Spring 2019

Complete Streets in Venice, California

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DEPARTMENT OF CIVIL, ENVIRONMENTAL AND SUSTAINABLE ENGINEERING

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ABSTRACT

In response to the growing pattern of fatal traffic accidents involving pedestrians and bicyclists in the City of Los Angeles, a new initiative has been started to reduce these accidents by improving current designs and adding signage and striping to add more visibility. The city-wide project also focused on these redesigns to help boost the surrounding economy by encouraging residents to bike and walk instead of drive. Though met with much criticism and protest from residents, the traffic data after one year of the pilot implementation proved accident rates and fatalities had decreased with the new safety measures installed. This Senior Design Project extended the design into another traffic corridor outlined by the Los Angeles Department of Transportation (LADOT) as a spot that needs a redesign. The corridor that was focused on was Abbot Kinney Boulevard in the neighborhood of Venice, the intersection of Venice Boulevard and Abbot Kinney, and Venice Boulevard heading east to Lincoln Boulevard.

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COMPLETE STREETS in VENICE, CALIFORNIA

I. INTRODUCTION

For many years now, Los Angeles has been known to have some of the worst traffic and the highest number of collisions not only in the United States but worldwide as well. In 2015, the City of Los Angeles worked with communities across the City to help reduce vehicular traffic, vehicle collisions with pedestrians and bicyclists, and lastly to upgrade street stripings to be more visible and less confusing to drivers, calling these new advanced streets "Complete Streets" or "Great Streets". Many traffic studies were conducted across the City, mapping out traffic corridors that have seen large increases in collisions with these pedestrians and bicyclists. These maps were then used to identify trouble spots within different communities, and a plan was created to make sure these problems would be solved using new street designs. Another important factor that was studied includes when a pedestrian is struck by a moving vehicle at various speeds, which showed that if a vehicle is traveling at 20 miles per hour (mph) and strikes someone crossing the street, the chance they survive is 80%. That number is reduced to 10% if the vehicle is traveling at 40 mph. Los Angeles City Mayor, Eric Garcetti, introduced a new initiative named "Vision Zero", which will eliminate all traffic-related deaths by 2025.

By 2017, a pilot project along Venice Boulevard was implemented in a small community named Mar Vista, with the intent to reduce the amount of cars on the street and make it safer for pedestrians and bicyclists. By increasing the number of crosswalks, designing a new bike and parking lane, adding more striping, and reducing the number of vehicle traffic lanes on Venice Boulevard, the surrounding community has become a small "downtown", helping to boost the local economy. Despite large groups of opposition coming from residents and establishments, the pilot design is going to remain in place, especially after a report published a year after the design was installed showed the project reduced the number of collisions with other vehicles, pedestrians and bicyclists, and reduced the average speeds of vehicles traveling in the corridor. Known as a "road diet" in the community, it has reduced the number of cars on Venice Boulevard and even discouraged other drivers from using the street altogether.

The project that this team worked on is a continuation of this segment of the Great Streets along Venice Boulevard towards the ocean, and along another street named Abbot Kinney Boulevard, home to many affluent small stores and establishments. This corridor was identified as a trouble zone by the Vision Zero initiative, meaning at some point Abbot Kinney Boulevard will receive a similar redesign seen in Mar Vista along Venice Boulevard. Since Abbot Kinney Boulevard is one of the biggest attractions in Los Angeles County, it is important to cater to tourists walking and biking around the area. The objective of this redesign is to reduce the number of collisions between vehicles, pedestrians and bicyclists, as well as providing safer facilities such as crosswalks and bike lanes with boundaries, maintaining a healthier community by encouraging more walking and biking, all while maintaining the existing vehicular traffic service.

Figure #1: displays statistics taken by the City of Los Angeles.

II. PROJECT SCOPE

For the project, the team decided to expand the work that has been done as the Pilot Program on Venice Boulevard and implement the "Complete Streets" design down the High Injury Network into the area of Venice Boulevard, specifically Venice and Abbot Kinney

Boulevards. The Los Angeles Department of Transportation (LADOT)'s High Injury Network identified both streets as streets that have high collisions with pedestrians and bicyclists due to the high tourism seen in the area. The team decided to analyze and design these two streets and produce a course of action and a corresponding cost estimate for that plan.

The entire corridor, end to end, is approximately 1.7 miles long, stretching from the intersection of Venice Boulevard and Lincoln Boulevard, to Abbot Kinney Boulevard and Main Street. With the high number of collisions over the past few years, suggestions on how to mediate these collisions with a low cost was a priority to ensuring the safety of drivers and others in the vicinity. On Abbot Kinney Boulevard, the team decided to redesign the street layout to include a new separated bike lane that is not shared with the vehicle lane, as it is currently aligned.

Figure #2: displays the City of Los Angeles' 'High Injury Network' in West Los Angeles, outlining Venice and Abbot Kinney Boulevards.

III. EXISTING CONDITIONS

These two streets along this corridor saw a large increase in vehicular, pedestrian and bicyclist volumes in the last decade, correlating to the new development of "Silicon Beach", and

area of Los Angeles where many large technology companies are currently building new headquarters. Along with these higher volumes due to the increased new flow of people moving into the area, other conditions have sprung, such as a higher usage of app-sharing methods of transportation. An example of this increased usage is the rise in the app-sharing scooter system called “Bird” and “Lime”, which people have been seen riding in the middle of the street and on sidewalks.

Venice Boulevard, one of the most famous streets in Los Angeles, services thousands of residents everyday along its 13 mile stretch that runs from Downtown to the beach district of Venice. Due to wear and tear of the striping, many of the assets that provide safety for bicyclists do not work as efficiently as they once did. Abbot Kinney Boulevard, another famous street in Los Angeles, has seen an extreme increase in economic development in recent years due to the housing crisis. This crisis has made rent along the street climb so high that only exclusive retail stores can afford it, turning Abbot Kinney into a regular tourist destination. With city and county government transportation agencies promoting and encouraging the use of ride-share bicycles, it is important to provide the proper infrastructure to carry the higher capacity safely.

Using a traffic software called Synchro 10 and traffic signal and volume data obtained from LADOT, a simulation of the existing traffic conditions was produced. Syncho was able to display the entire Venice and Abbot Kinney Boulevard corridor showing vehicles, trucks, pedestrians and bicyclists. This simulation helped the team understand how the traffic flow moves across all the intersections, how the queues of cars line up behind the red light, and if the green light is long enough for the queue to dissipate. After inserting all the data, Synchro analyzed the data into Level of Services for each street and intersection, which is useful for determining how well the street performs compared with the type of street it is and the speeds and volumes the street experiences.

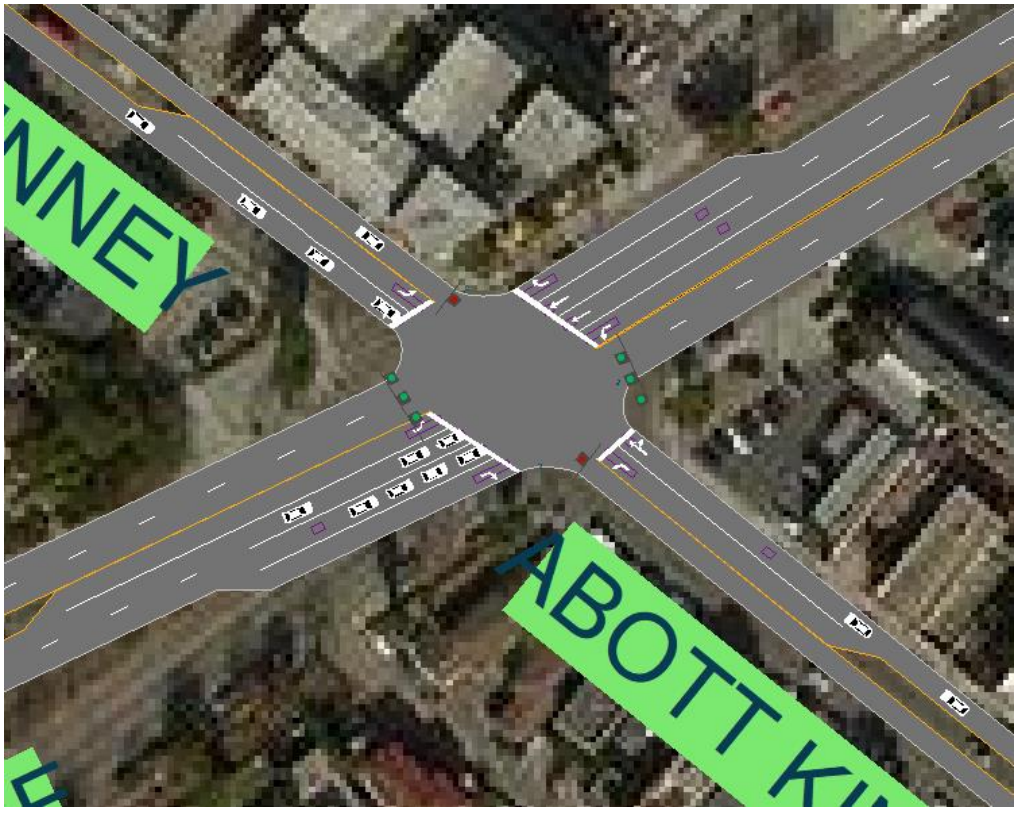

Figure #3: Screenshot of traffic software program Synchro 10 at intersection of Abbot Kinney Boulevard and Venice Boulevard

Official street design drawings from the LADOT were also received and analyzed. These drawings provided measurements needed to understand the existing conditions and how much space there is to work with. The drawings also gave the team an understanding of the different city assets, such as streetlights and crosswalks, that needed to be considered in the design of the new bike lanes for Abbot Kinney Boulevard.

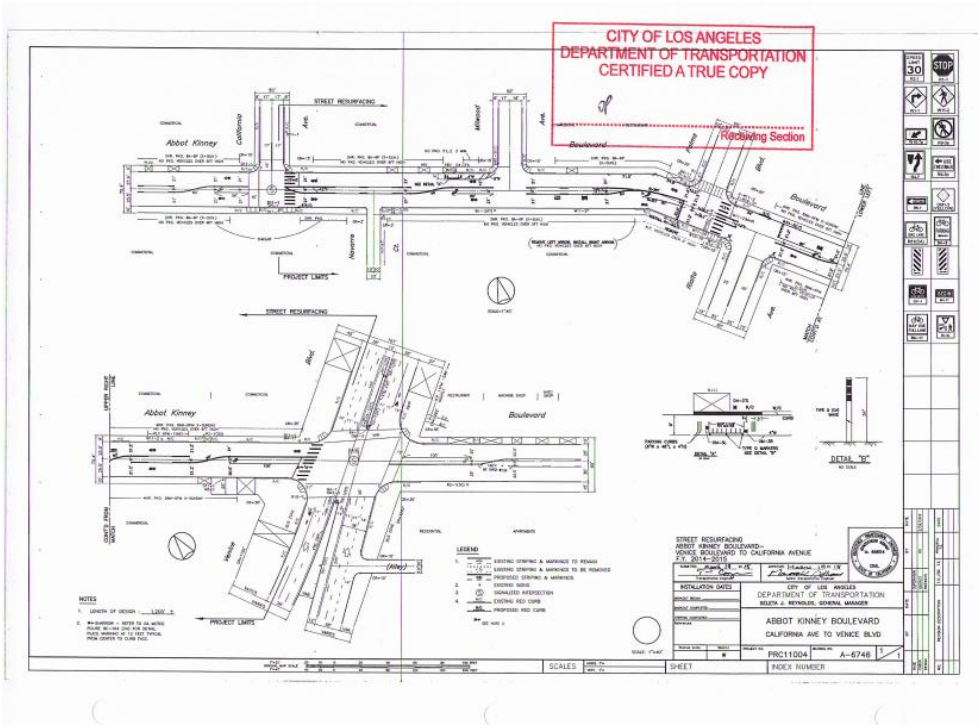

Figure #4: An example of the geometric street dimensions received from LADOT.

Based on the information from LADOT (Figure #5), some analysis was done on the accidents and collision rates of the intersections in question. One significant aspect that had to be considered for each individual intersection in order to design for improved safety, was the intersection's collision history given the existing conditions. Collision studies are typically conducted by the city or their hired subcontractors in order to gather information regarding how many collisions are occurring at the intersection of interest, what the majority crash type is, and other factors that may have contributed to allowing the incident to occur in the first place. This extent of the study period considered for the subsequent collision analysis cases (August 31, 2015 - August 31, 2018) follows the same study duration period of the information given by the City of Los Angeles.

Each analysis case considers the given information in order to identify the site's collision frequency and any possible trends that may aid in identifying collision mitigation suggestions.

Los Angeles
Intersection Collision History

Location: Lincoln Blvd & Venice Blvd
Dates: 08/31/2015 to 08/31/2018, Time: All
Total Collisions: 32

Date Created: 01/24/2019

Case ID	Flag	Date & Time	Location	Offset Dist. & Dir	Collision Severity	Collision Type	Motor Veh Involved With	Ped Action	PCF Violation	Inj	Kill	Movement Prec Coll	Dir of Travel
7115416	No	09/18/15 13:50	Lincoln Blvd & Venice Blvd	33 ft. South	Complaint of Pain	Head-On	Other Motor Vehicle	No Pedestrian Involved	Improper Turning	1	0	Making Right Turn	East
												Stopped	North
7106567	No	10/17/15 22:00	Lincoln Blvd & Venice Blvd	30 ft. North	Property Damage Only (PDO)	Rear End	Other Motor Vehicle	No Pedestrian Involved	Following Too Closely	0	0	Proceeding Straight	South
												Stopped	South
												Stopped	South
7104413	No	10/20/15 13:30	Venice Blvd & Lincoln Blvd	129 ft. East	Property Damage Only (PDO)	Rear End	Other Motor Vehicle	No Pedestrian Involved	Traffic Signals and Signs	0	0	Making Left Turn	South
												Proceeding Straight	East
												Stopped	East
7104409	No	10/20/15 19:05	Lincoln Blvd & Venice Blvd	At Int	Property Damage Only (PDO)	Rear End	Other Motor Vehicle	No Pedestrian Involved	Following Too Closely	0	0	Proceeding Straight	North
												Slowing / Stopping	North
7110370	No	10/25/15 16:15	Venice Blvd & Lincoln Blvd	At Int	Other Visible Injury	Broadside	Bicycle	No Pedestrian Involved	Traffic Signals and Signs	1	0	Proceeding Straight	North
												Traveling Wrong Way	West

CITY OF LOS ANGELES
DEPARTMENT OF TRANSPORTATION
CERTIFIED A TRUE COPY

Receiving Section

Page 1 of 6

Figure #5: An example of the collision history data received from LADOT.

Seen in Figure #5, the following analysis examines the collision history for six intersections along the Venice Blvd. and Abbot Kinney Blvd. corridors. Based on the City's data for the six intersections, only three had enough data for the three year span to warrant implementing increased safety measures. According to the FHWA, a rate of 10 collisions per year can be considered a high collision intersection. This threshold rate was used in order to focus on the high collision intersections and disregard the Venice Blvd. intersection at Oakwood Ave. and the Abbot Kinney Blvd. intersections at California and Westminster Ave., which experienced less than five collisions each for the three year span.

Figure #6: Map of intersections considered for collision analysis.

Collision Analysis Case: Abbot Kinney Blvd. and Venice Blvd.

Over the course of the three year period observed, the Abbot Kinney Blvd. and Venice Blvd. intersection experienced a total of 37 collisions. Of these collisions, approximately 70% occurred at night time and 24.3% involved bicyclists and pedestrians. The spot map of the intersection collisions, seen in Figure #7, shows that most of the collisions happened along the surrounding corridors rather than in the heart of the intersection.

Figure #7: Collision spot-map at the Abbot Kinney Blvd. and Venice Blvd. intersection.

Shown in Figure #8, collisions such as those categorized as Sideswipe and Broadside, made up the majority of the types of collisions experienced, with each making up approximately 27% of the total collisions. The majority of these types of collisions occur as drivers become negligent of their awareness to their surroundings but may also be facilitated by outdated traffic control systems.

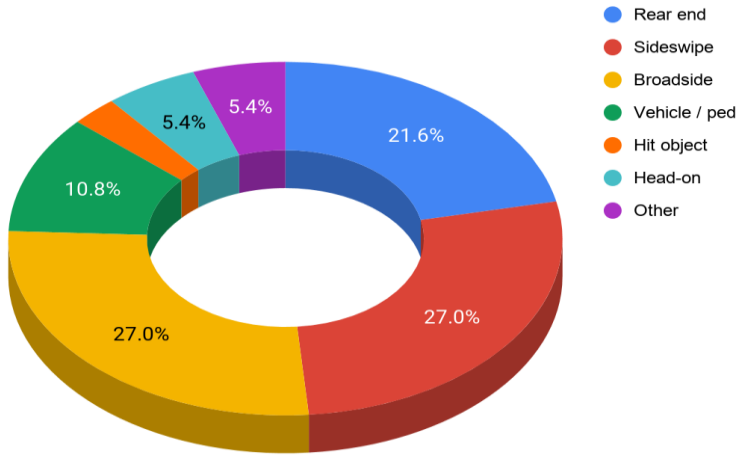

Figure #8: Collision type distribution for Abbot Kinney Boulevard and Venice Boulevard.

Collision Analysis Case: Lincoln Blvd. and Venice Blvd.

In the case of the Lincoln Blvd. and Venice Blvd. intersection, the intersection experienced a total of 32 collisions with approximately 63% occurring at night time and 22% involving bicyclists and pedestrians. The spot map of the intersection collisions, seen in Figure #9, shows that most of the collisions happened near or at the intersection center.

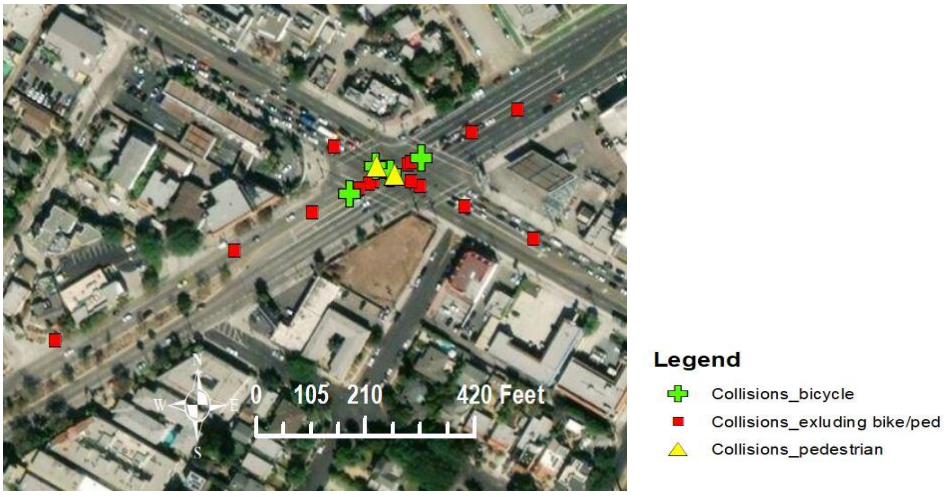

Figure #9: Collision spot-map at the Lincoln and Venice Boulevard intersection.

Shown in Figure #10, collisions such as those categorized as rear end made up the majority of the types of collisions experienced. At 31.3% of the total collisions experienced, rear end type collisions may be indicative of a problem occurring with the traffic control system's ability to get vehicles to safely slow down. The majority of these types of collisions occur as drivers experience a sudden decrease in speed.

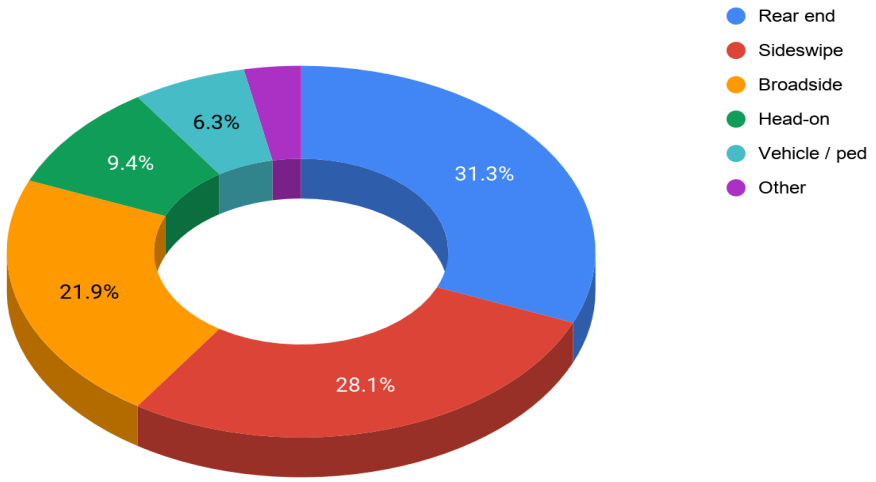

Figure #10: Collision type distribution for Venice Blvd. and Abbot Kinney Blvd.

Collision Analysis Case: Abbot Kinney Boulevard and Main St.

In the case of the intersection of Abbot Kinney Boulevard and Main St., the intersection experienced a total of 13 collisions with approximately 77% occurring at night time and 38.5% involving bicyclists and pedestrians. The spot map of the intersection collisions, seen in Figure #11, also shows that most of the collisions happened near or at the intersection center.

Figure #11: Collision spot-map at the Main St. and Abbot Kinney Boulevard intersection.

Shown in Figure #12, collisions such as those categorized as Sideswipe and Broadside, made up the majority of the types of collisions experienced, with each making up approximately 30.8% of the total collisions. Similar to the Abbot Kinney Blvd. and Venice Blvd., the majority of these types of collisions are caused by negligence but may be facilitated by the intersections existing traffic control systems.

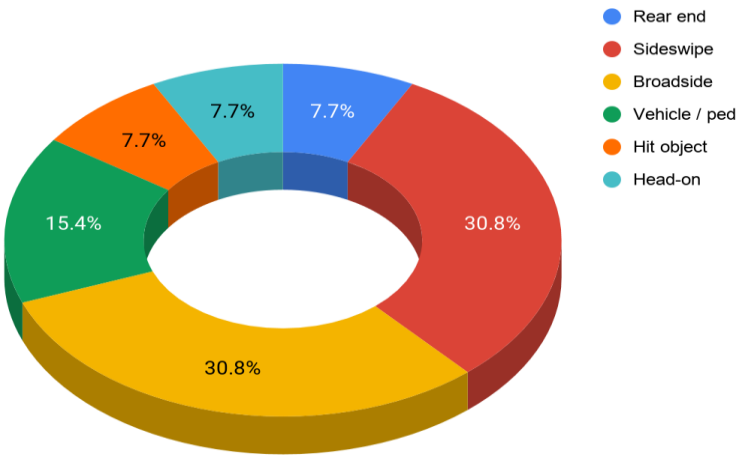

Figure #12: Collision type distribution for Main St. and Abbot Kinney Blvd.

In Figure #13, the annual number of collisions experienced for the three year duration were compared for each of the three intersections. The general trend shown suggests a slight decrease in collisions, but for the two intersections with the highest volumes, the annual rate still lands above the FHWA threshold of 10 collisions per year.

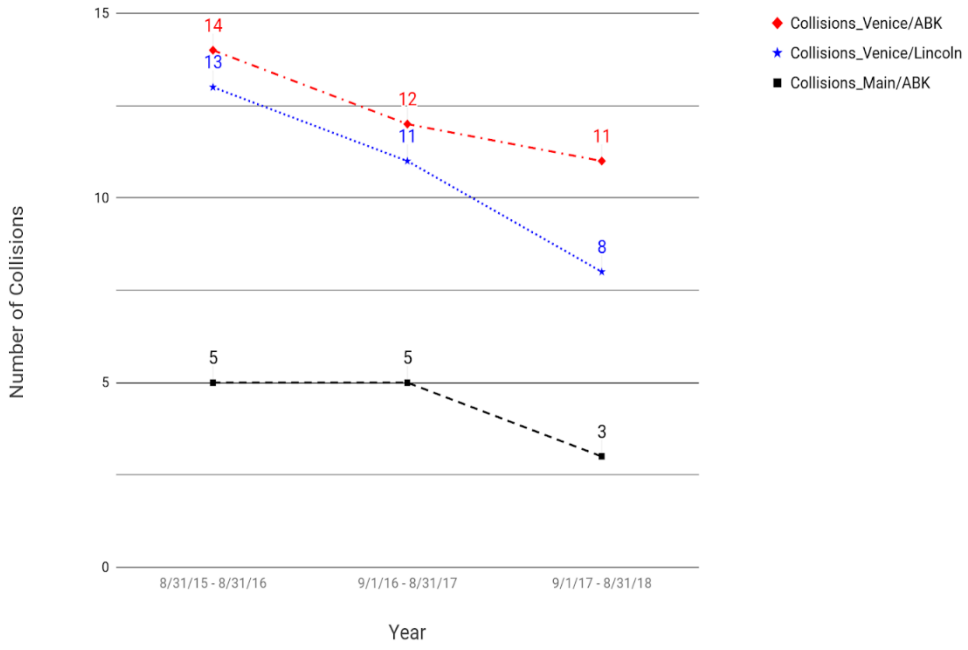

Figure #13: Reported collisions for high frequency intersections.

Suggested Action

Upon completion of the analysis for the intersections of interest, the team determined potential design considerations that could benefit the overall driver and pedestrian safety. For each of the intersections considered, collisions during night hours represented a large portion of the total reported collisions. During these hours, low visibility is typically the main contributing factor for collisions. There are a number of ways to increase visibility during night hours but the recommended method is installation of highly reflective thermoplastic paint with inclusions of small glass beads. This recommendation is to be considered for all intersections in the ensuing design iterations.

Another recommendation that could be made based on the collision history is that all intersections receive an improved signal timing plan. For the intersections with a majority of sideswipe and broadside collisions, this suggestion would most likely consider a modification of the yellow, red, and all-red traffic light phases. Changing of these timing plans is essential to allowing the driver an increased chance to make clear and safe maneuvers in and out of the intersection rather than forcing them to split decisions on a split-second notice. Similarly,

intersections with a majority of rear end type collision, such as the Lincoln Blvd. and Venice Blvd. intersection, could see an improvement in safety if drivers are allowed an appropriate time to clear the intersections instead of being forced to hurry through or make a hard stop before entering. These decisions can cause traffic speed variations, which are known for having high influence on a driver's ability to make safe maneuvers through traffic. In the case of the Venice Blvd. and Lincoln Blvd. intersection, it is additionally recommended that the speed limit be lowered in order to reduce the high number of rear end collisions happening at the intersection.

IV. DESCRIPTION OF REDESIGN

In the redesign, the team decided to incorporate the collision data with traffic volume and existing street dimensions in order to come up with a solution to make Abbot Kinney Boulevard a safer route for bicyclists. Using the Venice Boulevard Pilot Project and the California Department of Transportation (CalTrans)'s different bike lane templates as guidance for the new design on Abbot Kinney, different alternative designs were formed that provide more safety for bicyclists and pedestrians. The team emphasized the importance of making sure that all factors and conditions were accounted for, such as minimum widths for vehicle and bicycle lanes specified by CalTrans, while ensuring these safety measures won't affect traffic flow negatively.

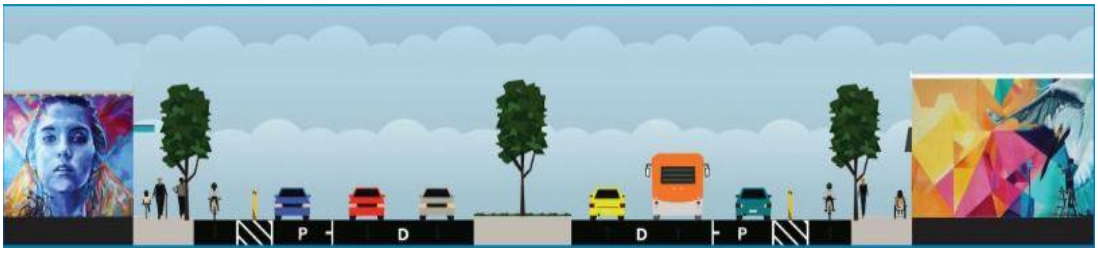

Figure #14: Visualization of the cross section of the Venice Boulevard Pilot Project.

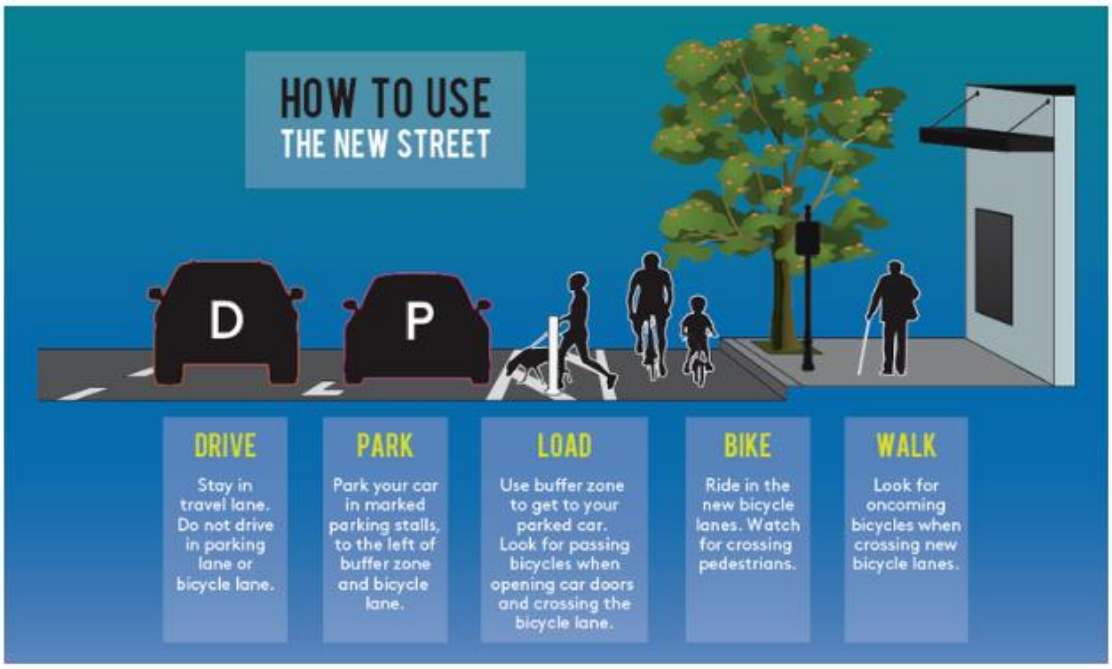

Figure #15: An informative developed by the City of Los Angeles for the public to read explaining the new street design.

The Venice Boulevard Pilot Design confronted a different set of problems than the team is addressing for Abbot Kinney Boulevard. In order to bring down the average vehicle speed on Venice Boulevard, engineers decided to subtract a vehicle lane in both directions, going from three down to two. This increased the congestion on the street as the average daily traffic volume remained the same, effectively bringing down the average vehicle speed on the street. With the new space that resulted from the subtraction of the vehicular lane, a new protected bike lane was installed next to the curb, with a buffer zone to protect traveling bicyclists. This Pilot design was taken into consideration to be installed on Abbot Kinney Boulevard; however the team insisted on making sure that the vehicle speeds remained near the same in order to maintain the level of service on the street and intersections. Using the different classes of bike lane templates designed by CalTrans, the team looked at other alternatives that could be used while incorporating some of the safety factors that led to success in the Pilot design.

There are four main classes of bicycle lanes that CalTrans designed for municipalities across the State when implementing bicycle lanes. These designs can be implemented based on

the existing street conditions and dimensions, and safety concerns or patterns that need to be addressed. The existing bike lane on Abbot Kinney Boulevard is a Class III, called a bike route, which is a street that makes vehicles and bicyclists share the same lane. This design works for streets that do not have high speeds or high volume of vehicles because the safety for bicyclists is at risk. With the increase in scooter riders that share the bike lane with bicyclists, it is important that their safety is accounted for, while also making sure that the vehicles have enough space in their respective lanes.

Figure #16: Class III Bike Lane that shares lane with vehicular traffic.

Class I, a regular bike lane or bike path, gives exclusive right-of-ways to bicyclists in a protected manner by minimizing the number of cross flows with vehicle traffic. Some of these designs also include a pedestrian walkway separated from the bicycle lane. The implementations of Class I are used for designs near canals, rivers and within school campuses.

Figure #17: Class I Bike Lane physically separated from street.

Class II bike lanes are lanes that dedicate space on streets, marked by street striping and signage to aid visibility and protection. This lane also includes a design called a buffered bike lane, which gives even more protection to bikers by giving a couple feet of separation from the vehicles. The buffered bike lane is suitable for streets with high volumes of traffic and high speeds.

Figure #18: shows a Class II Bike lane with a strip of striping separating the lane from vehicular traffic.

Figure #19: A Class II Bike lane with a small space for added protection.

Class IV bikeway, called a Separated Bikeway, is a lane on the street separated from vehicular lanes physically with the use of small vertical barriers. By providing physical separation from motor traffic, Class IV bikeways can reduce the level of stress, improve comfort for more types of bicyclists, and contribute to an increase in bicycle volumes and mode share.

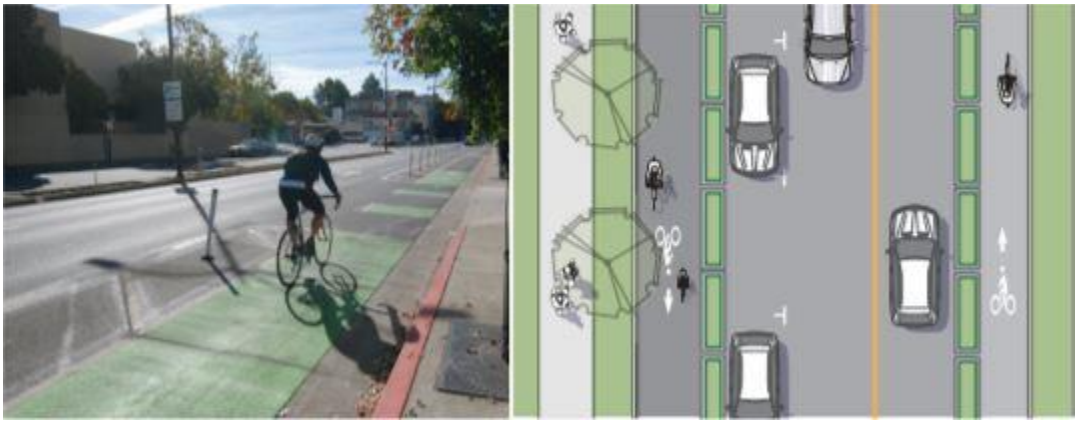

Figure #20: A Class IV Bike Lane with physical barriers to protect bikers in the lane.

The team chose to implement a Class IV bikeway because it was deemed to be the safest for all people using the street. The success with the implementations of the Class IV in the Pilot Design led to this decision. Class II was deemed to not be as safe as Class IV due to the small striping lane that any vehicle or bicyclist can travel over easily, especially with the increase in scooter ride-sharing apps that potentially bring riders that can make unwise decisions. Class I would not have been a suitable option in these existing conditions, as there is

not sufficient space to build a separated bike lane away from the street. With the dimensions found using CalTrans bike lane standards and the different existing conditions and standards factored in, three alternative designs were drawn out and analyzed.

Design #1

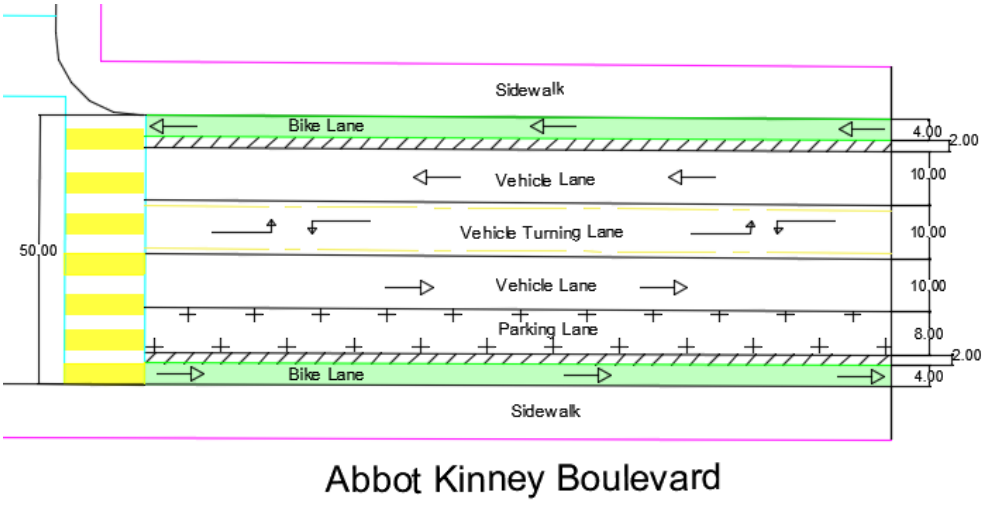

Figure #21: AutoCAD drawing of Alternative Design #1.

Design #1 features two Class IV bike lanes along each curb, measuring four feet wide with a parallel adjacent boundary lane with vertical bollards in the lane. The bottom curb also has an eight foot wide parking lane that can be used for emergency vehicles, quick loading and unloading and short-term parking. This design is similar to the Venice Pilot Design applied to Abbot Kinney Boulevard, with the exception of a missing parking lane along the top curb.

Design #2

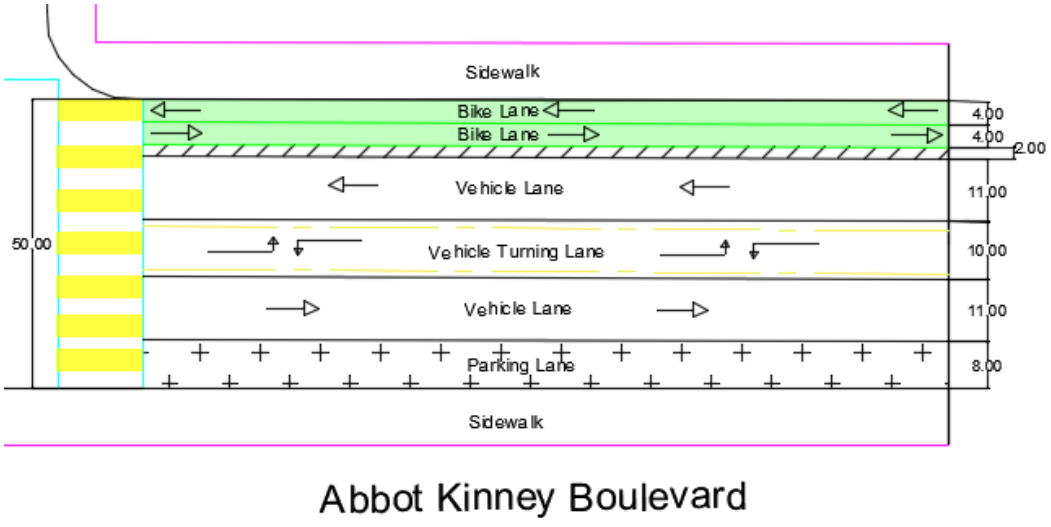

Figure #22: AutoCAD Drawing of Alternative Design #2.

Design #2 moved the bike lane that was on the bottom curb up to the top curb so that the lane is adjacent to the other bike lane traveling in the opposite direction. This design increased the bike lane space from four feet on each side to a larger single lane of eight feet, increasing the space allocated for bicyclists to overtake and pass other scooters or bicyclists. The vehicle lanes were increased to 11 feet as opposed to 10 in Design #1, giving a little more room for trucks and vans. Lastly, the eight foot parking lane is adjacent to the sidewalk, giving a loading space for the businesses' deliveries and shipments.

Design #3

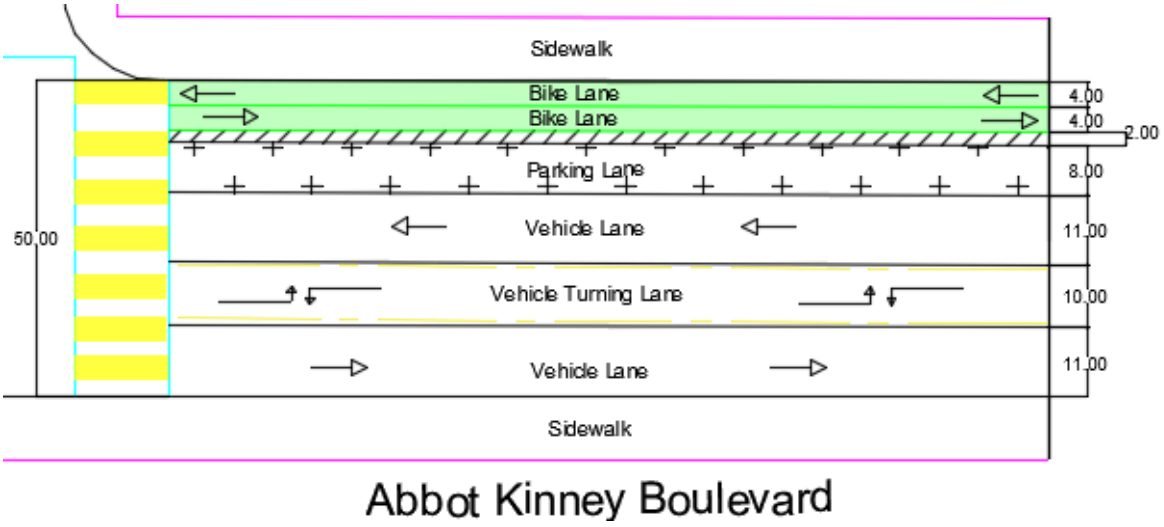

Figure #23: AutoCAD drawing of Alternative Design #3.

Design #3 was a combination of safety elements taken from Design #1 and Design #2. The bike lane design was taken from Design #2, with the eight foot wide double Class IV bike lane for both directions of bicycle and scooter traffic. It is then protected with a physical barrier to ensure the safety of those traveling in the bicycle lane. As seen in Design #1 and the Pilot design, there is an eight foot parking lane that is adjacent to the protection barrier lane. The vehicle lanes are 11 feet wide, the turning lane was 10 feet wide, and the protection barrier lane was two feet wide.

The team decided to use Design #2 because it provided the most safety for all parties involved: drivers, bicyclists, pedestrians, and the local businesses. The eight-foot bike lane proved to be a deciding factor between Design #1 and Design #2 because it allows people traveling in the bike lanes to have enough space to pass others. The team did not approve the idea of having a vehicle lane adjacent to the sidewalk and curb for safety reasons; in case a pedestrian accidentally steps into the street without looking first.

Figure #24: An example of the protected bike lane to be used in design.

The team used Synchro 10 traffic software to demonstrate how Abbot Kinney Boulevard would behave with an added bike lane by adjusting the conditions set in the initial condition simulation and adding new conditions. In the initial conditions at the intersection of Venice Boulevard and Abbot Kinney Boulevard, the team implied that since the bicyclists were sharing the lane with the vehicles, the bikes acted as vehicles and the conditions for the street were adjusted, such as the speed and volume. The speed of the vehicles in the simulation on Abbot Kinney Boulevard was reduced to 20 mph, the maximum speed of a bicyclist, while the existing speed limit is 30 mph. In the new simulation for the bike lane design, the bicyclists were then switched into simulated bicyclists and the speeds of the vehicles were increased back up to 30 mph, the speed limit. The simulation showed that the design did work in decreasing the congestion leading to the intersection, helping clear the queue lines behind the crosswalks at a faster rate than the initial conditions.

V. COST ESTIMATES

Following the determination of the final design, a cost estimate was necessary to ensure a low cost option. Seen in Table #1, each work item for the proposed design is quantified and priced along with alternative items that could be chosen at the discretion of the LADOT. For the chosen design, a total estimate of $106,680 was figured with a unit price of $14.91 per linear foot.

Table #1: Tabulated bare costs for proposed design work including unit costs for each work item.

No.	Line Item	Units	Quantity	Unit Cost	Total Cost
1	Site Survey & Layout	Lump Sum	--	--	$ 6,416
2	Road Stripe Removal	LF	11,025	$ 0.026	$283
3	Install Lane Partition Paint (Acrylic-based)	LF	11,025	$ 0.47	$ 5,182
4	Install Bike lane paint cover (Acrylic-based)	SF	57,240	$ 1.43	$ 81,853
5	Removable Bike lane delineators	EA	348	$ 19.96	$ 6,946
6	Signal Retiming plan	EA	3	$2,000	$ 6,000.00
Total					$106,680

The provided alternate in Table #2 includes having highly reflective thermoplastic paint as opposed to typical acrylic-based paint at the lane partitions and bike lane. This alternate work was considered in order to confirm if the safety improvement is relatively inexpensive compared to the total bare cost. This alternate estimate is approximately $114,431 with a unit price of $15.99 per linear foot.

Table #2: Alternate pricing considering highly reflective glass-bead thermoplastic paint at all new lane partitions and at bike lane paint cover instead of typical acrylic-based paint.

No.	Line Item	Units	Quantity	Unit Cost	Total Cost
1	Site Survey & Layout	Lump Sum	--	--	$ 6,416
2	Road Stripe Removal	LF	11,025	$ 0.0257	$283
3	Glass-bead Thermoplastic lane partitions	LF	11,025	$ 0.55	$ 6,064
	Glass-bead Thermoplastic bike lane cover	LF	57,240	$ 1.55	$ 88,722
5	Removable Bike lane delineators	EA	348	$ 19.96	$ 6,946
6	Signal Retiming plan	EA	3	$2,000	$ 6,000.00
Total					$114,431

Should the LADOT consider to pick up the proposed work, the team decided to propose alternate pricing options to emphasize the financial feasibility of considering the safety upgrades. A unit price is also included in Table #3 for any considerations of adding a crosswalk along the Abbot Kinney corridor to further upgrade pedestrian safety in the area. Installation of this crosswalk at unsignalized intersections includes thermoplastic crosswalk hatching with two call buttons and mounting brackets.

Table #3: Alternate work item to be considered at the discretion of party considering performing the work.

No.	Line Item	Units	Quantity	Unit Cost	Total Cost
1	Install signalized crosswalk	EA	1	$ 4,660.00	$ 4,660

VI. CONCLUSIONS

Overall, the team succeeded in presenting a viable alternative for the existing conditions at the Abbot Kinney Blvd. and Venice Blvd. corridors considered in the study. The main goals for this project were to improve, or at least maintain, the Level of Service (LOS) while improving upon the pedestrian and vehicle safety at a relatively low cost to the City. With the proposed bike lane design and improved signal timing plans, the LOS ultimately improved to a higher quality of the same LOS rating. The total bare cost for the project could also be considered inexpensive in comparison to the cost of the Pilot Program first implemented in the area. Although the new bike lane is expected to severely improve the level of safety for the cyclists, further studies must be conducted to confirm the magnitude of improvement.

APPENDIX

A. REFERENCES

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