Improving Bicyclist and Pedestrian Safety in Riverside, California

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June 2019

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Approval Page

Title: Improving Bicyclist and Pedestrian Safety in Riverside, California

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Date Submitted: June 03, 2019

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Acknowledgement

I would like to express my deepest gratitude to my parents and friends who supported me throughout my time at Cal Poly. To my fellow CRP students, you have truly been an amazing experience to get to know each and every one of you. Without all of you, this could not be possible

I would like to give special thanks to Professor Cornelius Nuworsoo. Without his guidance, my senior project could not be completed. Thank you so much for your wisdom and expertise!

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Executive Summary

There is great potential within the City of Riverside to increase the number of pedestrians and bicyclists. Currently, the largest barrier to this increase is user fear for health and safety. The geographic location of Riverside, which funnels pollutants from the Greater Los Angeles Area into the region, contributes to the region having very few good air days. This creates a barrier between those who potentially would walk or bike from actually doing so due to health risks.

The City of Riverside has identified in its Bike Master Plan that it currently has twice as many bicyclists than the national average. One of the main reasons that this number is not higher, although there is an interest among citizens to bike, is the perceived lack of safety of biking within the City.

In 2018, there were a reported 88 bicyclist-related and 95 pedestrian-related collisions within the City of Riverside. A large proportion of these collisions occurred in the downtown area.

Case studies from the cities of Seattle, Boston, and Los Angeles were examined and recommendations to the City of Riverside are presented based on these findings. Recommendations include adopting a Vision Zero Plan, developing programing to promote safe circulation including expansion of the bike network, and creating specific plans for dangerous corridors.

Introduction

The Environmental Protection Agency states that the Transportation Sector is one of the largest sources of greenhouse gas emissions in the United States, as shown in Figure 1 below. Around 90% of total transportation emissions come from private vehicle trips. As a result, cities across the nation are looking to get people out of private cars for other modes to help reduce emissions.

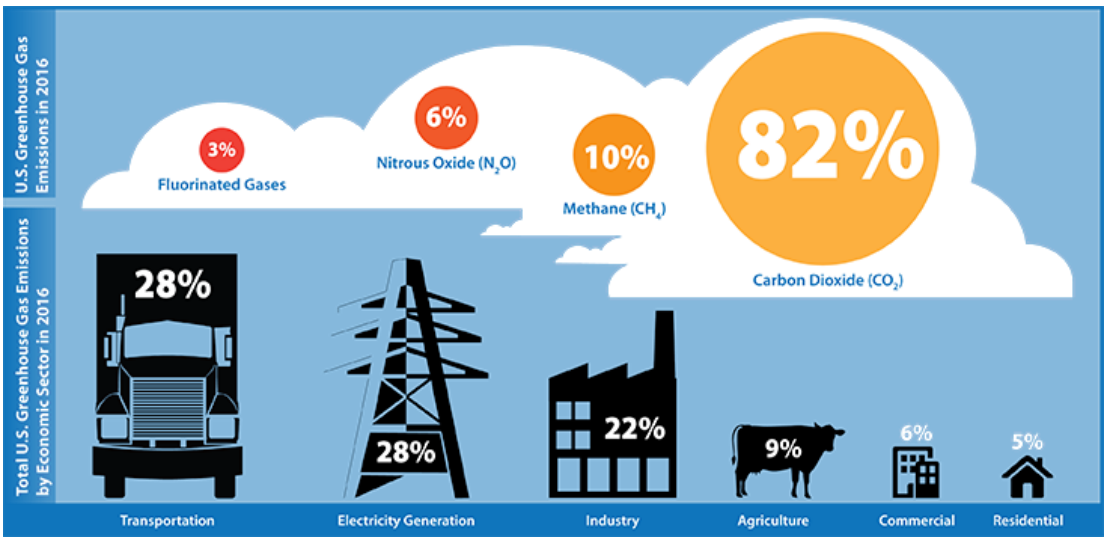


Figure 1: Greenhouse gas emissions by sector

In addition, communities that have more walkers and bikers generally see an increase in community health. Streets that are planned for walkers and bikers and make their safety a main priority see an increase of those uses. In return, these walkable and bikeable communities are often healthier than car-dependent cities. According to a study in the International Journal of Hygiene and Environmental Health, walkable communities have a lower risk for cardiovascular disease, reduced risk of obesity, type 2 diabetes, and cardio-metabolic disease (Sarkar et al., 2018). According to the 2013 Community Health Profile published by Riverside County, the County has a much higher percent of the population that is obese than the state average. This is shown in Figure 2. Encouraging more individuals to

walk to work more frequently could help reduce this and other health risks prevalent in the community (Tran, 2016)

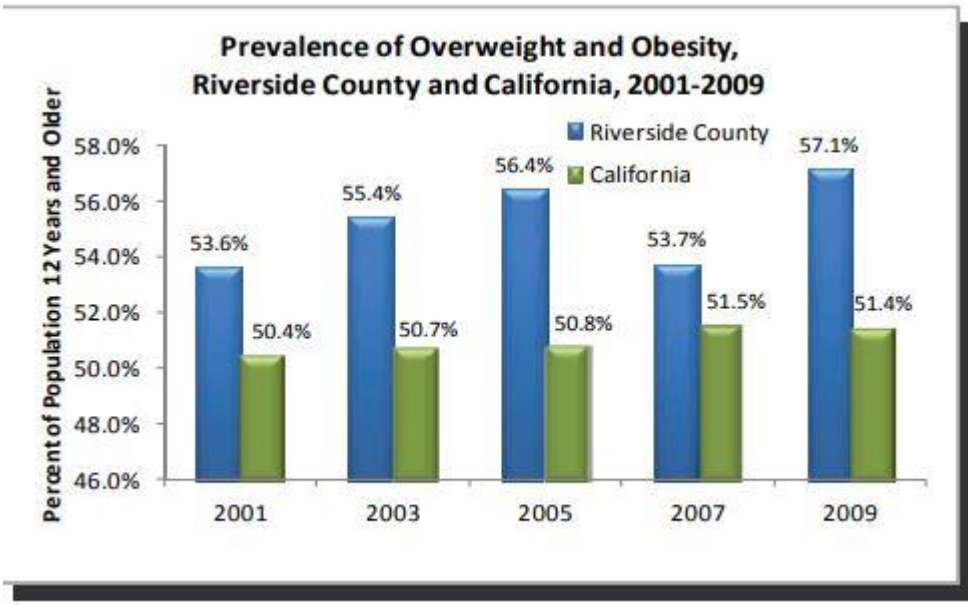


Figure 2: Prevalence of overweight and obesity in Riverside County vs California 2001 - 2009

One of the largest barriers to bikeable and walkable communities is safety. Those who do not feel safe walking or biking are not likely to use facilities provided. Many large cities across the country have adopted a Vision Zero commitment to eliminate all traffic-related deaths. In Los Angeles, nearly half of the people killed in traffic collisions were those who were walking or biking, with a large number of them being children or older adults.

Background

With a dense urban core, Riverside has the potential to see a large increase in those who walk or bike to major destinations in the City. It is prudent therefore that the safety of those traveling by means other than private vehicles be addressed. The increase in those walking and biking could help reduce greenhouse gases and the contribution of increased private vehicle use to aforementioned health risks.

Riverside, California, is 55 miles east of Downtown Los Angeles and is a part of the Greater Los Angeles Metropolitan Area as Figure 3 shows. Riverside has several major destinations, including the University of California Riverside, California Baptist University, the Riverside Fox Theater, and the Mission Inn Hotel.

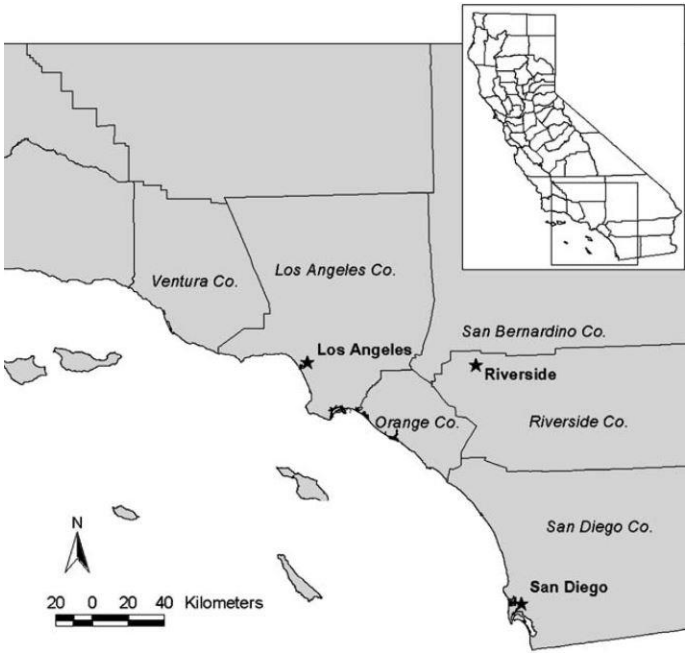


Figure 3: Riverside regional context map

According to the 2010 US Census, Riverside was the 12th most populous city in the state with a population of 303,871. In the 2017 American Community Survey, this number

was estimated to have grown to 321,570 individuals. The 2013-2017 American Community Survey estimated that 88.9% of individuals in the City of Riverside use private vehicles for work trips with only 14.1% of these trips occurring by carpool. Of all the workers in the City, 3% walked and 0.7% biked to work. By comparison, an estimated 2.7% of the population walked and 1.1% biked to work in the State of California. Table 1 shows major similarities in the shares of work trips by mode between the City and the State, Superficially, the City of Riverside has a slightly higher percentage of those walking to work, but slightly lower bicycle-based work trips (U.S. Census Bureau, 2017).

Table 1: 2017 commuting characteristics of the City of Riverside and State of California.

	CAR, TRUCK, OR VAN	DROVE ALONE	CARPOOLED	WALKED	BIKED
RIVERSIDE	88.9%	74.7%	14.1%	3.0%	0.9%
CALIFORNIA	84.0%	73.6%	10.4%	2.7%	1.1%

Air quality in Riverside is of particular concern, as the geographical conditions such as mountains funnel pollutants from the Greater Los Angeles Area into the region which causes additional exposure to contaminants. According to the Environmental Protection Agency Air Quality Index Report in 2017, Riverside-San Bernardino-Ontario region was the Metropolitan area with the least amount of "good" air quality days in California. Table 2 shows the comparison. Decreasing the use of private vehicles could improve the overall air quality of the region through the reduction of greenhouse gases. However, the current high levels of air pollutions present a health risk to anyone who is engaged in prolonged aerobic activity such as walking and biking. This is a serious concern that needs consideration in planning for improvements.

Table 2: Environmental Protection Agency Air Quality Index Report, 2017

CBSA	#Days with AQI	#Days Good	#Days Moderate	#Days Unhealthy for Sensitive Groups	#Days Unhealthy	#Days Very Unhealthy	AQI Max	AQI 90th %ile	AQI Median	#Days CO	#Days NO2	#Days O3	#Days SO2	#Days PM2.5	#Days PM10
Riverside-San Bernardino-Ontario, CA	365	25	165	95	53	27	366	190	99	.	11	223	1	98	32
Los Angeles-Long Beach-Anaheim, CA	365	38	205	76	38	8	224	156	79	.	25	176	.	162	2
Bakersfield, CA	365	76	150	115	24	.	197	140	84	.	.	250	.	102	13
San Diego-Carlsbad, CA	365	83	220	56	6	.	174	112	65	.	1	238	.	126	.
Visalia-Porterville, CA	365	93	145	96	31	.	168	147	80	.	1	232	.	123	9
Hanford-Corcoran, CA	365	95	197	52	21	.	181	125	70	.	.	197	.	122	46
Fresno, CA	365	102	143	93	26	1	207	140	74	.	2	234	.	116	13
El Centro, CA	365	112	212	36	2	3	331	104	61	.	2	167	.	107	89
Sacramento--Roseville--Arden-Arcade, CA	365	128	172	62	3	.	164	112	61	.	.	235	.	126	4
Madera, CA	365	142	175	42	6	.	166	105	58	.	1	238	.	110	16

Sidewalk connectivity in the downtown area is complete which can promote pedestrian mobility. However, the sidewalk quality in the downtown varies, which presents challenges to those with limited mobility and overall decreases the desire to walk. Figures 4 and 5 show the varying levels of sidewalk quality in the downtown area. While some portions of the sidewalk are wide and free of clutter, other portions of the sidewalk within the downtown area are narrower and riddled with cracks and uneven surfaces. These sidewalk conditions may discourage certain people from walking to their destinations and prevent those with limited mobility to even consider it as an option.

Figure 4: Sidewalk conditions along Lime Street in Downtown Riverside

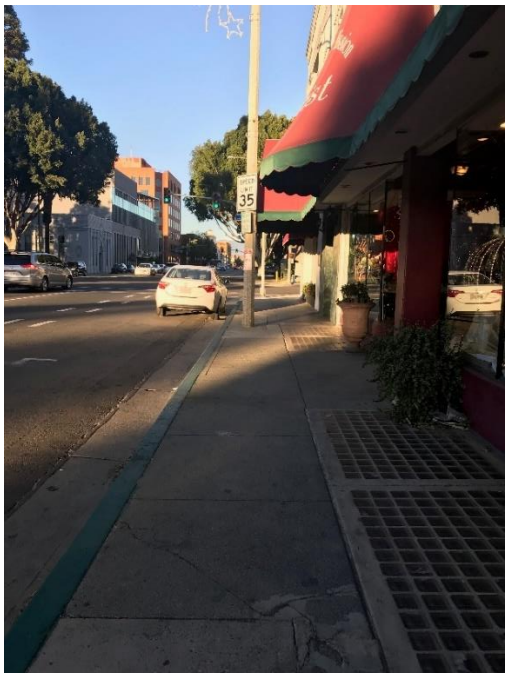


Figure 5: Sidewalk conditions along Market Street in Downtown Riverside

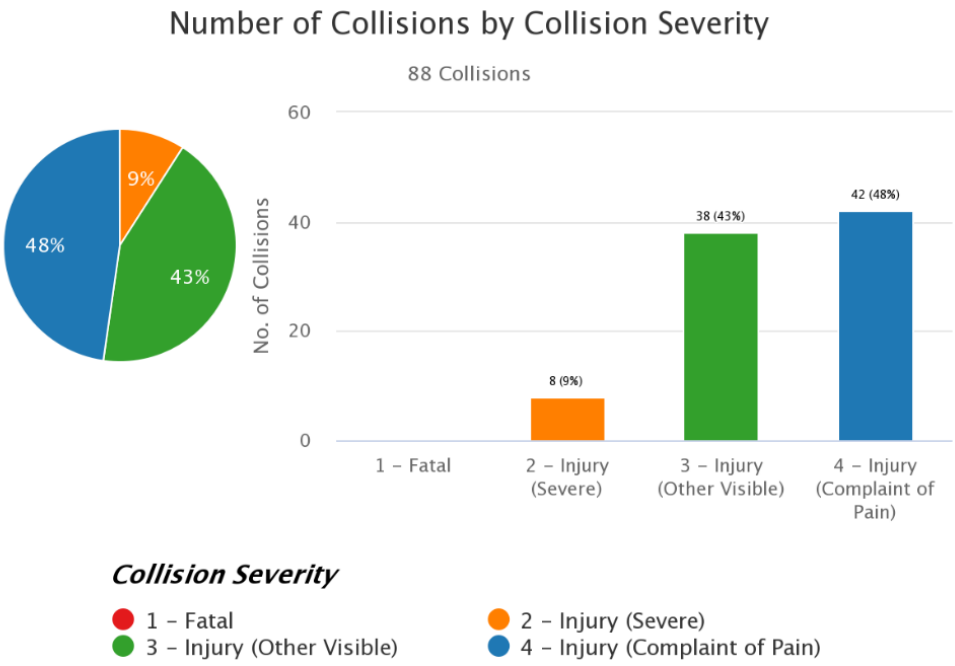
In 2018, the City had 101.5 miles of on-street (Class 2) Bike Lanes, but there was a lack of a cohesive system that linked major destinations to make biking a safe and feasible option to those interested. Figure 6 illustrates the lack of a cohesive bike lane network system in the downtown area. Although this area possesses a high job density, the lack of bike lanes that end in these destinations may be deterring individuals from biking to work. There is also a lack of such bicycle facilities as bike racks and lockers at end destinations which the City believes may be deterring individuals from considering this mode of circulation (City of Riverside, 2007)

Figure 6: Current bike lanes in downtown Riverside, CA.

The City's Bicycle Master Plan was originally adopted in 2007 and updated in 2012 along with the Circulation and Community Mobility Element. As a result, these plans are lacking certain safety aspects common in similar documents. Many major metropolitan areas have adopted a Vision Zero commitment but as of 2019 the City of Riverside has not done so. This is an important pledge to improve bicyclist and pedestrian safety in cities and encourage an increase in use of these two modes. SHAPE Riverside County, a nonprofit organization dedicated to increasing the health of the county, acknowledges the importance of safe active transportation options. According to the organization, as of 2015 there were 16 bicyclist collisions per 100,000 population, which is significant considering the low number of bicyclists in the City (Shape Riverside County: Strategic Health Alliance Pursuing Equity, n.d).

In the 2007 Riverside Bike Master Plan, the City identified that although Riverside has twice as many bicyclists as the national average one of the main reasons that this number

has not increased is the perceived lack of safety of biking within the City. This can be attributed to high vehicle speeds and a lack of designated lanes for bicyclists. The University of California Berkeley has developed a Transportation Injury Mapping System (TIMS) that geocodes and maps reported traffic collisions. Using provisional 2018 data, TIMS reports that 88 collisions involving bicycles occurred in the City of Riverside. Figure 7 shows the distribution of collisions by severity. Of these 88 collisions, Figure 8 shows that a large portion of bicyclist-related injury collisions were concentrated within the downtown area of Riverside.



Collision Severity	Count	%
2 - Injury (Severe)	8	9.09%
3 - Injury (Other Visible)	38	43.18%
4 - Injury (Complaint of Pain)	42	47.73%

Figure 7: Bicyclist collisions from 1/1/2018 to 12/31/2018 in Riverside, California.

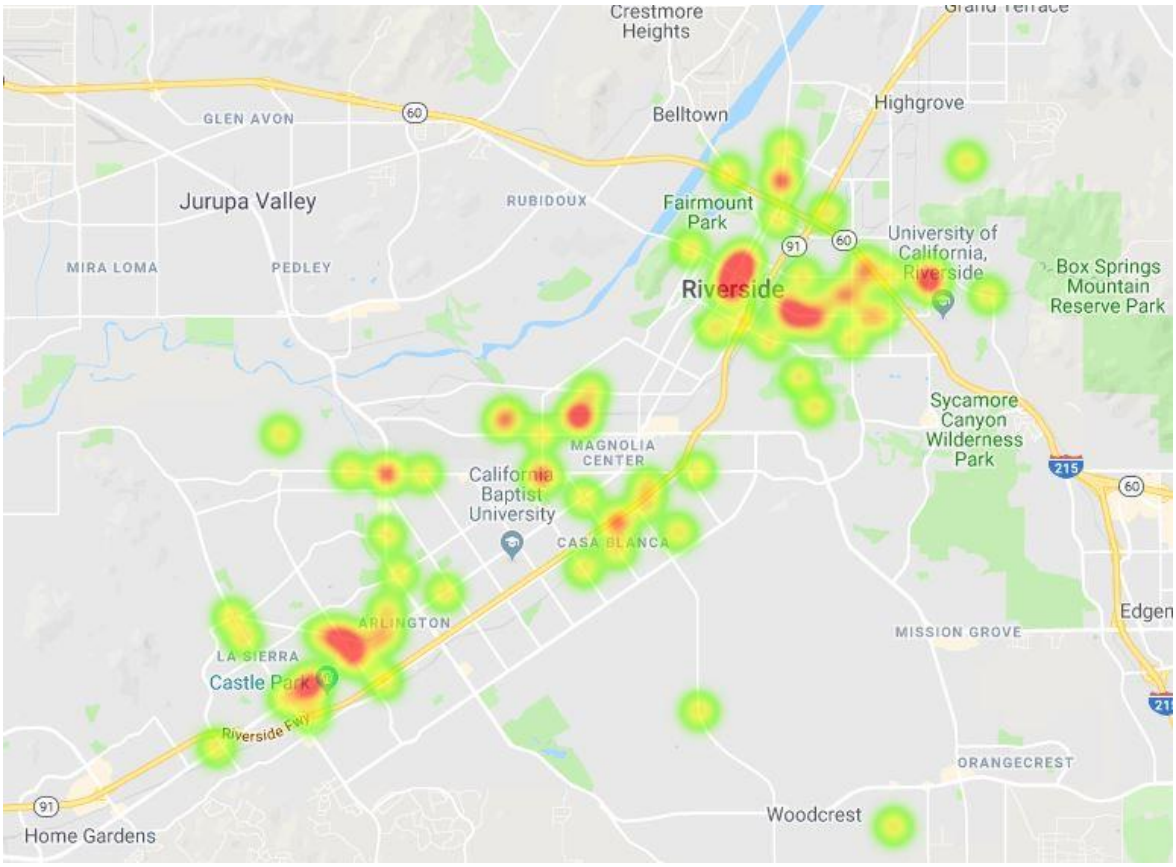
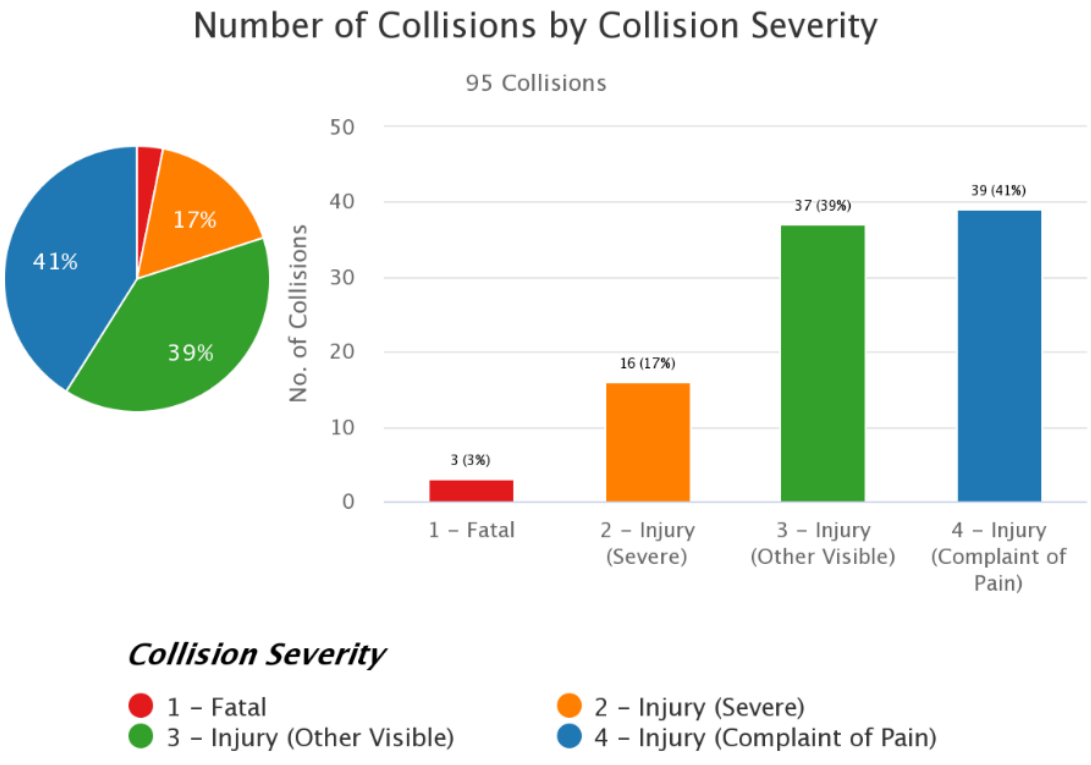


Figure 8: Bicyclist collisions heatmap from 1/1/2018 to 12/31/2018 in Riverside, California.

In addition to bicycle-related collisions, TIMS also has collected traffic incidents involving pedestrians as shown in Figure 9. There was a total of 95 pedestrian-related collisions in 2018, with 3 being reported as fatal. As found with the bicyclist collisions during this same time frame, Figure 10 shows that a large portion of pedestrian collisions occurred within the downtown area.

As a result of this information, it is clear that there is a need for the City of Riverside to improve the safety of pedestrians and bicyclists within the downtown area. This realization prompted the conduct of this study.



Collision Severity	Count	%
1 - Fatal	3	3.16%
2 - Injury (Severe)	16	16.84%
3 - Injury (Other Visible)	37	38.95%
4 - Injury (Complaint of Pain)	39	41.05%

Figure 9: Pedestrian collisions from 1/1/2018 to 12/31/2018 in Riverside, California.

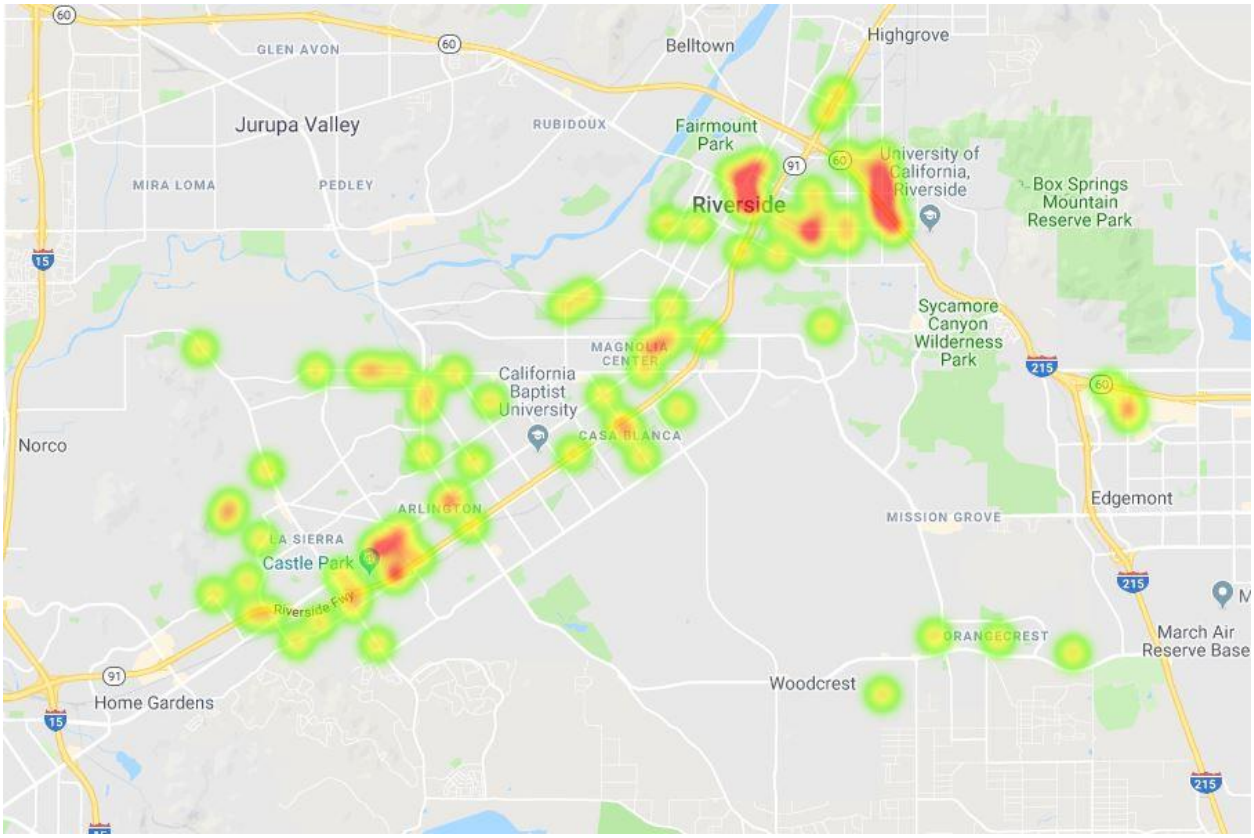


Figure 10: Pedestrian collisions heatmap from 1/1/2018 to 12/31/2018 in Riverside, California.

Case Studies and Study Methodology

Several cities were reviewed for their successes in making a safe, multimodal circulation system. Three of these cities were selected for in-depth case studies after various sources indicated that the cities have taken measures to improve safety of bicyclists and pedestrians and have seen promising results. The cities that are highlighted in this report are Seattle, Boston, and Los Angeles.

Seattle:

The Seattle Department of Transportation has adopted several Vision Zero Projects individualized for specific corridors throughout the City. This is in contrast to a more common methodology where goals are adopted to address the circulation system as a whole. In Seattle's method, the City identified key issues unique to given areas and made plans to address these issues on a much finer scale. A past project for the City that has been successful is the NE 75th Street Redesign project, which was started and completed in 2013. NE 75th Street provides access to Interstate 5 and is utilized as an east-west connection from the interstate. Prior to the redesign, there was one general purpose lane in each direction with parking allowed on both sides of the street as Figure 11 shows. NE 75th Street also was serviced by city transit services and was used by bikers although no clear infrastructure was implemented for bicyclists. In a parking survey conducted by the City, out of the 140 parking spaces along the corridor, on-street parking was vastly underutilized with a maximum of 23 cars parked at a given time. With very few cars parked, the intended 2-lane road functioned as a 4-lane road.

Figure 11: Street conditions along NE 75th Street in June 2011 prior to street redesign.

Based on community outreach and studies conducted by the City, several measures were implemeted to improve conditions along this corridor. Early improvements included repainting crosswalks and street lane markings, installing flashing lights near school zones, installing pedestrian countdown signals, and pedestrian signals in school zones. In addition to these improvements, Seattle also redesigned the corridor after conducting studies to improve the safety and transportation options. On both sides of the road, five foot wide on-street (Class II) bike lanes were implemented. Travel lanes were narrowed to be 10.5 feet with travel in one lane of either direction, and a middle 9 foot wide two-way center left turn lane was also introduced as Figure 12 shows. Crosswalks throughout the corridor were also painted and new pedestrian countdown signals were installed at large intersections. As a result of these improvements, the frequency of collisions have been reduced by 50%. Aggressive speedng has also been signicantly decreased and overall vehicle speeds are closer to the speed limit which has helped to improve the pedestrian and bicylist environment.

Figure 12: Street conditions along NE 75th Street in October 2018 after street redesign.

The success of the NE 75th Street Redesign has influenced several other projects including the Banner Way NE Project, which is currently still underway in the corridor identified in Figure 13. Along this corridor, the City reports that from 2013 to 2016, there were three pedestrian collisions and one bicycle collision. In addition, vehicles commonly traveled above the speed limit which increased the number of traffic accidents. During community outreach, the City reported that the desire for new bike facilities, the improvement of safety at pedestrian crossings, the improvement of visibility, and the improvement of signage for pedestrians were common requests by residents. After working with the community and conducting research, Seattle decided to implement new safety measures along this corridor including signage improvements, arterial traffic calming, roadway design changes, traffic signal modifications, pavement repair, and safety enhancements for people walking and biking.

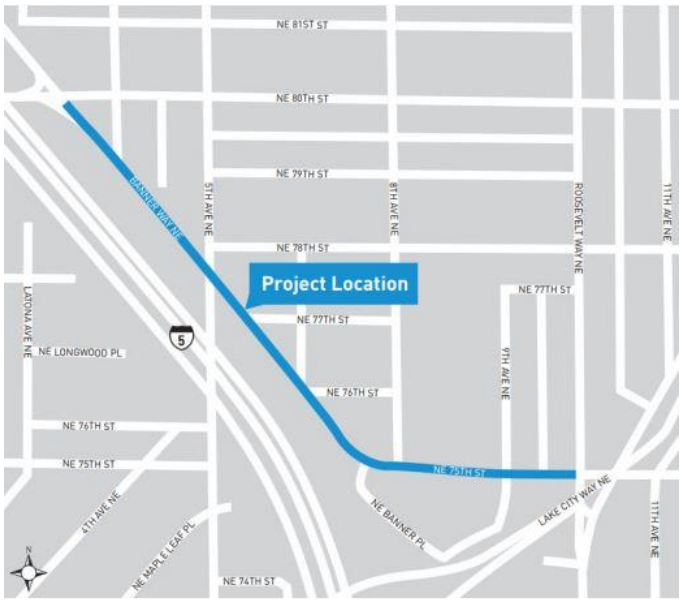


Figure 13: Project area for Seattle's Banner Way NE project.

Boston:

The City of Boston has also adopted a Vision Zero pledge. Incorporated into this, Boston has pledged to increase the number of bike lanes within the City and improve how safe they are for users. As these bike lanes help to connect the entire city, Boston has reported an increase in those who use bikes as their main choice of transportation mode. The City recognizes that a main barrier to riding bikes is the lack of perceived safety.

A program within the City is called "Better Bike Lanes". This program includes creating buffered bike lanes and separated bike lanes where possible. The buffered bike lanes would provide a barrier between people biking, people driving, and parked vehicles. These buffers are usually 1 to 2 feet wide and are located on one or both sides of the bike lane. In instances that buffered bike lanes are located adjacent to car parking, the buffer is to provide a bit more space for people to open car doors without hitting bikers. The separated bike lanes are similar to buffered bike lanes as they provide a barrier between bikers and

cars, but separated bike lanes also provide vertical separation between people on bikes and people in cars. Where there is on-street parking, the separated bike lanes can be located between the parked cars and the curb. This layout of bike lanes reduces the risks of bicyclists swerving into the travel lane and to avoid being hit by an opening car door. This also helps bicyclists become slightly more visible to vehicles at intersections. Some of these projects are to include the installation of sidewalk-level bike lanes. These bike lanes are at the same height as the sidewalk; there is to be signage asking pedestrians not to walk on these bike lanes but are able to cross them to access bus stops, access parked cars, or to cross the street.

The City of Boston has also adopted the "Boston's Safest Driver Competition", which is conducted through a smartphone app. The app provides helpful feedback on personal driving based on five categories: speed, acceleration, braking, cornering and phone distraction. Once the app is downloaded, the app analyzes the user's trip and gives an overall score at the end of the day accompanied by tips to improve their score. The app promoted competition between friends, family, co-workers, and neighbors to see who the best driver is. In 2016, the City ran a competition open to the residents of Boston and all of the cities in the Metro Boston area and gave cash prizes to the top drivers. Figure 14 shows the layout of the app, including personal achievements, ranking among friends, and personal score.

Figure 14: The Boston's Safest Driver App.

The City of Boston has also started to redesign streets to be Complete Streets. An example of this is the Centre and South Streets, Jamaica Plain project. This two-mile corridor is a highly active, vital area with ample community-based retail, service businesses, and new restaurants and shops within the Jamaica Plain neighborhood. This corridor also serves as a link between two large employment centers within Boston. Jamaica Plain is considered to be the bicycling hub of Boston as many neighborhood residents use bicycles to travel locally and to run daily errands. The redevelopment project was designed to improve

safety and accessibility, enhance the pedestrian environment, promote bicycling, improve traffic-flow, manage parking, and facilitate access to public transit. To improve the pedestrian environment on the corridor, Boston strived to provide a well-lit street environment, increase street trees, expand public art, employ sustainable design strategies to reduce the corridor's carbon footprint and increase energy efficiency, reduce visual sidewalk/street clutter, focus on creating continuous sidewalk paths that serve the needs of all users, and plan appropriate space for community events. Through this, the City of Boston hopes to decrease the number of people using private vehicles along this corridor by promoting a better biking and walking experience.

Los Angeles

The City of Los Angeles reports that there are around 200 yearly deaths on City streets, with nearly half of those killed being pedestrians or bicyclists. Of these deaths, most of them are children and older adults; the City reports that traffic collisions are a leading cause of death for children in Los Angeles (Vison Zero Los Angeles, n.d.). The City has identified a network of streets, called the High Injury Network where most of these collisions occur. Despite making up only 6% of city streets, nearly two-thirds of all deaths and severe injuries involving pedestrians occur on these roads. As a result, the City has adopted a Vision Zero pledge and has committed to having zero traffic-related deaths by the year 2025 with a focus on the streets in the High Injury Network. To do this, the City has adopted several measures to help eliminate these deaths. The first is to implement a Leading Pedestrian Interval (LPI) as Figure 15 shows. By reprogramming crossing signals to be on an LPI, the pedestrian crossing changes 3-7 seconds faster than car traffic signals. At locations with increased traffic flow or longer crossing times, start for the pedestrian crossing

head may be increased up to 10 seconds. This allows pedestrians to have a head start while crossing intersections, increasing their visibility when vehicular traffic is given the green light. Turning traffic yields to pedestrians already in the crosswalk and intersections with heavy bicycling traffic can also have a bicycling head start that correlates with the LPI. To make the LPI system more effective, some intersections have implemented curb cutouts as well to further increase visibility.

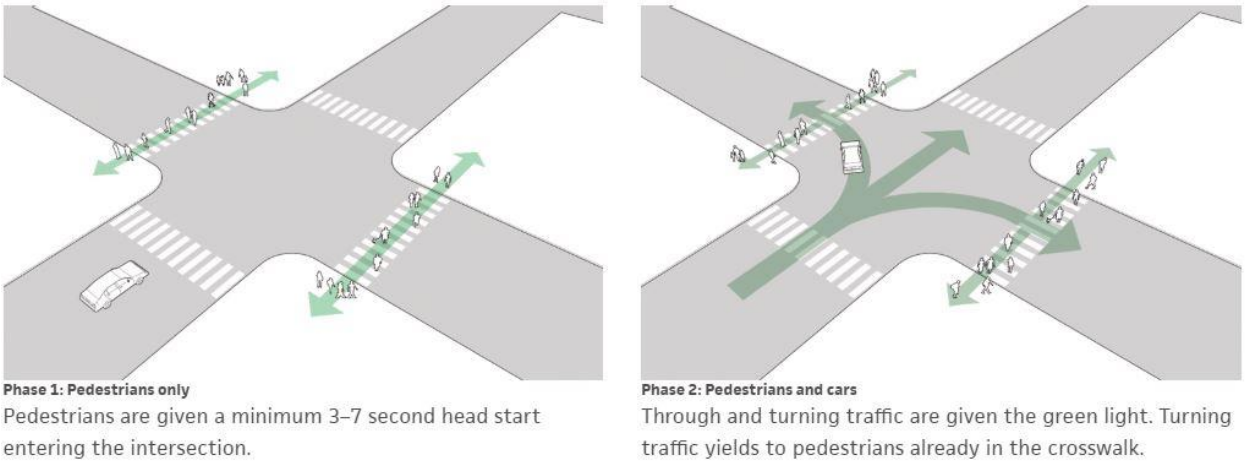


Figure 15: Diagram illustrating the implementation of a LPI system.

The City of Los Angeles, in an attempt to reduce the fatalities of children in traffic-related accidents, has adopted a Safe Walk to School program. The City has completed 14 walking safety assessments. First implemented in October 2017, over 180 schools and 47,000 students participated in Walk to School Day Los Angeles. This program has greatly increased in number every year and the success of the program has garnered national attention and recognized both Mayor Eric Garcetti and Superintendent Michelle King on the success of the project. Across the High Injury Networks, the programs have launched a traffic safety education campaign including over 2,000 community surveys on perceived

safety along these corridors. As a result of this work, the City has documented that 80% of those asked expressed great concern about traffic safety issues in their communities and 65% of respondents said that Vision Zero is extremely important for the City. Overall, the understanding and awareness of Vision Zero has increased 20% after the campaign had concluded.

Findings and Recommendations

The first recommendation for the City of Riverside is to adopt a Vision Zero plan as a way to promote the safety of people from transportation-related accidents; the successes of Vision Zero plans adopted in Boston, Seattle, and Los Angeles indicate that Riverside could have similar success in reducing traffic-related deaths. In addition to the strategies proposed by the case studies, Vision Zero Network has guidelines for creating an effective Vision Zero plan. Vision Zero Network has identified four main components that should be included in successful Vision Zero implementations along with detailed explanation of how to draft each component as Figure 16 shows. Evaluation is to lead to help identify fundamental elements for improvement. These are to be captured in a state of strategies for implementation. Every comprehensive Vision Zero plan is a dynamic document that is always changing after evaluation and community input is collected. So, it will be vital for the City of Riverside to develop and maintain community outreach efforts for its Vision Zero plan.

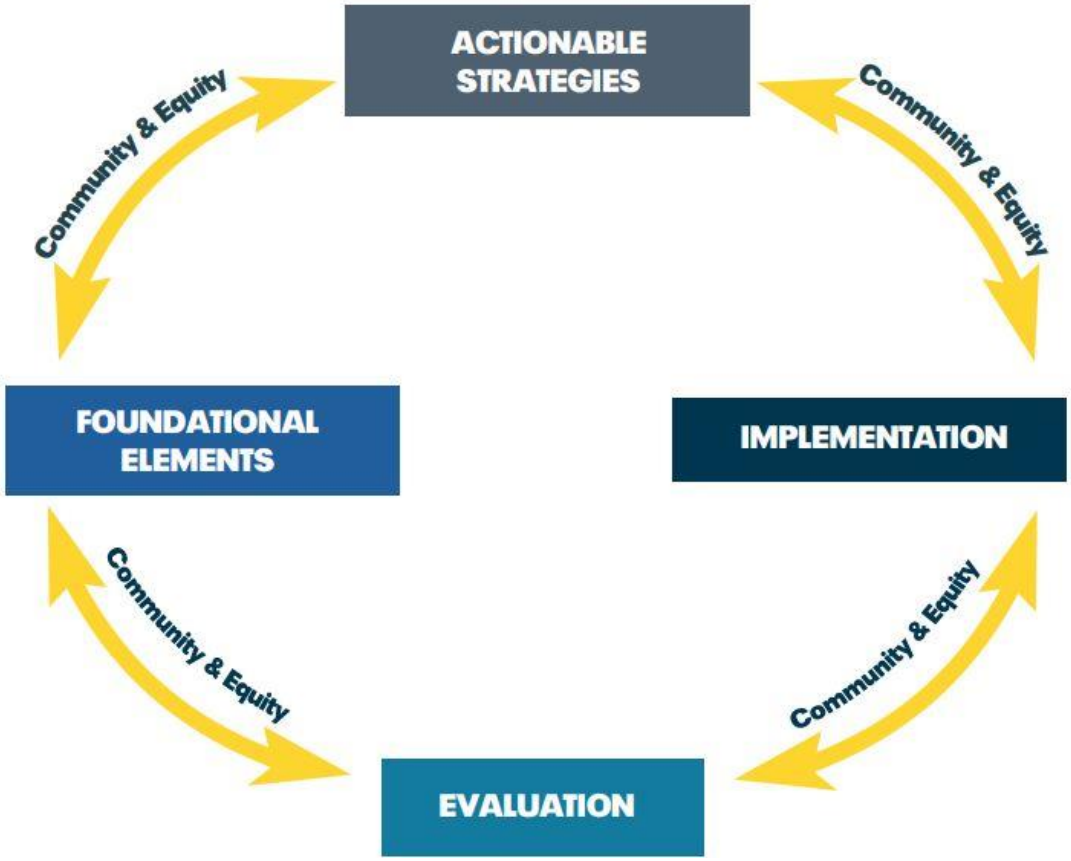


Figure 16: Vision Zero Network's suggested approach to drafting a Vision Zero Plan.

The second recommendation is for the City of Riverside to develop programs to help foster walking and biking within the City. An example of this is to adopt a Safe Routes to School program to encourage youth to walk or bike for school-related trips. While there is already a county-wide measure adopted to promote multi-modal school trips, it would be beneficial for the City to develop a program specific to the City to more closely address issues preventing Riverside youth from walking and biking to school. It would be vital for the City to educate students on safe biking and walking habits, including checking for cars, safety from crime, and concerns linked to poor air quality. Another example of an

educational program would be to create programs intended to get older citizens to increase walking or biking for daily trips. It is recommended that the City of Riverside partner with larger employers to construct bike racks and lockers near their businesses along with giving incentives to workers to walk or ride bikes. The City should also conduct workshops and seminars to inform residents how to maintain and fix their bicycles. For the last program recommended to the City, Riverside should consider developing a safe driver app similar to what Boston developed. This would help inform citizens of their driving habits and promote changes that would make the circulation system safer for bicyclists and walkers.

The third recommendation to the City of Riverside is to improve existing infrastructure. As mentioned in this document previously, both the sidewalk and bike lane network are inconsistent. Less experienced bicyclists may not feel comfortable sharing the road with drivers and therefore may be less willing to bicycle throughout the City as a result. The City should reexamine where there are gaps within the bike lane network around the downtown area and determine where additional bike lanes can be added; priority should be given to streets that would allow for separated bike lanes to improve perceived safety for bicyclists. There should be a focus to increase Northwest-Southeast connections within the downtown as this is the area that could benefit the most from the new infrastructure. It is also recommended that the City of Riverside look to further strengthen connections between the downtown and residential neighborhoods as a way to bolster the network and encourage more individuals to bicycle. Figure 17 shows an example of future bike lanes that could be adopted within the downtown area shown in blue. These proposed bike lanes on 12th Street, University Avenue, and 5th Street can help connect the downtown area further with the existing matrix. These streets, after redesign, would have space for Class 2 bike lanes which

would also help connect the downtown with northwest and southeast residential neighborhoods. These bike lanes would also help make a stronger connection with major destinations within the downtown area including major employers and tourist attractions.

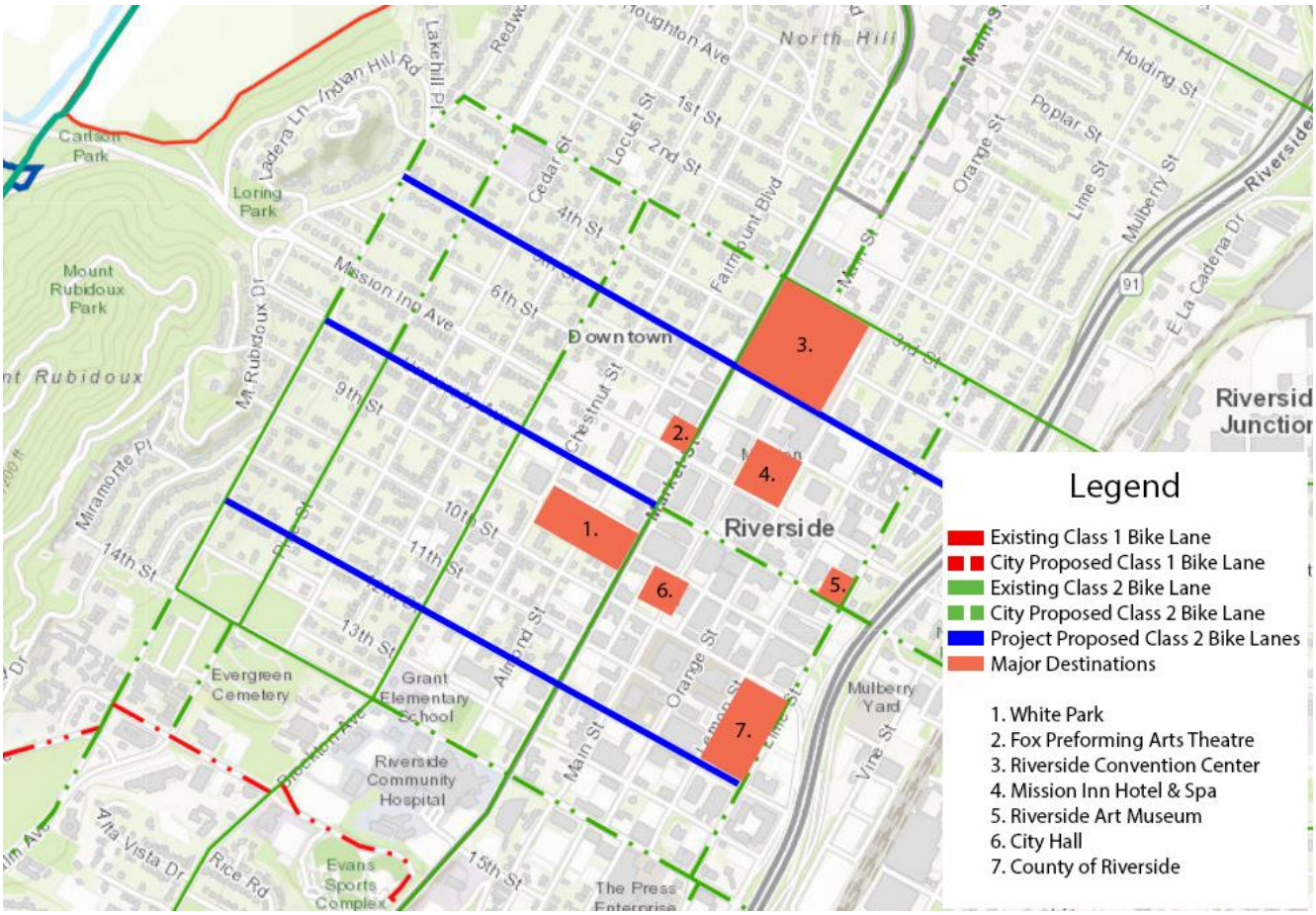


Figure 17: Recommended future bike lanes in downtown Riverside.

Another area of improvement would be to improve existing sidewalks and strengthen sidewalk connections to surrounding neighborhoods. Individuals with limited mobility may be persuaded against walking to their destinations. Additionally, sidewalks that are ill-maintained are less appealing and are less likely to encourage individuals to walk to their destinations. Street trees, benches, and other public amenities should also be considered to encourage people to regularly use sidewalks. Furthermore, it would be beneficial for

pedestrian safety for the City of Riverside to consider LPI systems at intersections of concern for pedestrian safety within the downtown area to improve pedestrian visibility.

One more recommendation for the City of Riverside is to develop specific plans for problematic corridors within the downtown area. As illustrated in all three case studies, there was great success in improving safety and number of multi-modal users as specific tools and strategies necessary for each unique location were created. This recommendation includes increasing the community engagement of those who frequent the corridors. This engagement may encourage additional individuals to use bicycling and walking as their main modes of transportation if their specific concerns on the routes they would take are being addressed.

Conclusion

The City of Riverside has great potential to increase the safety of bicyclists and pedestrians within the downtown area. With high citizen interest in biking and walking being hindered by fear for personal safety, it will be vital for the City of Riverside to take measures to improve pedestrian and bicyclist safety. In 2018, 88 bicyclist and 95 pedestrian-related collisions were reported within the City with a large proportion of these collisions occurring in the downtown area. A recommendation to the City to improve pedestrian and bicyclist safety is to adopt a Vision Zero plan, which would indicate Riverside's commitment to improve traffic safety. A second recommendation is to create programs that promote safe circulation among the youth and adults, including Safe Routes to School programs specific to the City and an app that would give users a score based on their driving performance. A third recommendation is to improve existing infrastructure including strengthening connections between residential neighborhoods and the downtown and increasing the amount of bike lanes found within the City. One more recommendation is to create specific plans for problematic corridors within the downtown to help create distinctive safety related solutions relevant to these locations.

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