CITY OF Richmond CALIFORNIA

LOCAL ROADWAY SAFETY PLAN

July 2022

Statement of Protection of Data from Discovery and Admissions

Section 148 of Title 23, United States Code

REPORTS DISCOVERY AND ADMISSION INTO EVIDENCE OF CERTAIN REPORTS, SURVEYS, AND INFORMATION — Notwithstanding any other provisions of law, reports, surveys, schedules, lists, or data compiled or collected for any purpose relating to this section, shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at the location identified or addressed in the reports, surveys, schedules, lists, or other data.

This study applies a systemic safety approach that identifies certain features on particular roadways that are correlated with specific collision types and frequencies. This broad approach is necessitated by the inherent nature of covering an entire agency's facilities in one study and the limited scope/budget available to prepare LRSPs. Limited time is available to perform field observations throughout the study area to contextualize the data, and therefore, it is beyond the scope of work to perform in-depth "hot spot" evaluations at all locations.

Acknowledgments

The City of Richmond and Contra Costa County have completed multiple safety-related plans with more in progress, and this Local Roadway Safety Plan (LRSP) is an exciting opportunity to bring together multiple streams of work for a comprehensive picture of safety in Richmond.

The 2022 City of Richmond Local Roadway Safety Plan was primarily funded through a Local Roadway Safety Plan (LRSP) grant provided by the California Department of Transportation (Caltrans) and supplemented by a local matching grant. Additional funding was provided by the Metropolitan Transportation Commission (MTC) in relation to a Vehicle Miles Traveled (MTC) Reduction Pilot Project. Input was sought from an advisory group consisting of staff from the City of Richmond and partner public agencies. Fehr & Peers assisted the City of Richmond in preparing the plan.

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Glossary

(A)ADT (annual) average daily traffic

ABAG Association of Bay Area Governments

ADA Americans with Disabilities Act

AHSC Affordable Housing and Sustainable Communities

ATP Active Transportation Program

AV Autonomous Vehicle

B/C Benefit/Cost

BTA Bicycle Transportation Account

BUILD Better Utilizing Investments to Leverage Development

CDBG Community Development Block Grant

CIP Capital Improvement Plan

CRF Crash Reduction Factor

CSSA Complete Streets Safety Assessment

CCTA Contra Costa Transportation Authority

CVC California Vehicle Code

DOT Department of Transportation

DUI Driving Under the Influence

EMS Emergency Medical Services

FHWA Federal Highway Administration

GIS Geographic Information System

HSIP Highway Safety Improvement Program

ITE Institute of Transportation Engineers

KSI Killed or Severely Injured

LED Light-emitting Diode

LPI Leading Pedestrian Interval

LPP Local Partnership Program

LRSM Local Roadway Safety Manual

LRSP Local Road Safety Plan

LSRP Local Streets and Roads Program

LTF Local Transportation Fund

MTC Metropolitan Transportation Commission

MUT Median U-Turn

MUTCD Manual on Uniform Traffic Control Devices

OTS Office of Traffic Safety

PCF Primary Collision Factor

PHB Pedestrian Hybrid Beacon

RCUT Restricted Crossing U-Turn

RRFB Rectangular Rapid Flashing Beacon

SCCP Solution for Congested Corridors Program

SGC Strategic Growth Council

SR2S/SRTS Safe Routes to School

STIP State Transportation Improvement Program

SWITRS Statewide Integrated Traffic Records System

TCC Transportation Climate Communities

TDA Transit Development Act

TIGER Transportation Investment Generating Economic Recovery

TIMS Transportation Injury Mapping System

TNC Transportation Network Company

VMT Vehicle Miles Traveled

Table of Contents

A Safe System acknowledges the vulnerability of the human body when designing and operating a transportation network to minimize serious consequences of crashes

Chapter 1

Introduction

The City of Richmond is committed to prioritizing safety and decreasing/eliminating the amount of traffic related deaths and serious injuries on City streets. This Local Road Safety Plan (LRSP) proactively evaluates hot spots throughout the City to identify the proven countermeasures that can be implemented through the current and future Capital Improvement Plan (CIP). This section defines the Safe Systems approach, an idea which underlies this LRSP, and provides background on safety work in Richmond.

What is the Safe System approach?

Each day, people are killed and seriously injured on our roads. Crashes can irreversibly change the course of human lives, touching victims, their families and loved ones, and society as a whole. Through collective action on the part of all roadway system stakeholders—from system operators and vehicle manufacturers, to law enforcement and everyday users—we can move to a Safe System approach that anticipates human mistakes, with the goal of eliminating fatal & serious injuries for all road users. A Safe System acknowledges the vulnerability of the human body – in terms of the amount of kinetic energy transfer a body can withstand – when designing and operating a transportation network to minimize serious consequences of crashes.

According to the World Health Organization, the goal of a Safe System is to ensure that if crashes occur, they "do not result in serious human injury."[1] A Safe System approach addresses the five elements of a safe transportation system – safe road users, safe vehicles, safe speeds, safe roads, and post-crash care – in an integrated manner, through a wide range of interventions (see **Figure 1**).

Figure 1. The Safe System Approach

Source: Fehr & Peers for FHWA

The Safe System approach to road safety started internationally as part of the Vision Zero proclamation that, from an ethical standpoint, no one should be killed or seriously injured on the road system.[2] [3] It is founded on the principle that people make mistakes, and that the road system

should be adapted to anticipate and accommodate human mistakes and the physiological and psychological limitations of humans.[4] Countries that have adopted the Safe System approach have had significant success reducing highway fatalities, with reductions in fatalities between 50 and 70%.[5]

The Institute of Transportation Engineers (ITE) and the Road to Zero Coalition's Safe Systems Explanation and Framework articulate that to anticipate human mistakes, a Safe System seeks to:

- Separate users in a physical space (e.g., sidewalks, dedicated bicycle facilities),
- Separate users in time (e.g., pedestrian scramble, dedicated turn phases),
- Alert users to potential hazards,
- Accommodate human injury tolerance through interventions that reduce speed or impact force.

Creating a Safe System means shifting a major share of the responsibility from road users to those who design the road transport system. "Individual road users have the responsibility to abide by laws and regulations"[6] and do so by exhibiting due care and proper behavior on the transportation system. While road users are responsible for their own behavior, this is a shared responsibility with those who design, operate, and maintain the transportation network: including the automotive industry, law enforcement, elected officials, and government bodies.[7] In a Safe System, roadway system designers and operators take on the highest level of ethical responsibility.

Background

This will be the first comprehensive safety plan for the City of Richmond which provides the City and its major stakeholders a blueprint for a safe and more accessible community. This LRSP will assist the City when it applies for safety infrastructure funding sources. For example, the Cycle 11 Highway Safety Improvement Program (HSIP) funding cycle anticipated in 2022 will require an LRSP for an agency to be eligible to apply for funds.

About Richmond

The City of Richmond, located in Contra Costa County, is home to approximately 116,450 people.[8] Richmond residents identify as 20% White alone, 19% Black or African American alone, 4% Asian alone, 2% American Indian and Alaska Native alone, 1% Native Hawaiian and other Pacific Islander alone, 31% some other race alone, and 13% two or more races. Additionally, approximately 45% of Richmond's population identifies as being of Hispanic or Latino origin and 54% of residents speak a language other than English at home. The citywide median household income in 2020 was $72,463. Several census tracts within the City are identified as Disadvantaged Communities based on the State of California's measures of health, economic and environmental factors. Seven of the City's census tracts are also in the lowest quartile for healthcare access according to the California Healthy Places Index, including one tract in the 8th percentile.

ITE Safe System Framework: Focus on Safe Speeds

The ITE Safe System framework provides important context for the focus on safe speeds within a Safe System approach. For vulnerable users speed is a determining factor in survivability – a human's chance of surviving being struck by a vehicle increases from 20% at 40 miles per hour to 60% at 30 miles per hour to 90% at 20 miles per hour. Reducing speed in the presence of = vulnerable users is a key Safe System strategy. Approaches include:

- Physical roadway designs (width, horizontal alignment) to limit free flow speeds,
- Traffic calming treatments that induce slower speeds,
- Traffic signal timing that minimizes high speed flow,
- Traditional or automated enforcement that discourages speeding.

Endnotes

1 World Health Organization (2011). Decade of Action for Road Safety 2011-2020. Retrieved from https://www.who.int/roadsafety/decade_of_action/plan/plan_en.pdf, p. 9.

2 Johansson, R. (2009). Vision Zero - Implementing a policy for traffic safety. Safety Science, 47, 826-831.

3 Tingvall, C., & Haworth, N. (1999). An Ethical Approach to Safety and Mobility. Paper presented at the 6th ITE International Conference Road Safety and Traffic Enforcement. 6-7 September 1999, Melbourne, Australia.

4 Belin, M.-Å., Tillgren, P., & Vedung, E. (2012). Vision Zero - a road safety policy innovation. International Journal of Injury Control and Safety Promotion, 19, 171-179.

5 World Resources Institute (2018). Sustainable and Safe: A Vision and Guidance for Zero Road Deaths. Retrieved from https://www.wri.org/publication/sustainable-and-safe-vision-and-guidance-zero-road-deaths.

6 World Health Organization (2011). Decade of Action for Road Safety 2011-2020. Retrieved from https://www.who.int/roadsafety/decade_of_action/plan/plan_en.pdf, p. 9.

7 World Health Organization (2011). Decade of Action for Road Safety 2011-2020. Retrieved from https://www.who.int/roadsafety/decade_of_action/plan/plan_en.pdf.

8 U.S. Census Bureau, 2020 Decennial Census Redistricting Data (PL 94-171).

Together, the vision statement and goals establish a concise yet comprehensive focus for investments in infrastructure, education, emergency services, and enforcement

Chapter 2

Vision and Goals

Vision Statement

Traffic safety impacts the health and comfort of all those who live and travel in the City of Richmond. The implementation of this plan is a step towards making the transportation system safer and more equitable for users of all transportation modes.

The City of Richmond vision statement was developed during early stakeholder meetings and outreach efforts. The vision statement highlights the central importance of improving health, safety and equitable access to multimodal transportation facilities for all roadway users. Complementary goals for the LRSP, developed through stakeholder outreach and data analysis, represent a mix of discrete, measurable goals for specific facets of the transportation system set alongside higher-level holistic objectives for communitywide health and safety improvements. Together, the vision statement and goals establish a concise yet comprehensive focus for investments in infrastructure, education, emergency services, and enforcement.

Goals

Goal 1: Reducing Collisions

Reduce fatal and serious injury collisions, particularly those involving people walking and biking.

Goal 2: Equity

Ensure equitable traffic safety investments in neighborhoods needing them most.

Goal 3: Pedestrian Crossings

Enhance roadway crossings, especially near schools and other high pedestrian activity areas, to promote and support safe travel for people walking and biking.

Goal 4: Nighttime Visibility

Improve the visibility of roadway and sidewalk users traveling at night.

Goal 5: Safe Speeds, DUI Prevention

Encourage safe driving practices (such as driving at lower speeds, obeying railroad crossing controls, and avoiding driving under the influence) through roadway design and outreach.

Goal 6: Climate Resiliency

Invest in the next generation of people in Richmond through climate-resilient transportation safety infrastructure, particularly near schools and on neighborhood streets.

Goal 7: Post-Crash Care

Improve post-crash care through increased multi-jurisdictional collaboration and appropriate emergency vehicle access.

Priorities for community outreach included engagement with community councils and partnering with local organizations

Chapter 3

Safety Partners

Stakeholders were identified in collaboration with City of Richmond staff to ensure the LRSP included the perspective of various departments and organizations. The stakeholder group included representatives from the following:

- **Richmond City Council**
- **Richmond Community Development Department**
- **Richmond Fire Department**
- **Richmond Police Department**
- **Richmond Public Works**

First Stakeholder Meeting

At the first stakeholder meeting on June 8, 2021, the group discussed the LRSP vision and priorities, and existing safety conditions in the City of Richmond. An Overview of the Safe System Approach, existing collision trends, community concerns, and sample safety countermeasures were provided. Additional discussion focused on prioritization schemes for locating and implementing countermeasures, the potential for incorporating green infrastructure into traffic calming measures, community outreach strategies, and project budget and funding. Priorities for community outreach included engagement with community councils and partnering with local organizations like the RYSE Center and Rich City Rides. Reported locations of particular concern to the community included Carlson Boulevard, Tehama Avenue, Esmond Avenue, and Garvin Avenue.

Lastly, a visioning exercise was conducted to establish a framework for identification of the LRSP safety vision and goals. The stakeholder-generated word cloud of vision priorities is shown in **Figure 2**.

Second Stakeholder Meeting

At the second stakeholder meeting on August 30, 2021, the group discussed the draft vision statement and goals, existing safety trends, collision profiles identified via the safety analysis, and preliminary countermeasures. Feedback on the vision statement and goals called for the inclusion of goals pertaining to transit-specific safety and access, school-related safety, traffic calming, and efficient mobility. Stakeholders reported observed safety trends of concern to the community including speeding issues, poor sidewalk condition and gaps, discomfort riding bikes or using bicycle facilities adjacent to high-speed traffic, and poor signal visibility. Stakeholders emphasized the importance of prioritizing countermeasures that facilitate safe connections between modes (i.e., colocation of crosswalks and transit bus stops) and slow speeds to make existing bicycle and pedestrian facilities safer and more comfortable. Accounting for the long-term maintenance of countermeasures was also identified as an LRSP priority.

Figure 2. Stakeholder responses to the prompt, "What words come to mind when you think of a safety vision for Richmond?"

Third Stakeholder Meeting

At the third stakeholder meeting on April 13, 2022, the group reviewed the collision profiles and related countermeasures for implementation. Additionally, stakeholders were presented with how priority corridors were identified using the City's multimodal High Injury Network and reviewed the proposed priority corridors and projects and related countermeasures. Stakeholders inquired about how vehicle donuts and sideshows were being addressed in the profiles and countermeasures. Stakeholders emphasized the importance of information about costs and funding, particularly with respect to quick-build opportunities and how the LRSP document itself affects funding eligibility. In the corridor-specific discussions, stakeholders emphasized that safety was the highest priority and inquired about how green infrastructure and curbside management was being incorporated.

The Richmond General Plan, Bicycle Master Plan, and Pedestrian Plan establish goals for improving safety on the transportation network in Richmond and set a vision for infrastructure in the City

Chapter 4

Existing Efforts

In recent years, the City's efforts to improve safety have been most visible through a range of plans and programs. These range from citywide plans that set safety-focused policies and goals to corridor plans that detail multimodal access and safety recommendations for specific corridors, and area plans that prioritize improvements across broader regions. Together, these existing efforts establish goals for improving safety on the transportation network in Richmond and set a vision for infrastructure in the City. They are further supported by ongoing engagement with the community regarding safety planning and implementation as well as systematic enforcement of Richmond's existing traffic policies.

Citywide and Area Plans

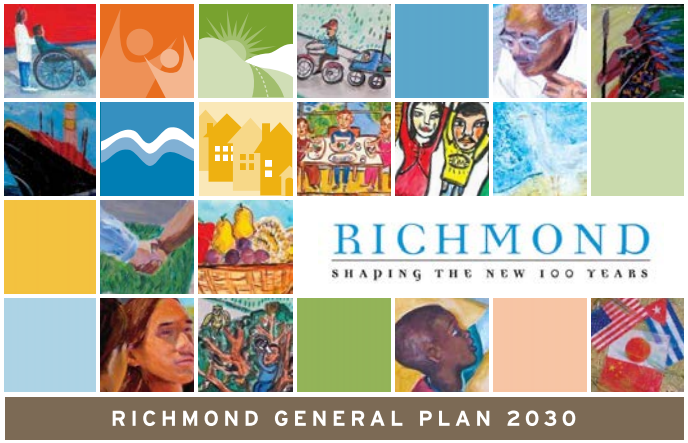
Richmond General Plan

The Circulation Element of the Richmond General Plan (2012) lays out a community vision and policy framework for transportation planning in Richmond. In this vision, a grid-based network balances modes of travel, with traffic calming, bike routes, trails, and sidewalks supporting safe and comfortable conditions for people walking and biking.

The Circulation Element outlines a place-based circulation classification system that is tailored to surrounding land use, street function, and desired character. This classification system assigns modal priorities to each accessway type and provides design recommendations for each one.

While the General Plan does not include a transportation safety analysis, policies and actions in the Circulation Element set safety as a high priority:

- Policy CR1.5 calls for safe and convenient walking and bicycling.



- Action CR1.C calls for the development and implementation of Bicycle and Pedestrian Plans.
- Policy CR3.1 focuses on safety and accessibility, with focus on walking, bicycling, and transit. The policy also emphasizes at-grade railroad safety, with a dedicated action item for rail crossing improvements.
- Action CR3.B calls for traffic calming on streets that experience speeding or cut-through traffic.

Richmond Bicycle Master Plan

The City of Richmond Bicycle Master Plan (2011) sets forth a blueprint for a 145-mile system of bikeways and support facilities within the City of Richmond. It focuses on connections between neighborhoods, safe routes to schools and access to major destinations such as employment centers, stores and shops, parks, trails, and open space areas.

The Bicycle Master Plan outlines four main goals, with Goal 3 focused on making Richmond's streets safer for bicyclists, both during the day and at night. In the network development and prioritization, safety was worth three out of twenty points, scored based on number of previous bicycle collisions per mile.

The chapter on collision history in the Bicycle Master Plan identified four main "hot spot" corridors, which also all received high priority for bikeway implementation in the project list:

- 13th Street/Harbour Way
- Macdonald Avenue
- 22nd and 23rd Streets
- Cutting Boulevard

While these key corridors all received bikeway project recommendations in the Bicycle Master Plan, new design best practices including Class IV bikeways are not reflected in the network. Since 2011, 24 miles of bike facilities have been installed in Richmond. Key hot spot corridors have also undergone more in-depth safety and Complete Street studies, including Harbour Way, Rumrill/13th Street, and 23rd Street.

Richmond Pedestrian Plan

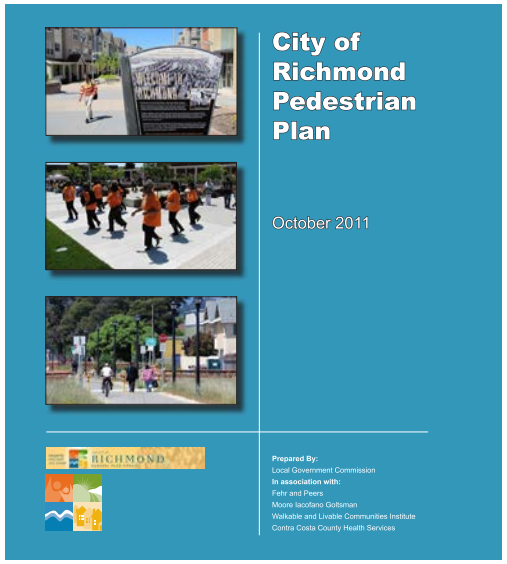
Completed in 2011, the Richmond Pedestrian Plan aims to improve the safety, convenience, and appeal of walking throughout the City. Central Richmond, comprised of the Downtown, Civic Center, transit center and a number of historic mixed income and low-income neighborhoods, is the focus of the plan.

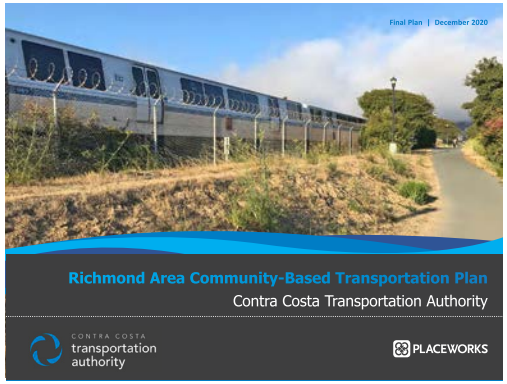
The Pedestrian Plan includes a safety and connectivity analysis with criteria for project prioritization focusing on proximity to Pedestrian Improvement Districts (General Plan), community connectivity, safety, and ease of implementation. Top tier projects from the Richmond Pedestrian Plan include Marina Way, Nevin Avenue, the Richmond Greenway, South 23rd Street, Barrett Avenue, 6th Street, Ohio Avenue, and Harbour Way.

The Pedestrian Plan also includes a Crosswalk Policy, treatment toolbox, action plan, and roundabout concept for Cutting Boulevard at Carlson Boulevard.

Richmond Area Community-Based Transportation Plan

Led by CCTA and completed in 2020, the Community-Based Transportation Plan (CBTP) for the Richmond Area recommended a series of projects and programs identified during community outreach and review of existing studies in parts of Richmond and several neighboring areas. These recommendations were prioritized using evaluation criteria developed with plan advisors. The CBTP focuses on addressing the needs of economically disadvantaged communities in Contra Costa County through robust





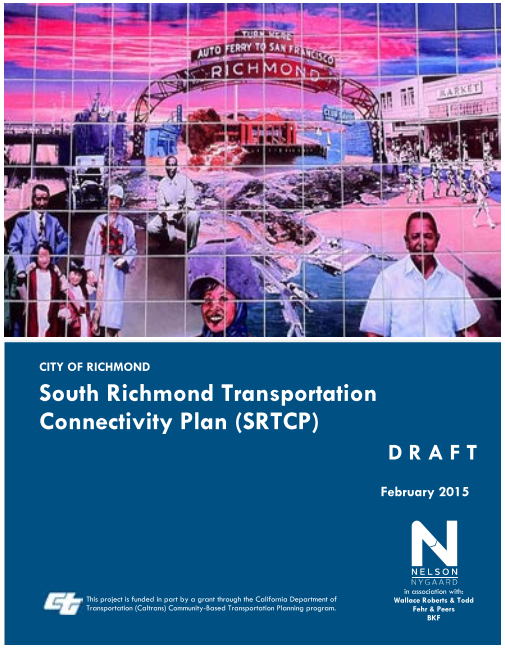
community engagement and demographic analysis to identify issues, priorities, and potential solutions for mobility.

Based on feedback from a Project Working Group, the Richmond Area CBTP selected four criteria for project prioritization: community priorities, increased access, financial feasibility, and ease of implementation. Based on these criteria, the CBTP outlines a set of high need and high potential projects and programs. While a collision analysis was not central to the CBTP, results of the robust community outreach process centered largely on improving safety and accessibility of the transportation network. Priorities in Richmond included a focus on ADA accessibility in North Richmond, sidewalk gaps and arterial safety along San Pablo Avenue, and arterial corridor safety on MacDonald Avenue.

South Richmond Transportation Connectivity Plan (SRTCP)

Focusing on key corridors in South Richmond, the South Richmond Transportation Connectivity Plan (2015) identifies deficiencies in the existing transportation system and provides specific recommendations to improve multimodal connectivity to and within the area. Key objectives of the SRTCP include connecting South Richmond Neighborhoods to opportunities for employment, education and recreation on the South Shoreline and connecting key opportunity sites in South Richmond with major transit hubs at Richmond and El Cerrito BART stations and the WETA ferry terminal.

With a focus on connectivity, the SRTCP proposes complete streets designs for major corridors in South Richmond including Harbour Way South, Marina Way South, Hoffman Boulevard, Carlson Boulevard, Central Avenue, and Bayview Avenue. Multimodal safety was one of six criteria to determine project and corridor prioritization. The SRTCP also informed the development of the more recent Ferry to Bridge to Greenway Complete Streets Plan, with multimodal investments on Harbour Way designed and funded.



Corridor and Neighborhood Plans

The following corridor and area plans expand on the goals from the citywide plans and develop more specific improvement recommendations throughout the City.

23rd Street Streetscape Improvement Plan

The 23rd Street Project Report (2009) focuses on a one-mile stretch of 23rd Street and 22nd Street within the City of Richmond, between the Carlson Boulevard over-crossing at the south to Costa Avenue at the north and the stretch of 22nd Street between the Carlson Boulevard over-crossing at the south to the Brooks Avenue crossover. The 23rd Street corridor hosts a major commercial district and provides a north-south arterial connection between the Cities of Richmond and San Pablo and Interstate 580. The recommended improvements outlined in the report aim to promote pedestrian and bicycle safety along the corridor by reducing the number of travel lanes, widening the sidewalks, shortening crossing distances for pedestrians, and improving overall pedestrian and bicycle visibility.

Rumrill/13th Street Complete Street Study

The Rumrill Boulevard and 13th Street Complete Streets Study (2015) was developed through an intensive community-based design process focused on transforming the street into a safe and friendly place for people and business

Yellow Brick Road Iron Triangle Walkable Neighborhood Plan.
Source: Fehr & Peers.

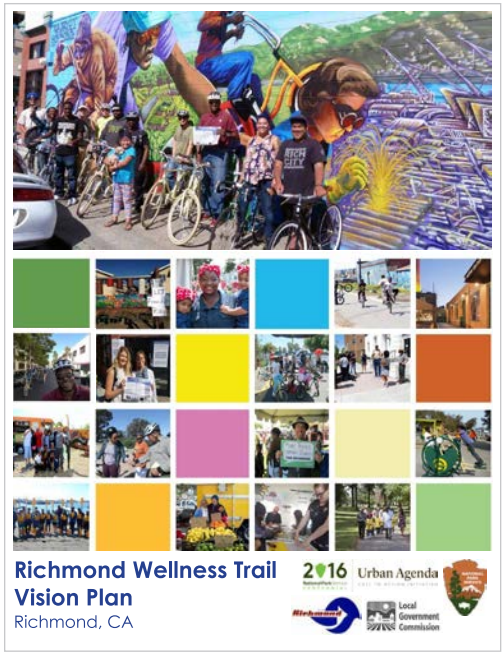
by improving conditions for walking, bicycling, and transit. Both the Cities of San Pablo and Richmond and community members of adjacent neighborhoods identified Rumrill Boulevard/13th Street as a corridor in need of a safety, comfort, and placemaking vision for the corridor. The Study documents the identification of existing conditions, alternatives development for corridor-wide improvements, and a preferred concept alternative for the community's complete streets vision for the corridor.

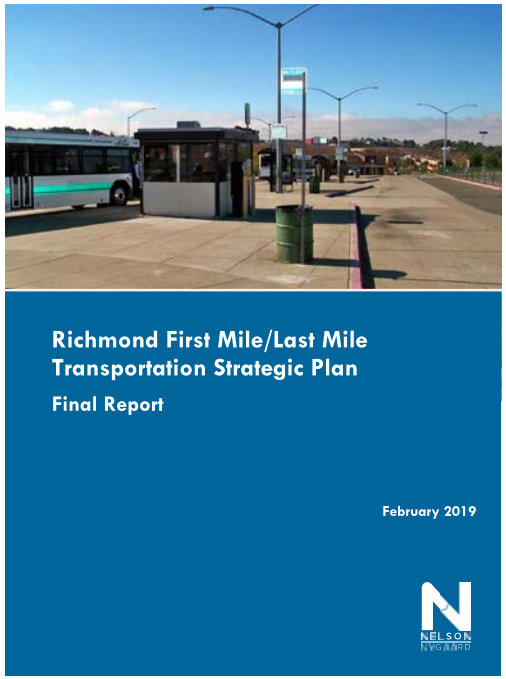
Yellow Brick Road Iron Triangle Walkable Neighborhood Plan

The Yellow Brick Road Walkable Neighborhoods Project (2015) addresses key community-identified barriers, issues, and opportunities in the community to design and implement complete streets improvements along roadways in the community-identified Yellow Brick Road (YBR) network. The routes would connect the key assets in the neighborhood, including local elementary schools, parks, and transit. The Yellow Brick Road concept was conceived by local youth living in the Iron Triangle neighborhood to safely link key areas in the neighborhood through bright yellow brick patterns on the sidewalks and roadways.

Richmond Wellness Trail Study

The 2016 Richmond Wellness Trail Vision Plan provides a comprehensive plan for a north-south corridor connecting existing transit facilities and key destinations, with the main spine along Marina Way from the shoreline to Central Richmond. The locations along the corridor include the Bay Trail, Ferry Terminal, Greenway,





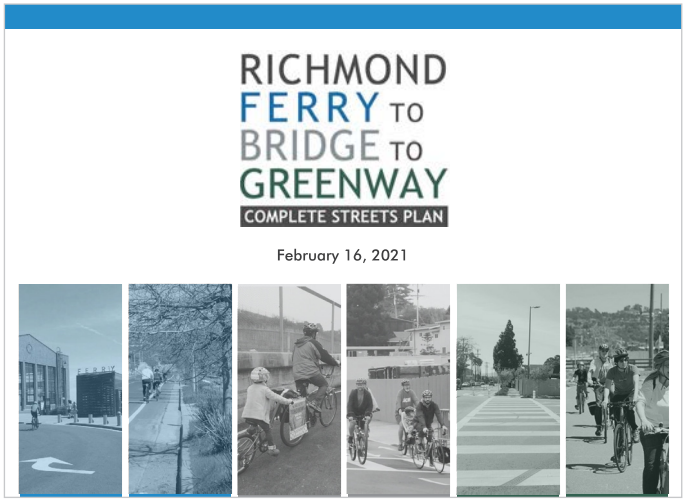
Marina Bay, Richmond BART Station and Richmond Kaiser Permanente Medical Center. Using the Pedestrian Plan and Bicycle Master Plan as a foundation, the plan proposes a series of bicycle enhancements and pedestrian amenities that work in tandem with the city's existing infrastructure.

First Mile/Last Mile Transportation Strategic Plan

The 2017 Richmond First Mile/Last Mile Transportation Strategic Plan provides an assessment of existing conditions and recommended projects addressing first mile/last mile gaps to ultimately connect the city's varied transit services and enhance its transportation network. The plan identifies barriers in bicycle, pedestrian and transit networks leading up to the Richmond Ferry Terminal and the Richmond BART Station. With a set of prioritization criteria that include safety based on collision history, the study recommends ten priority projects that will help to facilitate easy, safe, and efficient access to Richmond's transit hubs.

Harbour Way Complete Streets

A concept for a two-way separated cycle track and pedestrian improvements was first developed in 2018 as part of a California Active Transportation Program grant application. Since then, the concept has been expanded and updated as part of the Ferry to Bridge to Greenway Complete Streets Plan. Now, a quick-build design for the Complete Streets improvements on Harbour Way South from the ferry terminal to Hoffman Boulevard is funded



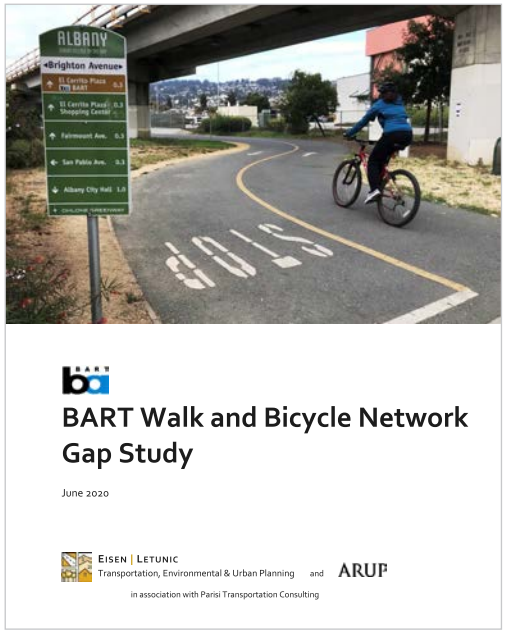
and will be constructed in 2022 along with a coordinated complete streets project on Hoffman and Cutting Boulevards.

Ferry to Bridge to Greenway Complete Streets Plan

The Richmond Ferry to Bridge to Greenway Complete Streets Plan (F2B2G Plan, 2020) envisions valuable connections for walking and bicycling to and between the Richmond Ferry, the Richmond-San Rafael Bridge Trail, and the Richmond Greenway. The F2B2G Plan, when implemented, will provide a balance of permanent regional connections and local safety improvements for people of all ages and abilities, including those in disadvantaged and traditionally underserved areas of the City, such as the Iron Triangle and Santa Fe neighborhoods, as well as in the Marina Bay and Point Richmond neighborhoods.

BART Walk and Bicycle Network Gap Study

The BART Walk and Bicycle Network Gap Study (2020) evaluated potential improvements to the pedestrian network within a half-mile of 17 focus stations. The study summarizes outcomes and near- to mid-term recommendations from a series of stakeholder walk audits that took place over three years. For the Richmond BART station, recommendations include improvements on Nevin Avenue to the west of the station, safety upgrades at Barrett Avenue and Marina Way, safer crossings and bike lane gap closures on Barrett Avenue, and pedestrian improvements along 19th Street between Macdonald and Barrett Avenues.



BART Walk and Bicycle Network Gap Study

June 2020

Eisen | Letunic
Transportation, Environmental & Urban Planning and ARUP
in association with Parisi Transportation Consulting

Complete Streets Safety Assessment

The Contra Costa Transportation Authority (CCTA) requested that SafeTREC at the University of California, Berkeley conduct a Complete Streets Safety Assessment (CSSA) study for various locations within the City of Richmond. The objectives of the CSSA are to improve pedestrian and bicycle safety and to enhance walkability and accessibility for all pedestrians and bicyclists in Richmond. To assess pedestrian safety conditions in City of Richmond, the expert team conducted a benchmarking analysis to understand how the City's existing conditions compared with current national best practices. Additionally, a walking audit was conducted at seven intersections to develop recommendations for potential improvements.

Engagement

The City of Richmond is currently conducting a citywide planning and engagement effort called Travel Safe Richmond (TSR). The goal of TSR is to create unified policies and infrastructure recommendations for improving roadway conditions and safety throughout the City of Richmond for all users: people walking, biking, rolling, and driving. Travel Safe Richmond includes two concurrent planning efforts: this Local Roadway Safety Plan (LRSP) and a separate Bicycle and Pedestrian Action Plan. Input from City stakeholders and community members is a critical component of both planning efforts. A community workshop was hosted by the City on December 8, 2021, to share

information with the public about Travel Safe Richmond and gather feedback on where the City should make infrastructure improvements. A second community workshop was held on May 18, 2022 to introduce the community to the proposed recommendations for improving safety for active transportation, engage them for feedback on those projects, and ask them to share any additional walking, biking, rolling, or travel safety-related comments and concerns. Additional outreach on TSR was conducted through presentations at various Neighborhood Council meetings and at the Richmond Neighborhood Coordinating Council meeting on May 9, 2022.

Enforcement

Since 2020, the Richmond Police Department has leveraged one or more Office of Traffic Safety (OTS) grants per year to bolster its capacity to enforce traffic policies. Grants have primarily focused on addressing driving under the influence, but also address traffic safety issues such as distracted driving and bicycle and pedestrian safety enforcement operations. The City's Engineering and Capital Improvement Projects department is in charge with conducting speed surveys and performs or manages updated studies on an approximately 5-year cycle. Speed surveys inform ongoing programmatic and infrastructure improvements throughout the City. These and other City of Richmond departments collaborate on planning and engineering efforts to mitigate persistent hazards in the public right-of-way and seek to reduce the occurrence of sideshows and other unsafe driving practices.

This broad collision assessment for the City of Richmond will inform the project prioritization and countermeasures for the City

Chapter 5

Safety Analysis

The City investigated collision records on local roadways and expressways from 2015-2019 to describe historic collision trends and identify high-risk locations. This information acts as a primary resource for the Richmond LRSP, providing the underlying data to support key analyses.

The data-driven process included:

- **Collision Trends:** Review of collision statistics to evaluate when, where, and why collisions occur and who is involved.
- **High Injury Network:** Identification of corridors with the highest concentrations of fatal and serious injury collisions.
- **Collision Profiles:** Combination of collision factors to identify 8 prevalent collision types.
- **Countermeasure Toolbox:** Identification of effective, nationally proven countermeasures applicable to different collision profiles (see Chapter 6).
- **Priority Project Locations:** Identification of 4 priority project locations based on collision density and community verification (see Chapter 7).

Caltrans' Local Roadway Safety Manual (LRSM)

Chapter 2 of Caltrans' LRSM states that safety practitioners should "consider a wide range of data sources to get an overall picture of the safety needs" (p. 14).

Both collision data and contextual data were collected and analyzed as part of this plan.

Note: Collision data for 2018 and 2019 was considered provisional and subject to change at the time this analysis was conducted.

Collision Analysis Summary

Chapter 2 of Caltrans' Local Roadway Safety Manual (LRSM) instructs safety practitioners to "consider a wide range of data sources to get an overall picture of the safety needs." Crash data and contextual data were collected and analyzed as part of this LRSP, as well as anecdotal input from City staff and community stakeholders. This analysis considers injury collisions from 2015 through 2019 available through the Transportation Injury Mapping System (TIMS) as of April 2021.TIMS reports injury collisions from the Statewide Integrated Traffic Records System (SWITRS).

Collision databases have been found to have certain reporting biases, including:

- Collisions involving people walking, on bicycles, or on motorcycles are less likely to be reported than collisions involving people driving
- Property damage collisions are less likely to be reported compared to more severe collisions
- Younger victims are less likely to report collisions
- Alcohol-involved collisions may be under-reported

Race, income, immigration status, and English proficiency may also impact reporting, but there is limited research on these factors. With those caveats in mind, this analysis identified several collision trends and risk factors in Richmond, including:

- People walking and biking are more likely to be fatally or severely injured in a collision
- Unsafe speed is the most frequent factor listed for fatal and severe collisions
- Drugs or alcohol increase the likelihood that a collision will be more severe
- A large share of injuries to people walking occur when people are walking in the road or crossing not in a crosswalk
- A larger share of collisions where someone was killed or severely injured (KSI collisions) occurred at night

Collisions by Year and Mode

Table 1 provides a summary of collisions by mode and severity within the 5-year dataset. From 2015 to 2019, there were 1,670 total injury collisions, and 142 collisions where victims were killed or severely injured (KSI). On average, six people were killed each year in Richmond due to traffic collisions.

People walking and biking are involved in 20 percent of all injury collisions, but 39 percent of KSI collisions. People walking are particularly over-represented in KSI collisions, as they are involved in only 13 percent of all injury collisions, but 30 percent of KSI collisions.

The number of collisions for each year by mode is shown on **Figure 3**. The number of collisions per year is on an overall upward trend through 2019. This is in line with national trends of increasing traffic injuries and fatalities.

Collision Type

The three most common collision types in Richmond are Broadside (39%), Rear End (17%), and Vehicle/Pedestrian (12%), as shown in **Figure 4**. For KSI collisions, Vehicle/Pedestrian collisions are most common (28%), followed closely by Broadside collisions (27%), and with Hit Object and Head-On collisions being tied for third-most common (13%). This further illustrates the disproportionate share pedestrians make of KSI collisions in the City. It also shows that Hit Object collisions are more likely, compared to other collision types, to result in a fatality or severe injury.

Table 1. Collision Summary

	INJURY COLLISIONS (CITY OF RICHMOND, 2015-2019)			
	Vehicle-Only	Bicycle-Involved	Pedestrian-Involved	Total
Total	1,342	115*	216*	1,670
Fatal or Severe	87	12	43	142

* Three non-severe injury collisions involved both a bicyclist and a pedestrian.

Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.

Figure 3. Injury Collisions by Year and Mode (City of Richmond, 2015-2019)
Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.

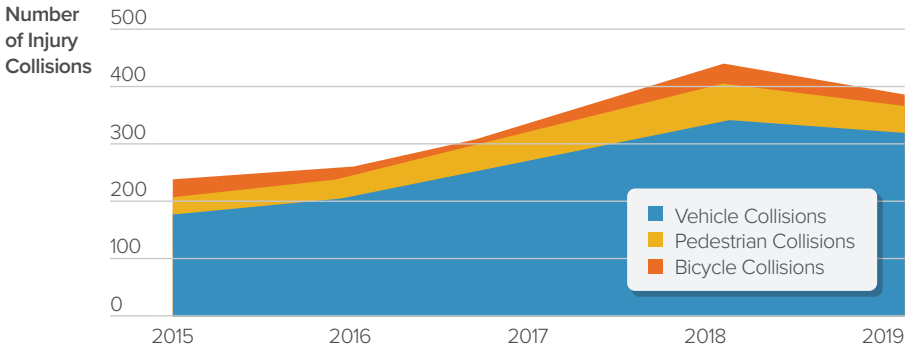
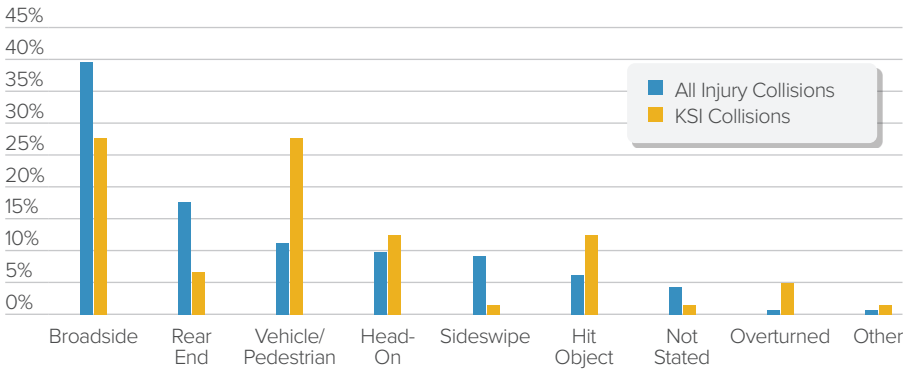


Figure 4. Injury Collisions by Collision Type (City of Richmond, 2015-2019)
Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.



Killed or Severely Injured in a Collision

Severe injuries resulting from a traffic collision can result in a number of catastrophic impacts, including permanent disability, lost productivity and wages, and ongoing healthcare costs.

Throughout this plan, the acronym **KSI** is used to denote collisions where someone was killed or severely injured.

Primary Collision Factor (PCF)

A primary collision factor (PCF) is the one element or driving action which, in an investigating officer's opinion, best describes the primary or main cause of a collision. In Richmond, the most common PCFs are Vehicle Right of Way Violation (23%), Unsafe Speed (18%), and Traffic Signals and Signs (16%). For KSI collisions, the most common PCFs are Unsafe Speed (20%), Traffic Signals and Signs (15%), and Pedestrian Violation (13%). **Figure 5** compares the cited primary collision factors for all injury collisions versus KSI collisions.

The Traffic Signals and Signs PCF indicates that a vehicle violated a traffic signal or sign, such as running a stop sign. The Pedestrian Violation PCF indicates that the pedestrian violated a rule of the road, such as crossing outside of a crosswalk, as opposed to the Pedestrian Right of Way Violation PCF, where the vehicle violates the pedestrian's right of way. The Pedestrian Violation category overrepresentation in the data may be reflective of lack of clear information related to collision circumstances.

Driving Under the Influence

Drugs or alcohol increase the likelihood that a collision will be more severe in Richmond. While 10 percent of all injury collisions involve drugs or alcohol, 25 percent of KSI collisions and 35 percent of KSI pedestrian-involved collisions involve drugs or alcohol, as shown in **Figure 6**. These percentages reflect the portion of

Figure 5. Injury Collisions by Primary Collision Factor (City of Richmond, 2015-2019)
Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.

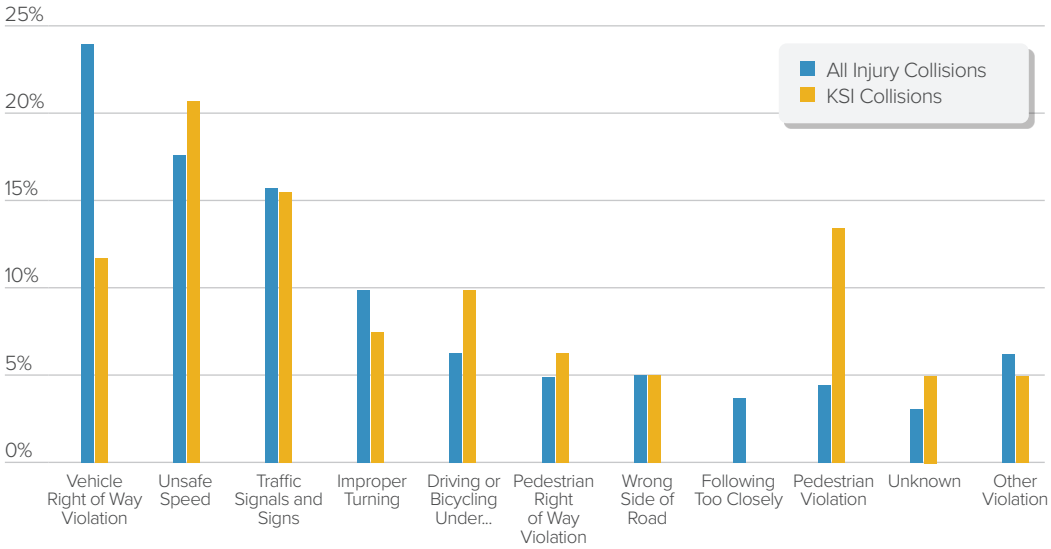
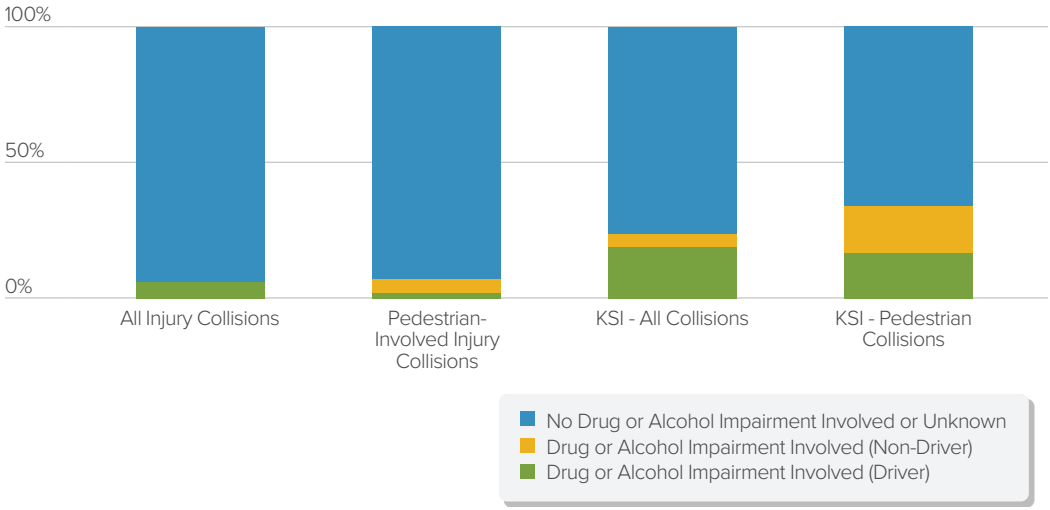


Figure 6. Collisions Involving Drug or Alcohol Impairment (City of Richmond, 2015-2019)
Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.



collisions involving one or more parties determined to be under the influence of drugs or alcohol. Driving under the influence may not always be listed as the primary collision factor even if a driver is found to be under the influence.

Pedestrian Location

As shown in **Figure 7**, collisions with people walking frequently involved pedestrians crossing not in a crosswalk (31%), or walking in the road, including the shoulder (19%). For KSI collisions, pedestrians crossing not in a crosswalk are an even higher percentage (37%), again followed by pedestrians in the road, including the shoulder (29%). People crossing the street outside of crosswalks and walking in the road may indicate that there are unmet pedestrian desire lines, and could be evaluated to identify potential locations for new crosswalks and sidewalks.

Lighting Conditions

A larger share of KSI collisions occur at night. Collisions between 6PM and 6AM are 37 percent of all injury collisions, but 54 percent of KSI collisions. Nighttime crashes also disproportionately affect people walking, with 47 percent of pedestrian injury collisions occurring

Figure 7. Pedestrian Actions Preceding Injury Collisions (City of Richmond, 2015-2019)

Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.

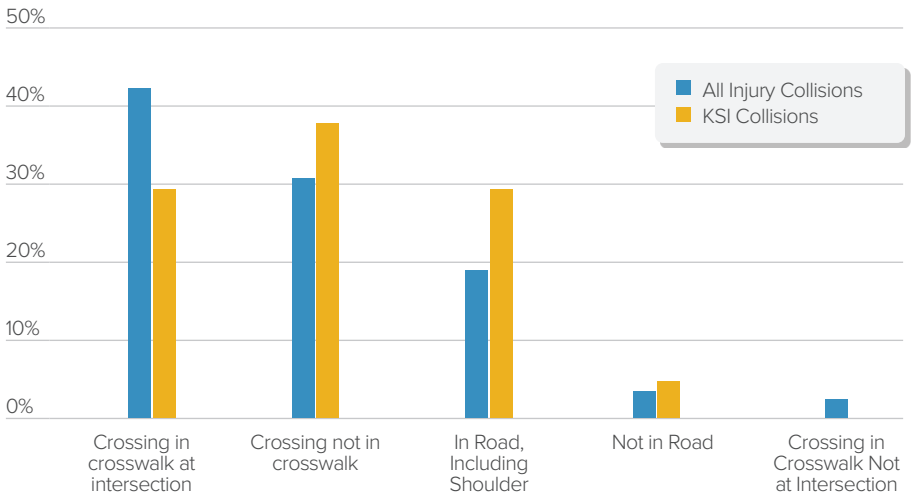
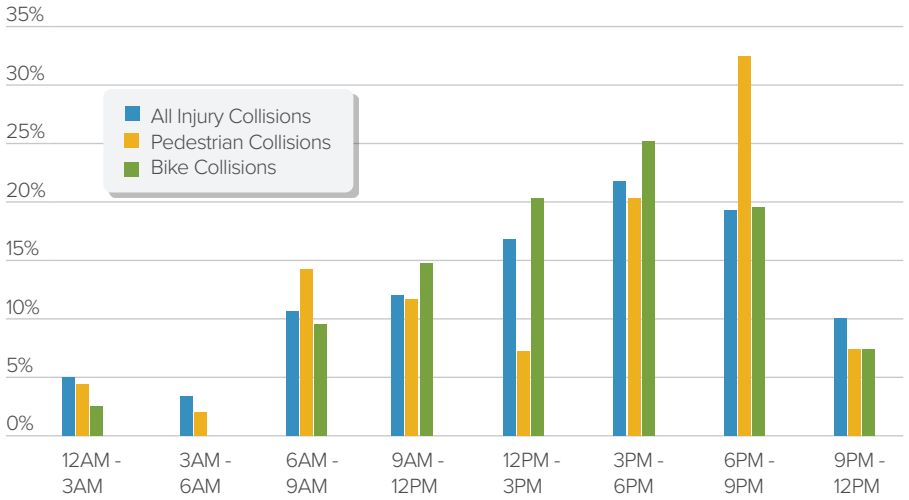


Figure 8. Injury Collisions by Time of Day and Mode (City of Richmond, 2015-2019)

Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.



Nighttime collisions are more likely than daytime collisions to result in a fatality or severe injury.

between 6PM and 6AM. **Figure 8** shows the distribution of injury collisions by mode and time of day.

Victim Profile

Fatal and severe collisions are disproportionately affecting young adults (ages 15-34). People between the ages of 15 and 34 are 30 percent of the City's population but represent 44 percent of all injury crashes and 46 percent of KSI crashes. The age distribution of collision victims is shown on **Figure 9**.

Vulnerable age groups (under 15 years old and 65 or older) have not experienced a disproportionate share of crashes in Richmond. People under the age of 15 are 18 percent of the City's population but represent less than 10 percent of all injury and KSI injury crashes. People 65 years and older are 13 percent of the City's population but represent 7 percent of all injury crashes and 9 percent of KSI crashes.

Compared to other age groups, young adults (15-34) are more likely to be involved in collisions with driving under the influence cited as the primary collision factor. The 25-34 age group has the highest percentage of collisions involving

Figure 9. Collision Victim Age Distribution (City of Richmond, 2015-2019)

Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.

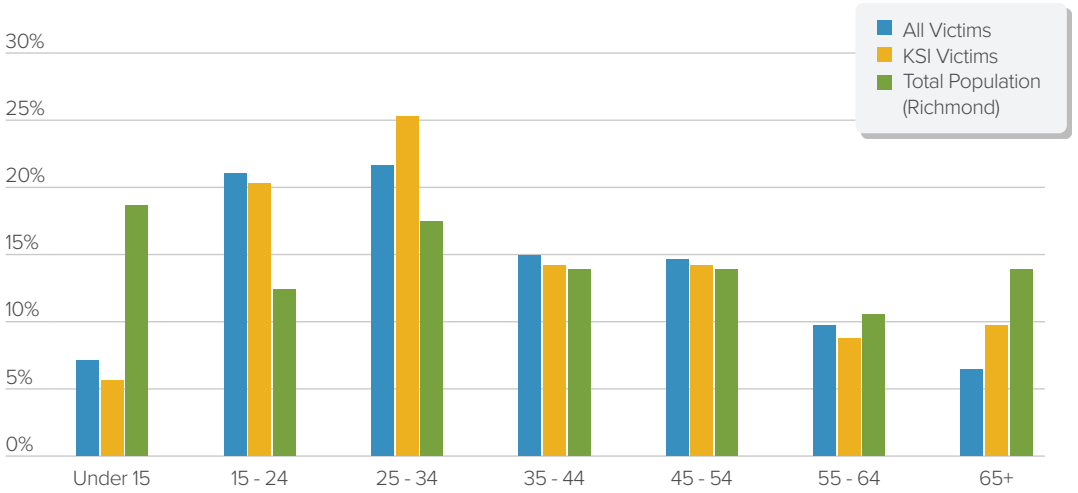
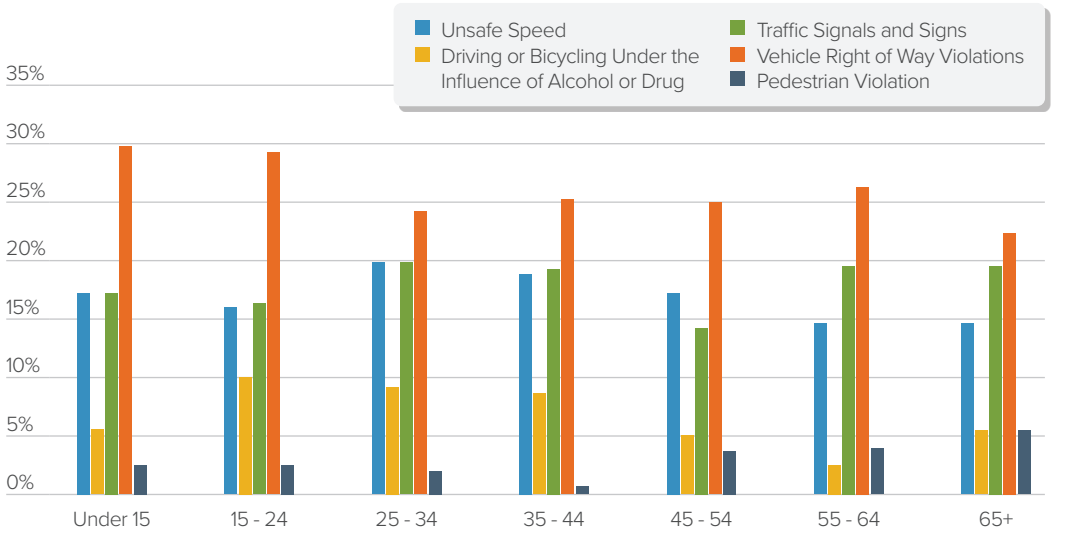


Figure 10. Primary Collision Factors by Age Group (City of Richmond, 2015-2019)

Source: Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.



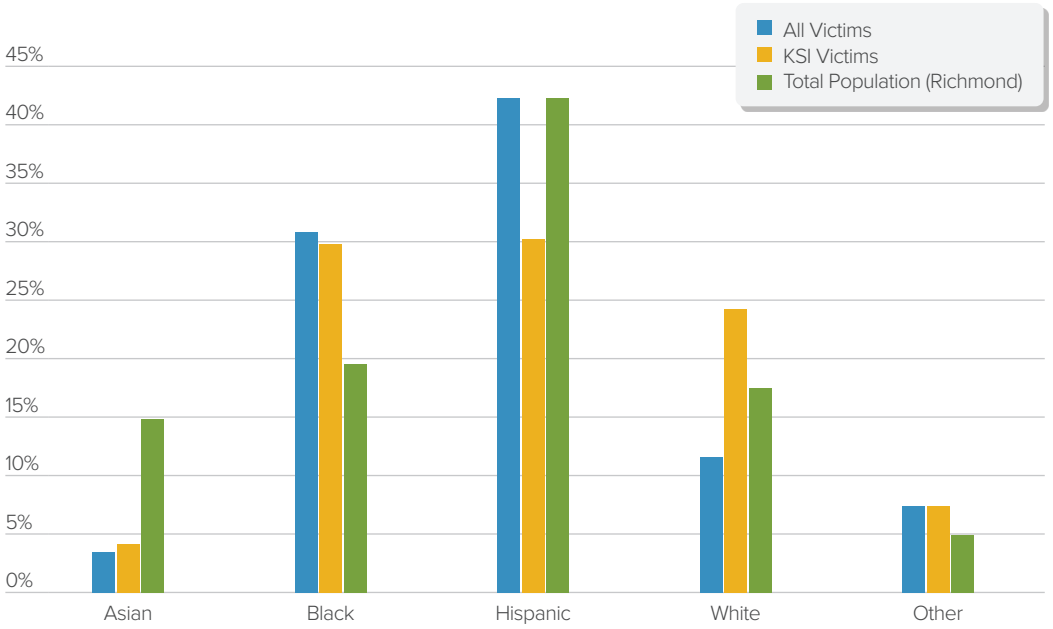
unsafe speed as a primary collision factor. **Figure 10** shows the distribution of five common primary collision factor violations across all age groups.

As shown in **Figure 11**, people identified as Black or "Other" race are over-represented in crashes. It is important to note that race is determined at the discretion of the reporting officer and is only reported at the party level. If people of multiple races are present in a vehicle, only the driver's race will be reported.

People identified as Black represent 32 percent of victims, but only 20 percent of the population of Richmond. As noted at the beginning of this chapter, race, income, immigration status, and English proficiency may impact collision reporting, but there is limited research on these factors.

Figure 11. Collision Victim Race Distribution (City of Richmond, 2015-2019)

Source: American Community Survey 5-Year Estimates (2015-2019), Transportation Injury Mapping System (TIMS), 2015-2019; Fehr & Peers, 2021.



Systemic Analysis

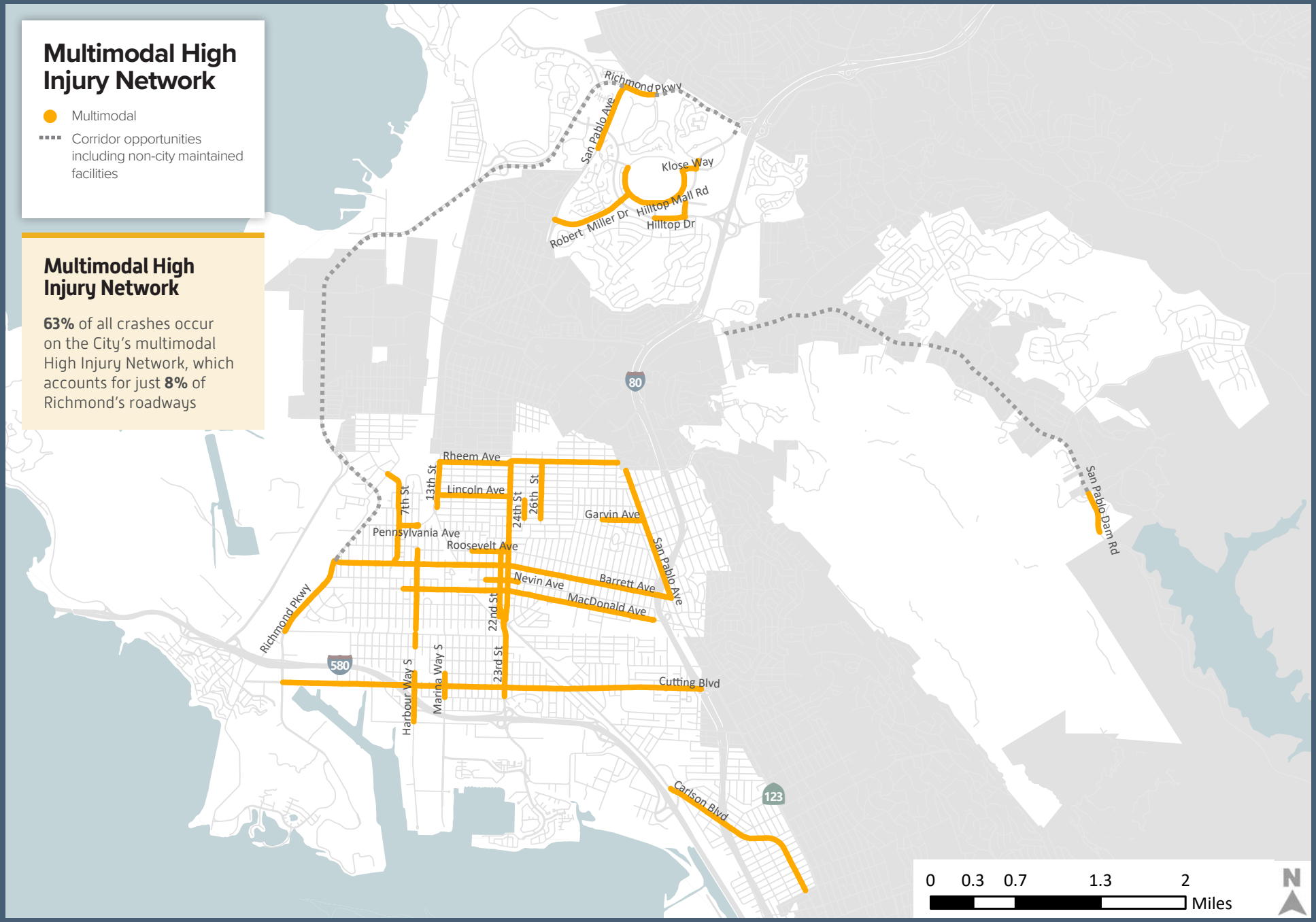
Systemic analysis is a proactive safety approach that focuses on evaluating an entire roadway network using a defined set of criteria. It looks at collision history on an aggregate basis to identify high-risk roadway characteristics in addition to looking at high collision locations. By merging adjacent road and intersection features with collision data, relationships can be uncovered between contextual factors and the risk of frequent and severe collisions. This systemic process relied on mapping all Richmond collisions, identifying the City's High-Injury Network, and identifying key safety issues and locations.

High-Injury Network

The City developed a High Injury Network (HIN) which identifies the corridors with the highest levels of fatal and serious crashes for pedestrians, bicyclists, and motorists. There are 257 total roadway miles in the City of Richmond, but KSI crashes do not occur on the majority of those roads. By developing the HIN, the City is able to focus safety improvements on priority corridors where the most serious crashes happen with the most frequency.

Richmond's HIN accounts for 63% of all crashes and 74% of KSI crashes, which occur on just eight percent (22 miles) of Richmond's roadway network. When looking at mode-specific HINs, the motor vehicle specific HIN is shown to cover eight percent of Richmond's roadway network, while the pedestrian- and bicycle-specific HINs have an even smaller footprint and cover a mere five percent of the City's roadway network.

The HIN map at right shows the the City's HIN for all modes combined and indicates where mode-specific pedestrian, bicycle, and vehicle HIN deviate from the all-modes network. Separate mode-specific HIN maps are included in **Appendix A**.


Multimodal High Injury Network
Multimodal
Corridor opportunities including non-city maintained facilities
Multimodal High Injury Network
63% of all crashes occur on the City's multimodal High Injury Network, which accounts for just 8% of Richmond's roadways
Richmond Pkwy
San Pablo Ave
Klose Way
Hilltop Mall Rd
Robert Miller Dr
Hilltop Dr
80
Rheem Ave
Lincoln Ave
13th St
7th St
24th St
26th St
Garvin Ave
Pennsylvania Ave
Roosevelt Ave
Nevin Ave
Barrett Ave
MacDonald Ave
San Pablo Ave
San Pablo Dam Rd
Richmond Pkwy
580
22nd St
23rd St
Marina Way S
Harbour Way S
Cutting Blvd
Carlson Blvd
123
0 0.3 0.7 1.3 2
Miles
N

Collision Typing

In developing systemic analysis, it is important to understand the relationship between collision characteristics and the contextual characteristics of the collision location. A systemic matrix was developed to identify the number of collisions for a given collision characteristic (e.g. location of pedestrian) and a contextual characteristic (e.g. posted speed limit of the roadway). Each combination of a collision characteristic and a contextual characteristic represents a collision type. The highest occurring collision types and collision types with the largest share of severe collisions were considered for further study. This process evaluates risk across the entire roadway system, rather than only managing risk at certain locations where collisions have occurred.

From these matrices, the most frequent and most severe collision types across a broad range of roadway and land use contexts within Richmond were identified.

Collision Profiles

The collision typing and stakeholder and community feedback informed the development of eight main collision profiles. These collision profiles are listed below, with an explanation of what makes each a key safety issue.

Unsafe speeds

These collisions occur when vehicles are traveling at speeds above the posted speed limit or above an appropriate speed given environmental conditions. Traveling at an unsafe speed reduces the time available for drivers or other roadway users to maneuver and avoid a collision and increases the physical consequences of a collision. This is the top violation for citywide vehicle-only KSI collisions and is involved in mid-block collisions with a fixed object and non-severe rear ends at or near intersections. Unsafe speeds are implicated in 25% of pedestrian and 26% of vehicle KSI collisions.

Driving under the influence

When the driver of a vehicle is under the influence of alcohol or drugs they may have impaired judgment, elicit erratic driving behavior, and exhibit increased response times to the unexpected presence of other roadway users or hazards. Many collisions where someone is driving under the influence include hitting fixed objects or parked cars and driving the wrong way and often result in a fatality or severe injury. Driving under the influence is implicated in 16% of pedestrian and 14% of vehicle KSI collisions in Richmond.

Collisions Involving the 15-24 Age Group

Young adult victims, aged 15 to 24 years old, are the most overrepresented age group in Richmond KSI collisions. This age group is more likely to be involved in collisions involving vehicle right-of-way violations and driving under the influence. Highlighted in stakeholder outreach as a key demographic to consider in LRSP development, this age group is involved in 19% of pedestrian and 23% of vehicle collisions (as drivers and passengers), respectively, but represent only 13% of the population.

Stop Sign Violations at Stop-Controlled Intersections

These violations occur when one party fails to stop at an all-way or two-way stop-controlled intersection. This violation is implicated in 37% of all injury collisions but 42% of KSI collisions indicating collisions resulting from this violation tend to be more severe than those occurring at other intersection types in Richmond. By mode, this violation is implicated in 13% of all bicycle collisions and 14% of vehicle collisions. Furthermore, all violations in which a driver failed to yield at a stop sign resulting in a KSI collision occurred near a school. Six out of seven of the KSI collisions with this violation occurred at side street stop intersections.

Left Turns at Signalized Intersection

This collision occurs when left-turning vehicles strike pedestrians or other vehicles at signalized intersections. The collision often occurs where a driver fails to observe a pedestrian crossing parallel to the vehicle's initial position when the driver initiates a left turn during the green signal phase. This action is implicated in 11% of all pedestrian collisions and 7% of vehicle KSI collisions in Richmond.

Pedestrian ROW Violations at Uncontrolled Crossings

This collision occurs when a driver violates the pedestrian right-of-way at uncontrolled crossings such as at two-way stop-controlled intersections and mid-block crossings. This is the top violation for pedestrian-involved injury collisions, implicated in 21% of pedestrian KSI collisions. Of these violations, 44% occurred at nighttime and all took place on multilane roadways (with more than one lane in each direction).

Pedestrians Crossing Outside Crosswalk or Legal Crossings

This violation occurs where pedestrians cross outside a marked crosswalk or legal crossing. A legal crossing may include both marked and unmarked crosswalks at intersections and marked mid-block locations. This violation accounts for approximately 16% of pedestrian KSI collisions with the majority of these violations (71%) occurring midblock where pedestrians are crossing outside of a crosswalk or else walking in the roadway, including the shoulder.

Contraflow Bike Riding

This violation occurs where bicyclists travel in the opposite direction of vehicle traffic, either in the roadway or on a sidewalk, often where there are no dedicated bicycle facilities. This violation presents safety concerns because motorists do not anticipate seeing or yielding to bicyclists traveling against traffic which leaves both parties susceptible to collisions, for example when a driver is pulling out of a driveway. Furthermore, when contraflow riding leads a cyclist to travel toward rather than away from a vehicle or other bike moving with traffic, the gap between parties closes more quickly leaving less time for maneuvering and collision avoidance. This is a top violation for bicycle collisions implicated in 17% of bicycle KSI collisions, occurring most often on roadways with a speed limit of 30-35 mph and that lack dedicated bicycle facilities.

This plan's focus on the Safe System approach helps to provide alignment with current LRSP guidelines, but also sets the City of Richmond up for success in recognition of emerging safety best practices

Chapter 6

Countermeasure Toolbox

The full set of countermeasures recommended for implementation in Richmond are listed on the following pages categorized by focus area. The toolbox containing detailed descriptions of each countermeasure along with relevant cost and implementation characteristics is included in Appendix B. Note, approximate countermeasure costs are categorized as low ($10,000), medium ($10,000-100,000), and high (greater than $100,000) for general planning purposes. Additional considerations for equitable implementation of these countermeasures are noted throughout the chapter.

The safety strategies in this chapter also cover the five elements of a Safe System, as shown in **Figure 12**.

California is in the process of adopting the Safe System approach and a focus on equity as part of its Strategic Highway Safety Plan. This plan's focus on the Safe System approach helps to provide alignment with current LRSP guidelines, but also sets the City of Richmond up for success in recognition of emerging safety best practices.

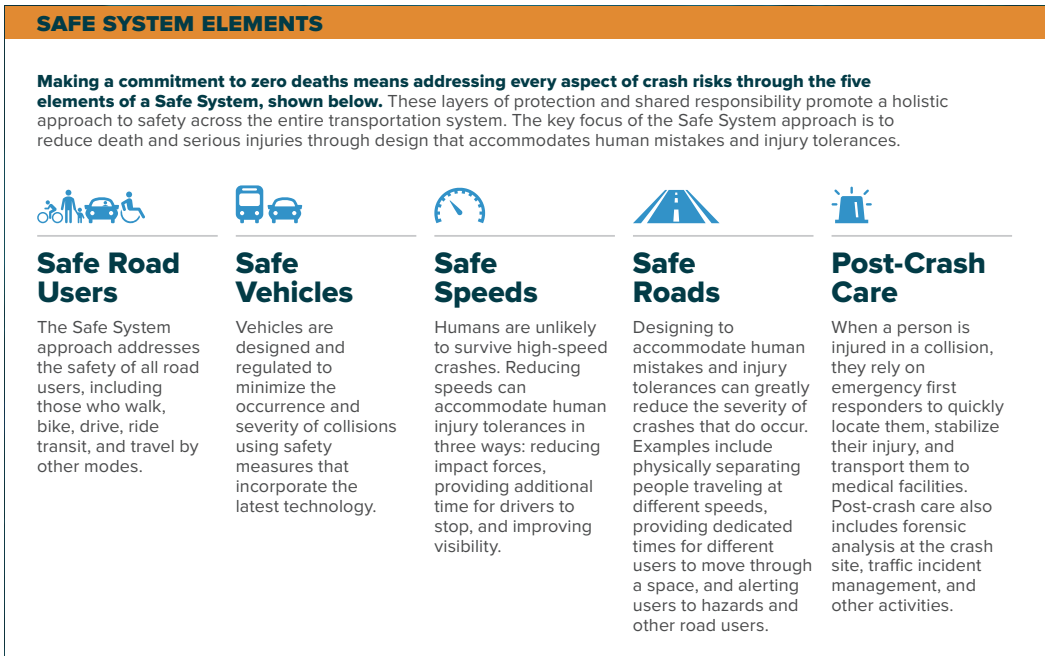


Figure 12. Safe System Elements

Source: Fehr & Peers for FHWA

ENGINEERING

Summary of Countermeasures

✔ Indicates a countermeasure identified in the Local Road Safety Manual

Bikeways

- Bicycle Crossing (Solid Green Paint)
- Bicycle Ramp
- Bicycle Signal/Exclusive Bike Phase
- ✔ Bike Box
- Bike Detection
- ✔ Class II Bike Lane
- Extended Bike Lane to Intersection
- Floating Transit Island
- Green Conflict Striping
- ✔ Class IV Separated Bikeway
- Mixing Zone
- Parking Buffer
- Two-State Turn Queue Bike Box
- ✔ Extend Green Time for Bikes
- Bicycles May Use Full Lane Sign

Intersections & Roadways

- ✔ Rumble Strips
- ✔ All-Way Stop Control
- Centerline Hardening
- Close Slip Lane
- ✔ Directional Median Openings to Restrict Left Turns
- ✔ Guardrail
- ✔ Median Barrier
- ✔ Roundabout
- ✔ Signal
- Intersection Reconstruction and Tightening
- Lane Narrowing
- Left Turn Enhanced Daylighting/ Slow Turn Wedge
- Paint and Plastic Median
- Paint and Plastic Mini Circle
- Partial Closure/Diverter
- Protected Intersection
- ✔ Raised Crosswalk
- ✔ Raised Intersection
- ✔ Raised Median
- ✔ Refuge Island
- ✔ Reduced Left-Turn Conflict Intersection
- ✔ Road Diet
- Speed Hump or Speed Table
- ✔ Splitter Island
- Straighten Crosswalk

Other

- Access Management/Close Driveway
- ✔ Intersection Lighting
- ✔ Segment Lighting
- Curbside Management
- Far-Side Bus Stop
- ✔ Delineators, Reflectors, and/ or Object Markers
- Median Guardrail
- Speed Limit Reduction
- Relocate Hazardous Utility Poles
- ✔ Remove Obstructions For Sightlines
- Upgrade Lighting to LED
- Red Light Camera

Pedestrian Facilities

- Audible Push Button Upgrade
- ✓ Add Sidewalk
- ✓ Install/Upgrade Pedestrian Crossing at Uncontrolled Locations (Signs and Markings Only)
- Co-Locate Bus Stops and Pedestrian Crossings
- Curb Extensions
- Extended Time Pushbutton
- ✓ High-Visibility Crosswalk
- ✓ Pedestrian Countdown Timer
- ✓ Pedestrian Hybrid Beacon
- Landscape Buffer
- ✓ Leading Pedestrian Interval and Pedestrian Recall
- Pedestrian Detection
- Removing Crossing Prohibition
- Restripe Crosswalk
- Upgrade Curb Ramp
- Widen Sidewalk
- ✓ Rectangular Rapid Flashing Beacon

Signals

- ✓ Retroreflective Tape on Signals
- ✓ Supplemental Signal Heads
- ✓ Advanced Dilemma Zone Detection
- ✓ Extend Pedestrian Crossing Time
- ✓ Extend Yellow and All Red Time
- Flashing Yellow Turn Phase
- ✓ Pedestrian Scramble
- ✓ Prohibit Left Turn
- Prohibit Turns During Pedestrian Phase
- ✓ Protected Left Turns
- Prohibit Right-Turn-on-Red
- Separate Right-Turn Phasing
- Shorten Cycle Length
- ✓ Signal Interconnectivity and Coordination / Green Wave
- ✓ Speed Sensitive Rest in Red Signal
- ✓ Upgrade Signal Head

Signing & Striping

- ✓ Advance Stop Bar
- Advance Yield Markings
- ✓ Flashing Beacon as Advance Warning
- ✓ LED-Enhanced Sign
- Painted Centerline and Raised Pavement Markers at Curves on Residential Streets
- Speed Feedback Sign
- Speed Legends on Pavement at Neighborhood Entries
- ✓ Striping Through Intersection
- Time-Based Turn Restriction
- ✓ Upgrade Intersection Pavement Markings
- ✓ Upgrade Signs with Fluorescent Sheeting
- Upgrade Striping
- ✓ Upgrade to Larger Warning Signs
- Wayfinding
- ✓ Yield to Pedestrian Sign

ENGINEERING

Engineering

Crosswalk Policy Best Practices

Uncontrolled pedestrian crossings occur where sidewalks or designated walkways intersect a roadway at a location where no traffic control (e.g., traffic signal or stop sign) exists. This crossing type occurs at intersections (marked or unmarked) and at mid-block locations (where they must be marked). Research has demonstrated the importance of marking uncontrolled crossings to facilitate access to key destinations while ensuring that additional safety treatments are applied at these locations if they have higher traffic speeds and volumes. The FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations proposes countermeasures based on road conditions, crash causes, and pedestrian safety issues.

Figure 13 summarizes recommendations from the guide, includes a comprehensive matrix and list of FHWA-approved pedestrian crash countermeasures suggested for application at uncontrolled crossing locations per roadway and traffic features.

Key

1 High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs

2 Raised crosswalk

3 Advance "Yield Here To (Stop Here For) Pedestrians" sign and yield (stop) line

4 In-street pedestrian crossing sign

5 Curb extension

6 Pedestrian refuge island

7 Rectangular rapid-flashing beacon (RRFB)*

8 Road diet

9 Pedestrian hybrid beacon (PHB)*

*It should be noted that the PHB and RRFB are not both installed at the same crossing location

Figure 13. Application of Pedestrian Crash Countermeasures by Roadway Features

Source: FHWA

	POSTED SPEED LIMIT AND AADT																	
	Vehicle AADT <9,000									Vehicle AADT 9,000–15,000								
Roadway Configuration	≤30 mph			35mph			≥40mph			≤30 mph			35mph			≥40mph		
2 lanes 1 lane in each direction	1	2		1			◇1			1			1			◇1		
	4	5	6		5	6		5	6	4	5	6		5	6		5	6
				7		9	7		9				7		9	7		9
3 lanes **WITH RAISED MEDIAN** 1 lane in each direction	1	2	3	1		3	◇1		3	◇1		3	◇1		3	◇1		3
	4	5			5			5		4	5			5			5	
				7		9	7		9	7		9	7		9	7		9
3 lanes **WITHOUT RAISED MEDIAN** 1 lane in each direction with a two-way left-turn lane	1	2	3	1		3	◇1		3	◇1		3	◇1		3	◇1		3
	4	5	6		5	6		5	6	4	5	6	4	5	6		5	6
	7		9	7		9			9	7		9	7		9			9
4+ lanes **WITH RAISED MEDIAN** 2 or more lanes in each direction	1		3	1		3	◇1		3	◇1		3	◇1		3	◇1		3
		5			5			5			5			5			5	
	7	8	9	7	8	9		8	9	7	8	9	7	8	9		8	9
4+ lanes **WITHOUT RAISED MEDIAN** 2 or more lanes in each direction	1		3	◇1		3	◇1		3	◇1		3	◇1		3	◇1		3
		5	6		5	6		5	6		5	6		5	6		5	6
	7	8	9	7	8	9		8	9	7	8	9	7	8	9		8	9

# Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location. The absence of a number (#) signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.	**Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.**	◇ **Signifies that crosswalk visibility enhancements should always occur** in conjunction with other identified countermeasures.

Demand Considerations for Crosswalks

Uncontrolled and mid-block crossings should be identified as a candidate for marking if there is a demonstrated need for a crosswalk. **Figure 14** provides a protocol for deciding if a crosswalk is appropriate. Engineering judgment should ultimately be used to select locations appropriate for a marked, uncontrolled crossing. Enhanced treatments beyond basic striping and signing should be considered for uncontrolled locations, as shown on the facing page.

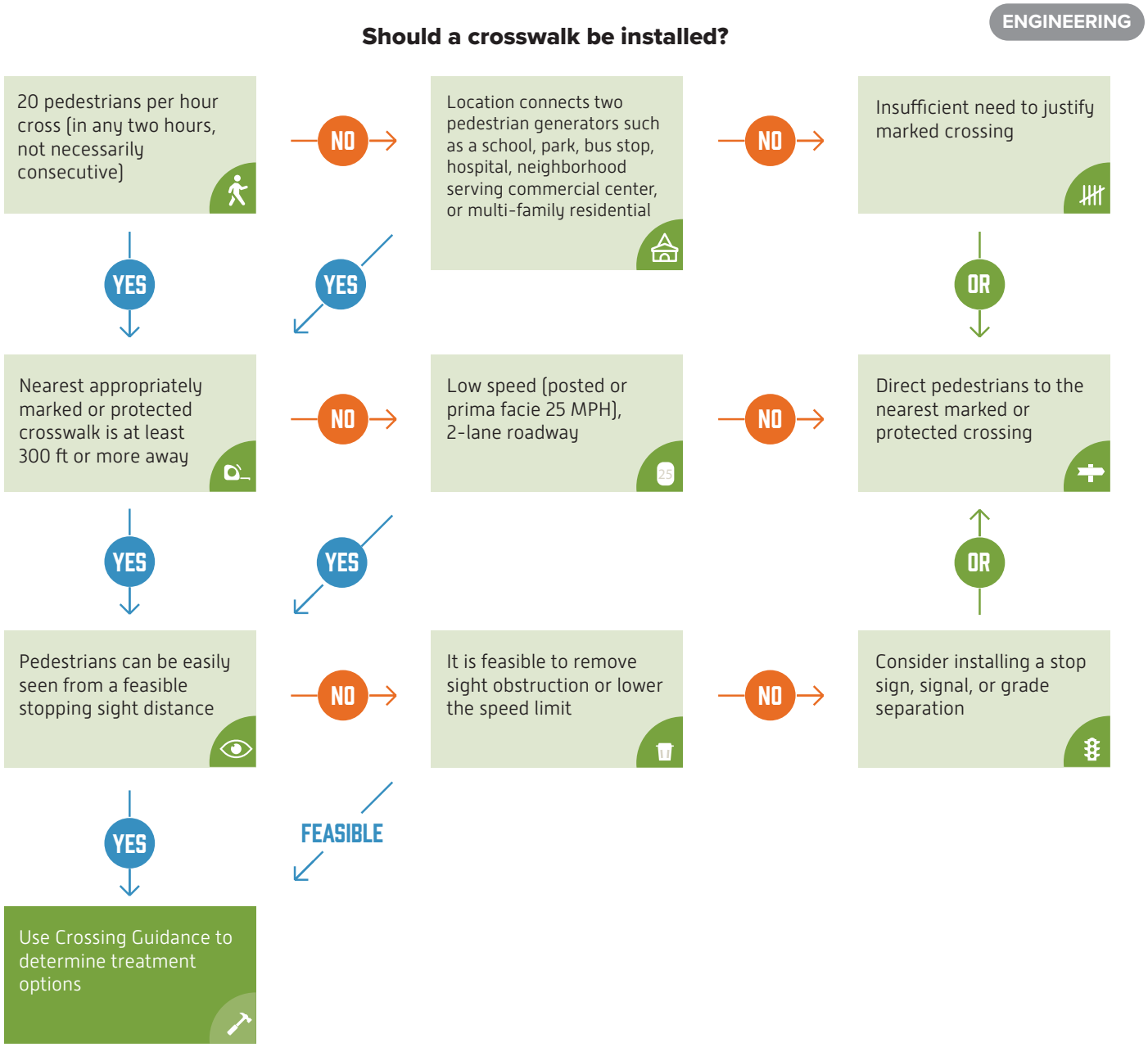


Figure 14. Samples of Decision Tree for Marking Crosswalks

Source: Fehr & Peers

ENGINEERING

Crosswalk Markings

Crosswalk markings help drivers know where to expect pedestrians and provide guidance for pedestrians crossing the roadway by defining and delineating paths on approaches to uncontrolled and mid-block locations. The use of high visibility striping is appropriate at both uncontrolled crossing locations, and signalized locations as traffic volumes, speeds, and vehicle-pedestrian conflicts require. There are several treatments for high visibility markings, including the ladder, continental and triple-four (also called double continental) markings, shown in **Figure 15**. The City of Richmond should choose a preferred style to use, so it is consistently applied. The City may also want to adopt a policy of using high visibility markings at all marked crosswalks when intersection upgrades occur.

Continental striping is often chosen to communicate sensitive pedestrian crossing areas as the designated high visibility tool. Research shows that continental crosswalk markings are more visible to drivers at night than parallel line markings.[9] Crosswalks with longitudinal lines parallel to traffic flow allow drivers to see the marked crosswalk from a greater distance, when compared with standard markings. This increased visibility distance gives drivers more time to safely stop for a pedestrian waiting to cross.

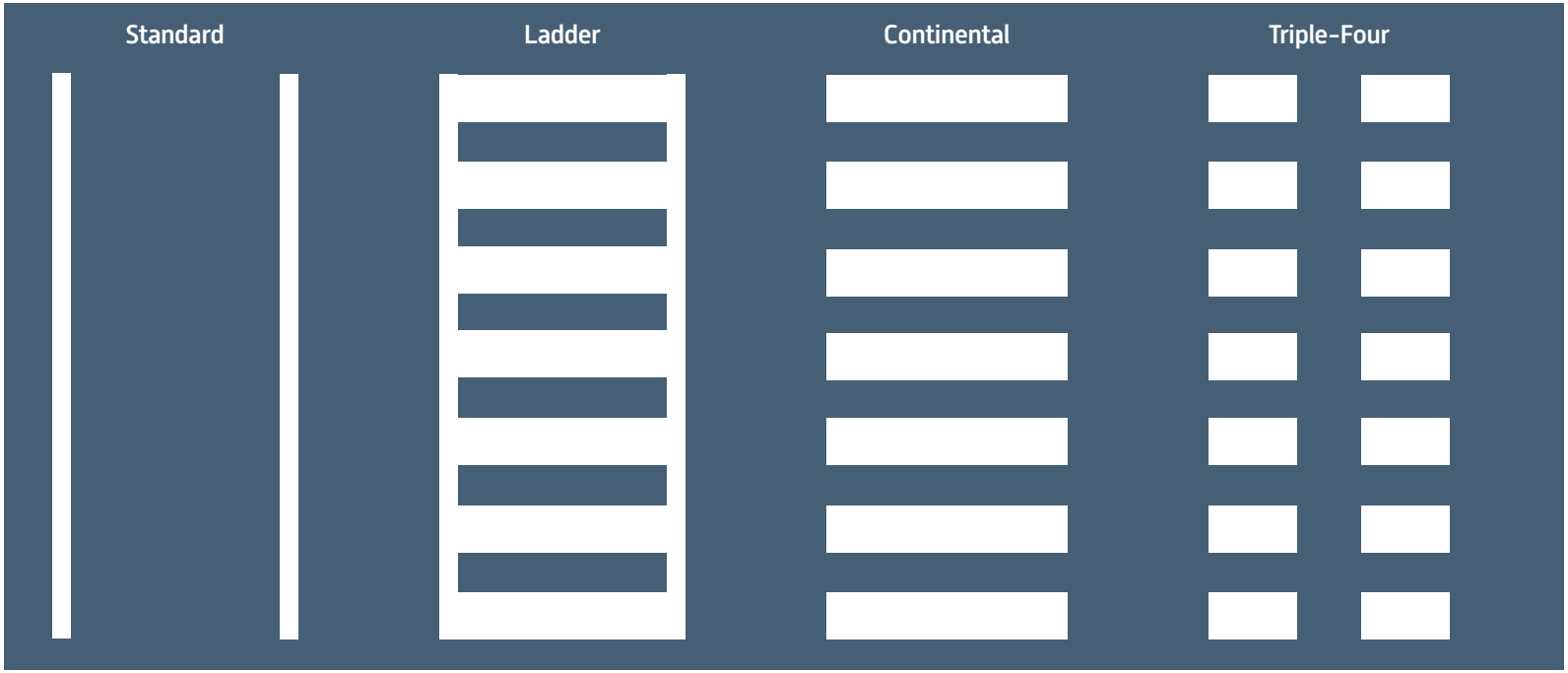
Additional Resources

9 Fitzpatrick, K., S. Chrysler, V. Iragavarapu, and E.S. Park. Detection Distances to Crosswalk Markings: Transverse Lines, Continental Markings, and Bar Pairs. Transportation Research Record: Journal of the Transportation Research Board, No. 2250. Transportation Research Board of the National Academies, Washington, DC, 2011.

Figure 15. Crosswalk Marking Examples

Source: Fehr & Peers

Triple-four markings include two dashed lines on the outside with a clear space in the center to direct pedestrian traffic and are often enhanced with outer rows of raised pavement markers. They may be less costly to install and maintain as they require less paint than a standard high visibility crosswalk.



Education

Traffic safety education plays an important role in shaping and shifting behavior. Many cities, such as Seattle, Oakland, and Los Angeles, are including community engagement and education to make streets safer for all. Education on traffic safety requires a collaborative process among many stakeholders to achieve the goal of increased safety. Targeted education can be directed at vulnerable populations, with the help of local partners, and at certain behaviors of drivers, pedestrian, and bicyclists to deter specific collision types. Such programs can be structured classes, such as road school for cyclists, or outreach campaigns, such as signs that discourage distracted driving.

Public Education Media Campaign

A public education media campaign focused on discouraging drinking and driving and/or speeding, along with encouraging increased awareness of pedestrians and bicyclists at night and appropriate crosswalk behaviors, can help promote behavior change. Messages about safe and responsible driving, moving over for EMS vehicles, awareness of bicyclists and pedestrians, and increasing visibility at night can help promote behaviors that prevent fatal and severe collisions. As an example, collaborating with local radio stations can help spread the message to drivers. Richmond can develop targeted outreach education campaigns that focus on the common violations that lead to fatalities and severe injuries. Based on collision profiles developed for this LRSP, education and outreach campaigns may include the programs listed here.

For drivers this may include:

- Education campaign that emphasizes that speeding is deadly because unsafe speeding caused 19 percent of crashes and 20 percent of KSI crashes.
- Education campaign around driving under the influence, as 10 percent of Richmond KSI crashes involve drugs or alcohol.
- Education campaign encouraging drivers to be aware of left-turn conflicts and pedestrians in the road because left-turn vehicle right-of-way violations are responsible for 2 percent of all KSI and pedestrian right-of-way violations at uncontrolled crossings are involved in 15 percent of bicycle and pedestrian KSI.

For people biking:

- Classes that teach bicyclists how to use on-street bike facilities, especially for those facility types that are new to or relatively uncommon in the City.

For people walking:

- Education campaign encouraging crossing in crosswalks because 10 percent of bicycle and pedestrian KSI occurred when a pedestrian was crossing not in a crosswalk. However, other approaches are also needed to mitigate pedestrian crashes because many pedestrian crashes occurred when a pedestrian was using a legal crossing.

Partner with Local Schools on Traffic Safety

Local schools can be partners in promoting safe driver behavior during school pick-up and drop offs. Education campaigns can involve students promoting safer driving to their parents, such as holding signs during pick-up and drop offs that encourage safer driving. Educational campaigns that involve both students and parents can be more impactful as they involve parents, who are actually driving, and students, who may not only remind their parents but also retain safe driving behavior if they eventually drive.

Culturally Relevant Engagement

Community engagement is not a one-size-fits-all model as different communities have different needs. By developing culturally relevant engagement strategies, all participants are invited into conversations about safety. Culturally relevant engagement strategies can help education and programming around traffic safety reach a larger audience and be more impactful. For example, including cultural markers of a local community, such as contracting with popular local food vendors to cater engagement activities, can be a creative and welcoming way of engaging residents. Meeting people "where they are" to gather input on safety issues at local parks can more effectively engage parents and children rather than expecting families to attend a meeting at a government building.

EDUCATION

Figure 16. Community Engagement Examples

EDUCATION

Developing Education Materials Related to Roadway Design Changes

Temporary demonstrations, like pop-up installations, can physically showcase proposed safety infrastructure to the public and emergency response in a tangible way. Lastly, preparing materials and videos focused on new types of roadway design and Richmond's major violation issues (e.g. speed, DUIs, left-turn violations, pedestrian crossings, and contraflow bike riding) can direct community conversations for meaningful outcomes.

Partner with Community Experts

Local partners can serve as community liaisons between the City and the public. Working with community partners such as Rich City Rides and the RYSE Center, and public institutions, such as the Richmond Public Library, that have relationships with residents strengthens the engagement process by building trust and engaging an established base of stakeholders. Local partners can help tailor the engagement process or help incorporate engagement into existing programs and resources to educate people more effectively about roadway safety.

Education Program Efficacy

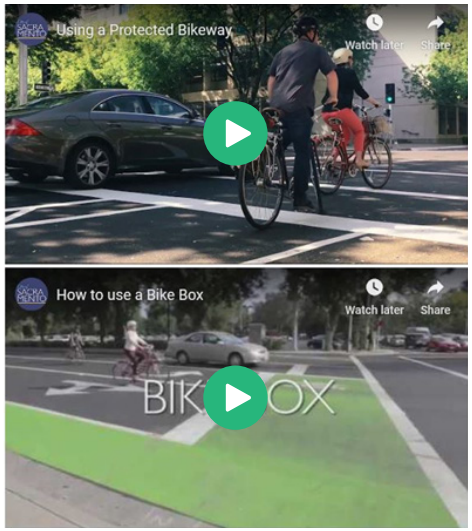
NHTSA has compiled a comprehensive report on efficacy for programmatic safety countermeasures in their Countermeasures that Work (2017) report. This report includes many education strategies, such as:

- Education regarding medication
- Driver education for younger and older drivers
- Driver training for pedestrian and bicyclist safety
- Bicycle safety education for children and adults

However, research on the efficacy of education programs is limited, and each of these education countermeasures is rated in the report as having still undetermined effectiveness or limited/ no high-quality evaluation evidence.

Figure 17. (Left to Right) City of Sacramento Education Videos, SFMTA Vision Zero Informational Signs, LADOT Pop-Up Installation Enforcement

Sources: LA Streetsblog, Vision Zero SF, City of Sacramento



ENFORCEMENT

Enforcement

Equity Considerations

Enforcement of traffic laws is a common strategy to increase street safety, but historical enforcement techniques and strategies have raised concerns about racial profiling, police violence, and the impacts of policing on communities of color. According to the US Department of Justice, Black and Hispanic people are more likely than white people to experience use of force when they are stopped by police. To ensure that efforts to improve safety recognize that all people have the right to move about their communities safely, cities have shifted to equity-based strategies that target specific reckless behaviors that pose the highest safety risk while working to mitigate potential inequities in enforcement. In 2020, the Safe Routes to School Partnership removed enforcement as part of its 6 E's for Safe Routes to School and replaced it with engagement as a strategy for encouraging safe travel to school. In 2021, the Governor's Highway Safety Association made recommendations to invest in social programs to alleviate enforcement burdens and prevent recidivism, along with training for officers on topics of racism, bias, and de-escalation.

High Visibility Enforcement

High visibility enforcement is a multifaceted approach to enforcement that involves garnering public attention to traffic safety laws through highly visibly patrols, such as checkpoints, saturation patrols, or message boards. Across several topic areas, high visibility enforcement is often the most effective form of enforcement, in terms of safety outcomes, according to NHTSA research. The goal of high visibility

Equity considerations can be considered in a range of enforcement strategies, including:

- Progressive traffic fine structures, such as a sliding scale for traffic fines based on a driver's income, developing payment plans, or giving first offenders the opportunity to take a safety class focuses enforcement on behavior change.
- Analyzing available demographic data in traffic citations can help the City of Richmond understand if traffic enforcement is being implemented universally or if specific communities are experiencing disparities in enforcement.
- Since enforcement practices, like traffic stops, require the discretion of police officers, it is possible for implicit bias to affect how and to whom officers issue traffic citations. Assessing traffic citation demographic and geographic data can help uncover inequities in policing and the enforcement of traffic safety.

Figure 18. Automated Speed Enforcement
Source: CBC News

ENFORCEMENT

enforcement is to promote voluntary compliance with traffic laws. High visibility enforcement can target specific traffic violations for a short period of time to encourage drivers to stop engaging in a traffic violation. For example, speeding can be targeted in an area so that the public is aware that speed limits are enforced in the area. Another high visibility enforcement strategy is publicized sobriety checkpoints which are used to deter impaired driving on national holidays or weekends where more people are likely to drink and drive.

Automated Enforcement

Automated enforcement, such as redlight cameras or speed cameras, target the specific drivers who are behaving dangerously. A strictly data-driven approach to automated enforcement might place red-light or speed cameras in locations with the highest number of collisions. Speed safety cameras are a tool that has been proven in cities across the United States and abroad to reduce excessive speeding and severe and fatal injury traffic collisions. The National Highway Traffic Safety Administration reports that fixed speed cameras reduce injury crashes by 20 to 25 percent, and mobile speed cameras reduce injury collisions by 21 to 51 percent. Seattle saw the average number of traffic violations decrease by 64% in a two-year period after installation of speed cameras. 90% of offenders in Seattle did not receive another citation after being cited one time for speeding. This tool is not yet legal in California so a change to state law would be required before this technology could be applied in Richmond.

Figure 19. Lower Speed Limits in School Zone

Source: Tim Berger/Burbank Leader

Speed Limit Setting

The California Zero Traffic Fatalities Task Force conducted a year-long study to assess the existing speed limit setting methodology in California. The Task Force found that the existing methodology, which sets speed limits as the 85th percentile of speed and traffic surveys, is not flexible enough to meet the needs of urban areas and recommends the development of a new context-sensitive approach that sets speed limits to prioritize safety for all users. Lower maximum speed limits reduce crashes and fatalities. While lower posted speeds can help reduce crashes, they are more effective at encouraging driving at desired speeds when implemented through comprehensive efforts including installation of road safety improvements or enforcement. The passage of AB 43 in 2021 provides jurisdictions flexibility to set speed limits below the 85th percentile for "safety corridors" with a documented history of severe and fatal collisions.

Beyond Traditional Enforcement

Alternatives to law enforcement involve investing in cross-sector partnerships to promote traffic safety.

Alternatives include:

- **Community partners** can be hired as Street Safety Ambassadors and canvas along corridors where there are severe traffic fatalities or where communities are experiencing the most traffic stops or tickets for traffic violations. Hiring community members as Street Safety Ambassadors also serves as an opportunity to build trust between government agencies and the public since community partners typically have preexisting relationships in the community.
- **Hiring Social Workers, Mental Health Counselors, Addiction Specialists**, and other unarmed, specifically trained professionals can serve as a supplement to traffic enforcement.
- **Partnering with local departments of mental health and public health** can deescalate traffic enforcement by treating traffic safety violations as a public safety issue.

ENFORCEMENT

- **De-escalating traffic enforcement** through government partnerships with public-facing agencies can also work to foster trust with the public during moments where there are national discussions on public safety regarding the police. For example, the City of Oakland partners with parking enforcement to enforce traffic laws in a deliberate effort to disarm the enforcement of traffic violations. This approach shifts traffic safety to nonsworn officers while still enforcing traffic laws.

Enforcement Efficacy

The National Highway Traffic Safety Administration (NHTSA) has compiled a comprehensive report on efficacy for enforcement safety countermeasures in their ***Countermeasures that Work (2017)*** report. This report includes many enforcement strategies, and those with the highest safety efficacy rating are listed below:

- Publicized sobriety checkpoints
- High-visibility DUI patrols
- High-Visibility seat belt laws enforcement
- Communications and outreach supporting enforcement efforts
- High-visibility child restraint laws enforcement
- Automated speed enforcement
- Speed limits
- High-visibility cell phone laws enforcement
- Learner's permit and intermediate driver license restrictions, including nighttime and passengers
- License screening, testing and restriction for older drivers
- Pedestrian Safety Zones, pairing enforcement and education with engineering countermeasures at a specific location

Strategies for DUI Collisions

Driving under the influence is a major factor in fatal and severe collisions that is most effectively addressed through enforcement and related strategies. Three types of policy instruments have been used to reduce rates of driving under the influence:

- Deterrence
- Prevention
- Limited access

Deterrence policies focus on raising the actual and perceived risk of detection of driving under the influence. These policies should be highly visible to increase awareness of the risks of driving under the influence. Publicized sobriety checkpoints, saturation patrol, and other forms of high visibility and enforcement are effective for safety outcomes.

Prevention and education policies focus on mobilizing and educating the community and intervening before driving under the influence takes place. According to NHTSA research, alcohol problem assessment and treatment programs, as well as alcohol intervention in settings such as a doctor's office, are highly effective strategies for improving safety outcomes.

Partnerships with healthcare providers in Richmond can be an important piece of combating DUIs. Other opportunities include partnering with TNCs (e.g., Lyft or Uber) to reduce drinking and driving can help promote safety on the road and prevent fatal and severe collisions. Limited access policies focus on making underage access to alcohol and drugs more difficult and limiting excessive alcohol consumption.

EMERGENCY SERVICES

Emergency Services

Traffic collision victims have a higher chance of survival if they can quickly receive medical care. In many cases, law enforcement officers and fire department staff are the first responders to arrive at a collision location. In addition to equipping all first responders with the appropriate training, improving response times for Emergency Medical Services will help improve collision victims' chances of survival. Traffic crashes can also put first responders' and other road users' lives at risk due to increased congestion, which may lead to secondary crashes. Strategies to improve response time and safety for EMS include designing emergency vehicles to be highly visible (e.g. retroreflective striping and chevrons, high-visibility paint, and built-in passive light) and implementing emergency vehicle signal preemption, which allows emergency vehicles to break a normal signal cycle and proceed through an intersection. Lastly, emergency responders can use data collected on historical medical care in the City to improve care and use best practices.

Trauma Care

Effective emergency trauma care can increase crash survival rates by as much as 25 percent, and an effective countywide trauma care coordination system can reduce fatalities by 50 percent. Key factors that influence the survivability of crashes are: proximity to care (how near is an appropriate trauma care center), response time, equipment, technology, and EMS training. The faster a traumatic injury victim receives medical care, the higher the chances are of preventing death. Recommended strategies to improve trauma care include providing funding for appropriate first responder equipment (e.g. hydraulic and pneumatic extrication tools), research and adoption of technology aimed at reducing triage time (e.g. automatic vehicle reporting of severe crashes to EMS, EMS vehicle collision avoidance systems, and geolocation of nearest appropriate EMS vehicles), and promotion of federal and state-certified training programs. Expanded access to and number of trauma care facilities is another major factor in improving outcomes for crash victims.

Data Sharing

Sharing data regarding on-scene time, patient destination and patient outcomes (as allowable by privacy law) would allow Richmond to effectively monitor triage performance and EMS system effectiveness. Issuing annual research regarding the findings could assist with increasing transparency and accountability to the public. Other strategies for improving data sharing could include comparing and merging EMS and hospital data with police and other relevant agency records to better inform policies, projects, programs and needed data quality improvements. Equity variables could be evaluated to document potential inequities related to homelessness, race/ethnicity, language, and income to guide policy for addressing disproportionate trauma and fatalities.

Fatal Crash Response Team

In the event of a traffic fatality, analysis and evaluation is a key towards addressing the burden of traffic mortality and tracking progress towards eliminating fatalities on Richmond's roads. One strategy is to establish a cross-agency fatal crash team of EMS, police, transportation, public health, and City officials to convene at the crash site after a fatal crash. This would assist with accurate investigation and documentation of potentially relevant infrastructural and environmental crash factors, while identifying other additional response factors that may have contributed to the fatal crash outcome.

Emerging Technology

Recent advancements in transportation technology have not only introduced new modes and travel patterns but have also presented opportunities to better understand travel behavior and encourage safe behavior. The proliferation of new mobility devices, services and technologies (e.g. ride-hailing services) have presented numerous needs and options for addressing road safety. Among these new technologies, artificial intelligence allows for more detailed data collection and the proliferation of autonomous vehicle (AV) usage. AVs have potential to reduce human error and improve street safety, but AVs also incur different challenges. The following represent a summary of emerging technology trends related to safety.

Data Collection and Management

Up-to-date data on transportation infrastructure, including roadway characteristics, intersection characteristics, and signs, is valuable for planning and implementing future improvements. Service providers that can assist with this work include:

- **Mapillary**, uses crowdsourced or privately provided street level imagery to extract and map signs, street lamps, sidewalks, signals, and other objects. https://www.mapillary.com/
- **EcopiaTech** uses satellite imagery to extract features such as road centerlines, roadway cross-sections, sidewalks, and more. https://www.ecopiatech.com/

Smart Signal Technology

As part of its strategy to bolster road safety, Richmond could explore the feasibility of deploying smart signal technology on its roads. Smart signal technology enables cities to collect data along multiple intersections, providing high-resolution data on how people are using the roadway in real time. Connected vehicles are another part of this system. They wirelessly communicate with other vehicles and infrastructure (like signals) to provide data for instantaneous decision-making (e.g. reporting driver speed or collisions). Data from signals in combination with data from vehicles can allow for real time speed-related signal operations, allowing for enhanced safety through adaptable systems.

AV Readiness Planning

Having strategies prepared to meet and address the oncoming challenges posed by AV technology will be crucial in advancing road safety in Richmond. Fully automated vehicles have the potential to transform travel behavior and safety outcomes given that AVs are ultimately designed to operate without any human intervention. Some strategies for preparation include educating the public on current and future safety features and limitations, developing signing and striping standards, and conducting reviews of equity implications. Without appropriate research and guidance, AVs could widen accessibility and safety gaps for vulnerable communities.

Near Miss Data

Near misses have historically been difficult to study in practical safety applications due to an overall lack of reported information. In the absence of sufficient crash data, near miss data is an important indicator for guiding crash prevention. There are several technologies detailed below that are closing the gap and providing key safety insights regarding near misses:

- **Video Data:** Video machine learning is an effective means of classifying collisions and collecting near miss data. The City should consider investing in these technologies (e.g. along key roadways and intersections) to proactively enact safety countermeasures.
- **Incidence Data from Connected Vehicles:** With the capability of vehicles to capture and transmit real-time data on driver behavior wirelessly, these data are increasingly becoming an integral part of reporting near misses especially given the introduction of AVs on public roadways.
- **Public Crowdsourcing:** Online web crowdsourcing platforms, like UC Berkeley's SafeTREC Street Story tool, allow anyone to anecdotally report incidents of near misses. These data are available publicly for analysis and contain important contextual information based on geographic location (e.g. road conditions, street lighting and travel mode). Utilizing a platform like Street Story could also advance community education and engagement around road safety.

The twelve emphasis areas are a combination of four priority corridors and eight collision profiles that were identified based on the number of total collisions, number of fatal and severe injury (KSI) collisions, and stakeholder input

Chapter 7

Emphasis Areas and Strategies

The following twelve emphasis areas are a combination of four priority corridors and eight collision profiles that were identified based on the number of total collisions, number of fatal and severe injury (KSI) collisions, and stakeholder input. Each priority corridor is presented on a cutsheet that includes a collision summary, location summary, safety goals, strategies to help the City achieve the identified goals, and relevant grant opportunities.

The location summary for each emphasis area includes the violations and collision types that account for the most severe or highest number of collisions. The underlying safety analysis and collision profile details are discussed in Chapter 5.

The strategies, which were selected to address the collision types and violations and contribute to achieving the safety-related goals are identified as primary countermeasures which correspond to the factors identified in the location summary and are best suited for competitive HSIP grant applications. Each emphasis area also indicates if the collisions are located in or near a school, retail, transit corridor, or park. Proximity to schools, parks, transit and retail was defined as within a 1,000 ft radius.

Unit cost estimates represent general unit costs based on prior Bay Area or statewide projects, and are not specific to the location. High-level benefit estimates assume a collision cost-based benefit related to all relevant collisions for a location or collision type, to allow for an apples-to-apples comparison of countermeasures. More information on benefit calculations can be found in the LRSM, Appendix D, page A-55. Further engineering studies will be required to develop more detailed estimates and designs.

Emphasis Areas

1. 23rd Street, Grant Avenue to Maricopa Avenue
2. 23rd Street & 22nd Street Couplet
3. Barrett Avenue, Harbour Way to 24th Street
4. Cutting Boulevard, Hoffman Boulevard to Carlson Boulevard
5. Unsafe Speeds
6. Driving Under the Influence
7. Collisions Involving the 15-24 Age Group
8. Stop Sign Violations at Stop-Controlled Intersections
9. Left Turns at Signalized Intersections
10. Pedestrian Right-of-Way Violations at Uncontrolled Crossings
11. Pedestrians Crossing Outside Crosswalk or Legal Crossings
12. Contraflow Bicycle Riding

23rd Street Grant Avenue to Maricopa Avenue

PRIORITY CORRIDOR

Collision Summary

- 59 Total Collisions
- 5 KSI Collisions
- 19 Bicycle and Pedestrian Collisions
- 2 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Vehicle right-of-way violation
- Unsafe speed
- Improper turning
- Pedestrian right-of-way violation
- Wrong side of road
- Driving or under the influence of alcohol or drug

COLLISION TYPES

- Broadside
- Rear end
- Vehicle-Pedestrian
- Head-on

ROADWAY & CONTEXTUAL FACTORS

- 4-lane road with parking, no median
- 30-35 mph speed limit
- Multiple offset intersections

Goals

- Reduce vehicle speeds throughout the corridor
- Increase pedestrian visibility with enhanced striping and signage, especially near schools and parks
- Reduce frequency of intersection conflicts, particularly left-turn conflicts, using traffic control and intersection enhancements
- Create consistency with the three-lane portion of the road in City of San Pablo
- Continue to build out bicycle network

Countermeasure	Issue Area		Time Frame	Unit Cost
Green Conflict Striping	To address	Contraflow bicycle riding	Short	$1,000 per location
Advanced Stop Bar	To address	Pedestrian right-of-way, Not stopping	Short	$1,000 per location
High-visibility Crosswalks	To address	Pedestrian right-of-way	Medium	$5,000 per location
Pedestrian Hybrid Beacons (or RRFB)	To address	Pedestrian right-of-way	Medium	$50,000 per location
Class II Bicycle Lanes	To address	Contraflow bicycle riding	Medium	$90,000 per mile
PHB	To address	Pedestrian right-of-way	Medium	$250,000
Road Diet	To address	Unsafe Speed, Pedestrian right-of-way, Contraflow bicycle riding	Medium-Long	$80,000 - $50,000 per mile
Protected Left-Turn Phasing	To address	Left-turns	Medium-Long	$250,000 per intersection

23rd Street, Grant Avenue to Maricopa Avenue

In December 2021 the Contra Costa Transportation Authority (CCTA) published a City of Richmond Complete Streets Safety Assessment. Where noted, CSSA recommendations should be implemented to improve safety.

In May 2018 a draft 23rd Street Streetscape Plan was developed. Implementation of this plan would include the elements listed here and would further Richmond's safety goals for this corridor, including improving the ability for bicyclists and pedestrians to cross 23rd Street on intersecting bicycle boulevards.

Whole-Corridor Improvements

- **Implement a road diet (4-to-3 lane conversion)**
- **Install Class 2 bicycle lanes and green conflict striping at intersections to provide a separate space for bikes and reduce conflicts at intersections**

23rd Street & 22nd Street Couplet

PRIORITY CORRIDOR

Collision Summary

- 105 Total Collisions
- 4 KSI Collisions
- 21 Bicycle and Pedestrian Collisions
- 2 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Traffic signals and signs
- Unsafe speed
- Pedestrian right-of-way violation
- Improper turning
- Vehicle right-of-way violation
- Pedestrian violation
- Driving or bicycling under the influence of alcohol or drugs

COLLISION TYPES

- Broadside
- Vehicle/Pedestrian
- Rear end
- Head-on
- Sideswipe

ROADWAY & CONTEXTUAL FACTORS

- 22nd Street: 2-lane road with parking
- 23rd Street: 3-lane road with parking
- 30-35 mph speed limit
- Multiple offset intersections

Goals

- Reduce vehicle speeds throughout the corridor
- Increase pedestrian visibility with enhanced striping and signage
- Reduce frequency of intersection conflicts, particularly left-turn conflicts, using traffic control and intersection enhancements
- Continue to build out bicycle network

Countermeasure	Issue Area		Time Frame	Unit Cost
Advanced Stop Bar	To address	Pedestrian right-of-way, Not stopping	Short	$1,000 per location
Speed Hump or Speed Table	To address	Unsafe Speed	Short-Medium	$5,000 per location
Pedestrian Hybrid Beacons (or RRFB)	To address	Pedestrian right-of-way	Medium	$250,000 per location
High-visibility Crosswalks	To address	Pedestrian right-of-way	Medium	$5,000 per location
Road Diet	To address	Unsafe Speed, Pedestrian right-of-way, Contraflow bicycle riding	Medium-Long	$80,000 - $500,000 per mile
Protected Left-Turn Phasing	To address	Left-turns	Medium-Long	$250,000 per intersection
Close Slip Lane	To address	Unsafe Speed, Pedestrian right-of-way	Long	$200,000 per location

23rd Street & 22nd Street Couplet

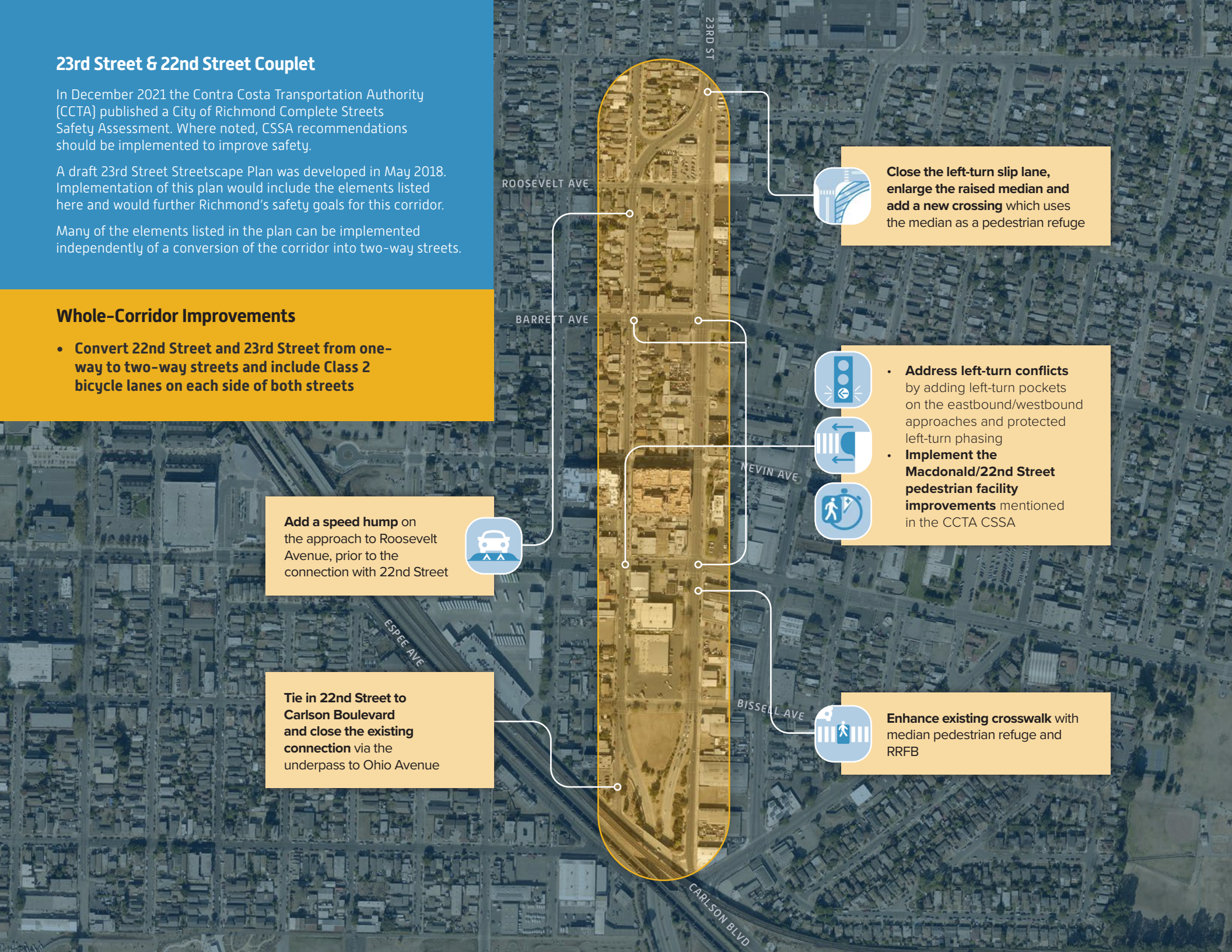
In December 2021 the Contra Costa Transportation Authority (CCTA) published a City of Richmond Complete Streets Safety Assessment. Where noted, CSSA recommendations should be implemented to improve safety.

A draft 23rd Street Streetscape Plan was developed in May 2018. Implementation of this plan would include the elements listed here and would further Richmond's safety goals for this corridor.

Many of the elements listed in the plan can be implemented independently of a conversion of the corridor into two-way streets.

Whole-Corridor Improvements

- **Convert 22nd Street and 23rd Street from one-way to two-way streets and include Class 2 bicycle lanes on each side of both streets**



Close the left-turn slip lane, enlarge the raised median and add a new crossing which uses the median as a pedestrian refuge

- **Address left-turn conflicts** by adding left-turn pockets on the eastbound/westbound approaches and protected left-turn phasing
- **Implement the Macdonald/22nd Street pedestrian facility improvements** mentioned in the CCTA CSSA

Add a speed hump on the approach to Roosevelt Avenue, prior to the connection with 22nd Street

Enhance existing crosswalk with median pedestrian refuge and RRFB

Tie in 22nd Street to Carlson Boulevard and close the existing connection via the underpass to Ohio Avenue

Barrett Avenue Harbour Way to 24th Street

PRIORITY CORRIDOR

Collision Summary

- 109 Total Collisions
- 4 KSI Collisions
- 23 Bicycle and Pedestrian Collisions
- 2 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Traffic signals and signs
- Vehicle right-of-way violation
- Improper turning
- Pedestrian right-of-way violation
- Unsafe speed
- Driving or bicycling under the influence of alcohol or drug
- Pedestrian violation

COLLISION TYPES

- Broadside
- Vehicle/Pedestrian
- Rear end
- Sideswipe
- Head-on

ROADWAY & CONTEXTUAL FACTORS

- 4-to-5-lane road with parking and partial raised median
- 30-35 mph speed limit
- Discontinuous bicycle facilities
- Train (BART and UPRR/ Amtrak) overpass

Goals

- Reduce vehicle speeds throughout the corridor
- Prevent use of turning lanes as through lanes
- Slow and channelize traffic through the undercrossing
- Create consistency with the three-lane portion of the road to the east
- Continue to build out the bicycle network by closing a gap in a crosstown bike route

Countermeasure	Issue Area		Time Frame	Unit Cost
Advanced Stop Bar	To address	Pedestrian right-of-way, Not stopping	Short	$1,000 per location
Speed Hump or Speed Table	To address	Unsafe Speed	Short-Medium	$5,000 per location
High-visibility Crosswalks	To address	Pedestrian right-of-way	Medium	$5,000 per location
Road Diet	To address	Unsafe Speed, Pedestrian right-of-way, Contraflow bicycle riding	Medium-Long	$80,000 - $500,000 per mile
Protected Left-Turn Phasing	To address	Left-turns	Medium-Long	$250,000 per intersection

Barrett Avenue, Harbour Way to 24th Street

In December 2021 the Contra Costa Transportation Authority (CCTA) published a City of Richmond Complete Streets Safety Assessment. Where noted, implement these CSSA recommendations to improve safety.

Whole-Corridor Improvements

- **Implement a road diet throughout the corridor (to match lane configurations east of 24th Street) and implement raised medians at all intersections along the corridor to discourage use of the two-way turn lane as a passing lane**

- **Enhance the existing crosswalk** with median and RRFB
- **Implement pedestrian facility improvements** mentioned in the CCTA CSSA

Add new enhanced crosswalks to the eastern leg of the 19th Street intersection and western leg of 21st Street intersection

- **Implement the roadway, bicycle and pedestrian facility improvements** mentioned in the CCTA CSSA
- **Convert the southernmost eastbound lane to a right-turn only lane**

- **Remove one through lane** in each direction to accommodate a bicycle lane (buffered or protected where possible)
- **Add channelizers and striping** on approach to 18th Street, remove eastbound right-turn lane and add a left-turn lane
- **Widen sidewalks** through the underpass. Currently, sidewalks are only provided on the north side.

Address left-turn conflicts and enhance crossings per recommendations provided for the 22nd Street & 23rd Street Couplet

Cutting Boulevard Hoffman Boulevard to Carlson Boulevard

PRIORITY CORRIDOR

Collision Summary

- 90 Total Collisions
- 12 KSI Collisions
- 22 Bicycle and Pedestrian Collisions
- 5 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Vehicle right-of-way violation
- Traffic signs and signals
- Improper turning
- Driving under the influence of alcohol or drug
- Following too closely
- Pedestrian violation
- Wrong side of road

COLLISION TYPES

- Broadside
- Vehicle/pedestrian
- Rear end
- Sideswipe
- Head-on

ROADWAY & CONTEXTUAL FACTORS

- 4-to-5-lane road with parking and partial raised median
- 30-35 speed limit
- Multiple unsignalized, unenhanced crossings and areas absent safe crossings
- Railroad crossing adjacent high-traffic intersection

Goals

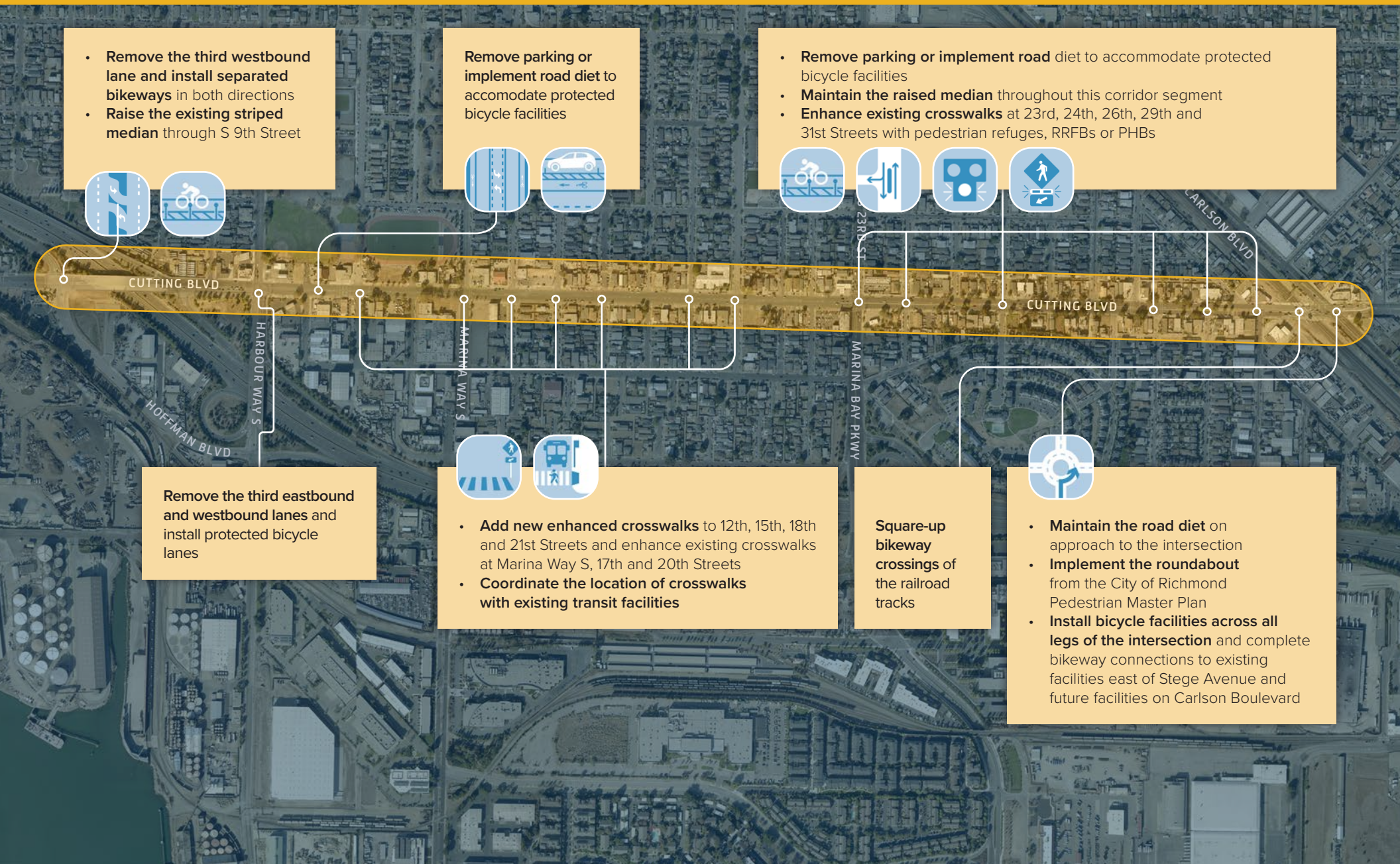
- Reduce vehicle speeds throughout the corridor
- Provide separate and protected facilities for people who walk and bike
- Improve visibility of bicyclists and pedestrians at intersections
- Encourage multimodal transportation with multimodal infrastructure and lower vehicle speeds
- Continue to build out bicycle network
- Coordinate improvements with the proposed grade crossing improvement on Cutting Boulevard at Carlson Boulevard.

Countermeasure	Issue Area		Time Frame	Unit Cost
Advanced Stop Bar	To address	Pedestrian right-of-way, Not stopping	Short	$1,000 per location
Speed Hump or Speed Table	To address	Unsafe Speed	Short-Medium	$5,000 per location
High-visibility Crosswalks	To address	Pedestrian right-of-way	Medium	$5,000 per location
Road Diet	To address	Unsafe Speed, Pedestrian right-of-way, Contraflow bicycle riding	Medium-Long	$80,000 - $500,000 per mile
Median Refuge	To address	Pedestrian Crossing	Medium-Long	$25,000 per location
Close Slip Lane	To address	Unsafe Speed, Pedestrian right-of-way	Long	$200,000 per location

Cutting Boulevard, Hoffman Boulevard to Carlson Boulevard

Whole-Corridor Improvements

- **Implement a road diet (5-to-3 lanes) throughout the corridor and install protected bicycle lanes buffered either by parking or constructed barriers**



- **Remove the third westbound lane and install separated bikeways** in both directions
- **Raise the existing striped median** through S 9th Street

Remove parking or implement road diet to accomodate protected bicycle facilities

- **Remove parking or implement road** diet to accommodate protected bicycle facilities
- **Maintain the raised median** throughout this corridor segment
- **Enhance existing crosswalks** at 23rd, 24th, 26th, 29th and 31st Streets with pedestrian refuges, RRFBs or PHBs

Remove the third eastbound and westbound lanes and install protected bicycle lanes

- **Add new enhanced crosswalks** to 12th, 15th, 18th and 21st Streets and enhance existing crosswalks at Marina Way S, 17th and 20th Streets
- **Coordinate the location of crosswalks with existing transit facilities**

Square-up bikeway crossings of the railroad tracks

- **Maintain the road diet** on approach to the intersection
- **Implement the roundabout** from the City of Richmond Pedestrian Master Plan
- **Install bicycle facilities across all legs of the intersection** and complete bikeway connections to existing facilities east of Stege Avenue and future facilities on Carlson Boulevard

Unsafe Speeds

COLLISION PROFILE

Collision Summary

- 297 Total Collisions
- 29 KSI Collisions
- 18 Bicycle and Pedestrian Collisions
- 6 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS ✓
- OTHER

Location Summary

VIOLATIONS

- Unsafe speed

COLLISION TYPES

- Rear end
- Hit object
- Broadside
- Head-on
- Sideswipe
- Overturned
- Vehicle/pedestrian

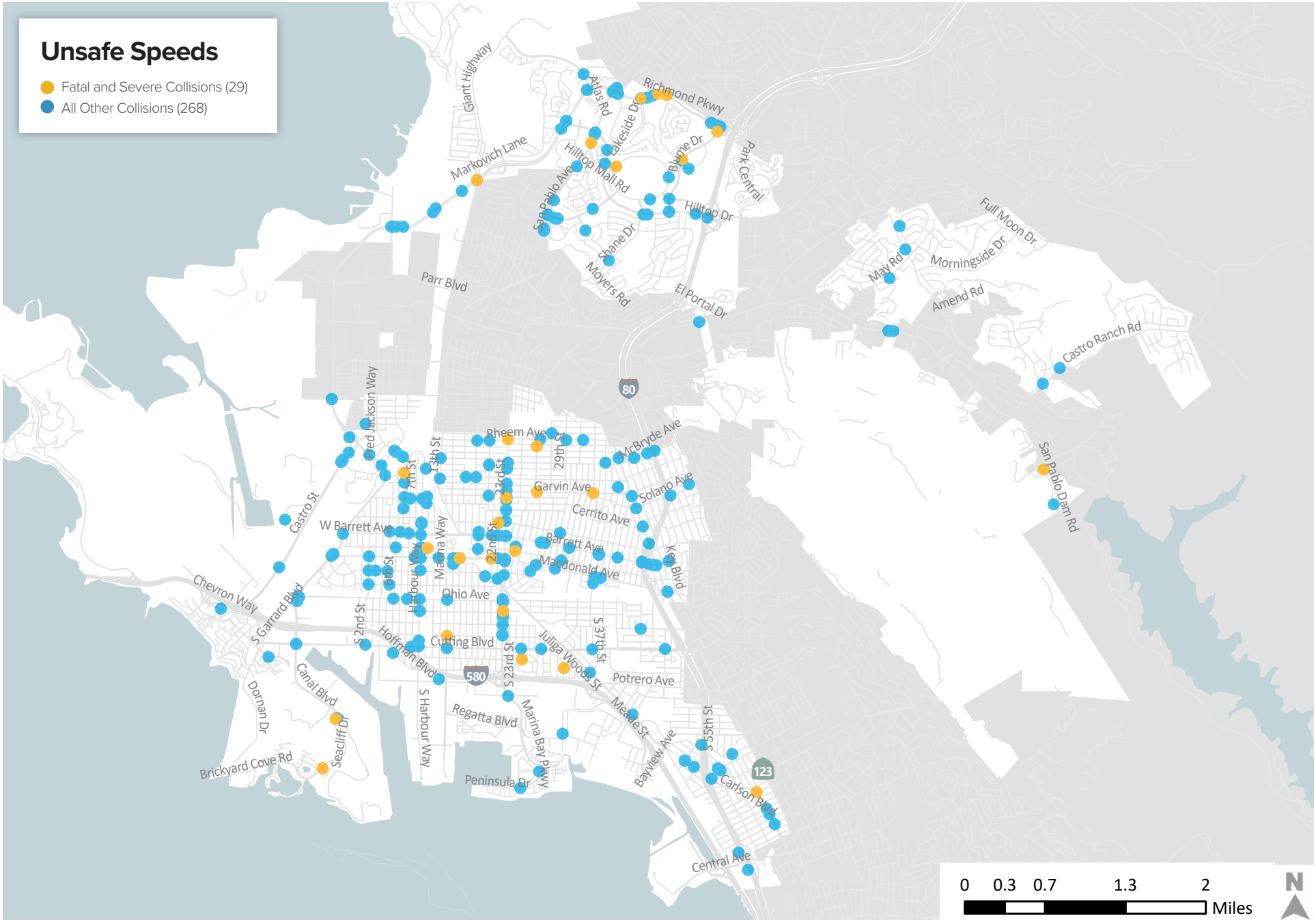
ROADWAY & CONTEXTUAL FACTORS

- Citywide issue

Goals

- Reduce vehicle speeds through roadway design
- Improve visibility of people who walk and bike, particularly at intersections
- Encourage slower speeds via education and enforcement, including development of neighborhood slow zones, and Safe Routes to Schools

Countermeasure	Time Frame	Unit Cost
Radar Speed Feedback Signs	Short	$10,000 per location
Speed Hump or Speed Table	Short-Medium	$5,000 per location
Road Diet	Medium-Long	$80,000 - $500,000 per mile
Close Slip Lane	Long	$200,000 per location


Unsafe Speeds
Fatal and Severe Collisions (29)
All Other Collisions (268)
Giant Highway
Atlas Rd
Richmond Pkwy
Lakeside Dr
Blume Dr
Park Central
Markovich Lane
Hilltop Mall Rd
San Pablo Ave
Hilltop Dr
Shane Dr
Moyers Rd
Parr Blvd
El Portal Dr
Full Moon Dr
Morningside Dr
May Rd
Amend Rd
Castro Ranch Rd
San Pablo Dam Rd
80
Reed Jackson Way
Rheem Ave
29th St
McBryde Ave
12th St
7th St
23rd St
Garvin Ave
Solano Ave
Cerrito Ave
Castro St
W Barrett Ave
22nd St
Barrett Ave
Macdonald Ave
Key Blvd
Marina Way
Harbour Way
6th St
Chevron Way
Ohio Ave
S Garrard Blvd
S 2nd St
Hoffman Blvd
Cutting Blvd
Juliga Woods St
S 37th St
S 23rd St
580
Potrero Ave
Meade St
Canal Blvd
Dornan Dr
Seacliff Dr
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
Brickyard Cove Rd
Peninsula Dr
Bayview Ave
S 55th St
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

Driving Under the Influence

COLLISION PROFILE

Collision Summary

- 108 Total Collisions
- 14 KSI Collisions
- 4 Bicycle and Pedestrian Collisions
- 2 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS ✓
- OTHER

Location Summary

VIOLATIONS

- Driving or bicycling under the influence of alcohol or drug

COLLISION TYPES

- Broadside
- Rear end
- Hit object
- Sideswipe
- Head-on
- Vehicle/Pedestrian
- Overturned

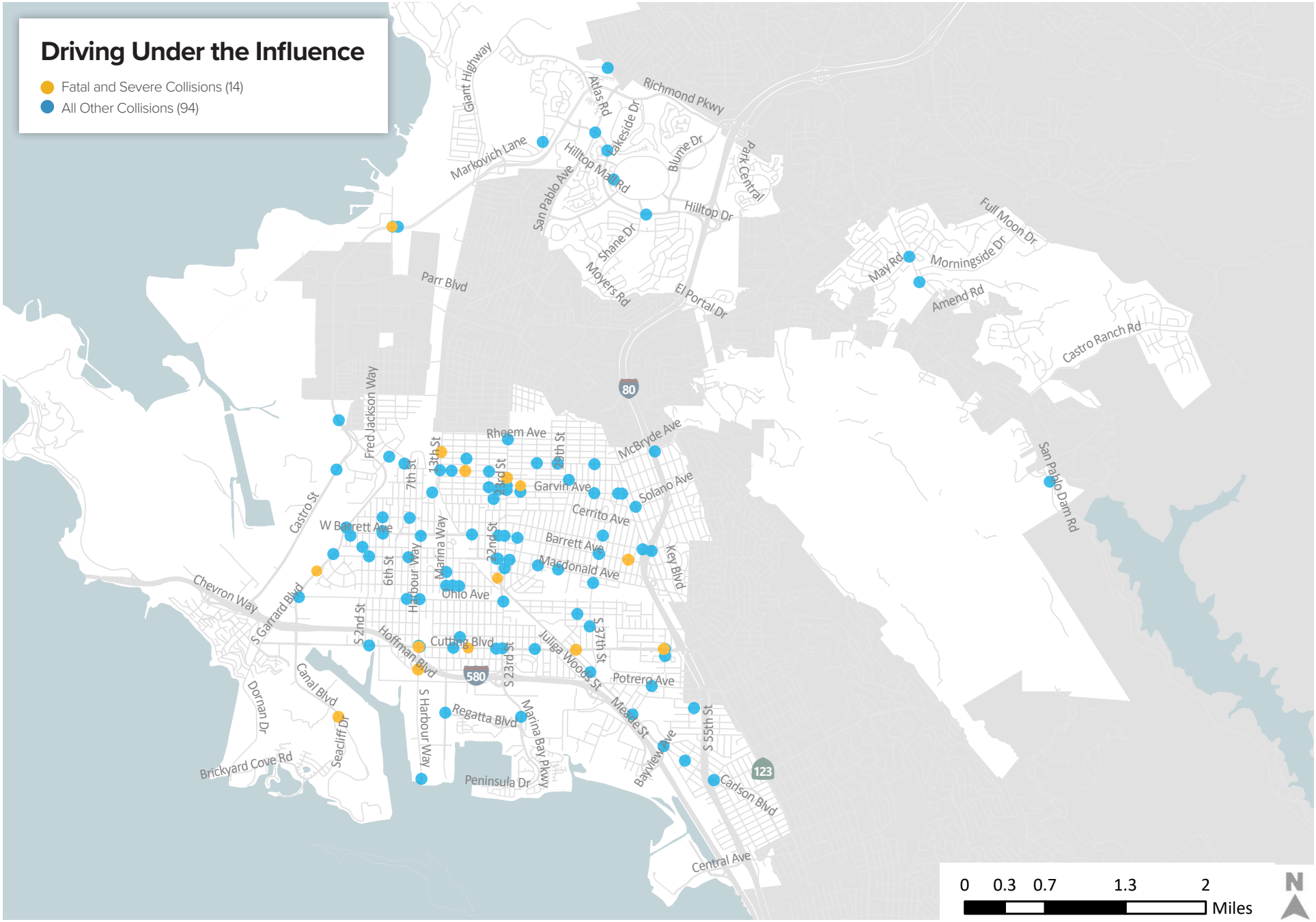
ROADWAY & CONTEXTUAL FACTORS

- Citywide issue

Goals

- Reduce the severity of collisions caused by driving under the influence with roadway design
- Reduce driving under the influence with enforcement and partnerships

Countermeasure	Time Frame	Unit Cost
Extended Yellow and All Red Time	Short	$500 per location
Impact Attenuators	Medium	$50,000 each
Median Barrier	Medium	$75 per linear foot
Guardrail	Medium	$50 per linear foot
Edgeline Rumble Strips	Medium	$50 per linear foot
Intersection Lighting	Long	$30,000 per intersection
Roadway Lighting	Long	$10,000 per light


Driving Under the Influence
Fatal and Severe Collisions (14)
All Other Collisions (94)
Giant Highway
Atlas Rd
Richmond Pkwy
Lakeside Dr
Markovich Lane
Hilltop Mall Rd
Blume Dr
Park Central
San Pablo Ave
Hilltop Dr
Shane Dr
Moyers Rd
El Portal Dr
Parr Blvd
Full Moon Dr
May Rd
Morningside Dr
Amend Rd
Castro Ranch Rd
San Pablo Dam Rd
80
Fred Jackson Way
Rheem Ave
McBryde Ave
13th St
7th St
23rd St
Garvin Ave
Solano Ave
Cerrito Ave
Castro St
W Barrett Ave
Barrett Ave
Marina Way
22nd St
Macdonald Ave
Key Blvd
6th St
Harbour Way
Ohio Ave
Chevron Way
S Garrard Blvd
S 2nd St
Hoffman Blvd
Cutting Blvd
S 23rd St
Juliga Woods St
S 37th St
580
Potrero Ave
Meade St
Canal Blvd
Dornan Dr
Seacliff Dr
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
S 55th St
Bayview Ave
Brickyard Cove Rd
Peninsula Dr
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

Collisions Involving the 15-24 Age Group

COLLISION PROFILE

Collision Summary

- 498 Total Collisions
- 41 KSI Collisions
- 72 Bicycle and Pedestrian Collisions
- 11 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP ✓
- OTS ✓
- OTHER ✓

Location Summary

VIOLATIONS

- Vehicle right-of-way violation
- Unsafe speed
- Traffic signals and signs
- Improper turning
- Driving or bicycling under the influence of alcohol or drug
- Wrong side of road
- Pedestrian right-of-way violation
- Pedestrian violation

COLLISION TYPES

- Broadside
- Rear end
- Head-on
- Sideswipe
- Vehicle/pedestrian
- Hit object

ROADWAY & CONTEXTUAL FACTORS

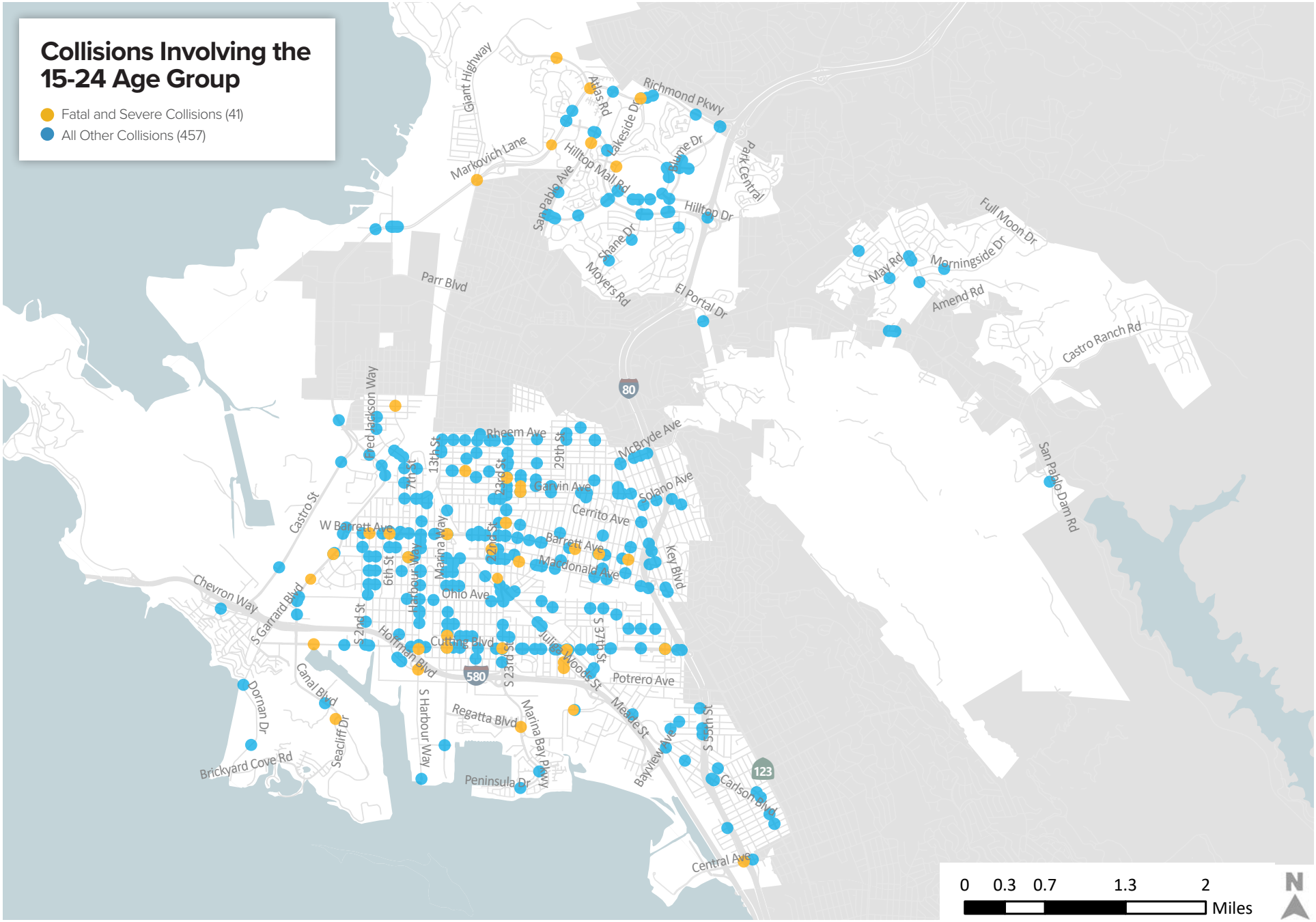
- Citywide issue

Goals

- Increase the visibility of intersection signs and signals and pedestrian crossings
- Reduce speeds via roadway design, particularly near schools and high-traffic areas
- Encourage safe behavior with community-wide sustained outreach safety campaigns and targeted outreach

Non-Engineering Countermeasure	Time Frame*	Cost*
Safe Routes to Schools Program	Short	$
Public Information Campaigns	Medium	$$
Youth Education	Medium	$$

* These estimates do not include the costs of enacting legislation or establishing policies.


Collisions Involving the 15-24 Age Group
Fatal and Severe Collisions (41)
All Other Collisions (457)
Giant Highway
Markovich Lane
Atlas Rd
Richmond Pkwy
Lakeside Dr
Hilltop Mall Rd
San Pablo Ave
Shane Dr
Moyers Rd
Hilltop Dr
Park Central
Parr Blvd
El Portal Dr
Full Moon Dr
May Rd
Morningside Dr
Amend Rd
Castro Ranch Rd
San Pablo Dam Rd
80
Ted Jackson Way
Rheem Ave
13th St
7th St
29th St
McBryde Ave
Garvin Ave
Solano Ave
Cerrito Ave
Castro St
W Barrett Ave
Barrett Ave
Macdonald Ave
Key Blvd
Marina Way
Harbour Way
6th St
Ohio Ave
Chevron Way
S Garrard Blvd
S 20th St
Hoffman Blvd
Cutting Blvd
S 23rd St
Julio Woods St
S 37th St
Potrero Ave
Meade St
580
Canal Blvd
Dornan Dr
Seacliff Dr
Brickyard Cove Rd
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
Peninsula Dr
Bayview Ave
S 39th St
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

Stop Sign Violations at Stop-Controlled intersections

COLLISION PROFILE

Collision Summary

- 103 Total Collisions
- 13 KSI Collisions
- 18 Bicycle and Pedestrian Collisions
- 1 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS ✓
- OTHER

Location Summary

VIOLATIONS

- Traffic signals and signs

COLLISION TYPES

- Broadside
- Sideswipe
- Head-on
- Vehicle/pedestrian
- Overturned

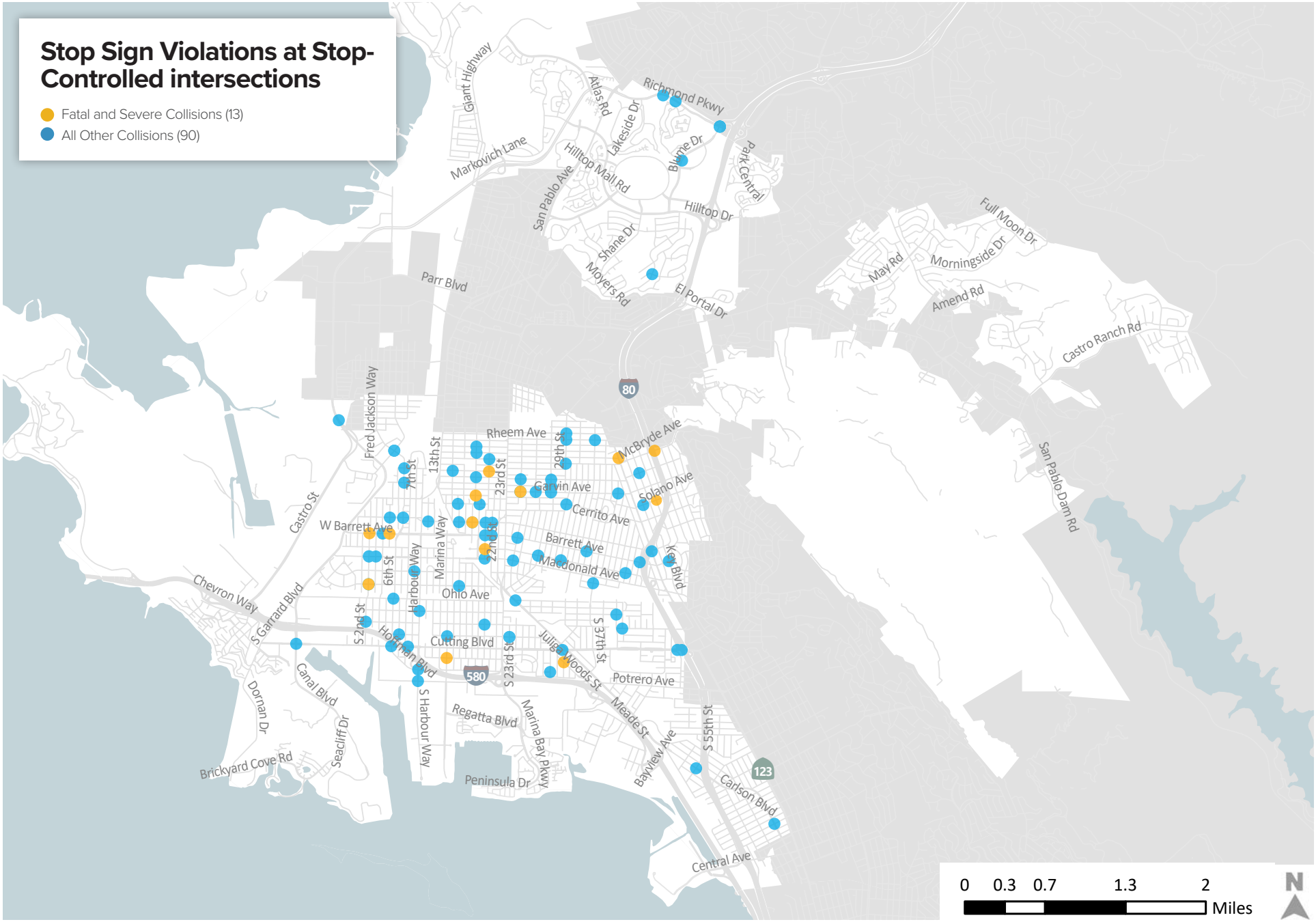
ROADWAY & CONTEXTUAL FACTORS

- All-way or two-way (i.e., side-street) stop-controlled intersections
- School zones (or intersections near schools)

Goals

- Slow vehicle speeds throughout the corridor and reduce the occurrence of broadside collisions
- Increase driver awareness of intersections, sign and signal controls with enhanced warning signs and by enhancing signal visibility
- Reduce stop sign violations through improved enforcement.

Countermeasure	Time Frame	Unit Cost
Advanced Warning Signs	Short	$1,500 per location
Road Diet	Medium-Long	$80,000 - $500,000 per mile
Bulbouts	Medium-Long	$50,000 per corner


Stop Sign Violations at Stop-Controlled intersections
Fatal and Severe Collisions (13)
All Other Collisions (90)
Giant Highway
Atlas Rd
Richmond Pkwy
Lakeside Dr
Blume Dr
Park Central
Markovich Lane
Hilltop Mall Rd
San Pablo Ave
Hilltop Dr
Shane Dr
Moyers Rd
El Portal Dr
Full Moon Dr
Morningside Dr
May Rd
Amend Rd
Castro Ranch Rd
Parr Blvd
Fred Jackson Way
80
Rheem Ave
McBryde Ave
13th St
29th St
23rd St
7th St
Garvin Ave
Solano Ave
Cerrito Ave
San Pablo Dam Rd
Castro St
W Barrett Ave
Marina Way
22nd St
Barrett Ave
Macdonald Ave
Key Blvd
6th St
Harbour Way
Chevron Way
Ohio Ave
S Garrard Blvd
S 2nd St
Hoffman Blvd
Cutting Blvd
S 23rd St
Julian Woods St
S 37th St
580
Potrero Ave
Meade St
Canal Blvd
Dornan Dr
Seacliff Dr
Brickyard Cove Rd
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
Peninsula Dr
Bayview Ave
S 55th St
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

Left Turns at Signalized Intersections

COLLISION PROFILE

Collision Summary

- 49 Total Collisions
- 3 KSI Collisions
- 5 Bicycle and Pedestrian Collisions
- 0 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Vehicle right-of-way violation

COLLISION TYPES

- Broadside
- Head-on
- Sideswipe
- Hit object
- Not stated
- Vehicle/Pedestrian

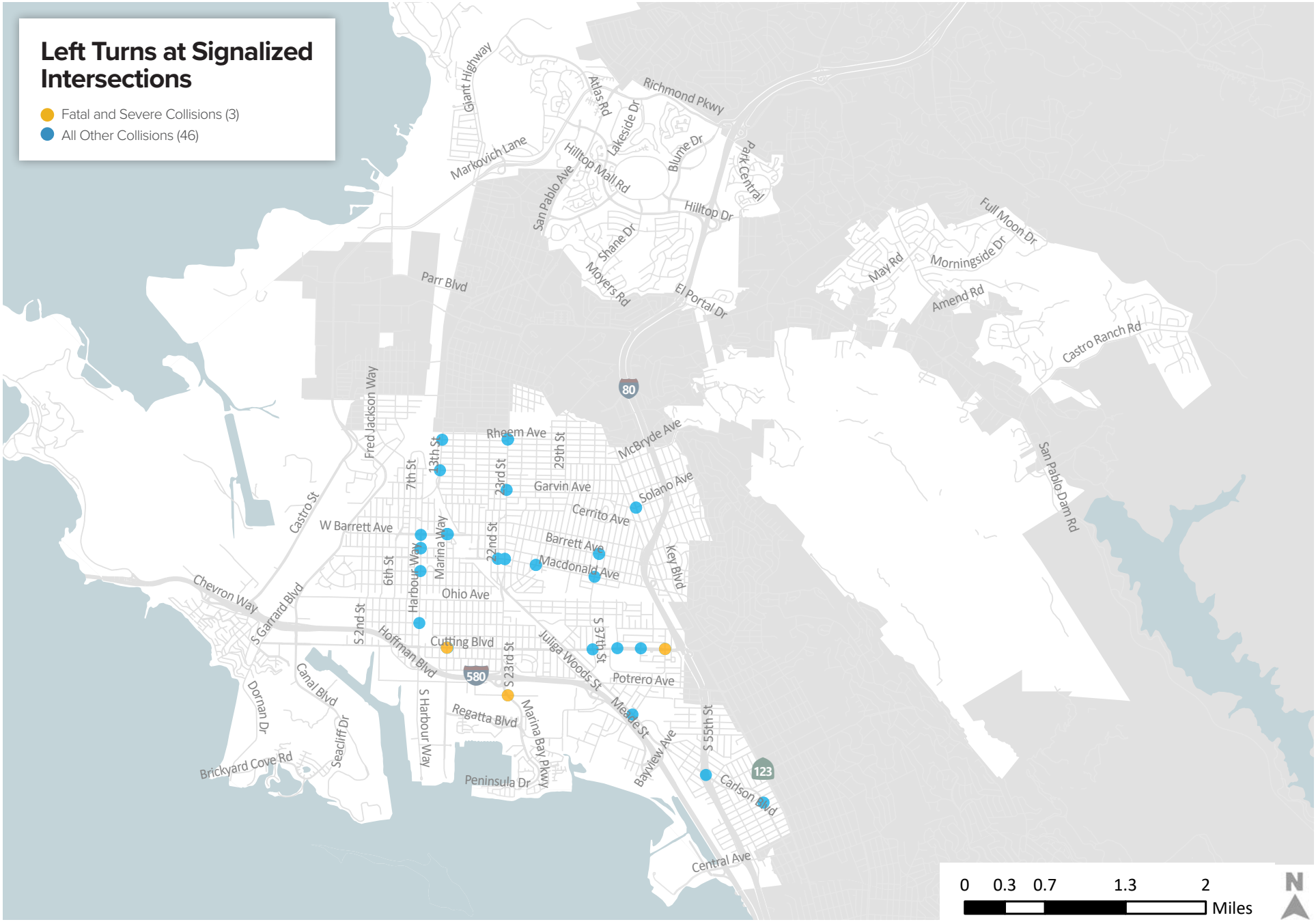
ROADWAY & CONTEXTUAL FACTORS

- Signalized intersections lacking a left-turn phase

Goals

- Reduce number and severity of left-turn collisions at signalized intersections
- Reduce number and severity of broadside collisions at signalized intersections

Countermeasure	Time Frame	Unit Cost
Protected Left-turn Phasing	Medium-Long	$250,000 per intersection
Raised Median	Medium-Long	$150 per linear foot


Left Turns at Signalized Intersections
Fatal and Severe Collisions (3)
All Other Collisions (46)
Giant Highway
Atlas Rd
Richmond Pkwy
Lakeside Dr
Markovich Lane
Hilltop Mall Rd
Blume Dr
Park Central
San Pablo Ave
Hilltop Dr
Shane Dr
Moyers Rd
Parr Blvd
El Portal Dr
Full Moon Dr
May Rd
Morningside Dr
Amend Rd
Castro Ranch Rd
San Pablo Dam Rd
80
Fred Jackson Way
Rheem Ave
McBryde Ave
13th St
29th St
7th St
23rd St
Garvin Ave
Solano Ave
Cerrito Ave
Castro St
W Barrett Ave
Marina Way
22nd St
Barrett Ave
Key Blvd
6th St
Harbour Way
Macdonald Ave
Chevron Way
Ohio Ave
S Garrard Blvd
S 2nd St
Hoffman Blvd
Cutting Blvd
Juliga Woods St
S 37th St
580
S 23rd St
Potrero Ave
Canal Blvd
Dornan Dr
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
Meade St
Bayview Ave
S 55th St
Seacliff Dr
Brickyard Cove Rd
Peninsula Dr
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

Pedestrian Right-of-Way Violations at Uncontrolled Crossings

COLLISION PROFILE

Collision Summary

- 39 Total Collisions
- 8 KSI Collisions
- 39 Bicycle and Pedestrian Collisions
- 8 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Pedestrian right-of-way violation

COLLISION TYPES

- Vehicle/Pedestrian
- Sideswipe
- Broadside
- Not stated

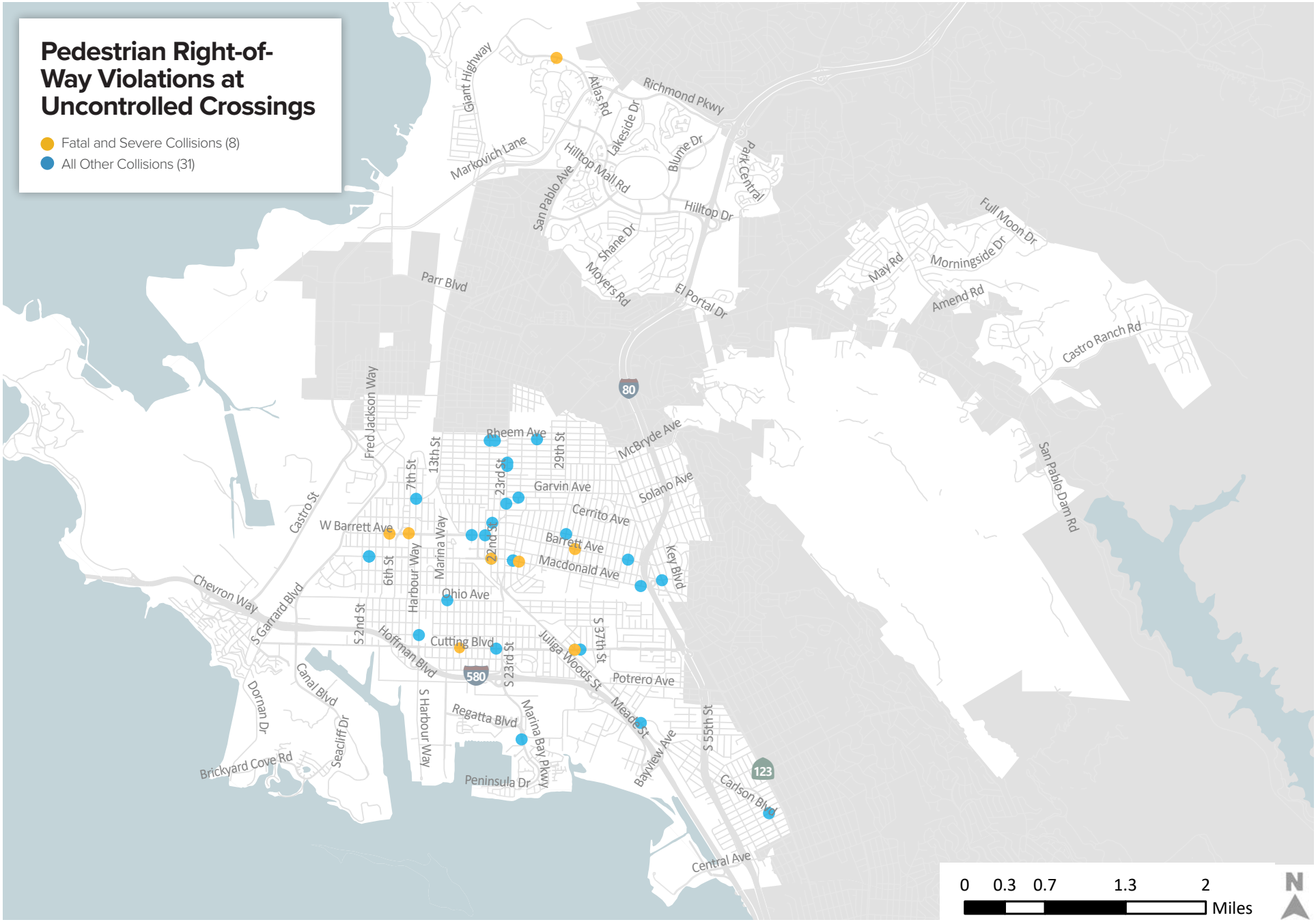
ROADWAY & CONTEXTUAL FACTORS

- Uncontrolled crossings, two-way stop-controlled crossings and midblock crossings
- Multilane roadways (more than one lane in each direction)
- Nighttime and/or low-light conditions

Goals

- Provide separate and protected facilities for people who walk
- Increase visibility for people who drive and walk at night with intersection, roadway and pedestrian lighting
- Reduce pedestrian exposure to vehicle traffic by upgrading or filling gaps in facilities such as sidewalks and crosswalks

Countermeasure	Time Frame	Unit Cost
Pedestrian Hybrid Beacons (or RRFB)	Medium	$50,000
PHB	Medium	$250,000
High-visibility Crosswalk	Medium	$5,000 per location
Bulbouts	Medium-Long	$50,000 per corner
Median Refuge	Medium-Long	$25,000 per location
Road Diet	Medium-Long	$80,000 - $500,000 per mile


Pedestrian Right-of-Way Violations at Uncontrolled Crossings
Fatal and Severe Collisions (8)
All Other Collisions (31)
Giant Highway
Atlas Rd
Richmond Pkwy
Lakeside Dr
Markovich Lane
Hilltop Mall Rd
Blume Dr
Park Central
San Pablo Ave
Hilltop Dr
Shane Dr
Moyers Rd
El Portal Dr
Parr Blvd
Full Moon Dr
May Rd
Morningside Dr
Amend Rd
Castro Ranch Rd
San Pablo Dam Rd
80
Fred Jackson Way
Rheem Ave
McBryde Ave
29th St
13th St
23rd St
7th St
Garvin Ave
Solano Ave
Castro St
Cerrito Ave
W Barrett Ave
Barrett Ave
22nd St
Marina Way
6th St
Harbour Way
Macdonald Ave
Key Blvd
Chevron Way
Ohio Ave
S Garrard Blvd
S 2nd St
Hoffman Blvd
Cutting Blvd
S 23rd St
Juliga Woods St
S 37th St
580
Potrero Ave
Canal Blvd
Dornan Dr
Seacliff Dr
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
Meade St
Bayview Ave
S 55th St
Brickyard Cove Rd
Peninsula Dr
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

Pedestrians Crossing Outside Crosswalk or Legal Crossings

COLLISION PROFILE

Collision Summary

- 32 Total Collisions
- 7 KSI Collisions
- 32 Bicycle and Pedestrian Collisions
- 7 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Pedestrian violation

COLLISION TYPES

- Vehicle/Pedestrian
- Head-on
- Sideswipe
- Not stated
- Other

ROADWAY & CONTEXTUAL FACTORS

- Outside of a crosswalk or legal crossing (marked and unmarked crosswalk)
- Midblock or along roadway shoulder

Goals

- Reduce pedestrian exposure to vehicular traffic by upgrading or filling in gaps in facilities such as sidewalks and crosswalks
- Improve sight distance and/or visibility between motor vehicles and pedestrians
- Reduce vehicle speeds

Countermeasure	Time Frame	Unit Cost
Median Barricades	Medium	$50 per linear foot
High-visibility Crosswalk	Medium	$5,000 per location
Road Diet	Medium-Long	$80,000 - $500,000 per mile
Roadway Lighting	Long	$10,000 per light


Pedestrian Crossing Outside Crosswalk or Legal Crossings
Fatal and Severe Collisions (7)
All Other Collisions (25)
Giant Highway
Markovich Lane
Atlas Rd
Richmond Pkwy
Lakeside Dr
Blume Dr
Park Central
Hilltop Mall Rd
San Pablo Ave
Hilltop Dr
Shane Dr
Moyers Rd
Parr Blvd
El Portal Dr
Full Moon Dr
Morningside Dr
May Rd
Amend Rd
Castro Ranch Rd
80
Fred Jackson Way
Rheem Ave
McBryde Ave
29th St
13th St
7th St
23rd St
Garvin Ave
Solano Ave
Cerrito Ave
Castro St
W Barrett Ave
Barrett Ave
Macdonald Ave
22nd St
Marina Way
6th St
Harbour Way
Key Blvd
San Pablo Dam Rd
Chevron Way
S Garrard Blvd
Ohio Ave
S 2nd St
Hoffman Blvd
Cutting Blvd
Julian Woods St
S 37th St
S 23rd St
580
Potrero Ave
Meade St
Canal Blvd
Dornan Dr
Seacliff Dr
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
S 55th St
Brickyard Cove Rd
Peninsula Dr
Bayview Ave
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

Contraflow Bicycle Riding

COLLISION PROFILE

Collision Summary

- 24 Total Collisions
- 2 KSI Collisions
- 24 Bicycle and Pedestrian Collisions
- 2 Bicycle and Pedestrian KSI Collisions

Location Attributes

- NEAR SCHOOL ✓
- NEAR RETAIL ✓
- NEAR TRANSIT ✓
- NEAR PARK ✓

Relevant Grant Opportunities

- HSIP ✓
- ATP
- OTS
- OTHER

Location Summary

VIOLATIONS

- Wrong side of road

COLLISION TYPES

- Broadside
- Head-on
- Sideswipe

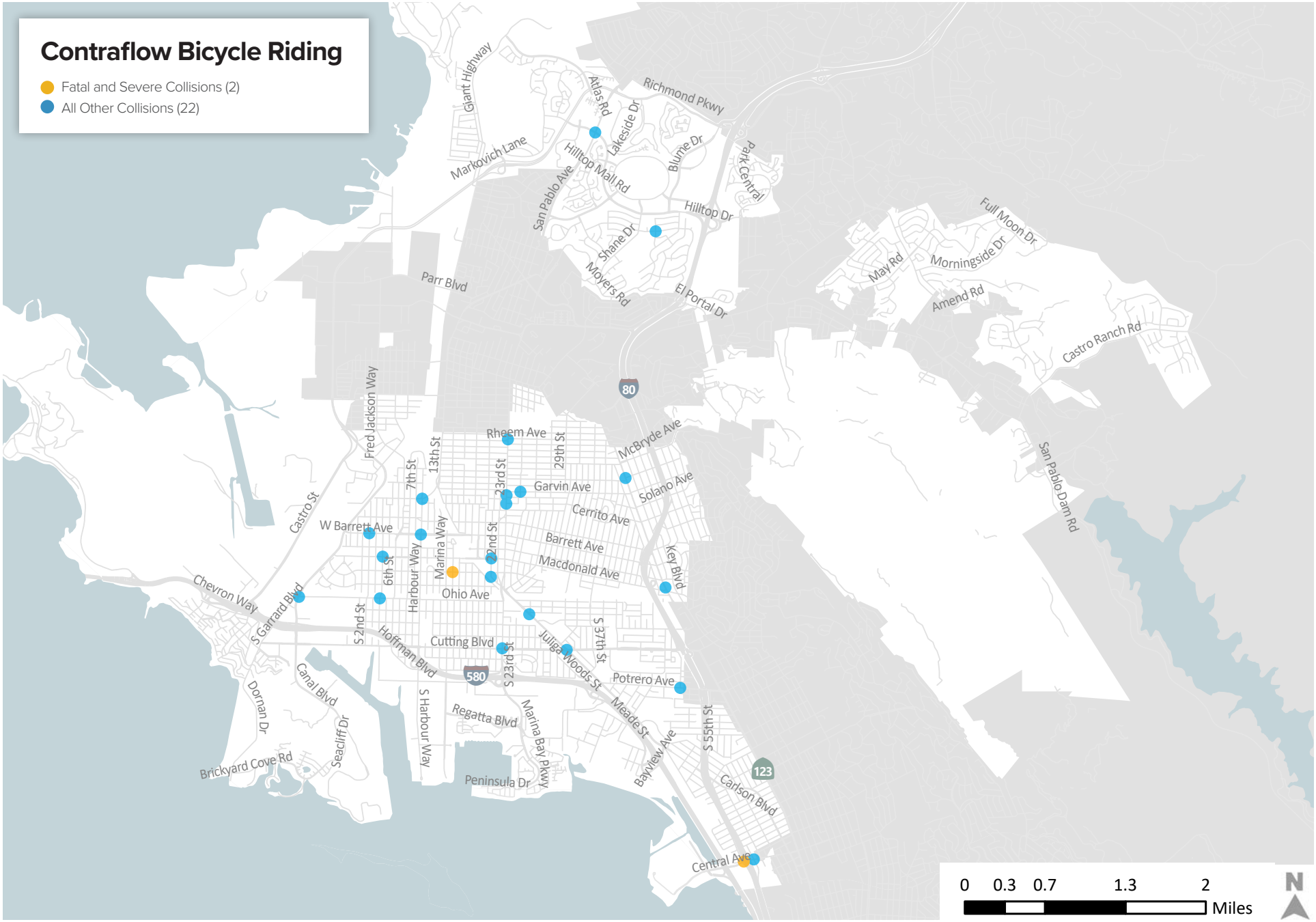
ROADWAY & CONTEXTUAL FACTORS

- Multiple-lane roadways
- 30-35 mph speed limit
- No dedicated bicycle facilities

Goals

- Reduce bicyclist exposure to vehicular traffic by upgrading or filling gaps in facilities such as bicycle lanes
- Improve sight distance and/or visibility between motor vehicles and bicyclists, particularly at intersections

Countermeasure	Time Frame	Unit Cost
Green Conflict Striping	Short	$1,000 per location
Class II Bicycle Lanes	Medium	$90,000 per mile
Road Diet	Medium-Long	$80,000 - $500,000 per mile
Separated Bikeway	Long	$1,250,000 per mile


Contraflow Bicycle Riding
Fatal and Severe Collisions (2)
All Other Collisions (22)
Giant Highway
Atlas Rd
Richmond Pkwy
Lakeside Dr
Markovich Lane
Hilltop Mall Rd
Blume Dr
Park Central
San Pablo Ave
Hilltop Dr
Shane Dr
Full Moon Dr
Morningside Dr
May Rd
Amend Rd
Moyers Rd
El Portal Dr
Parr Blvd
Castro Ranch Rd
80
Fred Jackson Way
Rheem Ave
McBryde Ave
13th St
29th St
23rd St
7th St
Garvin Ave
Solano Ave
San Pablo Dam Rd
Castro St
Cerrito Ave
W Barrett Ave
Barrett Ave
2nd St
Marina Way
Harbour Way
6th St
Macdonald Ave
Key Blvd
Chevron Way
Ohio Ave
S Garrard Blvd
S 2nd St
Hoffman Blvd
Cutting Blvd
S 23rd St
S 37th St
Julian Woods St
580
Potrero Ave
Canal Blvd
Dornan Dr
Seacliff Dr
S Harbour Way
Regatta Blvd
Marina Bay Pkwy
Meade St
Bayview Ave
S 55th St
Brickyard Cove Rd
Peninsula Dr
123
Carlson Blvd
Central Ave
0 0.3 0.7 1.3 2
Miles
N

While many safety projects will perform well in the HSIP process, others may be successfully funded through other sources that consider additional factors such as increasing walking and biking, improving accessibility, and making the transportation system more equitable

Chapter 8

Evaluation and Implementation

While a major goal of the Local Roadway Safety Plan is to prepare the City of Richmond to submit successful Highway Safety Improvement Program (HSIP) applications, safety projects can be funded through a wide range of additional sources at the regional, state, and federal levels. HSIP funds are largely awarded based on a benefit/cost analysis using a set of Caltrans-approved countermeasures with documented collision reduction factors and historic collision data. While many safety projects will perform well in the HSIP process, others may be successfully funded through other sources that consider additional factors such as increasing walking and biking, improving accessibility, and making the transportation system more equitable.

Funding Opportunities

The sources in this chapter may be used to fund a broad scope of projects targeting air quality and sustainability, affordable housing, and transportation. Successful projects often entail creative solutions that address impact areas beyond transportation safety alone, but that can include, and often benefit from, the countermeasures identified in this report.

Local, regional, state and federal funding opportunities relevant to LRSP projects are listed on the following pages. Where possible, details about upcoming funding application cycles are provided, however, many of these are in flux due to impacts from the ongoing Covid-19 pandemic. We recommend that the City of Richmond periodically review this list and check for updates regarding funding availability until funding cycles stabilize.

Local and Regional Sources

Contra Costa County Measure J Funding

Administered through the Contra Costa Transportation Authority (CCTA), Measure J provides funding for countywide and local transportation projects in Contra Costa County.

Frequency: Apportioned annually by CCTA

Developer Fees

California law allows local governments to establish and charge a fee on residential and non-residential developments to fund public facilities and to service population growth. Public facility fees can be charged to new development based on density and traffic impacts, and can go to a variety of public facilities, one being local roadways.

Frequency: Not applicable

Lifeline Transportation Program

The Metropolitan Transportation Commission (MTC) has created the Lifeline Transportation Program to evaluate state and federal funds to provide grants for mobility and accessibility needs in low-income communities across the Bay Area. New guidelines are established for each cycle and the projects must address transportation gaps or barriers identified in community-based transportation plans or other local planning efforts in low-income neighborhoods.

Frequency: Biennial funding cycle

Program for Arterial System Synchronization (PASS)

PASS delivers financial and technical assistance to cities and counties to enhance signal coordination across jurisdictions. This includes engineering help for local governments seeking to re-time signals, adjustments to existing traffic-responsive timing systems, "flush" plans for managing traffic incidents, and more.

Frequency: Annual funding cycle

Transportation Development Act Article 3 (TDA3) Funding

Administered through the Metropolitan Transportation Committee (MTC), TDA3 provides funding annually for bicycle and pedestrian projects. Each county coordinates a consolidated annual request for projects to be funded in the county. Some counties competitively select projects, while other counties distribute the funds to jurisdictions based on population.

Frequency: Annual funding cycle

State Sources

Active Transportation Program (ATP)

ATP is a statewide competitive grant application process with the goal of encouraging increased use of active modes of transportation. The ATP consolidates existing federal and state transportation programs, including the Transportation Alternatives Program (TAP), Bicycle Transportation Account (BTA), and State Safe Routes to School (SRTS), into a single program with a focus to make California a national leader in active transportation. The ATP is administered by the Division of Local Assistance, Office of State Programs.

Frequency: Biennial funding cycle

Next funding opportunity: Cycle 7 timeline yet to be announced; likely summer 2024.

California Natural Resources Agency Environmental Enhancement and Mitigation (EEM) Program

This program supports projects that "contribute to mitigation of the environmental effects of transportation facilities." According to the program guidelines, projects that fall under the following category can apply: "Mitigation Projects Beyond the Scope of the Lead Agency responsible for assessing the environmental impact of the proposed transportation improvement."

Frequency: Annual funding cycle

California Natural Resources Agency Urban Greening Program

This program supports projects that "use natural systems or systems that mimic natural systems to achieve multiple benefits." Eligible projects include "Non-motorized urban trails that provide safe routes for travel between residences, workplaces, commercial centers, and schools."

Frequency: Biennial funding cycle

Next funding opportunity: Round 5 timeline yet to be announced; likely spring 2024.

California Office of Traffic Safety (OTS) Grant Program

OTS administers traffic safety grants in the following areas: Alcohol Impaired Driving, Distracted Driving, Drug-Impaired Driving, Emergency Medical Services, Motorcycle Safety, Occupant Protection, Pedestrian and Bicycle Safety, Police Traffic Services, Public Relations, Advertising, and Roadway Safety and Traffic Records. This funding is primarily geared to enforcement and outreach efforts.

Frequency: Annual funding cycle

Next funding opportunity: FY 2024 application materials and workshops will be announced December 2022; grant applications are due January 31, 2023.

California Strategic Growth Council (SGC) Transformative Climate Communities (TCC) Program

The Transformative Climate Communities (TCC) Program empowers the communities most impacted by pollution to choose their own goals, strategies, and projects to reduce greenhouse gas emissions and local air pollution.

Frequency: Annual funding cycle

Next funding opportunity: Round 5 timeline yet to be announced; likely spring/summer 2024.

Caltrans Strategic Partnerships Grants

These grants, a subset of Caltrans' Sustainable Transportation Planning Grant Program, fund multi-modal planning studies, with a focus on transit, of regional, interregional, and statewide significance. Studies are conducted in partnership with Caltrans and must assist in achieving the Caltrans Mission and Grant Program Objectives.

Frequency: Annual funding cycle

Next funding opportunity: FY 2023/2024 application period yet to be announced.

Clean California

The Clean California Local Grant Program (CCLGP), operated by Caltrans, was created by AB 149 in 2021 to beautify and clean up local streets and roads, tribal lands, parks, pathways, transit centers, and other public spaces. The program will allocate $296 million in state funds, in grants not to exceed $5 million, to local and regional public agencies that install beautification measures and art in public spaces and remove litter and debris to enhance communities and improve spaces for walking and recreation. The goals of the CCLGP are to: reduce the amount of waste and debris within public rights-of-way, pathways, parks, transit centers, and other public spaces; enhance, rehabilitate, restore, or install measures to beautify and improve public spaces and mitigate the urban heat island effect; enhance public health, cultural connection, and community placemaking by improving public spaces for walking and recreation; and advance equity for underserved communities.

Frequency: three-year cycle

Next funding opportunity: Cycle 2 timeline yet to be announced; likely winter 2024.

Highway Safety Improvement Program (HSIP)

California's Local HSIP focuses on infrastructure projects with nationally recognized crash reduction factors (CRFs). Local HSIP projects must be identified based on collision experience, collision potential, collision rate, or other data-supported means. There are opportunities to include systemic safety projects as well.

Frequency: Annual funding cycle

Next funding opportunity: HSIP Cycle 11 application deadline yet to be announced; likely due fall 2022.

SB 1 Local Partnership Program (LPP)

The purpose of this program is to provide local and regional transportation agencies that have passed sales tax measures, developer fees, or other imposed transportation fees with a continuous appropriation of $200 million annually from the Road Maintenance and Rehabilitation Account to fund road maintenance and rehabilitation, sound walls, and active transportation projects. There is also a competitive grant portion of this project.

Frequency: Biennial funding cycle

Next funding opportunity: 2022 program guidelines available summer 2022; applications due winter 2022.

SB 1 Local Streets and Roads Program (LSRP)

SB 1 dedicated approximately $1.5 billion per year in new formula revenues apportioned by the State Controller to cities and counties for basic road maintenance, rehabilitation, and critical safety projects on the local streets and roads system.

Frequency: Annual funding cycle

Next Funding Opportunity: Eligible project lists due Summer–Fall 2022.

SB 1 Solutions for Congested Corridors Program (SCCP)

The Solutions for Congested Corridors Program funds projects designed to reduce congestion in highly traveled and highly congested corridors. This statewide, competitive program makes $250 million available annually for projects that implement specific transportation performance improvements and are part of a comprehensive corridor plan by providing more transportation choices while preserving the character of local communities and creating opportunities for neighborhood enhancement.

Frequency: Annual funding cycle

Next funding opportunity: Cycle 3 (FY 2023/2024) program guidelines available summer/fall 2022; applications due winter 2022.

SB 1 State Transportation Improvement Program (STIP)

The State Transportation Improvement Program (STIP) is the biennial five-year plan for future allocations of certain state transportation funds for state highway improvements, intercity rail, and regional highway and transit improvements.

Frequency: Biennial funding cycle

Next funding opportunity: 2024 cycle funding estimate and program details likely to be released Summer 2023.

SGC Affordable Housing and Sustainable Communities (AHSC) Program

The Affordable Housing and Sustainable Communities (AHSC) Program makes it easier for Californians to drive less by making sure housing, jobs, and key destinations are accessible by walking, biking, and transit.

Frequency: Annual funding cycle

Next funding opportunity: Round 7 applications due February 2023.

Federal Sources

Community Development Block Grant (CDBG) Program

The Community Development Block Grant (CDBG) program is a flexible program that provides communities with resources to address a wide range of unique community development needs. Communities often use CDBG funds to construct and repair streets and sidewalks.

Frequency: Annual funding cycle

Next funding opportunity: Housing and Community Development program application cycle yet to be announced; likely January-February 2023.

Congestion Mitigation and Air Quality (CMAQ) Improvement Program

The FAST Act continued the CMAQ program to provide a flexible funding source to State and local governments for transportation projects and programs to help meet the requirements of the Clean Air Act. Funding is available to reduce congestion and improve air quality for areas that do not meet the National Ambient Air Quality Standards for ozone, carbon monoxide, or particulate matter (nonattainment areas) and for former nonattainment areas that are now in compliance (maintenance areas).

Frequency: Annual funding cycle

Next funding opportunity: Funding apportioned via metropolitan planning organizations (MPOs) based on a formula.

Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Discretionary Grant Program

This program supports projects that are "road or bridge projects eligible under title 23, United States Code;" and "intermodal projects." Previously the BUILD grant, this program replaces the TIGER program.

Frequency: Annual funding cycle

Next funding opportunity: FY 2023 timeline yet to be announced; likely spring/summer 2023.

Implementation Considerations

Implementation of the LRSP is a vital step in the process in which the identified strategies and projects are executed. To successfully implement programs and projects, partnerships, trust, funding, and coordination need to be proactively managed. Successful implementation requires sustained and coordinated support from key stakeholders, elected officials, and City staff. Some strategies are outlined below:

Oversight & Accountability

To ensure effective delivery of safety projects and programs, establishing a committee or Task Force with key officials and stakeholders (in and outside of the City) that meets bi-annually or quarterly is recommended. Having appointed leadership will be a crucial part of maintaining buy-in and support for the LRSP from not only officials, but the community as well. Leadership could additionally include members from identified LRSP partners. Some duties could include conducting briefings and presentations at board and agency meetings, collecting and sharing information on a regular basis, and updating a public-facing database (or scorecard) on LRSP goal progress.

Coordination & Partnership

Throughout the lifetime of the LRSP, coordination and partnership amongst diverse stakeholders will be essential for effective delivery of the LRSP. Some strategies include regularly informing leaders and stakeholders on progress and key milestones, consulting partner agencies early on in the implementation process to gather suggestions and feedback, and finding opportunities for partnership via project bundling (e.g. integrating LRSP projects with pavement resurfacing and maintenance).

Funding

One major hurdle to plan implementation is often funding. As part of an implementation strategy, it is recommended that the City stay up to date on potential grant opportunities and place the most competitive projects forward as grant sources evolve. Additionally, review current capital projects to find where LRSP elements could overlap for possible project bundling. See previous section "Funding Opportunities" for more details.

Communication

Having continued communication and transparency with stakeholders and community members can allow for greater trust and support of the LRSP's goals. Some strategies include communication across diverse channels (e.g. updated webpage, news, and social media), actively addressing community concerns, publishing updated factsheets on plan progress, and regular public meetings using effective community engagement techniques. An oversight committee or Task Force (as proposed above) could aid with leading efforts on communication and trust-building. The Neighborhood Councils and/or the Neighborhood Coordinating Council and the Richmond Bicycle and Pedestrian Advisory Committee present key opportunities to coordinate with Richmond residents.

Evaluation Strategies

Evaluation identifies possible opportunities to inform future decision-making and it will allow the City to understand how it is doing with regards to meeting its safety goals. It provides the basis for determining selection of priority areas, countermeasures, and locations to reduce crashes (and the harm resulting from them). Recommendations include:

Update the Plan Regularly

For example, scheduling an update every two years could assist with organizing and directing evaluation efforts. As conditions within the City and County could change, it will be necessary to update the LRSP in the future.

Identify Target Metrics and Measure Goal Performance in Priority Areas

To understand progress and safety conditions, several metrics should be used in LRSP evaluation. Examples of measuring goal performance include:

- Monitoring collisions, specific to the goals outlined in this plan
- Monitoring the number of safety infrastructure improvements installed

Additional regular measurement of goal progress in priority areas can be performed every year (e.g. safety scorecard). Safety scorecards that are released annually can be a powerful tool for measuring effectiveness, highlighting areas that need further attention and resources, and identifying tasks and deadlines for responsible stakeholder parties.

Safety scorecard examples can be found at the following links:

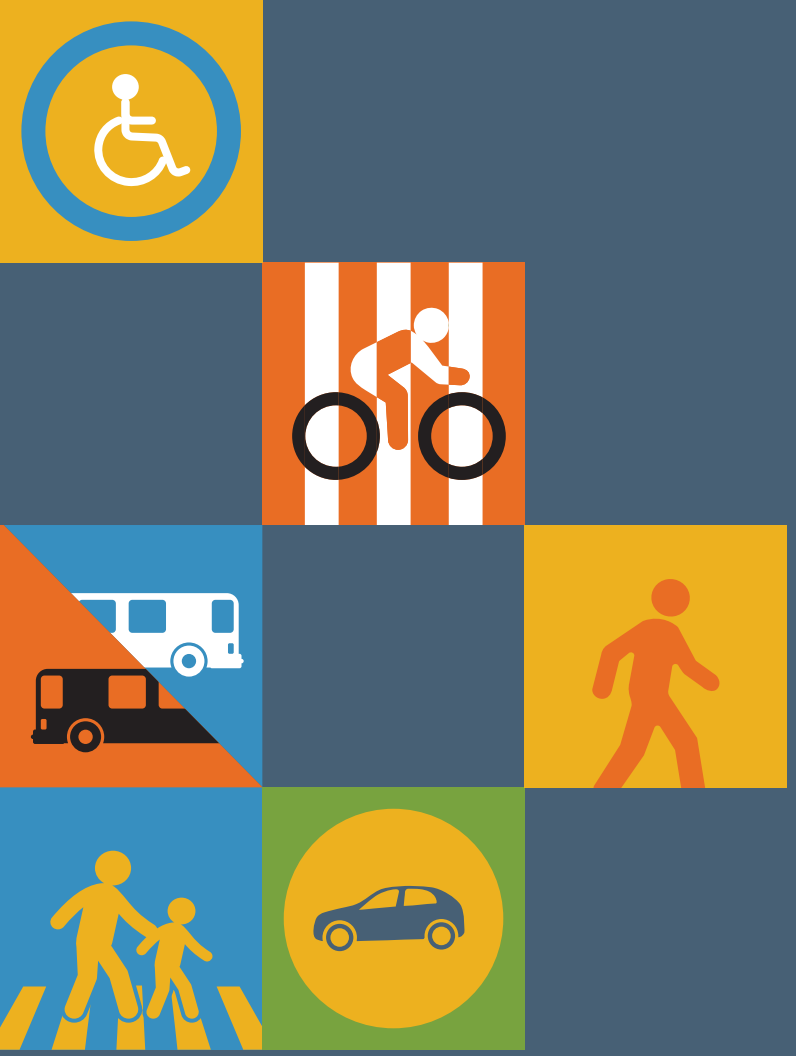
https://www1.nyc.gov/content/visionzero/pages/vision-zero-scorecard

https://roadsafetyatwork.ca/tool-kits/road-safety-snapshot/

Continue Engagement of Stakeholders

Efforts around evaluation should include expanding partnerships from diverse sources (e.g. officials, agencies, community advocacy groups). Input from identified partners and future partners, along with collected target metrics, could be used to adapt the plan based on community feedback and expert insight as projects and programs are rolled out.

Conduct pre- and post- surveys with community members to measure how their actions and views have shifted after engagement around traffic safety. Local partners can be tasked with disseminating the pre- and post-surveys to residents. Surveys should evaluate whether respondents express a shift in behavior after having participated in traffic safety programming. The metrics for evaluation can also be developed with local partners to ensure accessibility for the public.



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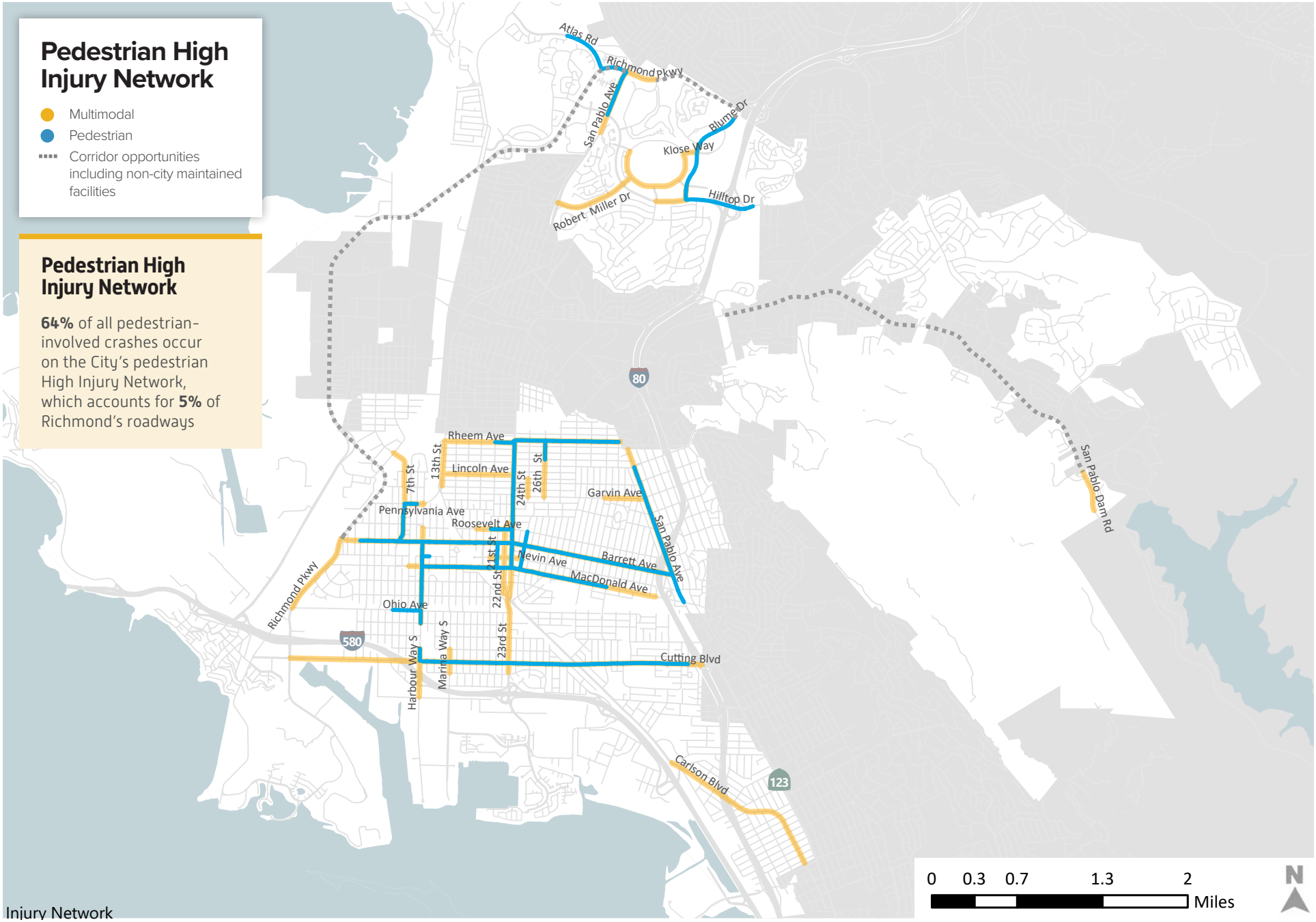
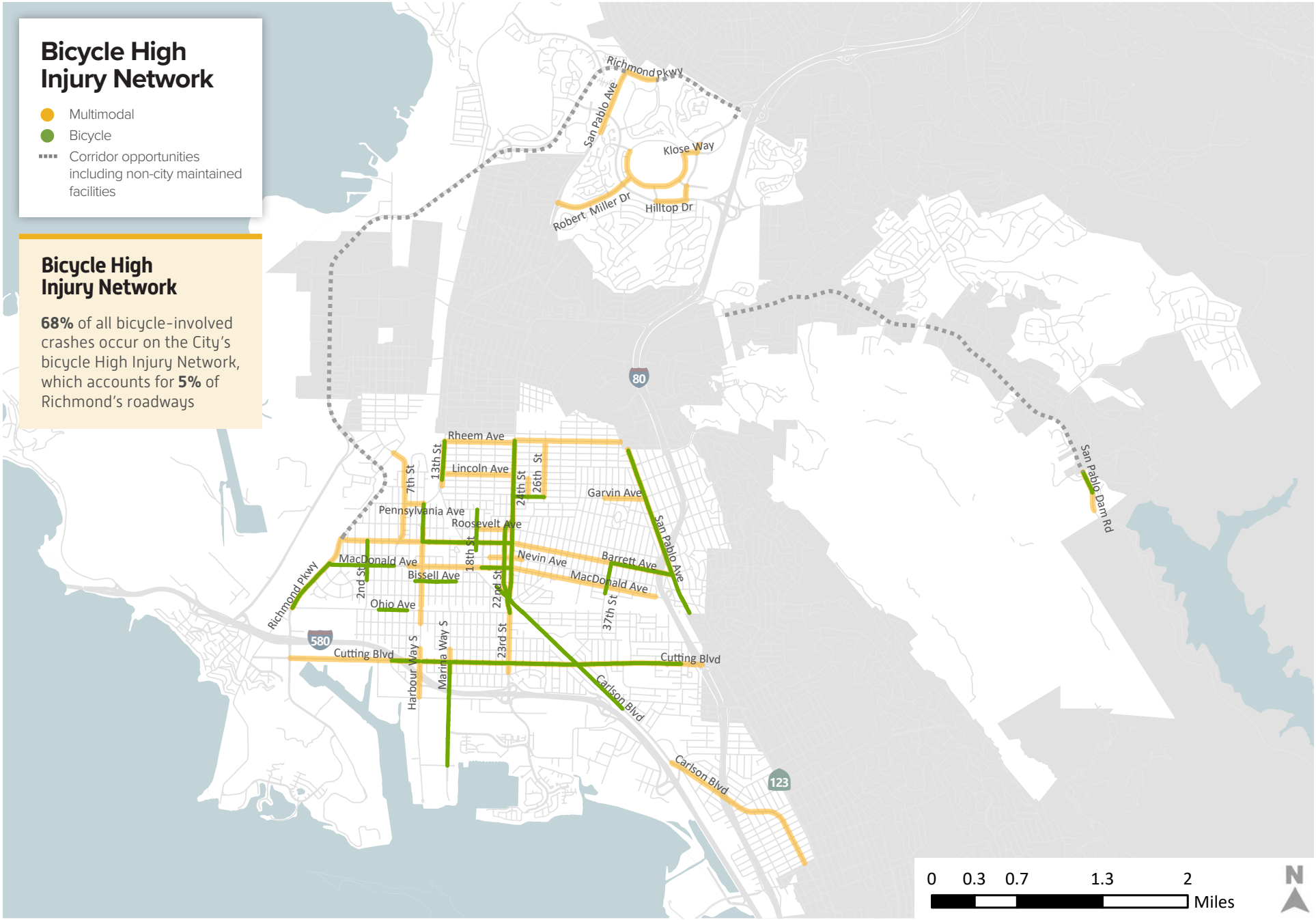
Appendix A

High Injury Networks

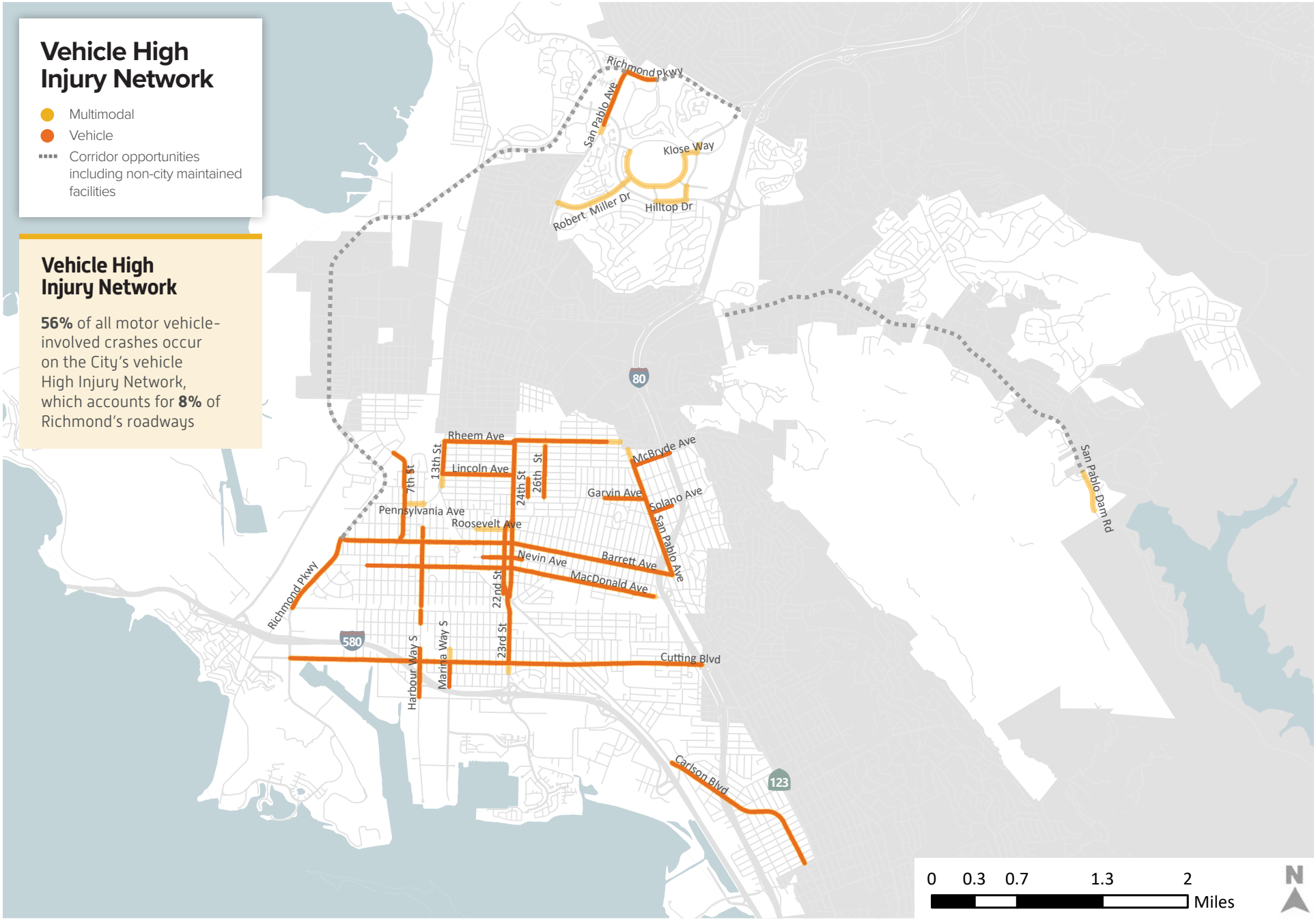


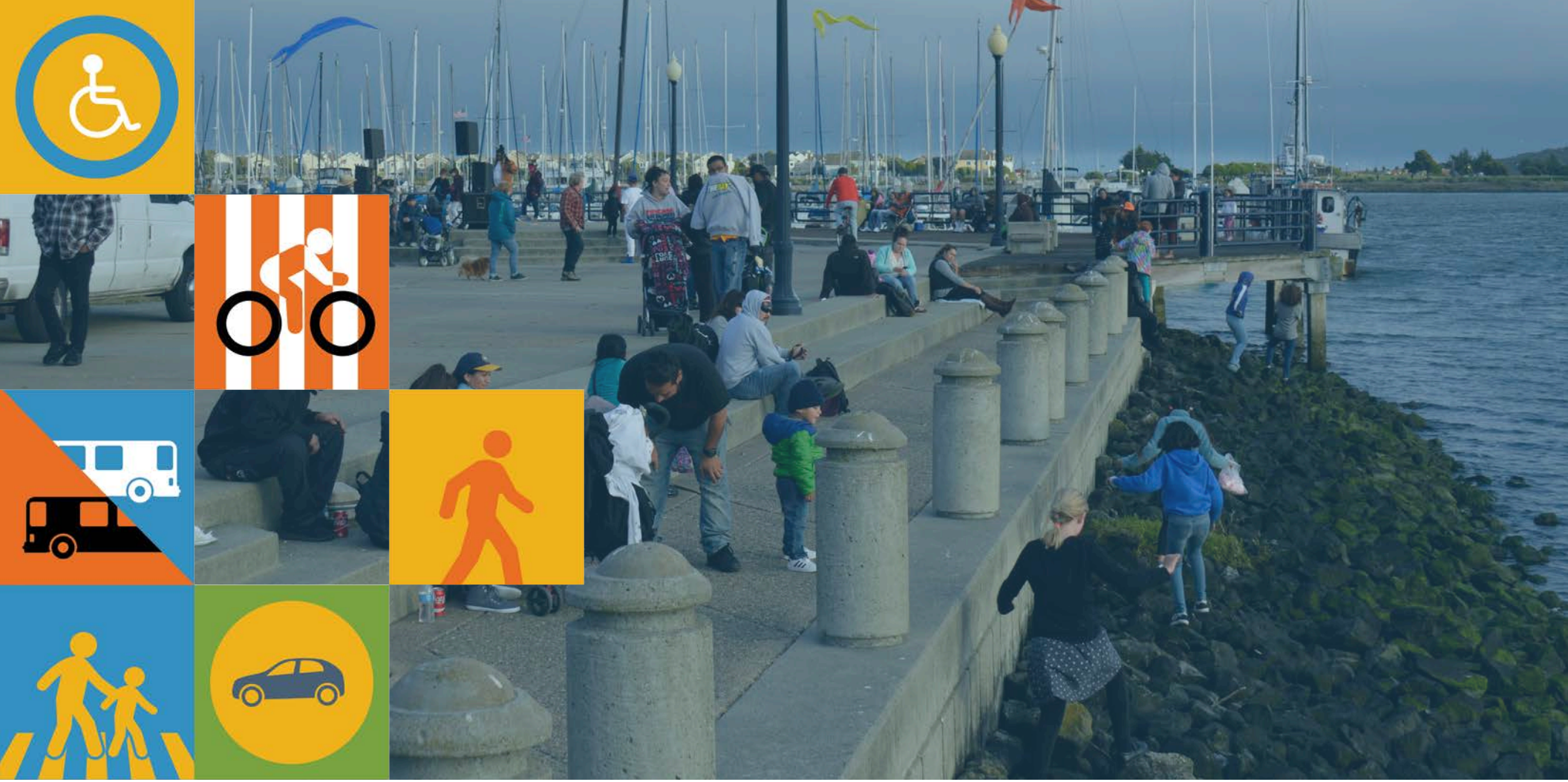
Injury Network



Bicycle High Injury Network

68% of all bicycle-involved crashes occur on the City's bicycle High Injury Network, which accounts for **5%** of Richmond's roadways


Vehicle High Injury Network
Multimodal
Vehicle
Corridor opportunities including non-city maintained facilities
Vehicle High Injury Network
56% of all motor vehicle-involved crashes occur on the City's vehicle High Injury Network, which accounts for 8% of Richmond's roadways
Richmond Pkwy
San Pablo Ave
Klose Way
Robert Miller Dr
Hilltop Dr
80
Rheem Ave
13th St
7th St
Lincoln Ave
24th St
26th St
McBryde Ave
Garvin Ave
Solano Ave
San Pablo Ave
Pennsylvania Ave
Roosevelt Ave
Nevin Ave
Barrett Ave
MacDonald Ave
22nd St
23rd St
Richmond Pkwy
580
Harbour Way S
Marina Way S
Cutting Blvd
Carlson Blvd
123
San Pablo Dam Rd
0 0.3 0.7 1.3 2
Miles
N



Appendix B

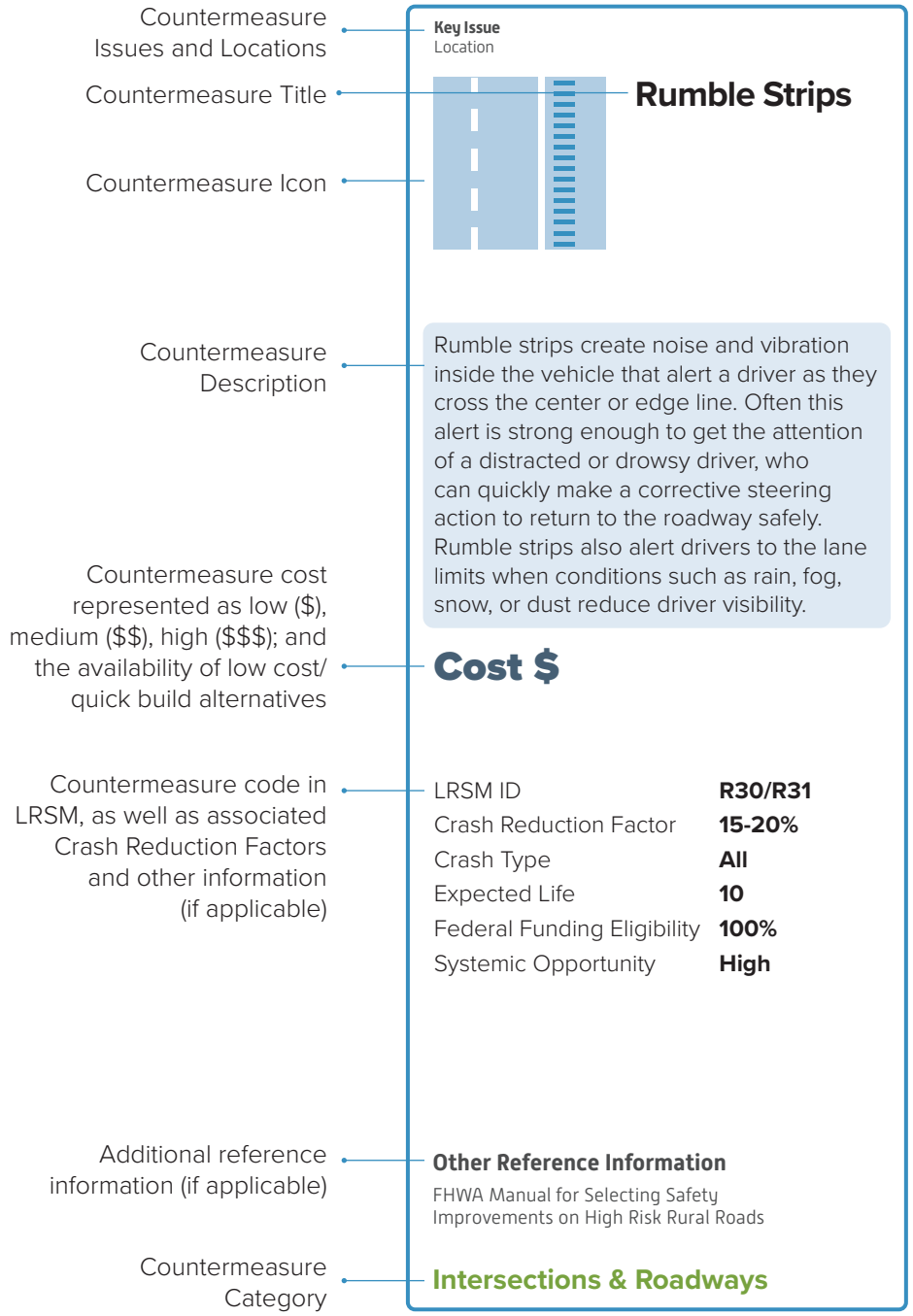
Countermeasure Toolbox

ENGINEERING

What You'll See in this Toolbox

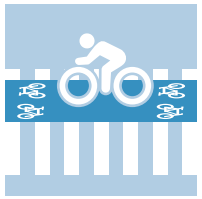
Local Roadway Safety Manual

Many of these countermeasures are recommended for the 10 emphasis areas included in this report. Most of the countermeasures are included in the 2020 Caltrans Local Roadway Safety Manual (LRSM) and can be advantageous for use in Caltrans Highway Safety Improvement Program (HSIP) grant funding applications. There are many effective safety countermeasures beyond those listed in the LRSM, and several are included in this toolbox.



Contraflow Bicycle Riding
Macdonald Avenue & 23rd Street

ENGINEERING



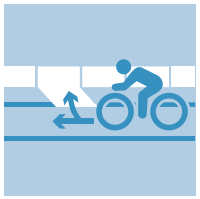
Bicycle Crossing (Solid Green Paint)

Solid green paint across an intersection that signifes the path of the bicycle crossing. Increases visibility and safety of bicyclists traveling through an intersection.

Cost $

Low Cost / Quick Build alternative available

Bikeways

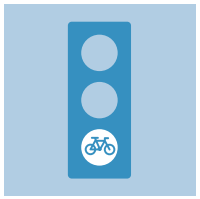


Bicycle Ramp

Connects bicyclists from the road to the sidewalk or a shared use path.

Cost $

Bikeways



Bicycle Signal/ Exclusive Bike Phase

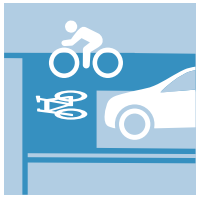
A traffic signal directing bicycle traffic across an intersection. Separates bicycle movements from conficting motor vehicle, streetcar, light rail, or pedestrian movements. May be applicable for Class IV facilities when the bikeway is brought up to the intersection.

Cost $$$

Bikeways

Contraflow Bicycle Riding
Barrett Avenue & Marina Way

ENGINEERING



Bike Box

A designated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S20PB**
Crash Reduction Factor	**15%**
Crash Type	**All**

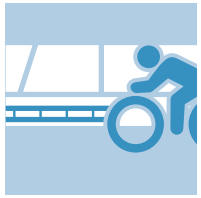
Bikeways

Bike Detection

Bike detection is used at signalized intersections, either through use of push-buttons, in-pavement loops, or by video or infrared cameras, to call a green light for bicyclists and reduce delay for bicycle travel. Discourages red light running by bicyclists and increases convenience of bicycling.

Cost $$

Bikeways



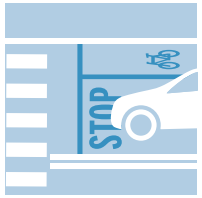
Bike-Friendly Drain

Bike friendly drains avoid placing grating in the right-of-way that may pose a hazard to bicyclists by increasing their risk of falling.

Cost $$

Bikeways

Contraflow Bicycle Riding
23rd Street



Bike Lane (Class II)

A bike lane provides dedicated street space, typically adjacent to outer vehicle travel lanes, with designated lane markings, pavement legends, and signage. Bike lanes improve safety by reducing conflicts between bicycles and vehicles on the road and by creating a road-narrowing effect with striping, which may reduce vehicle speeds.

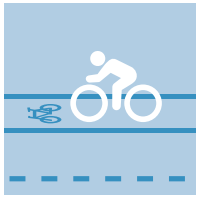
Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**R32PB**
Crash Reduction Factor	**35%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**High**

Bikeways

Contra low Bicycle Riding
22nd Street & 23rd Street



Extend Bike Lane to Intersection

In locations where a bike lane is dropped due to the addition of a right turn pocket, the intersection approach may be restriped to allow for bicyclists to move to the left side of right turning vehicles ahead of reaching the intersection.

Cost $

Low Cost / Quick Build alternative available

Bikeways

Contraflow Bicycle Riding, Pedestrian Right-of-Way
Macdonald Avenue & 23rd Street

Floating Transit Island

ENGINEERING

An in-street transit boarding island is used in conjunction with a Class IV bike facility, separating transit traffic from bicycle traffic, reducing confict between the two modes, and lowering the risk of collision.

Cost $$

Low Cost / Quick Build alternative available

Bikeways

ENGINEERING

Contraflow Bicycle Riding
22nd Street & 23rd Street

Green Conflict Striping

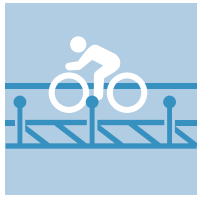
Green conflict striping is green markings painted in a dashed pattern on bike lanes approaching an intersection and/or going through an intersection. Green conflict striping improves safety by increasing the visibility bicyclists and identifying potential conflict points so bicyclists and motorists use caution when traveling toward and through an intersection.

Cost $

Low Cost / Quick Build alternative available

Bikeways

Contraflow Bicycle Riding, Unsafe Speed
Cutting Boulevard



Separated (Class IV) Bikeway

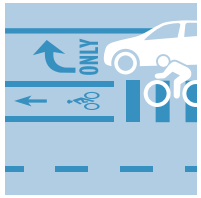
A separated bikeway provides dedicated street space, typically adjacent to outer vehicle travel lanes, with physical separation from vehicle traffic, designated lane markings, pavement legends, and signage. Physical separation may consist of plastic posts, parked vehicles, or a curb. Separated bikeways improve safety by reducing conflicts between bicycles and vehicles on the road and by creating a road-narrowing effect with buffers or vertical barriers, which may reduce vehicle speeds. A raised barrier of plastic posts and painted pavement is a low-cost/quick build option.

Cost $$$

Low Cost / Quick Build alternative available

LRSM ID	**R33PB**
Crash Reduction Factor	**45%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**High**

Bikeways



Mixing Zone

Places a suggested bike lane within the inside portion of a dedicated motor vehicle turn lane. Lane markings delineate space for bicyclists and motorists within the same lane and indicate the intended path for bicyclists to reduce confict with turning motor vehicles.

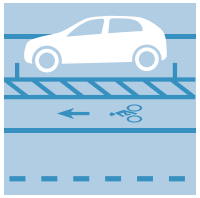
Cost $

Low Cost / Quick Build alternative available

Bikeways

Contraflow Bicycle Riding, Unsafe Speed
Cutting Boulevard

ENGINEERING



Parking Buffer

Pavement markings denoting door zone of parked vehicles to help bicyclists maintain safe positioning on the roadway

Cost $

Low Cost / Quick Build alternative available

Bikeways

Shared Sidewalk Sign

Signs communicate to pedestrians that bicyclists may also use the sidewalk and that bicyclists must yield to pedestrians.

Cost $

Low Cost / Quick Build alternative available

Bikeways

Two-Stage Turn Queue Bike Box

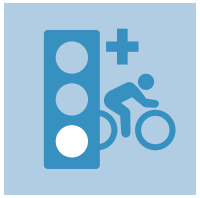
This roadway treatment provides bicyclists with a means of safely making a left turn at a multi-lane signalized intersection from a bike lane or cycle track on the far right side of the roadway. In this way, bicyclists are protected from the flow of traffic while waiting to turn. Usage could be mirrored for right-turns from a one-way street with a left-side bikeway.

Cost $

Low Cost / Quick Build alternative available

Bikeways

ENGINEERING



Extend Green Time For Bikes

Prolongs the green phase when bicyclists are present to provide additional time for bicyclists to clear the intersection. Can occur automatically in the signal phasing or when prompted with bicycle detection. Topography should be considered in clearance time.

Cost $

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systematic Opportunity	**Very High**

Bikeways

Bicycles May Use Full Lane Sign

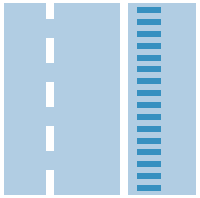
A sign placed on roads with lanes that are too narrow to allow safe side-by-side passing to indicate that bicyclists may occupy the full lane. This discourages unsafe passing by motorists.

Cost $

Low Cost / Quick Build alternative available

Bikeways

Driving Under the Inf uence
Richmond Parkway



Rumble Strips

Rumble strips create noise and vibration inside the vehicle that alert a driver as they cross the center or edge line. Often this alert is strong enough to get the attention of a distracted or drowsy driver, who can quickly make a corrective steering action to return to the roadway safely. Rumble strips also alert drivers to the lane limits when conditions such as rain, fog, snow, or dust reduce driver visibility.

Cost $

LRSM ID	**R30/R31**
Crash Reduction Factor	**15-20%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systematic Opportunity	**High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways

Left-Turns
Cutting Boulevard & S 37th Street

ENGINEERING

All-Way Stop Control

An all-way stop-controlled intersection requires all vehicles to stop before crossing the intersection. An all-way stop controlled intersection improves safety by removing the need for motorists, bicyclists, and pedestrians on a side-street stop-controlled intersection to cross free-flowing lanes of traffic, which reduces the risk of collision. An “ALL WAY” sign should be placed under the octagonal stop sign at all-way stop-controlled intersections as required by the California Manual on Uniform Traffic Control Devices (MUTCD).

Cost $

LRSM ID	**NS02**
Crash Reduction Factor	**50%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Intersections & Roadways

Centerline Hardening

Centerline hardening is a technique to make intersections safer for pedestrians by encouraging drivers to make left turns at slower speeds.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways

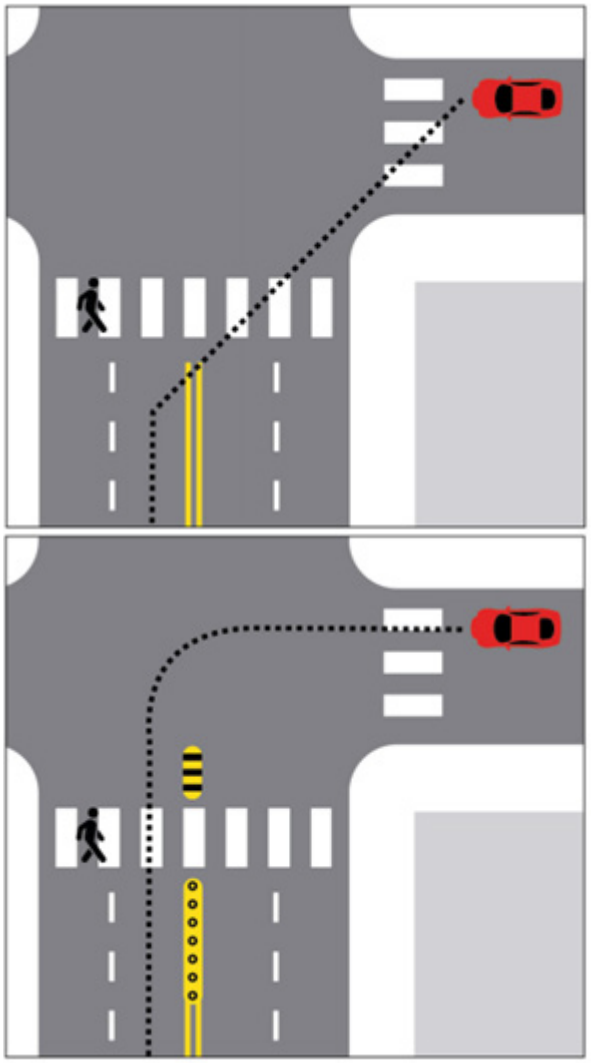


Figure 20. Centerline Hardening

Source: Seattle Department of Transportation (SDOT), https://www.theurbanist.org/2021/05/13/rainier-ave-crosswalks-to-receive-pedestrian-improvements-in-form-of-hardened-centerlines/

Hardened centerlines are bollards that prevent left-turners from crossing the centerlines to make a turn. Rubber speed bumps are often used in conjunction with hardened centerlines and placed in an intersection. There are a variety of design configurations.

Unsafe Speed, Pedestrian Crossing
23rd Street & Brooks Avenue

ENGINEERING

Close Slip Lane

Modifes the corner of an intersection to remove the sweeping right turn lane for vehicles. Results in shorter crossings for pedestrians, reduced speed for turning vehicles, better sight lines, and space for landscaping and other amenities.

Cost $$$

Other Reference Information
FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=24

Intersections & Roadways

Directional Median Openings to Restrict Left Turns

A directional median opening restricts specific turning movements, such as allowing a left-turn from a major street but not from a minor street. A directional median opening to restrict left turn improves safety by reducing the number of conflict points.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**S14**
Crash Reduction Factor	**50%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways

Improved Pavement Friction

A roadway must have an appropriate level of pavement friction to ensure that drivers are able to keep their vehicles safely in the lane. Poor pavement conditions, especially wet pavement, have been identified as one of the major contributing factors in roadway departure crashes. When a pavement surface is wet, the level of pavement friction is reduced, and this may lead to skidding or hydroplaning. Pavement friction is critical for changing vehicle direction and ensuring the vehicle remains in its lane. Traditional friction courses or high friction surface treatments should be considered for curves with numerous wet weather crashes or severe curves with higher operating speeds.

Cost $$

LRSM ID	**R21**
Crash Reduction Factor	**55%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways

Safety Edge

When a vehicle leaves the traveled way and encounters a pavement-shoulder drop-off, it can be difficult for the driver to return safely to the roadway. A safety edge is a treatment intended to minimize drop-off-related crashes. With this treatment, the shoulder pavement edge is sloped at an angle (30-35 degrees) to make it easier for a driver to safely reenter the roadway after inadvertently driving onto the shoulder. This treatment is designed to be a standard policy for any overlay project.

Cost $

Crash Reduction Factor	**8-15%**
Crash Type	**All**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways

Driving Under the Influence
S Gerrard Boulevard

Guardrail

Guardrail redirects a vehicle away from embankment slopes or fixed objects and dissipates the energy of an errant vehicle. Guardrail is installed to reduce the severity of lane departure crashes. However, guardrail can reduce crash severity only for those conditions where striking the guardrail is less severe than going down an embankment or striking a fixed object.

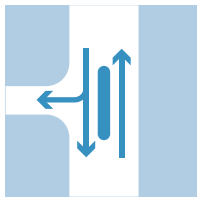
Cost $$

LRSM ID	**R04**
Crash Reduction Factor	**25%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways

Unsafe Speed
Barrett Avenue Undercrossing



Median Barrier

ENGINEERING

Barrier in the center of the roadway that physically separates opposing vehicular traffic. Median barriers can also help control access to and from side streets and driveways, reducing conflict points.

Cost $$$

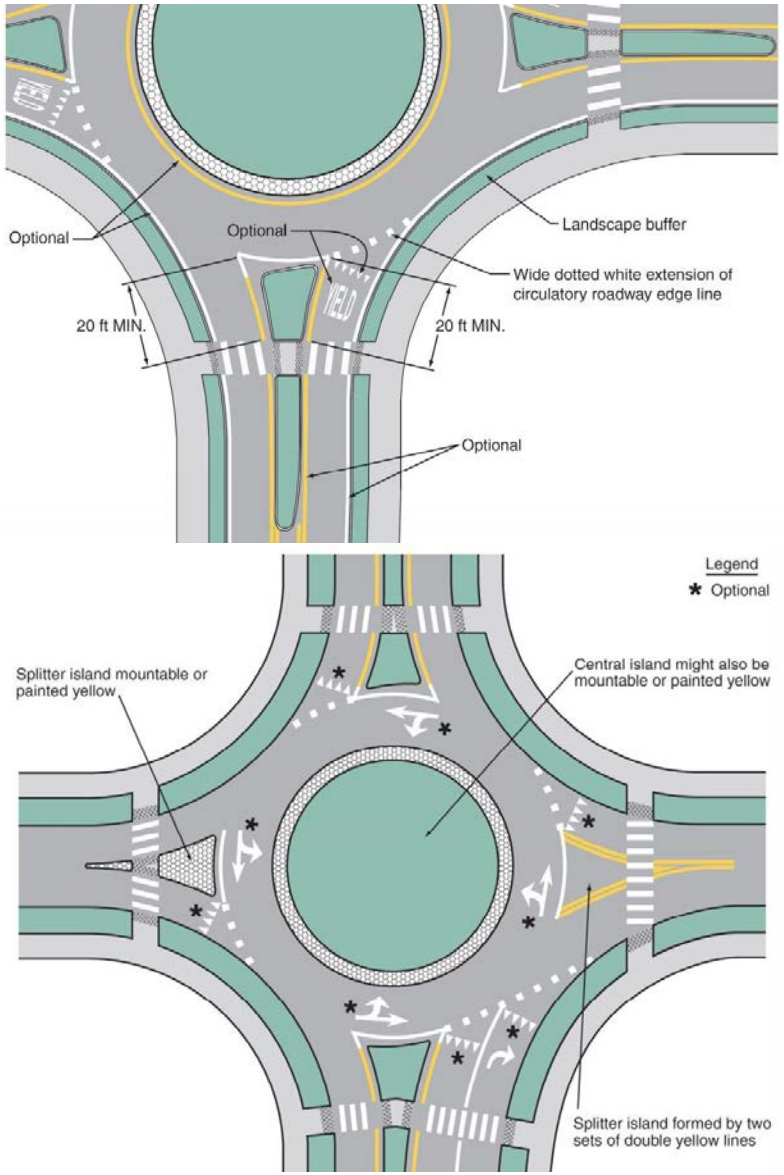
Low Cost / Quick Build alternative available

LRSM ID	**R03**
Crash Reduction Factor	**25%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Medium**

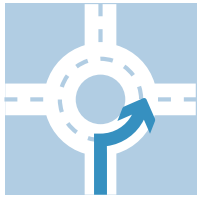
Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways

Figure 21. Examples Markings for One-Lane Roundabouts
Source: CA MUTCD



Unsafe Speeds, Not Stopping, Pedestrian Crossing
Cutting Boulevard & Carlson Boulevard Intersection



Roundabout

A roundabout is a type of circular intersection in which road traffic is permitted to flow in one direction around a central island, and priority is typically given to traffic already in the junction. The types of conflicts that occur at roundabouts are different from those occurring at conventional intersections; namely, conflicts from crossing and left-turn movements are not present in a roundabout. The geometry of a roundabout forces drivers to reduce speeds as they proceed through the intersection; the range of vehicle speeds is also narrowed, reducing the severity of crashes when they do occur. Pedestrians only have to cross one direction of traffic at a time at roundabouts, thus reducing the potential for vehicle/pedestrian conflicts.

Cost $$$

Low Cost / Quick Build alternative available

LRSM ID	**S16/NS04**
Crash Reduction Factor	**Varies**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Low**

Intersections & Roadways

Signal

Traffic signals at intersections control the flow of traffic. Traffic signals have the potential to reduce the most severe type crashes but will likely cause an increase in rear-end collisions. A reduction in overall injury severity is likely the largest benefit of traffic signal installation.

Cost $$$

LRSM ID	**NS03**
Crash Reduction Factor	**30%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Low**

Other Reference Information
Currently the CMF Clearinghouse has only one reference for ped/vehicle collisions which indicates an increase in crash likelihood. However, a majority of references for all crash types show a decrease in collisions. See additional reference: FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways

Superelevation at Horizontal Curve Locations

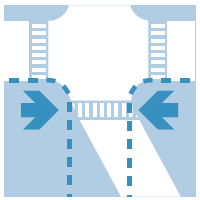
Superelevation is the rotation of the pavement on the approach to and through a horizontal curve and is intended to assist the driver in negotiating the curve by counteracting the lateral acceleration produced by tracking. In other words, the road is designed so that the pavement rises as it curves, offsetting the horizontal sideways momentum of the approaching vehicle.

Cost $$

Crash Reduction Factor **40%**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways



Intersection Reconstruction and Tightening

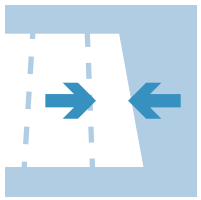
Irregular intersections can be overbuilt and confusing, presenting safety hazards to all users. “Squaring up” an intersection as close to 90 degrees as possible involves intersection reconstruction to provide better visibility for all road users, also reducing high speed turns and reducing pedestrian crossing length.

Cost $$$

Low Cost / Quick Build alternative available

Intersections & Roadways

Unsafe Speed
Cutting Boulevard



Lane Narrowing

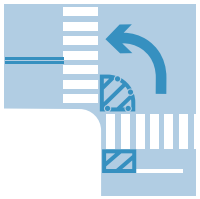
ENGINEERING

Lane narrowing reduces lane widths to encourage motorists to travel at slower speeds. Lane Narrowing improves safety by lowering the risk of collision among bicyclists, pedestrians, and other motorists.

Cost $

Intersections & Roadways

ENGINEERING



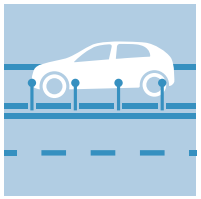
Left Turn Enhanced Daylighting/ Slow Turn Wedge

Uses paint and bollards to extend the curb and slow left turns at intersections of one-way to one-way or two-way streets. Widening the turning radii of left-turning vehicles expands the feld of vision for drivers and increases the visibility of pedestrians.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways



Paint and Plastic Median

A painted median with plastic posts between the two directions of travel. Reduces vehicular speeding and discourages risky turning movements, increasing pedestrian safety.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways

Paint and Plastic Mini Circle

Mini circles use paint and soft hit posts to replace stop-controlled intersections with a circular design that slows trafc and eliminates left turns, also reducing confict points with pedestrians. Also helps traffic flow more efficiently.

Cost $

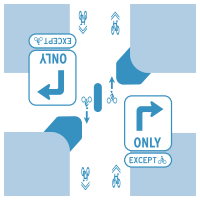
Low Cost / Quick Build alternative available

Other Reference Information

FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=34

Intersections & Roadways

ENGINEERING



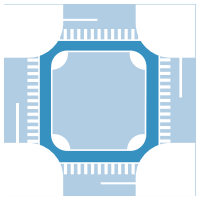
Partial Closure/ Diverter

A roadway treatment that restricts through vehicle movements using physical diversion while allowing bicyclists and pedestrians to proceed through an intersection in all directions.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways



Protected Intersection

Protected intersections use corner islands, curb extensions, and colored paint to delineate bicycle and pedestrian movements across an intersection. Slower driving speeds and shorter crossing distance increase safety for pedestrians. Separates bicycles from pedestrians

Cost $$$

Low Cost / Quick Build alternative available

Other Reference Information

Evolution of the Protected Intersection, Alta Planning and Design, December 2015. https://altaplanning.com/wp-content/uploads/Evolution-of-the-Protected-Intersection_ALTA-2015.pdf

Intersections & Roadways

Raised Crosswalk

A Raised Crosswalk is a pedestrian crosswalk that is typically elevated 3-6 inches above the road or at sidewalk level. A Raised Crosswalk improves safety by increasing crosswalk and pedestrian visibility and slowing down motorists.

Cost $$

LRSM ID	**R36PB**
Crash Reduction Factor	**35%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways

ENGINEERING

Raised Intersection

Elevates the intersection to bring vehicles to the sidewalk level. Serves as a traffic calming measure by extending the sidewalk context across the road.

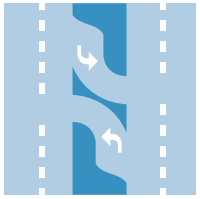
Cost $$$

Other Reference Information

Note: some studies in CMF Clearinghouse show an increase in crashes. See additional source below showing decrease. [1] Perkins+Will Consultant Team. "Pedestrians at Multi-Modal Intersections." Better Market Street Existing Conditions & Best Practices, Part Two: Best Practices 36-58, City & County of San Francisco, San Francisco. http://www.bettermarketstreetsf.org/about-reports-existing-conditions.html [2] Bhatt, Shailen, Natalie Barnhart, Mark Luszcz, Tom Meyer, & Michael Sommers. "Delaware Trafifc Calming Design Manual." Delaware Department of Transportation, State of Delaware, Dover, DE. https://nacto.org/wp-content/uploads/2015/04/DE-Trafc-Calming-Manual_2012.pdf [3] King, Michael R, Jon A Carnegie, and Reid Ewing. "Pedestrian Safety through a Raised Median and Redesigned Intersections." Journal of the Transportation Research Board 1828 (1), 56-66, Transportation Research Board, Washington, DC. https://trid.trb.org/view/663867 [4] Fitzpatrick, Kay, Mark D Wooldridge, and Joseph D Blaschke. "Urban Intersection Design Guide: Volume 1– Guidelines." Texas Transportation Institute, Texas A&M University System, Texas Department of Transportation, Austin, TX. https://static.tti.tamu.edu/tti.tamu.edu/documents/0-4365-P2.pdf

Intersections & Roadways

Left-Turns, Pedestrian Right-of-Way
Cutting Boulevard, I-580 Approach



Raised Median

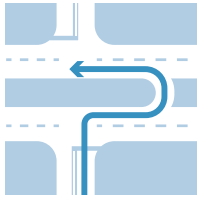
Curbed sections in the center of the roadway that are physically separated from vehicular traffc. Raised medians can also help control access to and from side streets and driveways, reducing confict points.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**S12/NS14/R08**
Crash Reduction Factor	**25%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways



Reduced Left-Turn Conflict Intersection

Geometric designs that alter how left-turn movements occur can simplify decisions and minimize the potential for related crashes. Two highly effective designs that rely on U-turns to complete certain left-turn movements are known as the restricted crossing U-turn (RCUT) and the median U-turn (MUT).

Cost $$$

LRSM ID	**NS16**
Crash Reduction Factor	**50%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

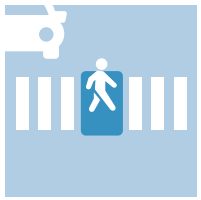
Intersections & Roadways

Right Turn Slip Lane

A right turn slip lane is a traffic lane provided at an intersection to allow vehicles to turn right without actually entering it and interfering with through traffic. Where the main intersection is controlled by traffic signals, a slip lane is often controlled by yield or stop sign.

Cost $$$

Pedestrian Crossing
23rd Street & Esmond Avenue



Refuge Island

A Raised Median, or Refuge Island, is a raised barrier in the center of the roadway that can restrict certain turning movements and provide a place for pedestrians to wait if they are unable to finish crossing the intersection. A Raised Median improves safety by reducing the number of potential conflict points with designated zones for vehicles to turn, and a pedestrian refuge island improves safety by reducing the exposure time for pedestrians crossing the intersection. Pedestrian refuge areas constructed from paint and plastic may be implemented as part of a low-cost/quick build project.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**NS19PB**
Crash Reduction Factor	**45%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Figure 22. Refuge Island

Source: Seattle Streets Illustrated, https://streetsillustrated.seattle.gov/design-standards/intersections/pedcrossing/. Fehr & Peers Traffic Calming Toolbox.

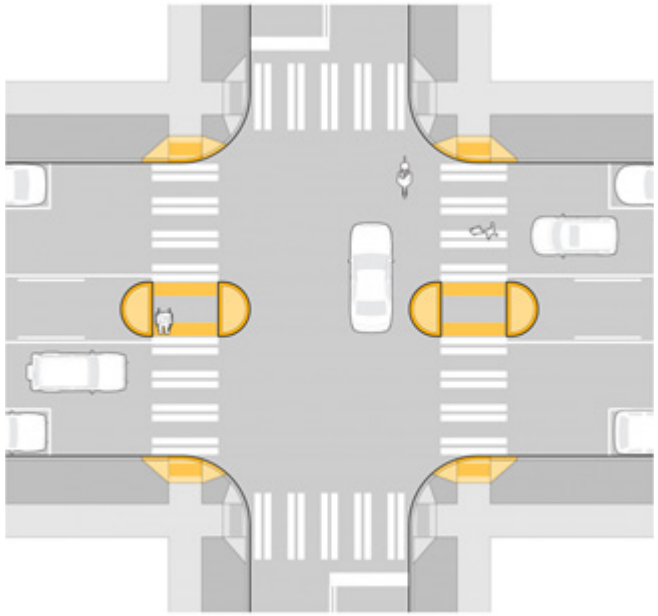
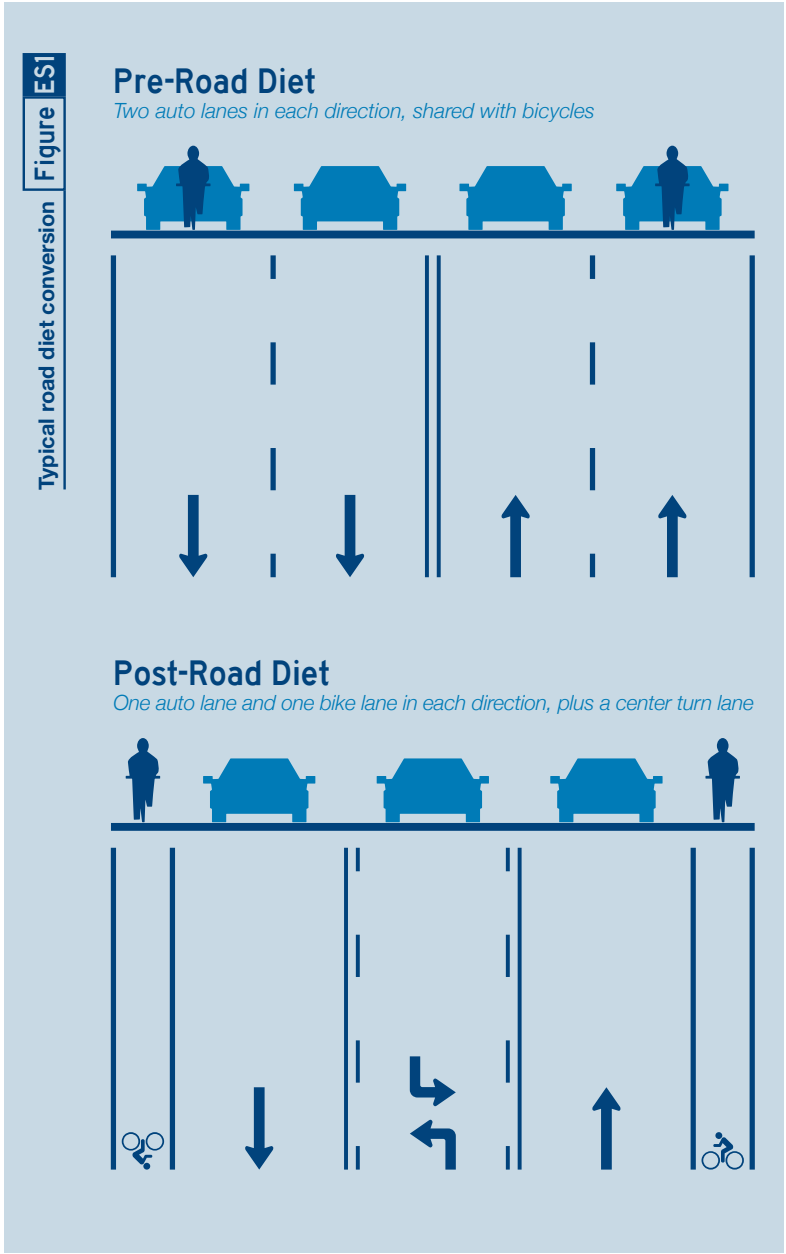
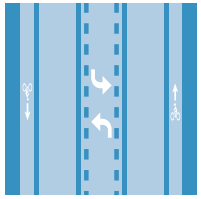


Figure 23. Figure 19 Typical Road Diet Configuration
Source: Fehr & Peers



Unsafe Speed, Pedestrian Right-of-Way
23rd Street



Road Diet

A Road Diet reduces roadway space dedicated to vehicle travel lanes to create room for bicycle facilities, wider sidewalks, or center turn lanes. A Road Diet improves safety by reducing vehicle speeds and creating designated space for all road users.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**R14**
Crash Reduction Factor	**30%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways

Splitter Island

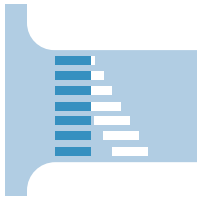
A raised area that separates the two directions of travel on the minor street approach at an unsignalized intersection or roundabout. Helps channelize traffic in opposing directions of travel. Typically installed at skewed intersections or where speeds on minor roads are high. Provides a refuge for pedestrians.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**NS13**
Crash Reduction Factor	**40%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways



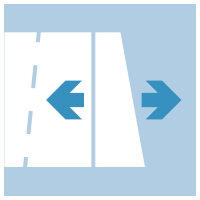
Straighten Crosswalk

Straightening crosswalks improves sight lines, making pedestrians more visible to oncoming drivers, and may shorten the crossing distance, reducing the length of time required for pedestrians to cross an intersection.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways



Widen/Pave Shoulder

Widened and paved shoulders, which may also include flattening the slopes along the sides of the roadway, create a separated space for bicyclists and also provide motor vehicle safety benefits, such as space for inoperable vehicles to pull out of the travel lane. The addition of a paved shoulder to an existing road can help to reduce run-off-road crashes. Benefits can be realized for high risk rural roads without paved shoulders, regardless of existing lane pavement width. Adding paved shoulders within horizontal curve sections may help agencies maximize benefits of the treatment while minimizing costs as opposed to adding paved shoulders to an entire corridor.

Cost $$

LRSM ID	**R15**
Crash Reduction Factor	**30%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Intersections & Roadways

Unsafe Speed
22nd Street & Roosevelt Avenue

Speed Hump or Speed Table

ENGINEERING

These traffic calming devices use vertical defection to raise the entire wheelbase of a vehicle and encourage motorists to travel at slower speeds to avoid damage to the undercarriage of an automobile.

Cost $

Intersections & Roadways

ENGINEERING

Access Management/ Close Driveway

Vehicles entering and exiting driveways may conflict with pedestrians and with vehicles on the main road, especially at driveways within 250 feet of intersections. Closing driveways near intersections with high collision rates related to driveways may reduce potential conflicts.

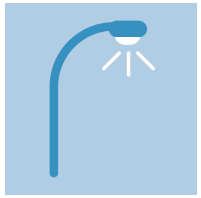
Cost $$

Other Reference Information

The CMF Clearinghouse has limited research related to vehicle/pedestrian crashes. See additional reference: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=20

Other

Driving Under the Inf uence
Cutting Boulevard



Intersection Lighting

Lighting is added at an intersection. Adding intersection and/or pedestrian-scale lighting at intersections improves safety by increasing visibility of all road users. This countermeasure is most effective at reducing or preventing collisions at intersections at night.

Cost $$

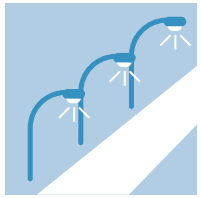
LRSM ID	**NS01**
Crash Reduction Factor	**40%**
Crash Type	**Night**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Medium**

Other Reference Information

Pedestrian-Level Lighting: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=8

Other

Driving Under the Influence
Cutting Boulevard



Segment Lighting

Providing roadway lighting improves safety during nighttime conditions by increasing driver awareness, increasing sight distance, and improving visibility of pedestrians and bicyclists.

Cost $$

LRSM ID	**R01**
Crash Reduction Factor	**35%**
Crash Type	**Night**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Medium**

Other

ENGINEERING

Create or Increase Clear Zone

A clear zone is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. The width of the clear zone should be based on risk (also called exposure). Key factors in assessing risk include traffic volumes, speeds, and slopes. Clear roadsides reduce risk from fixed objects (such as utility poles) as well as terrain that may increase the likelihood of a rollover. Creating or increasing clear zones within horizontal curve sections may help agencies maximize benefits of the treatment while minimizing costs, as opposed to providing a clear zone throughout an entire corridor.

Cost $$

Crash Reduction Factor	**13-44%**
Crash Type	**All, KSI**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

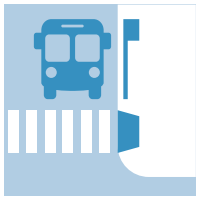
Other

Curbside Management

Curbside management can better prioritize reliable transit and safe bicycling infrastructure, freight deliveries, passenger pick-ups/drop-ofs,green stormwater infrastructure, public spaces, and parking management.

Cost $

Other



Far-Side Bus Stop

Far-side bus stops are located immediately after an intersection, allowing the bus to pass through the intersection before stopping for passenger loading and unloading. Far-side stops encourage pedestrians to cross behind the bus for greater visibility and can improve transit service reliability.

Cost $

Other

ENGINEERING

Delineators, Reflectors, and/or Object Markers

Delineators, reflectors and/or object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed. They are generally less costly than Chevron Signs as they don't require posts to place along the roadside, avoiding an additional object with which an errant vehicle can crash into.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**R27**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Other

Impact Attenuators

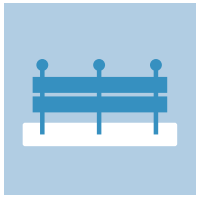
Impact attenuators bring an errant vehicle to a more-controlled stop or redirect the vehicle away from a rigid object. Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. Attenuators should only be installed where it is impractical for the objects to be removed.

Cost $$

LRSM ID	**R05**
Crash Reduction Factor	**25%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Other



Median Guardrail

The installation of median guardrail is most suitable for use in traversable medians having no or little change in grade and cross slope. While these systems may not reduce the frequency of crashes due to roadway departure, they can help prevent a lane-departure crash from becoming a head-on collision.

Cost $$

Other

ENGINEERING

Speed Limit Reduction

Setting speed limits to reflect the surrounding context of the roadway and that meet with driver expectations can help improve driver respect for speed limits. Speed limits that appear inconsistent may be ignored by the majority of drivers and this may contribute to lack of respect for speed limit and other traffic laws.

Cost $

Other Reference Information
TRB Study on Setting Speed Limits

Other

Relocate Select Hazardous Utility Poles

Relocating or removing utility poles from within the clear zone alleviates the potential for fixed-object crashes. If utility poles cannot be completely eliminated from within the clear zone, efforts can be made to either relocate the poles to a greater offset from the road or delineated.

Cost $$

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Other

Remove Obstructions For Sightlines

Remove objects that may prevent drivers and pedestrians from having a clear sightline. May include installing red curb at intersection approaches to remove parked vehicles (also called “daylighting”), trimming or removing landscaping, or removing or relocating large signs.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**NS11**
Crash Reduction Factor	**20%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Other

ENGINEERING

Upgrade Lighting to LED

Upgrading Lighting to LED replaces high-pressure sodium light bulbs with LED light bulbs in street lights. Upgrading Lighting to LED improves safety by increasing the visibility of pedestrians in crosswalks through greater color contrast and larger areas of light distribution.

Cost $$

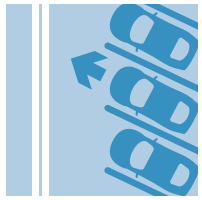
Other

Red Light Camera

A red light camera enforces traffic signal compliance by capturing the image of a vehicle that has entered an intersection in spite of the traffic signal indicating red. The automatic photographic evidence is used by authorities to enforce traffic laws and issue traffic violation tickets.

Cost $$

Other



Back-In Angled Parking

Back-In Angled Parking requires motorists to back into an angled on-street parking spot and to drive forward when exiting a parking spot. Back-in angled parking improves safety by increasing visibility of passing vehicles and bicycles while exiting a spot, particularly if large adjacent vehicles obstruct sight, and allows trunk unloading to happen on the curb instead of in the street.

Cost $

Low Cost / Quick Build alternative available

Other

Pedestrian Right-of-Way
Barrett Avenue Undercrossing

Add Sidewalk

Adding sidewalks provides a separated and continuous facility for people to walk along the roadway. Adding sidewalks improves safety by minimizing collisions with pedestrians walking in the road.

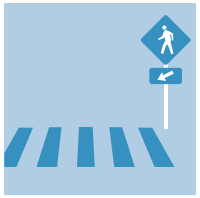
Cost $$

LRSM ID	**R34PB**
Crash Reduction Factor	**80%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Other Reference Information
Data in the CMF Clearinghouse is currently limited to bicycle/vehicle collisions. See additional reference: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=1

Pedestrian Facilities

Pedestrian Crossing, Pedestrian Right-of-Way
Cutting Boulevard & S 12th Street



Install/Upgrade Pedestrian Crossing at Uncontrolled Locations (Signs and Markings Only)

A pedestrian crossing at an intersection or on a segment provides a formalized location for people to cross the street, reducing the risk of people crossing outside crosswalks where drivers are not expecting them. Crosswalk striping, signs, and other enhanced safety features alert drivers that there may be a pedestrian crossing.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**R35PB**
Crash Reduction Factor	**35%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Pedestrian Facilities

Pedestrian Crossing
Cutting Boulevard & S 26th Street

Co-Locate Bus Stops and Pedestrian Crossings

ENGINEERING

Place bus stops and pedestrian crossings in close proximity to allow transit riders to cross the street safely.

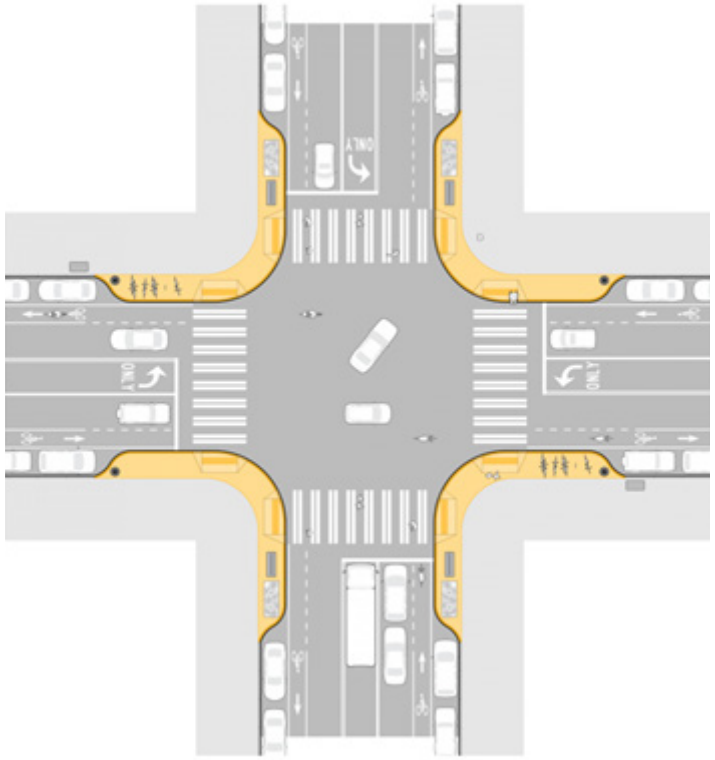
Cost $

Low Cost / Quick Build alternative available

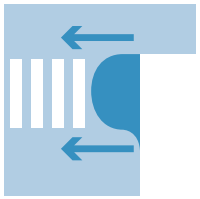
Pedestrian Facilities

Figure 24. Curb Extension

Source: : Seattle Streets Illustrated, https://streetsillustrated.seattle.gov/design-standards/intersections/pedcrossing/#CurbBulbs



Pedestrian Crossing
Macdonald Avenue & 22nd Street



Curb Extensions

A curb extension is a traffic calming measure which widens the sidewalk for a short distance to enhance the pedestrian crossing. This reduces the crossing distance and allowing pedestrians and drivers to see each other when parked vehicles would otherwise block visibility. Paint and plastic curb extensions are a low-cot/quick build option.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**NS21PB**
Crash Reduction Factor	**35%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Medium**

Other Reference Information

(1) Application of Pedestrian Crossing Treatments for Streets and Highways, NCHRP, 2016. https://www.nap.edu/catalog/24634/application-of-pedestrian-crossing-treatments-for-streets-and-highways
(2) Development of Crash Modifcation Factors for Uncontrolled Pedestrian Crossing Treatments, NCHRP, 2017. https://www.nap.edu/catalog/24627/development-of-crash-modifcation-factors-for-uncontrolled-pedestrian-crossing-treatments
(3) Evaluation of Pedestrian-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014. http://www.pedbikeinfo.org/cms/downloads/PedestrianLitReview_April2014.pdf

Pedestrian Facilities

Extended Time Pushbutton

A pushbutton that can be pressed to request extra time for using the crosswalk, beyond the standard crossing time. Ideal near senior-serving land uses.

Cost $

Other Reference Information

Audible Push Button Upgrade and Extended Time Pushbutton: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=52

Pedestrian Facilities

Pedestrian Crossing, Pedestrian Right-of-Way
Cutting Boulevard & Marina Way S

High-Visibility Crosswalk

A high-visibility crosswalk has a striped pattern with ladder markings made of high-visibility material, such as thermoplastic tape, instead of paint. A high-visibility crosswalk improves safety by increasing the visibility of marked crosswalks and provides motorists a cue to slow down and yield to pedestrians.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S18/NS20**
Crash Reduction Factor	**25%**
Crash Type	**Ped and Bike**
Expected Life	**10-20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Pedestrian Facilities

Pedestrian Right-of-Way
Macdonald Avenue & 22nd Street

Pedestrian Countdown Timer

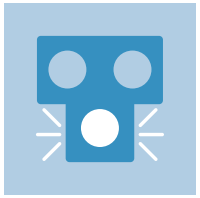
Displays “countdown” of seconds remaining on the pedestrian signal. Countdown indications improve safety for all road users, and are required for all newly installed traffic signals where pedestrian signals are installed.

Cost $$

LRSM ID	**S17PB**
Crash Reduction Factor	**25%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Pedestrian Facilities

Pedestrian Right-of-Way
Cutting Boulevard & 24th Street



Pedestrian Hybrid Beacon

A pedestrian-hybrid beacon (PHB) is used at unsignalized intersections or mid-block crosswalks to notify oncoming motorists to stop with a series of red and yellow lights. Unlike a traffic signal, the PHB rests in dark until a pedestrian activates it via pushbutton or other form of detection.

Cost $$$

LRSM ID	**NS23PB**
Crash Reduction Factor	**55%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Low**

Pedestrian Facilities

ENGINEERING

ENGINEERING

Landscape Buffer

Separating drivers from bicyclists and pedestrians using landscaping provides more space between the modes and can produce a traffc calming effect by encouraging drivers to drive at slower speeds, lowering the risk of crashing.

Cost $$

Pedestrian Facilities

Pedestrian Crossing, Left-Turns
Macdonald Avenue & 23rd Street

Leading Pedestrian Interval and Pedestrian Recall

At intersection locations that have a high volume of turning vehicle and have high pedestrian vs. vehicle crashes, a leading pedestrian interval gives pedestrians the opportunity to enter an intersection 3 - 7 seconds before vehicles are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn left or right.

Cost $

LRSM ID	**S21PB**
Crash Reduction Factor	**60%**
Crash Type	**Ped and Bike**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Other Reference Information
Pedestrian Phase Recall: Evaluation of Pedestrian-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014. http://www.pedbikeinfo.org/cms/downloads/PedestrianLitReview_April2014.pdf

Pedestrian Facilities

Pedestrian Detection

An intersection treatment that relies on sensors to detect when a pedestrian is waiting at a crosswalk and automatically triggers the pedestrian “WALK” phase. Reduces crossings at inappropriate times and ensures that pedestrians have enough time to safely cross the roadway.

Cost $$

Other Reference Information
FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=11

Pedestrian Facilities

ENGINEERING

Remove Crossing Prohibition

Removes existing crossing prohibitions and provides marked crosswalk and other safety enhancements for pedestrians to cross the street.

Cost $

Low Cost / Quick Build alternative available

Pedestrian Facilities

Restripe Crosswalk

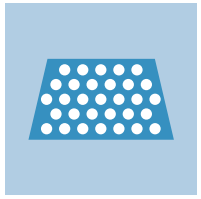
Periodic restriping of crosswalks is necessary to ensure the traffic markings are visible. Crosswalk may be restriped with high visibility markings.

Cost $

Low Cost / Quick Build alternative available

Other Reference Information
FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=4

Pedestrian Facilities



Upgrade Curb Ramp

Tactile warning devices must be detectable to visually impaired pedestrians. Curb ramps must follow the DIB 82-06 design guidelines.

Cost $$

Other Reference Information
FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=3

Pedestrian Facilities

ENGINEERING

Audible Push Button Upgrade

Push buttons must comply with the Americans with Disability Act (ADA) standards for accessibility. Pushbuttons should be visible and conveniently located for pedestrians waiting at a crosswalk. Accessible pedestrian signals, including audible push buttons, improve access for pedestrians who are blind or have low vision. DIB 82-06 includes accessibility design guidance.

Cost $

Other Reference Information
Audible Push Button Upgrade and Extended Time Pushbutton: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=52

Pedestrian Facilities

Pedestrian Right-of-Way
Barrett Avenue Undercrossing

Widen Sidewalk

Widening sidewalks provides a more comfortable space for pedestrians, particularly in locations with high volumes of pedestrians, and provides space to accommodate people in wheelchairs. Widening sidewalks improves safety by minimizing collisions with pedestrians walking in the road.

Cost $$

Pedestrian Facilities

Pedestrian Right-of-Way
Barrett Avenue & 18th Street

Rectangular Rapid Flashing Beacon

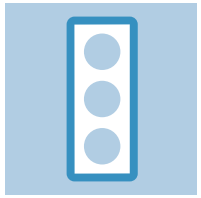
A rectangular rapid flashing beacon (RRFB) is a pedestrian-activated flashing light with additional signage to alert motorists of a pedestrian crossing. An RRFB improves safety by increasing the visibility of marked crosswalks and provides motorists a cue to slow down and yield to pedestrians.

Cost $$

LRSM ID	**NS22PB**
Crash Reduction Factor	**35%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Medium**

Pedestrian Facilities

ENGINEERING



Retroreflective Tape on Signals

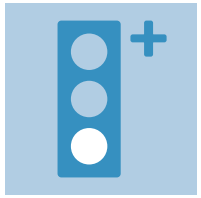
Retroreflective borders enhance the visibility of traffic signals for aging and color vision impaired drivers enabling them to understand which signal indication is illuminated. Retroreflective borders may also alert drivers to signalized intersections during periods of power outages when the signals would otherwise be dark, and non–reflective signal heads and backplates would not be visible.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S02**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signals



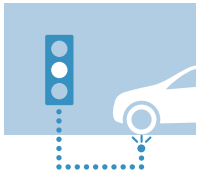
Supplemental Signal Heads

Additional signal heads allow drivers to anticipate signal changes farther away from intersections. Supplemental traffic signals may be placed on the near side of an intersection, far-left, far-right, or very high.

Cost $$

LRSM ID	**S02**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signals



Advanced Dilemma Zone Detection

The Advanced Dilemma-Zone Detection system adjusts the start time of the yellow-signal phase (i.e. earlier or later) based on observed vehicle locations and speeds. The Advanced Dilemma-Zone Detection system improves safety by minimizing the number of drivers that are faced with the dilemma of determining if they should stop at the intersection or drive through the intersection based on their speed and distance from the intersection.

Cost $$

LRSM ID	**S04**
Crash Reduction Factor	**40%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Other Reference Information

FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signals

ENGINEERING

Pedestrian Crossing
Cutting Boulevard

Extend Pedestrian Crossing Time

Increases time for pedestrian walk phases, especially to accommodate vulnerable populations, such as children and the elderly.

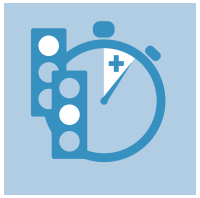
Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systemic Opportunity	**Very High**

Signals

Driving Under the In uence
Cutting Boulevard



Extend Yellow and All Red Time

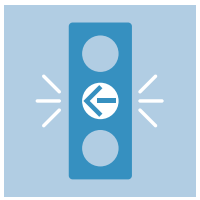
Extending yellow and all red time increases the time allotted for the yellow and red lights during a signal phase. Extending yellow and all red time improves safety by allowing drivers and bicyclists to safely cross through a signalized intersection before conflicting traffic movements are permitted to enter the intersection.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systemic Opportunity	**Very High**

Signals



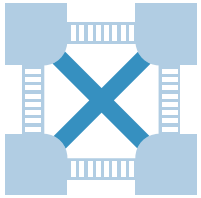
Flashing Yellow Turn Phase

Flashing yellow turn arrow alerts drivers to proceed with caution and decide if there is a sufcient gap in oncoming trafc to safely make a turn. To be used only when a pedestrian walk phase is not called. Protected-only phases should be used when pedestrians are present.

Cost $$

Signals

ENGINEERING



Pedestrian Scramble

A form of pedestrian "WALK" phase at a signalized intersection in which all vehicular traffic is required to stop, allowing pedestrians to safely cross through the intersection in any direction, including diagonally.

Cost $

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systemic Opportunity	**Very High**

Signals

Prohibit Left Turn

Prohibitions of left turns at locations where a turning vehicle may confict with pedestrians in the crosswalk or where opposing traffc volume is high. Reduces pedestrian interaction with vehicles when crossing.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S15/NS16**
Crash Reduction Factor	**50%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Signals

Prohibit Turns During Pedestrian Phase

Restricts left or right turns during the pedestrian crossing phase at locations where a turning vehicle may confict with pedestrians in the crosswalk. This restriction may be displayed with a blank-out sign.

Cost $

Signals

Left-Turns
Rheem Avenue & 23rd Street

ENGINEERING

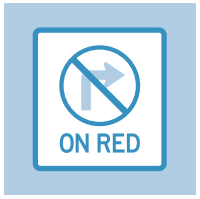
Protected Left Turns

A protected left turn can be implemented at signalized intersections (with existing left turns pockets) that currently have a permissive left-turn or no left-turn protection that have a high frequency of angle crashes involving left turning, opposing through vehicles, and non-motorized road users. Left turns are widely recognized as the highest-risk movements at signalized intersections. Providing protected left-turn phases for signalized intersections significantly improve the safety for left-turn maneuvers by removing the need for the drivers to navigate through gaps in oncoming/opposing through vehicles.

Cost $$

LRSM ID	**S06/S07**
Crash Reduction Factor	**30-55%**
Crash Type	**All**

Signals



Prohibit Right-Turn-on-Red

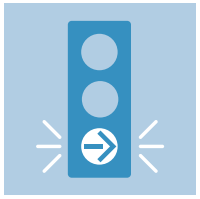
Prohibiting right-run-on-red movements should be considered at skewed intersections, or where exclusive pedestrian “WALK” phases, Leading Pedestrian Intervals (LPIs), sight distance issues, or high pedestrian volumes are present. Can help prevent crashes between vehicles turning right on red from one street and through vehicles on the cross street, and crashes involving pedestrians.

Cost $

Low Cost / Quick Build alternative available

Other Reference Information
Currently the CMF Clearinghouse does not include specifc studies; however, permitting right-turns-on-red shows an increase in ped/vehicle crashes. Additional information is available at the FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=49

Signals



Separate Right-Turn Phasing

Provides a green arrow phase for right-turning vehicles. Avoids conficts between right-turning traffic and bicyclists or pedestrians crossing the intersection on their right.

Cost $$$

Other Reference Information
(1) Evaluation of Pedestrian-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014. http://www.pedbikeinfo.org/cms/downloads/PedestrianLitReview_April2014.pdf (2) FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signals

ENGINEERING

Shorten Cycle Length

Traffic signal cycle lengths have a significant impact on the quality of the urban realm and consequently, the opportunities for bicyclists, pedestrians, and transit vehicles to operate safely along a corridor. Long signal cycles, compounded over multiple intersections, can make crossing a street or walking even a short distance prohibitive and frustrating. Short cycle lengths of 60–90 seconds are ideal for urban areas.

Cost $

Low Cost / Quick Build alternative available

Other Reference Information

FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=45

Signals

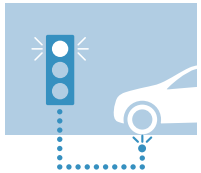
Signal Interconnectivity and Coordination / Green Wave

Certain timing, phasing, and control strategies can produce multiple safety benefits. Sometimes capacity improvements come along with the safety improvements and other times adverse effects on delay or capacity occur. The emphasis of improving signal coordination for this countermeasure is to provide an opportunity for slow speed signal coordination. Coordinating signals to allow for bicyclist progression, also known as a 'green wave,' gives bicyclists and pedestrians more time to safely cross through the 'green wave' intersections.

Cost $$

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systemic Opportunity	**Very High**

Signals



Speed Sensitive Rest in Red Signal

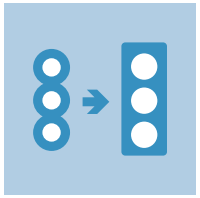
At certain hours (eg. late night) a signal remains red for all approaches or certain approaches until a vehicle arrives at the intersection. If the vehicle is going faster than the desired speed, the signal will not turn green until after vehicle stops. If the vehicle is going the desired speed the signal will change to green before the vehicle arrives. This signal timing provides operational beneft to drivers traveling at the desired speed limit. Can be paired with variable speed warning signs.

Cost $$

LRSM ID	**R26**
Crash Reduction Factor	**30%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Signals

ENGINEERING



Upgrade Signal Head

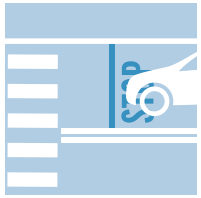
Upgrading Signal Heads replaces existing 8-inch signal heads with 12-inch signal heads to comply with the California MUTCD's 2014 guidelines. Upgrading signal heads improves safety by providing better visibility of intersection signals and by aiding drivers' advanced perception of upcoming intersections.

Cost $

LRSM ID	**S02**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**

Signals

Pedestrian Right-of-Way, Not Stopping
Barrett Avenue & Marina Way



Advance Stop Bar

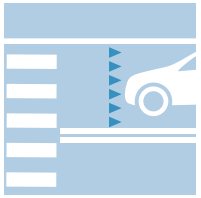
An advanced stop bar is a horizontal stripe painted ahead of the crosswalk at stop signs and signals to indicate where drivers should stop. An advanced stop bar improves safety by reducing instances of vehicles encroaching on the crosswalk. Creating a wider stop bar or setting the stop bar further back may be appropriate for locations with known crosswalk encroachment issues.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S20PB**
Crash Reduction Factor	**15%**
Crash Type	**Ped and Bike**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signing & Striping



Advance Yield Markings

Yield lines are placed 20 to 50 feet in advance of multi-lane pedestrian crossings to increase visibility of pedestrians. They can reduce the likelihood of a multiple-threat crash.

Cost $

Low Cost / Quick Build alternative available

Signing & Striping

ENGINEERING

Curve Advance Warning Sign

A curve advance warning sign notifies drivers of an approaching curve and may include an advisory speed limit as drivers navigate around the curve. This warning sign is ideally combined with other infrastructure that alerts drivers of the curve, such as chevron signs, delineators, and flashing beacons. A curve advance warning sign improves safety by giving drivers additional time to slow down for the curve.

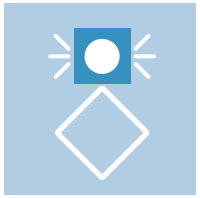
Cost $

Low Cost / Quick Build alternative available

LRSM ID	**R24**
Crash Reduction Factor	**25%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signing & Striping



Flashing Beacon as Advance Warning

A flashing beacon as Advanced Warning is a blinking light with signage to notify motorists of an upcoming intersection or crosswalk. A flashing beacon improves safety by providing motorists more time to be aware of and slow down for an intersection or yield to pedestrians crossing a crosswalk.

Cost $$

LRSM ID	**S10**
Crash Reduction Factor	**30%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Medium**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signing & Striping

Chevron Signs on Horizontal Curves

Post-mounted chevrons are intended to warn drivers of an approaching curve and provide tracking information and guidance to the drivers. They can be beneficial on roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**R23**
Crash Reduction Factor	**40%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signing & Striping

ENGINEERING

LED-Enhanced Sign

An LED-Enhanced Sign has LED lights embedded in the sign to outline the sign itself or the words and symbols on the sign. The LEDs may be set to flash or operate in a steady mode. An LED-enhanced sign improves safety by improving the visibility of signs at locations with visibility limitations or with a documented history of drivers failing to see or obey the sign (e.g. at STOP signs).

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**NS08**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Signing & Striping

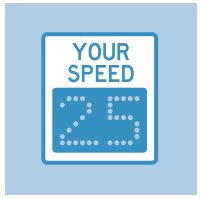
Painted Centerline and Raised Pavement Markers at Curves on Residential Streets

A raised pavement marker is a small device attached to the road and used as a positioning guide for drivers.

Cost $

Low Cost / Quick Build alternative available

Signing & Striping



Speed Feedback Sign

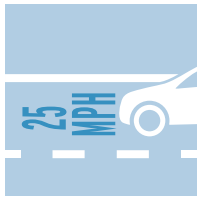
A speed feedback sign notifies drivers of their current speed, usually followed by a reminder of the posted speed limit. A speed feedback sign improves safety by providing a cue for drivers to check their speed and slow down, if necessary.

Cost $

Low Cost / Quick Build alternative available

Signing & Striping

ENGINEERING



Speed Legends on Pavement at Neighborhood Entries

Speed legends are numerals painted on the roadway indicating the current speed limit in miles per hour. They are usually placed near speed limit signposts.

Cost $

Low Cost / Quick Build alternative available

Signing & Striping

Striping Through Intersection

Adding clear pavement markings can guide motorists through complex intersections. Intersections where the lane designations are not clearly visible to approaching motorists and/or intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection can benefit from this treatment.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S09**
Crash Reduction Factor	**10%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signing & Striping

Time-Based Turn Restriction

Restricts left-turns or right-turns during certain time periods when there may be increased potential for confict (e.g., peak periods, school hours).

Cost $

Low Cost / Quick Build alternative available

Signing & Striping

ENGINEERING

Upgrade Intersection Pavement Markings

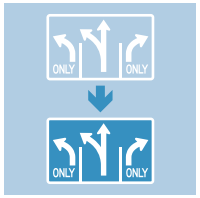
Upgrading intersection pavement marking can include “Stop Ahead” markings and the addition of centerlines and stop bars. Upgrading intersection pavement markings can improve safety by increasing the visibility of intersections for drivers approaching and at the intersection.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**NS07**
Crash Reduction Factor	**25%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signing & Striping



Upgrade Signs with Fluorescent Sheeting

Upgrading signs with fluorescent sheeting replaces existing signs with new signs that can clearly display warnings by reflecting headlamp light back to vehicles. Upgrading signs with fluorescent sheeting improves safety by increasing visibility of signs to drivers at night.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**R22**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Other Reference Information

FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signing & Striping

Upgrade Striping

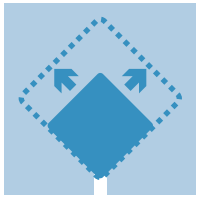
Restripe lanes with refective striping to improve striping visibility and clarify lane assignment, especially where the number of lanes changes.

Cost $

Low Cost / Quick Build alternative available

Signing & Striping

ENGINEERING



Upgrade to Larger Warning Signs

Upgrading to larger warning signs replaces existing signs with physically larger signs with larger warning informaiton. Upgrading to larger warning signs improves safety by increasing visibility of the information provided, particularly for older drivers.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**NS06**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

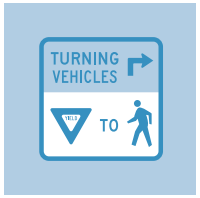
Signing & Striping

Wayfinding

A network of signs that highlight nearby pedestrian and bicycle facilities. Can help to reduce crossings at locations with poor sight distance or limited crossing enhancements.

Cost $

Signing & Striping



Yield To Pedestrians Sign

"Yield Here to Pedestrians" signs alert drivers about the presence of pedestrians. These signs are required with advance yield lines. Other sign types can be placed on the centerline in the roadway.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**NS06**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signing & Striping

ENGINEERING

Improve Crash Data Collection

Improve the accuracy, breadth, and consistency of crash data by creating a near-miss and unreported crash database, developing a standardized electronic reporting form for all crashes, forming agreements with shared mobility operators to acquire crash data, and/or creating a multi-jurisdiction crash database that can be updated by paramedics, police, City staff, and hospitals.

Non-Engineering: Better Data

Bicycle Safety Education Events

Partner with local bike shops and other partners to host events/fairs to educate residents on bicycle safety. For example, host rides to introduce residents to new bicycle facilities as they are opened; offer tune ups at safety fairs.

Non-Engineering: Education

Youth Education

Launch a countywide transportation safety education campaign targeting youth that covers a wide range of topics, such as alcohol and drug impairment, speeding, and potentially distracted driving. Local schools can also be partners in promoting safe driver behavior during school pick-up and drop offs. Educational campaigns that involve both students and parents can be more impactful as they involve parents, who are actually driving, and students, who may not only remind their parents but also retain safe driving behavior if they eventually drive.

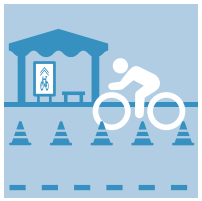
Non-Engineering: Education

ENGINEERING

Education Campaigns for Vulnerable Groups

Launch targeted public education campaigns for seniors, non-English speaking populations, or other vulnerable groups.

Non-Engineering: Education



Pilot Demonstration Safety Projects

Implement pilot demonstration safety projects. Projects can either be implemented on a temporary basis (tactical urbanism) or permanent basis with room for modification (quick builds).

Non-Engineering: Education

Public Information Campaigns

Launch public safety education campaigns. Example campaign topics include safe speeds, yielding to pedestrians, distracted driving, drinking and driving, awareness of bicyclists and pedestrians, appropriate crosswalk behavior, rail safety, moving over for EMS vehicles, etc. Campaigns may include yard signs, wall boards/posters in prime injury-corridor neighborhoods, ads on bus exteriors, radio ads, etc. Public education may also involve making safety and crash data publically available on project websites, the local agency's data portal, social media, and other avenues as appropriate.

Non-Engineering: Education

ENGINEERING

Keep Roadways Clear of Debris

A smoothly paved surface free of debris enhances safety for vehicles and bicyclists.

Non-Engineering: Maintenance

Safe Routes to School

Establish a Safe Routes to School (SRTS) program in partnership with school districts.

Non-Engineering: Partnerships

Update City Policies and Standards

Update policies, standards, and guidelines on topics such as signal timing, street design, street lighting, complete streets, and pedestrian crossings to incorporate current best practices and improve safety for all modes.

Non-Engineering: Policies and Programs

ENGINEERING

Neighborhood Slow Zones

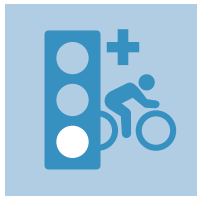
Develop a neighborhood slow zone program to allow neighborhoods to request treatments to slow motor vehicles to 15 to 20 mph using traffic calming features, signs, and markings. Selected locations are typically in areas serving children, seniors, public transit users, commercial activity, and pedestrian/bicycle activity.

Non-Engineering: Policies and Programs

Targeted Enforcement and Deterrence

When developing a program of targeted enforcement and deterrence, use collision history and corridors on the High Injury Network as one criterion for where to concentrate enforcement efforts. Add extra patrols to look for distracted drivers as part of a statewide distracted driving campaign, with focus on where data indicates that the most traffic safety benefit can be realized. Implement deterrence policies that are highly visible, such as publicized sobriety checkpoints, saturation patrol, and other forms of high visibility enforcement that are effective for safety outcomes.

Non-Engineering: Policies and Programs



Extend Green Time For Bikes

Prolongs the green phase when bicyclists are present to provide additional time for bicyclists to clear the intersection. Can occur automatically in the signal phasing or when prompted with bicycle detection. Topography should be considered in clearance time.

Cost $

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systemic Opportunity	**Very High**

Bikeways

All-Way Stop Control

An all-way stop-controlled intersection requires all vehicles to stop before crossing the intersection. An all-way stop controlled intersection improves safety by removing the need for motorists, bicyclists, and pedestrians on a side-street stop-controlled intersection to cross free-flowing lanes of traffic, which reduces the risk of collision. An “ALL WAY” sign should be placed under the octagonal stop sign at all-way stop-controlled intersections as required by the California Manual on Uniform Traffic Control Devices (MUTCD).

Cost $

LRSM ID	**NS02**
Crash Reduction Factor	**50%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Intersections & Roadways

Directional Median Openings to Restrict Left Turns

A directional median opening restricts specific turning movements, such as allowing a left-turn from a major street but not from a minor street. A directional median opening to restrict left turn improves safety by reducing the number of conflict points.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**S14**
Crash Reduction Factor	**50%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways

Raised Crosswalk

A Raised Crosswalk is a pedestrian crosswalk that is typically elevated 3-6 inches above the road or at sidewalk level. A Raised Crosswalk improves safety by increasing crosswalk and pedestrian visibility and slowing down motorists.

Cost $$

LRSM ID	**R36PB**
Crash Reduction Factor	**35%**
Crash Type	**Ped and Bike**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways

Splitter Island

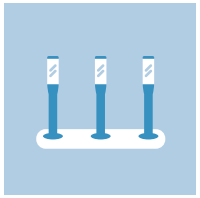
A raised area that separates the two directions of travel on the minor street approach at an unsignalized intersection or roundabout. Helps channelize traffic in opposing directions of travel. Typically installed at skewed intersections or where speeds on minor roads are high. Provides a refuge for pedestrians.

Cost $$

Low Cost / Quick Build alternative available

LRSM ID	**NS13**
Crash Reduction Factor	**40%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Intersections & Roadways



Delineators, Reflectors, and/or Object Markers

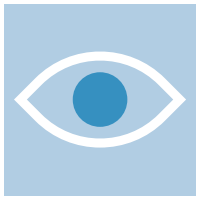
Delineators, reflectors and/or object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed. They are generally less costly than Chevron Signs as they don't require posts to place along the roadside, avoiding an additional object with which an errant vehicle can crash into.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**R27**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Other



Remove Obstructions For Sightlines

Remove objects that may prevent drivers and pedestrians from having a clear sightline. May include installing red curb at intersection approaches to remove parked vehicles (also called “daylighting”), trimming or removing landscaping, or removing or relocating large signs.

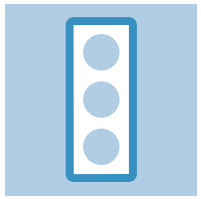
Cost $

Low Cost / Quick Build alternative available

LRSM ID	**NS11**
Crash Reduction Factor	**20%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Other



Retroreflective Tape on Signals

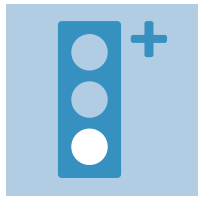
Retroreflective borders enhance the visibility of traffic signals for aging and color vision impaired drivers enabling them to understand which signal indication is illuminated. Retroreflective borders may also alert drivers to signalized intersections during periods of power outages when the signals would otherwise be dark, and non–reflective signal heads and backplates would not be visible.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S02**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signals



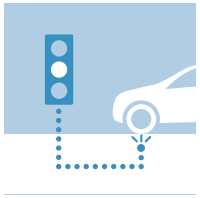
Supplemental Signal Heads

Additional signal heads allow drivers to anticipate signal changes farther away from intersections. Supplemental traffic signals may be placed on the near side of an intersection, far-left, far-right, or very high.

Cost $$

LRSM ID	**S02**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signals



Advanced Dilemma Zone Detection

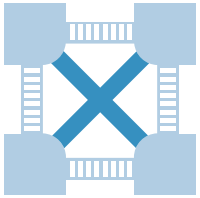
The Advanced Dilemma-Zone Detection system adjusts the start time of the yellow-signal phase (i.e. earlier or later) based on observed vehicle locations and speeds. The Advanced Dilemma-Zone Detection system improves safety by minimizing the number of drivers that are faced with the dilemma of determining if they should stop at the intersection or drive through the intersection based on their speed and distance from the intersection.

Cost $$

LRSM ID	**S04**
Crash Reduction Factor	**40%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signals



Pedestrian Scramble

A form of pedestrian "WALK" phase at a signalized intersection in which all vehicular traffic is required to stop, allowing pedestrians to safely cross through the intersection in any direction, including diagonally.

Cost $

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systemic Opportunity	**Very High**

Signals

Prohibit Left Turn

Prohibitions of left turns at locations where a turning vehicle may confict with pedestrians in the crosswalk or where opposing traffc volume is high. Reduces pedestrian interaction with vehicles when crossing.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S15/NS16**
Crash Reduction Factor	**50%**
Crash Type	**All**
Expected Life	**20**
Federal Funding Eligibility	**90%**
Systemic Opportunity	**Medium**

Signals

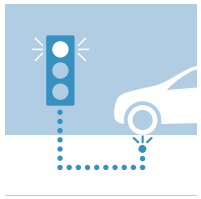
Signal Interconnectivity and Coordination / Green Wave

Certain timing, phasing, and control strategies can produce multiple safety benefits. Sometimes capacity improvements come along with the safety improvements and other times adverse effects on delay or capacity occur. The emphasis of improving signal coordination for this countermeasure is to provide an opportunity for slow speed signal coordination. Coordinating signals to allow for bicyclist progression, also known as a 'green wave,' gives bicyclists and pedestrians more time to safely cross through the 'green wave' intersections.

Cost $$

LRSM ID	**S03**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**50%**
Systemic Opportunity	**Very High**

Signals



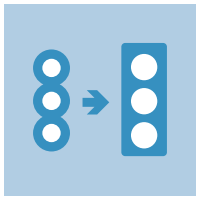
Speed Sensitive Rest in Red Signal

At certain hours (eg. late night) a signal remains red for all approaches or certain approaches until a vehicle arrives at the intersection. If the vehicle is going faster than the desired speed, the signal will not turn green until after vehicle stops. If the vehicle is going the desired speed the signal will change to green before the vehicle arrives. This signal timing provides operational beneft to drivers traveling at the desired speed limit. Can be paired with variable speed warning signs.

Cost $$

LRSM ID	**R26**
Crash Reduction Factor	**30%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Signals



Upgrade Signal Head

Upgrading Signal Heads replaces existing 8-inch signal heads with 12-inch signal heads to comply with the California MUTCD's 2014 guidelines. Upgrading signal heads improves safety by providing better visibility of intersection signals and by aiding drivers' advanced perception of upcoming intersections.

Cost $

LRSM ID	**S02**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**

Signals

LED-Enhanced Sign

An LED-Enhanced Sign has LED lights embedded in the sign to outline the sign itself or the words and symbols on the sign. The LEDs may be set to flash or operate in a steady mode. An LED-enhanced sign improves safety by improving the visibility of signs at locations with visibility limitations or with a documented history of drivers failing to see or obey the sign (e.g. at STOP signs).

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**NS08**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**High**

Signing & Striping

Striping Through Intersection

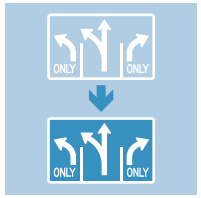
Adding clear pavement markings can guide motorists through complex intersections. Intersections where the lane designations are not clearly visible to approaching motorists and/or intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection can benefit from this treatment.

Cost $

Low Cost / Quick Build alternative available

LRSM ID	**S09**
Crash Reduction Factor	**10%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Signing & Striping



Upgrade Signs with Fluorescent Sheeting

Upgrading signs with fluorescent sheeting replaces existing signs with new signs that can clearly display warnings by reflecting headlamp light back to vehicles. Upgrading signs with fluorescent sheeting improves safety by increasing visibility of signs to drivers at night.

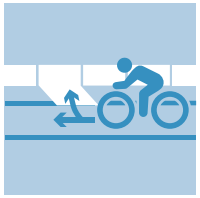
Cost $

Low Cost / Quick Build alternative available

LRSM ID	**R22**
Crash Reduction Factor	**15%**
Crash Type	**All**
Expected Life	**10**
Federal Funding Eligibility	**100%**
Systemic Opportunity	**Very High**

Other Reference Information
FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signing & Striping

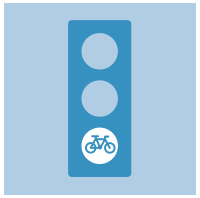


Bicycle Ramp

Connects bicyclists from the road to the sidewalk or a shared use path.

Cost $

Bikeways



Bicycle Signal/ Exclusive Bike Phase

A traffic signal directing bicycle traffic across an intersection. Separates bicycle movements from conficting motor vehicle, streetcar, light rail, or pedestrian movements. May be applicable for Class IV facilities when the bikeway is brought up to the intersection.

Cost $$$

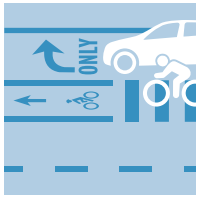
Bikeways

Bike Detection

Bike detection is used at signalized intersections, either through use of push-buttons, in-pavement loops, or by video or infrared cameras, to call a green light for bicyclists and reduce delay for bicycle travel. Discourages red light running by bicyclists and increases convenience of bicycling.

Cost $$

Bikeways



Mixing Zone

Places a suggested bike lane within the inside portion of a dedicated motor vehicle turn lane. Lane markings delineate space for bicyclists and motorists within the same lane and indicate the intended path for bicyclists to reduce confict with turning motor vehicles.

Cost $

Low Cost / Quick Build alternative available

Bikeways

Two-Stage Turn Queue Bike Box

This roadway treatment provides bicyclists with a means of safely making a left turn at a multi-lane signalized intersection from a bike lane or cycle track on the far right side of the roadway. In this way, bicyclists are protected from the flow of traffic while waiting to turn. Usage could be mirrored for right-turns from a one-way street with a left-side bikeway.

Cost $

Low Cost / Quick Build alternative available

Bikeways

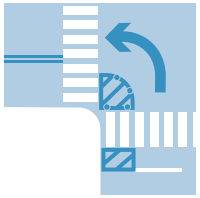
Bicycles May Use Full Lane Sign

A sign placed on roads with lanes that are too narrow to allow safe side-by-side passing to indicate that bicyclists may occupy the full lane. This discourages unsafe passing by motorists.

Cost $

Low Cost / Quick Build alternative available

Bikeways



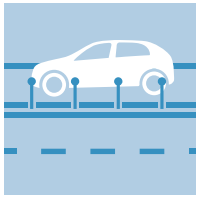
Left Turn Enhanced Daylighting/ Slow Turn Wedge

Uses paint and bollards to extend the curb and slow left turns at intersections of one-way to one-way or two-way streets. Widening the turning radii of left-turning vehicles expands the feld of vision for drivers and increases the visibility of pedestrians.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways



Paint and Plastic Median

A painted median with plastic posts between the two directions of travel. Reduces vehicular speeding and discourages risky turning movements, increasing pedestrian safety.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways

Paint and Plastic Mini Circle

Mini circles use paint and soft hit posts to replace stop-controlled intersections with a circular design that slows trafc and eliminates left turns, also reducing confict points with pedestrians. Also helps traffic flow more efficiently.

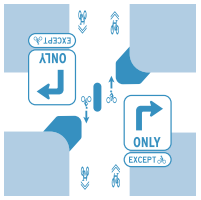
Cost $

Low Cost / Quick Build alternative available

Other Reference Information

FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=34

Intersections & Roadways



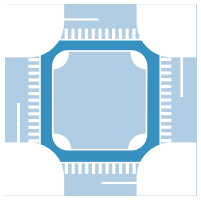
Partial Closure/ Diverter

A roadway treatment that restricts through vehicle movements using physical diversion while allowing bicyclists and pedestrians to proceed through an intersection in all directions.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways



Protected Intersection

Protected intersections use corner islands, curb extensions, and colored paint to delineate bicycle and pedestrian movements across an intersection. Slower driving speeds and shorter crossing distance increase safety for pedestrians. Separates bicycles from pedestrians

Cost $$$

Low Cost / Quick Build alternative available

Other Reference Information

Evolution of the Protected Intersection, Alta Planning and Design, December 2015. https://altaplanning.com/wp-content/uploads/Evolution-of-the-Protected-Intersection_ALTA-2015.pdf

Intersections & Roadways

Raised Intersection

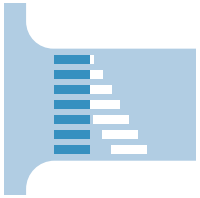
Elevates the intersection to bring vehicles to the sidewalk level. Serves as a traffic calming measure by extending the sidewalk context across the road.

Cost $$$

Other Reference Information

Note: some studies in CMF Clearinghouse show an increase in crashes. See additional source below showing decrease. [1] Perkins+Will Consultant Team. "Pedestrians at Multi-Modal Intersections." Better Market Street Existing Conditions & Best Practices, Part Two: Best Practices 36-58, City & County of San Francisco, San Francisco. http://www.bettermarketstreetsf.org/about-reports-existing-conditions.html [2] Bhatt, Shailen, Natalie Barnhart, Mark Luszcz, Tom Meyer, & Michael Sommers. "Delaware Trafifc Calming Design Manual." Delaware Department of Transportation, State of Delaware, Dover, DE. https://nacto.org/wp-content/uploads/2015/04/DE-Trafc-Calming-Manual_2012.pdf [3] King, Michael R, Jon A Carnegie, and Reid Ewing. "Pedestrian Safety through a Raised Median and Redesigned Intersections." Journal of the Transportation Research Board 1828 [1], 56-66, Transportation Research Board, Washington, DC. https://trid.trb.org/view/663867 [4] Fitzpatrick, Kay, Mark D Wooldridge, and Joseph D Blaschke. "Urban Intersection Design Guide: Volume 1– Guidelines." Texas Transportation Institute, Texas A&M University System, Texas Department of Transportation, Austin, TX. https://static.tti.tamu.edu/tti.tamu.edu/documents/0-4365-P2.pdf

Intersections & Roadways



Straighten Crosswalk

Straightening crosswalks improves sight lines, making pedestrians more visible to oncoming drivers, and may shorten the crossing distance, reducing the length of time required for pedestrians to cross an intersection.

Cost $

Low Cost / Quick Build alternative available

Intersections & Roadways

Access Management/ Close Driveway

Vehicles entering and exiting driveways may conflict with pedestrians and with vehicles on the main road, especially at driveways within 250 feet of intersections. Closing driveways near intersections with high collision rates related to driveways may reduce potential conflicts.

Cost $$

Other Reference Information

The CMF Clearinghouse has limited research related to vehicle/pedestrian crashes. See additional reference: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=20

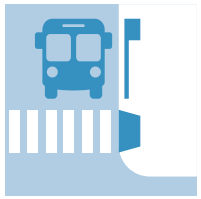
Other

Curbside Management

Curbside management can better prioritize reliable transit and safe bicycling infrastructure, freight deliveries, passenger pick-ups/drop-ofs,green stormwater infrastructure, public spaces, and parking management.

Cost $

Other



Far-Side Bus Stop

Far-side bus stops are located immediately after an intersection, allowing the bus to pass through the intersection before stopping for passenger loading and unloading. Far-side stops encourage pedestrians to cross behind the bus for greater visibility and can improve transit service reliability.

Cost $

Other

Speed Limit Reduction

Setting speed limits to reflect the surrounding context of the roadway and that meet with driver expectations can help improve driver respect for speed limits. Speed limits that appear inconsistent may be ignored by the majority of drivers and this may contribute to lack of respect for speed limit and other traffic laws.

Cost $

Other Reference Information

TRB Study on Setting Speed Limits

Other

Relocate Select Hazardous Utility Poles

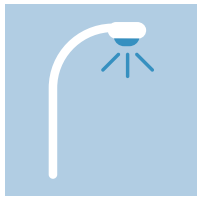
Relocating or removing utility poles from within the clear zone alleviates the potential for fixed-object crashes. If utility poles cannot be completely eliminated from within the clear zone, efforts can be made to either relocate the poles to a greater offset from the road or delineated.

Cost $$

Other Reference Information

FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Other



Upgrade Lighting to LED

Upgrading Lighting to LED replaces high-pressure sodium light bulbs with LED light bulbs in street lights. Upgrading Lighting to LED improves safety by increasing the visibility of pedestrians in crosswalks through greater color contrast and larger areas of light distribution.

Cost $$

Other

Red Light Camera

A red light camera enforces traffic signal compliance by capturing the image of a vehicle that has entered an intersection in spite of the traffic signal indicating red. The automatic photographic evidence is used by authorities to enforce traffic laws and issue traffic violation tickets.

Cost $$

Other

Audible Push Button Upgrade

Push buttons must comply with the Americans with Disability Act (ADA) standards for accessibility. Pushbuttons should be visible and conveniently located for pedestrians waiting at a crosswalk. Accessible pedestrian signals, including audible push buttons, improve access for pedestrians who are blind or have low vision. DIB 82-06 includes accessibility design guidance.

Cost $

Other Reference Information

Audible Push Button Upgrade and Extended Time Pushbutton: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=52

Pedestrian Facilities

Extended Time Pushbutton

A pushbutton that can be pressed to request extra time for using the crosswalk, beyond the standard crossing time. Ideal near senior-serving land uses.

Cost $

Other Reference Information
Audible Push Button Upgrade and Extended Time Pushbutton: FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=52

Pedestrian Facilities

Landscape Buffer

Separating drivers from bicyclists and pedestrians using landscaping provides more space between the modes and can produce a traffc calming effect by encouraging drivers to drive at slower speeds, lowering the risk of crashing.

Cost $$

Pedestrian Facilities

Pedestrian Detection

An intersection treatment that relies on sensors to detect when a pedestrian is waiting at a crosswalk and automatically triggers the pedestrian “WALK” phase. Reduces crossings at inappropriate times and ensures that pedestrians have enough time to safely cross the roadway.

Cost $$

Other Reference Information
FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=11

Pedestrian Facilities

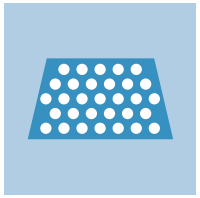
Remove Crossing Prohibition

Removes existing crossing prohibitions and provides marked crosswalk and other safety enhancements for pedestrians to cross the street.

Cost $

Low Cost / Quick Build alternative available

Pedestrian Facilities



Upgrade Curb Ramp

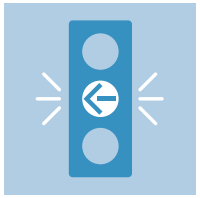
Tactile warning devices must be detectable to visually impaired pedestrians. Curb ramps must follow the DIB 82-06 design guidelines.

Cost $$

Other Reference Information

FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=3

Pedestrian Facilities



Flashing Yellow Turn Phase

Flashing yellow turn arrow alerts drivers to proceed with caution and decide if there is a sufcient gap in oncoming trafc to safely make a turn. To be used only when a pedestrian walk phase is not called. Protected-only phases should be used when pedestrians are present.

Cost $$

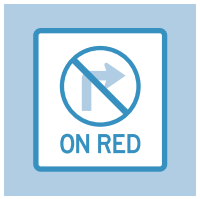
Signals

Prohibit Turns During Pedestrian Phase

Restricts left or right turns during the pedestrian crossing phase at locations where a turning vehicle may conflict with pedestrians in the crosswalk. This restriction may be displayed with a blank-out sign.

Cost $

Signals



Prohibit Right-Turn-on-Red

Prohibiting right-run-on-red movements should be considered at skewed intersections, or where exclusive pedestrian "WALK" phases, Leading Pedestrian Intervals (LPIs), sight distance issues, or high pedestrian volumes are present. Can help prevent crashes between vehicles turning right on red from one street and through vehicles on the cross street, and crashes involving pedestrians.

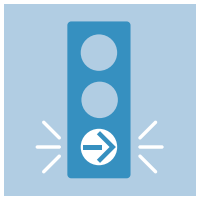
Cost $

Low Cost / Quick Build alternative available

Other Reference Information

Currently the CMF Clearinghouse does not include specifc studies; however, permitting right-turns-on-red shows an increase in ped/vehicle crashes. Additional information is available at the FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=49

Signals



Separate Right-Turn Phasing

Provides a green arrow phase for right-turning vehicles. Avoids conficts between right-turning traffic and bicyclists or pedestrians crossing the intersection on their right.

Cost $$$

Other Reference Information

(1) Evaluation of Pedestrian-Related Roadway Measures, Pedestrian and Bicycle Information Center, 2014. http://www.pedbikeinfo.org/cms/downloads/PedestrianLitReview_April2014.pdf (2) FHWA Manual for Selecting Safety Improvements on High Risk Rural Roads

Signals

Shorten Cycle Length

Traffic signal cycle lengths have a significant impact on the quality of the urban realm and consequently, the opportunities for bicyclists, pedestrians, and transit vehicles to operate safely along a corridor. Long signal cycles, compounded over multiple intersections, can make crossing a street or walking even a short distance prohibitive and frustrating. Short cycle lengths of 60–90 seconds are ideal for urban areas.

Cost $

Low Cost / Quick Build alternative available

Other Reference Information

FHWA Pedestrian Safety Guide and Countermeasure Selection System. http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=45

Signals

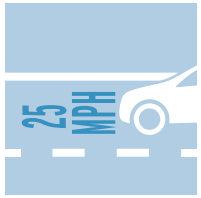
Painted Centerline and Raised Pavement Markers at Curves on Residential Streets

A raised pavement marker is a small device attached to the road and used as a positioning guide for drivers.

Cost $

Low Cost / Quick Build alternative available

Signing & Striping



Speed Legends on Pavement at Neighborhood Entries

Speed legends are numerals painted on the roadway indicating the current speed limit in miles per hour. They are usually placed near speed limit signposts.

Cost $

Low Cost / Quick Build alternative available

Signing & Striping

Time-Based Turn Restriction

Restricts left-turns or right-turns during certain time periods when there may be increased potential for confict (e.g., peak periods, school hours).

Cost $

Low Cost / Quick Build alternative available

Signing & Striping

Wayfinding

A network of signs that highlight nearby pedestrian and bicycle facilities. Can help to reduce crossings at locations with poor sight distance or limited crossing enhancements.

Cost $

Signing & Striping

Improve Crash Data Collection

Improve the accuracy, breadth, and consistency of crash data by creating a near-miss and unreported crash database, developing a standardized electronic reporting form for all crashes, forming agreements with shared mobility operators to acquire crash data, and/or creating a multi-jurisdiction crash database that can be updated by paramedics, police, City staff, and hospitals.

Non-Engineering: Better Data

Bicycle Safety Education Events

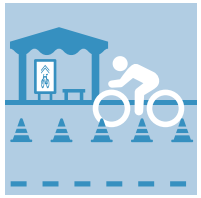
Partner with local bike shops and other partners to host events/fairs to educate residents on bicycle safety. For example, host rides to introduce residents to new bicycle facilities as they are opened; offer tune ups at safety fairs.

Non-Engineering: Education

Education Campaigns for Vulnerable Groups

Launch targeted public education campaigns for seniors, non-English speaking populations, or other vulnerable groups.

Non-Engineering: Education



Pilot Demonstration Safety Projects

Implement pilot demonstration safety projects. Projects can either be implemented on a temporary basis (tactical urbanism) or permanent basis with room for modification (quick builds).

Non-Engineering: Education

Keep Roadways Clear of Debris

A smoothly paved surface free of debris enhances safety for vehicles and bicyclists.

Non-Engineering: Maintenance

Update City Policies and Standards

Update policies, standards, and guidelines on topics such as signal timing, street design, street lighting, complete streets, and pedestrian crossings to incorporate current best practices and improve safety for all modes.

Non-Engineering: Policies and Programs

Neighborhood Slow Zones

Develop a neighborhood slow zone program to allow neighborhoods to request treatments to slow motor vehicles to 15 to 20 mph using traffic calming features, signs, and markings. Selected locations are typically in areas serving children, seniors, public transit users, commercial activity, and pedestrian/bicycle activity.

Non-Engineering: Policies and Programs

Targeted Enforcement and Deterrence

When developing a program of targeted enforcement and deterrence, use collision history and corridors on the High Injury Network as one criterion for where to concentrate enforcement efforts. Add extra patrols to look for distracted drivers as part of a statewide distracted driving campaign, with focus on where data indicates that the most traffic safety benefit can be realized. Implement deterrence policies that are highly visible, such as publicized sobriety checkpoints, saturation patrol, and other forms of high visibility enforcement that are effective for safety outcomes.

Non-Engineering: Policies and Programs