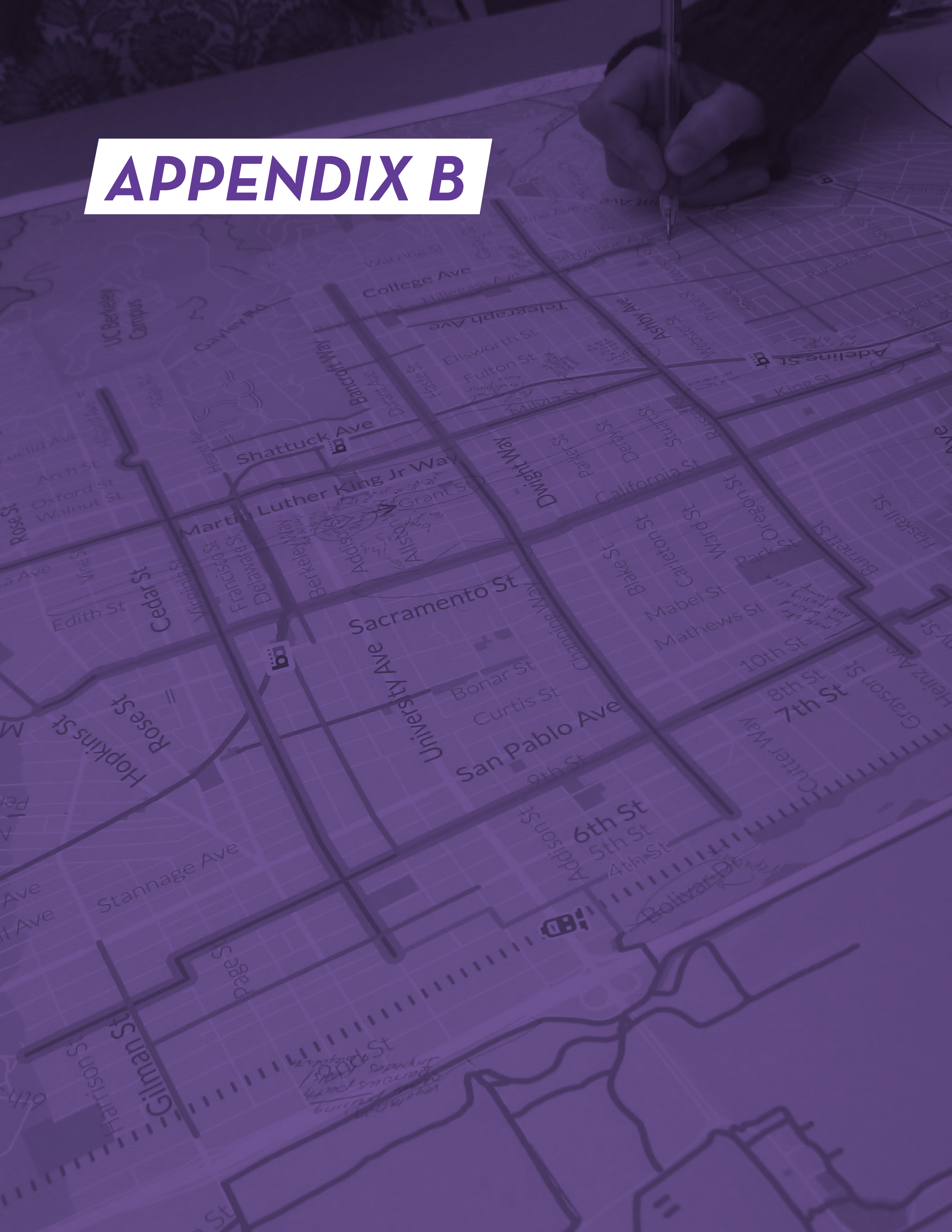
APPENDIX B


College Ave
Telegraph Ave
UC Berkeley Campus
Gayley Rd
Bancroft Way
Ellsworth St
Fulton St
Ashby Ave
Adeline St
King St
Shattuck Ave
Martin Luther King Jr Way
Grant St
Dwight Way
Parker St
Derby St
California St
Euclid Ave
Arch St
Oxford St
Walnut St
Rose St
Cedar St
Virginia St
Francisco St
Delaware St
Berkeley Way
Addison St
Allston Way
Sacramento St
Blake St
Carleton St
Ward St
Oregon St
Park St
Mabel St
Mathews St
Edith St
Burnett St
Haskell St
University Ave
Bonar St
Curtis St
San Pablo Ave
10th St
8th St
7th St
Grayson St
Heinz Ave
Hopkins St
Channing Way
Cutter Way
9th St
6th St
5th St
4th St
Addison St
Bolivar Dr
Stannage Ave
Page St
Gilman St
Harrison St

APPENDIX B.

Collision Analysis

Bicycle-related collisions and collision locations in Berkeley were analyzed over the most recent twelve-year period of available data, 2001-2012. A bicycle-related collision describes a collision involving a bicycle with a second party (e.g. motor vehicle, pedestrian, stationary object) or without a second party (e.g. the person riding a bicycle has a solo-crash due to slippery road conditions or rider error). The term "collision location" describes a geographic location where at least one collision was recorded over the twelve-year period.

Collision data for this report was generated from the California Statewide Integrated Traffic Report System (SWITRS). Because SWITRS combines records from all state and local police departments, data varies due to differences in reporting methods. It is important to note that the number of collisions reported to SWITRS is likely an underestimate of the actual number of collisions that take place because some parties do not report minor collisions to law enforcement, particularly collisions not resulting in injury or property damage. Although under-reporting and omissions of "near-misses" are limitations, analyzing the crash data lets us look for trends both spatially and in behaviors (motorist and cyclist) or design factors that cause bicycle collisions in Berkeley.

The analysis of reported bicycle-related collisions can reveal patterns and potential sources of safety issues, both design and behavior-related. These findings can provide the City of Berkeley with a basis for infrastructure and program improvements to enhance bicycle safety. A list of primary findings is below, and described in the following sections.

- Bicycle-involved collisions were concentrated along **roadway segments without bikeway infrastructure near major activity centers** such as commercial corridors, UC-Berkeley, and Ashby BART station. This suggests that people bicycling in Berkeley are willing to ride on routes without bikeway infrastructure if it is the most direct and accessible route to their destination.
- On streets with bikeway infrastructure, **Milvia Street had the highest number of total collisions** between 2001 and 2012, which suggests that programmatic and design changes may be necessary to accommodate the mix of roadway users along Berkeley's Downtown Bicycle Boulevards.
- Along Bicycle Boulevards, the **highest density of collisions occurred where the Bicycle Boulevard crossed a major arterial** such as Shattuck Avenue, University Avenue, College Avenue, and Martin Luther King Jr Way. This finding aligns with public input, which called for improved crossings of Bicycle Boulevards at major streets.

- Collisions resulting in **severe injuries were concentrated at intersections**, particularly along Ashby Avenue, Adeline Street, College Avenue, and Channing Way.
- Approximately **50 percent of reported collisions involved bicyclists between the ages of 20 and 39**, over representing the Census' reported total number of residents within this age range by roughly 10 percent. This may be the most common age of people who bicycle in Berkeley. This finding may also suggest that targeted programming for college students and young professionals could help reduce collisions for which the person bicycling is at fault.
- The most common factors resulting in a bicycle-involved collision were a right-of-way violation, hazardous violation, unsafe speed, and improper turning. Potential collision mitigation strategies to address these violations may include bikeway channelization along major arterials, distracted driving programming, additional strategies to slow people riding bicycles on non-Bicycle Boulevards with steep downhill slopes, and improved intersection design. Further definition on these collision factors are included below.

B.1. NUMBER, LOCATION, AND TRENDS

Between 2001 and 2012, there were 1,773 total reported bicycle collisions in Berkeley, with a concentration of bicycle collisions occurring downtown, near the UC campus, and on major roadways. **Figure B-4** maps the density of bicycle collisions over the twelve-year study period. The streets with the highest number of bicycle collisions (see **Table B-1**) include: Shattuck Avenue, College Avenue, San Pablo Avenue, Martin Luther King Jr. Way, and University Avenue, all of which serve important functions as direct routes through the City and as commercial and retail service destinations. None of these streets have bikeways, which suggests that the absence of a bikeway will not necessarily deter a person who wants to bike the most direct route through the city or needs to access a local restaurant, store, or business.

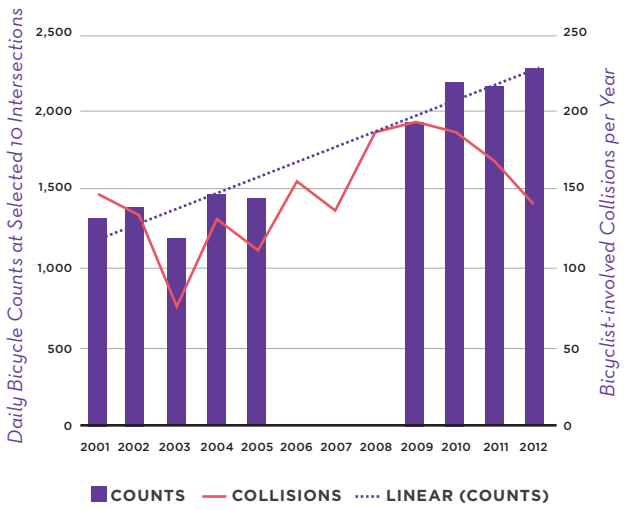
***Table B-1:** High Bicycle-Involved Collision Corridors, 2001-2012*

CORRIDOR	BICYCLE-INVOLVED COLLISIONS
Shattuck Avenue	101
College Avenue	66
San Pablo Avenue	64
Martin Luther King Jr Way	60
University Avenue	50
Milvia Street	48

On streets with bikeways, including on the Bicycle Boulevard network, Milvia Street had the highest number of bicycle collisions, with a high density of collisions between Hearst Avenue and Derby Street. This location also received a high number of public comments, which is discussed in Section 4.6.

Figure B-1 compares the number of collisions to bicycle counts conducted from 2001-2012. The City has conducted comprehensive counts for most years; however, due to staff shortages, limited or no counts were performed from 2006-2008. There has been an overall 73 percent increase in bicycle volumes and a 5 percent decrease in the number of reported bicycle collisions throughout Berkeley from 2001 to 2012. Although the rate of collisions compared to counts fluctuated from 2001 to 2005, in the more recent years there has been an 18 percent increase in bicycle volumes and a 27 percent decrease in the number of reported bicycle collisions throughout Berkeley, from 194 in 2009 to 141 in 2012 (**Figure B-1**). This trend is consistent with volume and collision statistics from other cities where the number of bicycle-related collisions correlates inversely with the number of people riding bicycles: the more people riding bicycles, the fewer collisions per bicyclist there are.[1] It is important to note that changes in the collision rate may be a result of random variability or other factors not included in the analysis.

***Figure B-1:** Trends of citywide bicycle counts compared with collisions*



1 Jacobsen, P. L. "Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling" Injury Prevention (2003), 9:205-209. http://injuryprevention.bmj.com/content/9/3/205.full.

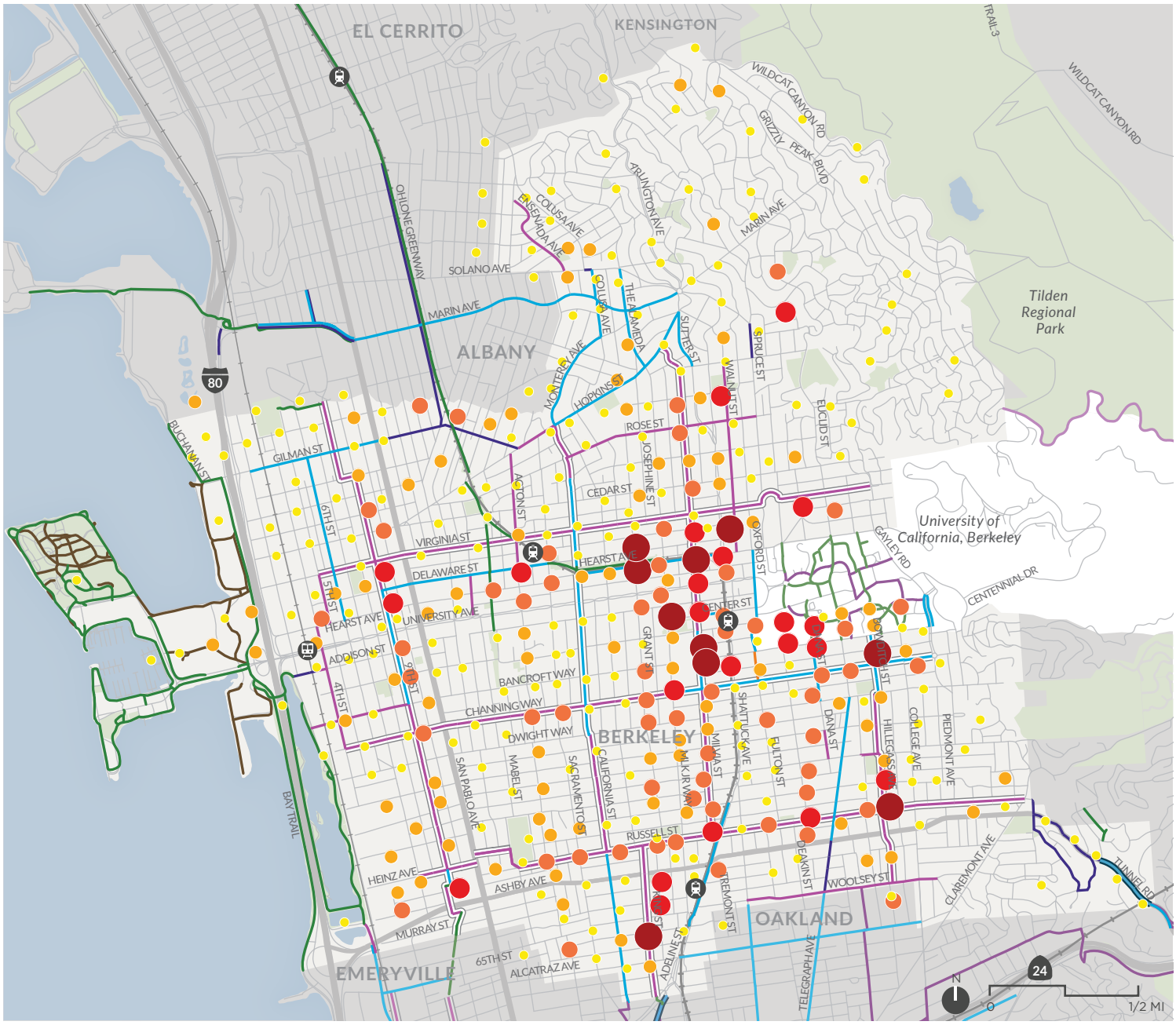


FIGURE B-1: BICYCLE COLLISION DENSITY

NUMBER OF BICYCLE-INVOLVED COLLISIONS, *2001 to 2012*

1 - 3 | 4 - 6 | 7 - 10 | 11 - 14 | 15 - 22

- PAVED PATH [1A]
- UNPAVED PATH [1B]
- STANDARD BIKE LANE [2A]
- UPGRADED BIKE LANE [2B]
- SIGNAGE-ONLY [3A]
- SHARROWS [3C]
- BICYCLE BOULEVARD [3E]
- CYCLETRACK [4A]

BICYCLE BOULEVARD NETWORK

- PARK/REC
- RAILROAD
- BART STATION
- AMTRAK STATION

B.1.1. Highest Incidence Locations

Table B-2 illustrates the ten intersections where the most bicycle collisions have occurred between 2001 and 2012 as recorded in SWITRS, indicating intersections that may warrant priority study for safety improvements.

The ten intersections with the highest number of collisions are located in downtown Berkeley, with the exception of the two intersections on College Avenue and the intersection on Adeline Street. The majority of the roadways for these intersections either lack any bicycle infrastructure or are designated as a Bicycle Boulevard and the collisions occurred where the Bicycle Boulevard crosses a major roadway or arterial.

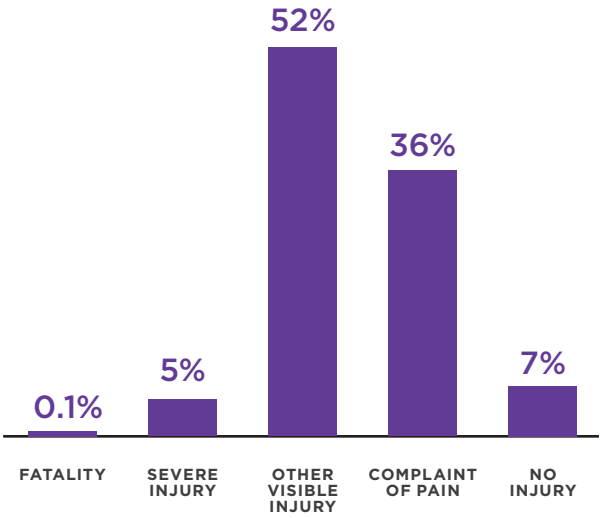
Table B-2: Locations with the Highest Number of Collisions, 2001-2012

	INTERSECTION		NUMBER OF COLLISIONS
1	Martin Luther King Jr Way	University Avenue	22
2	Hearst Avenue	Between Oxford Street and Spruce Street	22
3	Adeline Street	Alcatraz Avenue	22
4	College Avenue	Woolsey Street	21
5	Shattuck Avenue	Durant Avenue	20
6	Shattuck Avenue	University Avenue	19
7	College Avenue	Haste Street	17
8	Milvia Street	Between Allston Way and Kittredge Street	16
9	Channing Way	Shattuck Avenue	16
10	Martin Luther King Jr Way	Hearst Street	15

B.1.2. Severity of Collisions

Of the 1,773 reported bicycle collisions over the twelve year period, 52 percent (929) of reported bicycle collisions resulted in an injury categorized as "other visible injury," 36 percent (633) of reported collisions resulted in a "complaint of pain," and 7 percent (116) of collisions did not result in an injury. Two collisions, or 0.1 percent of all bicycle collisions, resulted in a fatality. The city has a low proportion of collisions that resulted in a fatality or severe injury. **Figure B-3** summarizes collisions by severity of injury and **Figure B-3** shows the location of the collisions by severity. The two fatal collisions occurred at the intersection of Adeline Street and Fairview Street, and at the intersection of Bancroft Way and Fulton Street.

***Figure B-2:** Summary of collision severity, 2001-2012*



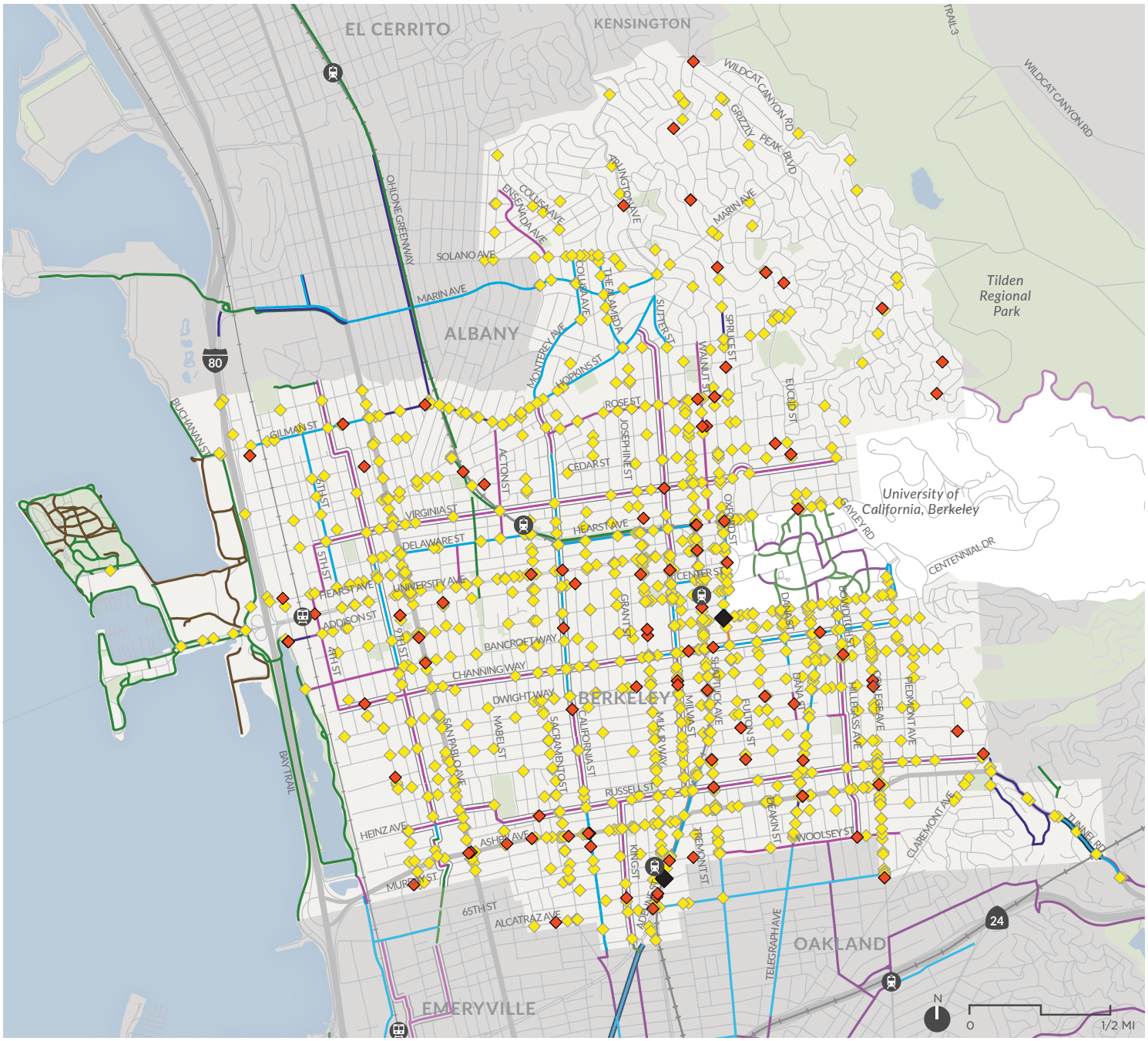


FIGURE B-3: BICYCLE COLLISION SEVERITY

MINOR INJURY

- PAVED PATH [1A]
- UNPAVED PATH [1B]

SEVERE INJURY

- STANDARD BIKE LANE [2A]
- UPGRADED BIKE LANE [2B]

FATALITY

- SIGNAGE-ONLY [3A]
- SHARROWS [3C]
- BICYCLE BOULEVARD [3E]
- CYCLETRACK [4A]

BICYCLE BOULEVARD NETWORK

- PARK/REC
- RAILROAD
- BART STATION
- AMTRAK STATION

B.1.3. Collisions: Time of Day and the Year

As shown in **Figure B-5**, bicycle collisions peak during the evening commute period. Thirty-seven percent of collisions occurred between 3 pm and 7 pm. The high number of bicycle collisions in the evening period is consistent with the national trend for when bicycle-involved fatalities occur.[2]

Figure B-6 shows that collisions occur throughout the year and peak in September and October. This peak in September and October correlates with favorable fall weather and the start of the school year, which also corresponds to the highest levels of cycling during a given year, and may bring with it an influx of new people bicycling.

2 NHTSA, 2013 http://www-nrd.nhtsa.dot.gov/Pubs/812151.pdf.

***Figure B-5:** Bicycle collision events by hour (all collision events), 2001-2012*

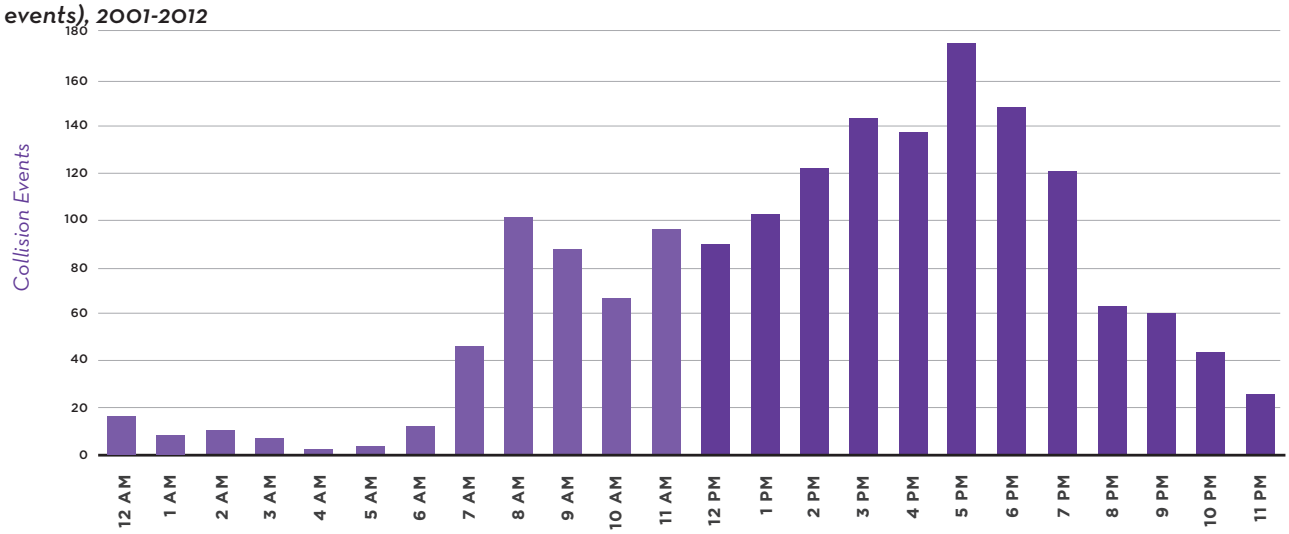
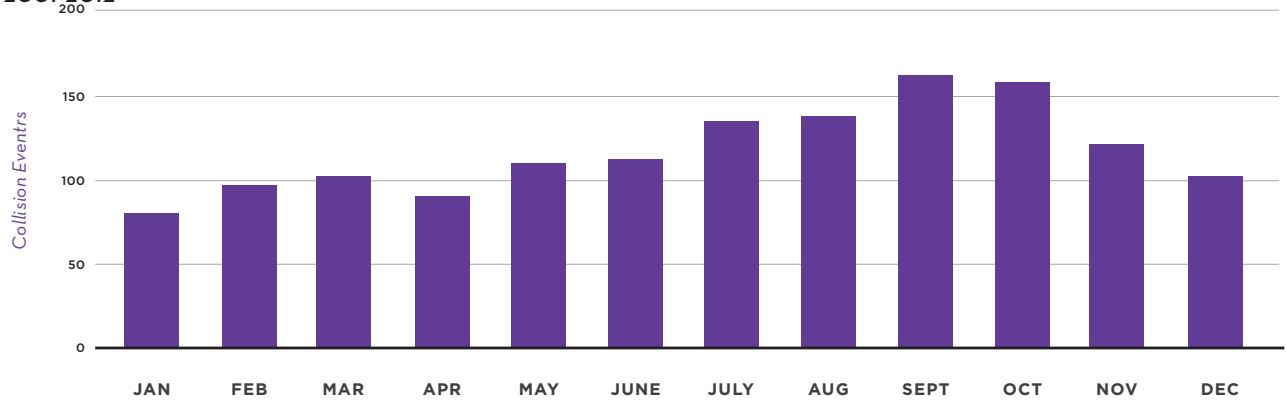


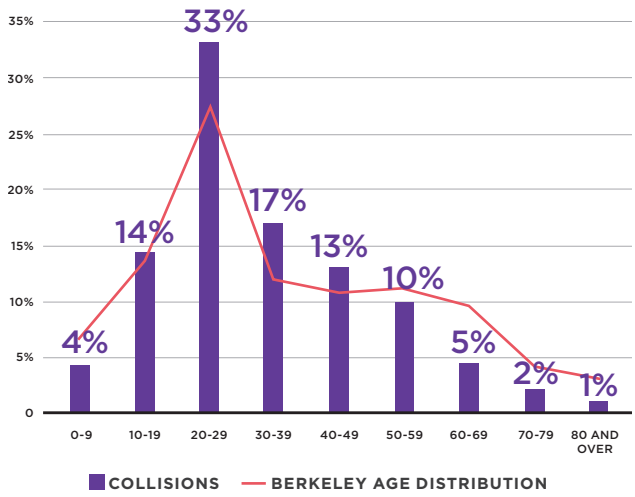
***Figure B-6:** Bicyclist-involved collisions by month of year, 2001-2012*



B.1.4. Age of Collision Involved Parties

Thirty-three percent of bicycle collisions involved bicyclists aged 20-29 followed by 17 percent of collisions involving bicyclists aged 30-39, and 14 percent of collisions with bicyclists aged 10-19. **Figure B-7** illustrates the age distribution of all Berkeley residents according to the 2010 US Census as well as the age distribution of people riding bicycles involved in collisions between 2001 and 2012. People riding bicycles aged 20-29 and 30-39 are overrepresented in bicycle collisions in Berkeley as compared to their distribution among the Berkeley population, which may be explained by higher rates of bicycling among young adults.

***Figure B-7:** Age distribution of bicyclist collisions, 2001-2012 and all residents, 2010*



B.2. COLLISION FACTORS

Table B-3 lists the six most common primary collision factors attributed to bicycle collisions. The primary collision factor can provide insight into people's behavior or roadway feature(s) that may account for the collision. Twenty-eight percent of collisions were attributed to a right-of-way violation; other hazardous violations and unsafe speed were each attributed to 18 percent of collisions, and improper turning was attributed to 17 percent of collisions. This Plan will consider how improvements can reduce the most common collision factors.

***Table B-3:** Primary Collision Factor Definitions*

PRIMARY COLLISION FACTOR	EXAMPLE
Right-of-way	Driver or person on a bicycle fails to yield to and then collides with a vehicle, pedestrian or bicyclist already in an intersection
Other Hazardous Violation	Driver or person on a bicycle is talking on a cell phone
Unsafe Speed	Driver or a person on a bicycle travels above the posted speed limit or at an unsafe speed for the existing roadway conditions
Improper Turning	Driver or a person on a bicycle makes a U-turn at an intersection without a four way stop that resulted in a collision with bicyclist or other vehicle
Traffic Signals and Signs	Driver or a person on a bicycle fails to stop at a stop sign and collides with a vehicle, pedestrian, or person on a bicycle
Wrong Side of Road	Drive or a person on a bicycle is traveling on wrong side of road (against the flow of traffic)

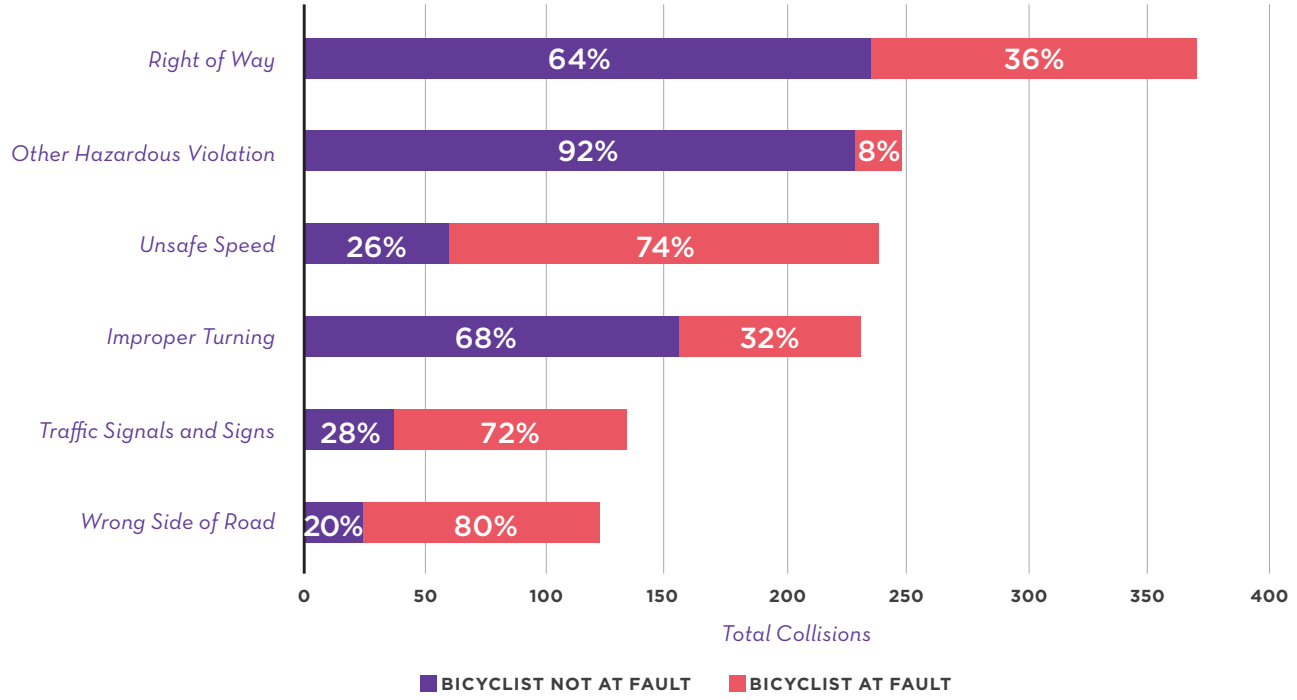
B.2.1. Collision Factors and Fault

Figure B-8 presents a breakdown of collisions by the five most common primary collision factors and the party (person riding bicycle or driving motor vehicle) at fault. **Figure B-9** and **Figure B-10** present collisions by primary collision factor and the party (person riding bicycle or driving motor vehicle) at fault. The collision factors and party at fault may reveal trends along certain intersections or corridors that could benefit from improvements. Overall, people riding bicycles were determined to be at fault for 55 percent of bicycle-involved collisions, and people driving, people walking, and other factors were at fault for the remaining 45 percent of bicycle-involved collisions.

PERSON RIDING BICYCLE AT FAULT

A right-of-way violation is the most common type of collision involving a person riding a bicycle. Right-of-way collisions have occurred throughout the city with concentrations on San Pablo Avenue, Shattuck Avenue, Telegraph Avenue, Sacramento Avenue (between Russell Street and Alcatraz Avenue) and along the southern border of the UC Berkeley campus. When a person riding a bicycle is at fault, right-of-way violation occurs when the person riding a bicycle fails to yield to another roadway user who has the right-of-way.

***Figure B-8:** Six most prevalent primary collision factors for bicycle collisions (out of 1,345 total collisions), 2001-2012*



The second most common type of bicycle-involved collision is one caused by the person riding a bicycle traveling at an unsafe speed. The majority of the collisions that have occurred in the hills of Berkeley were due to unsafe speed, which may be due to the steep topography. It is important to note that most of the collisions caused by a person riding a bicycle traveling at unsafe speeds were also solo-collisions, in which the person riding a bicycle did not collide with any other party, such as a vehicle, pedestrian or other person riding a bicycle.

There is a pattern of people riding bicycles on the wrong side of the road on major roads and commercial streets, including San Pablo Avenue, Shattuck Avenue, and Telegraph Avenue. In general, these types of violations are occurring along roadways that lack bicycle infrastructure, which suggests that the roadway configuration in these areas may not be conducive to riding directly to the person's destination.

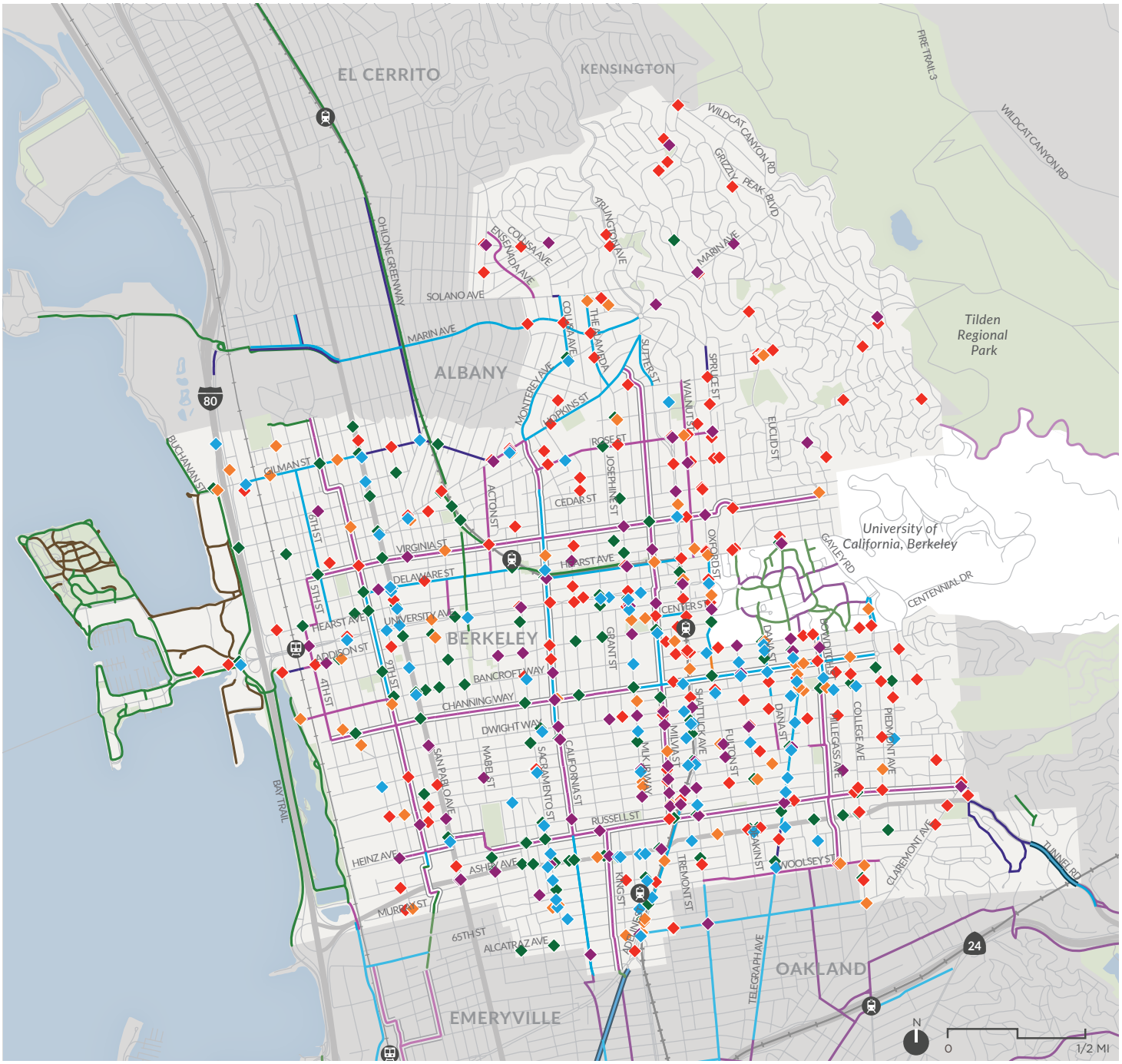


FIGURE B-9: BICYCLE COLLISIONS, BICYCLIST AT FAULT

RIGHT OF WAY

UNSAFE SPEED

IMPROPER TURN

SIGNAL VIOLATION

WRONG SIDE OF ROAD

PAVED PATH [1A]

UNPAVED PATH [1B]

STANDARD BIKE LANE [2A]

UPGRADED BIKE LANE [2B]

SIGNAGE-ONLY [3A]

SHARROWS [3C]

BICYCLE BOULEVARD [3E]

CYCLETRACK [4A]

BICYCLE BOULEVARD NETWORK

PARK/REC

RAILROAD

BART STATION

AMTRAK STATION

PERSON DRIVING MOTOR VEHICLE AT FAULT

As shown in **Figure B-10**, a right-of-way violation is the most common type of collision for which the motorist is at fault. An example of a right-of-way violation is when a motorist fails to yield when turning left and hits a person who is bicycling straight in the opposite direction. The motorist may not have seen the person riding a bicycle, may have underestimated the bicycle's speed, or may have assumed that the person riding a bicycle would stop. Right-of-way collisions have occurred throughout the city with concentrations on Gilman Street/Hopkins Street, Virginia Street, Channing Way, and Telegraph Avenue.

The second most common type of motorist-at-fault collision is "other hazardous violation." This includes any type of collision which does not fall under the other set categories, such as a motorist being on a mobile phone while driving.

Sixty-eight percent of the 231 violations due to improper turning were the fault of the motor vehicle. An example of an improper turn violation is when a vehicle does not merge into the bike lane to complete a right turn. The traffic law requires that the approach to a right turn be made from the far right portion of the road. A motorist right turn collision occurs when a right-turning motorist collides with a cyclist to his or her right. It can occur when the motorist tries to make a right turn from too far to the left, but it can also be caused by a bicyclist who passes on the right, in the motorist's blind spot. Common locations for improper turning collisions include Shattuck Avenue, Ashby Avenue, and San Pablo Avenue. In general, these types of violations occur along roadways that have many turns or driveways, but lack bicycle infrastructure. This could mean that drivers are not expecting a person riding a bicycle and therefore not using caution prior to turning. **Figure B-10** shows the collision locations where motorists were at fault.

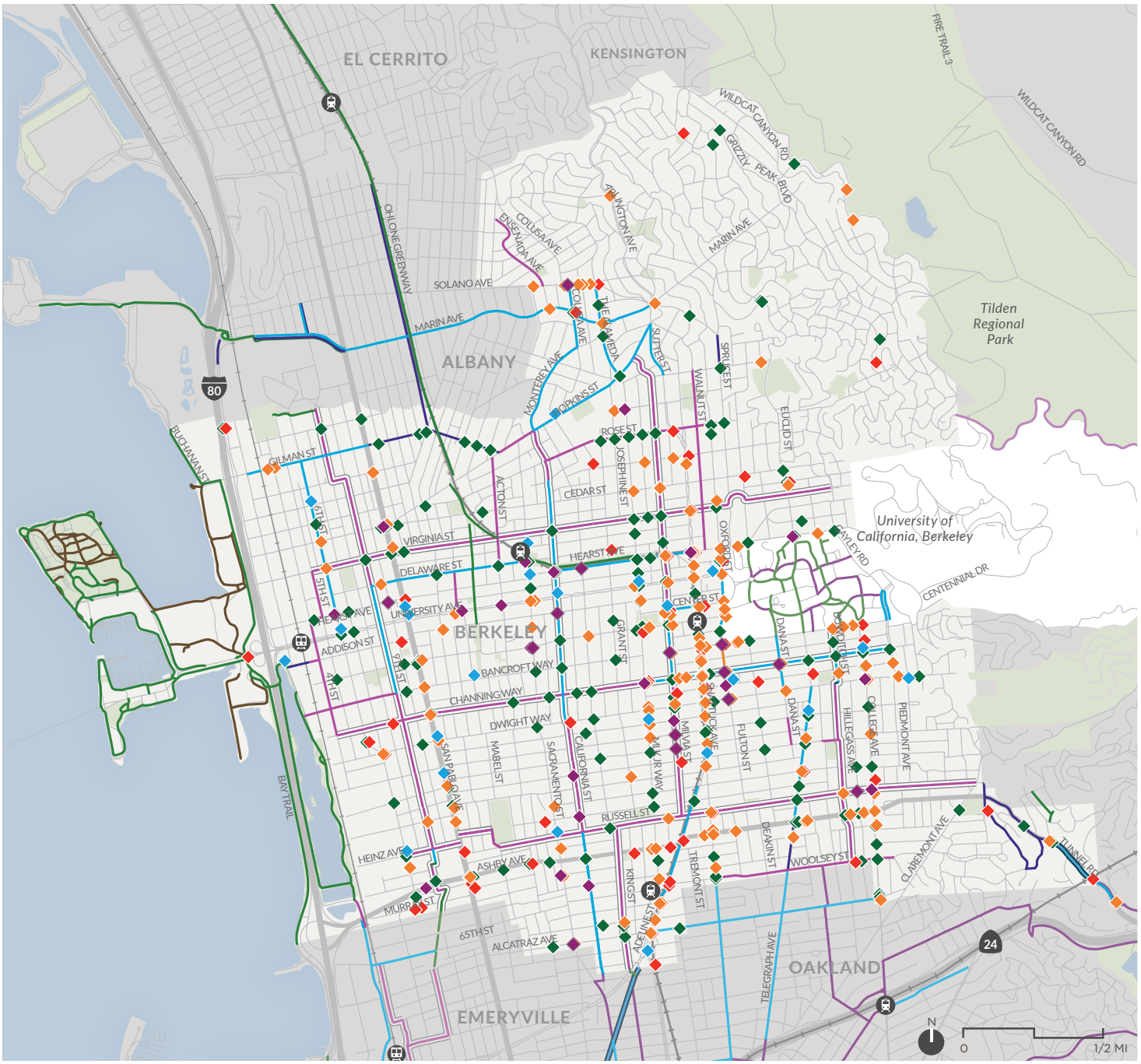


FIGURE B-10: BICYCLE COLLISIONS, MOTORIST AT FAULT

RIGHT OF WAY

UNSAFE SPEED

IMPROPER TURN

SIGNAL VIOLATION

WRONG SIDE OF ROAD

PAVED PATH [1A]

UNPAVED PATH [1B]

STANDARD BIKE LANE [2A]

UPGRADED BIKE LANE [2B]

SIGNAGE-ONLY [3A]

SHARROWS [3C]

BICYCLE BOULEVARD [3E]

CYCLETRACK [4A]

BICYCLE BOULEVARD NETWORK

PARK/REC

RAILROAD

BART STATION

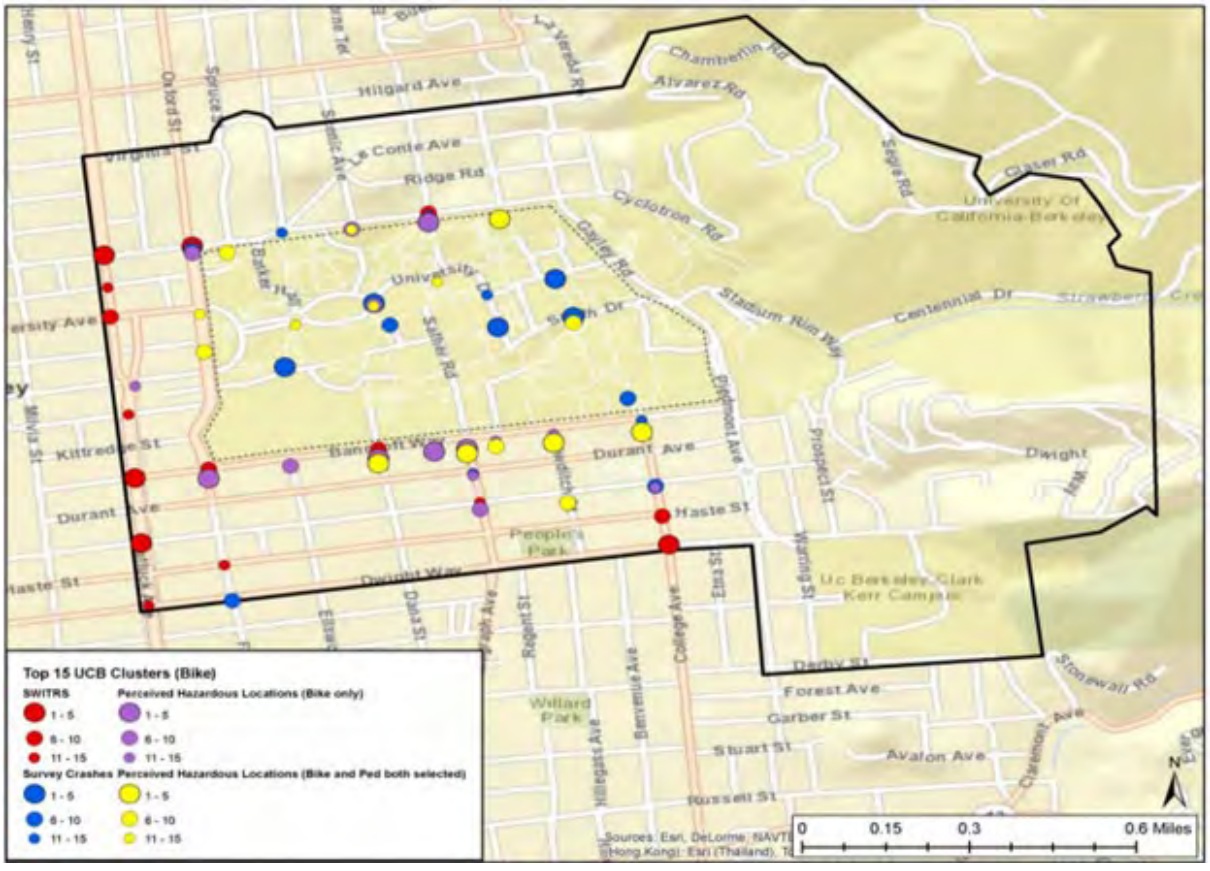
AMTRAK STATION

B.2.2. Collisions within 1/4-Mile of UC Berkeley Campus

In 2014, the UC Berkeley Safe Transportation Research and Education Center (SafeTREC) published a report on bicyclist and pedestrian safety around the UC Berkeley campus. The researchers asked students to identify locations where they had been involved in a collision or areas perceived to be dangerous for pedestrians or people bicycling. This data is supplemental to SWITRS data and gives a more complete picture of where collisions are occurring or could occur around the UC Berkeley campus so that countermeasures can be considered as preventative measures. **Figure B-11** shows a map of the bicycle collisions pulled from the SafeTREC survey and SWITRS data.

Bicycle collisions occurred along major traffic corridors surrounding the campus, especially Shattuck Avenue, although many were located in the interior of campus. The purple circles represent locations perceived as hazardous by students, most notably along Bancroft Avenue and Hearst Avenue. Bicycle-involved collisions did not occur at every intersection on Bancroft Way along the board of campus, however every intersection is perceived as hazardous by students. This data suggests that the absence of bicycle-involved crashes does not eradicate the potential or perceived danger of the location. Further, the perception of a location may influence a person's decision to bicycle more so than the location's collision history.

***Figure B-11:** Top 15 bicycle collision clusters on and adjacent to UC Berkeley (2002-2011)*



Source: "A Comparative Analysis of Pedestrian and Bicyclist Safety around University Campuses." University of California Transportation Center. (2014) http://www.uctc.net/research/papers/UCTC-FR-2014-03.pdf.

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