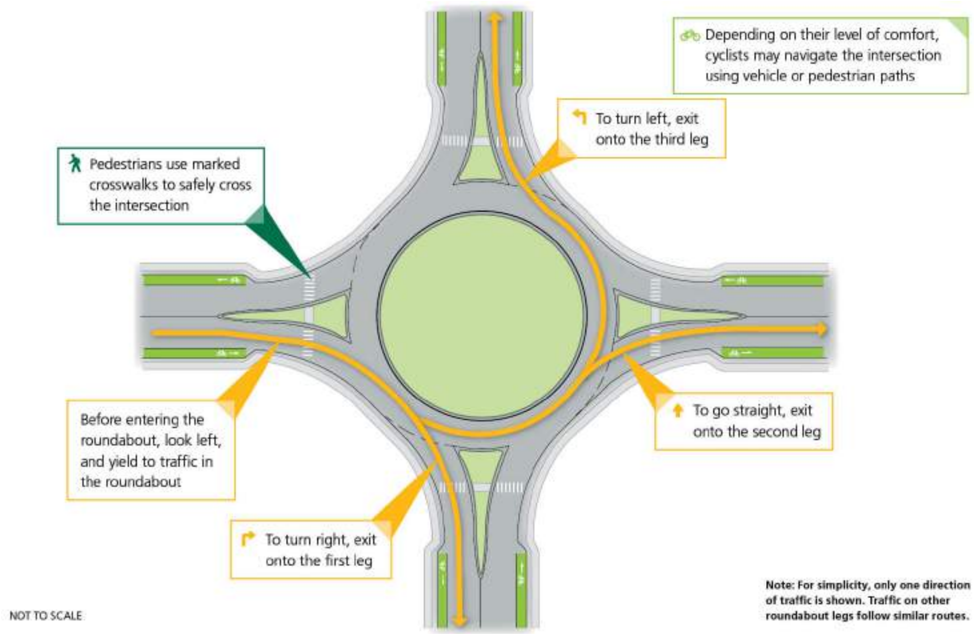


Exhibit 6-11 Roundabout Intersection Layout

A displaced left-turn (DLT) intersection, by moving left-turning vehicles to the other side of opposing through traffic before turning, reduces the number of conflict points at the intersection. By operating with fewer signal phases, this type of intersection can increase an intersection's lane-by-lane capacity. A DLT intersection can improve operations along a major arterial corridor since increased signal green time for major movements can offer better arterial traffic progression. A DLT is also compatible with high-volume turning movements which may be present at the intersection of two arterials. While a DLT intersection may require more right-of-way than a conventional intersection, it requires less right-of-way at the intersection approaches compared to some other alternative intersection configurations.

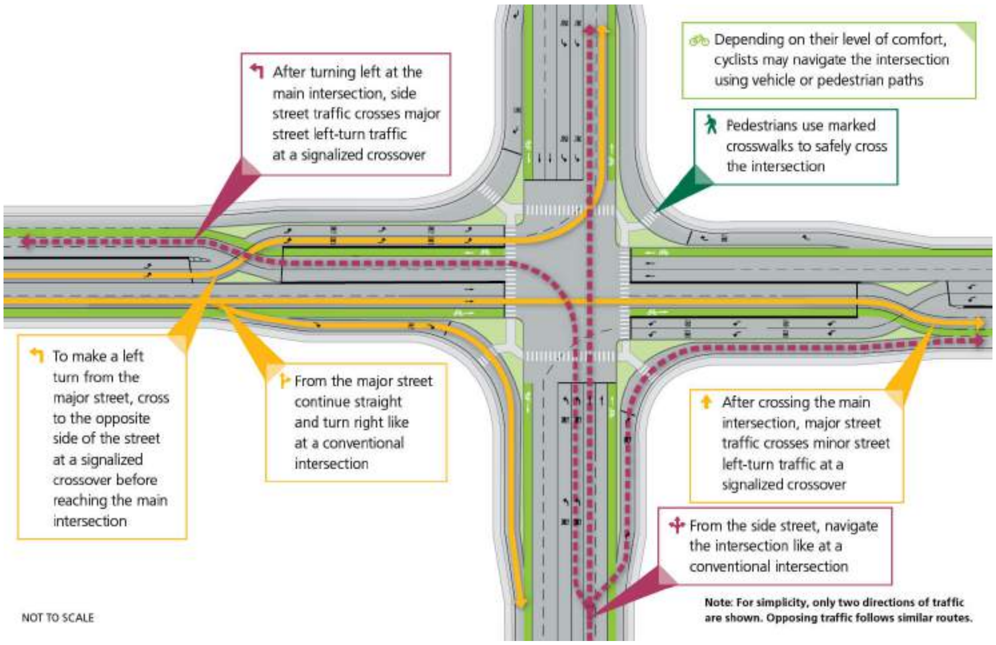


Exhibit 6-12 Displaced Left-Turn Intersection Layout

A median U-turn (MUT) intersection, eliminates left turns at the intersection, thus reducing the number of traffic signal phases and conflict points at the main crossing intersection and resulting in improved operations and safety. Overall, delay on the main intersecting arterial is lower than a conventional intersection since through movements are less likely to stop. However, delay may be higher for left-turning vehicles. In comparison to conventional intersections and other alternative intersection configurations, an MUT intersection requires substantially more right-of-way along the intersection approaches and the arterial street, which is typically infeasible or extremely costly in urban or suburban areas.

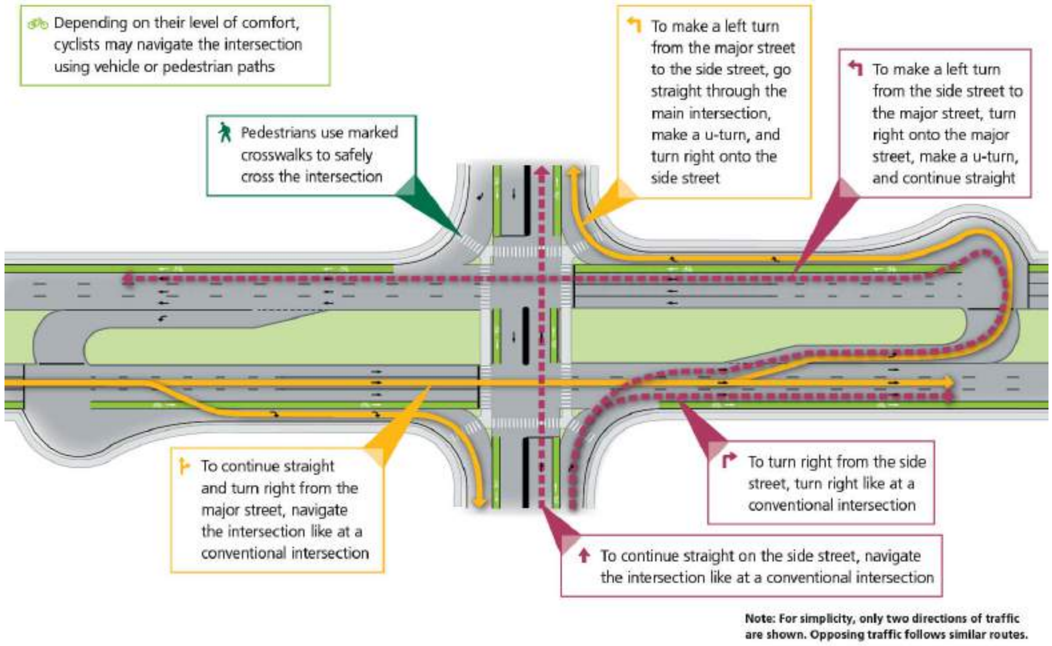


Exhibit 6-13 Median U-Turn Intersection Layout

At a restricted crossing U-turn (RCUT) intersection, all side-street movements at the intersection become a right turn, with those vehicles then using dedicated U-turns at downstream median openings for all through movements and left turns. This improves progression along the main arterial and reduces overall travel time at the intersection, especially for arterial through traffic. However, this intersection type is not typically suitable for an intersection of two arterials. In addition, significant right-of-way is required along the arterial leading to and from the intersection, including for the medians.

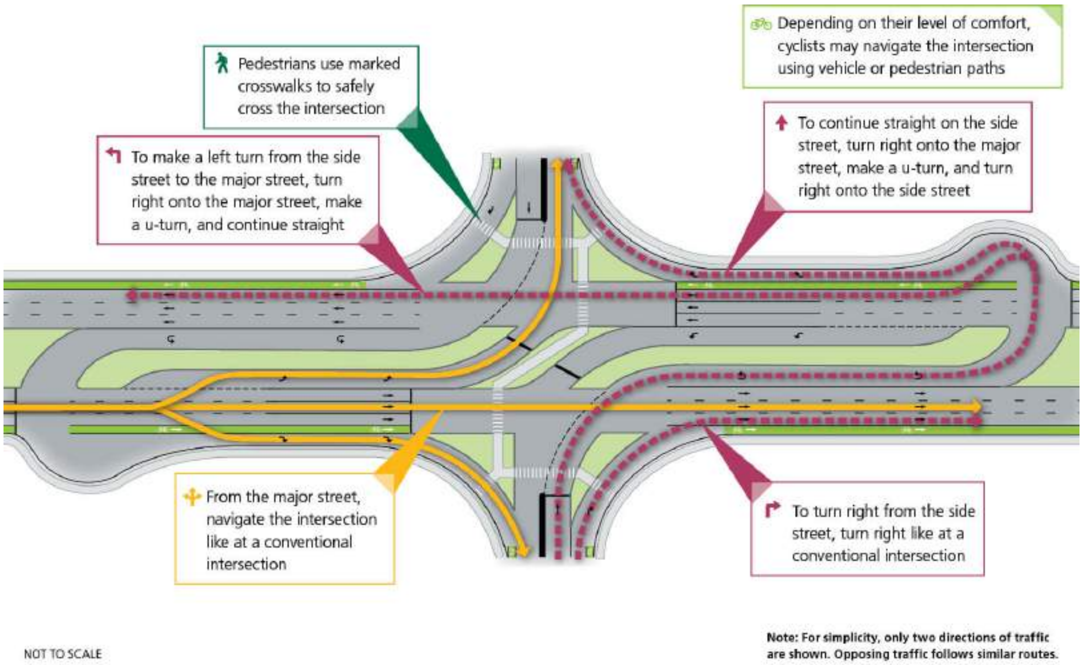


Exhibit 6-14 Restricted Crossing U-Turn Intersection Layout

While the four alternative intersection configurations outlined above offer improved operations and traffic flow along arterials, the MUT intersection and RCUT intersection are generally not applicable to an urban setting. However, the DLT intersection and roundabout can be appropriate in an urban setting such the Project Corridor. This is due to their appropriateness for arterial intersections with high volumes as well as lower right-of-way needs at the intersection approaches and along the arterial. Locations along the Project Corridor that may be suitable for a DLT intersection or a roundabout are shown in Figure 6-3. DLT intersections could be considered along eight-lane segments, and roundabouts could be considered along six-lane segments due geometric requirements, turning movement volumes, and right-of-way availability.

6.4.8.1 Key Findings

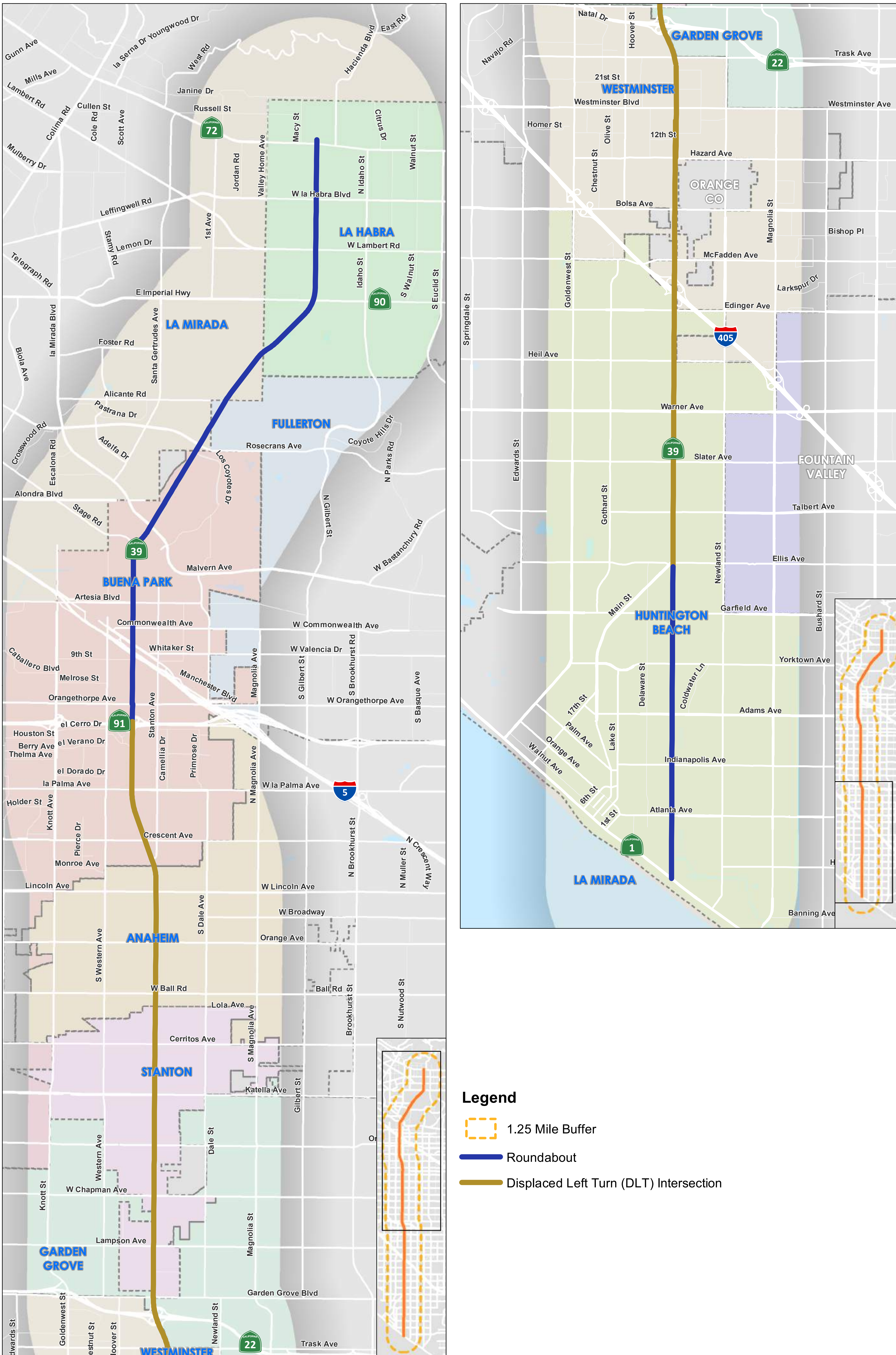
In general, the benefits of DLT intersections and roundabouts include:

- Improved delay and flow for arterial traffic through the intersection
- Increased lane capacity and compatibility with high-volume turning movements compared to conventional intersections
- Lower right-of-way requirements at intersection approaches for roundabouts compared to conventional intersections

- Reduced number of conflict points between turning and through movements at the intersection

Some issues of implementation include:

- Higher right-of-way requirements at the intersection compared to conventional intersections
- The cost to reconfigure the intersection and arterial approaches
- Driver unfamiliarity with intersections that deviate from conventional designs



Alternative Intersection Configuration Locations
Beach Boulevard Corridor Study

Figure
6-3

OCTA

Coordinate System: NAD 1983 StatePlane California VI FIPS 0406 Feet
Data Source: Delete if there isn't one.

Section 7
TOOLBOX

The purpose of this section is to present the reference sheets for each toolbox element. The information contained in this section is intended to serve as a tool for agencies to help determine the types of improvements available for the Project Corridor.

Each reference sheet includes the following 11 items and a legend sheet is also provided for reference:

- The name of the toolbox element.
- An icon that notes whether the toolbox element would be a local/city-specific project or one that would need to be studied and implemented across multiple cities or along the entire corridor as a regional project.
- An icon that notes which mode of travel the toolbox element applies to.
- Photos or diagrams showing applications of the toolbox element.
- A section describing the toolbox element and the potential strategies and benefits of applying the toolbox element.
- The study analyzed potential corridor segmentation options, resulting in a recommendation of six corridor segments based on physical roadway characteristics. They are as follows:

  1 - Pacific Coast Highway to Yorktown Avenue

  2 - Yorktown avenue to McFadden Avenue

  3 - McFadden Avenue to La Palma Avenue

  4 - La Palma Avenue to Malvern Avenue

  5 - Malvern Avenue to Imperial Highway

  6 - Imperial Highway to Whittier Boulevard

  A location key map is provided showing which of the six segments the toolbox element could be applied in. See Appendix for a detailed map of corridor segmentation.

- A section outlining how the toolbox element addresses each of the Project goals. Many of the toolbox elements may affect multiple modes of travel and thus support several Project goals. As such, the primary and secondary benefits and impacts have been identified for each element. Goals that are primarily by the element either positively (red) or negatively (green) would have two highlighted bars and secondary effects would be shown with a single bar highlighted. Should the goals not be affected by the element, the bars would show in grey.

- A design considerations section that documents plans and guidelines and implementation issues to consider for the toolbox element.
- An applications section which documents where each toolbox element could be applied. This section distinguishes either specific or typical applications of the toolbox element. Specific applications are provided for elements with identified locations, whereas typical applications are provided for elements that can be applied at locations throughout the corridor.
- A cost range section which provides a visual representation of the cost ranges for each toolbox element. Detailed cost estimates were developed per mile or per location for each element in order to determine the cost range.
- A coordination needed section which provides a visual representation coordination needed to implement each toolbox element. The coordination types are broken down to coordination with utility provider (U), adjacent private property owners should right-of-way be needed (P), OCTA transit for all transit related improvements (O), and adjacent businesses for those elements that may affect access and operations of businesses along the corridor (B).

A summary figure of the components of each element is provided below for reference.

The toolbox elements are organized in the same order as the refined list of elements in Section 5 and 6. The sheets are grouped by mode as follows:

- Transit – reference sheets 1-5
- Pedestrians – reference sheets 6-16
- Bicycles – reference sheets 17-20
- Vehicles – reference sheets 21-28

This icon notes whether the toolbox element would be a local/city-specific project or one that would need to be studied and implemented across multiple cities or along the entire corridor as a regional project.

This icon notes which mode of travel the toolbox element applies to.

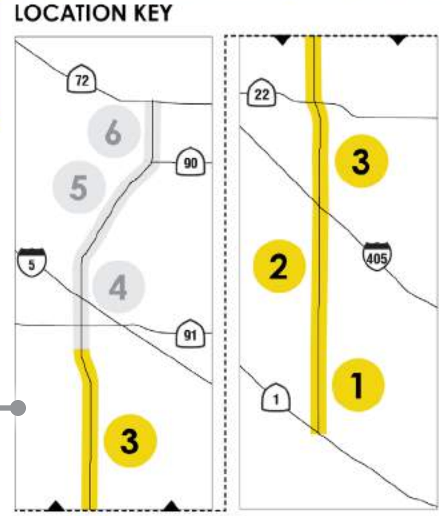
LOCAL PROJECT | Pedestrians

NAME OF TOOLBOX ELEMENT

Photos or diagrams showing applications of toolbox elements.

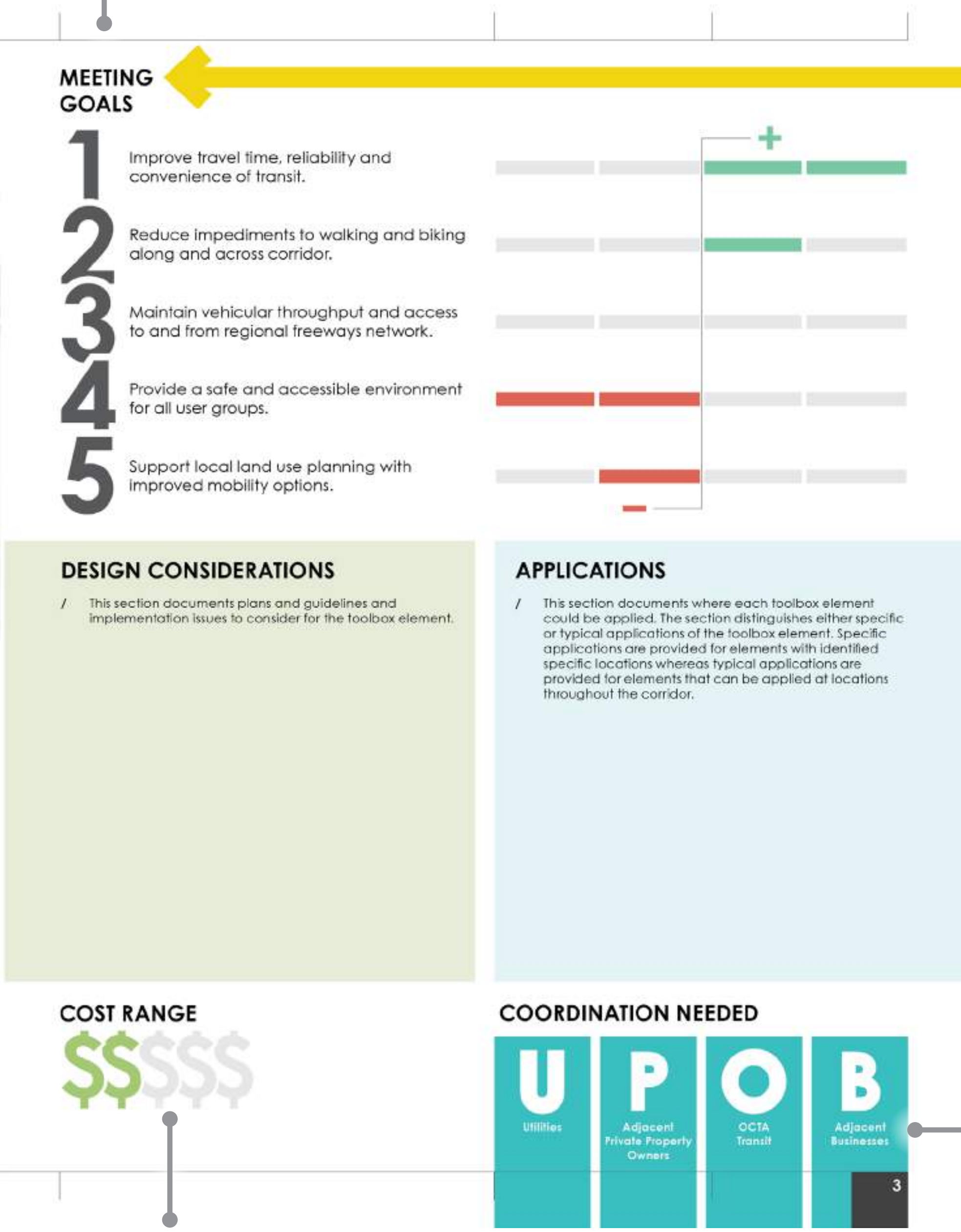
This section provides a description of the toolbox element and potential strategies and benefits of applying the toolbox element.

LOCATION KEY



The Project Corridor was segmented into six segments. This map outlines which segments the toolbox element could be applied to.

This section outlines how the toolbox element addresses each of the Project goals. Many of the toolbox elements may affect multiple modes of travel and thus support several Project goals. As such, the primary and secondary benefits and impacts have been identified for each element. Goals that are primarily by the element either positively (red) or negatively (green) would have two highlighted bars and secondary affects would be shown with a single bar highlighted. Should the goal not be affected by the element, the bars would show in grey.



This section provides a visual representation coordination needed to implement each toolbox element. The icons are as follows:

U = The toolbox element may affect utilities and would require coordination with the various utility providers

P = The toolbox element may require additional right-of-way and would require coordination with adjacent private property owners

O = The toolbox element would affect transit and would require coordination with OCTA transit

B = The toolbox element may affect access and operations of business along the corridor and would require coordination with adjacent businesses

This section provides a visual representation of the cost ranges for each toolbox element. Detailed cost estimates were developed per mile or per location for each element. The cost ranges are presented as follows:

$ - Low Cost ($0 to $500,000)

$$ - Low-Medium Cost ($500,001 to $1,000,000)

$$$ - Medium Cost ($1,000,001 to $2,000,000)

$$$$ - Medium-High Cost ($2,000,001 to $5,000,000)

$$$$$ - High Cost (>$5,000,001)

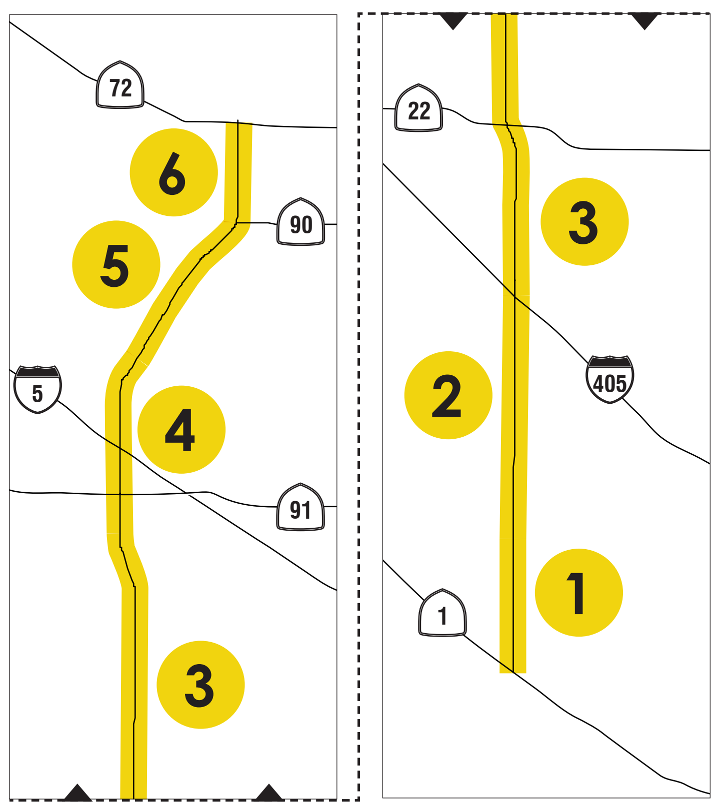
TOOLBOX ELEMENTS SUMMARY TABLE

MODE OF TRAVEL	TOOLBOX ELEMENT	LOCAL/REGIONAL PROJECT	AFFECTED SEGMENTS	PROJECT GOALS: TRANSIT	PROJECT GOALS: ACTIVE TRANSPORTATION	PROJECT GOALS: VEHICULAR TRAFEL	PROJECT GOALS: SAFETY	PROJECT GOALS: NEIGHBORHOOD CONNECTIVITY	COST RANGE	COORDINATION NEEDED
TRANSIT	Bus stops and stations amenities	L	123456	▲	△	--	△	△	$	UPOB
TRANSIT	First/last mile improvements at major stops	L	234	▲	△	--	△	△	$	UPOB
TRANSIT	Transit signal priority treatments	R	234	▲	△	--	△	△	$$$	UPOB
TRANSIT	Transit preferential treatments	R	234	▲	△	--	△	△	$$$$	UPOB
TRANSIT	Dedicated transit lanes (for BRT)	R	234	▲	△	--	△	△	$$	UPOB
PEDESTRIAN	Close gaps in sidewalk network	L	1356	--	▲	--	△	△	$$	UPB
PEDESTRIAN	High-visibility crosswalks	L	123456	--	△	--	▲	--	$	-
PEDESTRIAN	Realigned crosswalks at freeway ramps	R	234	--	△	▽	▲	--	$	U
PEDESTRIAN	Pedestrian countdown signal heads	L	123456	--	△	--	▲	--	$$	-
PEDESTRIAN	Sidewalk amenities	L	123456	--	△	--	▲	--	$	UPB
PEDESTRIAN	Remove sidewalk obstructions	L	23456	--	▲	--	△	△	$	UPO
PEDESTRIAN	Pedestrian scrambles	L	12456	--	▲	--	△	△	$	-
PEDESTRIAN	Pedestrian refuge islands	L	12456	--	△	△	▲	△	$$$	UP
PEDESTRIAN	Corner/sidewalk bulbs	L	123456	▲	△	--	△	△	$$	UPOB
PEDESTRIAN	Mid-block signalized pedestrian crossings	L	123456	▲	△	--	△	△	$$	U
PEDESTRIAN	On-street parking or loading zones	R	123456	▽	--	▽	△	▲	$	UB
BICYCLE	Bike on sidewalk treatments	L	123456	--	▲	--	▼	△	$	UPB
BICYCLE	Close gaps in bicycle network (on parallel streets)	L	123456	--	▲	--	▼	△	$	UPB
BICYCLE	Bicycle preferential treatments	L	123456	▽	△	△	▲	△	$	UP
BICYCLE	Protected bike lanes (on Beach Boulevard)	R	123456		△	△	▲	△	$$$	OB
VEHICLES	On-street parking or loading zones removal	L	1456	△	△	△	▽	▽	$	B
VEHICLES	Advanced traffic signal timing/ITS	R	123456	▲	△	--	△	△	$$$$	U
VEHICLES	Consolidate mid-block unsignalized intersections	L	123456	△	--	▲	△	--	$$	UPB
VEHICLES	Access management	L	123456	▲	△	▲	△	--	$	PB
VEHICLES	Active traffic management	R	123456	△	△	--	△	△	$$$$	U
VEHICLES	Pedestrian bridges	L	1234	△	△	▲	△	△	$$$	UPB
VEHICLES	Adjust interchange ramp locations/ configurations	R	234	--	△	▽	▲	--	$$$	UPB
VEHICLES	Alternative intevrsection configurations	R	123456	▽	▽	▲	△	--	$$$$$	UPB

BUS STOP AND STATION AMENITIES

In addition to providing bus rapid transit service, bus stop and station amenities can increase transit ridership and provide a safer and more comfortable transit user experience. Different types of amenities that can improve ridership can include a unique or attractively design shelter, illumination, and climate or temperature control. General passenger amenities include seating, trash containers, bus arrival information, wayfinding, shade, and automated passenger information systems.

LOCATION KEY



MEETING GOALS

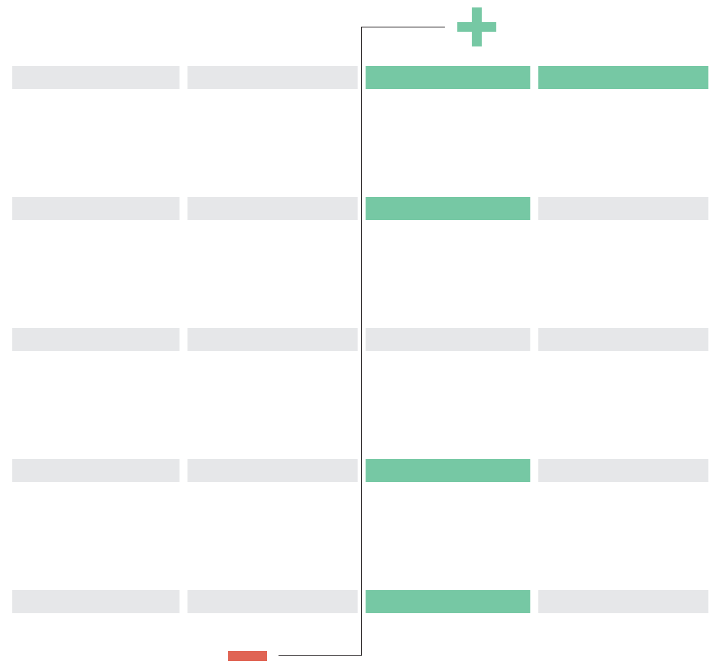
1 Improve travel time, reliability and convenience of transit.

2 Reduce impediments to walking and biking along and across corridor.

3 Maintain vehicular throughput and access to and from regional freeways network.

4 Provide a safe and accessible environment for all user groups.

5 Support local land use planning with improved mobility options.



DESIGN CONSIDERATIONS

/ Consistency with OCTA and Federal Transit Administration (FTA) bus stop and station design standards

/ Consistency with ADA design guidelines

/ Cost to implement amenities throughout the corridor

/ Potential right-of-way and physical constraints around a stop or station

/ Need for regular maintenance of some amenity types

/ May need to have electricity provided

TYPICAL APPLICATIONS

/ Locations with bus rapid transit or other improved local transit service

/ Areas with high transit ridership or the potential for significant demand that can benefit from stop or station amenities

/ Stop and station locations with perceived transit user discomfort

COST RANGE

$$$$$

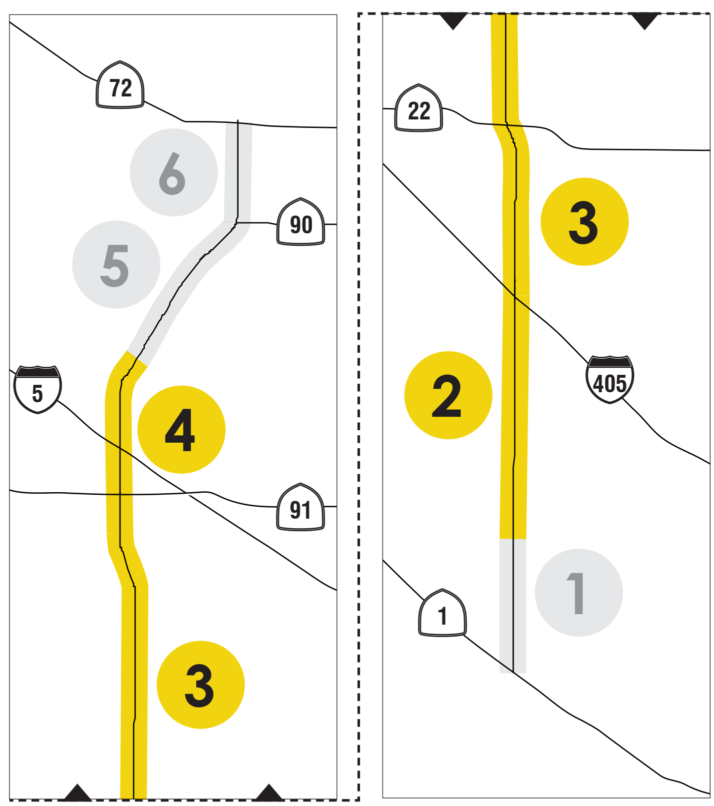
COORDINATION NEEDED

U	P	O	B
Utilities	Adjacent Private Property Owners	OCTA Transit	Adjacent Businesses

FIRST-LAST MILE IMPROVEMENTS AT MAJOR STOPS

The first and last mile of a transit user's trip is the portion of the trip to and from the transit stop or station that they must complete on their own. Strategies that can improve the first and last mile experience can include improvements that are oriented towards bicyclists, pedestrians, and rideshare/vanpool users. Improvements can increase ridership, provide a better active transportation network for those connecting to transit or not, can encourage carpooling, and help improve safety and local connectivity.

LOCATION KEY



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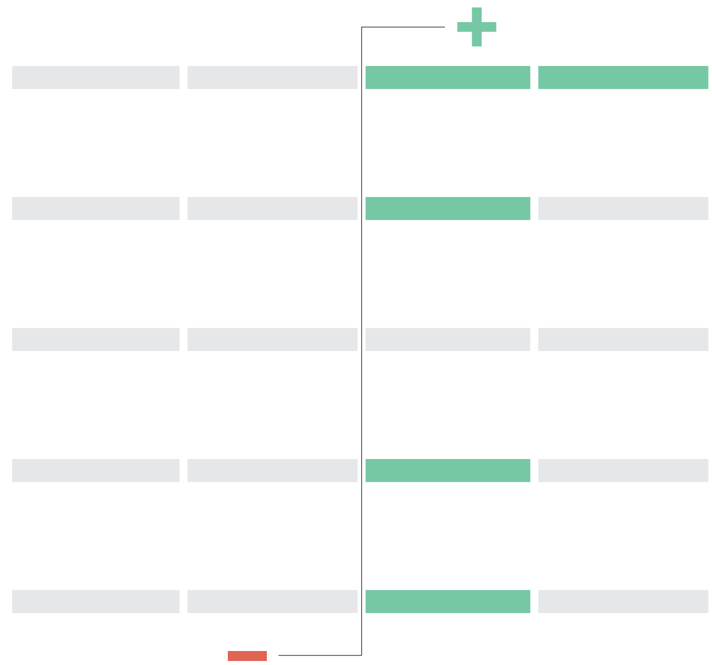


DESIGN CONSIDERATIONS

/ Consistency with Caltrans, OCTA, and local jurisdiction active transportation plans

/ Consistency with ADA design guidelines

/ Cost to design, implement and maintain improvements

/ Potential need to acquire right-of-way or physical constraints at stations and areas leading to stations that would undergo first-last mile treatments

/ Coordination of designs and amenities across jurisdictional lines to maintain connectivity

TYPICAL APPLICATIONS

/ Locations with major transit service and barriers to walking, biking, or taking rideshare to stops

/ Areas with high transit ridership but low levels of walking or biking to stops and stations

/ Stops near major destinations or nearby transfer locations

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

P Adjacent Private Property Owners

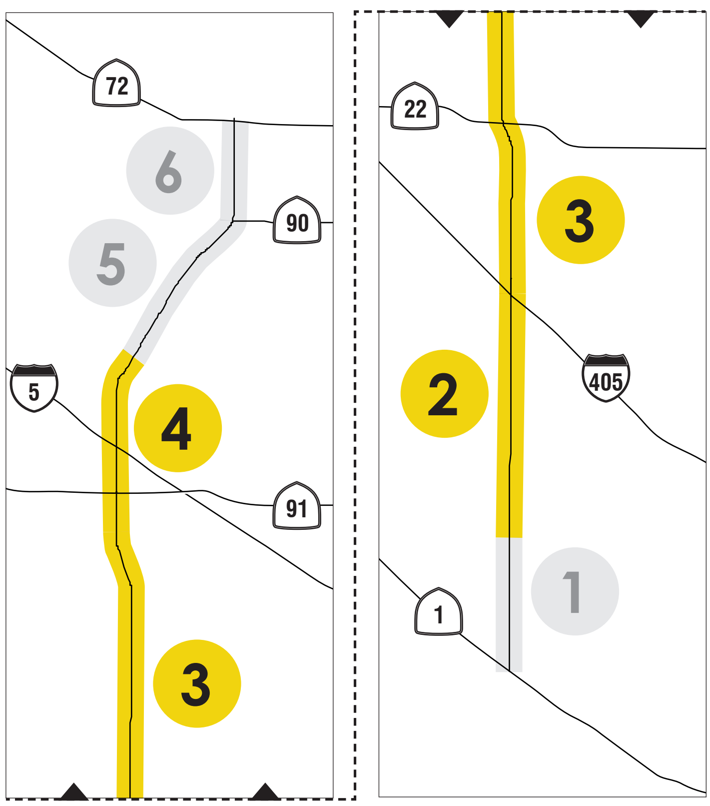
O OCTA Transit

B Adjacent Businesses

TRANSIT SIGNAL PRIORITY

Transit Signal Priority (TSP) systems give transit vehicles priority over other vehicles at signalized intersections. Typical TSP strategies extend traffic signal green time, or turn the traffic signal green earlier than scheduled, to provide priority passage through the intersection to transit vehicle. TSP systems can improve schedule reliability and on-time performance, reduce fuel usage, and can provide a smoother ride which increases ridership and transit vehicle and passenger throughput.

LOCATION KEY



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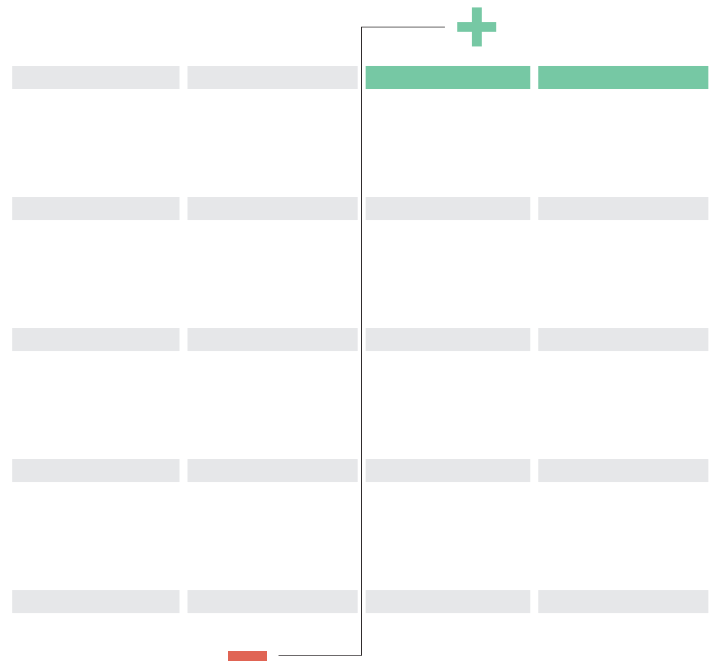


DESIGN CONSIDERATIONS

/ Coordination of implementation across jurisdictional lines

/ Travel time for other non-transit vehicles may increase due to preferential treatments for transit

/ Depending on the TSP type, there may be cost to the transit operators to purchase, install and maintain communication systems

TYPICAL APPLICATIONS

/ Along high transit ridership corridors with congestion

/ Where transit schedule is unreliable because of signal related delays

/ Where transit vehicles experience a high frequency of signal related stops

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

P Adjacent Private Property Owners

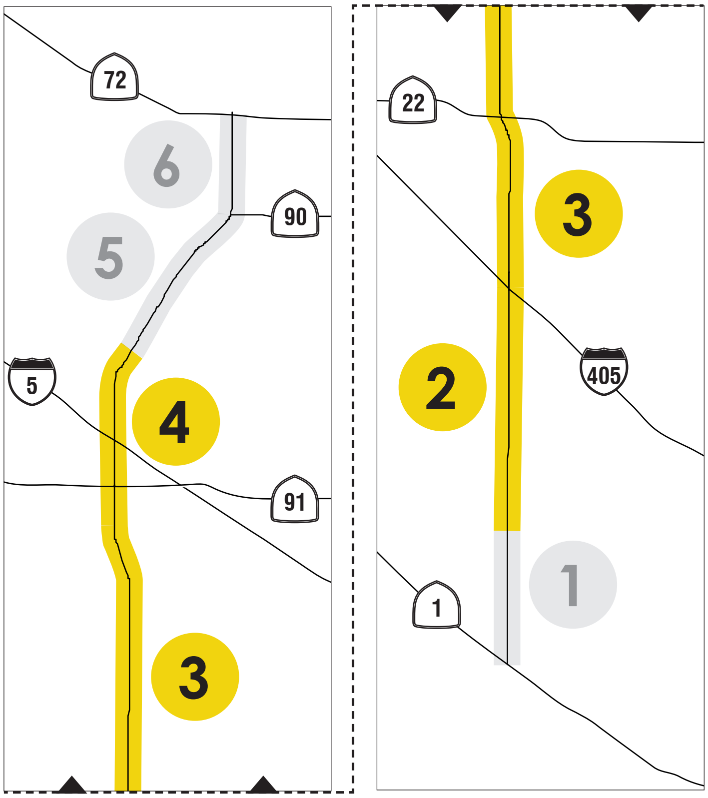
O OCTA Transit

B Adjacent Businesses

TRANSIT PREFERENTIAL TREATMENT

Successful transit must be reliable and efficient and removing sources of delay have proven to be more effective than increasing transit vehicle travel speeds. Reducing sources of transit delay shortens trip times and reduces the time and cost expenditures for each transit vehicle, allowing for shorter headways and more frequent service using the same number of vehicles. The design strategies include stop design factors, stop configurations, station and stop elements, transit lanes, and intersection and signal operations and design. Far-side in-lane stops provide the highest level of priority for transit operations.

LOCATION KEY



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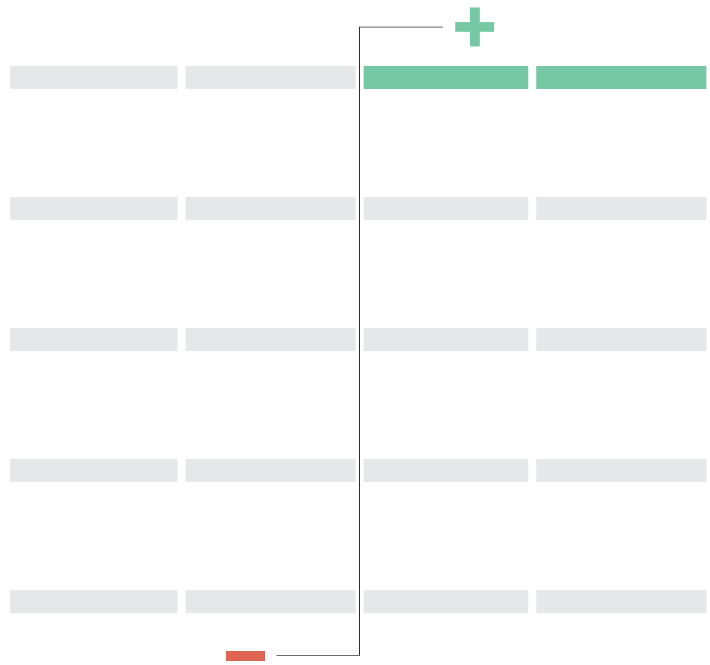


DESIGN CONSIDERATIONS

/ Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines

/ Effect on access and right-of-way of adjacent businesses

/ Cost to implement significant infrastructure improvements

/ Travel time for other non-transit vehicles may increase due to preferential treatments for transit

TYPICAL APPLICATIONS

/ Along high transit ridership corridors

/ Where transit schedule is unreliable due to roadway congestion

/ Where transit vehicles experience delays due to intersection operations

COST RANGE

$$$$$

COORDINATION NEEDED

U — Utilities

P — Adjacent Private Property Owners

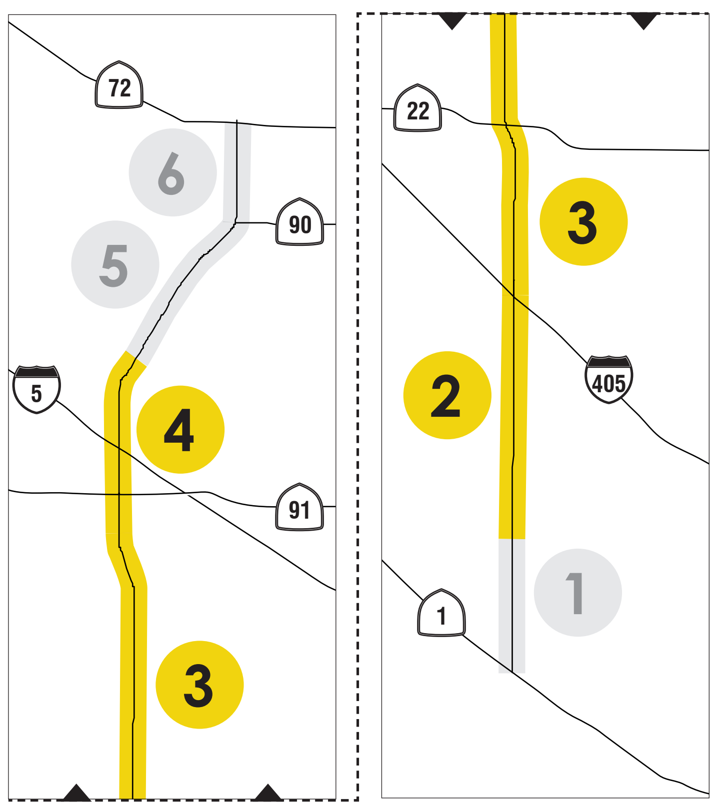
O — OCTA Transit

B — Adjacent Businesses

DEDICATED TRANSIT LANES (FOR BRT)

In addition to features of BRT service such as improved stations, vehicles, and service, an exclusive running way (dedicated transit lane) is effective in increasing ridership along a transit line. This is due to its improving on transit speed, reliability, identity/image, safety/security (of vehicles), and capacity. Dedicated transit lanes can be effective when combined with other BRT strategies such as off-board fare payment, all-door boarding, transit signal priority, queue jumps, and improved bus shelters.

LOCATION KEY



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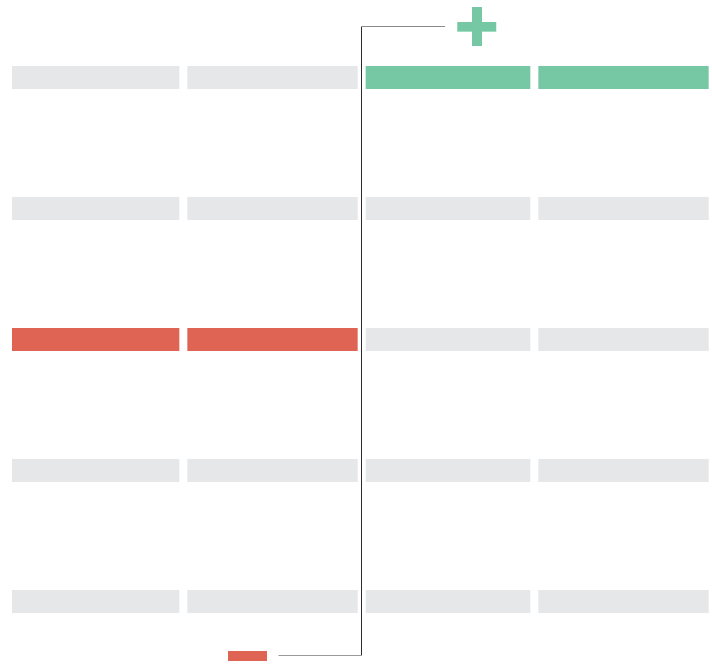


DESIGN CONSIDERATIONS

- / Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines
- / Potential need for additional right-of-way
- / Potential increase in delay and congestion for passenger vehicles with lane reduction
- / Modification of corridor signal timing and coordination to incorporate bus-only lanes
- / Coordination across jurisdictional lines
- / Driveway and access conflicts for businesses and other properties along the bus lane

TYPICAL APPLICATIONS

- / Along high transit ridership corridors with congestion
- / Corridors with bus rapid transit service

COST RANGE

$$$$$

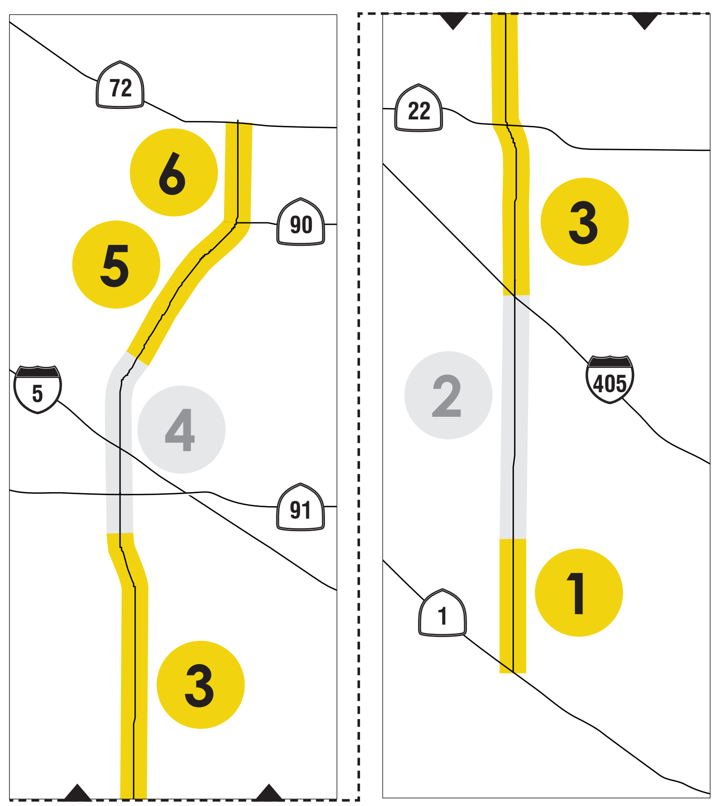
COORDINATION NEEDED

U	P	O	B
Utilities	Adjacent Private Property Owners	OCTA Transit	Adjacent Businesses

CLOSE GAPS IN SIDEWALK NETWORK

The presence of sidewalks is a basic element of pedestrian mobility. Gaps in the pedestrian network can result in pedestrians needing to walk in the street or crossing in unsafe locations to access sidewalk facilities. In general, completing a sidewalk network can increase active travel and reduce automobile travel as well reduce roadside collisions. Providing a completed network would also be consistent with regional and local policies and address ADA access concerns.

LOCATION KEY



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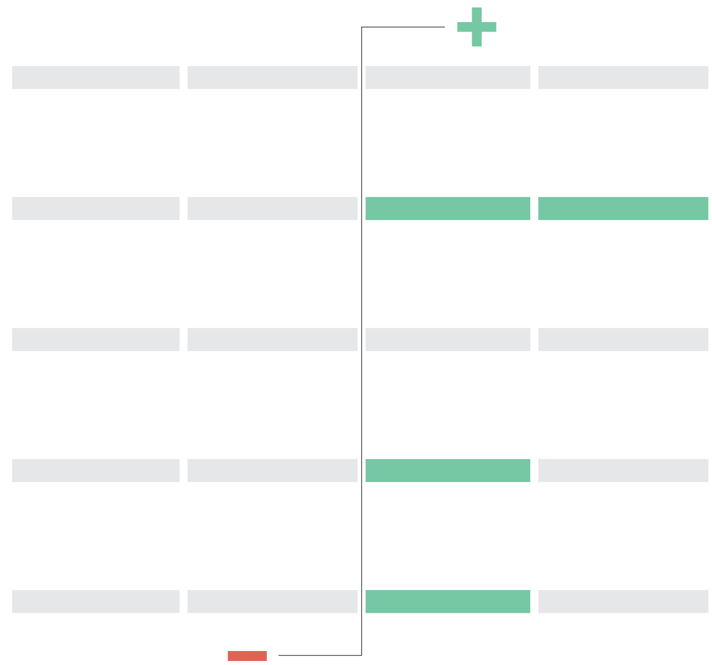


DESIGN CONSIDERATIONS

/ Consistency with ADA design guidelines

/ Consistency with Orange County Council of Governments Complete Streets Design Guidelines

/ Consistency with the pedestrian facility design standards per the Caltrans Highway Design Manual and Standard Plans

/ Consistency with the pedestrian facility design standards for the affected City or County

SPECIFIC APPLICATIONS

At the following locations:

/ Huntington Beach – east side south of Indianapolis Avenue

/ County of Orange – west side north of McFadden Avenue

/ Westminster – west side north of 21st Street

/ Anaheim/Buena Park – east side north of Stanton Avenue

/ Buena Park – west side south of La Palma Avenue

/ Buena Park – east side north of Argyle Drive

/ La Habra – west side south of Imperial Highway

COST RANGE

$$$$$

COORDINATION NEEDED

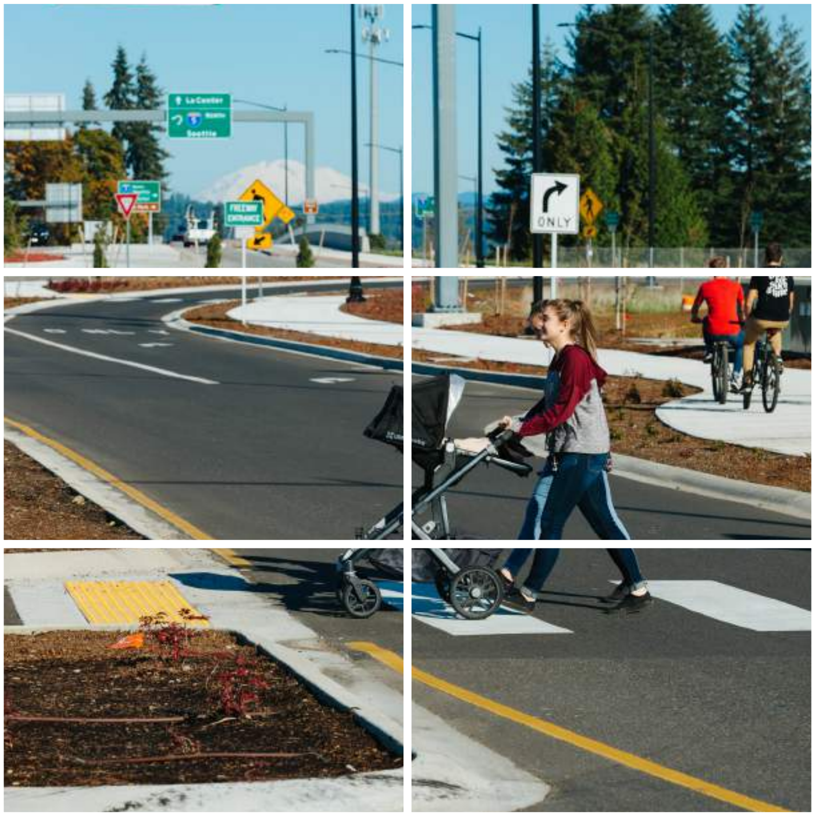
U — Utilities

P — Adjacent Private Property Owners

O — OCTA Transit

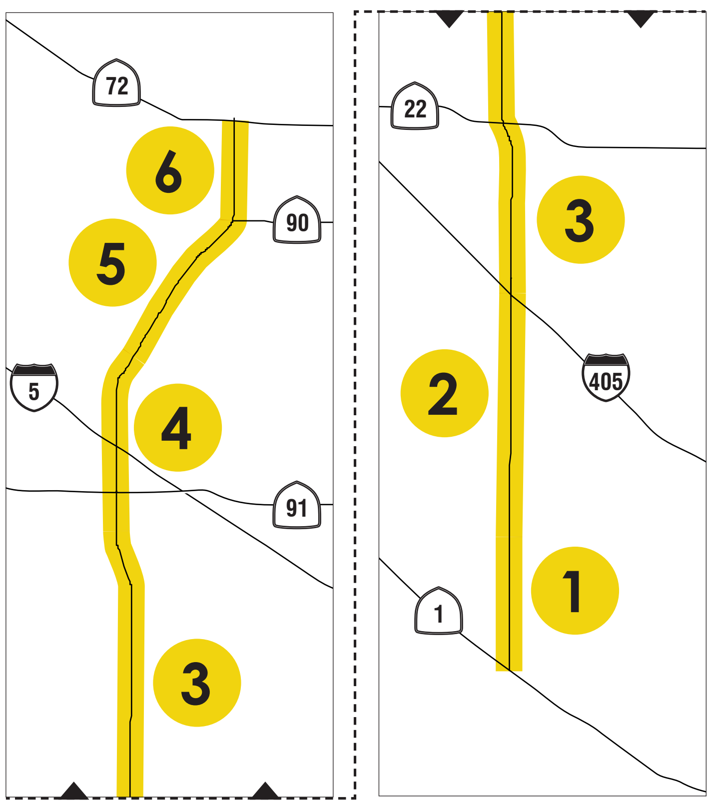
B — Adjacent Businesses

HIGH-VISIBILITY CROSSWALKS



A high-visibility crosswalk is much easier for an approaching motorist to see and improves yielding behavior by drivers and as a result improves pedestrian safety while crossing. High-visibility ladder and zebra marking are preferable to parallel or dashed markings.

LOCATION KEY



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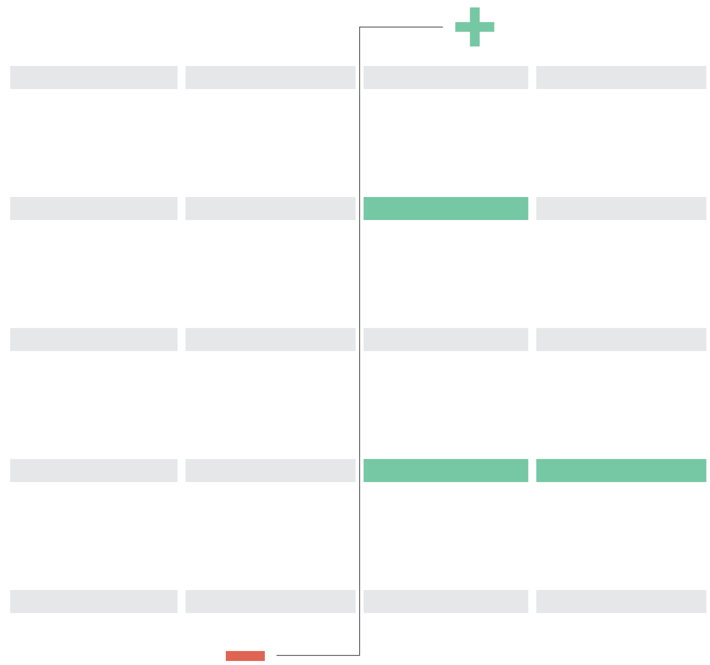


DESIGN CONSIDERATIONS

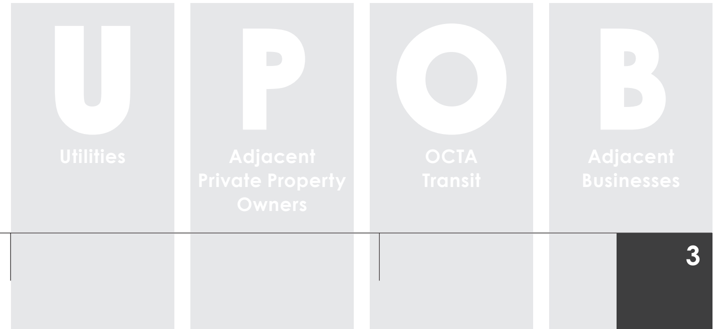
- Consistency with the California MUTCD and local jurisdiction guidelines
- Consistency with ADA guidelines
- Cost of maintenance compared to standard crosswalks

TYPICAL APPLICATIONS

- At crosswalk locations with a minimum of 20 pedestrian crossings or more than 15 elderly or child pedestrians per peak hour at a particular location

COST RANGE

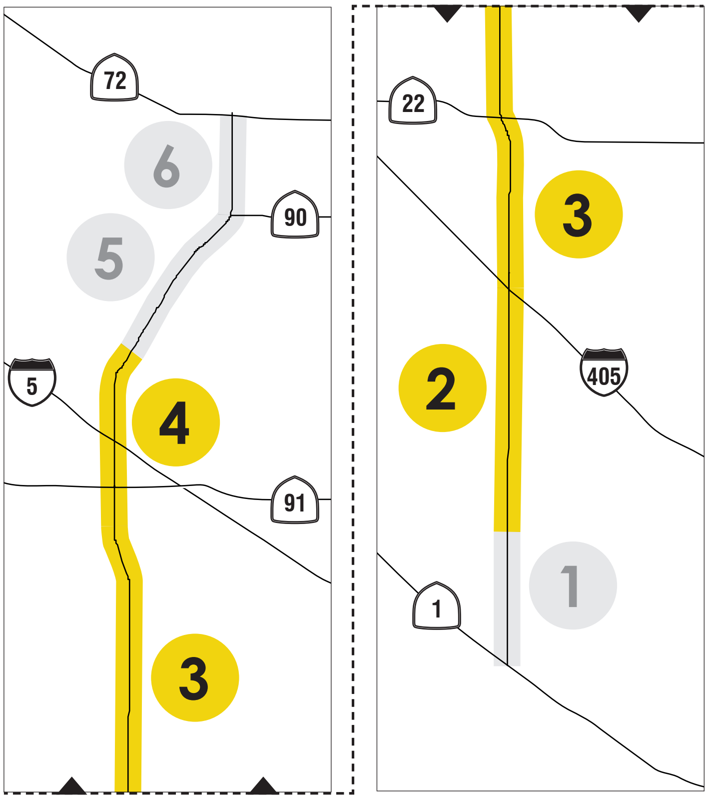
COORDINATION NEEDED



REALIGNED CROSSWALKS AT FREEWAY RAMPS

Multiple factors contribute to provide safe pedestrian crossings at freeway ramps including type of ramp, turning-angles, signalization, visibility, pedestrian crossing distance, and directness of route. Improving crosswalk location and alignment would improve motor vehicle awareness of pedestrians crossing which would reduce vehicle and pedestrian collisions and create a safer environment for pedestrians.

LOCATION KEY



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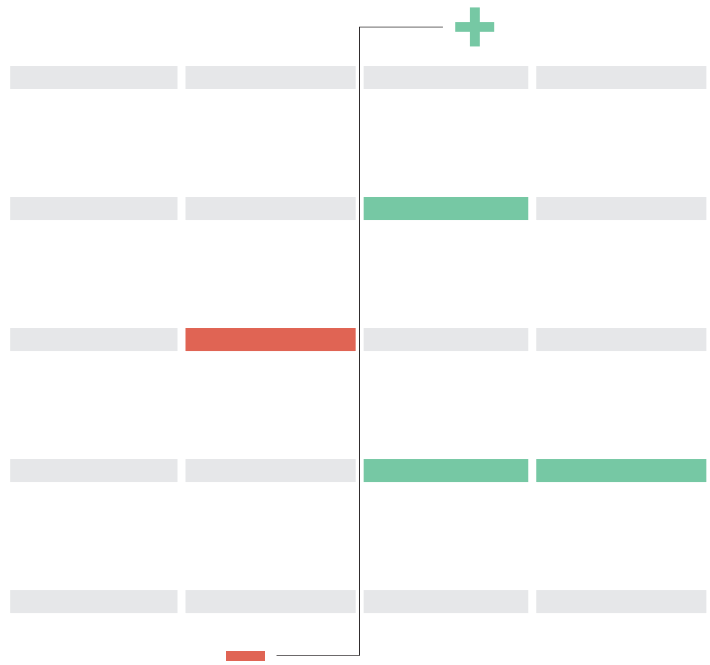


DESIGN CONSIDERATIONS

/ Consistency with the Caltrans Highway Design Manual and Standard Plans and local guidelines

/ Consistency with ADA guidelines

/ Cost to implement improvement strategies to crosswalks

/ Cost to reconfigure freeway ramps to be safer for pedestrians

/ Potential delays for vehicles entering and exiting the freeway

SPECIFIC APPLICATIONS

At locations where the ramp configurations can negatively affect pedestrian crossings and safety, at the following freeway interchanges

/ At the I-405 interchange

/ At the SR-22 interchange

/ At the SR-91 interchange

/ At the I-5 Interchange

COST RANGE

$$$$$

COORDINATION NEEDED

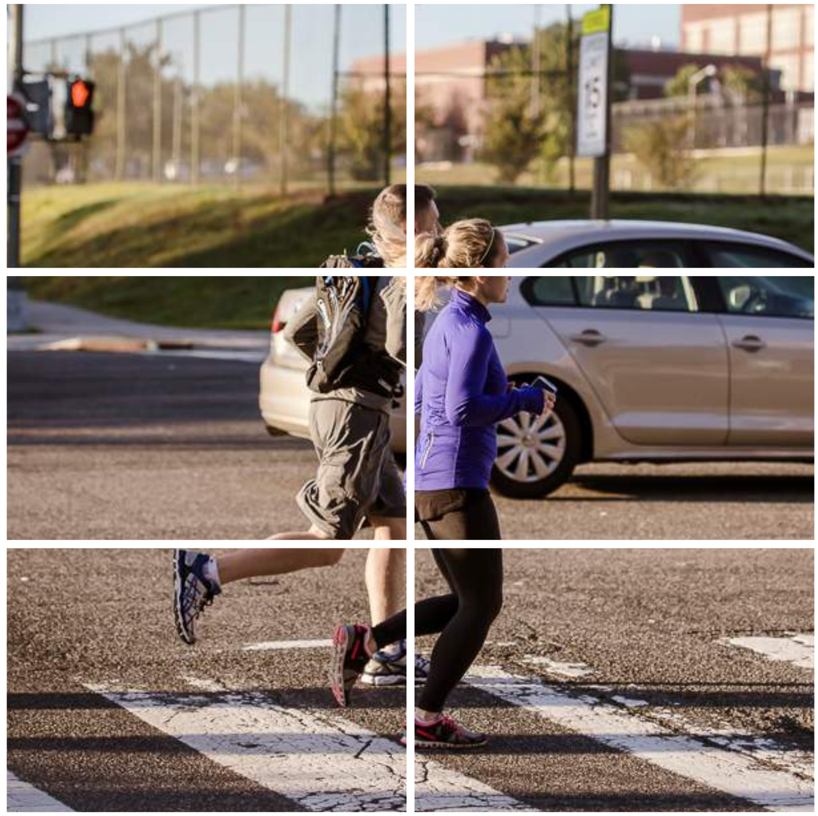
U Utilities

P Adjacent Private Property Owners

O OCTA Transit

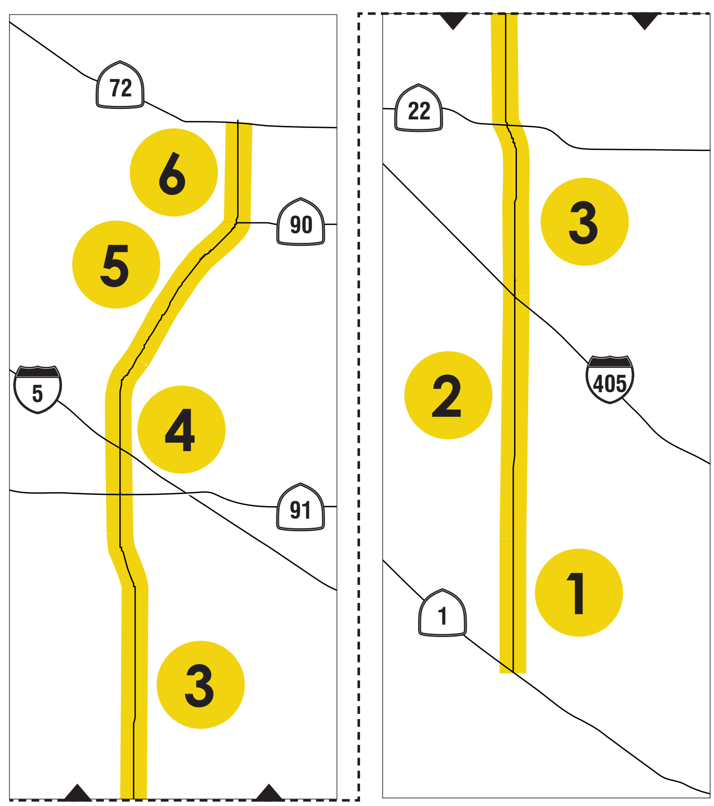
B Adjacent Businesses

PEDESTRIAN COUNTDOWN SIGNAL HEADS



The pedestrian countdown signal device provides a numeric countdown display that indicates the number of seconds remaining for a pedestrian to complete his/her crossing of a street. Implementation of countdown signal heads has been shown to reduce pedestrian injury collisions and has positive reception from pedestrians over the conventional don't walk or raised hand pedestrian signal heads.

LOCATION KEY



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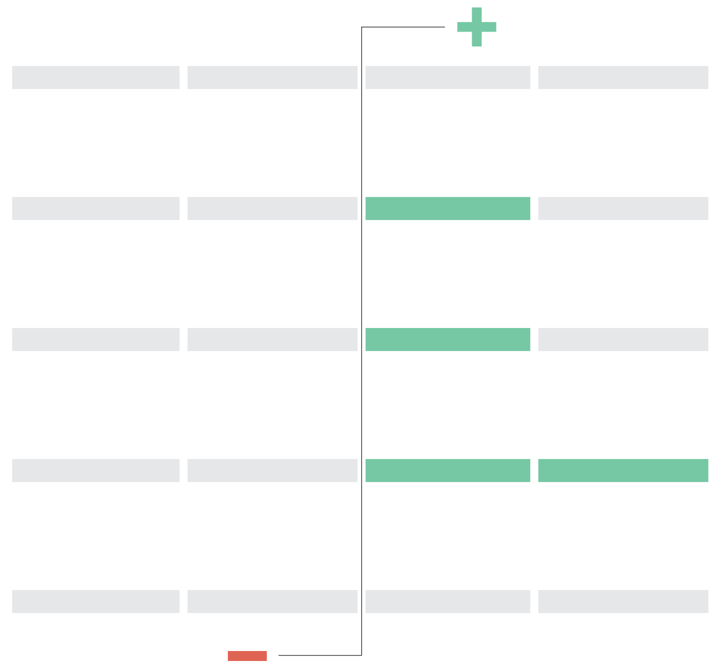


DESIGN CONSIDERATIONS

/ Consistency with the California MUTCD and local jurisdiction guidelines

/ Consistency with ADA guidelines

/ Cost of installing of replacing conventional signal heads with pedestrian countdown signal heads

TYPICAL APPLICATIONS

/ At all new or modified signalized crosswalks

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

P Adjacent Private Property Owners

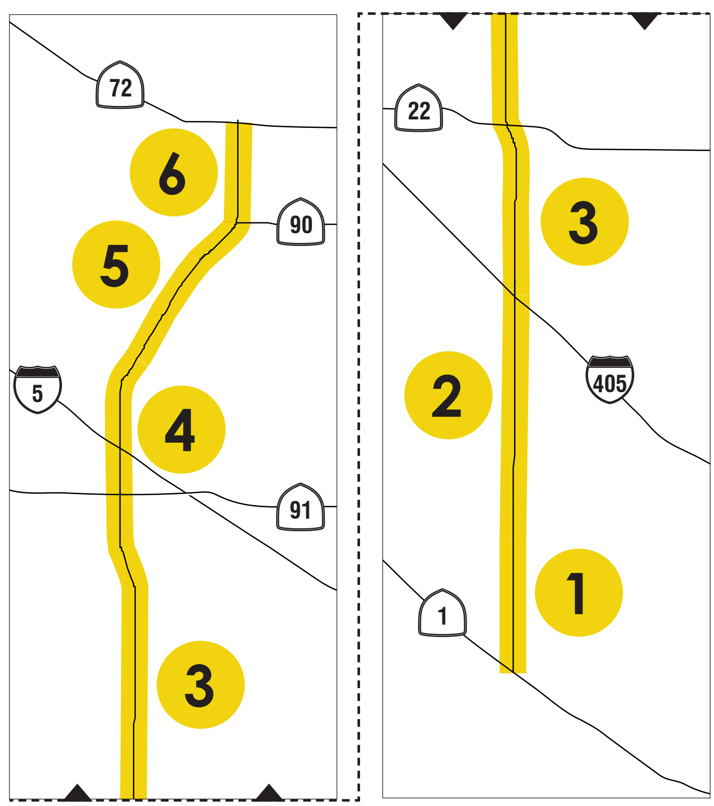
O OCTA Transit

B Adjacent Businesses

SIDEWALK AMENITIES

Sidewalk amenities can make for a safer pedestrian environment by separating users from fast moving traffic and providing features like adequate lighting, street furniture, and wayfinding signs. Case studies have demonstrated that sidewalk amenities can improve safety, increase walking and active trips, and contribute to a cleaner street environment through the provision of trash/recycling receptacles.

LOCATION KEY



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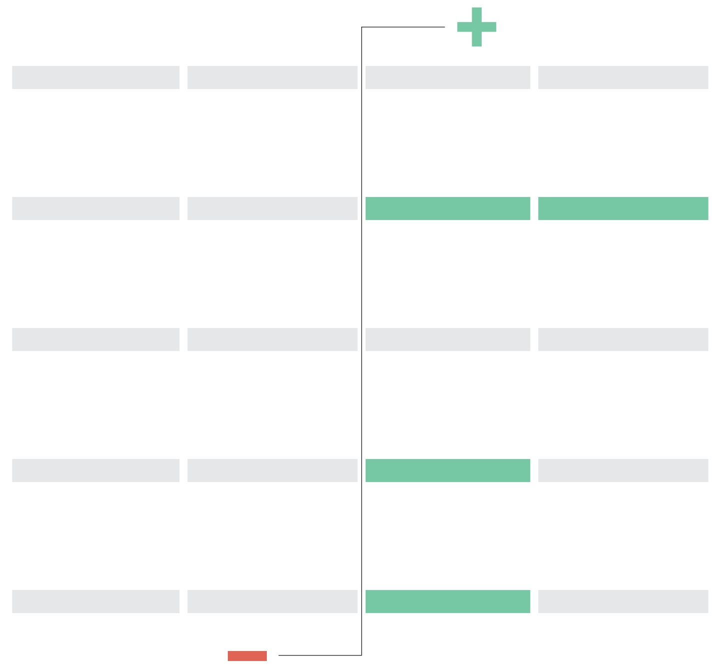


DESIGN CONSIDERATIONS

/ Consistency with NACTO recommended design measures

/ Sidewalk space constraints

/ Pedestrian-scale lighting in addition to overhead lighting for vehicles

/ Seating designed into existing structures or placed within the frontage zones

/ Adequate lighting beneath scaffolding and other construction sites

/ Using permeable metal shutters on storefronts at night, where security concerns exist, to protect and preserve amenities

TYPICAL APPLICATIONS

/ Where there are significant pedestrian volumes and minimal space constraints, threats to personal safety, lacking pedestrian sightlines, and access to local amenities

/ Where amenities would not compromise mobility and space for elderly pedestrians, mobility-impaired users, and adults with strollers

/ Where businesses and pedestrians would benefit from pedestrian-scale design, such as commercial corridors

/ Where high traffic speeds and volumes may make pedestrians feel unsafe and avoid walking

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

P Adjacent Private Property Owners

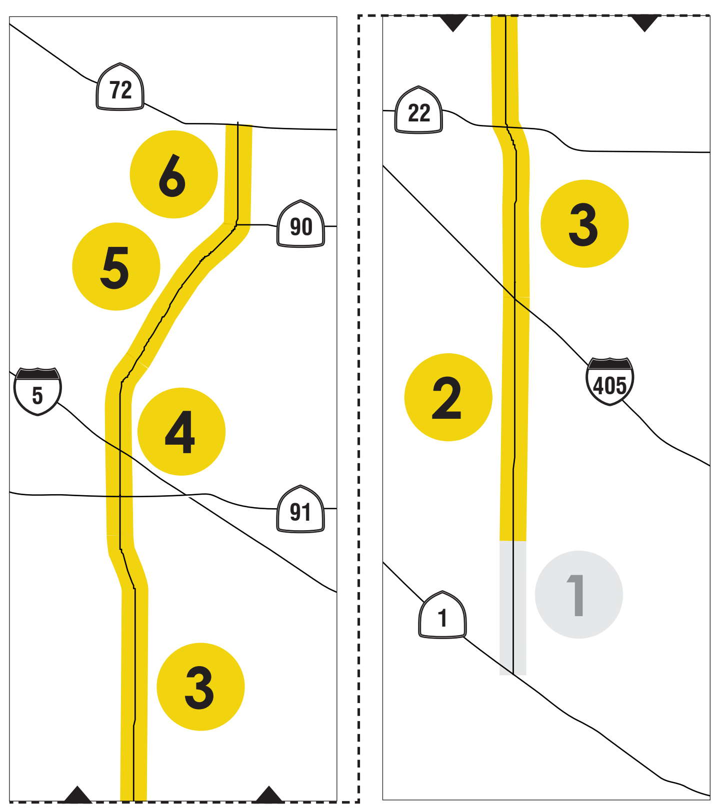
O OCTA Transit

B Adjacent Businesses

REMOVE SIDEWALK OBSTRUCTIONS

Sidewalks are how the majority of pedestrians access routes and should provide a continuous path that connects pedestrians to accessible elements, spaces, and facilities. Minimum sidewalk clear widths should be kept free of all obstructions including utilities, furniture, signs and others. Removing sidewalk obstructions improves pedestrian experience, addresses the needs for users with limited mobility or users who are most vulnerable and ensures compliance with ADA guidelines.

LOCATION KEY



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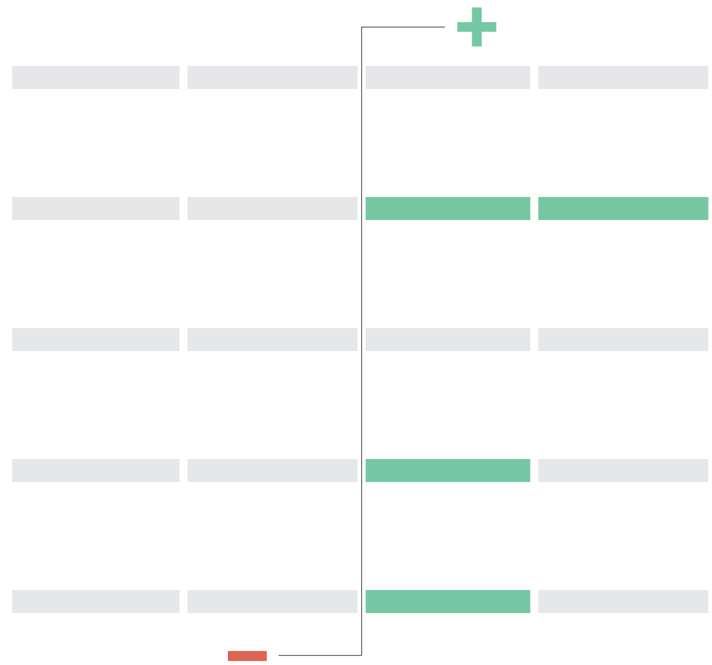

DESIGN CONSIDERATIONS

- / Consistency with the Caltrans Highway Design Manual and Standard Plans and local jurisdiction guidelines
- / Consistency with ADA guidelines
- / Continual maintenance of sidewalks
- / Cost to move or remove permanent obstructions obstacles i.e., utility boxes
- / Right-of-way availability to re-locate obstructions
- / Coordination across jurisdictional lines

TYPICAL APPLICATIONS

- / At locations where an obstruction interfere with the pedestrian clear path of travel

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

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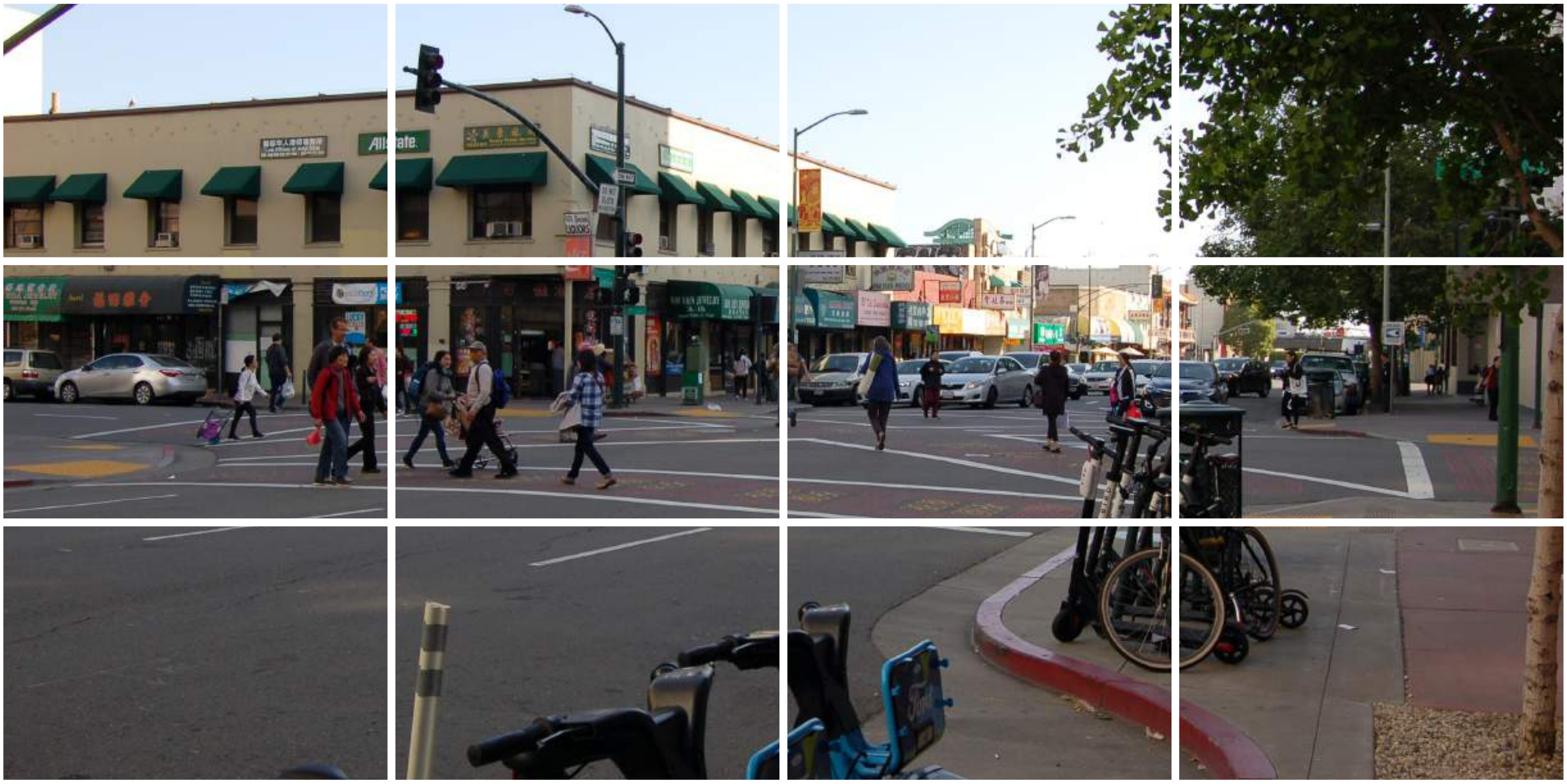
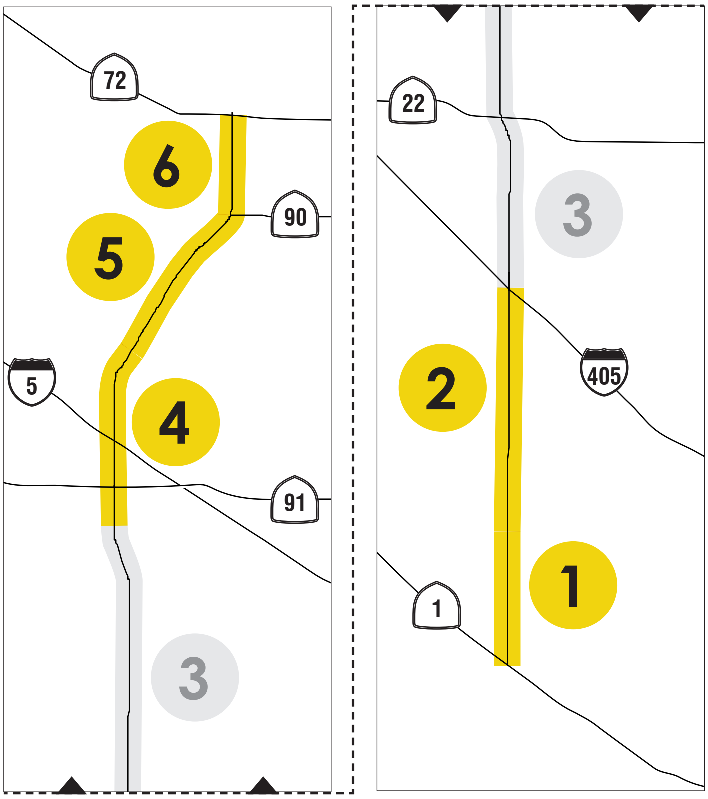
PEDESTRIAN SCRAMBLES



A pedestrian scramble crossing gives pedestrians an exclusive signal phase at an intersection during which all vehicle approaches are stopped. Crossing directions can include crossing diagonally which negates the need to cross twice to reach a destination. A pedestrian scramble phase reduces conflicts between motorist and pedestrians by isolating movements in separate signal cycles.

LOCATION KEY



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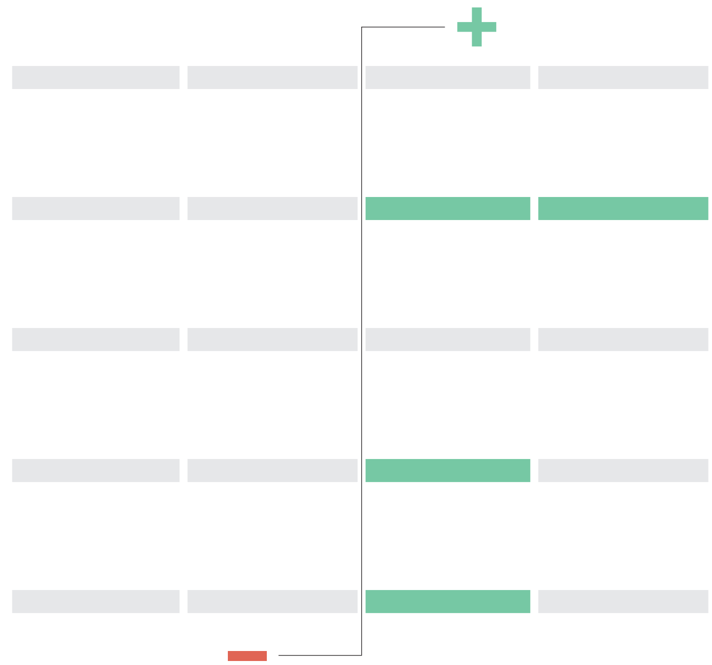


DESIGN CONSIDERATIONS

/ Consistency with ADA design guidelines

/ Consistency with the pedestrian facility design standards per the Caltrans Highway Design Manual and Standard Plans and local guidelines

/ Potential increase in pedestrian violations (pedestrians crossing on “do not walk symbol”)

/ Trade-off in increased wait times for all intersection users

/ Potential confusion for visually impaired pedestrians who rely on traffic sounds to cross

/ Potential to affect the ability to synchronize timing at adjacent traffic signals

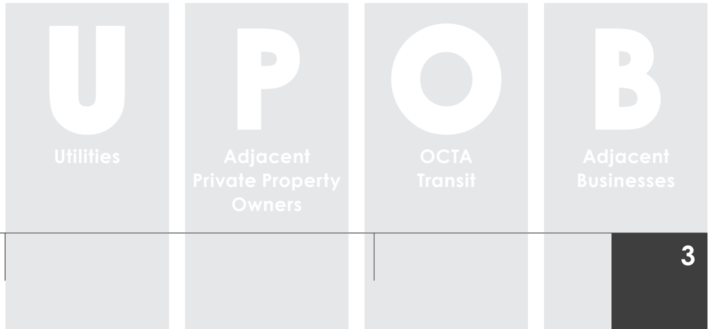
TYPICAL APPLICATIONS

/ Where high pedestrian volumes conflict with high volume vehicle turning movements

/ Where a high number of pedestrians cross the intersection twice

COST RANGE

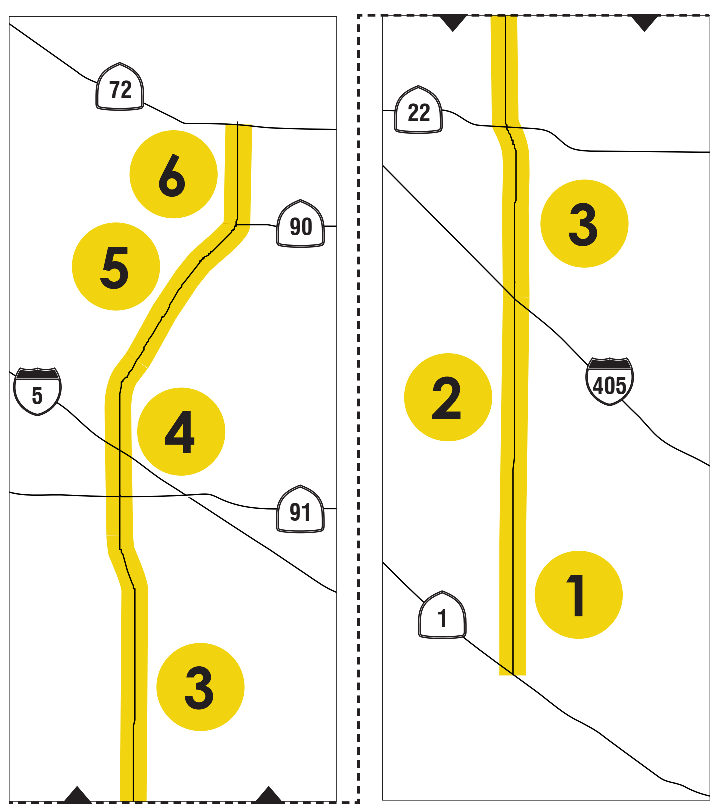
COORDINATION NEEDED



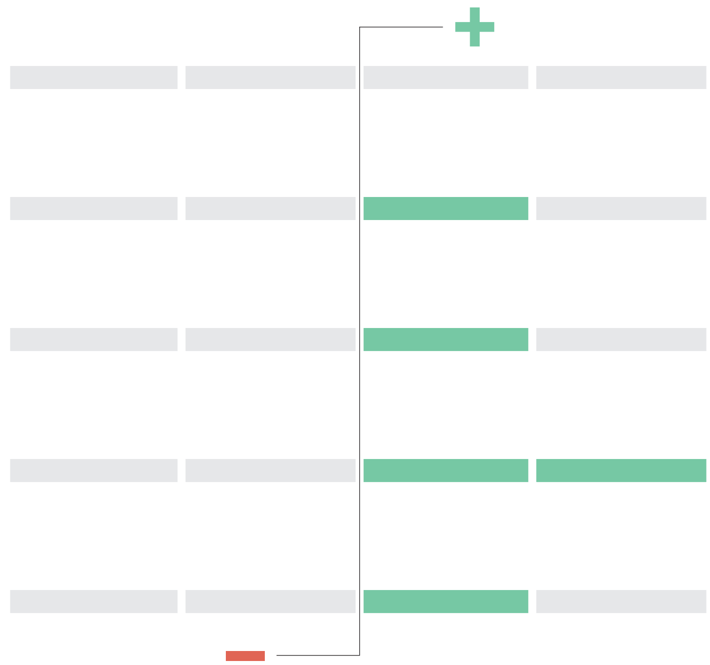
PEDESTRIAN REFUGE ISLANDS

A pedestrian refuge island splits the crossing journey into two steps which can make it more manageable and safer for those crossing. Pedestrian refuge islands are valuable at both signalized and unsignalized intersections and midblock crossings especially along high-volume and/ or high-speed corridors. Pedestrians can cross with less exposure to vehicles when able to concentrate on only one direction of the roadway and wait partially through their crossing on a refuge island. Crossing a shorter distance is also beneficial for those with reduced mobility.

LOCATION KEY



MEETING GOALS



1. Improve travel time, reliability and convenience of transit.
2. Reduce impediments to walking and biking along and across corridor.
3. Maintain vehicular throughput and access to and from regional freeways network.
4. Provide a safe and accessible environment for all user groups.
5. Support local land use planning with improved mobility options.

DESIGN CONSIDERATIONS

/ Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines

/ Consistency with NACTO's Urban Street Design Guide's critical design guidelines

/ Consideration of NACTO's Urban Street Design Guide's recommended design guidelines

/ Right-of-way requirements of at least 6 feet for a refuge island

/ Installation of pedestrian push button on the refuge island as needed

/ Cost to install and maintain

TYPICAL APPLICATIONS

/ Where roads have four or more lanes with speed limits are 35 mph or higher and/or high traffic volumes

/ Where pedestrians crossing high-capacity signalized intersections would benefit from a refuge island

/ Where pedestrians with reduced mobility are frequently crossing wide and busy roads

COST RANGE

$$$$$

COORDINATION NEEDED

U — Utilities

P — Adjacent Private Property Owners

O — OCTA Transit

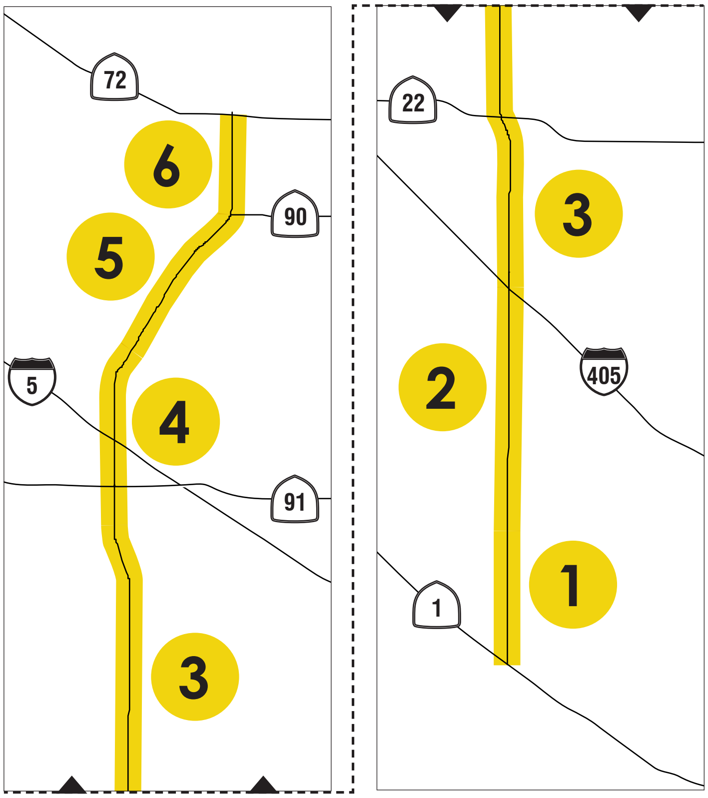
B — Adjacent Businesses

CORNER OR SIDEWALK BULBS

Source: NACTO Urban Street Design Guide

Curb extensions extend the line of the curb into the roadway, reducing the width of the street, and typically are used at pedestrian crossing locations. Curb or sidewalk bulbs can increase the visibility of pedestrians, reduce crossing distances, and slow vehicle turning speeds. Curb extensions have been shown to improve safety and reduce the number of pedestrian-involved collisions.

LOCATION KEY



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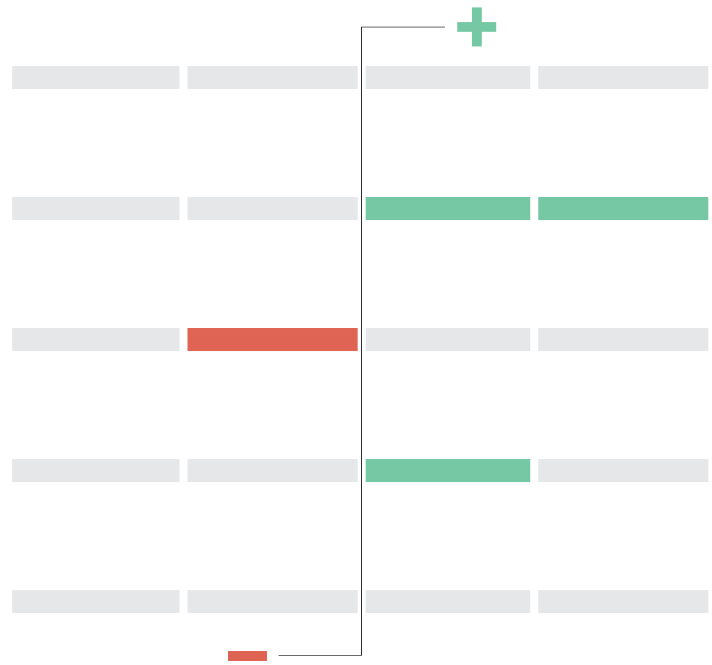


DESIGN CONSIDERATIONS

- Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines
- Consistency with the NACTO Global Street Design Guide
- Right-of-way requirements for adding corner or sidewalk bulbs
- May affect drainage and utility access

TYPICAL APPLICATIONS

- Where on-street parking and high pedestrian crossing demand exists
- Where pedestrians could benefit from slower vehicle turning speeds and increased visibility
- At mid-block crossing locations to reduce pedestrian crossings times and improve visibility

COST RANGE

$$$$$

COORDINATION NEEDED

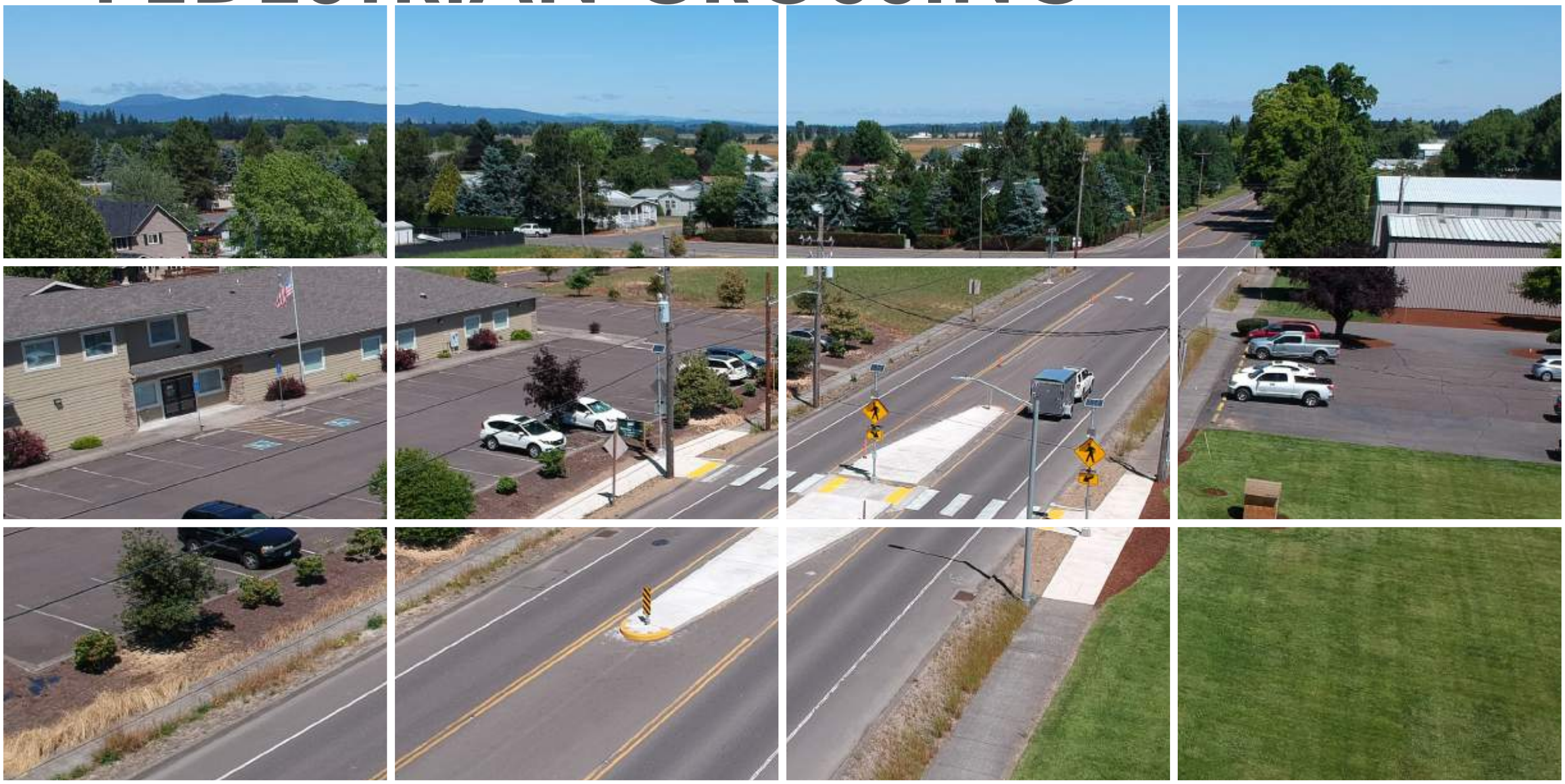
U Utilities

P Adjacent Private Property Owners

O OCTA Transit

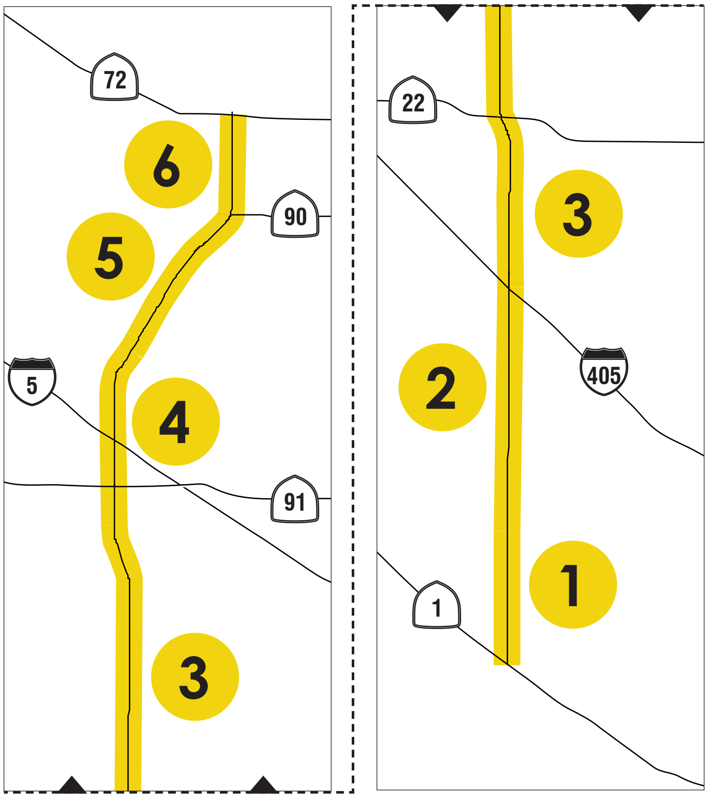
B Adjacent Businesses

MID-BLOCK SIGNALIZED PEDESTRIAN CROSSING



Along busy streets with multitude of destinations along each side and long block lengths, pedestrians may seek to cross mid-block than walk the additional distance to the nearest signalized intersection. To improve pedestrian safety, the installation of signalized mid-block crossings could be beneficial to pedestrian safety and improve convenience. Mid-block locations are often controlled by pedestrian hybrid beacons, or are tied into new traffic signals. Signalized mid-block crossings are most valuable on multi-lane arterial streets with high traffic volumes and speeds with distances between signals from before 0.25 to 0.5 miles.

LOCATION KEY



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DESIGN CONSIDERATIONS

/ Consistency with the California MUTCD

/ Consistency with ADA guidelines

/ Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines

/ Ensuring vehicles stop for flashing lights

/ Cost of installing signalization if connections required to adjacent signals

/ Designing a highly visible crosswalk to ensure pedestrian safety

TYPICAL APPLICATIONS

/ Where midblock crossings are warranted by either pedestrian volume, distance between signalized crossings, or land use / destinations

/ Where the traffic volume on a major street leads to excessive delay for pedestrians

/ Where instances of jaywalking are frequently observed

/ Where collisions with vehicles and pedestrian crossing incidents occur

COST RANGE

COORDINATION NEEDED

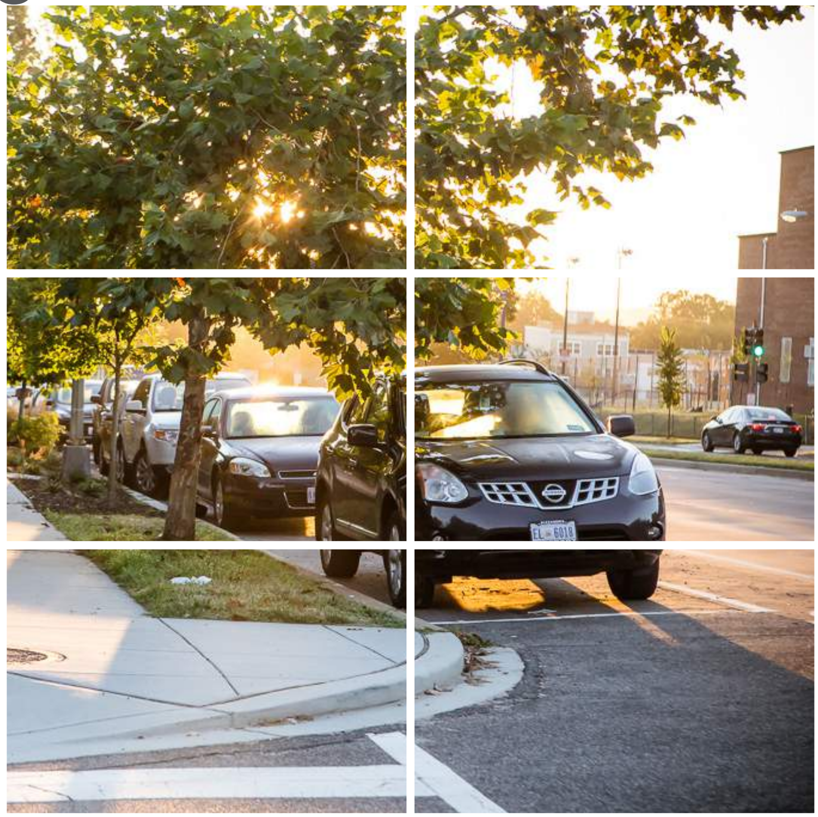
U Utilities

P Adjacent Private Property Owners

O OCTA Transit

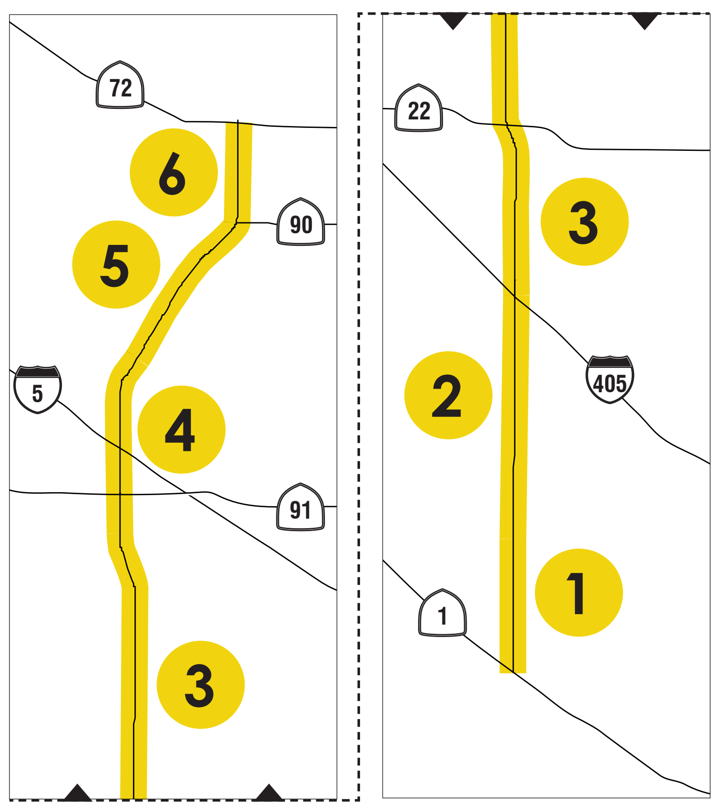
B Adjacent Businesses

ON-STREET PARKING OR LOADING ZONES



The addition of on-street parking can be used to improve the street pedestrian environment. Parking lanes narrow the travel right-of-way, which can slow down traffic as well as reducing crossing distances for pedestrians. On-street parking can also act as a buffer between traffic and pedestrians on the sidewalk. Parking can also be good for businesses and improve neighborhood connectivity and allow space for commercial deliveries.

LOCATION KEY



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DESIGN CONSIDERATIONS

- / Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines
- / Consistency of parking system design across jurisdictional lines
- / Consideration of payment systems for paid parking options
- / Effect of travel lane reduction on vehicle throughput and congestion
- / Additional design features required to mitigate visual barrier between pedestrians and oncoming traffic during crossing
- / Cost to implement and maintain parking along the corridor including parking payment systems and additional safety design features

TYPICAL APPLICATIONS

- / Throughout the Project Corridor especially in locations with storefronts and residential adjacent to the Project Roadway

COST RANGE

$$$$$

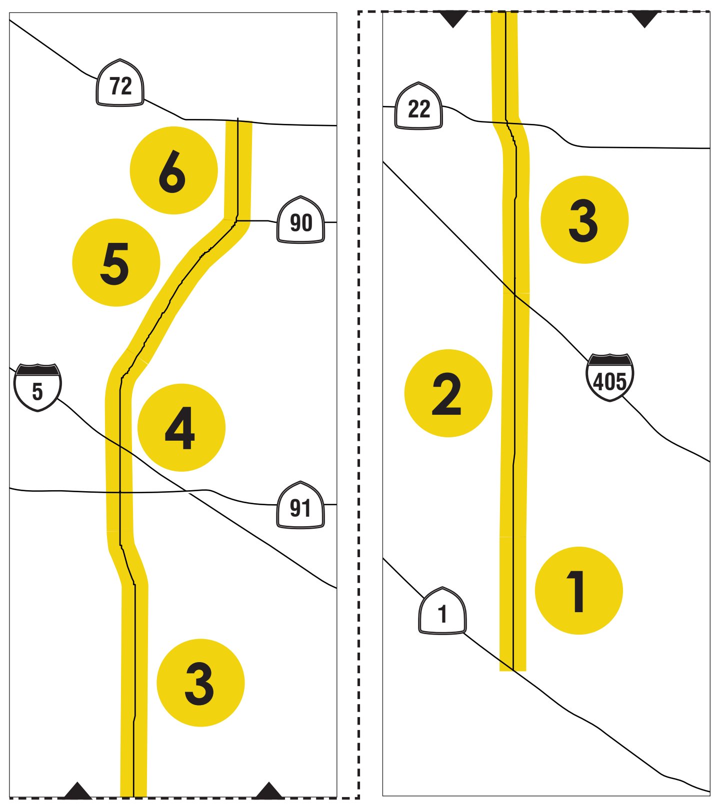
COORDINATION NEEDED

U	P	O	B
Utilities	Adjacent Private Property Owners	OCTA Transit	Adjacent Businesses

BIKE ON SIDEWALK TREATMENTS

Allowing bicyclists to ride on the sidewalk can improve safety and security for cyclists and reduce the potential for conflict between bikes and motorists in the vehicle right-of-way. Bike on sidewalk allowance would also provide bikeway continuity along high speed or heavily traveled roadways with inadequate space for bicyclists. Due to the increased potential for pedestrian-bicyclist collisions on the sidewalk, a form of indication or signage would be necessary to distinguish where people cycling travel and where people walking travel and to warn vehicles to look both ways for bikes.

LOCATION KEY



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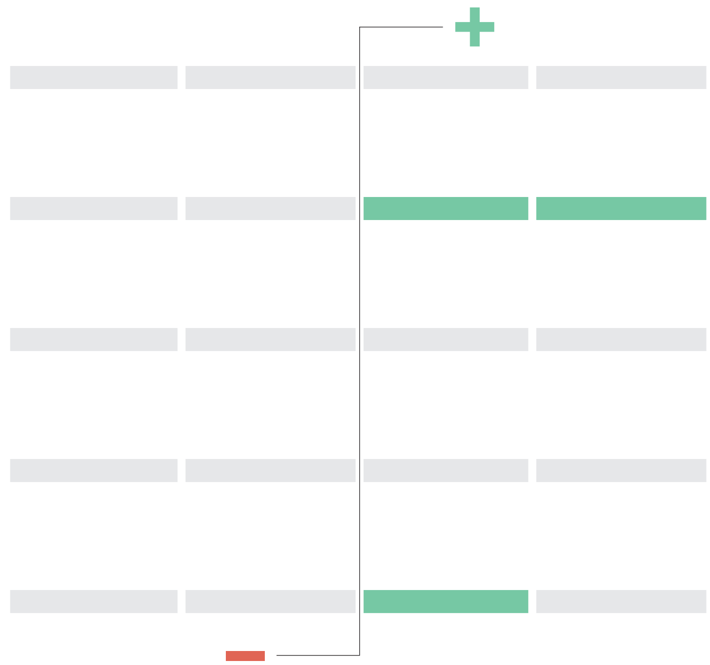


DESIGN CONSIDERATIONS

- / Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines
- / Consistency with ADA guidelines
- / Current laws in Orange County do not allow bicyclists on sidewalks
- / Potential increase in pedestrian and bicyclist collisions
- / Distinguishing pedestrian and bicyclist paths of travel
- / Right-of-way constraints
- / Maintenance of sidewalk facilities for bicyclists
- / Design to minimize the potential for vehicle and bicyclist collisions at driveways

TYPICAL APPLICATIONS

- / Where bike lanes are not available or cannot be provided
- / Where cyclists are not currently safe or comfortable riding in vehicle travel lanes
- / Where current or planned sidewalk widths would allow safe pedestrian/bicycle travel
- / To provide connections between east-west bicycle routes and major destinations

COST RANGE

COORDINATION NEEDED

U — Utilities

P — Adjacent Private Property Owners

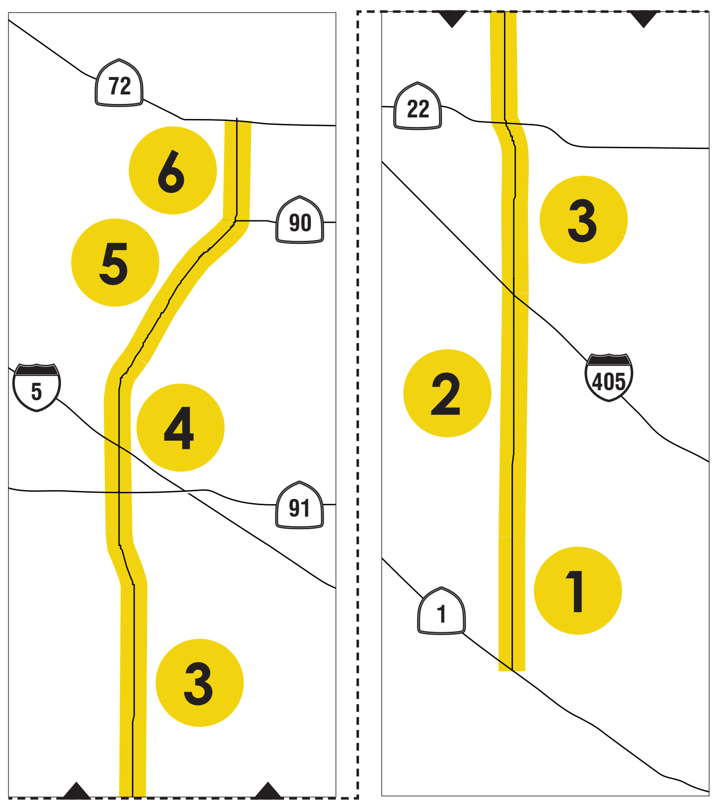
O — OCTA Transit

B — Adjacent Businesses

CLOSE GAPS IN BICYCLE NETWORK

Connected and consistent networks for bicycles are important for enabling a comfortable and direct trip for those traveling by bike and can encourage higher levels of bicycling. Well delineated and designed facilities for bicyclists can reduce conflict with pedestrians and motor vehicles. To accomplish good bicycle connectivity where the bike facility cannot be accommodated on the primary arterial, steps can be taken on parallel lower-traffic streets to provide a safer and continuous bicycle route. These bike facilities may be lower cost than implementing separated bike lanes along the primary arterial.

LOCATION KEY



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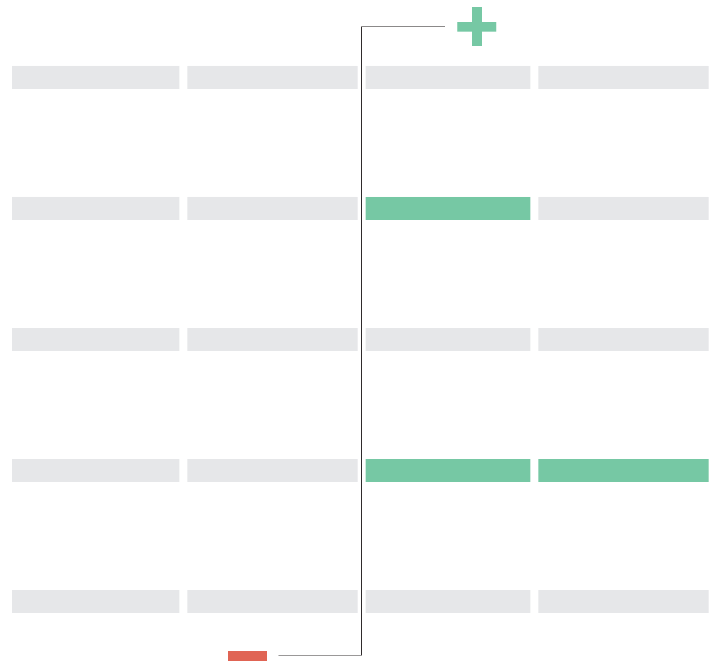


DESIGN CONSIDERATIONS

/ Consistency with the California MUTCD and local jurisdiction guidelines

/ Consistency with ADA guidelines

/ Consistency with Caltrans, OCTA, and local bike plans and guidelines

/ Selection of bikeways facility type within the context of the number or bicyclists and the street environment

/ Wayfinding along route that runs along different streets

/ Creating bicycle connection from parallel routes back over to Beach Boulevard for connections to destinations

/ Coordination and continuation of routes across jurisdictional lines

TYPICAL APPLICATIONS

Primarily, on the following streets for parallel routes east and west of Beach Boulevard:

West Parallel Corridor

/ Western Avenue

/ Beach Boulevard between Pacific Avenue and La Habra Boulevard

/ La Habra Boulevard

/ Dexford Drive/Rigsby Street

East Parallel Corridor

/ Newland Street

/ Dale Street

/ Stanton Avenue

/ Beach Boulevard between Franklin Street and Lambert Road

/ Lambert Road

/ Idaho Street

COST RANGE

$$$$$

COORDINATION NEEDED

U — Utilities

P — Adjacent Private Property Owners

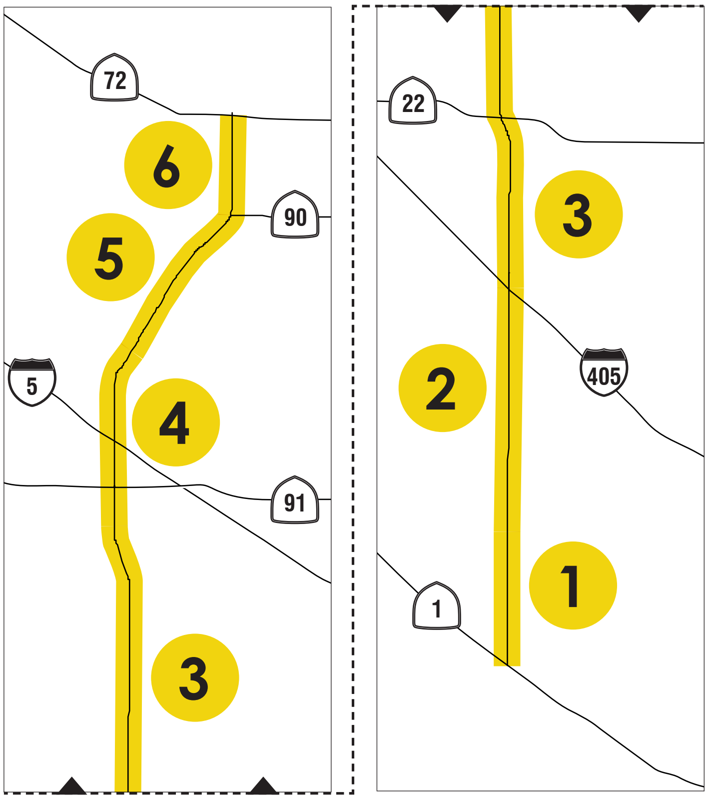
O — OCTA Transit

B — Adjacent Businesses

BIKE PREFERENTIAL TREATMENTS

Bicyclist-oriented improvements focus on implementing or improving bikeways along roads whereas bicyclist preferential treatments can help improve bicyclist comfort and safety and encourage bicycling for all ages and abilities. These treatments allow bicyclists to navigate stressful intersections and roadway segments. Treatments can reduce conflict points between bicyclists and other modes and improve bicyclist safety at intersections. A secondary affect of bike preferential treatments is an increase in bicycle ridership and utilization of bike facilities along roads such as bike lanes.

LOCATION KEY



MEETING GOALS

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2 Reduce impediments to walking and biking along and across corridor.

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5 Support local land use planning with improved mobility options.

DESIGN CONSIDERATIONS

/ Consistency with California MUTCD, Caltrans Highway Design Manual and Standard Plans and local guidelines

/ Consistency with NACTO guidance

/ Consistency with Caltrans, OCTA, and local active transportation plans

/ Potential need for right-of-way

/ Updates to and maintenance of signal timing to incorporate protected bike signal and/or leading bike intervals

/ Potential increase in vehicular delay

TYPICAL APPLICATIONS

/ Where bicyclist-involved collisions are frequently observed

/ Where bicyclist does not feel safe and comfortable to navigate through intersections

/ Where the utilization of bike facilities along roads is low

COST RANGE

$$$$$

COORDINATION NEEDED

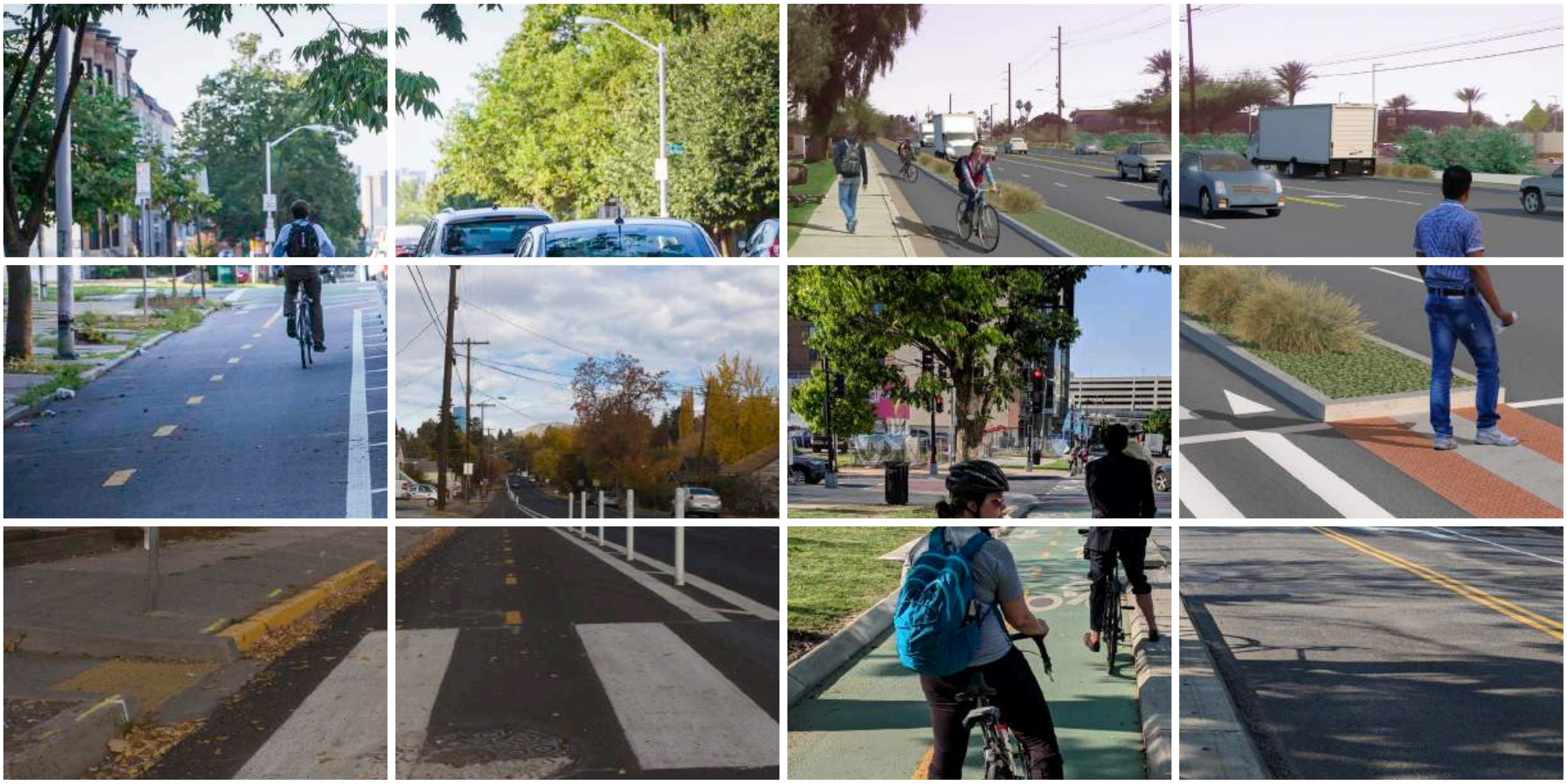
U Utilities

P Adjacent Private Property Owners

O OCTA Transit

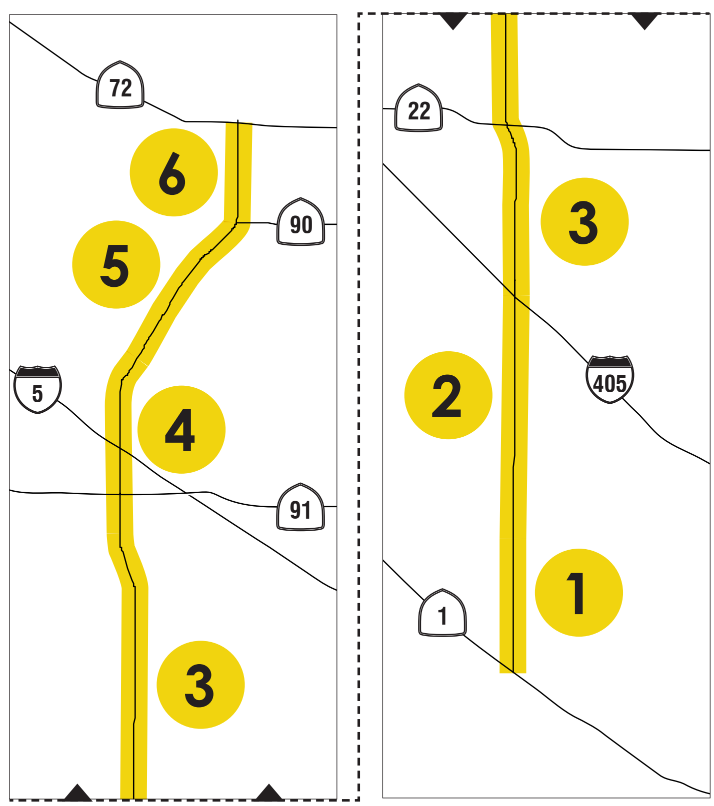
B Adjacent Businesses

PROTECTED BIKE LANES



Protected bike lanes are facilities exclusively for bicyclists that are within or directly adjacent to the roadway but have an element of physical separation from vehicle traffic. By separating bicyclists from traffic, bikeways become low-stress and safer for bicyclists. They have the potential to improve traffic safety for all street users and can increase the volumes of those bicycling. Protected bike lanes can also improve access to community destinations and transit.

LOCATION KEY



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DESIGN CONSIDERATIONS

- / Consistency with the Caltrans, OCTA, and local jurisdiction plans active transportation
- / Educating and building community support for separated bike lanes
- / Designing for bicycle safety at intersections
- / Cost to implement and maintain
- / Coordination and continuation of facility across jurisdictional lines
- / Additional right-of-way may be required

TYPICAL APPLICATIONS

- / Where right-of-way is available
- / At locations with a high demand for bicycle activity
- / Where there are high corridor speeds that warrant separated facilities

COST RANGE

$$$$$

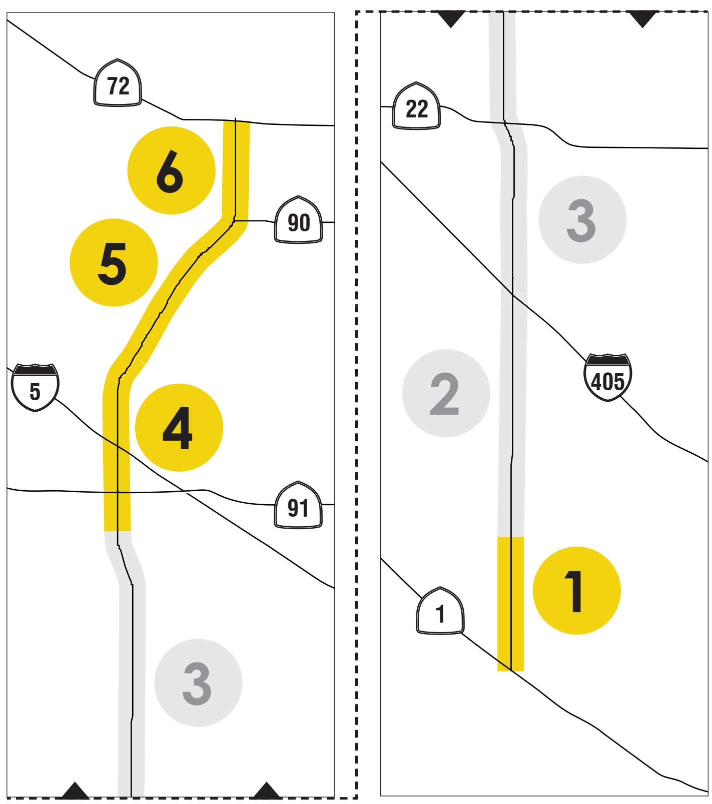
COORDINATION NEEDED

U	P	O	B
Utilities	Adjacent Private Property Owners	OCTA Transit	Adjacent Businesses

ON-STREET PARKING OR LOADING ZONES REMOVAL

On-street parking zones (for short-term parking, handicapped parking, passenger loading, or deliveries) can provide an amenity for users and a buffer for pedestrians along adjacent sidewalks. However, their presence can negatively affect local traffic operations at high-turnover locations, due to the friction caused by vehicles entering and exiting parking spaces. In addition, high-demand spaces can result in increases in traffic volumes due to vehicles circling while looking for available parking spaces. The elimination of on-street parking can therefore improve circulation conditions and vehicular throughput. In addition, the presence of on-street parking can affect visibility issues for crossing pedestrians, delay transit operations, and result in increase conflicts with adjacent bicycle facilities.

LOCATION KEY



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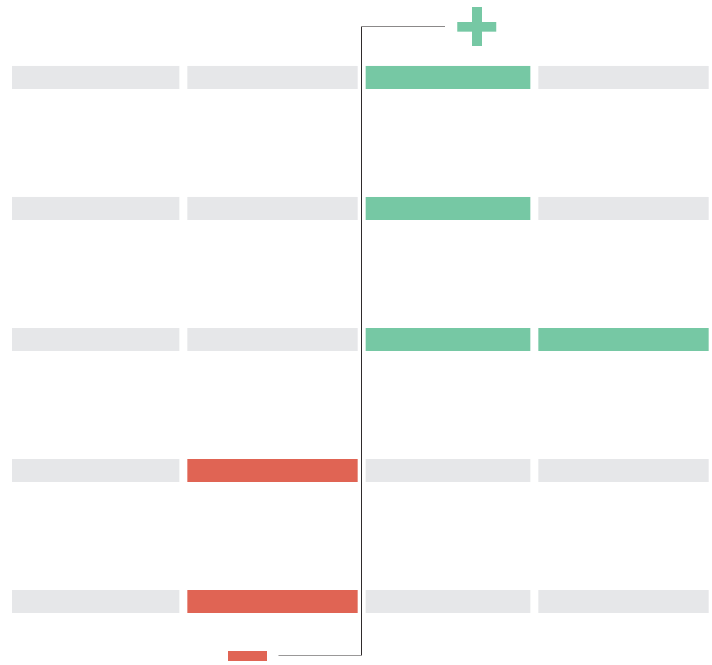


DESIGN CONSIDERATIONS

/ Consistency with the Caltrans Highway Design Manual and Standard Plans and local jurisdiction guidelines

/ Eliminates parking spaces for convenient parking by business patrons

/ Usually opposed by adjacent business owners

/ Removal of buffer between travel lanes and pedestrians

/ Loss of city revenue with metered parking removal

/ Can result in double-parking or parking/stopping in illegal spaces.

SPECIFIC APPLICATIONS

/ Where parking maneuvers cause significant delay and congestion

/ Where parking maneuvers create safety concerns for pedestrian, bicyclists, and through traveling vehicles

/ Current on-street parking or loading zones are at the following locations

  / Generally from SR 1 to Ellis Avenue

  / Generally from Hillsborough Drive to SR 72

COST RANGE

$$$$$

COORDINATION NEEDED

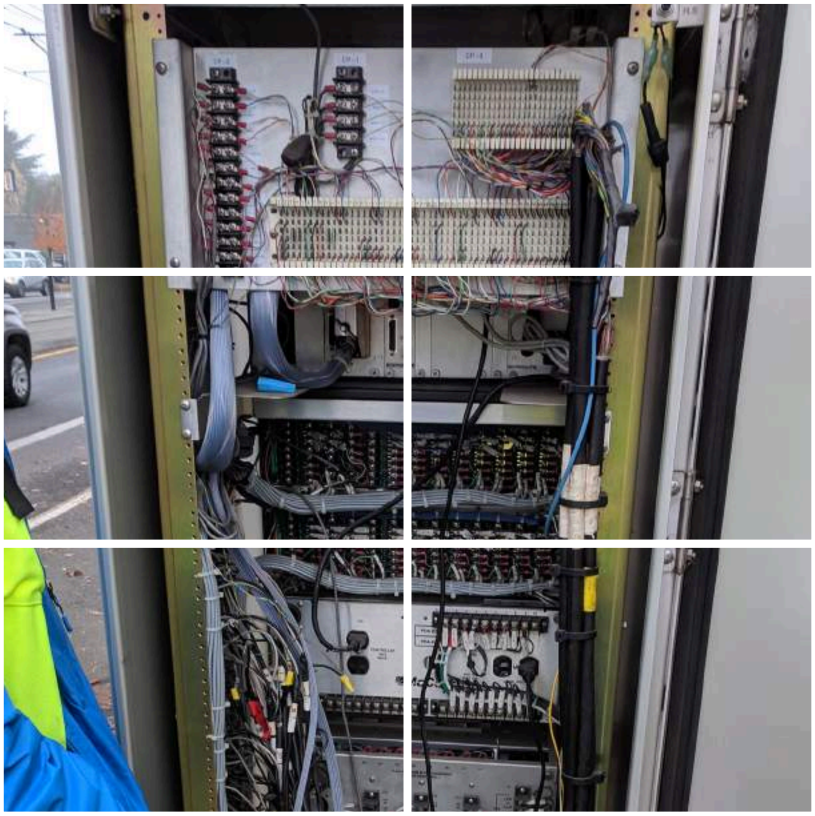
U Utilities

P Adjacent Private Property Owners

O OCTA Transit

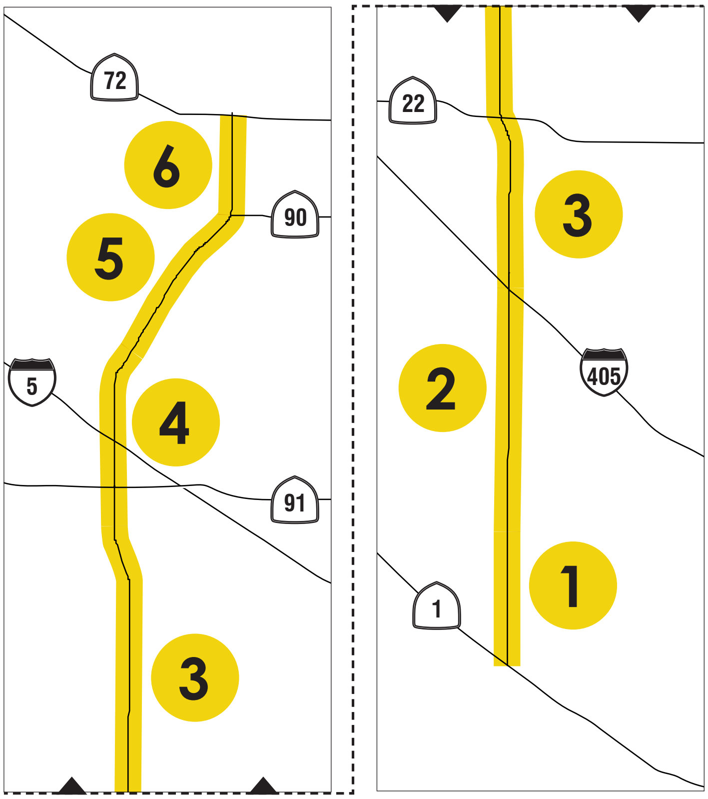
B Adjacent Businesses

ADVANCED TRAFFIC SIGNAL TIMING OR ITS



Implementation of advanced traffic signal timing and intelligent transportation systems can reduce stops, vehicle delays, travel time, fuel consumption, and emissions. In addition to the operational benefits, signal coordination can also reduce vehicle conflicts, particularly rear-end collisions, as vehicles tend to move more in platoons from intersection to intersection. Implementation would require an interconnected system and integration into a traffic management center.

LOCATION KEY



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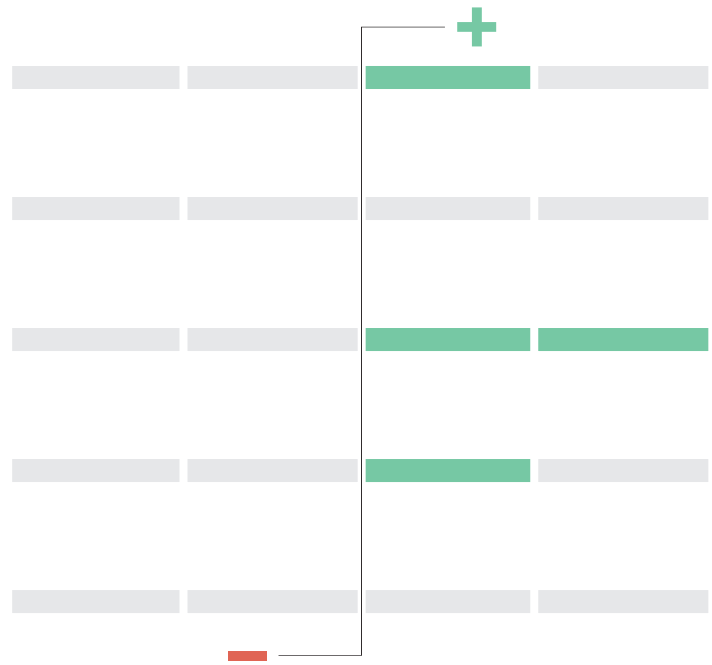


DESIGN CONSIDERATIONS

/ Consistency with Caltrans, OCTA, and local signal timing guidance and operational goals

/ Most effective if implemented along long segments of roadway

/ Required periodical signal timing plan updates

/ Potential for longer pedestrian and side-street delays due to longer cycle lengths

/ Cost to install and maintain new traffic signals and operate traffic control centers

TYPICAL APPLICATIONS

At the following locations:

/ Where traffic delay and congestion occurs

/ Where distances between intersections are less than 0.5 miles

COST RANGE

$$$$$

COORDINATION NEEDED

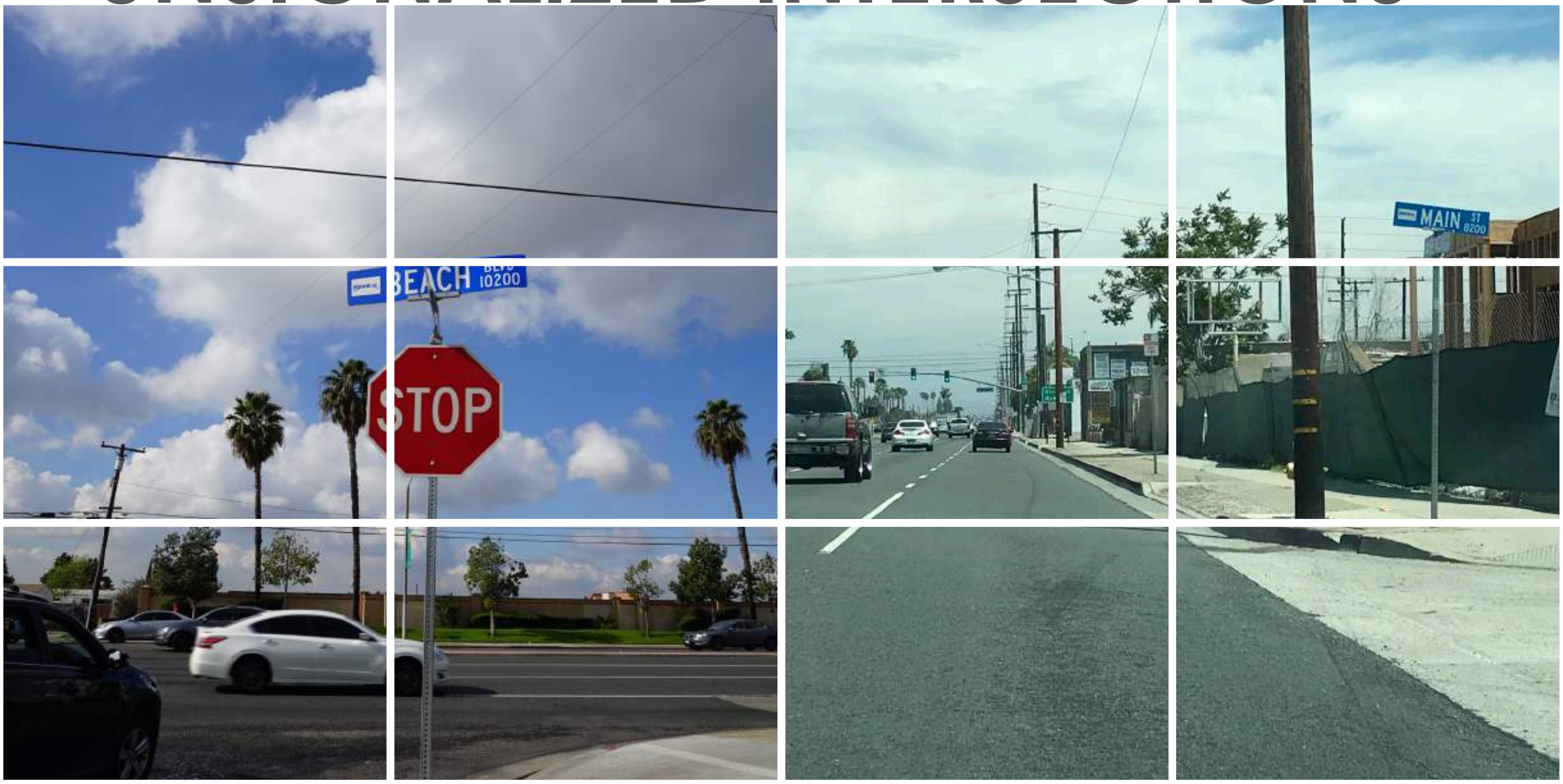
U Utilities

P Adjacent Private Property Owners

O OCTA Transit

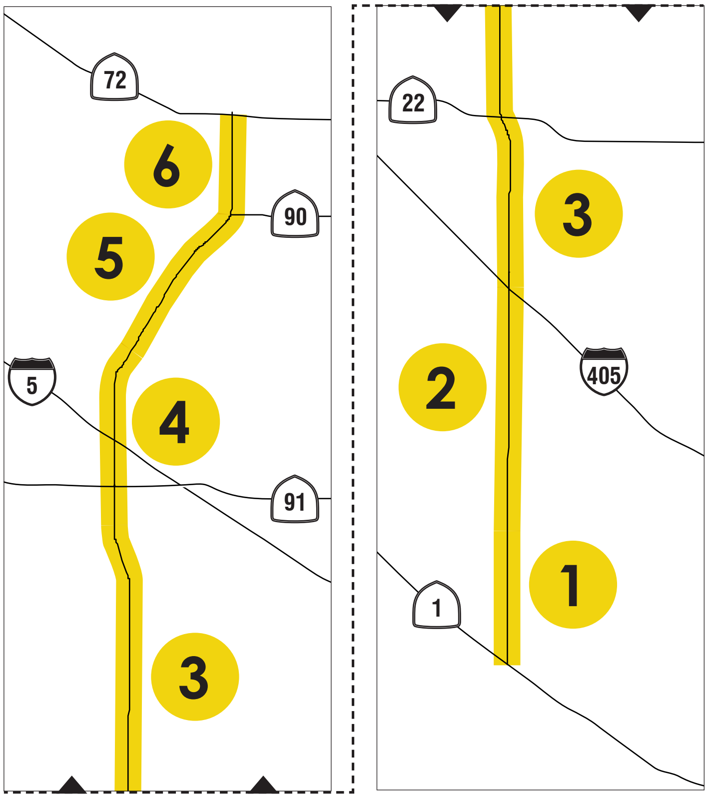
B Adjacent Businesses

CONSOLIDATE MID-BLOCK UNSIGNALIZED INTERSECTIONS



Consolidation of mid-block unsignalized intersections can reduce vehicle conflict points which can reduce localized congestion and increase speeds and travel times. In addition, the elimination of intersections can reduce collision rates for turning vehicles. At the consolidated locations, new traffic signals can be provided which would increase safety and allow for the provision of additional crosswalk locations.

LOCATION KEY



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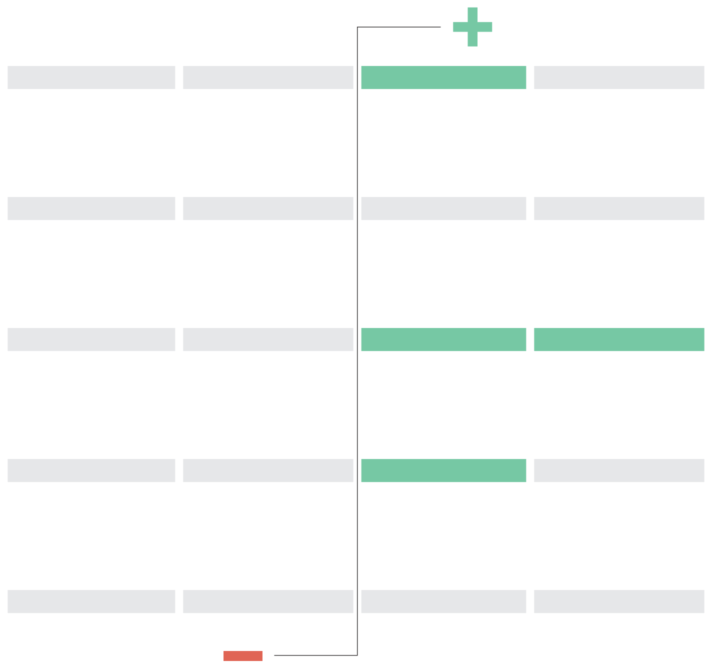


DESIGN CONSIDERATIONS

- / Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines
- / Increase in u-turn movements at upstream/ downstream intersections
- / Increase in delay at upstream or downstream intersections
- / Maintain access to all land parcels
- / Signalization needed at consolidated intersections, including pedestrian crossings

TYPICAL APPLICATIONS

- / Where unsignalized intersections are close to signalized intersections
- / Where corridors speed is 45 mph or greater and whose primary purpose is mobility
- / Where collisions are frequently observed at non-signalized intersections or driveways
- / Where left turns increase delays and decrease accessibility of driveways

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

P Adjacent Private Property Owners

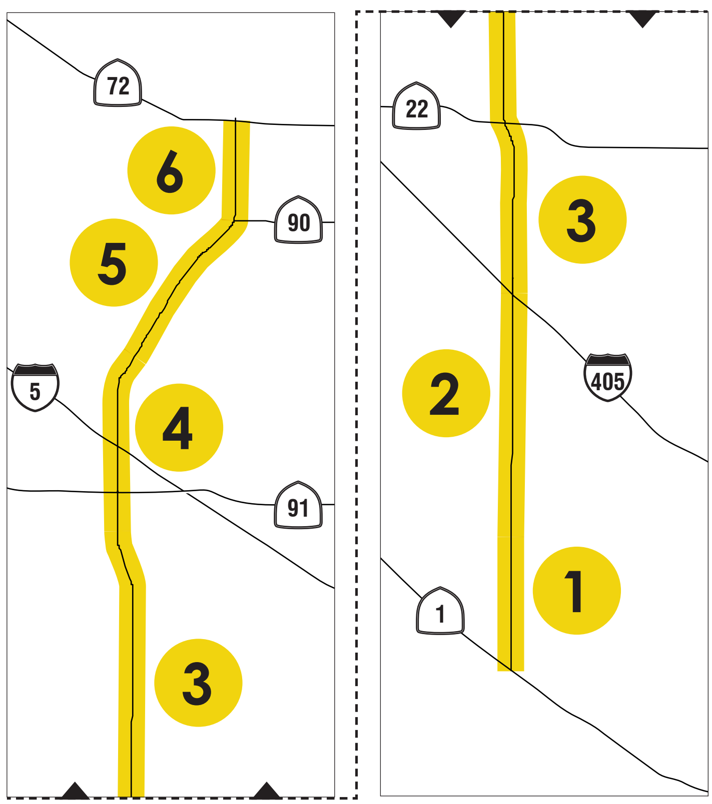
O OCTA Transit

B Adjacent Businesses

ACCESS MANAGEMENT

Access management is the proactive management of vehicular access to land parcels adjacent to roadways. Access management encompasses a set of techniques to control access to highways, major arterials, and other roadways. Access management can reduce congestion and improve overall traffic flow and travel time as well as increase roadway capacity. It can reduce vehicle and pedestrian conflict points thereby reducing the number of collisions. Typically, this involved consolidating access points to reduce the number of driveways and curb-cuts.

LOCATION KEY



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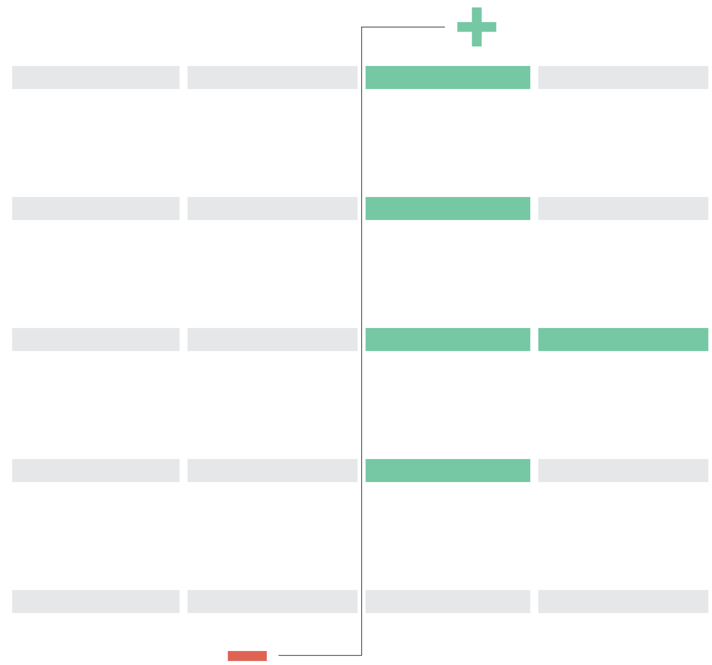


DESIGN CONSIDERATIONS

- Consistent approach to development project review between Caltrans and local jurisdictions
- Manage driveway access based on the feasible access between two signalized intersection
- Maintain access to all land parcels
- May not be acceptable to property owners

TYPICAL APPLICATIONS

- Where access points are close to signalized intersections
- Where driveways are closely spaced
- Where shared access can be provided

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

P Adjacent Private Property Owners

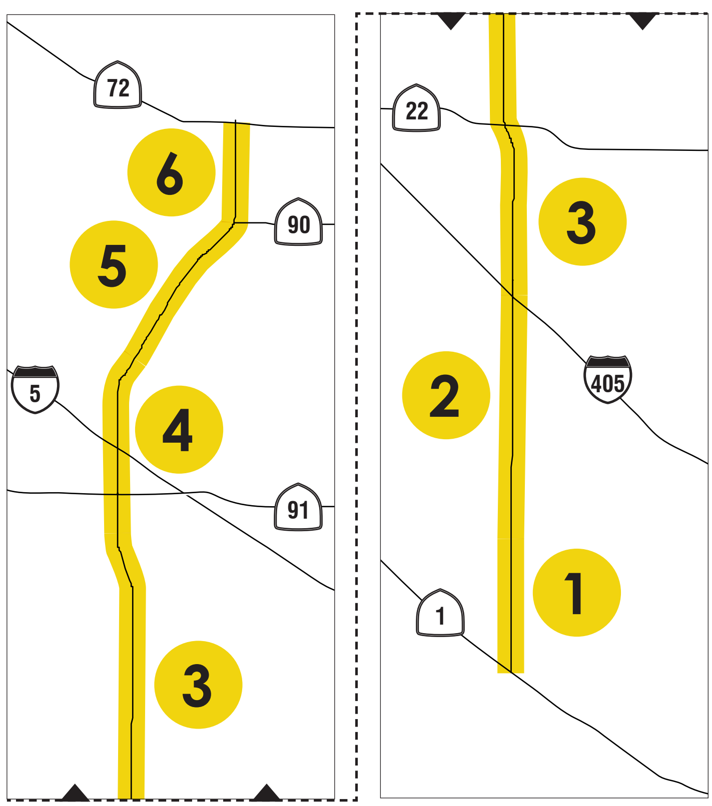
O OCTA Transit

B Adjacent Businesses

ACTIVE TRAFFIC MANAGEMENT

Active traffic management (ATM) is the ability to dynamically manage recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions. ATM tools help maximize the effectiveness and efficiency of the corridor and enhance trip reliability. ATM approaches focus on influencing travel behavior with respect to lane choices and operations. Various ATM strategies can be deployed concurrently to meet system-wide needs of congestion management, traveler information, and safety. ATM can increase corridor travel speeds and trip reliability increasing throughput and can also reduce the number of collisions due to slowed or stopped traffic.

LOCATION KEY



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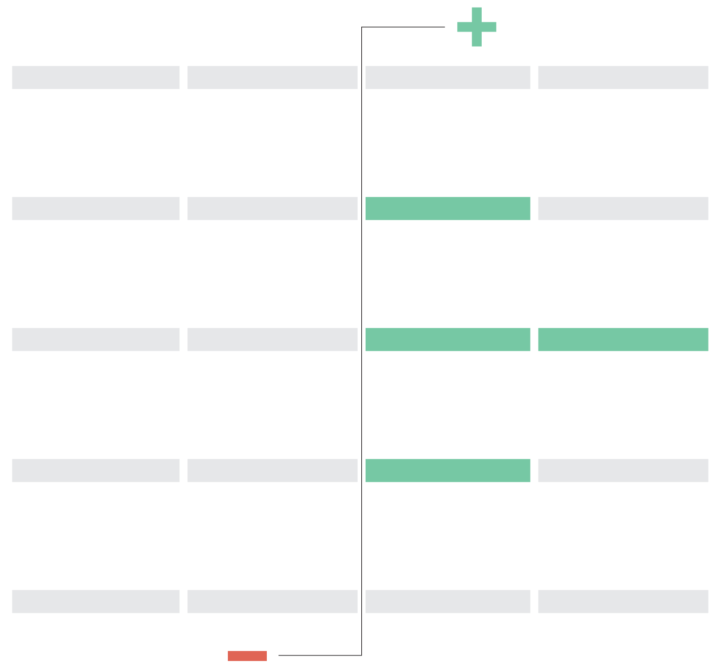


DESIGN CONSIDERATIONS

/ Consistency with the FHWA ATM implementation and operations guide

/ Consistency with Caltrans, OCTA, and local guidelines

/ Cost to implement active traffic management strategies

/ May result in additional traffic on parallel routes due to detours or temporary rerouting of vehicles

TYPICAL APPLICATIONS

During periods with high congestion caused by:

/ Freeway on- and off-ramps

/ Near ramps

/ Due to construction

/ Due to an accident

/ Due to events

COST RANGE

$$$$$

COORDINATION NEEDED

U Utilities

P Adjacent Private Property Owners

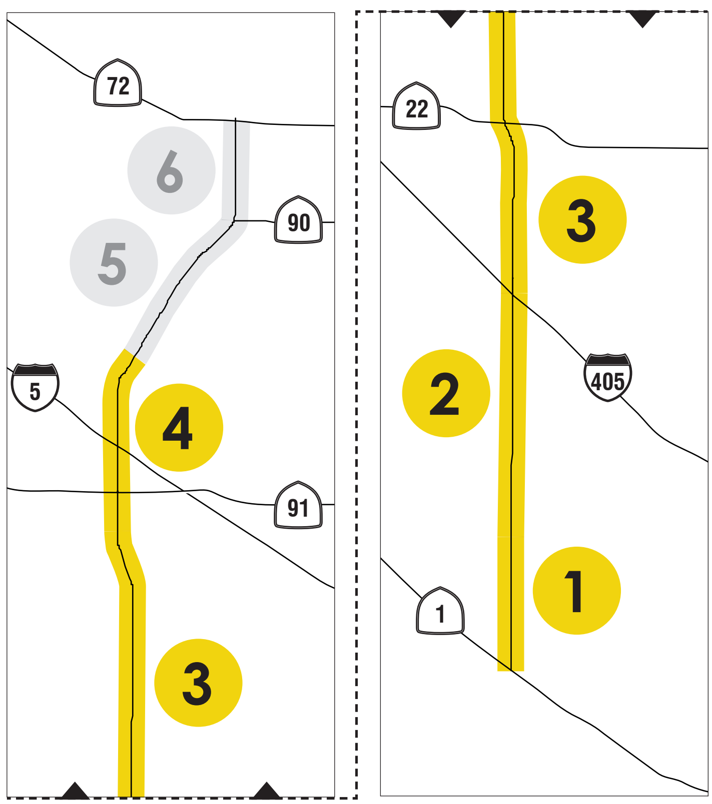
O OCTA Transit

B Adjacent Businesses

PEDESTRIAN BRIDGES

Pedestrian bridges are typically provided in areas of high pedestrian volumes crossing streets with high vehicular volumes. By separating the crossing pedestrians, pedestrian/vehicular conflicts can be eliminated which can improve conditions for roadway and transit operations (by eliminating pedestrian signal phases). Adequate areas at the end of the bridges are needed to accommodate bridge access, via stairs, ramps and/or elevators.

LOCATION KEY



MEETING GOALS

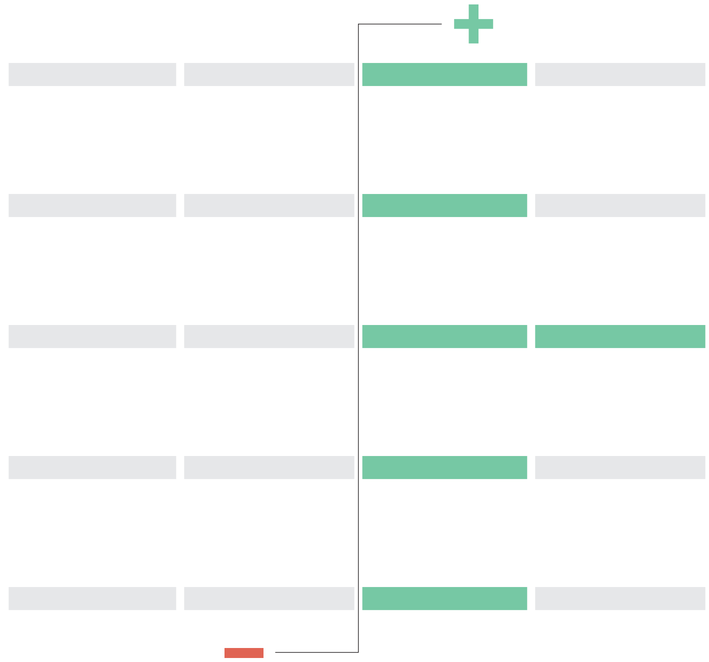
1 Improve travel time, reliability and convenience of transit.

2 Reduce impediments to walking and biking along and across corridor.

3 Maintain vehicular throughput and access to and from regional freeways network.

4 Provide a safe and accessible environment for all user groups.

5 Support local land use planning with improved mobility options.



DESIGN CONSIDERATIONS

/ Consistency with Caltrans Highway Design Manual and Standard Plans and local guidelines

/ Consistency with ADA requirement guidelines

/ Designed to provide convenient access and reduced number of steps or ramps to ensure usage

/ Required additional space for constructing a landing point and approach ramp

/ May pose a personal security risk if not well-lit or has inadequate surveillance

/ Cost to construct and maintain

/ Designed to meet vertical clearance requirements

APPLICATIONS

/ Where pedestrian demand land uses are severed by a high-speed road network

/ Where continuity for bicycle and pedestrian routes can be enabled by bridges

/ Where an at-grade crossing is not feasible

COST RANGE

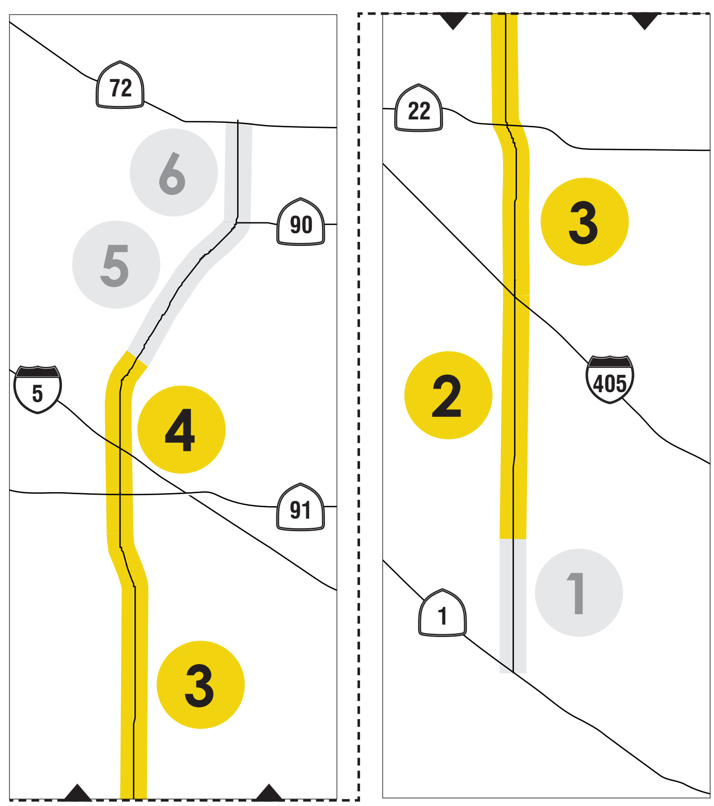
COORDINATION NEEDED

U	P	O	B
Utilities	Adjacent Private Property Owners	OCTA Transit	Adjacent Businesses

ADJUST INTERCHANGE RAMP LOCATIONS AND/OR CONFIGURATIONS

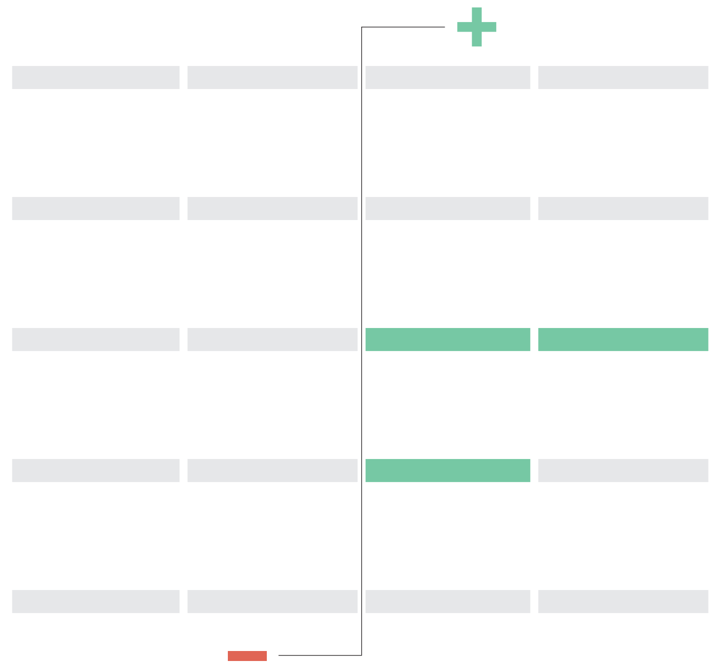
At interchange locations, there can be significant localized congestion due to the volume of vehicles entering and exiting the freeway. Typically, these locations encounter high volumes of turning movements, which result in the need for multiple signal phases, long turn pockets, and addition turn lanes. In addition, these facilities can have multiple conflict points with crossing bicyclists and pedestrians. Modifications to the intersection design can improve conditions by consolidating ramp locations and streamlining movements, and may affect the design and configuration of the entire interchange.

LOCATION KEY



MEETING GOALS

1. Improve travel time, reliability and convenience of transit.
2. Reduce impediments to walking and biking along and across corridor.
3. Maintain vehicular throughput and access to and from regional freeways network.
4. Provide a safe and accessible environment for all user groups.
5. Support local land use planning with improved mobility options.



DESIGN CONSIDERATIONS

/ Consistency with FHWA design guidelines

/ Consistency with the Caltrans Highway Design Manual and Standard Plans

/ Consistency with OCTA and local arterial design standards

/ Cost of reconfiguring interchanges

/ Potential additional right-of-way requirements

/ Some configurations require more complicated signalization that would need to be design, installed and maintained.

/ Driver unfamiliarity with newer or non-traditional interchange designs

SPECIFIC APPLICATIONS

At the following locations:

/ At the I-405 interchange

/ At the SR-22 interchange

/ At the SR-91 interchange

/ At the I-5 Interchange

COST RANGE

$$$$$

COORDINATION NEEDED

U — Utilities

P — Adjacent Private Property Owners

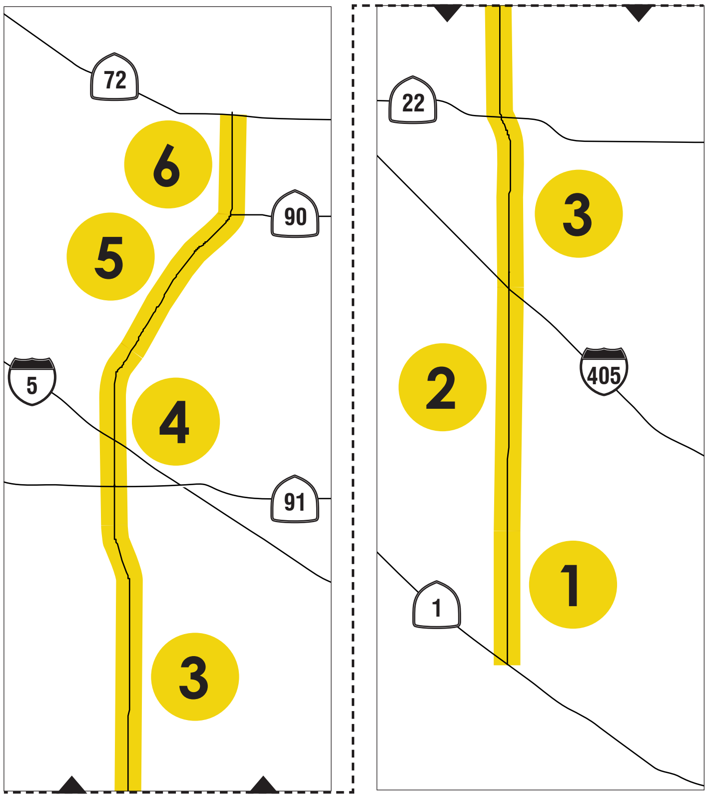
O — OCTA Transit

B — Adjacent Businesses

ALTERNATIVE INTERSECTION CONFIGURATIONS

The number of lanes along a corridor and its functional classification affect its overall capacity and flow; it is also affected by the spacing and type of intersections. While improving capacity at intersections has traditionally involved lane additions, alternative intersection types offer the potential to reduce delay (and improve safety) at a lower cost and with fewer impacts. Roundabouts and displaced left-turn intersections are two alternative intersection configurations that can offer improved operations and traffic flow along urban arterials setting.

LOCATION KEY



MEETING GOALS

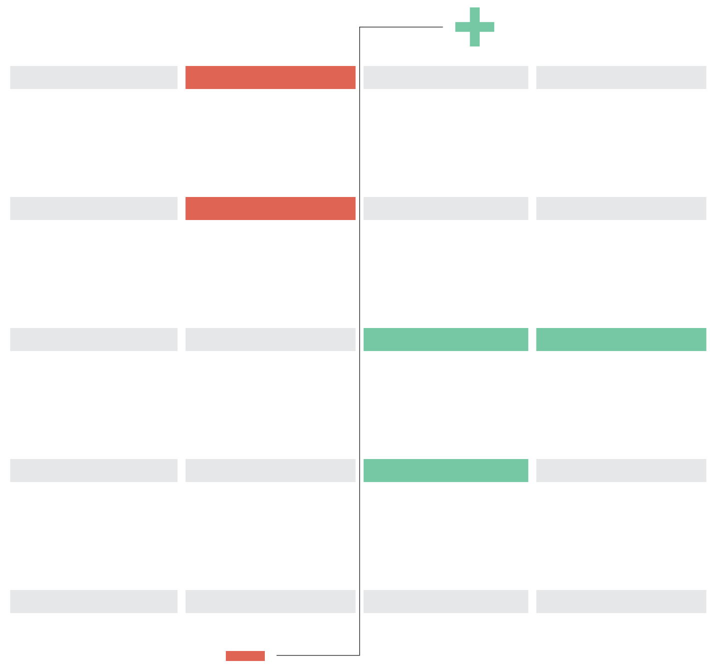
1 Improve travel time, reliability and convenience of transit.

2 Reduce impediments to walking and biking along and across corridor.

3 Maintain vehicular throughput and access to and from regional freeways network.

4 Provide a safe and accessible environment for all user groups.

5 Support local land use planning with improved mobility options.



DESIGN CONSIDERATIONS

/ Consistency with the Caltrans Highway Design Manual

/ Consistency with the arterial design standards for OCTA and the affected Cities

/ Potentially higher right-of-way requirements at the intersection compared to conventional intersections

/ Cost of reconfiguring the intersection as well as the arterial approaches

/ Driver unfamiliarity with intersections that deviate from conventional designs

/ Design to maintain access to adjacent properties

/ Can be implemented at one intersection or designed to operate as a system

TYPICAL APPLICATIONS

/ Typical applications are in the three lane segments with lower volume cross-streets

/ With a two lane roundabout, the intersection approaches would need to be narrowed therefore the 3-lane segments would be best to accommodate the roundabout as the third lane could be dropped or trapped into a right only lane

/ The displaced left-turn can accommodate heavy left turning volumes and would require roadway widening or could be accommodated with narrowing of the existing roadway segment

/ With the displace left-turn, the 4-lane segments would best accommodate lane reduction and reconfiguration

COST RANGE

$$$$$

COORDINATION NEEDED

U — Utilities

P — Adjacent Private Property Owners

O — OCTA Transit

B — Adjacent Businesses

Section 8
CASE STUDIES

The purpose of this section is to present case studies where various toolbox elements are applied to typical locations throughout the Project Corridor.

Case studies were prepared at the following types of locations along the Project Corridor:

- Major intersection
- Minor intersection
- Freeway ramp intersection
- 6-lane roadway segment
- 8-lane roadway segment

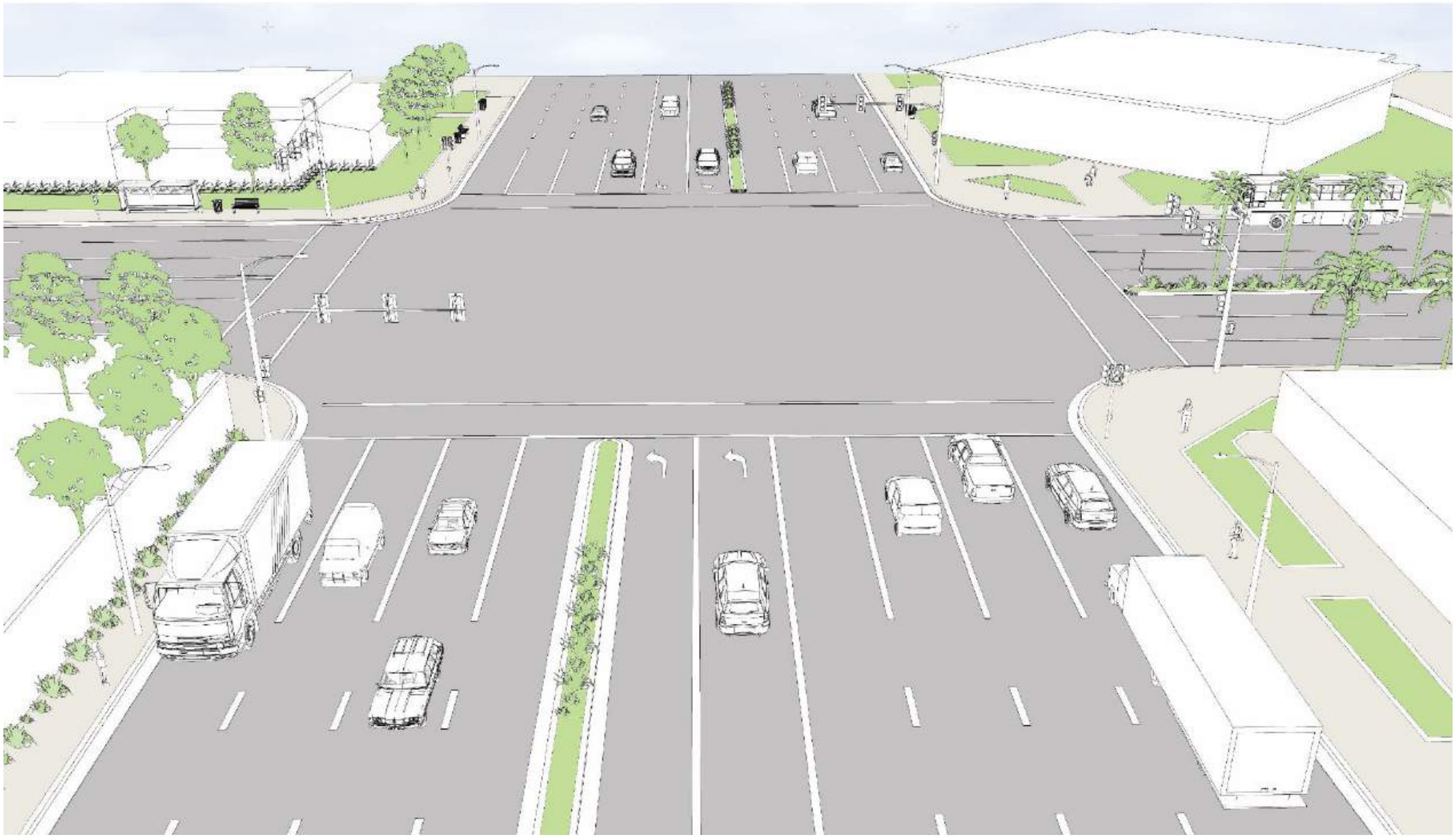
The case study location types were chosen to represent various intersection and roadway segments experienced throughout the Project Corridor and would present opportunities for implementation of different toolbox elements. Information on the case studies is presented below:

- **Major Intersection:** These represents the intersection of Beach Boulevard with another high-volume arterial. These locations are expected to have significant turn volumes to and from the Project Corridor and would have dual left-turn lanes. The intersections are also expected to have a major transit stop and thus are the locations for a transfer point for crossing lines. Therefore, these intersections could be candidates for advanced vehicular and transit throughput as well as transit stop improvements.
- **Minor Intersection:** Minor intersections represent signalized intersections with smaller collector roads, residential streets or communities, and entrances to commercial or institutional uses. These smaller intersections would be smaller on the crossing legs and could be candidates for various pedestrian safety and transit throughput improvements.
- **Freeway Ramp Intersection:** The Project Corridor is traversed by four freeways with multiple ramp configurations. These intersections would have significant volumes entering and exiting the Project Corridor. As freeway ramps are primarily designed to effectively move volumes to and from the freeway, these locations could be candidates for improvements that would decrease delay along the Project Corridor and increase safety for pedestrians crossing the various ramps.

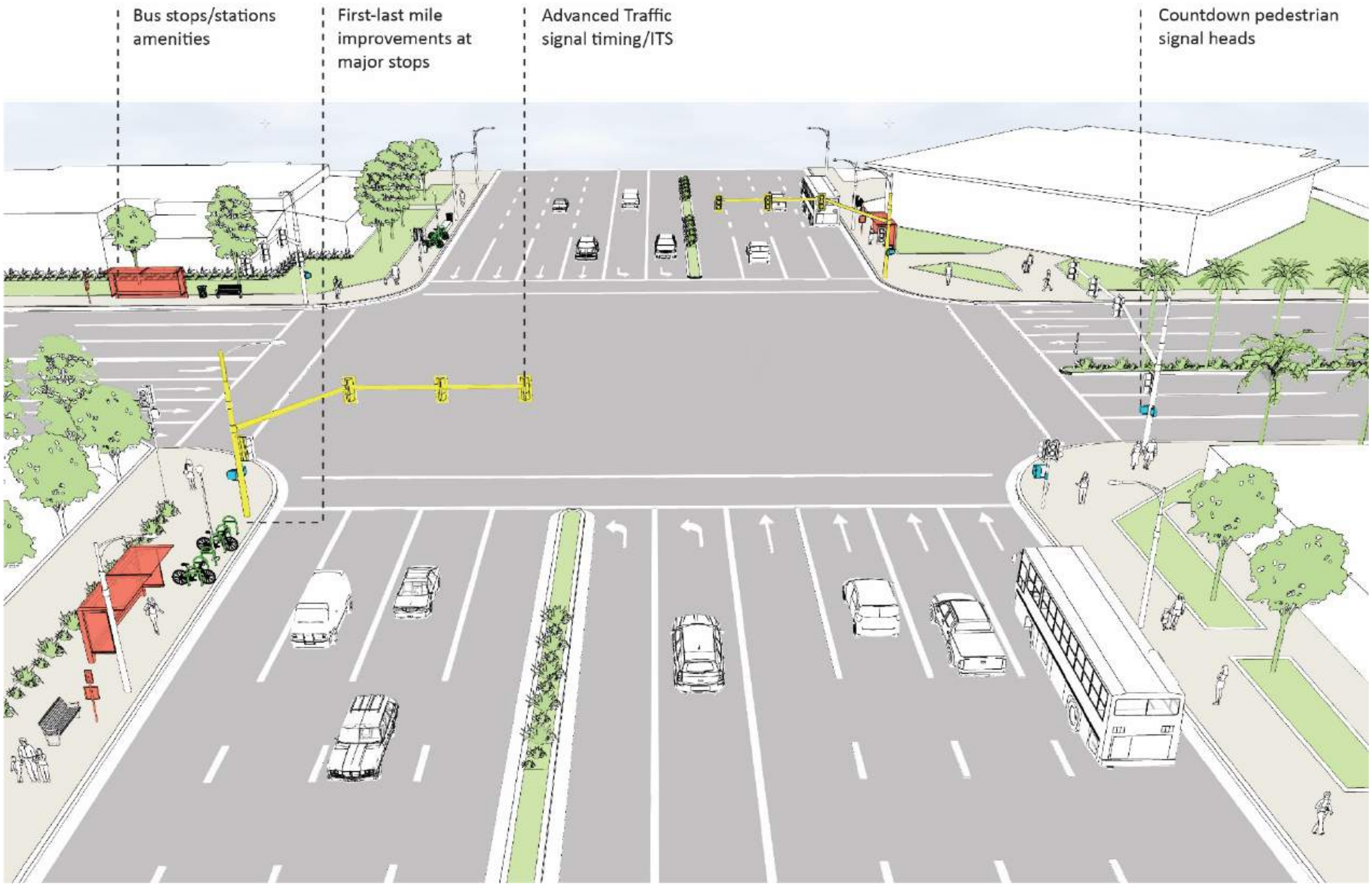
- **6-Lane Roadway Segment:** The 6-lane roadway segments represent one of the two roadway segment configurations along the Project Corridor, primarily located at the south and north ends. These segments could be candidates for mobility and safety improvements geared towards pedestrians.
- **8-Lane Roadway Segment:** The 8-lane roadway segment represents the other roadway segment configuration along the Project Corridor. These segments could be candidates for advanced corridor management improvements, as well as improvements to pedestrian and bicycle environments. These segments also present more opportunity for lane reduction improvements due to the wider curb-to-curb distances.

8.1 CASE STUDY 1 – MAJOR INTERSECTION

Major Intersection - Before

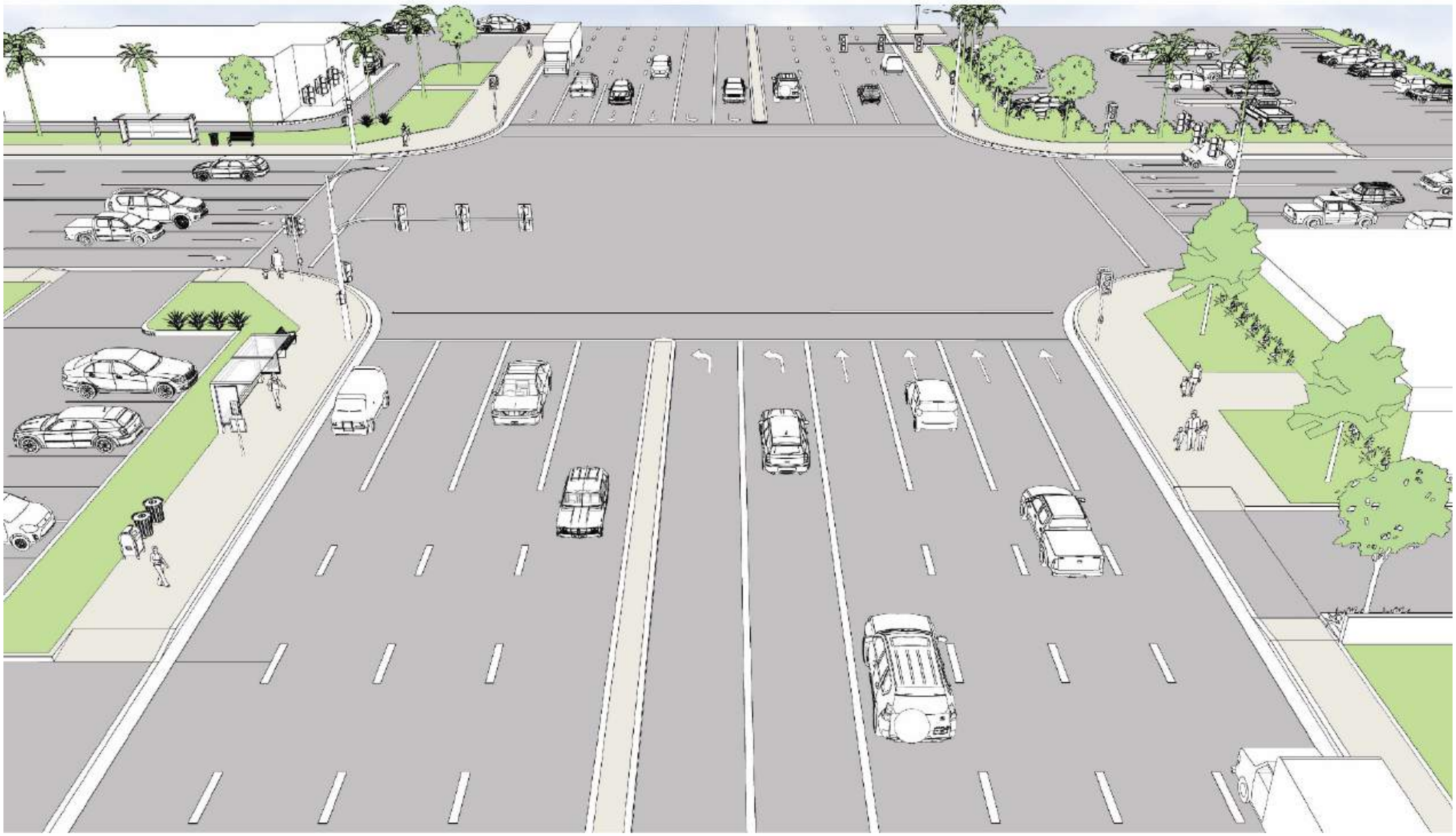


Major Intersection - After

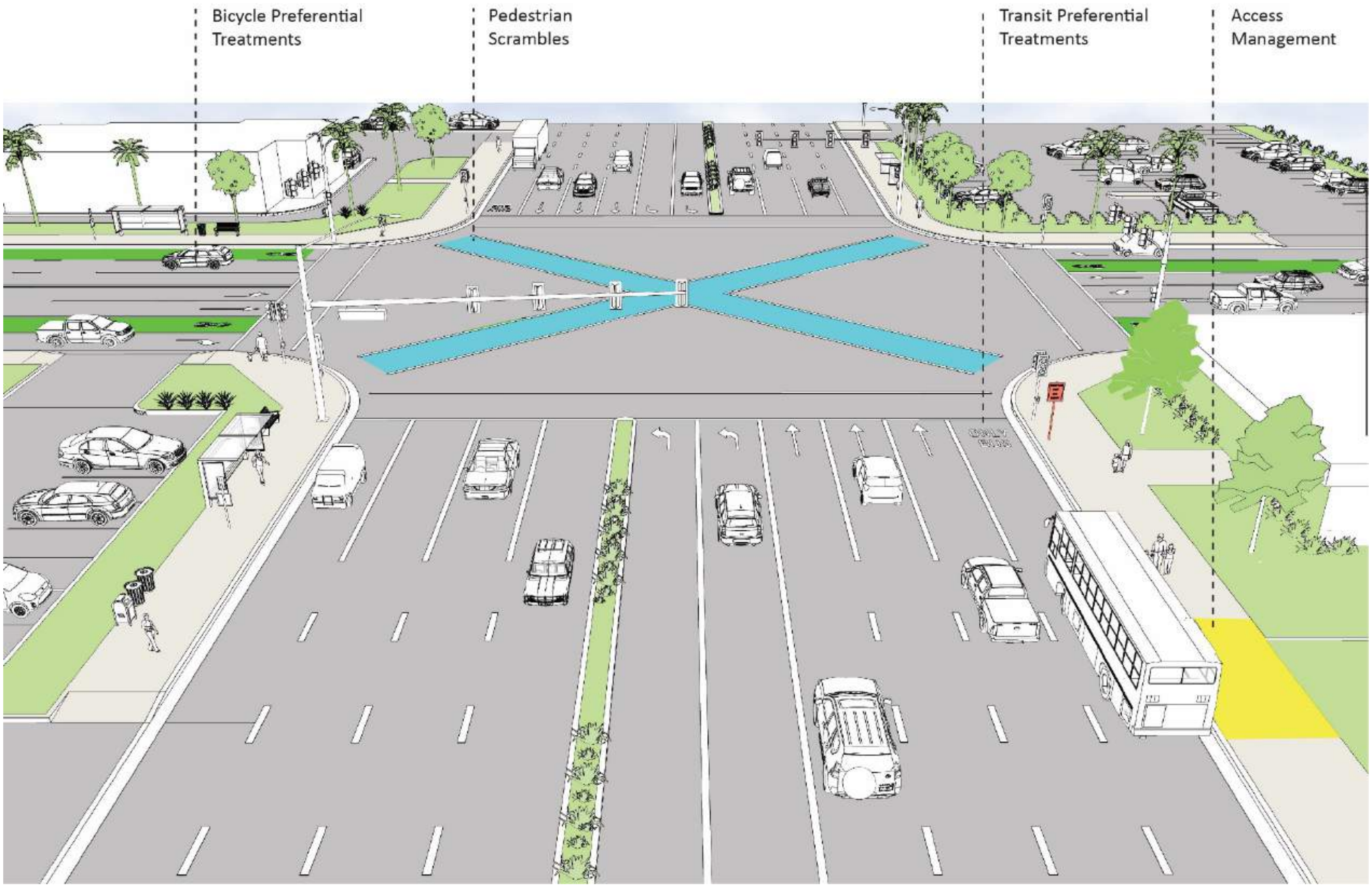


8.2 CASE STUDY 2 – MINOR/RESIDENTIAL INTERSECTION

Minor Intersection - Before

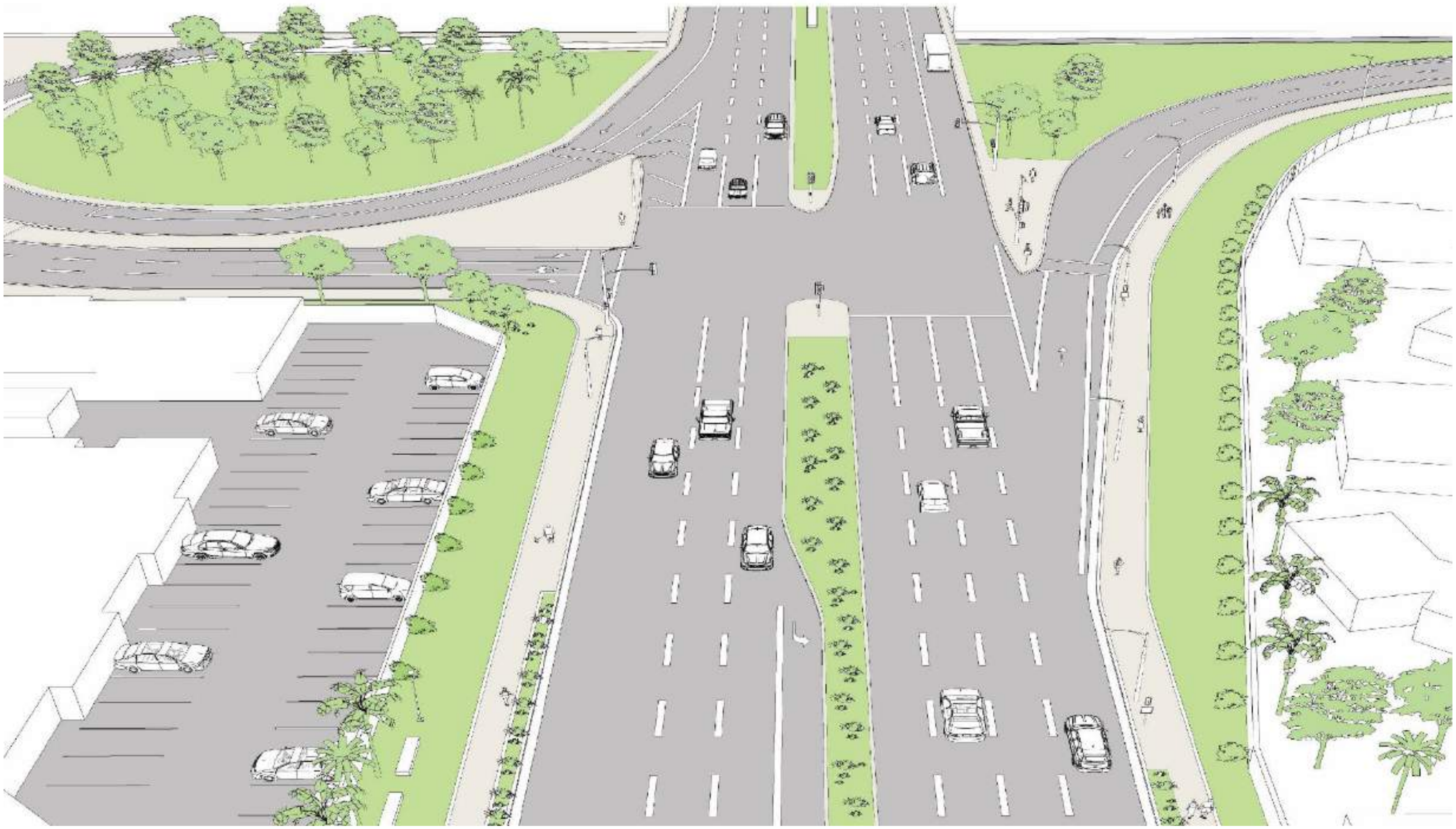


Minor Intersection - After

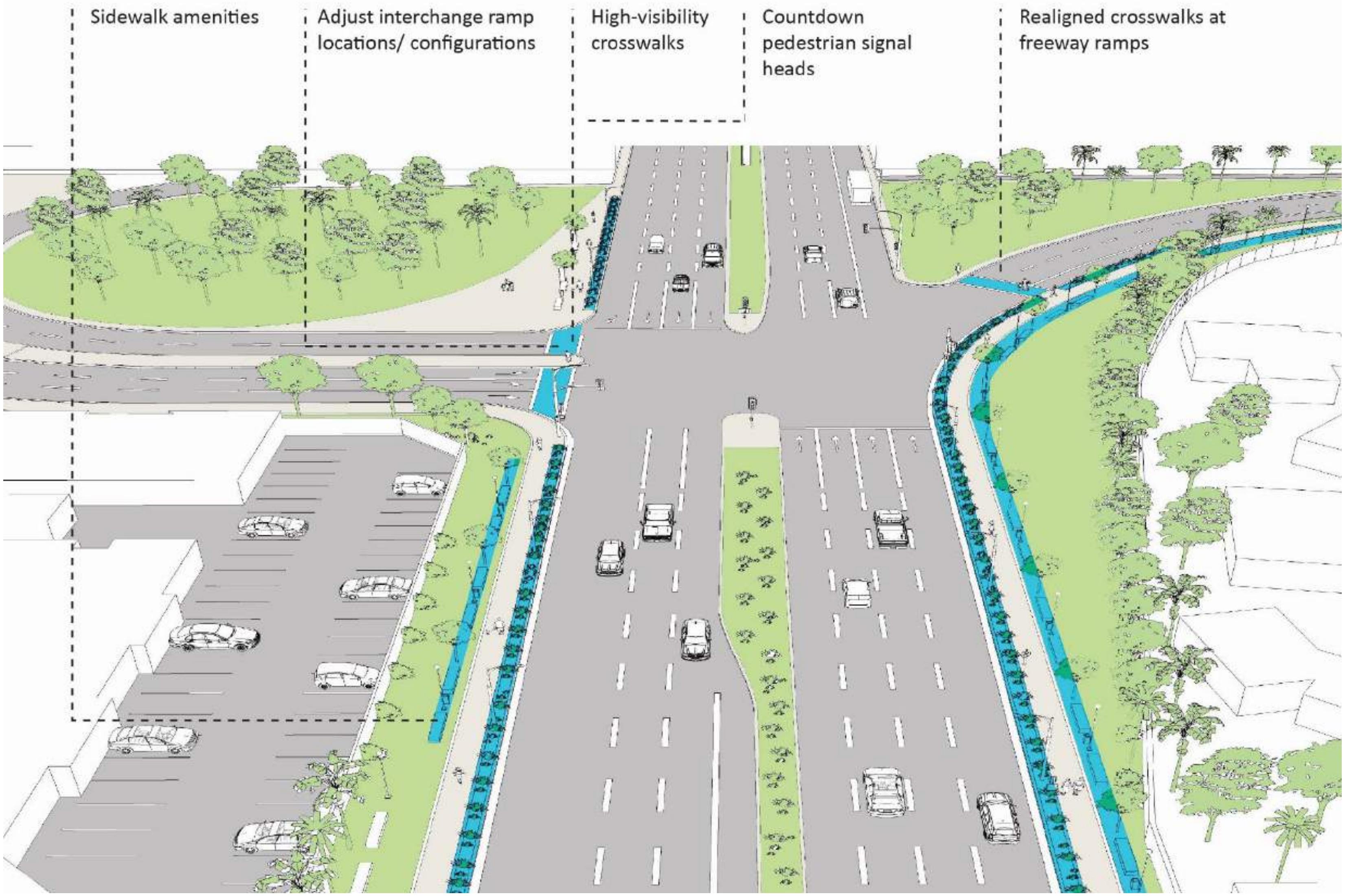


8.3 CASE STUDY 3 – FREEWAY RAMP INTERSECTION

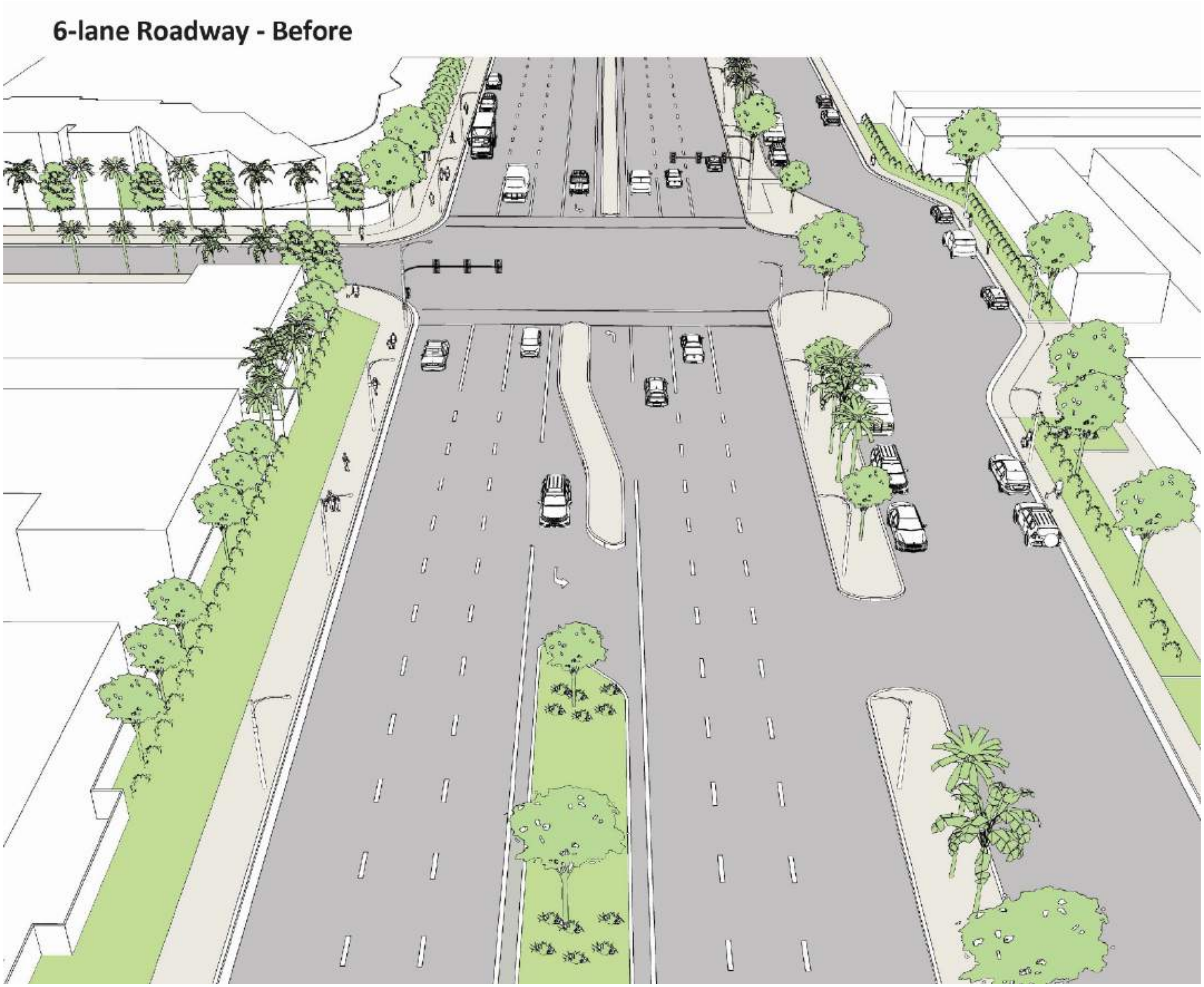
Freeway Ramp Intersection - Before



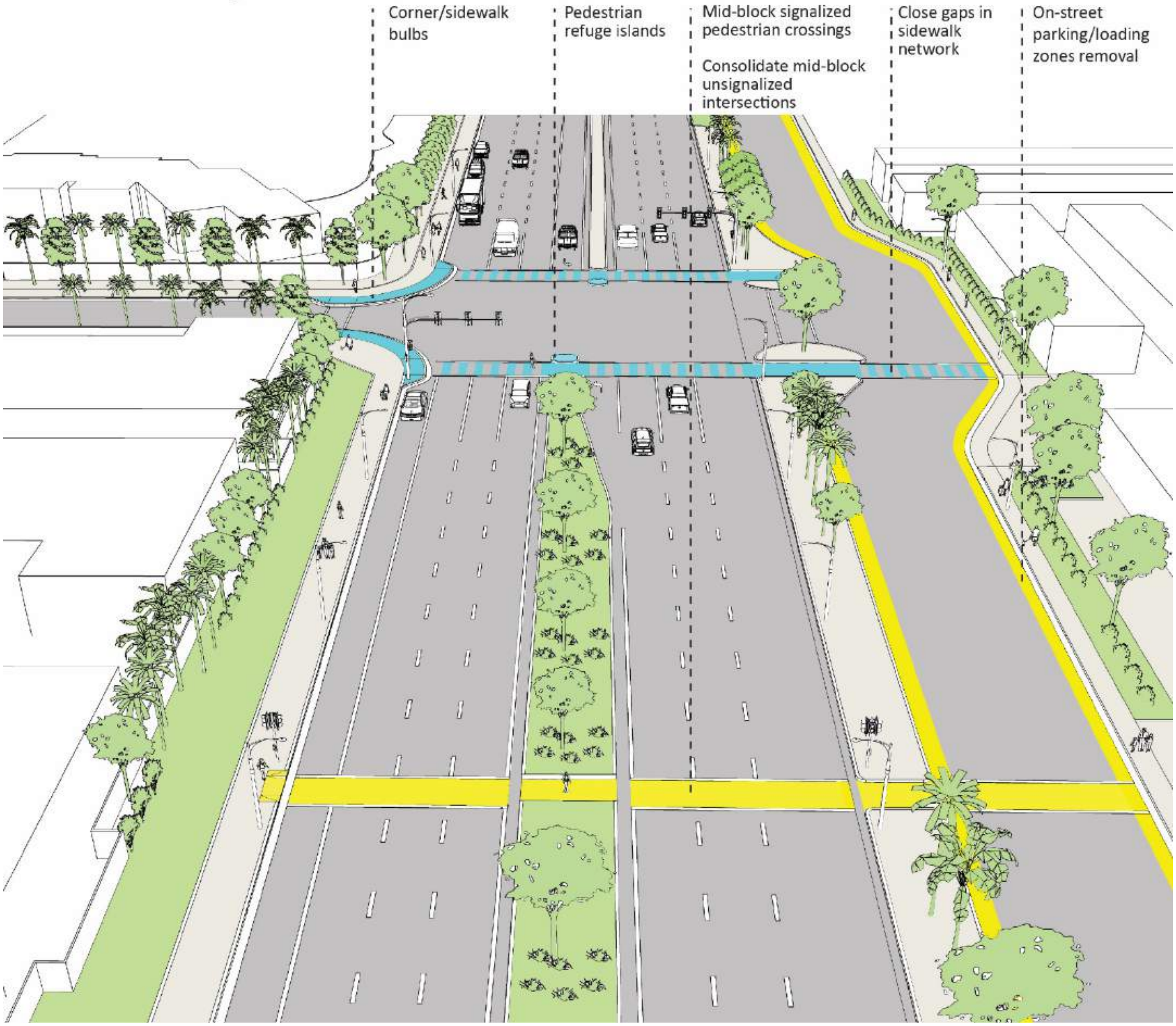
Freeway Ramp Intersection - After



8.4 CASE STUDY 4 – 6-LANE ROADWAY SEGMENT

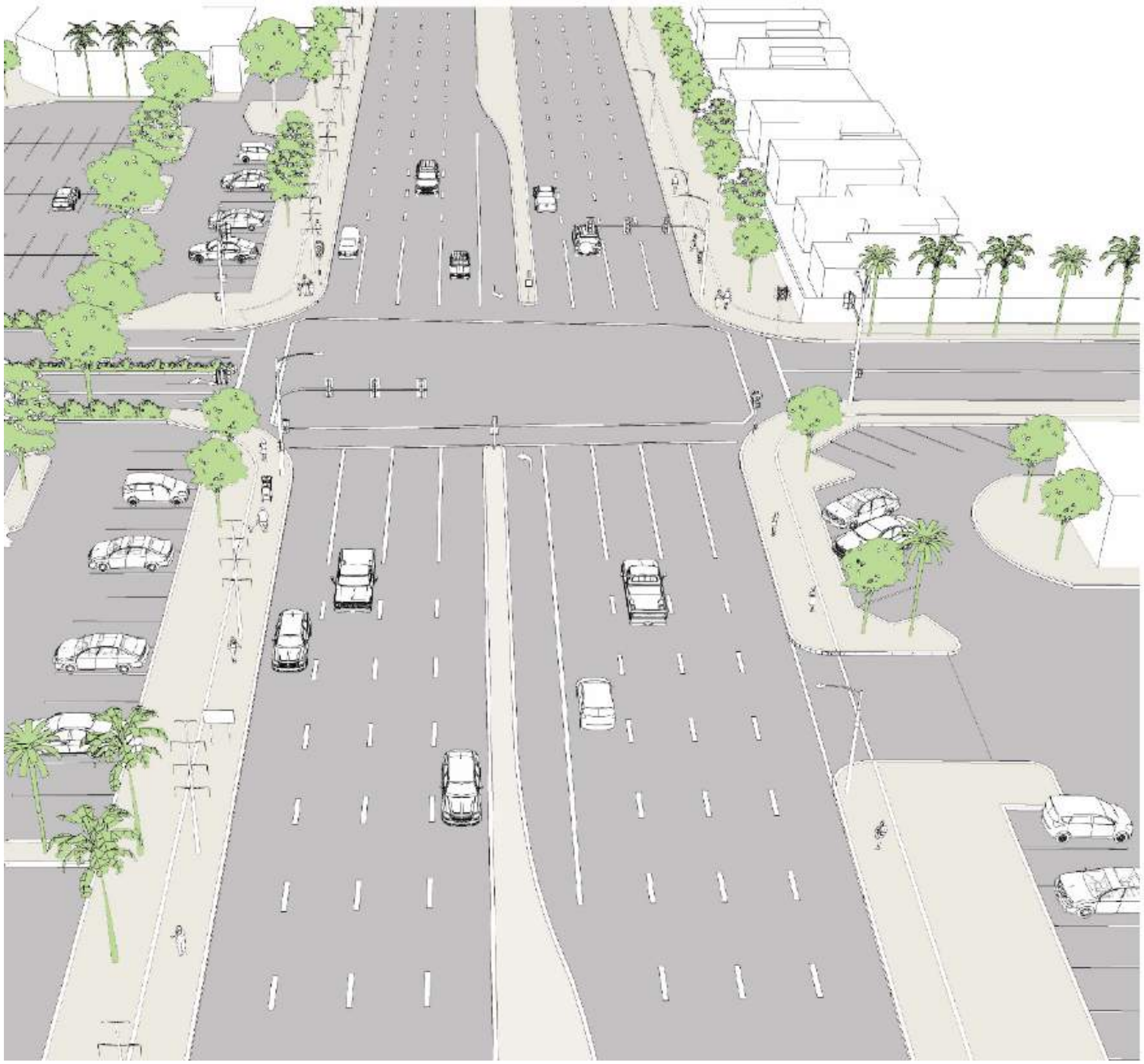


6-lane Roadway - After

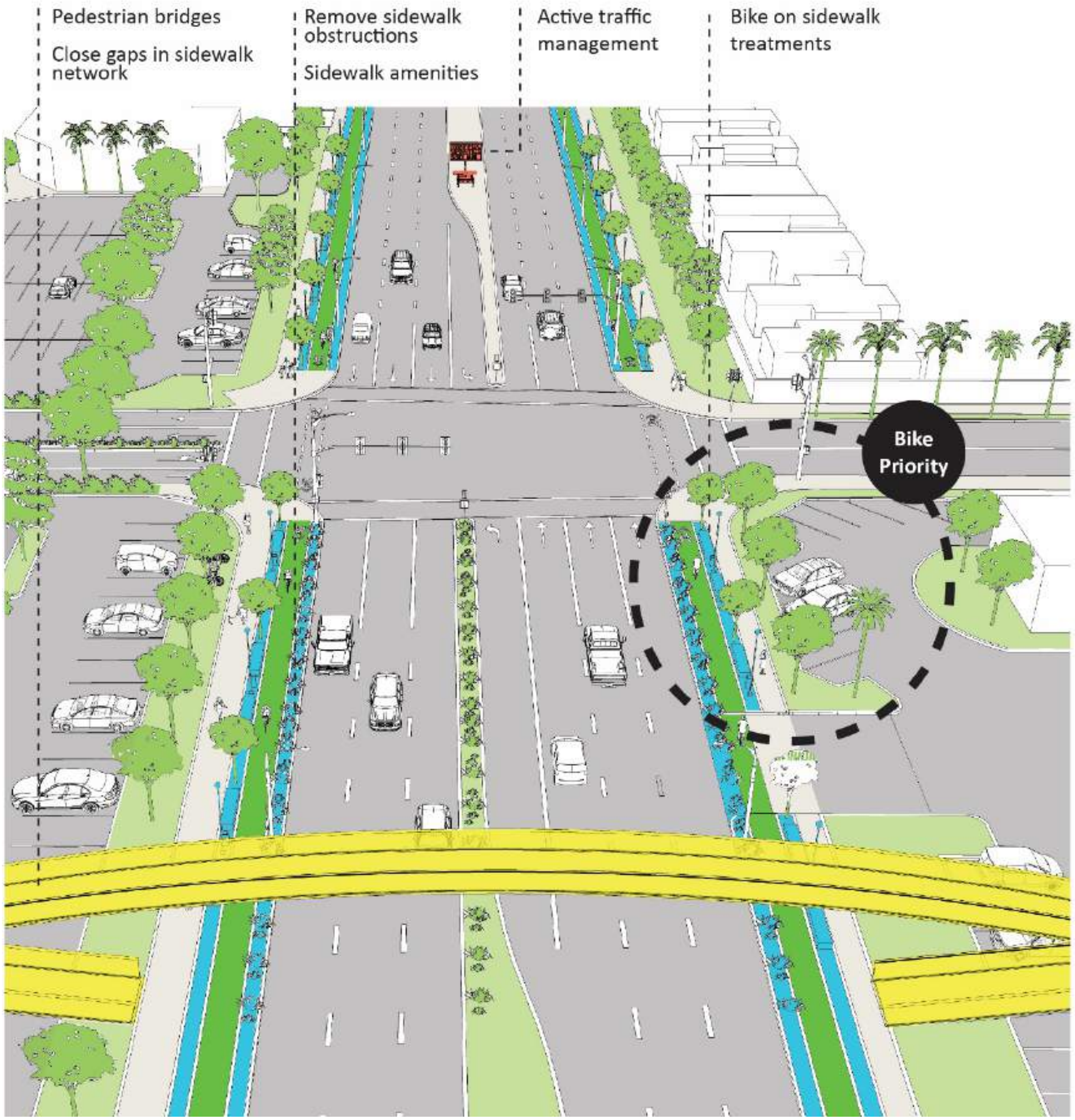


8.5 CASE STUDY 5 – 8-LANE ROADWAY SEGMENT

8-Lane Roadway - Before



8-Lane Roadway - After



Section 9
IMPLEMENTATION APPROACH

The purpose of this section is to provide guidance on the future implementation of the toolbox elements. In particular, information regarding local/regional coordination needed, potential available funding sources, and corridor-wide planning has been summarized. In addition, this section includes additional details on the cost estimating process associated with the toolbox elements.

9.1 COORDINATION

Given that the majority of Beach Boulevard is under jurisdiction of Caltrans, implementation of any toolbox element would require some level of coordination and approvals by Caltrans.

Depending on the type and scale of the proposed improvement, one of the following three additional levels of coordination would be required.

- **Local:** For a project that would be completely within a city limits and would have the likelihood of minimal impacts to adjacent cities (or county) property, the standard city review and approval processes would be applicable.
- **Multi-city:** Some projects would have the potential to affect adjacent jurisdictions or would span city borders (for instance, access management or implementation of first/last mile improvements at major transit stops). For these project types, additional cross-city coordination would be required to minimize potential negative impacts and to ensure consistency in the design treatments and standards.
- **Regional:** Projects that could influence regional travel activities (such as implementation of active traffic management) would need to be reviewed and approved on a regional basis. Although individual cities could propose to implement regional improvements within their boundaries, the potential for affects to other locations should be addressed. As such, it is likely that a regional sponsor, such as OCTA or Caltrans, would need to be involved.

In addition, some projects could be proposed by Caltrans, as the owner of the facility, or by OCTA. It is anticipated that these projects would include involvement from the local agencies within the project study area, through efforts like a Technical Working Group

(TWG), Technical Advisory Committee (TAC), or a Project Development Team (PDT).

9.2 FUNDING SOURCES

The purpose of this section is to present information on funding programs at the Federal, State, and regional/local levels that could be potentially used for the various project improvements identified throughout the Project Corridor.

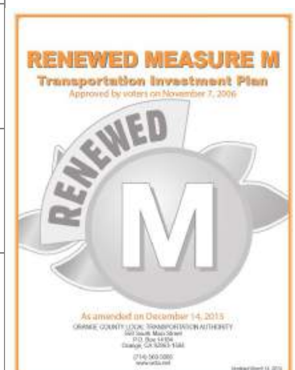
The list of potential funding sources are identified using the list of toolbox elements and is not an exhaustive list of funding sources. The list is intended to be a starting point of information for Caltrans, OCTA, or local jurisdictions should they pursue implementation of any toolbox element. The application process for many of the funding sources is competitive and may require multiple jurisdictions to submit together to win the funding.

Table 9-1 below lists the various funding sources. The table correlates funding sources with qualifying project types including transit, pedestrian, bicycle, vehicle, or safety projects. The table provides a general correlation and all toolbox elements under each project type may not qualify under the funding source.

Table 9-1. Potential Funding Sources

Funding Source	Qualifying Project Types				
	Transit	Pedestrian	Bicycle	Vehicles	Safety
Federal					
Recreational Trails Program (RTP)		X	X		
TIGER Discretionary Grant	X	X	X	X	
Highway Safety Improvement Program (HSIP)		X	X	X	X
State					
Active Transportation Program		X	X		X
Cap and Trade: Affordable Housing & Sustainable Communities Program	X	X	X		X

Funding Source	Qualifying Project Types				
	Transit	Pedestrian	Bicycle	Vehicles	Safety
Cap and Trade: Low Carbon Transit Operations Program	X	X	X		X
Senate Bill 1 (SB1) Transportation Funding	X	X	X	X	X
State Transportation Improvement Program (STIP)		X	X		
State Highway Operations Protection Program (SHOPP)				X	
Regional & Local					
Bicycle Improvement Program Call for Projects (federally funded by the CMAQ program)		X	X		X
Measure M2 - Regional Capacity Program (Project O)		X		X	
Measure M2 - Signal Synchronization (Project P)	X	X	X	X	X
Measure M2 - Local Fair Share Program (Project Q)	X	X	X	X	X
Measure M2 - Community Based Transit/ Circulators	X	X			
Development Impact Fees	X	X	X	X	
Local Gas Tax Subvention	X	X	X	X	
Enhanced Infrastructure		X	X		X
City General or Other Discretionary Funds	X	X	X	X	X



9.3 COST

The purpose of this section is to document the cost estimation process for the toolbox elements presented earlier in this report. In general, the cost estimates were developed using local data sources (as available) and standard unit costs. As Beach Boulevard is mostly under the jurisdiction of Caltrans, the Caltrans process for cost estimation under Chapter 20 of the Project Development Procedures Manual and the Preparation Guidelines for Project Development Cost Estimates – Cost Estimating Guidelines were the basis for the cost estimate template format.

9.3.1 Data Sources and Compilation

Data sets from the corridor cities (Huntington Beach, Westminster, Garden Grove, Stanton, Anaheim, Buena Park, Fullerton, La Mirada, and La Habra) as well as unincorporated Orange County were formally requested in the form of as-built plans and associated contractor bid summaries from recent construction projects. The data was intended to help supplement and support the information used to prepare the cost estimates for the toolbox elements which also provided realistic examples of bid items and unit prices to the current market. From the request, feedback from the cities of Huntington Beach, Fullerton, and Stanton were received as well as from the County of Orange. Similarly, references to cost estimates from recent OCTA projects such as the I-405 Improvement Project and the West County Connectors Project were used, which included similar items identified for most of the toolbox elements.

9.3.2 Cost Estimate Template Format

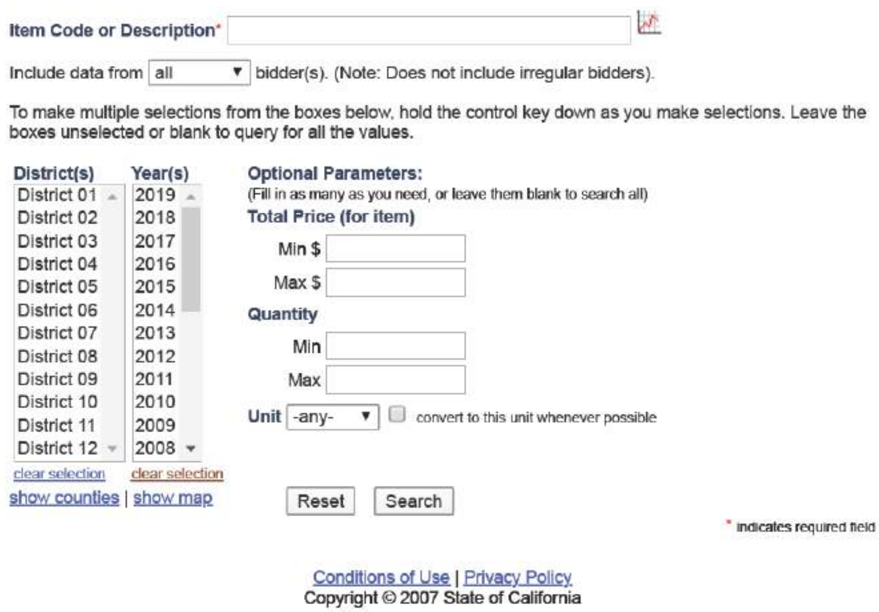
The basis for the cost estimates is the Caltrans 11-spreadsheet tab planning cost estimate template available at the Caltrans website[61]. The estimate is generally broken down by 13 subsections under the roadway category and separate sections each for structure, right-of way, and support costs. For the purpose of estimating the toolbox elements at a planning level, the order of magnitude of each cost estimate was assumed to be high-level estimates with the assumption that further studies and engineering level design would be necessary to develop a more refined and detailed cost estimate. With this assumption, a 30% contingency was added to each estimate to generally cover unforeseen items of work upon further studies and engineering. Furthermore, with a high-level estimate,

[61] Caltrans Cost Estimating Resources. https://dot.ca.gov/programs/design/cost-estimating-improvements. Accessed November 2019.

partial or full acquisition of adjacent properties along the Project Corridor were not included with the cost estimates.

9.3.3 Unit Price Determination

Once items of work were identified for each toolbox element, categorized into the various roadway subsections or structures, and quantified, the next step in the cost estimation process was to determine the unit prices from both the city data and Caltrans Contract Cost Database. The categories of items of work used to determine the unit prices for roadway mostly encompassed work items for traffic signing and striping, pavement structural section, drainage, and traffic signals.



The Caltrans Contract Cost Database[62] is used on all Caltrans projects during all phases of project development. The tool allows the user to search parameters by Caltrans District, year(s), minimum or maximum costs, and unit types from all Caltrans bid items. Each search provides a summary of unmodified and adjusted unit prices based on the Caltrans Construction Cost Index.

Comparison of costs using a combination of bid item prices from the city project and Caltrans Contract Cost Database against the estimated quantity were analyzed. The unit prices identified in the city bid summaries were used as a check against the Caltrans unit prices. Consistency in the determination of unit prices, especially for common items from the toolbox elements, was conducted in order

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[62] Caltrans Contract Cost Database. https://sv08data.dot.ca.gov/contractcost/. Accessed November 2019.

to have a controlled comparison for future use of the estimate. The detailed cost estimate sheets are provided on the Project webpage.

9.4 LAND USE AND CORRIDORWIDE PLANNING

Given the close relationship between transportation and land use, additional review and coordination should be conducted when performing land use planning and transportation network changes along the Study Corridor. This would be appropriate for individual development projects, area/specific plans, and changes to the roadway. Information on these efforts is provided in the following sections.

- **Local development projects:** As part of the development review process (such as within the transportation impact study, environmental documentation or design review phases), the number and location of driveways along the Project Corridor should be considered in association with the principles outlined in the Access Management toolbox element. Where possible, development should be encouraged to utilize shared driveways and minimize the number and width of curb-cuts to maintain good pedestrian conditions. In addition, opportunities to widen sidewalks through set-backs, and locations where sidewalk obstructions can be relocated, should be explored. Care should be taken if on-street parking or loading zones are proposed to be established to ensure they do not negatively affect vehicular throughput or reduce visibility for pedestrians or bicyclists. Finally, all development projects should continue to promote walking and biking by providing contiguous sidewalk facilities and incorporating on-site bicycle amenities.

- **Area/Specific plans:** Planning for larger areas should address the ability to minimize the effect on the roadway network by encouraging the use of alternative modes and implementing travel demand management (TDM) elements.

  The opportunity should be taken to explore systemic improvements to pedestrian facilities, bicycle lanes, and first/last mile connections to transit services. In addition, plans should explore means to improve connectivity along and across Beach Boulevard through implementation of toolbox ideas such as High Visibility Crosswalks, Pedestrian Bridges, or

Corner/Sidewalk Bulbs. With the larger areas of these planning studies, it can be more appropriate to evaluate the effect and benefit of these improvements over case-by-case efforts.

- **Transportation facility modifications:** When changes are being considered along Beach Boulevard or within the Study Area, opportunities to implement Tier 0 toolbox elements should explored. For example, it may be possible to add the striping of High Visibility Crosswalks to a repaving or resurfacing project, or Pedestrian Countdown Signal Heads can be added when traffic signals are being replaced. Typically, these projects would have minimal cost and timeframe implications and thus could be incorporated without significant efforts.

Through the incorporation of the toolbox elements through ongoing and future planning within the Study Area, existing circulation and mobility challenges can be addressed, and conditions can be improved to account for the future growth anticipated throughout the area.

9.5 LONG-TERM CORRIDOR VISION

Implementation of the various transportation projects identified in this study will help address current and future multimodal needs throughout the Study Area. In particular, the proposal, approval and construction of these elements (by either cities or agencies) will improve overall multimodal circulation and access for various user groups.

In addition to addressing known and anticipated future conditions, it may be beneficial to consider the long-term potential for the Project Corridor. Considering recent trends in mobility services, transportation planning, urban design, land use planning, and economic development, a comprehensive vision of the future may help guide upcoming land use and transportation policy and programming choices.

The following highlights potential long-term elements for consideration along the Project Corridor:

- **Mobility Hubs:** Mobility hubs are locations that integrate different modes of transportation, multimodal-supportive infrastructure, and land use/urban design elements to create centers that support circulation and access. Typically, these hubs are positioned adjacent to major transit centers and include amenities such as bikeshare stations, carshare facilities, rideshare loading spaces, sheltered waiting areas, retail and supportive services, and information/wayfinding. In addition, first/last mile elements, such as bicycle and pedestrian infrastructure, are also typically incorporated into the mobility hub service area. The identification and implementation of a network of mobility hubs would encourage the use of transit services and active transportation modes by improving the connectivity between modes and providing the necessary services to support each mode of travel in one centralized location.

- **Connected corridors:** As connected vehicle technologies continue to be developed, there are opportunities to establish a roadway that has integration between vehicles and infrastructure. These facilities have the ability to connect traffic sensing, traffic control and predictive traffic modeling techniques to improve travel conditions for people traveling, living and working along the corridor. Primarily, there are two major approaches to implement connected corridors. The first is integrated corridor management, in which real-time traffic information and probe data from GPS sources is used to dynamically route vehicles and adjust signal timing and roadway geometry to improve areawide flow (e.g., incident management). The second is traffic signal systems, when vehicle location and movement information (in combination with other sources, like cell phone GIS data), is used in real-time to modify signalization plans to account for pedestrians, vehicle platoons, transit priority, or other modes. In both applications, the infrastructure and mobile data sources are in constant communication to optimize conditions.

- **Autonomous vehicles:** The vision for automated vehicles is to have cars, trucks and transit (whether personal or shared) operate within local and regional roadway facilities without a driver. Once these systems are operational, there will be substantial effects to transportation infrastructure and land uses. For example, with shared autonomous vehicles, there would be a reduced need for business-adjacent parking spaces, as vehicles will be able to park themselves at remote parking facilities. This would allow for a reimaging of curb space and on-street parking spaces, or the reduction in city parking requirements. Similarly, autonomous vehicles would likely be able to operate more efficiently on roadways and thus may allow for the reallocation of right-of-way from vehicles to other uses or users.
- **Microtransit:** Compared to traditional fixed-route transit systems (e.g., OCTA buses), microtransit is small-scale, on-demand transit service that can offer fixed routes and flexible routes with on-demand scheduling. Also known as demand responsive transit, these services can be provided by both public transit providers and private entities. Typically, microtransit providers establish routes and utilize vehicles to match supply and demand, which improves the efficiency and accessibility of transit. With these services, pick-up/drop-off locations are usually at designated locations which can require additional curb space and supportive infrastructure. The anticipated benefits of microtransit are the ability to better serve transit-dependent populations, improve service during off-peak hours, and reduce the distance between the transit stop locations and the actual origin/destination of the trips.
- **Micromobility:** Collectively, micromobility is the category of modes of travel that are provided via personal or shared light-duty vehicles, such as scooters, skateboards and bicycles. These are typically electrified vehicles with motors or electric-assists to improve speeds and range of operations. Although these vehicles can be owned, the majority are operated through a sharing network with designed (docked) or undesignated (undocked) pick-up and drop-off locations. In addition, neighborhood electric vehicles (NEVs) can be used to provide transportation for one or two passengers in an enclosed vehicle. Micromobility can help address first/last mile issues and provide the ability to travel short distances without the use of a personal vehicle or a shared-ride vehicle.

To better accommodate and account for these modes, supportive infrastructure and legislation may be required.

The application and adoption of these trends, either individually or collectively, could significantly affect the design and operation of the Project Corridor and the surrounding land use and urban design environment. As such, additional study efforts will be needed in the future to identify, plan and implement each area and will likely necessitate additional coordination and collaborate among the stakeholders and controlling agencies.

APPENDIX
CORRIDOR SEGMENTATION MAP

Corridor Segmentation by Physical Roadway Characteristics
Beach Boulevard Corridor Study

OCTA

Figure
1

Coordinate System: NAD 1983 StatePlane California VI FIPS 0406 Feet
Data Source: Delete if there isn't one.