University of California Transportation Center
UCTC-FR-2014-03

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Norman Wong, UCLA;
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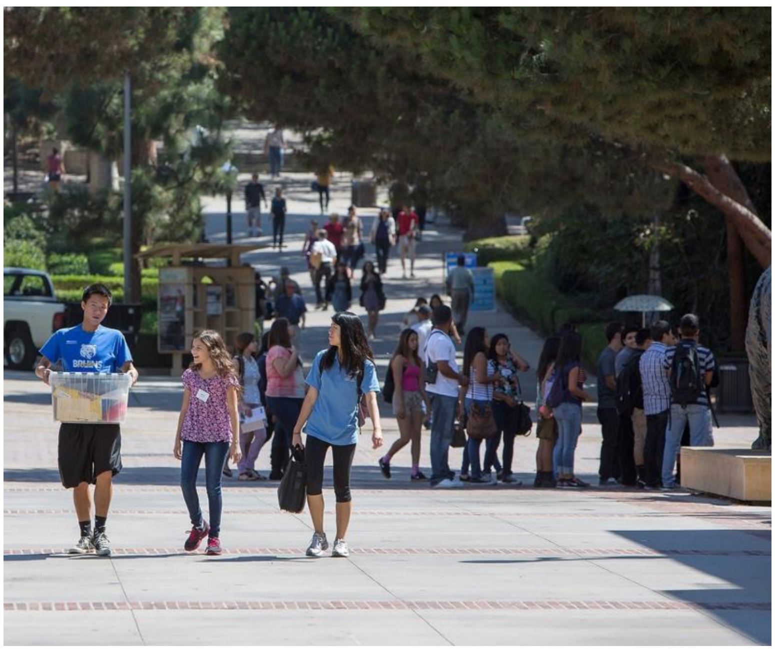
California State University, Sacramento

March 2014

DISCLAIMER



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ABSTRACT

Large college campuses generate considerable volumes of traffic in a variety of modes, and in greater numbers, than found in most U.S. settings. This setting presents a unique study opportunity, as well as a significant potential for conflicts between motorized and non-motorized users of the transportation system, surrounded as most campuses are by mixed-use environments e.g. retail, restaurant, entertainment and high-density residential facilities such as apartments and dorms. At the same time, university campuses are also typically characterized by a central core area where most trips are made by bicycle or on foot in larger volumes than off campus. This study examines the campus cores and peripheries of the University of California, Berkeley, the University of California, Los Angeles, and California State University, Sacramento, in order to compare safety risks for pedestrians and bicyclists among the three locations. Together, they comprise a wide number of characteristics in terms of setting, size, mode share and layout. The primary goal of the study is to identify possible relationships between pedestrian and bicycle crashes and the environments where these crashes occur, in terms of urban form, traffic characteristics and more. Using approaches from public health, planning, engineering and urban design, crash data (both police-reported and self-reported) and urban form data from all three campuses were examined, and the spatial and temporal distribution of pedestrian and bicycle crashes in each campus were studied. In order to account for under-reporting of pedestrian and bicycle crashes, an online survey was developed to solicit self-reported data from campus travelers about their crash experiences and perceptions about safety. This information was subsequently analyzed to identify collision hotspots reported by travelers on the three campuses, as well as hotspots indicated by reported crash data. The hotspots were studied in detail to identify the characteristics of the built environment that contributed to the incidence of pedestrian and bicycle crashes, and to suggest areas where design changes would be most likely to improve pedestrian and bicycling safety.

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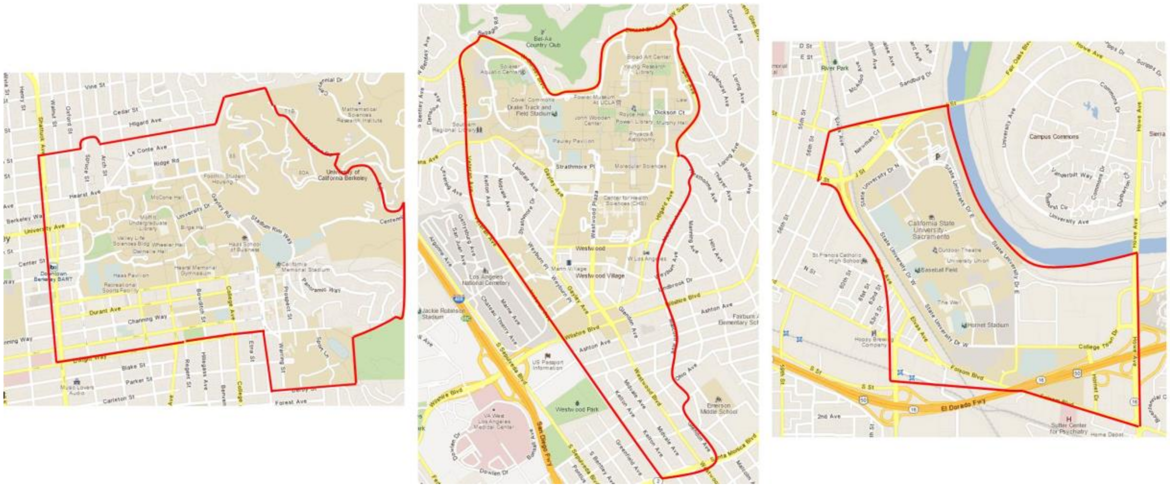
1. Introduction

Large college campuses generate considerable volumes of traffic in a variety of modes, and in greater numbers, than found in most U.S. settings. Such locations have characteristics similar to a central business district: experiencing heavy inbound trips in the morning and outbound trips in the afternoon and evening. While some of the trips involve a long commute by private vehicle or public transit, many originate from nearby locations and are better suited for walking and bicycling. The result is a multi-modal environment with high levels of walking and biking in conjunction with high levels of vehicle traffic, which increases the potential for conflict between the different transportation modes and may result in high risk and discomfort for pedestrians and bicyclists. Inside the campus boundary, motorized traffic is usually restricted or prohibited, and people generally walk or use bicycles at levels much higher than found in most U.S. settings.

Traffic safety is a primary concern for pedestrians and bicyclists as vulnerable road users. This concern is justified. In a collision between a vehicle and a pedestrian or bicyclist, the probability of being injured or killed for a pedestrian or a bicyclist is very high compared to a vehicle occupant. Data from California shows that pedestrians and bicyclists suffer 36.9 and 14.9 times more injuries, respectively, than they inflict when involved in a crash (Grembek 2010).

However, the poor quality of data about pedestrian and bicycle traffic safety compromises the ability to estimate the actual frequency and burden of crashes. Traffic crash data is typically based on police reports, but they are less likely to be filed if there is very little property damage, or if the crash did not involve a serious injury; both of which are often the case in pedestrian and bicycle crashes. As a result, researchers have found significant underreporting of the total number of crashes involving pedestrians and bicyclists (Reynolds et al. 2009; USDOT 2010).

This study compares pedestrian and bicycle safety on the campuses and the peripheries of the University of California, Berkeley (UCB), which is a rectangular, 1,232-acre parcel surrounded by a grid street network with easy access to the Bay Area Rapid Transit system (BART) and a dense network of buses; the University of California, Los Angeles (UCLA), a 419-acre parcel, which is surrounded by multiple arterials, one of which serves as a feeder for many campus trips leading to the main entrance on the south side of campus, and which is also served by an extensive bus network; and California State University, Sacramento (CSUS), which is an urban commuter campus occupying 300 acres with a large share of trips to and from campus made by private automobile. The maps of the campuses and their peripheries are shown in Figure 1.1.



(a) UCB **(b) UCLA** **(c) CSUS**

Figure 1.1 Study Area Boundary at the Three Campuses (Not to uniform scale).

The three campuses differ in other ways such as the size of the daytime populations, and the type and volume of traffic generated around the peripheries. Nearly 37,000 students and more than 16,000 faculty and staff travel to UCB. Overall, 75% of people either walk, use transit, or bicycle to and from campus, which is reflected in the 12,000 weekday riders who enter the Downtown Berkeley BART station, which is closest to campus, according to the BART Station Profile Study (2010).

UCLA's population is considerably larger with approximately 41,000 students and 26,000 faculty and staff. In 2011, pedestrian trips accounted for close to 13% of employee and 29% of student commutes, respectively. An additional 2% of the campus employees (staff and faculty) and nearly 5% of student commuters reported bicycling as their mode of choice (UCLA Transportation 2011). The UCLA campus has 13 gateways, the busiest of which is the Westwood Plaza at Le Conte Ave., which accounts for 22% of all trips to campus. An overwhelming majority of pedestrians and bicyclists enter the campus through this gateway.

CSUS is the smallest of the three campuses, with approximately 29,000 students and about 2,800 faculty and staff. Although traditionally an urban "commuter" campus with a high private automobile mode share (79%), the campus is also accessed by bicyclists (6%), pedestrians (7%), and transit users (8%). The Sacramento Regional Transit 65th Street Light Rail Station is a short walk from the campus.

While the three campuses generally involve the same type of activity and age groups, the urban environment, traffic characteristics and safety outcomes are different, providing the opportunity to draw comparisons to show how the different features may affect traffic safety outcomes.

1.1 Research Questions

The study will seek to address the following questions:

1. What is the spatial and temporal distribution of pedestrian and bicycle crashes in each study area and do the three campuses have significantly different crash rates?
2. Is there a significant level of underreporting of crashes involving bicyclists and pedestrians?

3. Are characteristics of the built environment contributing to the incidence of pedestrian and bicycle crashes?
4. What are the characteristics of campus locations perceived as hazardous by pedestrians and bicyclists?
5. What policy and design changes could increase pedestrian and bicycling safety on these campuses?
6. Which if any of these findings are generalizable and transferable to other campuses?

1.2 Data Sources

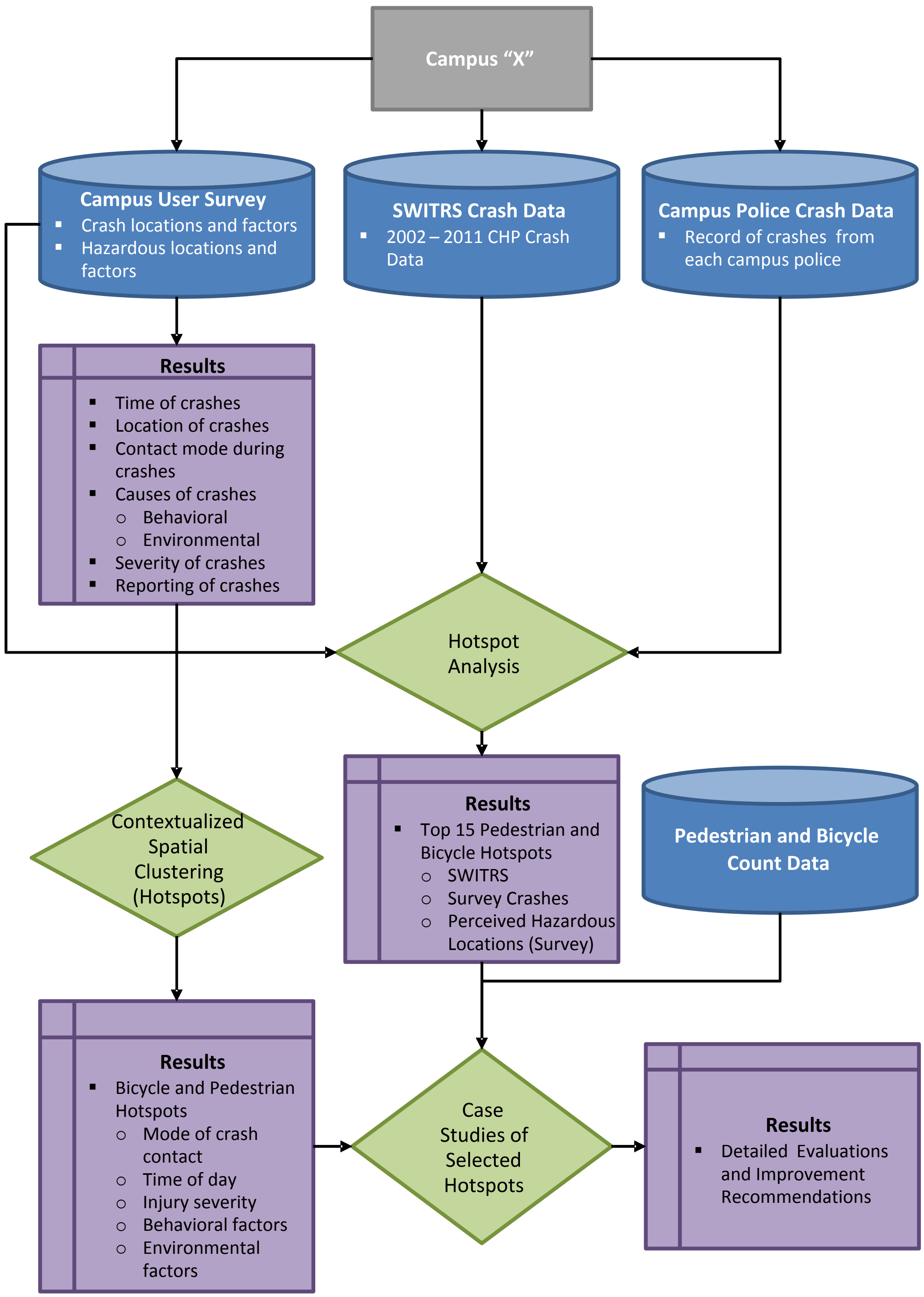
The main source of crash data within California is the Statewide Integrated Traffic Records System (SWITRS), which collects crashes reported by the California Highway Patrol. For this study, we supplemented SWITRS data with crashes reported by the three campuses' police units. Additionally, given the high level of underreporting of pedestrian and bicycle crashes in police records, an online survey was developed and administered at each campus which asked respondents about crashes they had experienced, as well as any locations within the study areas that were perceived as hazardous (described in detail in section 4).

Information was also collected about the built environment characteristics using available GIS layers and Google Earth imagery supplemented by field visits and researcher's direct knowledge of the area (presented in detail in section 6). Furthermore, automated and manual counts of pedestrians and bicycle volumes were also conducted at some locations (see section 6).

1.3 Layout of the Report

The section that follows gives a brief overview of the literature on pedestrian and bicycle safety. Emphasis is given to understanding the characteristics of the built environment that may contribute to or reduce pedestrian and bicyclist collisions. Section 3 provides descriptive data analysis of the spatial and temporal distribution of pedestrian and bicycle crashes on each campus using SWITRS data to determine if the distributions differ significantly across the campuses. Section 4 reports the findings of the online survey that was distributed to the three campuses. Section 5 presents a spatial analysis of the crashes and perceived hazardous locations at the three campuses as reported in the survey responses and subjects certain at-risk locations to further study. Section 6 undertakes individual case studies from each campus. Finally, section 7 discusses policy and design changes to increase pedestrian and bicyclist safety on and around campuses as well as recommendations about the transferability of the findings to other campuses.

Figure 1.2 helps illustrate the different data sources, analyses, and results discussed in the report in the form of a flowchart.


Campus "X"
Campus User Survey
Crash locations and factors
Hazardous locations and factors
SWITRS Crash Data
2002 – 2011 CHP Crash Data
Campus Police Crash Data
Record of crashes from each campus police
Results
Time of crashes
Location of crashes
Contact mode during crashes
Causes of crashes
Behavioral
Environmental
Severity of crashes
Reporting of crashes
Hotspot Analysis
Contextualized Spatial Clustering (Hotspots)
Results
Top 15 Pedestrian and Bicycle Hotspots
SWITRS
Survey Crashes
Perceived Hazardous Locations (Survey)
Pedestrian and Bicycle Count Data
Results
Bicycle and Pedestrian Hotspots
Mode of crash contact
Time of day
Injury severity
Behavioral factors
Environmental factors
Case Studies of Selected Hotspots
Results
Detailed Evaluations and Improvement Recommendations

2. Factors Influencing Crashes: A Brief Literature Review

Factors affecting crashes, including bicycle and pedestrian crashes, can generally be classified into two broad categories: 1) social and behavioral characteristics of the individuals involved in a crash; 2) environmental/urban form characteristics of the setting (e.g., road design, traffic speed, volume and mode share, physical and land use characteristics, etc.). In this study, the primarily focus was on the second group of factors related to bicycle and pedestrian crashes.

The traffic engineering field has examined the relationship between road characteristics (e.g. intersection geometry, street lighting, etc.) and pedestrian crashes in the past. A study in Seattle found that the highest number of pedestrian crashes (54%) occurred on main arterials, followed closely by minor arterials (39%) (Walgren, 2001). Studies have also examined the relationship between the availability of on-road bike lanes and bicycle crashes indicating that bike lanes may reduce injury rates by up to 50% (Lott and Lott 1976; Rodgers; 1997; Moritz 1996; 1998).

Exposure has been typically associated with crash risk. However, because of a general lack of data on pedestrian and bicycle volumes, analyses of the issue have not been able to include this important variable; instead, proxies such as population and employment density have been used with mixed findings. Nevertheless, even coarse measurements suggest that crashes involving pedestrians and bicyclists increase with increasing volumes as evident by the fact that 25% of the pedestrian collisions and nearly 20% of bicycle collisions[1] in the City of Berkeley occurred in the UCB campus periphery; an area of large pedestrian and bicycle volume. Yet the campus constitutes less than 6% of the city's area. Reducing pedestrian (and bicycle) crashes in campus periphery areas would go a long way toward reducing these crashes citywide.

Fewer studies have examined the effects of the built environment—the number, type, and positioning of streets, the number and type of intersections, the adequacy of street lighting, the condition of pavements and sidewalks, crosswalk markings, the type of land uses, etc.—on crashes. The indication is that certain physical and land use factors may amplify the risk of pedestrian and bicycle crashes, e.g. commercial/retail and high-density residential land uses tend to generate more risk for pedestrian collisions (Loukaitou-Sideris et al. 2007). However, such risk may be mediated with street-oriented buildings and pedestrian-friendly streetscapes (Dumbaugh and Li 2010).

Even fewer studies have examined the micro-environment of pedestrian or bicycle crash sites even though there is a strong indication that certain urban form elements may be enhancing or mitigating the risk of crashes. Examining hotspots of pedestrian crashes in Los Angeles, Loukaitou-Sideris et al. (2007) found that long blocks, multiple driveways, visual impairments for motorists and pedestrians, and relatively low levels of pedestrian lighting were related to higher incidence of crashes.

2.1 Important Built Environment Variables

Detailed data are required to assess the characteristics of the built environment that contribute to or prevent pedestrian and bicyclist collisions. A review of the existing literature suggests certain elements (e.g., crosswalks), which have been previously studied and provided a direction about what data should be collected for the analysis. Six different studies were considered to develop a comprehensive list of elements to collect and analyze for this study.

[1] Unless otherwise noted, "crashes" refers to those reported in official crash databases (in this case SWITRS).

In 2006, the Federal Highway Administration (FHWA) released a publication entitled "Pedestrian and Bicyclist Intersection Safety Indices" to help transportation engineers and planners develop safety indices for ranking intersection and street approaches. (Note: because these indices address only variables that can be placed in a street or roadway, sidewalks are not listed.) The FHWA divided the variables into two groups: pedestrian site variables and bicycle study site variables. The variables are shown in Table 2.1; some variables overlap (e.g., traffic control), while others are specific to their group.

Table 2.1 Federal Highway Administration (FHWA) List of Pedestrian and Bicycle Study Site Variables (2006)

Pedestrian Study Site Variables	**Bicycle Study Site Variables**
• Traffic control (presence and type) • Traffic speed • Traffic volumes • Number of intersection legs • One way or two way • Number of lanes • Crossing width • Crosswalks (presence and type) • Median islands (presence and type) • Pedestrian signals (presence and type) • Pedestrian-related signs • Right-turn curb radii • On-street parking • Right turn on red allowance • Street lighting • Surrounding development type	• Traffic control (presence and type) • Traffic speed • Traffic volumes • Number of intersection legs • One way or two way • Number of lanes • Bike facilities (bike lanes, wide curb lanes, etc.) • Left/right turn lane design (shared or exclusive) • Crossing width • Crosswalks (presence and type) • Median islands (presence and width) • Right-turn curb radii • On-street parking • Street lighting • Surrounding development type • Right turn on red allowance • Sight distance • Number of driveways on main street

In 2011, Kim and Catalano conducted a study to determine the environmental factors that contribute to pedestrian and bicyclist collisions in Riverside County, California. Some of the variables analyzed included signalized intersections, crosswalks, medians, streetlights, street signs, sidewalks, planters, driveways, bus stops, and bicycle facilities. The study revealed that median widths and types were important in improving the safety of pedestrians and bicyclists as they provide an emergency shelter, or refuge. Wide planters along sidewalks were also found to be an important element in protecting pedestrians on the sidewalks. On the other hand, driveways that interrupted the sidewalk were discovered to negatively affect safety as they created points of conflict between automobile and pedestrian and bicycle traffic.

In 2013, Schneider et al. examined pedestrian and bicyclist safety around the University of California, Berkeley. Some of the variables collected in the study are listed in Table .

Table 2.2 Variables in Schneider et al. (2013) Affecting Pedestrian and Bicyclist Safety

• Speed(represented by the posted speed limit) • Bicycle lane • Bicycle parking infrastructure • Crossing distance • Vehicle volumes • Number of travel lanes • Raised median • Number of operational bus stops • Off-street parking	• On-street parking • Number of right turn lanes on an intersection approach • Allowance of right turn on red • Type of traffic control • Sidewalks • Turning vehicles across bicycle movement • Surrounding land use types

Another study conducted by Schneider et al. in 2010 analyzed pedestrian crash risk at 81 intersections in Alameda County, California. Over 30 variables were considered for developing a statistical model. The statistically significant variables are listed in Table 2.. The final pedestrian crash model found the presence of a median, number of right-turn-only lanes, number of non-residential driveways, and number of commercial properties to affect pedestrian safety.

Table 2.3 Variables Affecting Pedestrian Safety Identified by Schneider et al. (2010)

• Type of traffic control • Crossing distance • Median • Number of travel lanes • Number of non-residential driveways	• Curb radius • Number of left/right turn only lanes • Right turn islands • Surrounding land use types • Number of bus stops

In 2012, MetroPlan Orlando adopted a Pedestrian Safety Action Plan to help reduce the number of pedestrian crashes around the metro area. Safety measures proposed included completing sidewalks, retrofitting existing medians or adding new ones and improving lighting at problematic locations. Along high-speed roads, it was proposed to install high emphasis crossings such as High intensity Activated crossWalK (HAWK[2]) beacons and Rectangular Rapid Flashing Beacons (RRFB[3]). Bulb-outs were also discussed as a method of shortening pedestrian crossing distance, improving pedestrian visibility and slowing vehicular traffic.

In 2007, Loukaitou-Sideris et al. used built environment data to study pedestrian crashes in the Los Angeles area. The study variables were grouped into three categories: street characteristics, sidewalk

[2] The HAWK is a pedestrian-activated warning device located on the roadside or on mast arms over midblock pedestrian crossings. The beacon head consists of two red lenses above a single yellow lens.
[3] RRFBs are user-actuated amber LEDs that supplement warning signs at un-signalized intersections or mid-block crosswalks. They can be activated by pedestrians manually by a push button or passively by a pedestrian detection system.

characteristics, and urban form and land use characteristics. Pertinent variables associated with each of these groups are shown in Table 2..

Table 2.4 Pedestrian Safety Variables Collected in Loukaitou-Sideris et al. (2007)

Street Characteristics	**Sidewalk Characteristics**	**Urban Form and Land Use**

• Number of lanes
• Direction
• Median
• Turning
  ○ U-turn allowed
  ○ Right on red allowed
  ○ Right turn lane presence
  ○ Left turn allowed
  ○ Left turn lane presence
• Marked crosswalk presence
	• Width (ft)
	• Number of driveways
	• Pedestrian volumes
	• Pedestrian warning sign
	• Street lighting
	• Pedestrian lighting
	• Visibility
	• Visual impairment
	• Sidewalk impediments
	• Midblock crossing
		• Block length
		• Bus stops
		  ○ Number of bus lines
		  ○ Number of stops close to an intersection
		  ○ Number of bus riders at a stop

Variables frequently used in the abovementioned reports were included in this study. Furthermore, additional consideration was given to less common variables to determine the feasibility of their inclusion. Table 2. shows the variables considered in this study.

Table 2.5 Variables in the Tri-Campus Study of Pedestrian and Bicyclist Safety

Intersection Characteristics	• Number of approaches • Number of approaches • Intersection type • Control type
Street Approach Characteristics	• Speed limit • Number of travel lanes • One way or two way • Left/right turn lane design • Right turn on red allowance • Right turn curb radius • Median • Right turn island • On street parking • Presence of parking on apron/sidewalk • Block length • Sidewalk presence • Sidewalk width • Driveway crossings • Street lighting • Pedestrian lighting

	• Commercial properties • Residential properties • Length • Pedestrian signal • Advanced yield or stop line • In pavement lights • Rectangular rapid flashing beacon • High intensity activated crosswalk (HAWK) beacon • Presence of marked or unmarked crosswalks • Visibility
Bike Facilities	• Bike facility type • Width • Turning vehicles across bicycle movement • Presence of bicycle parking
Bus Stops	• Location (farside or nearside) • Number of operational stops in a 24-hour period
Traffic Calming	• Type
Parking Lots and Garages	• Number of spaces

A few of the variables included in this study were not mentioned in the literature review but were included because the researchers determined them to be important and relevant variables (e.g., "presence of parking on apron/sidewalk").

3. Online Survey of the Three Campuses

A survey was conducted as part of a series of data collection activities that also involved pedestrian counts and mapping of urban form elements at specific locations (hotspots). The survey, named the Tri-Campus Travel Safety Survey, was the first phase of the data collection, and initial findings from the survey analysis informed subsequent data gathering, including the location of user-reported crashes and hazardous hotspots.

3.1 Survey Purpose

The Tri-Campus Travel Safety Survey had two primary goals: 1) to identify bicycling, pedestrian, and motor vehicle crash sites on three large urban university campuses (UC Berkeley, UCLA, CSU Sacramento) and their adjacent areas, and gather the details of where, how, and why these crashes took place via responses from survey participants (as opposed to official crash databases collected by law enforcement); and 2) to locate places perceived by pedestrians and bicyclists to be hazardous for them and identify the factors – environmental and behavioral – related to the perceived hazards.

3.2 Survey Design

An email containing a link to the survey was sent to all faculty, staff, and students of the three campuses who had university email accounts and had not asked to be excluded from email notifications. Any individual with access to the link could participate in the survey resulting in the inclusion of respondents who did not have campus email accounts. Each campus hosted its own survey site, though the surveys were identical in function and form. In addition to crash histories and perception of safety hazards, the survey collected information about respondents' age, educational status, their university status (student, faculty, staff or no affiliation) and other demographic information, as well as their history of travel to the campus and the modes used (see Appendix 1 for a copy of the complete survey).

The first section of the survey inquired about any crashes in which the respondent had been involved as a bicyclist, pedestrian, or a motorist in a defined geographical area around the campus (see Appendix 2 for campus maps and study boundaries). The options included various combinations of contact by mode (e.g. pedestrian-bicycle, bicycle-bicycle, pedestrian-vehicle, etc.) but did not include pedestrian-pedestrian or vehicle-vehicle crashes. Respondents were given the option to identify the approximate location of the incident using a Google Maps interface by dropping an icon after navigating, zooming in and using a satellite view of the area. The mapping feature allowed for collecting precise locational data (i.e., the specific latitude and longitude of the location of the crash). Follow-up questions asked respondents to provide details about where and when the crash had occurred, the parties involved, the factors that the respondents believed contributed to the crash, the severity of the crash, and whether it was reported to the police. In addition, respondents had the opportunity to provide a narrative description of the crash in an open-ended question format. Respondents who did not indicate experiencing any crashes on or around their respective campuses were immediately directed to the second section of the survey.

The second section of the survey asked respondents about locations on and around campus that they perceived as hazardous for bicyclists and pedestrians. Using the Google Maps interface, respondents indicated specific hazardous locations and the factors that made them dangerous. Respondents also reported whether they had experienced a "near miss" at the location or witnessed a crash or a "near miss." Respondents also had the opportunity to provide details about a "near miss" or crash by providing a detailed response to an open-ended question.

3.3 Survey Administration

The survey was administered at the three campuses in February and March of 2013. At UCLA and UC Berkeley, a notice about the survey was sent via email to all current students, faculty, and staff members through the Office of the Vice Chancellor for Research at each campus. At UCLA, the notice went out to a total of 42,751 email addresses and at UC Berkeley to more than 53,000 addresses. At CSU Sacramento, a notice of the survey was distributed through the Office of the Provost and went to 39,314 email addresses.

The survey analysis included 5,167 completed surveys, with the majority of respondents being current students (41.4%) and staff members (45.4%). The response rate at UCLA was 6.8%, at UC Berkeley just under 5%, and at CSUS only 1.0%. The surprisingly low response at CSUS rate may be attributable to the fact that the large majority of students, staff, and faculty still drive to this campus.

More than half of all survey responses, 56.5%, came from the UCLA survey; 36.4% came from Berkeley; and a smaller share, 7.2%, came from CSUS. Respondents reported a total of 662 separate crashes across the three campuses while bicycling, walking, or driving. Respondents also reported 4,837 hazardous locations: 2,537 from respondents on the UCLA campus, 1,819 from respondents on the UC Berkeley campus, and 481 from respondents on the CSUS campus. A detailed account of these hazardous locations is provided in Section 5. Table 3.1 summarizes the composition of respondents at the three campuses and the share of responses from all three campuses.

Table 3.1 Campus Affiliations of Survey Respondents

Affiliation	CSUS		UCB		UCLA		All Campuses	
Current student	43	11.6%	1077	57.3%	1017	34.9%	2137	41.4%
Current faculty member	73	19.7%	126	6.7%	363	12.4%	562	10.9%
Current staff member	173	46.8%	647	34.4%	1528	52.4%	2348	45.4%
No university affiliation	81	21.9%	29	1.5%	10	0.3%	120	2.3%
Total	370	7.2%	1879	36.4%	2918	56.5%	5167	100.0%

As Table 3.1 shows, a large portion of responses at CSUS (21.9%) came from individuals not affiliated with the university. It is assumed that the email sent to the campus community was likely forwarded by recipients to members of an active local bicycle advocacy group. A number of local bicyclists not affiliated with the CSUS use the American River Bicycle Trail, which runs adjacent to the CSUS campus.

3.4 Survey Challenges and Weaknesses

Depending on the number of crashes that a respondent wanted to report, the survey could become long and time-consuming to complete (up to 30 minutes), and no incentives were given to encourage participation. The response rates, however, were typical of many campus surveys. Notably, a number of respondents took the time to add detailed comments about crashes they had experienced or places on or around the campus that they perceived as hazardous.

A number of survey weaknesses may have led to some bias in the findings. The survey primarily targeted all current students, faculty members, and staff at the three campuses. The online survey format facilitated recruitment through the primary email contact list of the universities. However, while the blanket emails from the university central administrations ensured a wide distribution of the survey to the majority of the campus communities, they mostly missed people who travel to campus for specific purposes but are not affiliated with it (with the exception of CSUS as explained previously).

Survey respondents were self-selected, which may have led to the over-representation of some groups and the under-representation of others. It is, for example, possible that some people, such as bicycle advocates, were more motivated to respond than others. Additionally, people who had experienced one or more crashes may have been more motivated to respond.

Since the survey asked people to remember certain details of past crashes, the issue of selective memory—remembering some but not all crash details—posed a challenge. It is likely that people remembered more clearly the occurrence and details of recent crashes than less recent ones. Lastly, the survey did not particularly focus on skateboarding crashes, and some open-ended responses revealed that a number of crashes involved skateboarders, particularly on the UCLA campus.

3.5 Survey Findings

Respondents reported 662 crashes on the three campuses: 371 at UC Berkeley, 228 at UCLA, and 63 at CSUS. More than half (52.6%) of all crashes occurred while the respondent was bicycling, 41.7% while walking, and 5.7% while driving (Table 3.2). The majority of reported crashes (56.0%) by all modes were reported on or around the UC Berkeley campus, 34.4% were reported on or around the UCLA campus, and the remaining 9.5% were reported on or around the CSUS campus (Table 3.3).

Table 3.2 All Crashes by Mode

Respondent Mode Type	**Crashes**	**Percent of Total**	**Per 100 Respondents**
Biking	348	52.6%	23.1
Walking	276	41.7%	5.5
Driving	38	5.7%	0.9
Total	662	100.0%	6.1

Table 3.3 All Crashes by Campus

Campus	**Crashes**	**Percent of Total**	Per 100 Respondents
CSUS	63	9.5%	17.0
UCB	371	56.0%	19.7
UCLA	228	34.4%	7.8
Total	662	100.0%	12.8

Tables 3.2 and 3.3 also show the crash responses as normalized rates (crashes reported per 100 respondents reporting crashes). Bicycling is the mode with the highest crash rate at 23.1 crashes per 100 respondents reporting crashes. Although walking accounted for more than two-fifths of reported crashes, only 5.5 out of 100 pedestrians had experienced a crash. Thus, the crash rate for bicycling was over four times that of walking. Driving crashes occurred at a rate of 0.9, less than one crash per 100 respondents. (Note: a "driving crash" involved someone who as a driver had a crash with a pedestrian or a bicyclist). Among UC Berkeley and CSUS respondents, the number of crashes reported per 100 respondents was fairly close at 19.7 and 17.0, respectively. Crashes reported on the UCLA campus made up over one-third of the reported crashes on all three campuses, but the rate per 100 respondents was the lowest at 7.8.

3.5.1 Time of Crashes

A high percentage of the respondents indicated that they did not remember the year the crash occurred (14.9% of respondents at UCLA, 10.2% at UC Berkeley, and 7.9% at CSUS) suggesting that the recollection of specific crash details was challenging. Of the respondents who did report the year of their crash, 36.4% reported that the crash had occurred in 2012, the year prior to the survey administration, with another 16.4% of reported crashes taking place in 2011. About one-third (33.0%) of all reported crashes occurred prior to 2011. The reported crashes by mode and campus show a similar pattern overall with the majority of crashes occurring in 2012 and 2011, but with several exceptions: over half of bicycling and driving crashes on the CSUS campus and driving crashes at UC Berkeley occurred before 2011[4] (Figure 3.1).

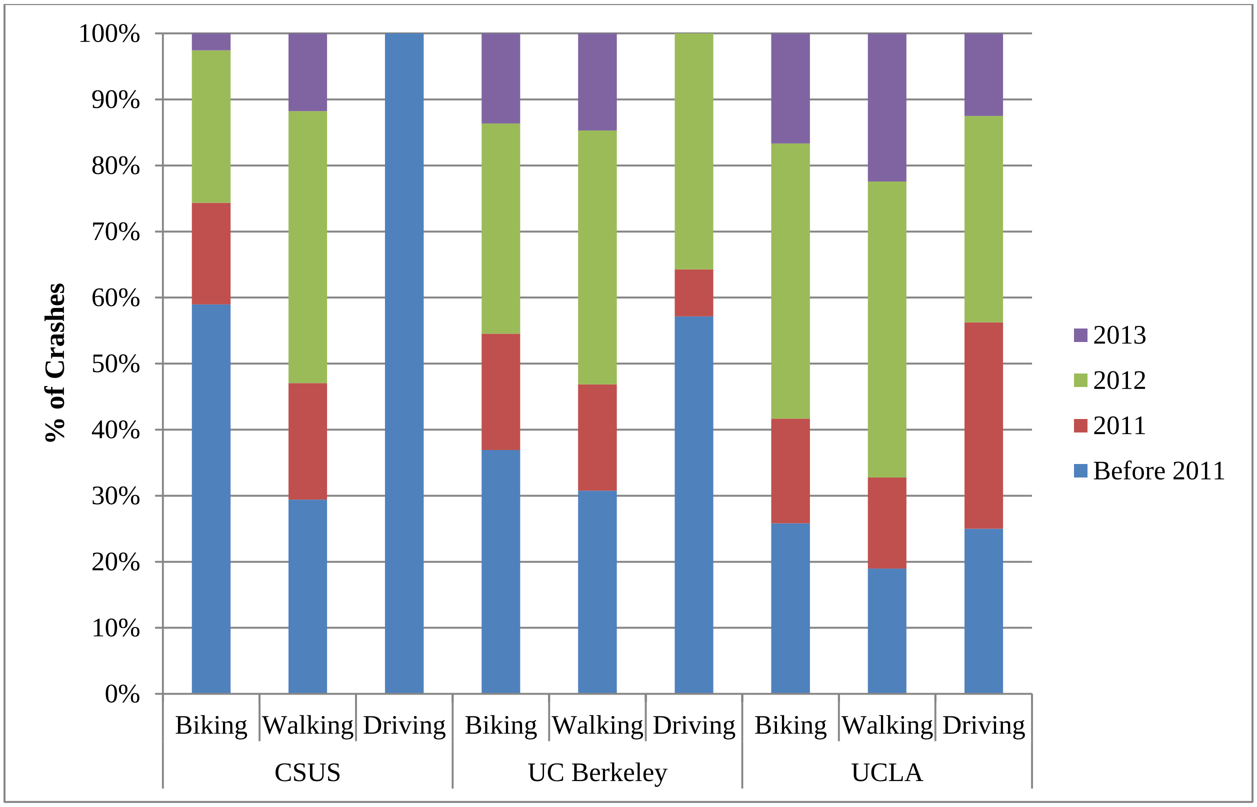


Figure 3.1 Crashes by Year for All Modes and All Three Campuses

[4] Only two driving crashes were reported at CSUS and both occurred before 2011 (100% of crashes in that category).

The concentration of crashes in the more recent years was likely a reflection of two factors. First, the survey sample drew from current students, faculty, and staff. Students as a demographic group have a limited tenure on campus (generally four to five years for undergraduates and as little as two or three if transferring from a local community college), and their more recent time on the campus is likely reflected in more recent experiences with crashes. Second, the issue of selective memory discussed earlier was also a likely influence in respondents' reporting of more recent crashes for which they recall the event and related details more readily.

A significant percentage of respondents on all three campuses could not remember the month in which they were involved in a crash: 46.2% at UCLA, 39.8% at UC Berkeley, and 25.8% at CSUS. For respondents who did report the month of their crash, the number of crashes was lowest during the late spring and summer months: May (4.1% of all crashes), June (5.4%), July (3.1%), and August (4.1%). Respondents reported the highest numbers of crashes in February (17.3%) and October (14.9%) (Figure 3.2). This finding was not surprising because many respondents (especially students and faculty) generally do not travel to their campuses as frequently during the summer months. Therefore, the number of bicyclists, pedestrians, and drivers would be fewer during the summer than during the months when regular classes are in session.

The low percentage of crashes during summer months remained generally consistent across modes and across the three campuses (Figure 3.2). For example, UC Berkeley reported the highest number of bicycling crashes (123 total), and most occurred in February and September[5] (17.9% of all crashes happened in these two months), while less than 5% occurred during the summer months. At UCLA, with 80 reported bicycling crashes for which the month of the crash was specified, the highest numbers occurred in February and October (16.3% of crashes occurred in these two months). Respondents also reported that over one-fifth of pedestrian crashes at UC Berkeley and UCLA happened in February (20.2% and 20.6%, respectively). At UC Berkeley, however, only 3.4% of crashes occurred during the summer months and at UCLA only 2.9%. The only instance of a higher percentage of crashes during the summer months compared to the school year were bicycle crashes on the CSUS campus (14.7%), but the very small number of the crashes (five) rules out attributing any statistical significance to this finding.

Most respondents reporting crashes did recall the approximate time of day of their crash – only about 4% to 8 % of respondents on each campus reported not remembering the time of the crash (5.3% of UCLA respondents, 4.3% of UC Berkeley respondents, and 7.9% of CSUS respondents). Of the respondents who reported the time of their crash, the majority (86.9%) reported being involved in pedestrian crashes during the morning, afternoon, or early evening hours (between 7:00 AM and 6:00 PM). More than eight out of 10 (83.8%) of driving crashes occurred during these times and almost three-quarters of bicycling crashes (72.4%) as well. This finding was not surprising since most classes take place during these times. While a smaller percentage of crashes occurred in the evening (6:00 PM to 11:59 PM), almost a quarter (23.2%) of bicycle crashes and 16.2% of driving crashes occurred during this time. The temporal distribution of reported crashes reflects the general travel patterns on and around the campus and the peak morning and

[5] UC Berkeley and CSUS start classes in late August, so September is the first full month of classes for the new term for this campus. UCLA starts classes in late September, so October is the first full month of classes for this campus.

afternoon travel times when most students, faculty, and staff travel to and from the campuses.

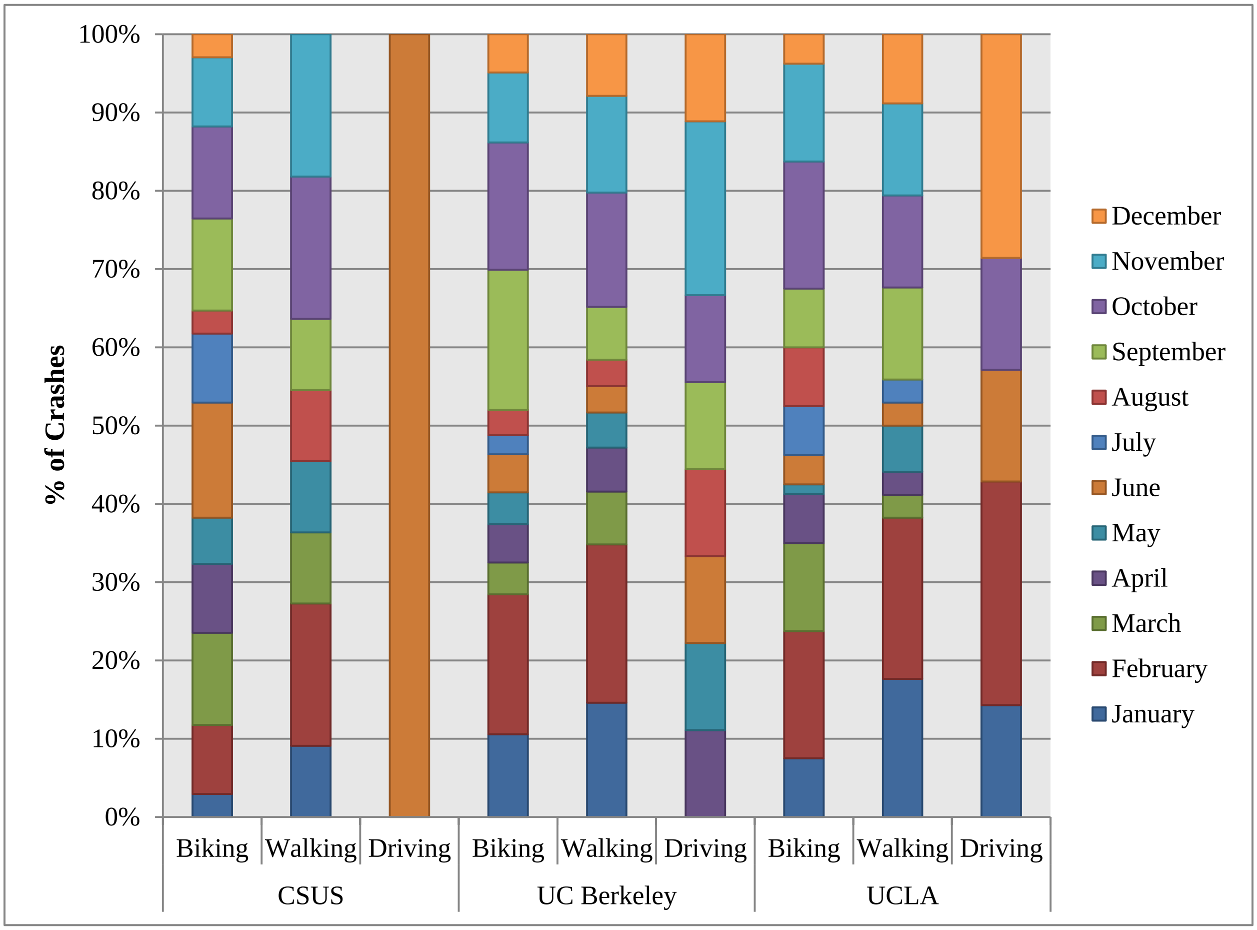


Figure 3.2 Month of Crashes for All Modes and All Three Campuses

Figure 3.3 shows the reported times of day of crashes on the three campuses and by the three modes of travel. Similarly, the majority of crashes occurred in the morning and afternoon. On the CSUS campus, a higher percentage of crashes by the three modes occurred during the morning hours. At UC Berkeley, most crashes occurred in the afternoon. Almost a third (31.1%) of bicycling crashes on the UCLA campus occurred during the evening hours; the highest percentage during this time for any of the modes on the three campuses.

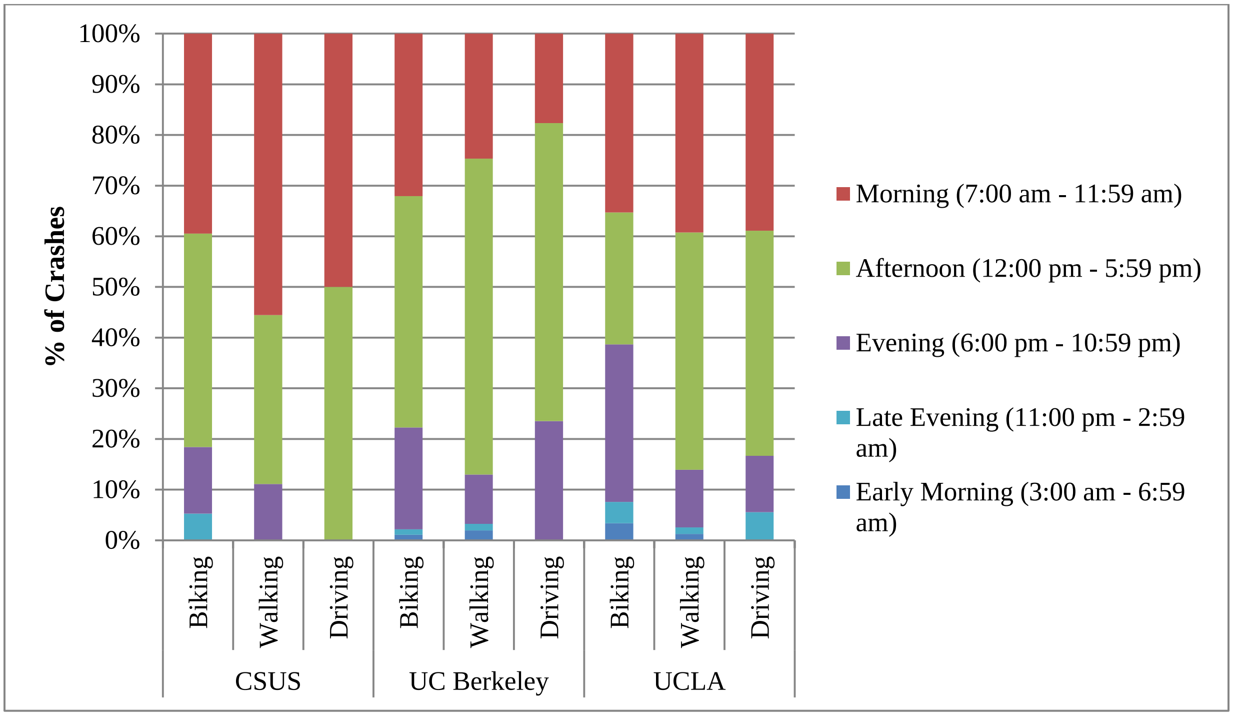


Figure 3.3 Time of Day of Crashes for All Modes and All Three Campuses

3.5.2 Location of crashes

Table 3.4 shows the distribution of crash sites by campus and mode. The majority of bicycling crashes at UCLA and UC Berkeley (42.1% and 35.3%, respectively) occurred on roadways. The second most common location of reported crashes involving bicycles on these campuses were intersections: UCLA (19.8% of reported crashes) and UC Berkeley (17.6%). CSUS differed from the other two campuses in that the highest percentage of bicycling crashes occurred on multi-use paths (32.5%). However, roadways were also the sites of a significant percentage of crashes (27.5%). The most common intersection type for bicycling crashes on or near the three campuses was at signalized intersections: UCLA (14.0%), UC Berkeley (7.5%), and CSUS (7.5%) as shown in Figure 3.4. Unsignalized intersections accounted for 7.5% of bicycling crashes at CSUS.

Table 3.4 Location of Crashes for All Modes and All Three Campuses

Location	CSUS			UC Berkeley			UCLA		
	Biking	Walking	Driving	Biking	Walking	Driving	Biking	Walking	Driving
Sidewalk	2.5%	28.6%	0.0%	15.0%	23.4%	0.0%	9.9%	34.1%	0.0%
Driveway	0.0%	4.8%	0.0%	3.7%	0.6%	11.8%	5.0%	5.7%	0.0%
Roadway	27.5%	0.0%	0.0%	35.3%	4.8%	35.3%	42.1%	2.3%	31.6%
Mid-block Crossing	5.0%	9.5%	0.0%	0.5%	5.4%	5.9%	0.0%	0.0%	0.0%
Intersections(all types)	17.5%	4.8%	100.0%	17.6%	36.5%	29.4%	19.8%	40.9%	47.4%
Bike Lane on Road	0.0%	0.0%	0.0%	7.5%	0.0%	5.9%	11.6%	1.1%	0.0%
Separated Bike Path	2.5%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	1.1%	0.0%
Multi-use Path	32.5%	47.6%	0.0%	16.0%	23.4%	0.0%	4.1%	1.1%	0.0%
Parking Lot	2.5%	0.0%	0.0%	0.0%	0.6%	11.8%	2.5%	1.1%	5.3%
Parking Structure	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	2.3%	10.5%
Other	10.0%	4.8%	0.0%	3.7%	5.4%	0.0%	4.1%	10.2%	5.3%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

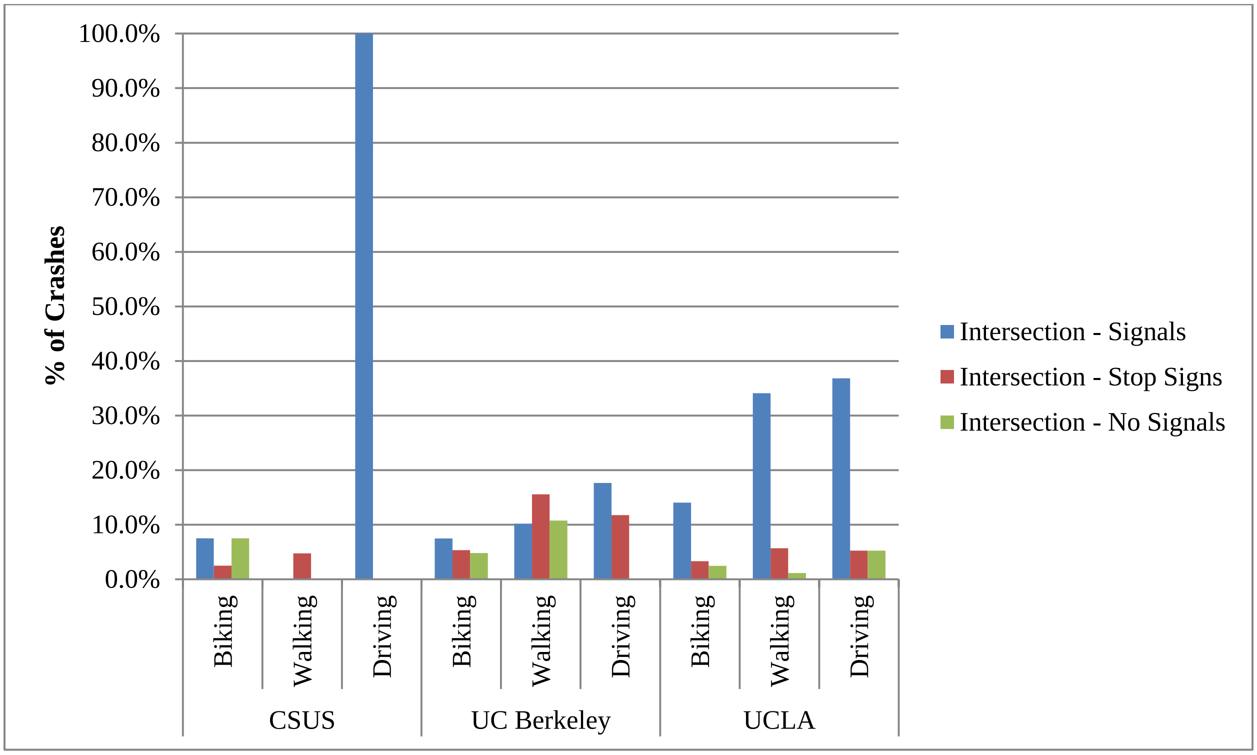


Figure 3.4 Location of Crashes by Intersection Type for All Modes and All Three Campuses

On the CSUS campus, most pedestrian crashes (47.6%) were reported to have occurred on multi-use paths; at Berkeley multi-use paths were the site of the same share of pedestrian crashes as sidewalks (23.4%), which were tied for the most common site for pedestrian crashes; by contrast, only 1.1% of crashes at UCLA occurred on multi-use paths. The next most common location for crashes reported by pedestrians on and around the CSUS campus was sidewalks where 28.6% of the crashes occurred. At UCLA and UC Berkeley, sidewalks were also a common site for crashes with over one-third (34.1%) of the reported crashes at UCLA occurring on sidewalks and 23.4% at UC Berkeley. Intersections were the most common location of pedestrian crashes at UCLA (40.9%) and UC Berkeley (36.5%). The two campuses differed in terms of the type of intersection where the most pedestrian crashes occurred – at UCLA, most pedestrian crashes (34.1%) occurred at signalized intersections while at UC Berkeley the most common site was stop-controlled intersections (15.6%).

3.5.3 Contact Made During Crashes

The sites of most collisions of pedestrians or bicyclists with autos on and around the three campuses were intersections (47.4% for UCLA, 29.4% for UC Berkeley, and the two reported crashes with autos at CSUS). In the case of the two CSUS crashes, both occurred at signalized intersections. This type of site was also the most common for crashes involving pedestrians or bicyclists and autos at UCLA (36.8%) and UC Berkeley (17.6%). Roadways were also common sites for crashes involving vehicles on and around the UC Berkeley (35.3%) and UCLA (31.6%) campuses. (See Figure 3.5.)

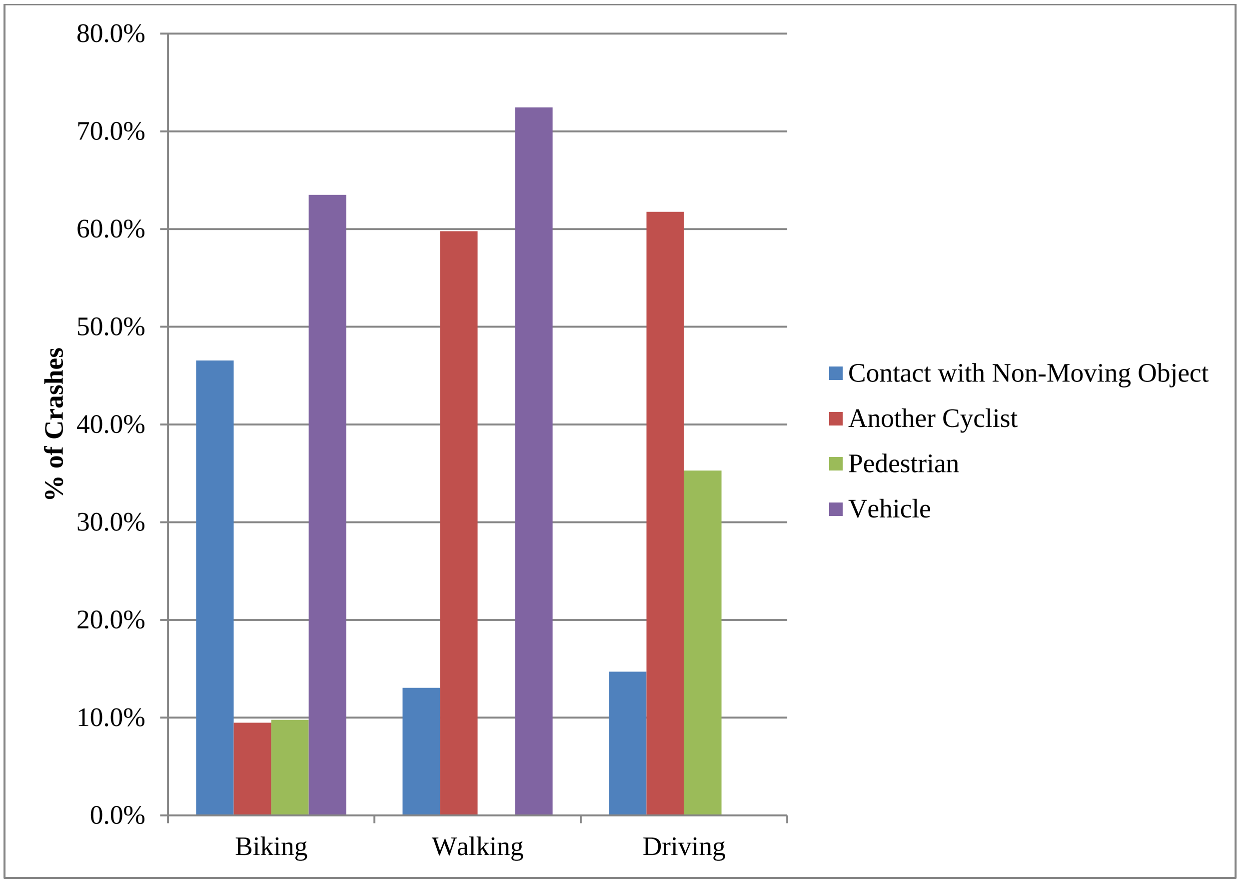


Figure 3.5 Contact Made during Crashes for All Three Modes at All Three Campuses

3.5.4 Causal Factors of Crashes

The survey also explored the primary factors that respondents said contributed to their crashes. Two major categories of factors were explored: behavioral and environmental.

Behavioral

The survey first asked respondents reporting a crash to indicated the behavioral factors for all parties involved that they believed contributed to the crash. The factors from which they could choose included those affecting or impairing the cognitive abilities of bicyclists, pedestrians, and drivers (such as intoxication or fatigue), violations of traffic regulations (such as illegal crossings or ignoring traffic controls), and dangerous traffic maneuvers (such as avoiding obstructions or emerging from behind a vehicle) (Table 3.5). Inattention was the most commonly reported behavioral factor for all modes at all three campuses: 56.6% of bicyclists in bicycling crashes, and 60.5% of pedestrians and drivers. For bicyclists, excessive speed was involved in almost one-quarter of crashes (23.3%), while trying to avoid a bicyclist, pedestrian, or vehicle was a factor in 22.1% of crashes. For respondents involved in pedestrian crashes between bicyclists or autos, excessive speed was reported more than twice as often (48.9%), followed by failure to yield to the right-of-way (45.7%). Respondents involved in crashes as drivers reported passing another vehicle or improper lane usage as a factor in 23.7% of the crashes while illegal crossings and excessive speed were factors in 15.8% of crashes (Figure 3.6).

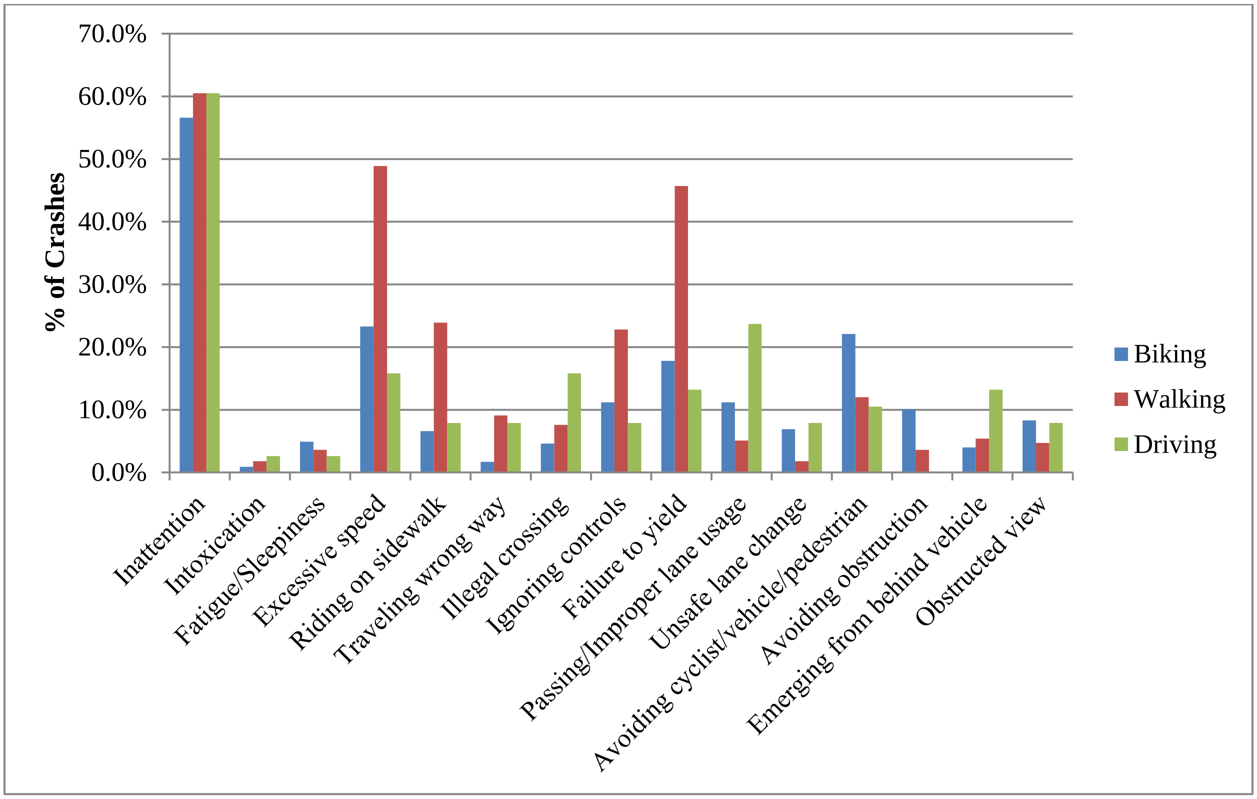


Figure 3.6 Behavioral Causes of Crashes for All Three Modes at All Three Campuses

Table 3.5 presents a breakdown of responses relating to behavioral causes of crashes from the three campuses showing some differences. Inattention was reported in 68.2% of pedestrian crashes at UCLA, versus the three-campus average of 56.6%. Excessive speed was a factor in 71.4% of pedestrian crashes on the CSUS campus versus the three-campus average of 48.9%. At UC Berkeley, excessive speed was a factor in 29.4% of driving crashes, but only 5.3% at UCLA. (With only two reported driving crashes, CSUS was not included in this analysis.) On all three campuses, failure to yield was a significant factor in pedestrian crashes—52.4% at CSUS, 52.3% at UCLA, and 41.3% at UC Berkeley.

Table 3.5 Behavioral Causes of Crashes (Percent of Respondents Reporting as a Factor) at Each of the Three Campuses for All Three Modes

	CSUS			**UC Berkeley**			**UCLA**		
	Biking	**Walking**	**Driving**	**Biking**	**Walking**	**Driving**	**Biking**	**Walking**	**Driving**
Inattention	50.0%	61.9%	0.0%	51.3%	56.3%	64.7%	66.9%	68.2%	63.2%
Intoxication	2.5%	0.0%	0.0%	0.5%	1.2%	5.9%	0.8%	3.4%	0.0%
Fatigue/Sleepiness	2.5%	4.8%	0.0%	5.9%	2.4%	0.0%	4.1%	5.7%	5.3%
Excessive speed	35.0%	71.4%	0.0%	23.5%	47.9%	29.4%	19.0%	45.5%	5.3%
Riding on sidewalk	7.5%	23.8%	0.0%	3.2%	19.2%	0.0%	11.6%	33.0%	15.8%
Traveling wrong way	2.5%	4.8%	0.0%	1.6%	7.8%	5.9%	1.7%	12.5%	10.5%

Illegal crossing	0.0%	0.0%	0.0%	4.8%	10.8%	23.5%	5.8%	3.4%	10.5%
Ignoring controls	22.5%	28.6%	0.0%	7.5%	18.0%	11.8%	13.2%	30.7%	5.3%
Failure to yield	25.0%	52.4%	0.0%	16.6%	41.3%	0.0%	17.4%	52.3%	26.3%
Passing/Improper lane usage	12.5%	4.8%	0.0%	8.6%	3.0%	23.5%	14.9%	9.1%	26.3%
Unsafe lane change	2.5%	0.0%	0.0%	4.8%	1.2%	11.8%	11.6%	3.4%	5.3%
Avoiding cyclist/vehicle/pedestrian	30.0%	19.0%	0.0%	24.1%	12.0%	11.8%	16.5%	10.2%	10.5%
Avoiding obstruction	15.0%	9.5%	0.0%	8.0%	3.0%	0.0%	11.6%	3.4%	0.0%
Emerging from behind vehicle	2.5%	4.8%	0.0%	4.3%	6.0%	5.9%	4.1%	4.5%	21.1%
Obstructed view	27.5%	4.8%	0.0%	5.3%	6.0%	11.8%	6.6%	2.3%	5.3%

Environmental

The survey also asked respondents about environmental factors that they believed contributed to their crashes. The factors included inadequately maintained infrastructure (such as cracked or uneven sidewalks or roadways) and poorly designed elements of the built environment (such as narrow sidewalks or bike lanes).

Across the three campuses, narrow bike lanes (23.0%) and cracked or uneven roadways (16.7%) were the most frequently reported environmental factors related to bicycling crashes (Figure 3.7). Two sidewalk-related features were cited as causes of one in 10 bicycle crashes: cracked and uneven sidewalks (10.9%) and lack of sidewalks (11.2%). For pedestrian crashes, respondents reported that narrow sidewalks were a factor 6.9% of the time, close to cracked or uneven roadways (6.2%). For driving crashes, narrow or interrupted bike lanes were a factor in 10.5% of crashes, and obstructed bike lanes in 7.9%.

In general, the environmental factors included in the survey were cited less often than the behavioral factors previously discussed. However, a significant percentage of respondents (over half of those involved in bicycling and driving crashes and 42.1% in pedestrian crashes), named an array of additional environmental factors other than the ones listed in the closed-ended survey responses.[6] These factors ranged from poorly designed or maintained bicycling infrastructure, to poorly located bicycle facilities or features, lack of bike lanes or paths, poor signage, crowded pathways, debris on roads or paths, construction, traffic, and lack of traffic signals or controls. The variety of specific environmental conditions and factors reported suggested that these issues can be very context-specific and may involve both fixed design characteristics (such as bicycling facilities or signage) as well as conditions that vary by time or location (such as traffic or construction).

Narrow bike lanes were a factor in about one-quarter of bicycling crashes on the three campuses: 25.0% at CSUS, 21.9% at UC Berkeley, and 24.0% at UCLA (Table 3.6). On the UCLA campus, narrow bike lanes were a factor in 21.1% of driving crashes, but were not reported as a contributing factor on the other two campuses. For bicycling crashes at CSUS, driveways interrupting the sidewalk and poor lighting were reported as factors for 22.5% of crashes. UCLA respondents reported cracked and uneven roadways as a factor in 22.3% of bicycling crashes as compared with 14.4% and 10.0% at UC Berkeley and CSUS, respectively.

[6] These environmental factors are listed as "other" in Figure 3.7

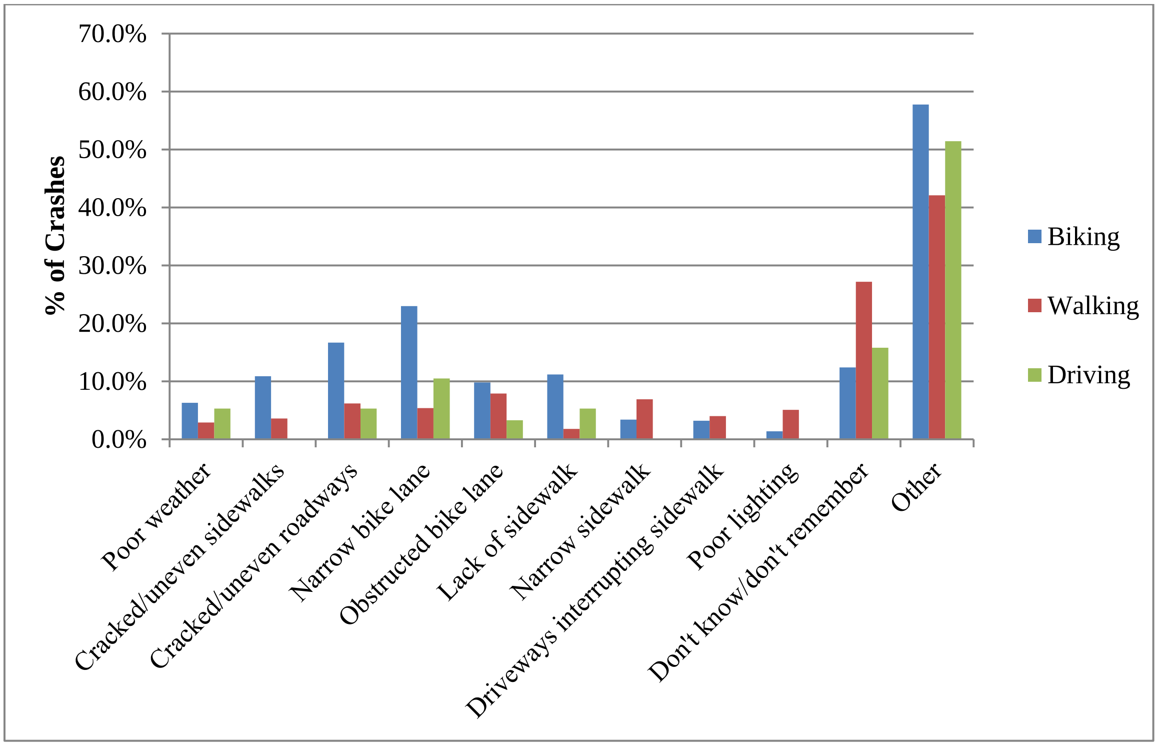


Figure 3.7 Environmental Causes of Crashes for All Three Modes at All Three Campuses

Table 3.2 Environmental Causes of Crashes (Percent of Respondents Reporting as a Factor) at Each of the Three Campuses for All Three Modes

	CSUS			**UC Berkeley**			**UCLA**		
	Biking	**Walking**	**Driving**	**Biking**	**Walking**	**Driving**	**Biking**	**Walking**	**Driving**
Poor weather	7.5%	0.0%	0.0%	8.0%	4.8%	5.9%	3.3%	0.0%	5.3%
Cracked/uneven sidewalks	12.5%	0.0%	0.0%	12.3%	3.0%	0.0%	8.3%	5.7%	0.0%
Cracked/uneven roadways	10.0%	0.0%	0.0%	14.4%	6.0%	11.8%	22.3%	8.0%	0.0%
Narrow bike lane	25.0%	0.0%	0.0%	21.9%	6.6%	0.0%	24.0%	4.5%	21.1%
Obstructed bike lane	7.5%	4.8%	0.0%	1.6%	8.4%	0.0%	5.0%	4.5%	0.0%
Lack of sidewalk	0.0%	4.8%	0.0%	3.7%	4.2%	0.0%	3.3%	3.4%	0.0%
Narrow sidewalk	0.0%	0.0%	0.0%	0.5%	4.2%	0.0%	3.3%	8.0%	0.0%
Driveways interrupting sidewalk	22.5%	0.0%	0.0%	7.5%	3.0%	5.9%	9.1%	4.5%	10.5%
Poor lighting	22.5%	0.0%	0.0%	8.0%	1.8%	5.9%	12.4%	2.3%	5.3%
Don't know/don't remember	22.5%	19.0%	0.0%	14.4%	25.7%	23.5%	9.1%	31.8%	10.5%
Other	55.0%	76.2%	100.0%	39.6%	49.1%	58.8%	45.5%	40.9%	42.1%

3.5.5 Severity of Crashes

The severity of reported crashes across the three campuses varied by mode, with bicycle crashes resulting in the most injury in most categories. Most crashes resulted in non-serious injuries[7], or none at all (Table 3.7). About 10% (10.3%) of bicycling crashes resulted in either serious or very serious injuries. On the other hand, almost half of bicycling crashes (47.4%) resulted in non-serious injuries and 31.4% resulted in no injury. In the case of pedestrian crashes, the majority (56.2%) resulted in no injuries or property damage, while 22.1% resulted in minor injuries. In 71.1% of driving crashes, no injuries or property damage was involved, while 21.1% of the crashes involved some property damage but no injuries.

Table 3.3 Injury Severity of Crashes (Percentage of Reported Crashes) for All Three Modes at All Three Campuses

Injury Severity	Biking	Walking	Driving
Very serious	2.0%	0.0%	0.0%
Serious	8.3%	2.5%	0.0%
Not serious	47.4%	17.8%	2.6%
Minor	10.9%	22.1%	5.3%
No injuries, property damage	3.2%	1.4%	21.1%
No injuries, no property damage	28.2%	56.2%	71.1%
Total	100.0%	100.0%	100.0%

3.5.6 Reporting of Crashes

Very few crashes were reported to either the campus police or local law enforcement: at CSUS, more than nine out of 10 crashes involving all modes were not reported (Figure 3.8). The same was true at UCLA and UC Berkeley for bicycling and pedestrian crashes. At these two campuses, driving crashes were the crashes most often reported to the police, but the reporting rate was still low: 17.6% at UC Berkeley and 10.5% at UCLA.

When the respondents were asked to indicated all the reasons for failing to report crashes to the authorities, the most common response for all crash types, for all modes and on all the campuses was that the crash was minor (72.6%), or the respondents did not believe that the police would do anything about it (25.8%). (Figure 3.9 shows the proportion of reported and non-reported crashes.) For example, 66.5% of respondents at UC Berkeley who had experienced pedestrian crashes said that the crash was minor and that was why they did not report it to the police. Over one-quarter (26.8%) said that they did not believe the police would do anything. Similarly, at UCLA, over two-thirds of respondents (69.0%) involved in pedestrian crashes said that they did not report the crash to the authorities because it was minor, but a high percentage (44.8%) also did not think the police would do anything. About one-fifth of respondents reporting bicycling crashes on each of the three campuses said they did not report the crash because no one else was involved.

[7] Very Serious (overnight hospital stay); Serious (hospital visit, not overnight); Not serious (scrapes and bruises); Minor (no visible scrapes or bruises); No injuries, property damage only; No injuries, no property damage

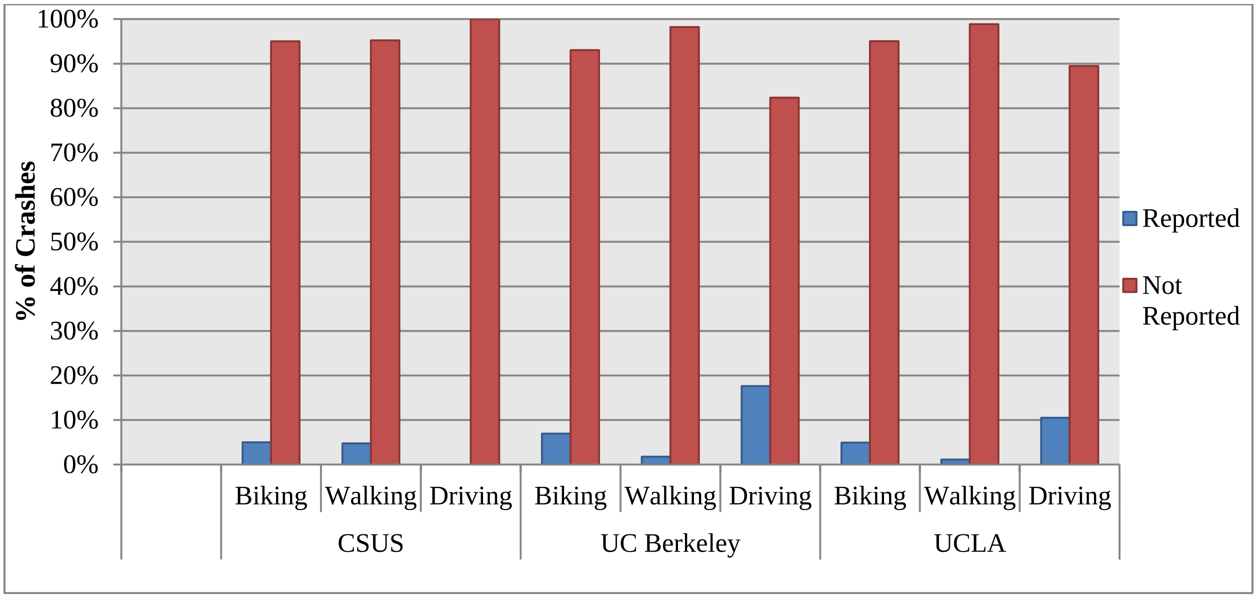


Figure 3.8 Reporting of Crashes to Law Enforcement for All Three Modes at All Three Campuses

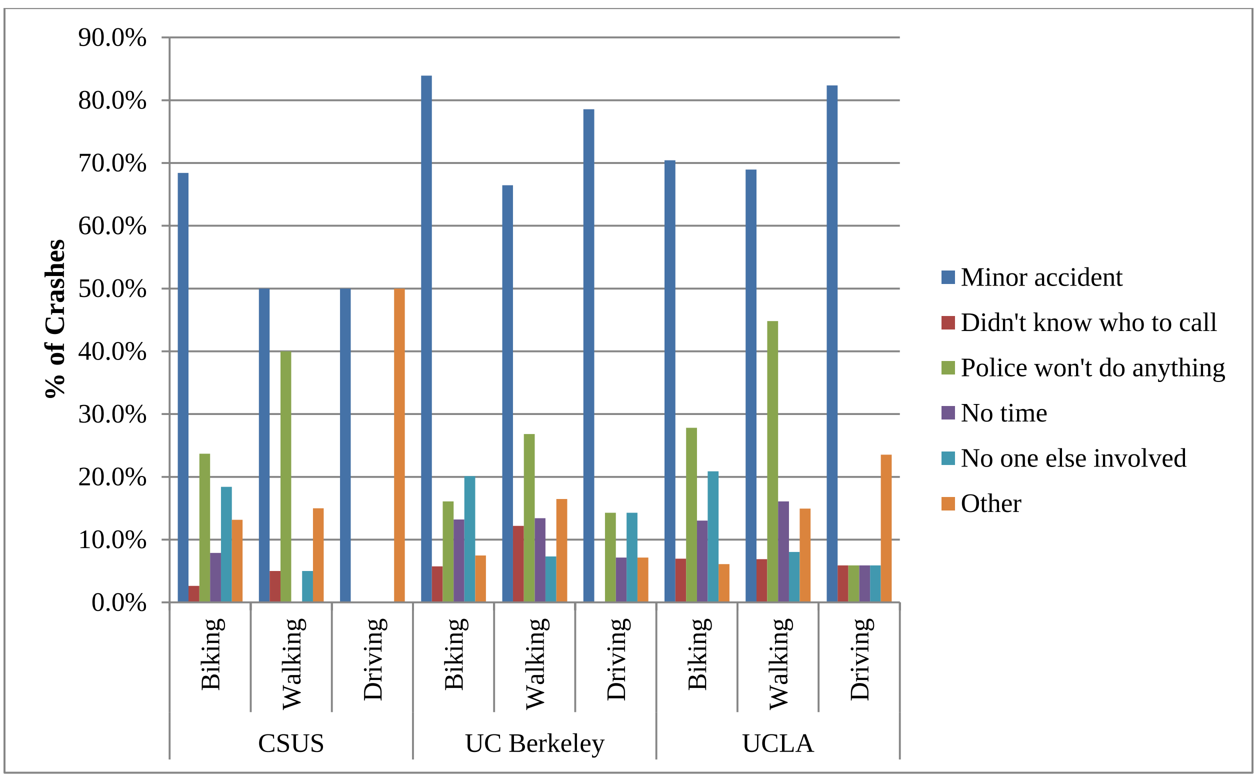


Figure 3.9 Reasons for Not Reporting of Crashes to Law Enforcement for All Three Modes at All Three Campuses

3.6 Discussion

Overall, the survey revealed a wealth of information about the location and type of a variety of crashes on or near the three campuses, people's perceptions of hazardous campus locations, as well as the perceived factors contributing to these crashes. Information from this survey helped guide the subsequent selection of crash hotspots to map at each campus and a deeper examination of the environmental and social characteristics for the purpose of developing policy and design changes for safer campuses.

4. Spatial Analysis of Crashes and Hazardous Locations

In this section we develop a methodology to identify locations within the three campus areas that can be quantified as high-frequency crash locations or, hotspots. Caution should be taken in working with raw crash data, because they can be spatially dispersed either due to natural variation in crash locations or human errors such as inaccuracies in the crash reporting process, both of which can distort the hotspot identification process. In order to correct for such distortions, individual crash locations were associated with a reference location, such as an intersection or mid-block crossing, which can then represent a potentially hazardous segment of the road network.

4.1 Data

The data used for the spatial analysis came from the following sources:

1. SWITRS (Statewide Integrated Traffic Records System): It is a statewide repository of traffic collision data collected by the California Highway Patrol. Crashes were examined from 2002 to 2011 (the most recently available records) for each campus study area.

Table 4.1 A Summary of Pedestrian and Bike Crashes for Walking and Bicycling for All Three Campuses (SWITRS 202-2011).

Mode	CSUS	UCB	UCLA
Pedestrian	39	277	197
Bicycle	92	326	69

2. Self-Reported Crashes in the Online Survey: As part of the online survey described in the previous section, respondents marked the sites where they experienced a crash on an online map. This meant that crashes that may not have not been reported in SWITRS were available for the study.

3. Perceived Hazardous Locations: In addition to crashes, the survey also asked respondents to identify locations they perceived as hazardous from a bicyclist's or pedestrian's perspective. These locations may or may not overlap with locations where crashes were reported by respondents.

The abovementioned dataset included location information, which was utilized in the process of identifying hotspots. A separate hotspot analysis was carried out for each data type, since they came from different sources. Finally, the analysis only addressed pedestrian and bicycle crash responses because there was a comparatively small sample of reported (auto) driver-involved crashes.

4.2 Methodology

Traditional clustering algorithms evaluate a candidate hotspot location by counting the number of crashes occurring within a certain distance of a location. The most common distance metric used for this purpose is the "Euclidean distance," which calculates the shortest path between a crash and a hotspot location. A limitation of the Euclidean distance metric is that it overlooks the presence of an underlying network structure. Recently, network distance-based approaches have been utilized (Steenberghen *et al.* 2010), which recognize that the region surrounding a candidate hotspot location may have road networks of varying densities and thus, varying levels of traffic volume.

Figure 4.1 illustrates the difference between the network distance and the Euclidean distance metric. In this example the objective is to count the total number of crashes occurring within a distance *D* from the point of measurement as shown in the figure. The network distance metric (Figure 4.1a) indicated that four crashes occurred, whereas the Euclidean distance metric (Figure 4.1b) indicated the presence of six crashes. In this case, the Euclidean distance metric overestimates the total number of crashes taking place in the vicinity of the candidate location because it counts crashes on the surrounding road network, which is denser than the road network being studied.

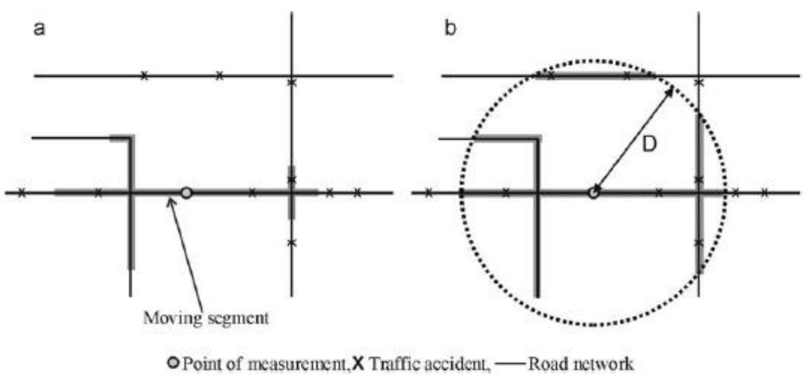


Figure 4.1 Comparing (a) a Network Distance-Based Approach and (b) a Euclidean Distance Metric (Steenberghen *et al* 2010)

However, there are some practical issues associated with using the network distance-based approach:

- It is possible that some of the crashes obtained from the survey were not marked on the road network; such deviations are difficult to correct for systematically.
- Another challenge is that the campuses' road network GIS layers were not readily available, inhibiting the calculation of network distances when analyzing hotspots on or near the campus.

By comparison, a Euclidean distance metric approach does not require any network layers in GIS, and, if the block sizes are similar in magnitude to the maximum distance (*D* in the example above), using the Euclidean distance will produce the same results as that of using the network distance. As a result, it was decided to use the Euclidean distance metric approach for this study. A more detailed explanation for selecting the Euclidean distance metric is provided in section 4.3.

4.3 Important Attributes

4.3.1 Candidate Hotspot Location

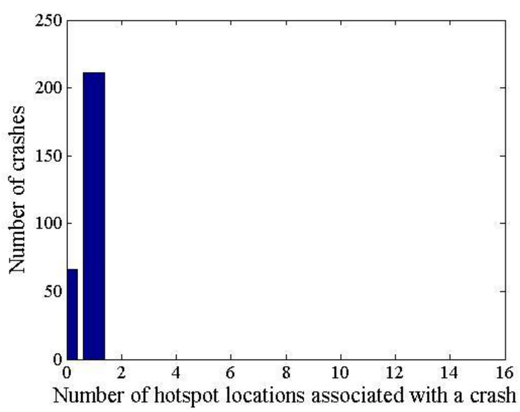
For this study, candidate locations were intersections as well as certain mid-block crossings and heavily traveled on-campus locations. The set of intersections around each campus area were automatically generated using a GIS software (ArcGIS 10.1), with additional mid-block and on-campus locations selected based on researcher's intimate knowledge of the campus area. Alternately, the raw crash data were also observed for any visual clustering patterns.

4.3.2 Influence distance (D)

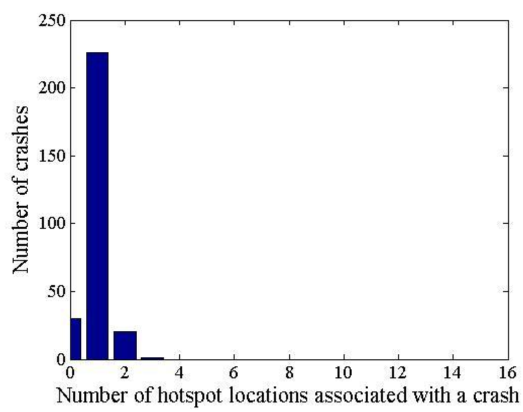
The influence distance represents the maximum allowable distance for a crash to be attributed to a candidate hotspot location. For instance, an influence distance of 100 m would imply that any crash taking place within a distance of 100 m can be associated with the candidate hotspot location.

The choice of D can be made either empirically, i.e., by observing the distribution of crashes along the network, or by re-implementing the algorithm for different values of D and assessing the results. One of the factors affecting the choice of D is the number of intersections that a crash can be attributed to. For instance, it is reasonable to think that in some cases, crashes taking place in the middle of a block can be attributed to either of the two adjacent intersections. If a block is long, then a crash might be allocated to only one intersection. However, if a crash has five to 10 intersections within its influence distance, then the chosen D is too large.

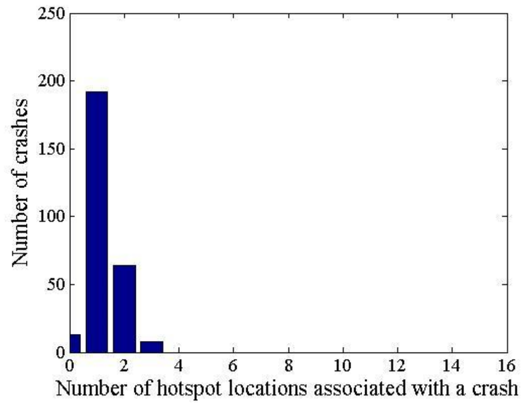
To illustrate this issue, consider the set of pedestrian crashes taken from the SWITRS database for the UC Berkeley campus. Figure 4.2 plots the histogram of the number of candidate hotspot locations associated with a pedestrian crash. Figure 4.2 shows that as D increases, the maximum number of hotspot locations associated with a crash increases. Similarly, as D increases, the number of non-attributed crashes (for which the number of associated candidate locations is zero) decreases. Out of these cases, D = 0.03 and D = 0.05 show a large percentage of 1 and 2 hotspot locations per crash, but D = 0.05 miles contains fewer non-attributed crashes. Therefore, D = 0.05 miles was selected for use in this study.

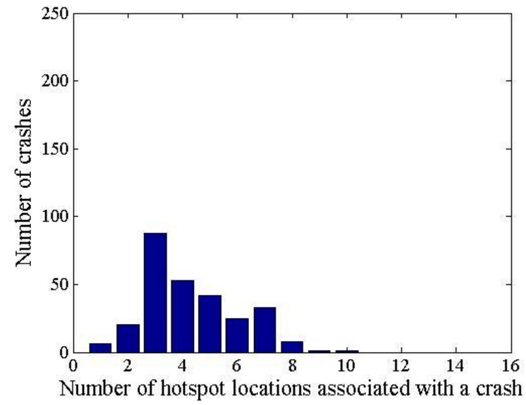


(a) *D* = 0.01 miles



(b) *D* = 0.03 miles





(c) *D* = 0.05 miles **(d) *D* = 0.10 miles**

Figure 4.2 Histogram of Number of Hotspot Locations within a Distance *D* of a Pedestrian Crash (SWITRS) for UC Berkeley

In order to illustrate the implications of the chosen influence distance, Figure 4.3 shows the distance between two adjacent intersections along the shorter edge of a block in Berkeley. It can be seen that the distance between the two intersections (0.06 miles/328 ft.) is more than the chosen influence distance (0.05 miles/264 ft.). This observation implies that a crash taking place at one of the intersections cannot get attributed to the other intersection, and if a crash is located in between the two intersections, then it can only be attributed to either of the two intersections. In addition, since the block lengths are longer than the influence distance, the radius of influence is not likely to cover intersections belonging to the other side of the block. Hence, the use of Euclidean distance should provide similar results to a network distance-based clustering method in this case. It is also interesting to note that an influence distance of 0.05 miles closely resembles the recommended influence distance obtained by Steenberghen *et al.* (2010).

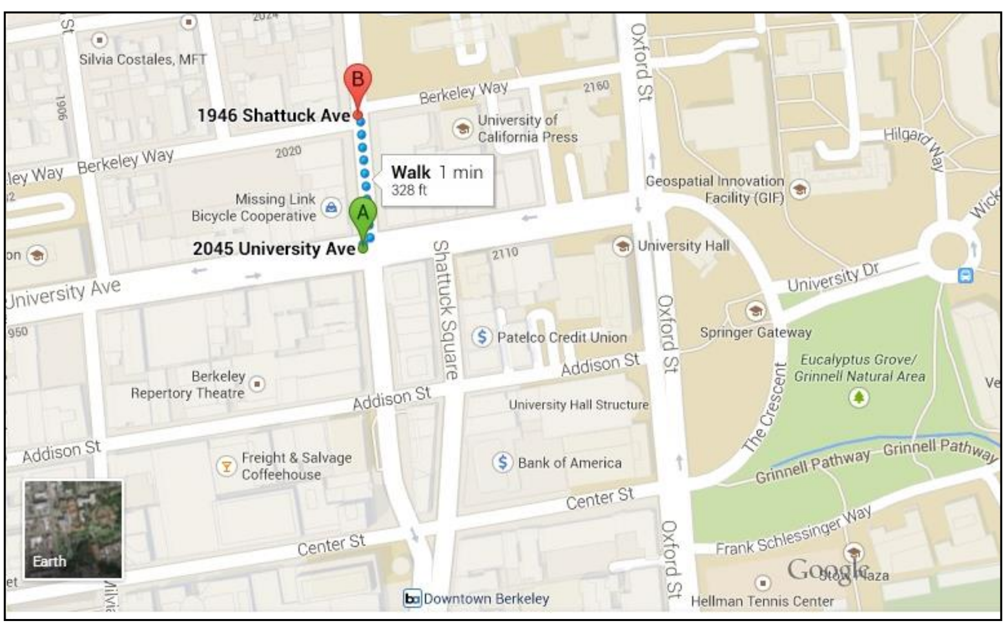


Figure 4.3 Comparing the choice of the influence distance with the length of a shorter edge of a block in Berkeley (328 ft.) (Source: Google Maps)

4.3.3 Dangerousness index (DI_i):

After selecting the influence distance and the candidate hotspot locations, the next step was to define a metric by which the candidate hotspot locations could be ranked. An important consideration here was to quantify the extent to which a given crash could be attributed to a candidate hotspot location. For instance, if a crash was located 0.04 miles away from an intersection, how likely was it to have been influenced by this intersection? How much stronger is the association likely to be if the crash was 0.004 miles away? In order to address these issues, a dangerousness index, DI_i, is defined as the weighted number of crashes that occur within the influence distance of the candidate location. It is represented as follows:

$$DI_i = \sum_{j=1}^{n} w_{ij} I_D(d_{ij}),$$

where,
n: number of crashes observed,
w_{ij}: weight associated with crash j for location i,
d_{ij}: Euclidean distance between crash j and location i,
$I_D(d_{ij})$: 1 if $d_{ij} \leq D$; 0 otherwise.

Herein, the weight represents the strength of the relationship between the crash and the candidate location and can be selected in different ways. Some of the common weighting options are shown below:

- distance band: each crash has the same weight: $w_{ij} = 1$,
- inverse distance: the weight decreases inversely with the distance from the location: $w_{ij} = 1/d_{ij}$,
- linear distance: the weight decreases linearly within the distance: $w_{ij} = \left(D - d_{ij}\right)/D$.

Based on the descriptions provided above, it can be inferred that the *distance band* gives the same weight (w_{ij}=1) to all crashes present within the influence distance, whereas the *inverse distance* option gives a very high weight to the crashes located close to the candidate location and the weight decreases rapidly as the distance increases ($0 < w_{ij} < \infty$). Finally, the *linear distance* metric can be seen as a compromise between the first two metrics, wherein there is a steady decrease in the weight from the candidate location to the edge of the influence distance ($0 \leq w_{ij} \leq 1$).

Among the three options, the inverse distance metric bears the closest resemblance to reality as one expects the relationship between the crash and the hotspot location to rapidly decay when the crash is farther from the candidate hotspot location. However, this metric still suffers from a limitation that the weight calculation can be extremely sensitive to minute variations in the distance when a crash is extremely close to the candidate location ($d_{ij} \sim 0, w_{ij} \sim \infty$). As a result, an error resulting from an imprecise marking of a crash by a survey respondent could lead to substantial variations. Hence, as part of this study, a hybrid weighting factor was proposed, which modified the inverse distance metric to make it less sensitive to the distance when the crash was near the candidate location. The resulting hybrid weight, which can be seen as a mix of the distance band and the inverse distance metric is mathematically represented as follows:

$$w_{ij} = \frac{1}{\max(0.01, d_{ij})}.$$

The equation above implies that a constant weight is attributed to all crashes located within 0.01 miles of a point of measurement, exceeding which, the weight decreases inversely with the distance. Herein, 0.01 miles (~ 53 feet) represents a buffer zone around the candidate location to account for any imprecision in marking. Figure 4.4 depicts the decay in the weight as the distance increases.

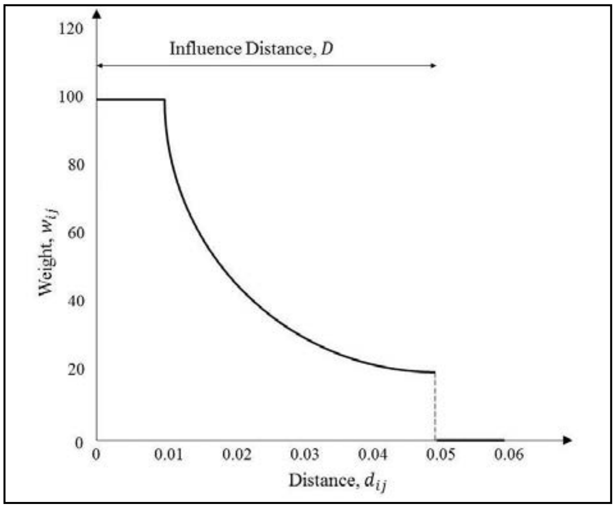


Figure 4.4 Hybrid Weighting Factor Using the Inverse Distance and Distance Metric with a 0.01 Buffer

4.3.4 Normalizing the Weights

In calculating the dangerousness index, DI_i as described in the previous section, a crash can be attributed to more than one location. For example, a crash associated with two intersections would receive a higher cumulative weight than a crash associated with a single intersection. To avoid this, the weights were normalized so that all weights associated with a single crash sum up to one. Hence, the revised weight can be calculated as follows:

$$\widetilde{w}_{ij} = \frac{w_{ij}}{\sum_k w_{kj}}.$$

Finally, the dangerousness index is computed as:

$$DI_i = \sum_{j=1}^{n} \widetilde{w}_{ij} I_D(d_{ij}).$$

An additional benefit of normalizing the weights is that the dangerousness index can now be interpreted as the total number of crashes associated with the corresponding candidate hotspot location. For instance, $DI_i = 7.5$ implies that upon aggregation, 7.5 crashes are associated with location i. Herein, a non-integer value implies that some of the associated weights, $\widetilde{w}_{ij}$, are fractional in nature as they belong to more than one intersection.

4.4 Hotspot Identification

Once the dangerousness index was calculated for all the candidate locations, the hotspot locations were ranked and the top ranking hotspots were identified. This process was completed for crashes in all the datasets in order to determine if any significant variation in the top hotspot locations for each type of data.

4.5 Top 15 Hotspots in Each Campus

Using the methodology described in the previous sections, hotspots on each of the three campuses for each mode type (pedestrian or bicycle) and data source (SWITRS, survey crashes, perceived hazardous locations) were identified. The subsequent sections present a discussion of the top 15 hotspot locations for each mode and dataset combination on each campus, details of which are available in Appendix C.

4.5.1 California State University, Sacramento

1. Pedestrian Hotspots (Figure 4.5 and Table C.1)

   Figure 5.5 shows the top 15 pedestrian hotspots for each data source. A dotted boundary drawn inside the study area boundary's solid black line indicated the main campus area. Some of the major observations obtained from this analysis are as follows:

   i. The hotspots obtained using SWITRS crashes (red) tended to lie farther away from the core campus area, such as along Howe Avenue and Folsom Boulevard. In comparison, the hotspots obtained using the survey crashes (blue) were predominantly focused around the campus. Some reasons for the difference between the survey and the SWITRS hotspots could be that the survey largely focused on the campus community, whereas SWITRS tends to underrepresent campus activity.
   ii. The overlap between the perceived hazardous locations (yellow and purple) and the survey crashes (blue) was not significant except for the Guy West Footbridge, and the intersection of Sinclair Road & State University Drive West. The limited overlap is perhaps due to the survey crashes being significantly fewer (22) than the perceived hazardous locations (149 pedestrian only and 230 bike and pedestrian combined locations) in the context of CSUS.

From Figure 4.5, it can be observed that only a few of the top 15 intersections that were perceived as hazardous for pedestrians overlap with the top intersections perceived as hazardous for both pedestrians and bicyclists.

2. Bicycle Hotspots (Figure 4.6, Table C.2)
   i. Similar to the case of the hotspots of pedestrian crashes, the hotspots for bicycle crashes shown in SWITRS lie along the periphery of the campus study area.
   ii. A comparison of the survey results for bicycle and pedestrian crashes (Figures 4.5 and 4.6) showed that the bike hotspots were more dispersed, which may be because bicycles travel longer distances.
   iii. Finally, the top hotspots for the perceived hazardous locations for bicycling are similar to those developed for pedestrians (Figure 4.5), in particular near the intersections of 65^{th} Street & Elvas Avenue, and Sinclair Road & State University Drive West.

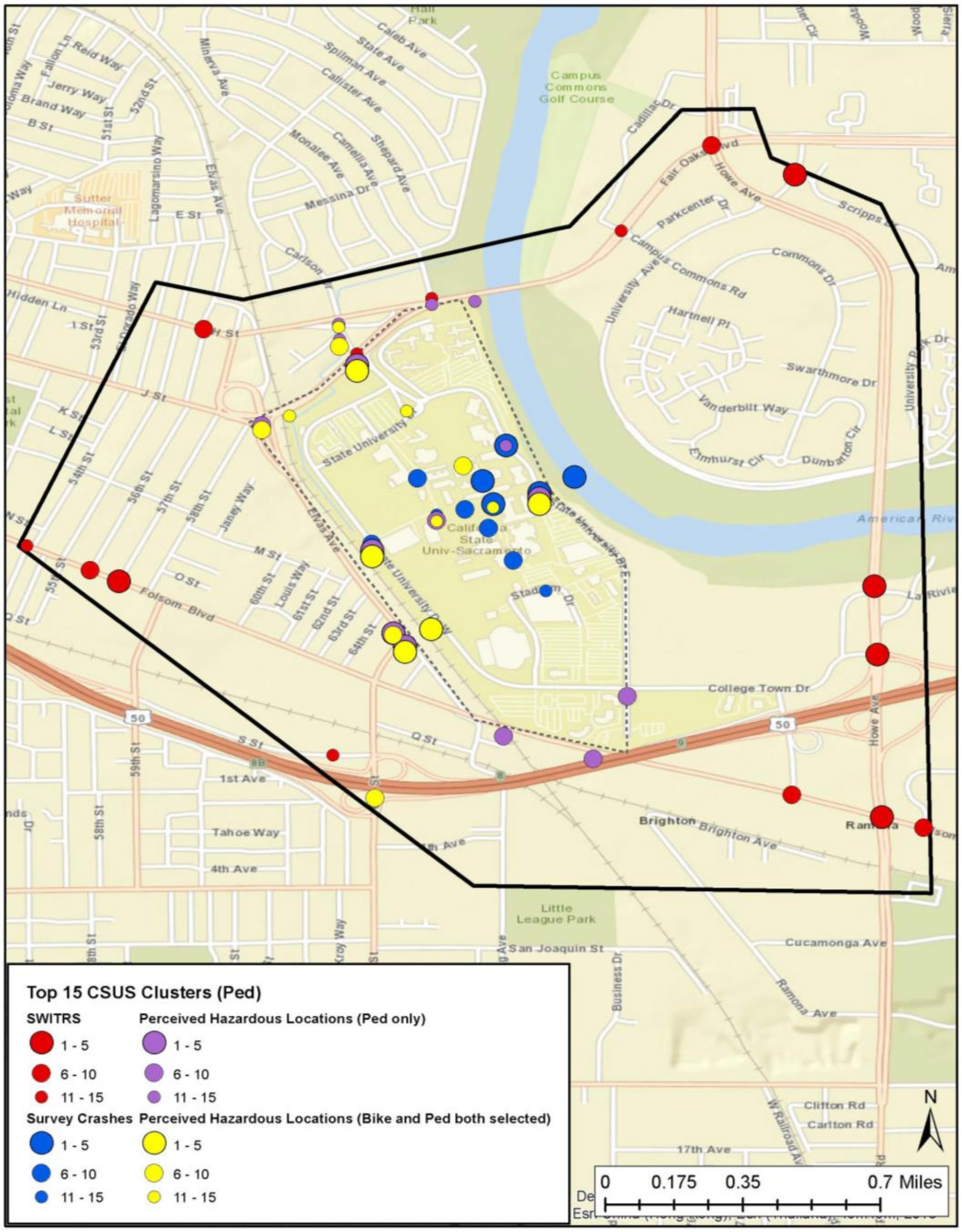


Figure 4.5 CSUS Hotspots (Pedestrian) Using SWITRS, Survey Reports of Crashes, and Survey Reports of Perceived Hazardous Locations

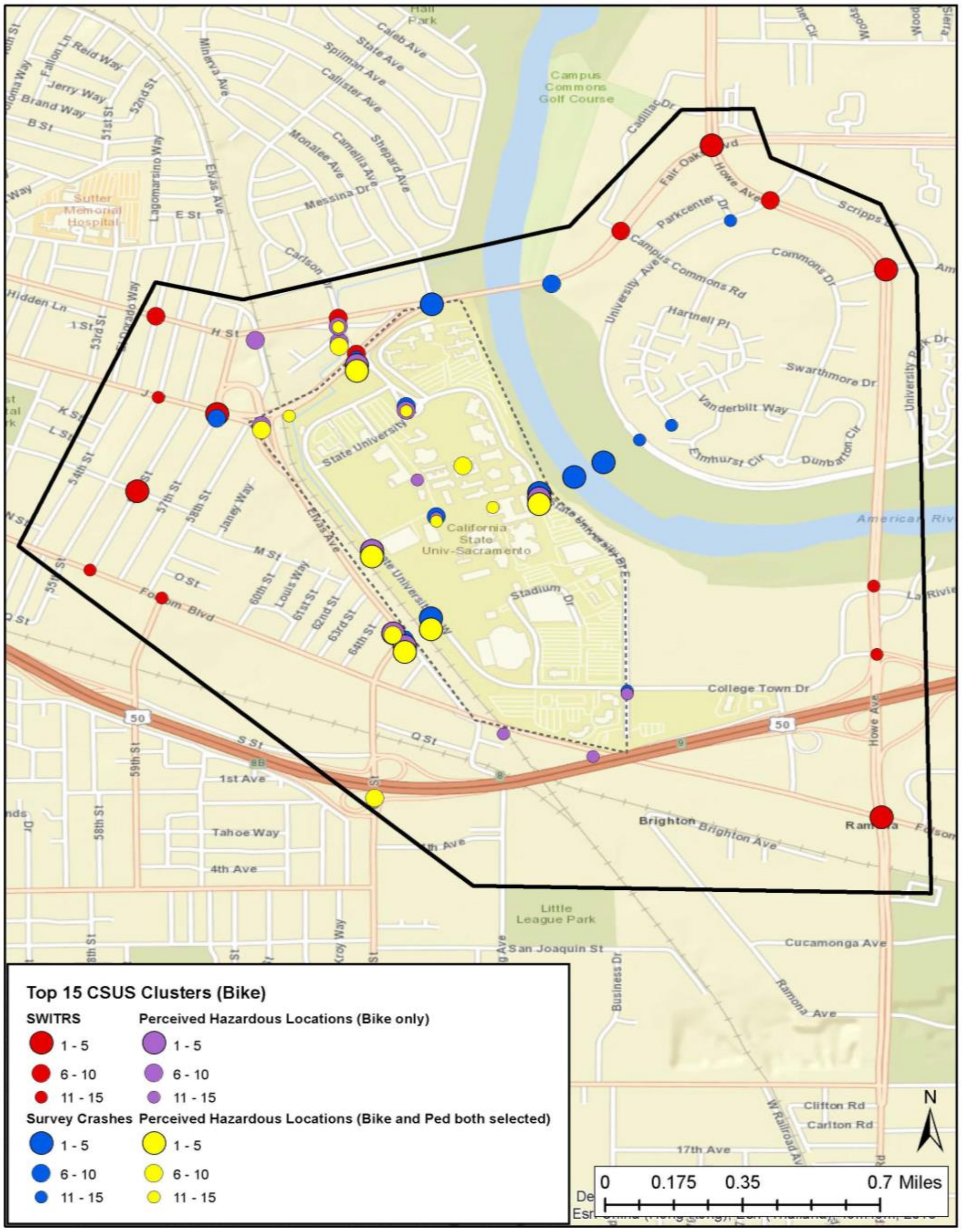


Figure 4.6 CSUS Hotspots (Bike) Using SWITRS, Survey Reports of Crashes, and Survey Reports of Perceived Hazardous Locations

4.5.2 UC Berkeley

1. Pedestrian Hotspots (Figure 4.7, Table C.3)
   i. Similar to the CSUS campus, the SWITRS hotspots in UCB were located outside the campus along the major traffic corridors (Shattuck, Bancroft, and Telegraph Avenues).
   ii. The top survey hotspots align themselves either at the interface of campus activity and vehicular traffic (i.e. along Shattuck, Bancroft, and Hearst Avenues), or at sites with major pedestrian activity (e.g., Sproul Plaza).
   iii. The hotspots pertaining to the perceived hazardous locations for pedestrians also were found along major campus entrances and exits such as Telegraph and Bancroft Avenues on the south side, and Euclid and Hearst Avenues on the north side.
   iv. In addition, some of the major hotspots, such as Le Roy and Hearst Avenues, Recreational Sports Facility (Dana Street and Bancroft Avenue), and Oxford and Addison Avenues, were common to SWITRS, survey-reported crashes, and survey-reported perceived hazardous locations.

2. Bicycle Hotspots (Figure 4.8, Table C.4)
   i. The SWITRS hotspots for bicycle crashes were also located along the major traffic corridors, especially Shattuck Avenue.
   ii. As opposed to the pedestrian crashes, most of the hotspots of bicycle crashes reported in the survey were located in the interior of the campus. However, SWITRS and survey crash hotspots also overlap at locations such as the intersection of Hearst and Oxford Avenues, which lies at the base of a long downhill stretch of road along Hearst Avenue.
   iii. Similarly, most of the hotspots of perceived hazardous locations existed along Bancroft and Hearst Avenue where there is a slope along the east-west direction.

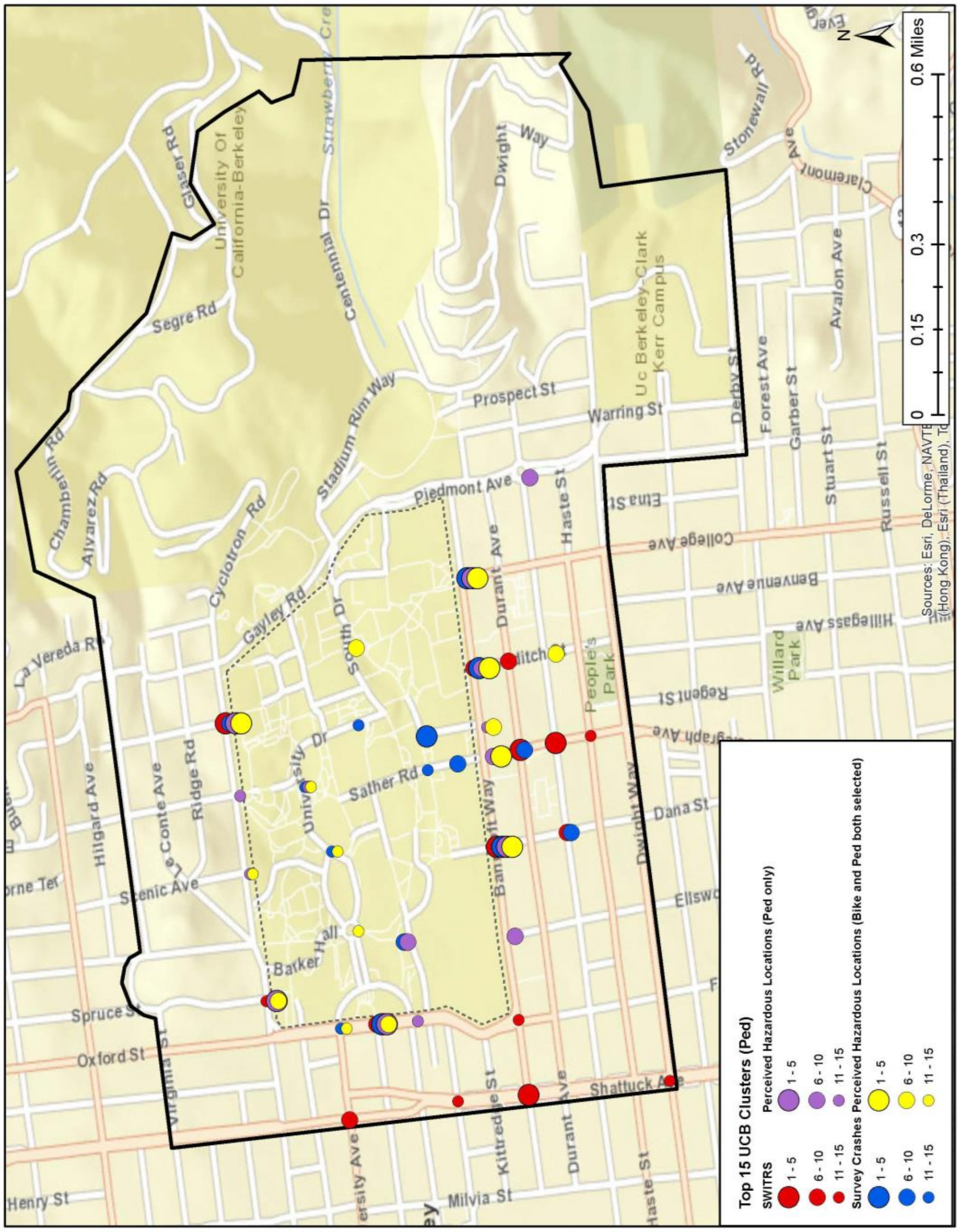


Figure 4.7 UCB Hotspots (Pedestrian) Using SWITRS, Survey Reports of Crashes, and Survey Reports of Perceived Hazardous Locations

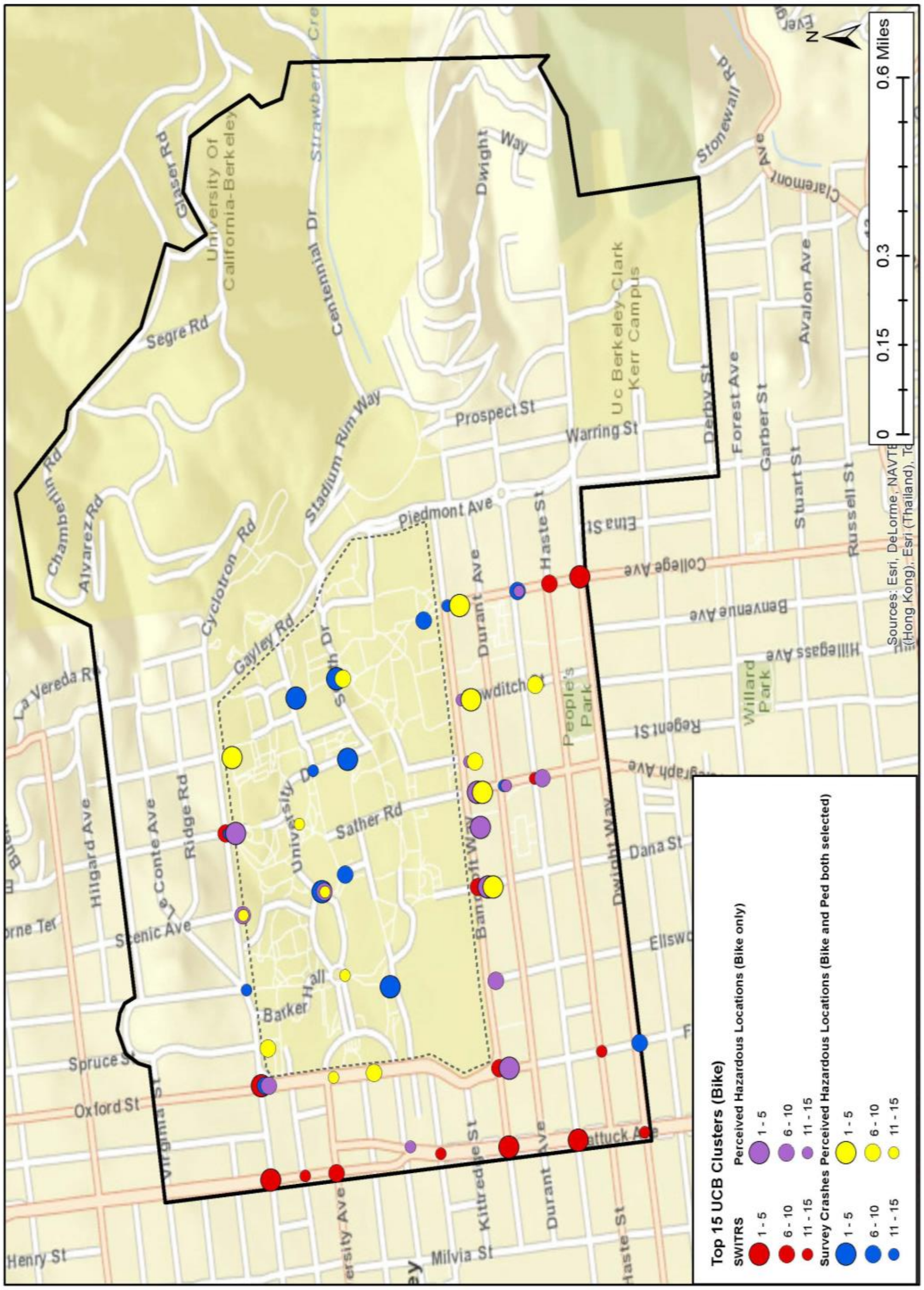


Figure 4.8 UCB Hotspots (Bike) Using SWITRS, Survey Reports of Crashes, and Survey Reports of Perceived Hazardous Locations

4.5.3 UCLA

1. Pedestrian Hotspots (Figure 4.9, Table C.5)
   i. SWITRS hotspots were observed along Westwood Boulevard and Wilshire and Le Conte Avenues, primarily along the periphery and outside the campus boundaries.
   ii. The crash clusters reported in the survey were concentrated around areas with high pedestrian activity, like Bruin Plaza, Strathmore Place, and Westwood Avenue. Similar to the other two campuses, the crashes reported in the survey were located primarily inside the campus boundaries.
   iii. The top few clusters of perceived hazardous locations for pedestrians coincided with the clusters of SWITRS and/or survey crashes, such as the intersections of Le Conte and Westwood Avenues, Wilshire Avenue and Westwood Boulevard, and Weyburn and Wilshire Avenues.

2. Bicycle Hotspots (Figure 4.10, Table C.6)
   i. As shown in figure 4.10, it appears that SWITRS-reported hotspots for bicycles were more spread out than those for pedestrians (figure 4.9). For instance, some hotspots on Westwood Boulevard lie close to the study boundary, near Santa Monica Boulevard.
   ii. Some prominent hotspots of survey-reported crashes were seen along the Westwood Boulevard corridor, while other clusters included the intersections of Gayley and Le Conte Avenues, and Veteran and Wilshire Avenues.
   iii. The perceived hazardous hotspots included regions near the Southern Regional Library on the west side of campus, the east campus entrance areas along Charles Young Drive, and the Westwood Village areas on the south side. Clusters for perceived hazardous locations for pedestrians and cyclists were also seen along Wilshire Avenue.
   iv. Finally, SWITRS, survey-reported crashes, and perceived hazardous locations coincided at Le Conte Avenue and Westwood Boulevard, which is the busiest entrance to the UCLA campus. Similarly, SWITRS and perceived hazardous locations also coincided at Westwood Boulevard and Wilshire Avenue.

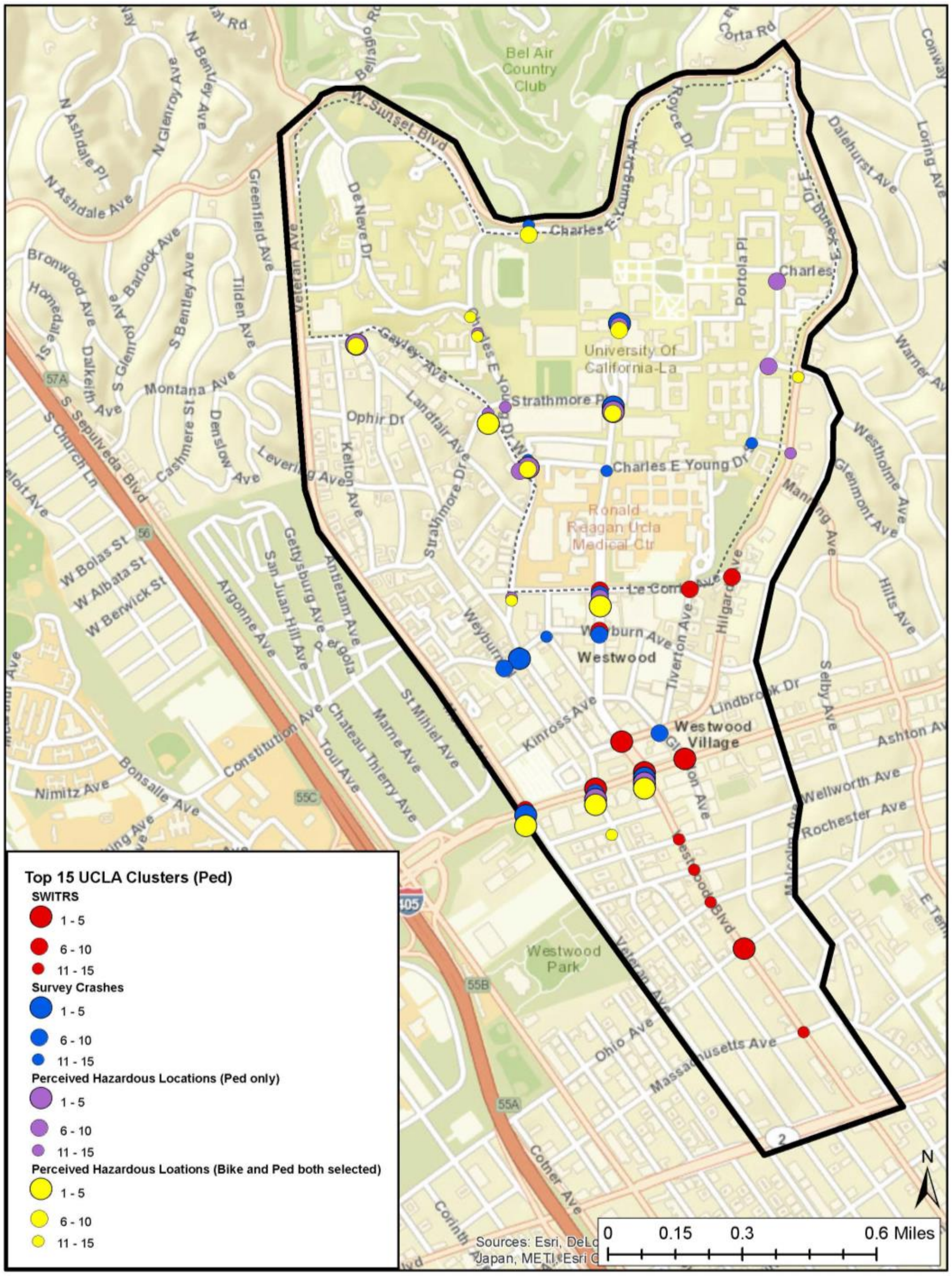


Figure 4.9 UCLA Hotspots (Pedestrian) Using SWITRS, Survey Reports of Crashes, and Survey Reports of Perceived Hazardous Locations

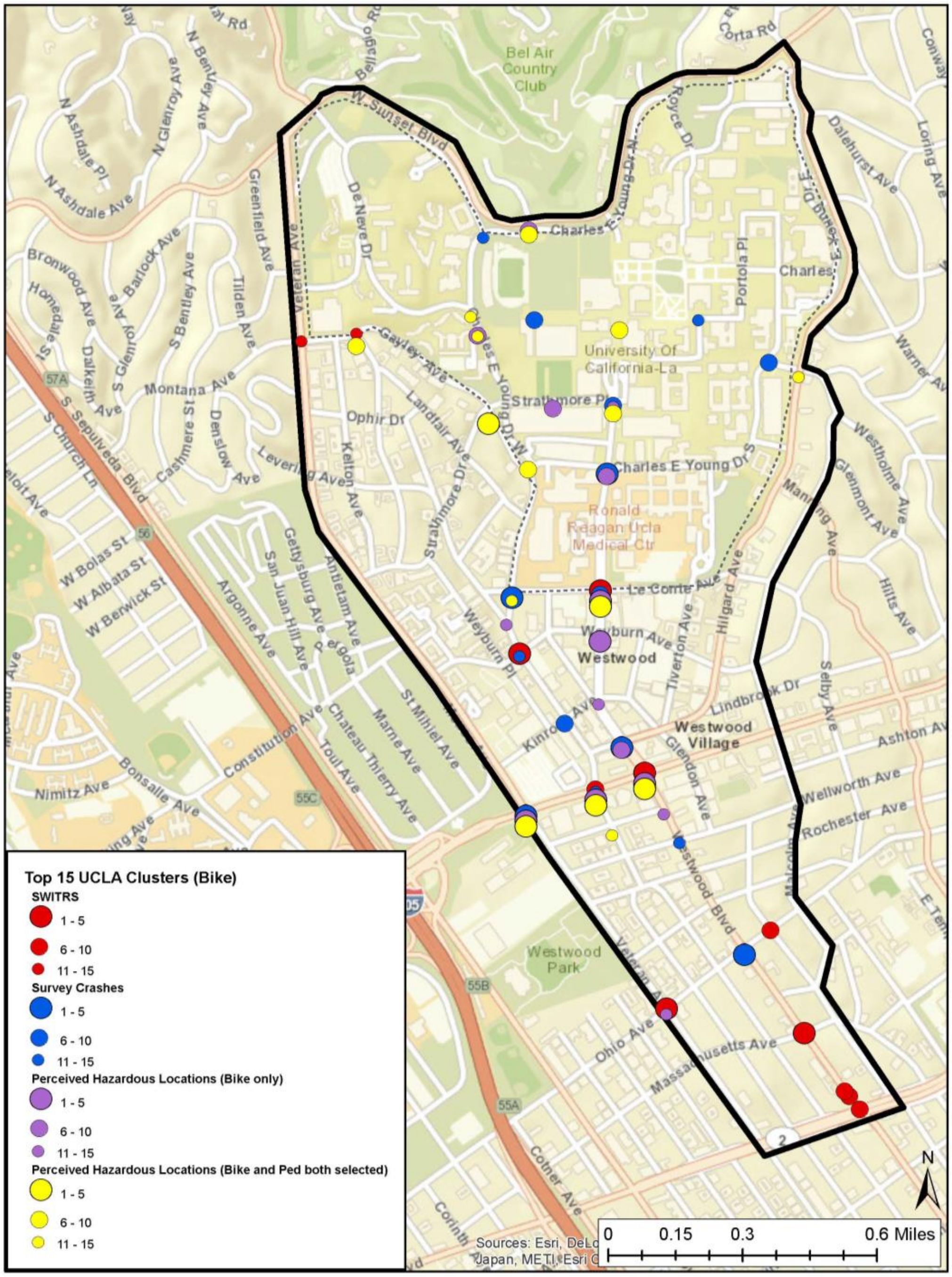


Figure 4.10 UCLA Hotspots (Bike) Using SWITRS, Survey Reports of Crashes, and Survey Reports of Perceived Hazardous Locations

4.5.4 Risk Analysis of On- vs. Off-Campus Areas using Survey Data

The built environment of a university campus is typically quite different from the city outside Consequently, the risk for pedestrians and bicyclists as they traverse these two diverse environments can be very different, which may explain the results of the hotspot analysis, which indicated that a large concentration of hotspots lie at the interface of the main campus area and the surrounding city. In this section, the focus is on the risk faced by the campus community on as well as off the campus.

The definition of risk used is the number of crashes experienced by users of given mode divided by the number of units of that mode that are exposed to the possibility of a crash. For this section, the crash estimates were taken from the survey data, both reported crashes, and perceived hazardous locations. The exposure estimates were not readily available for the three campuses; consequently, some assumptions were made to arrive at their values.

In order to estimate the exposure values for bicycles and pedestrians on the three campuses, the campus demographic estimates discussed in Chapter 1 and repeated in Table 4.2 acted as the starting point. It is assumed that the entire student, faculty, and staff community can be counted as pedestrians, irrespective of their commute mode. Travel surveys conducted in and around the campus areas were used as a reference to estimate the fraction of the population that bicycles to campus. Finally the differentiation between on-campus and off-campus crashes was made by intersecting the crash layers with the main campus boundary using ArcGIS. Table 4.2 lists the risk analysis calculation for the three campuses using these methods.

Presumably, because of the higher levels of pedestrian and bicyclist exposure, the common trend across the three campuses was that the risk to pedestrians is greater on campus than off. The risk to bicycles is estimated to be much greater than that for pedestrians both on campus and off. Beyond that, it was not possible to make a fair comparison of the risk estimates across campuses because of the widely varying survey response rates across the three campuses. Instead, we carried out a risk analysis for each campus separately. The results are discussed below:

- CSUS: Due to a small sample of survey crashes, absolute magnitudes of the risk estimates were very low. However, the results indicated that the risk to bicyclist on campus is much greater than it is off campus. The trend is similar in the case of the perceived hazardous locations. In the case of pedestrians, the risk estimates were higher on campus as well, but the low numbers of off-campus crashes and the high number of perceived hazardous locations indicated that there may be a problem of underreporting.
- UCB: Based on the survey crashes, the risk to pedestrians and bicyclists was greater on campus than off. However, the analysis of the perceived hazardous locations revealed that while the risk to pedestrians was still greater inside the campus, the risk to bicyclists was greater off campus. This finding could be due to the significant increase in the conflicts between bicycles and autos outside of the main campus area, as autos have limited access to the campus.
- UCLA: In the case of pedestrians, both the survey crash data as well as the perceived hazardous locations indicated that the risk to pedestrians was greater on campus than off. However, both datasets indicated that the risk to bicycles was greater off campus.

Table 4.2 On-Campus vs. Off-Campus Risk Analysis for Walking and Biking at All Three Campuses: Survey-Reported Crashes and Survey-Reported Perceived Hazardous Locations

	Risk Analysis (Survey Crashes)			Risk Analysis (Perceived Hazardous Locations)		
	UCB	**UCLA**	**CSUS**	**UCB**	**UCLA**	**CSUS**
	Campus Demographic			Campus Demographic		
Student	37,000	41,000	29,000	37,000	41,000	29,000
Faculty + Staff	16,000	26,000	2,800	16,000	26,000	2,800
	Mode-specific exposure			Mode-specific exposure		
Pedestrians*	53,000	67,000	31,800	53,000	67,000	31,800
Bicycles*	5,880	2,570	1,908	5,880	2,570	1,908
	Mode-Specific Crashes			Mode-specific Perceived Hazardous Locations		
Pedestrians	167	88	21	710	903	99
Bicycles	187	121	40	425	710	149
	Crashes Off-Campus			Perceived Hazardous Locations Off-Campus		
Pedestrians	57	39	3	234	361	9
Bicycles	64	66	17	268	390	39
	Crashes On-Campus			Perceived Hazardous Locations On-Campus		
Pedestrians	110	49	18	476	542	90
Bicycles	123	55	23	157	320	110
	Overall Risk			Overall Risk		
Pedestrians	**3.15**	**1.31**	**0.66**	**13.40**	**13.48**	**3.11**
Bicycles	**31.80**	**47.08**	**20.96**	**72.28**	**276.26**	**78.09**
	Risk Off-Campus			Risk Off-Campus		
Pedestrians	**1.07**	**0.58**	**0.09**	**4.42**	**5.39**	**0.28**
Bicycles	**10.81**	**25.75**	**9.14**	**45.58**	**151.75**	**20.44**
	Risk On-Campus			Risk On-Campus		
Pedestrians	**2.08**	**0.73**	**0.57**	**8.98**	**8.09**	**2.83**
Bicycles	**20.99**	**21.33**	**11.82**	**26.70**	**124.51**	**57.65**

* Mode share sources: BART Station Profile Study (2010); UCLA Transportation (2011)

4.5.5 Discussion

Based on the discussion in the previous section, a number of similar patterns can be identified across the three campuses; they are summarized into the following common hotspot characteristics:

1. *SWITRS vs. survey-reported hotspots.* Hotspots obtained from SWITRS lie farther away from campus, whereas survey-reported hotspots tend to be closer or inside the campus. Possible reasons for this result could be the underrepresentation of campus crashes in the SWITRS database, and/or that SWITRS-based clusters may not be representative of campus activity. A comparison between the distributions of crashes/perceived hazardous locations, both inside and outside of the main campus area shown in Table 4.3. In that same table, it can be seen that a very small percentage of SWITRS crashes fall within the main campus area. In comparison, more than half the survey-reported crashes

do, suggesting that survey data collection can address the underreporting problem that public crash databases experience in terms of campus data.

Table 4.3 Distribution of Crashes Inside and Outside Main Campus Area for Walking and Biking at All Three Campuses: SWITRS, Survey-Reported Crashes and Survey-Reported Perceived Hazardous Locations

Crash type	CSUS		UCB		UCLA	
	Inside campus	Outside campus	Inside campus	Outside campus	Inside campus	Outside campus
SWITRS (Ped)	3	36	54	223	25	172
SWITRS (Bike)	11	81	56	270	11	58
Survey Crashes (Pedestrian)	18	3	111	56	49	39
Survey Crashes (Bike)	23	17	113	74	55	66
Perceived Hazardous Locations (Ped only)	90	9	427	283	479	424
Perceived Hazardous Locations (Bike only)	110	39	190	235	256	454
Perceived Hazardous Locations (Bike and Ped both selected)	168	62	392	276	480	400

2. Certain corridor effects are also observed within each study area, with clusters aligning themselves along major arterials. Such examples include Folsom Boulevard and Howe Avenue in CSUS; Bancroft and Shattuck Avenues in UCB, and Westwood Boulevard and Wilshire Avenue in UCLA.
3. The hotspots obtained using the perceived hazardous locations do overlap somewhat with the survey crash-based hotspots, in particular, some of the top four or five hotspots.
4. Hotspots of bicycle crashes tend to be more spread out than hotspots obtained for pedestrian crashes/perceived hazardous locations. A possible reason for this result could be that bicycles are used for longer commutes, and hence respondents using bicycles might observe hazardous locations farther away from campus.

5. Contextualized Spatial Clustering

5.1 Introduction

One of the limitations of the hotspot analysis conducted in the previous chapter is that by only considering the total number of crashes associated with each cluster, the detailed information associated with each crash, such as the time of crash, the injury severity, and the associated environmental and behavioral factors, is not utilized. In chapter 3, the analysis of the survey results discussed these attributes to uncover some macroscopic trends across the three campuses. However, if the details can also be spatially associated with the hotspots, they can provide some insights into understanding the nature of the hotspots and help differentiate one from another.

In chapter 4, the dangerousness index for a hotspot location, *i*, was defined as follows:

$$DI_i = \sum_{j=1}^{n} \widetilde{w}_{ij} I_D(d_{ij}).$$

Each crash, *j*, has a set of *K* attributes notated as $\mathbf{X}_j = [x_{1j}, x_{2j}, .. x_{Kj}]$**.** Hence, in order to evaluate the presence of an attribute, *k*, at the cluster level, the following modification is made to the above equation:

$$k_i = \frac{\sum_{j=1}^{n} \widetilde{w}_{ij} x_{kj} I_D(d_{ij})}{DI_i}.$$

It is assumed that the attribute, x_{kj}, is a binary variable, which is *1*, if it is significant for crash *j*, *0* otherwise.

It is also observed that the cluster-level attribute, k_i, is calculated as a fraction of the dangerousness index, DI_i. Hence, if a factor, $\mathbf{x}_i$, is common to all the crashes attributed to the cluster, k_i, it will be equal to 1. Alternately, if an attribute did not feature in any of the crashes associated to the cluster, the corresponding k_i will be calculated to be zero. This allows for additional context for the hotspots, which are referred to in this study as "contextualized spatial clustering."

5.2 Survey Crash Analysis Using Contextualized Spatial Clustering

Contextualized spatial clustering was conducted on the survey crash data's top 15 hotspots as described in the previous chapter. The factors which were used in the contextualized analysis were:

- Contact (bicycle, pedestrian, auto or any other object)
- Time of day of the crash (morning, afternoon, evening, etc.)
- Injury severity (serious, minor, etc.)
- Behavioral attributes (excessive speed, inattention, obstructed views, etc.)
- Environmental attributes (poor lighting, cracked pavement, lack of sidewalk, etc.)

The results of the contextualized spatial clustering are described qualitatively in the subsequent sections and the corresponding numerical results are available in appendix D.

5.2.1 CSUS

5.2.1.1 Pedestrian Crash Hotspots (The corresponding numerical results are shown in table D.1)

5.2.1.1.1 Contact

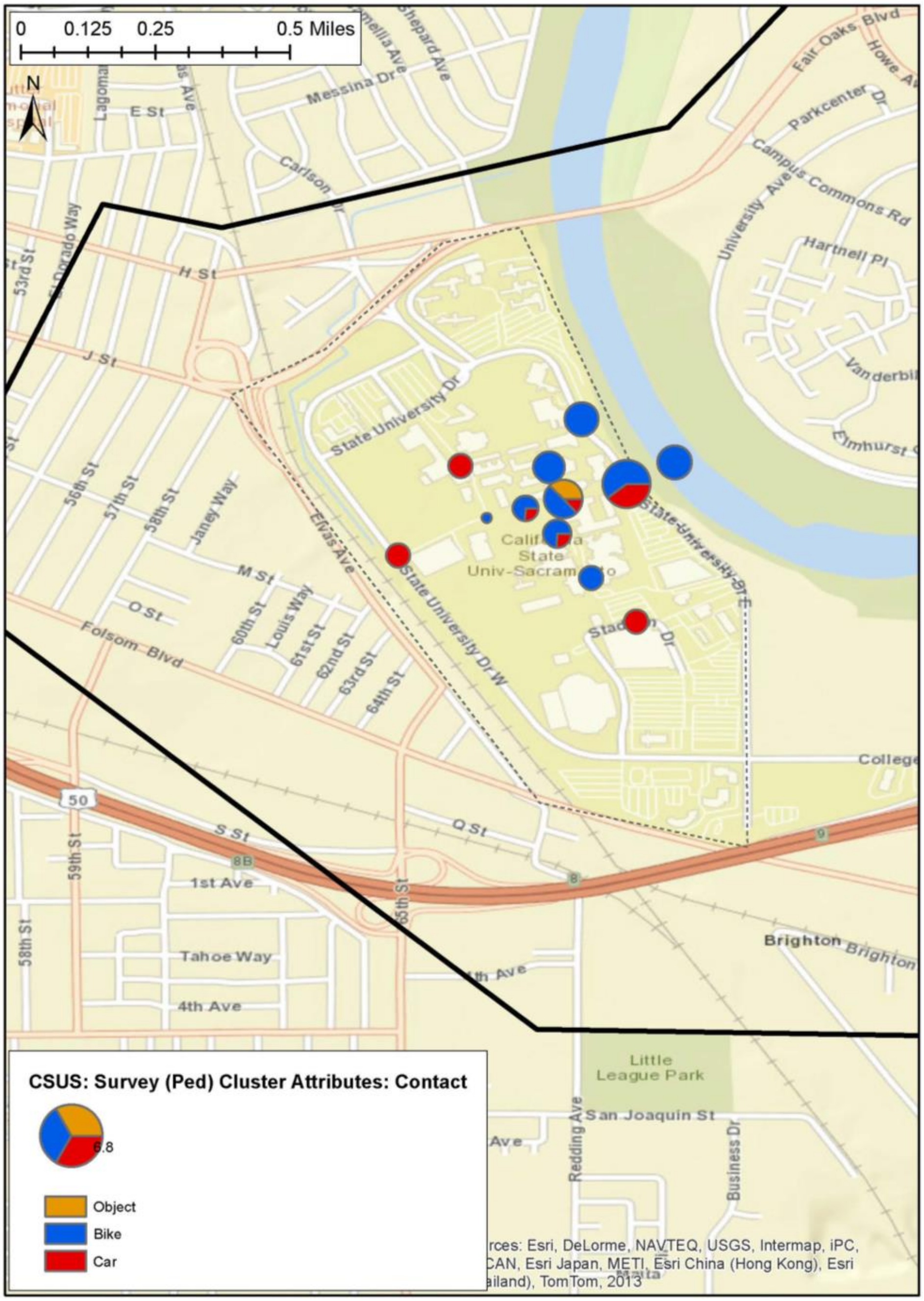


Figure 5.1 CSUS Survey Hotspots (Pedestrian) Contextualized Spatial Clustering by Contact

In Figure 5.1, the pedestrian hotspots for CSUS show a mix of crashes involving contact with different modes/objects. In particular, the pedestrian hotspots closer to the center of the campus and near the Guy West Bridge had bicycles involved. In contrast, the pedestrian crashes involving autos were concentrated along the major roads, such as State University and Stadium Drives.

5.2.1.1.2 Time of Day

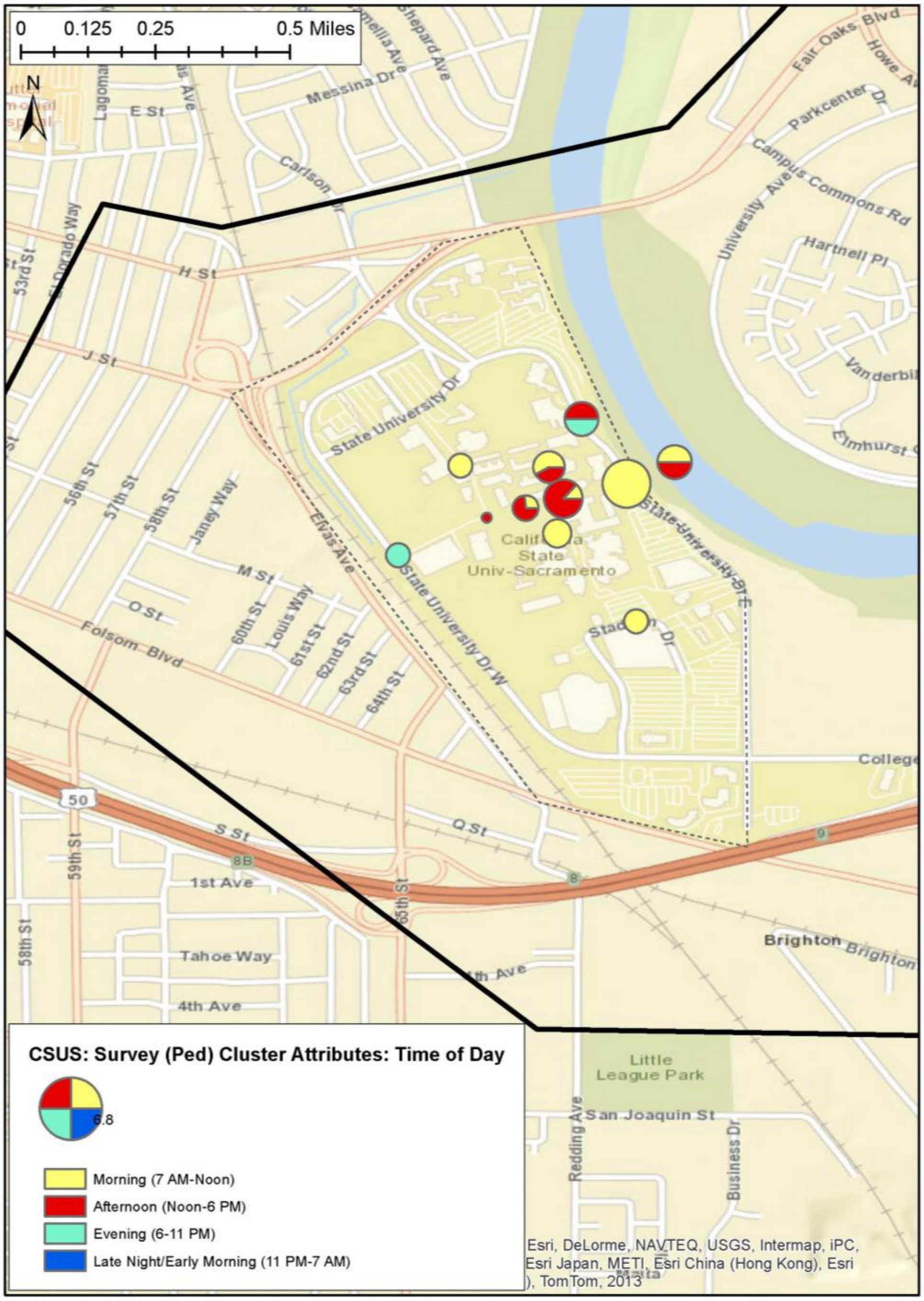


Figure 5.2 CSUS Survey Hotspots (Pedestrian) Contextualized Spatial Clustering by Time of Day

Most of the pedestrian crashes among the top pedestrian hotspots occurred during the day. The only evening crashes occurred along State University Drive.

5.2.1.1.3. Injury Severity

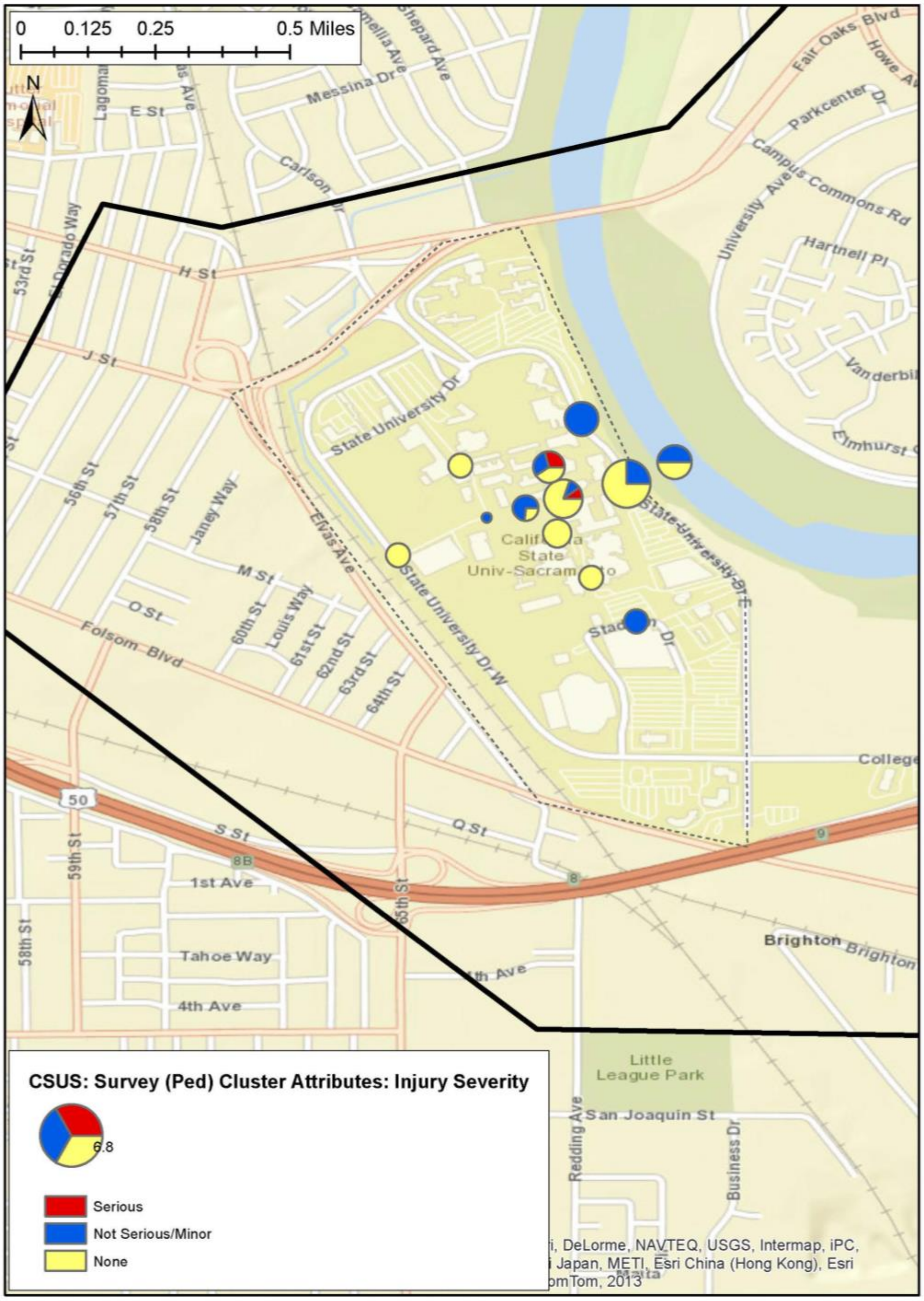


Figure 5.3 CSUS Survey Hotspots (Pedestrian) Contextualized Spatial Clustering by Injury Severity

Most of the pedestrian crashes involved either not serious/minor injuries, or no injuries at all as shown in Figure 5.3.

5.2.1.1.4 Behavioral Attributes

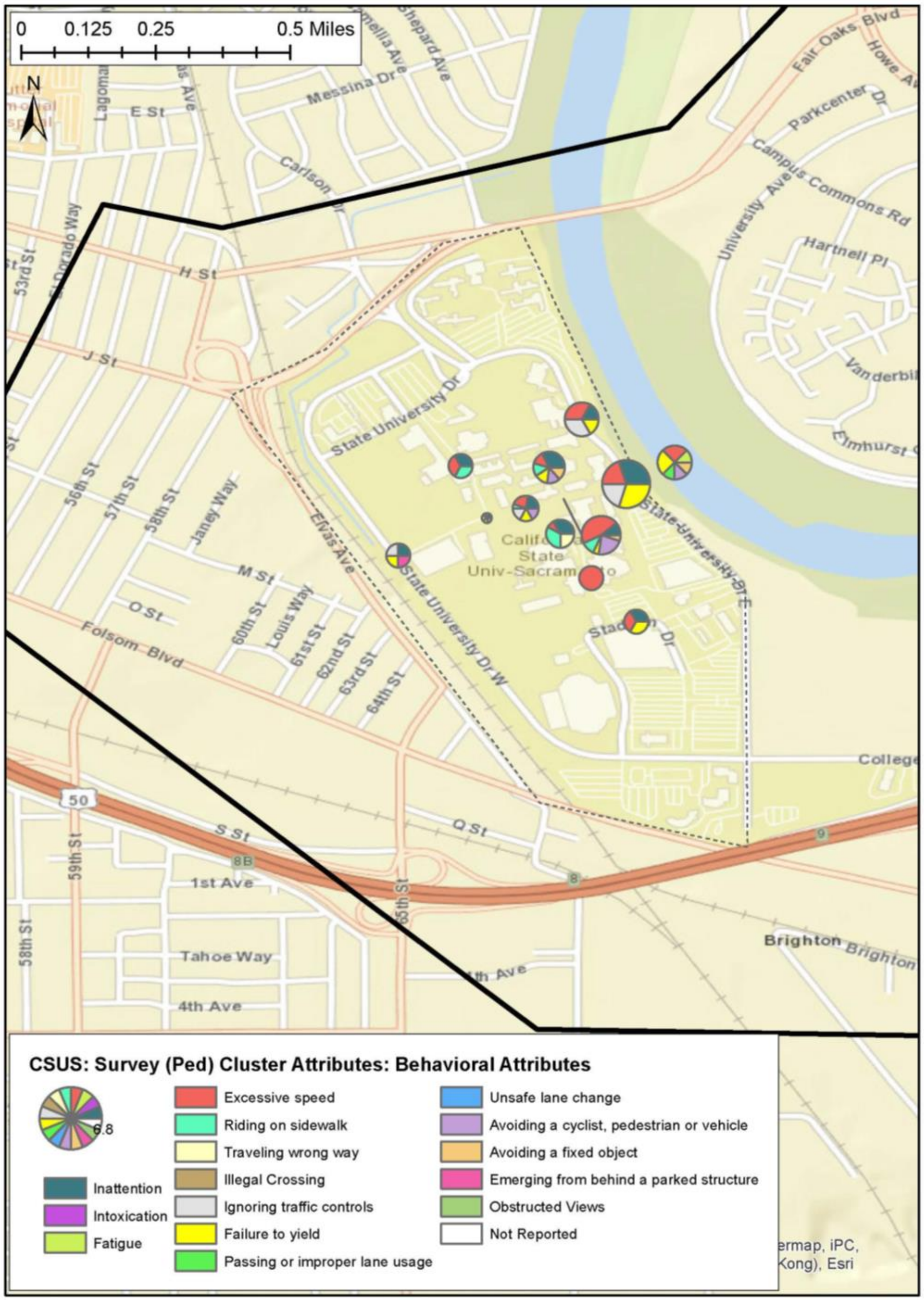


Figure 5.4 CSUS Survey Hotspots (Pedestrian) Contextualized Spatial Clustering by Behavioral Attributes

Some of the major behavioral factors cited by the survey respondents were inattention, excessive speed, and failure to yield as described in Figure 5.4.

5.2.1.1.5 Environmental Attributes

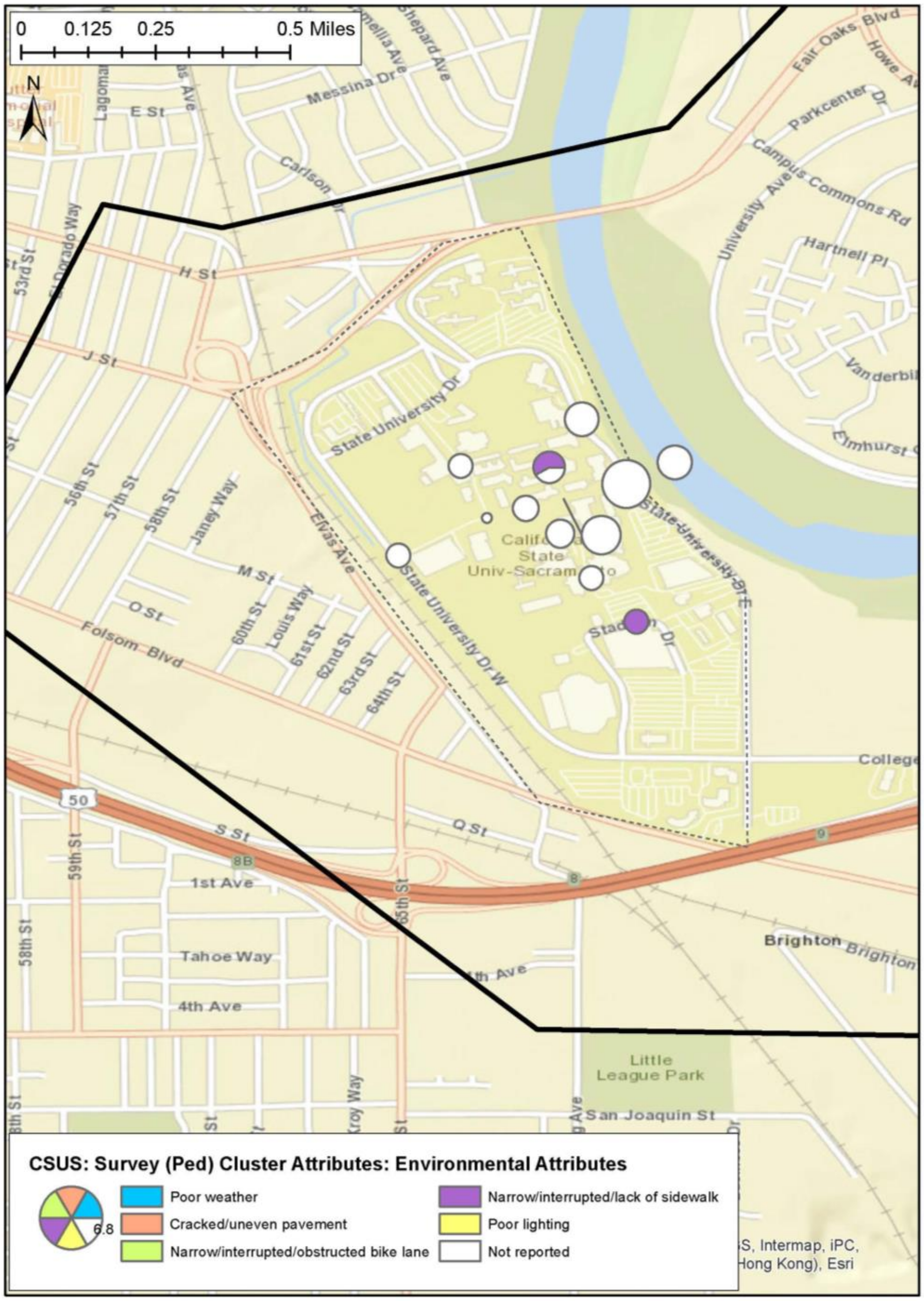


Figure 5.5 CSUS Survey Hotspots (Pedestrian) Contextualized Spatial Clustering by Environmental Attributes

The only environmental attributes listed by the survey respondents were narrow/interrupted/lack of sidewalk. However, it can be seen that Figure 5.5 is sparsely populated, since environmental attributes were not described by the survey respondents for all crashes.

5.2.1.2 Bicycle Crash Hotspots (Table D.2)

5.2.1.2.1 Contact

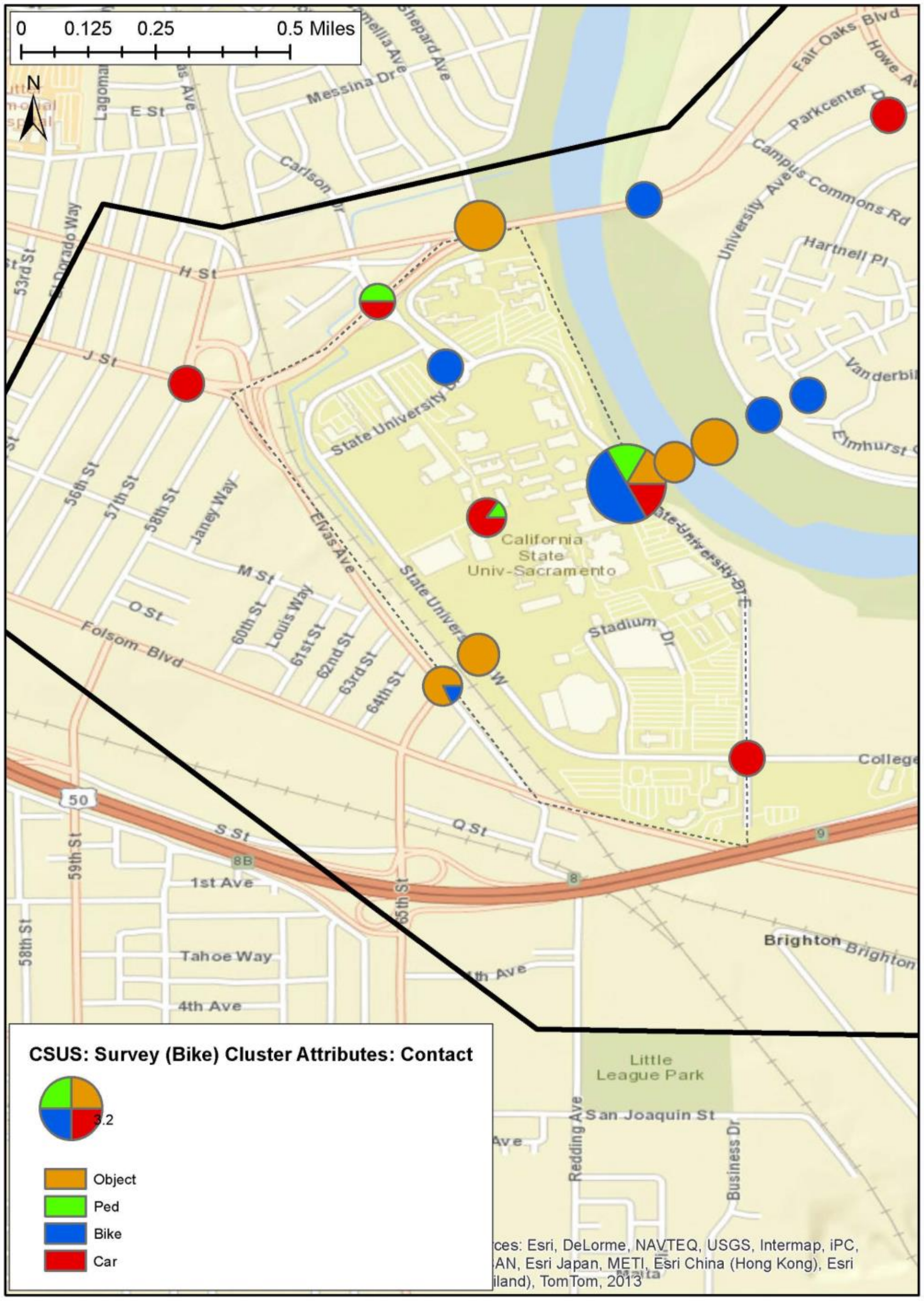


Figure 5.6 CSUS Survey Hotspots (Bike) – Contextualized Spatial Clustering by Contact

In the case of the bicycle crash hotspots, Figure 5.6 shows that bicycles were involved in crashes with a wide mix of modes/objects. In particular, it can be seen that a significant number of bicycle crashes occurred involving objects other than pedestrians, autos or other bicycles.

5.2.1.2.2 Time of Day

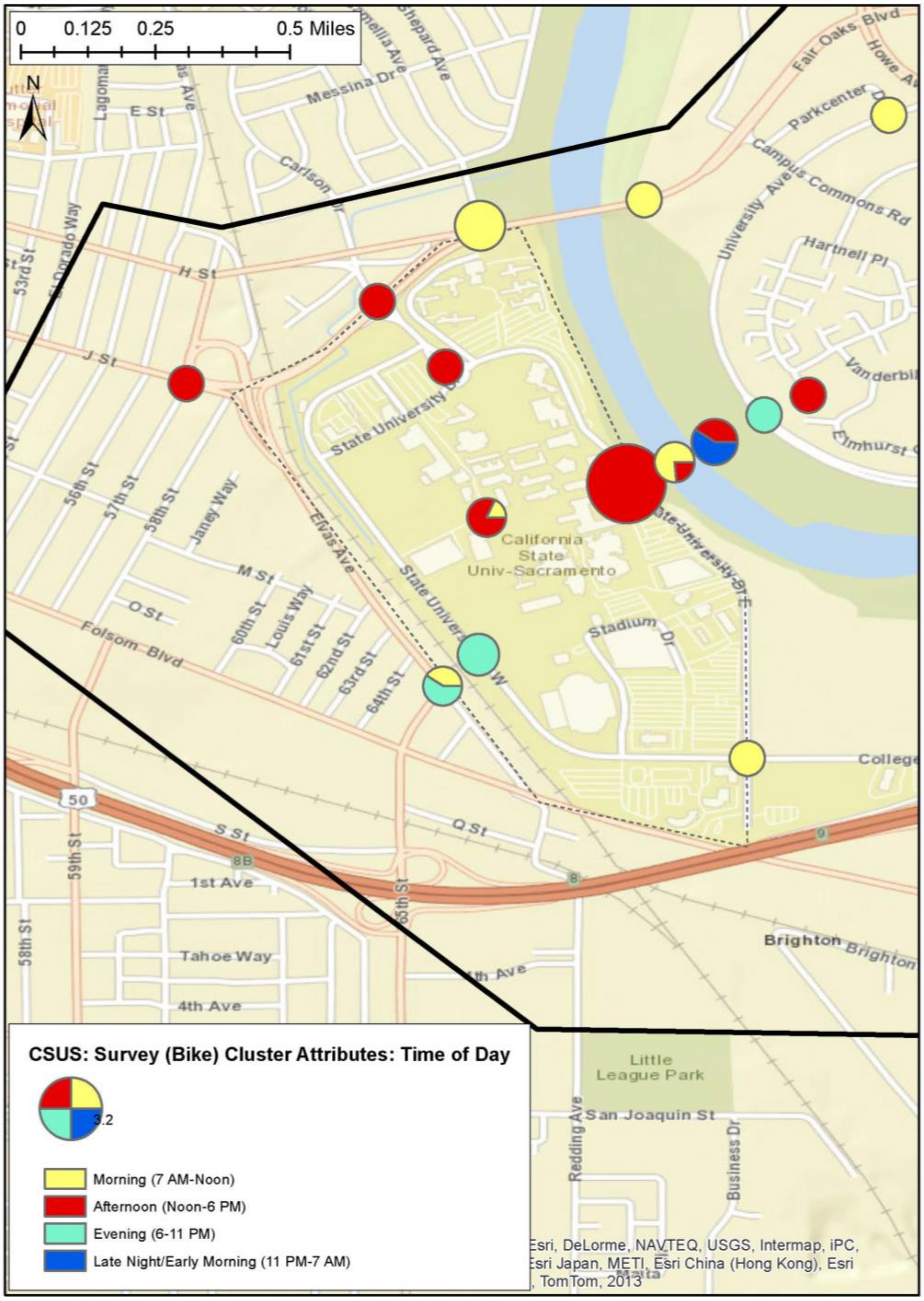


Figure 5.7 CSUS Survey Hotspots (Bike) – Contextualized Spatial Clustering by Time of Day

Unlike the pedestrian crash hotspots, more bicycle crash hotspots involved crashes in the evening and at night, in particular around the arterials. Comparing the results with Figure 5.6, Figure 5.7 shows that most of the evening and late night crashes that occurred involved either other objects or bicycles.

5.2.1.2.3 Injury Severity

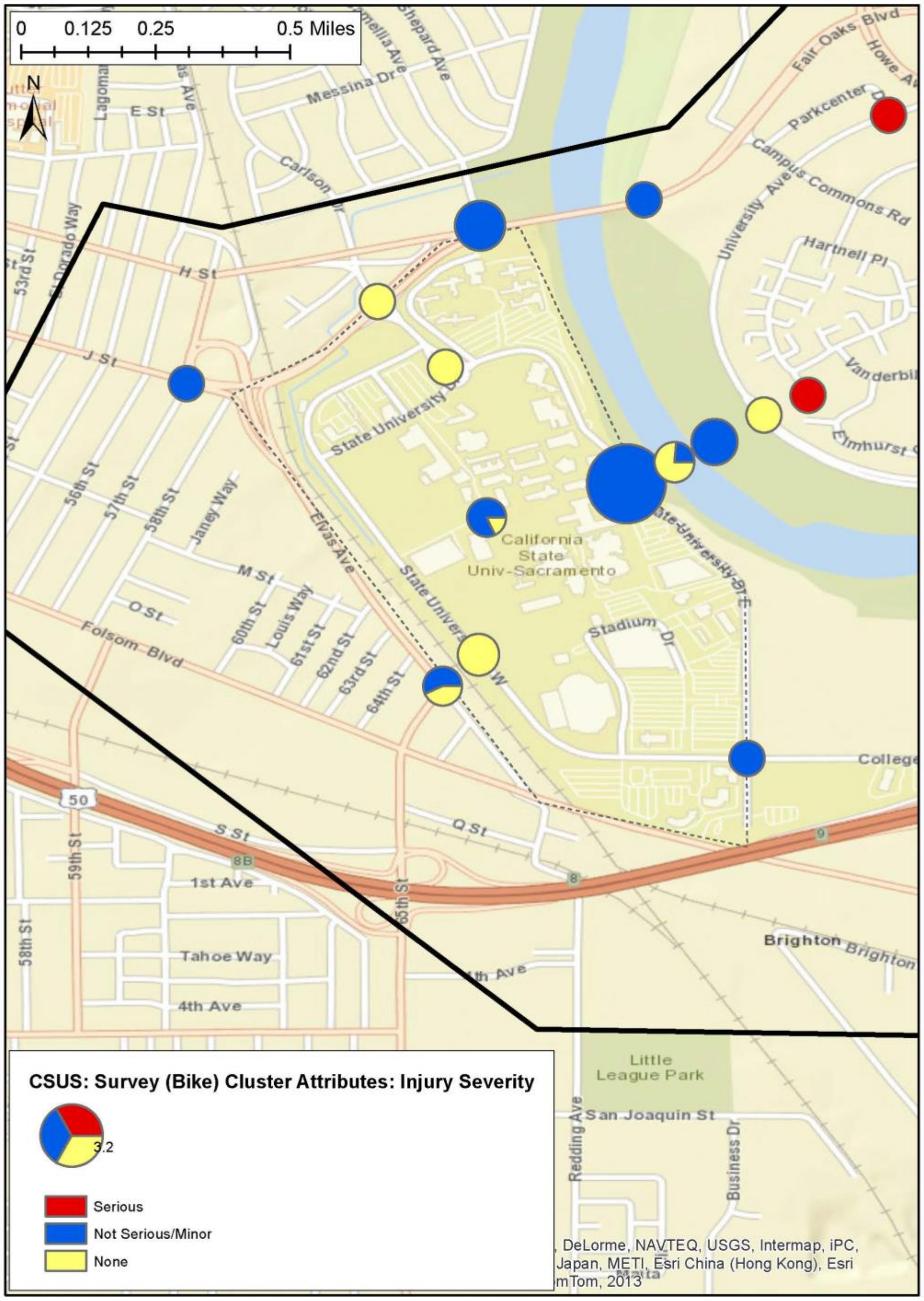


Figure 5.8 CSUS Survey Hotspots (Bike) – Contextualized Spatial Clustering by Injury Severity

When compared to the injury severity associated with the pedestrian crash hotspots (Figure 5.3), Figure 5.8 shows there were more minor injuries associated with bicycle crashes. A possible reason could be higher speeds associated with bicycling.

5.2.1.2.4 Behavioral Attributes

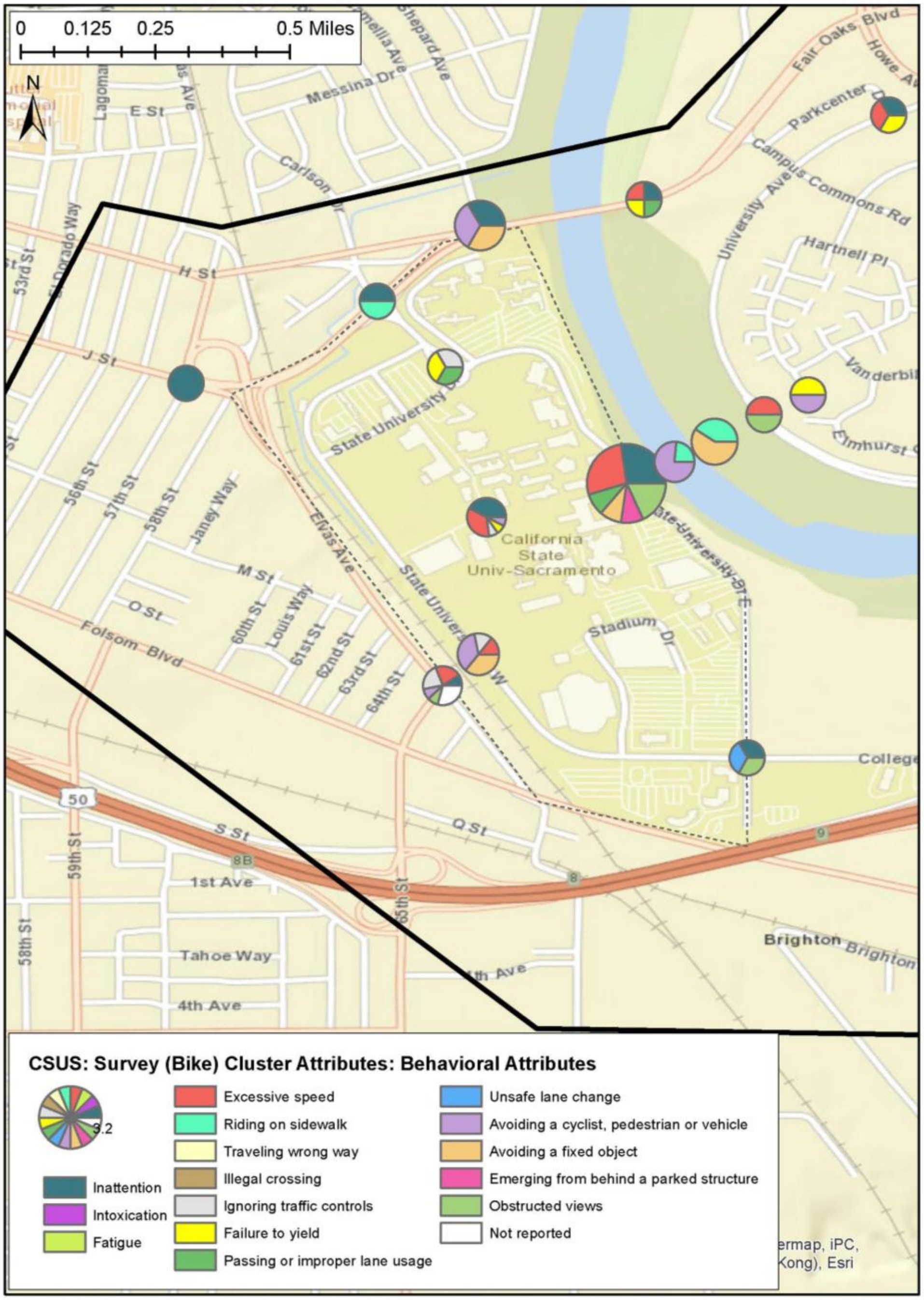


Figure 5.9 CSUS Survey Hotspots (Bike) – Contextualized Spatial Clustering by Behavioral Attributes

The major behavioral attributes associated with the top bicycle crash hotspots were inattention, avoiding a cyclist/pedestrian/vehicle. Along the Guy West Bridge, avoiding objects/vehicles and riding on sidewalks were cited as relevant behavioral factors.

5.2.1.2.5 Environmental Attributes

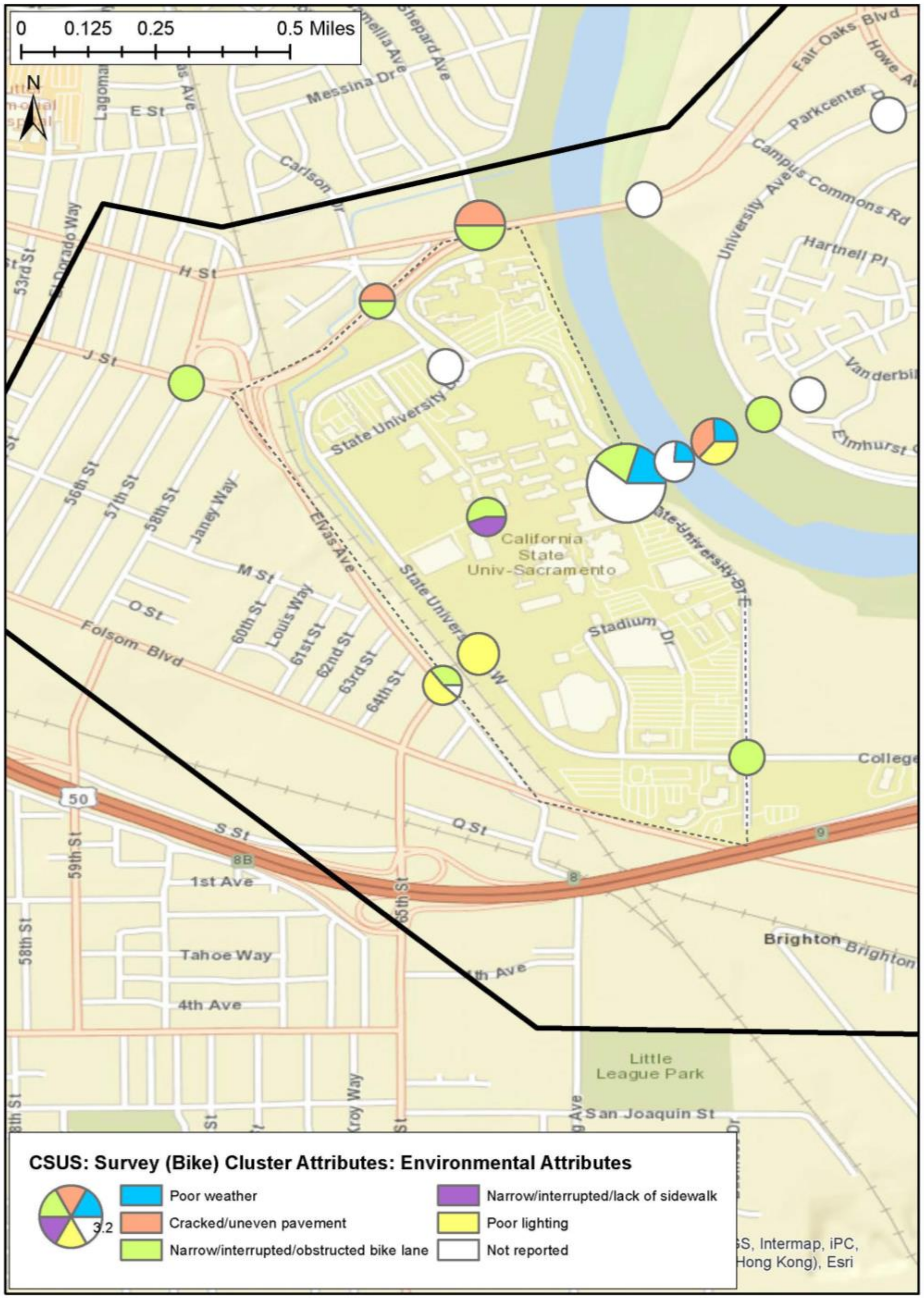


Figure 5.10 CSUS Survey Hotspots (Bike) – Contextualized Spatial Clustering by Environmental Attributes

Figure 5.10 indicated that narrow/interrupted/obstructed bicycle lanes were a concern in different parts of the study area. Poor lighting was also cited as a concern near the intersections of 65th Avenue and Elvas Avenue/ State University Drive West through the Hornet Tunnel. Similarly, poor weather was cited as a relevant factor along the Guy West Bridge.

5.2.2 UCB

5.2.2.1 Pedestrian Crash Hotspots (Table D.3)

5.2.2.1.1 Contact

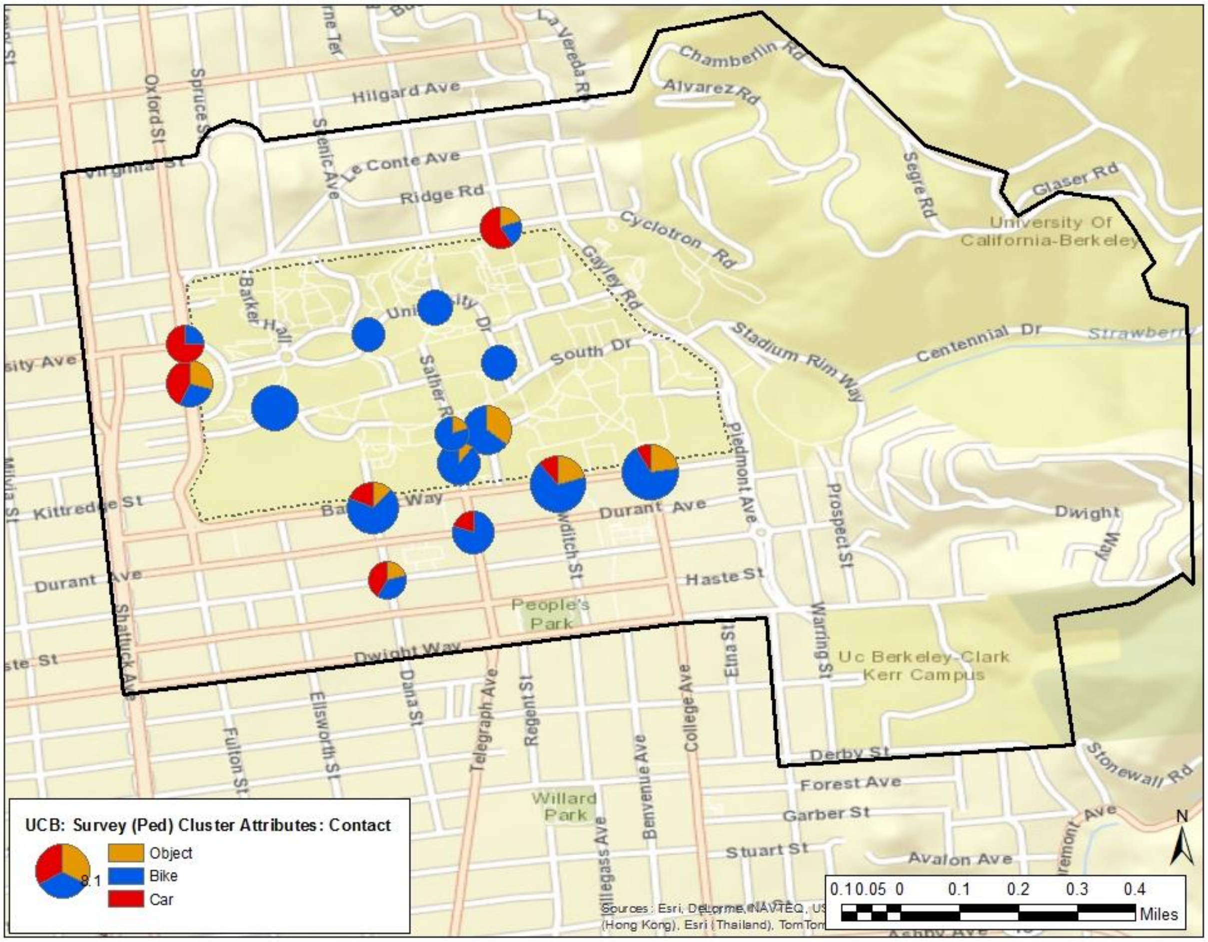


Figure 5.11 UCB Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Contact

Figure 5.11 shows that UCB’s top pedestrian crash hotspots involved a significant number of pedestrian-bicycle collisions. This pattern was particularly distinct from the CSUS campus.

Most of the pedestrian crashes involving autos were outside of the main campus area.

5.2.2.1.2 Time of Day

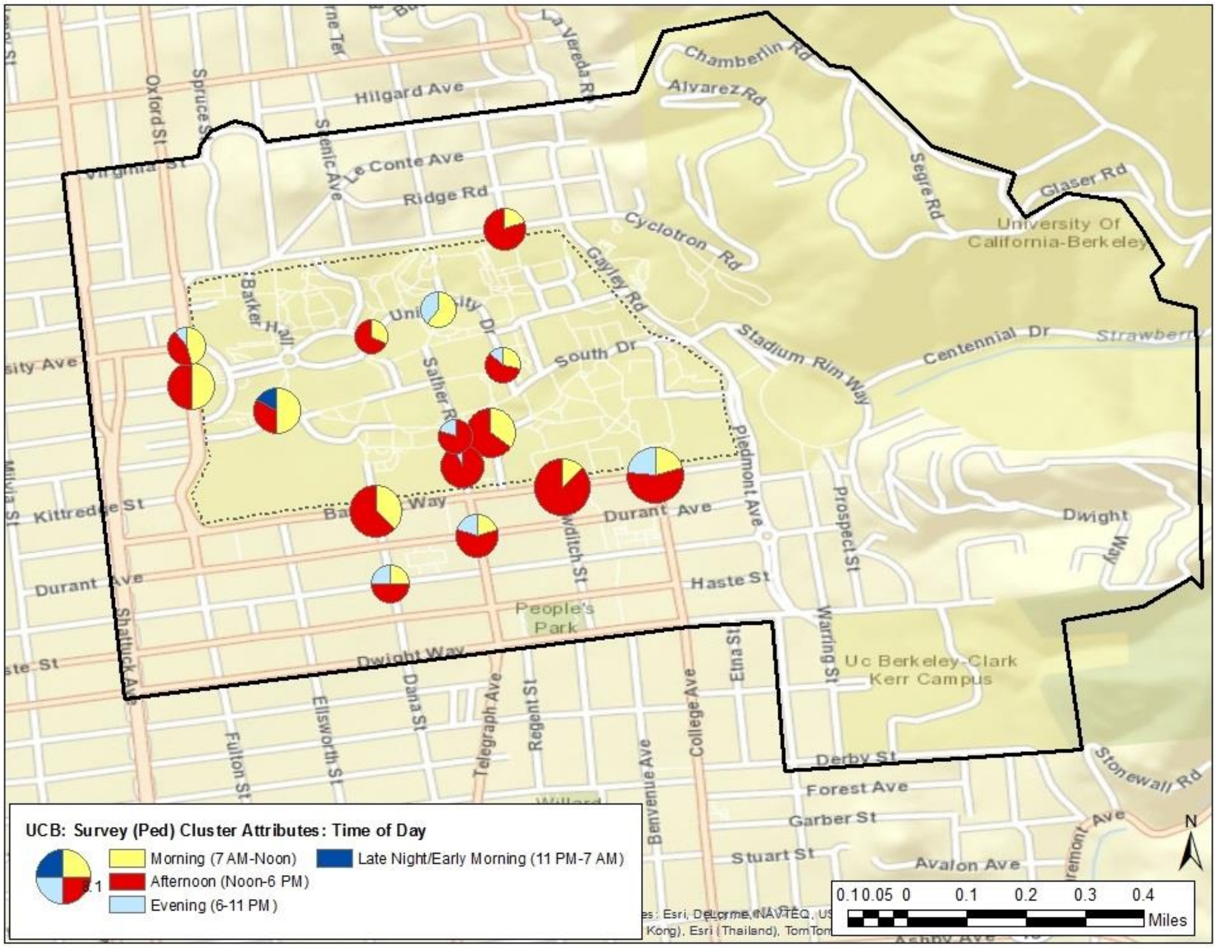


Figure 5.12 UCB Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Time of Day

Similar to the CSUS campus, most of the pedestrian crashes occurred during the day as illustrated in Figure 5.12.

5.2.2.1.3 Injury Severity

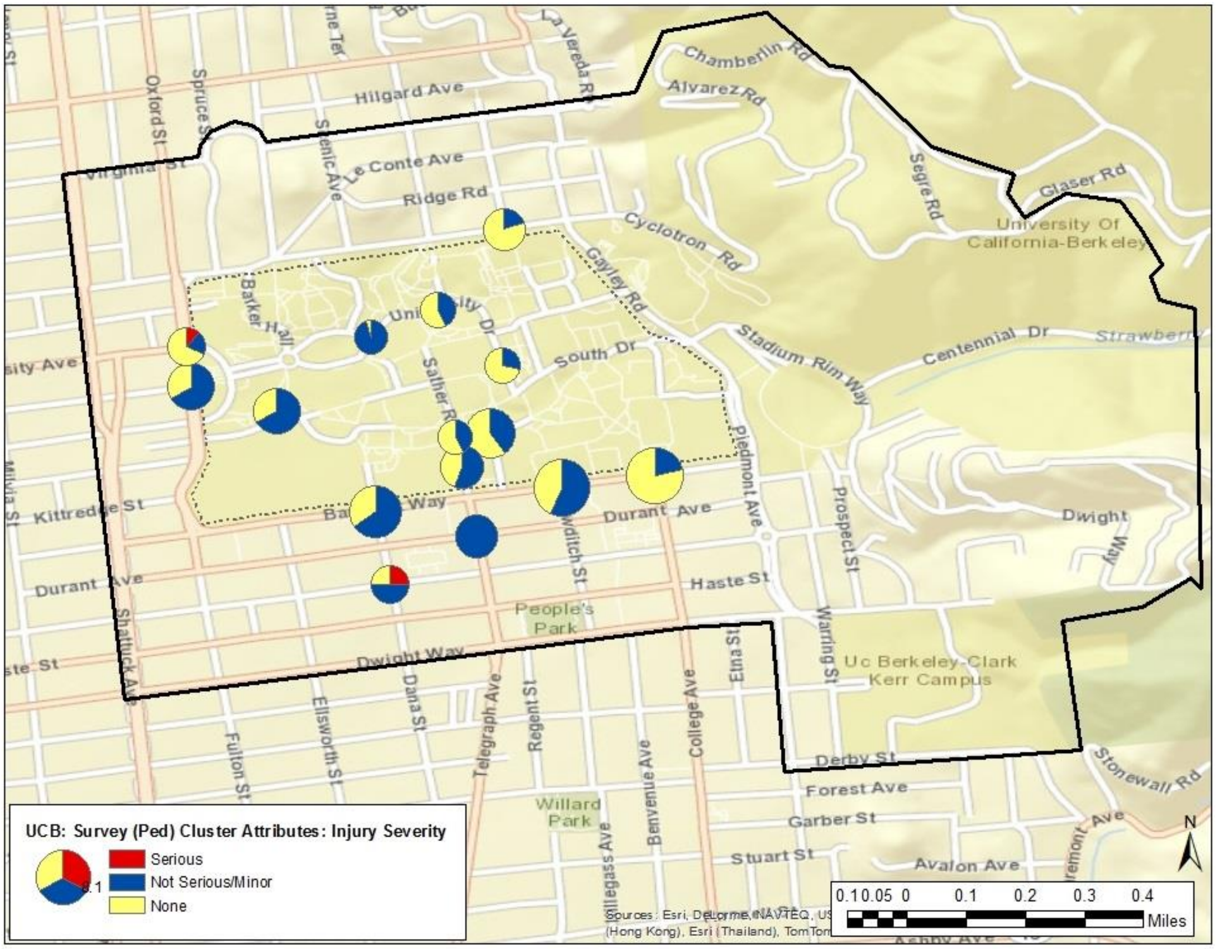


Figure 5.13 UCB Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Injury Severity

Figure 5.13 shows that most of the pedestrian crashes at hotspots resulted in either non-serious or no injuries.

The trends inside and outside of the main campus areas were largely identical, except for the presence of a few serious crashes outside the main campus area.

5.2.2.1.4 Behavioral Attributes

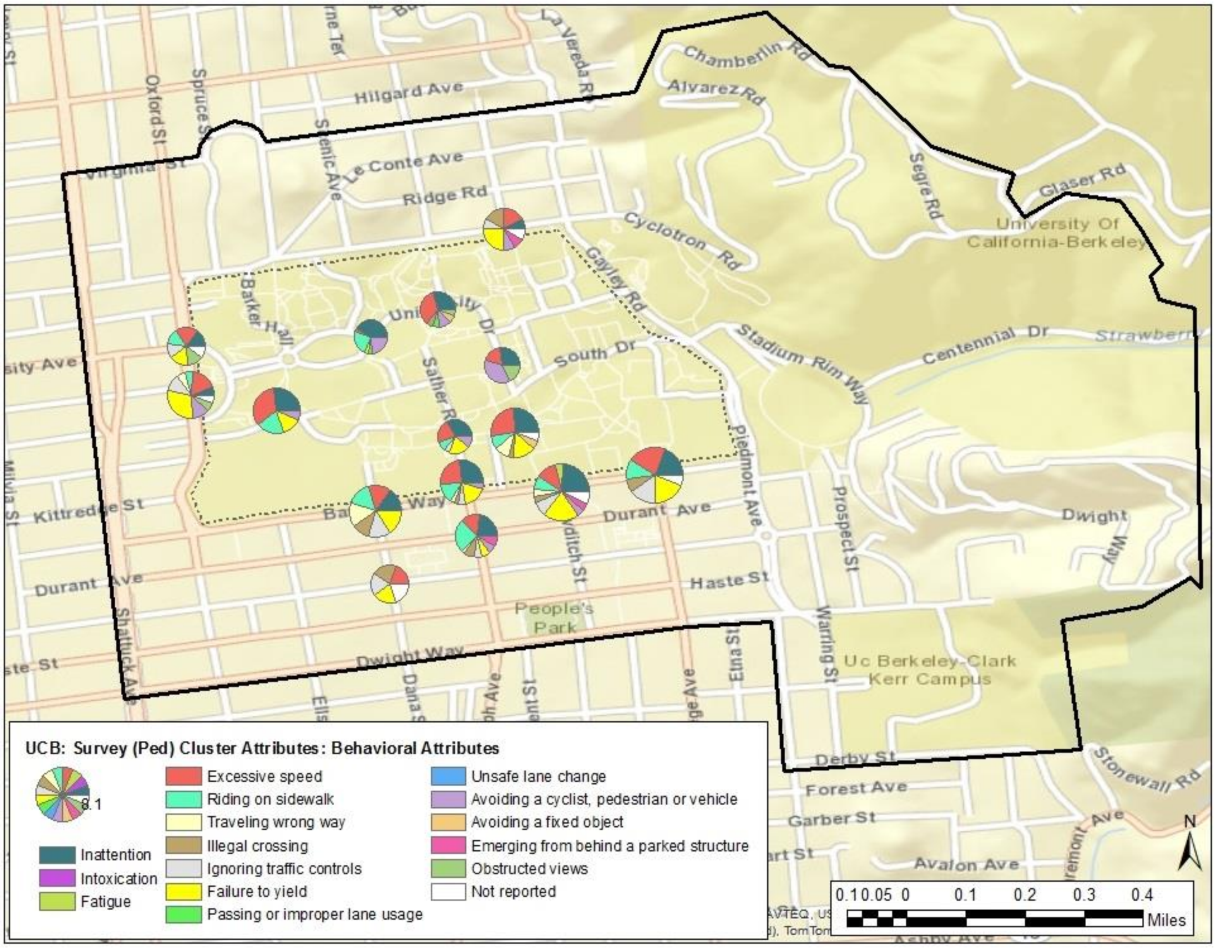


Figure 5.14 UCB Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Behavioral Attributes

As in the case of CSUS, inattention and excessive speed were commonly cited as relevant behavioral attributes for crashes at UCB as depicted in Figure 5.14. In addition, failure to yield was a significant attribute among the hotspots lying outside the main campus area.

5.2.2.1.5 Environmental Attributes

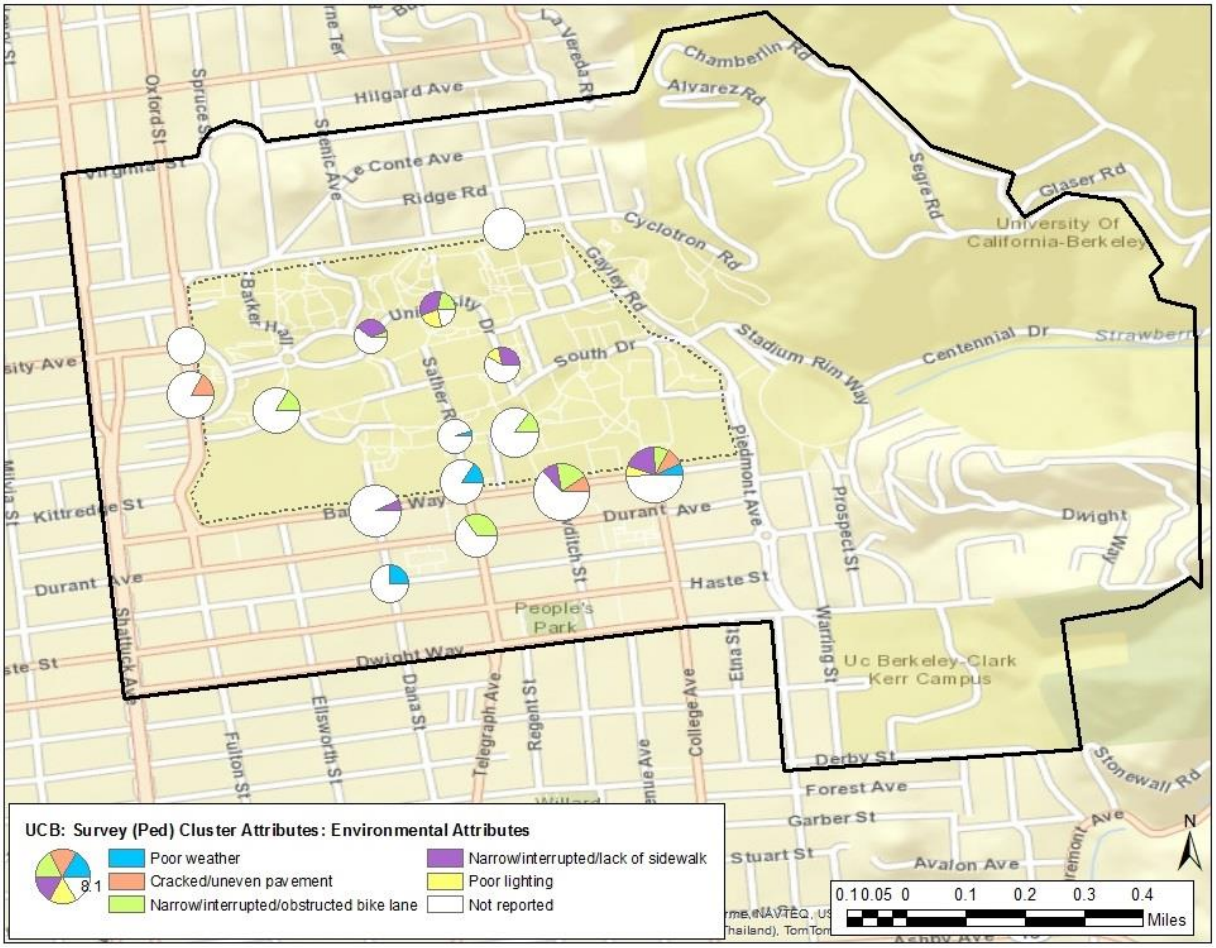


Figure 5.15 UCB Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Environmental Attributes

Figure 5.15 shows that details about the environmental attributes were not provided in a majority of survey responses. In terms of environmental factors indicated, lack of sidewalks and bicycle lanes were important factors among the pedestrian crash hotspots. In particular, the hotspots around Sproul Plaza indicated poor weather as being a factor.

5.2.2.2 Bicycle Crash Hotspots (Table D.4)

5.2.2.2.1 Contact

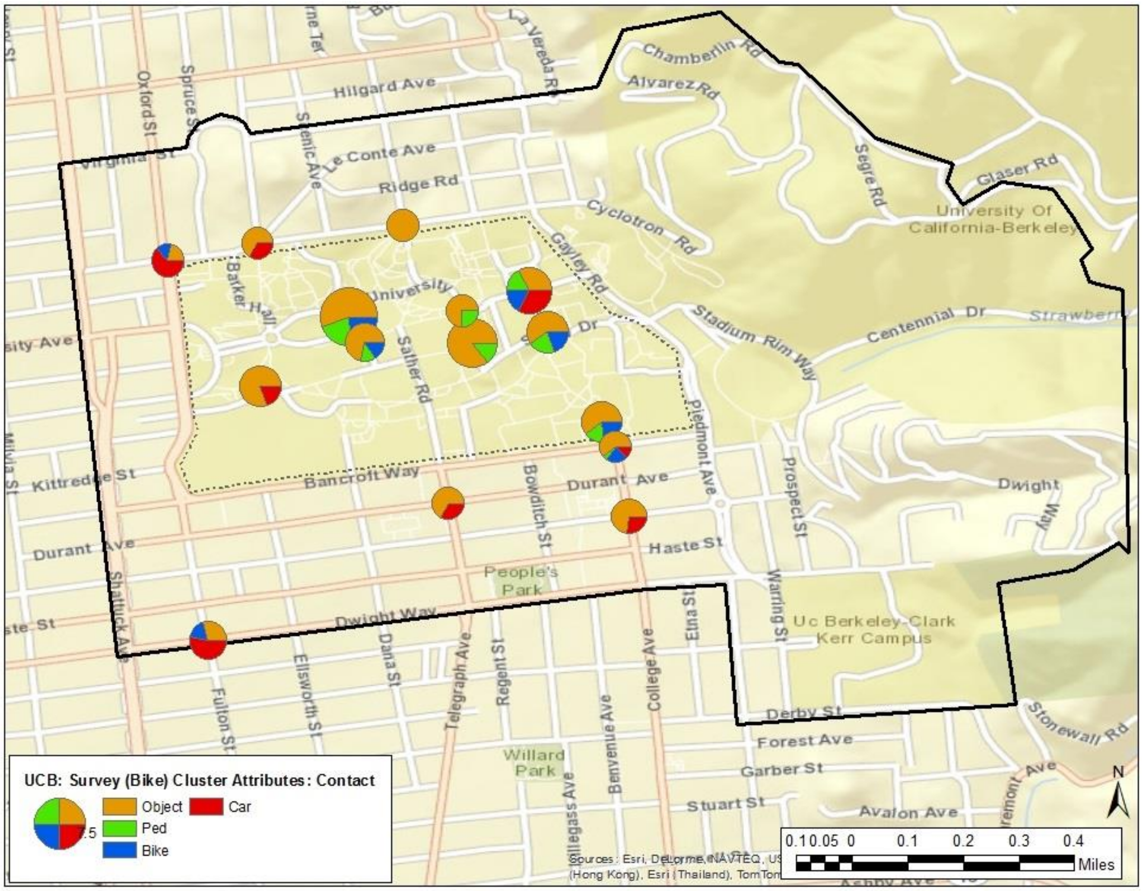


Figure 5.16 UCB Survey Hotspots (Bike) – Contextualized Spatial Clustering by Contact

Figure 5.16 shows an interesting observation pertaining to UCB's bicycle crash hotspots in that most of the bicycle crashes involved contact with objects other than autos, bicycles, or pedestrians.

5.2.2.2.2 Time of Day

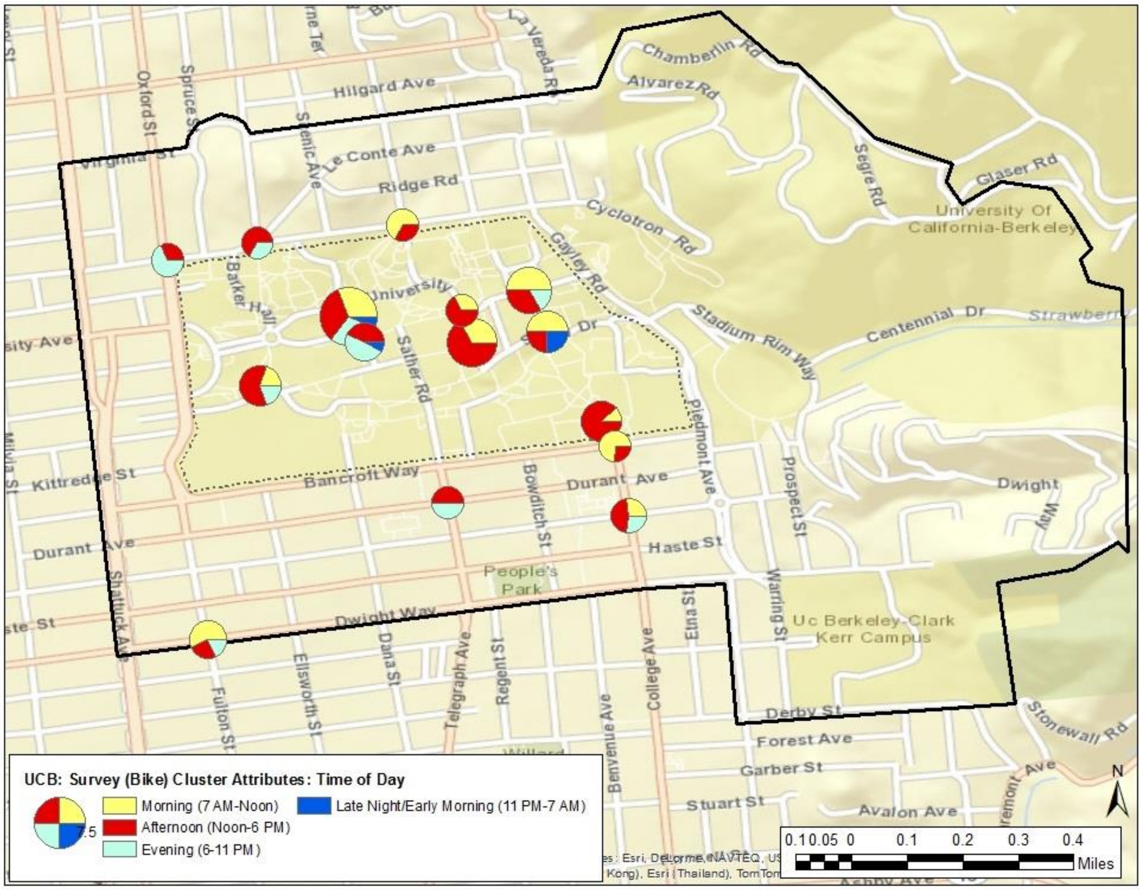


Figure 5.17 UCB Survey Hotspots (Bike) — Contextualized Spatial Clustering by Time of Day

Figure 5.17 shows that similar to bicycle crash hotspots at CSUS, a significant portion of the bicycle crashes at UCB occurred in the evening/night, both within and outside of the main campus area.

5.2.2.2.3 Injury Severity

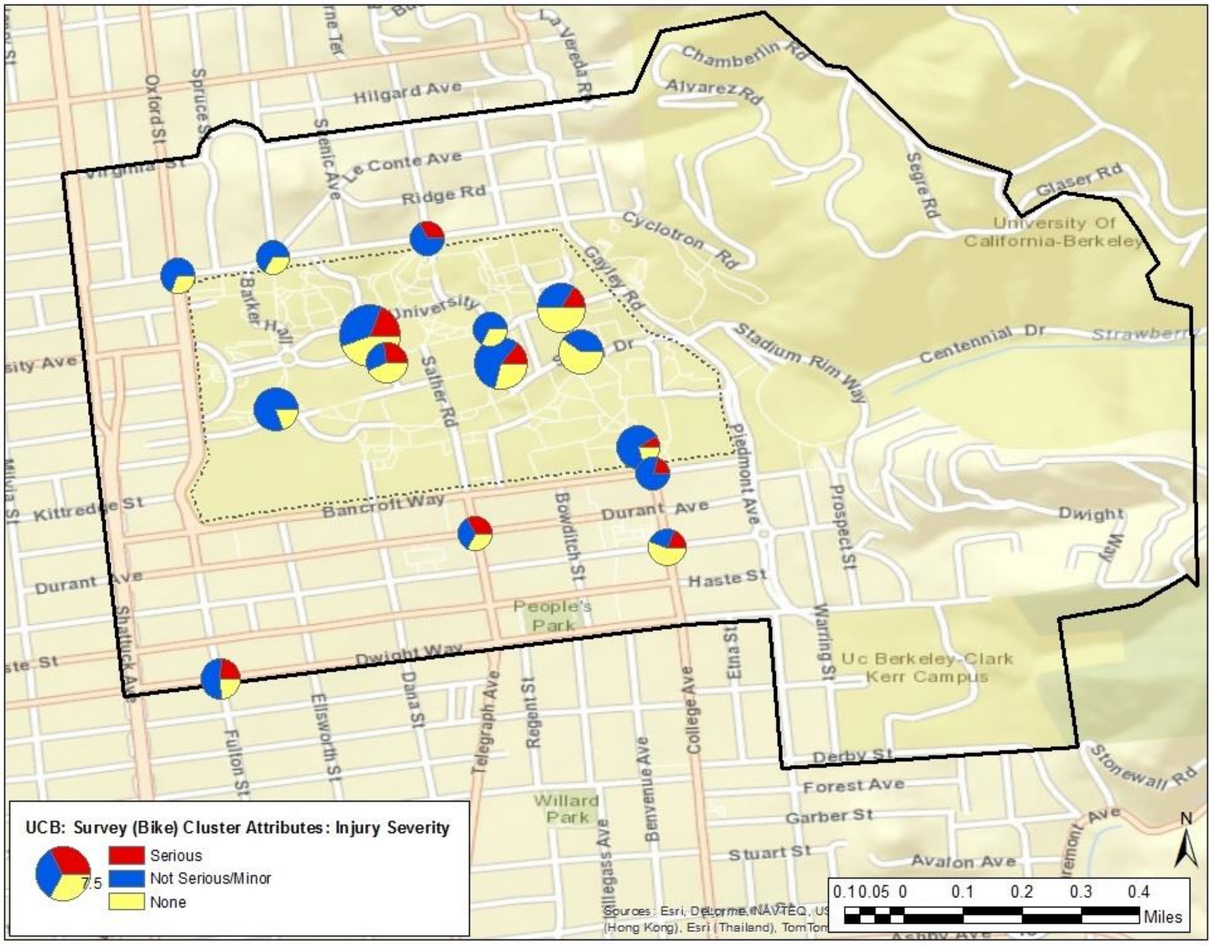


Figure 5.18 UCB Survey Hotspots (Bike) — Contextualized Spatial Clustering by Injury Severity

Figure 5.18 shows that unlike CSUS and the pedestrian crash hotspots at UCB, the bicycle crash hotspots had a higher concentration of severe and non-serious crashes.

5.2.2.2.4 Behavioral Attributes

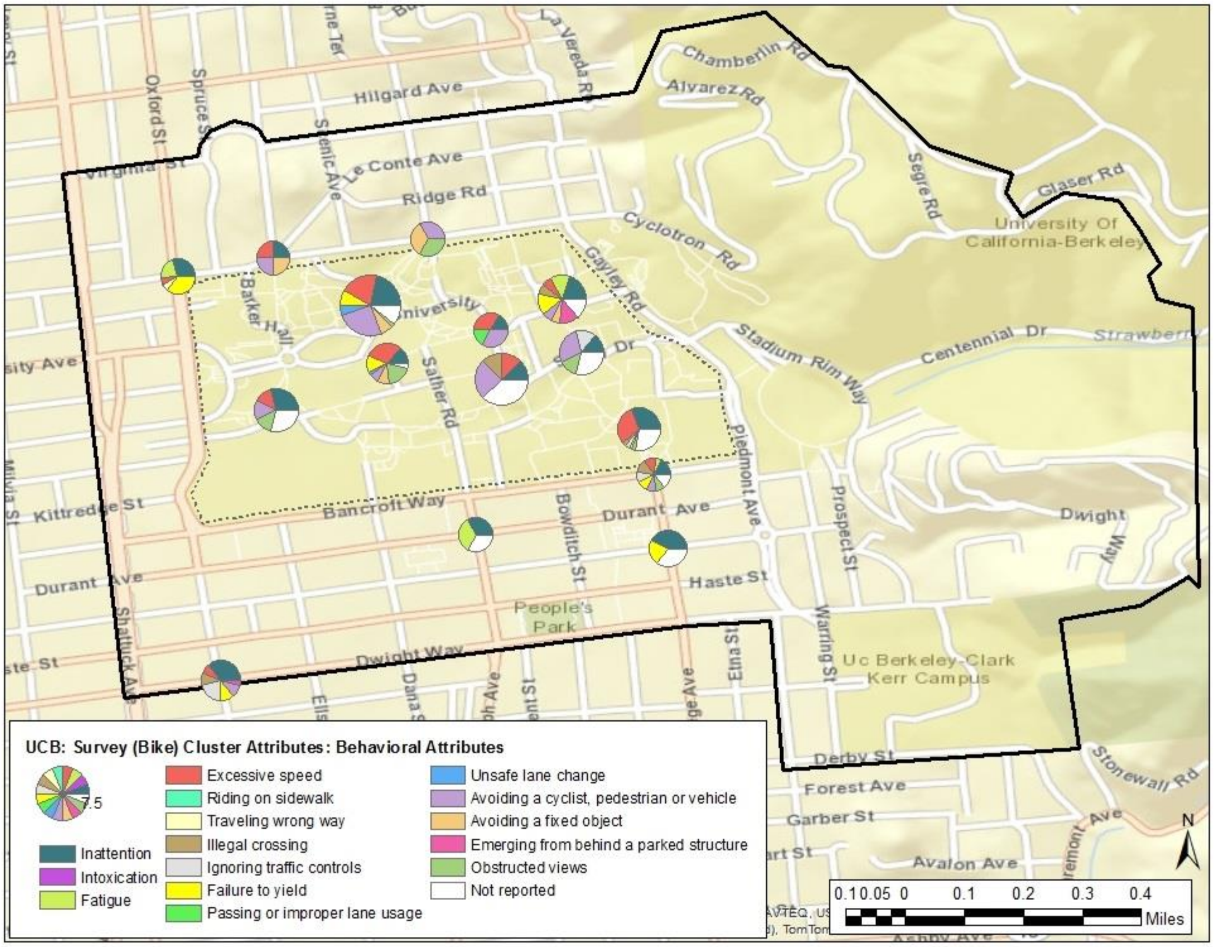


Figure 5.19 UCB Survey Hotspots (Bike) – Contextualized Spatial Clustering by Behavioral Attributes

Inattention, excessive speed and avoiding a bicyclist, pedestrian or vehicle were the top behavioral factors among UCB's bicycle crash hotspots as illustrated in Figure 5.19. In particular, excessive speed and avoiding other modes of travel seemed to be of significant concern within the campus.

5.2.2.2.5 Environmental Attributes

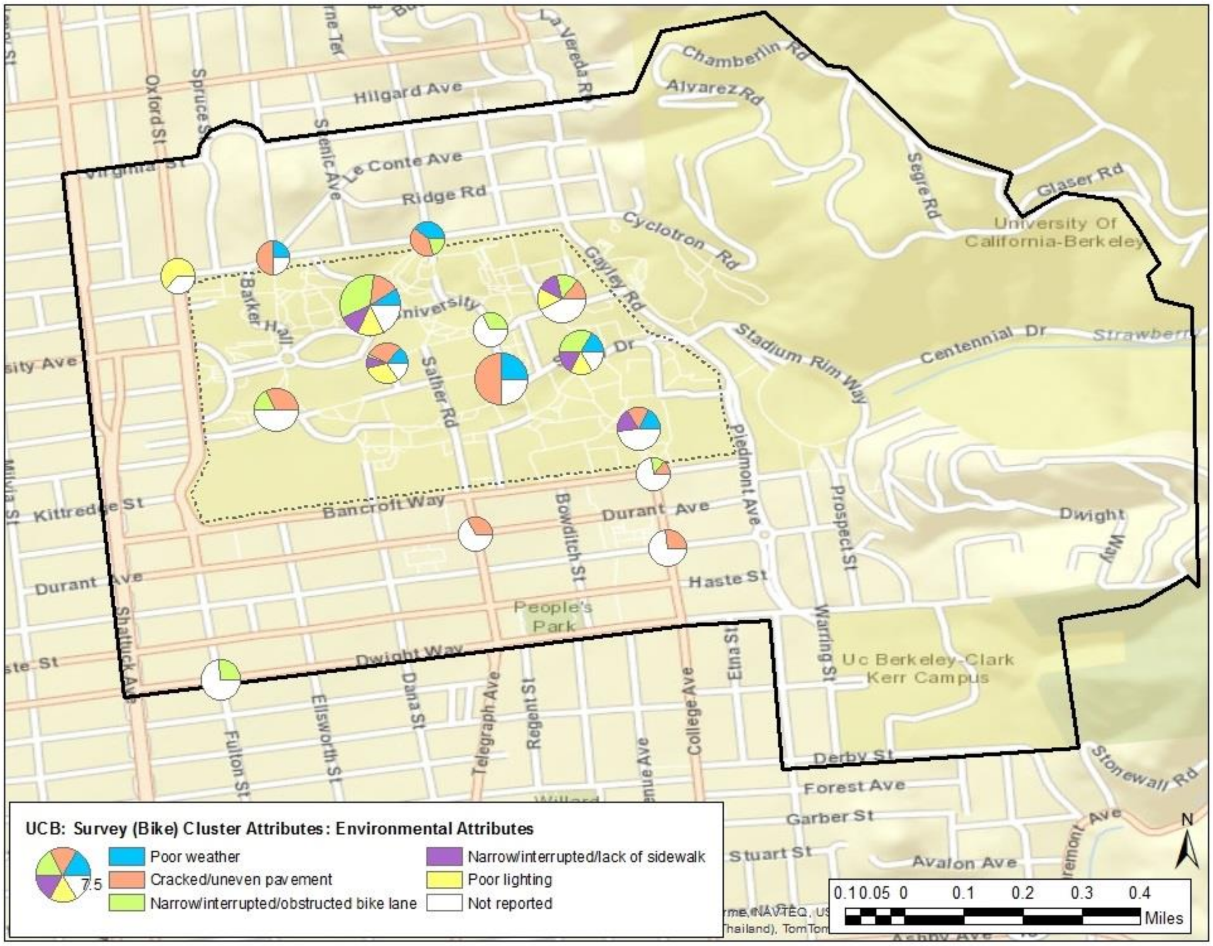


Figure 5.20 UCB Survey Hotspots (Bike) – Contextualized Spatial Clustering by Environmental Attributes

Figure 5.20 shows that the most prominent environmental factors for the bicycle crashes were obstructed bicycle lanes/sidewalks (possibly due the presence of multi-use paths), while cracked pavements were cited as a problem in most of the hotspots.

5.2.3 UCLA

5.2.3.1 Pedestrian Crash Hotspots

5.2.3.1.1 Contact

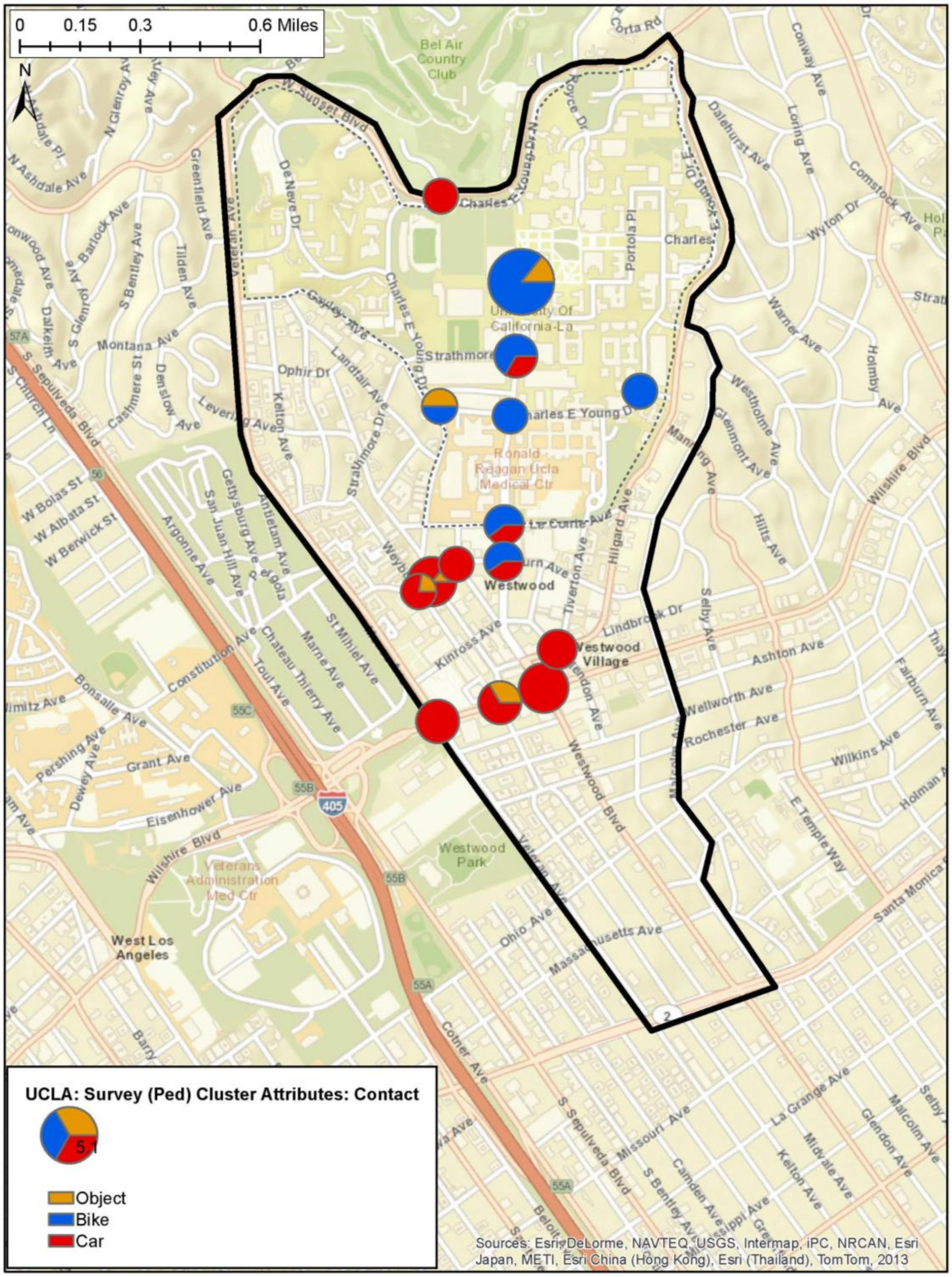


Figure 5.21 UCLA Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Contact

The primary mode of contact in pedestrian crashes was bicycles on campus and autos off campus at UCLA as shown in Figure 5.21.

5.2.3.1.2 Time of Day

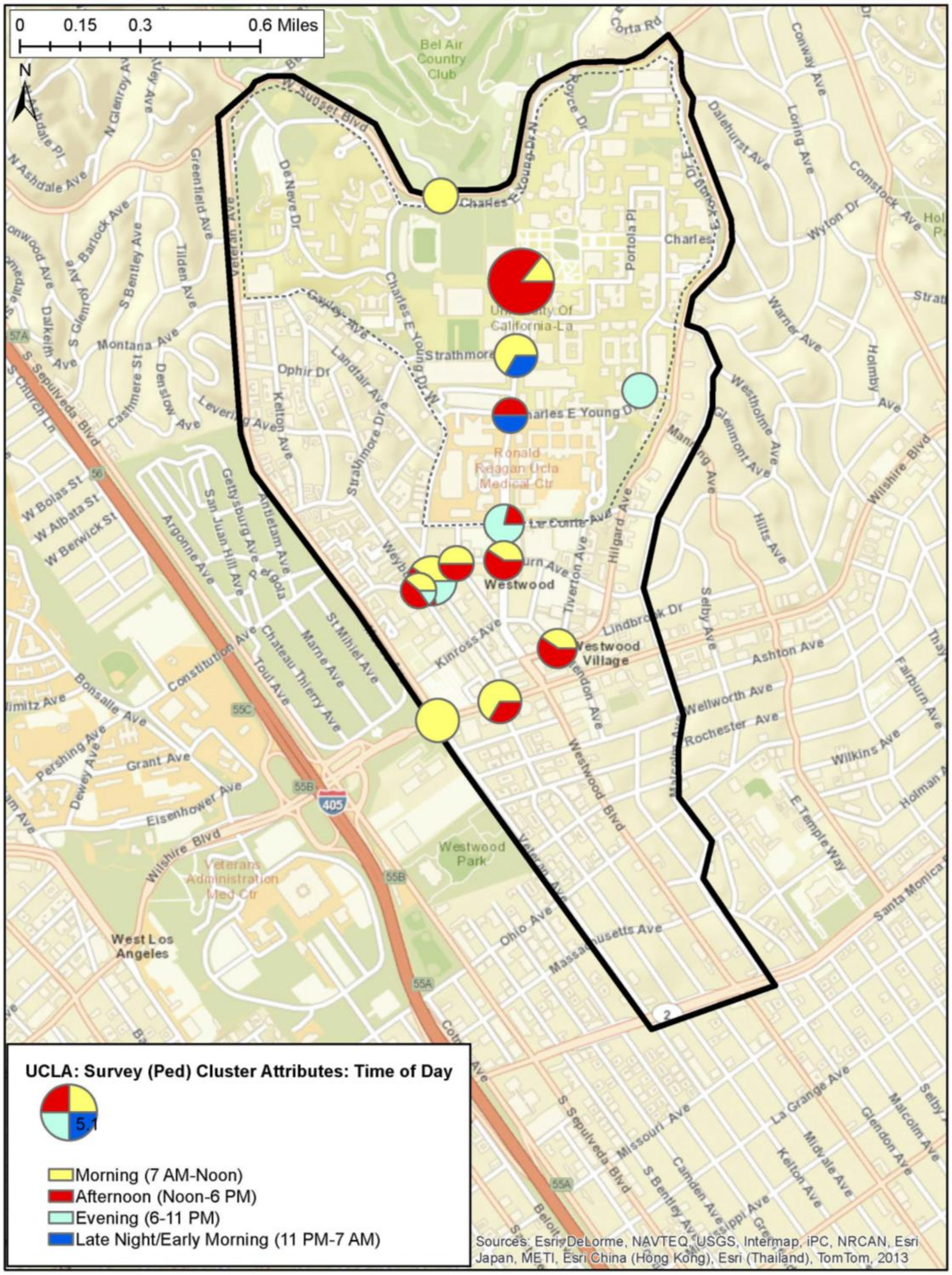


Figure 5.22 UCLA Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Time of Day

Figure 5.22 shows that the pedestrian crashes occurred across all time periods at UCLA campus. However, crashes during the evening and late night were more common closer to the main campus area.

5.2.3.1.3 Injury Severity

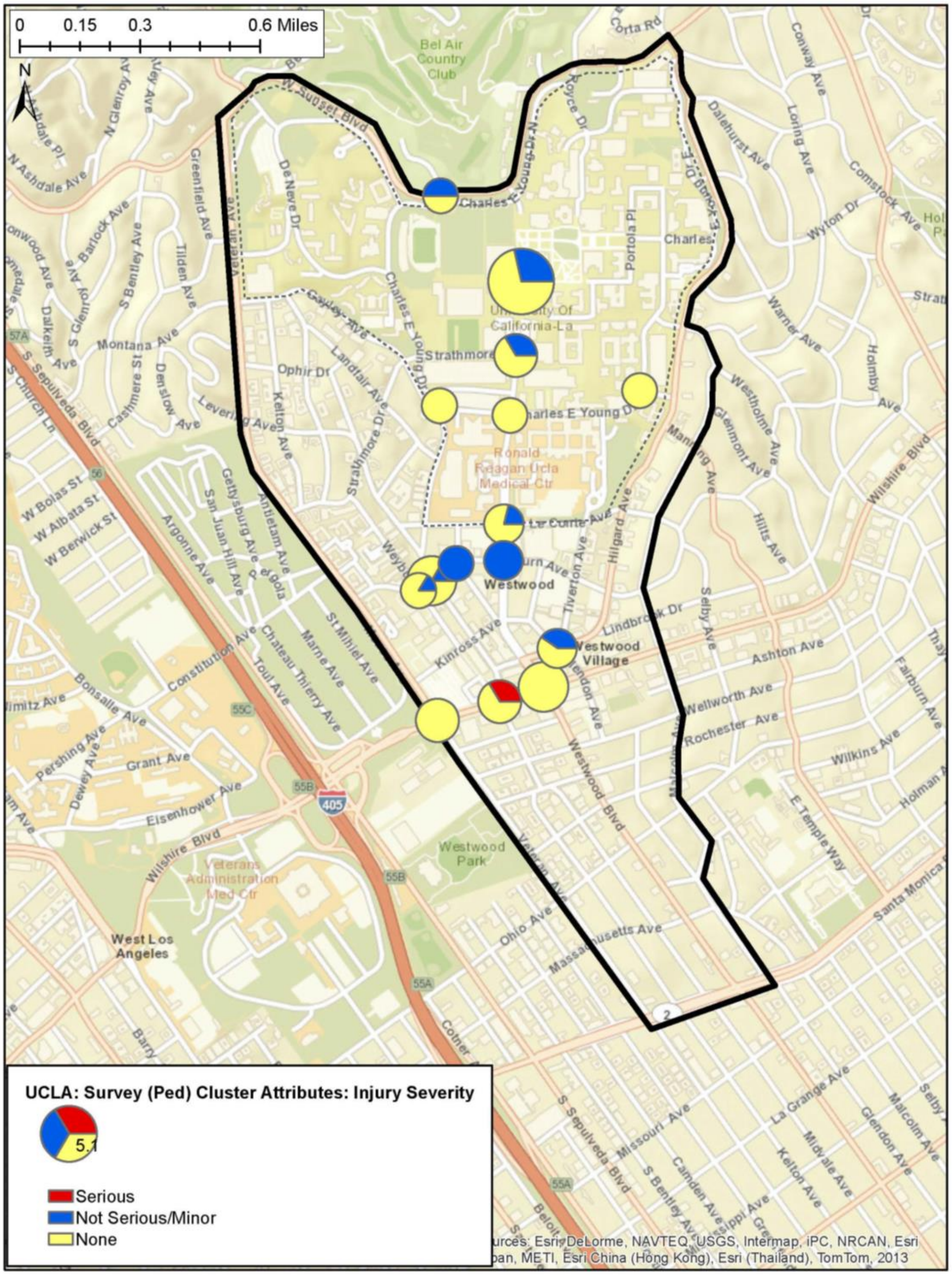


Figure 5.23 UCLA Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Injury Severity

The on-campus pedestrian crash hotspots predominantly included crashes without any injuries. However, crashes with some non-serious/minor injuries occurred near Westwood Blvd. and Weyburn Ave. as shown in Figure 5.23

5.2.4 Behavioral Attributes

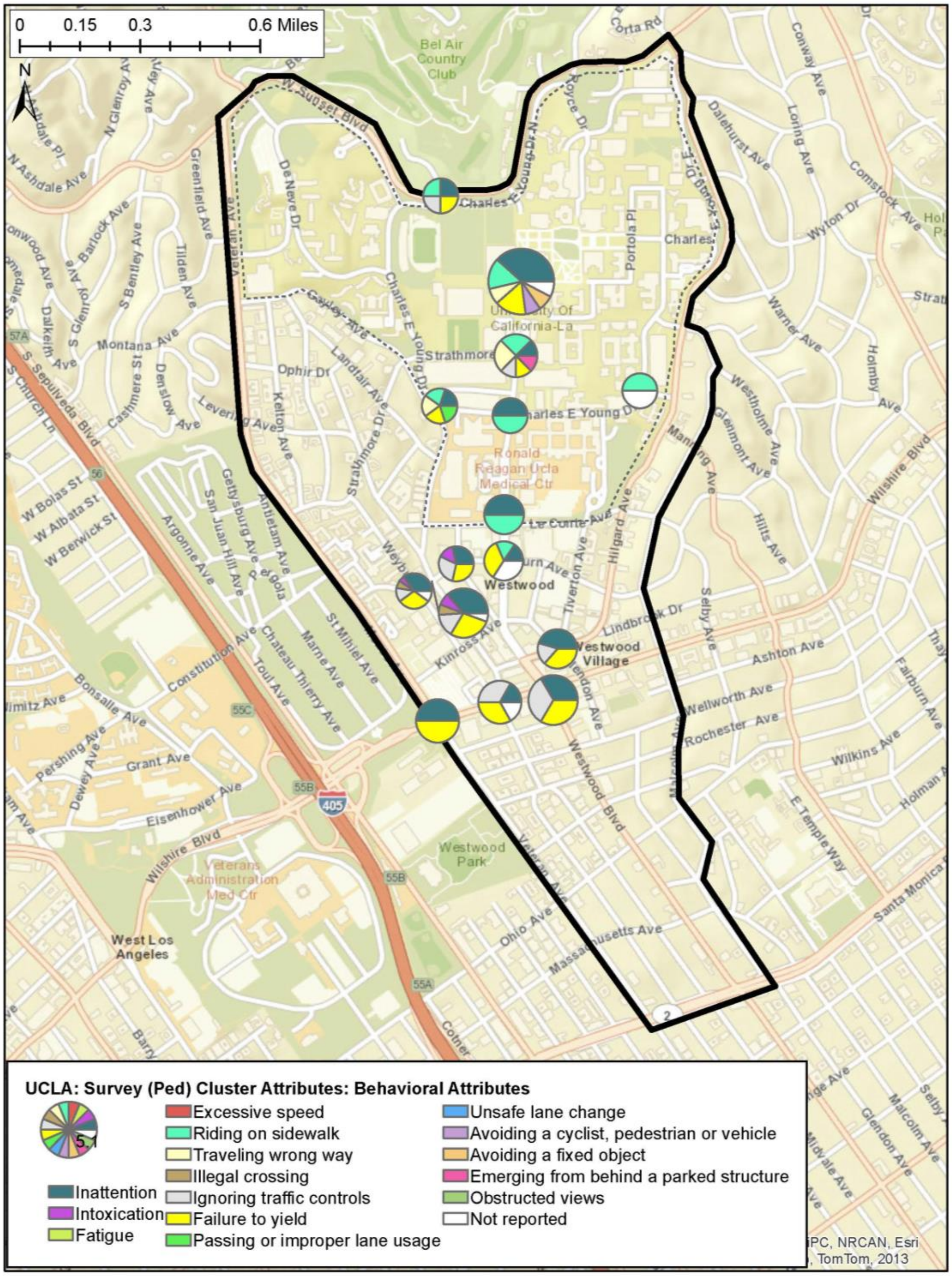


Figure 5.24 UCLA Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Behavioral Attributes

The primary behavioral attributes were inattention (both on- and off-campus areas), riding on sidewalks (on campus), failure to yield and ignoring traffic controls (outside of the main campus area) at UCLA campus pedestrian crash hotspots as shown in Figure 5.24

5.2.3.1.5 Environmental Attributes

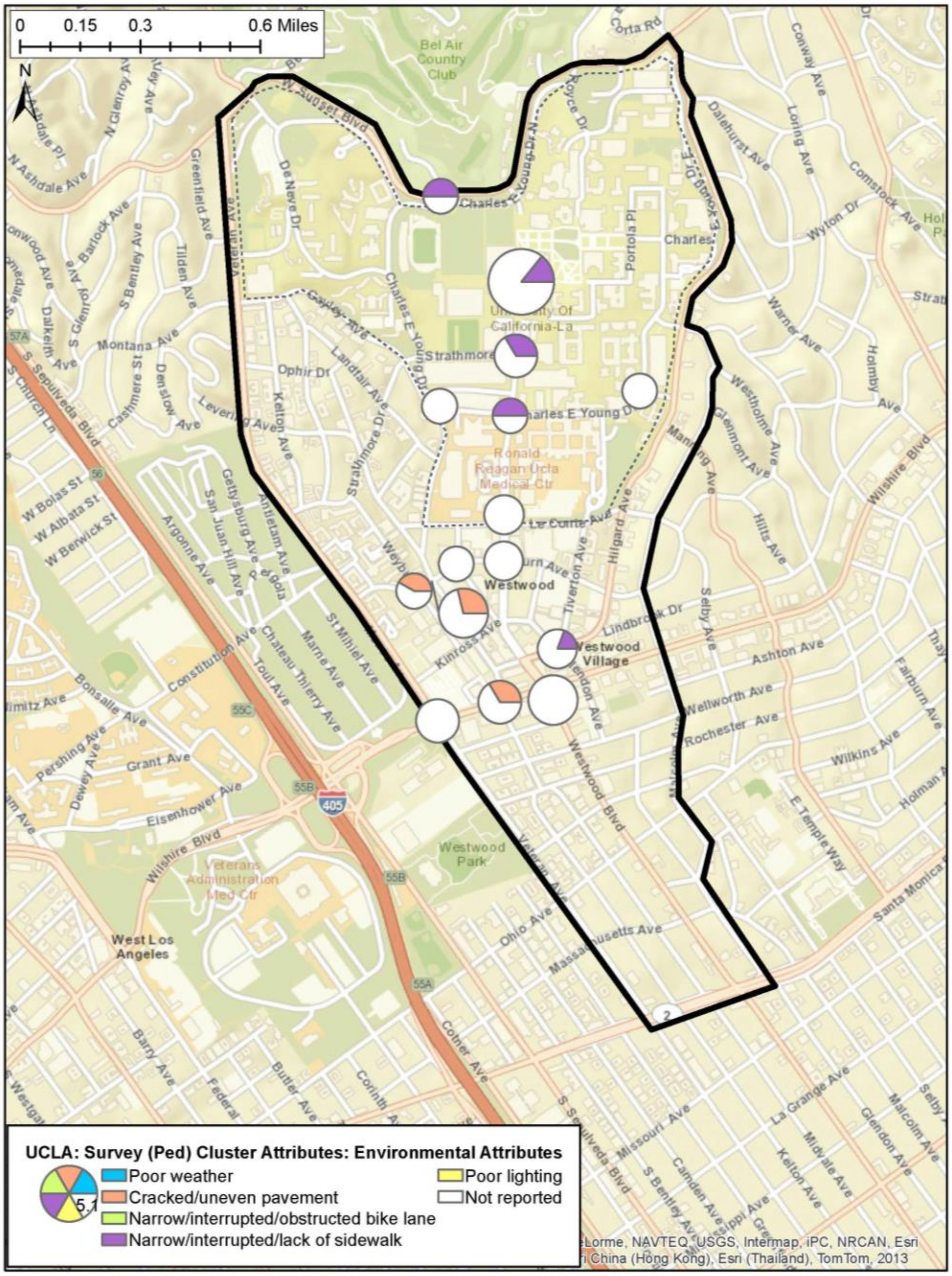


Figure 5.25 UCLA Survey Hotspots (Pedestrian) – Contextualized Spatial Clustering by Environmental Attributes

The on-campus pedestrian crash hotspots indicated that the underlying crashes involved narrow/interrupted sidewalks as shown in Figure 5.25. Similarly, the off-campus locations showed that cracked/uneven pavements were relevant environmental factors. However, since only a fraction of the crashes contained information about the environmental factors, it might be misleading to believe that all the crashes associated with the hotspots shared the same characteristics.

5.2.3.2 Bicycle Crash Hotspots

5.2.3.2.1 Contact

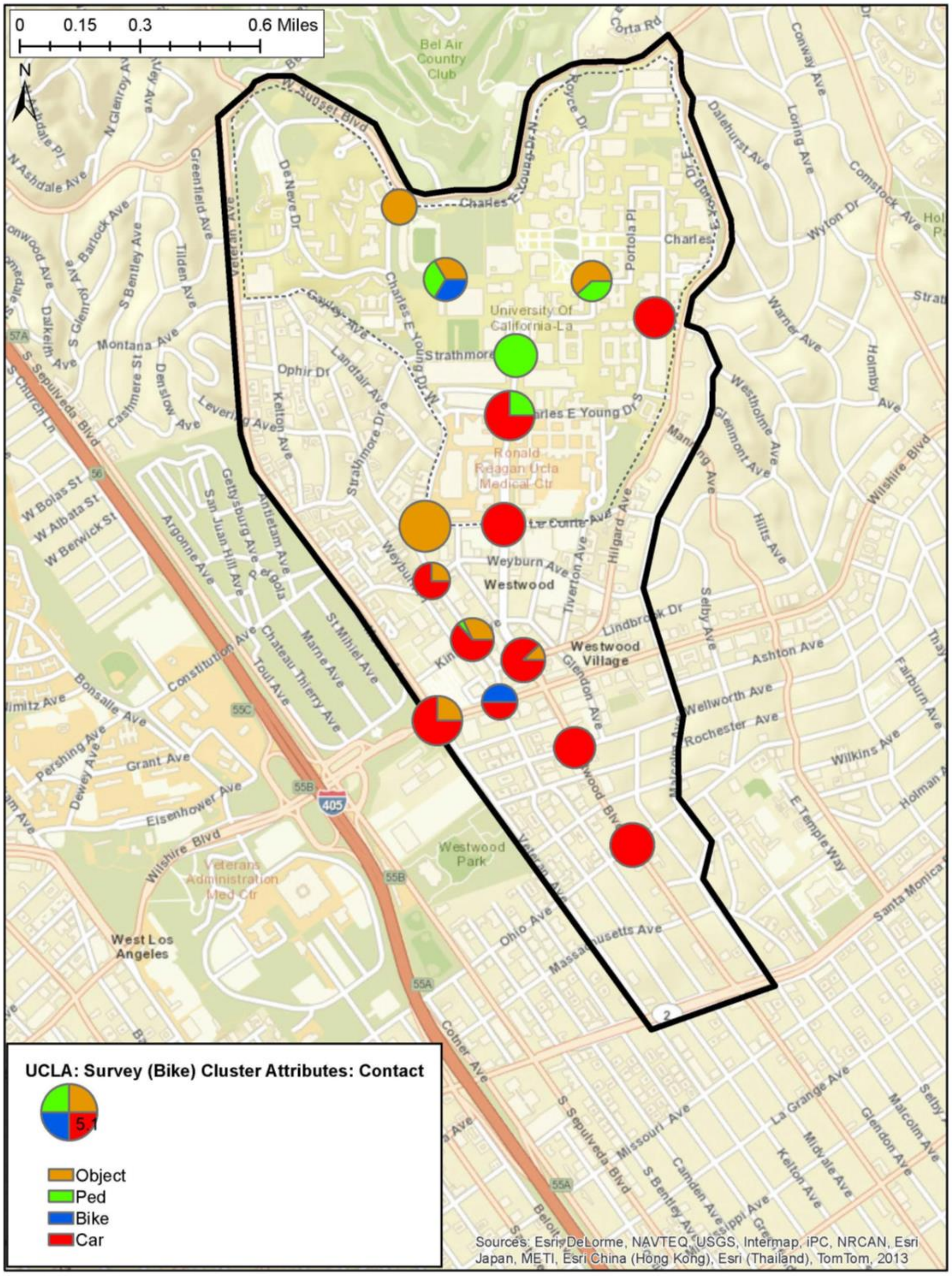


Figure 5.26 UCLA Survey Hotspots (Bicycle) – Contextualized Spatial Clustering by Contact

The UCLA bicycle crash hotspots had a mix of different mode types/objects involved as illustrated in Figure 5.26. However, most bicycle crashes outside of the main campus area had contact with autos.

5.2.3.2.2 Time of Day

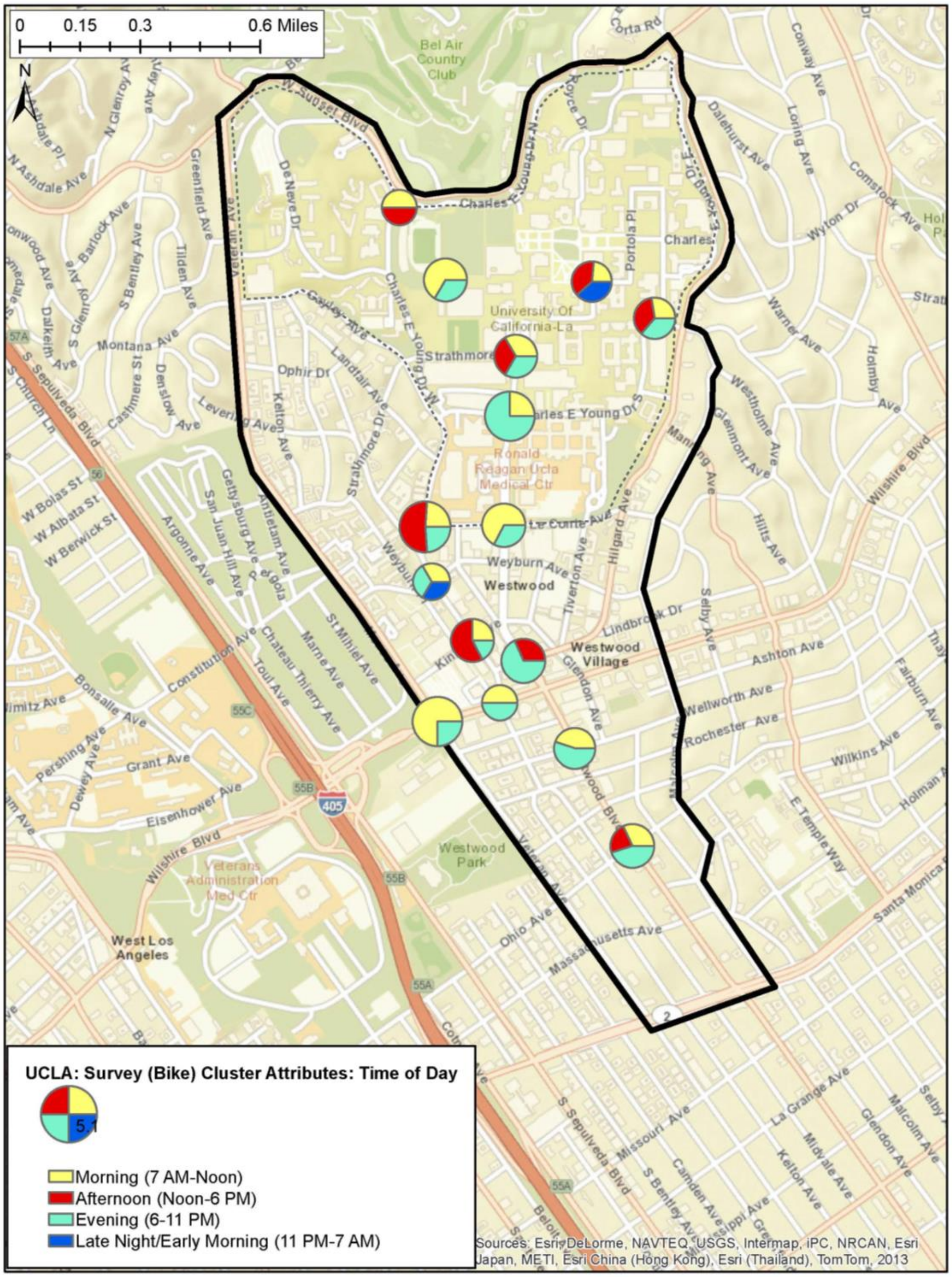


Figure 5.27 UCLA Survey Hotspots (Bicycle) – Contextualized Spatial Clustering by Time of Day

In comparison to CSUS and UCB, there were a large number of bicycle crash hotspots at UCLA involving crashes occurring during the evening, both inside and outside of the main campus area as shown in Figure 5.27.

5.2.3.2.3 Injury Severity

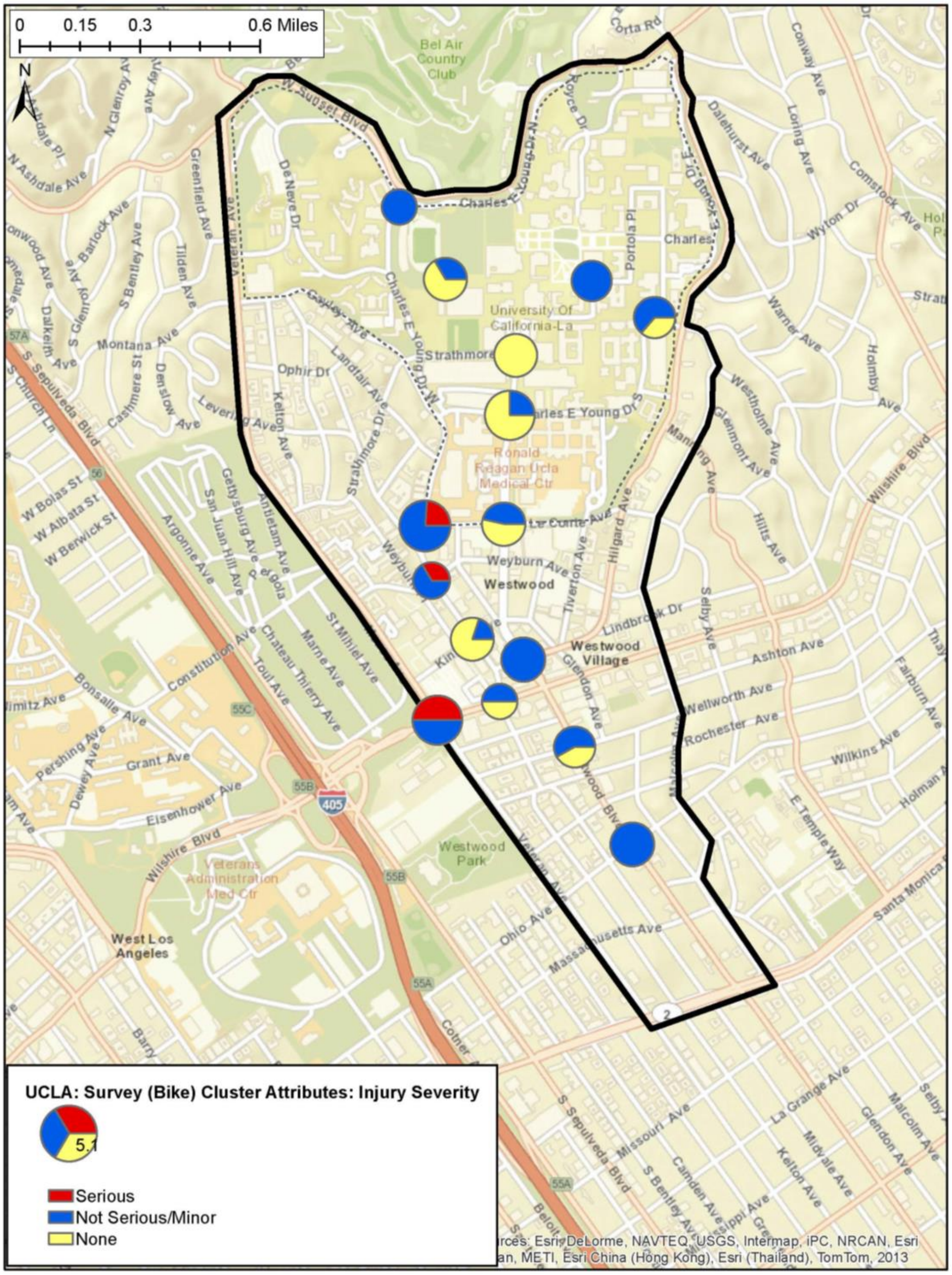


Figure 5.27 UCLA Survey Hotspots (Bike) – Contextualized Spatial Clustering by Injury Severity

Most of the on-campus bicycle crash hotspots included crashes with either minor or no injuries as shown in Figure 5.28. However, the hotspots outside of the campus indicated a higher percentage of minor crashes, along with a few serious injuries.

5.2.3.2.4 Behavioral Attributes

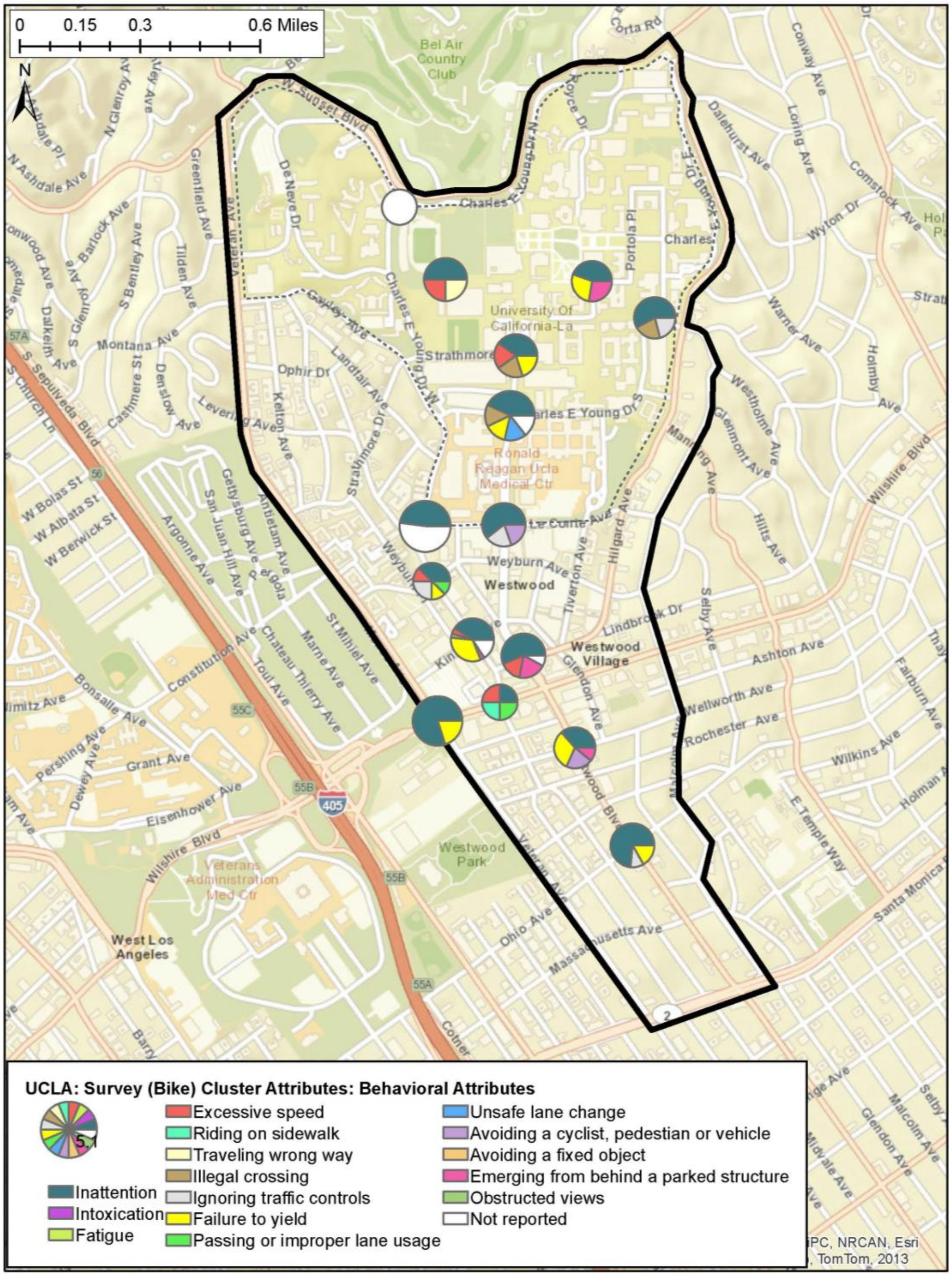


Figure 5.28 UCLA Survey Hotspots (Bike) – Contextualized Spatial Clustering by Behavioral Attributes

The most prominent behavioral attributes among the top hotspots were inattention and failure to yield. Among the on-campus hotspots, illegal crossing was an additional prominent factor as shown in Figure 5.29.

5.2.3.2.5 Environmental Attributes

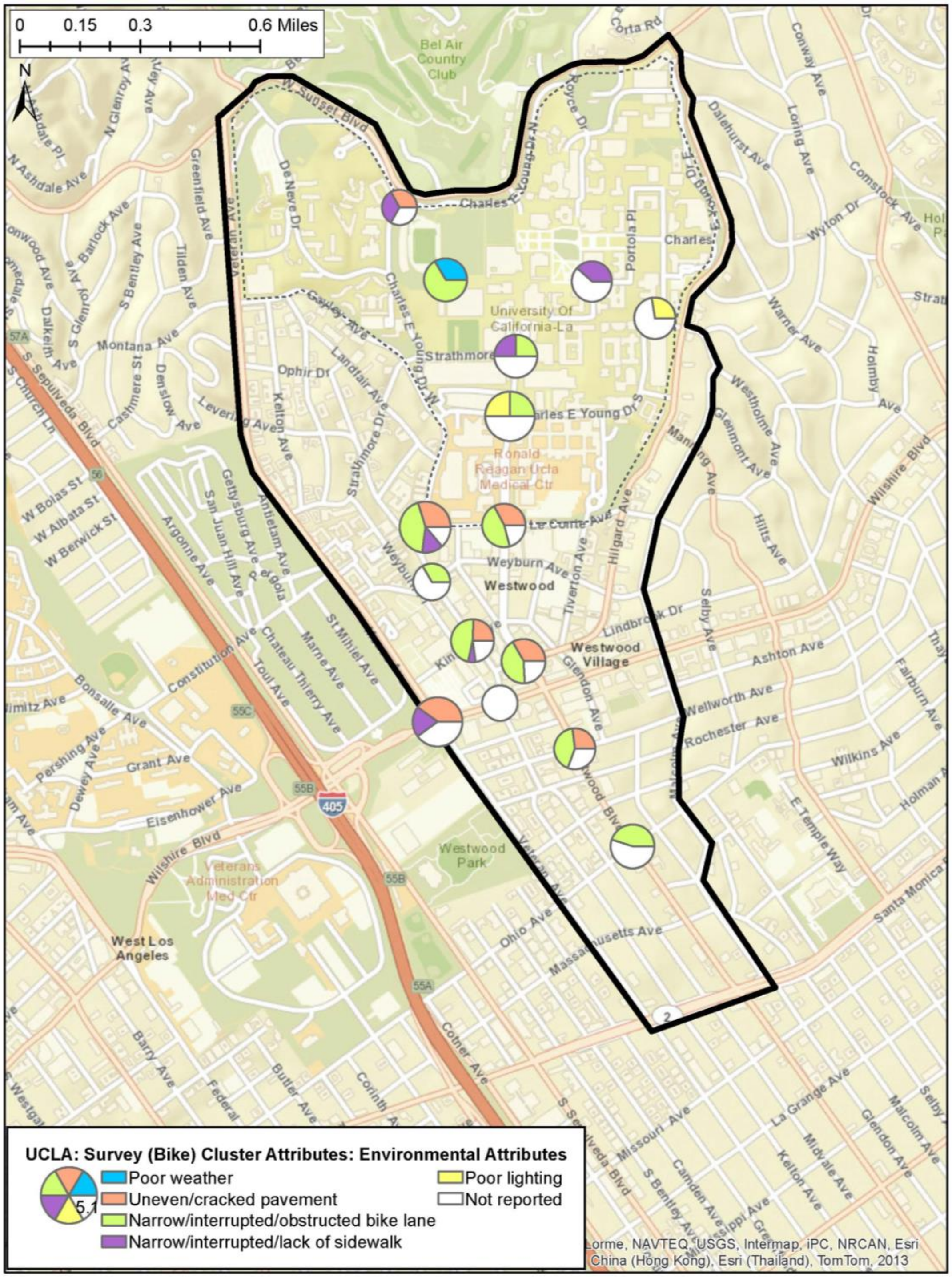


Figure 5.29 UCLA Survey Hotspots (Bicycle) – Contextualized Spatial Clustering by Environmental Attributes

Narrow/interrupted bicycle lanes (both on and off campus) and cracked/uneven pavements (off campus) were the most prominent environmental attributes among the UCLA bicycle crashes as depicted in Figure 5.30.

5.2.3.3 Conclusions

As shown by the results in the previous section, contextualized spatial clustering provided a more nuanced description than would otherwise be obtained by merely aggregating the number of crashes in the vicinity of a location. The technique harnesses supplementary information about the crashes to help differentiate one hotspot from another. In addition, any spatial trends noticed through the contextualized spatial clustering maps help identify differences between different regions (off-campus vs. on-campus hotspots) and across campuses. For example, the maps indicated that a higher percentage of the bicycle crashes pertaining to the top hotspots in UCLA occurred in the evening compared with UCB and CSUS. Similarly, avoiding a pedestrian, bicyclist, or a vehicle is a greater concern for on-campus bicyclists at UCB than at CSUS and UCLA.

In order to best utilize the results for an individual hotspot, the contextualized spatial clustering results for each supplementary attribute were evaluated simultaneously so as to acquire a holistic understanding of the type of crashes occurring at that location. Such an analysis can provide safety engineers with more than one metric to identify at-risk locations, which aids in assessing sites through direct inspection. For instance, it is possible that a location with the highest number of crashes might involve no injuries at all, but a location with fewer crashes might involve a higher percentage of injuries and thus be awarded a higher priority for improvements. In terms of guiding the types of improvements, a hotspot with a high percentage of a given behavioral/environmental attribute might be slated for a particular type of intervention that addresses that attribute (e.g., issues of excessive speeding might require more traffic calming-oriented interventions).

In the following chapter, a few of the hotspots are studied in greater detail, combining the results of the contextualized spatial clustering with pedestrian and bicycle counts, as well as on-site inspections of the location.

6. Case Studies of Hotspots

Based on researchers' local knowledge and observations, a few of the top 15 pedestrian and bicycle crash hotspots from each campus were subjected to more detailed investigation. Such locations also distinguished themselves from others because of their presence in the top 15 hotspots of two or more databases, and in some cases, across both bicycle and pedestrians crash hotspots. A discussion of specific case studies along with recommendations stemming from this work are presented in this chapter. Each location was visually inspected, its vehicular, non-motorized, and pedestrian traffic were assessed, and the survey responses for the location were analyzed in greater depth. Detailed descriptions of the infrastructure attributes of these locations are presented in appendix E.

6.1 CSUS Hotspots

6.1.1 Guy West Bridge Ramp at Jed Smith Drive

6.1.1.1 Location

The Guy West Bridge links the east side of CSUS to American River Bike Trail, a multi-use path that transects the campus. The bridge has a ramp that curves and descends onto the campus next to a large bicycle parking compound. Together, they create an irregular three-approach, unsignalized intersection with a university service road formerly known as Jed Smith Drive. Jed Smith Drive is a two-lane roadway that was once open to outside traffic but is now only open to bicycles, pedestrians, and university service vehicles. On the east side of this location is a bicycle parking compound which attracts bicycle traffic. The west side of intersection is located in front of the main entrance to Riverside Hall, the home to the College of Engineering and Computer Science, which generates pedestrian traffic. The only sidewalk at this location is on the west side of Jed Smith Drive, as shown in Figure 6.1b, but pedestrians and bicyclists share the entire roadway.

Despite the frequent interaction between bicyclists and pedestrians, there is little transportation infrastructure surrounding this intersection. It has no traffic controls ("stop" or "yield" signs), no pavement markings, and no other signage. There are also eight concrete pillars located where the ramp and bicycle compound entrance meet, as shown in Figure 6.1b. There is a faculty/staff parking lot (Lot 4) located to the southeast of the intersection, as visible in the lower left corner of Figure 6.1c.

(a) Southbound Jed Smith Drive

(b) Bicycle Parking Compound, Concrete Pillars, and Guy West Bridge Ramp in background

(c) Aerial View

Figure 6.1 Aerial and Street View of Guy West Bridge and Jed Smith Drive at CSUS

6.1.1.2 Traffic Exposure

Figure 6.2 shows the results of a two-hour manual count done at the Guy West Bridge and Jed Smith Drive on Thursday, October 24, 2013, from 11:00 AM to 1:00 PM. The results indicated the following:

- Pedestrians:
    - There is significant movement of pedestrians along Jed Smith Drive.
- Bicyclists:
    - Most of the bicycle traffic (455) emanates from the bicycle parking compound – not the Guy West Bridge ramp (178).

    - Only 81 of bicyclist through traffic on Jed Smith Drive are individuals who bicycle past the compound and ramp.
- Automobiles:
    - Vehicle traffic is restricted through this intersection. Although some university service vehicles are permitted to use this intersection, they were not counted.

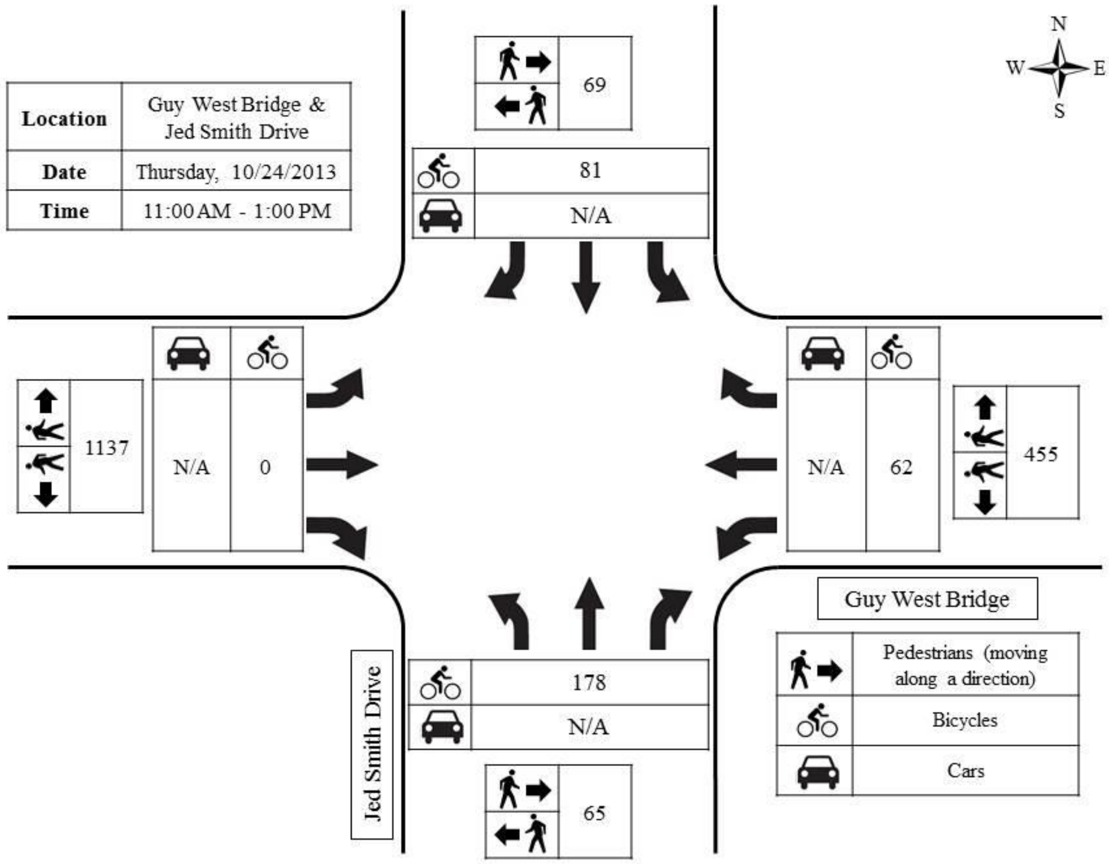


Figure 6.2 Two-Hour Manual Counts at Jed Smith Drive and Guy West Bridge (10/24/2013)

6.1.1.3 Risk

The clustering analysis of the intersection of the Guy West Bridge with Jed Smith Drive produced the following results:

- Pedestrian hotspots: Rank 1 (survey crashes), Rank 5 (pedestrian only perceived hazardous locations),
- Bicycle hotspots: Rank 1 (survey crashes), Rank 4 (bicycle only perceived hazardous locations),
- Ranked 2 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

Note: In cases, where no rank is displayed for a particular data source (such as SWITRS), it is implied that this location did not feature among its top 15 hotspots. In other words, the rankings are only shown for cases where the location was featured among the top 15 hotspots.

The hotspot rankings indicated that this location is of particular concern for bicyclist and pedestrians even though it was not among the top crash locations identified by SWITRS.

The results of the contextualized spatial clustering for pedestrian survey crashes (figures 5.11-15) indicated that 75% of the pedestrian crashes reported contact with bicycles. These crashes occurred during the day, and about 75% of the crashes involved no injuries. In terms of the relevant behavioral attributes of these crashes, inattention (75%), failure to yield (75%), ignoring traffic controls (50%), and excessive speed (50%) were cited as major factors.

The results of the contextualized spatial clustering for the bicycle survey crashes (Figures 5.16-20) indicated that 60% of the bicycle crashes near this location reported contact with other bicycles. These crashes primarily occurred during the day, and all the crashes reported some minor injuries. In terms of the relevant behavioral attributes of these crashes, inattention (60%), excessive speed (60%), and obstructed views (40%) were cited as major factors.

Finally, some of the survey respondents' descriptions of the crashes relevant to this intersection are shown below:

- *"Cyclists coming down off the path via the ramp behind the Union. Travel too fast and ride on the sidewalks instead of the using the roadway."*
- *"I go running from my office in campus 4 or 5 times a week. Bicycles near the foot of Guy West Bridge go zooming through what is in essence a four way intersection without slowing down or stopping"*
- *"When bicyclists come down the footbridge from Guy West Bridge next to Sequoia and across the street Riverside they are moving fast and sometimes barely miss you. Same for the bicyclist entering the footbridge they working up speed to get up it. Dangerous area for pedestrians!!"*
- *"It is an awkward way to get onto the bridge for bikes. Some of the pillars should be removed by the bike lot."*
- *"As I approached the bicycle ramp near the base of the Bicycle Compound across from Riverside Hall, I made a wide turn to avoid the big concrete column that blocks the right lane. The other cyclist was riding downward and we collided head on."*

6.1.1.4 Discussion and Recommendations

Based on the survey results and observations of pedestrian and vehicular activity, it appears that the location is of concern to both pedestrians and bicyclists over potential conflicts. Because there is plenty of physical space available at this location, a simple separation of bicycle and pedestrian modes would help alleviate any conflicts. A wide pedestrian walkway along the west side of Jed Smith Drive can be separated from a dedicated, painted bicycle lane on the east side of Jed Smith Drive, for access to either the bicycle corral or the Guy West Bridge. Conflicts between bicycles accessing the Guy West Bridge and bicyclists accessing the bicycle corral can be minimized by relocating the access to the bicycle corral away from the ramp.

Additional signage and pavement marking should be instituted to require bicyclists descending from the Guy West Bridge Ramp to slow down and yield to bicyclists who may be emerging from the bicycle corral. The recommended pavement markings are a series of triangles that point in the direction of traffic that is required to yield and is not unlike the pavement marking commonly used on ramps descending from river bridges (grade-separated bicycle paths) to at-grade bicycle paths in the City of Portland, Oregon. Additionally, pavement markings on the ramp encouraging bicyclists to slow and yield along with bicycle yield signs should be utilized, as shown in Figure 6.3.

Figure 6.3 Yield Marking and Signage Connecting Two Bicycle Grade-Separated Paths in Portland (Source: http://bikeportland.org/2008/11/24/new-markings-meant-to-tame-bike-traffic-11270)

Finally, the concrete pillars along with bollards at the base of the ramp are potential crash hazards and should be removed or minimized as much as possible. The concrete pillars do not support a building, only a pergola shade structure.

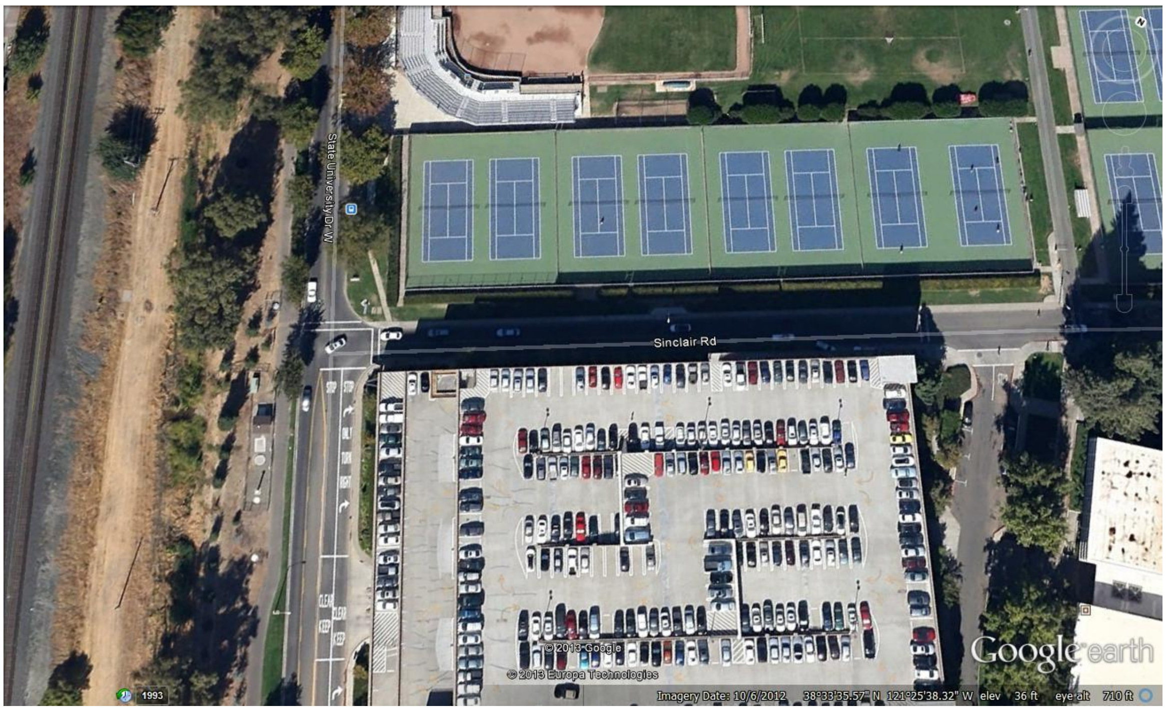
6.1.2 State University Drive West and Sinclair Road

6.1.2.1 Location

The intersection of State University Drive West (SUD West) and Sinclair Road lies along the west edge of the CSUS campus. It is an unsignalized, stop-controlled intersection with three vehicular approaches. The western approach is comprised of a separated, multi-use path that travels parallel to SUD West and turns to connect to Sinclair Drive as shown in Figure 6.4a. SUD West comprises of one/two through lanes and a right turning lane along the western approach, whereas Sinclair Road is a one way street. On the eastern approach of the intersection there are tennis courts on the north side and Parking Structure I (PS1) on the south side (Figure 6.4b). The sidewalk here is also connected to a pedestrian path that leads to the western entrance of the campus (Figure 6.4c). It is important to note that the west side of this intersection leads to an elevated railroad facility that runs along the entire west side of the CSUS campus. The only access under this railroad facility is by the multi-use path, which eventually connects to the west part of this intersection. Although this multi-use path is used by bicyclists to connect to the American River Bike Trail and by pedestrians accessing campus from the west, it does not have a stop sign or any other traffic control. North of this intersection, on the east side, adjacent to the tennis courts, there is a Hornet Express Shuttle bus stop on northbound SUD West.

(a) Southbound SUD West with Multi-Use Path on Right Edge of Photo

(b) Eastbound Sinclair Road: Tennis Courts on Left Edge of Photo, Parking Structure, Right



(c) Aerial View of Intersection Showing Parking Structure and Tennis Courts and Elevated Railroad Facility along Left Edge of Photo, All Located on Western Side of Campus

Figure 6.4 Aerial and Street View of State University Drive West and Sinclair Road at CSUS

6.1.2.2 Exposure

Figure 6.5 shows the results of a two-hour manual count collected on Thursday, October 24, 2013, between 4:30 PM and 6:30 PM, during which 211 pedestrians and 113 bicyclists were observed.

- Pedestrians:
  - There were several pedestrians that crossed the north approach traveling east or west and then crossed the west "approach" to travel north and south on the multi-use trail to access the west campus non-motorized tunnel.

- Bicycles:
  - Most of the bicyclists in the afternoon were leaving campus from the west. There were still a surprisingly high number of bicyclists entering campus from the south using both the separated multi-use trail on the west approach of the intersection and the roadway on the south approach of the intersection. It is possible that since Sinclair Road has a posted speed limit of only 25 mph, bicyclists were more willing to share the road with the motorized vehicles and access this intersection from multiple directions.
- Automobiles:
  - Vehicular traffic was not measured during the bicycle and pedestrian counts.

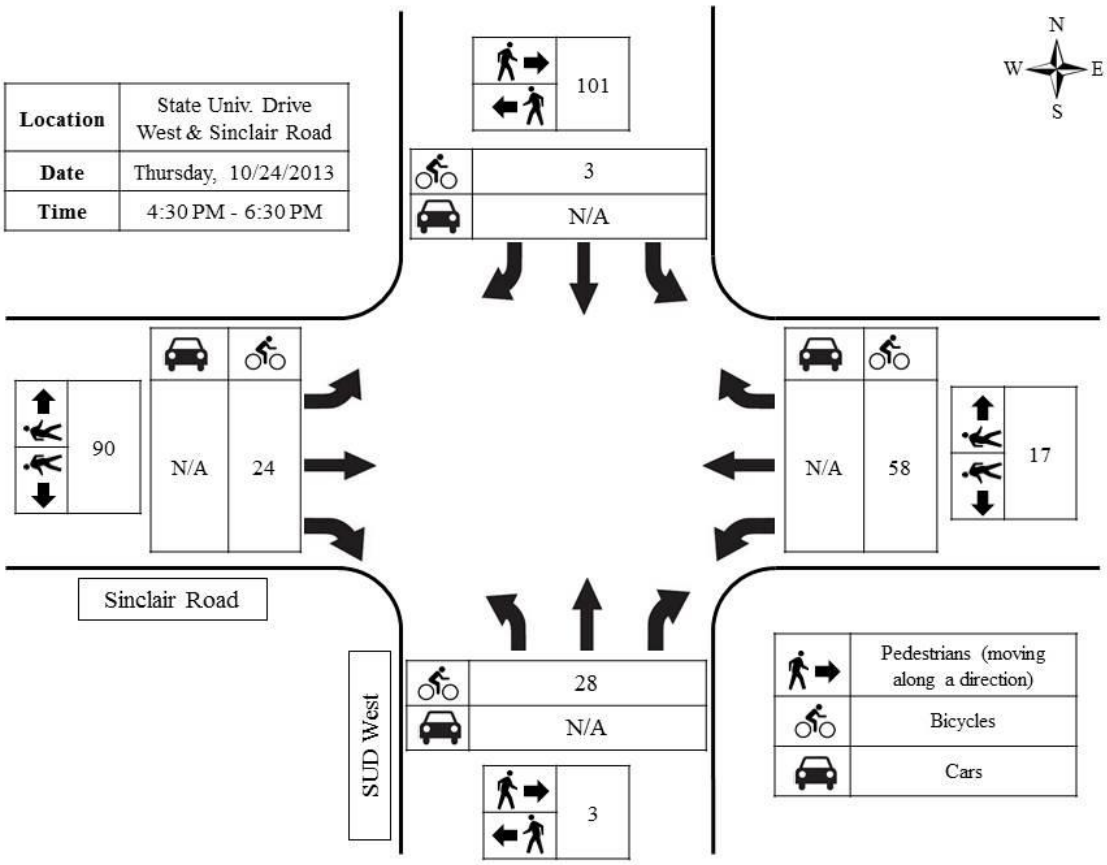


Figure 6.5 Two-Hour Manual Counts at State University Drive West and Sinclair Road (10/24/2013)

6.1.2.3 Risk

The clustering analysis of the intersection at SUD West and Sinclair Road produced the following results:

- Pedestrian hotspots: Rank 8 (survey crashes), Rank 4 (pedestrian only perceived hazardous locations),
- Bicycle hotspots: Rank 5 (bicycle only perceived hazardous locations)
- Ranked 4 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

The hotspot rankings indicated that the location is of concern to pedestrians. Owing to a low number of observed crash responses, the contextualized spatial clustering analysis did not provide any general insights about the location. The one pedestrian crash that was identified close to the location involved an auto and did not result in any injuries, and cited inattention, failure to yield and emerging from a parking structure as the relevant behavioral factors.

Finally, some of the survey respondents' descriptions of the crashes relevant to this intersection are shown below:

- *"I was crossing the exit to the parking structure and got clipped by a driver."*
- *"The area leading into Parking Structure 1 is especially dangerous during peak hours of the day. Many pedestrians cross the street at Sinclair and Univ. Drive W. Cyclists often do not stop or obey traffic laws and Sinclair Rd is too narrow to allow them to safely share the road with vehicles. The second entrance to the parking structure is only accessible by faculty and staff (who only occupy half of the first, second, and third levels). This means that all vehicles entering and exiting have to funnel through a single two-lane entrance. Pedestrians are often nearly hit inside the structure by cars entering due to a blind spot."*
- *"Location: The south 'staff only' vehicle (with the control arms) entrance to the parking structure. Problem: Pedestrians are often walking through the driveway to take a shortcut through parking structure"*
- *"Coming into campus from State Univ. Drive W. this is the first entrance for cyclists. However, there is no bike lane OR sidewalk on the right hand side next to the parking structure and this is extremely dangerous for cyclists who have no choice but to go around cars who are driving very fast in and out of the parking structure, sometimes not expecting a cyclist to be on either side of them."*
- *"Drivers do not watch for cyclists as they exit Parking Structure One. They barely watch for cars."*

6.1.2.4 Discussion and Recommendations

Based on the survey's quantitative and qualitative insights, it appears that conflicts exist between the autos emerging out of the parking structure and bicyclists and pedestrians. Because one of the three large parking structures on the campus is located adjacent to Sinclair Road, it is a busy corridor with a significant number of automobile and non-motorized users (including drivers who park there and then became pedestrians when they finish their journey). A stop sign along with flashing beacons at the west approach may help, but separating the motorized and non-motorized traffic would reduce the number of unnecessary conflicts. Much of the non-motorized traffic using the Hornet Crossing Tunnel under the railroad track can be re-directed to access the campus core at a different location – such as near the new Recreation and Wellness Center.

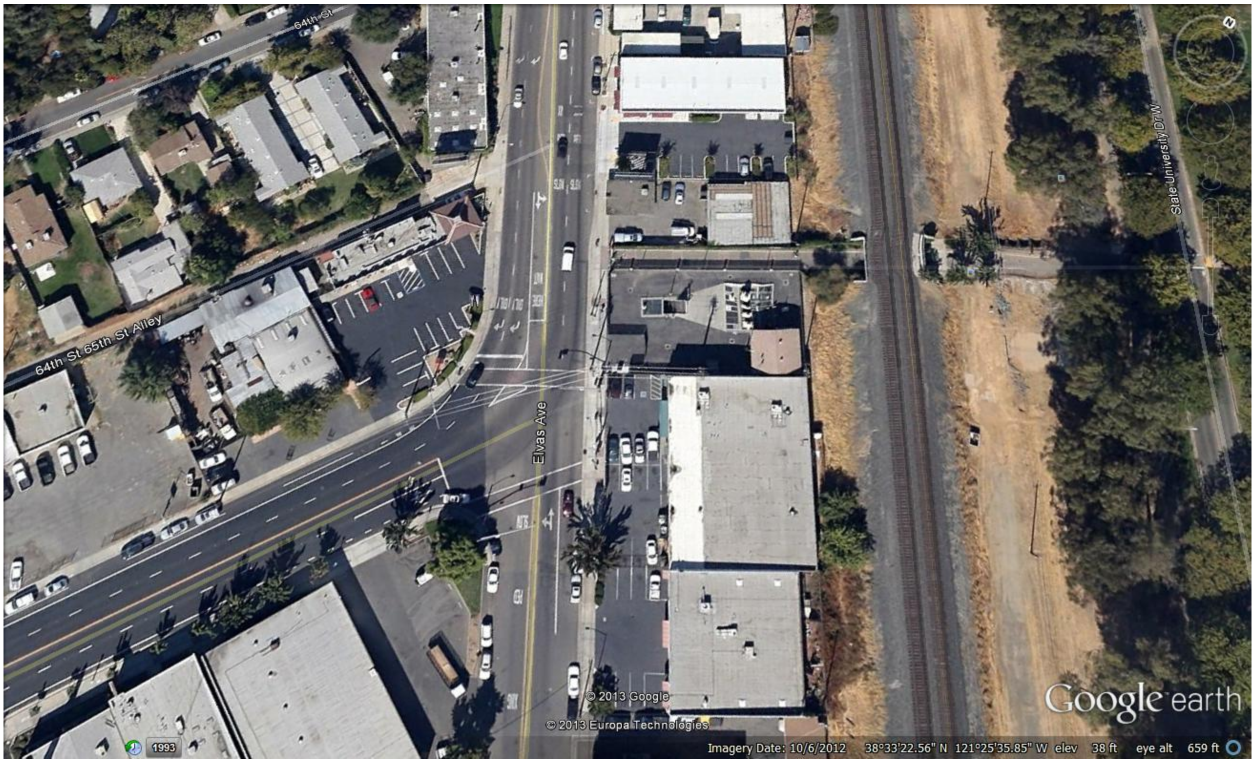
6.1.3 Elvas Avenue and 65^{th} Street

6.1.3.1 Location

The intersection of Elvas Avenue and 65^{th} Street is a signalized intersection, located on the west side of Hornet Crossing Tunnel on the west part of the campus. As mentioned previously, this tunnel serves as the primary bicycle and pedestrian access point to the campus from the west (shown on the left side of the photo in Figure 6.8a and upper left corner of Figure 6.8b). It also serves travelers to campus who use the 65^{th} Street Transit Center, located approximately 1,000 feet south on 65^{th} Street. As a result, this intersection experienced heavy pedestrian traffic. The Hornet Tunnel is also a major connector between the M Street Corridor (a low-speed, low-volume Class III bicycle facility) and the American River Bike Trail on the east side of campus. As a result, this intersection also experience heavy bicycle traffic. Like the SUD West and Sinclair intersection discussed earlier, this intersection also has a slightly unusual geometric configuration with three legs occupied by automobiles and the Hornet Tunnel Crossing non-motorized path almost acting as a fourth approach to the intersection, shown in Figure 6.8c. Elvas Avenue comprises of one/two through lanes and two dedicated right turning lanes along its southbound approach, whereas 65^{th} Street includes a left turning lane and a through/right turning lane.

(a) Southbound Elvas Avenue: Hornet Crossing Tunnel on Left Edge of Photo

(b) Eastbound 65^{th} Street



(d) Aerial View: A complex Intersection for Vehicular Traffic Is Joined by a Heavily Trafficked Pedestrian-Bicyclist Route (the Hornet Crossing Tunnel Just Above Midline of the Photo

Figure 6.8 Aerial and Street View of Elvas Avenue & 65th Street at CSUS

6.1.3.2 Exposure

Figure 6.9 shows the results of a two-hour manual count collected as part of an earlier campus study on October 24, 2013 between 7:30 AM and 9:30 AM.

- Pedestrians:
  - As expected, heavy pedestrian volumes were experienced across the south and east approaches of the intersection, which serves pedestrians walking from the 65th Street Transit Center to the Hornet Crossing Tunnel. There were no pedestrians crossing the west approach, which may be explained by the fact that there is no crosswalk.
- Bicycles:
  - Most of the bicycle volumes were experienced out of the Hornet Crossing Tunnel and across Elvas Avenue from the M Street Corridor.
- Automobiles:
  - Vehicular traffic was not measured.

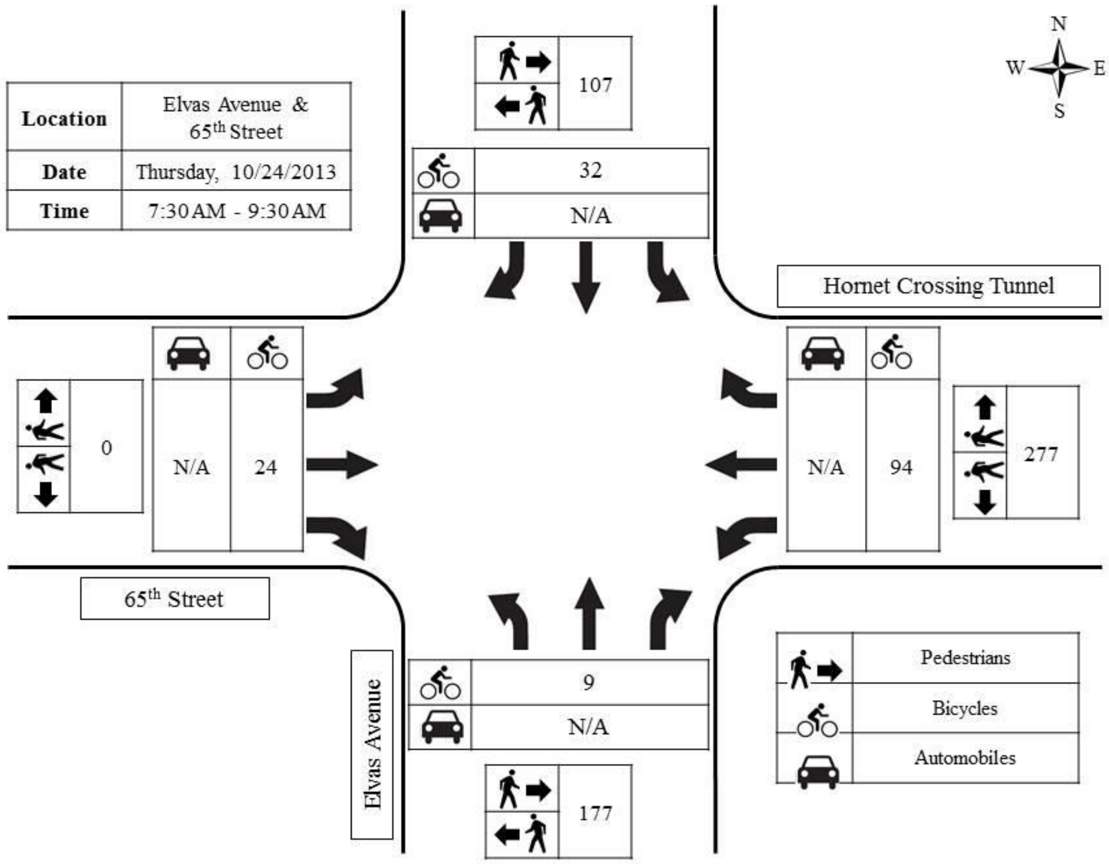


Figure 6.9 Two-Hour Manual Counts at Elvas Avenue & 65th Street (10/24/2013)

6.1.3.3 Risk

The clustering analysis of the intersection at Elvas Avenue and 65th Street produced the following results:

- Pedestrian hotspots: Unranked (SWITRS), Unranked (survey crashes), Ranked 2 (pedestrian only perceived hazardous locations),
- Bicycle hotspots: Unranked (SWITRS), Ranked 6 (survey crashes), Ranked 2 (bicycle only perceived hazardous locations),
- Ranked 5 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

The results of the clustering analysis suggested that the risk to bicycles was the greatest at this location. The contextualized spatial clustering analysis indicated that around 83% percent of the pedestrian crashes involved contact with other objects, and 56% of them involved non-serious injuries. Excessive speed and ignoring traffic controls (both 43.3%) were reported as major attributes.

Finally, some of the survey respondents' descriptions relevant to this intersection are shown below:

- *"A lot of walking and cycling traffic goes through the Hornet Tunnel. The corners at the end of the tunnel at Elvas are blind. You can't see what's / who's on the sidewalk before making the turn. A turn mirror there would help."*

- *“Median barrier prevents turn to reach Hornet Crossing entry. In addition, Hornet Crossing does not have curb cut. As a result some cyclists ride on Elvas sidewalk endangering pedestrians.”*
- *“Pedestrians and cyclists disregard traffic rules on the bike paths. When they go the wrong way, incoming and outgoing traffic have close calls. I cannot stress how dangerous it is and how many times I have seen people narrowly miss each other.”*

6.1.3.4 Discussion and Recommendations

The problems with this intersection appear to be attributable to narrow and obstructed views in and out of the Hornet Tunnel to Elvas Avenue. The Hornet Tunnel is a long right-of-way access path underneath the railroad with limited visibility on Elvas Avenue as shown in Figure 6.10. Combined with heavy pedestrian volumes, a dangerous condition is created where bicyclists turning right may be travelling too fast to see pedestrians entering the tunnel from the left. Also problematic is the fact that there are no bicycle facilities on Elvas Avenue between the Hornet Tunnel and the bicycle-friendly M Street Corridor located a few blocks north at 62nd and Elvas Avenue.

Figure 6.10 Hornet Crossing Tunnel Connection to Elvas Avenue at CSUS

A potential design change to alleviate these problems would be to provide a rolled curb along the sidewalk adjacent to the campus. The rolled curb would provide bicyclists with an alternate passageway to cross the intersection, while also providing a more direct route for the southbound bicycle flow. In addition, as suggested by a few of the survey respondents, a turn mirror might be beneficial.

6.2 UCB Hotspots

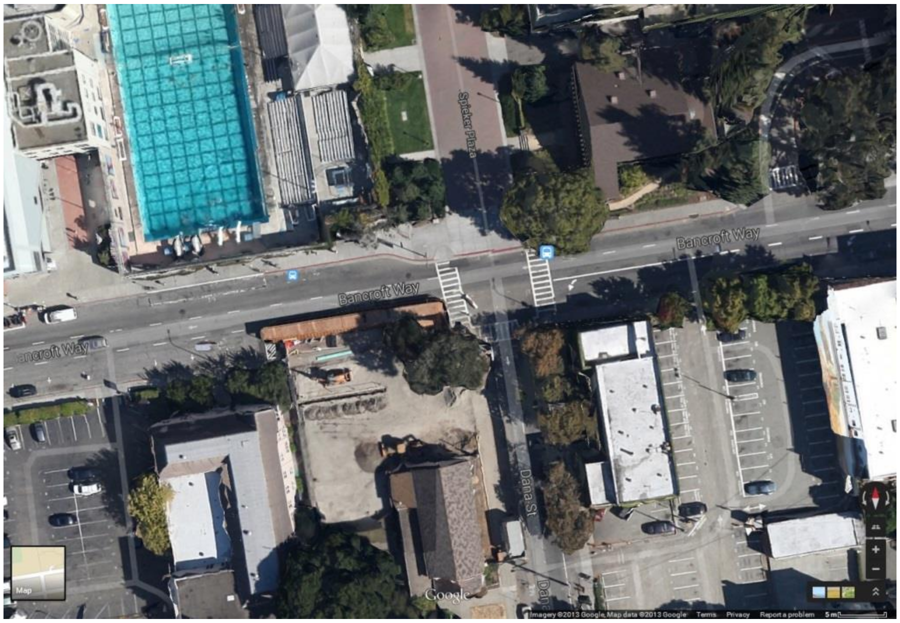
6.2.1 Bancroft Way and Dana Street

6.2.1.1 Location

The intersection of Bancroft Way and Dana Street is on the south side of the campus. It is an unsignalized three-way intersection with no stop signs. At this location, Bancroft Way is a three-lane one-way street westbound (Figure 6.11a), and Dana Street is a two-lane one-way street southbound, attracting left-turning traffic from Bancroft Avenue (Figure 6.11b). Finally, the northern edge of this intersection is a sidewalk forming a part of the campus boundary. The significant built environment in terms of traffic generation is the Recreational and Sports Facility (RSF), which is the campus gymnasium, and the Haas Pavilion, the campus' basketball stadium, which lie to the north (Figure 6.11c).

(a) Looking Westbound along Bancroft Way: Dana Street at Left

(b) Looking North Toward Bancroft Way on Dana Street



(c) Top View: Crosswalks Mark Dana Street and Bancroft Way Intersection; the Recreational Sports Facility and Haas Pavilion to Right of Pools (Blue Rectangle)

Figure 6.11 Aerial and Street view of Dana Street and Bancroft Way UCB

In terms of the transportation infrastructure surrounding this intersection, there are pedestrian-activated flashing beacons on the eastern crosswalk. This crosswalk provides access to the campus via the Spieker Plaza, which is a bicycle-accessible, multi-purpose path adjacent to the gymnasium. Immediately south of the intersection is a bus stop that is served by nine bus lines, including the campus shuttle, which circulates around the campus periphery. Finally, there are surface parking lots to the east and west of the intersection, as visible in Figure 6.1c.

6.2.1.2 Traffic Exposure

Figure 6.12 shows the results of a two-hour manual count done at Dana & Bancroft Way on Wednesday, August 31, 2011, from 2:10 PM to 4:10 PM. The results indicated the following:

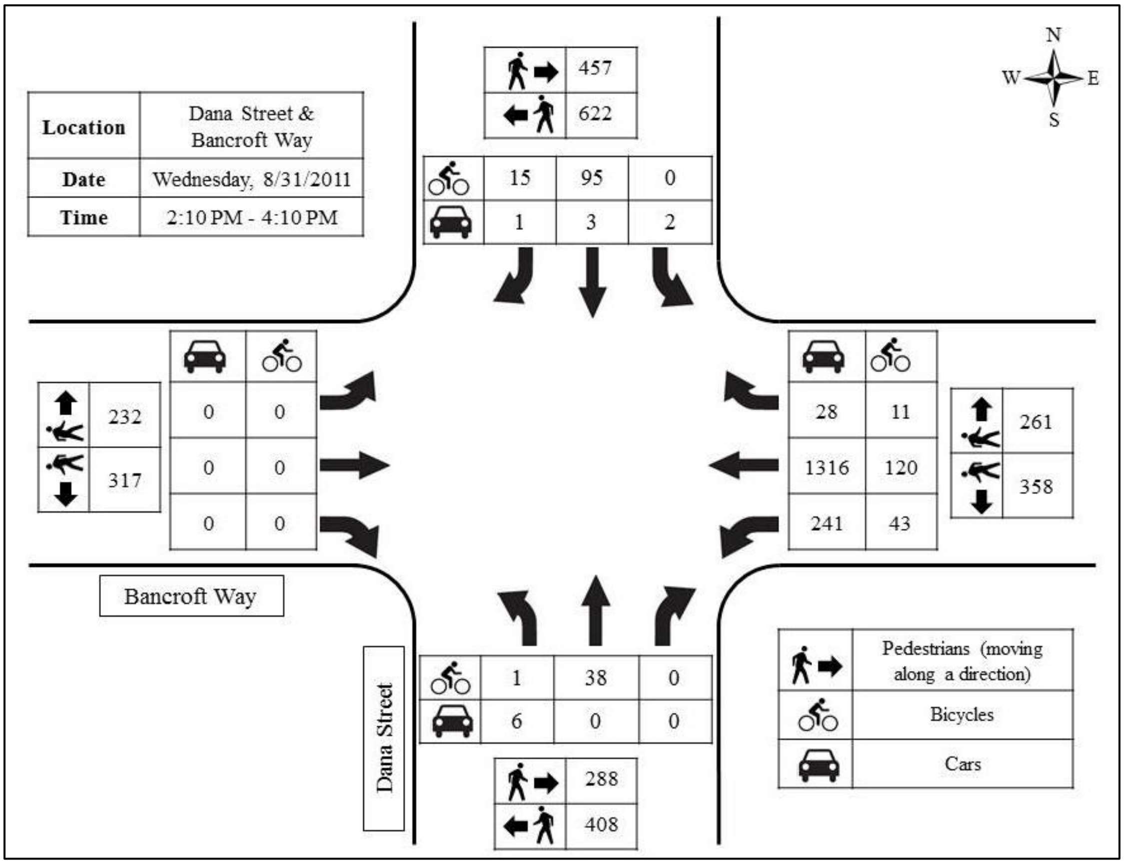


Figure 6.12 Two-Hour Manual Counts at Dana Street and Bancroft Way (8/31/2011)

- Pedestrians:
    - There was significant movement along all four directions, with the northern edge of the intersection, comprising a sidewalk, having the highest pedestrian count. This could perhaps be because the sidewalk stretches right through the southern edge of the campus, and there is a bus stop situated along that side of the road.
- Bicycles:
    - Most of the bicycle traffic emanates from Bancroft Way, which has a downward slope along the westbound direction.
    - In addition, there is also a significant flow of bicycles to and from campus along the Spieker Plaza - Dana Street route. In particular, it should be noted that there is a not-insignificant number of bicycles traveling wrong-way (northbound) on Dana Street.
- Autos:
    - Most of the auto traffic is restricted to Bancroft Way, although some autos do make a left turn onto Dana St.

6.2.1.3 Risk

The clustering analysis of the intersection of Dana Street and Bancroft Way produced the following:

- Pedestrian hotspots: Ranked 2 (SWITRS), Rank 3 (survey crashes), Rank 3 (pedestrian only perceived hazardous locations),
- Bicycle hotspots: Ranked 9 (SWITRS), 1 (bicycle only perceived hazardous locations),
- Ranked 2 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

The hotspot rankings indicated that the location is of concern to both bicycles and pedestrians across all the datasets. The results of contextualized spatial clustering analysis of the pedestrian survey crashes (Figures 5.11-15) indicated that 78% of the pedestrian crashes reported contact with bicycles. These crashes occurred during the day, and about 65% of the crashes involved minor/non-serious injuries. In terms of the relevant behavioral attributes of the crashes, inattention, failure to yield, riding on sidewalks, ignoring traffic controls, and excessive speed were cited as major factors in 50% of cases.

Finally, some of the survey respondents' descriptions of the crashes relevant to this intersection are shown below:

- *"I was crossing in the crosswalk and a cyclist zoomed past me super fast, just swiped my arm, no injury but pretty scary. He could've run me over."*
- *"I was crossing Bancroft and Dana. I was on the phone and paid no attention to the car, until I suddenly heard a strong car brake."*
- *"A bike rider hit me while I was in a crosswalk at Dana & Bancroft. He did not stop."*
- *"I stopped using the bike lane on Dana for 2 reasons:*
    1. *Cyclists use the lane to go the wrong way on a one way street and*
    2. *Drivers generally do not look for or yield to cyclists in the left lane.*

  There are more left turns on Dana between Bancroft and Dwight than there are right turns, making it extra dangerous. Also, I go straight along Dana after Dwight, but there is no way to safely do this from the bike lane."

- *"This is the only convenient way to ride onto campus from the southwest so cyclists have three equally bad alternatives:*

    1. *Ride the wrong way up Bancroft.*
    2. *Ride the wrong way up Dana.*
    3. *Ride the right way up Telegraph but then be forced to dismount in order to cross the campus.*

  Why are we making it inconvenient/potentially dangerous for people to commute in an environmentally friendly way?"

6.2.1.4 Discussion and Recommendations

Based on the survey results and the observed pedestrian and vehicular activity, it appears that the location is of concern to both pedestrians and bicyclists. It is possible that the conflict between the pedestrians and bicyclists arises due to bicycles trying to cross the street using the crosswalk so as to share the right of way with the pedestrians. The other complication for bicyclists is that while Spieker Plaza allows bicyclists access to and from campus, the bicycle lane on Dana Street operates in only one direction, leading bicyclists to use the bicycle lane against the direction of traffic.

Some of the potential improvements which can be suggested to reduce conflicts at this intersection include having signage in the plaza to better organize the bicycle traffic. For instance, some signage can be installed at the edge of Spieker Plaza prompting bicyclists to slow down and use the rolled part of the sidewalk's curb to enter the intersection (Figure 6.13), or walk their bicycles when using the crosswalk to cross the intersection.

Figure 6.13 Rolled Curb along the Spieker Plaza Sidewalk to Facilitate Vehicle Access

The wrong-way bicycle riding in the bicycle lane on Dana Street is also a cause for concern. Depending on the extent of the bicycle flow, it might be worthwhile to consider allowing contraflow in the bicycle lane during certain times of the day, or suggesting alternate bicycle routes to enter the campus from the south side. The City of Berkeley's Southside Plan for the City and the University proposes the installation of a traffic signal at the location and changing Dana Street from a one-way to a two-way street to calm the vehicular and non-motorized traffic.[8] This proposition has the potential of making the intersection more complex, but the signalization could reduce conflicts.

6.2.2 Oxford and Addison Streets

6.2.2.1 Location

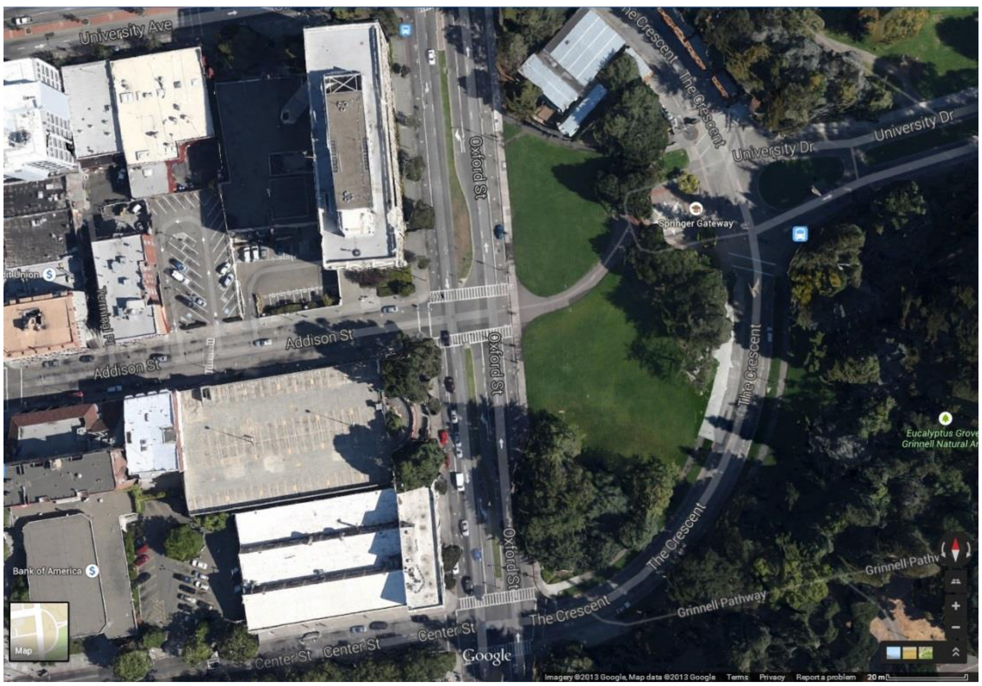
The intersection of Oxford and Addison Streets is situated on the western boundary of the campus. It is an unsignalized three-way intersection with a stop sign on Addison Street. Oxford Street is a major north-south thoroughfare, with a grass median along much of its length, and two travel lanes, a bicycle lane and parking lane in each direction. Addison Street is a much smaller, two-way street with a travel lane and a parking lane in each direction. (Figure 6.14). The eastern edge of the intersection is a sidewalk adjoining the campus boundary. This sidewalk is also connected to a pedestrian path that leads to the western entrance of the campus (Figure 6.14c). It is also important to note that neither of the crosswalks on Oxford Street have any stop signs on them. The closest bus stop is one block away on Oxford Street and University Avenue. However, there is a parking structure to the west of the intersection off Addison Street.[9]

[8] http://www.ci.berkeley.ca.us/Planning_and_Development/Home/Southside_Plan_-_DDS_5_Transportation_Element.aspx

[9] In the time between the conclusion of this analysis and the finalization of this report, the parking structure was demolished, as part of a larger project that will result in an art museum, hotel, and convention center on the site, which promises to increase foot and auto traffic in the vicinity.

(a) Looking East (Toward Campus) along Addison Street

(b) Looking North at the Southbound Lanes along Oxford Street



(c) Top view

Figure 6.14 Aerial and Street View of Oxford and Addison Streets at UCB

6.2.2.2 Exposure

Figure 6.15 shows the results of a two-hour manual count collected as part of an earlier campus study in 2011.

- Pedestrians:
    - There are a significant number of pedestrians crossing along all four directions, with the eastern edge of the intersection being a sidewalk. Eastbound and westbound movements across Oxford Street are exposed to vehicular traffic the most.

- Bicycles:
  - Most of the bicyclists travel in the north-south direction using the bicycle lanes, involving a low fraction of turning movements.
- Autos:
  - The majority of the vehicular traffic travels north-south direction along Oxford Street.

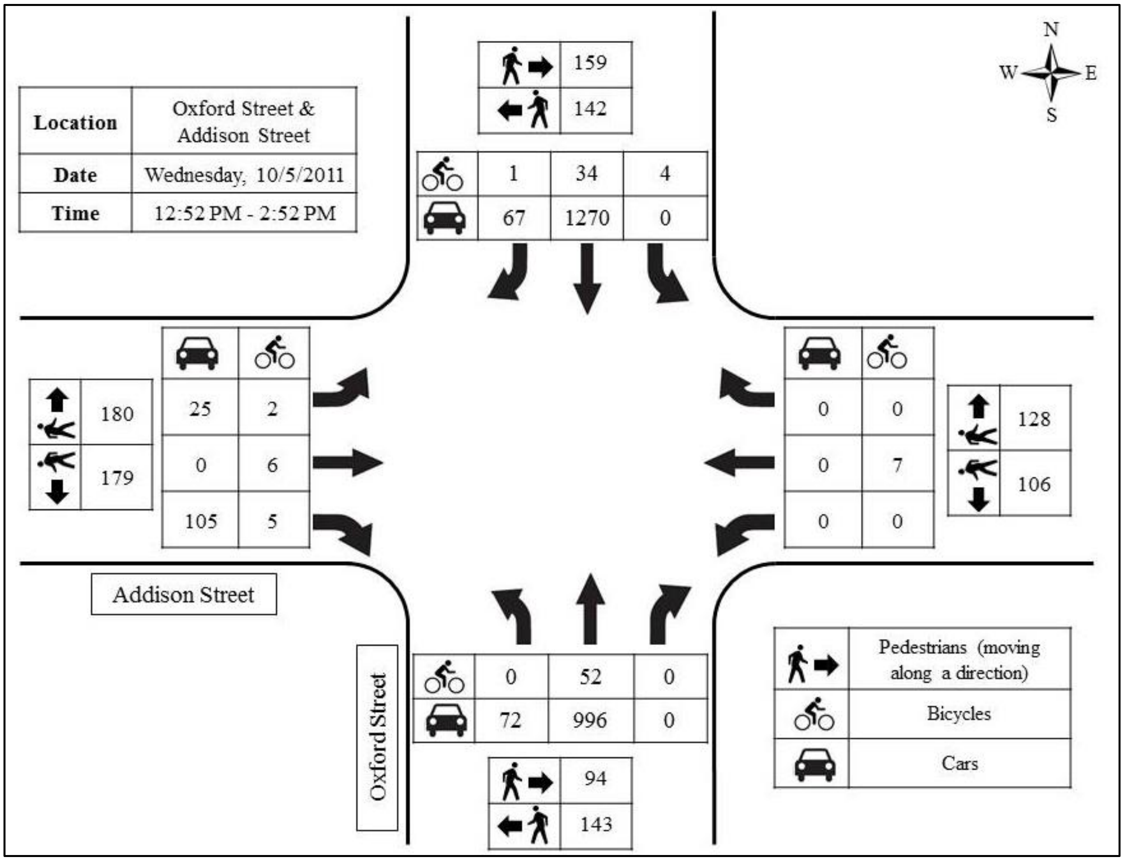


Figure 6.15 Two-Hour Manual Counts at Oxford and Addison Streets (10/5/2011)

6.2.2.3 Risk

The clustering analysis of the intersection at Oxford and Addison Streets produced the following:

- Pedestrian hotspots: Ranked 10 (SWITRS), 5 (survey crashes), 2 (pedestrian only perceived hazardous locations),
- Ranked 7 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

The hotspot rankings indicated that the location was of concern to pedestrians. The contextualized spatial clustering analysis of the pedestrian survey crashes (Figures 5.11-15) indicated contact with cars (50%), bicycles (33%), as well as other objects (33%). These crashes occurred during the day, with most of them involving minor/non-serious injuries (67%). In terms of the attributes of these crashes, failure to yield was cited as factor in 83% of the crashes.

Finally, some of the descriptions provided by survey respondents are shown below:

- *"In crosswalk crossing Oxford from Addison. Cars do not yield to people in this crosswalk a great deal. Had to move out of way. Also saw a lady with a baby stroller almost run down by a car in this crosswalk. Very dangerous."*
- *"Pedestrians crossing Oxford St. at Addison on designated cross-walks mid-block are routinely threatened with being hit by cars / bicycles not stopping on Oxford St. There should be at least 3-way stop signs at this intersection for pedestrian safety."*
- *"While three lanes of traffic stopped for me, a van decided to jump the fourth, close enough that I was able to slap the side of the van as breezed in front of me."*
- *"Uncontrolled crosswalk across two lanes of traffic each way. Cars seldom stop - those in second lane less so."*

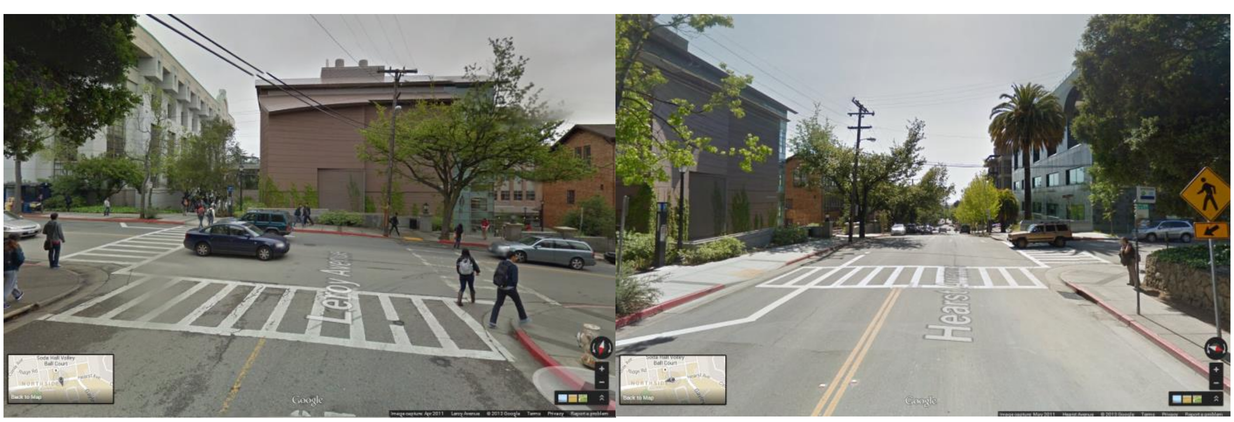
6.2.2.4 Discussion and Recommendations

Based on the survey's quantitative and qualitative insights, it appears that conflicts with autos while crossing Oxford Street are a major concern for pedestrians. Since Oxford Street is a busy corridor, three-way stop control could excessively slow down traffic at the intersection. Hence, the relevant merits/demerits of it should also be analyzed through extensive traffic flow studies. On the other hand, a possible design solution to address this issue would be the installation of push-button operated flashing beacons, along with early warning signs prompting cars to actively look out for pedestrians. Another, less-expensive solution would be to advance stop lines at the crosswalks.

6.2.3 Hearst and Le Roy Avenues

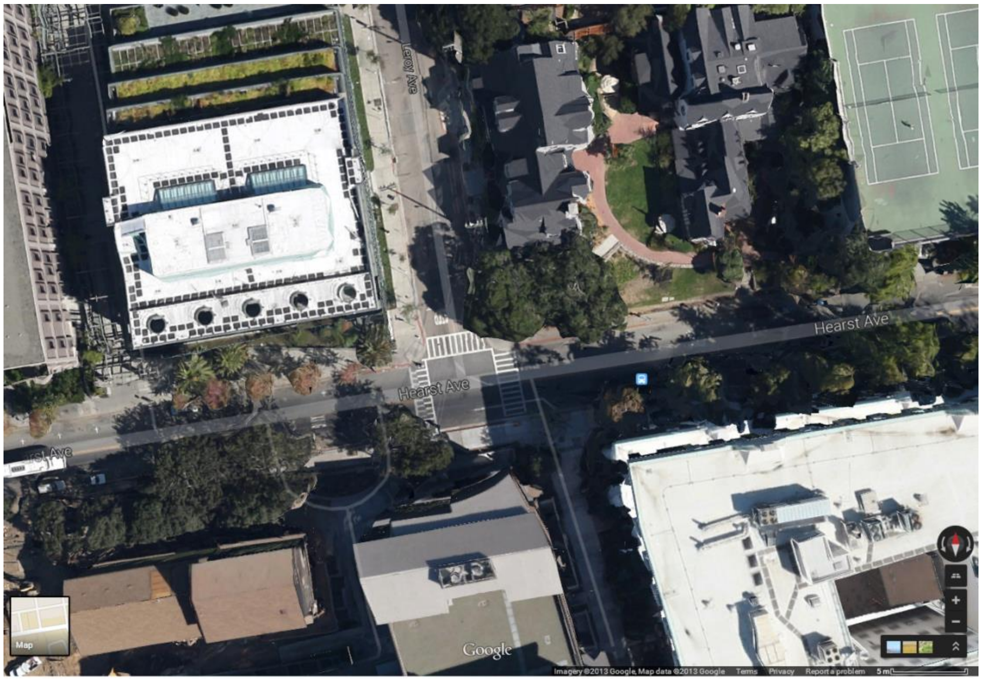
6.2.3.1 Location

The intersection of Hearst and Le Roy Avenues is situated on the northern edge of campus. It is an unsignalized three-way intersection with a stop sign on Le Roy Avenue. Both Hearst and Le Roy Avenues, are two-way roads with a single traffic lane and parking lane on each side (Figure 6.16). It is in close proximity to most of the engineering department buildings, as well as the Goldman School of Public Policy. It is served by four bus lines, including UC Berkeley and Lawrence Berkeley Lab's shuttles. Unlike the previous intersections, this location is situated along a steady incline. A major parking structure is located a block to the east on the northern side of Hearst Avenue. The southern edge of the intersection is a sidewalk on the campus's north edge, which supplies pedestrian access to the north side of the campus.



(a) Looking South Toward Campus from Le Roy Avenue

(b) Looking East (Downhill) along Hearst Avenue



(c) Top view

Figure 6.16 Aerial and Street View of Hearst (Running East-West) and Le Roy Avenues

6.2.3.2 Exposure

Figure 6.17 shows the results of a two-hour manual count collected as part of an earlier campus study on October, 14, 2011, between 2:25 PM and 4:25 PM.

- Pedestrians:
  - High pedestrian volumes were witnessed along all the four sides of the intersection, owing to the high density of the campus buildings in all four directions.
- Bicycles:
  - Since the intersection is situated around the uphill part of the campus, there are significantly fewer bicyclists at this intersection.
- Autos:
  - The major traffic movement at this intersection lies along Hearst Avenue, though there is some flow to and from Le Roy Avenue.

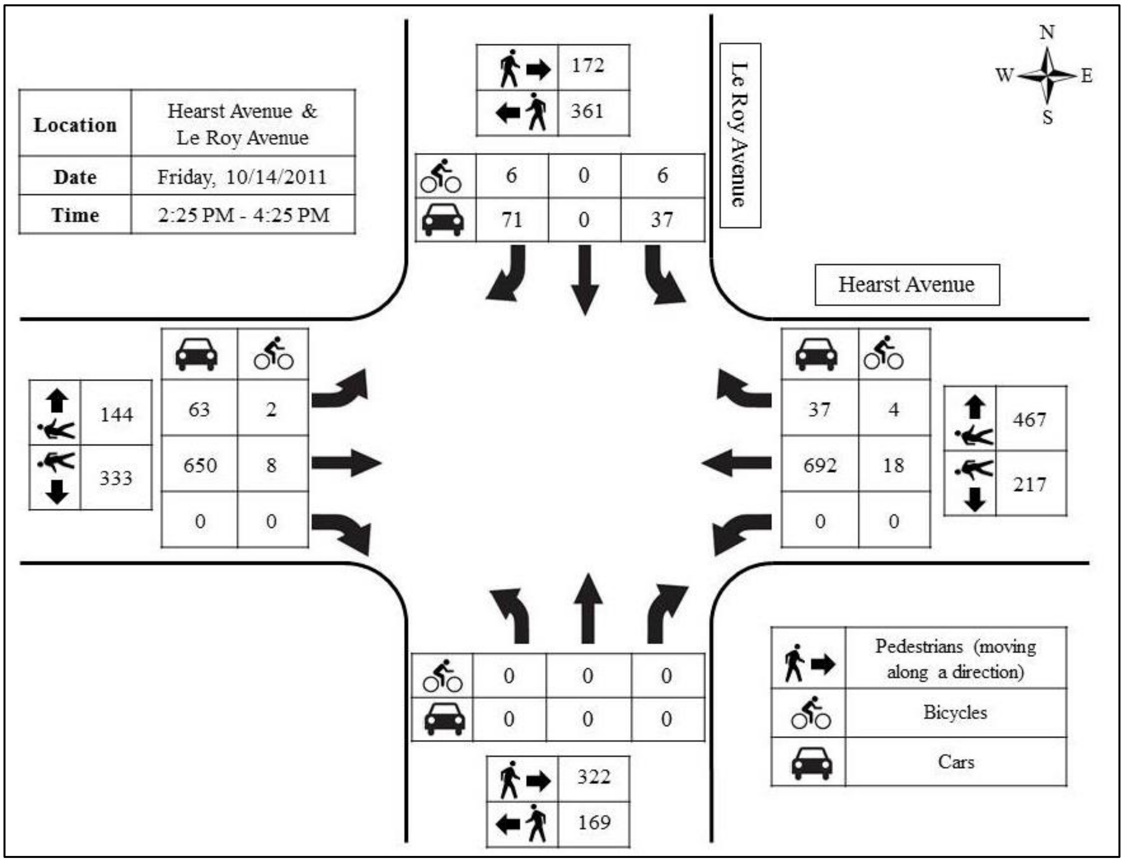


Figure 6.17 Two-Hour Manual Counts at Hearst and Le Roy Avenues (10/14/2011)

6.2.3.3 Risk

The clustering analysis of the intersection at Hearst and Le Roy Avenues produced the following results:

- Pedestrian hotspots: Ranked 5 (SWITRS), Ranked 8 (survey crashes), Ranked 1 (pedestrian only perceived hazardous locations),
- Ranked 3 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

Similar to the intersection at Addison Street and Oxford Avenues, the most affected mode at this intersection was walking. The contextualized spatial clustering analysis of the pedestrian survey crashes (Figures 5.11-15) indicated that 60 % involved contact with autos and happened during the day. However, most of these crashes (80%) were reported to have not caused any injuries. In terms of the attributes of these crashes, failure to yield was cited as a factor in 60% of crashes, and excessive speed was mentioned in 40%.

Finally, some of the descriptions provided by survey respondents are shown below:

- *"Me jaywalking across Hearst, not seeing very fast-moving downhill cyclist."*
- *"Haven't seen any accident, but it seems that people travel quite fast down Hearst. Also, cars do not always stop at the crossover across Hearst towards Soda Hall. At night, I am not sure how safe it is to walk there (but due to crime)."*
- *"It is poorly lit; students are oblivious crossing from Soda Hall to campus like it is part of the campus, and drivers speed down Hearst, because of lack of stop signs."*
- *"I was walking in the cross walk and a cyclist was coming down the hill (on Hearst Ave.) at a moderate rate of speed and had to swerve to miss me, and almost hit a car in the process."*

6.2.3.4 Discussion and Recommendations

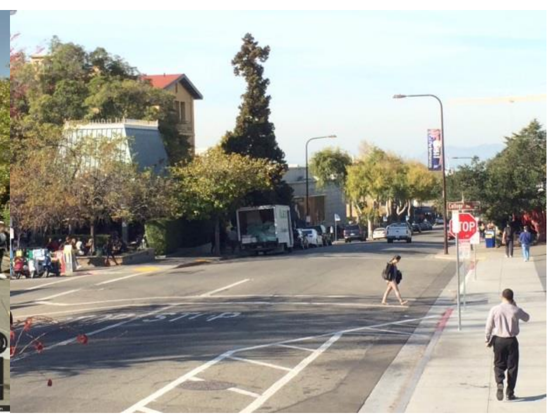
Based on the survey, it appears that the concerns with the location are primarily driven by unsafe rates of speed owing to the steep downhill pitch along Hearst Avenue as well as failure to yield to pedestrians. Potential interventions to improve pedestrian visibility, especially at night, include having better lighting in the region, and installation of pedestrian-activated flashing beacons along the Hearst Avenue crosswalks.

6.2.4 College Avenue and Bancroft Way

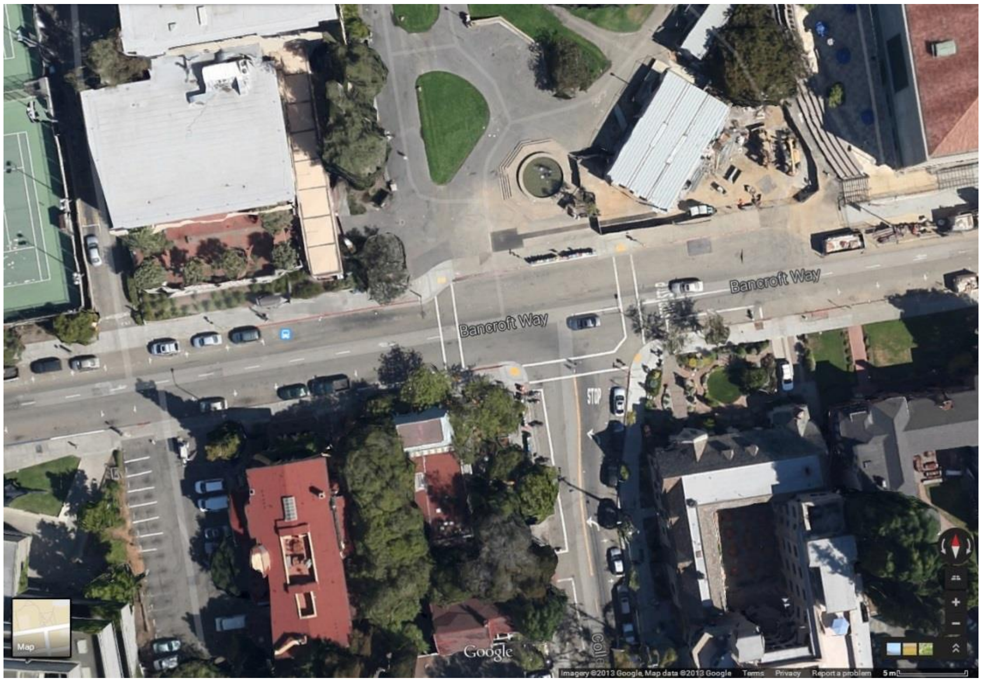
6.2.4.1 Location

The intersection of College Avenue and Bancroft Way is located on the southeastern part of the campus boundary. It is an unsignalized three-way intersection with stop signs on both streets. College Avenue consists of a two-way street with a single travel lane and a parking lane in each direction (Figure 6.18), By contrast, Bancroft Way is a one-way road westbound with two travel lanes and a parking lane on either side. The northern edge of the intersection provides pedestrian and bicycle access to the south side of campus via a broad pedestrian plaza, with the Anthropology Library, Kroeber Hall (Music), the College of Environmental Design, and Berkeley Law in closest proximity. The intersection is also near student housing, such as the dormitories, fraternity houses and the Berkeley International House. There is a bus stop slightly west of the intersection along Bancroft Way, which is served by five bus lines including campus shuttles.

(a) Looking south along College Avenue



(b) Looking east along Bancroft Way



(c) Top view

Figure 6.18 Aerial and Street View of Bancroft Way and College Avenue

6.2.4.2 Exposure

Figure 6.19 shows the results of a two-hour manual count collected as part of an earlier campus study on August, 31, 2011, between 11:10 AM and 1:10 PM.

- Pedestrians:
    - High pedestrian volumes are witnessed along all the four sides of the intersection. The west crosswalk has the highest flows, perhaps due to the presence of a bus stop as well as a popular coffee shop on both sides of the crosswalk.
- Bicycles:
    - Most of the bicycle flow takes place between the campus on the north side of intersection and College Avenue on the south side.
- Autos:
    - Vehicular traffic emanates from both roads, with westbound traffic on Bancroft primarily continuing straight through the intersection; College Avenue traffic tends to have volumes in both directions, northbound turning left on Bancroft and westbound Bancroft turning left to travel south on College.

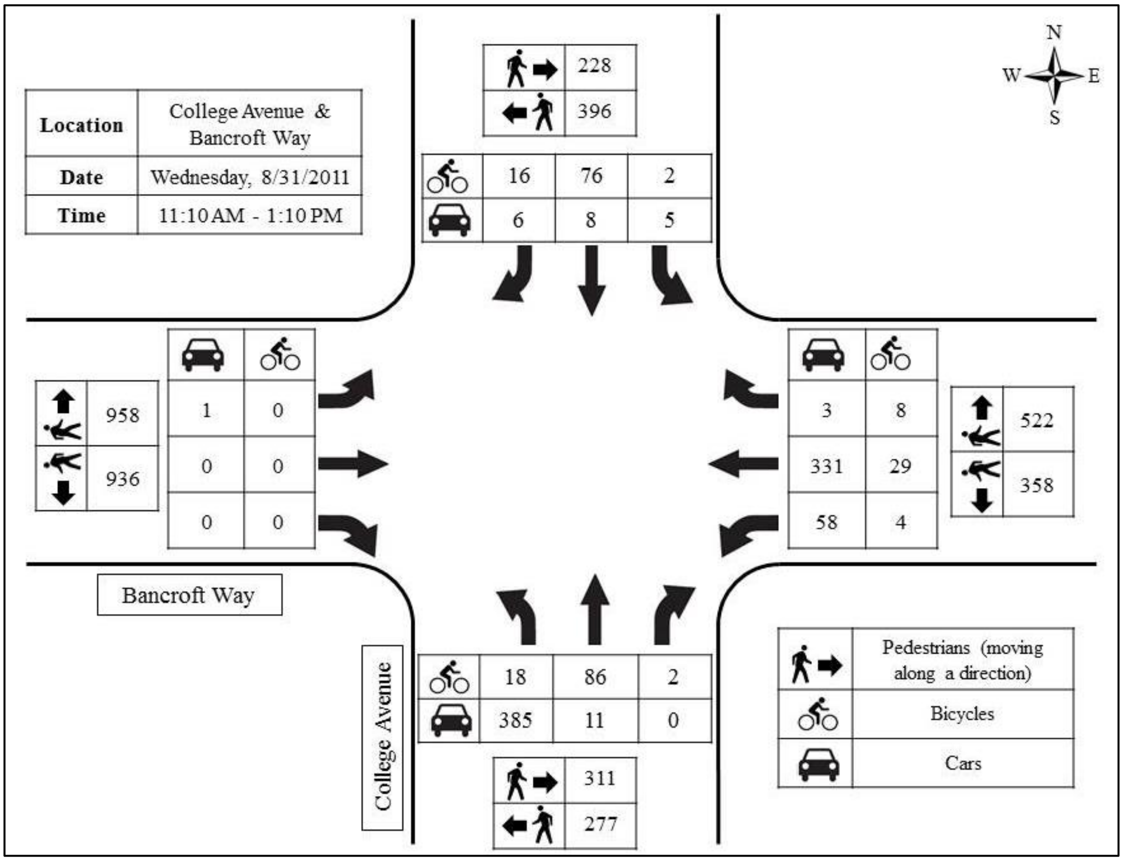


Figure 6.19 Two-Hour Manual Counts at College Avenue and Bancroft Way (8/31/2011)

6.2.4.3 Risk

The clustering analysis of the intersection at College Avenue and Bancroft Way produced the following results:

- Pedestrian hotspots: Ranked 1 (survey crashes), 4 (pedestrian only perceived hazardous locations),
- Bicycle hotspots: Ranked 15 (survey crashes)
- Ranked 1 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

Based on the results of the clustering analysis, pedestrians appeared to be most at-risk at this location. The results of contextualized spatial clustering indicated that around 83% percent of the pedestrian crashes reported in the survey involved contact with bicycles. Out of these crashes, 75% occurred during the day, while the rest occurred in the late evening. 78% of these crashes were reported to have not caused any injuries, while the rest involved some minor/non-serious injuries. In terms of the attributes of these crashes, excessive speed (60%) and failure to yield (50%) were reported as the major factors.

Finally, some of the descriptions respondents provided in the survey are shown below:

- *"A cyclist bumped into me, from behind, as I was walking on the sidewalk, at the intersection on College and Bancroft, on the campus side. I was going into Kroeber Hall."*
- *"Vespa narrowly avoided hitting me in crosswalk as it zoomed through without stopping or slowing."*

- *“I was crossing the crosswalk outside Caffe Strada intersection and out of nowhere the cyclist just rode his bicycle right in front of me making me to have a sharp stop myself...”*
- *“Many people roll through the stop sign on College and don't stop. While on my bike several times, I've had to veer out of the way of a car that was watching pedestrians but not for cyclists.”*
- *“It is very difficult for motorists to proceed through this intersection because of the very high volume of pedestrians. Cars tend sometimes to push their way through, creating a hazard for pedestrians. This intersection needs a traffic light or under/overpasses.”*

6.2.4.4 Discussion and Recommendations

Based on the results and descriptions obtained from the survey, it was evident that conflicts existed for pedestrians with both bicycles and autos at this intersection. The bicyclists use the crosswalk to cross Bancroft Way since the sidewalk along the northern edge of the intersection ends abruptly with a vertical-faced curb. An additional design flaw of the intersection is that the western edge of the crosswalk does not align itself with College Avenue, leading to the bicyclists travelling against the direction of vehicular traffic to get on to College Avenue (southbound traffic). Figure 6.20 shows a bicyclist trying to cross Bancroft Avenue by travelling against the direction of vehicular traffic. The vertical-faced curb (in red) is also visible in the figure.

Figure 6.20 Cyclist Traveling Against the Flow of Traffic to Access College Avenue

A potential design change to alleviate the problems is to provide a rolled curb along the sidewalk adjacent to the campus. The rolled curb would provide bicyclists with an alternate passageway to cross the intersection, while also providing a more direct route for the southbound bicycle flow.

For vehicular traffic, the major challenge, as indicated by the survey quotes above, is to navigate through the intersection in the presence of a constant stream of pedestrians. This occurrence leads to scenarios such as the one shown in Figure 6.21 where the autos pass through the stop signs, enter the intersection, and wait near the crosswalk. The City of Berkeley's Southside Plan for the City and the University proposes the installation of a traffic signal at this location to calm the vehicular and non-motorized traffic.[10]

Figure 6.21 Vehicles Waiting Near the Crosswalk on Bancroft Avenue

6.3 UCLA Hotspots

6.3.1 Wilshire and Westwood Boulevards

6.3.1.1 Location

The intersection of Wilshire and Westwood Boulevards is one of the busiest intersections in Los Angeles. It has four travel lanes running through and two left turning lanes along Wilshire Avenue, and three travel lanes running through and one left turning lane on Westwood Boulevard (one of its approaches also had a dedicated right turning lane). The crossing distances are in excess of 100 feet across Wilshire Boulevard and 90 feet across Westwood Boulevard. In addition, over 100,000 private vehicles cross the intersection daily (LADOT, 2010) and buses from several different public transit operators, and numerous pedestrians results in an extremely busy and potentially dangerous intersection (Figure 6.22).

[10] http://www.ci.berkeley.ca.us/Planning_and_Development/Home/Southside_Plan_-_DDS_5_Transportation_Element.aspx

(a) Along Westwood Boulevard (b) Along Wilshire Boulevard

(c) Top View

Figure 6.22 Aerial and Street View of Wilshire and Westwood Boulevards

6.3.1.2 Traffic Exposure

In addition to the sheer physical size and traffic volume of this intersection, it has parking lots on three of four approaches and serves many bus lines. These factors create additional conflicts and distractions. The crosswalks are extremely long, and lack safety enhancements. Pedestrians trying to cross must compete with vehicles turning right on red. Figure 6.23 displays the pedestrian volumes at one approach to this intersection along Westwood Boulevard. Based on the distribution, the average 2-hour peak pedestrian traffic along this approach is estimated to be 700 pedestrians between 12 PM and 2 PM on weekdays.

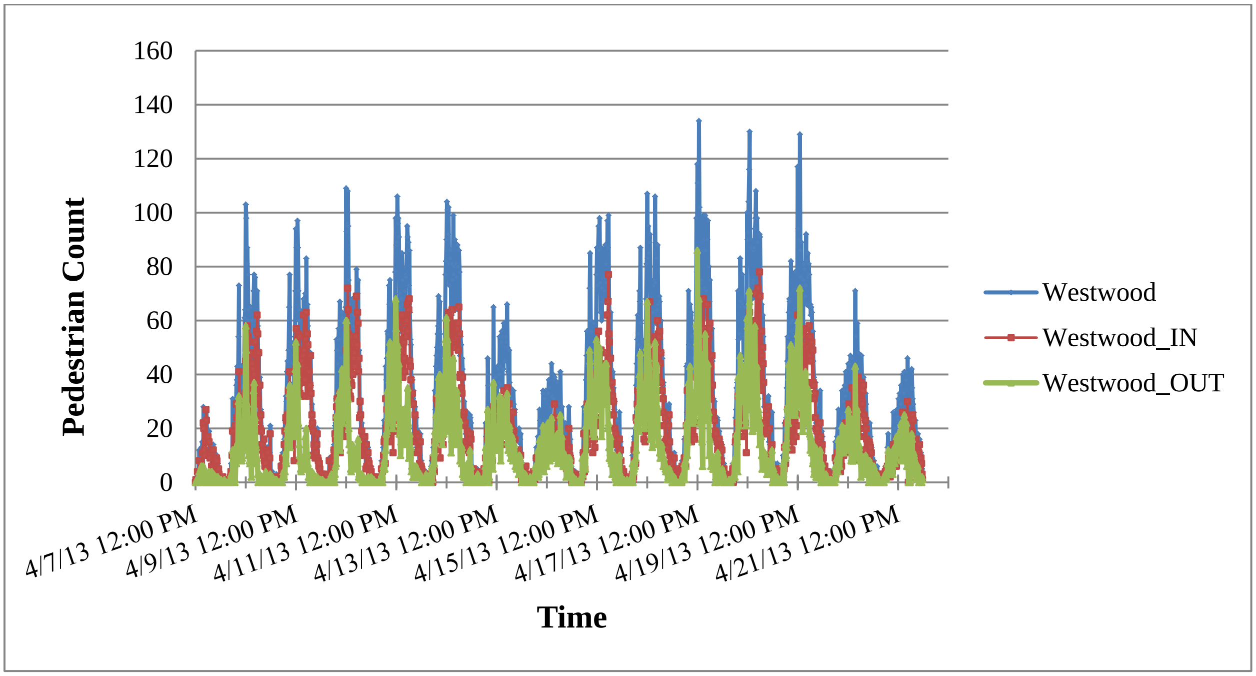


Figure 6.23 Automated Pedestrian Count Data from April 7 – 21, 2013

6.3.1.3 Risk

The clustering analysis of the intersection of Wilshire and Westwood Boulevards produced the following results:

- Pedestrian hotspots: Ranked 1 (SWITRS), 2 (survey crashes), 1 (pedestrian only perceived hazardous locations),
- Bicycle hotspots: Ranked 5 (SWITRS), 1 (bicycle only perceived hazardous locations),
- Ranked 1 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

The hotspot analysis revealed that the location has safety implications for both pedestrians and bicyclists. In terms of the contextualized spatial clustering, the associated pedestrian crashes were all involved with autos, and did not lead to any injuries. The major behavioral factors included inattention, ignoring traffic controls, or failing to yield right-of-way.

Finally, some of the descriptions of the crashes relevant to this intersection provided by the survey respondents are shown below:

- *"I (bike) was waiting on the left lane to turn onto Wilshire. The driver behind me accelerated and hit my rear wheel."*
- *"Riding to school northbound on Westwood. I was riding between cars approaching the Wilshire light. A car half changed lanes in front of me requiring me to stop abruptly and fall against the side of another car (pretty gently) as I was clipped in to my bike."*
- *"Traffic signal changes too fast to cross safely in the time allotted."*

- *"As a pedestrian I have encountered many dangerous situations trying to cross during rush hour using crosswalks because of vehicles that try to run red lights or obstruct the intersection and crosswalks."*

6.3.1.4 Discussion and Recommendations

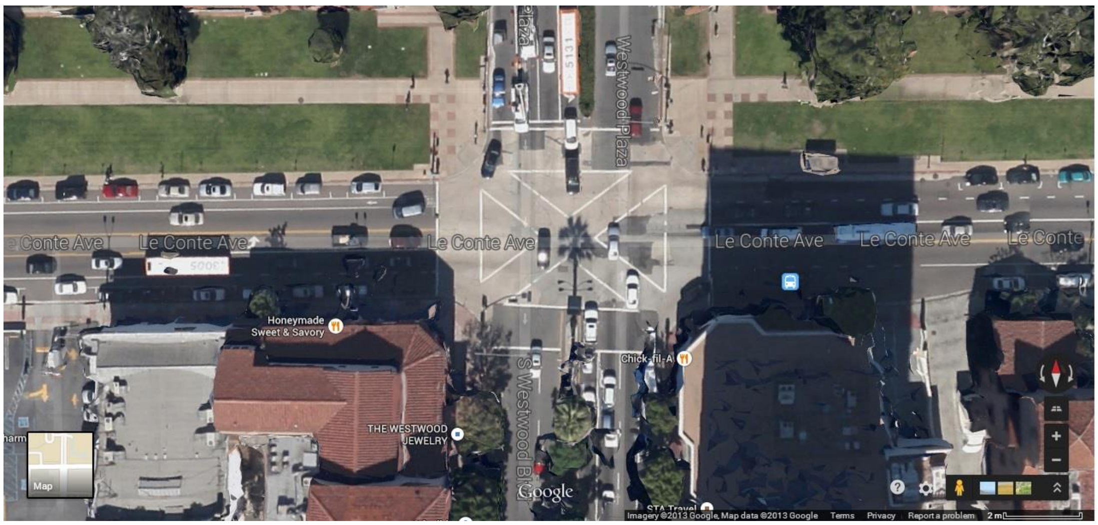
Inattention and failure to yield on the part of the driver were cited as causes of crashes in most cases, suggesting that this intersection would benefit from pedestrian enhancements, such as a ladder or continental crosswalk, advanced stop markings, prohibited right turns on red, or a scramble crossing (in which there is a pedestrian-only signal phase where signals in all directions are red). The layout of the intersection provides very little separation between stopped cars and crossing pedestrians. Advanced stop markings and signage would keep vehicles further upstream from the intersection to provide a physical separation from pedestrians and bicyclists as well as enhanced visibility, a process known as "daylighting" a crosswalk. A scramble crossing would certainly reduce conflicts between vehicles and other road users, though this crossing type tends to complicate signal timing and reduce the time the pedestrian has to complete the crossing. Additional bicycle infrastructure, such as designated bicycle paths, would also help, but many bicyclists at this intersection cross while pedestrians are still on the crosswalk or use a parallel street instead.

6.3.2 Westwood Boulevard and Le Conte Avenue

6.3.2.1 Location

The intersection of Westwood Boulevard and Le Conte Avenue is the busiest entrance to the UCLA campus (Figure 6.24) with approximately 30,000 vehicles crossing the intersection daily (LADOT, 2010). There are one/two through lanes and a left turning lane along Le Conte and two through, one left and a right turning lane along Westwood Boulevard. Many public transit buses pick up and drop off passengers at this intersection, and it is also the primary entrance to the campus for bicyclists. Examining the urban form elements of this intersection, it was observed that only three of its eight approaches have driveways, and only one of them has a major parking lot. This intersection features some safety enhancements. There are bicycle lanes present on some approaches (along Le Conte Avenue and the northward-bound leg of Westwood Boulevard); Westwood Boulevard has a median on both legs; and the crosswalk is a pedestrian scramble. The reported incidents date back to 2009, and the date of installation for the scramble could not be confirmed, so some survey responses might predate it.

(a) Along Westwood Boulevard (b) Along Le Conte Avenue



(c) Top View

Figure 6.24 Aerial and Street View of Le Conte Avenue and Westwood Boulevard

6.3.2.2 Traffic Exposure

The manual counts at this intersection showed 774 pedestrians crossing during one average morning peak hour and 1,392 during one average evening peak hour. The trends of the automated pedestrian count data are shown in Figure 6.25. Once again, the pedestrian counter is located along one of the approaches of Westwood Boulevard associated with the intersection. As per the distribution, the average weekday 2-hour peak pedestrian count is 890 pedestrians between noon and 2 pm.

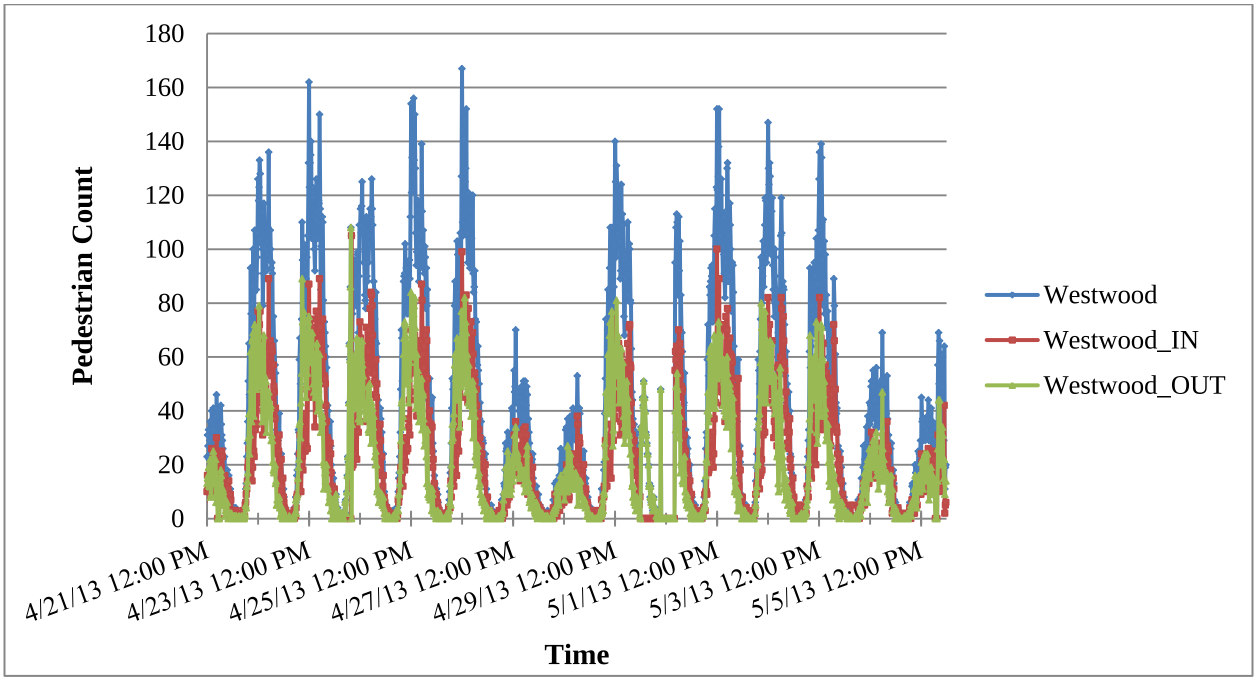


Figure 6.25 Automated Pedestrian Count Data from April 21 – May 5, 2013

6.3.2.3 Risk

The clustering analysis of the intersection of Wilshire and Westwood Boulevards produced the following results:

- Pedestrian hotspots: Ranked 8 (SWITRS), 7 (survey crashes), 8 (pedestrian only perceived hazardous locations),
- Bicycle hotspots: Ranked 1 (SWITRS), 6 (survey crashes), 5 (bicycle only perceived hazardous locations),
- Ranked 2 among the hotspots based on bicycle and pedestrian perceived hazardous locations.

The hotspot rankings indicated that the location was of concern to both bicycles and pedestrians across all the datasets. In addition, the results of contextualized spatial clustering of the pedestrian survey crashes (Figures 5.21-25) indicated that 61% of the pedestrian crashes reported contact with bicycles. 78% of the pedestrian crashes near this location occurred during the evening, though about 79% of the crashes involved no injuries. In terms of the relevant behavioral attributes of the crashes, inattention and riding on sidewalks (both 60%) were cited as the prominent factors.

With regards to the bicycle-related crashes, all of them involved contact with cars, and most of them occurred during the day (68%). Around 46% involved minor/non-serious injuries, with inattention as the most cited behavioral factor among the crashes (100%). In terms of the environmental factors, the presence of a narrow/interrupted/obstructed bicycle lane was cited as a factor in 46% of crashes, while the presence of a cracked/uneven pavement was mentioned as a factor in 32.7% of the total crashes.

Finally, some of the descriptions of the crashes relevant to this intersection provided by the survey respondents are shown below:

- *"Crossing at Le Conte and Westwood, Bike was flowing into pedestrian crossway from street (riding on street like a vehicle then switching to crossway like pedestrian) As I was finishing my cross the bike went back into what would be the street to ride north and cut in front of me."*
- *"Speeding cyclist hit me from behind, knocked me down, kept riding."*
- *"I was going forward in front of a lady's car and she sped up in front of me when her side mirror pushed up on me. The bike lane in that area is not clearly visible so cars tend to get very close to cyclists there."*
- *"Trying to cross Le Conte at Westwood. Was stopped on the right side of the lane, a car didn't see me, tried to turn right, and bumped into my bike (not going fast enough for damage, stopped just in time)."*
- *"There is gravel all over the right side of the lane causing me to bike in the way of cars."*

6.3.2.4 Discussion and Recommendations

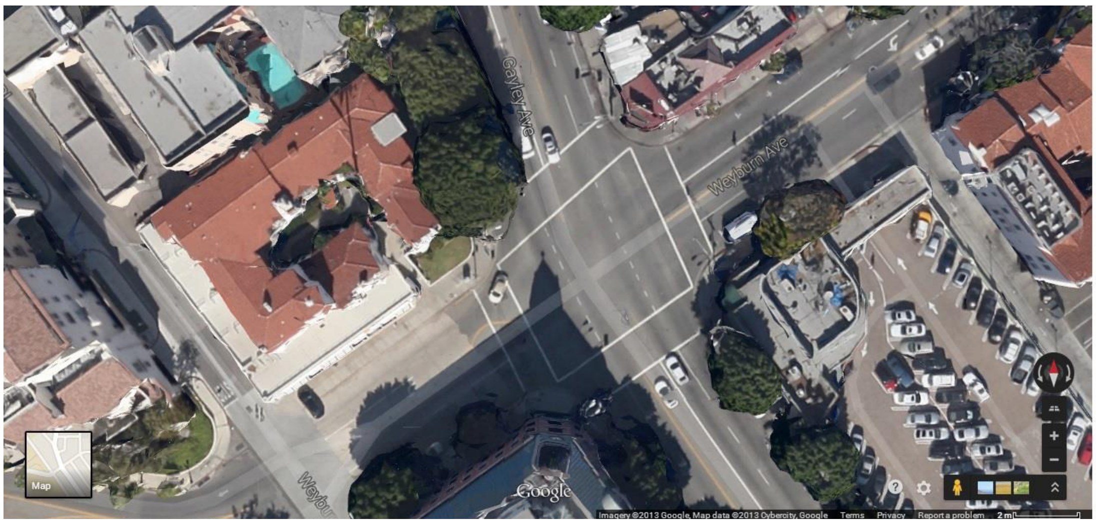
This intersection seems to suffer from bicycle and pedestrian conflicts with each other as well as with motor vehicle traffic. The scramble crossing seems to offer safe passage for pedestrians from autos but the discontinuous bicycle infrastructure along with pavement quality issues seem to contribute to more collisions involving bicyclists. During the observation of this intersection, multiple motorists were observed to nearly collide with bicyclists when the drivers made right turns on red. The best solution at this intersection would be to complete the bicycle lanes, clearly delineating a space for cyclists and discouraging them from riding on the sidewalk. Many bicyclists also seemed unsure of whether or not they were allowed to cross during the scramble signal. Allowing bicyclists to cross during the scramble could encourage them to stay on the road instead of using the sidewalk but it might also contribute to further pedestrian and bicyclist conflicts during the crossing.

6.3.3 Gayley and Weyburn Avenues

6.3.3.1 Location

The intersection of Gayley and Weyburn Avenues is located adjacent to a large university graduate housing complex. At this location, Weyburn Avenue consists of one/two through lanes, and a dedicated left turning lane on one of its legs. Gayley Avenue consists of two/three through lanes and a left turning lane on both legs (Figure 6.26). There is curbside parking along all the approaches of the intersection, and a bicycle lane along one of the approaching Gayley Avenue approaches which gets interrupted a few meters away from the intersection.

(b) Along Gayley Avenue (b) Along Weyburn Avenue



(d) Top View

Figure 6.26 Aerial and Street view of Gayley and Weyburn Avenues

6.3.3.2 Traffic Exposure

Approximately 20,000 vehicles pass through the intersection on an average day (LADOT, 2010). There are few public transit buses on this corridor, though UCLA does run campus shuttles here. Motorists often drive significantly faster on Gayley Avenue compared to other streets in Westwood. An automated count at one leg of this intersection on Weyburn Avenue yielded the volumes as shown in Figure 6.27 below. A significant difference in the pedestrian traffic distribution at this location was that while the peak hour demands were not as high as the previous two locations, it remained constant at this leg through the afternoon and evening periods. For instance, the average pedestrian counts between 12- 2 pm, 3- 5 pm, 6-8 pm, and 10 pm to midnight were 427, 434, 439 and 420 pedestrians, respectively.

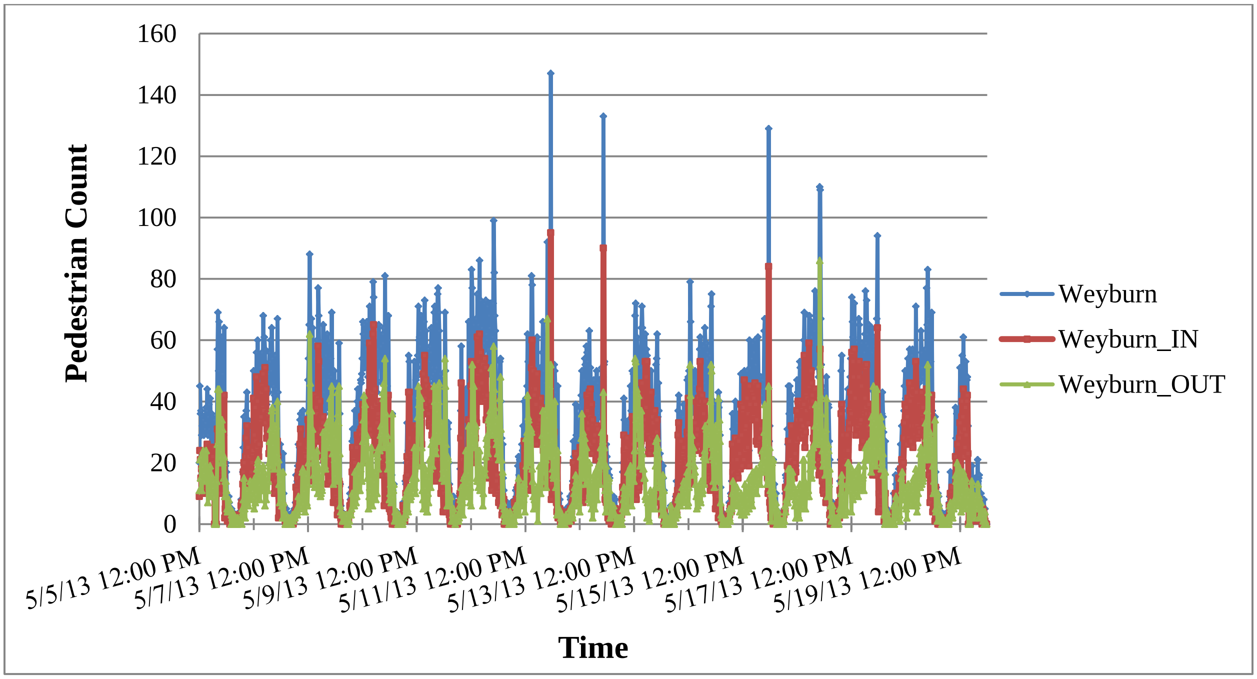


Figure 6.271 Automated Pedestrian Count from May 5 – 19, 2013

6.3.3.3 Risk

The clustering analysis of the intersection of Wilshire and Westwood Boulevards produced the following results:

- Pedestrian hotspots: Ranked 14 (SWITRS), 3 (survey crashes),
- Bicycle hotspots: Ranked 3 (SWITRS), 13 (survey crashes),

The hotspot rankings indicated that the location was of concern to both bicycles and pedestrians across different data sets. In terms of contextualized spatial clustering (Figures 5.21-25), the results indicated that 87% of the pedestrian crashes reported contact with cars. 67% of these crashes occurred during the evening, and most of them (83%) involved no injuries. In terms of the relevant behavioral attributes of these crashes, inattention (87%) and failure to yield (66%) were cited as the prominent factors in the crashes.

Finally, some of the descriptions of the crashes relevant to this intersection provided by the survey respondents are shown below:

- *"The driver clearly was too impatient to let people cross the crosswalk, even though there was a walk sign. She hit my leg and continued driving. It doesn't even look like she noticed."*
- *"Trying to cross the street and a car turning right almost hit me.... I had the green and they didn't see me."*
- *"Car making left turn went when I was in the intersection. No contact, but missed me by a few inches. Close enough for me to back up and I could've hit the car with my hand."*
- *"Riding SB Gayley in bike lane going to Santa Monica. Light turns green when I'm about 3-4 car-lengths back from the intersection. The first car in the right lane doesn't start moving until I'm about half-way past it. He starts turning and hits my back wheel as I'm trying to ride past. Note that there was a break in the bike lane line before the intersection such that if the driver*

knew he was turning right, he should have been in the shoulder lane. Also, no blinker indicating a turn."

6.3.3.4 Discussion and Recommendations

This intersection would benefit from advance stop bars to keep automobiles farther back from the crosswalk and increase visibility. Completed bicycle lanes would certainly help, as would a prohibition against right turns on red to prevent pedestrian conflicts. Again, the potential change in queuing and signal timing requirements might make a right turn on red prohibition complicated, but it is worth exploring.

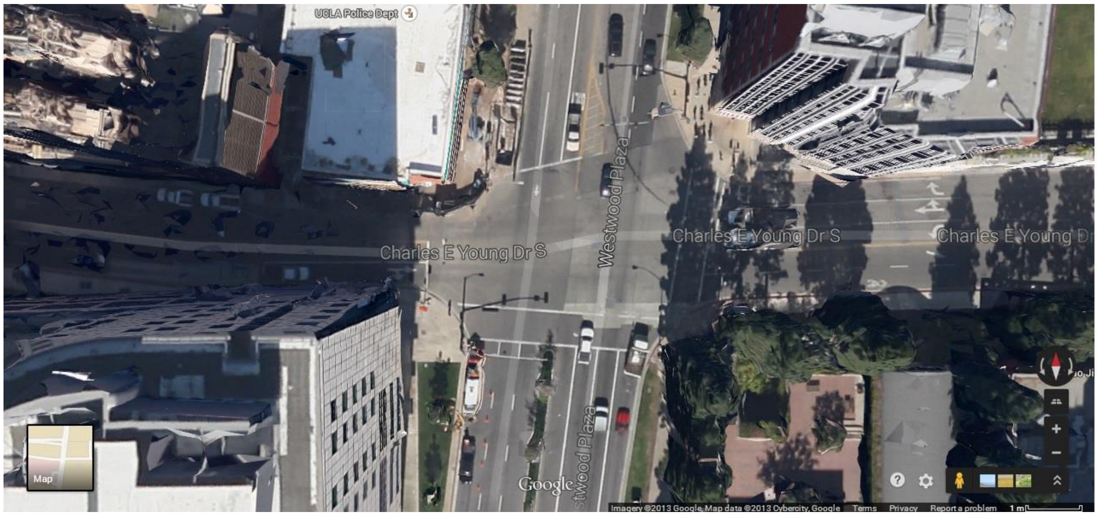
6.3.4 Westwood Plaza and Charles E Young Drive South

6.3.4.1 Location

Westwood Plaza and Charles E Young Drive South was the only case study intersection examined that is located on the UCLA campus (Figure 6.28). Westwood Plaza going southward comprises of two through lanes, one left turning lane and curbside parking; Westwood Plaza going northward comprises of two through lanes, one left turning lane and a dedicated right turning lane; Charles Young Drive South going westward has one through lane, one left turning lane and a dedicated right turning lane; and finally, Charles Young Drive South going eastward comprises of one left turning lane and one through/right turning lane. Consequently this intersection experiences a wide variety of traffic movements. Many public transit and campus shuttle buses cross this intersection, and it is close to two parking structures as well as the campus police department and facilities building.

(a) Along Westwood Plaza

(b) Along Charles E Young Drive South



(c) Top View

Figure 6.28 Aerial and Street View of Westwood Plaza and Charles E Young Drive South

6.3.4.2 Traffic Exposure

This intersection has several large parking structures nearby and also serves many public transit buses, contributing to complicated interactions. The lack of bicycle infrastructure going northbound and southbound on Westwood Plaza likely contributes to confusion for drivers, and the presence of many buses may cause bicyclists to feel uncomfortable on the street causing them to ride on the sidewalk instead. The complicated turning movements as Charles E Young Drive South enters the intersection going westbound also appear to cause some conflicts. The research team had time for only one manual count at this location and it averaged 2,676 pedestrians during two evening hours.

6.3.4.3 Risk

In terms of the hotspot rankings, the intersection fares as follows:

- Pedestrian hotspots: Ranked 14 (survey crashes),
- Bicycle hotspots: Ranked 2 (survey crashes), 8 (bicycle only perceived hazardous locations).

The hotspot rankings indicated that the location was primarily of concern to bicyclists. In terms of contextualized spatial clustering (Figures 5.26-30), the results indicated that 75% of the bicycle crashes reported contact with cars, which occurred during the evening, and did not involve any injuries. In terms of the relevant behavioral attributes of these crashes, inattention (87%) and failure to yield (66%) are cited as the prominent factors in the crashes. Inattention was a commonly reported cause, while various other causes were reported, including excessive speed, riding on the sidewalk, illegal crossing, failure to yield right-of-way, and unsafe lane change.

Finally, some of the descriptions of the crashes relevant to this intersection provided by the survey respondents are shown below:

- *"Location: at the intersection of Young and Westwood, sitting on Young on the east side of the street (waiting for the light to change so we could go west, toward Gayley). There are three lanes here: left turn, right turn, and the middle lane which is both right turn and straight. I was in the middle lane on my bike and a UCLA maintenance truck was also in this lane, immediately in front of me at the light. The light changed, we both started to move (me straight across the intersection and the truck to the right), and the truck cut across my path and I had to fall off my bike to avoid being run over. This can be avoided by just making the middle lane straight only (rather than straight or right turn)."*
- *"This has occurred to me several times: biking on Westwood Plaza on the approach to campus, buses must always cut into the right lane to turn right or stop; there is no bike lane or any directions, so buses and bikes and cars run into each other as drivers and bicyclists attempt to navigate."*
- *"There is no sensor for bicyclists waiting at this light, so if am trying to bike home at midnight, I could literally wait here all night long. Am I supposed to run the light?"*
- *"There is no room for bicyclists when the road narrows going north here. It would be nice if there was at least signage or shared lane markings on the pavement for cyclists going to Ackerman."*

6.3.4.4 Discussion and Recommendations

Charles E Young Drive South is slated to receive bicycle treatments in the near future; this may contribute to fewer crashes at this intersection. In addition, the Ackerman turnaround will be closing this summer for three years for construction, resulting in the displacement of many of the buses traveling through this intersection. UCLA Transportation should focus on simplifying the movements on Charles E Young going westbound and provide clear north-south bicycle facilities. Observation of this intersection showed pedestrians able to cross with relative ease, so improving the intersection for bicyclists should contribute to better safety for all road users. The possibility of enabling signal phase activation through bicycle presence should also be looked into.

6.4 Conclusions

The case studies discussed in the previous sections help illustrate how the survey along with the accompanying analysis was combined with on-site investigation to identify safety concerns at at-risk locations around campus communities. An additional benefit of the clustering analysis was that it helped isolate the crashes that were relevant to that location. The rich, descriptive narrative provided as part of the supplementary information in the survey were utilized to get a better understanding of the effects of built environment or traffic dynamics as contributing factors in crashes and/or injuries in the vicinity of that hotspot. In some cases, these descriptions contained valuable suggestions for improvement, which were considered.

7. Policy and Design Changes to Help Increase Pedestrian and Bicyclist Safety on and around Campuses

In this concluding section, we summarize our responses to the research questions posed in the introduction.

7.1 Common and Divergent Trends Among the Campuses

The 5,167 individuals who responded to the survey reported experiencing a total of 662 crashes while walking, bicycling, or driving on or around the three campuses. In the vast majority of cases, they did not consider the crashes to be serious. More than half of the crashes (52.6%) involved a bicyclist. While these are significant numbers, it should also be remembered that campuses are settings that attract a very high numbers of pedestrians and bicyclists and host multiple thousands of trips every day. Of greater concern is the fact that respondents also reported a total of 4,837 locations they perceived as hazardous. This list of locations could serve to guide future campus transportation improvements.

UCLA had significantly lower numbers of crashes reported per 100 respondents (7.8) than UCB (19.7) or CSUS (17.0). It is difficult to explain the differential in crash rates. Topography could be a factor, as UCB's generally hillier layout could contribute to hazards for bicyclists. Conversely, UCLA's generally drier climate could reduce dangers from slippery surfaces and reduced visibility. Furthermore, hillier terrain could discourage biking and walking, and the warmer climate could encourage it. More data is needed on the volumes of trips made by the different travel modes to get a clearer explanation.

In terms of the hotspot analysis, a common feature across the three campuses was that the top hotspots obtained through SWITRS tended to lie further away from the main campus area. In comparison, the hotspots obtained using the survey databases yielded a higher number within the main campus area or along its boundary.

Some of the top hotspots (particularly the top five) across the three campuses appeared as hotspots across three or more data sources. For instance, the Guy West Footbridge in CSUS, Bancroft Way and College Avenue in UCB, and Wilshire and Westwood Boulevards were denoted as hotspots through the survey crashes, pedestrian-only perceived hazardous locations, as well as the perceived hazardous locations for both bicycles and pedestrians. In some other cases, SWITRS and survey-based hotspots overlapped. However, the results of the contextualized spatial clustering revealed that the nature of these hotspots differed from each other, owing to the differences in characteristics of the campus and the surrounding city.

7.2 Temporal distribution of crashes in the three campuses

Across all three campuses, crashes were not equally distributed temporally: significantly higher numbers of crashes occurred during the late fall and winter which could be explained by the fact that the weather is dry in summer, and fewer classes are in session. While this pattern was consistent across the three campuses, some differences were also noted. For all three campuses, the majority of crashes occurred in the morning and afternoon hours, presumably when each campus has the highest numbers of people on it. However, there were some differences: at CSUS most crashes happened in the morning (7:00-11:59 am), whereas at UCB and UCLA, most happened in the afternoon; finally, UCLA experienced a significant share of bicycling crashes during the evening hours.

7.3 Underreporting

Scholars researching bicycle and pedestrian crashes find underreporting to be a very common issue. Similarly, this study found a significant amount of underreporting as well. For example, the UCLA campus police had only 15 crashes involving pedestrians or bicyclists on file for the period 2009-2012. By contrast, survey respondents at UCLA reported 126 crashes during the same period, with the vast majority saying that they had failed to report their crash to the police or other campus authority. In explaining this lack of reporting, about three-quarters of those who did not report the crash said they considered it to be too minor to report, while the remaining one quarter did not believe that the police would follow up or do anything about it. This finding should be of concern to campus administrators because of the likelihood that seemingly minor crashes could be indicators of hazards whose elimination would be beneficial to overall campus travel safety.

A comparison of the distribution of the on-campus and off-campus crashes for the different databases also revealed that the number of on-campus crashes obtained using SWITRS was much lower than those obtained through the survey. This indicated that the use of periodic surveys could help address the issue of underreporting in public crash databases when studying safety issues around campus communities.

7.4 Behavioral and Environmental Contributors to Crashes

One of the objectives of this study was to identify features of the built environment that may be particularly predictive of the incidence of crashes. The majority of survey responses, however, pointed to behavioral factors as primary contributors to crashes, with the most common for all three modes and for all three campuses being lack of attention on the part of at least one party. Excessive speeds on the part of bicyclists and motorists and their failure to yield were also commonly reported behaviors behind the incidence of crashes.

When environmental factors were cited as contributing to crashes, narrow, non-existent, or obstructed bicycle lanes that often forced bicyclists to enter space occupied by pedestrians or cars, and cracked or uneven roadways that led to falls were the most significant on all three campuses. In some cases, lack of sidewalks was also mentioned as a cause of crashes involving pedestrians. A small number of respondents cited other environmental factors: poor signage, debris on roads and paths, driveways interrupting the sidewalk, construction traffic, lack of traffic signals, congested pathways, and poorly designed or maintained bicycle infrastructure. These environmental factors tended to differ from one campus to the other. Notable were concerns about poor lighting voiced by a number of bicyclists on the three campuses because a significant portion of bicycle crashes occurred during the evening when visibility was poorer.

In terms of the campus-specific attributes, the contextualized spatial clustering for UCB’s bicycle crashes revealed that a majority of the bicycle crashes on campus involved contact with other objects. The behavioral attributes attributed to these crashes indicated that excessive speed and avoiding other modes were the most prominent reasons, while the most cited environmental factors were narrow/obstructed bicycle lanes, perhaps owing to the presence of multi-use paths on campus. It is also possible that the hilly terrain of the campus also played a role in bicycles traveling faster along certain routes.

7.5 Characteristics of Hazardous Campus Locations

It is impossible to identify with certainty common characteristics among the 662 crash locations or the 4,837 locations perceived as hazardous by the survey respondents. However, we can obtain a clearer view if the number of locations is narrowed down by concentrating on hotspots. Hotspots indicated that a high number of crashes tended to occur at the interface of campus activity and vehicular traffic, at sites of major pedestrian activity, and near major campus entrances. Outside the campus, hotspots of crashes often followed a linear pattern along major arterials in the vicinity of the campus (e.g. Telegraph Avenue, Bancroft Way, and Shattuck Avenue at UCB; Westwood Boulevard, Wilshire Boulevard, and Le Conte Avenue at UCLA; Folsom Boulevard at CSUS). Not surprisingly, most of the crashes occurred on roadways and intersections. But even in this context, there were some notable differences across the campuses. The top hotspots identified in UCB were all unsignalized intersections, whereas the hotspots obtained in UCLA and CSUS involved signalized intersections. Separated bicycle paths were safe, but multi-use paths (utilized by both pedestrians and bicyclists) had a worse safety record at CSUS and to some extent at UCB.

The results of the contextualized spatial clustering also indicated that the factors associated with the hotspots inside of the main campus area and those outside of it varied significantly. These differences may predominantly arise because of limited vehicular traffic inside the campuses, which resulted in different types of conflicts on campus, such as, a higher percentage of bicycle-pedestrian and bicycle-object crashes on campus (as is the case in UCB). Some of the prominent behavioral factors for crashes on campus were bicyclists riding on sidewalk (for pedestrian crashes in UCLA) and avoiding a cyclist/pedestrian/vehicle (for bicycle crashes in UCB).

7.6 Increasing Pedestrian and Bicycling Safety on Campuses

What can universities do to enhance travel safety on campuses? It is clear that no singular design or policy action can address all the behavioral and environmental factors that contribute to crashes. Nevertheless, it is emphasized that specific design changes and improvements of the built environment at hazardous locations may enhance pedestrian and bicycling safety. Such changes should be context-specific; it is suggested that specific improvements for certain hotspots in the three campuses in Section 6. Findings from this study also lead us to propose the following general guidelines, which can be applicable to all university campuses.

Development of campus master plans for walking and biking. Walking and biking are the primary modes of travel on most campuses. It is, thus, very important that campuses develop comprehensive master plans for walking and biking that outline a 5-10 year vision of improving the pedestrian and bicycling environment and safety on campus and identify and prioritize implementable projects to do so. These plans should be revisited every five years, as needs and conditions on campuses change. Some campuses already have such plans. UCLA, for example, issued its first *UCLA Bicycle Master Plan* in 2006 with the purpose "*to serve as a guide for improving bicycling conditions and encouraging the use of the bicycle as a mode of transportation on, to and from the UCLA campus*" (http://bart.ts.ucla.edu/pdf/0306FinalMasterBikePlan.pdf, pp. 7-8). The plan outlines strategies, programs, and projects to improve bicycle safety and bicycle use on campus; however, it does not discuss the campus walking environment. Similar plans also exist for UC Berkeley (http://pt.berkeley.edu/sites/default/files/UCB_BikePlanFinal.pdf) and are currently being developed for the CSUS campus (http://www.csus.edu/masterplan/). However, an important takeaway from this study is also that involving the campus community can provide insights into the needs and concerns of the pedestrians and bicyclists on campus.

Safety audit/identification of hotspots. Campus resources for infrastructure improvements that enhance the safety of bicycling and walking are not limitless and should be targeted to the particular campus locations where crashes seem most concentrated. A web-based survey, similar to the one utilized in this study, can be administered periodically to the campus population and can serve as a safety audit to identify the major crash hotspots.

Special treatment/retrofit of campus activity hubs. This study showed that most of the campus hotspots coincided with areas that had significant amounts of walking, biking, and driving. Prominent areas that typically include all three modes are: major entrances to universities and entrances to major parking facilities on campus. Other areas where major pedestrian and bicycling activity may occur in their vicinity include libraries, campus eateries, bookstores, and plazas. Such activity hubs should be given special attention through traffic calming strategies, good signage, and lighting.

Dedicated bike and pedestrian network on campus, where possible. This study found that a number of crashes occurred on multi-use paths. Ideally, pedestrians, bicyclists, and motorists on campus should be adequately separated through the development of dedicated bicycle and pedestrian networks. However, this addition is often not possible because space on most campuses is limited, particularly within urban settings.

Lowering speed limits on campus. Vehicle speeds on many campuses are typically lower than in the surrounding streets, which is a major reason why the vast majority of the crashes reported in our survey did not involve major injuries. Campus administrations should consider lowering the speed limit within their campus boundaries to a maximum of 20 mph, particularly on interior two-lane roads.

Good lighting on campus travel routes and on bicycles. It was found that a number of bicycle crashes occurred in the evening hours. A possible explanation for some of these incidents was that the parties involved in these crashes did not have good visibility. Campuses should put particular emphasis on retrofitting their travel routes with good lighting. Campus police should also enforce the law that all bicycles have lights mounted to their front and red reflectors attached to their back or adopt policies to encourage bicyclists to carry lights.

Improved bicycle infrastructure on arterials leading to campus. Our study showed that a significant number of crashes occurred outside the perimeter but in the close vicinity of each campus. Such crashes tend to be more serious in nature than those encountered within the campus proper, and often involve automobiles travelling at higher speeds. In our survey, we heard a number of complaints about the absence or discontinuity of bicycle lanes along the arterials leading to the campuses. While universities do not control the roadways outside their campus boundaries, they can work to encourage city departments of transportation to retrofit campus-adjacent major arterials with clearly indicated bicycle lanes.

Retrofit of walking and bicycling infrastructure in campus vicinity. More than 500 regional and local jurisdictions have adopted some kind of Complete Streets policy (see Smart Growth America Complete Streets Atlas, http://www.smartgrowthamerica.org/complete-streets/changing-policy/complete-streets-atlas). The immediate vicinities of university campuses appear to be prime candidates for such initiatives as they typically attract very high concentrations of trips by walking, biking, and motor vehicle. In addition to the improved bicycle lanes discussed above, other retrofits of the major roadways leading to campuses could include shared lane bicycle markings (sharrows), bicycle boxes, and good signage and lighting. For pedestrians, advanced stop lines at crosswalks, fixing cracked pavements, adding pedestrian-activated flashing beacons at crosswalks, and installing median refuges on wide streets can enhance the real and perceived safety. While skateboarding was outside the scope of this report, the aforementioned improvements would also improve safety for the numerous skateboarders on and around campuses.

In the last decade, a number of university campuses have touted sustainability as a major goal of campus planning. Encouraging and supporting travel to campus by modes other than the private automobile can play a major role in achieving a “greener” and more sustainable university campus. It is hoped that the findings of this report represent a step in this direction.

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APPENDIX A

SURVEY QUESTIONNAIRE

Campus Safe Travel Survey

Welcome to the Campus Safe Travel Survey

There are 166 questions in this survey

General Questions

1 [Q2_affil] ***What is your campus affiliation? ****

Please choose **only one** of the following:

- ○ Current student
- ○ Current faculty member
- ○ Current staff member
- ○ No university affiliation

2 [Q2_yr_trvl] ***What year did you first start traveling to this campus? ****

Please choose **only one** of the following:

- ○ 2013
- ○ 2012
- ○ 2011
- ○ 2010
- ○ 2009
- ○ 2008
- ○ 2007
- ○ 2006
- ○ 2005
- ○ 2004
- ○ 2003
- ○ 2002
- ○ before 2002

3 [Q2_map_CSUS]

The boundaries of our study for this campus are shown on the map below. Please refer only to locations within these boundaries when completing this survey.

View CSUS in a larger map

Only answer this question if the following conditions are met:
° ((**Q2_campus_HIDDEN.NAOK** == "CSUS"))

4 [Q2_map_UCLA]

The boundaries of our study for this campus are shown on the map below. Please refer only to locations within these boundaries when completing this survey.

View UCLA in a larger map

Only answer this question if the following conditions are met:
° ((Q2_campus_HIDDEN.NAOK == "UCLA"))

5 [Q2_map_UCB]

The boundaries of our study for this campus are shown on the map below. Please refer only to locations within these boundaries when completing this survey.

View UC Berkeley in a larger map

Only answer this question if the following conditions are met:
° ((Q2_campus_HIDDEN.NAOK == "UCB"))

Accident History

6 [Q3_bike]*Have you <u>biked</u> on or near the campus since {if(Q2_yr_trvl!=1,'{Q2_yr_trvl}',' 2002')}? **

Please choose **only one** of the following:

- ○ Yes
- ○ No

7 [Q3_bike_Y]*<u>While biking on or near the campus</u>, have you had an accident where you fell, you caused someone else to fall, or you made contact with another cyclist, a pedestrian, or a vehicle? **

Only answer this question if the following conditions are met:
° ((Q3_bike.NAOK == "1"))

Please choose **only one** of the following:

- ○ Yes
- ○ No

8 [Q3_bike_Y_num]

If <u>yes</u>, please indicate the number of times you have had a biking-related accident.

*

Only answer this question if the following conditions are met:
° ((Q3_bike_Y.NAOK == "1"))

Please write your answer here:

[ ]

9 [Q3_walk]*Have you <u>walked</u> on or near the campus since {if(Q2_yr_trvl!=1,'{Q2_yr_trvl}',' 2002')}? **

Please choose **only one** of the following:

- ○ Yes
- ○ No

10 [Q3_walk_Y]*<u>While walking on or near the campus</u>, have you had an accident where a cyclist or a motorist caused you to fall, or you made contact with a cyclist or a vehicle? **

Only answer this question if the following conditions are met:
° ((Q3_walk.NAOK == "1"))

Please choose **only one** of the following:

- ○ Yes
- ○ No

11 [Q3_walk_Y_num]

If yes, please indicate the number of times you have had a walking-related accident.

*

Only answer this question if the following conditions are met:
° ((Q3_walk_Y.NAOK == "1"))

Please write your answer here:

12 [Q3_drive] ***Have you driven on or near the campus since {if(Q2_yr_trvl!=1,'{Q2_yr_trvl}',' 2002')}? ****

Please choose **only one** of the following:

- Yes
- No

13 [Q3_drive_Y] ***While driving on or near the campus, have you had an accident where your vehicle caused a cyclist or a pedestrian to fall, or your vehicle made contact with a cyclist or a pedestrian? ****

Only answer this question if the following conditions are met:
° ((Q3_drive.NAOK == "1"))

Please choose **only one** of the following:

- Yes
- No

14 [Q3_drive_Y_num]

If yes, please indicate the number of times you have had a driving-related accident.

*

Only answer this question if the following conditions are met:
° ((Q3_drive_Y.NAOK == "1"))

Please write your answer here:

15 [Q3_next] ***We will now ask you for details about each of these accidents. Please click "Next."***

Only answer this question if the following conditions are met:
° ((Q3_bike_Y.NAOK == "1")) or ((Q3_walk_Y.NAOK == "1")) or ((Q3_drive_Y.NAOK == "1"))

Accident Details (Bike) - 1

You reported that you had {INSERTANS:257214X2X137} accident{if(Q3_bike_Y_num>1,'s','')} while biking.

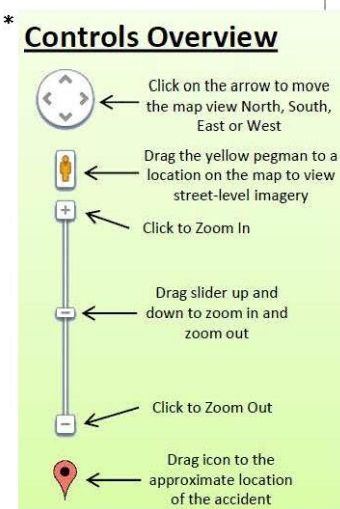
Please answer the following questions about {if(Q3_bike_Y_num==1,'the accident','each accident')}.

If you indicated more than 5 accidents, please answer the following questions based on the 5 most recent accidents.

Accident: 1 of {INSERTANS:257214X2X137}

16 [Q4_bike_map] ***Please identify the approximate location of the accident on the map below by clicking and dragging the icon. You may also zoom in, move around, and use the satellite view of the map to help indicate the location more precisely.***

*



Please write your answer here:

17 [Q4_bike_yr]*What year did this accident occur?* *

Please choose **only one** of the following:

- ◯ 2013
- ◯ 2012
- ◯ 2011
- ◯ 2010
- ◯ 2009
- ◯ 2008
- ◯ 2007
- ◯ 2006
- ◯ 2005
- ◯ 2004
- ◯ 2003
- ◯ 2002
- ◯ before 2002
- ◯ Don't know/Don't remember

18 [Q4_bike_month]*What month did this accident occur?*

Please choose **only one** of the following:

- ◯ January
- ◯ February
- ◯ March
- ◯ April
- ◯ May
- ◯ June
- ◯ July
- ◯ August
- ◯ September
- ◯ October
- ◯ November
- ◯ December
- ◯ Don't know/Don't remember

19 [Q4_bike_time]*About what time of day?* *

Please choose **only one** of the following:

- ◯ Early morning (3:00 AM – 6:59 AM)
- ◯ Morning (7:00 AM – 11:59 PM)
- ◯ Afternoon (12:00 PM – 5:59 PM)
- ◯ Evening (6:00 PM – 10:59 PM)
- ◯ Late evening (11:00 PM – 2:59 AM)
- ◯ Don't know/Don't remember

20 [Q4_bike_where]*Which of the following best describes where this accident took place? **

Please choose **only one** of the following:

- ○ Sidewalk
- ○ Driveway
- ○ Roadway/traffic lane
- ○ Mid-block street crossing
- ○ Intersection crossing (with traffic signals)
- ○ Intersection crossing (stop signs)
- ○ Intersection crossing (without traffic signals or stop signs)
- ○ Bike lane on road
- ○ Separated bike path
- ○ Multi-use path (bike and pedestrian path)
- ○ Parking lot (surface lot)
- ○ Parking structure (garage)
- ○ Other [ ]

21 [Q4_bike_contact]*Did you make contact with any of the following (check all that apply)? **

Please choose **all** that apply:

- ☐ Contact with a non-moving permanent object (e.g. structure, ground). Please describe below...
- ☐ Another cyclist
- ☐ A pedestrian
- ☐ A vehicle

22 [Q4_bike_contact_de]You indicated that you made contact with a structure, object, or the ground. Please describe what that was.

Only answer this question if the following conditions are met:
° ((Q4_bike_contact_1.NAOK == "Y"))

Please write your answer here:

[ ]

23 [Q4_bike_matrix]*What factors do you believe contributed to this accident for each party involved? (check all that apply)*

	Myself	Other Cyclist	Pedestrian	Vehicle
Inattention	☐	☐	☐	☐
Intoxication	☐	☐	☐	☐
Fatigue or sleepiness	☐	☐	☐	☐
Excessive speed	☐	☐	☐	☐
Riding on the sidewalk	☐	☐	☐	☐
Traveling wrong way	☐	☐	☐	☐
Illegal crossing	☐	☐	☐	☐
Ignoring traffic controls (e.g., signals, stop signs)	☐	☐	☐	☐
Failure to yield to right-of-way	☐	☐	☐	☐
Passing or improper lane usage	☐	☐	☐	☐
Unsafe lane change	☐	☐	☐	☐
Avoiding a cyclist, vehicle or pedestrian	☐	☐	☐	☐
Avoiding obstruction (e.g., pothole or tree branch)	☐	☐	☐	☐
Emerging from behind a parked vehicle or other structure	☐	☐	☐	☐
Obstructed views (please explain below)	☐	☐	☐	☐

24 [Q4_bike_matrix_txt]*You indicated that one or some of the parties involved in the accident had obstructed views (please explain):* *

Only answer this question if the following conditions are met:
° ((Q4_bike_matrix_15_1.NAOK == "1")) or ((Q4_bike_matrix_15_2.NAOK == "1")) or ((Q4_bike_matrix_15_3.NAOK == "1")) or ((Q4_bike_matrix_15_4.NAOK == "1"))

Please write your answer here:

25 [Q4_bike_env]*Which of these additional factors do you believe contributed to this accident?* *

Please choose **all** that apply:

- ☐ Poor weather conditions
- ☐ Cracked/uneven **sidewalk** pavement
- ☐ Cracked/uneven **roadway** pavement
- ☐ Narrow/interrupted bike lane
- ☐ Obstructed bike lane (e.g. double parking, garbage cans)
- ☐ Lack of sidewalk
- ☐ Narrow sidewalk
- ☐ Driveways interrupting sidewalk
- ☐ Poor lighting
- ☐ Don't know/don't remember
- ☐ Other:

26 [Q4_bike_seri]*How serious was this accident for you?* *

Please choose **only one** of the following:

- ○ Very Serious (overnight hospital stay)
- ○ Serious (hospital visit, not overnight)
- ○ Not serious (scrapes and bruises)
- ○ Minor (no visible scrapes or bruises)
- ○ No injuries, property damage only
- ○ No injuries, no property damage

27 [Q4_bike_seri_oth]*How serious was this accident for the <u>other</u> person(s)?* *

Only answer this question if the following conditions are met:
° ((Q4_bike_contact_2.NAOK == "Y" or Q4_bike_contact_3.NAOK == "Y" or Q4_bike_contact_4.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Very Serious (overnight hospital stay)
- ○ Serious (hospital visit, not overnight)
- ○ Not serious (scrapes and bruises)
- ○ Minor (no visible scrapes or bruises)
- ○ No injuries, property damage only
- ○ No injuries, no property damage

28 [Q4_bike_report]*Did you report this accident to the police?* *

Please choose **only one** of the following:

- ○ Yes
- ○ No

29 [Q4_bike_report_no]*Why did you not report this accident to the police? (check all that apply)* *

Only answer this question if the following conditions are met:
° (((! is_empty(Q4_bike_report.NAOK) && (Q4_bike_report.NAOK == "0"))))

Please choose **all** that apply:

- ☐ Thought the accident was minor/not necessary to report
- ☐ Didn't know who to call to report
- ☐ Didn't think the police would do anything
- ☐ No time
- ☐ No one else involved
- ☐ Other: ______

Accident Details (Walk) - 1

You reported that you had {INSERTANS:257214X2X138} accident{if(Q3_walk_Y_num>1,'s','')} while walking.

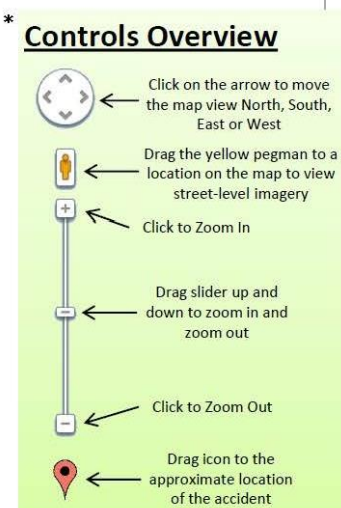
Please answer the following questions about {if(Q3_walk_Y_num==1,'the accident','each accident')}.

If you indicated more than 5 accidents, please answer the following questions based on the 5 most recent accidents.

Accident: 1 of {INSERTANS:257214X2X138}

91 [Q4_walk_map] ***Please identify the approximate location of the accident on the map below by clicking and dragging the icon. You may also zoom in, move around, and use the satellite view of the map to help indicate the location more precisely.***

*



Please write your answer here:

92 [Q4_walk_yr]*What year did this accident occur?* *

Please choose **only one** of the following:

- 2013
- 2012
- 2011
- 2010
- 2009
- 2008
- 2007
- 2006
- 2005
- 2004
- 2003
- 2002
- before 2002
- Don't know/Don't remember

93 [Q4_walk_month]*What month did this accident occur?* *

Please choose **only one** of the following:

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December
- Don't know/Don't remember

94 [Q4_walk_time]*About what time of day?* *

Please choose **only one** of the following:

- Early morning (3:00 AM – 6:59 AM)
- Morning (7:00 AM – 11:59 PM)
- Afternoon (12:00 PM – 5:59 PM)
- Evening (6:00 PM – 10:59 PM)
- Late evening (11:00 PM – 2:59 AM)
- Don't know/Don't remember

95 [Q4_walk_where]*Which of the following best describes where this accident took place? **

Please choose **only one** of the following:

- ○ Sidewalk
- ○ Driveway
- ○ Roadway/traffic lane
- ○ Mid-block street crossing
- ○ Intersection crossing (with traffic signals)
- ○ Intersection crossing (stop signs)
- ○ Intersection crossing (without traffic signals or stop signs)
- ○ Bike lane on road
- ○ Separated bike path
- ○ Multi-use path (bike and pedestrian path)
- ○ Parking lot (surface lot)
- ○ Parking structure (garage)
- ○ Other [ ]

96 [Q4_walk_contact]*Did you make contact with any of the following (check all that apply)? **

Please choose **all** that apply:

- ☐ Contact with a non-moving permanent object (e.g. structure, ground). Please describe below...
- ☐ A cyclist
- ☐ A vehicle

97 [Q4_walk_contact_de]You indicated that you made contact with a structure, object, or the ground. Please describe what that was.

Only answer this question if the following conditions are met:
° ((Q4_walk_contact_1.NAOK == "Y"))

Please write your answer here:

[ ]

98 [Q4_walk_matrix]*What factors do you believe contributed to this accident for each party involved? (check all that apply)*

	Myself	Cyclist	Vehicle
Inattention	☐	☐	☐
Intoxication	☐	☐	☐
Fatigue or sleepiness	☐	☐	☐
Excessive speed	☐	☐	☐
Riding on the sidewalk	☐	☐	☐
Traveling wrong way	☐	☐	☐
Illegal crossing	☐	☐	☐
Ignoring traffic controls (e.g., signals, stop signs)	☐	☐	☐
Failure to yield to right-of-way	☐	☐	☐
Passing or improper lane usage	☐	☐	☐
Unsafe lane change	☐	☐	☐
Avoiding a cyclist, vehicle or pedestrian	☐	☐	☐
Avoiding obstruction (e.g., pothole or tree branch)	☐	☐	☐
Emerging from behind a parked vehicle or other structure	☐	☐	☐
Obstructed views (please explain below)	☐	☐	☐

99 [Q4_walk_matrix_txt]*You indicated that one or some of the parties involved in the accident had obstructed views (please explain): **

Only answer this question if the following conditions are met:
° ((Q4_walk_matrix_15_1.NAOK == "1")) or ((Q4_walk_matrix_15_2.NAOK == "1")) or ((Q4_walk_matrix_15_4.NAOK == "1"))

Please write your answer here:

100 [Q4_walk_env]*Which of these additional factors do you believe contributed to this accident? **

Please choose **all** that apply:

- ☐ Poor weather conditions
- ☐ Cracked/uneven **sidewalk** pavement
- ☐ Cracked/uneven **roadway** pavement
- ☐ Narrow/interrupted bike lane
- ☐ Obstructed bike lane (e.g. double parking, garbage cans)
- ☐ Lack of sidewalk
- ☐ Narrow sidewalk
- ☐ Driveways interrupting sidewalk
- ☐ Poor lighting
- ☐ Don't know/don't remember
- ☐ Other:

101 [Q4_walk_seri]*How serious was this accident for you?* *

Please choose **only one** of the following:

- ○ Very Serious (overnight hospital stay)
- ○ Serious (hospital visit, not overnight)
- ○ Not serious (scrapes and bruises)
- ○ Minor (no visible scrapes or bruises)
- ○ No injuries, property damage only
- ○ No injuries, no property damage

102 [Q4_walk_seri_oth]*How serious was this accident for the <u>other</u> person(s)?* *

Only answer this question if the following conditions are met:
° ((Q4_walk_contact_2.NAOK == "Y" or Q4_walk_contact_4.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Very Serious (overnight hospital stay)
- ○ Serious (hospital visit, not overnight)
- ○ Not serious (scrapes and bruises)
- ○ Minor (no visible scrapes or bruises)
- ○ No injuries, property damage only
- ○ No injuries, no property damage

103 [Q4_walk_report]*Did you report this accident to the police?* *

Please choose **only one** of the following:

- ○ Yes
- ○ No

104 [Q4_walk_report_no]*Why did you not report this accident to the police? (check all that apply)* *

Only answer this question if the following conditions are met:
° (((! **is_empty**(Q4_walk_report.NAOK) && (Q4_walk_report.NAOK == "0"))))

Please choose **all** that apply:

- ☐ Thought the accident was minor/not necessary to report
- ☐ Didn't know who to call to report
- ☐ Didn't think the police would do anything
- ☐ No time
- ☐ No one else involved
- ☐ Other: ____________

105 [Q4_walk_desc]*Please briefly describe this accident (e.g., what happened, where you were located, where you were going).*

Please write your answer here:

Campus Safe Travel Survey - Part 2

Welcome to the Campus Safe Travel Survey

There are 133 questions in this survey

Accident Details (Drive) - 1

You reported that you had {INSERTANS:652817X136X4745} accident{if(Q3_drive_Y_num>1,'s','')} while driving.

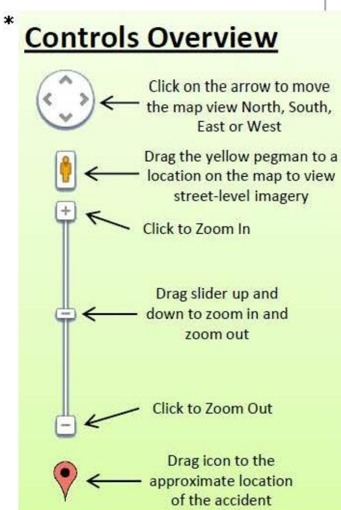
Please answer the following questions about {if(Q3_drive_Y_num==1,'the accident','each accident')}.

If you indicated more than 5 accidents, please answer the following questions based on the 5 most recent accidents.

Accident: 1 of {INSERTANS:652817X136X4745}

1 [Q4_drive_map] ***Please identify the approximate location of the accident on the map below by clicking and dragging the icon. You may also zoom in, move around, and use the satellite view of the map to help indicate the location more precisely.***

*



Please write your answer here:

2 [Q4_drive_yr]*What year did this accident occur?* *

Please choose **only one** of the following:

- 2013
- 2012
- 2011
- 2010
- 2009
- 2008
- 2007
- 2006
- 2005
- 2004
- 2003
- 2002
- before 2002
- Don't know/Don't remember

3 [Q4_drive_month]*What month did this accident occur?* *

Please choose **only one** of the following:

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December
- Don't know/Don't remember

4 [Q4_drive_time]*About what time of day?* *

Please choose **only one** of the following:

- Early morning (3:00 AM – 6:59 AM)
- Morning (7:00 AM – 11:59 PM)
- Afternoon (12:00 PM – 5:59 PM)
- Evening (6:00 PM – 10:59 PM)
- Late evening (11:00 PM – 2:59 AM)
- Don't know/Don't remember

5 [Q4_drive_where]*Which of the following best describes where this accident took place?* *

Please choose **only one** of the following:

- ◯ Sidewalk
- ◯ Driveway
- ◯ Roadway/traffic lane
- ◯ Mid-block street crossing
- ◯ Intersection crossing (with traffic signals)
- ◯ Intersection crossing (stop signs)
- ◯ Intersection crossing (without traffic signals or stop signs)
- ◯ Bike lane on road
- ◯ Separated bike path
- ◯ Multi-use path (bike and pedestrian path)
- ◯ Parking lot (surface lot)
- ◯ Parking structure (garage)
- ◯ Other ____________

6 [Q4_drive_contact]*Did you make contact with any of the following (check all that apply)?* *

Please choose **all** that apply:

- ☐ Contact with a non-moving permanent object (e.g. structure, ground). Please describe below...
- ☐ A cyclist
- ☐ A pedestrian

7 [Q4_drv_contact_de]You indicated that you made contact with a structure, object, or the ground. Please describe what that was.

Only answer this question if the following conditions are met:
° ((Q4_drive_contact_1.NAOK == "Y"))

Please write your answer here:

____

8 [Q4_drive_matrix] ***What factors do you believe contributed to this accident for each party involved? (check all that apply)***

	Myself	Cyclist	Pedestrian
Inattention	☐	☐	☐
Intoxication	☐	☐	☐
Fatigue or sleepiness	☐	☐	☐
Excessive speed	☐	☐	☐
Riding on the sidewalk	☐	☐	☐
Traveling wrong way	☐	☐	☐
Illegal crossing	☐	☐	☐
Ignoring traffic controls (e.g., signals, stop signs)	☐	☐	☐
Failure to yield to right-of-way	☐	☐	☐
Passing or improper lane usage	☐	☐	☐
Unsafe lane change	☐	☐	☐
Avoiding a cyclist, vehicle or pedestrian	☐	☐	☐
Avoiding obstruction (e.g., pothole or tree branch)	☐	☐	☐
Emerging from behind a parked vehicle or other structure	☐	☐	☐
Obstructed views (please explain below)	☐	☐	☐

9 [Q4_drive_matrix_txt] ***You indicated that one or some of the parties involved in the accident had obstructed views (please explain): ****

Only answer this question if the following conditions are met:
° ((Q4_drive_matrix_15_1.NAOK == "1")) or ((Q4_drive_matrix_15_2.NAOK == "1")) or ((Q4_drive_matrix_15_3.NAOK == "1"))

Please write your answer here:

10 [Q4_drive_env] ***Which of these additional factors do you believe contributed to this accident? ****

Please choose **all** that apply:

- ☐ Poor weather conditions
- ☐ Cracked/uneven **sidewalk** pavement
- ☐ Cracked/uneven **roadway** pavement
- ☐ Narrow/interrupted bike lane
- ☐ Obstructed bike lane (e.g. double parking, garbage cans)
- ☐ Lack of sidewalk
- ☐ Narrow sidewalk
- ☐ Driveways interrupting sidewalk
- ☐ Poor lighting
- ☐ Don't know/don't remember
- ☐ Other:

11 [Q4_drive_seri]*How serious was this accident for you?* *

Please choose **only one** of the following:

- ○ Very Serious (overnight hospital stay)
- ○ Serious (hospital visit, not overnight)
- ○ Not serious (scrapes and bruises)
- ○ Minor (no visible scrapes or bruises)
- ○ No injuries, property damage only
- ○ No injuries, no property damage

12 [Q4_drive_seri_oth]*How serious was this accident for the <u>other</u> person(s)?* *

Only answer this question if the following conditions are met:
° ((Q4_drive_contact_2.NAOK == "Y" or Q4_drive_contact_3.NAOK == "Y"))

Please choose **only one** of the following:

- ○ Very Serious (overnight hospital stay)
- ○ Serious (hospital visit, not overnight)
- ○ Not serious (scrapes and bruises)
- ○ Minor (no visible scrapes or bruises)
- ○ No injuries, property damage only
- ○ No injuries, no property damage

13 [Q4_drive_report]*Did you report this accident to the police?* *

Please choose **only one** of the following:

- ○ Yes
- ○ No

14 [Q4_drive_report_no]*Why did you not report this accident to the police? (check all that apply)* *

Only answer this question if the following conditions are met:
° (((! is_empty(Q4_drive_report.NAOK) && (Q4_drive_report.NAOK == "0"))))

Please choose **all** that apply:

- ☐ Thought the accident was minor/not necessary to report
- ☐ Didn't know who to call to report
- ☐ Didn't think the police would do anything
- ☐ No time
- ☐ No one else involved
- ☐ Other: ________

15 [Q4_drive_desc]*Please briefly describe this accident (e.g., what happened, where you were located, where you were going).*

Please write your answer here:

Hazardous Sites/Hot Spots Locations

76 [Q5_other_hzd]*Are there locations on or near this campus <u>other than the accident location(s) you reported earlier</u> that you think are hazardous for cycling and/or walking? **

Only answer this question if the following conditions are met:
° ((AnyAccidents.NAOK == "1"))

Please choose **only one** of the following:

- ○ Yes
- ○ No

77 [Q5_hzd]*Are there locations on or near this campus that you think are hazardous for cycling and/or walking? **

Only answer this question if the following conditions are met:
° (((! is_empty(AnyAccidents.NAOK) && (AnyAccidents.NAOK == "0"))))

Please choose **only one** of the following:

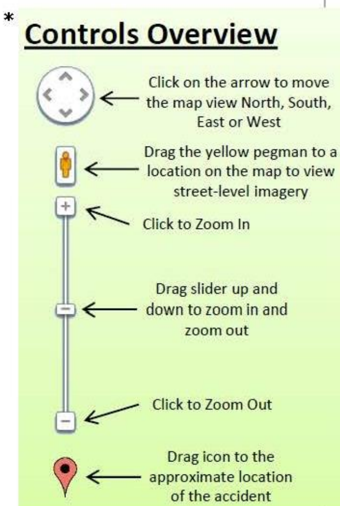
- ○ Yes
- ○ No

Hazardous Sites/Hot Spots Locations - Details (1/5)

Please indicate where you think there is a hazardous site/hot spot location. You may add additional locations (up to 5) by answering "Yes" to the last question.

78 [Q5_hzd_map] ***Please identify the hazardous site/hot spot location on the map below by clicking and dragging the icon. You may also zoom in, move around, and use the satellite view of the map to help indicate the location more precisely.***

*



Please write your answer here:

79 [Q5_hzd_type] ***Please indicate if this is a dangerous location for cycling or walking or both.***

Please choose **all** that apply:

- ☐ Cycling
- ☐ Walking

80 [Q5_hzd_matrix]Why do you think this location is dangerous for cycling and/or walking?

	Cycling	Walking
Obstructed views	☐	☐
Trees/foliage obstructing visibility	☐	☐
Cracked/uneven sidewalk pavement	☐	☐
Cracked/uneven roadway pavement	☐	☐
Inadequate traffic controls (e.g., signals, stop signs)	☐	☐
Inadequate lanes or paths	☐	☐
Lack of sidewalk	☐	☐
Narrow sidewalk	☐	☐
Driveways interrupting sidewalk	☐	☐
Inadequate lighting	☐	☐
Too many vehicles	☐	☐
Too many cyclists	☐	☐
Too many pedestrians	☐	☐
Vehicles travel too fast	☐	☐
Cyclist travel too fast	☐	☐
Other	☐	☐
Don't know/don't remember	☐	☐

81 [Q5_hzd_matrix_txt]*You indicated other reasons why this location is dangerious for cycling and/or walking. Please explain:* *

Only answer this question if the following conditions are met:
° ((Q5_hzd_matrix_16_1.NAOK == "1")) or ((Q5_hzd_matrix_16_2.NAOK == "1"))

Please write your answer here:

82 [Q5_hzd_add_dtl]*Please provide any additional details about this location and why you think it is dangerous for cyclists/pedestrians.*

Please write your answer here:

83 [Q5_hzd_miss]*Have you experienced a near miss at this location?* *

Please choose **only one** of the following:

- ○ Yes
- ○ No

84 [Q5_hzd_miss_y]Please describe the incident

Only answer this question if the following conditions are met:
° Q5_hzd_miss == '1'

Please write your answer here:

85 [Q5_hzd_witness]*Have you witnessed an accident or near miss at this location?* *

Please choose **only one** of the following:

- ○ Yes
- ○ No

86 [Q5_hzd_witness_y]Please describe the incident.

Only answer this question if the following conditions are met:
° Q5_hzd_witness == '1'

Please write your answer here:

87 [Q5_next]Would you like to add another hazardous site/hot spot location? *

Please choose **only one** of the following:

- ○ Yes
- ○ No

Respondent Information

127 [Q6_gender]*Gender* *

Please choose **only one** of the following:

- Female
- Male

128 [Q6_birthyr]*Please select your year of birth* *

Please choose **only one** of the following:

- 1995
- 1994
- 1993
- 1992
- 1991
- 1990
- 1989
- 1988
- 1987
- 1986
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○ 1901
○ 1900

129 [Q6_trvl_mode]*What are your primary travel modes to campus? **

Please choose **all** that apply:

- ☐ Walking
- ☐ Cycling
- ☐ Transit
- ☐ Drive (alone)
- ☐ Drive (carpooling)
- ☐ Other (Please describe below)

130 [Q6_trvl_mode_oth]*You indicated another travel mode above. Please indicate what that is.*

Only answer this question if the following conditions are met:
° ((Q6_trvl_mode_6.NAOK == "Y"))

Please write your answer here:

[ ]

131 [Q6_trvl_mode_freq]*How often do you use your primary modes to travel to campus? If you use more than one mode, check any that apply.*

Please choose the appropriate response for each item:

	Walk	Cycle	Transit	Drive (alone)	Drive (carpool)	Other
5 or more times a week	○	○	○	○	○	○
3-4 times a week	○	○	○	○	○	○
1-2 times per week	○	○	○	○	○	○
Less than 4 times per month	○	○	○	○	○	○
Less than once per month	○	○	○	○	○	○

132 [Q6_zipcode]*5-digit zip code for place of residence (ex: 99999) **

Please check the format of your answer.

Please write your answer here:

[ ]

End of Survey

133 [Q7_End]

Please click "Submit" to submit your completed survey.

Note: You will not be able to have access or make changes to your survey once you submit it.

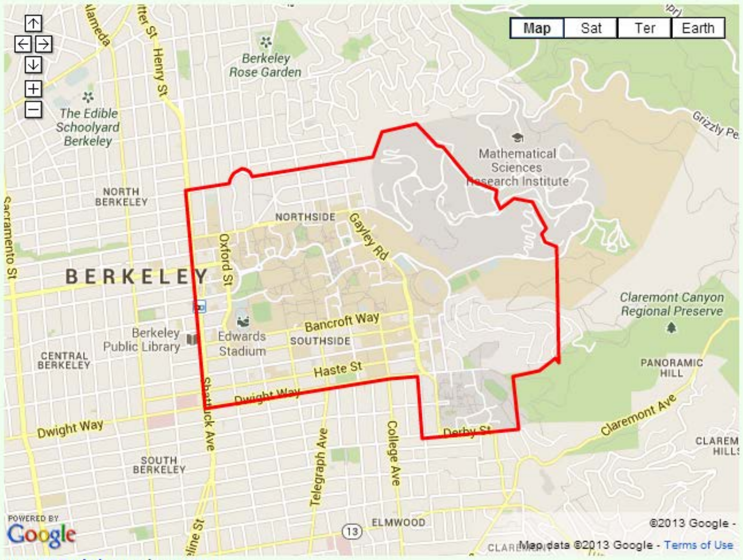
Thank you for your participation.

APPENDIX B

CAMPUS MAPS AND BOUNDARIES

UC Berkeley Campus

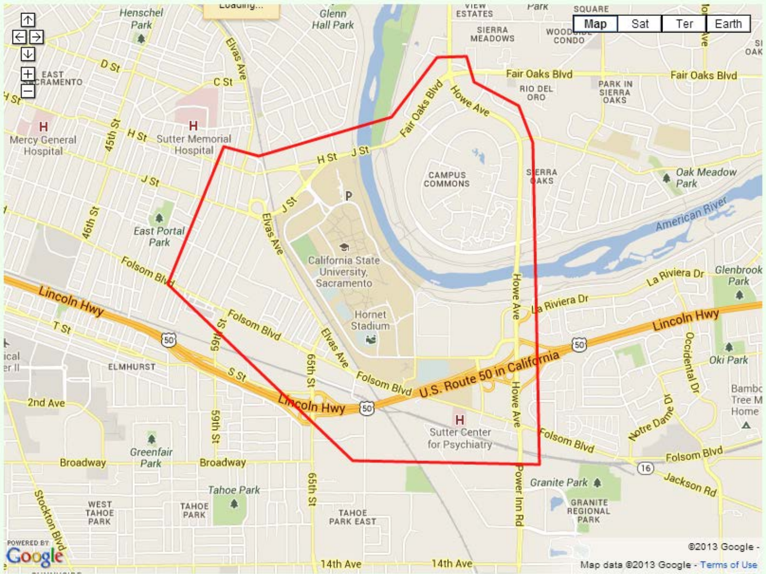
The boundaries of our study for this campus are shown on the map below. Please refer only to locations within these boundaries when completing this survey.



View UC Berkeley in a larger map

UCLA Campus

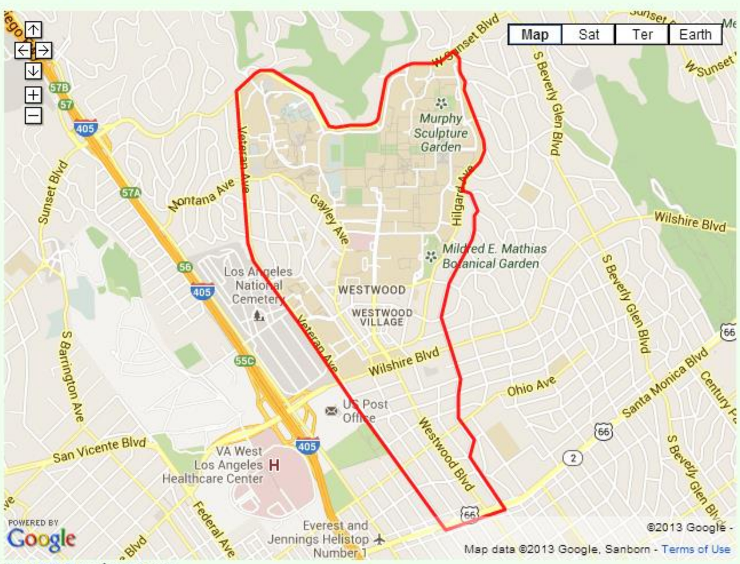
The boundaries of our study for this campus are shown on the map below. Please refer only to locations within these boundaries when completing this survey.



View CSUS in a larger map

CSUS Campus

The boundaries of our study for this campus are shown on the map below. Please refer only to locations within these boundaries when completing this survey.



View UCLA in a larger map

APPENDIX C

LIST OF TOP 15 HOTSPOT LOCATIONS

Table C.1 Top CSUS Hotspots (Pedestrian)

Location	Rank	Weight	Data Source
Folsom Blvd&Power Inn Rd&State Hwy 16	1	7	SWITRS
57Th St&Folsom Blvd	2	3	SWITRS
College Town Dr&Howe Ave	3	2.504355	SWITRS
Scripps Dr&University Ave	4	1.467596	SWITRS
Howe Ave&La Riviera Dr	5	1.398647	SWITRS
56Th St&Folsom Blvd	6	1	SWITRS
56Th St&H St	7	1	SWITRS
Bicentennial Cir&Folsom Blvd	8	1	SWITRS
Fair Oaks Blvd&Howe Ave	9	1	SWITRS
Folsom Blvd&Hornet Dr	10	1	SWITRS
Sacramento Municipal Utility Servivce Center &S St	11	1	SWITRS
Camellia Ave&H St&J St	12	1	SWITRS
Carlson Dr&Esplanade&J St	13	1	SWITRS
Campus Commons Rd&Fair Oaks Blvd	14	0.823408	SWITRS
54Th St&Folsom Blvd	15	0.80216	SWITRS
Guy West Footbridge&Jed Smith Dr	1	4	SURVEY CRASHES
Humboldt and Brighton Hall	2	2.623078	SURVEY CRASHES
State University Drive E and River Front Center	3	2	SURVEY CRASHES
Guy West Footbridge Midsection	4	2	SURVEY CRASHES
Placer Hall and Alpine/Calaveras Hall	5	1.718989	SURVEY CRASHES
Santa Clara Hall	6	1.357179	SURVEY CRASHES
Eureka and Brighton Hall	7	1.133972	SURVEY CRASHES
Sinclair Rd&W State University Dr	8	1	SURVEY CRASHES
Solano and Kadema Hall	9	1	SURVEY CRASHES
Academic Information Resource Center and University Union	10	1	SURVEY CRASHES
Stadium Drive and Parking Lot	11	1	SURVEY CRASHES
Moraga Way&Sinclair Rd	12	0.166782	SURVEY CRASHES
Carlson Dr&Esplanade&J St	1	17.50198	PERCEIVED HAZARDOUS
64Th St 65Th St Aly&Elvas Ave	2	5.963922	PERCEIVED HAZARDOUS
65Th St&Elvas Ave	3	5.583866	PERCEIVED HAZARDOUS
Sinclair Rd&W State University Dr	4	4	PERCEIVED HAZARDOUS
Guy West Footbridge&Jed Smith Dr	5	4	PERCEIVED HAZARDOUS
Elvas Ave&J St	6	3.643991	PERCEIVED HAZARDOUS
Folsom Blvd&Jed Smith Dr	7	3	PERCEIVED HAZARDOUS
Moraga Way&Sinclair Rd	8	3	PERCEIVED HAZARDOUS

Folsom Street and Rail Overpass	9	3	PERCEIVED HAZARDOUS
College Town Dr&Jed Smith Dr&S State University Dr	10	3	PERCEIVED HAZARDOUS
State University Drive E and River Front Center	11	3	PERCEIVED HAZARDOUS
Carlson Dr&Newman Ct&Ramp	12	2.593232	PERCEIVED HAZARDOUS
Camellia Ave&H St&J St	13	2.483363	PERCEIVED HAZARDOUS
Carlson Dr&H St&Ramp	14	2.3459	PERCEIVED HAZARDOUS
H St&Levee	15	2.155433	PERCEIVED HAZARDOUS
Carlson Dr&Esplanade&J St	1	26.09116	BIKE AND PED PERCEIVED HAZARDOUS
Guy West Footbridge&Jed Smith Dr	2	22	BIKE AND PED PERCEIVED HAZARDOUS
State University Drive W	3	7.779503	BIKE AND PED PERCEIVED HAZARDOUS
Sinclair Rd&W State University Dr	4	7	BIKE AND PED PERCEIVED HAZARDOUS
65Th St&Elvas Ave	5	6.525782	BIKE AND PED PERCEIVED HAZARDOUS
Carlson Dr&Newman Ct&Ramp	6	6.059371	BIKE AND PED PERCEIVED HAZARDOUS
&65Th St	7	6	BIKE AND PED PERCEIVED HAZARDOUS
64Th St 65Th St Aly&Elvas Ave	8	5.608746	BIKE AND PED PERCEIVED HAZARDOUS
Elvas Ave&J St	9	5.591179	BIKE AND PED PERCEIVED HAZARDOUS
Douglass and Lassen Hall	10	5.404799	BIKE AND PED PERCEIVED HAZARDOUS
Carlson Dr&H St&Ramp	11	5.385611	BIKE AND PED PERCEIVED HAZARDOUS
J St&Ramp	12	4.408821	BIKE AND PED PERCEIVED HAZARDOUS
Moraga Way&Sinclair Rd	13	4.403876	BIKE AND PED PERCEIVED HAZARDOUS
Humboldt and Brighton Hall	14	4.05256	BIKE AND PED PERCEIVED HAZARDOUS
Esplanade&N State University Dr	15	4	BIKE AND PED PERCEIVED HAZARDOUS

Table C.2 Top CSUS Hotspots (Bike)

Location	Rank	Weight	Data Source
Folsom Blvd&Power Inn Rd&State Hwy 16	1	10	SWITRS
56Th St&M St	2	4	SWITRS
American River Dr&Howe Ave	3	4	SWITRS
57Th St&J St	4	3	SWITRS
Fair Oaks Blvd&Howe Ave	5	3	SWITRS
Howe Ave&University Ave	6	3	SWITRS
Carlson Dr&Esplanade&J St	7	3	SWITRS
54Th St&H St	8	2.648909	SWITRS
Carlson Dr&H St&Ramp	9	2.642346	SWITRS
Campus Commons Rd&Fair Oaks Blvd	10	2.469176	SWITRS
55Th St&J St	11	2.257754	SWITRS
59Th St&Folsom Blvd	12	2.250759	SWITRS
Howe Ave&La Riviera Dr	13	2.241002	SWITRS
College Town Dr&Howe Ave	14	2.222458	SWITRS
56Th St&Folsom Blvd	15	2	SWITRS
Guy West Footbridge&Jed Smith Dr	1	5	SURVEY CRASHES
Camellia Ave&H St&J St	2	2	SURVEY CRASHES
Guy West Footbridge&Jedediah Smith Recreation Trl	3	1.69254	SURVEY CRASHES
State University Drive W	4	1.393211	SURVEY CRASHES
Guy West Footbridge Midsection	5	1.30746	SURVEY CRASHES
65Th St&Elvas Ave	6	1.223839	SURVEY CRASHES
Moraga Way&Sinclair Rd	7	1.216219	SURVEY CRASHES
57Th St&J St	8	1	SURVEY CRASHES
Esplanade&N State University Dr	9	1	SURVEY CRASHES
Fair Oaks Blvd&Jedediah Smith Recreation Trl	10	1	SURVEY CRASHES
Guy West Footbridge&University Ave	11	1	SURVEY CRASHES
Parkcenter Dr&University Ave	12	1	SURVEY CRASHES
Carlson Dr&Esplanade&J St	13	1	SURVEY CRASHES
College Town Dr&Jed Smith Dr&S State University Dr	14	1	SURVEY CRASHES
Driveway&Driveway&Driveway	15	1	SURVEY CRASHES
Carlson Dr&Esplanade&J St	1	23.12791	PERCEIVED HAZARDOUS
64Th St 65Th St Aly&Elvas Ave	2	6.461877	PERCEIVED HAZARDOUS
65Th St&Elvas Ave	3	6.170331	PERCEIVED HAZARDOUS
Guy West Footbridge&Jed Smith Dr	4	6	PERCEIVED HAZARDOUS
Sinclair Rd&W State University Dr	5	5	PERCEIVED HAZARDOUS
Elvas Ave&J St	6	4.643991	PERCEIVED HAZARDOUS
Carlson Dr&Newman Ct&Ramp	7	4.201597	PERCEIVED HAZARDOUS
Esplanade&N State University Dr	8	4	PERCEIVED HAZARDOUS
Elvas Ave&H St	9	3.38283	PERCEIVED HAZARDOUS
Carlson Dr&H St&Ramp	10	3.111598	PERCEIVED HAZARDOUS

Folsom Blvd&Jed Smith Dr	11	3	PERCEIVED HAZARDOUS
Moraga Way&Sinclair Rd	12	3	PERCEIVED HAZARDOUS
Folsom Street and Rail Overpass	13	3	PERCEIVED HAZARDOUS
College Town Dr&Jed Smith Dr&S State University Dr	14	3	PERCEIVED HAZARDOUS
Solano and Kadema Hall	15	3	PERCEIVED HAZARDOUS
Carlson Dr&Esplanade&J St	1	26.09116	BIKE AND PED PERCEIVED HAZARDOUS
Guy West Footbridge&Jed Smith Dr	2	22	BIKE AND PED PERCEIVED HAZARDOUS
State University Drive W	3	7.779503	BIKE AND PED PERCEIVED HAZARDOUS
Sinclair Rd&W State University Dr	4	7	BIKE AND PED PERCEIVED HAZARDOUS
65Th St&Elvas Ave	5	6.525782	BIKE AND PED PERCEIVED HAZARDOUS
Carlson Dr&Newman Ct&Ramp	6	6.059371	BIKE AND PED PERCEIVED HAZARDOUS
65Th St	7	6	BIKE AND PED PERCEIVED HAZARDOUS
64Th St 65Th St Aly&Elvas Ave	8	5.608746	BIKE AND PED PERCEIVED HAZARDOUS
Elvas Ave&J St	9	5.591179	BIKE AND PED PERCEIVED HAZARDOUS
Douglass and Lassen Hall	10	5.404799	BIKE AND PED PERCEIVED HAZARDOUS
Carlson Dr&H St&Ramp	11	5.385611	BIKE AND PED PERCEIVED HAZARDOUS
J St&Ramp	12	4.408821	BIKE AND PED PERCEIVED HAZARDOUS
Moraga Way&Sinclair Rd	13	4.403876	BIKE AND PED PERCEIVED HAZARDOUS
Humboldt and Brighton Hall	14	4.05256	BIKE AND PED PERCEIVED HAZARDOUS
Esplanade&N State University Dr	15	4	BIKE AND PED PERCEIVED HAZARDOUS

Table C.3 Top UCB Hotspots (Pedestrian)

Primary Rd	Secondary Rd	Rank	Weight	Data Source
TELEGRAPH AV	DURANT AV	1	9.7712092	SWITRS
DANA ST	BANCROFT WY	2	8.5553375	SWITRS
SHATTUCK AV	BANCROFT WY	3	8	SWITRS
CHANNING WY	TELEGRAPH AV	4	7.5584753	SWITRS
HEARST AV	LE ROY AV	5	7	SWITRS
CHANNING WY	DANA ST	6	7	SWITRS
UNIVERSITY AV	SHATTUCK AV	7	6.7213488	SWITRS
BANCROFT WY	BOWDITCH ST	8	6	SWITRS
DURANT AV	BOWDITCH ST	9	6	SWITRS
ADDISON ST	OXFORD ST	10	6	SWITRS
BANCROFT WY	FULTON ST	11	6	SWITRS

SHATTUCK AV	ALLSTON WY	12	6	SWITRS
DWIGHT WY	SHATUCK AVENUE	13	6	SWITRS
HEARST AV	SPRUCE ST	14	5.7535619	SWITRS
TELEGRAPH AV	HASTE ST	15	5.6703156	SWITRS
COLLEGE AV	BANCROFT AV	1	8.881352	SURVEY CRASHES
BANCROFT WY	BOWDITCH ST	2	8.8091018	SURVEY CRASHES
DANA ST	BANCROFT WY	3	7.1969781	SURVEY CRASHES
Barrow Lane	Eshleman Road	4	6.6167009	SURVEY CRASHES
ADDISON ST	OXFORD ST	5	6	SURVEY CRASHES
Grinnell Pathway		6	6	SURVEY CRASHES
Sproul Plaza		7	5.3428362	SURVEY CRASHES
HEARST AV	LE ROY AV	8	5	SURVEY CRASHES
TELEGRAPH AV	DURANT AV	9	4.9711795	SURVEY CRASHES
CHANNING WY	DANA ST	10	4	SURVEY CRASHES
OXFORD ST	UNIVERSITY AV	11	3.9696156	SURVEY CRASHES
CV Starr East Asian Library	Memorial Glade	12	3.5377692	SURVEY CRASHES
Sather Tower	South Hall Road	13	3.4691786	SURVEY CRASHES
Sather Gate		14	3.2632543	SURVEY CRASHES
Wickson Road	Moffitt	15	3.1699888	SURVEY CRASHES
HEARST AV	LE ROY AV	1	57	PERCEIVED HAZARDOUS
ADDISON ST	OXFORD ST	2	39.167834	PERCEIVED HAZARDOUS
DANA ST	BANCROFT WY	3	22.493372	PERCEIVED HAZARDOUS
COLLEGE AV	BANCROFT AV	4	22.232449	PERCEIVED HAZARDOUS
HEARST AV	SPRUCE ST	5	20.087306	PERCEIVED HAZARDOUS
Grinnell Pathway		6	18	PERCEIVED HAZARDOUS
BANCROFT WY	BOWDITCH ST	7	17.48533	PERCEIVED HAZARDOUS
CHANNING WY	PIEDMONT AV	8	16.063681	PERCEIVED HAZARDOUS
BANCROFT WY	TELEGRAPH AV	9	15.859561	PERCEIVED HAZARDOUS
BANCROFT WY	ELLSWORTH ST	10	14.695791	PERCEIVED HAZARDOUS
HEARST AV	SCENIC	11	14	PERCEIVED HAZARDOUS
HEARST AV	EUCLID AV	12	13	PERCEIVED HAZARDOUS
OXFORD ST	CENTER ST	13	12.960028	PERCEIVED HAZARDOUS
CV Starr East Asian Library	Memorial Glade	14	12.474491	PERCEIVED HAZARDOUS
BANCROFT WY	BARROWS LN	15	11.564164	PERCEIVED HAZARDOUS
COLLEGE AV	BANCROFT AV	1	40.022254	BIKE AND PED PERCEIVED HAZARDOUS
DANA ST	BANCROFT WY	2	32.738909	BIKE AND PED PERCEIVED HAZARDOUS
HEARST AV	LE ROY AV	3	31	BIKE AND PED PERCEIVED HAZARDOUS
BANCROFT WY	TELEGRAPH AV	4	28.260653	BIKE AND PED PERCEIVED HAZARDOUS
BANCROFT WY	BOWDITCH ST	5	19.894068	BIKE AND PED PERCEIVED HAZARDOUS

HEARST AV	SPRUCE ST	6	19.584408	BIKE AND PED PERCEIVED HAZARDOUS
ADDISON ST	OXFORD ST	7	18.107514	BIKE AND PED PERCEIVED HAZARDOUS
BOWDITCH	CHANNING WY	8	15.035541	BIKE AND PED PERCEIVED HAZARDOUS
Oppenheimer Way	Faculty Club	9	13	BIKE AND PED PERCEIVED HAZARDOUS
BANCROFT WY	BARROWS LN	10	12.43273	BIKE AND PED PERCEIVED HAZARDOUS
HEARST AV	SCENIC	11	12	BIKE AND PED PERCEIVED HAZARDOUS
CV Starr East Asian Library	Memorial Glade	12	12	BIKE AND PED PERCEIVED HAZARDOUS
Wickson Road	Moffitt	13	11.666817	BIKE AND PED PERCEIVED HAZARDOUS
West Circle		14	11.486606	BIKE AND PED PERCEIVED HAZARDOUS
OXFORD ST	UNIVERSITY AV	15	11.46082	BIKE AND PED PERCEIVED HAZARDOUS

Table C.4 Top UCB Hotspots (Bike)

Primary Rd	Secondary Rd	Rank	Weight	Data Source
SHATTUCK AV	HEARST AV	1	10.65671	SWITRS
HEARST AV	OXFORD ST	2	10.50897	SWITRS
SHATTUCK AV	BANCROFT WY	3	10.378567	SWITRS
CHANNING WY	SHATTUCK AVENUE	4	10	SWITRS
COLLEGE AV	DWIGHT WY	5	8.561681	SWITRS
UNIVERSITY AV	SHATTUCK AV	6	8.2547133	SWITRS
HEARST AV	EUCLID AV	7	7.5814598	SWITRS
BANCROFT WY	FULTON ST	8	7.3288096	SWITRS
DANA ST	BANCROFT WY	9	7.12356	SWITRS
COLLEGE AV	HASTE ST	10	6.9300227	SWITRS
CHANNING WY	TELEGRAPH AV	11	6.8291967	SWITRS
FULTON ST	HASTE ST	12	6.5943082	SWITRS
DWIGHT WY	SHATUCK AVENUE	13	6.3847804	SWITRS
SHATTUCK AV	ALLSTON WY	14	6.1205858	SWITRS
BERKELEY WY	SHATTUCK AV	15	5.9488366	SWITRS
Wickson Road	Moffitt	1	9.7618705	SURVEY CRASHES
Sather Tower	South Hall Road	2	7	SURVEY CRASHES
Hearst Mining Circle	Oppenheimer Way	3	6	SURVEY CRASHES
Oppenheimer Way	Faculty Club	4	5	SURVEY CRASHES
Grinnell Pathway		5	5	SURVEY CRASHES
Wurster Hall		6	4.7892078	SURVEY CRASHES
Harmon Way	FSM and VLSB	7	4.2567269	SURVEY CRASHES
DWIGHT WY	FULTON ST	8	4.0533916	SURVEY CRASHES

COLLEGE AV	CHANNING WY	9	3.6692566	SURVEY CRASHES
HEARST AV	OXFORD ST	10	3.1597265	SURVEY CRASHES
HEARST AV	EUCLID AV	11	3	SURVEY CRASHES
HEARST AV	ARCH ST	12	3	SURVEY CRASHES
TELEGRAPH AV	DURANT AV	13	3	SURVEY CRASHES
Bancroft Library	Memorial Glade	14	3	SURVEY CRASHES
COLLEGE AV	BANCROFT AV	15	2.9360709	SURVEY CRASHES
DANA ST	BANCROFT WY	1	15.45243	PERCEIVED HAZARDOUS
BANCROFT WY	(Mid-Block)	2	15.094553	PERCEIVED HAZARDOUS
HEARST AV	EUCLID AV	3	14	PERCEIVED HAZARDOUS
BANCROFT WY	TELEGRAPH AV	4	12.804802	PERCEIVED HAZARDOUS
BANCROFT WY	FULTON ST	5	12.510821	PERCEIVED HAZARDOUS
BANCROFT WY	ELLSWORTH ST	6	11	PERCEIVED HAZARDOUS
CHANNING WY	TELEGRAPH AV	7	10.265312	PERCEIVED HAZARDOUS
HEARST AV	SCENIC	8	9	PERCEIVED HAZARDOUS
HEARST AV	OXFORD ST	9	8.9422919	PERCEIVED HAZARDOUS
Wickson Road	Moffitt	10	8.8289852	PERCEIVED HAZARDOUS
CENTER ST E	SHATTUCK ST	11	7.6690934	PERCEIVED HAZARDOUS
BANCROFT WY	BARROWS LN	12	7.409747	PERCEIVED HAZARDOUS
BANCROFT WY	BOWDITCH ST	13	7.3158933	PERCEIVED HAZARDOUS
COLLEGE AV	CHANNING WY	14	7.0052869	PERCEIVED HAZARDOUS
TELEGRAPH AV	DURANT AV	15	6.7917001	PERCEIVED HAZARDOUS
COLLEGE AV	BANCROFT AV	1	40.022254	BIKE AND PED PERCEIVED HAZARDOUS
DANA ST	BANCROFT WY	2	32.738909	BIKE AND PED PERCEIVED HAZARDOUS
HEARST AV	LE ROY AV	3	31	BIKE AND PED PERCEIVED HAZARDOUS
BANCROFT WY	TELEGRAPH AV	4	28.260653	BIKE AND PED PERCEIVED HAZARDOUS
BANCROFT WY	BOWDITCH ST	5	19.894068	BIKE AND PED PERCEIVED HAZARDOUS
HEARST AV	SPRUCE ST	6	19.584408	BIKE AND PED PERCEIVED HAZARDOUS
ADDISON ST	OXFORD ST	7	18.107514	BIKE AND PED PERCEIVED HAZARDOUS
BOWDITCH	CHANNING WY	8	15.035541	BIKE AND PED PERCEIVED HAZARDOUS
Oppenheimer Way	Faculty Club	9	13	BIKE AND PED PERCEIVED HAZARDOUS
BANCROFT WY	BARROWS LN	10	12.43273	BIKE AND PED PERCEIVED HAZARDOUS
HEARST AV	SCENIC	11	12	BIKE AND PED PERCEIVED HAZARDOUS
CV Starr East Asian Library	Memorial Glade	12	12	BIKE AND PED PERCEIVED HAZARDOUS
Wickson Road	Moffitt	13	11.666817	BIKE AND PED PERCEIVED HAZARDOUS
West Circle		14	11.486606	BIKE AND PED PERCEIVED HAZARDOUS
OXFORD ST	UNIVERSITY AV	15	11.46082	BIKE AND PED PERCEIVED HAZARDOUS

Table C.5 Top UCLA Hotspots (Pedestrian)

Location	Rank	Weight	Data Source
Westwood & Wilshire	1	12	SWITRS
Gayley & Midvale & Wilshire	2	10.630731	SWITRS
Lindbrook & Westwood	3	10	SWITRS
Ohio & Westwood	4	9.6216546	SWITRS
Glendon & Wilshire	5	7	SWITRS
Hilgard & Le Conte	6	7	SWITRS
Le Conte & Tiverton	7	6	SWITRS
Le Conte & Westwood	8	6	SWITRS
Veteran & Wilshire	9	6	SWITRS
Westwood & Weyburn	10	6	SWITRS
Westwood & Wilkins	11	5	SWITRS
Massachusetts & Westwood	12	4.762006	SWITRS
Wellworth & Westwood	13	4.5959971	SWITRS
Gayley & Weyburn	14	4.5722	SWITRS
Rochester & Westwood	15	4.4040029	SWITRS
Bruin Plaza	1	7	SURVEY CRASHES
Westwood & Wilshire	2	4	SURVEY CRASHES
Gayley & Weyburn	3	3.9525582	SURVEY CRASHES
Strathmore Place and Westwood Plaza	4	3	SURVEY CRASHES
Veteran & Wilshire	5	3	SURVEY CRASHES
Gayley & Midvale & Wilshire	6	3	SURVEY CRASHES
Le Conte & Westwood	7	2.5400923	SURVEY CRASHES
Glendon & Lindbrook	8	2.4820926	SURVEY CRASHES
Westwood & Weyburn	9	2.4599077	SURVEY CRASHES
Ucla W Medical Campus & Weyburn	10	2.0474418	SURVEY CRASHES
Broxton & Weyburn	11	2	SURVEY CRASHES
Buenos Aires & Charles E Young	12	2	SURVEY CRASHES
Charles E Young & Manning	13	2	SURVEY CRASHES
Charles E Young & Westwood	14	2	SURVEY CRASHES
Groverton & Sunset	15	2	SURVEY CRASHES
Westwood & Wilshire	1	37.725712	PERCEIVED HAZARDOUS
Gayley & Landfair	2	32.234589	PERCEIVED HAZARDOUS
Buenos Aires & Charles E Young	3	30.207996	PERCEIVED HAZARDOUS
Strathmore Place and Westwood Plaza	4	30	PERCEIVED HAZARDOUS
Gayley & Midvale & Wilshire	5	25.610437	PERCEIVED HAZARDOUS
Bruin Plaza	6	25	PERCEIVED HAZARDOUS
& Charles E Young & Westholme	7	22.758513	PERCEIVED HAZARDOUS

Le Conte & Westwood	8	20.502499	PERCEIVED HAZARDOUS
Charles E Young & Circle & Dickson	9	20	PERCEIVED HAZARDOUS
Buenos Aires & Gayley	10	17.792004	PERCEIVED HAZARDOUS
Hilgard & Manning	11	15.502867	PERCEIVED HAZARDOUS
Charles E Young & Dykstra Hall	12	14.825346	PERCEIVED HAZARDOUS
Gayley & Strathmore	13	14.294099	PERCEIVED HAZARDOUS
Charles E Young & Strathmore	14	13.705901	PERCEIVED HAZARDOUS
Gayley & Le Conte	15	13.471005	PERCEIVED HAZARDOUS
Westwood & Wilshire	1	78.811579	BIKE AND PED PERCEIVED HAZARDOUS
Le Conte & Westwood	2	30	BIKE AND PED PERCEIVED HAZARDOUS
Veteran & Wilshire	3	30	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Midvale & Wilshire	4	28.467248	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Strathmore	5	25.557673	BIKE AND PED PERCEIVED HAZARDOUS
Strathmore Place and Westwood Plaza	6	23	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Landfair	7	19.086539	BIKE AND PED PERCEIVED HAZARDOUS
Groverton & Sunset	8	18	BIKE AND PED PERCEIVED HAZARDOUS
Buenos Aires & Charles E Young	9	16.609008	BIKE AND PED PERCEIVED HAZARDOUS
Bruin Plaza	10	16	BIKE AND PED PERCEIVED HAZARDOUS
Hilgard & Westholme	11	15.570357	BIKE AND PED PERCEIVED HAZARDOUS
Charles E Young & Dykstra Hall	12	15.269371	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Le Conte	13	13.285929	BIKE AND PED PERCEIVED HAZARDOUS
Bruin Walkway & Charles E Young & De Neve	14	12.730629	BIKE AND PED PERCEIVED HAZARDOUS
Ashton & Midvale	15	12.532752	BIKE AND PED PERCEIVED HAZARDOUS

Table C.6 Top UCLA Hotspots (Bike)

Location	**Rank**	**Weight**	**Data Source**
Le Conte & Westwood	1	4	SWITRS
Massachusetts & Westwood	2	3.7053722	SWITRS
Gayley & Weyburn	3	3.026228	SWITRS
Ohio & Veteran	4	3	SWITRS
Westwood & Wilshire	5	3	SWITRS
2 & Westwood	6	2.9363807	SWITRS
Alley & Westwood	7	2.9031596	SWITRS
Gayley & Midvale & Wilshire	8	2.618474	SWITRS
Alley & Westwood	9	2.6032468	SWITRS
Glendon & Ohio	10	2	SWITRS

Lindbrook & Westwood	11	2	SWITRS
Ohio & Westwood	12	2	SWITRS
Veteran & Wilshire	13	2	SWITRS
Gayley & Montana & Veteran	14	2	SWITRS
Gayley & Landfair	15	1.8286928	SWITRS
Gayley & Le Conte	1	4.1929837	SURVEY CRASHES
Charles E Young & Westwood	2	4	SURVEY CRASHES
Veteran & Wilshire	3	4	SURVEY CRASHES
Lindbrook & Westwood	4	3.1535524	SURVEY CRASHES
Ohio & Westwood	5	3.1422662	SURVEY CRASHES
Le Conte & Westwood	6	3.0567736	SURVEY CRASHES
Gayley & Kinross	7	3.012738	SURVEY CRASHES
Strathmore Place and Westwood Plaza	8	3	SURVEY CRASHES
Pauley Pavilion	9	3	SURVEY CRASHES
& Charles E Young & Westholme	10	2.7600017	SURVEY CRASHES
Wellworth & Westwood	11	2.726506	SURVEY CRASHES
Bruin Walk & Portola	12	2.6139489	SURVEY CRASHES
Gayley & Weyburn	13	2.1904273	SURVEY CRASHES
Charles E Young & Circle & De Neve	14	2	SURVEY CRASHES
Gayley & Midvale & Wilshire	15	2	SURVEY CRASHES
Westwood & Wilshire	1	37.725712	PERCEIVED HAZARDOUS
Gayley & Landfair	2	32.234589	PERCEIVED HAZARDOUS
Buenos Aires & Charles E Young	3	30.207996	PERCEIVED HAZARDOUS
Strathmore Place and Westwood Plaza	4	30	PERCEIVED HAZARDOUS
Gayley & Midvale & Wilshire	5	25.610437	PERCEIVED HAZARDOUS
Bruin Plaza	6	25	PERCEIVED HAZARDOUS
& Charles E Young & Westholme	7	22.758513	PERCEIVED HAZARDOUS
Le Conte & Westwood	8	20.502499	PERCEIVED HAZARDOUS
Charles E Young & Circle & Dickson	9	20	PERCEIVED HAZARDOUS
Buenos Aires & Gayley	10	17.792004	PERCEIVED HAZARDOUS
Hilgard & Manning	11	15.502867	PERCEIVED HAZARDOUS
Charles E Young & Dykstra Hall	12	14.825346	PERCEIVED HAZARDOUS
Gayley & Strathmore	13	14.294099	PERCEIVED HAZARDOUS
Charles E Young & Strathmore	14	13.705901	PERCEIVED HAZARDOUS
Gayley & Le Conte	15	13.471005	PERCEIVED HAZARDOUS
Westwood & Wilshire	1	78.811579	BIKE AND PED PERCEIVED HAZARDOUS
Le Conte & Westwood	2	30	BIKE AND PED PERCEIVED HAZARDOUS
Veteran & Wilshire	3	30	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Midvale & Wilshire	4	28.467248	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Strathmore	5	25.557673	BIKE AND PED PERCEIVED HAZARDOUS

Strathmore Place and Westwood Plaza	6	23	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Landfair	7	19.086539	BIKE AND PED PERCEIVED HAZARDOUS
Groverton & Sunset	8	18	BIKE AND PED PERCEIVED HAZARDOUS
Buenos Aires & Charles E Young	9	16.609008	BIKE AND PED PERCEIVED HAZARDOUS
Bruin Plaza	10	16	BIKE AND PED PERCEIVED HAZARDOUS
Hilgard & Westholme	11	15.570357	BIKE AND PED PERCEIVED HAZARDOUS
Charles E Young & Dykstra Hall	12	15.269371	BIKE AND PED PERCEIVED HAZARDOUS
Gayley & Le Conte	13	13.285929	BIKE AND PED PERCEIVED HAZARDOUS
Bruin Walkway & Charles E Young & De Neve	14	12.730629	BIKE AND PED PERCEIVED HAZARDOUS
Ashton & Midvale	15	12.532752	BIKE AND PED PERCEIVED HAZARDOUS

APPENDIX D

Contextualized Spatial Clustering Results

Table D.1 CSUS (Ped) Hotspots

ATTRIBUTES	Guy West Footbridge&Jed Smith Dr	Humboldt and Brighton Hall	State University Drive E and River Front Center	Guy West Footbridge Midsection	Placer Hall and Alpine/Calaveras Hall	Santa Clara Hall	Eureka and Brighton Hall	Sinclair Rd&W State University Dr	Solano and Kadema Hall	Academic Information Resource Center and University Union	Stadium Drive and Parking Lot	Moraga Way&Sinclair Rd
Rank	1	2	3	4	5	6	7	8	9	10	11	12
Weight	4	2.623078	2	2	1.718989	1.357179	1.133972	1	1	1	1	0.166782
w/ Object	0.0%	38.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
w/ Bike	75.0%	48.8%	100.0%	100.0%	100.0%	73.7%	73.5%	0.0%	0.0%	100.0%	0.0%	100.0%
w/ Car	50.0%	13.0%	0.0%	0.0%	0.0%	26.3%	26.5%	100.0%	100.0%	0.0%	100.0%	0.0%
Morning	50.0%	13.0%	0.0%	50.0%	58.2%	100.0%	26.5%	0.0%	100.0%	0.0%	100.0%	0.0%
Mid-day	0.0%	87.0%	50.0%	50.0%	41.8%	0.0%	73.5%	0.0%	0.0%	0.0%	0.0%	100.0%
Evening	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Late/Early	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Serious Injury	0.0%	10.7%	0.0%	0.0%	41.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Minor Injury	25.0%	10.7%	100.0%	50.0%	41.8%	0.0%	73.5%	0.0%	0.0%	0.0%	100.0%	100.0%
No Injury	75.0%	89.3%	0.0%	50.0%	58.2%	100.0%	26.5%	100.0%	100.0%	100.0%	0.0%	0.0%
Inattention	75.0%	23.8%	50.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%	100.0%
Intoxication	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fatigue	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Excessive Speed	50.0%	100.0%	100.0%	100.0%	41.8%	26.3%	100.0%	0.0%	100.0%	100.0%	100.0%	100.0%
Ride Sidewalk	0.0%	23.8%	0.0%	0.0%	41.8%	100.0%	26.5%	0.0%	100.0%	0.0%	0.0%	0.0%
Travel Wrong Way	0.0%	0.0%	0.0%	0.0%	0.0%	73.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Illegal Crossing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ignore Traffic Controls	50.0%	0.0%	100.0%	0.0%	0.0%	0.0%	73.5%	100.0%	0.0%	0.0%	0.0%	100.0%
Failure to yield	75.0%	10.7%	50.0%	100.0%	41.8%	0.0%	73.5%	100.0%	0.0%	0.0%	100.0%	100.0%

Passing or improper lane usage	0.0%	0.0%	0.0%	50.0 %	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Unsafe lane change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avoiding a cyclist, ped or vehicle	0.0%	48.8%	0.0%	50.0 %	41.8%	0.0%	73.5%	0.0%	0.0%	0.0%	0.0%	100.0%
Avoiding obstructio n	0.0%	10.7%	0.0%	50.0 %	41.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Emerging from behind a parked structure	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0 %	0.0%	0.0%	0.0%	0.0%
Obstructe d views	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not Reported	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Poor Weather	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cracked Pavement	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Narrow Bike lane	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Narrow Sidewalk	0.0%	0.0%	0.0%	0.0%	58.2%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0 %	0.0%
Poor Lighting	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not Reported	100.0 %	100.0%	100.0 %	100.0 %	41.8%	100.0%	100.0%	100.0 %	100.0 %	100.0 %	0.0%	100.0%

Table D.2 CSUS (Bike) Hotspots

ATTRIBUTES	&Guy West Footbridge&Jed Smith Dr	Camellia Ave&H St&J St	Guy West Footbridge&Jedediah Smith Recreation Trl	State University Drive W	Guy West Footbridge Midsection	65Th St&Elvas Ave	Moraga Way&Sinclair Rd	57Th St&J St	Esplanade&N State University Dr	Fair Oaks Blvd&Jedediah Smith Recreation Trl	Guy West Footbridge&University Ave	Parkcenter Dr&University Ave	Carlson Dr&Esplanade&J St	College Town Dr&Jed Smith Dr&S State University Dr	Driveway&Driveway&Driveway
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weight	5	2	1.69	1.39	1.30	1.2	1.21	1	1	1	1	1	1	1	1
w/ Object	20.0%	100.0%	100.0%	100.0%	100.0%	82.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
w/ Ped	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	17.8%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
w/ Bike	60.0%	0.0%	0.0%	0.0%	0.0%	17.7%	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
w/ Car	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%
Morning	0.0%	100.0%	0.0%	0.0%	76.5%	17.7%	17.8%	0.0%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Mid-day	80.0%	0.0%	40.9%	0.0%	23.5%	0.0%	82.2%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Evening	0.0%	0.0%	0.0%	100.0%	0.0%	25.6%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Late/Early	0.0%	0.0%	59.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Serious Injury	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Minor Injury	100.0%	100.0%	100.0%	0.0%	23.5%	56.7%	82.2%	100.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	0.0%
No Injury	0.0%	0.0%	0.0%	100.0%	76.5%	43.3%	17.8%	0.0%	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%
Inattention	60.0%	50.0%	0.0%	0.0%	0.0%	17.7%	100.0%	100.0%	0.0%	100.0%	0.0%	100.0%	100.0%	100.0%	0.0%
Intoxication	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fatigue	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Excessive Speed	60.0%	0.0%	0.0%	28.2%	0.0%	43.3%	82.2%	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%
Ride Sidewalk	0.0%	0.0%	40.9%	0.0%	23.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Travel Wrong Way	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Illegal Crossing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Ignore Traffic Controls	0.0%	0.0%	0.0%	28.2%	0.0%	43.3%	17.8%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Failure to Yield	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	17.8%	0.0%	100.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Passing or improper lane usage	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Unsafe lane change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
Avoiding a cyclist, ped or vehicle	0.0%	50.0%	0.0%	71.8%	76.5%	17.7%	17.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
Avoiding a fixed object	20.0%	50.0%	59.1%	71.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Emerging from behind a parked structure	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Obstructed views	40.0%	0.0%	0.0%	0.0%	0.0%	17.7%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%
Not reported	0.0%	0.0%	0.0%	0.0%	0.0%	56.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Poor Weather	20.0%	0.0%	40.9%	0.0%	23.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cracked Pavement	0.0%	50.0%	59.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Narrow Bike lane	20.0%	50.0%	0.0%	0.0%	0.0%	56.7%	100.0%	100.0%	0.0%	0.0%	100.0%	0.0%	100.0%	100.0%	0.0%
Narrow Sidewalk	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	82.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Poor Lighting	0.0%	0.0%	59.1%	100.0%	0.0%	82.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not reported	60.0%	0.0%	0.0%	0.0%	76.5%	17.7%	0.0%	0.0%	100.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%

Table D.3 UCB (Ped) Hotspots

ATTRIBUTES	College Ave. & Bancroft Way	Bancroft Way & Bowditch St.	Bancroft Way & Dana St.	Barrow Lane & Eshleman Road	Addison St. & Oxford St.	Grinnell Pathway	Sproul Plaza	Hearst & Le Roy Aves.	Telegraph & Durant Aves.	Channing Way & Dana St.	Oxford St. & University Ave.	CV Starr East Asian Library & Memorial Glade	Sather Tower & South Hall	Sather Gate	Wickson Road & Moffitt Library
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weight	8.88	8.81	7.20	6.62	6.00	6.00	5.34	5.00	4.97	4.00	3.97	3.54	3.47	3.26	3.17
w/ Object	28.2%	20.5%	13.9%	45.3%	33.3%	0.0%	11.1%	20.0%	0.0%	25.0%	0.0%	0.0%	0.0%	19.4%	0.0%
w/ Bike	83.0%	68.1%	78.9%	84.9%	33.3%	100.0%	88.9%	20.0%	79.9%	50.0%	25.2%	100.0%	100.0%	80.6%	100.0%
w/ Car	11.3%	11.4%	21.1%	0.0%	50.0%	0.0%	0.0%	60.0%	20.1%	50.0%	74.8%	0.0%	0.0%	0.0%	0.0%
Morning	20.6%	11.4%	37.2%	30.2%	50.0%	50.0%	0.0%	20.0%	20.1%	25.0%	45.5%	43.5%	28.8%	0.0%	31.5%
Mid-day	55.8%	77.3%	62.8%	54.7%	50.0%	33.3%	93.1%	80.0%	59.8%	50.0%	43.6%	0.0%	57.7%	80.6%	68.5%
Evening	23.7%	0.0%	0.0%	0.0%	0.0%	0.0%	6.9%	0.0%	20.1%	25.0%	10.9%	28.3%	13.5%	19.4%	0.0%
Late/Early	0.0%	0.0%	0.0%	0.0%	0.0%	16.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Serious Injury	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%	10.9%	0.0%	0.0%	0.0%	0.0%
Minor Injury	21.7%	56.8%	65.0%	39.5%	66.7%	66.7%	55.8%	20.0%	100.0%	50.0%	20.3%	43.5%	28.8%	42.9%	94.6%
No Injury	78.3%	43.2%	35.0%	60.5%	33.3%	33.3%	44.2%	80.0%	0.0%	25.0%	68.7%	56.5%	71.2%	57.1%	5.4%
Inattention	51.5%	68.1%	58.3%	69.8%	16.7%	66.7%	65.7%	20.0%	54.8%	0.0%	29.3%	71.7%	42.3%	57.5%	63.1%
Intoxication	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fatigue	0.0%	11.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Excessive Speed	60.5%	34.1%	51.1%	69.8%	50.0%	83.3%	59.0%	40.0%	34.7%	25.0%	36.1%	84.8%	28.8%	37.7%	5.4%
Ride Sidewalk	29.8%	22.7%	55.6%	24.4%	16.7%	50.0%	35.8%	0.0%	60.3%	0.0%	25.2%	0.0%	0.0%	14.5%	36.9%
Travel Wrong Way	0.0%	11.4%	55.6%	24.4%	16.7%	0.0%	7.2%	0.0%	4.9%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Illegal Crossing	20.5%	11.4%	41.7%	9.3%	0.0%	0.0%	7.2%	40.0%	20.1%	25.0%	0.0%	15.2%	0.0%	0.0%	0.0%
Ignore Traffic Controls	42.8%	22.7%	51.1%	0.0%	33.3%	0.0%	13.1%	20.0%	14.6%	25.0%	25.2%	0.0%	0.0%	9.2%	0.0%
Failure to yield	50.1%	56.8%	58.3%	39.5%	83.3%	33.3%	43.5%	60.0%	14.6%	25.0%	29.3%	0.0%	0.0%	32.4%	5.4%
Passing or improper lane usage	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.2%	0.0%	0.0%	5.4%

Unsafe lane change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avoiding a cyclist, ped or vehicle	0.0%	11.4%	0.0%	0.0%	33.3%	16.7%	11.1%	20.0%	14.6%	0.0%	0.0%	28.3%	57.7%	19.4%	36.9%
Avoiding obstruction	0.0%	0.0%	0.0%	15.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.2%	0.0%	0.0%	0.0%
Emerging from behind a parked structure	0.0%	11.4%	0.0%	0.0%	0.0%	0.0%	0.0%	20.0%	20.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Obstructed views	0.0%	0.0%	0.0%	0.0%	16.7%	0.0%	0.0%	0.0%	0.0%	0.0%	25.2%	15.2%	28.8%	0.0%	0.0%
Not Reported	17.0%	20.5%	0.0%	15.1%	16.7%	0.0%	0.0%	20.0%	0.0%	25.0%	20.3%	0.0%	0.0%	0.0%	0.0%
Poor Weather	6.7%	0.0%	0.0%	0.0%	0.0%	0.0%	15.5%	0.0%	0.0%	25.0%	0.0%	0.0%	0.0%	5.3%	0.0%
Cracked Pavement	11.3%	11.4%	0.0%	0.0%	16.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Narrow Bike lane	9.3%	22.7%	0.0%	15.1%	0.0%	16.7%	0.0%	0.0%	34.7%	0.0%	0.0%	28.3%	0.0%	0.0%	5.4%
Narrow Sidewalk	20.5%	11.4%	7.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	43.5%	28.8%	0.0%	36.9%
Poor Lighting	6.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	28.3%	13.5%	0.0%	0.0%
Not Reported	52.2%	77.3%	92.8%	84.9%	83.3%	83.3%	84.5%	100.0%	65.3%	75.0%	100.0%	28.3%	57.7%	94.7%	63.1%

Table D.5 UCB (Bike) Hotspots

ATTRIBUTES	Wickson Road & Moffitt Library	Sather Tower & South Hall	Hearst Mining Circle & Oppenheimer Way	Oppenheimer Way & Faculty Club	Grinnell Pathway	Wurster Hall	Harmon Way & FSM and VLSB	Dwight Way and Fulton St.	College Ave. and Channing Way	Hearst Ave. & Oxford St.	Hearst & Euclid Aves.	Hearst Ave. & Arch St.	Telegraph & Durant Aves.	Bancroft Library & Memorial Glade	College & Bancroft Aves.
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weight	9.76	7.00	6.00	5.00	5.00	4.79	4.26	4.05	3.67	3.16	3.00	3.00	3.00	3.00	2.94
w/ Object	55.8%	85.7%	33.3%	60.0%	80.0%	62.2%	71.4%	42.3%	72.7%	21.5%	100.0%	66.7%	66.7%	100.0%	77.4%
w/ Ped	20.5%	14.3%	16.7%	20.0%	0.0%	16.9%	12.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	6.5%
w/ Bike	23.8%	0.0%	16.7%	20.0%	0.0%	24.4%	16.0%	24.7%	0.0%	15.2%	0.0%	0.0%	0.0%	0.0%	28.3%
w/ Car	0.0%	0.0%	33.3%	0.0%	20.0%	0.0%	0.0%	75.3%	27.3%	63.3%	0.0%	33.3%	33.3%	0.0%	16.1%
Morning	30.7%	28.6%	50.0%	40.0%	20.0%	11.6%	0.0%	57.7%	27.3%	0.0%	66.7%	0.0%	0.0%	33.3%	73.9%
Mid-day	34.0%	57.1%	33.3%	20.0%	60.0%	88.4%	43.9%	24.7%	45.5%	31.6%	33.3%	66.7%	33.3%	66.7%	26.1%
Evening	29.0%	0.0%	16.7%	0.0%	20.0%	0.0%	47.0%	17.7%	27.3%	68.4%	0.0%	33.3%	33.3%	0.0%	0.0%
Late/Early	6.3%	0.0%	0.0%	20.0%	0.0%	0.0%	9.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Serious Injury	18.7%	14.3%	16.7%	0.0%	0.0%	8.9%	27.5%	24.7%	18.2%	0.0%	33.3%	0.0%	33.3%	0.0%	19.6%
Minor Injury	37.0%	57.1%	33.3%	40.0%	80.0%	70.2%	28.5%	50.7%	27.3%	68.4%	66.7%	66.7%	33.3%	66.7%	80.4%
No Injury	44.2%	28.6%	50.0%	60.0%	20.0%	20.9%	43.9%	24.7%	54.5%	31.6%	0.0%	33.3%	33.3%	33.3%	0.0%
Inattention	34.0%	14.3%	50.0%	20.0%	40.0%	41.3%	28.6%	82.3%	54.5%	68.4%	0.0%	33.3%	33.3%	33.3%	50.9%
Intoxication	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fatigue	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	46.8%	0.0%	0.0%	33.3%	0.0%	16.1%
Excessive Speed	32.2%	14.3%	16.7%	0.0%	20.0%	41.3%	63.0%	17.7%	0.0%	15.2%	0.0%	33.3%	0.0%	66.7%	34.8%
Ride Sidewalk	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Travel Wrong Way	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	15.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Illegal Crossing	0.0%	14.3%	16.7%	0.0%	0.0%	3.5%	0.0%	24.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	36.9%
Ignore Traffic Controls	0.0%	0.0%	0.0%	20.0%	0.0%	3.5%	0.0%	49.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	28.3%
Failure to Yield	13.5%	0.0%	33.3%	0.0%	0.0%	3.5%	28.6%	24.7%	27.3%	78.5%	0.0%	0.0%	0.0%	0.0%	28.3%
Passing or improper lane	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%

usage															
Unsafe lane change	8.5%	0.0%	0.0%	0.0%	0.0%	0.0%	4.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avoiding a cyclist, ped or vehicle	41.0%	28.6%	16.7%	40.0%	20.0%	0.0%	15.4%	24.7%	0.0%	0.0%	33.3%	33.3%	0.0%	66.7%	24.7%
Avoiding a fixed object	10.2%	0.0%	16.7%	0.0%	0.0%	0.0%	19.5%	0.0%	0.0%	0.0%	33.3%	33.3%	0.0%	0.0%	0.0%
Emerging from behind a parked structure	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	8.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Obstructed views	3.3%	0.0%	0.0%	20.0%	20.0%	3.5%	39.5%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	28.3%
Not reported	16.5%	42.9%	33.3%	40.0%	40.0%	37.8%	9.1%	0.0%	45.5%	0.0%	0.0%	0.0%	33.3%	0.0%	40.5%
Poor Weather	10.2%	28.6%	0.0%	20.0%	0.0%	20.9%	23.5%	0.0%	0.0%	0.0%	66.7%	33.3%	0.0%	0.0%	0.0%
Cracked Pavement	16.5%	57.1%	16.7%	0.0%	40.0%	20.9%	52.0%	0.0%	27.3%	0.0%	66.7%	66.7%	33.3%	0.0%	16.1%
Narrow Bike lane	39.2%	0.0%	16.7%	40.0%	20.0%	0.0%	4.0%	26.0%	0.0%	0.0%	33.3%	0.0%	0.0%	33.3%	16.1%
Narrow Sidewalk	13.5%	0.0%	16.7%	20.0%	0.0%	20.9%	16.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Poor Lighting	16.5%	0.0%	16.7%	20.0%	0.0%	0.0%	52.0%	0.0%	0.0%	63.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Not reported	20.5%	28.6%	50.0%	20.0%	60.0%	58.2%	27.9%	74.0%	72.7%	36.7%	0.0%	33.3%	66.7%	66.7%	83.9%

Table D.5 UCLA (Ped) Hotspots

ATTRIBUTES	Bruin Plaza	Westwood & Wilshire	Gayley & Weyburn	Strathmore Place and Westwood Plaza	Veteran & Wilshire	Gayley & Midvale & Wilshire	Le Conte & Westwood	Glendon & Lindbrook	Westwood & Weyburn	Ucla W Medical Campus & Weyburn	Broxton & Weyburn	Buenos Aires & Charles E Young	Charles E Young & Manning	Charles E Young & Westwood	Groverton & Sunset
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weight	7.00	4.00	3.95	3.00	3.00	3.00	2.54	2.48	2.46	2.05	2.00	2.00	2.00	2.00	2.00
w/ Object	14.3%	0.0%	13.8%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	22.1%	0.0%	100.0%	0.0%	0.0%	0.0%
w/ Bike	85.7%	0.0%	0.0%	66.7%	0.0%	0.0%	60.6%	0.0%	59.3%	0.0%	0.0%	100.0%	100.0%	100.0%	0.0%
w/ Car	0.0%	100.0%	86.2%	33.3%	100.0%	66.7%	39.4%	100.0%	40.7%	77.9%	100.0%	0.0%	0.0%	0.0%	100.0%
Morning	14.3%	0.0%	34.9%	66.7%	100.0%	66.7%	0.0%	40.3%	40.7%	30.3%	50.0%	0.0%	0.0%	0.0%	100.0%
Mid-day	85.7%	0.0%	32.2%	0.0%	0.0%	33.3%	21.3%	59.7%	59.3%	35.6%	50.0%	0.0%	0.0%	50.0%	0.0%
Evening	0.0%	0.0%	19.1%	0.0%	0.0%	0.0%	78.7%	0.0%	0.0%	12.0%	0.0%	0.0%	100.0%	0.0%	0.0%
Late/Early	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%
Serious Injury	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Minor Injury	28.6%	0.0%	16.8%	33.3%	0.0%	0.0%	21.3%	40.3%	100.0%	16.3%	100.0%	0.0%	0.0%	0.0%	50.0%
No Injury	71.4%	100.0%	83.2%	66.7%	100.0%	66.7%	78.7%	59.7%	0.0%	83.7%	0.0%	100.0%	100.0%	100.0%	50.0%
Inattention	71.4%	100.0%	86.2%	33.3%	100.0%	33.3%	60.6%	100.0%	18.7%	77.9%	100.0%	100.0%	0.0%	50.0%	50.0%
Intoxication	0.0%	0.0%	19.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	12.0%	50.0%	0.0%	0.0%	0.0%	0.0%
Fatigue	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Excessive Speed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ride Sidewalk	28.6%	0.0%	0.0%	66.7%	0.0%	0.0%	60.6%	0.0%	18.7%	0.0%	0.0%	100.0%	50.0%	50.0%	50.0%
Travel Wrong Way	14.3%	0.0%	0.0%	66.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%
Illegal Crossing	0.0%	0.0%	16.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	16.3%	0.0%	0.0%	0.0%	0.0%	0.0%
Ignore Traffic Controls	0.0%	100.0%	35.9%	33.3%	0.0%	66.7%	0.0%	40.3%	0.0%	28.3%	100.0%	0.0%	0.0%	0.0%	50.0%
Failure to yield	28.6%	100.0%	66.4%	33.3%	100.0%	66.7%	0.0%	80.6%	40.7%	67.1%	100.0%	100.0%	0.0%	0.0%	50.0%
Passing or	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%

improper lane usage															
Unsafe lane change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avoiding a cyclist, ped or vehicle	14.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avoiding obstruction	14.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Emerging from behind a parked structure	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Obstructed views	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not Reported	14.3%	0.0%	13.8%	0.0%	0.0%	33.3%	0.0%	0.0%	40.7%	22.1%	0.0%	0.0%	50.0%	0.0%	0.0%
Poor Weather	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cracked Pavement	0.0%	0.0%	29.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	41.7%	0.0%	0.0%	0.0%	0.0%	0.0%
Narrow Bike lane	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Narrow Sidewalk	14.3%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	19.4%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%
Poor Lighting	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not Reported	85.7%	100.0%	71.0%	66.7%	100.0%	66.7%	100.0%	80.6%	100.0%	58.3%	100.0%	100.0%	100.0%	50.0%	50.0%

Table D.6 UCLA (Bike) Hotspots

ATTRIBUTES	Gayley & Le Conte	Charles E Young & Westwood	Veteran & Wilshire	Lindbrook & Westwood	Ohio & Westwood	Le Conte & Westwood	Gayley & Kinross	Strathmore Place and Westwood Plaza	Pauley Pavilion	& Charles E Young & Westholme	Wellworth & Westwood	Bruin Walk & Portola	Gayley & Weyburn	Charles E Young & Circle & De Neve	Gayley & Midvale & Wilshire
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Weight	4.19	4.00	4.00	3.15	3.14	3.06	3.01	3.00	3.00	2.76	2.73	2.61	2.19	2.00	2.00
w/ Object	100.0%	0.0%	25.0%	12.1%	0.0%	0.0%	32.0%	0.0%	33.3%	0.0%	0.0%	61.7%	33.3%	100.0%	0.0%
w/ Ped	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	4.8%	100.0%	33.3%	0.0%	0.0%	38.3%	0.0%	0.0%	0.0%
w/ Bike	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%
w/ Car	0.0%	75.0%	75.0%	87.9%	100.0%	100.0%	63.2%	0.0%	0.0%	100.0%	100.0%	0.0%	100.0%	0.0%	50.0%
Morning	23.8%	25.0%	75.0%	0.0%	31.8%	67.3%	25.3%	33.3%	66.7%	27.5%	44.8%	23.5%	33.3%	50.0%	50.0%
Mid-day	52.3%	0.0%	0.0%	31.7%	23.1%	0.0%	57.3%	33.3%	0.0%	36.2%	0.0%	38.3%	0.0%	50.0%	0.0%
Evening	23.8%	75.0%	25.0%	68.3%	45.1%	32.7%	17.5%	33.3%	33.3%	36.2%	55.2%	0.0%	33.4%	0.0%	50.0%
Late/Early	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	38.3%	33.3%	0.0%	0.0%
Serious Injury	23.8%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%
Minor Injury	76.2%	25.0%	50.0%	100.0%	100.0%	46.5%	20.1%	0.0%	33.3%	63.8%	58.0%	100.0%	66.7%	100.0%	50.0%
No Injury	0.0%	75.0%	0.0%	0.0%	0.0%	53.5%	79.9%	100.0%	66.7%	36.2%	42.0%	0.0%	0.0%	0.0%	50.0%
Inattention	47.7%	75.0%	100.0%	87.9%	100.0%	100.0%	63.2%	66.7%	66.7%	100.0%	63.3%	61.7%	100.0%	0.0%	50.0%
Intoxication	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Fatigue	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Excessive Speed	0.0%	0.0%	0.0%	24.4%	0.0%	0.0%	7.4%	33.3%	33.3%	0.0%	0.0%	0.0%	33.3%	0.0%	50.0%
Ride Sidewalk	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%
Travel Wrong Way	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Illegal Crossing	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	4.8%	33.3%	0.0%	36.2%	0.0%	0.0%	0.0%	0.0%	0.0%
Ignore Traffic Controls	0.0%	0.0%	0.0%	0.0%	13.3%	32.7%	0.0%	0.0%	0.0%	36.2%	0.0%	0.0%	66.7%	0.0%	0.0%
Failure to Yield	0.0%	25.0%	25.0%	0.0%	23.1%	0.0%	50.5%	33.3%	0.0%	0.0%	55.2%	38.3%	33.3%	0.0%	0.0%
Passing	0.0%	0.0	0.0%	0.0%	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0%	0.0%	33.3	0.0%	50.0

or improper lane usage		%					%		%				%		%
Unsafe lane change	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Avoiding a cyclist, ped or vehicle	0.0%	0.0%	0.0%	0.0%	0.0%	32.7%	0.0%	0.0%	0.0%	0.0%	36.7%	0.0%	0.0%	0.0%	0.0%
Avoiding a fixed object	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Emerging from behind a parked structure	0.0%	0.0%	0.0%	31.7%	0.0%	0.0%	4.8%	0.0%	0.0%	0.0%	18.5%	38.3%	0.0%	0.0%	0.0%
Obstructed views	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not reported	52.3%	25.0%	0.0%	12.1%	0.0%	0.0%	24.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
Poor Weather	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cracked Pavement	52.3%	0.0%	50.0%	43.9%	0.0%	32.7%	32.0%	0.0%	0.0%	0.0%	36.7%	0.0%	0.0%	50.0%	0.0%
Narrow Bike lane	76.2%	25.0%	0.0%	56.1%	45.1%	46.5%	62.6%	33.3%	66.7%	0.0%	58.0%	0.0%	33.3%	0.0%	0.0%
Narrow Sidewalk	23.8%	0.0%	25.0%	0.0%	0.0%	0.0%	7.4%	33.3%	0.0%	0.0%	0.0%	38.3%	0.0%	50.0%	0.0%
Poor Lighting	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	27.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Not reported	23.8%	50.0%	50.0%	31.7%	54.9%	20.8%	30.1%	66.7%	0.0%	72.5%	42.0%	61.7%	66.7%	50.0%	100.0%

APPENDIX E

Infrastructure Data Corresponding to the Case Studies

Table E.1 Infrastructure data corresponding to the case studies

Intersection name	Approaches	No. of approaches	Ave. length (ft)	Signalized	Speed limit	Travel lanes	Parking lot driveway	Single driveway	Street Lights	Median
Wilshire and Westwood (UCLA)	To	4	303	4/4	32.5 (5)	21	2/4	1/4	4/4	1/4
	From	4	291	0/4	32.5 (5)	14	1/4	0/4	4/4	1/4
	All	**8**	**297**	**Yes**	**32.5 (5)**	**35**	**3/8**	**1/8**	**8/8**	**2/8**
Westwood and Le Conte (UCLA)	To	4	459	4/4	28.8 (5)	13	1/4	0/4	3/4	2/4
	From	4	455	0/4	28.8 (5)	7	0/4	2/4	3/4	2/4
	All	**8**	**457**	**Yes**	**28.8 (0)**	**20**	**1/8**	**2/8**	**6/8**	**4/8**
Gayley and Weyburn (UCLA)	To	4	230	4/4	30.0 (0)	11	2/4	0/4	3/4	0/4
	From	4	226	0/4	30.0 (0)	7	2/4	1/4	3/4	0/4
	All	**8**	**228**	**Yes**	**30.0 (0)**	**18**	**4/8**	**1/8**	**6/8**	**0/8**
Westwood and Charles E. Young (UCLA)	To	4	356	4/4	25.0 (0)	11	1/4	1/4	4/4	1/4
	From	4	357	0/4	25.0 (0)	8	2/4	0/4	4/4	1/4
	All	**8**	**256**	**Yes**	**25.0 (0)**	**19**	**3/8**	**1/8**	**8/8**	**2/8**
Bancroft & Dana (UCB)	To	1	388	0/1	25.0 (0)	3	2/2	0/2	1/1	0/1
	From	2	436	0/2	25.0 (0)	5	1/1	0/1	2/2	0/2
	All	**3**	**412**	**No**	**25.0 (0)**	**8**	**3/3**	**0/3**	**3/3**	**0/3**
Bancroft & College (UCB)	To	2	466	0/2	25.0 (0)	3	2/2	0/2	2/2	0/2
	From	2	452	1/2	25.0 (0)	3	2/2	0/2	2/2	0/2
	All	**8**	**460**	**No**	**25.0 (0)**	**6**	**4/4**	**0/4**	**3/4**	**0/4**
Oxford & Addison (UCB)	To	3	253	0/3	25.0 (0)	5	1/3	0/3	3/3	2/3
	From	3	253	1/3	25.0 (0)	5	1/3	0/3	3/3	2/3
	All	**6**	**253**	**No**	**25.0 (0)**	**10**	**2/6**	**0/6**	**6/6**	**4/6**
Hearst & Le Roy (UCB)	To	3	384	0/3	25.0 (0)	3	0/3	1/3	3/3	0/3
	From	3	384	2/3	25.0 (0)	3	1/3	2/3	3/3	0/3
	All	**6**	**384**	**No**	**25.0**	**6**	**1/6**	**3/6**	**6/6**	**0/6**

					(0)					
Guy West Bridge Ramp (CSUS)	To	3	410	1/3	31.7 (10)	5	3/3	0/3	3/3	3/3
	From	3	402	3/3	31.7 (10)	5	2/3	0/3	3/3	3/3
	All	**6**	**406**	**Yes**	**31.7 (10)**	**10**	**5/6**	**0/6**	**6/6**	**6/6**
University Drive West & Sinclair Road (CSUS)	To	3	1405	0/3	25 (0)	3	1/3	0/3	3/3	0/3
	From	3	1405	1/3	25 (0)	3	0/3	0/3	3/3	1/3
	All	**6**	**1405**	**No**	**25 (0)**	**6**	**1/6**	**0/6**	**6/6**	**1/6**
Elvas Avenue & 65th Street (CSUS)	To	3	127	0/3	15 (0)	7	0/3	0/3	2/3	0/3
	From	3	127	0/3	15 (0)	5	1/3	0/3	2/3	0/3
	All	**6**	**127**	**No**	**15 (0)**	**6**	**1/6**	**0/6**	**4/6**	**0/6**