THIS PRINT COVERS CALENDAR ITEM NO.: 11

SAN FRANCISCO
MUNICIPAL TRANSPORTATION AGENCY

DIVISION: Streets

BRIEF DESCRIPTION:

Informational packet of analysis memos for the Active Communities Plan.

SUMMARY:

- The San Francisco Municipal Transportation Agency (SFMTA) Active Communities Plan has conducted a range of analysis over the 2023 calendar year. This packet is meant to be an informational asset to SFMTA Board Directors.
- The **SFMTA ACP Network & Bike Count Analysis** analyzes bike network performance against a variety of metrics. Findings show that:
    - Protected bike lanes have the highest ridership per centerline mile
    - Bicycle & scooter ridership has bounced back to pre-pandemic levels in many neighborhoods (though not yet for commute-oriented trips downtown)
    - Bicycle trips increased 27% on streets that implemented a Quick-Build Project
    - The analysis also identified high-performing and low-performing sections of the bike network.
- The **SFMTA ACP Collision Analysis Descriptive Statistics** analyzes collisions for people on bikes and scooters over the past 5 years. Findings show that:
    - Pre-pandemic, collisions were concentrated in downtown while since the pandemic collision concentration is far more dispersed.
    - Bicycle collisions went down during the pandemic, but collision severity increased.
    - Pre-pandemic, the predominant collision type was turning movements; since the start of the pandemic, perpendicular collisions (running red lights) is much more prevalent.
    - African American males are substantially over-represented in bicycle collisions.
- The **SFMTA ACP Systemic Safety Analysis** analyzes risk factors for roadways, identifying streets with the highest likelihood to result in bicycle or scooter collisions.
- The **SFMTA ACP Resident Preference Survey Draft Findings** reports on a 1,000 count demographically-balanced survey conducted by the polling firm EMC, with 600 surveys conducted as in-person intercepts in Equity Priority Communities. The survey focused on questions of needs and barriers to active transportation, as well as ranking comfort levels for different kinds of streets. Key findings include:
    - 10% of San Franciscans use some type of active transportation device daily.
    - About 80% of San Franciscans are interested in using bikes, scooters, or other devices, but only 23% of San Franciscans feel today’s network is comfortable and safe enough for them to use it.
    - More than a quarter (29%) of San Franciscans report having had a bike or scooters stolen.
    - Residents across all communities express a higher level of comfort using bike

network facilities with greater separation from drivers.
    - In addition to network quality, affordability, access to bikes/scooters, and safe parking options are all substantial barriers to using the active transportation network.
- The **SFMTA ACP BCI Methodology** memo documents the process of developing and scoring the Bicycle Network Comfort Index (BCI), including the different data sources and metrics used.

ENCLOSURES:

1. SFMTA ACP Network & Bike Count Analysis
2. SFMTA ACP Collision Analysis Descriptive Statistics
3. SFMTA ACP Systemic Safety Analysis
4. SFMTA Resident Preference Survey Draft Findings
5. SFMTA ACP BCI Methodology

APPROVALS:		**DATE**
DIRECTOR		July 28, 2023
SECRETARY		July 28, 2023

ASSIGNED SFMTAB CALENDAR DATE: August 1, 2023

MEMORANDUM

June 23, 2023

To: Christopher Kidd and ACP Technical Advisory Committee
Organization: San Francisco Municipal Transportation Agency
From: Mia Candy, Joanna Wang, Peter Garcia, Adam Wood, Nan Jiang
Project: San Francisco Active Communities Plan

Re: Task 2A Draft Network and Count Analysis

Introduction

This memorandum presents findings from the Active Communities Plan (ACP) network and count analysis. Key findings are called out on pages 1 - 3, followed by more in-depth analysis and explanation of methods. Findings from this analysis will be used to inform next steps, including follow-up analysis, focused community engagement, and development of recommendations.

Purpose of the Network and Count Analysis

The purpose of this analysis is to understand the intensity of bike and micromobility use across San Francisco. By understanding where people ride today, and how ridership is related to the existing active transportation network, the project team can start to identify gaps in the network and opportunities for improvements. This analysis addresses the following key questions:

- Where are people riding bicycles and other micromobility devices? Where are people *not* riding? Why might ridership be distributed in the ways that it is?
- Where is ridership in relationship to the network? Are people using the network? Why or why not?
- Where is the network over- or under-performing? Where do we see low ridership on high-quality facilities, or vice versa?
- How is the network distributed across neighborhoods?
- What kind of ridership and network coverage is there in each of the six Equity Priority Communities (EPCs)?
- What can ridership and network coverage tell us about critical network gaps?

Key Findings

This analysis produced the following key findings:

- Network Coverage and Quality:
  - Twenty-four percent of centerline miles in San Francisco have bike facilities.
  - Eight percent of San Francisco's centerline miles have high-quality facilities, which are defined as separated bikeways, bike paths, slow streets, and car-free streets.
  - Of the six EPCs, SoMa has the best network coverage (36%) and quality (22%). On the other hand, Western Addition/ Filmore has zero high quality facilities.
- Bike Commute Rates:
  - In 2021, 3.1% of San Francisco residents biked or used another micromobility device to commute to work – down from 3.8% in 2018.
  - Bike commuting is concentrated in dense, flat, urban neighborhoods, areas with high job density, and in places with close access to bike facilities. For example, in Hayes Valley, over 8% of residents commute by bike.
  - In dense urban neighborhoods, bike commuting is associated with households that do not own cars.

    - In lower-density, primarily residential neighborhoods further from employment centers, there is no correlation between zero-car households and high rates of bike commuting.
- Micromobility Volumes:
    - Data from Bay Wheels (Lyft) and Scooter-Share vendors show that:
        - Micromobility activity is concentrated in dense urban areas, and on streets with bike facilities.
        - In busy commercial areas, micromobility riders tend to ride on higher-comfort routes (i.e., high Bicycle Comfort Index [BCI] scores) rather than parallel, lower-comfort routes. For example, micromobility activity is concentrated on Polk Street, rather than Van Ness Avenue.
        - Micromobility ridership is low in the south and west of the city, largely due to the low number of bikeshare stations in these areas. Bay Wheels policies do incentivize electric bikeshare (which do not need to be parked at a bikeshare station) in those service areas by capping rates and waiving fees, but it has not resulted in corresponding increases in ridership.
        - The Great Highway/Great Walkway is a major destination for people renting e-bikes and e-scooters.
- Bicycle Activity:
    - Data from the SFMTA's automated bicycle counters show that:
        - On average, volumes fell by about a third citywide between 2018 and 2022. But not all neighborhoods experienced this trend. Counters in the Inner Richmond, Inner Sunset, Potrero Hill, and Russian Hill captured an increase in volumes over the last five years.
        - On streets that received quick-build interventions in 2022, bicycle trips increased a total of 27%.
        - The Slow Streets with the highest bike volumes are Shotwell Street, Clay Street, Lake Street, and Page Street. These streets are either in dense, urban neighborhoods or provide key connections across the city. The Slow Streets with the lowest volumes are concentrated in the southeast of the city in neighborhoods with low bike volumes overall, mirroring these neighborhoods' lower rates of bicycle mode share overall.
- Network Performance:
    - Volumes vs Facility Type
        - Most trips in San Francisco take place off-network because most streets in the city do not have bike facilities. But when volume is normalized by centerline mileage, the data show that there is an association between ridership and quality facilities. Facilities with protection from cars (i.e., separated bikeways) have the highest ridership per centerline mile than any other facility type. *Ridership per centerline mile increases as protection from cars increases.*
    - Volumes vs Network Quality
        - Low ridership on high-quality facilities can be an indicator that network improvements are needed, especially in high-density neighborhoods. A number of Class IV separated bikeways in San Francisco are under-performing, likely due to the vertical barrier type not being appropriate for the adjacent vehicular speeds, volumes, and curbside turnover. Lack of connectivity to the larger bike network or challenges intersections are other potential factors. Examples include Turk Street and Golden Gate Avenue in the Tenderloin, and Alemany Boulevard and San Jose Avenue in St Mary's Park/Glen Park/Mission Terrace. During network development, the project team will examine the precise reason for under-performance to identify appropriate treatments, and what other factors may contribute to these outcomes.
        - High ridership on low-quality facilities can be an indicator of demand, and an opportunity for improving conditions for many riders, especially in low-density neighborhoods. Ocean Avenue in southwest San Francisco is a good example of a street with high volumes, despite having a Class III Bike Route and a relatively low comfort score. During public engagement, the project team will consider options to meet this latent demand for east-west travel with appropriately low-stress facilities on or near the corridor.
    - Off-Network Volumes

    - Off-network streets are a critical part of how San Franciscan’s get around. Off-network volumes can provide insight into key opportunities or network gaps. Where volumes are high, but bicycle comfort is low, it may indicate that there is a need for infrastructure enhancements or suitable parallel routes. Examples include Balboa Street and Clement Street in the Richmond and most of the off-network streets in the Tenderloin.
  - Volumes vs Network Coverage
    - When volumes are low, but network coverage is relatively high, it is an indication that the network may be under-performing due to other factors such as land use, density, connectivity, or network quality. Neighborhoods where the volumes are low relative to network coverage include Mission Terrace/Cayuga/Outer Mission, and the east-west corridors in the Sunset District. Further analysis is required to assess the precise reason for poor network performance, and identify appropriate policy, program, or infrastructure recommendations.

Next Steps

The project team will use the findings in this analysis to inform the following next steps:

- Conduct community engagement to ground-truth findings, and to collect feedback about why people may choose to ride in certain locations, and to avoid others.
- During community engagement, identify key destinations and barriers to identify gaps in and opportunities for improvement on the network.
- During community engagement, explore other barriers communities may experience that impacts use of the bike network.
- In places where the network is under-performing, conduct segment-level analysis to identify the precise reason for under-performance, and make appropriate network, policy, or program recommendations.
- In places where the network is over-performing, identify what precisely is working, and how that can inform network development and improvement in other parts of the city.
- Conduct an access or connectivity analysis to further identify geographic gaps in the network. Use the volume, safety, and Bicycle Comfort Index data to identify specific segments for improvement or priority.

Network Quality and Coverage

The project team analyzed network coverage across San Francisco's neighborhoods. Network coverage is defined here as the percent of centerline miles that have bike facilities. Table 1 shows that citywide, 24% of San Francisco centerline miles have any kind of bike facilities. Table 1 also shows that 8% of San Francisco centerline miles have "high quality" facilities which include:

- Class IV Bikeways (Separated Bikeways),
- Class I Bikeways (Bike Paths),
- Class III Bikeways (including only Class III facilities within the Slow Streets network), and
- Car-Free Streets (such as Car-Free JFK in Golden Gate Park and the Great Highway/Walkway)

The project team compared network coverage and quality in six Equity Priority Communities (EPCs) to citywide averages. Western Addition/Filmore and Excelsior have low network coverage, compared to the entire city as well as the other EPCs. SoMa, Mission, and Tenderloin are all located in San Francisco's dense urban center and as result, have some of the highest network coverage in the city.

When we evaluate *high quality* network coverage, SoMa has the highest share (22%) of centerline miles with high-quality facilities. This far exceeds the citywide average of 8%. Bayview-Hunters Point and Outer Mission/Excelsior have lower than average quality network coverage. Western Addition/Filmore has *zero* high quality facilities – there are no separated bikeways, bike paths, slow streets, or car-free streets within the formal neighborhood boundaries.

Table 1: Network Coverage and Network Quality Citywide vs. Equity Priority Communities

	Network Coverage	Network Quality	
Neighborhood*	**Percent of Centerline Miles with Bike Facilities**	**Percent of Centerline Miles with High Quality Facilities**	**Percent of Network that is High Quality**
Citywide Average	24%	8%	28%
Bayview-Hunters Point	23%	5%	21%
Outer Mission/	32%	7%	21%
Excelsior	9%	2%	16%
Mission District	30%	8%	28%
SoMa	36%	22%	61%
Tenderloin	28%	10%	38%
Western Addition/ Filmore	19%	0%	0%

*A table with the network coverage and network quality for all San Francisco neighborhoods is provided in Appendix A.

Bicycle Commuting

San Francisco's Climate Action Plan identifies a goal of 80% low-carbon trips by 2030. Converting commute trips from driving to active or shared modes will be a critical step in achieving the city's climate goals. To that end, the SFMTA is tracking bicycling commuting, and how it has changed year over year. The Active Communities Plan project team analyzed mode share data from the 2021 American Census Survey (ACS) 5-Year Estimates. Figure 1 and Figure 2 show bike commute mode share for San Francisco Census tracts in 2021 and 2018 (i.e., what percent of people living in each census tract commuted to work by bike). In 2021, bicycling made up 3.3% of citywide commute travel. This is down from 3.8% in 2018.[1] This decrease could be explained by COVID-related impacts, including the nationwide shift to remote work.

Where in San Francisco is bike commuting high, and why might that be the case?

The data show that bike commuting is concentrated in San Francisco's dense urban center in the neighborhoods surrounding Downtown and the Financial District. In Hayes Valley, the Mission District, Potrero Hill, and Haight Ashbury, over 6.8% of the workforce commutes to work by bike. Hayes Valley has particularly high rates of bike commuting – over 10%. Hayes Valley is also one of the few neighborhoods that did not see a decline in bike commuting between 2018 and 2021. Bike commuting is likely concentrated in these neighborhoods due to the density of (and proximity between) people, housing, and jobs. Compared to other parts of the city, bike routes in these neighborhoods are also relatively flat.

The data shows an association between bike commuting and bike infrastructure. There is a noticeable concentration of commuting around the "Wiggle" bike route which runs from Market Street to Fell Street. Bike commuting is also associated with a concentration of Class II Bike Lanes and Class IV Separated Bikeways in Haight Ashbury, North Panhandle, Duboce Triangle, and Inner Mission. The project team also compared high bike commuting rates to census tracts where vehicle ownership is low (Figure 3), to see if there is a correlation. In SoMa, the Mission District, and NoPa, there is some association between households that do not own cars and commuting by bike – likely due to proximity between where people live and where they work. The project team also found that there is some correlation between high-comfort network facilities and neighborhoods with high bike commute rates.

Where in San Francisco is bike commuting low, and why might that be the case?

Neighborhoods with relatively low bike commuting are located in the south and west of the city. In neighborhoods like Bayview-Hunter's Point, Outer Mission, Excelsior, and Lakeshore, low bike commuting may be a result of land use patterns – people simply living too far from their jobs to make commuting by bike an attractive option. In these neighborhoods, bike commuting is low even for households without cars (see Figure 3). In other neighborhoods with low bike commuting such as Chinatown, Twin Peaks, and Pacific Heights, steep slopes are likely a factor.

Table 2: Commute to Work by Bike Citywide vs. Equity Priority Communities

Neighborhood	Percent Commute to Work by Bike (2021)	Percent Bike Commuters that are Women (2021)
Citywide Average	3.1%	30.9%
Bayview-Hunters Point	1.3%	25.6%
Outer Mission/ Excelsior	0.7%	19.3%
Mission District	7.9%	34%
SoMa	4.1%	26.1%
Tenderloin	3.4%	22.1%
Western Addition & Filmore	4.3%	42.5%

A table with the bike commute rates for all San Francisco neighborhoods is provided in Appendix A.

[1] https://www.sfmta.com/getting-around/bike/bicycle-ridership-data/where-are-people-biking

Figure 1: Percent of People in Each Census Tract that Commute to Work by Bike (2021)

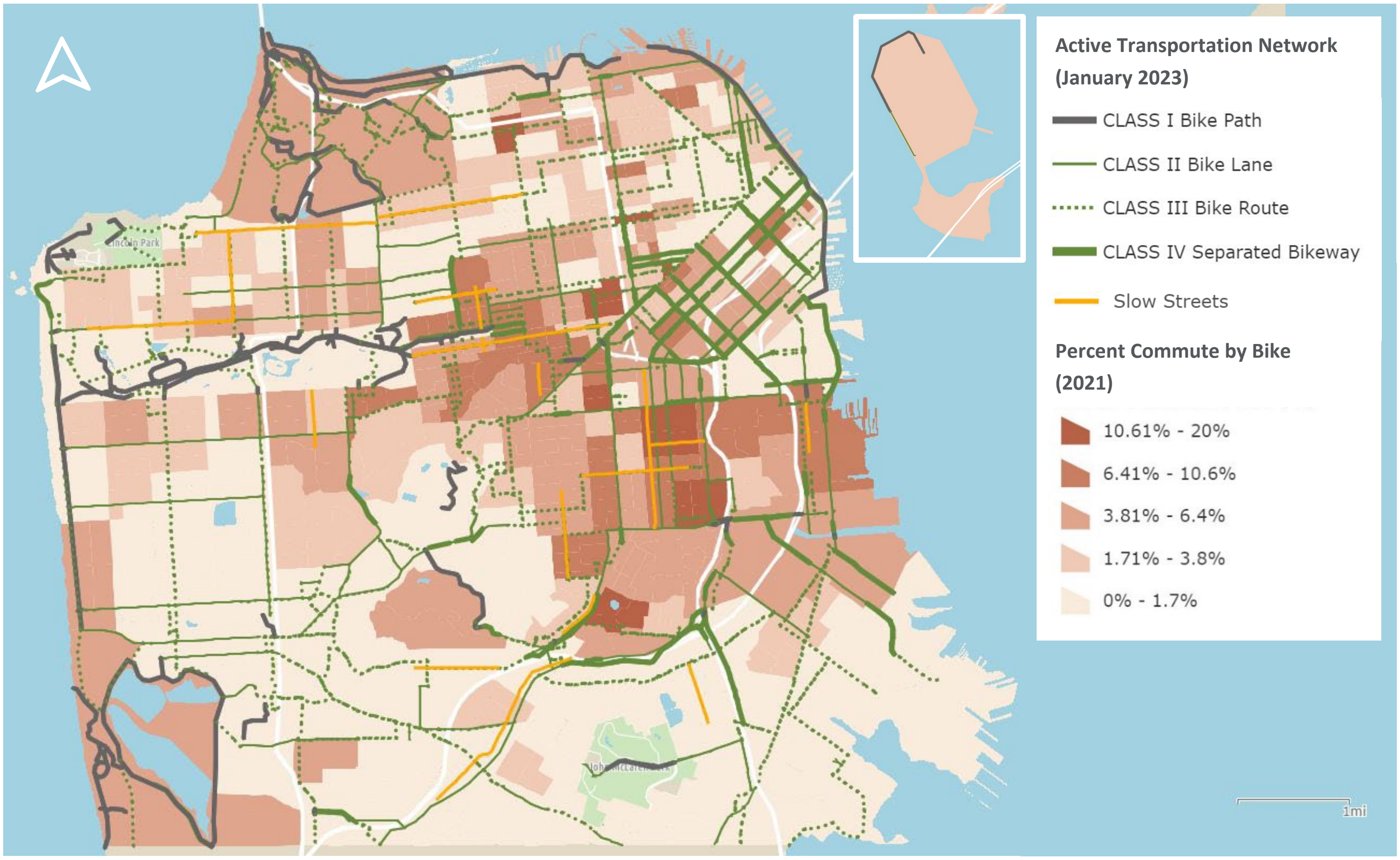
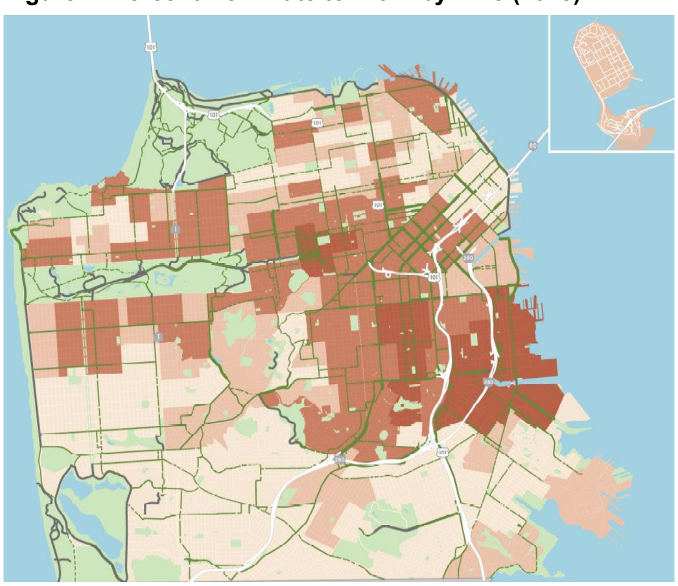


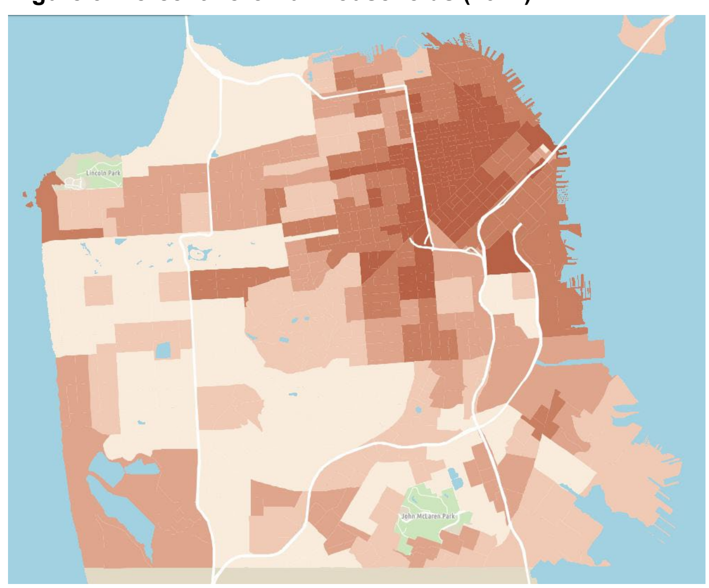
Figure 2: Percent Commute to Work by Bike (2018)



Percent Commute by Bike (%)

- 10.61% - 20%
- 6.41% - 10.6%
- 3.81% - 6.4%
- 1.71% - 3.8%
- 0% - 1.7%

Figure 3: Percent Zero Car Households (2021)



Percent Zero Car Households (%)

- Above 47%
- 28.8% - 46.9%
- 18.1% - 28.7%
- 11.3% - 18%
- 0% - 11.2%

Micromobility Activity

The San Francisco Active Communities Plan addresses biking as well as all other modes that can legally use the active transportation network, including scooters, e-bikes, and electric wheelchairs. To understand where micromobility activity is concentrated, the project team analyzed available 2022 micromobility data including:

- Bay Wheels e-bike volumes throughout the city (data from Lyft)
- Bay Wheels non-electric bike volumes at docking stations (data from Lyft)
- Electric scooter volumes throughout the city (data from vendors including Lime, Bird, and Spin)

It should be noted that available data is only from micromobility providers and does not capture privately-owned bikes and scooters. Figure 4 shows 2022 average annual daily micromobility volumes, including Bay Wheels e-bikes and scooter-share e-scooters. Street-level volumes shown in Figure 4 *do not* include activity for non-electric Bay Wheels bikes, because the manual bikes do not collect routing data. To visualize manual micromobility count data, Figure 4 also shows the number of bikes checked out of each docking station daily in 2022.

Where in San Francisco is micromobility ridership high, and why might that be the case?

The data shows that micromobility activity is concentrated along key commercial corridors and in dense urban areas including Market Street (about 900 trips per day), Valencia Street (about 500 trips), and Polk Street (about 400 trips). The Embarcadero also has a notable concentration of micromobility trips – over 1,800 trips per day. Ridership in the northeast of the city is likely due, in part, to the density of people, jobs, destinations, and tourist activity. Market, Valencia, and Polk are popular routes because they offer direct and convenient links between destinations.

Analysis via the SFMTA Bicycle Network Comfort Index shows that busy commercial corridors are relatively uncomfortable for riders due to high vehicular volumes, a prevalence of double parking, and curbside turnover. But the comfort data also shows that Market, Valencia, and Polk are relatively comfortable, compared to parallel streets. This indicates that micromobility riders avoid uncomfortable commercial corridors in favor of more comfortable, parallel routes – usually routes that have bike facilities. Table 3 shows how comfort and availability of facilities may be influencing where people choose to ride.

Table 3: Micromobility Ridership on Key Commercial Corridors

	Key Corridor	Comfort Score	Facility Type
Instead of riding on…	Van Ness Avenue	Low	None
Riders choose…	Polk Street	Moderate – High	Bike Route and Separated Bikeway
Instead of riding on…	Mission Street	Low - Moderate	None
Riders choose…	Market Street	Moderate	Bike Route and Separated Bikeway
Instead of riding on…	Guerrero Street or Dolores Street	Low - Moderate	None
Riders choose…	Valencia Street	Moderate - High	Bike Lane

Where in San Francisco is micromobility ridership low, and why might that be the case?

When we compare micromobility ridership to the Bay Wheels service area (Figure 5) and the scooter-share service areas (Figure 6), we can see that ridership is surprisingly low in the south and west of the city. The Richmond, Inner Sunset, Balboa Park, and Bayview-Hunters Point all have proximity to bikeshare stations, and fall within the micromobility service areas, but have relatively low volumes (less than 40 average daily rides). Figure 5 shows that Bay Wheels has two special service areas where fees are waived to incentivize e-bike ridership in the south and west of the city[2,3]. Despite this, ridership remains relatively low. Low ridership is likely due, in part, to relatively low network coverage in these neighborhoods, as well as land use patterns – destinations are further away and trips are longer, making micromobility a less attractive option to residents.

A notable exception to this trend is the Great Highway/Great Walkway, which has over 100 micromobility trips per day, despite being located far from bikeshare stations. San Franciscans and tourists are likely renting e-bikes and e-scooters specifically to ride the Great Highway, which suggests that the facility is an attractive recreational spot and key destination for residents and visitors.

What is the relationship between micromobility volumes and the active transportation network?

To understand the relationship between micromobility activity and the existing active transportation network, the project team evaluated volume data against existing infrastructure. Table 4 shows that micromobility volumes are relatively high on Class II Bikeways (Bike Lanes) and Class IV Bikeways (Separated Bikeways), compared to streets with no bicycle facility. It is notable that micromobility volumes are low on the city's Class I Bikeways (Bike Paths), including those in Golden Gate Park and the Presidio. This may be a result of service areas – Golden Gate Park falls outside of all micromobility service areas. In the Presidio, which does allow Bay Wheels bikes, low ridership may suggest that people are choosing micromobility for commuting or transportation purposes, as opposed to recreation.

Table 4: Micromobility Volume by Bike Facility

Bike Facility (Least modal separation to most)	Centerline Miles*	Micromobility Daily Volume (2022)	Micromobility Daily Volume Per Centerline Mile
No Facility	890.5	90,965	102
Class III – Bike Route	115.9	67,136	579
Class II – Bike Lane	90.3	64,701	716
Class IV – Separated Bikeway	29.8	43,666	1,464
Class III - Slow Street	13.8	5,841	425
Class I – Bike Path	40.5	8,794	217

* This analysis uses centerline miles as a core metric. This accounts for the difference between the mileage figures in Table 4 and the mileage figures listed on the SFMTA's website. The figures on the SFMTA website represent lane miles – in locations where the same facility is present on both sides of the street, both sides count toward the total mileage. In this network analysis, streets with the same facility on both sides of the street are *only counted once* toward total mileage. When a street has different facilities on each side of the street, the mileage is counted toward the total mileage *for both* facility types. This analysis uses the active transportation network as it was in January 2023.

[2] 2021 Scooter Permit Letters and Terms & Conditions

[3] Bikeshare Pricing Frequently Asked Questions (FAQ), SFMTA (2022)

Figure 4: Average Annual Daily Micromobility Volumes

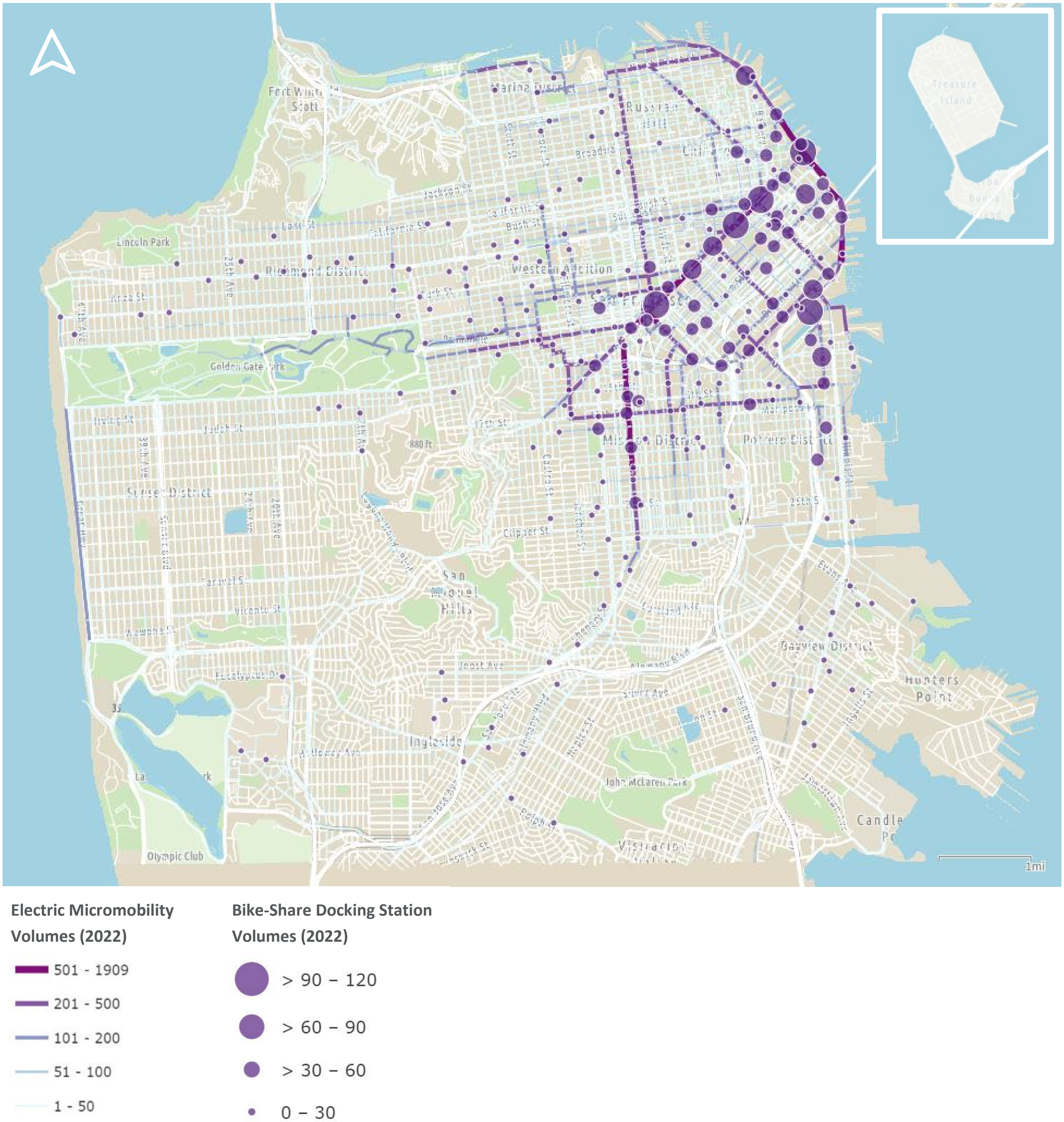


Figure 5: Bay Wheels Service Area and Incentive Pricing

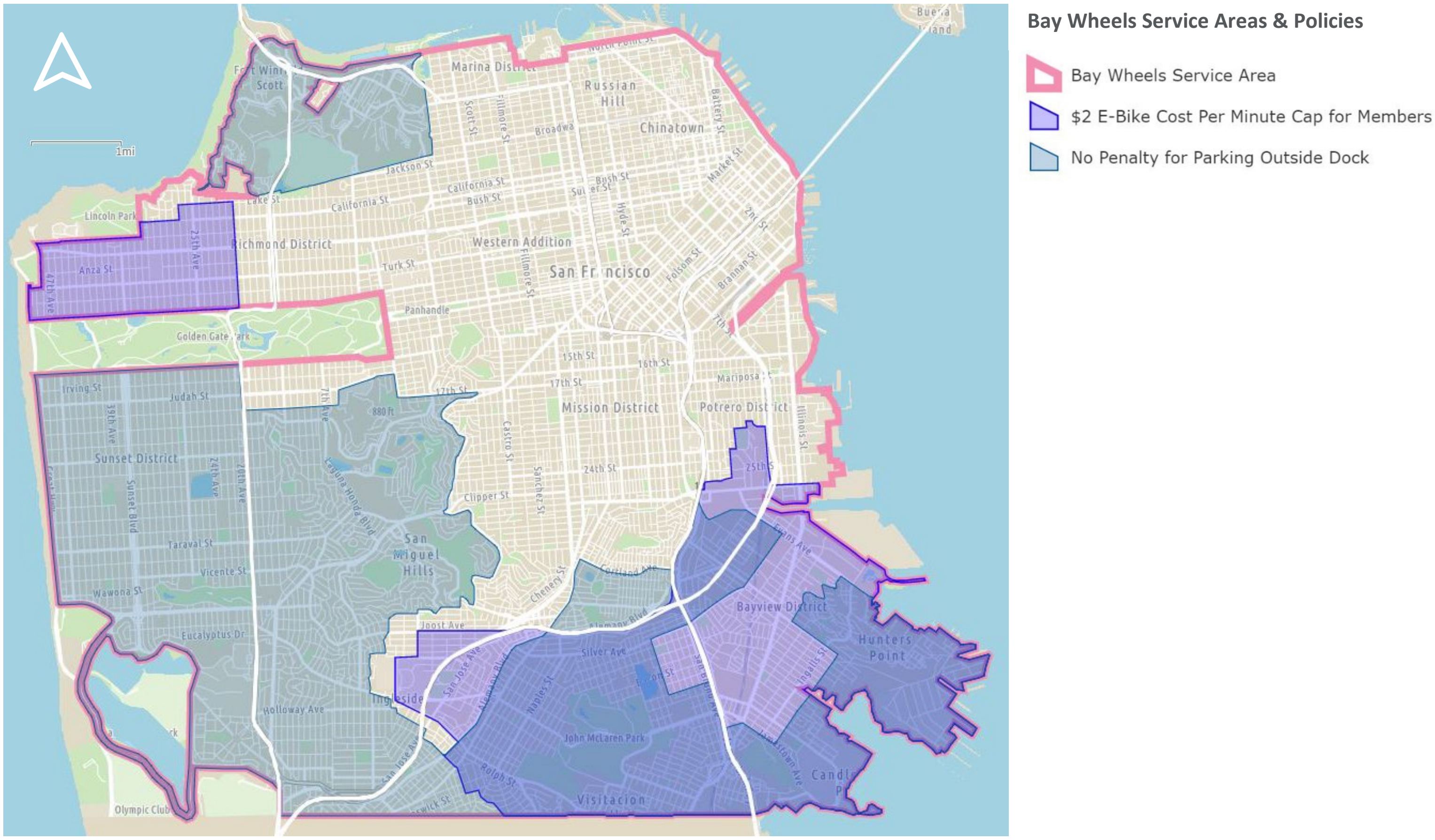
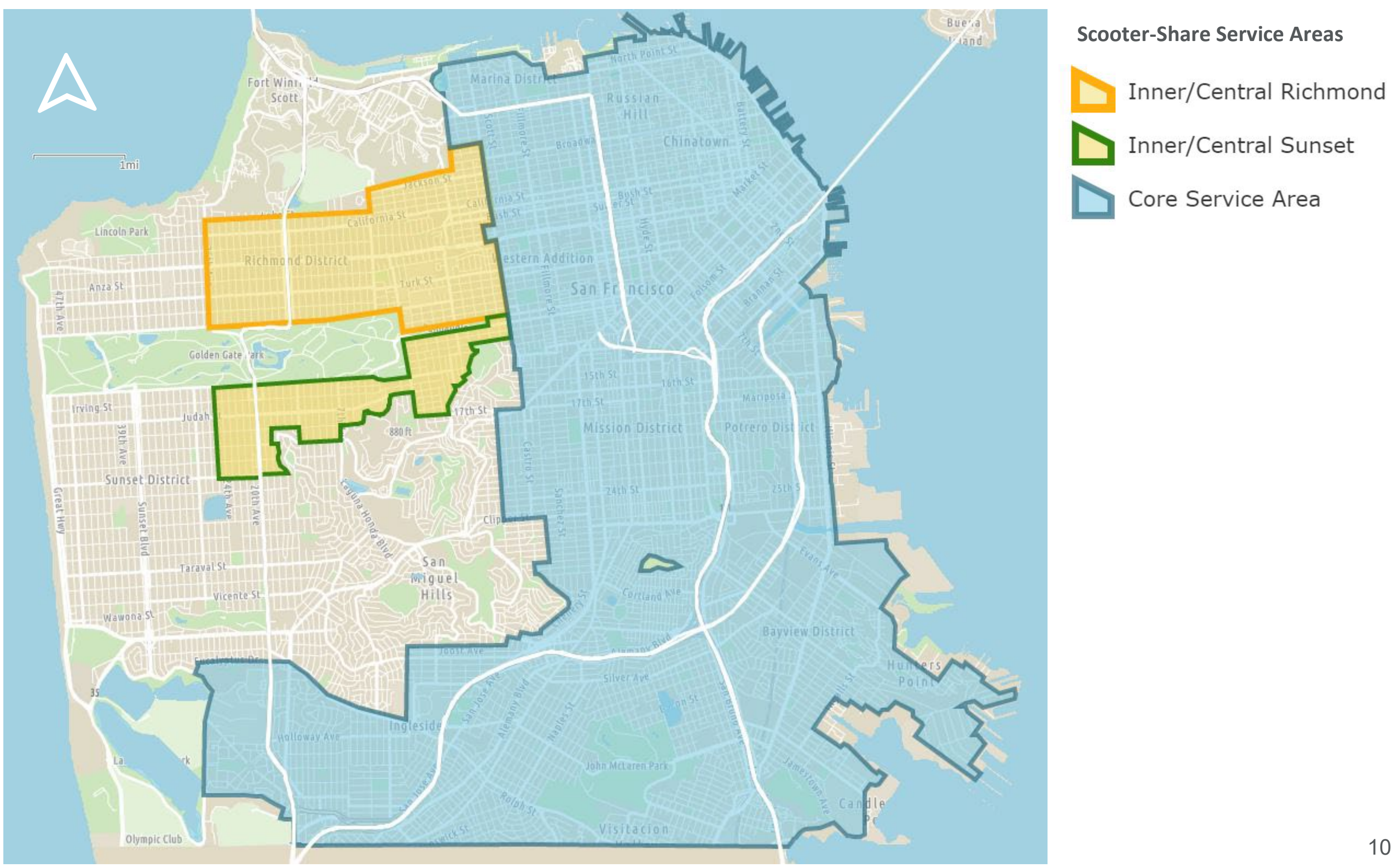


Figure 6: Scooter-Share Service Areas



Bicycle Activity

Bicycle volumes are notoriously challenging to measure at a city-wide scale. The data available for bike volumes in San Francisco include:

- 22 automated counters, which capture both bikes and micromobility devices
- Bike volume counts for 25 slow streets, collected during 2022
- Bike volumes for 13 streets before and after quick-build installations
- Estimated bike volumes for all San Francisco streets from Replica, and activity-based travel demand model

Before modelling citywide estimates, the project team reviewed the SFMTA's automated count data to understand if they show any volume trends. Table 5 shows volumes collected in eleven neighborhoods via 22 automated counters. A regression analysis showed that bikes account for approximately 60% of the trips captured by the counters. The other 40% represents people on micromobility devices riding in bike lanes. The data show that on average, volumes fell by about a third citywide. But not all neighborhoods experienced this trend. Counters in the Inner Richmond, Inner Sunset, Potrero Hill, and Russian Hill capture an increase in volumes between 2018 and 2022.

Table 5: Bike and Micromobility Volumes from Automated Counters (2018 – 2022)

Neighborhood	Number of Counters	Daily Volume 2018	Daily Volume 2022	Percent Change
Bayview	1	779	35	-96%
Bernal Heights	1	210	142	-32%
Inner Richmond	1	136	146	**7%**
Inner Sunset	2	233	278	**19%**
North Beach	1	955	723	-24%
Potrero Hill	1	146	162	**11%**
Russian Hill	1	282	620	**120%**
SoMa	6	8,216	5,023	-39%
The Marina	1	3,096	2,283	-26%
The Mission	3	2,454	1,964	-20%
Western Addition	4	3,223	2,938	-9%
TOTAL	**22**	**19,730**	**14,314**	**-27%**

Table 6 shows volumes on streets before and after they received quick-build projects. Streets that received quick-build projects in 2022 all saw an uptick in bike trips. Across all 13 project locations, bike trips increased by a total of 32%. Some quick-build projects did not install new bikeways, but the corresponding safety and traffic calming improvements may have influenced changes in bike trips.

Table 6: Bike Volumes Before and After Quick-Build Installations (2022)

Quick Build Project	Implementation Date	Daily Bike Volumes		
		Before	After	Change
7th Street Safety Project (Phase 1)	5/17/2022	369	372	1%
8th Street Safety Project	5/17/2022	539	576	7%
Folsom Near-Term	1/18/2022	373	444	19%
Polk Streetscape	5/19/2022	471	480	2%
2nd Street	4/19/2022	401	529	32%
Masonic Streetscape	8/18/2022	23	112	387%
Leavenworth Quick-Build (no new bikeways)	6/21/2022	22	36	64%

Quick Build Project	Implementation Date	Daily Bike Volumes		
		Before	After	Change
Golden Gate Ave Quick-Build	5/21/2022	31	52	68%
Valencia (north) Quick-Build	5/19/2022	642	1148	79%
6th Street Quick-Build (no new bikeways)	9/19/2022	146	157	8%
Taylor Quick-Build (no new bikeways)	6/19/2022	17	52	206%
Indiana Quick-Build	10/19/2022	66	94	42%
Fell Street	8/20/2022	790	1087	38%
TOTAL		**3,890**	**5,139**	**32%**

Table 7 shows bike volumes collected for 25 slow streets in 2022. Slow Streets with the highest volumes include Shotwell Street, Clay Street, Lake Street, and Page Street. Shotwell Street and Page Street are located in some of San Francisco's most dense urban neighborhoods. Together, Lake Street and Clay Street provide a key east-west connection across the city. Excelsior Avenue, Arkansas Street, Mariposa Street, Somerset Street, and Tompkins Avenue have some of the lowest bike volumes of all the Slow Streets. These streets are concentrated in the southeast of the city in neighborhoods with low bike volumes overall.

Table 7: Bike Volumes on Slow Streets (2022)

Slow Street (2022)	Avg. Day* Observed Bicycle Volume (24-Hr)	Standard Deviations from Mean	Volume**
Excelsior Avenue	5	-0.697	Low
Arkansas Street	10	-0.665	Low
Mariposa Street	10	-0.665	Low
Somerset Street	20	-0.603	Low
Tompkins Avenue	20	-0.603	Low
Ortega Street	30	-0.541	Moderate
Duncan Street	40	-0.478	Moderate
Noe Street	40	-0.478	Moderate
41st Avenue	50	-0.416	Moderate
Arlington Street	50	-0.416	Moderate
Minnesota Street	60	-0.353	Moderate
20th Avenue	70	-0.291	Moderate
Chenery Street	70	-0.291	Moderate
Golden Gate	80	-0.228	Moderate
Kirkham Street	80	-0.228	Moderate
Lombard Street	100	-0.104	Moderate
Pacific Avenue	100	-0.104	Moderate
Cabrillo Street	110	-0.041	Moderate
20th Street	120	0.021	Moderate
23rd Avenue	120	0.021	Moderate
Sanchez Street	120	0.021	Moderate
Shotwell Street	130	0.084	High
Clay Street	250	0.833	High
Lake Street	550	2.705	High
Page Street	680	3.517	High

*Day = average of the weekday and weekend volumes

**High = 0.5 Standard Deviations (STD) above the mean; Moderate = Between 0.5 STD and -0.5 STD; Low = Greater than -0.5 STD

Combined Bicycle and Micromobility Activity

To tell a cohesive story of active transportation activity in San Francisco, the project team modelled combined bicycle and micromobility volumes for San Francisco's active transportation network. The model combines micromobility volumes with bike volumes estimated by Replica, an activity-based travel demand model. Because Replica's bike count data is only moderately reliable, the project team calibrated the volumes against actual counts collected by the SFMTA. Calibrated against 31 manual counts, the project team found a linear regression model using the sum of both network-level volumes performed the best (i.e., produced volumes that aligned most closely with manual count data):

$$Bike\ Volume = 165.6 + 0.6 * (micromobility\ volume + Replica\ volume)$$

The results of the modelled volumes are shown in Figure 7. Actual count data collected from 22 manual counters is also shown in Figure 7.

Figure 7: Modelled Bike and Micromobility Volumes and Manual Counter Volumes

Network Performance: Volumes vs Quality

The network analysis is built on the assumption that there is a relationship between ridership volumes, and the quality, connectivity, and coverage of the network. Positive associations between volumes and network quality may indicate that the network is working well. Negative associations may indicate that the network is underperforming, could be improved, or that there is a mismatch between rider need, facility type, and surrounding conditions.

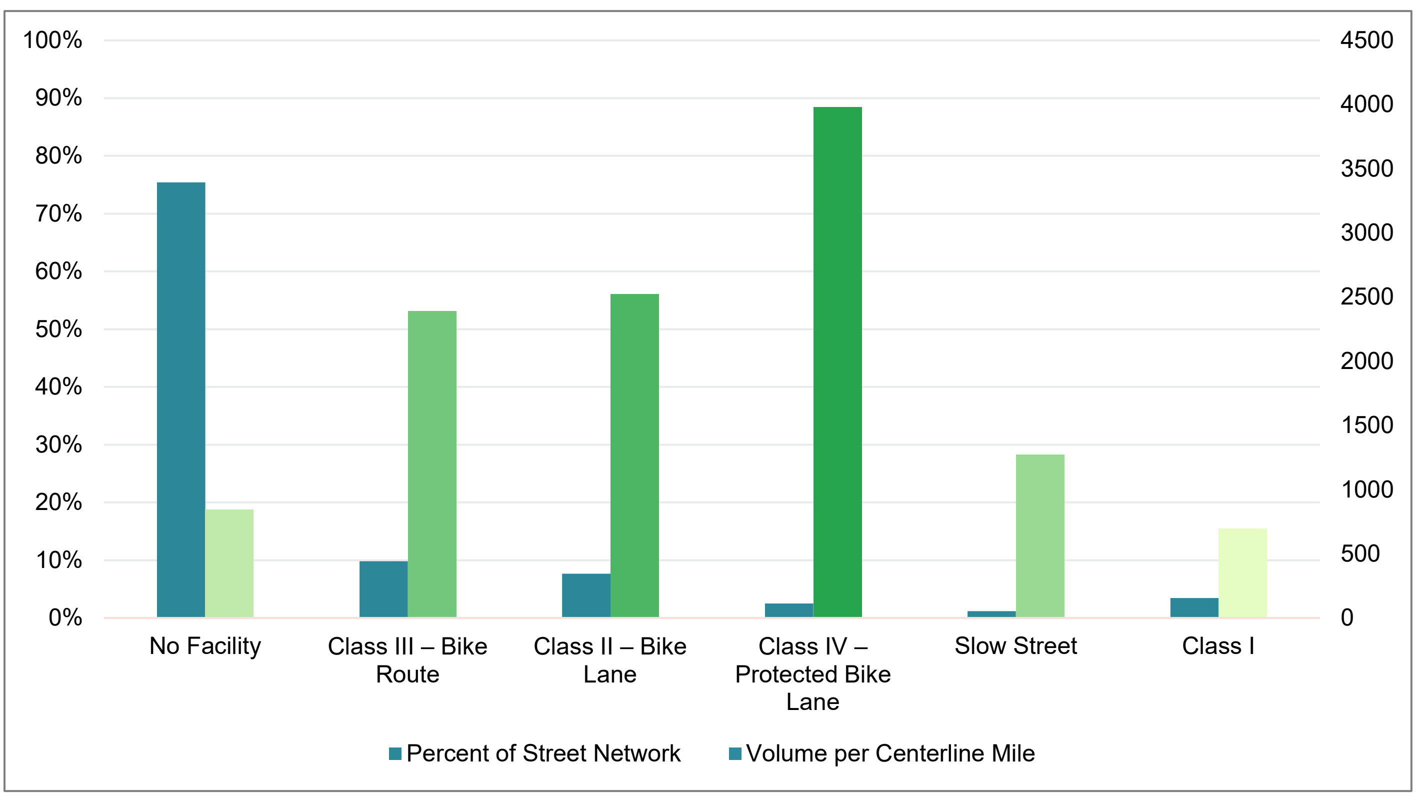
Most trips in San Francisco take place off-network because most streets in the city do not have bike facilities. There are simply more miles of off-network streets than any of the facility types. But when volume is normalized by centerline mileage, the data show that there is an association between ridership and quality facilities. Facilities with protection from cars – protected bike lanes – have the highest ridership per centerline mile than any other facility type. Ridership per centerline mile increases as protection from cars increases.

The exception to this finding is Class I Bike Paths. This is likely because bike paths in San Francisco are concentrated in the city's parks; Bike paths through the Presidio, Golden Gate Park, and Lake Merced may not offer quick and convenient connections to destinations and are more suitable for recreation than for daily transportation or commuting. Golden Gate Park is also outside of the shared micromobility service area which could explain lower volumes on those paths.

Table 8: Bike and Micromobility Volumes by Facility

Bike Facility (Least modal separation to most)	Centerline Miles*	Bike+ Micromobility Volumes (2022)	Bike+ Micromobility Volume Per Centerline Mile (2022)
No Facility	890.5	750,494	843
Class III Bikeway – Slow Street	13.8	17,568	1,273
Class III Bikeway – Bike Route	115.9	277,073	2,391
Class II Bikeway – Bike Lane	90.3	227,938	2,524
Class IV Bikeway – Separated Bikeway	29.8	118,554	3,978
Class I Bikeway – Off-Street Bike Path	40.5	28,162	695

Figure 8: Facility Type as Percent of Street Network vs. Volumes per Centerline Mile



High-Quality Network Performance

The project team compared bike and micromobility volumes to network quality and facility type. Network quality is defined here as streets with:

- Class IV Separated Bikeways,
- Class I Shared-Use Paths,
- Slow Streets, and
- Car-Free Streets (such as JFK and the Great Highway/Walkway).

Figure 9 shows volumes on the network's high-quality facilities. Darker lines represent high volumes and indicate places where the high-quality network is performing well. Lighter lines represent low volumes and indicate places where the high-quality network may be under-performing. The highest performing network segments are concentrated in SoMa, and on many of the city's Slow Streets. The lowest-performing network segments are scattered throughout the city and need to be evaluated on a case-by-case basis to understand why volumes may be low, and how these facilities could be improved.

Class IV Separated Bikeway Performance

Overall, Class IV bike facilities in the Financial District and SoMa have the highest volumes in the city, likely due to the density of land uses, people, housing, jobs, and destinations. The project team examined the low-performing protected bike lanes to understand what might be discouraging ridership. The following examples can offer lessons learned for implementation and maintenance of facilities throughout the city:

- On Turk Street and Golden Gate Avenue in the Tenderloin, low volumes may be due to the *barrier type not being appropriate for surrounding activity*. Both streets have flex posts which are often ignored or damaged. On both streets parking in the bike lane is common, curbside turnover is high, and there are frequent 311 reports of debris in the bike lane.
- On Alemany Boulevard and San Jose Avenue in St Mary's Park/ Glen Park/ Mission Terrace, barrier type may also play a role. In these cases, vehicular volumes and speeds are high, the flex posts may not offer riders the separation they need to feel comfortable. Where K-rail is present on both streets, other factors such as challenging intersections or challenging network connections may also play a role.
- In Hunters Point, Evans Avenue and Cargo Way both have concrete barriers separating riders from vehicular traffic. In these locations, low ridership is likely due to other factors, such as surrounding land use (low density), long distances from destinations, and overall network quality. In particular, the Class IV segments are surrounded by lower-comfort Class III bike routes. Enhancements to surrounding facilities could encourage more ridership throughout the neighborhood.

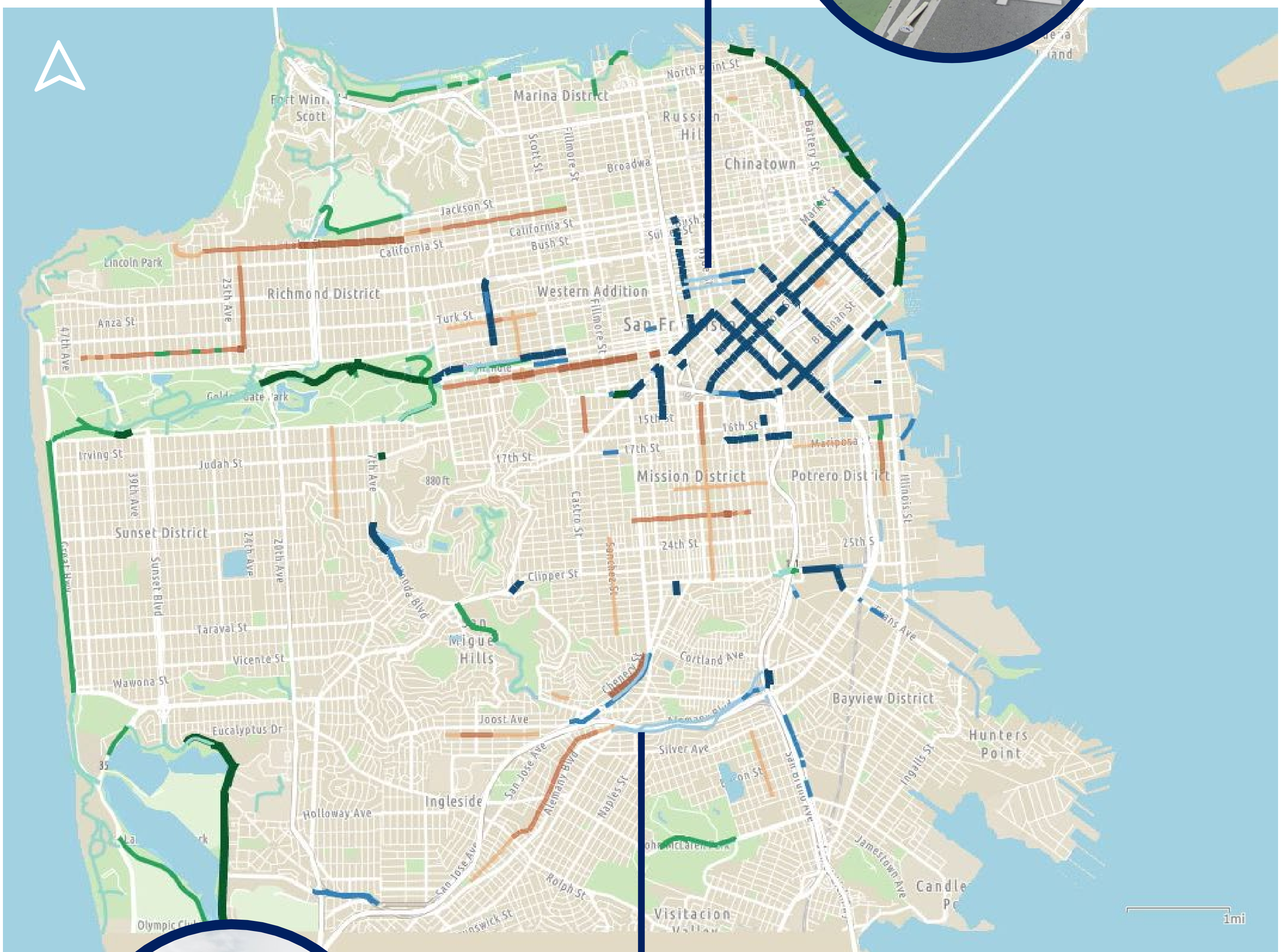
Class I Bike Path (and Car-Free Streets) Performance

For Class I bike paths, the high-performing segments include Car-Free JFK in Golden Gate Park, Lake Merced Boulevard along Lake Merced, Mason Boulevard in the Presidio along Crissy Fields, and segments along the embarcadero and Fisherman's Warf, possibly due to the flat, accessible paths and proximity to recreational sites and tourist attractions. Low volume Class I paths include O'Shaughnessy Boulevard in Glen Canyon Park and Twin Peaks Boulevard in Twin Peaks, possibly due to the steep hills.

Slow Streets Performance

Evaluating the performance of Slow Streets requires a slightly different approach. Low bicycle and micromobility volumes may not be an indication that the Slow Street is under-performing. Particularly in low-density neighborhoods, low volumes may be appropriate for the neighborhood context. On low-volume Slow Streets, community feedback is required to understand whether there are specific reasons why people choose not to ride on the street. However, Slow Streets with particularly high bicycle and micromobility volumes can be an indication of high-demand and high-need for safety infrastructure. The Slow Streets that are estimated to have the highest volumes include Lake Street and Page Street. It should be noted that Slow Streets serve other purposes than bicycle & micromobility trips, and as such should not be judged by that criteria alone. This estimation is consistent with manual bike counts on slow streets (Table 7).

Figure 9: High Quality Network Volumes



Bike Lanes and Bike Route Performance

Figure 10 shows volumes on the rest of the network, including all Class II Bike Lanes and Class III Bike Routes. The project team classified Class II and Class III facilities with high volumes as “over-performing”. On these streets, high volumes indicate that despite relatively low separation from cars, riders still choose these routes due to some combination of convenience, necessity, and comfort. Over-performing streets with Class II Bike Lanes and/or Class III Bike Routes include:

- Arguello Boulevard and Anza Street in the Richmond
- Sutter Street, Post Street, and McAllister Street which run parallel from Market Street towards NoPa/ South Pacific Heights
- North-South routes in the Sunset including 20th Avenue and 34th Avenue
- Valencia Street, Folsom Street, and Harrison Street in the Mission
- Columbus Avenue from the Financial District to North Beach
- Stockton Street in Chinatown
- Segments of Market Street, Page Street, Polk Street, 11th Street in downtown San Francisco
- Ocean Avenue in Ingleside/ Balboa Terrace

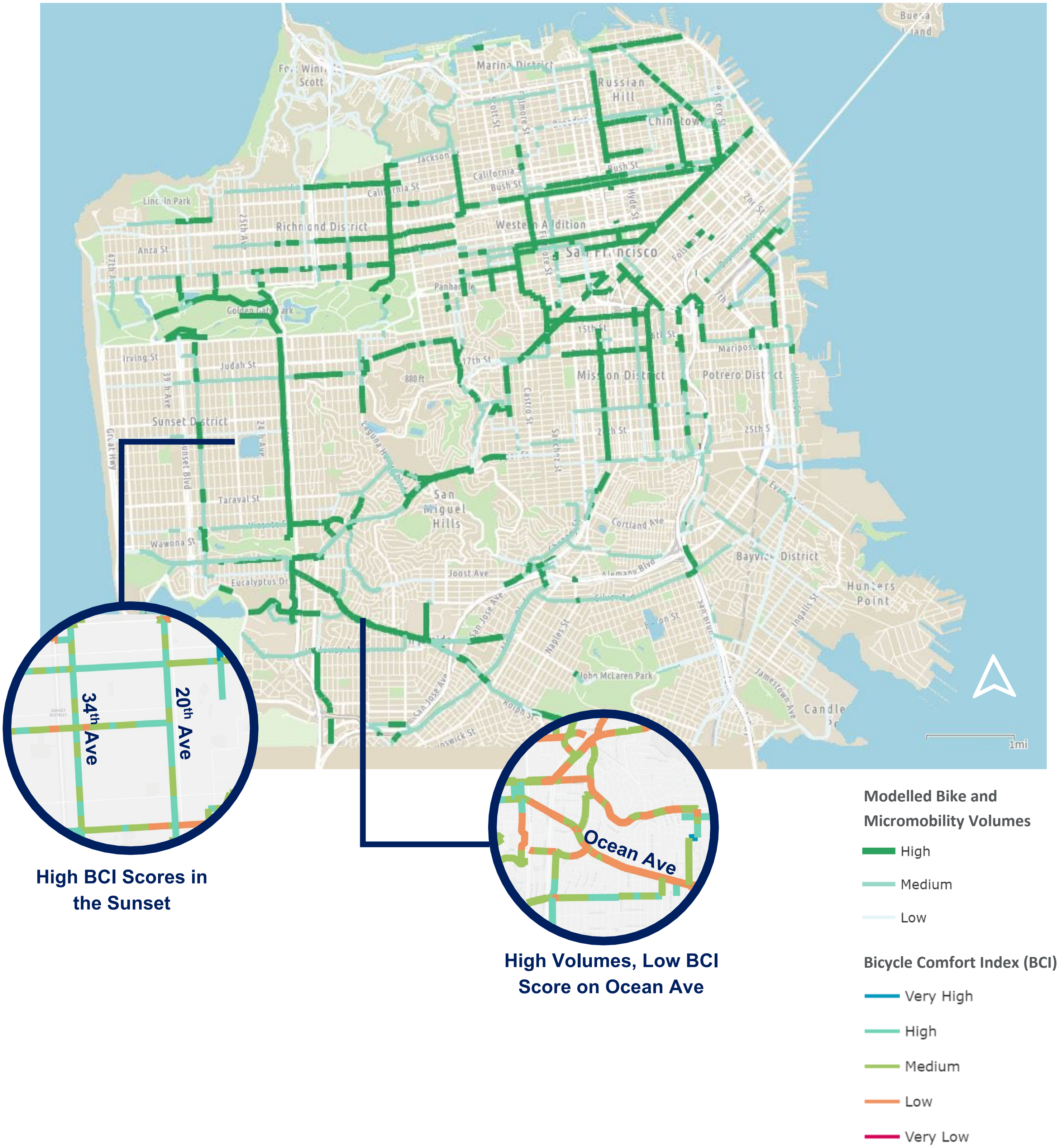
Over-performing streets need to be evaluated on a case-by-case basis to understand what is driving volumes, and whether high volumes indicate a gap in the network. In the dense urban center (on streets like Market and Valencia), high volumes are likely a result of surrounding density, as well as connections to higher-quality facilities. Bike and micromobility trips in these neighborhoods likely traverse multiple facility types of varying quality and comfort.

In lower-density neighborhoods like the Richmond, the Sunset, Ingleside, and Balboa Terrace, high ridership may be an indication of demand for bike facilities. But it may also be an indication that Class II and Class III facilities *are working* in these neighborhoods, and are appropriate facilities for the surrounding land use and traffic contexts. The Bicycle Comfort Index inset in Figure 10 shows 20th Avenue and 34th Avenue in the Sunset are high-comfort streets and may already have appropriate facilities. Public input is necessary to confirm this assumption.

Ocean Avenue is a good example of a street with relatively high ridership, despite having a Class III Bike Route and a relatively low bicycle comfort score. In addition, volumes on Ocean Avenue drop substantially west of 19th Avenue, even though the facility type upgrades to a Class II Bike Lane. Taken together, these factors may indicate a network gap and the need for an improved facility on Ocean Avenue. Public input is necessary to confirm this assumption.

Class II and Class III facilities with low ridership may be an indication that network upgrades are necessary. Ridership is relatively low on facilities throughout Bayview-Hunters Point, on the east-west corridors in the Sunset, and on Brannan Street in SoMa. Further analysis is necessary to determine the reason for low ridership in each case.

Figure 10: Bike Lane and Bike Route Volumes

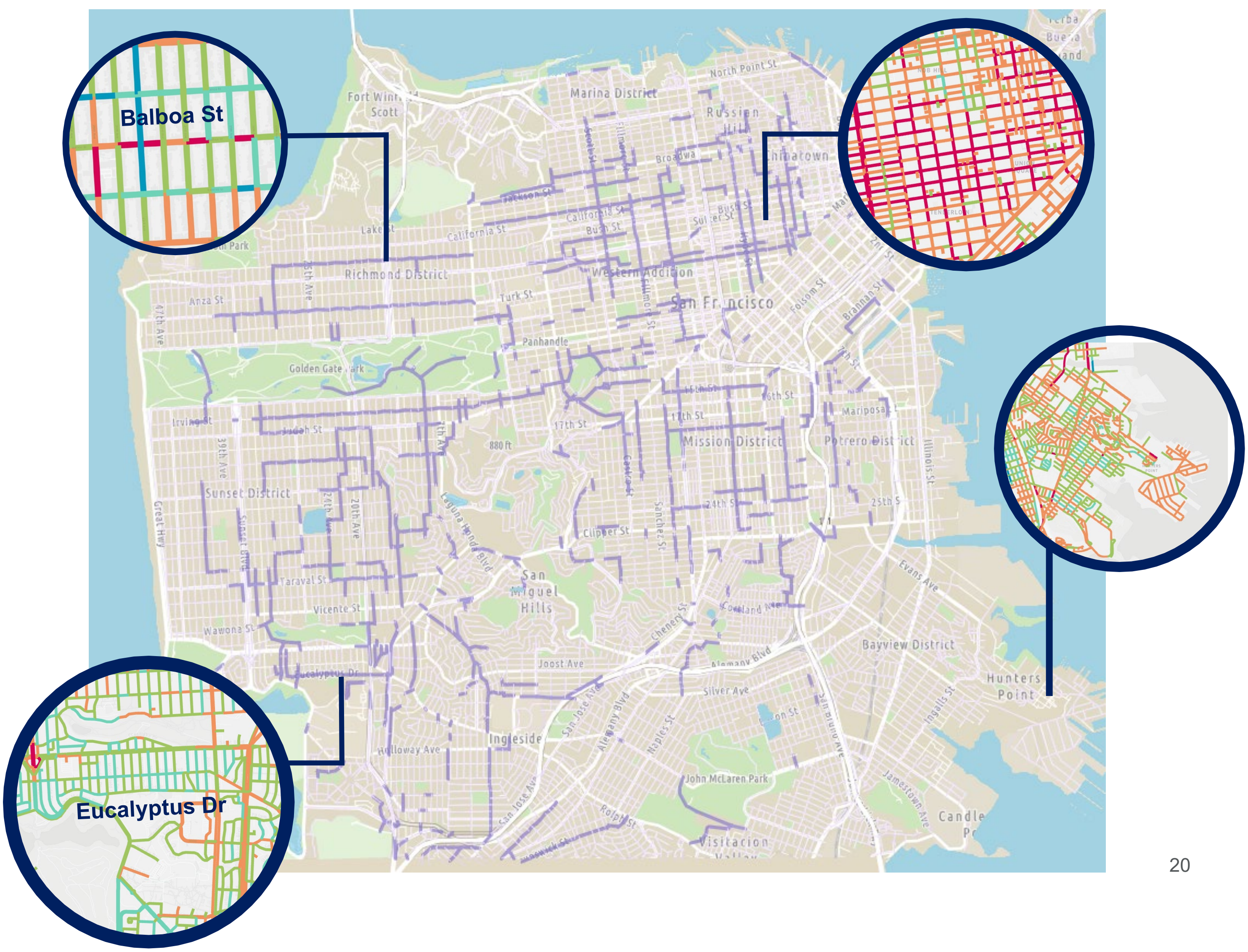


Off-Network Performance

Figure 11 shows modelled volumes outside of the active transportation network. Off-network streets are critical part of how San Franciscan's get around. In fact, most bike and micromobility trips take place off-network. To understand *why* volumes are high or low on certain streets (or in certain neighborhoods), the project team looked at the volume data alongside the Bicycle Comfort Index (BCI). BCI scores are shown as insets on Figure 11. It can be difficult to determine the precise reason for ridership trends, but the following correlations can be useful markers of infrastructure issues or network gaps:

- **High-Volumes, Low-Comfort:** Where volumes are high, but the BCI score is low, it may indicate that there is a need for infrastructure enhancements. Examples include Balboa Street and Clement Street in the Richmond, Yerba Buena Avenue in Sherwood Forest/ Monterey Heights, 24th Street in the Mission, and most of the off-network streets in the Tenderloin.
- **High-Volumes, High-Comfort:** Where volumes are high, and the BCI is high, it may indicate that the current infrastructure conditions are working. Examples include 42nd Avenue in the Sunset, Eucalyptus Drive in Lakeshore, Cabo Street in the Mission, and Eddy Street in Western Addition.
- **Low Volumes, Low Comfort:** Where volumes are low, and comfort is low, it may indicate that there are issues discouraging riders from choosing a particular route. Many parts of the Bayview-Hunter's Point neighborhood fall into this category.
- **Low-Volumes, High Comfort:** Low volumes where comfort is high may simply reflect a low population and land use context. In high-density neighborhoods, low volumes *could* indicate an issue that is preventing riders from choosing a specific route. It may also be the case that there are on-network facilities or more convenient routes nearby. For example, in SoMa, off-network volumes are notably low, but on-network volumes are some of the highest in the city.

Figure 11: Off-Network Volumes



Network Performance: Volumes vs Coverage

The project team calculated network coverage for each neighborhood in San Francisco. Network coverage is defined here as the percent of centerline miles in a neighborhood that have bicycle facilities. Figure 12 shows the network coverage overlaid with network volumes on the bike network. Table 9 provides a guide for reading the map, and summary of locations that are over- or under- performing. When volumes are low, but network coverage is relatively high, it may be an indication that the network is under-performing due to factors like land use (long distances between key destinations), connectivity (poor connections to destinations outside of the neighborhood), or network quality (such as lack of protected from cars). Low volumes may also simply be the result of low population density.

Neighborhoods where volumes are low relative to coverage include Bayview-Hunters Point, Mission Terrace/Cayuga/Outer Mission, and the east-west corridors in the Sunset District. As part of network development, the project team will assess the precise reason for poor network performance, and identify appropriate policy, program, or infrastructure recommendations.

Note that this metric should not be used to evaluate network performance in parks. Be definition, parks have relatively few streets or centerline miles, and relatively high network coverage. As a result, San Francisco parks (The Presidio, Golden Gate Park, Lakeshore, McLaren Park) appear to be "under-performing".

Table 9: Network Performance Based on Coverage and Volumes

Network Performance	Volumes* vs Network Coverage	Map Symbology	Example Neighborhoods and Streets
Over-Performing	Volumes are high, relative to network coverage	Lines are darker than the polygon	• Northeast San Francisco • The Mission District • Inner Richmond • Inner Sunset • Balboa Terrace/ Ingleside • North-South Streets in the Sunset • The "Wiggle"
Under-Performing	Volumes are low, relative to network coverage	Lines are lighter than the polygon	• Bayview-Hunters Point • Mission Terrace/ Cayuga/ Outer Mission • East-West Streets in the Sunset

*Modelled (combined) bike and micromobility volumes

Figure 12: Network Coverage vs Network Volumes

Appendix A: Neighborhood-Level Network Performance Metrics

Table A-1: Neighborhood-Level Network Performance

	Network Coverage	Network Quality	Volumes		
Neighborhood	**Percent of Centerline Miles with Bike Facilities**	**Percent of Lane Miles with High Quality Facilities (Class I, Class IV, Slow Street, or Car-Free Street)**	**Bike Commute Mode share (2021)**	**Percent Bike Commuters that Are Female (2021)**	**Modeled Average Daily Bike and Micromobility Volumes Per Centerline Mile (2022)**
Citywide Average	24%	8%	3.1%	30.9%	NA
Six Focus Equity Priority Communities					
Bayview-Hunters Point	23%	5%	1.3%	25.6%	761
Outer Mission/ Excelsior	19%	4%	0.8%	23.1%	1,223
Mission District	30%	8%	7.9%	23%	4,059
SoMa	36%	22%	4.1%	26.1%	5,265
Tenderloin	28%	10%	3.4%	22.1%	6,104
Western Addition/ Filmore	19%	0%	4.3%	42.5%	3,268
Other Neighborhoods					
Bernal Heights	16%	6%	5.7%	39.1%	1,426
Castro/Upper Market	19%	2%	4.2%	29.0%	2,592
Chinatown	18%	0%	0.4%	0.0%	5,139
Financial District/South	39%	12%	2.7%	29.9%	3,672
Glen Park	25%	13%	2.4%	54.8%	1,107
Golden Gate Park	55%	33%	0.0%	100.0%	1,382
Haight Ashbury	24%	9%	6.8%	37.6%	3,696
Hayes Valley	34%	7%	8.1%	28.6%	4,013
Inner Richmond	19%	0%	4.2%	25.8%	3,184
Inner Sunset	11%	2%	4.2%	26.0%	1,565
Japantown	40%	0%	4.7%	0.0%	4,853
Lakeshore	52%	25%	0.7%	18.7%	1,158
Lincoln Park	60%	25%	0.0%	100.0%	810
Lone Mountain/USF	38%	11%	6.0%	35.5%	4,053
Marina	18%	4%	2.9%	11.0%	2,263
McLaren Park	42%	23%	0.0%	100.0%	419
Mission Bay	31%	13%	2.1%	23.4%	2,927
Nob Hill	27%	0%	2.8%	43.7%	4,702
Noe Valley	19%	3%	4.2%	41.1%	1,715
North Beach	14%	3%	3.4%	14.4%	2,874
Oceanview/Merced/Ingleside	19%	3%	0.8%	27.8%	1,314
Outer Richmond	21%	4%	2.4%	35.1%	2,164
Pacific Heights	14%	5%	1.7%	10.5%	3,662
Portola	21%	9%	0.8%	0.0%	764
Potrero Hill	18%	6%	6.9%	27.5%	2,175
Presidio	58%	25%	3.9%	30.5%	696
Presidio Heights	24%	6%	1.5%	100.0%	3,353
Russian Hill	21%	2%	3.7%	44.3%	3,473
Seacliff	33%	1%	0.0%	100.0%	2,097
Sunset/Parkside	20%	1%	2.1%	24.8%	1425
Treasure Island	7%	5%	3.1%	40.0%	No Data
Twin Peaks	14%	7%	1.5%	0.0%	631
Visitacion Valley	7%	0%	0.1%	0.0%	259
West of Twin Peaks	19%	3%	1.4%	36.8%	1,166

Notes on Coverage Methodology:

- Network coverage was calculated as [roadway centerline miles/ facility centerline miles]
  - Network Coverage = 289/ 1,165 = 24.8%
- Total Roadway Centerline Miles = 1,165
  - For dual-carriageway streets, both carriageways are counted toward the total centerline mileage. There are 95 miles of dual carriageway streets in San Francisco = 189 total centerline miles of dual carriageways.
  - For all other streets, including one-way streets, centerline miles are only counted once.
- Total Facility Centerline Miles = 289
  - For streets with the same facility on both sides, centerline miles are counted once.
  - For dual carriageway streets, centerline miles are counted for both sides. This shouldn't inflate the percent coverage because centerline road miles (the denominator) are also counted twice.
  - For streets with different facilities on two sides, counting centerline mile twice. 15 centerline miles of roads have different facilities on two sides of the street. Therefore, total is inflated by 15 miles.
    - If we reduce the total mileage by 15 to remove this inflation, the total citywide coverage is 23.5%
  - For streets with facility only on one side, centerline miles are counted once.
- Network Coverage = 289/ 1,165 = 24.8%
  - Note that Class I facilities are concentrated in parks where roadway centerline mileage is relatively low. In parks (the Presidio, Lincoln Park, Golden Gate Park, and Lakeshore), the network coverage is very high. In addition, Class I paths tend to be concentrated outside of the areas typically though of as the city's street network.
  - Including Class I facilities in the total facility coverage could make overall coverage appear inflated.
  - If we remove Class I facilities from the equation:
    - Total centerline miles *excluding* Class I = 248
    - Citywide coverage *excluding* Class I = 21%

MEMO

TO: Christopher Kidd
FROM: Brian Almdale, MUPP and Rebecca Sanders, PhD RSP_{2B}
DATE: 03-10-2023
RE: Final Draft Crash Analysis – Step I
PROJECT: SFMTA Bike Plan

Table of Contents

Introduction

This memo summarizes the methodology and key findings for the first of two crash analyses being conducted as part of the San Francisco Active Communities Plan. The two primary questions these analyses aim to answer include:

- **Step I Analysis:** Who, where, when, and why of crashes involving bicyclists and other human-scale wheeled road users?
- **Step II Analysis:** What are the modifiable risk factors associated with (fatal and severe) bicyclist crashes?

The purpose of this Step I analysis will help us understand and communicate the who, where, when, and why of crashes involving bicyclists and other human-scale wheeled road users. The initial findings from this analysis will be shared with the public during Community Engagement Phase 2. The San Francisco Municipal Transportation Agency (SFMTA) staff will review the draft findings and determine, in collaboration with Safe Streets Research & Consulting (Safe Streets) and Toole Design which findings are appropriate for inclusion in a ESRI Story Map for public consumption.

The analysis looked at crashes that occurred during the pre-pandemic period (2017-2019) and during the pandemic (2020-2021) to control for changes in travel behaviors due to the COVID-19 pandemic.

Key findings

Reported crash data that involved a bicyclist was used as the primary dataset in this crash analysis. Reported crash data is critical to understanding crash patterns. While reported crash data is known to have problems with underreporting[1,2], it is often the most complete data source, in terms of the number and consistency of crash attributes available and the breadth and number of crashes included. As such, this data can provide the necessary detail for informing engineering treatments and help us understand who was involved in a crash. This report acknowledges the crash data used in this analysis provides us with an incomplete picture of crashes but allows us to use the most complete and readily available data that represents crash events and the people involved in crashes.

The below bulleted items are the key findings from this crash analysis.

Crashes

- ***Number of bicycle crashes***:
  - Pre-Pandemic (2017 – 2019): 1,668 (556.0 per year)
  - Pandemic (2020 – 2021): 775 (382.0 per year)
  - 5-Year Study Period (2017 – 2021): 2,443 (486.4 per year)
- ***Number of fatal and severe injury (KSI) bicycle crashes:***

[1] Stutts, J., & Hunter, W. (1998). Police reporting of pedestrians and bicyclists treated in hospital emergency rooms. Transportation Research Record: Journal of the Transportation Research Board, (1635), 88-92.

[2] San Francisco Department of Public Health-Program on Health, Equity and Sustainability. 2017. Vision Zero High Injury Network: 2017 Update – A Methodology for San Francisco, California. San Francisco, CA. Available at: https://www.sfdph.org/dph/files/EHSdocs/PHES/VisionZero/2017_Vision_Zero_Network_Update_Methodology_Final_20170725.pdf

- Pre-Pandemic 152 (52.7 per year)
  - Pandemic: 78 (39.0 per year)
  - 5-Year Study Period: 230 (47.2 per year)
- ***Number of fatal bicycle crashes:***
  - Pre-Pandemic: 7 (2.3 per year)
  - Pandemic: 2 (1.0 per year)
  - 5-Year Study Period: 9 (1.8 per year)
- ***Crashes by Year:***
  - Crashes and KSI crashes per year were highest during the pre-pandemic period.
  - There was a sharp reduction in crashes at the start of the pandemic. This reduction is likely related to changes in travel behaviors due to the COVID-19 pandemic safety precautions and Stay Home order that was in effect within San Francisco.
  - Crashes were slightly more likely to result in a KSI outcome in 2021 compared to previous years.
- ***Injury Severity***:
  - Injury severity distribution was similar between the two study periods. Most bicyclists suffer from complaints of pain or some other visible injury type.
- ***Pre-Crash Movement***:
  - Crash patterns between the pre-pandemic and pandemic period were similar.
  - Crashes that involved both the bicyclist and motorist proceeding straight accounted for the largest share of crashes and KSI crashes.
  - Crashes that involved a motorist making a left turn were on average more severe than crashes with motorists making a right turn.
  - Solo-bicyclist crashes were the most severe on average, but this is likely related to the nature in which solo-bicyclist crashes are reported. Less severe solo-bicycle crashes are generally not reported, therefore skewing the results.
  - Crashes that involved a stopped or parked motorist tend to result in a high rate of KSI outcomes. Many of these were dooring-related crashes and suggest the need for increased physical separation between bicyclists and vehicles.
- ***Relative Direction***:
  - ***Pre-Pandemic:*** Same direction crashes accounted for the largest share of crashes and KSI crashes, followed by perpendicular (i.e., broadside) crashes. Perpendicular crashes tend to be slightly more severe on average.
  - ***Pandemic:*** perpendicular crashes comprised the largest share of all crashes and KSI crashes, followed by same direction crashes.
- ***Crashes by Reported Violations:***
  - ***Pre-Pandemic:*** improper and unsafe turns accounted for the largest share of crashes and KSI crashes, followed by failure to yield while making a left turn and traveling too fast for conditions. Motorists were cited as the party at fault for 53% of all reported crashes and 46% of KSI crashes. Bicyclists were cited for 33% of all crashes and 36% of KSI crashes. Motorists were cited for most crashes related to improper or unsafe turns and failure to yield making a left turn. Bicyclists were cited for most crashes related to traveling too fast for conditions.
  - ***Pandemic:*** Improper or unsafe turn, disregarding a traffic signal, and too fast for conditions were the most common violation types. The party at fault for KSI crashes was substantially different during the pandemic period compared to the pre-pandemic

period. During the pre-pandemic, motorists were cited as the party at fault 47.4% of all crashes. Bicyclists were cited as the party at fault for 40.9% of those crashes. For KSI crashes, motorists were cited at fault in 29.1% of incidents, compared to 56.4% of KSI crashes where a bicyclist was cited at fault. Additionally, bicyclist at fault crashes were disproportionately severe relative to motorist at fault crashes.
    - ***2017-2021:*** Bicyclists were cited at the party at fault for 56% of fatal crashes during the 5-year study period. This should be interpreted with caution as the fatally injured bicyclist was unable to provide their testimony.
- ***Time of Day:***
    - Crash patterns by time of day were similar between the two study periods. Crashes were generally concentrated during the daytime, particularly around typical peak commute periods (6-9 AM and 3-6 PM).
    - When considering time of day by weekday vs. weekend, the pre-pandemic distributions followed common bicycle volumes distributions (weekend: highest crash frequencies during AM/PM commute periods; weekend: highest crash frequencies during midday). During the pandemic study period, the distribution of crashes for weekend and weekday crash patterns were nearly the same and were generally concentrated in the afternoon and evening.
- ***Day of Week***:
    - Crashes were concentrated during the week (compared to the weekend) for both study periods. KSI crashes were highest on Fridays and lowest during the weekend for the pre-pandemic study period. During the pandemic, KSI crashes were slightly more concentrated on the weekends compared to pre-pandemic crashes.
- ***Lighting Conditions:***
    - Daylight conditions accounted for most crashes as expected. Most trips occur during daylight conditions which contributes to higher crash frequencies.
    - Crashes that occurred during non-daylight conditions were more likely to result in a KSI outcome. The severity of nighttime crashes is likely related to reduced visibility and slower perception and reaction times, resulting in the motorist traveling at a higher speed (and having more kinetic energy) at the time of the crash.
- ***Alcohol:***
    - There were ten crashes that involved a party (bicyclist or motorist) who was under the influence of alcohol during the 5-year study period.
- ***Crash type - Mode:***
    - Most crashes included a bicyclist and motorist (83.1%), followed by solo-bicyclist (11.6%) and bicyclist-pedestrian (5.3%).
    - Just over one-fourth of bicycle KSI crashes involved only a bicyclist and no other parties (solo-bicycle crash). Solo-bicycle crashes were disproportionately severe compared to other crash types, which is likely associated with underreporting of less severe solo-bicycle crashes, therefore skewing the results.
- ***Weather Condition:***
    - Most crashes occurred during clear weather conditions for both the pre-pandemic period (86%) and pandemic period (90%).

Parties

- ***Race[3]:***
    - In both study periods, Black bicyclists and drivers are substantially overrepresented in crashes on a per capita (using San Francisco demographics) basis citywide. Census data show that Black residents make up 5% of San Francisco's population but accounted for 9.6% of all bicycle crash victims and 8.6% of KSI bike victims, pre-pandemic. During the pandemic, these figures rose – Black bicyclists were involved in 11% of all bike crashes and 11.5% of KSI bike crashes. Additional research is needed to better understand travel behaviors and mode preferences or usage for each race.
- ***Age:***
    - Bicyclists aged 25-39 accounted for the largest share of bicyclists involved in crashes, and particularly bicyclists aged between 30-34 years. Bicyclists aged between 20-34 were the most overrepresented parties involved in a crash for all three study periods.
    - Drivers aged 30-34 accounted for the largest share of drivers involved in crashes with a bicyclist for all three study periods while also being underrepresented in crashes on a citywide per capita basis. Drivers aged 20-24 and 35-59 were overrepresented in crashes on a citywide per capita basis.
- ***Gender[4]:***
    - Male bicyclists accounted for the majority of bicyclists involved in crashes and KSI crashes during both study periods. This may be a reflection of gender-specific comfort related to riding a bicycle in traffic, related to personal safety, or other factors. Additional research is recommended to better understand the underlying factors for this finding.

Next Steps

- Safe Streets will begin the Step II analysis, which focuses on crash risk and location-specific findings through a systemic safety analysis.
- SFMTA and DPH will coordinate with Safe Streets to better understanding DUI reporting.
    - DPH may consider comparing the DUI crash rates per year with 2014-2016 crash data to get a sense of DUI/BUI prevalence during those years.
- Safe Streets will deliver the following files to Toole Design:
    - Excel workbook with source data, cross tabs (Pivot Tables), and plots
    - CSV file of crash data with geospatial attributes (using PostGIS geometries)
    - Final Step I Crash analysis Word Document

[3] **Disclaimer:** Party race is based on officer's assumption or visual impression, which can be problematic and inaccurate. Additionally, there are only five racial categories (excludes "Not Stated") within the crash data, in contrast to the US Census, which has nearly twice as many race and ethnicity categories. The victim representation and comparison made to the San Francisco population should be interpreted with caution given these reporting shortcomings.

[4] **Disclaimer:** Party gender is based on officer's assumption or visual impression, which can be problematic and inaccurate. The only categorical values for gender in the crash report form include "male", "female", and "Not Stated" and do not include other personal gender identities. The victim representation and comparison made to the San Francisco population should be interpreted with caution given these reporting shortcomings.

- List of possible key findings and ides for how those finding can be illustrated with graphics

Methodology

This analysis examines who was involved in bicycle crashes, when the bicycle crashes occurred, and contributing factors and circumstances using the reported information within the crash data. This crash analysis looked at the data stratified by two time periods: 2017-2019 (pre-pandemic) and 2020-2021 (pandemic). Stratifying the study period into these timeframes allows the research team to objectively analyze the crash data while controlling for the significant effect that the COVID-19 pandemic had on travel and behavioral patterns[5].

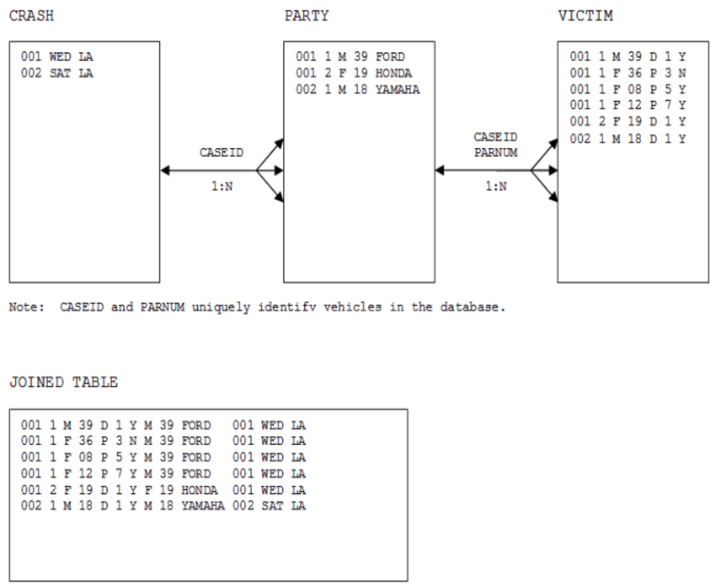
Crash Data Overview

Collision, party, and victim data were pulled from DataSF open data portal, which queries the crash data from TransBASE.sfgov.org. The crash data were downloaded on 11/22/2022, processed by Safe Streets, and loaded into a Postgres database for additional analysis. For detailed information regarding the sources of the collision records, please see detailed data summary hosted on DataSF's webpage (here).

The collision, party, and victim tables closely resemble the Statewide Integrated Transportation Record System (SWITRS) available via the Transportation Injury Mapping System (TIMS) hosted by UC Berkeley's Safe Transportation Research and Education Center (SafeTREC). Detailed information for the collision, party, and victim tables can be viewed here. The collision, party, and victim tables have a relational structure, which is common for storing collision data. For every reported collision, there is one collision record. The party table contains information for all the primary "actors" involved in the collision and has a many-to-one relationship – i.e., all relevant party records are matched via a case identification number to the one collision record. The party table contains information for each primary person such as age, sex, race, direction of travel, and vehicle characteristics. Lastly, the victim table contains attributes for all victims associated with each party, such as the driver and all the passengers of the vehicle. The victims table has a many-to-one relationship with both the parties and collision tables. This relationship is displayed in a graphic displayed Figure 1 below:

[5] Bureau of Transportation Statistics 2022. Daily Travel During the Covid-19 Public Health Emergency. Accessed February 15, 2022: https://www.bts.gov/daily-travel.

Figure 1: Relational Structure of Collision Data. Image Source: TIMS



The crash data used in this analysis was processed by Safe Streets to restructure the data, calculate and assign new variables, and assess the quality of the data though a robust quality control (QC) process. All reported crashes were processed (not just bicyclist crashes), but only crashes that involved at least one bicyclist are included in this analysis. These bicyclist crashes include any crash involving a bicyclist and motorist or pedestrian, as well as crashes in which there were no parties other than a single bicyclist (solo-bicyclist crashes).

Injury Severity Assignment

The officer-reported injury severity levels used in this analysis are specific to the most severely injured (MSI) bicyclist involved in the crash. This injury severity is different than the reported MSI assigned to each crash record (see Table 1, blue cells indicate the matched crash MSI and bicyclist MSI). In most cases, bicyclists are the most severely injured victim involved in the crash. Using the victim-level severity helps improve accuracy of summarizing injury severities. It should be noted that the San Francisco Department of Public Health (DPH) has documented reporting errors related to mis-coded injury severities, particularly for severe injuries[6], suggesting a need for some fluidity when discussing minor and serious injuries. This analysis does not have access to DPH's crash-level data to use the hospital reported or verified injury severities, so the results in this document reflect the best available data at the time.

For reference, the injury severities recorded in the crash data and summarized in this analysis are defined in the California Highway Patrol Collision Investigation Manual 555:

- **Fatal:** A fatal injury is any injury that results in death within 30 days after the motor vehicle collision in which the injury occurred. If the person did not die at the scene but died within 30 days of the motor vehicle collision in which the injury occurred, the injury classification should be changed from the injury previously assigned to "Fatal Injury

[6] https://www.visionzerosf.org/wp-content/uploads/2021/11/Severe-Injury-Trends_2011-2020_final_report.pdf

- **Injury (Severe):** A suspected serious injury is any injury other than fatal which results in one or more of the following:
    - Severe laceration resulting in exposure of underlying tissues/muscles/organs or resulting in significant loss of blood.
    - Broken or distorted extremity (arm or leg).
    - Crush injuries.
    - Suspected skull, chest or abdominal injury other than bruises or minor lacerations.
    - Significant burns (second and third degree burns over 10% or more of the body).
    - Unconsciousness when taken from the collision scene.
    - Paralysis.
- **Injury (Minor):** A minor injury is any injury that is evident at the scene of the collision, other than fatal or serious injuries. Examples include lump on the head, abrasions, bruises, and minor lacerations (cuts on the skin surface with minimal bleeding and no exposure of deeper tissue/muscle).
- **Injury (Possible)**: A possible injury is any injury reported or claimed which is not a fatal, suspected serious, or suspected minor injury. Examples include momentary loss of consciousness, claim of injury, limping, or complaint of pain or nausea. Possible injuries are those which are reported by the person or are indicated by their behavior, but no wounds or injuries are readily evident.

Table 1: Crash-level MSI and Bicycle MSI Comparison

Crash-Level MSI	Bike MSI	Total
Fatal	**Fatal**	**8**
Injury (Severe)	**Injury (Severe)**	**220**
	Injury (Other Visible)	*2*
	Injury (Complaint of Pain)	*1*
	unknown	*12*
Injury (Other Visible)	**Injury (Other Visible)**	**994**
	Injury (Complaint of Pain)	8
	unknown	*51*
Injury (Complaint of Pain)	Injury (Severe)	1
	Injury (Other Visible)	*2*
	Injury (Complaint of Pain)	**1,092**
	unknown	*51*
Medical[7]	*Fatal*	*1*
Total		***2,443***

As part of the crash data QC process, 114 crashes were found to be missing bicyclist victim records (see Table 2). The absence of bicyclist victim records prohibits assigning bicyclist MSI to each record with 100% certainty for all crashes. However, it's safe to assume the crash-level injury severity for solo-bicyclist crashes accurately reflects the bicyclist's injury. For crashes that involved a bicyclist and a motorist, it is generally safe to assume the bicyclist experience the most severe injury. While this may not be universally true, it is the likely outcome given that bicyclists are less protected than a motorist in a vehicle. For crashes that involved a pedestrian and bicyclist, however, assigning the crash-level injury severity to the bicyclist may be inaccurate as the MSI may apply to the pedestrian involved in the crash, not the bicyclist. The research team worked with the SFMTA to determine how to proceed with these crash records, presenting the SFMTA team with the following three options:

- **Option 1:** Drop bicyclist-pedestrian crashes without bicyclist victim records
- **Option 2:** Proportionally apply the injury levels from bicyclist-pedestrian crashes with known bicyclist MSI
- **Option 3:** Assign crashes a 50/50 split between Injury B (n=40) and Injury C (n=40), assuming all unknown MSI Injury A crashes (n=11) likely apply to the pedestrian

Ultimately, option two was selected as it applies the bicycle MSI informed by historic crash patterns. Crashes that were not assigned a bicycle MSI (injury C crashes; n=11) during this process were removed from the analysis.

[7] This value is likely an error in the source data, which has been recoded to 'fatal' for this analysis.

Table 2:Crashes without Bicycle Victim Records

Crash Type	Crash-level MSI	Total
Bike-Vehicle	Injury (Severe)	1
	Injury (Other Visible)	10
	Injury (Complaint of Pain)	11
Bike-Pedestrian	Injury (Severe)	11
	Injury (Other Visible)	40
	Injury (Complaint of Pain)	40
Solo-Bike	Injury (Other Visible)	1
Total		***114***

Descriptive Analysis[8]

Crashes by Year

Reported bicycle crashes by year are summarized in Table 3. There is a clear difference in crash frequencies between the two study periods, with each year of pre-pandemic crashes frequencies accounting for between 22% and 24% of crashes during the 5-year period. In contrast, the annual share of crashes dramatically dropped to roughly 16% of crashes per year during the pandemic. The same pattern can be observed when looking at KSI crashes. The percentage of crashes resulting in a KSI was highest in 2021 (8.1%).

Table 3: Reported Bicycle Crashes by Year, 2017-2021

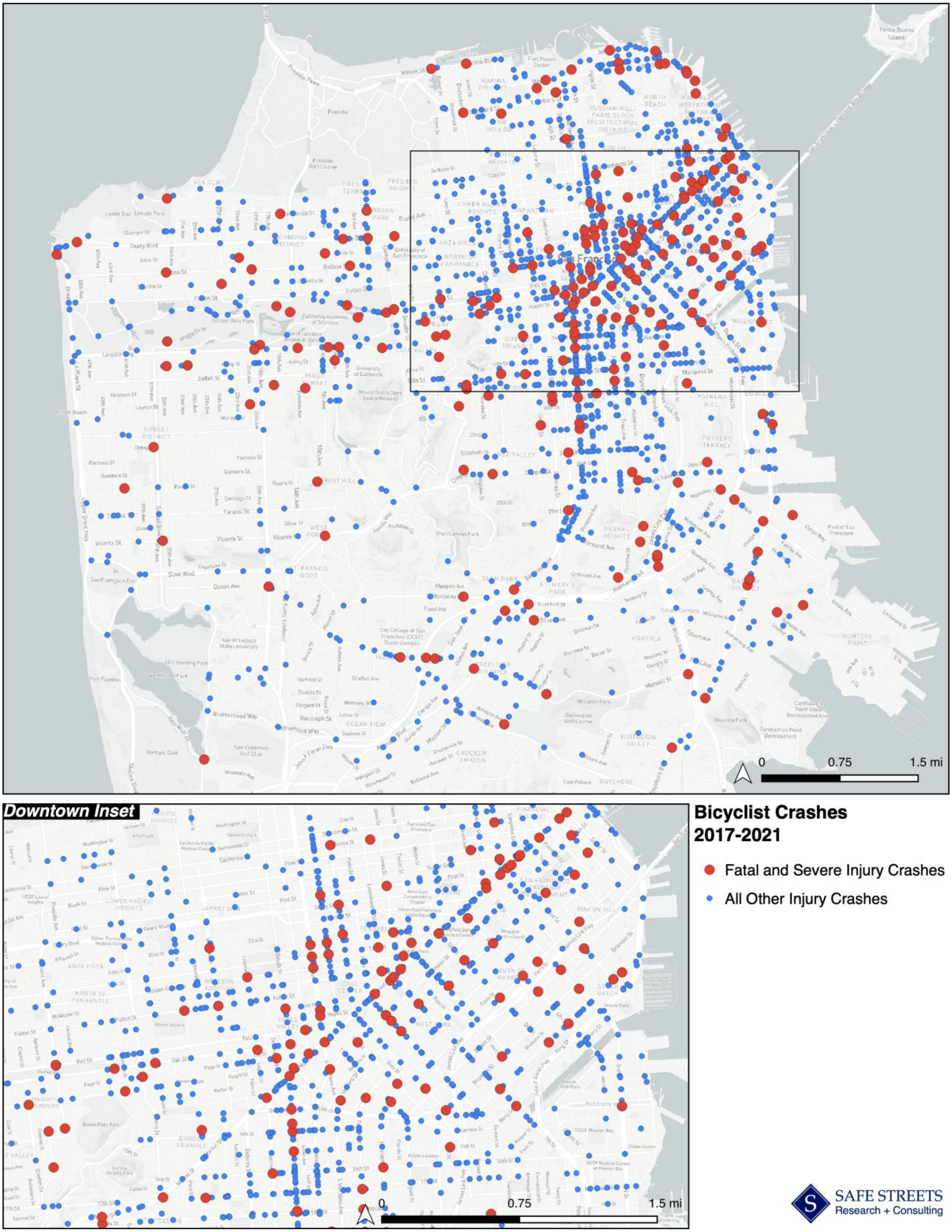
year	# Crashes	% Crashes	# KSI Crashes	% KSI	% Crashes that Resulted in KSI
2017	545	22.4%	35	21.2%	6.4%
2018	578	23.8%	40	24.2%	6.9%
2019	545	22.4%	35	21.2%	6.4%
2020	379	15.6%	24	14.5%	6.3%
2021	385	15.8%	31	18.8%	8.1%
Total	***2,432***	***100.0%***	***165***	***100.0%***	***6.8%***

Map 1 through Map 3 display the location of bicyclist crashes by study period. During the 5-year study period (Map 1), crashes were concentrated near the Downtown area and along corridors that connect nearby neighborhoods to Downtown. During the pre-pandemic (Map 2), crashes followed a similar pattern and were concentrated near Downtown or along corridors connecting to Downtown. Crashes that occurred during the pandemic (Map 3) were more geographically dispersed and less concentrated near Downtown than during the pre-pandemic period. Streets with noticeably lower crash densities during the pandemic study period include Valencia St, Market St, The Embarcadero, Polk St, and many other streets within or near Downtown. This likely reflects changes in commuting to Downtown and may also reflect other changes in bicyclist and motorist travel behaviors and route preferences during

[8] ***Magenta*** text in the summary tables denote values of interest or data points related to key findings.

this time period. Step II of the San Francisco Active Communities Plan will include a deeper dive analysis of location-specific crash patterns and will focus on identifying crash risk factors, analyzing crashes along the High Injury Network, and investigating spatial patterns between the two time-periods.

Map 1: Bicyclist Crashes, 2017-2021



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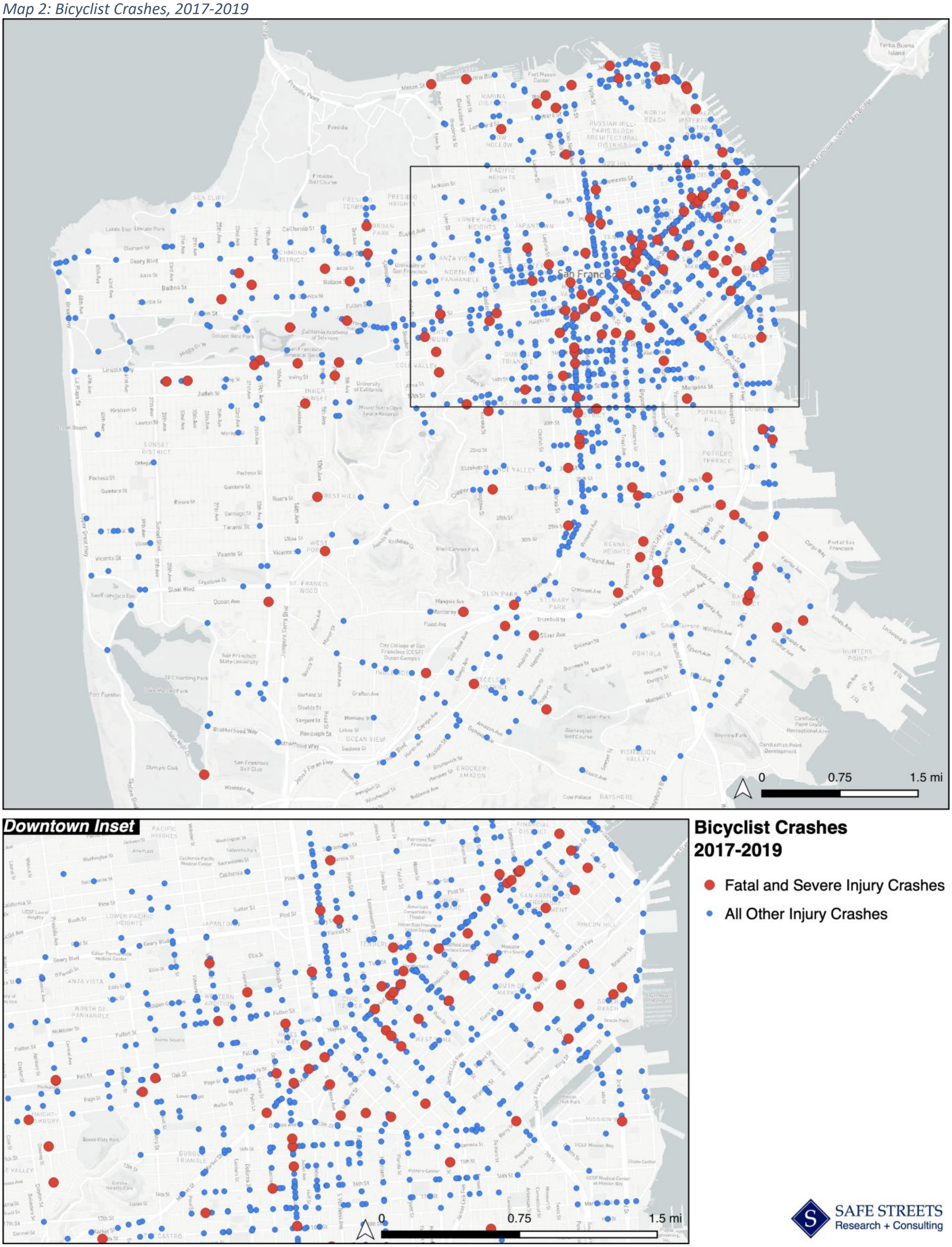
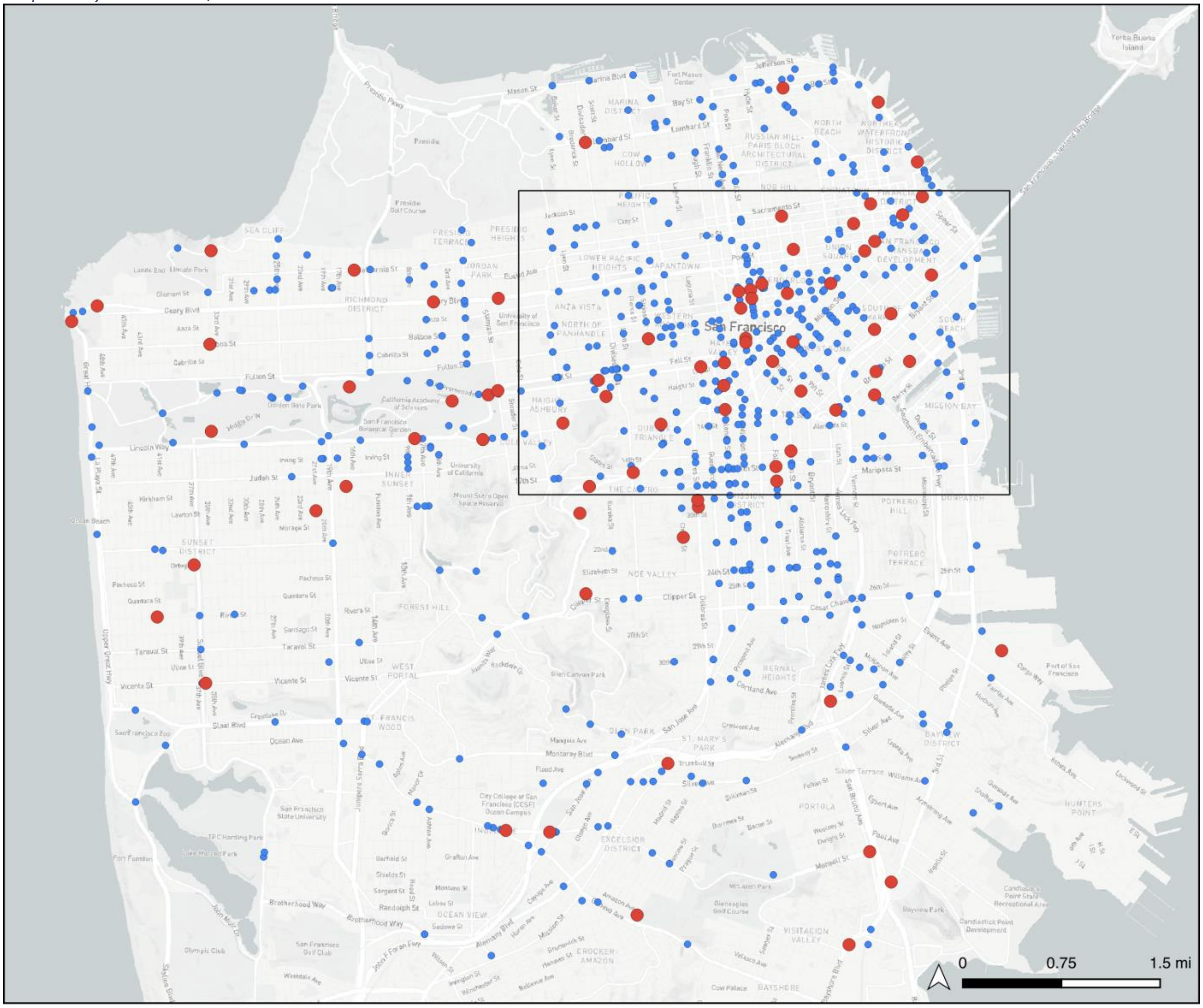
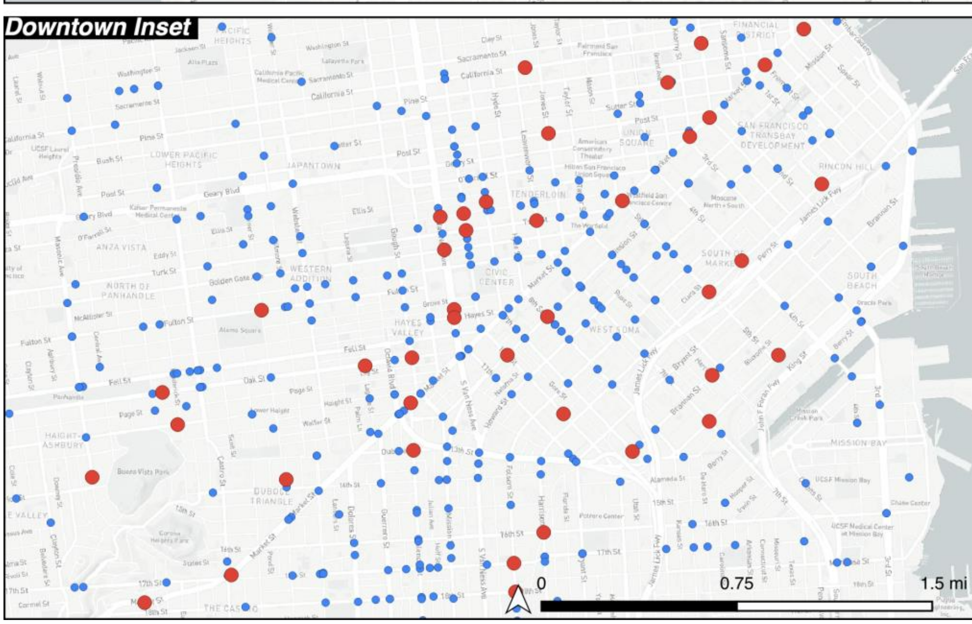
Map 2: Bicyclist Crashes, 2017-2019



Map 3: Bicyclist crashes, 2020-2021





Bicyclist Crashes 2020-2021

- Fatal and Severe Injury Crashes
- All Other Injury Crashes

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Crashes by Injury Type

Crashes are summarized by bicyclist MSI in Table 4. Most crashes that involved a bicyclist during the 5-year time frame resulted in less-severe injuries, reported as either complaint of pain (47.1%) or other visible injury (43.1%). Crash rates for all injury severities were higher during the pre-pandemic study period (556 crashes per year) than in the pandemic study period (382 crashes per year). This difference between crash rates is likely related to activity levels during the pre-pandemic relative to those during the COVID-19 pandemic. A *Stay Home order* throughout San Francisco was in effect March 19, 2020, and a corresponding drop in all travel, but particularly motor vehicle travel, could offset any naturally expected increase in crashes from higher bicycle travel in some areas. Regardless of crash rates, the distributions of injury types between the two study periods are similar.

Table 4: Bicycle Crashes by Injury Severity, 2017-2021

	2017-2019			2020-2021			2017-2021		
Injury Type	**# Crashes**	**% Crashes**	**Crash Rate/ Year**	**# Crashes**	**% Crashes**	**Crash Rate/ Year**	**# Crashes**	**% Crashes**	**Crash Rate/ Year**
Fatal	7	0.4%	2.3	2	0.3%	1.0	9	0.4%	1.8
Severe	151	9.1%	50.3	77	10.1%	38.5	228	9.4%	45.6
Other Visible	705	42.3%	235.0	344	45.0%	172.0	1,049	43.1%	209.8
Complaint of	805	48.3%	268.3	341	44.6%	170.5	1,146	47.1%	229.2
Total	***1,668***	***100.0%***	**556.0**	***764***	***100.0%***	**382.0**	***2,432***	***100.0%***	**486.4**

Crashes by Movement-Based Crash Types

Pre-crash movement crash types were developed by combining the bicyclist's pre-crash movement with the other primary party's pre-crash movement[9]. Solo-bicycle crashes are noted in the crash type and bicycle-pedestrian crashes use the pedestrian "action" (no bicycle-pedestrian crash types are in the top 10). See Appendix B for crashes summarizes for every crash type, not just the top 10.

Table 5 summarizes bicycle crashes that occurred during the pre-pandemic study period by injury severity and crash type for the ten crash types that had the highest frequency of reported crashes. Crashes that did not involve any type of turning movement (i.e., proceeded straight) accounted for the largest share of crashes, particularly crashes with both parties proceeding straight (18.6% crashes and 17.7% KSI crashes). Most of these crashes involved both parties traveling perpendicularly (57% of crashes; 68% KSI crashes), followed by same direction (33% of crashes; 21% KSI crashes).

Solo-bicyclist crashes had the largest share of KSI crashes (19.6%). This finding makes sense as most instances when someone riding a bicycle falls or strikes an object is involved in a crash, the victim generally will not report the crash unless they are severely injured and require medical help. Many of

[9] Note: this crash type process will be updated in the Step II analysis, which will incorporate crash location (intersection vs. mid-block) and intersection control. Crash location will be spatially defined by proximity to the nearest intersection centroid. This revised crash type will help the team better understand the crash dynamics unique to specific location types, roadway characteristics, and land use and inform possible countermeasures to systemically improve safety throughout San Francisco.

these crashes were cited as the bicyclist traveling too fast for conditions (42%) and few crashes had a reported roadway condition that contributed to the crash (12%).

Crashes that involved a motorist making a left turn and striking a bicyclist proceeding straight accounted for the second largest share of overall crashes (12.9%) and third largest share of KSI crashes (10.8%). Crashes that involved a motorist making a right turn and striking a bicyclist proceeding straight had the third largest share of crashes (12.1%), fifth largest share of KSI crashes (7.6%), and a moderate-low share of crashes that resulted in a KSI outcome (5.9%). This finding is expected as a motorist's speed making a right turn is often slower than a motorist's speed making a left turn or proceeding straight, resulting in comparatively less kinetic energy transfer at the moment of impact.

Crashes that involved a bicyclist proceeding straight and a stopped motorist had the highest share of crashes that resulted in a KSI outcome (11.5%) and accounted for roughly 8% of KSI crashes (fourth highest), despite comprising only 6.8% of all crashes. These KSI crashes involved a motorist opening the vehicle door into the path of the bicyclist (i.e., dooring), either the motorist or the bicyclist traveling too slow or too fast for conditions, and a vehicle parked in bike lane. Dooring crashes were the predominant violation type and may suggest the need for additional physical separation between bicyclists and motor vehicles as well as educational outreach.

Table 5: Top 10 Bicycle Crashes by Pre-Crash Movements, 2017-2019

Rank	Bike + Motorist Movements	# Crashes	% Crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
--	*Not top 10*	*491*	*29.4%*	*163.7*	*42*	*26.6%*	*14.0*	*8.6%*
1	Proceeding Straight, Proceeding Straight	310	**18.6%**	103.3	28	**17.7%**	9.3	9.0%
2	Proceeding Straight, Making Left	215	12.9%	71.7	17	**10.8%**	5.7	7.9%
3	Proceeding Straight, Making Right	202	12.1%	67.3	12	7.6%	4.0	5.9%
4	Solo Bike Proceeding Straight	139	8.3%	46.3	31	**19.6%**	10.3	**22.3%**
5	Proceeding Straight, Stopped	113	6.8%	37.7	13	**8.2%**	4.3	**11.5%**
6	Proceeding Straight, Parked	48	2.9%	16.0	5	3.2%	1.7	**10.4%**
7	Making Left Turn, Proceeding Straight	46	2.8%	15.3	4	2.5%	1.3	8.7%
8	Proceeding Straight, Making U Turn	40	2.4%	13.3	1	0.6%	0.3	2.5%
9	Proceeding Straight, Entering Traffic	33	2.0%	11.0	3	1.9%	1.0	9.1%
10	Proceeding Straight, Changing Lanes	31	1.9%	10.3	2	1.3%	0.7	6.5%
	Total	***1,668***	***100.0%***	***556.0***	***158***	***100.0***	***52.7***	***9.5%***

Table 6 summarizes bicycle crashes that occurred during the pandemic study period by injury severity and crash type for the top ten crash types. The top crash types were similar during the pandemic study period as the pre-pandemic study period, but there were different concentrations of crashes by crash type. In particular, the pandemic study period had a higher percentage of KSI crashes that resulted from a bicyclist proceeding straight – motorist proceeding straight crash (26.9%). Most of these crashes had the same reported contributing factors as the pre-pandemic study period: disregarded traffic signal, failure to stop at stop sign, and traveling at unsafe speeds. Like the pre-pandemic study period, most of these crashes involved both parties traveling perpendicularly (70% of crashes; 86% KSI crashes), followed by same direction (23% of crashes; 5% KSI crashes). Crashes that involved a bicyclist proceeding straight and a motorist making a left turn had a similar crash distribution as the pre-pandemic period, accounting for 13.7% of crashes and 9.0% of KSI crashes. Bicyclist proceeding straight and a motorist making a right turn accounted for a similar share of overall crashes (10.6%) but roughly half the share of KSI crashes (3.8%) compared to the pre-pandemic study period. Additionally, there were fewer crashes that involved a stopped or parked motor vehicle. Dooring crashes for these two crash types accounted for 63% (n=102) of crashes and 50% (n=9) of KSI crashes during the pre-pandemic period, in contrast to 46% of crashes (n=22) and 50% of KSI crashes (n=2) during the pandemic.

Table 6: Top 10 Bicycle Crashes by Pre-Crash Movements, 2020-2021

Rank	Bike + Motorist Movements	# Crashes	% Crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
--	*Not top 10*	*202*	*26.4%*	*101.0*	*23*	*29.5%*	*11.5*	*11.4%*
1	Proceeding Straight, Proceeding Straight	185	**24.2%**	92.5	21	**26.9%**	10.5	**11.4%**
2	Proceeding Straight, Making Left	105	13.7%	52.5	7	9.0%	3.5	6.7%
3	Proceeding Straight, Making Right	81	10.6%	40.5	3	3.8%	1.5	3.7%
4	Solo Bike Proceeding Straight	78	10.2%	39.0	16	**20.5%**	8.0	**20.5%**
5	Proceeding Straight, Stopped	34	4.5%	17.0	3	3.8%	1.5	8.8%
6	Making Left Turn, Proceeding Straight	24	3.1%	12.0	2	2.6%	1.0	8.3%
7	Proceeding Straight, Making U Turn	18	2.4%	9.0	1	1.3%	0.5	5.6%
8	Proceeding Straight, Parked	14	1.8%	7.0	1	1.3%	0.5	7.1%
9	Proceeding Straight, Entering	12	1.6%	6.0	1	1.3%	0.5	8.3%
10	Proceeding Straight, Changing	11	1.4%	5.5	0	0.0%	0.0	0.0%
	Total	***764***	***100.0%***	***382.0***	***78***	***100.0%***	***39.0***	***10.2%***

Crashes by Relative Direction (Bicycle-Motorist Crashes Only)

The relative direction of the bicyclist and motorist are summarized in Table 7 (pre-pandemic). Same direction crashes accounted for the largest share of crashes (46.5%) and KSI crashes (40.9%) but had a low percentage of crashes resulting in a KSI outcome (7.0%). Many of these crashes had a reported contributing factor cited as an improper or unsafe turn (29.1% crashes; 8.9% KSI crashes), dooring (15.8% crashes; 24.4% KSI crashes), and traveling too fast for conditions (12.5% crashes; 22.2% of KSI crashes). Perpendicular crashes accounted for the second largest share of crashes (34.0%) and KSI crashes (37.3%). Excluding unknown relative directions, perpendicular had the highest share of crashes that resulted in a KSI outcome (8.7%). Many of the perpendicular crashes involved a road user disregarding a traffic signal, improper or unsafe turn, failure to yield while making a turn, or disregarding a stop sign. Opposite direction crashes had the lowest share of crashes (13.0%) and KSI for crashes (10.9%) with known party direction of travel. Nearly half of the opposite direction crashes involved a party failing to yield while making a left turn or U-turn (34.8%), making an improper turn

(11.0%), or the bicyclist traveling in the wrong direction travel (9.9%). Crashes that involved a bicyclist traveling in the wrong direction of travel may be an indication of a bicycle network gap or lack of safe or comfortable crossing opportunities.

Table 7: Relative Direction of Travel between Bicyclist and Motorists, 2017-2019

Relative Direction	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Same	647	46.5%	215.7	45	40.9%	15.0	7.0%
Perpendicular	472	34.0%	157.3	41	37.3%	13.7	8.7%
Opposite	181	13.0%	60.3	12	10.9%	4.0	6.6%
Unknown	87	6.3%	29.0	12	10.9%	4.0	13.8%
Missing one party	3	0.2%	1.0	0	0.0%	-	0.0%
Total	***1,390***	***100.0%***	***463.3***	***110***	***100.0***	***36.7***	***7.9%***

Table 8 summarizes bicycle crashes by relative direction for crashes that occurred during the pandemic. Unlike pre-pandemic crashes, perpendicular crashes accounted for the largest share of crashes (47.1%) and KSI crashes (52.7%). Perpendicular crashes had a much larger share of KSI crashes and had a higher chance of a crash resulting in a KSI outcome (9.8%) compared to the pre-pandemic study period. Opposite direction crashes also accounted for a larger share of crashes. Many of these crashes are cited as the bicyclist traveling the wrong direction and the outcome had a higher chance of resulting in a KSI outcome compared to the pre-pandemic period. Aside from that difference, the contributing factors reported by the responding officer had similar distributions between study periods.

Table 8: Relative Direction of Travel between Bicyclist and Motorists, 2020-2021

Relative Direction	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Perpendicular	297	47.1%	148.5	29	52.7%	14.5	9.8%
Same	221	35.0%	110.5	16	29.1%	8.0	7.2%
Opposite	85	13.5%	42.5	8	14.5%	4.0	9.4%
Unknown	28	4.4%	14.0	2	3.6%	1.0	7.1%
Total	***631***	***100.0%***	***315.5***	***55***	***100.0%***	***27.5***	***8.7%***

Crashes by Reported Violations (Bicycle-Motor Vehicle Crashes Only)

The following section summarizes crashes by generalized reported violation types (see Appendix for the list of violation codes, definitions, and the generalized violation types summarized in the tables below). Similar violations have been grouped to simplify the analysis and to yield potentially more useful insights. It's important to note that some reporting bias or errors in reporting the primary collision violation may be present in some of these crashes. Responding officers attempt to assign each crash a primary collision violation based on the crash investigation and information provided from the parties (and/or witnesses) involved, but that does not always lead to the correct violation assignment.

Analyzing crash types, crash dynamics, and contextual characteristics can help provide a more objective picture of what contributed to the crash. It is recommended to interpret the following findings with caution.

Table 9 summarizes bicycle-motor vehicle crashes by reported violation types for crashes that occurred during the pre-pandemic period. The most frequent violation types include improper or unsafe turn (21.3% crashes; 15.5% KSI crashes), failure to yield while making a left turn (9.8% crashes, 7.3% KSI crashes), and traveling too fast for conditions (8.9% crashes; 15.5% KSI crashes). Improper turns and traveling too fast for conditions had the highest share of KSI crashes followed by disregarding the signal (11.8%) and dooring (10.0%). The majority of improper or unsafe turn crashes involved a motorist making a right turn (42.6%) followed by a motorist making a left turn (15.9%). A larger share of left turn crashes resulted in a KSI outcome (12.8%) than for right turn crashes (4.2%), which is likely due to left turning motorists traveling at a higher speed at the time of the crash.

The crash data includes a "party at fault" attribute *which should be interpreted with caution due to potential reporting biases or errors but may provide high-level insights into contributing factors*. *Additionally, bicyclists who were fatally injured were most likely unable to provide their testimony, which could lead to an inaccurate citation.* For overall bicycle-motor vehicle crashes, motorists were cited as the party at fault for 52.8% of crashes and 46.4% of KSI crashes, whereas bicyclists were cited as the party at fault for 33.4% of crashes and 35.5% of KSI crashes. Bicyclist at fault crashes were disproportionately severe compared to motorist at fault crashes. Looking at the party at fault for the highest frequency violation types may help us understand some behavioral patterns related to crashes.

Motorists were most frequently the party at fault for improper or unsafe turns (motorists cited in 72.3% of crashes and 88.2% of KSI crashes). There were roughly the same number of KSI crashes for at fault motorists making a right turn as there were making a left turn. The most common pre-crash movement for at fault bicyclists involved the bicyclist making a left turn while the motorists was proceeding straight (15 crashes; 1 KSI crash).

Failure to yield while making a left turn was cited as the motorist being at fault for 82.4% of crashes and 87.5% of KSI crashes. Most motorist at fault crashes involved both parties traveling in opposite directions (42.6% of crashes; 25.0% of KSI crashes) at the time of the crash, followed by perpendicular (30.9% of crashes; 37.5% of KSI crashes). Roughly half of these motorists at fault crashes occurred at a location with a functioning traffic control device[10].

Bicyclists were most frequently cited as the party at fault for traveling too fast for conditions[11] (57.3% of crashes; 58.8% of KSI crashes). Most crashes involved a bicyclist proceeding straight and traveling in the same direction as the motorist. For both bicyclist at fault and motorist at fault crashes, roughly 14% of crashes resulted in a KSI outcome.

[10] A more robust analysis into traffic control devices will be conducted using SFMTA traffic control data.

[11] Many cities throughout the US have observed an increased in motor vehicle speeds during the pandemic. Data related to bicyclist speed is not readily available and there is not known research that would suggest changes in bicyclist travel speeds before or during the pandemic. Additionally, the "traveling too fast for conditions" violation code may be used as a "catch-all" code for citing a bicyclist at fault, thereby artificially inflating the frequency of this violation type.

Table 9: Top 10 General Violation Types, 2017-2019

General Violation Type	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Improper or unsafe turn	296	21.3%	98.7	17	15.5%	5.7	5.7%
Failure to yield (left	136	9.8%	45.3	8	7.3%	2.7	5.9%
Too fast for conditions	124	8.9%	41.3	17	15.5%	5.7	13.7%
Dooring	124	8.9%	41.3	11	10.0%	3.7	8.9%
Disregard traffic signal	121	8.7%	40.3	13	11.8%	4.3	10.7%
Unknown	72	5.2%	24.0	7	6.4%	2.3	9.7%
Failure to yield	65	4.7%	21.7	3	2.7%	1.0	4.6%
Improper stop	64	4.6%	21.3	9	8.2%	3.0	14.1%
Overtaking	59	4.2%	19.7	1	0.9%	0.3	1.7%
Keep right	41	2.9%	13.7	2	1.8%	0.7	4.9%
Not Top 10 [12]	288	20.7%	96.0	22	20.0%	7.3	7.6%
Total	***1,390***	***100.0%***	***463.3***	***110***	***100.0%***	***36.7***	***7.9%***

Table 10 summarizes bicycle-motor vehicle crashes by reported violation type for crashes that occurred during the pandemic period. The most frequent violation types include improper or unsafe turn (20.0% of crashes; 12.7% of KSI crashes), disregarding a traffic signal (13.0% of crashes, 20.0% of KSI crashes), and traveling too fast for conditions (10.5% of crashes; 10.9% of KSI crashes).

For overall bicycle-motor vehicle crashes, during the pre-pandemic motorists were cited as the party at fault for 47.4% of crashes and 29.1% of KSI crashes, whereas bicyclists were cited as the party at fault for 40.9% of crashes and 56.4% of KSI crashes during the pandemic. The party at fault for KSI crashes was substantially different during the pandemic period compared to the pre-pandemic period. Similarly, bicyclist at fault crashes were disproportionately severe during the pandemic relative to motorist at fault crashes.

Improper or unsafe turns were associated with the largest share of overall crashes (20%) and the second largest share of KSI crashes (12.7%). These crashes generally involved an at fault motorist making a right turn (30.2%), making a left turn (12.7%), and changing lanes (7.9%). When the bicyclist was at fault, the bicyclist was most frequently making a left turn (7.9%), followed by changing lanes (5.6%). This violation type did not generally result in a high share of crashes resulting in a KSI outcome: 5.6% of these crashes resulted in a KSI compared to the pandemic average for all crash types of 8.7%.

Disregarding traffic signals had the largest share of KSI crashes and had a relatively high share of crashes that resulted in a KSI outcome (13.4%), indicating a potentially greater tendency toward severity than other violation types. Two-thirds of these crashes assigned fault to the bicyclist. Most crashes involved the bicyclist and motorist traveling in perpendicular travel directions.

[12] There were 26 violation types not in the top 10. The violation type with the largest share of crashes accounted for 2.4% of crashes.

Table 10: Top 10 General Violation Types, 2020-2021

General Violation Type	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Improper or unsafe turn	126	20.0%	42.0	7	12.7%	2.3	5.6%
Disregard traffic signal	82	13.0%	27.3	11	20.0%	3.7	13.4%
Too fast for conditions	66	10.5%	22.0	6	10.9%	2.0	9.1%
Failure to yield (left turn)	54	8.6%	18.0	3	5.5%	1.0	5.6%
Failure to yield	42	6.7%	14.0	3	5.5%	1.0	7.1%
Improper stop	42	6.7%	14.0	2	3.6%	0.7	4.8%
Unknown	37	5.9%	12.3	3	5.5%	1.0	8.1%
Keep right	32	5.1%	10.7	4	7.3%	1.3	12.5%
Dooring	27	4.3%	9.0	3	5.5%	1.0	11.1%
Overtaking	23	3.6%	7.7	5	9.1%	1.7	21.7%
Not Top 10[13]	100	15.8%	33.3	8	14.5%	2.7	8.0%
Total	***631***	***100.0%***	***210.3***	***55***	***100.0***	***18.3***	***8.7%***

Crashes by Time of Day

Crashes by time of day are summarized in Table 11 for the pre-pandemic time period. Bicycle crashes overall and KSI crashes specifically occurred most frequently near typical commute periods (6am-9am) and (3pm-6pm), with a moderate share of crashes that occurred midday and fewer crashes during the late-night/early morning hours. While crashes were less frequent during the late-night and early morning hours, those crashes tended to be more severe, with 13-29% of those crashes resulting in a KSI outcome compared to 7% during the day. The midnight-3am period only accounted for 2.3% of crashes but accounted for 7% of KSI crashes. This higher share of crashes resulting in a KSI outcome is consistent with the findings noted in the lighting conditions portion of this memo – dark lighting conditions are associated with higher injury severity when a crash occurs.

[13] There were 23 violation types not in the top 10. The violation type with the largest share of crashes accounted for 1.9% of crashes.

Table 11: Bicycle Crashes by Severity and Time of Day, 2017-2019

Time of Day	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
12:00-2:59am	38	2.3%	12.7	11	7.0%	3.7	29%
3:00-5:59am	11	0.7%	3.7	3	1.9%	1.0	27%
6:00-8:59am	241	14.4%	80.3	29	18.4%	9.7	12%
9:00-11:59am	310	18.6%	103.3	23	14.6%	7.7	7%
12:00-2:59pm	257	15.4%	85.7	19	12.0%	6.3	7%
3:00-5:59pm	365	21.9%	121.7	33	20.9%	11.0	9%
6:00-8:59pm	330	19.8%	110.0	25	15.8%	8.3	8%
9:00-11:59pm	112	6.7%	37.3	14	8.9%	4.7	13%
Unknown	4	0.2%	1.3	1	0.6%	0.3	25%
Total	***1,668***	***100.0%***	***556.0***	***158***	***100.0%***	***52.7***	***9%***

Table 12 summarizes crashes by time of day for crashes that occurred during the pandemic period. Like pre-pandemic crash patterns, crashes are generally concentrated around the peak commute period. Two noticeable differences between the two study periods include the larger share of midday and early evening crashes and a lower share of morning crashes during the pandemic study periods. Additionally, the crashes that did occur in the early morning hours were less likely to result in a KSI compared to those in pre-pandemic years. Conversely, the pandemic-era evening crashes were more likely to result in a KSI compared to pre-pandemic years.

Table 12: Bicycle Crashes by Severity and Time of Day, 2020-2021

Time of Day	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
12:00-2:59am	15	2.0%	7.5	3	3.8%	1.5	20%
3:00-5:59am	10	1.3%	5.0	2	2.6%	1.0	20%
6:00-8:59am	74	9.7%	37.0	8	10.3%	4.0	11%
9:00-11:59am	103	13.5%	51.5	9	11.5%	4.5	9%
12:00-2:59pm	159	20.8%	79.5	16	20.5%	8.0	10%
3:00-5:59pm	202	26.4%	101.0	15	19.2%	7.5	7%
6:00-8:59pm	144	18.8%	72.0	18	23.1%	9.0	13%
9:00-11:5pm	57	7.5%	28.5	7	9.0%	3.5	12%
Total	***764***	***100.0%***	***382.0***	***78***	***100.0%***	***39.0***	***10%***

Figure 2 and Figure 3 display crashes by hour of day stratified by weekend vs. weekday for the pre-pandemic and pandemic time periods, respectively. Weekday bicyclist volumes are typically concentrated during peak commute periods whereas weekend bicycle volumes are often highest midday, and it's common to observe higher frequencies of bicycle crashes during these time periods due to higher levels of exposure. This typicality is observable in Figure 2 (pre-pandemic), but not in Figure 3 (pandemic). This difference is likely associated with the Stay Home order and a higher rate of working from home, as well as increased recreational trips. A comparison between this finding and the Bike Count analysis being conducted as part of this planning effort may help nuance these findings.

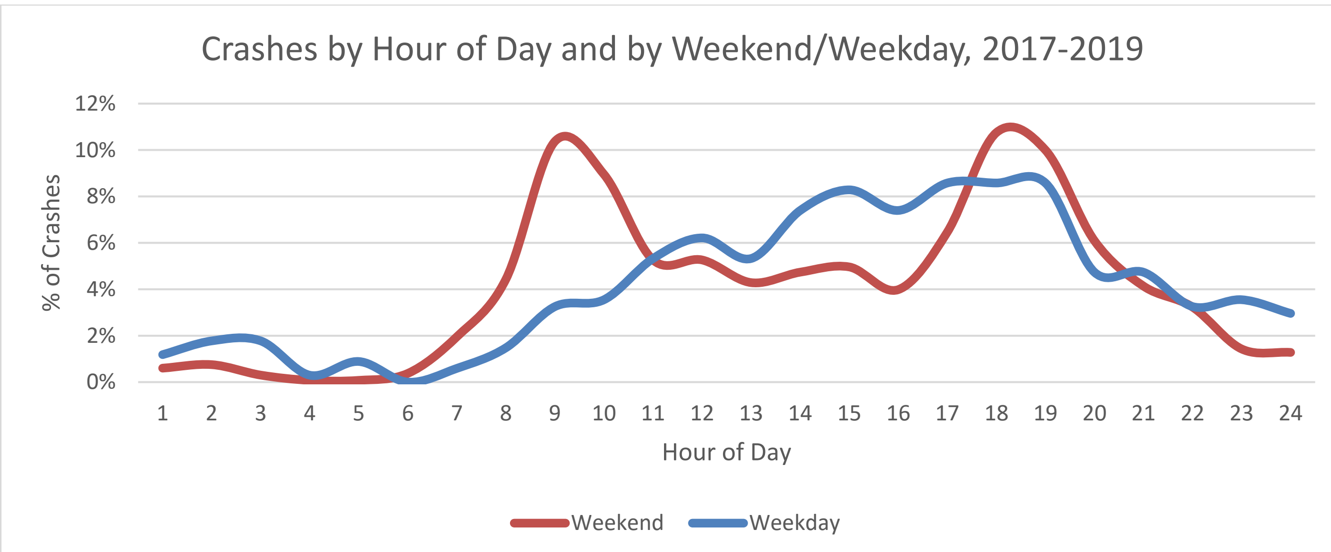


Figure 2: Crashes by Hour of Day Stratified by Weekend vs. Weekday, 2017-2019

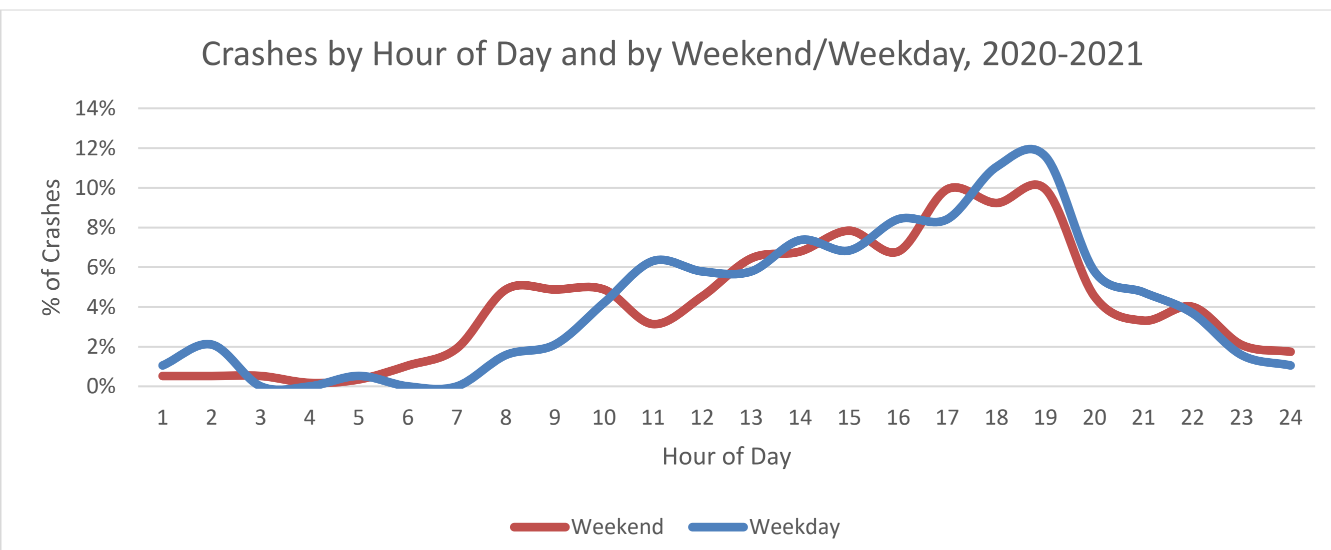


Figure 3: Crashes by Hour of Day Stratified by Weekend vs. Weekday, 2020-2021

Crashes by Day of Week

Crash rates by day of week, injury severity, and by study period are summarized in Table 13. Crash rates were generally higher for each day during the pre-pandemic study period. Overall crashes and KSI crashes were generally concentrated during the weekday for both study periods. During the pre-pandemic study period, crash rates were lowest during the weekend and on Monday. However, KSI crash rates were slightly more concentrated between Saturday through Monday during the pandemic study period compared to the pre-pandemic and 5-year study periods.

Table 13: Bicycle Crash Rates by Day of Week

	Crash Rate/Year			KSI Crash Rate/Year		
Day of Week	**2017-2019**	**2020-2021**	***2017-2021***	**2017-2019**	**2020-2021**	***2017-2021***
Sunday	52.00	44.50	***49.00***	3.67	4.50	***4.00***
Monday	70.67	41.00	***58.80***	5.33	6.00	***5.60***
Tuesday	87.33	61.50	***77.00***	8.67	4.00	***6.80***
Wednesday	95.67	59.00	***81.00***	10.00	6.00	***8.40***
Thursday	100.00	62.50	***85.00***	10.33	5.50	***8.40***
Friday	89.67	67.50	***80.80***	8.00	8.00	***8.00***
Saturday	60.67	51.00	***56.80***	4.67	5.00	***4.80***
Unknown	0.00	0.50	***0.20***	0.00	0.00	***0.00***
Total	***417.00***	***387.50***	***488.60***	***38.00***	***39.00***	***46.00***

The distribution of crashes by day of week is summarized in Table 14 (pre-pandemic) and Table 15 (pandemic). For both pre-pandemic and pandemic study periods, crashes occurred least often during the weekend and early weekdays (specifically Monday). Comparing the distribution of KSI crashes, pre-pandemic crashes were generally concentrated during weekdays (39.9% of KSI crashes; highest on Wednesday and Thursday), whereas KSI crashes during the pandemic period were highest on Fridays (20.5%) and otherwise relatively high on Monday, Wednesday, and Thursday (44.9% cumulatively).

The percentage of overall crashes and KSI crashes that occurred during the weekend was slightly higher during the pandemic study period compared to the pre-pandemic study period. This is likely associated with changes in travel behaviors, increases in recreational bicycling (typically occurring during the weekend), and higher rates of people working from home.

Table 14: Bicycle Crashes by Severity and Day of Week, 2017-2019

Day of week	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Sunday	156	9.4%	52.0	11	7.0%	3.7	7.1%
Monday	212	12.7%	70.7	17	10.8%	5.7	8.0%
Tuesday	262	15.7%	87.3	27	17.1%	9.0	10.3%
Wednesday	287	17.2%	95.7	32	20.3%	10.7	11.1%
Thursday	300	18.0%	100.0	31	19.6%	10.3	10.3%
Friday	269	16.1%	89.7	26	16.5%	8.7	9.7%
Saturday	182	10.9%	60.7	14	8.9%	4.7	7.7%
2017-2019 Total	***1,668***	***100.0%***	***556.0***	***158***	***100.0%***	***52.7***	***9.5%***

Table 15: Bicycle Crashes by Severity and Day of Week, 2020-2022

Day of week	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Sunday	88	11.5%	44.0	9	11.5%	4.5	10.2%
Monday	82	10.7%	41.0	12	15.4%	6.0	14.6%
Tuesday	119	15.6%	59.5	8	10.3%	4.0	6.7%
Wednesday	117	15.3%	58.5	12	15.4%	6.0	10.3%
Thursday	123	16.1%	61.5	11	14.1%	5.5	8.9%
Friday	132	17.3%	66.0	16	20.5%	8.0	12.1%
Saturday	102	13.4%	51.0	10	12.8%	5.0	9.8%
Unknown	1	0.1%	0.5	0	0.0%	0.0	0.0%
2020-2021 Total	***764***	***100.0%***	***382.0***	***78***	***100.0%***	***39.0***	***10.2%***

Crashes by Lighting Condition

Crashes by reported lighting condition are summarized in Table 16 (pre-pandemic) and Table 17 (pandemic). Both study periods have similar overall crash and KSI crash distributions – most crashes occurred during daylight conditions. This is expected as most trips are made during this period with daylight conditions. However, lighting condition clearly affects safety: crashes that occurred in darkness or low-light (i.e., dusk or dawn) conditions were much more likely to result in a KSI outcome compared to those that occurred during daylight. Lack of visibility and slower perception and reaction times are likely contributing factors for these nighttime crashes. Slower perception and reaction times can result in the motorist traveling at a higher speed (and transferring more kinetic energy) at the time of the crash, leading to a more severe outcome.

Table 16: Bicycle Crashes by Severity and Lighting Condition, 2017-2019

lighting	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Daylight	1,223	73.3%	407.7	95	62.5%	31.7	7.8%
Dark - Street Lights	320	19.2%	106.7	41	27.0%	13.7	**12.8%**
Dusk - Dawn	72	4.3%	24.0	9	5.9%	3.0	**12.5%**
Not Stated	34	2.0%	11.3	4	2.6%	1.3	11.8%
Dark - No Street Lights	16	1.0%	5.3	2	1.3%	0.7	12.5%
Dark - Street Lights Not	3	0.2%	1.0	1	0.7%	0.3	33.3%
2017-2019 Total	***1,668***	***100.0%***	***556.0***	***152***	***100.0%***	***50.7***	***9.1%***

Table 17: Bicycle Crashes by Severity and Lighting Condition, 2020-2022

lighting	# Crashes	% Crashes	Crash Rate/Year	# KSI	% KSI	KSI Crash Rate/Year	% Crashes Resulting in KSI
Daylight	563	73.7%	281.5	53	67.9%	26.5	9.4%
Dark - Street Lights	162	21.2%	81.0	19	24.4%	9.5	11.7%
Dusk - Dawn	23	3.0%	11.5	3	3.8%	1.5	13.0%
Not Stated	9	1.2%	4.5	0	0.0%	0.0	0.0%
Dark - No Street Lights	5	0.7%	2.5	2	2.6%	1.0	40.0%
Dark - Street Lights Not Functioning	2	0.3%	1.0	1	1.3%	0.5	50.0%
2020-2022 Total	***764***	***100.0%***	***382.0***	***78***	***100.0%***	***39.0***	***10.2%***

Crashes by Under the Influence of Alcohol

Between 2017-2021, only ten crashes that involved a motorist or a bicyclist who was under the influence and impaired. This is substantially fewer crashes than anticipated. Further research and coordination may help us understand this very low number of alcohol-related crashes.

Table 18: Bicycle Crashes that Involve a Party Who Was Under the Influence of Alcohol, 2017-2021

Party Type	2017-2019	2020-2022	Total
Bicyclist	1	3	***4***
Driver	3	2	***5***
Pedestrian	1	0	***1***
Total	***5***	***5***	***10***

Crashes by Weather Condition

Crashes are summarized by reported weather conditions for pre-pandemic crashes (Table 19) and pandemic crashes (Table 20). The vast majority of crashes occurred in clear weather conditions for both the pre-pandemic (86%) and pandemic (90%) study periods. Crashes that occurred during the pandemic when the weather condition was cloudy were slightly more severe compared to clear conditions, though the number of KSI crashes is relatively small and may be a contributing factor in the higher share of crashes resulting in a KSI outcome.

Table 19: Bicycle Crashes by Weather Condition, 20217-2019

Weather	# Crashes	% Crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
Clear	1,431	85.8%	477.0	136	86.1%	45.3	9.5%
Cloudy	125	7.5%	41.7	12	7.6%	4.0	9.6%
Raining	53	3.2%	17.7	3	1.9%	1.0	5.7%
Not Stated	39	2.3%	13.0	3	1.9%	1.0	7.7%
Other	14	0.8%	4.7	2	1.3%	0.7	14.3%
Wind	5	0.3%	1.7	1	0.6%	0.3	20.0%
Fog	1	0.1%	0.3	1	0.6%	0.3	100.0%
Total	***1,668***	***100.0%***	***556.0***	***158***	***100.0%***	***52.7***	***9.5%***

Table 20: Bicycle Crashes by Weather Condition, 2020-2021

Weather	# Crashes	% Crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
Clear	684	89.5%	342.0	69	88.5%	34.5	10.1%
Cloudy	57	7.5%	28.5	8	10.3%	4.0	14.0%
Raining	11	1.4%	5.5	0	0.0%	0.0	0.0%
Not Stated	9	1.2%	4.5	1	1.3%	0.5	11.1%
Other	3	0.4%	1.5	0	0.0%	0.0	0.0%
Total	***764***	***100.0%***	***382.0***	***78***	***100.0%***	***39.0***	***10.2%***

Parties Involved

This section reports on the number of parties involved in bicycle crashes – the main road users/vehicles involved in the crash, such as drivers, pedestrians, bicyclists, and parked vehicles. There will be more than one party for every crash record summarized in this memo except for solo-bicyclist crashes.

Analyzing the parties involved in crashes with at least one bicyclist provides additional insight into these crashes and potential crash dynamics. This analysis compared the distribution of parties involved in crashes to the population distribution of San Francisco. Values greater than one suggest that a certain segment of the population is overrepresented on a per capita basis, while values less than one suggest that that segment of the population is underrepresented on the same basis. It's important to note that this comparison is imperfect in two ways. First, if more or fewer people from a segment of the population bicycle, we would expect that to be reflected in crash rates, all else equal – and this proportion of people who bicycle may not reflect their per capita proportion. We likely see this, for example, in trends related to age and sex, and potentially related to race. In the absence of more nuanced exposure data, however, a per capita understanding is still valuable to help us understand how crashes are distributed among various segments of the population. Second, the home zip code is not readily available for all parties involved in the crash, so we cannot rule out that some people riding a bicycle or driving a motor vehicle live outside of San Francisco and their inclusion will therefore marginally affect the accuracy of the victim-to-population ratio. This affect is more likely to apply to drivers than to bicyclists in San Francisco.

Bicyclist Age

Table 21 summarizes the number of bicyclists involved in a crash by age for the three study periods, Figure 4 displays bicyclist representation by age, Figure 5 and displays KSI bicyclist representation by age. Bicyclists aged 25-39 – and particularly those aged 25-34 – accounted for the largest share of bicyclists involved in crashes in both time periods. Bicyclists aged 20-34 were the most overrepresented parties involved in a crash for all three study periods. Bicyclists aged 40-44 and 50-54 were overrepresented to a greater degree during the pandemic periods than in the pre-pandemic study period. Younger bicyclists were underrepresented in all years, but comprised a higher percentage of the parties during the pandemic compared to pre-pandemic crashes.

The distribution of KSI crashes by bicyclist age closely resembles the distribution for overall crashes. Similar to overall crashes, bicyclists aged between 20-25 and 30-39 were the most overrepresented in KSI crashes. There are some noticeable differences between the pre-pandemic and pandemic KSI bicyclist representation for bicyclists aged between 40-44 and 50-54, which is largely due to small sample sizes for both study periods.

Table 21: Number of Bicyclists Involved in a crash, by age and study period, 2017-2022

Bicyclist Age	% Parties			Population		Representation		
	2017-2019	2020-2022	All Years	#	%	2017-2019	2020-2022	All Years
0 – 4	0.0%	0.3%	0.1%	38,219	4.4%	0.00	0.06	0.02
5 – 9	0.2%	0.9%	0.4%	30,641	3.5%	0.05	0.25	0.12
10 – 14	0.7%	1.0%	0.8%	31,831	3.7%	0.18	0.28	0.21
15 – 19	2.6%	2.6%	2.6%	31,520	3.6%	0.70	0.70	0.70
20 – 24	9.1%	7.4%	8.6%	44,753	5.2%	1.77	1.44	1.66
25 – 29	18.5%	16.4%	17.8%	94,090	10.9%	1.70	1.51	1.64
30 – 34	18.8%	18.1%	18.6%	101,572	11.7%	1.60	1.54	1.58
35 – 39	12.3%	11.3%	12.0%	79,269	9.2%	1.34	1.23	1.31
40 – 44	8.6%	9.7%	9.0%	60,203	7.0%	1.24	1.40	1.29
45 – 49	7.3%	6.4%	7.0%	58,302	6.7%	1.08	0.95	1.04
50 – 54	6.6%	9.0%	7.4%	55,772	6.4%	1.03	1.39	1.14
55 – 59	6.1%	6.0%	6.1%	52,366	6.0%	1.01	1.00	1.00
60 – 64	3.0%	3.3%	3.1%	49,442	5.7%	0.53	0.58	0.55
65 – 69	2.3%	2.3%	2.3%	43,329	5.0%	0.47	0.46	0.46
70 – 74	1.0%	1.4%	1.1%	35,260	4.1%	0.25	0.35	0.28
75 – 79	0.4%	0.8%	0.5%	21,605	2.5%	0.17	0.31	0.21
80 – 84	0.2%	0.3%	0.2%	15,965	1.8%	0.13	0.14	0.13
85+	0.0%	0.0%	0.0%	21,794	2.5%	0.00	0.00	0.00
Unknown	2.3%	2.9%	2.5%	-	-	-	-	-
Total	**100.0%**	**100.0**	**100.0%**	**-**	**100.0%**	-	-	-
	1,676	**781**	**2,457**	**865,933**	**-**	**-**	**-**	-

Representation values greater than 1 indicates that age cohort is overrepresented in crashes. Values less than 1 indicate underrepresentation.

Figure 4: Bicyclist Representation by Age, 2017-2021

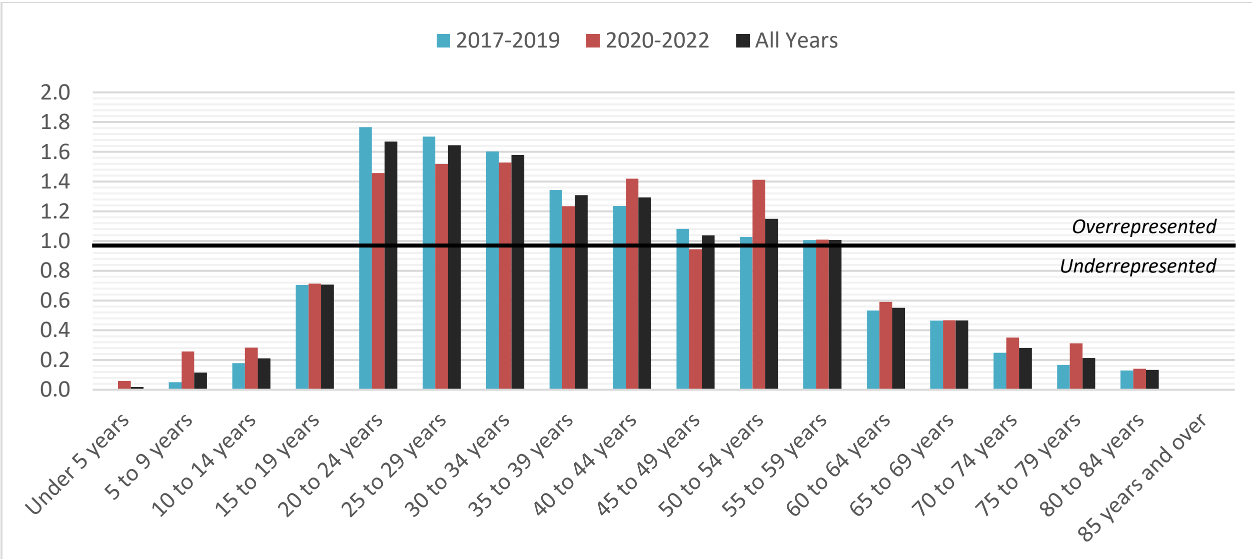
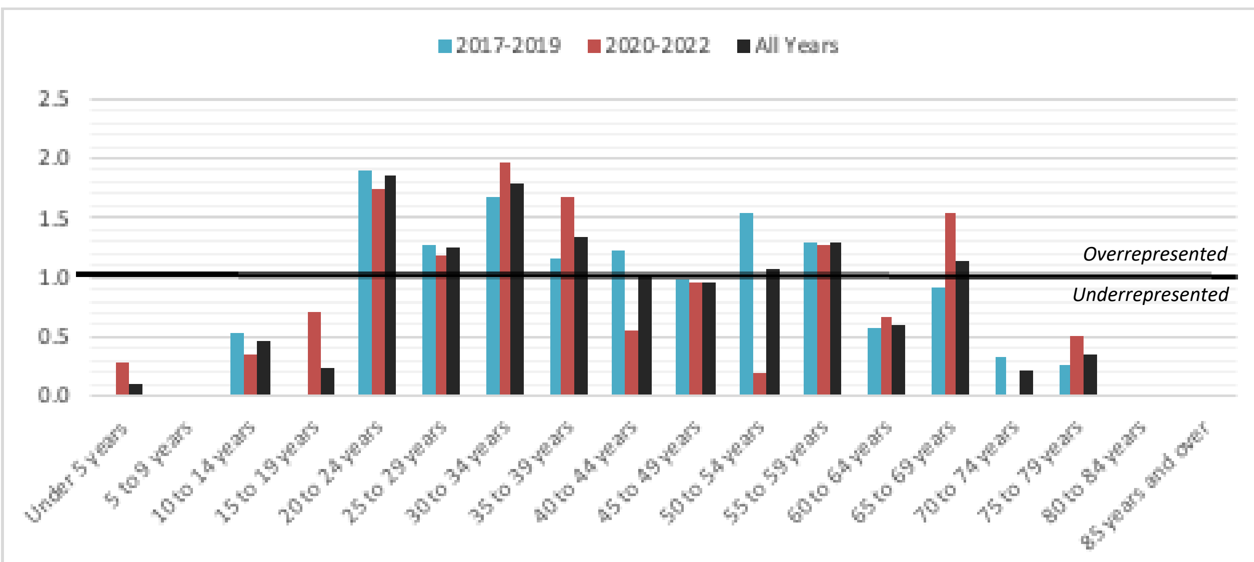


Figure 5: KSI Bicyclist Representation by Age, 2017-2021



Driver Age

Table 22 summarizes drivers involved in bicycle crashes by age and study period, Figure 6 displays the representation of drivers by age, Figure 7 and displays the representation of drivers by age involved in KSI crashes. The distributions of drivers between study periods are similar, with only minor differences no larger than two percentage points. Drivers aged 30-34 accounted for the largest share of drivers involved in crashes with a bicyclist for all three study periods. Like bicyclists, drivers were overrepresented on a per capita basis across a broad range of age cohorts in one or both time periods (20-24 and 35-59). Drivers aged 25-39 were generally underrepresented in these same time periods.

Driver representation in KSI crashes was slightly different than for overall crashes. Drivers aged 25-29 and 40-49 were the most overrepresented in the pre-pandemic period, whereas drivers aged 30-39 and 45-59 were the most overrepresented during the pandemic study period. Representation for both study periods should be interpreted with caution due to the smaller sample sizes for KSI crashes (116 drivers for pre-pandemic study period, 56 drivers for the pandemic study period).

Table 22: Number of Drivers Involved in a crash by age and study period, 2017-2022

Driver Age	% Parties			Population		Representation		
	2017-2019	2020-2022	All Years	# Population	% Population	2017-2019	2020-2022	All Years
0 – 4[14]	0.1%	0.5%	0.2%	38,219	4.4%	0.02	0.11	0.04
5 – 9	0.0%	0.0%	0.0%	30,641	3.5%	0.00	0.00	0.00
10 – 14	0.0%	0.0%	0.0%	31,831	3.7%	0.00	0.00	0.00
15 – 19	2.1%	1.3%	1.8%	31,520	3.6%	0.58	0.34	0.51
20 – 24	6.4%	5.9%	6.3%	44,753	5.2%	1.24	1.15	1.21
25 – 29	8.6%	6.9%	8.1%	94,090	10.9%	0.80	0.63	0.75
30 – 34	10.3%	10.2%	10.3%	101,572	11.7%	0.88	0.87	0.88
35 – 39	8.3%	10.2%	8.9%	79,269	9.2%	0.91	1.11	0.97
40 – 44	8.2%	8.3%	8.2%	60,203	7.0%	1.17	1.19	1.18
45 – 49	8.4%	8.3%	8.3%	58,302	6.7%	1.24	1.23	1.24
50 – 54	8.2%	7.8%	8.1%	55,772	6.4%	1.28	1.21	1.26
55 – 59	6.7%	8.3%	7.2%	52,366	6.0%	1.10	1.37	1.19
60 – 64	5.6%	4.9%	5.4%	49,442	5.7%	0.98	0.85	0.94
65 – 69	4.1%	2.8%	3.7%	43,329	5.0%	0.81	0.56	0.74
70 – 74	3.1%	2.2%	2.8%	35,260	4.1%	0.76	0.54	0.69
75 – 79	1.1%	1.9%	1.3%	21,605	2.5%	0.42	0.75	0.52
80 – 84	0.6%	0.9%	0.7%	15,965	1.8%	0.34	0.51	0.39
85+	0.0%	0.0%	0.0%	21,794	2.5%	0.00	0.00	0.00
Unknown	*18.3%*	*19.7%*	*18.7%*	-	-	-	-	-
Total	**100.0%**	**100.0%**	**100.0%**	-	**100.0%**	-	-	-
	1,423	**639**	**2,062**	**865,933**	-	**-**	**-**	-
Representation values greater than 1 indicates that age cohort is overrepresented in crashes. Values less than 1 indicate underrepresentation.								

[14] Values greater than 0% for cohorts younger than 16 years of age are likely reporting errors in the crash data.

Figure 6: Driver Representation by Age, 2017-2021

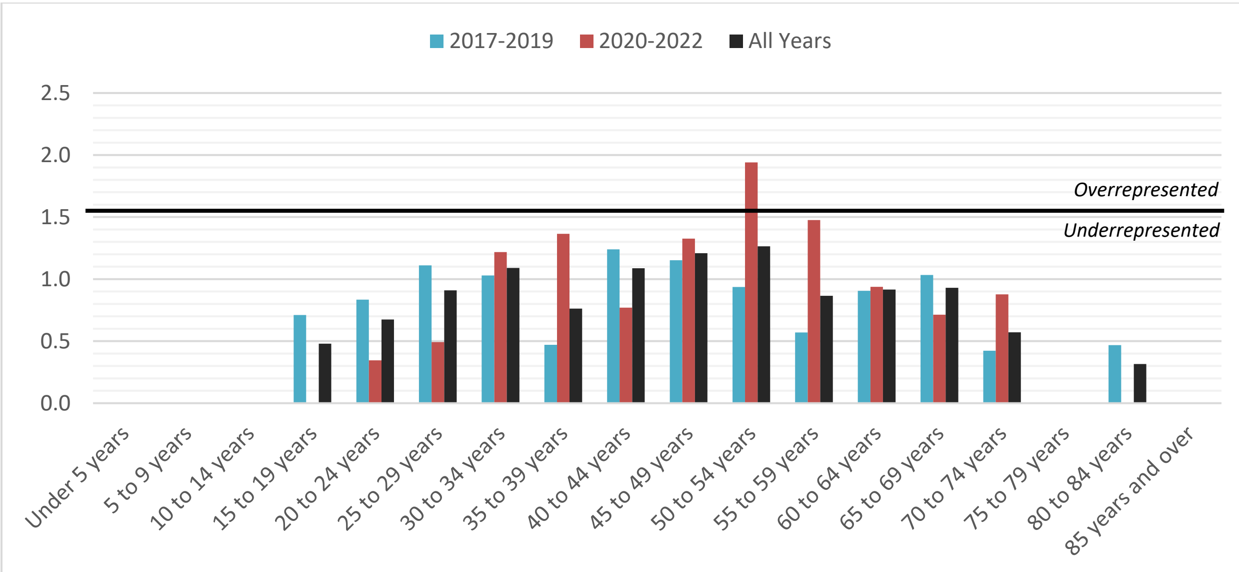
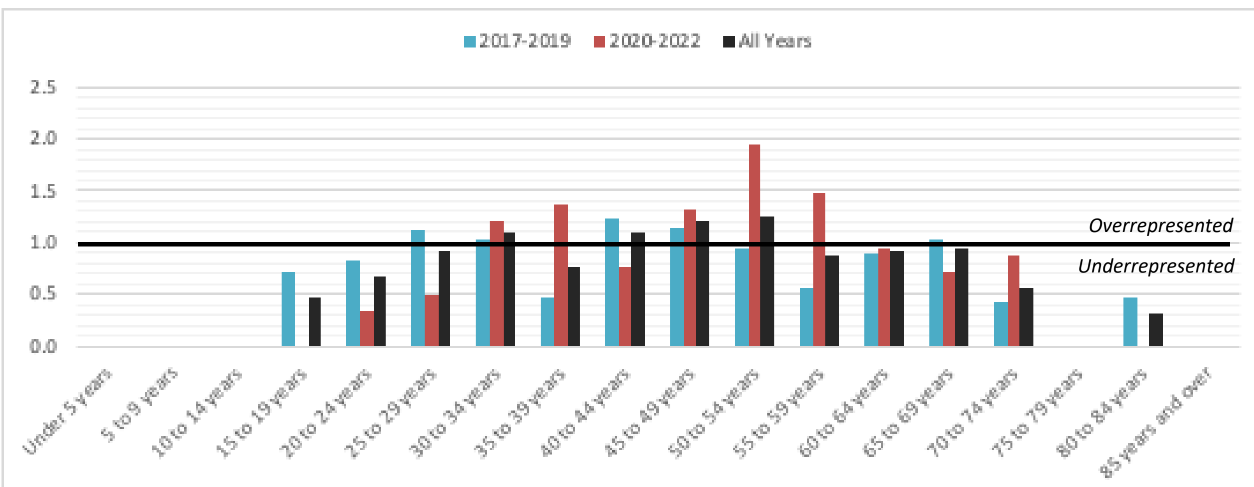


Figure 7: Driver Representation in KSI crashes by Age, 2017-2021



Bicyclist Race

Disclaimer: Party race is based on officer's assumption or visual impression, which can be problematic and inaccurate. Additionally, there are only five racial categories (excludes "Not Stated") within the crash data, in contrast to the US Census, which has nearly twice as many race and ethnicity categories. The victim representation and comparison made to the San Francisco population should be interpreted with caution given these reporting shortcomings.

Table 23 summarizes bicyclist race for the pre-pandemic study period. White bicyclists accounted for the largest share of bicyclists involved in a crash (57%), followed by Hispanic bicyclists (13%). When comparing the share of parties to the share of population by race, Black bicyclists were the most overrepresented (1.91) party involved in a crash, followed by white bicyclists (1.54). The Black population in San Francisco was 5%, but 9.6% of crashes involved a Black bicyclist. While these ratios do not account for the percentage of the population that rides a bike, they indicate a need to explore equity-related issues in order to understand the potential factors contributing to this disproportion. Additional research is needed to better understand the travel behaviors and mode use for each race.

Table 23: Bicyclist by Race, 2017-2019

Bicyclist Race	# Bicyclists	% of Bicyclists	# Population	% Population	Bicyclist Representation
Asian	182	10.9%	286,518	35.1%	0.31
Black	161	9.6%	40,955	5.0%	1.91
Hispanic	211	12.6%	128,030	15.7%	0.80
White	959	57.2%	302,182	37.1%	1.54
Other	131	7.8%	57,516	7.1%	1.11
Not Stated	32	1.9%	-	-	-
Total	***1,676***	***100%***	***815,201***	***100%***	-

Table 24 summarizes bicyclist race for the pre-pandemic study period for KSI crashes. The distribution and representation of KSI bicyclist by race was similar to overall crashes. Black bicyclists were the most overrepresented (1.70) followed by white bicyclists (1.62).

Table 24: KSI Bicyclist by Race, 2017-2019

Bicyclist Race	# KSI Bicyclists	% of KSI Bicyclists	# Population	% Population	KSI Bicyclist Representation
Asian	17	11.2%	286,518	35.1%	0.32
Black	13	8.6%	40,955	5.0%	1.70
Hispanic	18	11.8%	128,030	15.7%	0.75
White	91	59.9%	302,182	37.1%	1.62
Other	10	6.6%	57,516	7.1%	0.93
Not Stated	3	2.0%	-	0.0%	-
Total	***152***	***100.0%***	***815,201***	***100.0%***	**-**

Table 25 summarizes bicyclist race for the pandemic study period. The distribution of victims was somewhat like the pre-pandemic periods, but with some key differences. Black bicyclist representation in crashes was even higher in the pandemic period (2.19). Hispanic bicyclists were slightly overrepresented in crashes (1.19), compared to being underrepresented during the pre-pandemic period. Lastly, white bicyclists are still overrepresented in crashes but to a lesser degree than during the pre-pandemic period.

Table 25: Bicyclist by Race, 2020-2021

Bicyclist Race	# Bicyclists	% of Bicyclists	# Population	% Population	Bicyclist Representation
Asian	102	13.1%	286,518	35.1%	0.37
Black	86	11.0%	40,955	5.0%	2.19
Hispanic	146	18.7%	128,030	15.7%	1.19
White	394	50.4%	302,182	37.1%	1.36
Other	49	6.3%	57,516	7.1%	0.89
Not Stated	4	0.5%	-	-	-
Total	***781***	***100%***	***815,201***	***100%***	**-**

Table 26 summarizes bicyclist race for the pandemic study period for KSI crashes. The distribution and representation of KSI bicyclist by race was similar to overall crashes during the pandemic, with the exception that Hispanic bicyclists were underrepresented. Once again, Black bicyclists were the most overrepresented (2.30), followed by white bicyclists (1.49).

Table 26: KSI Bicyclist by Race, 2020-2021

Bicyclist Race	# KSI Bicyclists	% of KSI Bicyclists	# Population	% Population	KSI Bicyclist Representation
Asian	14	17.9%	286,518	35.1%	0.51
Black	9	11.5%	40,955	5.0%	2.30
Hispanic	9	11.5%	128,030	15.7%	0.73
White	43	55.1%	302,182	37.1%	1.49
Other	3	3.8%	57,516	7.1%	0.55
Total	***78***	***100.0%***	***815,201***	***100.0%***	**-**

Driver Race

The home zip code is not readily available for all parties involved in the crash, therefore we cannot rule out that some people driving a motor vehicle live outside of San Francisco and their inclusion will therefore marginally affect the accuracy of the victim-to-population ratio. This affect is more likely to apply to drivers than to bicyclists in San Francisco.

Table 27 summarizes driver race for the pre-pandemic study period. White drivers accounted for the largest share of drivers involved in a crash with a bicyclist (32%), followed by Asian (15.7%) and Black (15.5%) drivers. Like bicyclist representation, Black drivers were the most overrepresented driver group by a large margin, followed by “Other” (1.78).

Table 27: Driver by Race, 2017-2019

Driver Race	# Drivers	% of Drivers	# Population	% Population	Driver Representation
Asian	223	15.7%	286,518	35.1%	0.45
Black	191	13.4%	40,955	5.0%	2.67
Hispanic	217	15.2%	128,030	15.7%	0.97
White	453	31.8%	302,182	37.1%	0.86
Other	179	12.6%	57,516	7.1%	1.78
Not Stated	160	11.2%	-	-	-
Total	***1,423***	***100%***	***815,201***	***100%***	**-**

Table 28 summarizes driver race for the pre-pandemic study period for KSI crashes. The distribution of drivers by race involved in a KSI crashes is similar to the distribution for overall crashes except for the larger share of drivers that did not have an assigned racial category (22%). These crashes may be related to hit-and-run crashes, which are not identified in the study crash data. Similar to overall crashes, Black drivers were disproportionately involved in KSI crashes (2.23).

Table 28: Driver by Race Involved in KSI Crashes, 2017-2019

Driver Race	# Drivers	% of Drivers	# Population	% Population	Driver Representation
Asian	20	17.2%	286,518	35.1%	0.49
Black	13	11.2%	40,955	5.0%	2.23
Hispanic	18	15.5%	128,030	15.7%	0.99
White	31	26.7%	302,182	37.1%	0.72
Other	9	7.8%	57,516	7.1%	1.10
Not Stated	25	21.6%	-	0.0%	-
Total	***116***	***100.0%***	***815,201***	***100.0%***	**-**

Table 29 summarizes driver race for the pandemic study period. White drivers were again the most frequently involved racial category (26.6%), followed by Hispanic (18.9%) and Asian (18.2%) drivers (in contrast to the pre-pandemic period). Like the pre-pandemic period, Black drivers were the most overrepresented (2.65) group, followed by “Other” (1.66) and Hispanic (1.21). Hispanic drivers were slightly underrepresented during the pre-pandemic study period.

Table 29: Driver by Race, 2020-2021

Driver Race	# Drivers	% of Drivers	# Population	% Population	Driver Representation
Asian	116	18.2%	286,518	35.1%	0.52
Black	85	13.3%	40,955	5.0%	2.65
Hispanic	121	18.9%	128,030	15.7%	1.21
White	170	26.6%	302,182	37.1%	0.72
Other	75	11.7%	57,516	7.1%	1.66
Not Stated	72	11.3%	-	-	-
Total	***639***	***100%***	***815,201***	***100%***	**-**

Table 30 summarizes driver race for the pandemic study period for KSI crashes. The distribution of drivers by race involved in KSI crashes differed from the distribution for overall crashes, in that Asian (29%), Black (18%), and white (35%) drivers accounted for a larger share for KSI crashes compared to overall crashes. This difference may be related to changes to driving behaviors or statistical noise due to KSI crashes having a smaller sample size. Like overall crashes, Black drivers were disproportionately involved in KSI crashes (3.66).

Table 30: Driver by Race Involved in KSI Crashes, 2020-2021

Driver Race	# Drivers	% of Drivers	# Population	% Population	Driver Representation
Asian	14	28.6%	286,518	35.1%	0.81
Black	9	18.4%	40,955	5.0%	3.66
Hispanic	6	12.2%	128,030	15.7%	0.78
White	17	34.7%	302,182	37.1%	0.94
Other	3	6.1%	57,516	7.1%	0.87
Total	***49***	***100.0%***	***815,201***	***100.0%***	

Bicyclist and Driver Race

Table 31 and Table 32 summarize the number of parties involved in each crash for both the bicyclist and driver involved (only includes the first two parties involved – numbers will not match the previous race tables). Values greater than one indicate that particular bicyclist race was disproportionately involved in crashes with drivers of the corresponding driver race. These values are calculated by dividing the bicyclist percentage by the driver race percentage and are not per capita based, therefore these values cannot be compared to the other proportionality measures discussed in this analysis.

White bicyclists were not particularly overrepresented in crashes with a driver of other races during both study periods. Hispanic bicyclists were overrepresented in pre-pandemic crashes with white (1.13) and Asian (1.10) drivers, and were overrepresented in crashes during the pandemic study period with Hispanic (1.23) drivers. Asian bicyclists were slightly to moderately disproportionately involved in crashes during the pre-pandemic crashes with white (1.10), Hispanic (1.08), Asian (1.06), and other (1.12) drivers. Asian bicyclists were particularly overrepresented in pandemic crashes with Asian (1.44) and other (1.24) drivers. Black bicyclists were most disproportionately involved in crashes with

Hispanic (1.24) and Black (1.51) drivers during the pre-pandemic period. These patterns may reflect historic racial segregation and mobility in different neighborhoods throughout San Francisco. Additional research is needed to better understand the travel behaviors and mode preferences for each race.

Table 31: Primary Bicyclist and Primary Driver Race Representation, 2017-2019

Bicyclist Race	Driver Race: White	Hispanic	Asian	Black	Other	Not Stated	# Bicyclists
White	1.04	0.97	1.00	0.99	0.93	1.02	***774***
Hispanic	1.13	0.97	1.10	0.77	1.01	0.79	***181***
Asian	1.10	1.08	1.06	0.77	1.12	0.68	***133***
Black	0.76	1.24	1.03	1.51	0.95	0.76	***131***
Other	0.75	0.85	0.90	1.16	1.62	1.18	***107***
Not	0.67	1.13	0.28	0.64	0.00	4.30	***23***
# Drivers	***435***	***207***	***210***	***184***	***163***	***150***	

Table 32: Primary Bicyclist and Primary Driver Race Representation, 2020-2021

Bicyclist Race	Driver Race: White	Hispanic	Asian	Black	Other	Not Stated	# Bicyclists
White	1.02	0.96	0.96	1.07	0.84	1.17	***314***
Hispanic	0.92	1.23	0.90	0.90	1.05	1.05	***122***
Asian	0.98	1.06	1.44	0.77	1.24	0.24	***76***
Black	1.02	0.81	0.99	1.00	0.91	1.39	***66***
Other	1.15	0.77	0.91	1.05	1.63	0.44	***42***
Not	0.00	1.79	0.00	2.44	2.84	0.00	***3***
# Drivers	***167***	***116***	***114***	***85***	***73***	***68***	

Bicyclist Gender

Disclaimer: Party gender is based on officer's assumption or visual impression, which can be problematic and inaccurate. The only categorical values for gender in the crash report form include "male", "female", and "Not Stated" and do not include other personal gender identities. The victim representation and comparison made to the San Francisco population should be interpreted with caution given these reporting shortcomings.

Table 33 and Table 34 summarize bicyclists by gender for all crashes and KSI crashes respectively. Male bicyclists accounted for the majority of bicyclists involved in crashes and KSI crashes during both study periods. This may be a reflection of male bicyclists feeling more confident or comfortable riding a bicycle in San Francisco. This may also be a reflection of male bicyclists not experiencing perceived risk (crash or personal safety) that female or non-male-identifying bicyclists experience[15]. Additional

[15] https://safetrec.berkeley.edu/sites/default/files/whydontwomencycle_9.3_v2.pdf

research to better understand travel preferences and bicycling frequency by gender can help contextualize this finding.

Table 33: Number of Bicyclists Involved in a crash, by gender and study period, 2017-2022

Bicyclist Gender	% Parties			Population		Representation		
	2017-2019	2020-2022	All Years	# Population	% Population	2017-2019	2020-2022	All Years
Male	77.9%	78.6%	78.1%	443,653	51.2%	1.52	1.53	1.52
Female	21.4%	21.3%	21.4%	422,280	48.8%	0.44	0.44	0.44
Not Stated	0.7%	0.1%	0.5%	-	-	-	-	-
Total	***100.0%***	***100.0%***	***100.0%***	***865,933***	***100.0%***	**-**	-	-
Representation values greater than 1 indicates that age cohort is overrepresented in crashes. Values less than 1 indicate underrepresentation.								

Table 34: Number of fatally or severely injured Bicyclists Involved in a crash, by gender and study period, 2017-2022

Bicyclist Gender	% Parties			Population		Representation		
	2017-2019	2020-2022	All Years	# Population	% Population	2017-2019	2020-2022	All Years
Male	75.0%	80.8%	77.0%	443,653	51.2%	1.46	1.58	1.50
Female	23.7%	19.2%	22.2%	422,280	48.8%	0.49	0.39	0.45
Not Stated	1.3%	0.0%	0.9%	-	-	-	-	-
Total	***100.0%***	***100.0%***	***100.0%***	***865,933***	***100.0%***	**-**	**-**	**-**
Representation values greater than 1 indicates that age cohort is overrepresented in crashes. Values less than 1 indicate underrepresentation.								

Conclusion and Next Steps

This document summarized the who, when, and why questions related to bicycle crashes within San Francisco between 2017-2021 The findings of this analysis will be shared with the public during Community Engagement Phase 2 (April – June 2023). This is the final draft of the Step I analysis. The follow-up analysis (Step II) will begin and will use systemic safety principles to analyze where crashes occurred and what factors contributed to those crashes.

Appendix A

Generalized Violation Types

The table below represents the how violation types summarized in Table 9 and Table 10 have been grouped into similar violation types.

Table 35: California Vehicle Code Violation Types

Violation Code	Definition	Generalized Category
21657	The authorities in charge of any highway may designate any highway, roadway, part of a roadway, or specific lanes upon which vehicular traffic shall proceed in one direction at all or such times as shall be indicated by official traffic control devices. When a roadway has been so designated, a vehicle shall be driven only in the direction designated at all or such times as shall be indicated by traffic control devices.	Wrong way travel
21651	Bicyclists riding in the roadway or on a shoulder must ride in the same direction of traffic	Wrong way riding
21663	Must not operate a vehicle on a sidewalk except to enter or exit an adjacent properly	Vehicle on sidewalk
24002	Vehicles, loads, or other roadway equipment must not present a safety hazard and be lawfully equipped	Vehicle load ill-equipped
21209	Must not drive a vehicle in the bicycle lane	Vehicle in bike lane
22106	Must not stop, park, or reverse on a highway unless conditions are safe to do so	Unsafe stop
21712	Must not ride in a portion of a vehicle that is not intended for passengers (e.g., trunk)	Unsafe passenger position
21703	Must allow adequate space between vehicles traveling the same direction on a roadway	Unsafe pass
23336	It is unlawful to violate any rules or regulations adopted under Section 23334, notice of which has been given either by a sign on a vehicular crossing or by publication as provided in Section 23335.	Unknown
22515	Must set the brakes before leaving a vehicle unattended	Unattended vehicle
21960	The Department of Transportation and local authorities, by order, ordinance, or resolution, with respect to freeways, expressways, or designated portions thereof under their respective jurisdictions, to which vehicle access is completely or partially controlled, may prohibit or restrict the use of the freeways, expressways, or any portion thereof by pedestrians, bicycles or other nonmotorized traffic or by any person operating a motor-driven cycle, motorized bicycle, motorized scooter, or electrically motorized board.	Travel prohibited
21208	Bicyclists traveling at less than the normal speed of the roadway must travel in the bicycle lane if one is present, except when it is necessary to leave the lane to turn, overtake, or avoid a hazardous condition	Too slow condition
22400	Must not drive slower than a normal speed except when dangerous conditions are present, or stop unexpectedly on a roadway	Too slow condition
22350	Must drive at a reasonable speed	Too fast condition
21760	Must allow three feet of space between the vehicle and bicyclist when overtaking a bicyclist	Three feet safety
21461	Must obey all regulatory signals and signs (applies to pedestrians and drivers)	Disregard signal or sign
21457	Must abide by rules for flashing yellow and red signals	Disregard signal or sign
21229	If a class II bikeway is present, operators of motorized scooters shall ride in the bicycle lane, except when turning, overtaking, or avoiding a hazardous condition	Scooter needs to travel in bike lane
23103	Reckless driving occurs when a driver operates a vehicle with willful disregard for the safety of people or property	Reckless driving
21750	Must pass on the left if overtaking another vehicle	Overtaking

Violation Code	Definition	Generalized Category
21755	Must only pass another vehicle on the right if able to do so safely	Overtaking
21951	Must not overtake another vehicle that has stopped to yield to a pedestrian	Overtaking
21756	The driver of a vehicle overtaking any interurban electric or streetcar stopped or about to stop for the purpose of receiving or discharging any passenger shall stop the vehicle to the rear of the nearest running board or door of such car and thereupon remain standing until all passengers have boarded the car or upon alighting have reached a place of safety	Overtaking
12500	A person may not drive a motor vehicle upon a highway, unless the person then holds a valid driver license issued under this code, except those persons who are expressly exempted under this code.	No valid license
21235	Motorize scooter violation	Motorized Scooter Violation
21955	Pedestrians must cross in the middle of the block only where there is a crosswalk	Illegal mid-block crossing
21211	Must not loiter in a class I bikeway	Loiter in bike lane
21650	Must drive on right half of the highway except when passing another vehicle, making a legal left turn, or when the right half of the roadway is closed	Keep right
22110	The signals required by this chapter shall be given by signal lamp, unless a vehicle is not required to be and is not equipped with turn signals. Drivers of vehicles not required to be and not equipped with turn signals shall give a hand and arm signal when required by this chapter.	Improper signal
22105	Must not make a U-turn in areas where the driver does not have an unobstructed view for 200 feet in both directions	Improper U-turn
22102	Must not make a U-turn in a business district except at intersections or locations where U-Turns are permitted	Improper U-turn
22103	Must not make a U-turn in a residential district when any other vehicle is approaching in either direction within 200 feet, except at an intersection when the approaching vehicle is controlled by a traffic device	Improper U-turn
22107	Must turn in a safe place and use a turn signal	Improper turn
22100	Must make right- and left-hand turns as close as practicable to the right- and left-hand edge of roadway, respectively	Improper turn
22101	Must obey signals and signs indicating turning restrictions, such as no-turn-on-red signs or signals	Improper turn
21717	Whenever it is necessary for the driver of a motor vehicle to cross a bicycle lane that is adjacent to his lane of travel to make a turn, the driver shall drive the motor vehicle into the bicycle lane prior to making the turn and shall make the turn pursuant to Section 22100.	Improper turn
22450	Must stop at stop sign before intersection, or stop line, or crosswalk	Improper stop
22109	No person shall stop or suddenly decrease the speed of a vehicle on a highway without first giving an appropriate signal in the manner provided in this chapter to the driver of any vehicle immediately to the rear when there is opportunity to give the signal.	Improper stop
22500	A person shall not stop, park, or leave standing any vehicle whether attended or unattended, except when necessary to avoid conflict with other traffic or in compliance with the directions of a peace officer or official traffic control device	Improper parking
21658	Must drive within a single lane if roadway has been divided into two or more lanes, unless directed otherwise	Improper lane
23152	Must not drive while under the influence of alcohol	Impairment
23153	Must not drive while under the influence of alcohol and concurrently break the law	Impairment
21206	This chapter does not prevent local authorities, by ordinance, from regulating the registration of bicycles and the parking and operation of bicycles on pedestrian or bicycle facilities, provided such regulation is not in conflict with the provisions of this code	Illegal bicycle operation

Violation Code	Definition	Generalized Category
20001	Must stop if vehicle is involved in an accident resulting in an injury to a person, other than oneself	Hit and run
20002	The driver of any vehicle involved in an accident resulting only in damage to any property, including vehicles, shall immediately stop the vehicle at the nearest location that will not impede traffic or otherwise jeopardize the safety of other motorists.	Hit and run
21950	Must yield to pedestrian crossing the roadway at an intersection	Failure to yield to pedestrian
21952	Must yield to pedestrian before driving over or on any sidewalk	Failure to yield to pedestrian
21801	Must yield to oncoming traffic before turning left or making a U-Turn	Failure to yield – driver left turn
21804	Must yield to traffic when entering or crossing a highway	Failure to yield
21954	Pedestrians must yield right-of-way to vehicles except when at a marked crosswalk or an unmarked crosswalk at an intersection	Failure to yield
21800	Must yield to drivers already in an intersection when approaching an intersection	Failure to yield
21456	Pedestrians must obey pedestrian signal heads but must yield to vehicles legally in the intersection at the time that the signal is first shown	Failure to yield
21803	Drivers must obey yield signs at intersections controlled by a yield right-of-way sign	Failure to yield intersection
21451	A driver facing a circular green signal shall proceed straight through or turn right or left or make a U-turn unless a sign prohibits a U-turn. Any driver, including one turning, shall yield the right-of-way to other traffic and to pedestrians lawfully within the intersection or an adjacent crosswalk.	Failure to yield intersection
21707	No motor vehicle, except an authorized emergency vehicle or a vehicle of a duly authorized member of a fire or police department, shall be operated within the block wherein an emergency situation responded to by any fire department vehicle exists, except that in the event the nearest intersection to the emergency is more than 300 feet therefrom, this section shall prohibit operation of vehicles only within 300 feet of the emergency, unless directed to do so by a member of the fire department or police department, sheriff, deputy sheriff, or member of the California Highway Patrol.	Failure to yield emergency
22108	Any signal of intention to turn right or left shall be given continuously during the last 100 feet traveled by the vehicle before turning.	Failure to signal turn
21802	Must stop at stop sign and yield to drivers that do not have a stop sign	Fail to stop
21807	Drivers of emergency vehicles must drive with regard for the safety of all people and property	Emergency vehicle unsafe
21752	Must not drive on the left side of a roadway when approaching a grade or curve, or when the drivers vision is obstructed within 100 feet of a railroad crossing, intersection, bridge, or tunnel	Driving left of centerline
21203	Must not attach oneself to a streetcar or vehicle on the roadway if traveling by bicycle, motorcycle, skates, sled, or motorized bicycle	Drag tow
22517	Must not open vehicle door on the same side as moving traffic unless it will not interfere with moving traffic	Dooring
21460	Must not cross double parallel solid yellow or white lines	Do not cross solid line
23123	A person shall not drive a motor vehicle while using a wireless telephone unless that telephone is specifically designed and configured to allow hands-free listening and talking, and is used in that manner while driving.	Distracted phone
27400	A person operating a motor vehicle or bicycle may not wear a headset covering, earplugs in, or earphones covering, resting on, or inserted in, both ears.	Distracted headphones
21453	Must stop at red light	Disregard signal

Violation Code	Definition	Generalized Category
21202	Bicyclists must ride as close as practicable to the right-hand edge of the road, except when passing, preparing for a left-turn, avoiding roadway hazards, or preparing to turn right	Close practicable
21662	Must maintain control of vehicles on all roads and drive on the right side of the roadway if no center line is present	Close practicable
21751	Must not drive left of center on a two-lane roadway, except to pass	Close practicable
21956	Pedestrians must walk close to the right- or left-hand edge of the roadway	Close practicable
21200	Bicyclists must abide by the same rules as vehicle drivers	Bike-Vehicle violation
21201	Must not ride a bicycle on a roadway unless it is equipped with brakes, lights, and reflectors	Bike illegal equipment

Appendix B

Pre-Crash Movement (Full Tables)

The tables below expand upon Table 5 and Table 6 and display all crash types, not just the top 10 crash types.

Table 36: Bicycle Crashes by Pre-Crash Movements, 2017-2019

Bike + Motorist or Pedestrian Movements	# Crashes	% crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
Proceeding Straight, Proceeding Straight	310	18.6%	103.3	28	17.7%	9.3	9.0%
Proceeding Straight, Making Left Turn	215	12.9%	71.7	17	10.8%	5.7	7.9%
Proceeding Straight, Making Right Turn	202	12.1%	67.3	12	7.6%	4.0	5.9%
solo bike Proceeding Straight	139	8.3%	46.3	31	19.6%	10.3	22.3%
Proceeding Straight, Stopped	113	6.8%	37.7	13	8.2%	4.3	11.5%
Proceeding Straight, Parked	48	2.9%	16.0	5	3.2%	1.7	10.4%
Making Left Turn, Proceeding Straight	46	2.8%	15.3	4	2.5%	1.3	8.7%
Proceeding Straight, Making U Turn	40	2.4%	13.3	1	0.6%	0.3	2.5%
Proceeding Straight, Entering Traffic	33	2.0%	11.0	3	1.9%	1.0	9.1%
Proceeding Straight, Changing Lanes	33	2.0%	11.0	2	1.3%	0.7	6.1%
Proceeding Straight, Parking Maneuver	31	1.9%	10.3	3	1.9%	1.0	9.7%
Proceeding Straight, Crossing in Crosswalk at Intersection	31	1.9%	10.3	2	1.3%	0.7	6.5%
Making Right Turn, Proceeding Straight	23	1.4%	7.7	1	0.6%	0.3	4.3%
Proceeding Straight, Crossing Not in Crosswalk	23	1.4%	7.7	2	1.3%	0.7	8.7%
Stopped, Proceeding Straight	22	1.3%	7.3	0	0.0%	0.0	0.0%
Not Stated, Not Stated	17	1.0%	5.7	1	0.6%	0.3	5.9%
Proceeding Straight, Slowing/Stopping	16	1.0%	5.3	2	1.3%	0.7	12.5%
Proceeding Straight, Passing Other Vehicle	14	0.8%	4.7	0	0.0%	0.0	0.0%
Changing Lanes, Proceeding Straight	13	0.8%	4.3	0	0.0%	0.0	0.0%
Proceeding Straight, Backing	12	0.7%	4.0	0	0.0%	0.0	0.0%
Proceeding Straight, Other Unsafe Turning	12	0.7%	4.0	1	0.6%	0.3	8.3%
Proceeding Straight, Not Stated	12	0.7%	4.0	4	2.5%	1.3	33.3%
Proceeding Straight, nan	12	0.7%	4.0	0	0.0%	0.0	0.0%
solo bike Changing Lanes	11	0.7%	3.7	3	1.9%	1.0	27.3%
solo bike Making Left Turn	10	0.6%	3.3	1	0.6%	0.3	10.0%
Proceeding Straight, Not in Road	10	0.6%	3.3	0	0.0%	0.0	0.0%
Entering Traffic, Proceeding Straight	10	0.6%	3.3	2	1.3%	0.7	20.0%
Stopped, Stopped	9	0.5%	3.0	0	0.0%	0.0	0.0%
Proceeding Straight, In Road, Including Shoulder	9	0.5%	3.0	2	1.3%	0.7	22.2%
Passing Other Vehicle, Proceeding Straight	8	0.5%	2.7	0	0.0%	0.0	0.0%
Passing Other Vehicle, Stopped	7	0.4%	2.3	0	0.0%	0.0	0.0%
Proceeding Straight, Other	6	0.4%	2.0	2	1.3%	0.7	33.3%
solo bike Making Right Turn	6	0.4%	2.0	1	0.6%	0.3	16.7%
Traveling Wrong Way, Proceeding Straight	6	0.4%	2.0	0	0.0%	0.0	0.0%
Making Right Turn, Stopped	6	0.4%	2.0	0	0.0%	0.0	0.0%
Other, Proceeding Straight	5	0.3%	1.7	0	0.0%	0.0	0.0%
Making Left Turn, Making Left Turn	5	0.3%	1.7	2	1.3%	0.7	40.0%
Stopped, Making Right Turn	5	0.3%	1.7	0	0.0%	0.0	0.0%
Proceeding Straight, Merging	5	0.3%	1.7	0	0.0%	0.0	0.0%
Making Right Turn, Making Left Turn	5	0.3%	1.7	0	0.0%	0.0	0.0%
solo bike Other	4	0.2%	1.3	1	0.6%	0.3	25.0%
Traveling Wrong Way, Making Left Turn	4	0.2%	1.3	0	0.0%	0.0	0.0%
solo bike Passing Other Vehicle	4	0.2%	1.3	1	0.6%	0.3	25.0%
Traveling Wrong Way, Making Right Turn	4	0.2%	1.3	0	0.0%	0.0	0.0%
Other Unsafe Turning, Proceeding Straight	4	0.2%	1.3	0	0.0%	0.0	0.0%
solo bike Stopped	3	0.2%	1.0	0	0.0%	0.0	0.0%
Proceeding Straight, Ran Off Road	3	0.2%	1.0	0	0.0%	0.0	0.0%

Bike + Motorist or Pedestrian Movements	# Crashes	% crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
Changing Lanes, Stopped	3	0.2%	1.0	0	0.0%	0.0	0.0%
Passing Other Vehicle, Making Right Turn	3	0.2%	1.0	1	0.6%	0.3	33.3%
solo bike Slowing/Stopping	3	0.2%	1.0	1	0.6%	0.3	33.3%
Proceeding Straight, No Pedestrian Involved	3	0.2%	1.0	1	0.6%	0.3	33.3%
Making Left Turn, Parked	3	0.2%	1.0	0	0.0%	0.0	0.0%
Not Stated, Proceeding Straight	3	0.2%	1.0	1	0.6%	0.3	33.3%
Proceeding Straight, Crossing in Crosswalk Not at Intersection	3	0.2%	1.0	0	0.0%	0.0	0.0%
Making U Turn, Proceeding Straight	3	0.2%	1.0	0	0.0%	0.0	0.0%
Making Right Turn, Making Right Turn	3	0.2%	1.0	0	0.0%	0.0	0.0%
Not Stated, Making Left Turn	3	0.2%	1.0	0	0.0%	0.0	0.0%
Merging, Proceeding Straight	2	0.1%	0.7	0	0.0%	0.0	0.0%
Making Right Turn, Crossing in Crosswalk at Intersection	2	0.1%	0.7	0	0.0%	0.0	0.0%
Other, Other	2	0.1%	0.7	0	0.0%	0.0	0.0%
Entering Traffic, Making Right Turn	2	0.1%	0.7	0	0.0%	0.0	0.0%
Stopped, Making Left Turn	2	0.1%	0.7	0	0.0%	0.0	0.0%
Entering Traffic, nan	2	0.1%	0.7	0	0.0%	0.0	0.0%
Changing Lanes, Changing Lanes	2	0.1%	0.7	0	0.0%	0.0	0.0%
Not Stated, Stopped	2	0.1%	0.7	0	0.0%	0.0	0.0%
Making Left Turn, Stopped	2	0.1%	0.7	1	0.6%	0.3	50.0%
Making Left Turn, Crossing in Crosswalk at Intersection	2	0.1%	0.7	0	0.0%	0.0	0.0%
solo bike Ran Off Road	2	0.1%	0.7	1	0.6%	0.3	50.0%
Making Left Turn, nan	2	0.1%	0.7	0	0.0%	0.0	0.0%
Stopped, Passing Other Vehicle	2	0.1%	0.7	0	0.0%	0.0	0.0%
Not Stated, nan	2	0.1%	0.7	0	0.0%	0.0	0.0%
Other, Making Right Turn	2	0.1%	0.7	1	0.6%	0.3	50.0%
Proceeding Straight, Traveling Wrong Way	2	0.1%	0.7	0	0.0%	0.0	0.0%
Making Left Turn, Making Right Turn	1	0.1%	0.3	0	0.0%	0.0	0.0%
Passing Other Vehicle, Not Stated	1	0.1%	0.3	0	0.0%	0.0	0.0%
Passing Other Vehicle, Making Left Turn	1	0.1%	0.3	0	0.0%	0.0	0.0%
Making Left Turn, Other Unsafe Turning	1	0.1%	0.3	0	0.0%	0.0	0.0%
Stopped, In Road, Including Shoulder	1	0.1%	0.3	0	0.0%	0.0	0.0%
Proceeding Straight, Crossed Into Opposing Lane	1	0.1%	0.3	0	0.0%	0.0	0.0%
Traveling Wrong Way, Crossing Not in Crosswalk	1	0.1%	0.3	0	0.0%	0.0	0.0%
Other, Passing Other Vehicle	1	0.1%	0.3	0	0.0%	0.0	0.0%
Merging, Merging	1	0.1%	0.3	0	0.0%	0.0	0.0%
Entering Traffic, Backing	1	0.1%	0.3	0	0.0%	0.0	0.0%
solo bike Traveling Wrong Way	1	0.1%	0.3	0	0.0%	0.0	0.0%
Making Right Turn, nan	1	0.1%	0.3	0	0.0%	0.0	0.0%
Passing Other Vehicle, Parking Maneuver	1	0.1%	0.3	0	0.0%	0.0	0.0%
Other, Stopped	1	0.1%	0.3	0	0.0%	0.0	0.0%
Stopped, Slowing/Stopping	1	0.1%	0.3	0	0.0%	0.0	0.0%
Making Right Turn, Parked	1	0.1%	0.3	1	0.6%	0.3	100.0%
Passing Other Vehicle, Entering Traffic	1	0.1%	0.3	0	0.0%	0.0	0.0%
Parked, Proceeding Straight	1	0.1%	0.3	0	0.0%	0.0	0.0%
Not Stated, Making U Turn	1	0.1%	0.3	0	0.0%	0.0	0.0%
Entering Traffic, Crossing Not in Crosswalk	1	0.1%	0.3	0	0.0%	0.0	0.0%
Other Unsafe Turning, Making Right Turn	1	0.1%	0.3	0	0.0%	0.0	0.0%
Passing Other Vehicle, Slowing/Stopping	1	0.1%	0.3	0	0.0%	0.0	0.0%
Passing Other Vehicle, Parked	1	0.1%	0.3	0	0.0%	0.0	0.0%
Entering Traffic, Making Left Turn	1	0.1%	0.3	1	0.6%	0.3	100.0%
Stopped, Crossing in Crosswalk at Intersection	1	0.1%	0.3	0	0.0%	0.0	0.0%
Slowing/Stopping, Backing	1	0.1%	0.3	0	0.0%	0.0	0.0%
Other, Not in Road	1	0.1%	0.3	0	0.0%	0.0	0.0%
Slowing/Stopping, Parking Maneuver	1	0.1%	0.3	0	0.0%	0.0	0.0%
Traveling Wrong Way, Stopped	1	0.1%	0.3	0	0.0%	0.0	0.0%

Bike + Motorist or Pedestrian Movements	# Crashes	% crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
Slowing/Stopping, Proceeding Straight	1	0.1%	0.3	0	0.0%	0.0	0.0%
Stopped, Ran Off Road	1	0.1%	0.3	0	0.0%	0.0	0.0%
Slowing/Stopping, Traveling Wrong Way	1	0.1%	0.3	0	0.0%	0.0	0.0%
Not Stated, Crossing in Crosswalk at Intersection	1	0.1%	0.3	1	0.6%	0.3	100.0%
Parking Maneuver, Proceeding Straight	1	0.1%	0.3	0	0.0%	0.0	0.0%
Changing Lanes, Entering Traffic	1	0.1%	0.3	0	0.0%	0.0	0.0%
Passing Other Vehicle, Changing Lanes	1	0.1%	0.3	0	0.0%	0.0	0.0%
Backing, In Road, Including Shoulder	1	0.1%	0.3	0	0.0%	0.0	0.0%
Ran Off Road, Merging	1	0.1%	0.3	0	0.0%	0.0	0.0%
Ran Off Road, Proceeding Straight	1	0.1%	0.3	1	0.6%	0.3	100.0%
Making Left Turn, Passing Other Vehicle	1	0.1%	0.3	0	0.0%	0.0	0.0%
Total	***1668***	***100.0%***	***556.0***	***158***	***100.0%***	***52.7***	***9.5%***

Table 37: Bicycle Crashes by Pre-Crash Movements, 2020-2021

Bike + Motorist or Pedestrian Movements	# Crashes	% crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
Proceeding Straight, Proceeding Straight	185	24.2%	92.5	21	26.9%	10.5	11.4%
Proceeding Straight, Making Left Turn	105	13.7%	52.5	7	9.0%	3.5	6.7%
Proceeding Straight, Making Right Turn	81	10.6%	40.5	3	3.8%	1.5	3.7%
solo bike Proceeding Straight	78	10.2%	39.0	16	20.5%	8.0	20.5%
Proceeding Straight, Stopped	34	4.5%	17.0	3	3.8%	1.5	8.8%
Making Left Turn, Proceeding Straight	24	3.1%	12.0	2	2.6%	1.0	8.3%
Proceeding Straight, Making U Turn	18	2.4%	9.0	1	1.3%	0.5	5.6%
Proceeding Straight, Parked	14	1.8%	7.0	1	1.3%	0.5	7.1%
Proceeding Straight, Entering Traffic	12	1.6%	6.0	1	1.3%	0.5	8.3%
Proceeding Straight, Changing Lanes	11	1.4%	5.5	0	0.0%	0.0	0.0%
Changing Lanes, Proceeding Straight	11	1.4%	5.5	2	2.6%	1.0	18.2%
Making Right Turn, Proceeding Straight	10	1.3%	5.0	2	2.6%	1.0	20.0%
Entering Traffic, Proceeding Straight	9	1.2%	4.5	3	3.8%	1.5	33.3%
Not Stated, Not Stated	9	1.2%	4.5	1	1.3%	0.5	11.1%
Traveling Wrong Way, Proceeding Straight	8	1.0%	4.0	1	1.3%	0.5	12.5%
Proceeding Straight, In Road, Including Shoulder	8	1.0%	4.0	2	2.6%	1.0	25.0%
Proceeding Straight, Other	8	1.0%	4.0	1	1.3%	0.5	12.5%
Proceeding Straight, Crossing in Crosswalk at Intersection	7	0.9%	3.5	0	0.0%	0.0	0.0%
Proceeding Straight, Parking Maneuver	7	0.9%	3.5	1	1.3%	0.5	14.3%
Proceeding Straight, Not in Road	7	0.9%	3.5	0	0.0%	0.0	0.0%
Proceeding Straight, Crossing Not in Crosswalk	7	0.9%	3.5	0	0.0%	0.0	0.0%
solo bike Slowing/Stopping	6	0.8%	3.0	2	2.6%	1.0	33.3%
Stopped, Proceeding Straight	6	0.8%	3.0	0	0.0%	0.0	0.0%
Other, Proceeding Straight	6	0.8%	3.0	0	0.0%	0.0	0.0%
Stopped, Stopped	5	0.7%	2.5	0	0.0%	0.0	0.0%
solo bike Other	5	0.7%	2.5	1	1.3%	0.5	20.0%
solo bike Making Left Turn	4	0.5%	2.0	1	1.3%	0.5	25.0%
Proceeding Straight, Slowing/Stopping	4	0.5%	2.0	0	0.0%	0.0	0.0%
Making Left Turn, Making Right Turn	4	0.5%	2.0	0	0.0%	0.0	0.0%
Making Left Turn, Making Left Turn	3	0.4%	1.5	0	0.0%	0.0	0.0%
Traveling Wrong Way, Making Right Turn	3	0.4%	1.5	0	0.0%	0.0	0.0%
Other, Making Left Turn	3	0.4%	1.5	0	0.0%	0.0	0.0%
solo bike Changing Lanes	3	0.4%	1.5	1	1.3%	0.5	33.3%
Not Stated, Proceeding Straight	3	0.4%	1.5	0	0.0%	0.0	0.0%
Stopped, Making Right Turn	3	0.4%	1.5	0	0.0%	0.0	0.0%

Bike + Motorist or Pedestrian Movements	# Crashes	% crashes	Crash Rate/ Year	# KSI	% KSI	KSI Crash Rate/ Year	% Crashes Resulting in KSI
Changing Lanes, Changing Lanes	3	0.4%	1.5	0	0.0%	0.0	0.0%
solo bike Making Right Turn	2	0.3%	1.0	0	0.0%	0.0	0.0%
Changing Lanes, Stopped	2	0.3%	1.0	0	0.0%	0.0	0.0%
Making Right Turn, Making Left Turn	2	0.3%	1.0	0	0.0%	0.0	0.0%
Proceeding Straight, Backing	2	0.3%	1.0	0	0.0%	0.0	0.0%
Proceeding Straight, Traveling Wrong Way	2	0.3%	1.0	0	0.0%	0.0	0.0%
Making Left Turn, Other	2	0.3%	1.0	0	0.0%	0.0	0.0%
Making Left Turn, Stopped	2	0.3%	1.0	0	0.0%	0.0	0.0%
Proceeding Straight, Not Stated	2	0.3%	1.0	0	0.0%	0.0	0.0%
Slowing/Stopping, Other	1	0.1%	0.5	1	1.3%	0.5	100.0%
Crossed Into Opposing Lane, Proceeding Straight	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, Backing	1	0.1%	0.5	0	0.0%	0.0	0.0%
Making Right Turn, Making U Turn	1	0.1%	0.5	0	0.0%	0.0	0.0%
Making Left Turn, Crossing in Crosswalk at Intersection	1	0.1%	0.5	0	0.0%	0.0	0.0%
Traveling Wrong Way, Stopped	1	0.1%	0.5	0	0.0%	0.0	0.0%
Not Stated, Stopped	1	0.1%	0.5	0	0.0%	0.0	0.0%
Making U Turn, Proceeding Straight	1	0.1%	0.5	0	0.0%	0.0	0.0%
solo bike Not Stated	1	0.1%	0.5	0	0.0%	0.0	0.0%
Proceeding Straight, Merging	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, Stopped	1	0.1%	0.5	1	1.3%	0.5	100.0%
Proceeding Straight, nan	1	0.1%	0.5	1	1.3%	0.5	100.0%
Entering Traffic, Not Stated	1	0.1%	0.5	0	0.0%	0.0	0.0%
Merging, Other	1	0.1%	0.5	0	0.0%	0.0	0.0%
Slowing/Stopping, Stopped	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, Making Right Turn	1	0.1%	0.5	0	0.0%	0.0	0.0%
solo bike Entering Traffic	1	0.1%	0.5	0	0.0%	0.0	0.0%
Stopped, Backing	1	0.1%	0.5	0	0.0%	0.0	0.0%
Parked, Proceeding Straight	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, Not in Road	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, Entering Traffic	1	0.1%	0.5	0	0.0%	0.0	0.0%
Traveling Wrong Way, Entering Traffic	1	0.1%	0.5	0	0.0%	0.0	0.0%
Making Left Turn, Not in Road	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, Parking Maneuver	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, nan	1	0.1%	0.5	1	1.3%	0.5	100.0%
Merging, Proceeding Straight	1	0.1%	0.5	0	0.0%	0.0	0.0%
Other, Other	1	0.1%	0.5	1	1.3%	0.5	100.0%
Not Stated, Changing Lanes	1	0.1%	0.5	0	0.0%	0.0	0.0%
Traveling Wrong Way, Making Left Turn	1	0.1%	0.5	0	0.0%	0.0	0.0%
Not Stated, Making Left Turn	1	0.1%	0.5	0	0.0%	0.0	0.0%
Entering Traffic, Making Right Turn	1	0.1%	0.5	0	0.0%	0.0	0.0%
Not Stated, Making Right Turn	1	0.1%	0.5	0	0.0%	0.0	0.0%
Making Left Turn, Backing	1	0.1%	0.5	0	0.0%	0.0	0.0%
Parked, Stopped	1	0.1%	0.5	0	0.0%	0.0	0.0%
Total	***764***	***100.0%***	***382.0***	***78***	***100.0%***	***39.0***	***10.2%***

MEMO

SAFE STREETS Research + Consulting

TO: Christopher Kidd, SFMTA
FROM: Brian Almdale, MUPP, Rebecca Sanders, PhD, RSP_{2B}, and Jessica Schoner, PhD
DATE: 2023-07-12
RE: Final Draft Crash Analysis – Step II
PROJECT: SFMTA Bike Plan

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Introduction

This memo summarizes the methodology and key findings for the second phase of the bicycle crash analysis being conducted as part of the San Francisco Active Communities Plan. The first phase of crash analysis (Step I) focused on investigating factors related to who, where, when, and why crashes that involved a bicyclist occurred. This phase (Step II) investigated modifiable risk factors associated with fatal and severe bicyclist crashes. This Step II analysis will help us further understand the risk factors associated with bicycle crashes, which can then be used to inform the bicycle network development phase and countermeasure selection.

Most sections of this memo analyzed the 5-year study period (2017-2021) as the base study period. This analysis also looked at crashes that occurred during the pre-pandemic period (2017-2019) and during the pandemic (2020-2021) to control for changes in travel behaviors due to the COVID-19 pandemic.

Key findings

Reported crash data that involved a bicyclist was the primary dataset in this crash analysis. Reported crash data are critical to understanding crash patterns. While reported crash data are known to have problems with underreporting[1,2], they are often the most complete data source in terms of the number and consistency of crash attributes available and the breadth and number of crashes included. As such, these data can provide the necessary detail for informing engineering treatments and help us understand who was involved in a crash. This report acknowledges the crash data used in this analysis provides us with an incomplete picture of crashes but allows us to use the most complete and readily available data that represent crash events and the people involved in crashes. Key findings from this crash analysis include the following:

- ***Crash Location:***
  - The majority of crashes overall and KSI crashes in particular occurred at intersections (79.3% and 78.4%, respectively).
  - When looking only at KSI crashes, those occurring at midblock locations tended to result in a slightly more severe outcome than those at intersections, with 10.1% of crashes resulting in a KSI and an average EPDO score of 24.23.
- ***Neighborhoods:***
  - Changes in the distribution of crashes were observed between study periods in several neighborhoods. These differences most likely reflect changes in how people traveled during the pandemic, with fewer people working downtown and potentially an increase in recreational trips.
  - Neighborhoods with large differences in percentage points between the pre-pandemic and pandemic study period for bicyclist *KSI crashes* include: Castro/Upper Market (5.8%), Tenderloin (+5.8%), Mission (-5.6%), Golden Gate Park (+4.5%), Sunset/Parkside (+3.9%), North Beach (-3.8%), Bayview Hunters Point (-3.7%), and Outer Richmond (+3.2%).
  - Differences in *overall crash* distributions were highest in the following neighborhoods: Financial District (-3.6%), SOMA (-3.3%), Mission (-2.6%), North Beach (-1%), and Nob Hill (-0.9%).
- ***High Injury Network:***
  - The majority of the crashes that occurred along the HIN occurred at intersections (84% of all crashes and KSI crashes), most often at signalized intersections (80% of all crashes; 81% of KSI crashes). Half of the KSI crashes at signalized intersections along the HIN were reported as a roadway user disregarding a red signal.
  - Nearly 46% of the motorist-bicyclist crashes along the HIN were perpendicular crashes, half of which were broadside crashes.

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[1] Stutts, J., & Hunter, W. (1998). Police reporting of pedestrians and bicyclists treated in hospital emergency rooms. Transportation Research Record: Journal of the Transportation Research Board, (1635), 88-92.

[2] San Francisco Department of Public Health-Program on Health, Equity and Sustainability. 2017. Vision Zero High Injury Network: 2017 Update – A Methodology for San Francisco, California. San Francisco, CA. Available at: https://www.sfdph.org/dph/files/EHSdocs/PHES/VisionZero/2017_Vision_Zero_Network_Update_Methodology_Final_20170725.pdf

- The pandemic study period had a higher concentration of KSI crashes having occurred along the HIN. Additional monitoring of crashes and travel behaviors is recommended to better understand if the pandemic fundamentally changed travel behaviors.

- ***Functional Classification:***
  - Across all years (including pre-pandemic and mid-pandemic years) the most severe crashes occurred on major/highways and the most crashes overall occurred on collector roadways.
  - Arterials accounted for the largest number of crashes on a per mile basis followed by collectors.
  - When looking at intersection crashes and the highest and lowest functional classification present, collector-residential and residential-residential combinations had the largest share of all crashes and KSI crashes. Future evaluation is recommended, as there may be underlying data issues related to how some streets are coded, particularly for residential streets that have the characteristics of an arterial or collector.
  - The most severe crashes occurred at intersections with generally higher functional classes; crashes at intersections of major highways and arterials were the most severe (40.0 avg. EPDO), followed by intersections of major highways and collectors (31.9 avg. EPDO).
- ***Intersection Control:***
  - Uncontrolled stops and partial stop-controlled intersections had the highest average EPDO score per crash. This is likely due to a bicyclist attempting to cross a street in which the motorist does not have a traffic control device, therefore leading to higher kinetic energy transfer at the time of the crash.
  - The majority of the KSI crashes that occurred at signalized intersections occurred in non-residential areas, with 39% in mixed land use areas and 25% in commercial land use areas compared to 19% within residential land use areas.
- ***Number of Lanes:***
  - There is a clear and positive relationship between crash densities, severity, and the number of lanes: there were 108.2 crashes per 10 miles of 5-lane roads, 89.1 crashes per 10 miles of 3-lane roads, and 86.4 crashes per 10 miles on 4-lane roads, compared with just under 10.7 crashes per 10 miles on 2-lane roadways.
  - Certain roadway configurations seem more dangerous for bicyclists than others. In particular, while bicyclist crashes on 3-lane roadways were rarer than those on other roadway configurations, crashes on these roadways were disproportionately severe.
- ***Posted Speed Limit and Observed Speed:***
  - There were differences among crash trends when comparing reported crashes by posted speed limit and observed speed. There were more crashes on low speed limit facilities (≤ 25pmh), and on average more severe crashes were on roadways with a 30 mph posted speed limit. Higher observed speeds, however, were correlated with more severe safety outcomes for bicyclists; the most severe crashes occurred on facilities with prevailing speeds of 35-39 mph. While these relationships are likely confounded with the number of people cycling on the low-speed roads versus higher-speed roadways, it is clear that traveler speed is positively correlated with severe bicyclist crashes.
  - Nearly 80% of KSI crashes occurred along 25 mph streets. Of the crashes that occurred along 25 mph streets:
    - 27.5% of KSI crashes were solo bicyclist.
    - 79% of KSI crashes occurred at an intersection (slightly more than half at signalized intersections).
    - Same and perpendicular direction of travel between the motorist and bicyclists accounted for the largest share of crashes, both with 38.8% of KIS crashes.
    - Most of the KSI crashes along a 25mph street did not occur along a bike facility of any type.

- ***Bicyclist Volume Estimates:***
    - Unsurprisingly, the data show locations with higher bicycle volumes had a higher bicycle crash frequency due to higher levels of exposure. This does not necessarily mean locations with higher volumes of bicyclists have higher crash risk.
    - Relative to the percentage of all crashes that occur on the streets with the highest bicyclist ridership, there are fewer severe crashes than for other volume categories.
        - The proportion of midblock crashes resulting in a KSI outcome are quite low for the highest volume street (8.4%) whereas the lowest volume streets have the highest proportion of KSI outcomes (21.4%).
        - Intersections with higher volume estimates had fewer crashes that resulted in a KSI, whereas intersections with a lower volume estimate have a higher proportion of crashes that resulted in a KSI. This relationship between bicyclist volumes and the average severity of crashes at intersections may suggest a safety in numbers effect.
- ***Bike Facility Type:***
    - Over the study period, only about one-third of KSI crashes occurred along streets with a bike facility. Given how ridership tends to occur disproportionately along the bike network, these numbers suggest a protective effect of the bike network in terms of KSI crashes.
    - Bike facilities were further analyzed by comparing post-installation crashes per year rate by a number of variables to help us better understand the safety effect bicycle facilities have by facility type.
    - Class III facilities accounted for the largest share of both overall crashes and KSI crashes per year (39.7% and 48.2%, respectively), followed closely by Class II facilities (39.2% and 31.7%, respectively). Class IV accounted for the third highest share of crashes (20.1%) and KSI crashes (19%) per year.
    - While Class II facilities accounted for the large share of crashes, the percentage of crashes that *resulted in a KSI outcome* was the lowest (7.8%), followed by Class IV (9.0%). This finding suggests that the Class II and Class IV facilities and the type of physical separation they provide may help reduce the severity of crashes if they occur.
    - Regardless of bike facility type, the largest share of crashes by relative direction of travel between the bicyclists and motorists was the same direction (47.9% of all crashes; 42.4% of KSI crashes).
        - Exploring the same direction crashes further, the most common movement types involved a bicyclist proceeding straight and a motorist making a right turn (9% of all crashes, n=66; 5.1% of KSI crashes, n=3) while the most common movement type for KSI crashes was bike proceeding straight and the motorists stopped (5.6% of all crashes, n=41; 13.6% of KSI crashes, n=8). Five of the eight KSI crashes were dooring crashes.
    - Crashes along any type of bike facility were concentrated at intersections (81.5% of all crashes; 82.2% of KSI crashes), with KSI crashes occurred most frequently at signalized intersections (~60%).
    - Most intersection crashes along a bike facility were perpendicular (35.5% of all crashes; 39% of KSI crashes), followed by same direction (30.3% of all crashes; 24.7% of KSI crashes). Midblock crashes largely involved both parties traveling in the same direction (65.2% of all midblock crashes and 65.4% midblock KSI crashes).
    - Nearly all bicyclist-motorist KSI crashes (18 of 20) that occurred along a Class II facility were at an intersection. Similarly, 11 of the 13 KSI crashes along a Class IV facility were at an intersection. For KSI crashes along a Class IV facility at an intersection, most KSI crashes involved both parties traveling perpendicularly (54.5%).
    - Crashes along residential streets with a Class II or Class III facility also tended to be less severe, with fewer crashes resulting in a KSI outcome compared to collector or arterial streets. This is

likely due to lower vehicle volumes and speeds resulting in lower exposure and less kinetic energy at the time of the crash due to lower vehicle speeds.
  - Class I and Class IV facilities, which provide the greatest level of physical separation, had the lowest crash rates and KSI crash rates per year and per mile along streets with four lanes. This is a particularly interesting finding, given that Class I and IV facilities are often installed along streets with higher levels of stress and crash risk.
  - Roughly 60% of bicycle crashes and 55% of KSI crashes along a bike facility of any kind occurred along the HIN. Class II and Class III facilities along the HIN had the highest rate of crashes per year, followed by Class II and Class III facilities off the HIN. KSI crashes per year were highest along the Class III facilities along the HIN, followed by Class III facilities off the HIN. These findings underscore the need for bicycle facilities along these routes, but may also indicate insufficient protection gained from Class II and Class III facilities along these routes.
  - Nearly half (47.8%) of the crashes and KSI crashes (47.1%) along any bike facility type occurred along the HIN at an intersection.
- ***One-Way Streets:***
  - Crashes on one-way streets were more severe in terms of crashes per mile, KSI crashes per mile, and EPDO values per mile than other roadways across all years.
  - Most crashes along one-way streets occurred at intersections (91% of all crashes and KSI crashes). One quarter of the KSI crashes along a one-way street were cited as *disregard red signal*, followed by *dooring* (11.8%).
- ***Street Slope:***
  - The share of all crashes is distributed mostly among slopes between 1 - 6.9. KSI crashes are concentrated on roadways with slopes of 1- 4.9, which makes some sense given that steeper slopes are more difficult to access via bicycle.
- ***Bus Stops:***
  - Across the entire network, there were 26.6 crashes per 100 intersections, but there were notably more crashes per 100 intersections (46.8) when considering intersections with bus stops. This may point a relationship between intersections with more conflicting or complex traveler movements and bicycle crashes.
- ***Land Use:***
  - Severe crashes seem to be over-represented in commercial and mixed-use contexts. These findings may reflect that the complexity of interactions among roadway users in commercial and mixed-use spaces is an important factor in bicycle safety.
- ***Equity Priority Communities:***
  - Slightly more than half of the reported bicyclist crashes (N=2,432) occurred *outside of* EPCs (55.2%) and these crashes tend to be more severe, with an average EPDO score of 23.2 and 10.3% of crashes resulting in a KSI outcome.
  - There is a clear correlation between crashes along the HIN and EPCs: nearly 81% of all crashes and 80% of KSI crashes across all EPCs occurred along the HIN.
- ***Location-Movement Crash typing:***
  - The top three location-movement crash types include:
    - Intersection – perpendicular – bike proceeding straight, motorist proceeding straight (14.9% crashes; 21.8% KSI crashes)
    - Intersection – perpendicular – bike proceeding straight, motorist making left turn (6.4% crashes, 6.1% KSI crashes)
    - Intersection – same direction – bike proceeding straight, motorist making right turn (6.2% crashes; 4.2% KSI crashes)

- ***Safer Street Priority Finder (SSPF) Crash Risk Estimation***
    - The SSPF estimated the following streets to have high crash risk:
        - **Howard St** from Van Ness Ave to 3rd St
        - **Turk St** from Laguna St to Market St
        - **Taylor St** from Market St to Bush St
        - **Sansome St** from Broad Way to the Embarcadero (not along HIN)
        - **Silver Ave** from Alemany Blvd to Madison St (not along HIN) and Princeton St to Barneveld Ave
        - **3rd St** from Mariposa St to China Basin St (not along HIN)
        - **Valencia St** from 7th St to Market St
    - Many of these higher scoring corridors are located areas of the city that generally have higher volumes of bicycle and motor vehicle volumes such as the Financial District, SOMA, Mission, Tenderloin, Western Addition, and North Beach. Many of the highest scoring corridors are also within EPCs and overlap with sections of the HIN.

Next Steps

- Toole Design and SFMTA to review this draft analysis and provide comments for Safe Streets to address. Key questions to consider in during the review:
    - Are there any findings that do not reflect your current understanding of bicyclist safety in San Francisco?
    - Are there areas of this memo for which you would like additional information? If so, what else would you like to know?
- Once this analysis is finalized, Safe Streets will deliver the following files to Toole Design and SFTMA. Toole Design will use these files to produce any necessary graphics or maps.
    - CSV file of crash data with geospatial attributes
    - Crash analysis Word Document and PDF
    - Refined and contextualized intersection and segment data. Both data include aggregated crashes.

Data Preparation

Crash data were processed and evaluated as part of the Step I crash analysis. No other cleaning to the underling crash data occurred as part of the Step II analysis. Roadway characteristics, land use, and demographic data were processed as part of the Step II analysis and joined to a master intersection and centerline dataset. The crashes were joined to the intersection and centerline data to contextualize the crash data and to aggregate the crash data to the network data to allow for a systemic safety analysis to be conducted.

As part of the data preparation effort, the intersection and centerline data were thoroughly reviewed at the start of this analysis. A number of data quality issues with both the street centerline and intersection data were identified and are detailed in Appendix A: Network Data QC.

Crash Weights

Crashes have been assigned an Equivalent Property Damage Only value (EPDO) that will be used throughout this analysis to weight crashes based on the estimated crash cost. Applying severity-based weights to crashes allows us to better understand the general crash intensity when analyzing crash frequencies in cross tabs. A higher EPDO value may suggest a particular roadway characteristic is associated with higher crash severities and/or crash frequencies. Most tables in this report present EPDO values via the total EPDO by variables as well as the average EPDO score per score (total EPDO divided by the total number of crashes) to help us understand the average severity of crashes (see Table 1).

Table 1: Crash EPDO Scoring

Crash Severity*	Location Type	Crash Cost***	Equivalent Property Damage Only
**Fatal and Severe Injury (KA)	Signalized Intersection	$1,787,000	119.93
	Non-Signalized Intersection	$2,843,000	190.81
	Roadway	$2,461,000	165.17
Evident Injury – Other Visible (B)		$159,000	10.67
Possible Injury – Complaint of Pain (C)		$90,900	6.10
Property Damage Only (O)		$14,900	1.00

** The letters in parenthesis (K, A, B, C and O) refer to the KABCO scale commonly used by law enforcement agencies in their crash reporting efforts. The KABCO scale is further documented in the Highway Safety Manual (HSM).*
*** Figures were calculated based on an average Fatality (K) / Severe Injury (A) ratio for each area type, a crash cost for a Fatality (K) of $8,112,200, and a crash cost of a Severe/Disabling Injury (A) of $437,100. These costs are used in the HSIP Analyzer.*
**** Based on Table 7-1, HSM First Edition, 2010. Adjusted to 2022 Dollars.*

Descriptive Analysis

Crash Location (Intersection vs. Midblock)

Crashes were assigned a location type as either having occurred at an intersection or a midblock location. Crashes were coded as having occurred at an intersection if the geocoded data point was within 75 ft of an intersection centroid. All other crashes were coded as midblock. We performed a sensitivity analysis to inform this threshold by comparing the spatial location of several samples of crashes and whether each crash was coded as an intersection crash. Intersection crashes were reviewed with aerial imagery to ensure the results are intuitive. CHP's current approach is to assign each crash one of the following values: intersection ≤ 20 ft, intersection rear end ≤ 150 ft, or midblock > 20 ft. Caltrans' Highway Safety Improvement Program uses 250 ft as the threshold to define intersection crashes. For the purposes of this analysis, reflecting the density of San Francisco's streets, we used a tailored option of 75 ft to help us better understand risk factors and behavioral patterns associated with crashes and crash locations. The results of this approach are summarized in Table 2. The differences between this GIS proximity-based approach and the officer-reported locations resulted in 307 (13% of crashes) previously midblock crashes being coded as intersection crashes, and 33 (~1%) previously coded intersection crashes recoded as midblock crashes.

Table 2: Crashes by intersection relation and spatial proximity, 2017-2021

Location Type (SSRC)	Intersection (CHP)	# Crashes
intersection	Intersection ≤ 20 ft	**1,599**
intersection	Midblock > 20 ft	**307**
intersection	Intersection Rear End ≤ 150 ft	**37**
	Intersection Total	**1,943**
mid-block	Midblock > 20 ft	**456**
mid-block	Intersection Rear End ≤ 150 ft	**29**
mid-block	Intersection ≤ 20 ft	**4**
	Midblock Total	**489**

Table 3 summarizes bicyclist crashes by location type for crashes that occurred between 2017 and 2021. The majority of crashes (79.3%) and KSI crashes in particular (78.4%) occurred at intersections. This distribution is expected for bicyclist crashes, as most interactions between roadway users occur at intersection locations, rather than midblock. When looking at the percentage of crashes that resulted in a KSI, midblock crashes tended to result in a slightly more severe outcome, with 10.1% of crashes resulting in a KSI and an average EPDO score of 24.2. Motorist speeds are likely higher midblock than at intersections, resulting in higher kinetic energy and limited reaction time, both of which may contribute to midblock crashes being more likely to be severe. Of the midblock KSI crashes, 31.4% were solo-bicyclist crashes, and only 2 of the 51 midblock KSI crashes were coded as a dooring crash. For motorist-bicyclist KSI crashes, 21 out of the 22 KSI crashes included both roadway users traveling in the same direction.

The most common violation type for KSI crashes at an intersection included unsafe speed (20%), red signal – driver or bicyclist responsibility (14.1%), and Unknown (11.9%). The most common violation type for midblock KSI crashes includes unsafe speed (37.3%), unsafe turn or lane change prohibited (13.7%), and unknown (9.8%). Of the unsafe speed violations for both intersection and midblock crashes, 58.9% of those crashes were solo-bicyclist or bicyclist-pedestrian crashes.

Table 3: Bicyclist crashes by location type, 2017-2021

Location Type	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg EPDO per crash*
intersection	1928	79.3%	185	78.4%	41,169	77.1%	9.6%	21.4
midblock	504	20.7%	51	21.6%	12,211	22.9%	10.1%	24.2
Total	***2432***	***100.0%***	***236***	***100.0%***	***53,380***	***100.0%***	***9.7%***	***22.0***

Table 4 summarizes bicycle crashes by location type for the pre-pandemic study period. Most crashes (77.7%) and KSI crashes (79.1%) occurred at intersections. Unlike the 5-year study period, intersection crashes tended to result in a KSI outcome more often than midblock crashes, with 9.6% of crashes resulting in a KSI, but the average severity of crashes in terms of average EPDO score was similar between location types. The top three violation types for the pre-pandemic study period were the same as the 5-year study period for KSI intersection crashes, and similar for midblock crashes, with unsafe speed (7.6%), unknown (3.2%), and unsafe turn or lane change (2.5%) being the leading contributing factors.

Table 4: Bicyclist crashes by location type, 2017-2019

Location Type	# Crashes	% Crashes	# KSI	% KSI	EPDO	% EPDO	% Crashes resulting in KSI	Avg EPDO per crash
intersection	1296	77.7%	125	79.1%	27,668	77.0%	9.6%	21.4
midblock	372	22.3%	33	20.9%	8,254	23.0%	8.9%	22.2
Total	***1668***	***100.0%***	***158***	***100.0%***	***35,923***	***100.0%***	***9.5%***	***21.5***

Table 5 Summarizes bicycle crashes by location type for the pandemic study period. Like the pre-pandemic study period, most crashes (82.7%) and KSI crashes (76.9%) occurred at intersections. However, unlike the pre-pandemic study period, midblock crashes tended to result in a KSI outcome (13.6%) more often than intersection crashes (8.9%). Regardless of location type, crashes that occurred during the pandemic study period resulted in a KSI outcome slightly more often than during the pre-pandemic study period (10.2% compared to 9.5%, respectively). The top three violation types for the pandemic study period match the top three violation types for the 5-year study period for both intersection and midblock KSI crashes.

Table 5: Bicyclist crashes by location type, 2020-2021

Location Type	# Crashes	% Crashes	# KSI	% KSI	EPDO	% EPDO	% Crashes resulting in KSI	Avg EPDO per crash
intersection	632	82.7%	60	76.9%	13,501	77.3%	9.5%	21.4
mid-block	132	17.3%	18	23.1%	3,956	22.7%	13.6%	30.0
Total	***764***	***100.0%***	***78***	***100.0%***	***17,457***	***100.0%***	***10.2%***	***22.9***

Intersection Control

Table 6 summarizes intersection bicycle crashes by intersection control from 2017-2021. Most bicycle crashes occurred at signalized intersections both overall (67.9%) and particularly for KSI crashes (71.5%). Additionally, the number of crashes and KSI crashes per intersection with a traffic signal was substantially higher than intersections with other traffic control types. When looking at the average severity of crashes by intersection control type, crashes at signalized intersections tended to be the least severe with an average EPDO score of 20.2. Uncontrolled stops and partial stop-controlled intersections had the highest average EPDO score per crash (27.1 and 25.2, respectively). Perpendicular relative direction of travel (e.g., broadside, motorist left turn into bicyclist) is the most common crash type at partial stop-controlled intersections for bicyclist-motorist crashes (43.5% of all crashes; 40% of KSI crashes). This could be due to a bicyclist attempting to enter or cross a street in which the motorist does not have a traffic control device (or vice versa), therefore leading to higher kinetic energy at the time of the crash.

The majority of the KSI crashes that occurred at signalized intersections occurred in non-residential areas, with 39% occurring in mixed land use areas and 25% in commercial land use areas compared to 19% at signalized intersections within residential land use areas. This higher share of crashes at signalized locations in non-residential land uses is likely associated with higher bicyclist and motorist exposure levels at these locations. Additionally, there tend to be more interactions between moving bicyclists and motorists at signalized intersections compared to other location types. The most frequent reported violation types for KSI crashes at signalized intersections included *disregard red signal* (19.7%), *unsafe speed* (18.9%), *unknown* (13.6%), *unsafe turn or lane change* (8.3%), *violation right-of-way left turn* (8%), and *dooring* (8%).

Nearly 25% of the KSI crashes and 11% of overall crashes at signalized intersections were solo-bicyclist crashes, most of which were cited as traveling too fast for conditions or unknown. The signalized intersections with solo-bicyclist KSI crashes generally have a max slope between 2-4% grade, which is not especially steep for the city, but may still have contributed to a bicyclist or motorist going "too fast for conditions." This slope range accounts for 39% of the street network, but 68% of solo-bike KSI crashes at signalized intersections.

Table 6: Bicycle crashes by intersection control, 2017-2021

Intersection Control	*# Int*[3]	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg. EPDO per Crash
Signalized	1,323	18.4%	1,310	67.9%	133	71.5%	26,426	64.1%	99.0	10.1	20.2
Partial Stop	2,025	27.0%	291	15.1%	27	14.5%	7,331	17.8%	14.4	1.3	25.2
All-Way Stop	2,011	26.7%	230	11.9%	16	8.6%	4,847	11.8%	11.4	0.8	21.1
Uncontrolled	1,879	27.9%	97	5.0%	10	5.4%	2,630	6.4%	5.2	0.5	27.1
Total	***7,238***	***100.0%***	***1,928***	***100.0%***	***186***	***100.0%***	***41,234***	***100.0%***	**26.6**	**2.6**	**21.4**

Table 7 and Table 8 summarize intersection bicyclist crashes by intersection control type for the pre-pandemic and pandemic study periods respectively. The distribution of crashes was comparable between study periods with most crashes and KSI crashes having occurred at signalized intersections followed by partial stop-controlled intersections.

[3] "Intersections" are shortened to "Ints" in the tables throughout this document to allow the table to fit within an 8.5x11" portrait layout.

Table 7: Bicycle crashes by intersection control, 2017-2019

Intersection Control	***# Ints***	***% Ints***	***# Crashes***	***% Crashes***	***# KSI Crashes***	***% KSI Crashes***	***EPDO***	***% EPDO***	**Crashes per 100 Ints**	**KSI Crashes per 100 Ints**	**Avg. EPDO per Crash**
Signalized	1,323	18.4%	890	68.7%	89	71.2%	17,779	64.1	67.3	6.7	20.0
Partial Stop	2,025	27.0%	194	15.0%	15	12.0%	4,338	15.7	9.6	0.7	22.4
All-Way Stop	2,011	26.7%	146	11.3%	13	10.4%	3,595	13.0	7.3	0.6	24.6
Uncontrolled	1,879	27.9%	66	5.1%	8	6.4%	2,006	7.2%	3.5	0.4	30.4
Total	***7,238***	***100.0%***	***1,296***	***100.0%***	***125***	***100.0%***	***27,718***	***100.0***	***17.9***	***1.7***	***21.4***

Table 8: Bicycle crashes by intersection control, 2020-2021

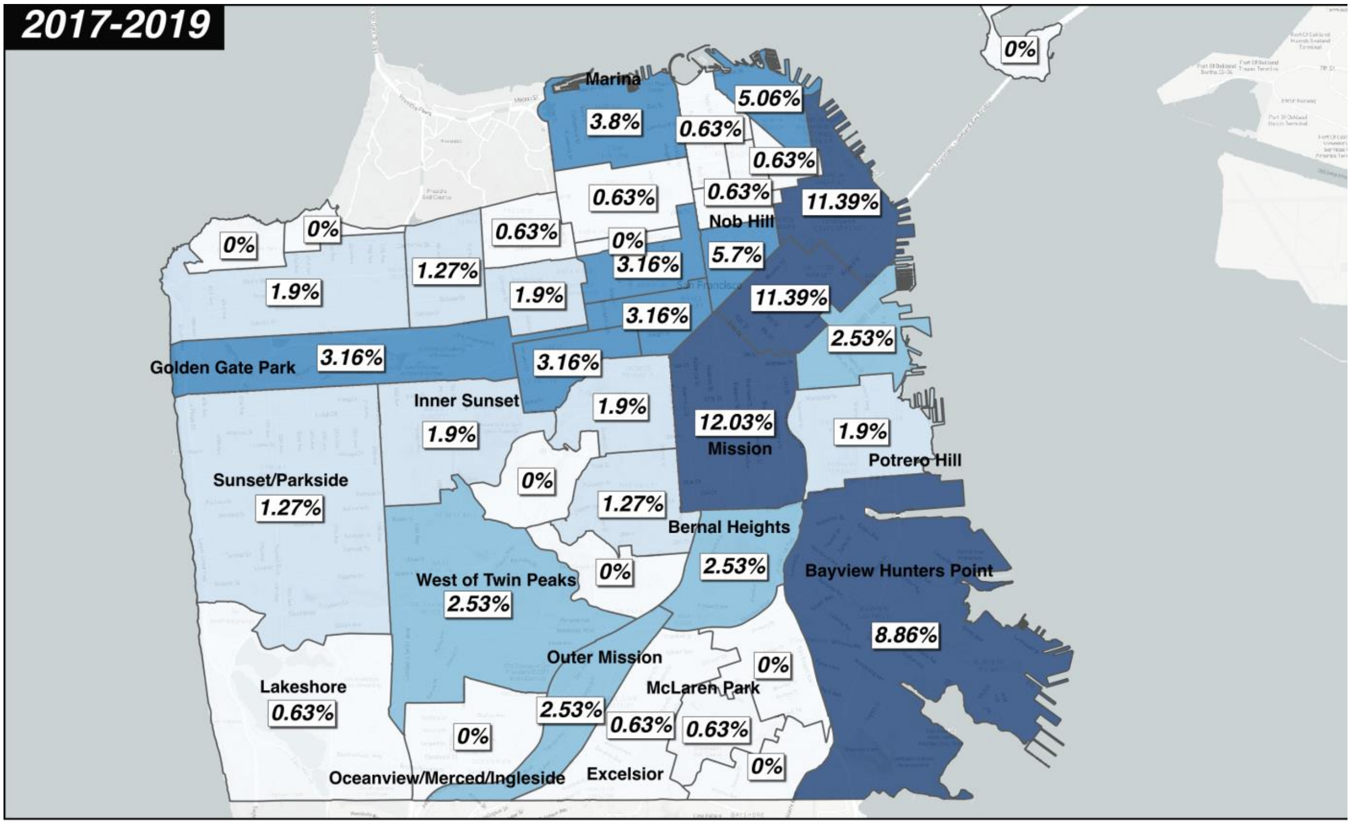
Intersection Control	***# Ints***	***% Ints***	***# Crashes***	***% Crashes***	***# KSI Crashes***	***% KSI Crashes***	***EPDO***	***% EPDO***	**Crashes per 100 Ints**	**KSI Crashes per 100 Ints**	**Avg. EPDO per Crash**
Signalized	1,323	18.4%	420	66.5%	44	72.1%	8,666	64.0%	31.7	3.3	20.6
Partial Stop	2,025	27.0%	97	15.3%	12	19.7%	2,995	22.1%	<0.1	<0.1	30.9
All-Way Stop	2,011	26.7%	84	13.3%	3	4.9%	1,258	9.3%	<0.1	<0.1	15.0
Uncontrolled	1,879	27.9%	31	4.9%	2	3.3%	626	4.6%	<0.1	<0.1	20.2
Total	***7,238***	***100.0%***	***632***	***100.0%***	***61***	***100.0%***	***13,545***	***100.0%***	***0.1***	***<0.1***	***21.4***

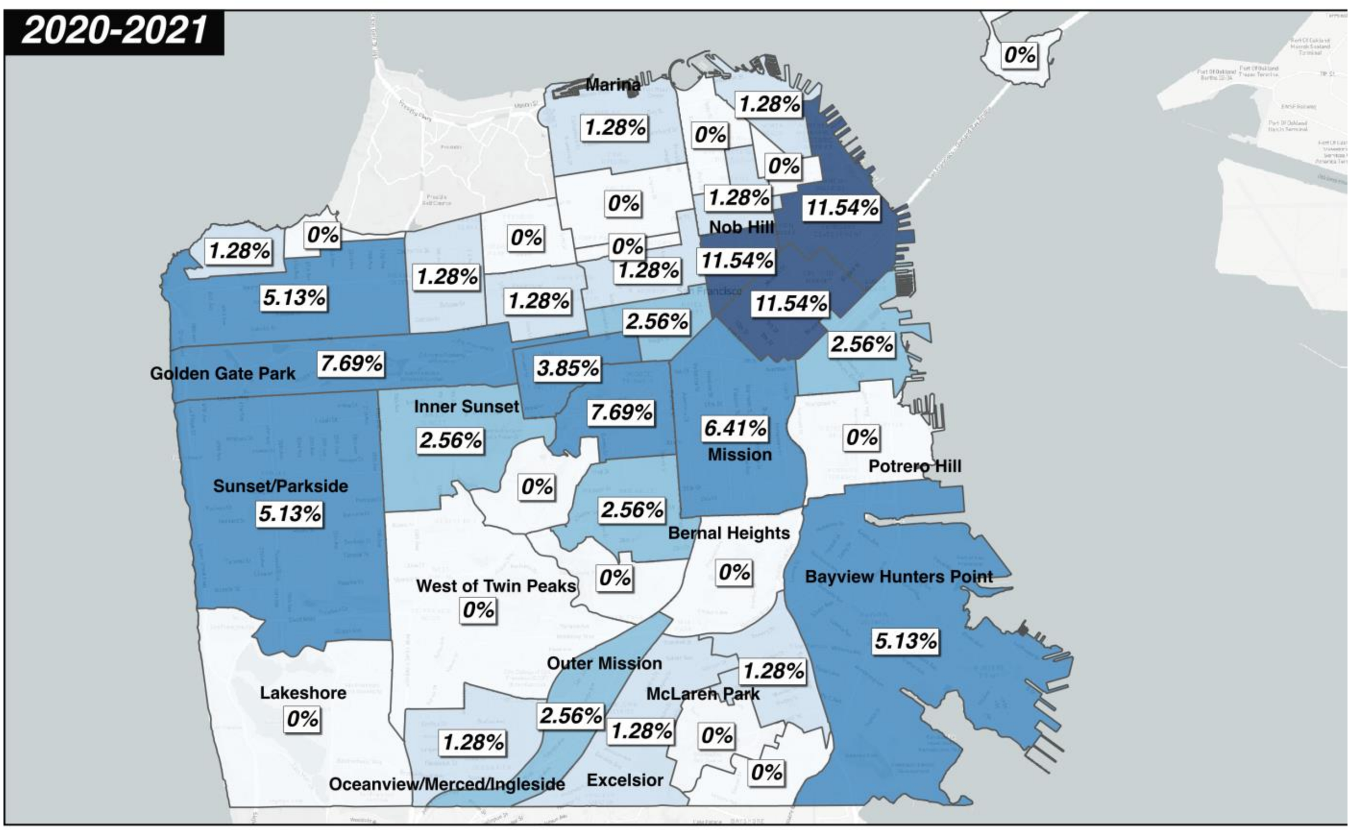
Neighborhoods

Map 1 displays the percentage of KSI crashes by neighborhood for pre-pandemic and pandemic study periods, to help us understand spatial patterns during the two study periods. For example, the Mission District accounted for approximately 12% of KSI crashes that occurred during the pre-pandemic study period, but only about 6.4% of KSI crashes in the pandemic study period. For both periods, KSI crashes were most concentrated within the Financial District and the surrounding neighborhoods, with some key differences in certain places between periods, including a noticeable reduction in the percentage crashes in the Bayview Hunters Point area and a contrasting increase near Golden Gate Park in the latter period.

These differences between the two study periods are further highlighted in Map 2, which depicts these KSI distribution changes as well as the difference between overall bicycle crash distribution. Neighborhoods with large differences in percentage points between the pre-pandemic and pandemic study period for bicyclist *KSI crashes* include: Castro/Upper Market (5.8%), Tenderloin (+5.8%), Mission (-5.6%), Golden Gate Park (+4.5%), Sunset/Parkside (+3.9%), North Beach (-3.8%), Bayview Hunters Point (-3.7%), and Outer Richmond (+3.2%). Differences in *overall crash* distributions were highest in the following neighborhoods: Financial District (-3.6%), SOMA (-3.3%), Mission (-2.6%), North Beach (-1%), and Nob Hill (-0.9%). These differences most likely reflect changes in how people traveled during the pandemic, with fewer people working downtown and potentially an increase in recreational trips. Further analysis and continued monitoring of travel behaviors and crash patterns will help the SFMTA to better understand longer-term impacts related to travel behavior changes associated with the COVID-19 pandemic and higher rates of people working from home.

Map 1: Percent of KSI bicyclist crashes by neighbor and study period





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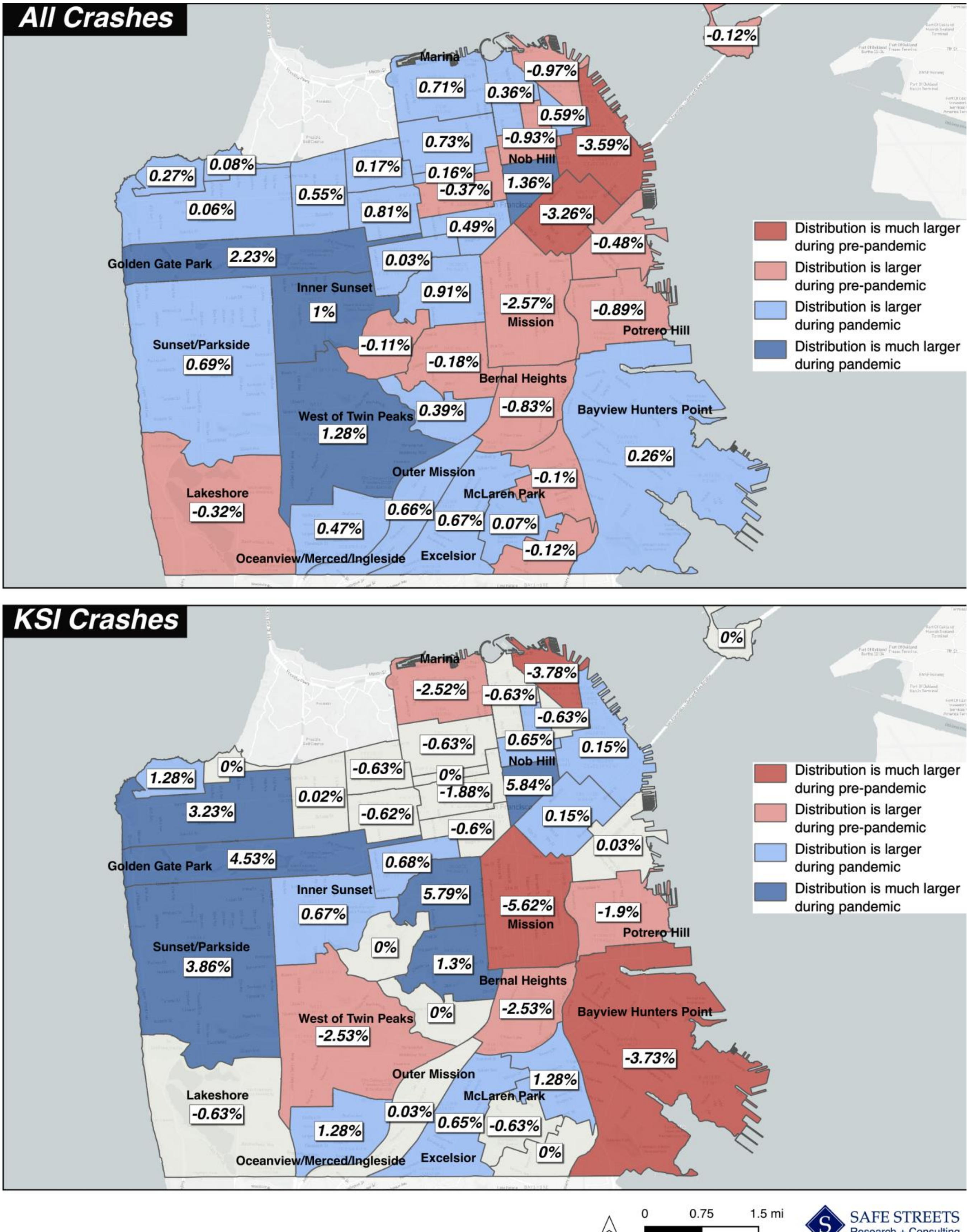
Map 2: Difference between crash and KSI crash distribution by neighborhood and study period



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High Injury Network

Table 9 summarizes bicycle crashes along the High Injury Network (HIN) for crashes that occurred between 2017-2021. Map 3 displays bicyclist crashes and the HIN from 2017-2021. As expected, both overall crashes and KSI crashes were concentrated along the HIN, accounting for 67% and 62.3% of all crashes and KSI crashes, respectively. The majority of the crashes that occurred along the HIN involved a bicyclist and a motorist (83.1% of all crashes; 67.8% of KSI crashes), as opposed to solo-bicyclist crash (11.3% of all crashes; 28.1% of KSI crashes). Interestingly, crashes that occurred along the HIN were less severe on average, as reflected in the average EPDO scores. This finding may be related to the HIN being informed by aggregating historic crash data, which does not necessarily account for risk or exposure (exposure is coarsely handled by HIN segmentation lengths). For example, many portions of the HIN have high volumes of people riding a bike, therefore we can expect a higher concentration of crashes. Streets not along the HIN can be either lower-risk or low-stress streets with few recorded crashes, or the conditions may be so stressful that few people ride their bikes along that street. The latter of the two scenarios may factor into crashes that occurred off the HIN being slightly more severe.

Of the crashes that occurred along the HIN, the majority occurred at intersections (84% of all crashes and KSI crashes). Crashes along the HIN were most often at signalized intersections (just over 80% of all crashes and KSI crashes), followed by partial stop-controlled intersections (10.8% of all crashes and % of KSI crashes). Half of the KSI crashes at signalized intersections along the HIN were reported as the *driver or bicyclist failing to obey a red signal* (19.6%), *unsafe speed* (18.6%), and *unknown* (13.7%). Digging deeper into the *disregard red signal* violation, we see that about 70% of these violations for crashes overall and for KSI crashes are attributed to the bicyclist. These violations can indicate an unmet need for cyclists (e.g., long wait times, unresponsive traffic signals, dangerous conditions) and prompt a need to examine signalized intersections and network connectivity overall for bicyclists, as well as to consider engaging in outreach, to better understand how the system could work better for bicyclists.

Nearly 46% of the KSI crashes that involved a motorist and a bicyclist that occurred along the HIN involved perpendicular pre-crash directions of travel between the motorist and bicyclist, with nearly half of those involving both parties proceeding straight (i.e., a broadside crash). The second most common crash type included both parties traveling in the same direction with the bicyclist proceeding straight and the motorist stopped (8.6% of KSI crashes); most of those crashes were related to the bicyclists getting doored. The third most common crash type along the HIN involved both parties traveling in perpendicular directions, with the bicyclist proceeding straight and the motorist making a left turn (7.6% of KSI crashes).

Table 9: Bicycle crashes along the High Injury Network, 2017-2021

HIN	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Yes	128.8	13.1%	1,625	67.0%	147	62.3%	32,850	61.7%	126.14	117.53	20.2
No	853.8	86.9%	801	33.0%	89	37.7%	20,402	38.3%	9.38	10.74	25.5
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.69***	***24.74***	***22.0***

Table 10 and Table 11 summarize crashes along the HIN for the pre-pandemic study period and pandemic study period respectively. The patterns are similar between study periods, though the pandemic study period had a higher concentration of KSI crashes having occurred along the HIN. As discussed above, additional monitoring of these data and periodic reevaluation of the HIN will help clarify whether pandemic era crashes differed from historic crashes in a short-term way, or if pandemic era travel fundamentally shifted the HIN longer-term in San Francisco.

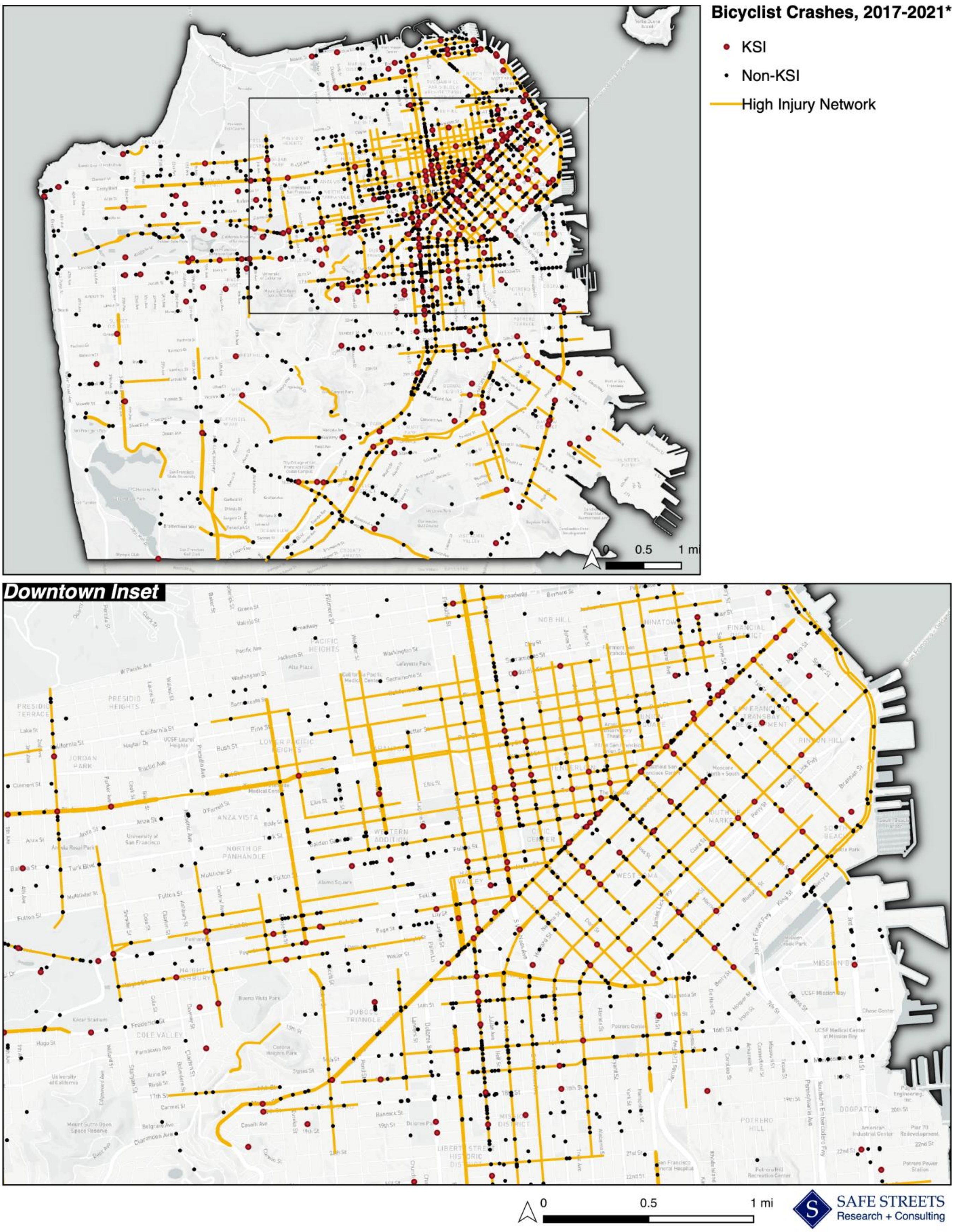
Table 10: Bicycle crashes along the High Injury Network, 2017-2019

HIN	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Yes	128.8	13.1%	1,127	67.8%	94	59.9%	21,736	60.7%	87.48	7.30	19.3
No	853.8	86.9%	536	32.2%	63	40.1%	14,047	39.3%	6.28	0.74	26.2
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.92***	***1.60***	***21.5***

Table 11: Bicycle crashes along the High Injury Network, 2020-2021

HIN	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Yes	128.8	13.1%	498	65.3%	53	67.1%	11,137	63.6%	38.66	4.11	22.4
No	853.8	86.9%	265	34.7%	26	32.9%	6,370	36.4%	3.10	0.30	24.0
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.76***	***0.80***	***22.9***

Map 3: Bicyclist crashes and High Injury Network, 2017-2021



Functional Classification

Table 12 summarizes bicyclist crashes by functional classification that occurred between 2017 and 2021, including both intersection and midblock crashes. Map 4 displays bicyclist crashes and functional classification. The highest functional classification was assigned to crashes that occurred at intersections. Most crashes occurred along collector streets (36.4% of all crashes and 33.5% of KSI crashes). When looking at the number of crashes on a per mile basis, crashes and KSI crashes are concentrated along major streets. Arterial streets had the highest concentration of crashes, with 94.6 crashes and 10.6 KSI crashes per 10 miles. Collectors had the second highest concentration of crashes per 10 miles (62.5), whereas major/highway had the second highest concentration of KSI crashes per 10 miles (9.9). Additionally, crashes were most severe on average along major/highway, although only 2.5% of crashes occurred along those streets. Crashes along arterials were the second most severe on average (22.8 avg. EPDO) and accounted for the largest share of KSI crashes, despite arterials only comprising 7.8% of the street network mileage. Table 13 and

Table 14 show crashes by functional class before and after the pandemic, and while there are some differences among total crash volumes and crash severity, the general trends (e.g., most servere crashes on major highways, most crashes on collector roadways, and highly concentrated crahses and KSI crashes on collectors and arterials) were the same during all time periods.

Table 12: Bicycle crashes by highest functional classification, 2017-2021

Functional Classification	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Collector	141.2	14.4%	883	36.4%	79	33.5%	18,555	34.8%	62.5	5.6	21.0
Residential	754.9	76.8%	760	31.3%	66	28.0%	16,465	30.9%	10.1	0.9	21.7
Arterial	76.4	7.8%	723	29.8%	81	34.3%	16,461	30.9%	94.6	10.6	22.8
Major/Highway	10.1	1.0%	60	2.5%	10	4.2%	1771	3.3%	59.3	9.9	29.5
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***22.0***

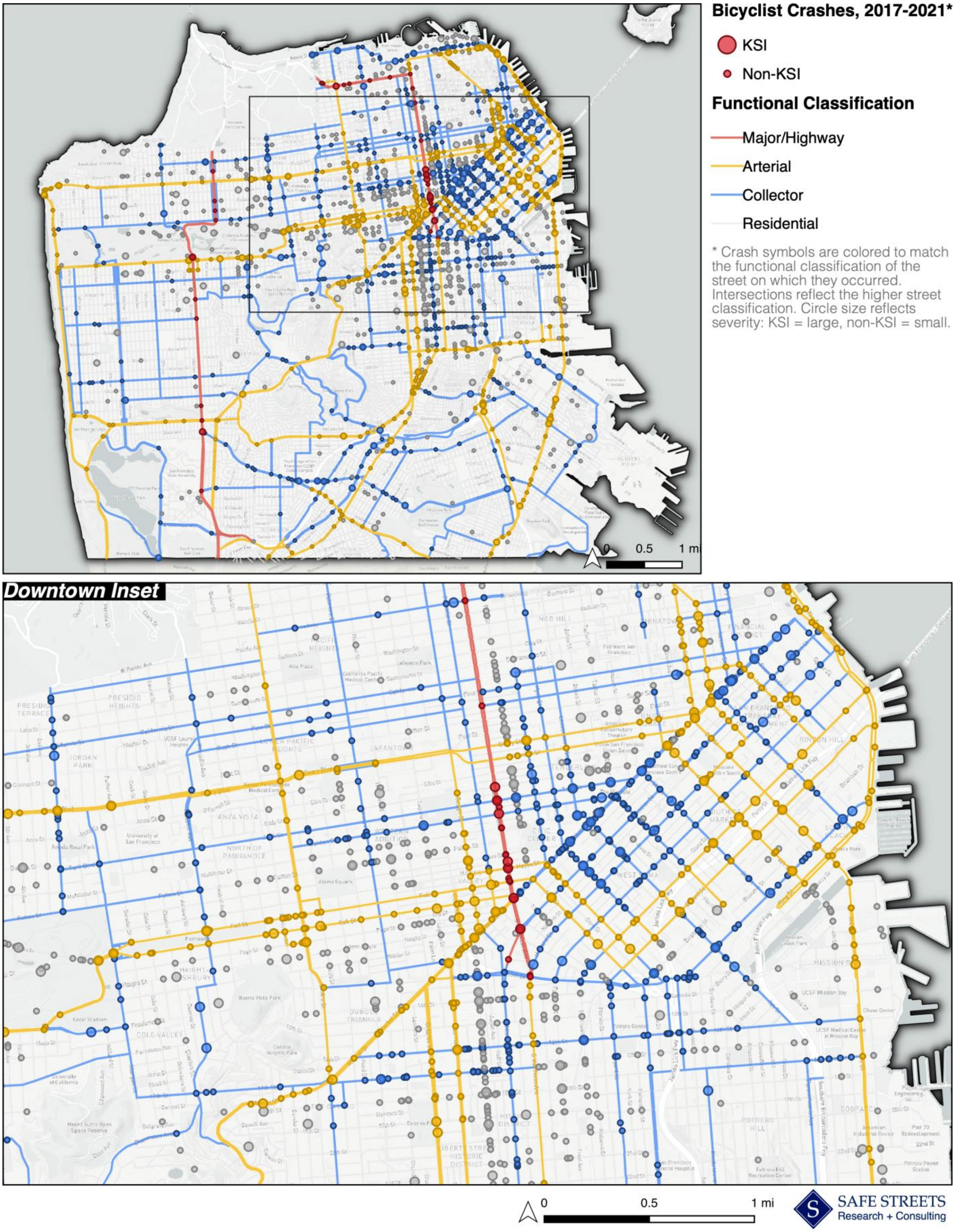
Table 13: Bicycle crashes by highest functional classification, 2017-2019

Functional Classification	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Collector	141.2	14.4%	595	35.8%	60	38.2%	13,554	37.9%	42.1	4.2	22.8
Residential	754.9	76.8%	533	32.1%	42	26.8%	10,932	30.6%	7.1	0.6	20.5
Arterial	76.4	7.8%	497	29.9%	50	31.8%	10,337	28.9%	65.1	6.5	20.8
Major/Highway	10.1	1.0%	38	2.3%	5	3.2%	960	2.7%	37.6	4.9	25.3
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***21.5***

Table 14: Bicycle crashes by highest functional classification, 2020-2021

Functional Classification	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg EPDO per crash
Collector	141.2	14.4%	288	37.7%	19	24.1%	5,012	28.6%	20.4	1.3	17.4
Residential	754.9	76.8%	227	29.8%	24	30.4%	5,546	31.7%	3.0	0.3	24.4
Arterial	76.4	7.8%	226	29.6%	31	39.2%	6,136	35.0%	29.6	4.1	27.2
Major/Highway	10.1	1.0%	22	2.9%	5	6.3%	813	4.6%	21.7	4.9	37.0
Total	***982.6***	***100.0***	***763***	***100.0%***	***79***	***100.0%***	***17,50***	***100.0%***	***7.8***	***0.8***	***22.9***

Map 4: Bicyclist crashes and functional classification, 2017-2021



Functional Classification – Intersection Crashes

Table 15 summarizes reported bicycle crashes at intersections by functional classification between 2017 and 2021. Crashes are categorized by both the minimum and maximum functional classification of the streets at the intersection. The most severe crashes occurred at intersections with generally higher functional classes, as risk factors would suggest; crashes at intersections of major highways and arterials were the most severe (40.0 avg. EPDO), followed by intersections of major highways and collectors (31.9 avg. EPDO). There are relatively few intersections between major/highway roads and either arterials or collectors, but crashes that occur there are disproportionately severe.

Surprisingly, a large share of overall crashes (26.8%) and KSI crashes (24.2%) occurred at intersections of residential-residential roadways, which make up 60.5% of all intersections, but are typically designed for slower speeds and less traffic. Additionally, the largest share of overall crashes (29.5%) and the second-largest share of KSI crashes (23.1%) occurred at intersections of collector and residential roadways, even though these intersections make up only 20.5% of all intersections – indicating that crashes at these intersections are overrepresented for both metrics. Upon review of these locations, many do not appear to fit the common characteristics of residential streets. Several intersections with at least one KSI crash are located downtown along collector streets and cross with very small alley-like streets (e.g., 8th St. and Minna St., 7th St. and Natoma St., and 5th St. and Natoma St.). Additionally, several streets stand out upon review. For example, Webster St. is coded as residential, but has a buffered bike lane, two general purpose lanes in each direction, a striped centerline, and a raised median – characteristics often found along arterial roadways. As seen in Map 4, Valencia St., Polk St., Harrison St., Folsom St., and Balboa St. are also coded as residential and as having no centerline, even though they have many of the characteristics of a collector or arterial and a centerline is visible through street view imagery. These potential miscodes may help explain why the residential functional classification is associated with such a large share of KSI crashes. If the SFMTA uses street classification for safety or throughput evaluation, we recommend revisiting these classifications and characteristics in the source data.

Table 16 and Table 17 show crashes during 2017 through 2019 and 2020-2021, respectively, and they share the same crash trends as the 5-year period, with some notable differences. Average EPDO per crash was highest (52.6) during 2020-2021, and lowest before the pandemic (37.8). Also, arterial intersections had highest number of crashes per intersection during the 5-year period and before the pandemic, but major/highway intersections with collectors and arterials had the highest number of crashes during the pandemic.

Table 15: Intersection bicyclist crashes by highest and lowest functional classification, 2017-2021

Max Functional Class	*Min Functional Class*	*# Int*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg EPDO per crash
Collector	Residential	1,524	20.5%	569	29.5%	43	23.1%	37.3	2.8	19.4
Collector	Collector	185	2.9%	165	8.6%	18	9.7%	89.2	9.7	20.9
Residential	Residential	4,384	60.5%	516	26.8%	45	24.2%	11.8	1.0	21.6
Arterial	Residential	816	11.2%	350	18.2%	40	21.5%	42.9	4.9	23.2
Arterial	Collector	141	2.0%	182	9.4%	22	11.8%	129.1	15.6	22.5
Arterial	Arterial	64	1.1%	89	4.6%	8	4.3%	139.1	12.5	18.7
Major/Highway	Residential	92	1.3%	33	1.7%	5	2.7%	35.9	5.4	27.9
Major/Highway	Collector	16	0.2%	17	0.9%	3	1.6%	106.3	18.8	31.9
Major/Highway	Arterial	10	0.1%	7	0.4%	2	1.1%	70.0	20.0	40.0
Major/Highway	Major/ Highway	5	0.1%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total		***7,237***	***100.0%***	***1,928***	***100.0%***	***186***	***1.0***	***26.6***	***2.6***	***21.4***

Table 16: Intersection bicyclist crashes by highest and lowest functional classification, 2017-2019

Max Functional Class	*Min Functional Class*	*# Ints*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg EPODO per crash
Collector	Residential	1,524	20.5%	371	28.6%	34	27.2%	24.3	2.2	22.0
Collector	Collector	185	2.9%	109	8.4%	12	9.6%	58.9	6.5	20.5
Residential	Residential	4,384	60.5%	357	27.5%	31	24.8%	8.1	0.7	21.7
Arterial	Residential	816	11.2%	239	18.4%	23	18.4%	29.3	2.8	20.0
Arterial	Collector	141	2.0%	123	9.5%	15	12.0%	87.2	10.6	22.4
Arterial	Arterial	64	1.1%	61	4.7%	5	4.0%	95.3	7.8	17.9
Major/Highway	Residential	92	1.3%	24	1.9%	3	2.4%	26.1	3.3	22.8
Major/Highway	Collector	16	0.2%	10	0.8%	2	1.6%	62.5	12.5	37.8
Major/Highway	Arterial	10	0.1%	2	0.2%	0	0.0%	20.0	0.0	8.5
Major/Highway	Major/Highway	5	0.1%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total		***7,237***	***100.0%***	***1,296***	***100.0%***	***125***	***100.0%***	***17.9***	***1.7***	***21.4***

Table 17: Intersection bicyclist crashes by highest and lowest functional classification, 2020-2021

Max Functional Class	*Min Functional Class*	*# Ints*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	Crashes per 100 Ints	KSI Crashes per 100 Ints	Avg EPODO per crash
Collector	Residential	1,524	20.5%	198	31.3%	9	14.8%	1.3	0.6	14.5
Collector	Collector	185	2.9%	56	8.9%	6	9.8%	3.0	3.2	21.8
Residential	Residential	4,384	60.5%	159	25.2%	14	23.0%	0.4	0.3	21.3
Arterial	Residential	816	11.2%	111	17.6%	17	27.9%	1.4	2.1	30.2
Arterial	Collector	141	2.0%	59	9.3%	7	11.5%	4.2	5.0	22.6
Arterial	Arterial	64	1.1%	28	4.4%	3	4.9%	4.4	4.7	20.5
Major/Highway	Residential	92	1.3%	9	1.4%	2	3.3%	1.0	2.2	41.4
Major/Highway	Collector	16	0.2%	7	1.1%	1	1.6%	4.4	6.3	23.7
Major/Highway	Arterial	10	0.1%	5	0.8%	2	3.3%	5.0	20.0	52.6
Major/Highway	Major/Highway	5	0.1%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total		***7,237***	***100.0%***	***632***	***100.0%***	***61***	***100.0%***	***0.9***	***0.8***	***21.4***

Number of Lanes

Table 18 summarizes all reported bicycle crashes by the number of roadway lanes between 2017 and 2021. The number of lanes reflects the overall number of general purpose lanes along the street in both directions of travel. Crashes at intersections were assigned the greatest number of lanes of the intersecting roadways. The number of lanes of roadways considered for this analysis ranged between 1 and 5+. Most roads (76.4%) considered in this study are two lane roadways, and these roadways were the site of about one-third of all crashes and KSI crashes. However, there is a clear and positive relationship between crash densities, severity, and the number of lanes: there were 108.2 crashes per 10 miles of 5-lane roads, 89.1 crashes per 10 miles of 3-lane roads, and 86.4 crashes per 10 miles on 4-lane roads, compared with just under 10.7 crashes per 10 miles on 2-lane roadways. The rate of KSI crashes per 10 miles and EPDO scores further illustrate the disproportionate burden that roadways with 3, 4, or 5+ lanes create for overall network safety. Furthermore, 53% of the 3-lane roadway mileage occurs along one-way streets; as shown later in this report, one-way traffic is often a separate risk factor in safety models (i.e., irrespective of lane numbers) due to the lack of oncoming traffic. This trend is the same during pre-pandemic years and during the pandemic, as shown in Table 19 and

Table 20.

Table 18: Bicycle crashes by number of lanes, 2017-2021

# Lanes	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
1	56.0	5.7%	13	0.5%	0	0.0%	108	0.2%	2.3	0.0	1.9
2	751.0	76.4%	802	33.1%	77	32.6%	19,054	35.8%	10.7	1.0	25.4
3	36.4	3.7%	324	13.4%	22	9.3%	5,573	10.5%	89.1	6.1	153.3
4	101.1	10.3%	874	36.0%	87	36.9%	18,597	34.9%	86.4	8.6	183.9
>=5	38.2	3.9%	413	17.0%	50	21.2%	9,920	18.6%	108.2	13.1	259.8
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***54.2***

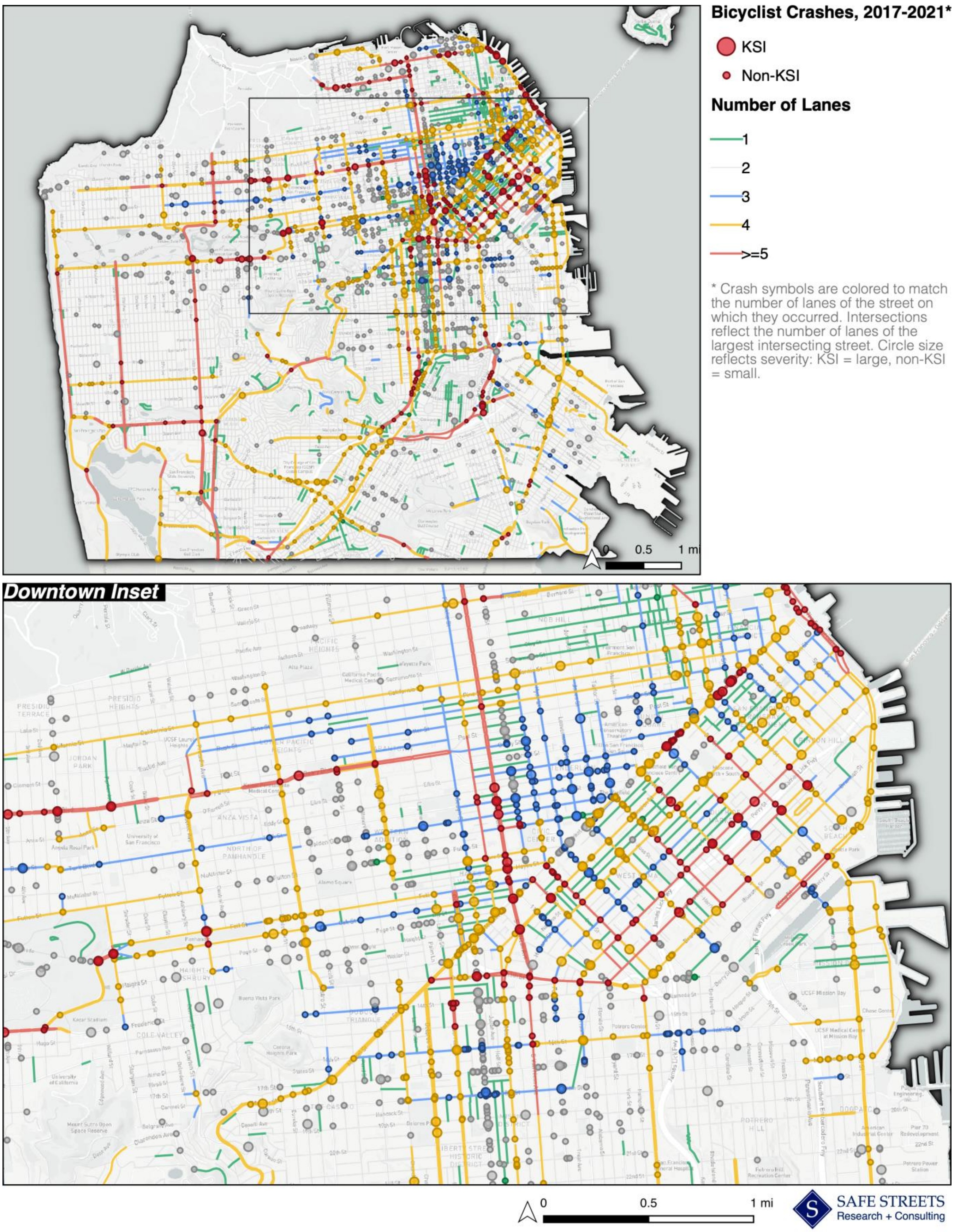
Table 19: Bicycle crashes by number of lanes, 2017-2019

# Lanes	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
1	56.0	5.7%	9	0.5%	0	0.0%	74	0.2%	1.6	0.0	1.3
2	751.0	76.4%	555	33.4%	53	33.8%	13,220	36.9%	7.4	0.7	17.6
3	36.4	3.7%	222	13.3%	16	10.2%	3,967	11.1%	61.1	4.4	109.1
4	101.1	10.3%	595	35.8%	57	36.3%	12,142	33.9%	58.8	5.6	120.1
>=5	38.2	3.9%	282	17.0%	31	19.7%	6,380	17.8%	73.9	8.1	167.1
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***36.4***

Table 20: Bicycle crashes by number of lanes, 2020-2021

# Lanes	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
1	56.0	5.7%	4	0.5%	0	0.0%	34	0.2%	0.7	0.0	0.6
2	751.0	76.4%	247	32.4%	24	30.4%	5,852	33.4%	3.3	0.3	7.8
3	36.4	3.7%	102	13.4%	6	7.6%	1,609	9.2%	28.1	1.7	44.3
4	101.1	10.3%	279	36.6%	30	38.0%	6,468	36.9%	27.6	3.0	64.0
>=5	38.2	3.9%	131	17.2%	19	24.1%	3,544	20.2%	34.3	5.0	92.8
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***17.8***

Map 5: Bicyclist crashes and number of lanes, 2017-2021



Posted Speed Limit

Table 21 summarizes the number of reported bicycle crashes categorized by the posted speed limit (i.e., not prevailing speed) between 2017 and 2021. Speed limits ranged between 25 mph (or less) to 45 miles per hour. About 3% of roadways in the network (26.7 miles) did not have speed limit data available. Most of the network (90.6%) has a posted speed limit of 25 mph, and most of the overall crashes (82%) and the KSI crashes (79%) occurred on these roadways, as shown in Map 6. Two-thirds of crashes and 60% of KSI crashes along 25 mph streets occurred along the HIN. Around 13% of crashes were on roadways with posted speeds of 30 mph, even though they make up less than 3% of the network. The 30 mph roadways also had the highest number of crashes per 10 miles (110.2), KSI crashes per 10 miles (10.9), and EPDO per 10 miles (2,357.4), indicating that a disproportionate share of severe injuries and fatalities occur on these roads. Similarly, it is notable that roadways with a speed limit of 35 mph have the second highest EPDO per 10 miles (1,268.9) and 8% of KSI crashes, despite comprising less than 3% of the network.

Most KSI crashes along 25 mph streets involved a bicyclist and a motorist (68%), followed by solo-bicyclist (27.5%) and bicyclist-pedestrian (4.5%) crashes. Nearly 80% of these KSI crashes occurred at an intersection, with 53% at a signalized intersection, 13% at a partial stop, and 8% at an all-way stop. Looking at bicyclist-motorists crashes, perpendicular and same direction crashes accounted for nearly 39% of KSI crashes each. The most frequent movement types for perpendicular KSI crashes were both parties proceeding straight (20.7%, n=25), followed by bicyclist proceeding straight and motorist making a left turn (4.1%, n=5). The most frequent movement types for same direction crashes were bike proceeding straight and motorist stopped (9.9%, n=12, 7 of the 12 were dooring related), followed by other/unknown (5.8%, n=7) and bike proceeding straight and motorists making a right turn (5%, n=6).

The majority (about two thirds) of the KSI crashes along 25mph streets did not occur along a bike facility of any type. Of the bicycle facilities along 25 mph streets, Class III facilities had the largest share of KSI crashes (54.8%), followed by Class II (36.7%) and Class IV (12.7%) facilities. Similar to the findings in the functional classification section of this analysis, intersections along 25 mph streets at collector-residential and residential-residential streets accounted for nearly 50% of KSI crashes. As stated earlier in this memo, several of these streets coded as a residential street may have the characteristics of a collector or arterial, including being major destination hubs with more motorist and bicyclist travel than we would expect on a typical residential street.

These trends do not differ between study years before the pandemic and during the pandemic, as shown in Table 22 and Table 23.

Table 21: Bicycle crashes by posted speed limit, 2017-2021

Posted Speed Limit	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	890.5	90.6%	1,983	81.7%	186	78.8%	42,915	80.6%	22.3	2.1	481.9
30	27.6	2.8%	304	12.5%	30	12.7%	6,503	12.2%	110.2	10.9	2,357.4
35	27.9	2.8%	117	4.8%	19	8.1%	3,544	6.7%	41.9	6.8	1268.9
40	6.7	0.7%	6	0.2%	1	0.4%	155	0.3%	8.9	1.5	231.2
45	3.2	0.3%	8	0.3%	0	0.0%	72	0.1%	24.7	0.0	221.9
unknown	26.7	2.7%	8	0.3%	0	0.0%	63	0.1%	3.0	0.0	23.6
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***541.9***

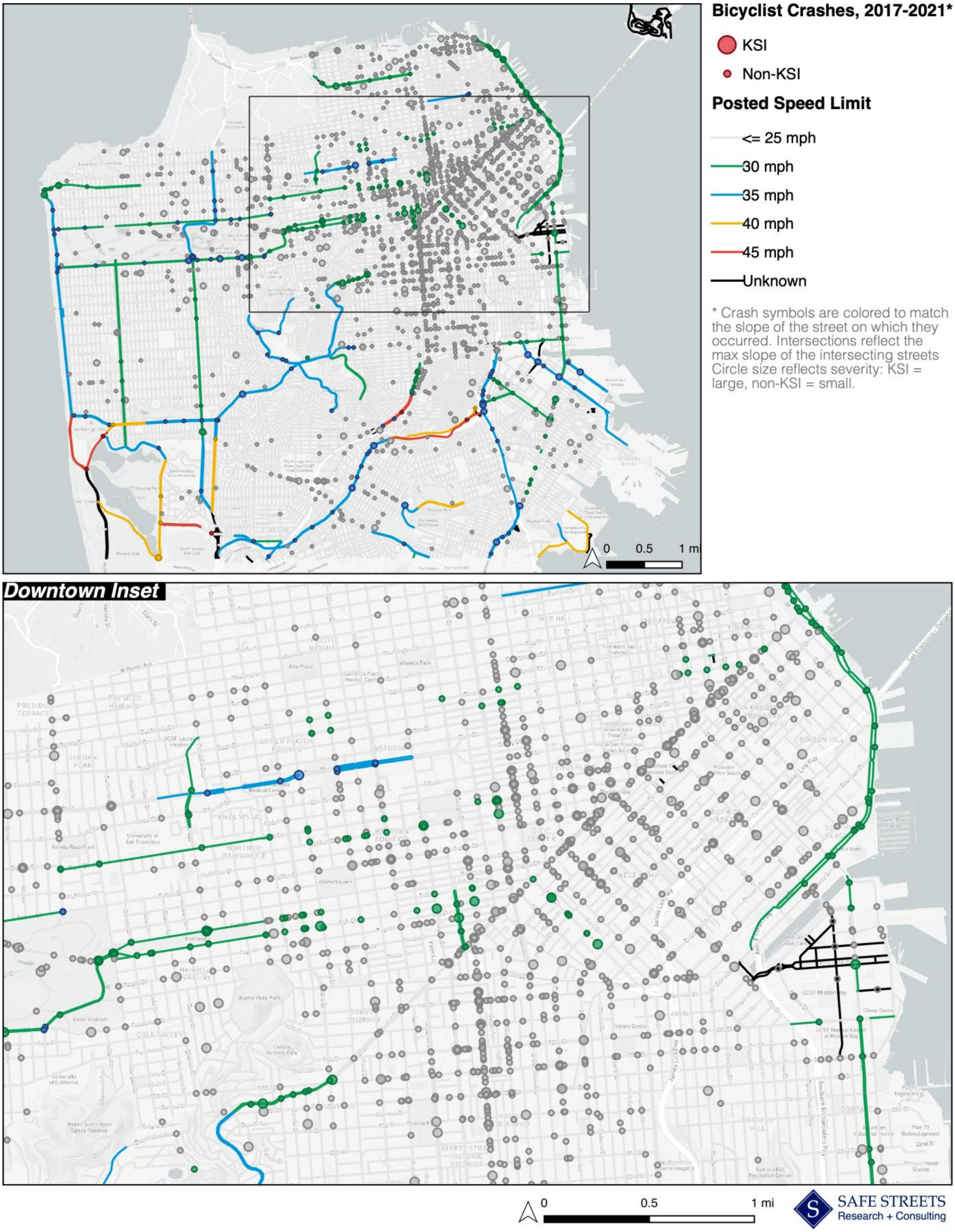
Table 22: Bicycle crashes by posted speed limit, 2017-2019

Posted Speed Limit	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	890.5	90.6%	1,378	82.9%	126	80.3%	29,415	82.2%	15.5	1.4	330.3
30	27.6	2.8%	198	11.9%	16	10.2%	3,614	10.1%	71.8	5.8	1,310.1
35	27.9	2.8%	73	4.4%	14	8.9%	2,531	7.1%	26.1	5.0	906.2
40	6.7	0.7%	4	0.2%	1	0.6%	143	0.4%	6.0	1.5	213.3
45	3.2	0.3%	5	0.3%	0	0.0%	40	0.1%	15.4	0.0	123.3
unknown	26.7	2.7%	5	0.3%	0	0.0%	40	0.1%	1.9	0.0	15.0
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***364.1***

Table 23: Bicycle crashes by posted speed limit, 2020-2021

Posted Speed Limit	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<=25	890.5	90.6%	605	79.3%	60	75.9%	13,532	77.3%	6.8	0.7	152.0
30	27.6	2.8%	106	13.9%	14	17.7%	2,893	16.5%	38.4	5.1	1,048.8
35	27.9	2.8%	44	5.8%	5	6.3%	1,014	5.8%	15.8	1.8	363.1
40	6.7	0.7%	2	0.3%	0	0.0%	12	0.1%	3.0	0.0	17.9
45	3.2	0.3%	3	0.4%	0	0.0%	33	0.2%	9.2	0.0	101.7
unknown	26.7	2.7%	3	0.4%	0	0.0%	23	0.1%	1.1	0.0	8.6
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***178.2***

Map 6: Bicyclist crashes and posted speed limit, 2017-2021



Mean Observed Speed

This analysis also looked at the relationship between mean *observed* speeds per segment. It is important to note that the nature of this analysis precludes analysis into top-end speeding that may be observed at times throughout the city. Table 24 summarizes bicycle crashes by categorized by the mean observed speed between 2017 and 2021. The mean observed speeds range from ≤ 25 mph to ≥ 45 mph, with categories separated into 5 mph bins. Intersection crashes were assigned the highest mean observed speed on the intersecting roadways. Less than 1% of roadways in the network (6.5 miles) lacked a reported speed, and only one of the crashes during the study period occurred on these roadways. Most crashes (96%) and most KSI (98%) crashes occurred on lower-speed roadways, which is likely confounded by the prevalence of lower mean speeds throughout the network, as well as the number of people cycling on the low-speed roads. Map 7 compares the posted speed limit data to the mean observed speed data, illustrating the predominance of 25 mph for both categories. The EPDO scores indicate higher crash severities for the very small percentage of the network where mean motorist speeds between 30 and 39 mph were observed, but there were only four KSI crashes on those roads, so crashes are not illustrated in this map comparison. That the KSI crashes occurred almost exclusively at lower observed speeds – contrasting with well-established injury severity research – suggests both that additional scrutiny is needed for these data and that these findings should be interpreted with caution.

While reported crash trends before the pandemic are similar to the 5-year reported trends (see Table 25), crash trends during the pandemic differ slightly (see Table 26). During the pandemic period, most crashes (95%) and KSI crashes (98%) still occurred on low-speed roadways, but crashes were slightly more distributed among higher speed roadways. Crashes on low-speed roads (≤ 25 mph) had low EPDO scores per 10 miles (176.3) when compared with roadways with 35-39 mph prevailing speeds (648.5), 25-29 mph prevailing speeds (350.6), and 45 mph or greater (220.5). There were also 30.4 crashes per 10 miles on roadways with observed speeds of 45 mph or greater, which is the highest of all categories. In keeping with the conclusion stated above, the extreme concentration of KSI crashes at lower observed speeds suggests caution with these data.

Table 24: Bicycle crashes by observed motorist speed, 2017-2021

Observed Motorist Speed	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	952.4	96.9%	2,331	96.1%	230	97.5	51,437	96.6%	24.5	2.4	540.1
25-29	10.4	1.1%	45	1.9%	2	0.8%	749	1.4%	43.1	1.9	717.4
30-34	7.7	0.8%	33	1.4%	3	1.3%	746	1.4%	43.0	3.9	971.4
35-39	3.1	0.3%	10	0.4%	1	0.4%	264	0.5%	32.1	3.2	847.5
40-44	1.2	0.1%	2	0.1%	0	0.0%	21	0.0%	16.5	0.0	173.6
45+	1.3	0.1%	4	0.2%	0	0.0%	29	0.1%	30.4	0.0	220.5
unknown	6.5	0.7%	1	0.0%	0	0.0%	6	0.0%	1.5	0.0	9.3
Total	**982.6**	**100.0%**	***2,426***	***100.0***	***236***	***100.0***	***53,252***	***100.0***	***24.7***	***2.4***	***541.9***

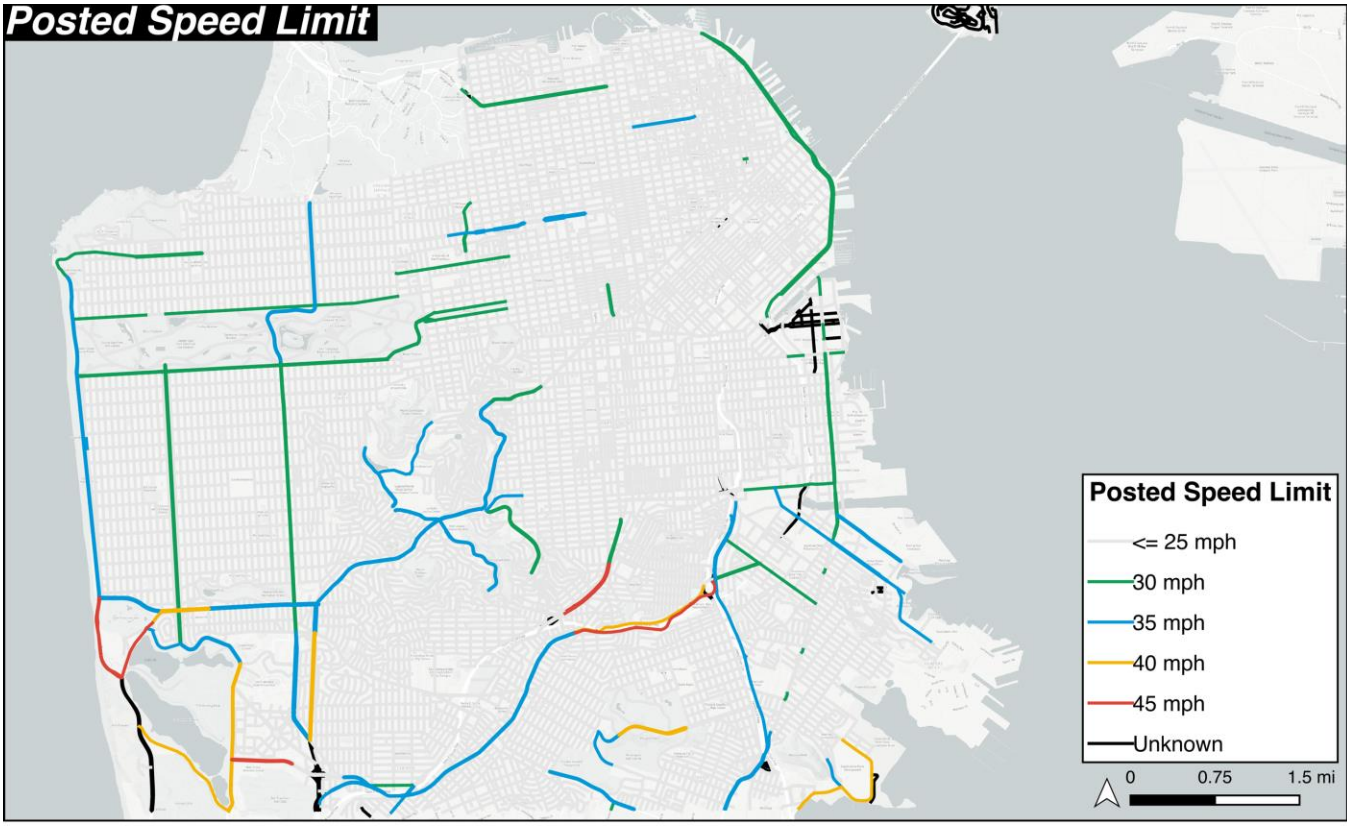
Table 25: Bicycle crashes by observed motorist speed, 2017-2019

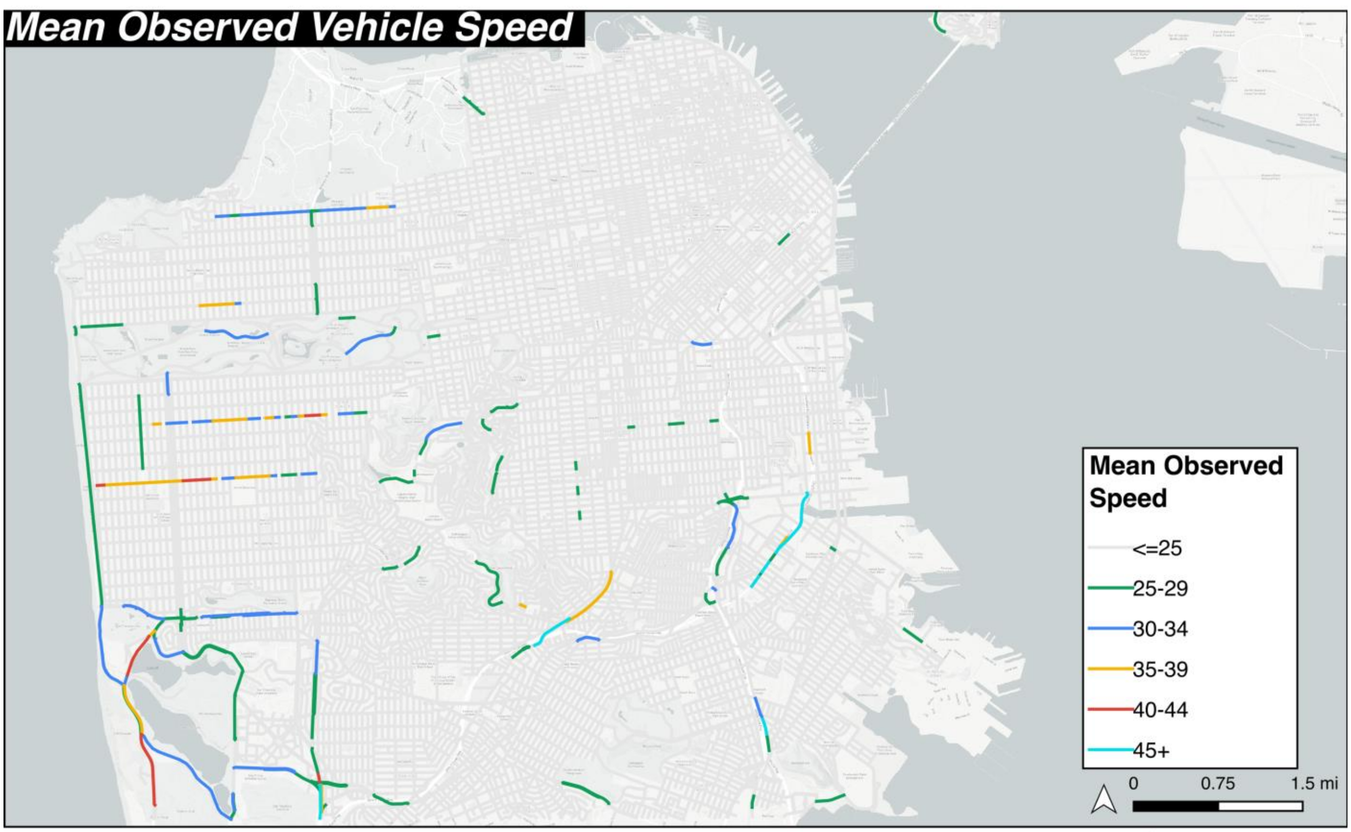
Observed Motorist Speed	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	952.4	96.9%	1,609	96.8%	153	97.5%	34,682	96.9%	16.9	1.6	364.1
25-29	10.4	1.1%	24	1.4%	1	0.6%	383	1.1%	23.0	1.0	366.9
30-34	7.7	0.8%	21	1.3%	3	1.9%	644	1.8%	27.3	3.9	838.5
35-39	3.1	0.3%	8	0.5%	0	0.0%	63	0.2%	25.7	0.0	202.2
40-44	1.2	0.1%	1	0.1%	0	0.0%	11	0.0%	8.3	0.0	90.9
45+	1.3	0.1%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0	0.0
unknown	6.5	0.7%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0	0.0
Total	**982.6**	**100.0%**	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***364.1***

Table 26: Bicycle crashes by observed motorist speed, 2020-2021

Observed Motorist Speed	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
≤25	952.4	96.9%	722	94.6%	77	97.5%	16,792	95.9%	7.6	0.8	176.3
25-29	10.4	1.1%	21	2.8%	1	1.3%	366	2.1%	20.1	1.0	350.6
30-34	7.7	0.8%	12	1.6%	0	0.0%	101	0.6%	15.6	0.0	131.5
35-39	3.1	0.3%	2	0.3%	1	1.3%	202	1.2%	6.4	3.2	648.5
40-44	1.2	0.1%	1	0.1%	0	0.0%	11	0.1%	8.3	0.0	90.9
45+	1.3	0.1%	4	0.5%	0	0.0%	29	0.2%	30.4	0.0	220.5
unknown	6.5	0.7%	1	0.1%	0	0.0%	6	0.0%	1.5	0.0	9.3
Total	**982.6**	**100.0%**	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***178.2***

Map 7: Posted Speed Limit and Mean Observed Vehicle Speed, 2017-2021





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Bike Volume Estimates

Citywide bicycle volumes along every street in San Francisco were estimated as part of the SFMTA ACP. Those estimates have been integrated into this analysis through a serious of descriptive crosstabs. Due to data limitations that affected the bicycle volume estimation process and outputs, these estimates are used in broad categories, rather than as raw numbers. The bicycle volume estimation task categorized the low, medium, and high bins based on the following break points: 166[4]-249, 250-499, and 500+. The low category accounts for 65.8% of the network by mileage, medium accounts for 27%, and high accounts for 7.2%.

The volume estimates for both intersection and midblock locations were separately binned into quantiles for the purpose of this analysis. Quintiles divide the segment and intersection data into five bines with roughly the same number of records (or locations) (lowest being the 20th percentile and below and highest being the 80th percentile and above). Segment and intersection crashes are analyzed separately given that the categories applied to intersections will have different values than segment categories. Additionally, the bike volume estimates were not conducted separately for the pre-pandemic and pandemic study periods. As such, the volume estimates will be used to analyze the 5-year study period, rather than the two study periods separately.

Unsurprisingly, the following tables show locations with higher bicycle volumes had a higher bicycle crash frequency due to higher levels of exposure. This does not necessarily mean locations with higher volumes of bicyclists have higher crash risk. Research has found that specific locations may have a non-linear relationship between bicyclist volumes and crash frequencies, meaning crash rates declined when bicyclist volume exceeded a certain threshold[5]. Research also suggests there is a change in motorist behavior in the presence of higher volumes of bicycle and pedestrian volumes. Additionally, there are many characteristics that influence bicyclist crash risk that are not captured by the ACP bicycle volume estimates and bike facility design that have been explored in previous efforts such as SFTMA's safety performance functions (SPFs). SFDPH will be developing another SPF for bicyclists which will explore the relationship between contextual variables and bicyclist volumes as they relate to crash risk. The following sections summarize the bicycle crashes by bicycle volume estimates as a way to explore the relationship between the data. This section does not suggest causation between the estimated bicycle volume, crashes, and other variables summarized in the following crosstabs.

Mid-block Crashes

Midblock crashes are summarized using two different classifications of bicyclist volume estimates. Table 27 summarizes bicycle crashes by the low, medium, and high classifications used in the ACP bike volume estimation task. As previously mentioned, blocks with higher bicycle volume estimates had a higher frequency of crashes. These blocks also have a much higher rate of crashes per mile, KSI crashes per mile, and EPDO per mile, but those are likely related to the method in which the low, medium, and high classifications were created. Blocks with high bicyclist volume estimates account for only 7.2% of the network but account for 38.4% and 24% of KSI crashes. Moreover, relative to the percentage of all crashes that occur on the streets with the highest bicyclist ridership, there are fewer severe crashes than for other volume categories.

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[4] There are no streets with an estimated bicycle volume less than 166, which is considered a data limitation for this crash analysis.

[5] Jacobsen P. L. (2003). Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury prevention: journal of the International Society for Child and Adolescent Injury Prevention*, *9*(3), 205–209. https://doi.org/10.1136/ip.9.3.205

Table 27: Midblock bicycle crashes by estimate bike volume, 2017-2021

Bicyclist Volume Estimates	***# Miles***	***% Miles***	***# Crashes***	***% Crashes***	***# KSI Crashes***	***% KSI Crashes***	***EPDO***	***% EPDO***	**Crashes per 10 Miles**	**KSI Crashes per 10 Miles**	**EPDO per Mile**
High	70.4	7.2%	191	38.4%	12	24.0%	3,496	29.1%	27.1	1.7	496.3
Medium	265.3	27.0%	159	31.9%	19	38.0%	4,292	35.7%	6.0	0.7	161.8
Low	646.9	65.8%	148	29.7%	19	38.0%	4,230	35.2%	2.3	0.3	65.4
Total	***982.6***	***100.0%***	**498**	**100.0%**	**50**	**100.0%**	**12,018**	**100.0%**	***5.1***	***0.5***	***122.3***

Table 28 summarizes midblock bicyclist volumes by classifying the bike volumes by quintiles. Like Table 27, streets with higher volume estimates had a higher frequency of overall crashes and KSI crashes. This aligns with our general expectations: as exposure increases, crashes are likely to increase as well. However, when we look at the proportion of midblock crashes that result in a KSI outcome, we can see there appear to be safety benefits along higher-volume streets for bicyclists. The proportion of midblock crashes resulting in a KSI outcome are quite low for the highest volume street (8.4%) whereas the lowest volume streets have the highest proportion of KSI outcomes (21.4%).

Map 8: Bicyclist crashes and estimated bicyclist volumes (low, medium, high), 2017-2021

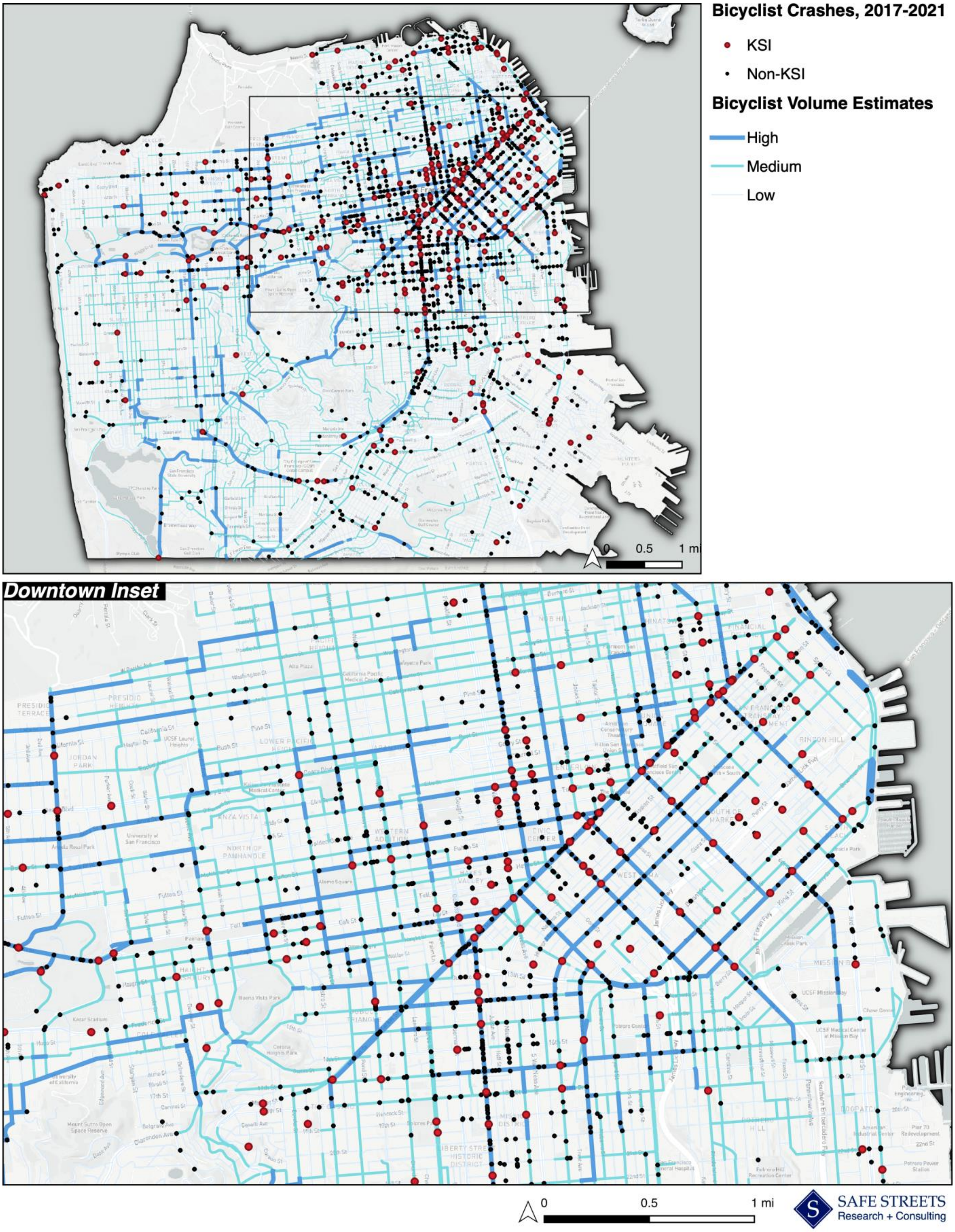

Table 28: Midblock bicycle crashes by estimate bike volume (quantiles), 2017-2021

Bicyclist Volume Estimates Quantiles	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	% Crashes resulting in KSI
5 (highest)	188.7	19.2%	287	57.6%	24	48.0%	6,179	51.4%	15.21	1.27	8.4%
4	191.9	19.5%	75	15.1%	10	20.0%	2,188	18.2%	3.91	0.52	13.3%
3	201.3	20.5%	76	15.3%	8	16.0%	1,914	15.9%	3.78	0.40	10.5%
2	194.2	19.8%	46	9.2%	5	10.0%	1,156	9.6%	2.37	0.26	10.9%
1 (lowest)	206.6	21.0%	14	2.8%	3	6.0%	581	4.8%	0.68	0.15	21.4%
Total	***982.7***	***100.0%***	***498***	***100.0%***	***50***	***100.0%***	***12,018***	***100.0%***	***5.07***	***0.51***	***10.0%***

Intersection Crashes

Intersections were categorized into quantiles like street centerlines, but the volume estimates were aggregated from all intersecting legs. The bicycle volume estimates do not differentiate directional volume estimates to allow for the volume estimates to be aggregated to intersections to reflect entering bicyclist volumes. Intersection bicyclist crashes by bicyclist volume estimates are summarized in Table 29. Like midblock crashes, bicyclist crashes were concentrated at intersections that have the highest bicyclist volume estimates (62.7% crashes; 58.1% of KSI crashes). Again, this is not a direct reflection of crash risk, but a representation of the reality that where there are higher volumes of bicyclists traveling, we can expect to observe a higher frequency of crashes. Interestingly, we do see an inverse relationship between the percentage of crashes that resulted in a KSI outcome and bicyclist volume estimates. Intersections with higher volume estimates had fewer crashes that resulted in a KSI, whereas intersections with a lower volume estimate have a higher proportion of crashes that resulted in a KSI. This relationship between bicyclist volumes and the average severity of crashes at intersections may suggest a safety in numbers effect.

Table 29: Intersection bicycle crashes by estimate bike volume (quantiles), 2017-2021

Bicyclist Volume Estimates Quantiles	# Int	% Ints	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 100 Ints	KSI Crashes per 100 Ints	% Crashes resulting in KSI
5 (highest)	1,447	20.0%	1,209	62.7%	108	58.1%	23,638	57.3%	83.6	7.5	8.9%
4	1,448	19.9%	370	19.2%	40	21.5%	8,728	21.2%	25.6	2.8	10.8%
3	1,438	19.2%	183	9.5%	17	9.1%	3,914	9.5%	12.7	1.2	9.3%
2	1,456	19.4%	113	5.9%	13	7.0%	3,119	7.6%	7.8	0.9	11.5%
1 (Lowest)	1,449	21.5%	53	2.7%	8	4.3%	1,835	4.5%	3.7	0.6	15.1%
Total	***7,238***	***100.0%***	***1,928***	***100.0%***	***186***	***100.0%***	***41,234***	***100.0%***	***26.6***	***2.6***	***9.6%***

Bike Facility[6]

To examine the relationship between bicycle facilities and crash patterns post-installation, all crashes were aggregated to the nearest roadway centerline if the crash occurred at least one year after the year the bike facility was installed[7]. The highest bike facility was assigned to each centerline (multiple facility types can be present along each block); Class I facilities were the highest and Class III facilities were the lowest. The corresponding facility install date in the data was used to screen for the crash aggregation. Class III facilities make up the largest portion of the bike network (46.4%) which may be due to their relatively minor impact on motor vehicle capacity or level of service and their relatively low cost for installation. Class II facilities comprise the second large share of network mileage (32.8%), followed by Class IV (13.8%) and Class I (7%).

***NOTE: Because the narrative and tables in this section summarize bicycle crashes that occurred along a street with a bike facility only if the crash occurred at least one year after the facility was installed, the crashes examined here are a subset of the overall sample of crashes citywide. Crashes that occurred before the facility was installed or along a street without a bike facility are excluded, as they are not influenced by the bicycle facility's presence.**

Post-installation bicycle crashes per year by bicycle facility type over the 5-year study are summarized in Table 30. Class III facilities accounted for the largest share of both overall crashes and KSI crashes per year (39.7% and 48.2%, respectively), followed closely by Class II facilities (39.2% and 31.7%, respectively). Class IV accounted for the third highest share of crashes (20.1%) and KSI crashes (19%) per year, while Class I facilities had the lowest share of crashes (1%) and KSI crashes (1.1%). While Class II facilities accounted for the large share of crashes, the percentage of crashes that *resulted in a KSI outcome* was the lowest (7.8%), followed by Class IV (9.0%). This finding suggests that the Class II and Class IV facilities and the type of physical separation they provide may help reduce the severity of crashes if they occur.

Most KSI crashes along a bike facility involved a bicyclist and a motorist (69.4%). Of the KSI crashes that occurred along a bike facility, 28.2% were a solo bicyclist, and those occurred most frequently along a Class III facility (18.8% of KSI crashes).

Interestingly, regardless of bike facility type, the largest share of crashes by relative direction of travel between the bicyclists and motorists was the same direction (47.9% of all crashes; 42.4% of KSI crashes), followed by perpendicular (33.2% of all crashes; 40.7% of KSI crashes). Exploring the same direction crashes further, the most common movement types involved a bicyclist proceeding straight and a motorist making a right turn (9% of all crashes, n=66; 5.1% of KSI crashes, n=3) while the most common movement type for KSI crashes was bike proceeding straight and the motorists stopped (5.6% of all crashes, n=41; 13.6% of KSI crashes, n=8). Five of the eight KSI crashes were dooring crashes. Exploring the perpendicular crashes further, most crashes involved both parties proceeding straight (10.7% of all crashes, n=78; 15.3% of KSI crashes, n=9) followed by the bicyclist proceeding straight and the motorist making a left turn (7.5% of all crashes, n=55; 10.2% of KSI crashes, n=6). Most of the crashes and KSI crashes involving both parties proceeding straight were cited as failure to obey a stop sign or disregarded red traffic signal.

Crashes along any type of bike facility were concentrated at intersections (81.5% of all crashes; 82.2% of KSI crashes). Most intersection crashes along a bike facility were perpendicular (35.5% of all crashes; 39% of KSI

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[6] Bicycle class definitions:

- Class I: Trail or shared-used path
- Class II: Bike lane
- Class III: Route or sharrows
- Class IV: Separated or protected bike lane

[7] This deviates from the approach uses elsewhere in this analysis. All other portions of this memo separate intersection crashes from midblock crashes and assign centerline characteristics to midblock crashes and intersection crashes to crashes that occurred within 75 feet of an intersection. This approach aggregated crashes to the nearest centerline regardless of proximity to an intersection.

crashes), followed by same direction (30.3% of all crashes; 24.7% of KSI crashes). Midblock crashes largely involved both parties traveling in the same direction (65.2% of all midblock crashes and 65.4% midblock KSI crashes).

Roughly 60% of KSI crashes along a bike facility occurred at a signalized intersection, with half (49.4%) of those crashes involving both parties traveling in perpendicular direction of travel and 31% involving the parties traveling in the same direction. Additionally, most KSI crashes at signalized intersections involved a motorist proceeding straight (44.8% of signalized intersection KSI crashes) followed by a motorist making a left turn (21.8% of signalized intersection KSI crashes).

Nearly all bicyclist-motorist KSI crashes (18 of 20) that occurred along a Class II facility were at an intersection. Similarly, 11 of the 13 KSI crashes along a Class IV facility were at an intersection. For KSI crashes at an intersection along a Class II facility, 44.4% involved both parties traveling in the same direction, followed by the parties traveling perpendicularly (38.9%). For KSI crashes along a Class IV facility at an intersection, most KSI crashes involved both parties traveling perpendicularly (54.5%).

***NOTE: Crashes per mile and KSI crashes per mile columns are included in the following tables. We recommend interpreting those measures with caution, as the results do not adjust for exposure. For example, Class IV facilities comprise 13.8% of the bike network by centerline mileage, but often have the largest share of bicyclist volumes due to the comfort and safety benefits they provide. Due to concerns about the precision of the exposure data, we did not estimate crashes per bicyclist traveling along a Class IV facility or through an intersection with a Class IV facility.**

Table 30: Bicycle post-installation crashes per year by bicycle facility type, 2017-2021

					Crashes per year AFTER the year the bike facility was installed						
Bike Facility Type	*# Miles*	*% Miles*	*# Crashes*	*# KSI Crashes*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*Crashes per year per 10 miles*	*KSI Crashes per year per 10 miles*	% Crashes per year resulting in KSI
CLASS I	12.3	7.0%	9	1	1.8	1.0%	0.2	1.1%	1.5	0.2	11.1%
CLASS II	58.0	32.8%	354	27	72.9	39.2%	5.7	31.7%	12.6	1.0	7.8%
CLASS III	81.9	46.4%	368	43	73.7	39.7%	8.6	48.2%	9.0	1.0	11.7%
CLASS IV	24.5	13.8%	152	14	37.4	20.1%	3.4	19.0%	15.3	1.4	9.0%
Total	***176.8***	***100.0%***	***883***	***85***	***185.9***	***100.0%***	***17.9***	***100.0%***	***1.5***	***0.2***	***9.6%***

Map 9: Bicyclist crashes and current bicycle network, 2017-2021

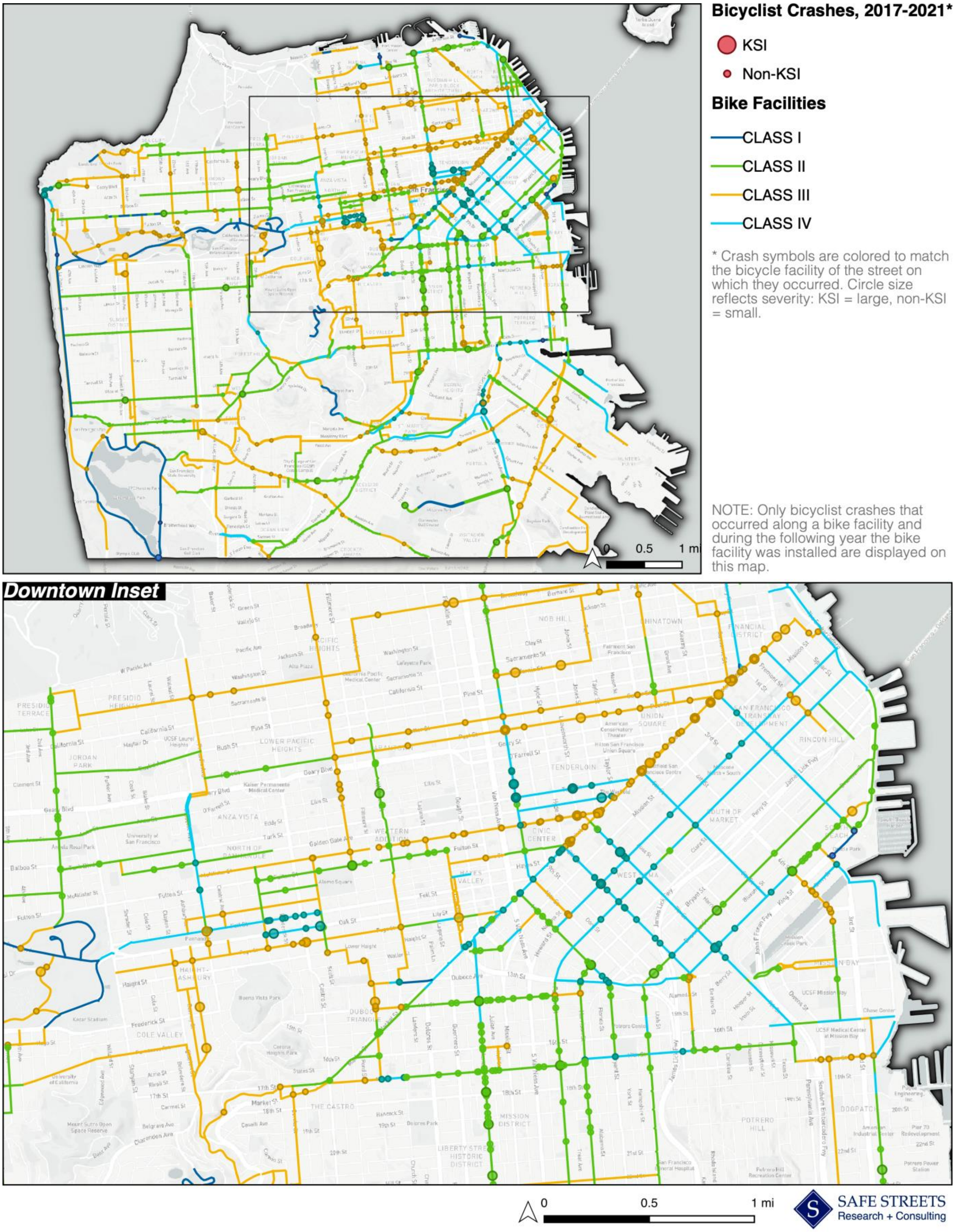


Table 31 summarizes bicycle crashes by bike facility type and bike volume estimates for the 5-year study period. Unsurprisingly, crashes rates (crashes per year) were generally highest along streets with higher bicycle volume estimates (47.7%) regardless of bicycle facility type. However, crashes generally occurred most often along high and medium volume street with a Class II or Class III facility. Crashes along those streets also tended to be more severe, with a higher percentage of crashes resulting in a KSI outcome compared to other medium to high volume streets with a Class I or Class IV facility.

Table 31: Bicycle post-installation crashes per year by bicycle facility type and bicycle volume estimates, 2017-2021

						Crashes per year AFTER the year the bike facility was installed				
Bike Volume Estimate	**Bike Facility Type**	**# Miles**	**% Miles**	**Total Cashes**	**Total KSI Crashes**	**Crashes per year**	**KSI Crashes per year**	**Crashes per year per 10 miles**	**KSI Crashes per year per 10 miles**	**% Crashes per year Resulting in KSI**
High	CLASS I	2.5	1.4%	2	1	0.4	0.2	1.6	0.8	50.0%
High	CLASS II	15.7	8.9%	160	8	33.2	1.6	21.1	1.0	4.8%
High	CLASS III	15.0	8.5%	153	16	30.6	3.2	20.4	2.1	10.5%
High	CLASS IV	11.6	6.6%	97	7	24.5	1.9	21.1	1.6	7.7%
Medium	CLASS I	5.2	2.9%	2	0	0.4	0.0	0.8	0.0	0.0%
Medium	CLASS II	28.1	15.9%	153	14	31.3	3.1	11.1	1.1	9.8%
Medium	CLASS III	39.7	22.5%	148	16	29.7	3.2	7.5	0.8	10.8%
Medium	CLASS IV	7.9	4.4%	38	3	8.7	0.6	11.1	0.8	6.9%
Low	CLASS I	4.7	2.7%	5	0	1.0	0.0	2.1	0.0	0.0%
Low	CLASS II	14.2	8.0%	41	5	8.3	1.0	5.9	0.7	12.0%
Low	CLASS III	27.2	15.4%	67	11	13.4	2.2	4.9	0.8	16.4%
Low	CLASS IV	5.0	2.8%	17	4	4.3	0.9	8.4	1.8	21.2%

Table 32 summarizes bicycle crashes by bike facility type and functional classification for the 5-year study period. Class II and Class II facilities along residential streets accounted for the largest share of crashes (Class II: 20.1%; Class III: 19.9%) and were in the top three location types in terms of percentage of KSI crashes (Class II 17.2%; Class III: 16.8%). Interestingly, crashes along residential streets with a Class II or Class III facility also tended to be less severe, with fewer crashes resulting in a KSI outcome compared to collector or arterial streets. This is likely due to lower vehicle volumes and speeds resulting in lower exposure and less kinetic energy at the time of the crash due to lower vehicle speeds.

Table 32: Bicycle post-installation crashes per year by bicycle facility type and functional classification, 2017-2021

						Crashes per year AFTER the year the bike facility was installed				
Bike Facility Type	Functional Classification	# Miles	% Miles	Total Cashes	Total KSI Crashes	Crashes per year	KSI Crashes per year	Crashes per year per 10 miles	KSI Crashes per year per 10 miles	% Crashes per year resulting in KSI
CLASS I	Arterial	2.2	1.2%	5	0	1.0	0.0	4.6	0.0	0.0%
CLASS I	Collector	4.0	2.3%	3	1	0.6	0.2	1.5	0.5	33.3%
CLASS I	Residential	6.2	3.5%	1	0	0.2	0.0	0.3	0.0	0.0%
CLASS II	Arterial	7.1	4.0%	66	6	13.2	1.2	18.7	1.7	9.1%
CLASS II	Collector	16.8	9.5%	112	7	22.7	1.4	13.5	0.8	6.2%
CLASS II	Residential	34.2	19.4%	176	14	37.0	3.1	10.8	0.9	8.3%
CLASS III	Arterial	9.1	5.2%	54	7	10.8	1.4	11.8	1.5	13.0%
CLASS III	Collector	16.9	9.6%	128	21	25.6	4.2	15.1	2.5	16.4%
CLASS III	Residential	55.9	31.7%	186	15	37.3	3.0	6.7	0.5	8.0%
CLASS IV	Arterial	5.9	3.4%	47	6	12.0	1.2	20.1	2.0	10.0%
CLASS IV	Collector	12.9	7.3%	72	6	17.5	1.7	13.6	1.3	9.5%
CLASS IV	Residential	5.4	3.0%	33	2	8.0	0.5	14.9	1.0	6.7%

Table 33 summarizes bicycle crashes by bike facility type and number of general purpose lanes for the 5-year study period. Similar to the findings reported earlier in this memo, streets with a bike lane and two general purpose lanes had a high rate of bicycle crashes per year. However, Class I and Class IV facilities, which provide the greatest level of physical separation, had the lowest crash rates and KSI crash rates per year and per mile along streets with four lanes. This is a particularly interesting finding, given that Class I and IV facilities are often installed along streets with higher levels of stress and crash risk.

When looking at all bicycle facility types along four-laned roads, most crashes occurred at intersections (89% of all crashes and 80% of KSI crashes), and particularly at signalized intersections (77% of all crashes; 80% of KSI crashes). Exploring motorist-bicyclist crashes along four-lane roads at intersections, we find that same direction crashes comprised the largest share of both overall crashes (38%) and KSI crashes (42%), followed by perpendicular movements (37.6% of all crashes; 37% of KSI crashes). For the same direction crashes, the motorist was most often making a right turn; for perpendicular crashes, the motorists were most often proceeding straight.

The majority of crashes along a bike facility on a two-lane road also occurred at intersections (60% of all crashes and 62% of KSI crashes), and most frequently at signalized intersections (38% of all crashes). Interestingly, of the intersection crashes along a two-lane road with a bike facility, signalized intersection and all-way stop controlled intersections had the same share of KSI crashes (39% of KSI crashes). Most intersection crashes along two-lane roads involved parties traveling in the same direction (43% of all crashes; 31% of KSI crashes), followed by perpendicularly to each other (37% of all crashes; 46% of KSI crashes). For both of these broad crash types, the motorist was most often proceeding straight. The same direction crashes, in particular, may indicate the need for separation in either time (e.g., via a bicycle signal) or space (e.g., via physical separation) between moving vehicle traffic and bicyclists along two-lane roads.

Table 33: Bicycle post-installation crashes per year by highest bicycle facility type and number of general purpose lanes, 2017-2021

						Crashes per year AFTER the year the bike facility was installed				
Bike Facility Type	***# Lanes***	***# Miles***	***% Miles***	***Total Cashes***	***Total KSI Crashes***	***Crashes per year***	***KSI Crashes per year***	***Crashes per year per 10 miles***	***KSI Crashes per year per 10 miles***	**% Crashes per year resulting in KSI**
CLASS I	4	2.5	1.4%	9	1	1.8	0.2	7.3	0.8	11.1%
CLASS II	1	1.1	0.6%	6	0	1.2	0.0	10.5	0.0	0.0%
CLASS II	2	39.8	22.5%	215	18	44.1	3.6	11.1	0.9	8.2%
CLASS II	3	3.8	2.2%	25	0	5.3	0.0	13.8	0.0	0.0%
CLASS II	4	10.6	6.0%	97	8	20.1	1.9	19.0	1.8	9.3%
CLASS II	≥5	2.7	1.5%	11	1	2.2	0.2	8.1	0.7	9.1%
CLASS III	1	1.8	1.0%	15	2	3.0	0.4	16.8	2.2	13.3%
CLASS III	2	59.8	33.8%	193	20	38.7	4.0	6.5	0.7	10.3%
CLASS III	3	4.1	2.3%	24	1	4.8	0.2	11.6	0.5	4.2%
CLASS III	4	13.3	7.5%	118	17	23.6	3.4	17.7	2.6	14.4%
CLASS III	≥5	2.9	1.7%	18	3	3.6	0.6	12.3	2.1	16.7%
CLASS IV	1	0.5	0.3%	2	1	1.0	0.5	21.7	10.9	50.0%
CLASS IV	2	6.2	3.5%	52	2	12.4	0.5	20.1	0.9	4.3%
CLASS IV	3	4.5	2.6%	31	4	7.0	0.9	15.5	2.0	12.8%
CLASS IV	4	10.5	6.0%	57	4	15.0	0.9	14.7	0.8	5.7%
CLASS IV	≥5	2.8	1.6%	10	3	2.0	0.6	7.2	2.2	30.0%

Table 34 summarizes bicycle crashes by bike facility type and if the street is along the HIN for the 5-year study period. Roughly 60% of bicycle crashes and 55% of KSI crashes along a bike facility of any kind occurred along the HIN. Class II and Class III facilities along the HIN had the highest rate of crashes per year, followed by Class II and Class III facilities off the HIN. KSI crashes per year were highest along the Class III facilities along the HIN, followed by Class III facilities off the HIN. These findings underscore the need for bicycle facilities along these routes, but may also indicate insufficient protection gained from Class II and Class III facilities along these routes. The data also showthat Class IV facilities along the HIN had a higher percentage of crashes resulting in a KSI (9.1%) compared to Class II facilities along the HIN (5.7%). These findings may reflect that Class IV facilities, due to their greater level of protection, tend to be installed in more complex locations with greater underlying risk factors. Additionally, these findings appear to further support the idea of separation in time via bike signal: the vast majority of crashes (94%) and all KSI crashes along a Class IV facility that is along the HIN occurred at locations *without* a bike signal.

Nearly half (47.8%) of all crashes and KSI crashes (47.1%) along any bike facility type occurred along the HIN at an intersection. Of the intersection crashes along the HIN, 82.2% of all crashes and 92.5% of KSI crashes were at signalized locations. The most common violation types at these locations include *unsafe turn or lane change* (18.2% of all crashes; 13.5% of KSI crashes), *disregard red signal* (14.1% of all crashes; 8.1% of KSI crashes), and *unsafe speed* (11.5% of all crashes; 13.5% of KSI crashes). Crashes involving a bicyclist and a motorist occurred most often between parties traveling in the same direction (42.4% of all crashes; 25% of KSI crashes), and most often along a Class II facility or Class III facility, likely related at least in part to higher bicyclist exposure in those locations, and potentially influenced by less protection for bicyclists. The most common motorist pre-crash movements for same direction crashes were proceeding straight and making a right turn. KSI crashes occurred most often between a bicyclist and motorist traveling in perpendicular directions (50% of KSI crashes), again, most often along Class II and Class III facilities. The most common motorist pre-crash movement was proceeding straight, followed by making a left turn.

Table 34: Bicycle post-installation crashes per year by highest bicycle facility type and HIN, 2017-2021

						Crashes per year AFTER the year the bike facility was installed				
HIN	Bike Facility Type	# Miles	% Miles	Total Cashes	Total KSI Crashes	Crashes per year	KSI Crashes per year	Crashes per year per 10 miles	KSI Crashes per year per 10 miles	% Crashes per year resulting in KSI
NO	CLASS I	11.0	6.2%	7	1	1.4	0.2	1.3	0.2	14.3%
NO	CLASS II	42.4	24.0%	142	15	28.8	3.1	6.8	0.7	10.9%
NO	CLASS III	65.9	37.3%	165	19	33.0	3.8	5.0	0.6	11.5%
NO	CLASS IV	10.3	5.8%	41	3	10.0	0.9	9.7	0.9	9.0%
YES	CLASS I	1.4	0.8%	2	0	0.4	0.0	2.9	0.0	0.0%
YES	CLASS II	15.6	8.8%	212	12	44.1	2.5	28.2	1.6	5.7%
YES	CLASS III	16.0	9.1%	203	24	40.7	4.8	25.4	3.0	11.8%
YES	CLASS IV	14.2	8.0%	111	11	27.4	2.5	19.4	1.8	9.1%

One-way vs. Two-way

Table 35 summarizes bicyclist crashes on one-way versus two-way streets during 2017-2021, including both intersection and midblock crashes. Just 0.4% of the roadways in the network did not have one- or two-way designations, and six crashes (but no KSI crashes) occurred along these facilities. Most of the roads in the network (88.2%) are two-way roads, but only 62% of all crashes and 59% of KSI crashes occurred on these facilities. In contrast, one-way facilities make up 11.4% of the network but account for a disproportionate 38% of all crashes and 41% of KSI crashes during the study period. These statistics equate to one-way roadway having 4.5 times the EPDO per 10 miles than two-way facilities.

Most crashes along one-way streets occurred at intersections (91.3% of all crashes; 90.5% of KSI crashes). Among these intersection crashes (N=210), 84.3% occurred at signalized locations, as did 95.2% of KSI crashes. One quarter of the KSI crashes along one-way streets were cited as *disregard red signal*, followed by *dooring* (11.8% of KSI crashes). The most common relative direction of travel of both parties was same direction (37.8% of all crashes; 32.4% of KSI crashes) followed by perpendicular movements (37.5% of all crashes; 45.6% of KSI crashes). Most of the same direction crashes involved the bicyclist proceeding straight and the motorist making a right turn (18.7% of all crashes, n=62; 11.1% of KSI crashes, n=3) followed by both parties proceeding straight (13.6% of all crashes, n=45; 7.4% of KSI crashes, n=2). Among the perpendicular crashes, the most frequent movement types involved both parties proceeding straight (41.1% of all crashes, n=120; 64.5% of KSI crashes, n=20), followed by bicyclist proceeding straight and the motorist making a left turn (14.5% of all crashes, n=42; 9.7% of KSI crashes, n=3).

These findings indicate that one-way facilities present significant safety issues for bicyclists that may need further study through specific roadway safety assessments. This trend is the same before (Table 36) and during (Table 37) the pandemic.

Table 35: Bicycle crashes by one-way street, 2017-2021

One-way	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes year 10 miles	KSI Crashes per 10 miles	EPDO per 10 Miles
NO	866.7	88.2%	1,509	62.2%	140	59.3	33,461	62.8	17.4	1.6	386.1
YES	111.7	11.4%	911	37.6%	96	40.7	19,745	37.1	81.6	8.6	1768.
Unknown	4.2	0.4%	6	0.2%	0	0.0%	46	0.1%	14.1	0.0	108.4
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0***	***53,252***	***100.0***	***24.7***	***2.4***	***541.9***

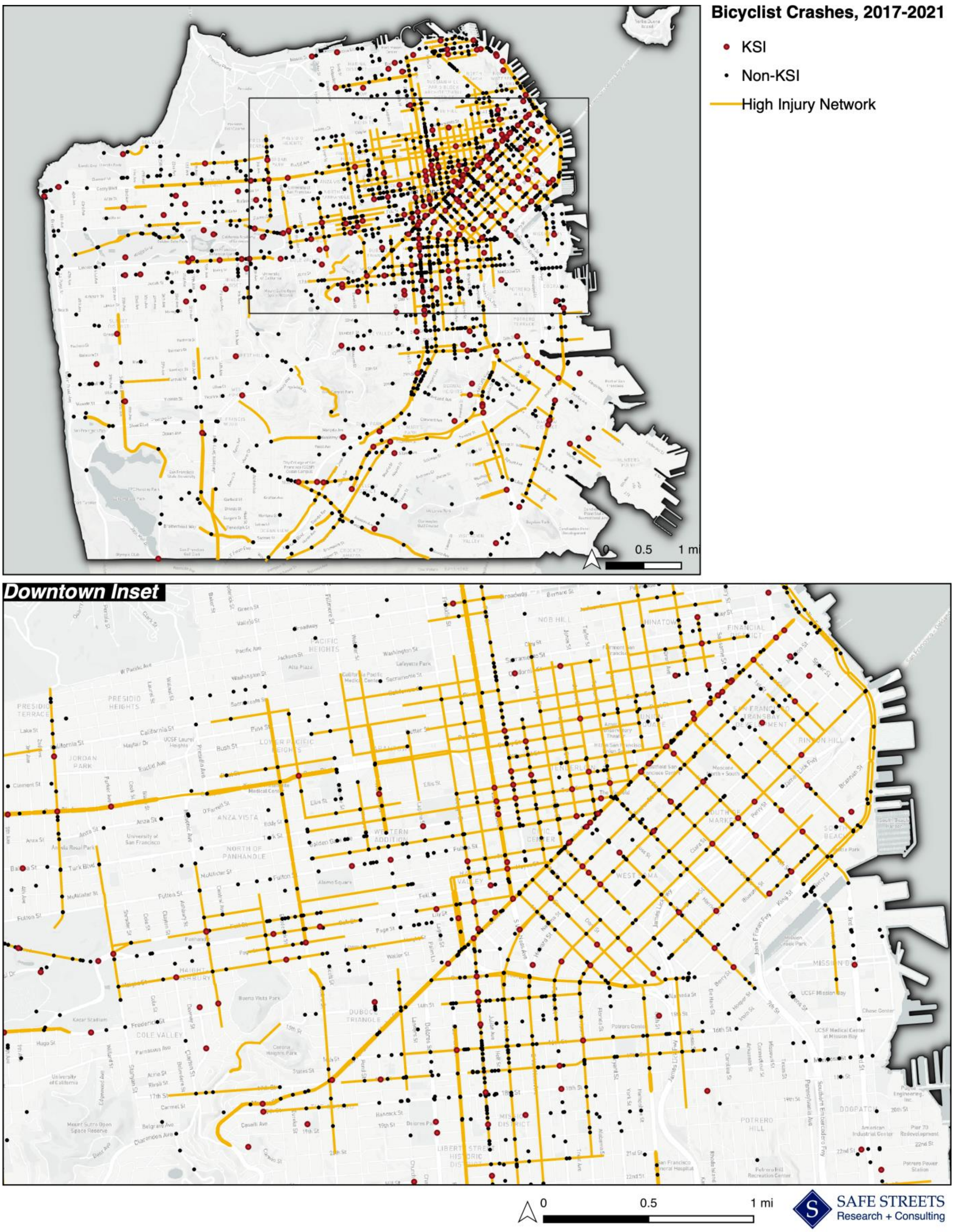
Table 36: Bicycle crashes by one-way street, 2017-2019

One-way	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes year 10 miles	KSI Crashes per 10 miles	EPDO per 10 Miles
NO	866.7	88.2%	1,004	60.4%	93	59.2%	22,125	61.8%	11.6	1.1	24.1
YES	111.7	11.4%	654	39.3%	64	40.8%	13,623	38.1%	58.6	5.7	114.9
Unknown	4.2	0.4%	5	0.3%	0	0.0%	35	0.1%	11.8	0.0	8.2
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***157***	***100.0%***	***35,783***	***100.0%***	***16.9***	***1.6***	***34.4***

Table 37: Bicycle crashes by one-way street, 2020-2021

One-way	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes year 10 miles	KSI Crashes per 10 miles	EPDO per 10 Miles
NO	866.7	88.2%	505	66.2%	47	59.5%	11,366	64.9%	5.8	0.5	131.1
YES	111.7	11.4%	257	33.7%	32	40.5%	6,130	35.0%	23.0	2.9	549.0
Unknown	4.2	0.4%	1	0.1%	0	0.0%	11	0.1%	2.4	0.0	25.9
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***178.2***

Map 10: Bicyclist crashes and one-way streets, 2017-2021



Street Slope

Table 38 shows bicycle crashes categorized by street slope between 2017 and 2021. Slopes vary somewhat evenly across the study area, with no category containing more than 28% of the network (the largest category, slope=1-2.9), and others ranging from 10-24% of the network. The steepest roadways (9+) comprise 22% of the network. The share of all crashes is distributed mostly among slopes between 1 - 6.9. KSI crashes are concentrated on roadways with slopes of 1- 4.9, which makes some sense given that steeper slopes are more difficult to access via bicycle. The most severe crashes also occur on these facilities; they have the highest EPDO per 10 miles (approximately 656.5-665.3). This five-year trend reflects the pre-pandemic period fairly well (Table 39). However, different crash trends emerge during the pandemic (Table 40), with more severe crashes on facilities with slopes between 7-8.9 (233.5 EPDO per 10 miles).

Table 38: Bicycle crashes by street slope, 2017-2021

Slope	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<1	9.1	0.9%	3	0.1%	0	0.0%	32	0.1%	3.3	0.0	35.3
1-2.9	272.7	27.8%	805	35.1%	78	34.7%	17,033	34.1%	31.2	3.0	665.3
3-4.9	230.5	23.5%	700	29.8%	67	29.2%	14,589	28.4%	31.4	3.0	656.5
5-6.9	151.8	15.4%	364	15.3%	30	13.1%	7,291	14.2%	24.5	2.0	497.6
7-8.9	102.1	10.4%	182	8.0%	19	9.3%	4,386	9.4%	18.9	2.2	492.1
9+	216.5	22.0%	265	11.4%	31	13.6%	7,022	13.7%	12.8	1.5	338.0
Total	**982.7**	**100.0%**	**2,325**	**100.0%**	**225**	**100.0%**	**50,399**	**100.0%**	***24.7***	***2.4***	***541.9***

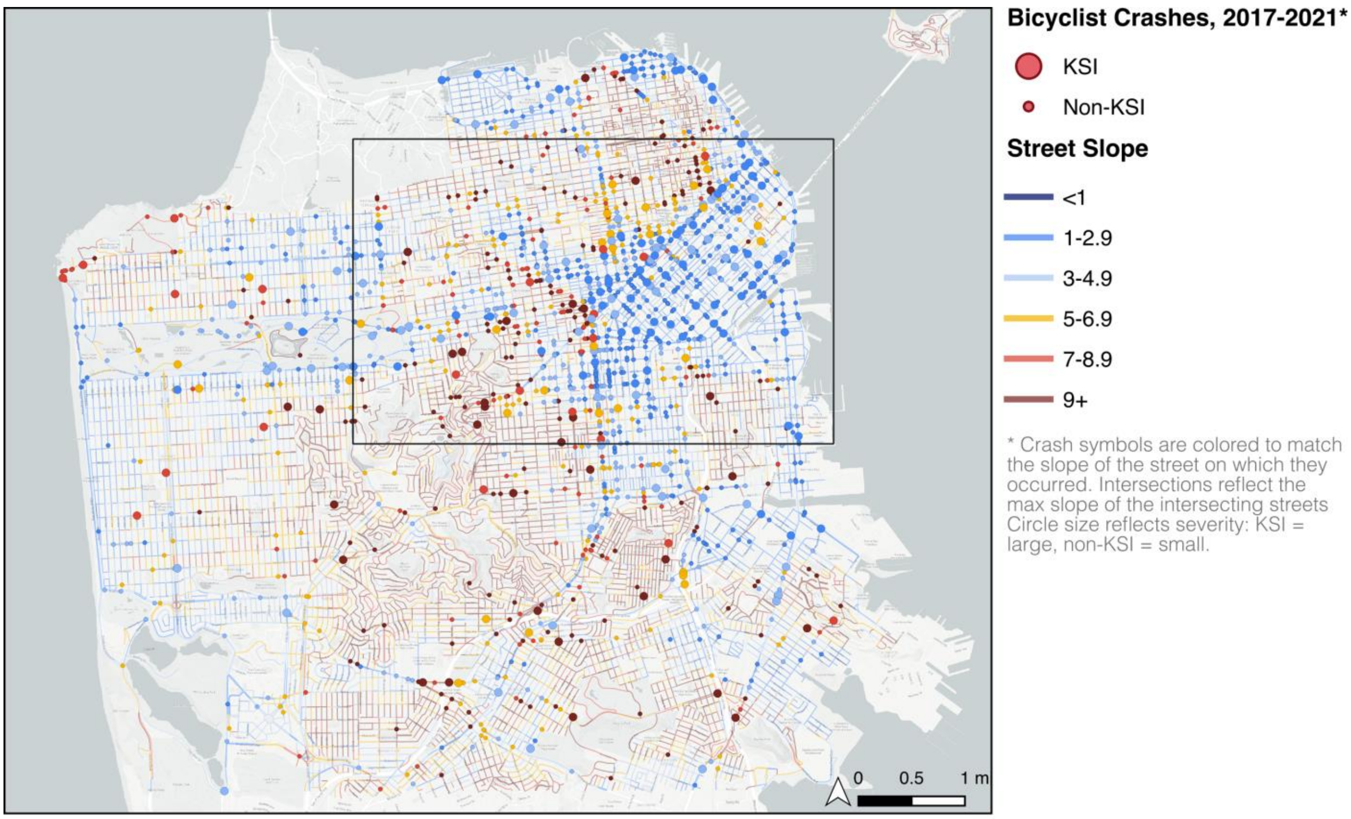
Table 39: Bicycle crashes by street slope, 2017-2019

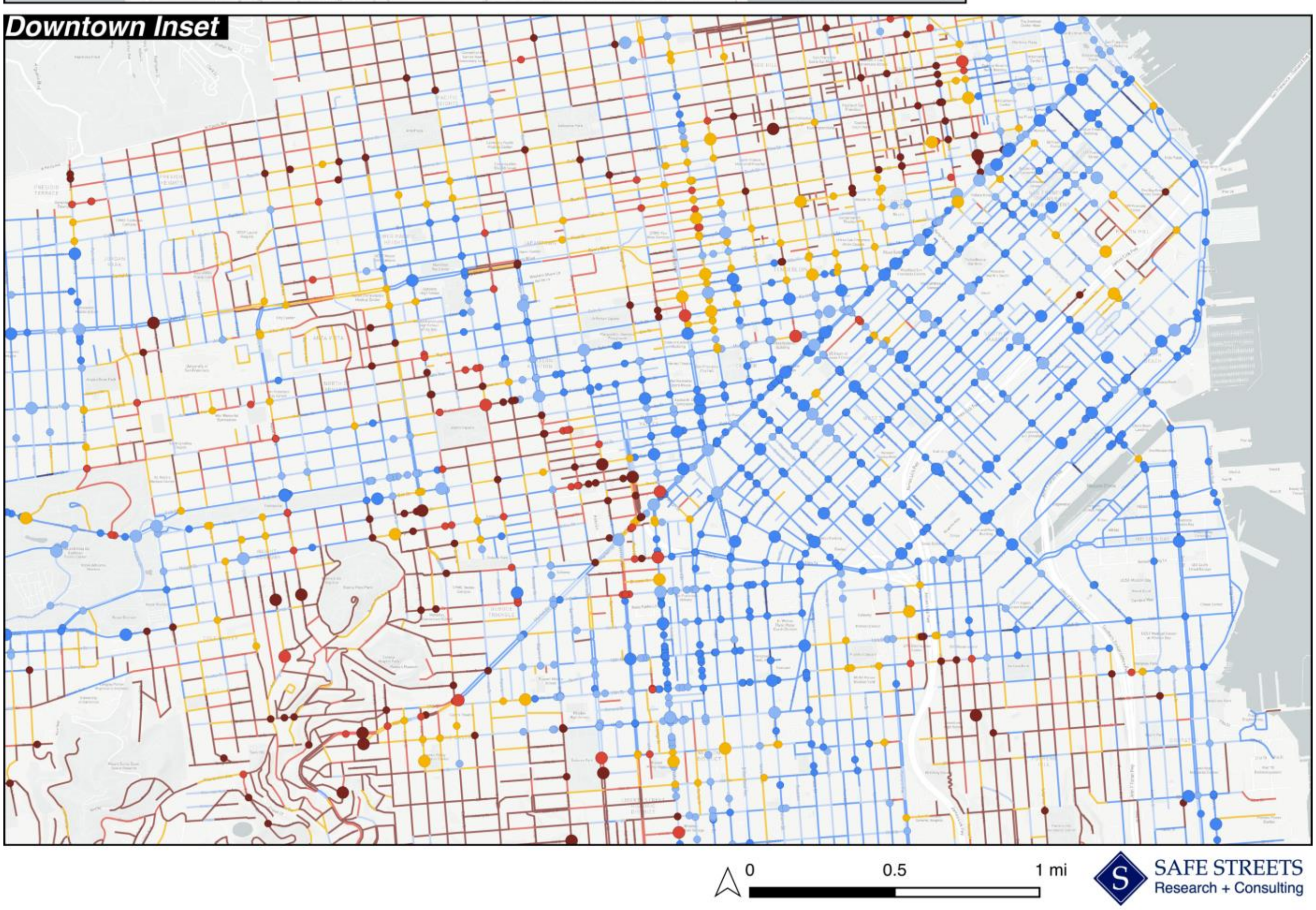
Slope	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<1	9.1	0.9%	3	0.2%	0	0.0%	32	0.1%	3.3	0.0	35.3
1-2.9	272.7	27.8%	593	37.5%	54	36.3%	12,127	36.1%	22.9	2.1	474.3
3-4.9	230.5	23.5%	474	29.3%	48	31.8%	10,106	29.6%	21.1	2.2	459.1
5-6.9	151.8	15.4%	233	14.3%	20	12.7%	4,922	13.9%	15.7	1.3	327.5
7-8.9	102.1	10.4%	129	8.2%	8	6.4%	2,227	7.4%	13.3	1.0	259.1
9+	216.5	22.0%	165	10.3%	19	12.7%	4,343	12.8%	7.9	0.9	212.3
Total	**982.7**	**100.0%**	**367**	**100.0%**	**32**	**100.0%**	**8,065**	**100.0%**	***16.9***	***1.6***	***364.1***

Table 40: Bicycle crashes by street slope, 2020-2021

Slope	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	EPDO per 10 Miles
<1	9.1	0.9%	0	0.0%	0	0.0%	0	0.0%	0.0	0.0	0.0
1-2.9	272.7	27.8%	212	29.9%	24	31.6%	4,915	29.8%	8.4	0.9	191.4
3-4.9	230.5	23.5%	226	30.9%	19	24.1%	4,494	26.1%	10.2	0.8	198.0
5-6.9	151.8	15.4%	131	17.6%	10	13.9%	2,373	14.8%	8.8	0.7	170.4
7-8.9	102.1	10.4%	53	7.5%	11	15.2%	2,164	13.6%	5.6	1.2	233.5
9+	216.5	22.0%	100	13.8%	12	15.2%	2,686	15.6%	4.9	0.6	126.2
Total	**982.7**	**100.0%**	**131**	**100.0%**	**18**	**100.0%**	**3,962**	**100.0%**	***7.8***	***0.8***	***178.2***

Map 11: Bicyclist crashes and street slope, 2017-2021





Transit

Table 41 shows reported bicyclist crashes at intersections and their proximity to transit facilities during the five-year period 2017 – 2021. Out of the 1,928 intersection crashes, 882 (or 45.7%) were near bus stops, and 85 of those were KSI crashes. Across the entire network, there were 26.6 crashes per 100 intersections, but there were notably more crashes per 100 intersections (46.8) when considering intersections with bus stops. This may point a relationship between intersections with more conflicting or complex traveler movements and bicycle crashes. This trend holds for both pre-pandemic and mid-pandemic years, as shown in Table 42 and Table 43.

Table 41: Bicycle crashes by proximity to a bus stop, 2017-2021

Near Bus Stop	*# Int*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Int	KSI Crashes per 100 Ints	Avg EPDO per crash
No	5,353	74.3%	1,046	54.3%	101	54.3%	23,532	57.1%	19.5	1.9	22.5
Yes	1,885	25.7%	882	45.7%	85	45.7%	17,702	42.9%	46.8	4.5	20.1
Total	***7,238***	***100.0%***	***1,928***	***100.0%***	***186***	***100.0%***	***41,234***	***100.0%***	**26.6**	**2.6**	***21.4***

Table 42: Bicycle crashes by proximity to a bus stop, 2017-2019

Near Bus Stop	*# Ints*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Int	KSI Crashes per 100 Ints	Avg EPDO per crash
No	5,353	74.3%	707	54.6%	70	56.0%	16,103	58.1%	13.2	1.3	22.8
Yes	1,885	25.7%	589	45.4%	55	44.0%	11,615	41.9%	31.2	2.9	19.7
Total	***7,238***	***100.0%***	***1,296***	***100.0%***	***125***	***100.0%***	***27,718***	***100.0%***	**17.9**	**1.7**	**21.4**

Table 43: Bicycle crashes by proximity to a bus stop, 2020-2021

Near Bus Stop	*# Ints*	*% Ints*	*# Crashes*	*% Crashes*	*# KSI Crashes*	*% KSI Crashes*	*EPDO*	*% EPDO*	Crashes per 100 Int	KSI Crashes per 100 Ints	Avg EPDO per crash
No	5,353	74.3%	339	53.6%	31	50.8%	7,443	55.0%	6.3	0.6	22.0
Yes	1,885	25.7%	293	46.4%	30	49.2%	6,102	45.0%	15.5	1.6	20.8
Total	***7,238***	***100.0%***	***632***	***100.0%***	***61***	***100.0%***	***13,545***	***100.0%***	**8.7**	**0.8**	**21.4**

Land Use

Table 44 summarizes bicyclist crashes by land use between 2017 and 2021, including both midblock and intersection crashes. Five different land use categories are considered: commercial, industrial, mixed use, public, and residential. The largest share of the network (64.2%) is within residential areas, followed by public land use (14.7%) and mixed uses (12.6%). Crashes in mixed used contexts seem to be slightly over-represented, as they make up 30% of all crashes. Similarly, severe crashes seem to be over-represented in commercial contexts; they make up 20% of KSI crashes despite only making up 3.9% of the network, and they have the highest crashes per 10 miles in the network. These findings may reflect the complexity of interactions among roadway users in commercial and mixed-use areas, which can impact bicycle safety outcomes. In general, this trend holds both during and before the pandemic as shown in Table 45 and Table 46, with some differences. Most notably, there were relatively more severe crashes in terms of EPDO scores near public spaces during the pandemic compared to pre-pandemic years (28.7 in 2020-2021, compared to 22.3 in 2017-2019). Additionally, there was a change in the percentage of KSI crashes near mixed land uses (31.2% in 2017-2019, compared to 20.3% in 2020-2021), which likely reflects changes in activity and travel behavior between those two periods.

Table 44: Bicyclist crashes by land use, 2017-2021

Land Use	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg. EPDO
Commercial	38.4	3.9%	419	17.3%	47	19.9%	9,472	17.8%	109.2	12.2	22.6
Industrial	44.8	4.6%	201	8.3%	18	7.6%	4,313	8.1%	44.9	4.0	21.5
Mixed Use	123.9	12.6%	714	29.4%	60	25.4%	13,297	25.0%	57.6	4.8	18.6
Public	144.8	14.7%	365	15.0%	38	16.1%	8,751	16.4%	25.2	2.6	24.0
Residential	630.9	64.2%	727	30.0%	73	30.9%	17,419	32.7%	11.5	1.2	24.0
Total	***982.6***	***100.0%***	***2,426***	***100.0%***	***236***	***100.0%***	***53,252***	***100.0%***	***24.7***	***2.4***	***22.0***

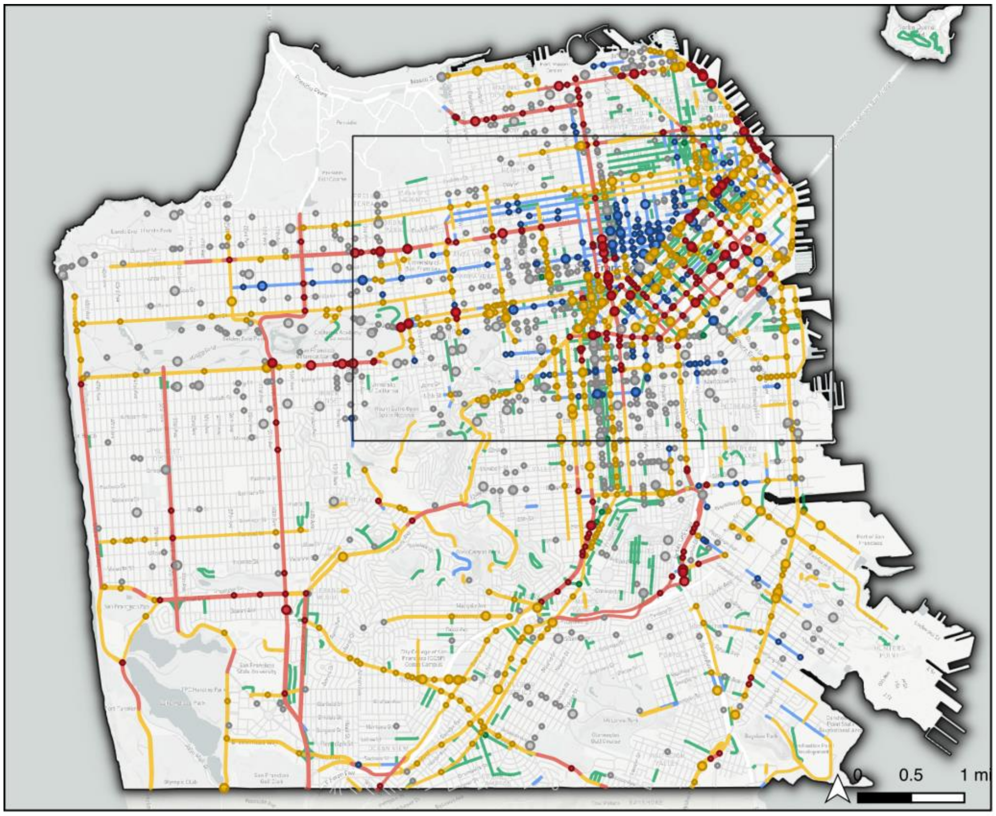
Table 45: Bicyclist crashes by land use, 2017-2019

Land Use	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg. EPDO
Commercial	38.4	3.9%	320	20.4%	25	20.0%	5,103	18.4%	1.7	0.2	19.3
Industrial	44.8	4.6%	140	8.2%	7	5.6%	2,019	7.3%	1.2	0.1	19.0
Mixed Use	123.9	12.6%	495	29.3%	39	31.2%	7,863	28.3%	2.2	0.2	20.7
Public	144.8	14.7%	229	11.9%	15	12.1%	3,444	12.4%	1.1	0.1	22.3
Residential	630.9	64.2%	479	30.3%	39	31.1%	9,321	33.6%	1.6	0.2	23.8
Total	***982.6***	***100.0%***	***1,663***	***100.0%***	***126***	***100.0%***	***27,750***	***100.0%***	***1.6***	***0.2***	***21.4***

Table 46: Bicyclist crashes by land use, 2020-2021

Land Use	# Miles	% Miles	# Crashes	% Crashes	# KSI Crashes	% KSI Crashes	EPDO	% EPDO	Crashes per 10 Miles	KSI Crashes per 10 Miles	Avg. EPDO
Commercial	38.4	3.9%	99	13.0%	15	19.0%	2,828	16.2%	25.8	3.9	28.6
Industrial	44.8	4.6%	61	8.0%	7	8.9%	1,383	7.9%	13.6	1.6	22.7
Mixed Use	123.9	12.6%	219	28.7%	16	20.3%	3,748	21.4%	17.7	1.3	17.1
Public	144.8	14.7%	136	17.8%	18	22.8%	3,899	22.3%	9.4	1.2	28.7
Residential	630.9	64.2%	248	32.5%	23	29.1%	5,649	32.3%	3.9	0.4	22.8
Total	***982.6***	***100.0%***	***763***	***100.0%***	***79***	***100.0%***	***17,507***	***100.0%***	***7.8***	***0.8***	***22.9***

Map 12: Bicyclist crashes and land use, 2017-2021



Bicyclist Crashes, 2017-2021*

- KSI
- Non-KSI

Number of Lanes

- 1
- 2
- 3
- 4
- >=5

* Crash symbols are colored to match the number of lanes of the street on which they occurred. Intersections reflect the number of lanes of the largest intersecting street. Circle size reflects severity: KSI = large, non-KSI = small.

0 0.5 1 mi

SAFE STREETS Research + Consulting

Equity Priority Communities – Citywide

Table 47 summarizes bicyclist crashes during the 5-year study period by proximity to an EPC. Slightly more than half of the reported bicyclist crashes (N=2,432) occurred not within an EPC (55.2%) and these crashes tend to be more severe, with an average EPDO score of 23.2 and 10.3% of crashes resulting in a KSI outcome. This pattern was similar when exploring crashes by pre-pandemic (see Table 48) and pandemic (see Table 49) study periods.

When looking at crashes that occurred within an EPC as they relate to the HIN, 80.5% of crashes and 79.6% of KSI crashes across all EPCs occurred along the HIN. There are several potential factors that may influence this concentration of crashes. One factor might be related to bicyclists riding along a smaller number of streets, increasing the volume along those streets, resulting in a higher crash frequency. Another potential factor might be related to systemic safety issues within these communities that increase bicyclist risk along the HIN or just expose bicyclists to greater risk due to a higher ratio of HIN streets to non-HIN streets. Acquiring comprehensive bike counts within EPCs can help us better understand bicyclist exposure and estimate crash risk within these communities.

The top three reported violations for KSI crashes within EPCs include *unsafe speed for conditions* (26.5%), *disregard red signal* (11.2%), and *unsafe turn or lane change* (10.2%). Excluding "unknown" violation types, these are also the top three report violations for crashes that occurred outside of EPCs.

Table 47: Bicyclist crashes by Equity Priority Community, 2017-2021

EPC	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
Not within EPC	1,342	55.2%	138	58.5%	31,116	59.1%	10.3%	23.2
Within EPC	1,090	44.8%	98	41.5%	21,555	40.9%	9.0%	19.8
Total	***2,432***	***100.0%***	***236***	***100.0%***	***52,671***	***100.0%***	***9.7%***	***21.7***

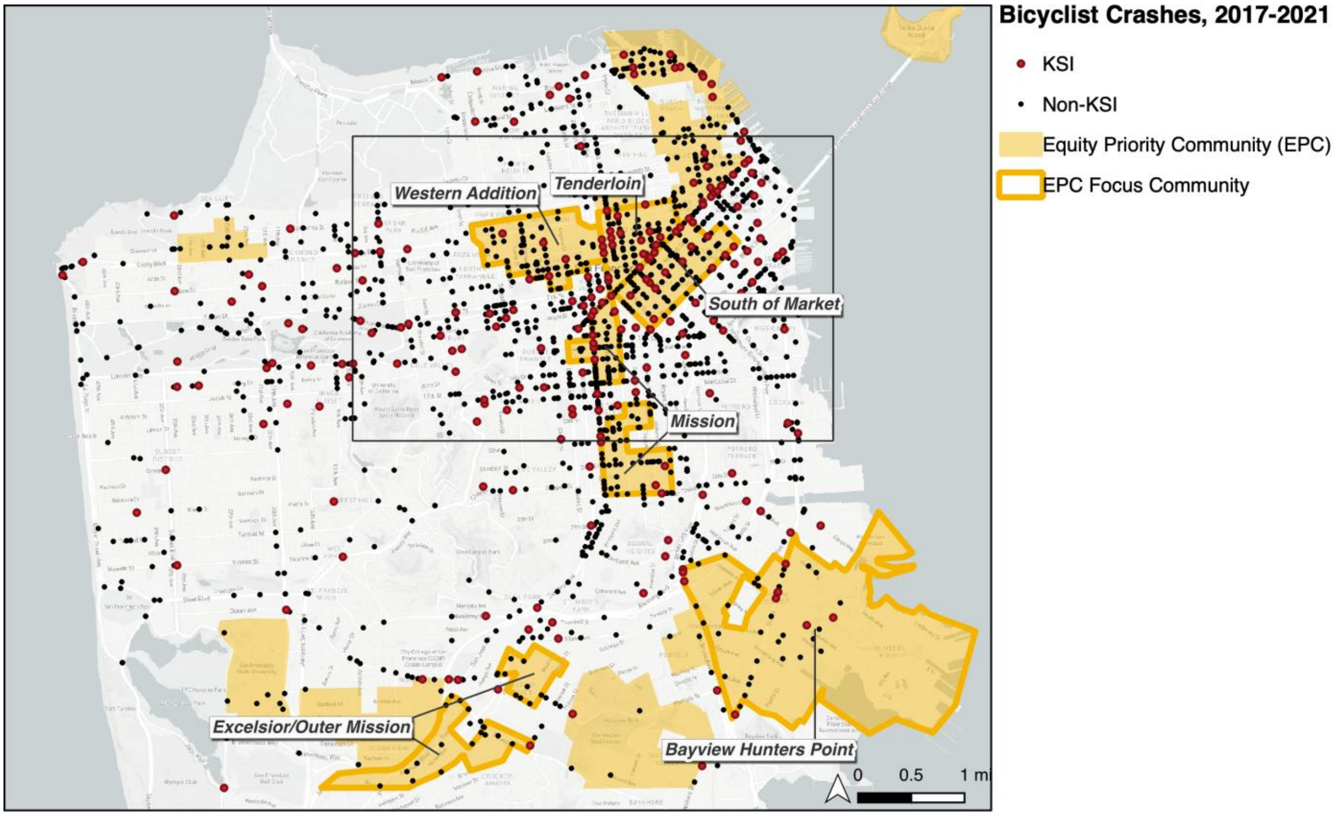
Table 48: Bicyclist crashes by Equity Priority Community, 2017-2019

EPC	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
Not within EPC	885	53.1%	90	57.0%	20,148	56.9%	10.2%	22.8
Within EPC	783	46.9%	68	43.0%	15,279	43.1%	8.7%	19.5
Total	***1,668***	***100.0%***	***158***	***100.0%***	***35,426***	***100.0%***	***9.5%***	***21.2***

Table 49: Bicyclist crashes by Equity Priority Community, 2020-2021

EPC	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
Not within EPC	457	59.8%	48	61.5%	10,969	63.6%	10.5%	24.0
Within EPC	307	40.2%	30	38.5%	6,276	36.4%	9.8%	20.4
Total	***764***	***100.0%***	***78***	***100.0%***	***17,244***	***100.0%***	***10.2%***	***22.6***

Map 13: Bicyclist crashes and Equity Priority Communities, 2017-2021



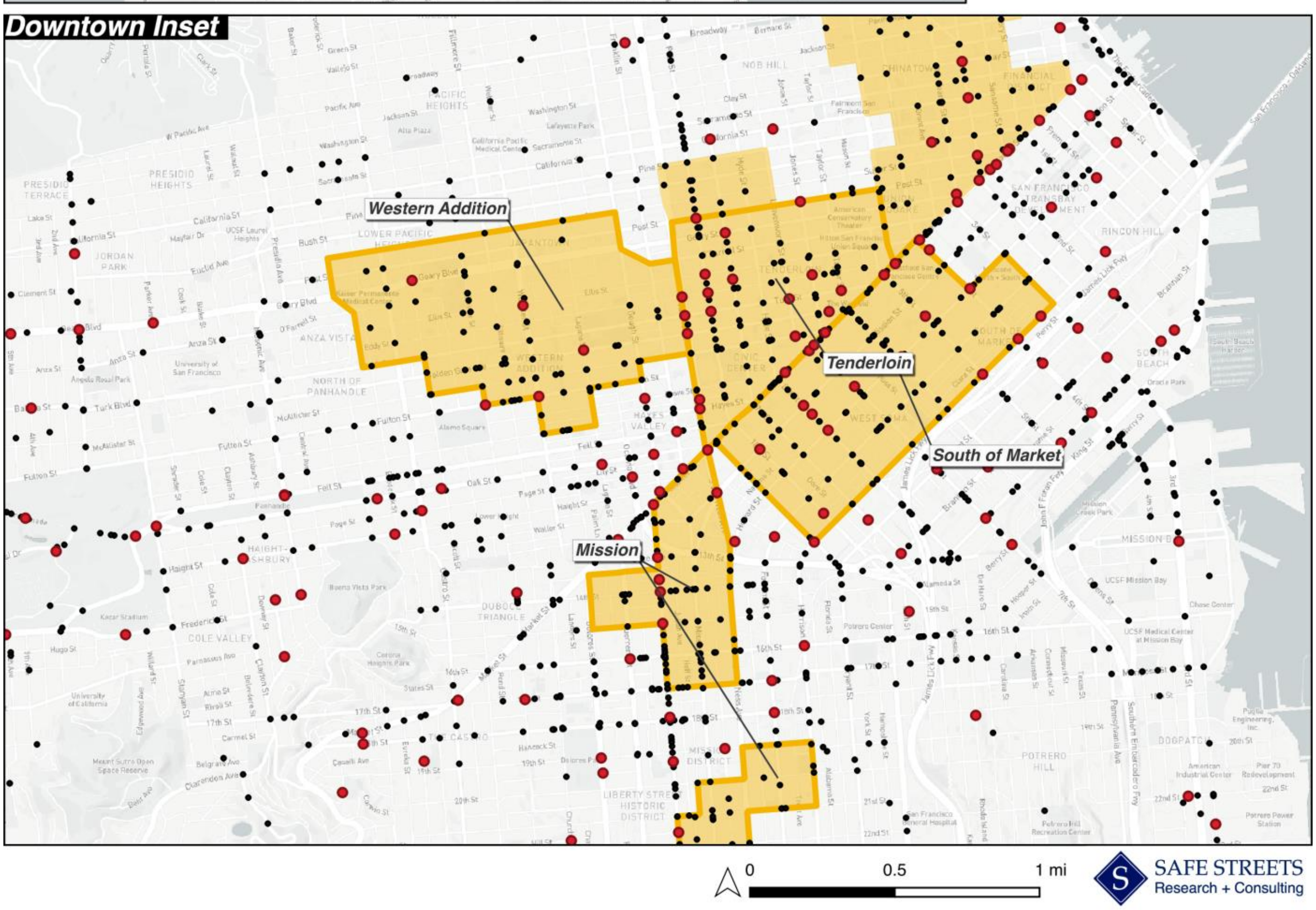


Table 50 summarizes bicyclist crashes by injury severity that occurred within the six EPC focus communities between 2015-2021. Neighborhoods that are closer to the central business district had higher crash frequencies, which is largely due to higher levels of exposure. Key findings for each neighborhood are outlined below.

Table 50: Bicyclist crashes by Focus EPC Community, 2017-2021[8]

Neighborhood	# Crashes	# KSI	# EPDO	% Crashes resulting in KSI	Avg. EPDO
Bayview Hunters Point	46	11	1,820	23.9%	39.6
Excelsior	28	1	376	3.6%	13.4
Mission	232	12	3,519	5.2%	15.2
Soma	279	23	5,488	8.2%	19.7
Tenderloin	243	26	5,167	10.7%	21.3
Western Addition	117	8	1,871	6.8%	16.0

Bayview Hunters Point

- 46 total crashes, 11 KSI crashes.
- 23.9% of crashes resulted in a KSI outcome.
- Most crashes occurred at an intersection (n=36), including 9 of the 11 KSI crashes.
- Most KSI crashes occurred at signalized intersection (7 of 11 KSI crashes).
- Failure to stop at a stop sign was the most common reported violation type (8 total crashes; 1 KSI crash), followed by unsafe speed (7 total crashes; 4 KSI crashes).
- Perpendicular crashes that involved the bicyclist and motorist proceeding straight accounted for the largest share of crashes (14 total crashes; 3 KSI crashes).
- Nearly half of the KSI crashes (n=5) occurred during dark lighting conditions.
- Half of the overall crashes (n=23) and most of the KSI crashes (n=7) occurred along the HIN.
- Most crashes occurred at or along an arterial (25 total crashes; 9 KSI crashes).
- Most crashes (n=19) and KSI crashes (n=5) occurred at or along a street with four vehicle lanes.
- Eight of the 11 KSI crashes occurred at or along streets with a posted speed limit of 30 mph or higher.

Excelsior

- 28 total crashes, 1 KSI crash.
- 3.6% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=21). The one KSI crash was midblock.
- Intersections with a stop sign accounted for most crashes (12 crashes).
- Failure to stop as a stop sign was the most common reported violation type (5 crashes) followed by unsafe speed (4 crashes).
- Perpendicular crashes that involved the bicyclist and motorist proceeding straight accounted for the largest share of crashes (6 crashes).
- 22 of the 28 crashes occurred during daylight conditions.
- Slightly more than half of the crashes occurred along the HIN (15 crashes).
- Nearly half of the crashes occurred at or along an arterial (13 crashes) .
- Most crashes (n=16) occurred at or along a street with four vehicle lanes.

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[8] Crashes that are located along the boundary of two EPCs were assigned to both EPCs and summarized in this table in the following section. The crash frequencies in this section should not be aggregated to create a "grand total" as some of these crashes are assigned to multiple EPCs. A 50 foot threshold was used as part of the EPC focus community analysis process.

- 23 of the 28 crashes occurred at or along streets with a posted speed limit of 25 mph.

Mission

- 232 crashes, 12 KSI crashes.
- 5.2% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=194), including 11 of the 12 KSI crashes.
- The most common reported violation type was unsafe turn or lane change (42 total crashes; 2 KSI crashes) followed by disregard red signal (22 total crashes; 0 KSI crashes) and dooring (21 total crashes; 1 KSI crash).
- Unlike citywide trends, most crashes involved both the driver and bicyclist traveling in the same direction (105 total crashes; 5 KSI crashes).
- Perpendicular crash with both the bicyclist and driver proceeding straight was the most common crash type (26 total crashes; 1 KSI crash) followed by same direction with the bicyclist proceeding straight and the motorists making a right turn ("right hook", 23 crashes; 2 KSI crashes) and same direction with both the driver and bicyclists proceeding straight (19 crashes and 2 KSI crashes).
- Most crashes (n=201) and KSI crashes (n=10) occurred at or along the HIN.
- Most crashes (n=108) and three quarters of KSI crashes (n=7) occurred at or along a street with four vehicle lanes.
- All 232 crashes (severe and non) occurred along a street speed limit of 25 mph or less.

Soma

- 279 total crashes and 23 KSI crashes.
- 8.2% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=238), including 20 of the 23 KSI crashes.
- Just over half of the reported crashes (n=165) and KSI crashes (n=14) were at signalized intersections.
- Unsafe turn or lane change was the most common reported violation (50 total crashes; 3 KSI crashes) followed by disregard unsafe speed (36 total crashes; 4 KSI crashes) and disregard red signal (31 total crashes; 3 KSI crashes).
- Same direction of travel between the driver and bicyclist was the most common crash type (108 total crashes; 5 KSI crashes) followed by perpendicular direction (96 total crashes; 9 KSI crashes).
- Perpendicular crashes involving both the driver and bicyclist proceeding straight was the most common crash type (11 total crashes; 4 KSI crashes).
- Most crashes (262 of 279 total crashes) and all 23 KSI crashes occurred along the HIN.
- Almost half of all crashes (n=135) and most KSI crashes (n=13) occurred at or along a street with four vehicle lanes.
- Most crashes (n=250), including most of the KSI crashes (n=19), occurred along streets with a posted speed limit of 25 mph.

Tenderloin

- 243 total crashes and 26 KSI crashes.
- 10.7% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=213), including 23 of the 26 KSI crashes.
- Unsafe speed was the most common reported violation (45 total crashes; 8 KSI crashes) followed by disregard red signal (34 total crashes; 4 KSI crashes) and unsafe turn or lane change (32 total crashes; 1 KSI crash).
- Perpendicular direction of travel between the driver and bicyclist was the most common crash type (86 total crashes; 10 KSI crashes) followed by same direction (83 total crashes; 4 KSI crashes).
- Perpendicular crashes involving both the driver and bicyclist proceeding straight was the most common crash type (29 total crashes; 5 KSI crashes).

- 16.5% of the reported total crashes and 30.8% of KSI crashes in the Tenderloin EPC were solo bicyclist crashes, which is higher than the other EPC neighborhoods and citywide trends.
- Nearly all crashes (240 of 243 total crashes) and all 26 KSI crashes occurred along the HIN.
- Crashes (n=104) and KSI crashes (n=11) occurred most frequently at or along a street with three vehicle lanes.
- 238 crashes, including 24 of the 26 KSI crashes, occurred along streets with a posted speed limit of 25 mph or less.

Western Addition

- 117 total crashes and 8 KSI crashes.
- 6.8% of crashes resulted in a KSI outcome.
- Most crashes occurred at intersection (n=95), including all 8 KSI crashes. 84 of those 95 crashes and all 8 KSI crashes were at signalized intersections.
- Unsafe turn or lane change was the most common reported violation (18 total crashes; 0 KSI crashes) followed by unsafe speed (15 total crashes; 0 KSI crashes) and disregard red signal (13 total crashes; 3 KSI crashes).
- Unlike citywide trends, crashes that involved both the driver and bicyclist traveling in the same direction accounted for the largest share of crashes (48 total crashes; 2 KSI crashes) followed by perpendicular (36 total crashes; 5 KSI crashes).
- Almost half of all crashes (44.4%) occurred at or along a street with two vehicle lanes. KSI crashes (n=4) occurred most often at or along streets with five or more vehicle lanes.
- 85 of the 117 crashes occurred along street with a posted speed limit of 25 mph; half of the KSI crashes occurred along street with 30 mph or higher.

Location-Movement Crash Typing

Location-movement crash types were developed as part of this analysis to help us understand the specific dynamics that contributed to bicyclist-motorists crashes. Solo-bicyclist and bicyclist-pedestrians are excluded from this section of the analysis given the low sample sizes and different dynamics compared to crashes involving bicyclists and motorists. The relative direction and pre-crash movements (analyzed during the Step I analysis) are in Appendix B: Relative Direction and Pre-Crash Movements for reference.

The top 15 location-movement crash types are summarized in Table 51 for crashes that involved a bicyclists and motorist during the 5-year study period. Roughly two-thirds of crashes, KSI crashes, and EPDO scores are accounted for within the top 15 crashes (there are 120 distinct location-movement crash types).

The **intersection – perpendicular – bike proceeding straight, MV proceeding straight** crash type accounted for the largest share of overall crashes (14.9%) and KSI crashes (21.8%). These crashes also tended to more severe than many other crash types with 12% of crashes resulting in a KSI and having an average EPDO score of 24. Most crashes occurred at signalized intersection (60.8% crashes; 69.4% KSI crashes) and were most had a contributing factor cited as disregarded red signal both overall crashes and KSI crashes. Of the crashes within this crash type, most occurred at an intersection with the highest functional class as a collector (36.5% of crashes), but the majority of KSI crashes occurred at intersections with an arterial (41.7% KSI crashes). Interestingly, most crashes occurred at intersections with the lowest functional classification was a residential street (80.4% crashes; 75% KSI crashes). Looking at highest and lowest functional classification collector-residential pairs accounted for the largest share of KSI crashes (27.8%) followed by residential-residential (25%) and arterial-residential (19.4%). Crashes that occurred at higher functional classifications were on average more severe than residential crashes, which is likely due to higher vehicle speed along higher functional classifications.

The **intersection – perpendicular – bike proceeding straight, MV making left turn** accounted for the second largest share of crashes (6.4%) and KSI crashes (6.1%). The distribution of KSI crashes is nearly a quarter of the share of KSI crashes than the first location-movement crash type, highlighting the severity of that crash type.

This pattern may suggest the frequencies of intersection between perpendicular bicyclists and motorists who are both proceeding straight are a critical issue. Similar to the previous crash type, most crashes occurred at signalized intersections (58.9% crashes; 80% KSI crashes). The most common reported violation type involved a motorist violating the bicyclist's right of way while making the left turn (46.5% of crashes). Most crashes occurred at residential-residential streets (32.6% crashes; only one KSI crash) followed by collector-residential intersections (26.4% crashes; only one KSI crash). Arterial-residential crashes accounted for the third share of crashes (19.4%) but also accounted for half of the KSI crashes (n=5) that occurred for this crash type.

The third most common location-movement crash type was **intersection – same – bike proceeding straight, MV making right turn** accounted for 6.2% of crashes and 4.2% of KSI crashes. These crashes tend to be less severe than other crash types with 5.6% of crashes resulting in a KSI outcome and having an average EPDO score of 16. Most crashes had a reported violation as unsafe turn or lane change (53.2%) followed by unsafe speed (7.9%). Crashes for this crash type generally occurred at arterial intersections with 41.3% of crashes having occurred at an arterial intersection and 37.3% at a collector.

Table 51: Location-Movement crash types for bicyclist-motorist crashes, 2017-2021

Location-Movement Crash Types	*# Crashes*	*% Crashes*	*# KSI*	*% KSI*	*# EPDO*	*% EPDO*	*% Crashes resulting in KSI*	*Avg. EPDO*
intersection - Perpendicular - Bike Proceeding Straight, MV Proceeding Straight	301	14.9%	36	21.8%	7,235	18.5%	12.0%	24.0
intersection - Perpendicular - Bike Proceeding Straight, MV Making Left Turn	129	6.4%	10	6.1%	2,300	5.9%	7.8%	17.8
intersection - Same - Bike Proceeding Straight, MV Making Right Turn	126	6.2%	7	4.2%	2,016	5.1%	5.6%	16.0
intersection - Opposite - Bike Proceeding Straight, MV Making Left Turn	118	5.8%	10	6.1%	2,233	5.7%	8.5%	18.9
intersection - Same - Bike Proceeding Straight, MV Proceeding Straight	108	5.3%	5	3.0%	1,527	3.9%	4.6%	14.1
intersection - Perpendicular - Bike Proceeding Straight, MV Making Right Turn	100	4.9%	4	2.4%	1,328	3.4%	4.0%	13.3
intersection - Same - Other	91	4.5%	6	3.6%	1,473	3.8%	6.6%	16.2
intersection - Same - Bike Proceeding Straight, MV Stopped	67	3.3%	9	5.5%	1,655	4.2%	13.4%	24.7
intersection - Perpendicular - Other	54	2.7%	5	3.0%	1,118	2.9%	9.3%	20.7
mid-block - Same - Other	50	2.5%	3	1.8%	878	2.2%	6.0%	17.6
mid-block - Same - Bike Proceeding Straight, MV Stopped	37	1.8%	4	2.4%	940	2.4%	10.8%	25.4
mid-block - Same - Bike Proceeding Straight, MV Proceeding Straight	37	1.8%	2	1.2%	635	1.6%	5.4%	17.2
intersection - Perpendicular - Bike Making Left Turn, MV Proceeding Straight	34	1.7%	3	1.8%	622	1.6%	8.8%	18.3
intersection - Same - Bike Proceeding Straight, MV Parked	29	1.4%	4	2.4%	909	2.3%	13.8%	31.3
intersection - Same - Bike Proceeding Straight, MV Changing Lanes	25	1.2%	1	0.6%	339	0.9%	4.0%	13.6
Not Top 15	*715*	*35.4%*	*56*	*33.9%*	*13,993*	*35.7%*	*7.8%*	*19.6*
Total	***2,021***	***100.0%***	***165***	***100.0%***	***39,201***	***100.0%***	***8.2%***	***19.4***

External Data and Analysis

The research team also looked at data analysis from the San Francisco Department of Public Health (SFDPH) and the USDOT Safer Streets Priority Finder (SSPF) to complement the data analysis presented above. Key findings from those analyses follow below.

San Francisco Department of Public Health

Among the many services the SFDPH provides to the city, their use of a trained epidemiologist to evaluate crashes from trauma centers relative to police-reported crash data provides an unparalleled understanding both of the degree of misclassification of injuries within the San Francisco Police Department (SFPD) data and the degree to which bicyclist crashes are underreported in the SFPD data. Due to HIPAA concerns, the research team lacked access to any detailed data for this comparison. However, high-level statistics from SFDPH suggest the following:

1. Most neighborhoods have a relatively low ratio of trauma center injuries compared to the count of SFPD injuries for the years 2017-2021. The Presidio is a clear exception in this area, given that the SFMTA and SFPD do not have jurisdiction over that area, but people injured there may still use the trauma services at ZSFG. Outside of the Presidio, the highest ratios occur in Presidio Heights, Bayview Hunters Point, Potrero Hill, and Castro/Upper Market (see Table 57 in Appendix C). The higher ratios are particularly concerning for Bayview Hunters Point and Castro/Upper Market, given their higher number of crashes overall.
2. Solo crashes are a significant problem in the city, despite appearing less frequently in the SFPD data (49% of all crashes in the SFDPH analysis, 82% of which were not linked to SFPD crashes). Paying particular attention to findings from this analysis relative to solo crashes may help ensure that these crashes are sufficiently addressed. However, the SFMTA may consider additional research specifically into solo crash dynamics through SFDPH to help clarify the extent to which solo crashes in SFPD data represent the larger population of solo crashes.
3. The difficulty of assessing injury severity at the scene results in misclassification of injury levels. Therefore, while it is critically important to focus on KSI crashes to aim to reduce the most harm in the city, it remains important to understand and address patterns of minor and moderate injury crashes, as well.

Safer Streets Priority Finder

The Safe Streets Priority Finder (SSPF)[9] was also used as a method to estimate bicycle crash risk. The SSPF is an open source too that analyzes crash data, network data, and the USDOT Pedestrian Fatality Risk Pilot data using a Bayesian statistical framework to estimate risk values across a street network for bicyclists and pedestrians separately. The general framework of the SSPF is displayed in Figure 1. For this project, the tool was only used to estimate bicycle crash within San Francisco.

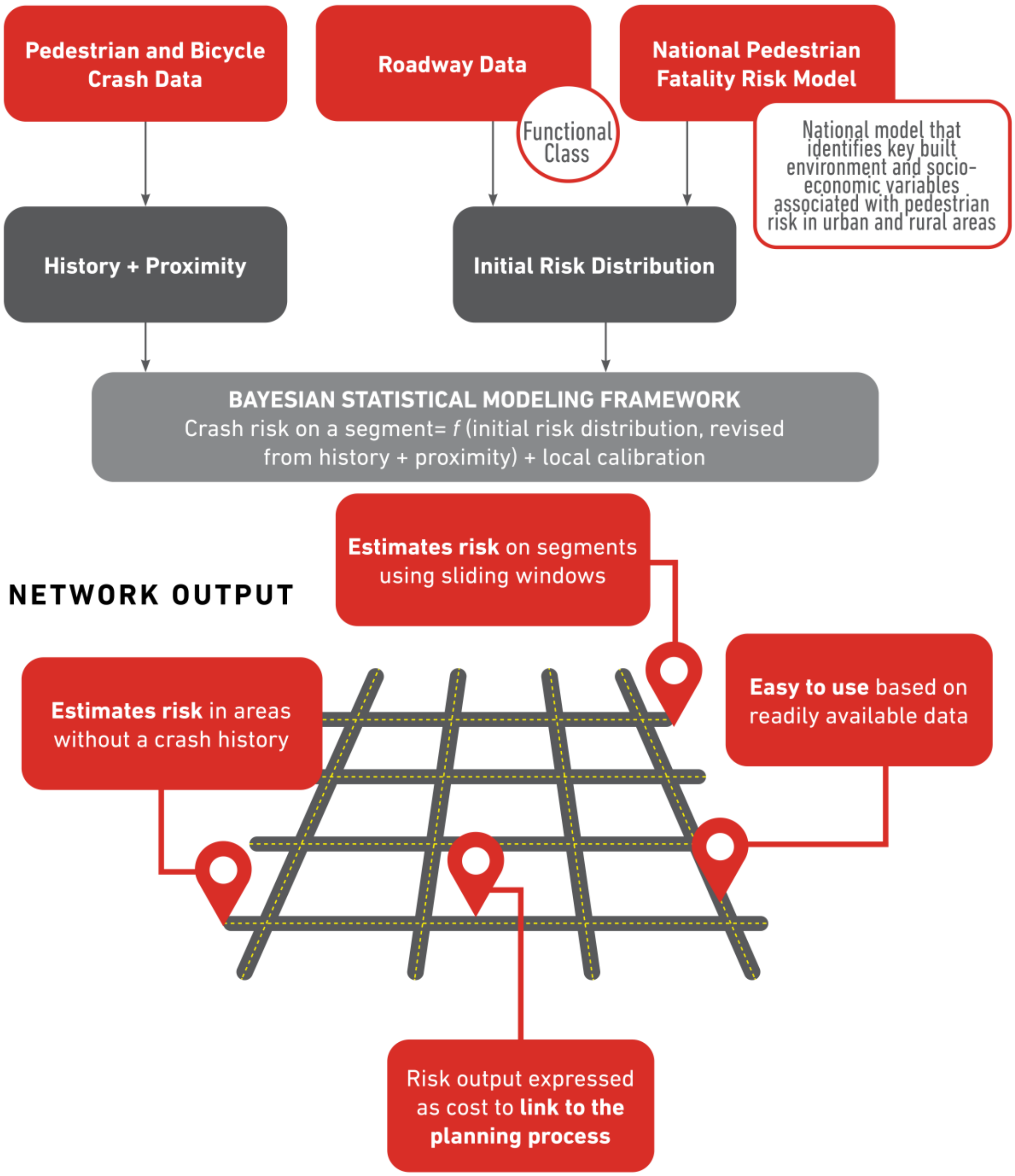


Figure 1: SSPF Framework. Image Source: https://www.saferstreetspriorityfinder.com

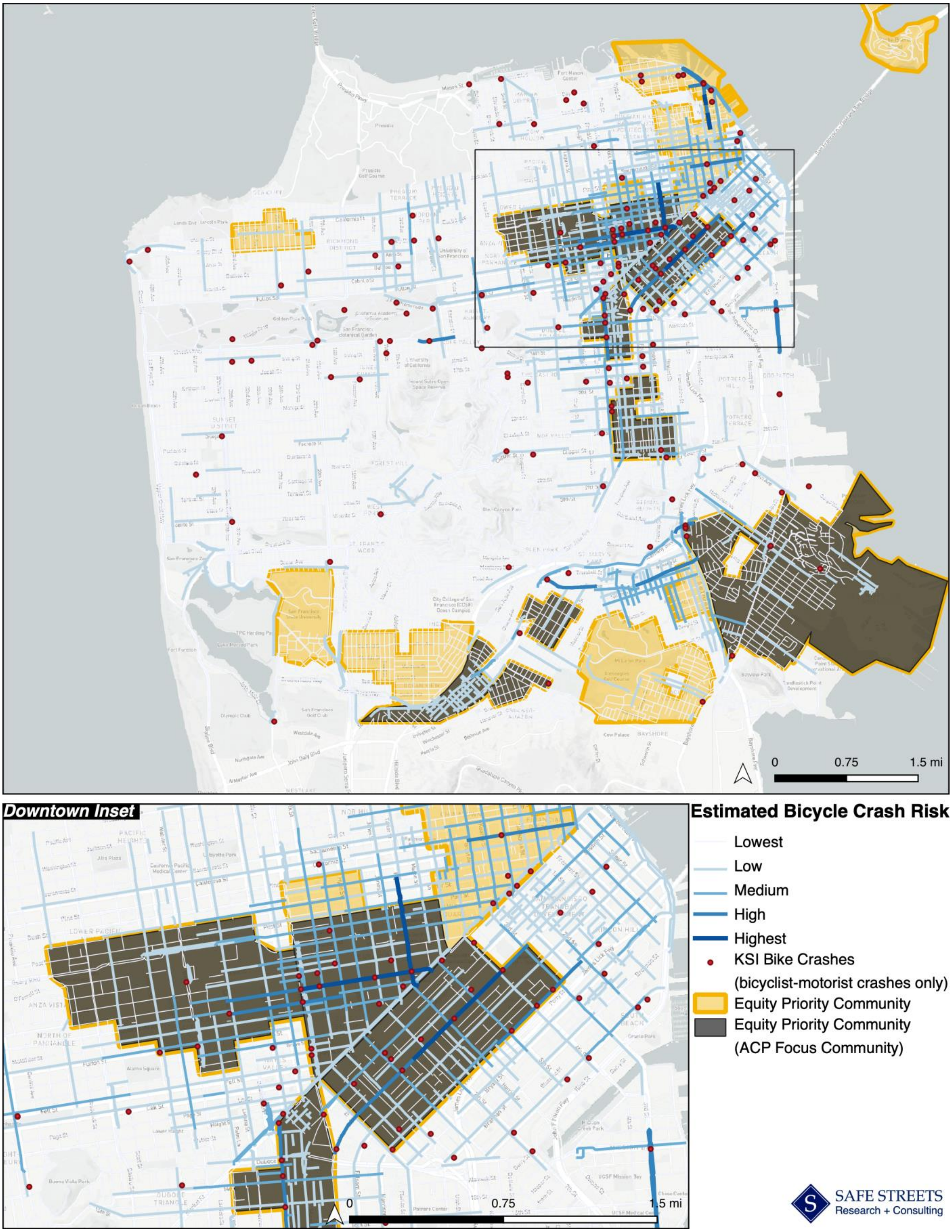
9 https://www.saferstreetspriorityfinder.com/

The bicyclist Safe Street Model outputs from the SSPF are displayed in Map 14. The following streets had relatively high estimates of crash risk. Note: the street limits assigned to each street below are general limits to help provide some context when reviewing the results.

- **Howard St** from Van Ness Ave to 3rd St
- **Turk St** from Laguna St to Market St
- **Taylor St** from Market St to Bush St
- **Sansome St** from Broad Way to the Embarcadero (not along HIN)
- **Silver Ave** from Alemany Blvd to Madison St (not along HIN) and Princeton St to Barneveld Ave
- **3rd St** from Mariposa St to China Basin St (not along HIN)
- **Valencia St** from 7th St to Market St

Many of these higher scoring corridors are located in areas of the city that generally have higher bicycle and motor vehicle volumes, such as the Financial District, SOMA, Mission, Tenderloin, Western Addition, and North Beach. The crash risk estimates are not adjusted for those volumes. Interestingly, many of the highest scoring corridors are within EPCs, whereas much of the western and central portions of the San Francisco have very low score streets. This correlation may reflect generally higher population densities and exposure within EPCs, but it may also reflect other risk factors that contribute to both the community being classified as an EPC and having a higher estimated crash risk score from the SSPF. The outputs from the SSPF align with the HIN in that most of the highest-scored streets from the SSPF analysis are along the HIN. In fact, when looking at non-residential streets, the median estimated SSPF crash risk estimates are roughly twice as high along the HIN than segments off the HIN, indicating that the HIN is predicting higher-risk segments in line with more advanced Bayesian statistical principles.

Map 14: Estimated Bicycle Crash Risk using the SSPF Tool, 2017-2021



Conclusion

This document summarized the results of a systemic safety analysis that explored roadway, land use, and behavioral factors related to bicycle crashes within San Francisco between 2017-2021. The findings of this analysis will be used to inform the network development task of the SFMTA ACP.

Key findings include that intersections are consistently the locations of the most bicyclist crashes and specifically KSI crashes. Signalized intersections, in particular, are associated with motorist-bicyclist crashes and KSI crashes, an expected finding given that signalized intersections also tend to carry higher amounts of motor vehicle traffic and to be located on streets with more lanes – all risk factors for crashes and injury severity. Continued work to address intersection safety, including through reducing motor vehicle traffic and speed, as well as separating bicyclist and motorist movements in space (e.g., via infrastructure) and time (e.g., via signals) can help reduce the number and severity of these conflicts.

Bicycle facilities, especially those with greater separation from motorists (e.g., Class IV and Class II compared to Class III) appear to be positively associated with bicyclist safety *when a crash occurs*. While we lacked the exposure data to fully control for bicyclist crash rates, these findings are further supported by research and volume estimates from San Francisco showing that people prefer riding with greater separation and that bicyclist volumes tend to be higher along these facilities. The fact that midblock crashes tended to be more severe than intersection crashes, despite being less prevalent, further supports the need for bicycle facilities to improve bicycling safety in the city.

There is a clear correlation between Equity Priority Communities, the HIN, and bicycle crashes and crash severity, underscoring a need for greater investment in street safety for the EPCs. The HIN continues to be a helpful tool for highlighting where bicycle safety improvements are needed throughout the city. Further prioritization within the HIN can be accomplished via an examination of risk factors like functional class and number of lanes, which are general proxies for higher vehicle volumes and often higher prevailing speeds. Bus stops, which are generally correlated with higher activity levels and therefore complexity, were also positively associated with bicycle crashes.

While a more detailed analysis is needed before deciding on countermeasures for specific locations, these findings provide a broad understanding of bicycle safety and risk factors in the city, setting up the next phases of the work in a data-driven manner.

Appendix A: Network Data QC

The intersection and centerline data used in this analysis is the same data used in other tasks in the Active Communities Plan. Additional variables have been calculated as part of this analysis. Some intersection and centerline features have been omitted form this analysis as part of the data quality control process. Those instances are noted in this section.

Dual carriageways mileage

Most sections of this analysis the summarize crash frequencies by specific network characteristics that are normalized by the network mileage to help us better understand potential crash risk. Some major streets in San Francisco are represented as dual carriageways in the GIS data. Dual carriageways representing a single street with two lines, rather than one line, which would artificially reduce the estimate risk estimates as the network mileage is roughly twice the actual length for dual carriageways. To control for these network segments being represented by two features, the average length is used for each dual carriageway feature. The image below illustrates how a dual carriageway is represented by two separate network features.

Figure 2: Example of dual carriageway

Number of lanes at/along dual carriageways

The number of lanes was recalculated for both intersections and network segments to account for dual carriageway. Currently, dual carriageways are represented by two separate links in the network data and coded as one-way streets. For the purposes of this analysis, dual carriageways are treated as two-way streets and the number of lanes were aggregated to represents the total number of lanes along each block and at each intersection. If dual carriageways are not accounted in the network data using this approach, both legs at this intersection (Geary Blvd and 33rd Ave) would have the same number of lanes in the intersection data and the network segment data (2 lanes) and thereby not accurately representing the design differences between each intersecting street. See the images below showing the existing conditions of this intersection.

Figure 3: Google Street View images displaying the number of lanes at dual carriageway intersections

One-Way Streets

Errors related to the presence of one-way streets was observed in the network segment data (oneway_yn) and in the intersection data (mix_way_yn and all_one_way_yn). These errors were discovered through an aggregation process in which the number of one-way legs were counted at each intersection, which did not universally match the mix_way_yn and all_one_way_yn attributes. A review of network data values, aerial imagery, and Google Street View found most of these discrepancies are along residential streets, some of which may be an issue related to residential dual carriageways. The image below illustrates some of these potential data errors:

- **Yellow Lines** = one-way street according to TransBASE
- **Red Dots** = intersections where mix_way_yn = 'Yes'

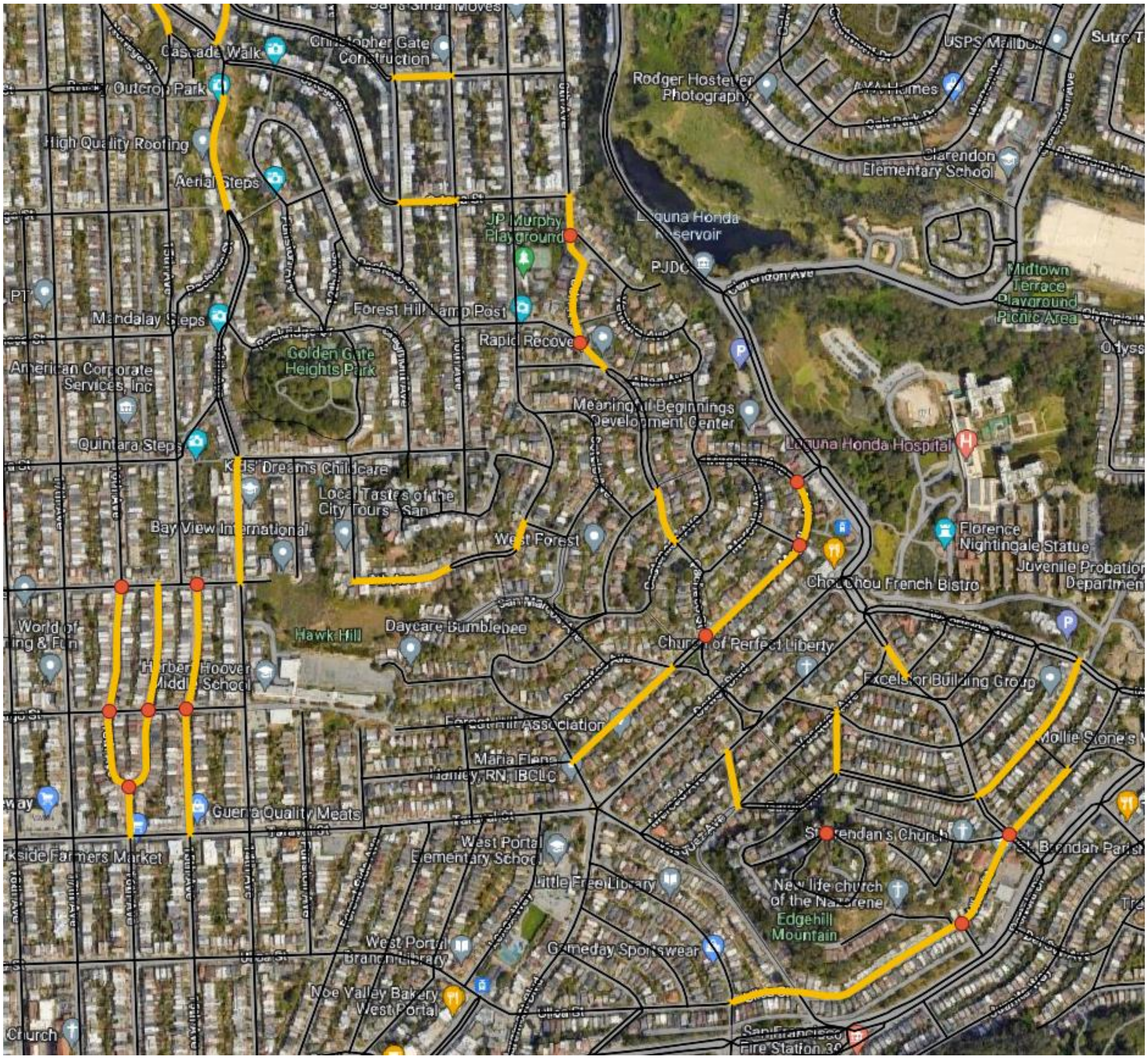


Figure 4: Example issues with one-way street classifications

Excluding Streets and Intersections

Private streets, pedestrian streets, stairs, and streets and intersections within NPS jurisdiction have been removed from the analysis. The decision to exclude streets and intersections within NPS jurisdictions was made due to SFMTA not having jurisdiction within those areas and do not maintain crash data.

To build a better understanding of crash risk within the City of San Francisco, SFMTA may consider supplementing their crash data with crash data that are located within these areas. While SFMTA does not have jurisdiction within those areas, it will help paint a better picture of crash risk within the city and inform a future systemic safety analysis.

Pseudo Intersections

Intersections between dead-end street and a typical through street are present in some locations of the city. The image below visualizes this particular type of pseudo intersection. The red box is an area in which Glendale St and Corbett Ave do not connect (excludes stairs). Other pseudo intersections include points that do not touch a network link. Most of these locations are near or along the Interstate or near/within Hunters Point. Lastly, intersection points that have fewer than three legs have been removed as these are often dead-ends, cul-de-sacs, or points where a network link is split at a non-intersection location.

Figure 5: Example where network GIS data incorrectly represent two intersecting streets.

Street and Intersection ID in crash data

The intersection ID in the crash data (*cnn_intrsctn_fkey*) has roughly 200 crashes that have an error in the intersection ID. The intersection ID should be an integer, but several are numeric with roughly 8 decimal places. These instances have been properly converted to the correct integer data type and value. After removing decimals and converting the data type to an integer, there were 159 crashes that are within 75 feet on the nearest intersection with a *cnn_intrsctn_pkey* (ID in the intersection data) that does not match the *cnn_intrsctn_fkey* in the collision data (13 severe, 71 injury (other visible), and 75 injury (complaint of pain) crashes). These have been correctly and assign the nearest intersection ID.

The segment id in the crash data (cnn_sgmt_fkey) has many errors and do not match the segment id (sgmt_infrstcr_pkey) in the centerline data. For non-intersection crashes, all crashes have been assigned the centerline ID of the centerline feature closest to the crash.

Posted Speed Limit

There are Null or 9999 posted speed limit values for all of Treasure Island, some neighborhood streets, several streets in Mission Bay, and some network links near the Interstate or highway ramps. Residential NULL speed limit values have been replaced with 25mph

Appendix B: Relative Direction and Pre-Crash Movements

The following tables were summarized in the Step I crash analysis for the pre-pandemic and pandemic study periods separately. These tables are included here for reference but for the 5-year study period.

Table 52: Relative Direction of Travel between Bicyclist and Motorists, 2017-2021

Relative Direction (Bicyclist and Motorist Crashes Only)	# Crashes	% Crashes	# KSI	% KSI	# EPDO	% EPDO	% Crashes resulting in KSI	Avg. EPDO
Perpendicular	769	38.1%	70	42.4%	15,494	39.5%	9.1%	20.1
Same	868	42.9%	61	37.0%	15,793	40.3%	7.0%	18.2
Opposite	266	13.2%	20	12.1%	5,047	12.9%	7.5%	19.0
Unknown	115	5.7%	14	8.5%	2,838	7.2%	12.2%	24.7
Missing one party direction	3	0.1%	0	0.0%	27	0.1%	0.0%	9.1
Total	***2,021***	***100.0%***	***165***	***100.0%***	***39,201***	***100.0%***	***8.2%***	***19.4***

Table 53: Pre-crash movements between Bicyclist and Motorists, 2017-2021

Bicyclist + Motorists Pre-Crash Movement	# Crashes	% Crashes	# KSI	% KSI	# EPDO	% EPDO	% Crashes resulting in KSI	Avg. EPDO
Bike Proceeding Straight, MV Proceeding Straight	495	24.5%	49	29.7%	10,684	27.3%	9.9%	21.6
Bike Proceeding Straight, MV Making Left Turn	320	15.8%	24	14.5%	5,727	14.6%	7.5%	17.9
Other	255	12.6%	19	11.5%	4,663	11.9%	7.5%	18.3
Bike Proceeding Straight, MV Stopped	147	7.3%	16	9.7%	3,333	8.5%	10.9%	22.7
Bike Proceeding Straight, MV Making Right Turn	283	14.0%	15	9.1%	4,404	11.2%	5.3%	15.6
Bike Making Left Turn, MV Proceeding Straight	70	3.5%	6	3.6%	1,361	3.5%	8.6%	19.4
Bike Proceeding Straight, MV Parked	62	3.1%	6	3.6%	1,515	3.9%	9.7%	24.4
Bike Entering Traffic, MV Proceeding Straight	19	0.9%	5	3.0%	817	2.1%	26.3%	43.0
Bike Proceeding Straight, MV Parking Maneuver	38	1.9%	4	2.4%	959	2.4%	10.5%	25.2
Bike Proceeding Straight, MV Entering Traffic	45	2.2%	4	2.4%	907	2.3%	8.9%	20.2
Bike Making Right Turn, MV Proceeding Straight	33	1.6%	3	1.8%	661	1.7%	9.1%	20.0
Bike Proceeding Straight, MV Other	14	0.7%	3	1.8%	708	1.8%	21.4%	50.6
Bike Not Stated, MV Not Stated	26	1.3%	2	1.2%	441	1.1%	7.7%	17.0
Bike Proceeding Straight, MV Slowing/Stopping	20	1.0%	2	1.2%	516	1.3%	10.0%	25.8
Bike Proceeding Straight, MV Changing Lanes	42	2.1%	2	1.2%	655	1.7%	4.8%	15.6
Bike Changing Lanes, MV Proceeding Straight	24	1.2%	2	1.2%	424	1.1%	8.3%	17.7
Bike Proceeding Straight, MV Making U Turn	58	2.9%	2	1.2%	791	2.0%	3.5%	13.6
Bike Traveling Wrong Way, MV Proceeding Straight	14	0.7%	1	0.6%	213	0.5%	7.1%	15.2
Bike Proceeding Straight, MV Backing	14	0.7%	0	0.0%	113	0.3%	0.0%	8.1
Bike Stopped, MV Proceeding Straight	28	1.4%	0	0.0%	203	0.5%	0.0%	7.2
Bike Stopped, MV Stopped	14	0.7%	0	0.0%	104	0.3%	0.0%	7.4
Total	***2,021***	***100.0%***	***165***	***100.0%***	***39,201***	***100.0%***	***8.2%***	***19.4***

Appendix C: San Francisco Department of Public Health Bicyclist Injury Summary

The following content was produced by the San Francisco Department of Public Health. The content has been formatted to match the format used throughout this document.

Summary Injury Statistics from Trauma Registry Data for Bicyclists

The current use of police collision reporting alone for transportation injury surveillance underrepresents injury to vulnerable groups, including pedestrians, cyclists, and people of color, due to differing reporting patterns and non-clinicians challenge in accurately evaluating injury severity[10]. To address this, incorporating hospital and EMS spatial data into injury surveillance systems that are historically reliant on police reports offers a trifold benefit by capturing injuries absent in police data, thus improving injury severity assessment, and informing interventions serving injury burdened populations and road users.

The San Francisco Department of Public Health and the Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG) are working to maintain a comprehensive Transportation related Injury Surveillance System (TISS) to conduct accurate, coordinated, and timely monitoring of transportation-related injuries and deaths in support of safety project prioritization, evaluation, and monitoring for the City's Vision Zero policy[11].

This system gathers and links existing transportation-related injury and fatality data collected by City and County of San Francisco agencies into a comprehensive database to provide a more complete picture of transportation-related injuries occurring in the city. The creation of this data system vastly expands the City's capacity to understand the geographic distribution, causes, costs, and consequences of transportation-related injuries in San Francisco, and provide data to inform Vision Zero's coordinated efforts to reduce preventable injuries and eliminate deaths on the city's streets.

The first (2013-2015) and second (2016-2021) versions of TISS used LinkSolv software to probabilistically link a SFPD reported traffic injury victim to a ZSFG patient record using several variables including: time of collision/time admitted to ZSFG, victim name/patient name, victim mode of travel mode/international classification of disease (ICD) v.10 E code, collision location, etc. Records can be either be matched (linked) or unmatched (unlinked) in each dataset. Linked records are found in both datasets, while unlinked records are found only in their source dataset. SFDPH is currently investigating alternatives to data record linkage with the ending of support for LinkSolv in 2021.

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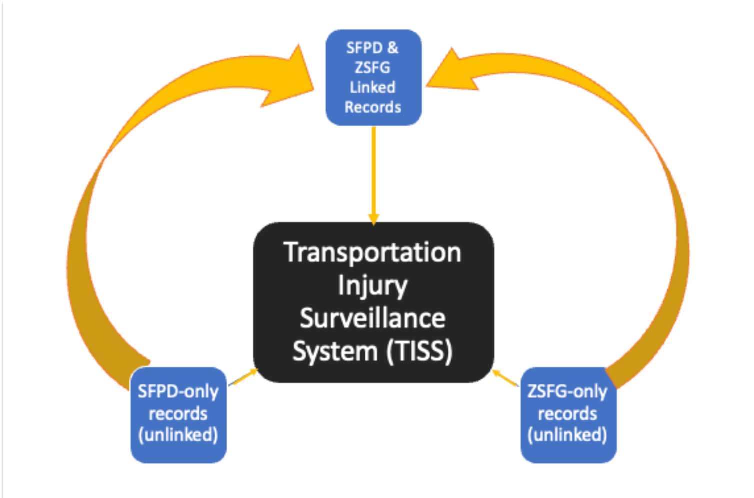
[10] Shamsi Soltani, Leilani Schwarcz, Devan Morris, Rebecca Plevin, Rochelle Dicker, Catherine Juillard, Adaobi Nwabuo, Megan Wier,
What is counted counts: An innovative linkage of police, hospital, and spatial data for transportation injury prevention, Journal of Safety Research, Volume 83, 2022, Pages 35-44, ISSN 0022-4375, https://doi.org/10.1016/j.jsr.2022.08.002. (https://www.sciencedirect.com/science/article/pii/S0022437522001074)

[11] San Francisco Department of Public Health. (2015). San Francisco’s Transportation-related Injury Surveillance System: A Centralized, Comprehensive Citywide Injury Data Resource for Vision Zero. Retrieved from https://www.sfdph.org/dph/files/EHSdocs/PHES/VisionZero/Transportation_Injury_Surveillance.pdf (Last accessed: 4/20/2023).



All unintentional linked and ZSFG Trauma Registry and Emergency Department - only victims (of any severity), including ungeocoded cases, where the injury occurred in San Francisco are included. This may encompass cyclist injury crashes in the Presidio, Fort Mason, freeway ramps, and other locations not typically covered by the San Francisco Police Department.

Linked and ZSFG Unlinked Unintentional Cyclist Injuries

Error! Reference source not found. presents data on unintentional cyclist injuries seen at ZSFG's trauma registry o r emergency department in San Francisco. The injuries are categorized as "Linked" and "Not Linked," based on whether they could be linked to a victim in a SFPD crash report or not. Overall, 54% (407) of the cyclist injuries were linked to an SFPD crash report, while 46% (352) were not. The data suggests that a significant proportion of cyclist injuries in San Francisco can be linked to crash reports, providing valuable information for understanding medical outcomes related to cycling safety in the city. However, a notable percentage of cases remain unlinked, indicating potential gaps in relying only on crash reports generated solely by the police.

Table 54: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries

Link Status	2017-2019	Percent	2020-2021	Percent	Total	Percent
Linked Report	271	53%	136	54%	407	54%
Not Linked	236	47%	116	46%	352	46%

ICD-10 e-code with cyclist injury

Table 55 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by ICD-10 E-codes, solo bicyclist status, and time period (2017-2019 and 2020-2021). Note that V19.40XA and V.18.4XXA were not used by EMS in their pre-patient care reports for 2020 and 2021, and more specific codes were used instead.

- The most common injury type in both time periods was related to pedal cycle drivers injured in collisions with cars, pick-up trucks, or vans in traffic accidents (V13.4XXA). This category represented 37% of the cases in 2017-2019 and 45% of the cases in 2020-2021.
- Injuries involving solo bicyclists in non-collision transport accidents in traffic accidents (V18.4XXA) accounted for 27% of the cases in 2017-2019 and 42% in 2020-2021.

- The percentage of pedal cycle drivers injured in collisions with unspecified motor vehicles in traffic accidents (V19.40XA) dropped from 8% in 2017-2019 to unreportable in 2020-2021, likely due to the change in EMS pre-patient care reporting.

Table 55: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injury ICD-10 E-codes

E-Code 10	ICD-10 E-code Description	Solo Bicyclist	2017-2019	Pct	2020-2021	Pct	Total	Pct
V13.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	190	37%	115	45%	305	40%
V18.4XXA	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	136	27%	107	42%	243	32%
V19.40XA~	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH UNSPECIFIED MOTOR VEHICLES IN	No	43	8%	< 5	--	43	6%
V18.4XXA~	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN TRAFFIC AC	Yes	42	8%	< 5	--	42	6%
V17.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH FIXED OR STATIONARY OBJECT IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	16	3%	13	5%	29	4%
V13.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN IN T	No	15	3%	< 5	--	15	2%
V11.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH OTHER PEDAL CYCLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	11	2%	< 5	--	15	2%
V19.40XA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH UNSPECIFIED MOTOR VEHICLES IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	11	2%	< 5	--	11	1%
V14.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH HEAVY TRANSPORT VEHICLE OR BUS IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	6	1%	< 5	--	6	1%
V17.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH FIXED OR STATIONARY OBJECT IN	Yes	6	1%	< 5	--	6	1%
V19.9XXA	PEDAL CYCLIST (DRIVER) (PASSENGER) INJURED IN UNSPECIFIED TRAFFIC ACCIDENT,	Ambiguous	6	1%	< 5	--	6	1%
V12.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH TWO- OR THREE-WHEELED MOTOR	No	5	1%	5	2%	10	1%

E-Code 10	ICD-10 E-code Description	Solo Bicyclist	2017-2019	Pct	2020-2021	Pct	Total	Pct
	VEHICLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER							
V13.5XXA	PEDAL CYCLE PASSENGER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	5	1%
V18.0XXA	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN NONTRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	< 5	--	< 5	--	5	1%
V14.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH HEAVY TRANSPORT VEHICLE OR BUS	No	< 5	--	< 5	--	< 5	--
V19.9XXA	PEDAL CYCLIST (DRIVER) (PASSENGER) INJURED IN UNSPECIFIED TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Ambiguous	< 5	--	< 5	--	< 5	--
V10.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH PEDESTRIAN OR ANIMAL IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	< 5	--
V11.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH OTHER PEDAL CYCLE IN TRAFFIC A	No	< 5	--	< 5	--	< 5	--
V13.5XXA	PEDAL CYCLE PASSENGER INJURED IN COLLISION WITH CAR, PICK-UP TRUCK OR VAN I	No	< 5	--	< 5	--	< 5	--
V15.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH RAILWAY TRAIN OR RAILWAY VEHICLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	< 5	--
V16.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH OTHER NONMOTOR VEHICLE IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	< 5	--
V17.0XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH FIXED OR STATIONARY OBJECT IN NONTRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	< 5	--	< 5	--	< 5	--
V18.0XXA	PEDAL CYCLE DRIVER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN NONTRAFFIC	Yes	< 5	--	< 5	--	< 5	--
V18.5XXA	PEDAL CYCLE PASSENGER INJURED IN NONCOLLISION TRANSPORT ACCIDENT IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	Yes	< 5	--	< 5	--	< 5	--

E-Code 10	ICD-10 E-code Description	Solo Bicyclist	2017-2019	Pct	2020-2021	Pct	Total	Pct
V14.4XXA	PEDAL CYCLE DRIVER INJURED IN COLLISION WITH HEAVY TRANSPORT VEHICLE OR BUS IN TRAFFIC ACCIDENT, INITIAL ENCOUNTER	No	< 5	--	< 5	--	< 5	--
V19.88XA	PEDAL CYCLIST (DRIVER) (PASSENGER) INJURED IN OTHER SPECIFIED TRANSPORT ACCIDENTS, INITIAL ENCOUNTER	Ambiguous	< 5	--	< 5	--	< 5	--

*One cyclist is repeated since they have more than one bicycle crash related e-code

~Starting in 2020 more specific codes were used instead of V19.40XA and V18.4XXA

ICD-10 e-code (comparison of solo-bicyclist injury crashes and linkage)

Table 56 presents data on crash types involving solo-bicyclists and those with vehicles involved, comparing linked and unlinked cases between two time periods, 2017-2019 and 2020-2021. Solo- bicyclists crashes were classified based on the code description with assistance from trauma registry staff.

- In both time periods, a significant percentage of solo-bicyclists crashes were found only in the ZSFG (Unlinked) data: 69% in 2017-2019 and 82% in 2020-2021.
- This finding suggests that police may not be called to crashes where no vehicle was involved, as these solo-bicyclists crashes were not linked to police reports.
- The total proportion of solo-bicyclists crashes increased from 41% in 2017-2019 to 49% in 2020-2021, while crashes involving vehicles decreased from 58% to 51% in the same periods.

Table 56: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries, Solo and Vehicle Involved Crashes Based on ICD-10 E-code

Crash Type	Linked				Unlinked				Total			
	2017-2019	Percent	2020-2021	Percent	2017-2019	Percent	2020-2021	Percent	2017-2019	Percent	2020-2021	Percent
Yes - Solo Crash	43	16%	28	20%	163	69%	95	82%	206	41%	123	49%
No - Vehicle Involved	229	84%	108	79%	65	28%	21	18%	294	58%	129	51%
Ambiguous Code	< 5	--	< 5	--	8	3%	< 5	--	8	2%	< 5	--

*One cyclist is repeated since they have more than one bicycle crash related e-code

Ratio of ZSFG-only injuries by Analysis Neighborhood

Table 57 presents the ratio of unreported ZSFG-only cyclist injuries to reported SFPD cyclist injuries in various neighborhoods of San Francisco from 2017 to 2021. For counts of ZSFG-only cyclist injuries less than 5, the number is excluded due to HIPAA patient privacy regulations. The Presidio neighborhood, which is outside of SFPD's jurisdiction, and they generally do not write crash reports for, has the highest ratio of ZSFG-only cyclist reported injuries.

- The Presidio had 25 unreported ZSFG-only cyclist injuries and 2 reported SFPD cyclist injuries, resulting in the highest ratio of 12.50.
- Oceanview/Merced/Ingleside had a ratio of 0.38, with 3 unreported ZSFG-only cyclist injuries and 8 reported SFPD cyclist injuries.

- As shown on Map 15, a cluster of neighborhoods on the southeast side of the city, such as Bayview Hunters Point, Potrero Hill, and Portola, have higher ratios, indicating a higher proportion of unreported ZSFG-only cyclist injuries compared to reported SFPD cyclist injuries.

Table 57: Ratio of ZSFG-only to ZSFG-SFPD Linked/SFPD-only Unintentional Cyclist Injuries by Analysis Neighborhood

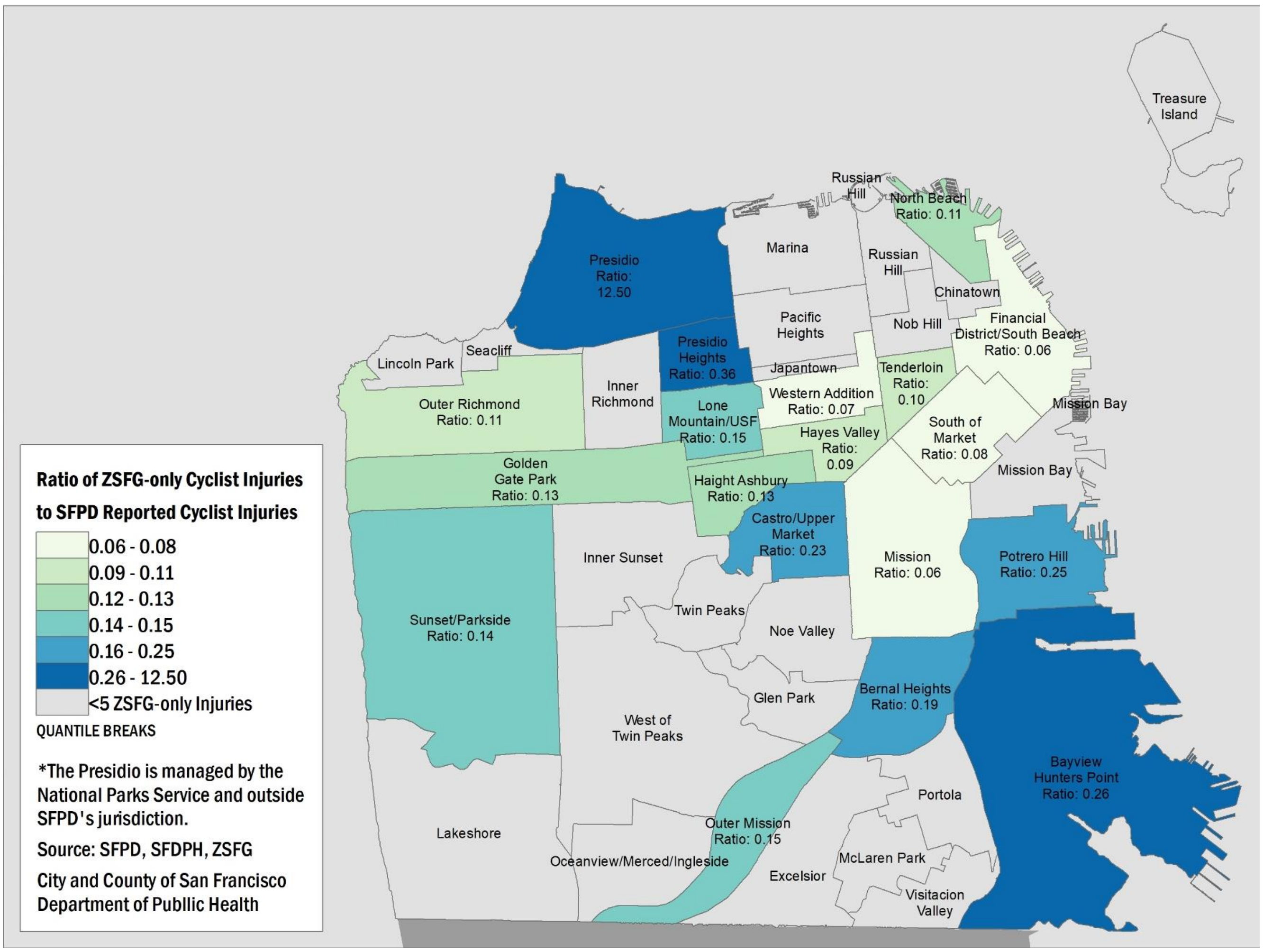
Neighborhood	Count Unreported ZSFG-only Injuries 2017-2021	Count of Reported SFPD Injuries 2017-2021	Ratio of ZSFG to SFPD Injuries
Presidio*	25	2	12.50
Presidio Heights	5	14	0.36
Bayview Hunters Point	24	93	0.26
Potrero Hill	8	32	0.25
Castro/Upper Market	18	77	0.23
Bernal Heights	10	53	0.19
Lone Mountain/USF	8	52	0.15
Outer Mission	6	40	0.15
Sunset/Parkside	7	50	0.14
Golden Gate Park	13	100	0.13
Haight Ashbury	6	45	0.13
North Beach	7	63	0.11
Outer Richmond	5	46	0.11
Tenderloin	15	154	0.10
Hayes Valley	10	108	0.09
South of Market	26	309	0.08
Western Addition	6	89	0.07
Mission	27	452	0.06
Financial District/South Beach	14	225	0.06
Lincoln Park	< 5	5	-
Noe Valley	< 5	19	-
Chinatown	< 5	25	-
Russian Hill	< 5	31	-
Inner Richmond	< 5	32	-
West of Twin Peaks	< 5	36	-
Oceanview/Merced/Ingleside	< 5	8	-
Portola	< 5	11	-
Lakeshore	< 5	17	-
Pacific Heights	< 5	28	-
Inner Sunset	< 5	33	-
Mission Bay	< 5	91	-
Glen Park	< 5	4	-
Japantown	< 5	8	-
McLaren Park	< 5	2	-
Seacliff	< 5	5	-
Twin Peaks	< 5	5	-

Neighborhood	Count Unreported ZSFG-only Injuries 2017-2021	Count of Reported SFPD Injuries 2017-2021	Ratio of ZSFG to SFPD Injuries
Excelsior	< 5	26	-
Nob Hill	< 5	40	-
Marina	< 5	58	-
Visitacion Valley	< 5	3	-
Treasure Island	< 5	4	-

* The Presidio is administered by the National Park Service and outside of SFPD's and MTA's jurisdiction.

Note that 57 out of 352 (16.2%) ZSFG-only crashes were unable to be geocoded.

Map 15: Ratio of Unlinked ZSFG-Only Cyclist Crashes to SFPD Reported Crashes by Analysis Neighborhood from 2017-2022: San Francisco, CA



ICD-10 e-code pedestrian injuries not on foot

Table 58 presents data on unintentional pedestrian injuries where individuals were traveling by means other than on foot seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by ICD-10 E-codes, and time period (2017-2019 and 2020-2021). The percentage calculated using the total of all pedestrian injuries including those injured while on foot. The table highlights trends and changes in the frequency of various types of pedestrian collisions involving alternative conveyances over the years, illustrating the evolving landscape of urban mobility and its impact on pedestrian safety.

- There was a noticeable increase between the two measurement periods in the percentage of pedestrians with other conveyances injured in collisions with cars, pick-up trucks, or vans in traffic accidents (V03.19XA) between 2017-2019 (4%) and 2020-2021 (7%), with a total of 63 incidents (5%).
- Pedestrians on skateboards injured in collisions with cars, pick-up trucks, or vans in traffic accidents (V03.12XA) remained consistent at 4% for both the 2017-2019 and 2020-2021 periods, totaling 50 incidents (4%).
- Collisions involving pedestrians on foot injured in accidents with pedal cyclists (V01.10XA) represent a very small percentage of pedestrian injuries, accounting for only 1% in 2017-2019 and 2% in 2020-2021, totaling 22 incidents (2%).

The "other conveyance" category can refer to the following: pedestrian with baby stroller, pedestrian on ice-skates, pedestrian on nonmotorized scooter, pedestrian on sled, pedestrian on snowboard, pedestrian on snow-skis, pedestrian in wheelchair (powered), and pedestrian in motorized mobility scooter. Prior to the creation of ICD-10 codes V00.031 (Pedestrian on foot injured in collision with rider of standing electric scooter) and V00.038 (Pedestrian on foot injured in collision with rider of other standing micro-mobility pedestrian conveyance) in late 2021, this category could also include standing electronic scooters and other micro-mobility devices.

Table 58: ICD-10 E-Codes of Pedestrians Not Walking on Foot Injured

E-Code 10	ICD-10 E-code Description	2017- 2019	Percent	2020-2021	Percent	Total	Percent
V03.19XA	Pedestrian with other conveyance injured in collision with car, pick-up truck or van in traffic accident	38	4%	25	7%	63	5%
V03.12XA	Pedestrian on skateboard injured in collision with car, pick-up truck or van in traffic accident	36	4%	14	4%	50	4%
V01.10XA	Pedestrian on foot injured in collision with pedal cycle in traffic accident	14	1%	8	2%	22	2%
V03.131A	Pedestrian on standing electric scooter injured in collision with car, pick-up or van in traffic accident	< 5	--	6	2%	6	0%
V03.02XA	Pedestrian on skateboard injured in collision with car, pick-up truck or van in nontraffic accident	< 5	--	< 5	--	< 5	--
V04.19XA	Pedestrian with other conveyance injured in collision with heavy transport vehicle or bus in traffic accident	< 5	--	< 5	--	< 5	--
V04.12XA	Pedestrian on skateboard injured in collision with heavy transport vehicle or bus in traffic accident	< 5	--	< 5	--	< 5	--
V03.92XA	Pedestrian on skateboard injured in collision with car, pick-up truck or van, unspecified whether traffic or nontraffic accident	< 5	--	< 5	--	< 5	--
V00.818A	Other accident with wheelchair (powered)	< 5	--	< 5	--	< 5	--
V01.19XA	Pedestrian with other conveyance injured in collision with pedal cycle in traffic accident	< 5	--	< 5	--	< 5	--
V02.19XA	Pedestrian with other conveyance injured in collision with two- or three-wheeled motor vehicle in traffic accident	< 5	--	< 5	--	< 5	--

E-Code 10	ICD-10 E-code Description	2017- 2019	Percent	2020-2021	Percent	Total	Percent
V03.99XA	Pedestrian with other conveyance injured in collision with car, pick-up truck or van, unspecified whether traffic or nontraffic accident	< 5	--	< 5	--	< 5	--
V04.11XA	Pedestrian on roller-skates injured in collision with heavy transport vehicle or bus in traffic accident	< 5	--	< 5	--	< 5	--
V05.19XA	Pedestrian with other conveyance injured in collision with railway train or railway vehicle in traffic accident	< 5	--	< 5	--	< 5	--
V01.11XA	Pedestrian on roller-skates injured in collision with pedal cycle in traffic accident	< 5	--	< 5	--	< 5	--
V01.12XA	Pedestrian on skateboard injured in collision with pedal cycle in traffic accident	< 5	--	< 5	--	< 5	--
V02.12XA	Pedestrian on skateboard injured in collision with two- or three-wheeled motor vehicle in traffic accident	< 5	--	< 5	--	< 5	--
V03.138A	Pedestrian on other standing micro-mobility pedestrian conveyance injured in collision with car, pick-up or van in traffic accident	< 5	--	< 5	--	< 5	--

ZSFG identified emerging mobility services and technologies (EMST) injuries of any ICD-10 category

In 2018, ZSFG initiated independent tracking of injuries related to the use of emerging mobility services and technologies (EMST) in their trauma registry[12], as these innovative transportation devices and technologies facilitating device-sharing saw increased usage. EMST includes: e-bikes (electric-assisted pedal bicycles), e-scooters (electric-powered stand-up kick scooters), motor-driven bicycles and mopeds (gasoline or electric-powered sit-down vehicles or assisted pedal bicycles), e-skateboards (electric-powered boards with four wheels), hoverboards/unicycles (one or two-wheeled electric-powered vehicles designed for standing), Segway-type vehicles (electric-powered, self-balancing stand-up vehicles with handlebars), Transportation Network Companies (TNCs, e.g., Uber, Lyft; motor vehicles providing ride-hail services through third-party apps), and Autonomous Vehicles (AVs; vehicles with partial or complete automation of driving, expected to increase as TNCs, shuttle services, and personal vehicles).

Table 59 presents the distribution of various EMST micro-mobility devices involved in injures seen at ZSFG during two time periods, 2018-2019 (when EMST started to be collected) and 2020-2021. The data reveals that electric bicycles and electric scooters make up most of these incidents.

- Electric bicycles constituted 43% of injuries in 2018-2019 and increased to 63% in 2020-2021, totaling 55% overall.
- Electric scooters (standup) accounted for 40% of injuries in 2018-2019 and 29% in 2020-2021, making up 33% of the total.

[12] Vision Zero SF Injury Prevention Research Collaborative. 2019. A Methodology for Emerging Mobility Injury Monitoring in San Francisco, California Utilizing Hospital Trauma Records: Version 2.0. San Francisco, CA. Available at: https://www.sfdph.org/dph/EH/PHES/PHES/TransportationandHealth.asp

- Electric skateboards injuries total 9% overall.

Table 59: ZSFG Identified Emerging Mobility Services and Technologies (EMST) Injuries of Any ICD-10 Category

EMST devices	2018-2019	Percent	2020-2021	Percent	Total	Percent
Electric bicycle	15	43%	33	63%	48	55%
Electric Scooter(standup)	14	40%	15	29%	29	33%
Electric skateboard	< 5	--	< 5	--	8	9%
Electric unicycle	< 5	--	< 5	--	< 5	--

Race

Table 60 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by race/ethnicity, link status (linked or unlinked to an SFPD crash report), and time period (2017-2019 and 2020-2021).

White cyclists (not Hispanic/Latino) represented the largest proportion of both linked and unlinked cases in both time periods, accounting for 48% and 51% of linked cases in 2017-2019 and 2020-2021, respectively, and 49% and 62% of unlinked cases in the same periods.

- The proportion of Hispanic/Latino cyclists of any race experiencing injuries was consistent across the time periods, comprising 23% and 17% of linked cases and 26% and 12% of unlinked cases in 2017-2019 and 2020-2021, respectively.
- The percentage of Black (not Hispanic/Latino) cyclist injuries saw a decline in both linked and unlinked cases between the two time periods. The proportion of linked cases decreased from 16% to 9%, and unlinked cases dropped from 11% to 7%.
- Asian (not Hispanic/Latino) cyclist injuries were relatively stable across time periods, representing 11% and 15% of linked cases and 11% and 14% of unlinked cases in 2017-2019 and 2020-2021, respectively.

Table 60: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by Race and Ethnicity

Race/Ethnicity		Linked				Unlinked				Total			
		2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct
American Indian	Not Hispanic/ Latino	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
Asian	Not Hispanic/ Latino	31	11%	20	15%	26	11%	16	14%	51	13%	42	12%
Black	Not Hispanic/ Latino	43	16%	12	9%	26	11%	8	7%	55	14%	34	10%
Other	Not Hispanic/ Latino	< 5	--	9	7%	7	3%	5	4%	12	3%	12	3%
White	Not Hispanic/ Latino	130	48%	69	51%	115	49%	72	62%	199	49%	187	53%
Native Hawaiian	Not Hispanic/ Latino	< 5	0%	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
***Nd**	Not Hispanic/ Latino	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
Any Race	Hispanic/ Latino	63	23%	23	17%	61	26%	14	12%	86	21%	75	21%

Age

Table 61 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by age group, link status (linked or unlinked to an SFPD crash report), and time period (2017-2019 and 2020-2021).

- The age group with the highest percentage of linked injuries in both time periods is 25-29 years old, accounting for 16% of linked cases in 2017-2019 and 15% in 2020-2021.
- The 30-34 age group had the highest proportion of unlinked cases in both time periods, with 12% in 2017-2019 and 16% in 2020-2021.
- The percentage of linked injuries increased with age until the 25-29 age group, then generally decreased with increasing age. A similar pattern can be observed in the unlinked cases.

Table 61: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by Age

Age Group	Linked				Unlinked				Total			
	2017-2019	Pct	2020-2021	Percent	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct
0 - 4	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--
5 - 9	5	2%	< 5	--	< 5	--	< 5	--	6	1%	< 5	--
10 - 14	5	2%	< 5	--	< 5	--	< 5	--	9	2%	< 5	--
15 - 19	5	2%	< 5	--	10	4%	5	4%	15	3%	9	4%
20 - 24	22	8%	7	5%	18	8%	< 5	--	40	8%	8	3%
25 - 29	44	16%	20	15%	24	10%	9	8%	68	13%	29	12%
30 - 34	33	12%	22	16%	29	12%	19	16%	62	12%	41	16%
35 - 39	21	8%	15	11%	24	10%	14	12%	45	9%	29	12%
40 - 44	27	10%	12	9%	19	8%	16	14%	46	9%	28	11%
45 - 49	31	11%	11	8%	24	10%	5	4%	55	11%	16	6%
50 - 54	30	11%	9	7%	23	10%	12	10%	53	10%	21	8%
55 - 59	21	8%	8	6%	26	11%	8	7%	47	9%	16	6%
60 - 64	8	3%	7	5%	17	7%	8	7%	25	5%	15	6%
65 - 69	9	3%	8	6%	8	3%	8	7%	17	3%	16	6%
70 - 74	7	3%	7	5%	8	3%	5	4%	15	3%	12	5%
75 - 79	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	7	3%
80 - 84	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--	< 5	--

Gender

Table 62 presents data on unintentional cyclist injuries seen at ZSFG's trauma registry or emergency department in San Francisco, categorized by gender, link status (linked or unlinked to an SFPD crash report), and time period (2017-2019 and 2020-2021).

- Males accounted for the majority of both linked and unlinked cyclist injuries in both time periods. In 2017-2019, 85% of linked and 79% of unlinked cases involved males, while in 2020-2021, the proportions were 86% and 78%, respectively.
- Female cyclist injuries represented a smaller percentage of the total cases, with 15% of linked and 21% of unlinked cases in 2017-2019, and 14% and 22% in 2020-2021.
- The distribution of injuries by gender remained relatively consistent between the two time periods, with males consistently representing a higher proportion of cases than females.
- Although the proportion of female injuries is smaller than that of males, it is noteworthy that the percentage of unlinked cases among females was slightly higher than the percentage of linked cases in both time periods.

Table 62: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by Gender

Gender	Linked				Unlinked				Total			
	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct	2017-2019	Pct	2020-2021	Pct
Male	229	85%	117	86%	187	79%	90	78%	416	82%	207	82%
Female	42	15%	19	14%	49	21%	26	22%	91	18%	45	18%

ICD-10 injuries (limited to top 20)

Table 63 displays the top 20 ICD-10 injury codes for cyclists, detailing the percentage of cyclists seen with each injury in two different time periods (2017-2019 and 2020-2021) and the total percentage across both periods. It's important to note that a cyclist can have multiple injuries.

- Abrasions and lacerations of head, knees, elbows, and hands were the most common injuries among cyclists.
- The top 3 injuries inflicted on cyclists were abrasions of other parts of the head (16%), lacerations without foreign body of other parts of the head (14%), and abrasions of the left knee (14%).
- Less common injuries included concussion without loss of consciousness (8%), contusion of scalp (8%), and abrasions of lower legs, shoulders, and forearms.
- Traumatic injuries, such as pneumothorax, skull base fractures, nasal bone fractures, and rib fractures, were also among the top 20 ICD-10 injury codes.
- Some differences in injury prevalence were observed between the two time periods (2017-2019 and 2020-2021), although most injury percentages remained relatively stable.

Table 63: SFPD-ZSFG Linked and ZSFG Unlinked Unintentional Cyclist Injuries by ICD-10 Injury Diagnosis Code

Injury Diagnosis ICD-10 Code	Description	2017-2019	Percent of Cyclist with this Injury	2020-2021	Percent of Cyclist with this Injury	Total	Percent of Cyclist with this Injury
S00.81XA	Abrasion of other part of head, initial encounter	83	16%	35	14%	118	16%
S01.81XA	Laceration without foreign body of other part of head, initial encounter	82	16%	24	10%	106	14%
S80.212A	Abrasion, left knee, initial encounter	74	15%	33	13%	107	14%
S80.211A	Abrasion, right knee, initial encounter	68	13%	35	14%	103	14%
S50.312A	Abrasion of left elbow, initial encounter	51	10%	16	6%	67	9%
S06.0X0A	Concussion without loss of consciousness, initial encounter	45	9%	13	5%	58	8%
S60.511A	Abrasion of right hand, initial encounter	45	9%	23	9%	68	9%
S00.83XA	Contusion of other part of head, initial encounter	44	9%	21	8%	65	9%
S60.512A	Abrasion of left hand, initial encounter	43	8%	23	9%	66	9%
S00.03XA	Contusion of scalp, initial encounter	40	8%	21	8%	61	8%

Injury Diagnosis ICD-10 Code	Description	2017-2019	Percent of Cyclist with this Injury	2020-2021	Percent of Cyclist with this Injury	Total	Percent of Cyclist with this Injury
S80.812A	Abrasion, left lower leg, initial encounter	36	7%	19	8%	55	7%
S50.311A	Abrasion of right elbow, initial encounter	35	7%	19	8%	54	7%
S40.212A	Abrasion of left shoulder, initial encounter	33	7%	13	5%	46	6%
S27.0XXA	Traumatic pneumothorax, initial encounter	30	6%	24	10%	54	7%
S01.01XA	Laceration without foreign body of scalp, initial encounter	29	6%	21	8%	50	7%
S02.19XA	Other fracture of base of skull, initial encounter for closed fracture	29	6%	23	9%	52	7%
S80.811A	Abrasion, right lower leg, initial encounter	29	6%	21	8%	50	7%
S22.42XA	Multiple fractures of ribs, left side, initial encounter for closed fracture	27	5%	17	7%	44	6%
S01.511A	Laceration without foreign body of lip, initial encounter	26	5%	10	4%	36	5%
S06.6X0A	Traumatic subarachnoid hemorrhage without loss of consciousness, initial encounter	26	5%	35	14%	61	8%
S50.812A	Abrasion of left forearm, initial encounter	26	5%	13	5%	39	5%
S02.2XXA	Fracture of nasal bones, initial encounter for closed fracture	24	5%	13	5%	37	5%
S30.811A	Abrasion of abdominal wall, initial encounter	24	5%	9	4%	33	4%
S50.811A	Abrasion of right forearm, initial encounter	24	5%	17	7%	41	5%
S02.0XXA	Fracture of vault of skull, initial	23	5%	19	8%	42	6%

Injury Diagnosis ICD-10 Code	Description	2017-2019	Percent of Cyclist with this Injury	2020-2021	Percent of Cyclist with this Injury	Total	Percent of Cyclist with this Injury
	encounter for closed fracture						

*Cyclists can have multiple injury codes

SFPD severity change

One of the benefits of utilizing TISS linked data is injury severity for SFPD-reported injury records linked to ZSFG records can be updated to reflect a more accurate, clinical assessment of the injury outcome as diagnosed by ZSFG medical staff. SFPD assessment of injury is determined by standards outlined in the California Highway Patrol Collision Investigation Manual prior to 2021 and is primarily based on an officer's visual assessment of a victim at the scene of the collision. Police officers have been trained to classify a crash as a severe (or serious) injury if it has the following characteristics[13]:

1. Broken of fractured bones
2. Dislocated of distorted limbs
3. Severe lacerations
4. Skull, spinal, chest or abdominal injuries that go beyond "Other Visible Injuries"
5. Unconsciousness at or when taken from the collision scene
6. Severe burns

In contrast, ZSFG data provides a clinical assessment of injury severity. In accordance with the Vision Zero Severe Injury Protocol[14], SFDPH classifies the following ZSFG patients as severe injuries:

1. Any patient entered into ZSFG Hospital's Trauma Registry who was injured in or outside of a vehicle involved in a crash within the public roadway due to impact with a vehicle or road structure within the City or County of San Francisco requiring hospital admission for treatment of their injuries.
2. Any patient entered into ZSFG Hospital's Trauma Registry who was injured in or outside of a vehicle (bus, truck, car, motorcycle, bike, moped, light rail vehicle (LRV), train, etc.) involved in a crash within the public roadway due to impact with a vehicle or road structure within the City or County of San Francisco and sustained an Injury Severity Score (ISS) greater than 15.

ISS is an established medical score to assess trauma severity[15]. It correlates with mortality, morbidity and hospitalization time after trauma. Major trauma is defined as being an Injury Severity Score greater than 15 and is associated with a greater than 10% risk of mortality[16]. This definition of severe traffic-related injury is

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[13] State of California, Business, Transportation and Housing Agency, Dept. of California Highway Patrol. 2003. Collision Investigation Manual. Sacramento, CA. Available at: https://www.nhtsa.gov/nhtsa/stateCatalog/states/ca/docs/CA_CHP555_Manual_2_2003_ch1-13.pdf

[14] San Francisco Department of Public Health. May 2017. Vision Zero Severe Traffic Injury Protocol. San Francisco: Program on Health, Equity and Sustainability. San Francisco, CA.

[15] Baker SP, O'Neill B, Haddon W, Long WB (1974). "The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care". *The Journal of Trauma*. Lippincott Williams & Wilkins. 14 (3): 187–196. doi:10.1097/00005373-197403000-00001. PMID 4814394

[16] Copes, W.S.; H.R. Champion; W.J. Sacco; M.M. Lawnick; S.L. Keast; L.W. Bain (1988). "The Injury Severity Score revisited". *The Journal of Trauma*. Lippincott Williams & Wilkins. 28 (1): 69–77.

consistent with previously established guidelines including those used by the American College of Surgeons, the National Trauma Data Bank, the California Department of Public Health, and the World Health Organization.

Injury severity for people in both the SFPD and ZSFG datasets was determined based on the severity as determined by ZSFG data, which could mean either upgrading or downgrading the severity classification of an injury initially assessed by SFPD at the scene. The following tables summarize changes in injury severity to linked cyclist injuries as originally assessed by SFPD based on ZSFG data using the above criteria.

Table 64 demonstrates how the injury severity assessment of SFPD-reported cases has been updated using ZSFG data, which provides a more accurate clinical assessment of injury outcomes. The data compares the severity updates between two time periods, 2017-2019 and 2020-2021.

- Of the SFPD-reported severe injuries, 28% (2017-2019) and 14% (2020-2021) were unlinked reports that remained severe since no clinical definition from ZSFG was available.
- For linked reports, 47% (2017-2019) and 57% (2020-2021) remained severe, as confirmed by the hospital data.
- The proportion of SFPD-linked reports that were downgraded to less severe based on ZSFG data was 53% (2017-2019) and 43% (2020-2021), highlighting the differences in severity assessment between SFPD and ZSFG.
- SFPD-reported other injuries (other visible injury and complaint of pain) accounted for 91% of cases in 2017-2019 and 84% in 2020-2021.
- Of these other injury reports, 5% in 2017-2019 and 14% in 2020-2021 were linked and upgraded to severe based on ZSFG data, indicating a significant increase in the proportion of injuries initially classified as less severe that were later determined to be more serious upon further clinical assessment.
- In total, 7% of SFPD-reported other injury cases were upgraded to severe after being linked to ZSFG data, emphasizing the importance of incorporating clinical assessments to determine injury severity more accurately.

This analysis highlights the potential discrepancies in injury severity classification between SFPD assessments and clinical assessments at ZSFG, underlining the need to consider both sources of data to ensure a comprehensive understanding of injury outcomes in traffic-related incidents.

Table 64: Changes in ZSFG-SFPD Linked Reported Injury Severity Based off ZSFG Trauma Registry

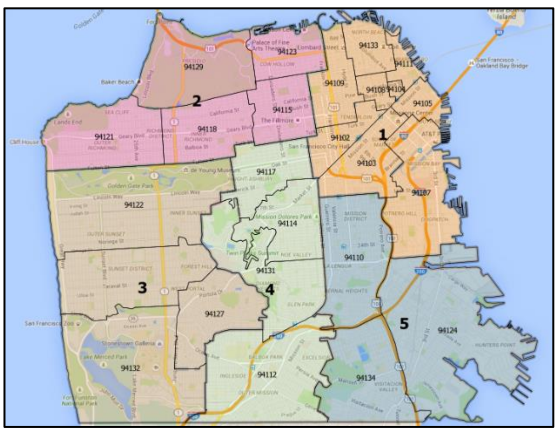
Injury Update	2017-2019	Pct	2020-2021	Pct	Total	Pct
SFPD report severe injuries	154	9%	82	16%	236	11%
SFPD unlinked reports that stayed severe	34	28%	10	14%	44	23%
SFPD linked reports that stayed severe (also severe per hospital)	56	47%	41	57%	97	51%
SFPD linked reports that were downgraded to less than severe	64	53%	31	43%	95	49%
SFPD report other injuries (complaint of pain or other visible)	1527	91%	440	84%	1967	89%
SFPD linked other injury reports that were upgraded to severe	79	5%	60	14%	139	7%

TO: San Francisco Municipal Transportation Agency & Toole Design Group
FROM: EMC Research, Inc.
RE: SFMTA Resident Preference Survey – Summary of Findings **(DRAFT)**
DATE: July 21, 2023

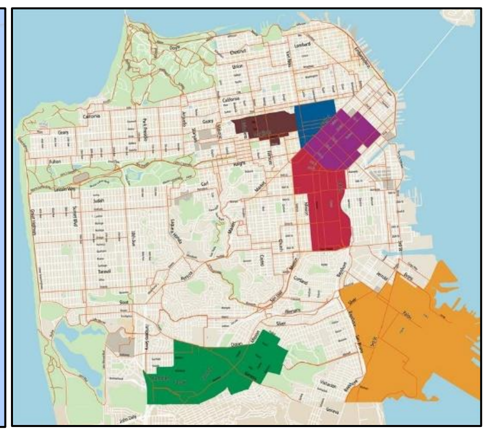
This memo outlines key findings from a recent web panel and intercept survey conducted among San Francisco residents from March 28-May 1, 2023. Four hundred (400) interviews were conducted online with a representative sample of adult San Francisco residents across the City, and an additional 600 interviews were conducted in person across the identified Equity Priority Communities (EPCs), with 100 interviews conducted in each EPC. The survey was made available in English, Spanish, Chinese, and Tagalog. The final distribution of survey respondents was weighted to reflect the actual demographic and geographic distribution of the adult population of San Francisco, according to US Census data.

The following maps show the five broad San Francisco analytic zones used for some of the analysis in this memo, as well as the six EPCs where the additional intercept interviewing was conducted. The five analytic zones were created using zip codes and have been used in prior analysis of survey results for SFMTA, and were sized to allow us analyze regional data with a reasonable number of interviews in each zone.

Analytic Zones



Equity Priority Communities



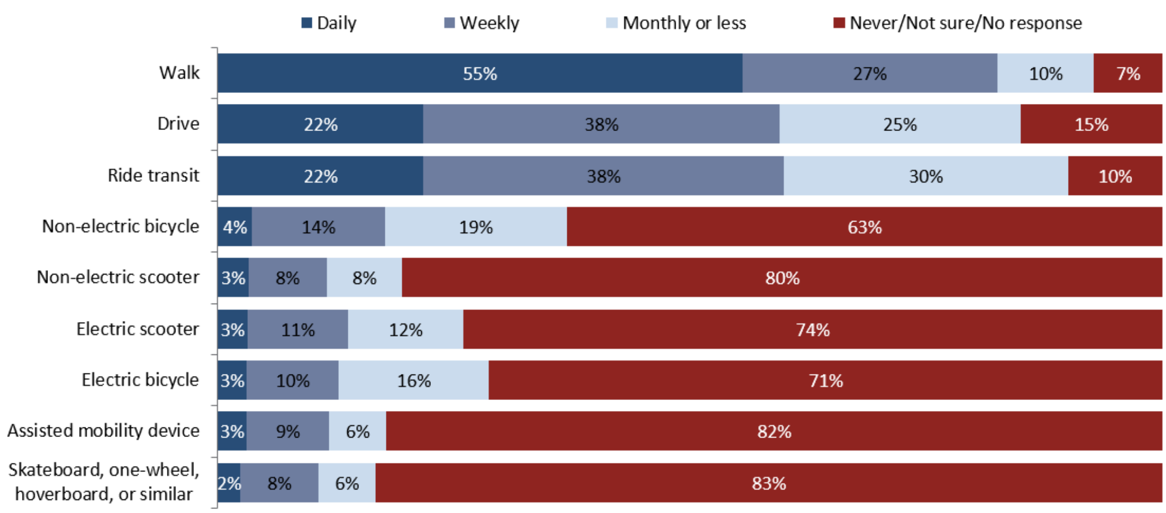
<u>Analytic Zone</u>	<u>Total interviews (including EPC intercepts)</u>	<u>Weighted interview distribution*</u>
Zone 1: Downtown/SOMA	321	27%
Zone 2: Marina/Richmond	108	17%
Zone 3: Sunset/Lake Merced	90	18%
Zone 4: Haight/Noe/Glen Park	163	22%
Zone 5: Mission/Visitacion Valley	318	16%

** Survey data weighted to reflect actual adult population distribution in San Francisco, according to U.S. Census estimates.*

San Francisco residents primarily walk, drive and ride transit to get around.

Walking is by far the most commonly used mode of transportation for San Francisco residents. Driving and riding transit command roughly equal usage by City residents, with a little more than one-fifth reporting they drive or use transit daily. Non-electric bicycles are the most common active transportation mode, with almost two-in-five residents reporting some level of usage.

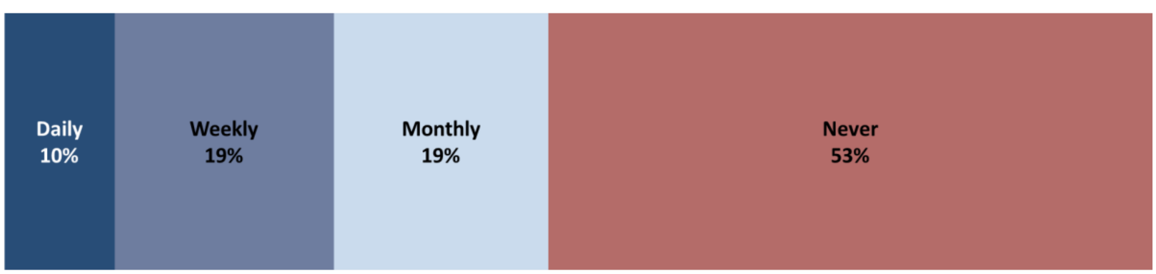
Transportation Mode Frequency



Just under half of San Francisco residents use active transportation devices on a regular basis.

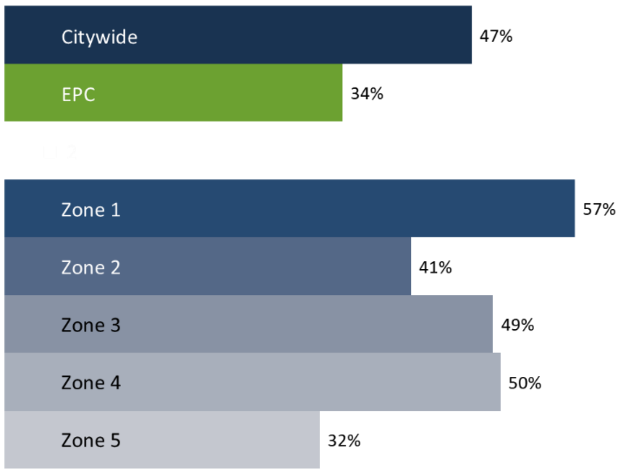
One in ten San Francisco residents report using one or more active transportation devices daily, with nearly half using one or more monthly or more frequently.

Active Transportation Device Usage



Those interviewed in the EPCs were less likely to report usage of active transportation devices than San Franciscans in general, while those in the downtown/SOMA area were most likely to report using active transportation devices on a regular basis.

Active Transportation Device Usage by EPCs & Zone

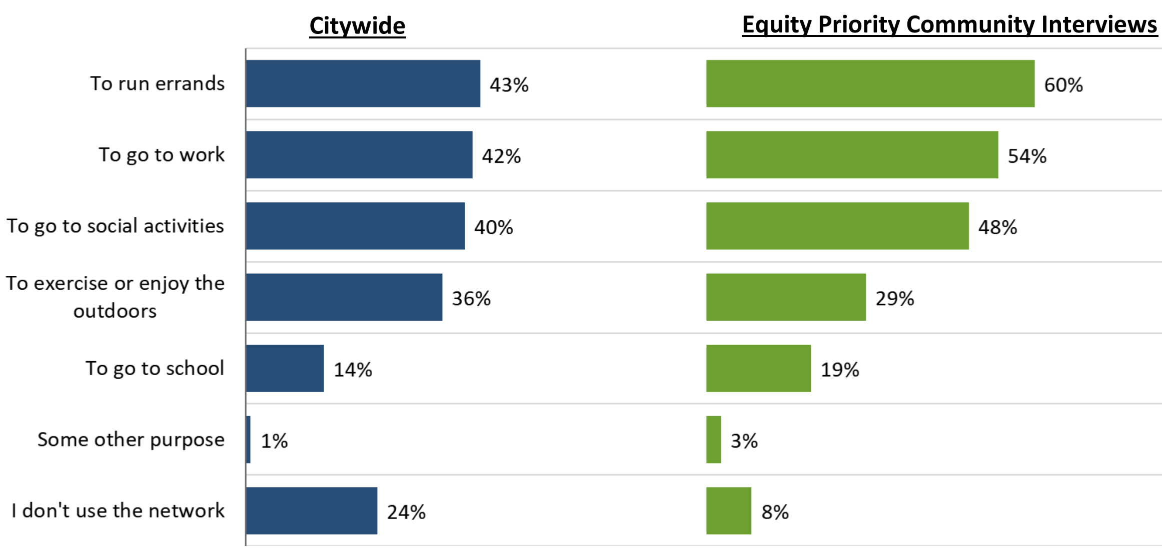


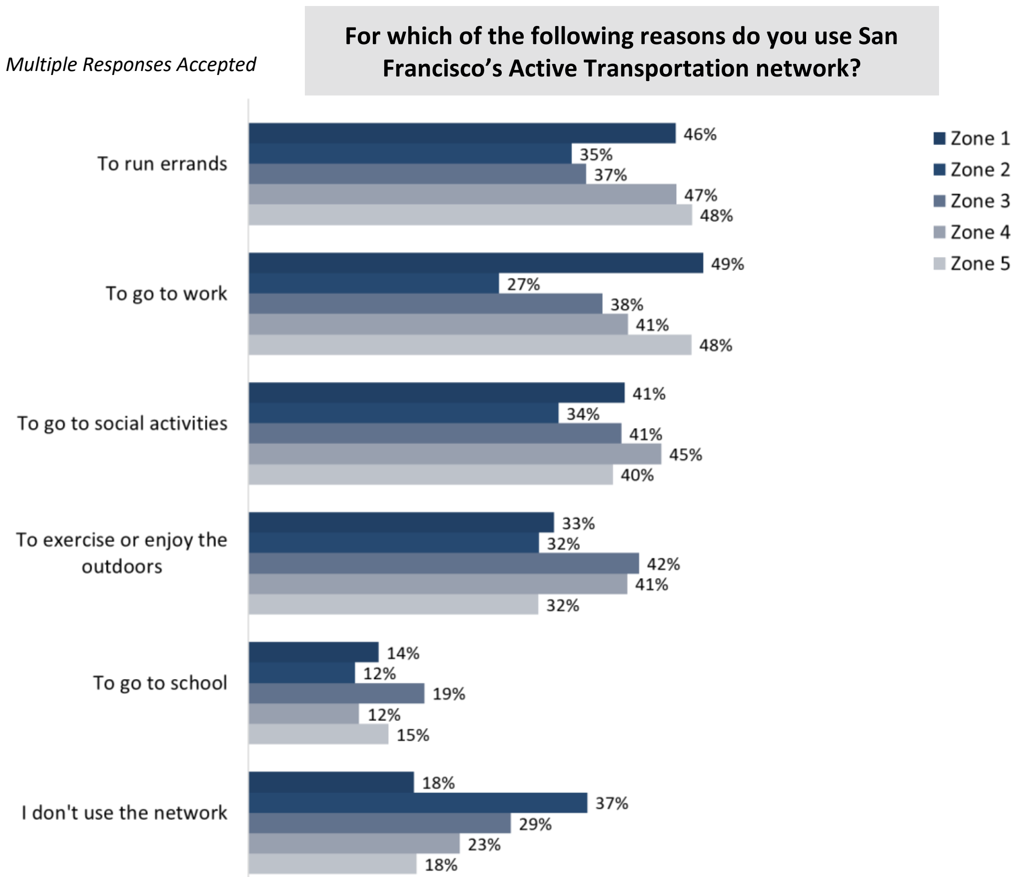
Residents in different parts of San Francisco have different reasons they use the Active Transportation Network.

Those interviewed in the EPCs were more likely to say they use the Active Transportation Network for functional trips, like errands and commutes. Residents of the downtown/SOMA area are more likely to say they use the Network for running errands or commuting, while central or western area residents say they use it more for social and exercise purposes.

Multiple Responses Accepted

For which of the following reasons do you use San Francisco's Active Transportation network?





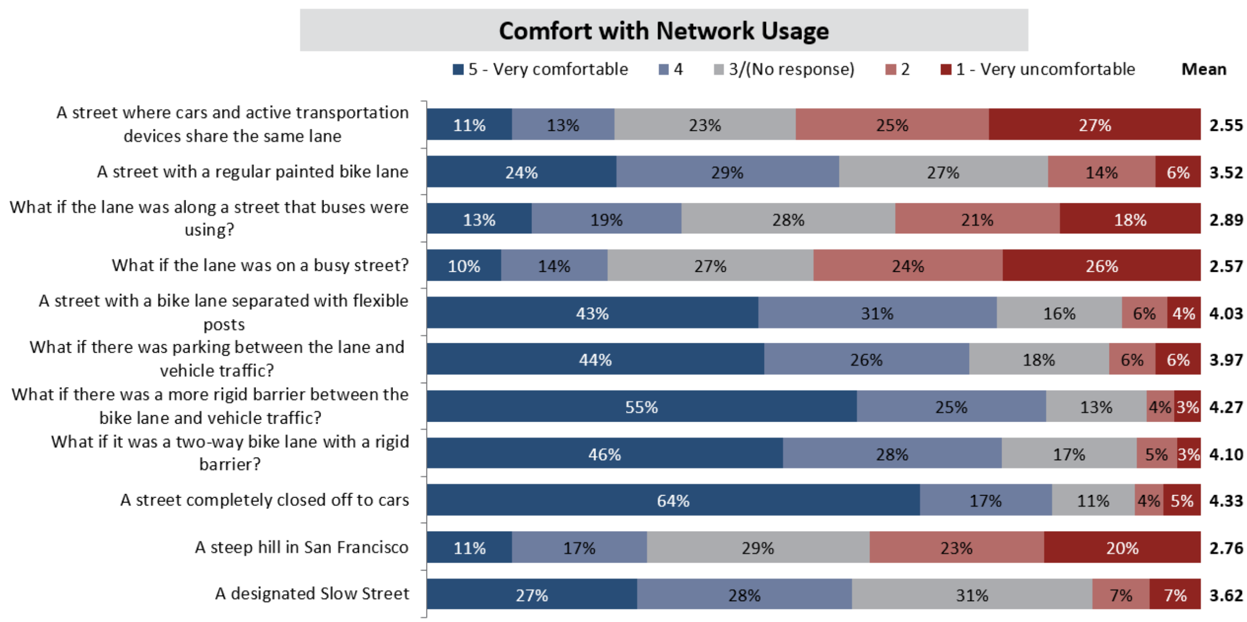
Equity Priority Community respondents also report using Slow Streets at a lower rate than city residents overall. Levels of participation in Sunday Streets and Bike to Work Day are more similar citywide and in the EPC interviews. Slow Streets are much more widely used in the central and western parts of the City than in other areas.

Which of the following have you done? *(multiple responses accepted)*	**Citywide**	**EPC**	**Zone 1**	**Zone 2**	**Zone 3**	**Zone 4**	**Zone 5**
Walked, biked, or rolled on one of San Francisco's designated **Slow Streets**	51%	32%	49%	52%	62%	61%	29%
Attended a **Sunday Streets** event in San Francisco	37%	34%	47%	32%	39%	30%	29%
Participated in **Bike to Work Day**	15%	10%	16%	11%	21%	29%	6%

Residents feel most comfortable using Active Transportation Network facilities that are physically separated from cars and other traffic.

Survey respondents were given an ordered set of questions with images that showed different environments they might encounter while using the Active Transportation Network and asked to rate their comfort in each. Photos were shown with some questions for clarity.

The chart below shows the results for that set of questions citywide; questions are shown in the order asked. A majority of residents express discomfort with the idea of using streets where cars and active transportation devices share the same lane. Comfort increases significantly for a painted bike lane environment, but concerns are higher when that lane is near buses or on a busy street. Facilities with physical protection from traffic are the most comfortable environments for a majority of users. As expected, a street completely closed off to cars is the most comfortable environment, with nearly two-thirds (64%) saying they are very comfortable in that environment.

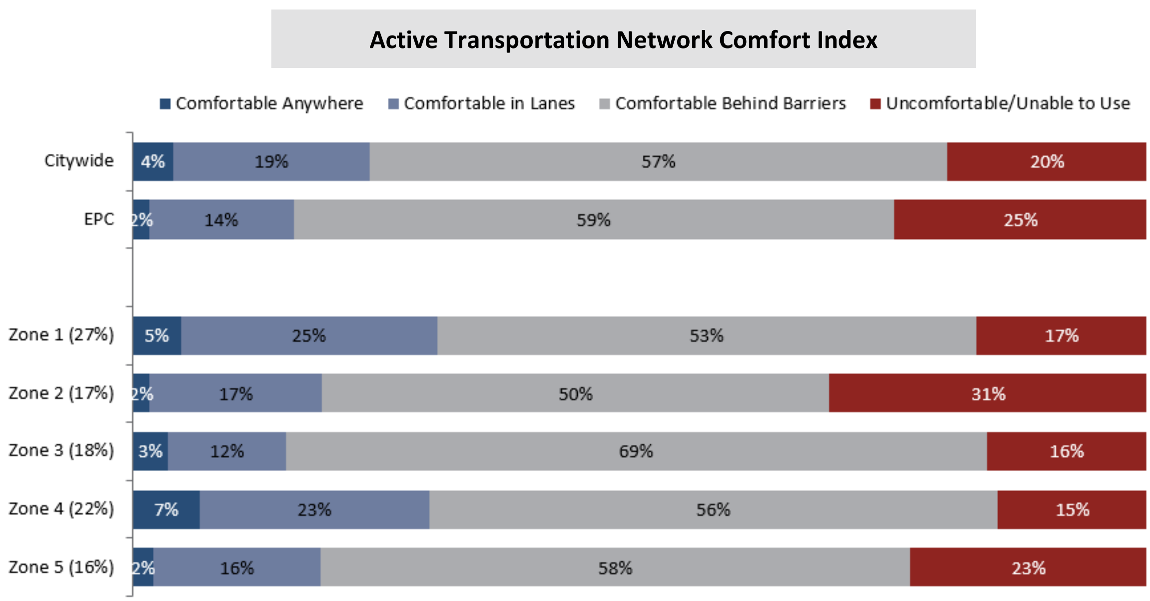


Analysis of comfort levels across a range of facility types in the City's Active Transportation Network reveals that few residents are completely comfortable across all types of ATN facilities.

The questions from the section above were used to create an **Active Transportation Network Comfort Index,** to understand how residents feel across a range of ATN facility types. The general approach was developed referencing the work of Roger Geller and Jennifer Dill on comfort level in cycling facilities, but adapted for this analysis.

The chart below shows the results of this analysis:

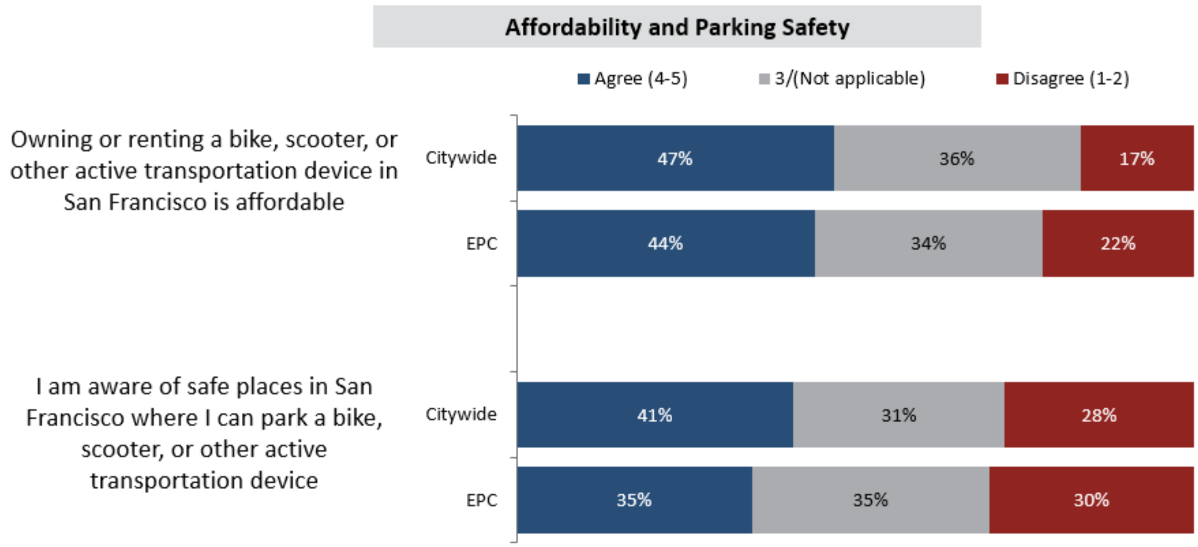
- Four percent (4%) of adult residents of San Francisco can be considered "**Comfortable Anywhere**" in their use of the ATN, meaning they feel very comfortable using all types of facilities shown in the survey.
- Another 19% are termed as "**Comfortable in Lanes**," meaning they are not very comfortable with shared facilities, but feel very comfortable on facilities with separate lane designations but no physical barriers.
- The largest share (57%) can be described as "**Comfortable Behind Barriers**" – these are people who are comfortable only on facilities that are separated from vehicle traffic by a physical barrier, such as flex posts, parked cars, or a rigid barrier.
- The remaining 20% ("**Uncomfortable / Unable to Use")** are either very uncomfortable with using any types of facilities, or are unable to use the network at all due to their own mobility capabilities.

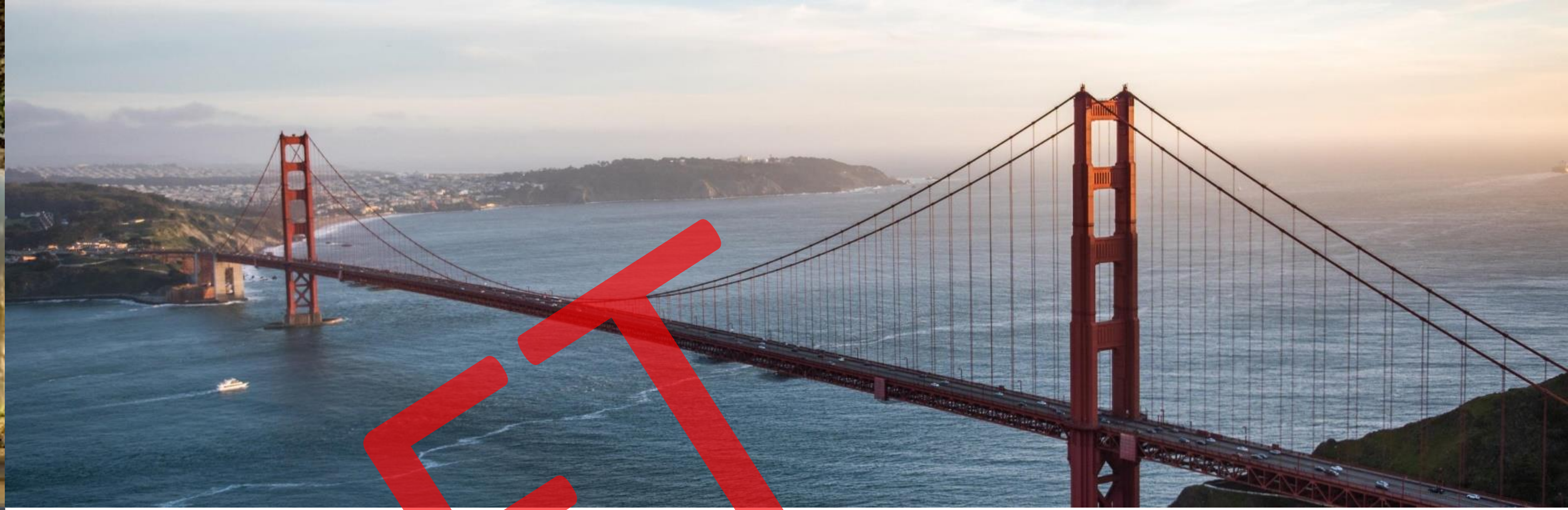


Residents in the northwest and southeast parts of the City are more likely to be uncomfortable or unable to use the ATN, as were respondents in the EPC interviews. Those who live in downtown/SOMA and the central part of the City are comfortable in the most types of active transportation facilities.

Affordability and safe parking places are potential barriers to using the Active Transportation Network.

Nearly half of adult San Francisco residents agree that owning or renting an active transportation device in San Francisco is affordable, and two in five agree they know of safe places to park devices. However, we do see a sizable minority not in agreement with those statements – 17% disagree that owning or renting is affordable, and 28% disagree that they are aware of safe places to park. Patterns are similar in the EPCs on these questions.





SFMTA

EMC research

SFMTA Active Communities Plan Resident Preference Survey Results

July 2023

Methodology

- A sample of 400 online interviews were conducted in English March 28 – April 4, 2023, using a pre-recruited web panel of San Francisco residents. The distribution of online interviews generally mirrored the geographic distribution of San Francisco adult residents.

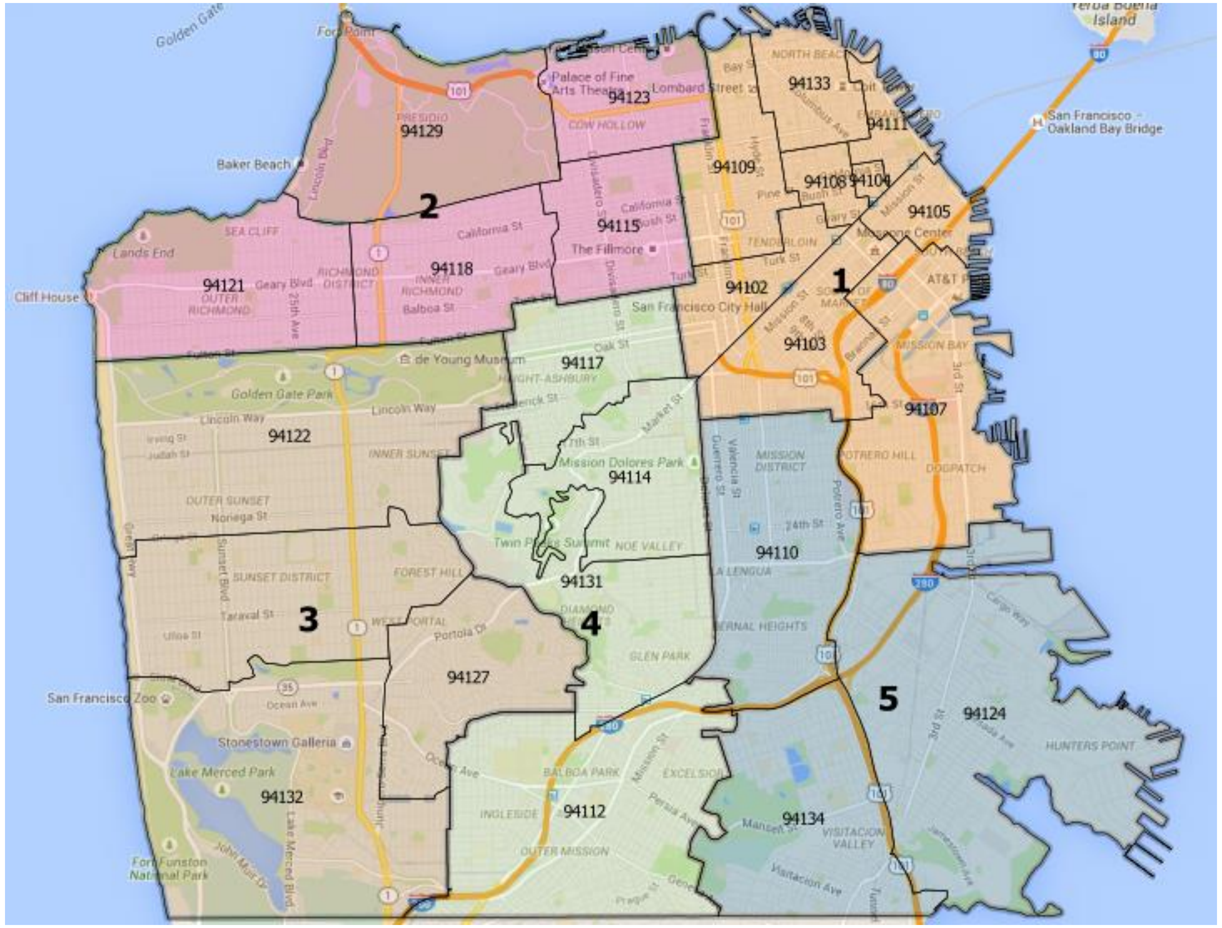
- An additional 600 intercept interviews were conducted April 4 – May 1, 2023 across six identified Equity Priority Communities (EPCs). These interviews were specifically targeted to populations underrepresented in the online surveys due to language and demographic characteristics, and reflected demographics largely present in the EPCs.
  - 100 interviews were conducted in each of the following EPCs: Western Addition, Tenderloin, Excelsior, Bayview/Hunters Point, SOMA, and Mission
  - Intercept surveys conducted in English, Spanish, Chinese and Tagalog by professional interviewers

- The final data from both components was combined into a single merged dataset designed to be demographically and geographically representative of San Francisco’s adult population.

Please note that due to rounding, some percentages may not add up to exactly 100%.

San Francisco Analytic Zones

The data is broken out into the five zones showed in this map in various places throughout this report, to investigate difference in usage and attitudes by general region of the City.

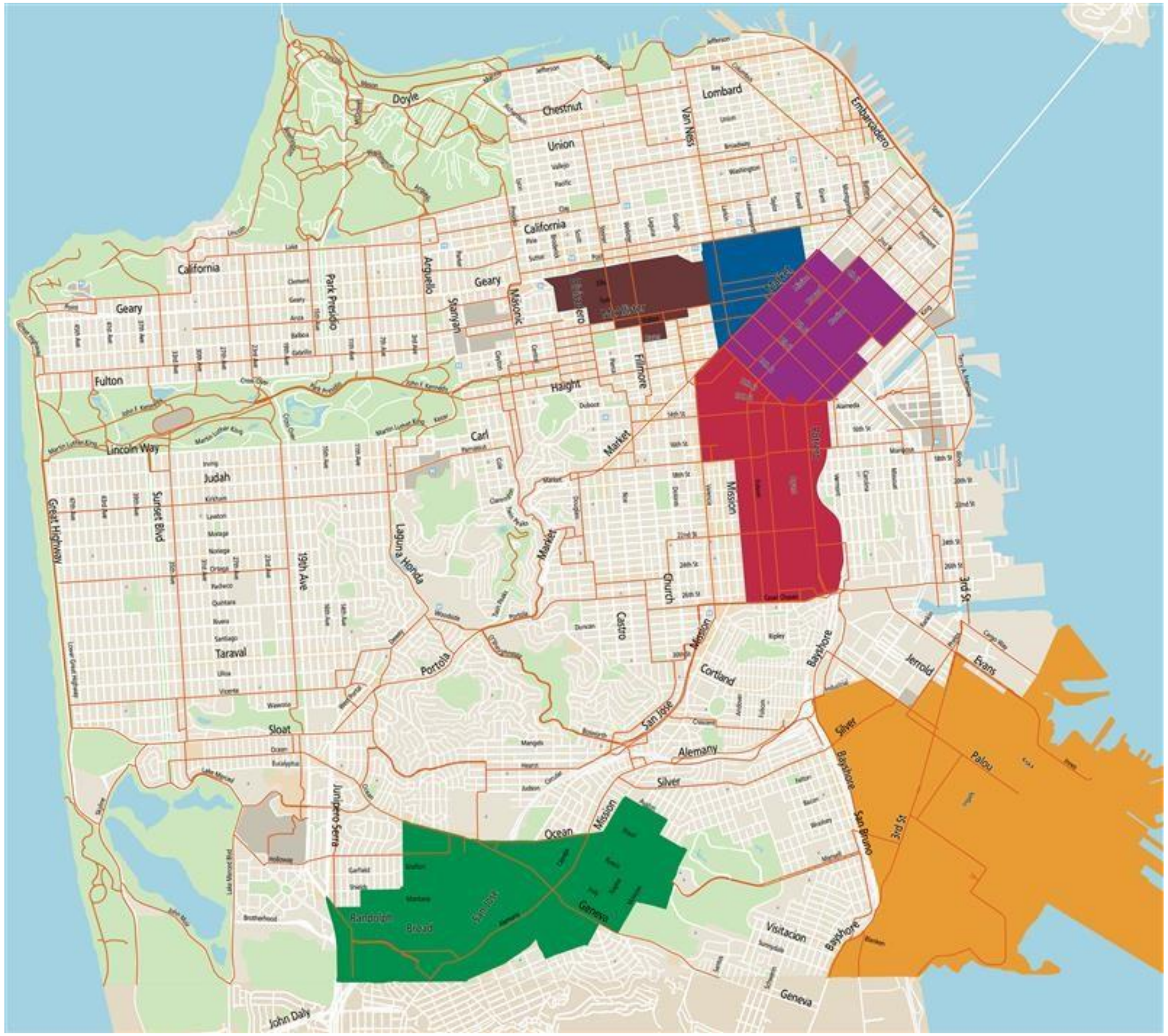


Zone	Total interviews (including EPC intercept)	Weighted interview distribution*
Zone 1: Downtown/SOMA	321	27%
Zone 2: Marina/Richmond	108	17%
Zone 3: Sunset/Lake Merced	90	18%
Zone 4: Haight/Noe/Glen Park	163	22%
Zone 5: Mission/Visitacion Valley	318	16%

** Final survey data weighted to reflect actual adult population distribution in San Francisco, according to U.S. Census estimates.*

EPC Zones (Intercept Only)

EMC research

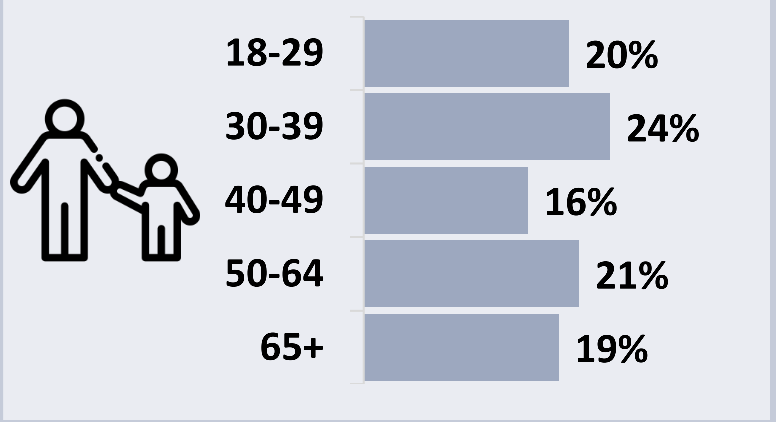


Equity Priority Community	Intercept Interviews
Western Addition	100
Tenderloin	100
Excelsior	100
Bayview/Hunter's Point	100
SOMA	100
Mission	100

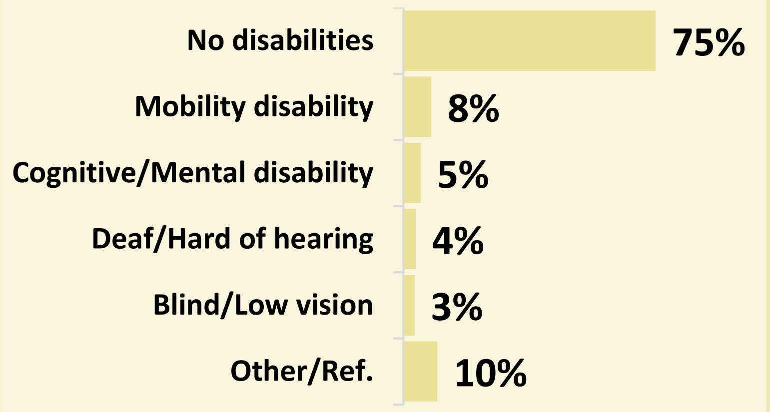
Demographic Profile of Final Dataset

EMC research

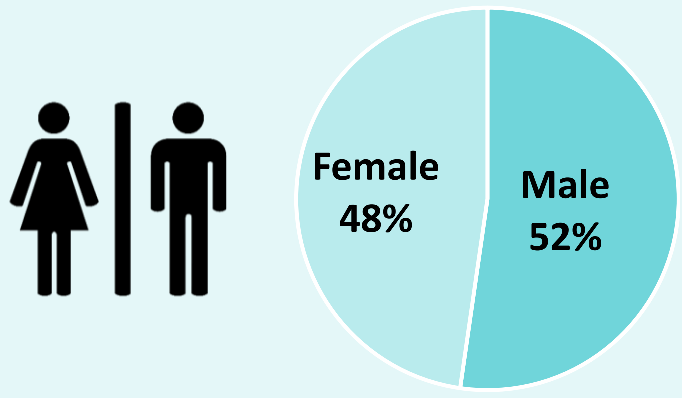
Age



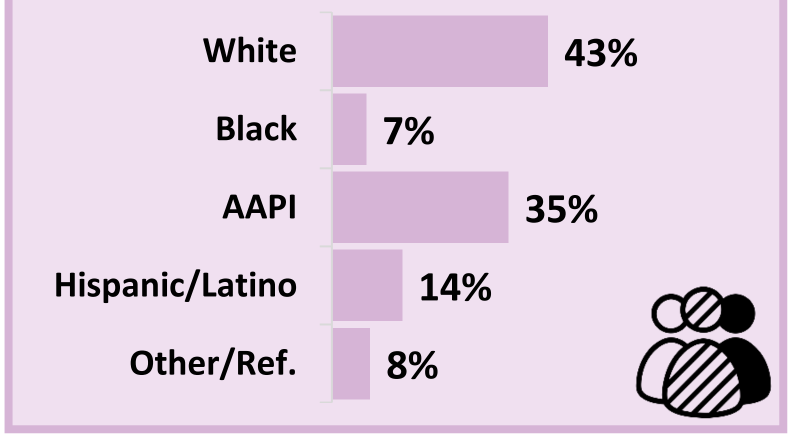
Disability Status



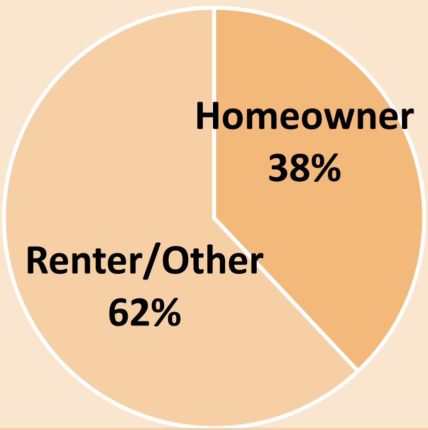
Gender



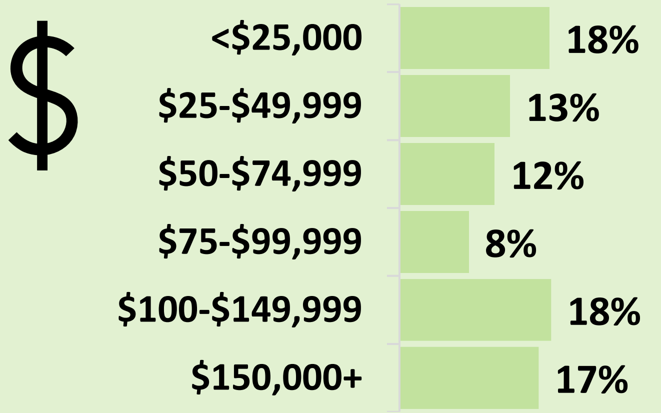
Ethnicity



Homeownership



Household Income



** Final survey data weighted to reflect actual adult population distribution in San Francisco, according to U.S. Census estimates.*

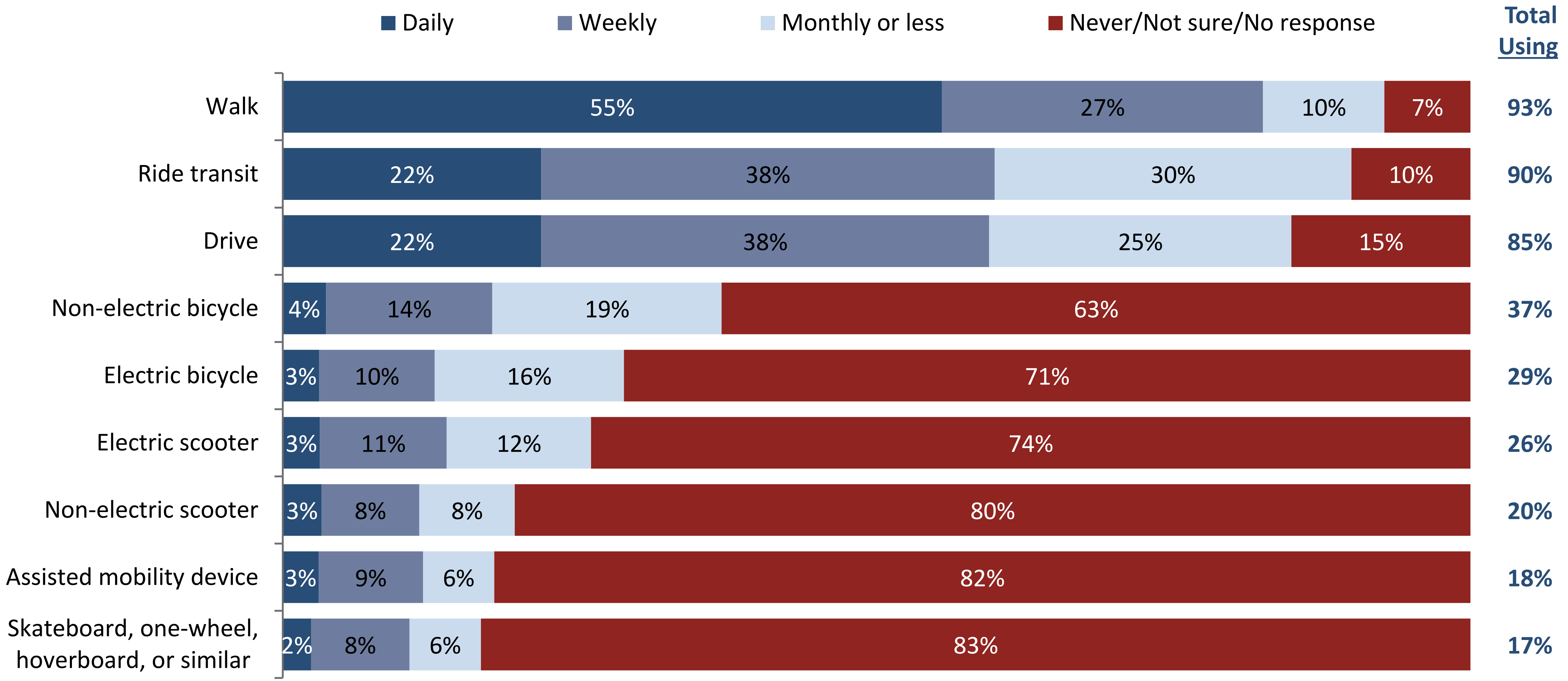
Key Findings

- While most residents walk, drive, and use transit to get around most frequently, just under half use active transportation devices on a regular basis, for a range of purposes. Residents in the downtown/SOMA area are the most likely to be using active transportation devices regularly.
- San Francisco residents feel most comfortable using Active Transportation Network facilities that are physically separated from cars and other vehicle traffic.
- Analysis of comfort levels across a range of facility types in the City's Active Transportation Network reveals that few residents are completely comfortable across all types of ATN facilities.
- Affordability and safe parking places are potential barriers to using the Active Transportation Network.
- Survey respondents in the Equity Priority Communities reported using active transportation devices less frequently, and felt less comfortable using ATN facilities.

Transportation Usage

Transportation Mode Frequency

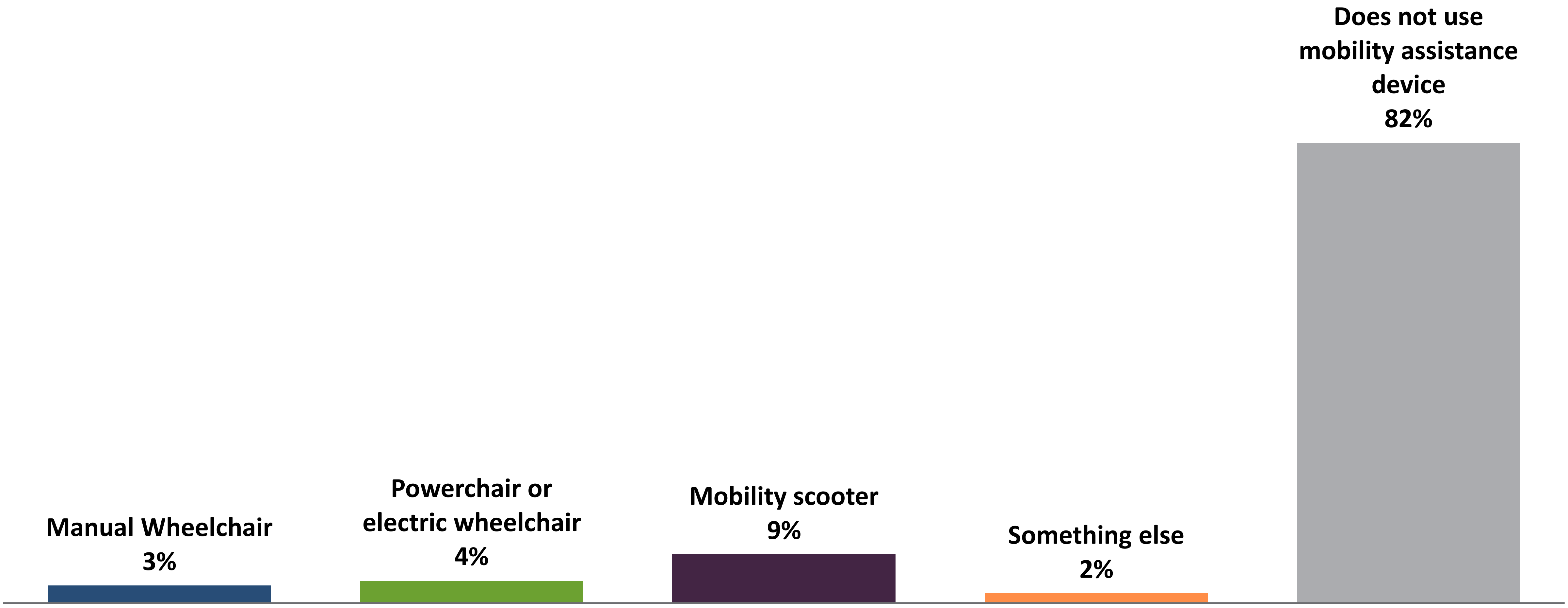
Nearly all San Franciscans walk, ride transit, and drive regularly. Non-electric bikes are the most used active transportation devices with 3-in-10 using at least monthly.



Q5-13. In general, how often do you get around San Francisco in each of the following ways?

Assisted Mobility Device Usage

Mobility scooters are the highest used assisted mobility device.



Q14. What type of mobility assistance devices do you typically use?

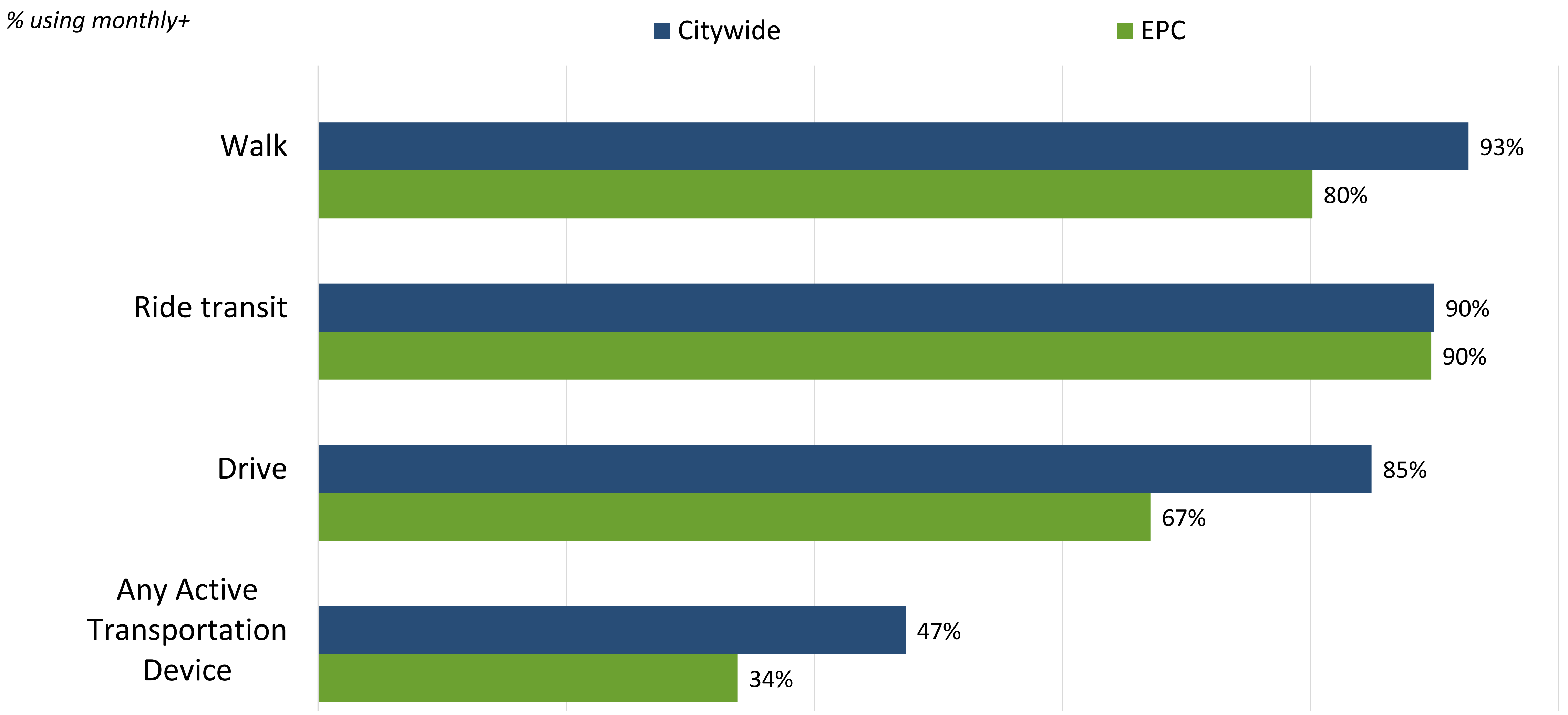
Active Transportation Device Usage

Approximately half of San Francisco residents use an active transportation device on a regular basis, with one in ten using them daily.

Daily: *Daily user of at least one active transportation device (bike, scooter, skateboard/one-wheel, or assisted mobility device)*
Weekly: *Weekly user of at least one active transportation device*
Monthly: *Monthly user of at least one active transportation device*
Never: *Never uses an active transportation device*

Transportation Device Usage

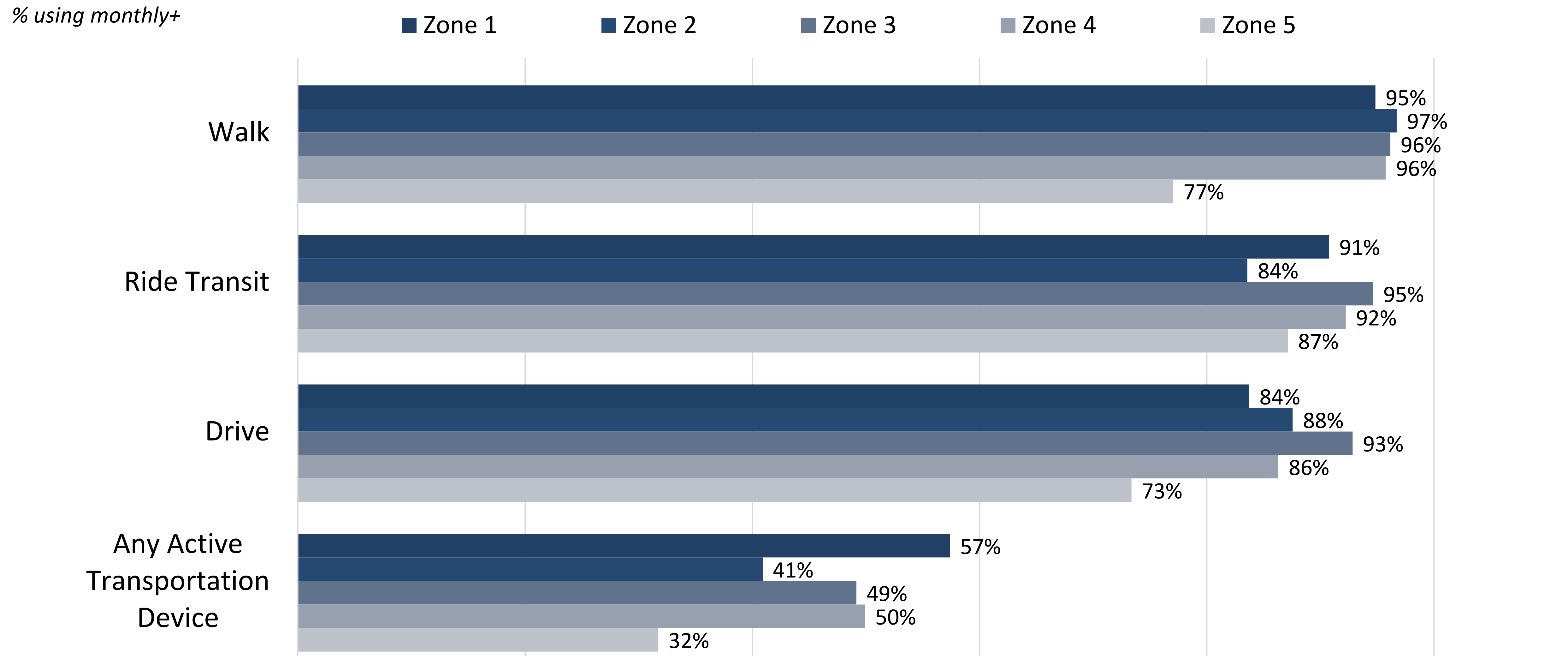
Those interviewed in the EPCs are less likely to use active transportation devices than San Franciscans in general.



Q5-13. In general, how often do you get around San Francisco in each of the following ways?

Transportation Device Usage by Zone

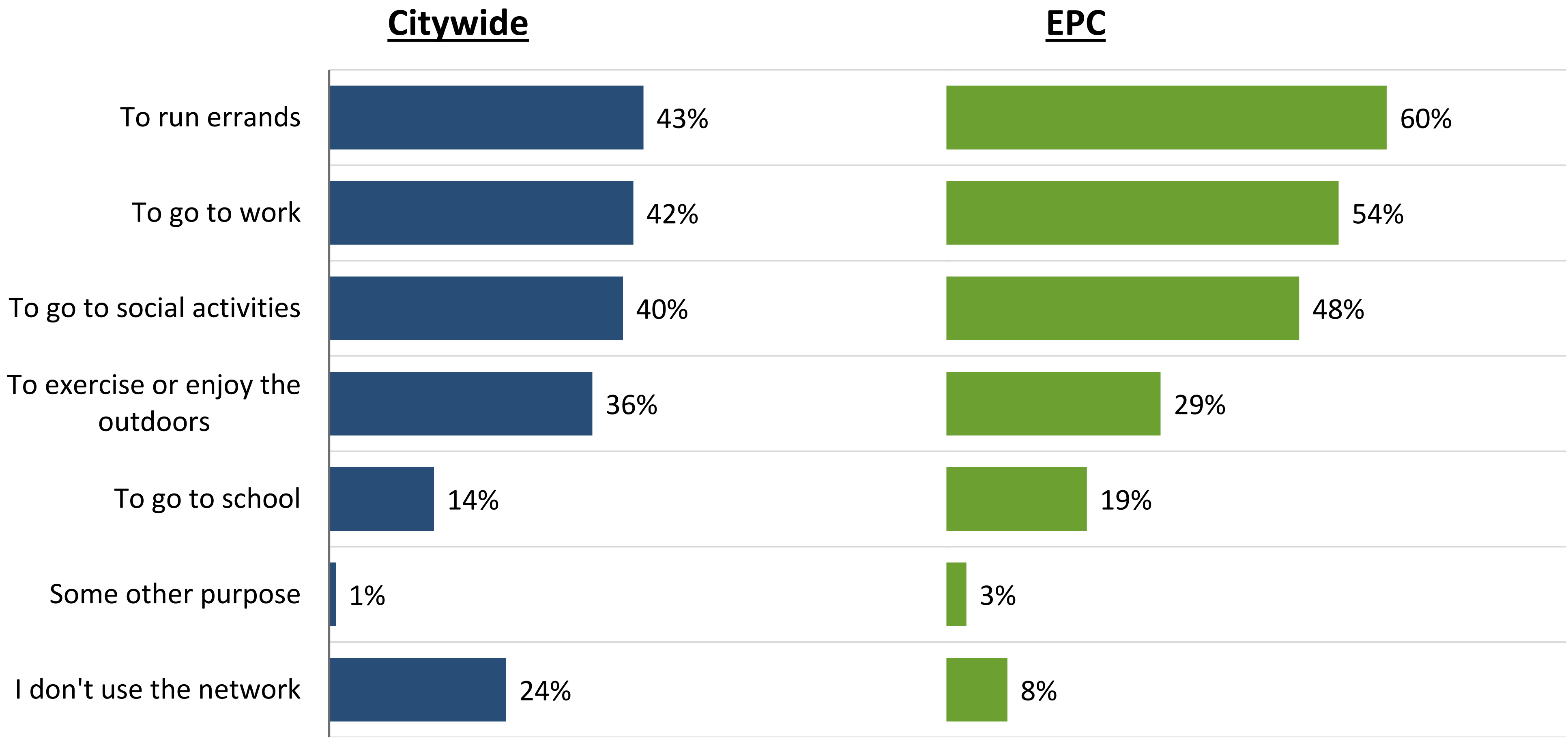
Active transportation device usage is highest in the northeast part of the city, and lowest in the southeast.



Q5-13. In general, how often do you get around San Francisco in each of the following ways?

Active Transportation Network Uses

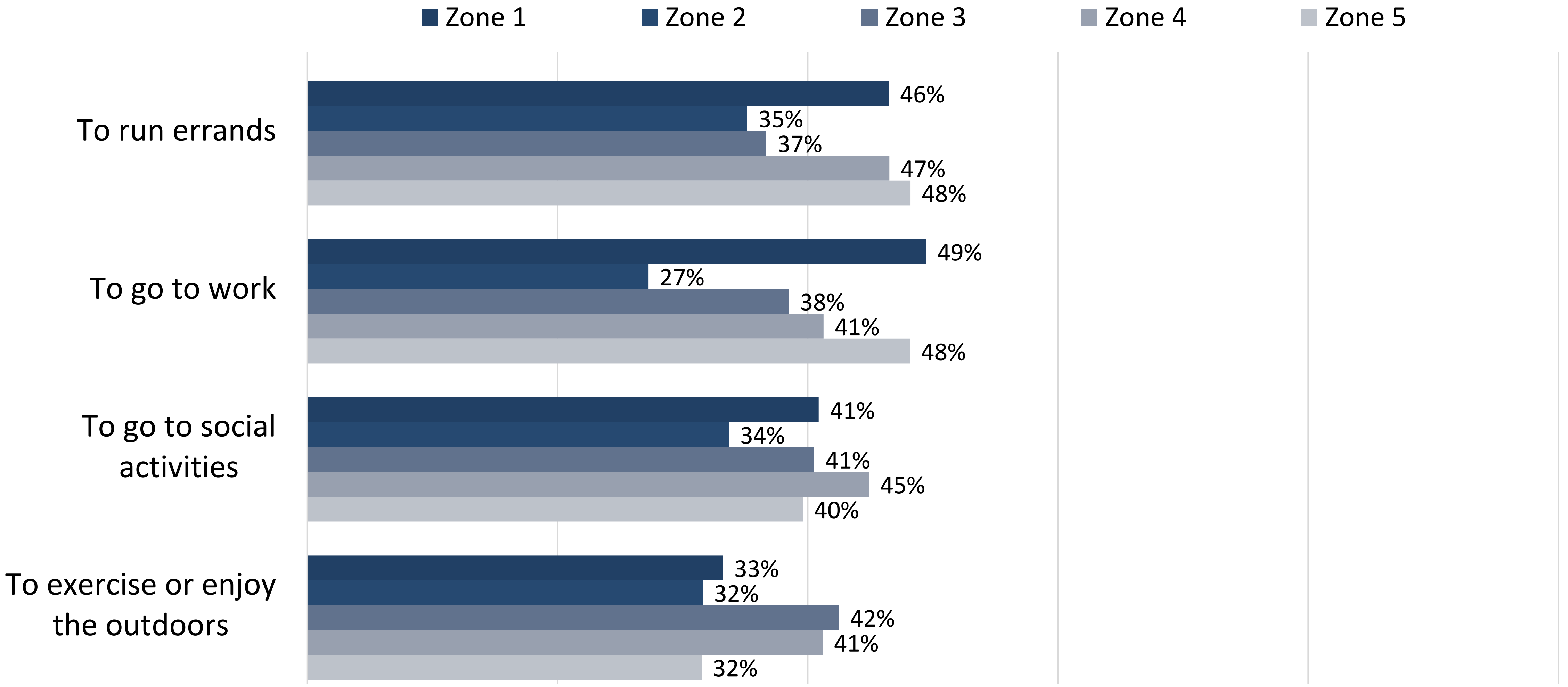
Those interviewed in the EPCs are more likely to say they use the Active Transportation Network for functional trips, like errands and commutes.



Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Active Transportation Network Uses by Zone

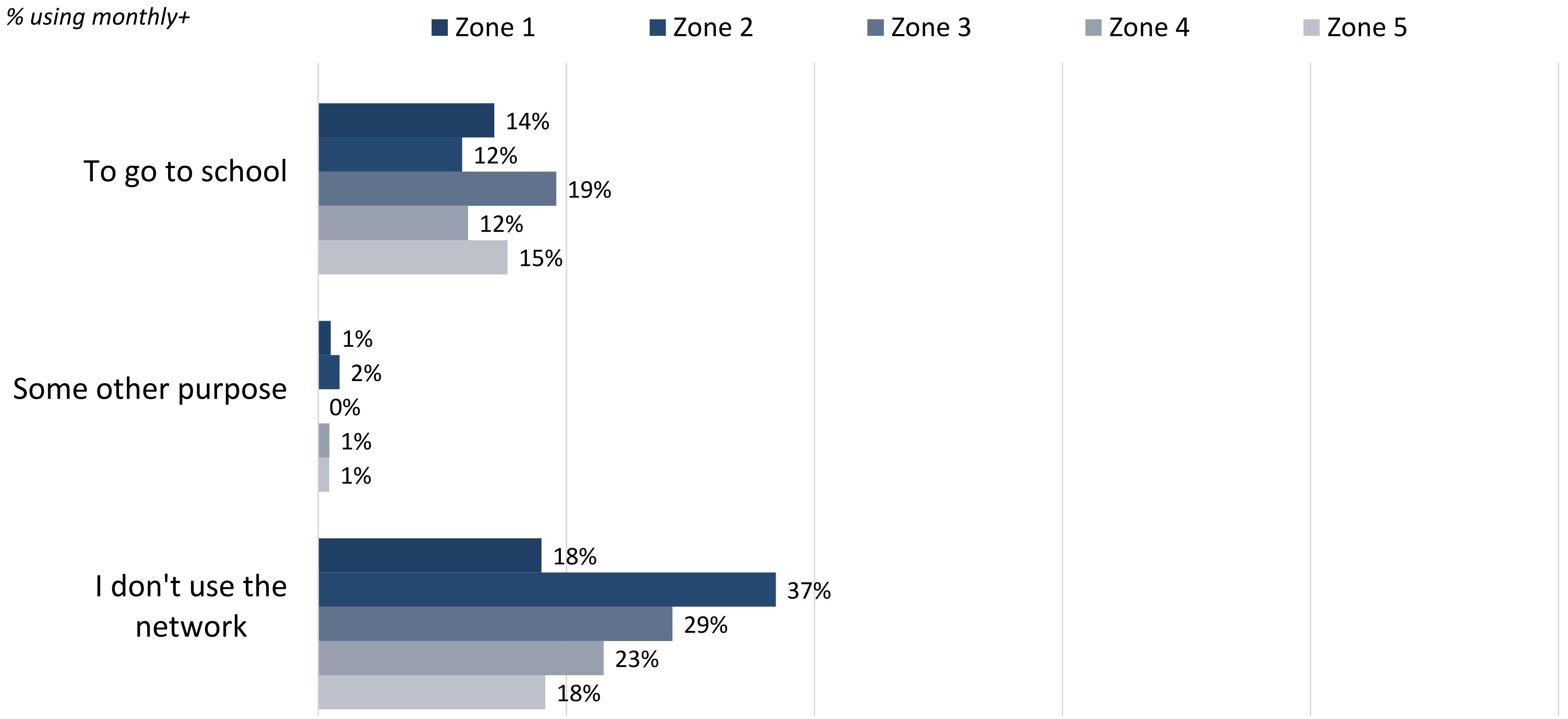
Those in the downtown & SOMA area are more likely to say they use the Network for running errands or commuting, while central or western region residents say they use it more for social and exercise purposes.



Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Active Transportation Network Uses by Zone

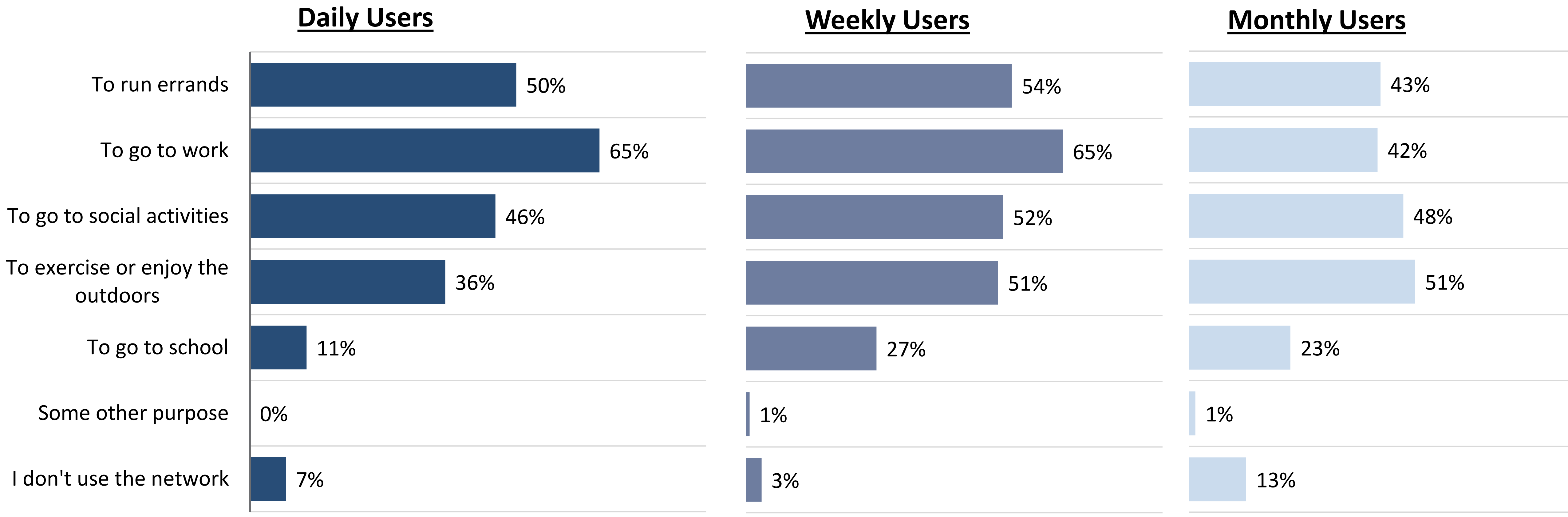
Over a third of residents in the Marina and Richmond area do not report using the Active Transportation Network.



Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Active Transportation Network Uses by Frequency

Those who use active transportation devices weekly or more are most likely to be using the network to travel to work, while those who use the devices only occasionally are most likely to use the network for exercise or recreation.



Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

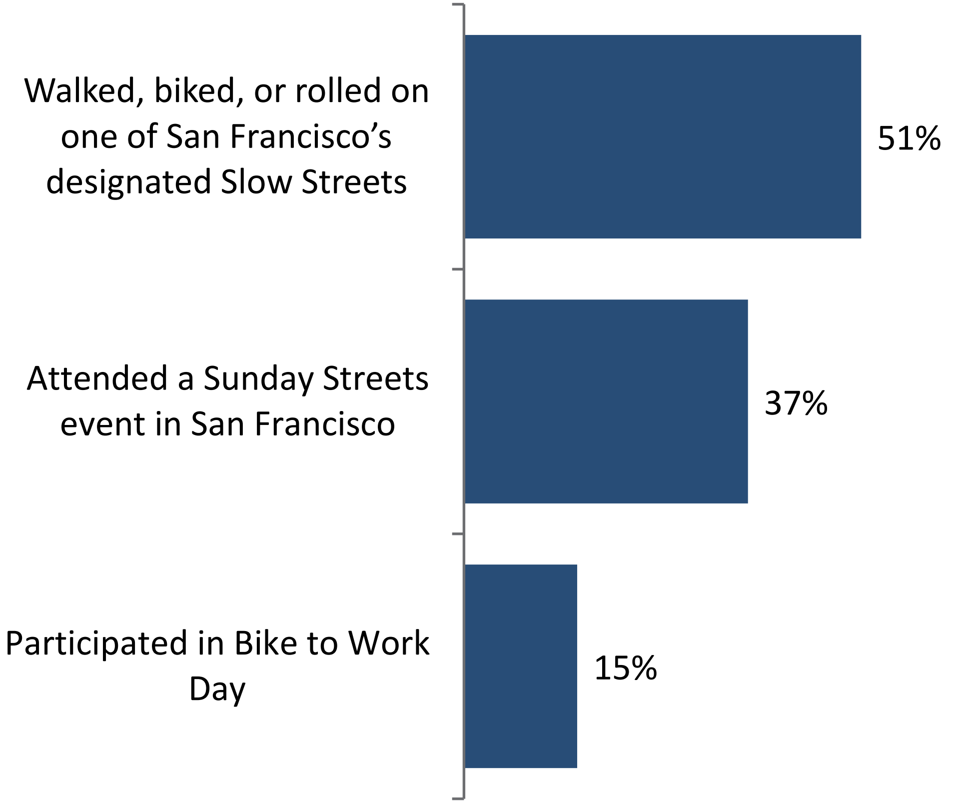
Active Transportation Program Participation

EMC research

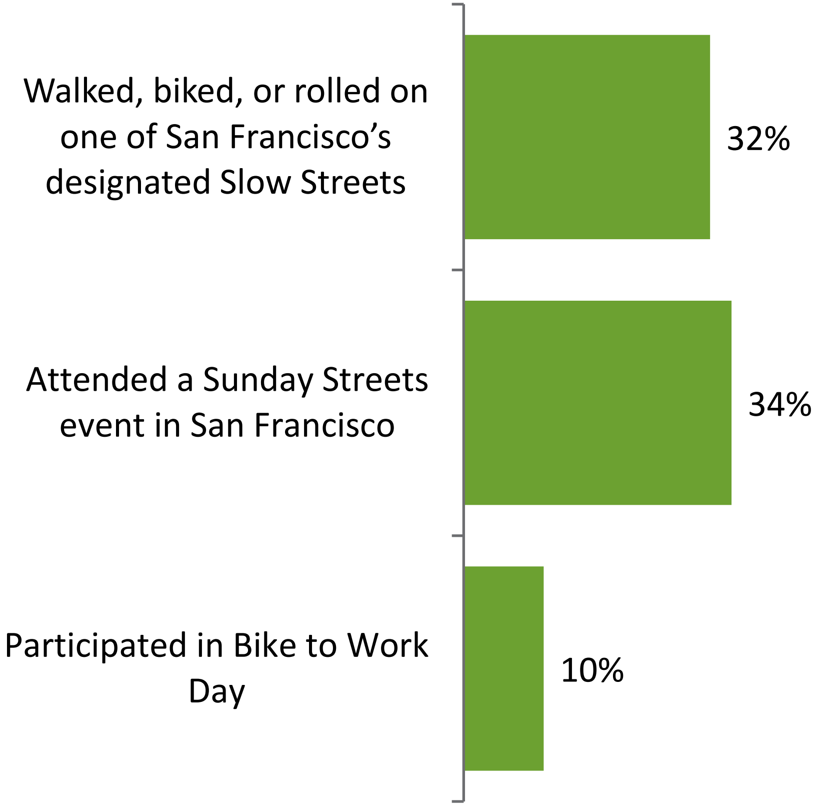
A majority of residents have used a Slow Street, but just one-third of those who participated in the EPC interviews did the same.

Which of the following have you done?
(multiple responses accepted)

Citywide



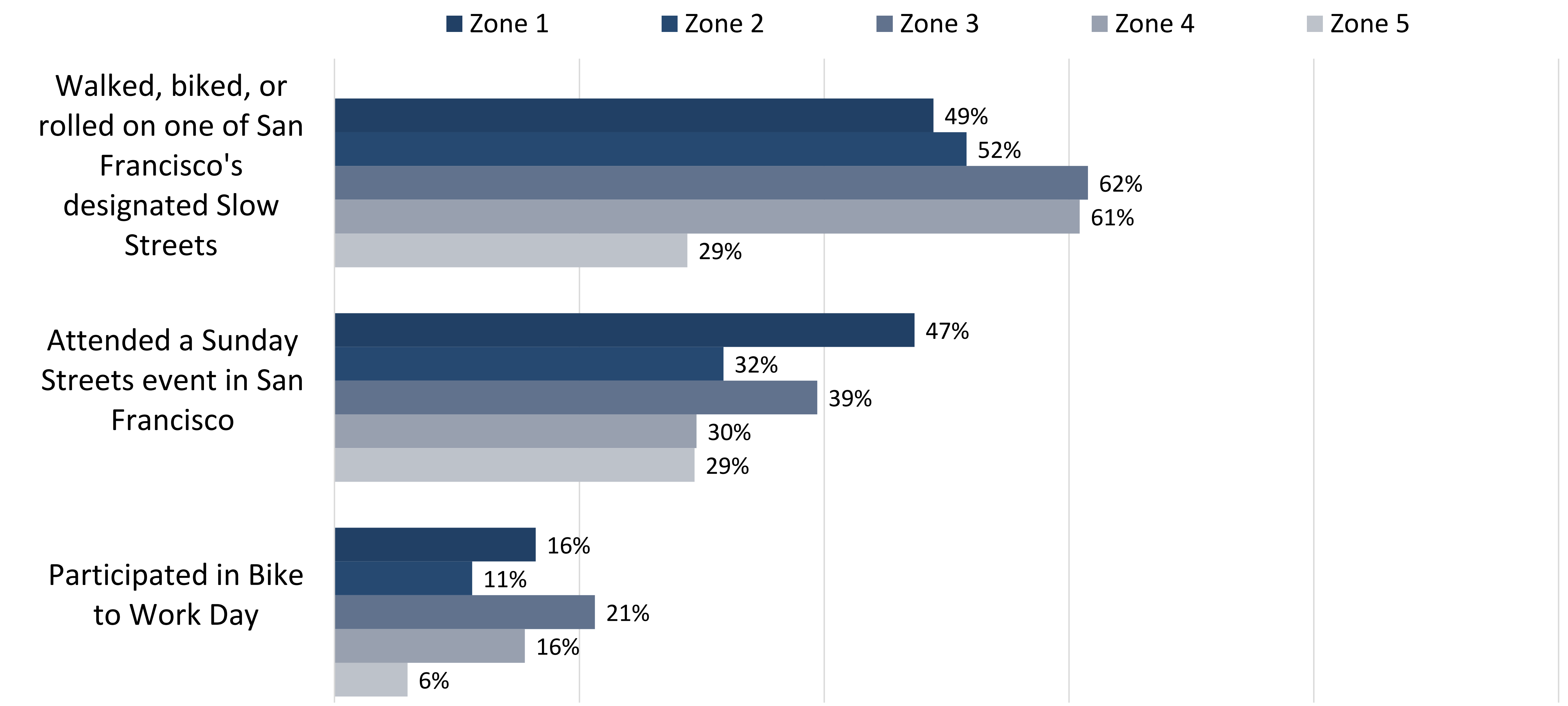
EPC



Q32.

Active Transportation Program Participation by Zone

There is some variation in participation in Active Transportation programs by zone.



Q32.

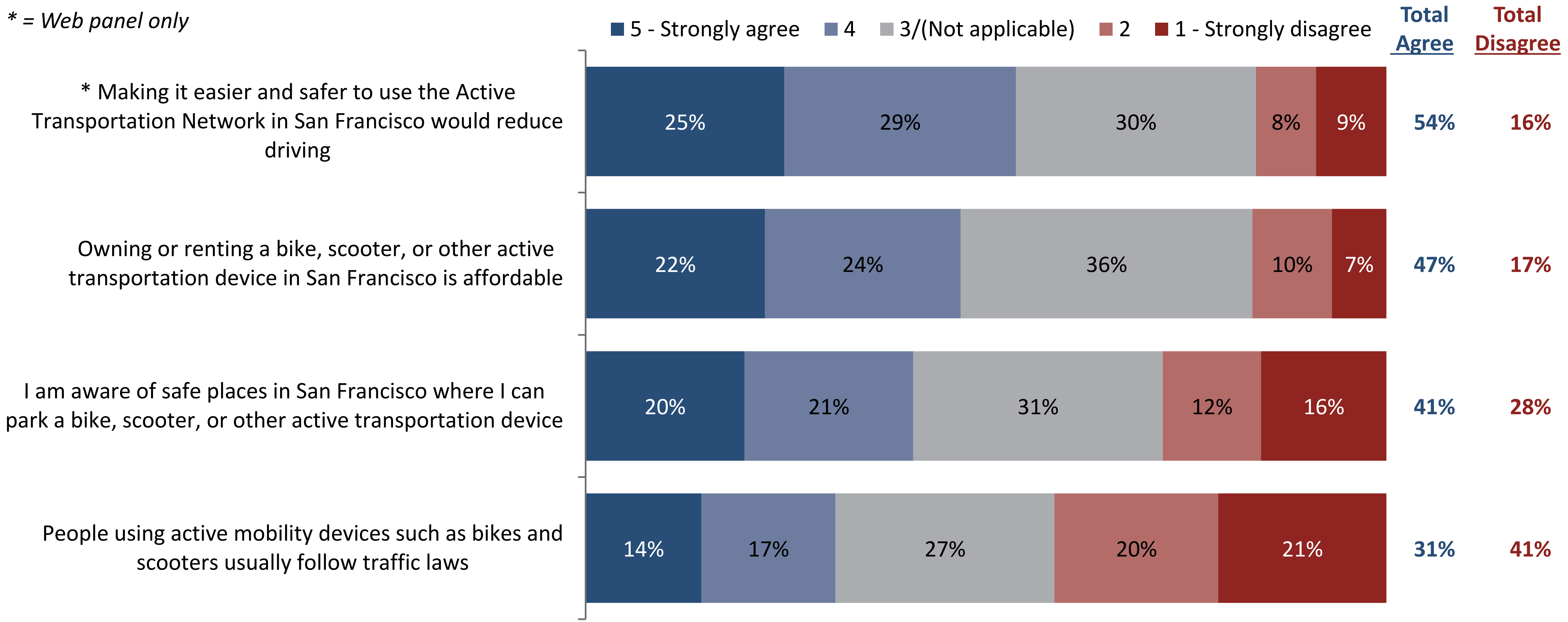
Active Transportation Attitudes

Active Transportation Perceptions

EMC research

A majority of San Franciscans agree that making it easier and safer to use the Active Transportation Network would reduce driving.

** = Web panel only*

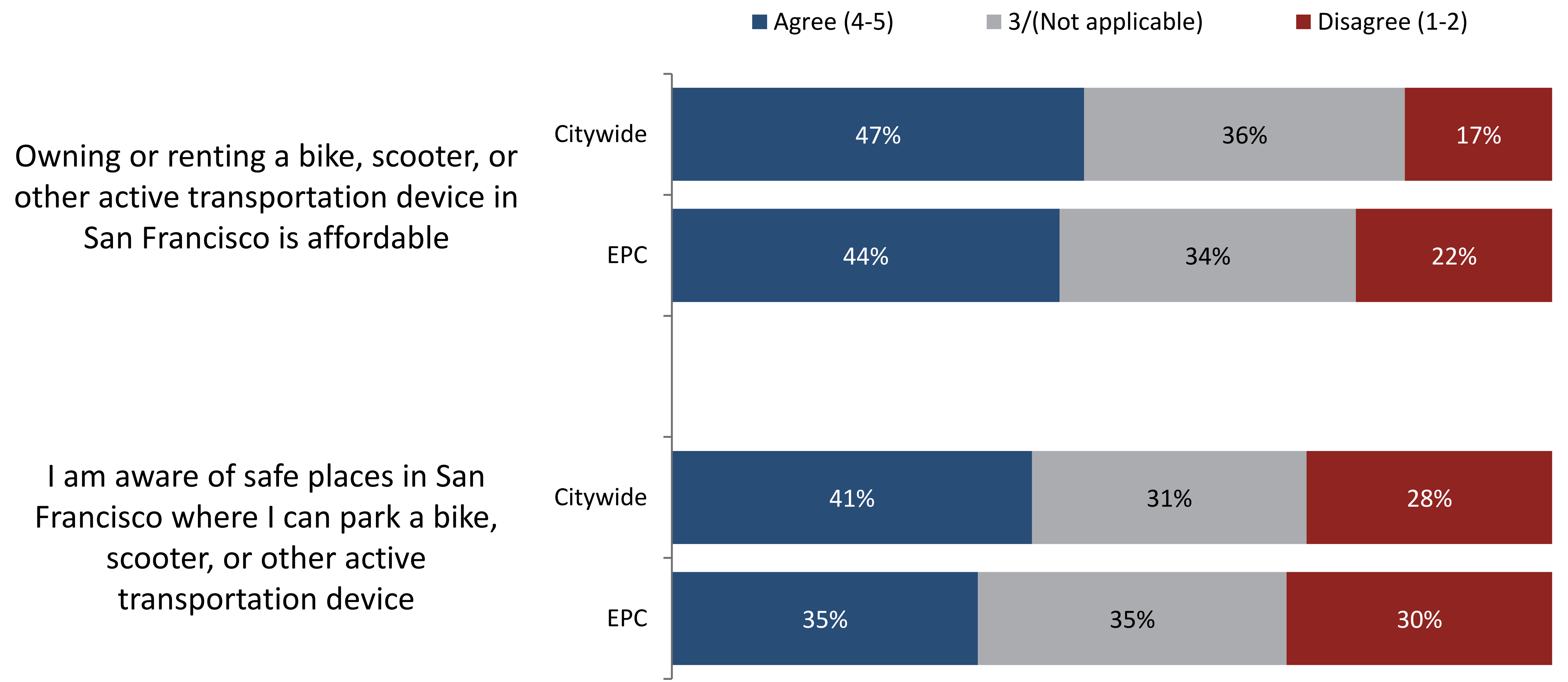


Q16-19. Regardless of how you personally get around, please rate your level of agreement or disagreement with each of the following statements:

Attitudes about Cost and Parking Access

EMC research

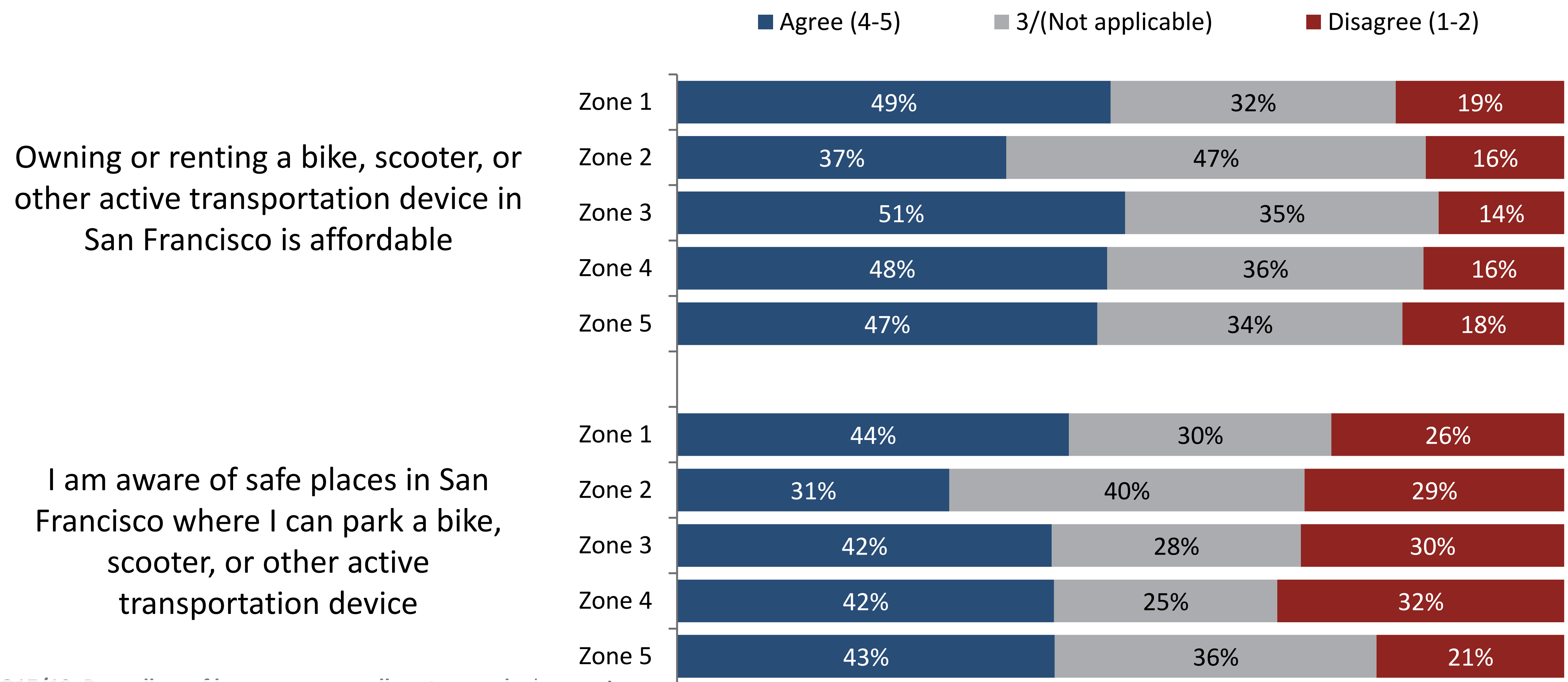
EPC survey respondents report being less aware of safe places to store their active transportation devices.



Q17/19. Regardless of how you personally get around, please rate your level of agreement or disagreement with each of the following statements: 1-5 scale

Attitudes about Cost and Parking Access by Zone

Marina and Richmond residents are least likely to agree active transportation devices are affordable or have safe places to park.

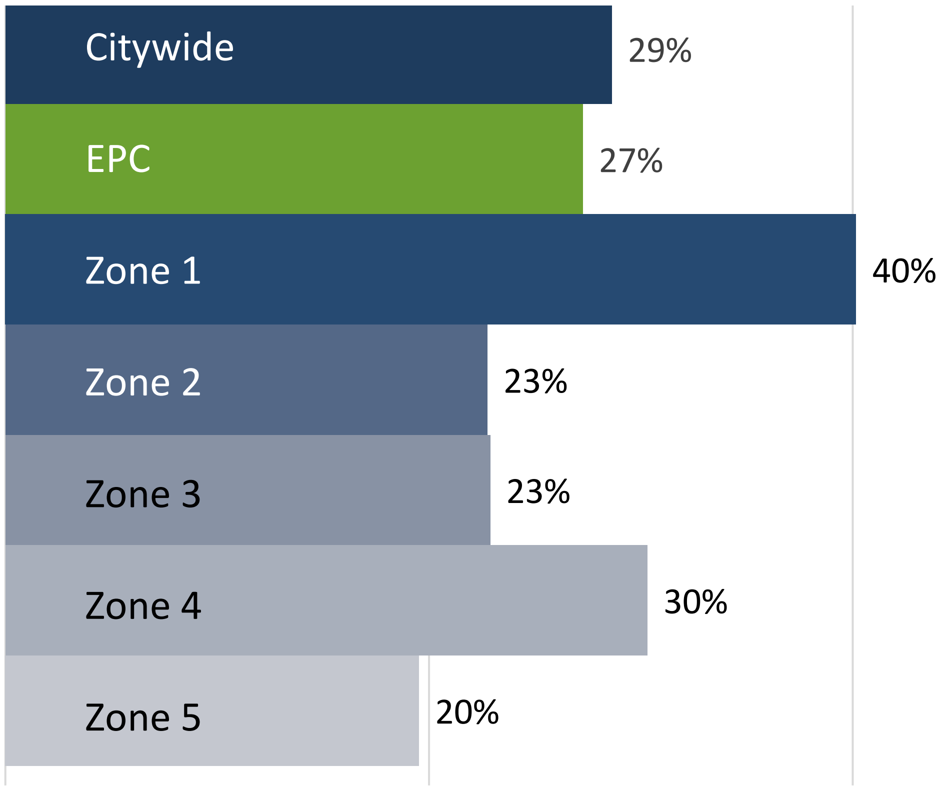


Q17/19. Regardless of how you personally get around, please rate your level of agreement or disagreement with each of the following statements: 1-5 scale.

Theft Experience

Three in ten residents have had part or all of a bike or scooter stolen in San Francisco; those in the downtown/SOMA area were most likely to report that experience.

% who have had all or part of their bike or scooter stolen in San Francisco

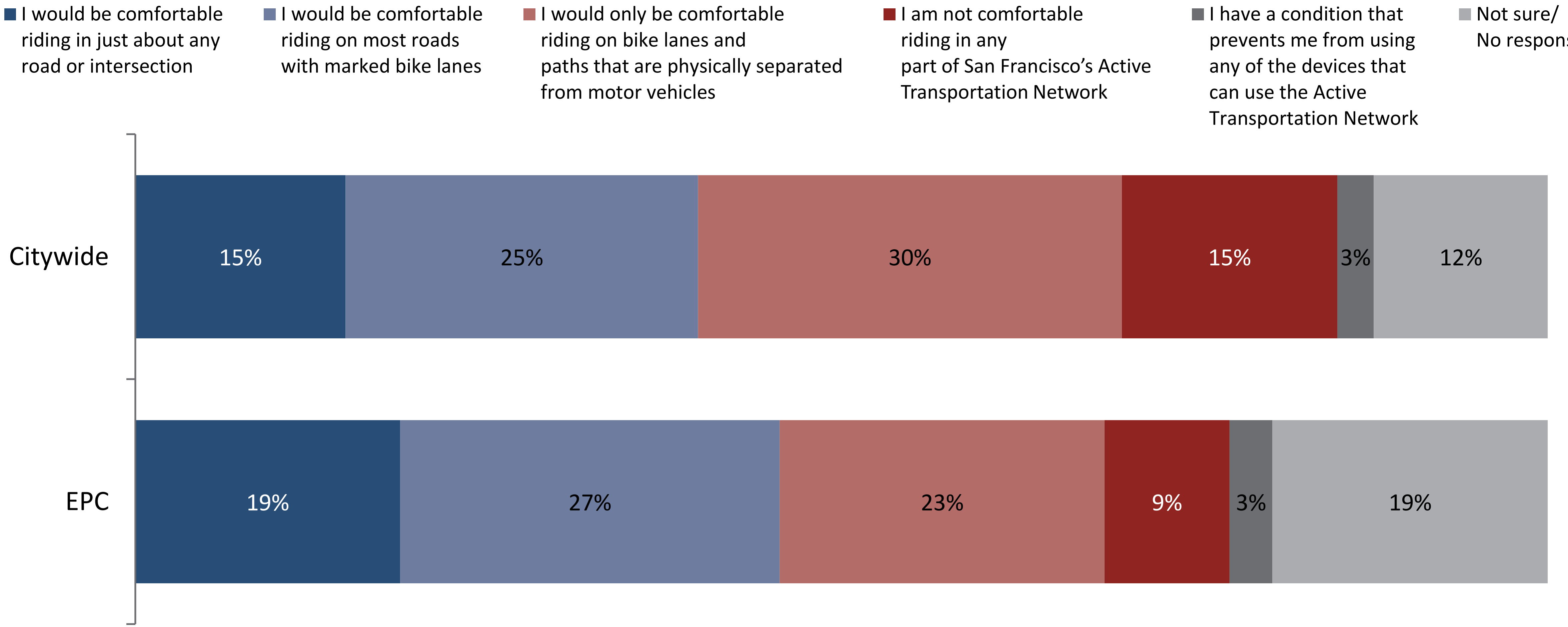


Q33. Have you ever had your bike or scooter stolen in San Francisco?

Comfort Levels in Active Transportation Facilities

Stated Comfort Level

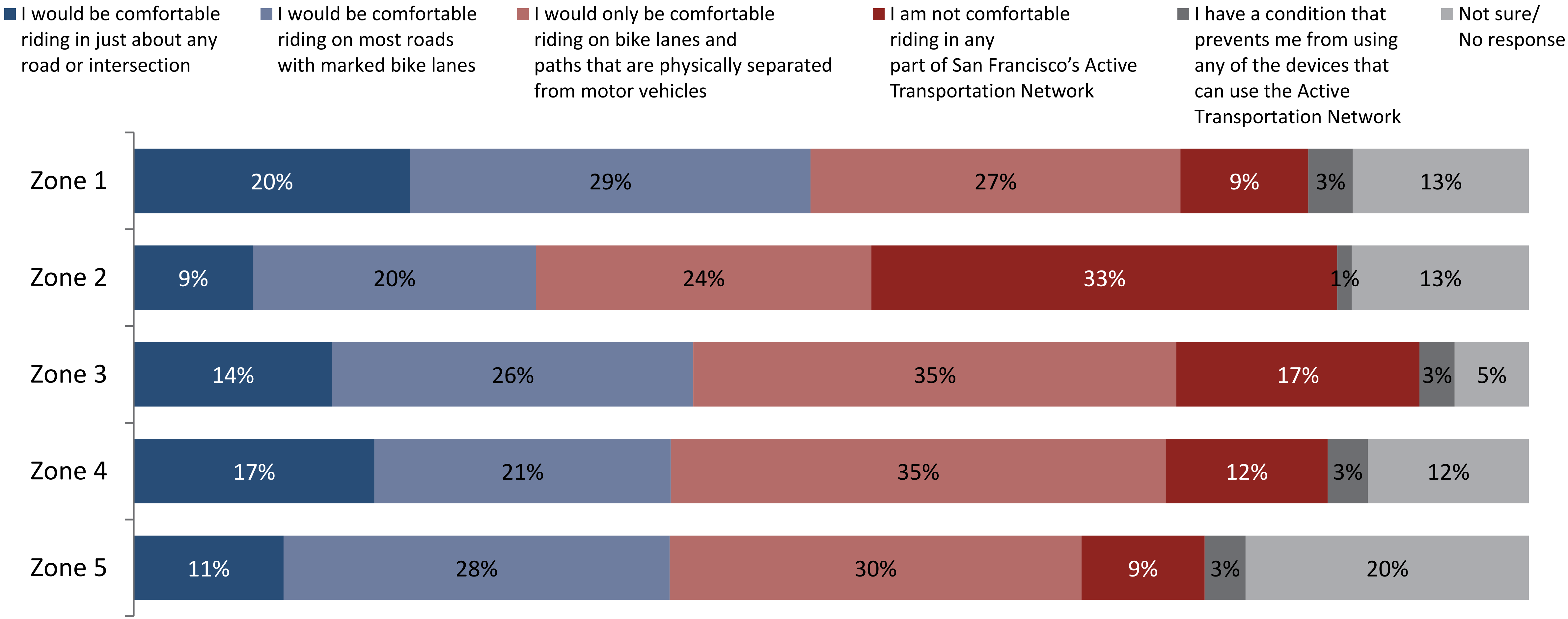
Fifteen percent of residents citywide and 19% of those interviewed in EPCs say they feel comfortable across all types of ATN facilities.



Q20. Which of the following statements best describes your comfort level using the Active Transportation Network, regardless of how frequently you use it?

Stated Comfort Level by Zone

Those in the Marina and the Richmond report feeling significantly less comfortable using ATN facilities than those in other areas.



Q20. Which of the following statements best describes your comfort level using the Active Transportation Network, regardless of how frequently you use it?

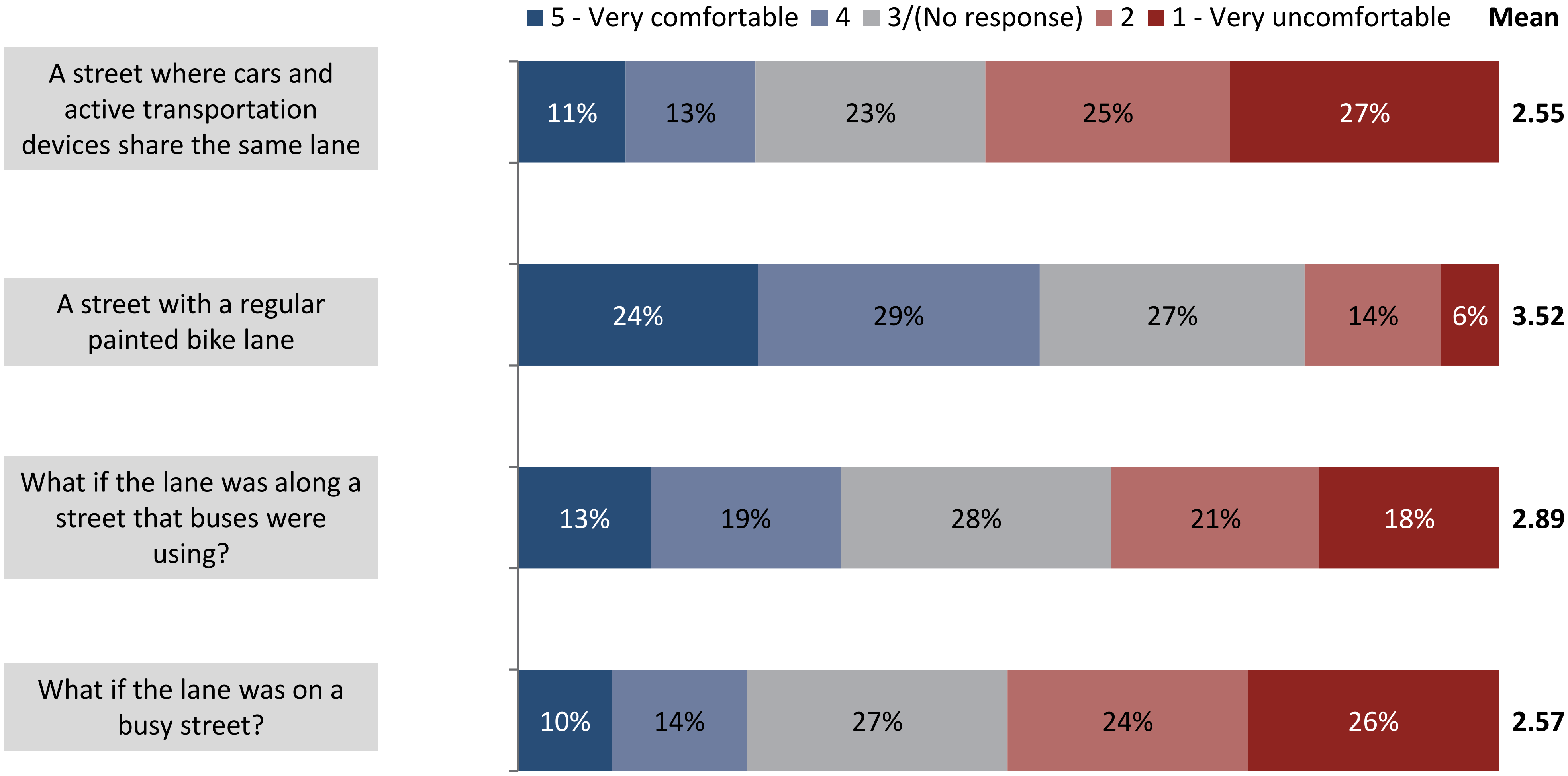
Stated Comfort in Shared and Painted Bike Lane Facilities

EMC research

Few feel very comfortable in shared use facilities; adding a painted bike lane increases comfort levels significantly, but that comfort is reduced in busier environments.







Q21-29. There are a number of different types of facilities in San Francisco's Active Transportation Network.
Please look at each of the following pictures and rate how comfortable you think you would be using each.

Stated Comfort in Separated Facilities

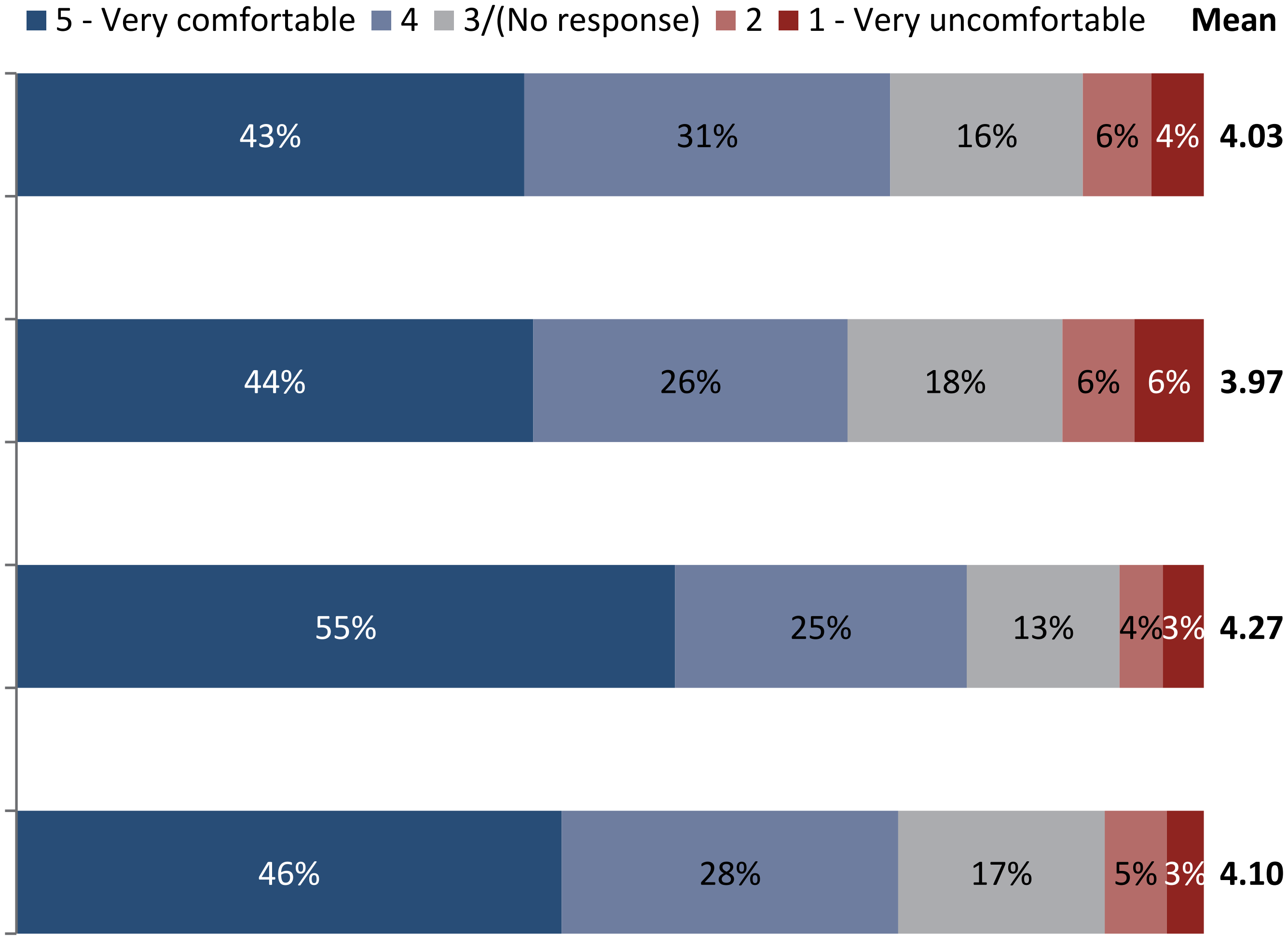
Adding a physical separator between vehicles and active transportation users makes a significant difference in stated comfort levels.

A street with a bike lane separated with flexible posts

What if there was parking between the lane and vehicle traffic?

What if there was a more rigid barrier between the bike lane and vehicle traffic?

What if it was a two-way bike lane with a rigid barrier?



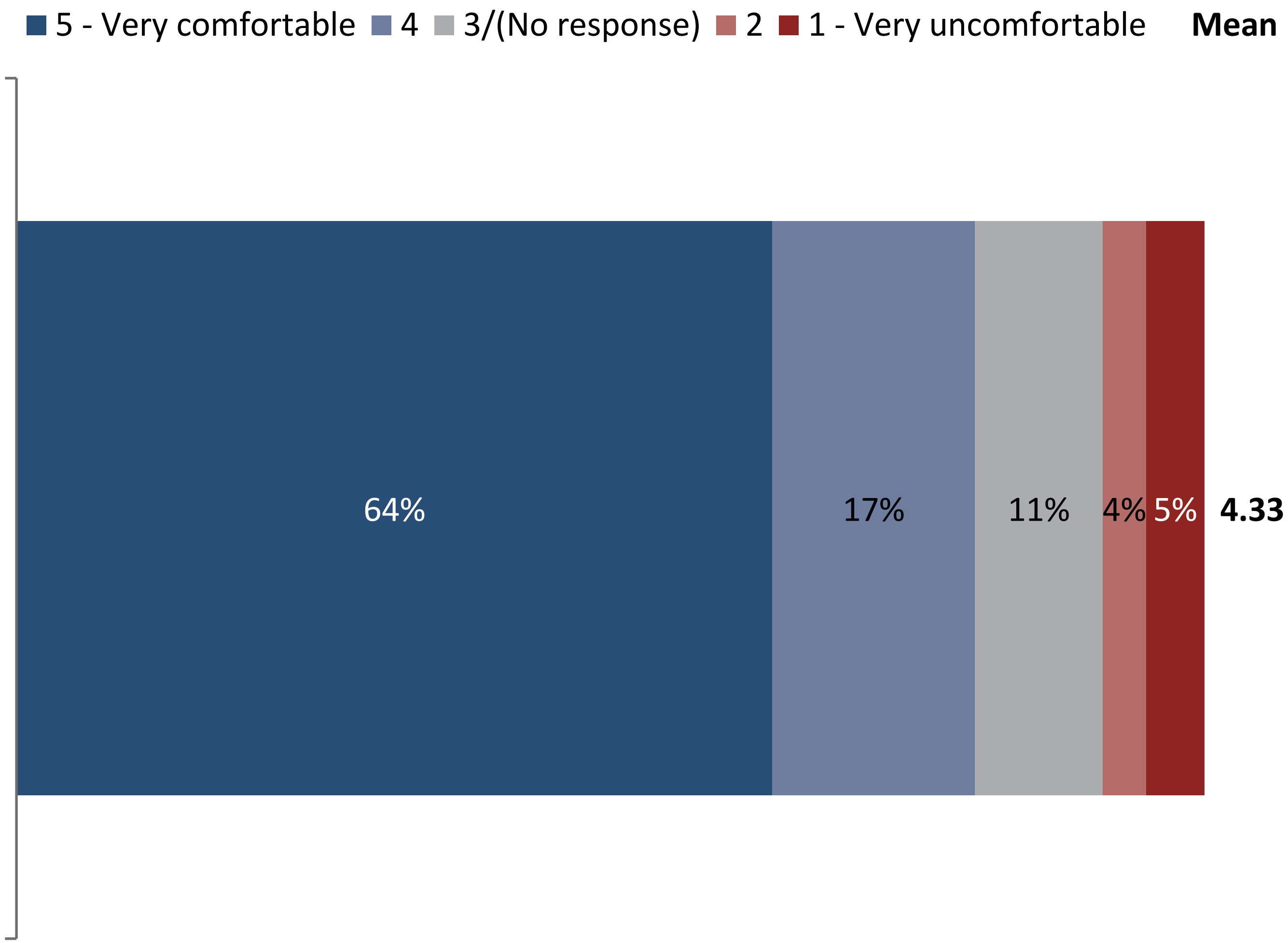
Q21-29. There are a number of different types of facilities in San Francisco's Active Transportation Network. Please look at each of the following pictures and rate how comfortable you think you would be using each.

Stated Comfort in Dedicated Facilities

EMC research

Residents feel most comfortable using active transportation facilities without any access for cars.

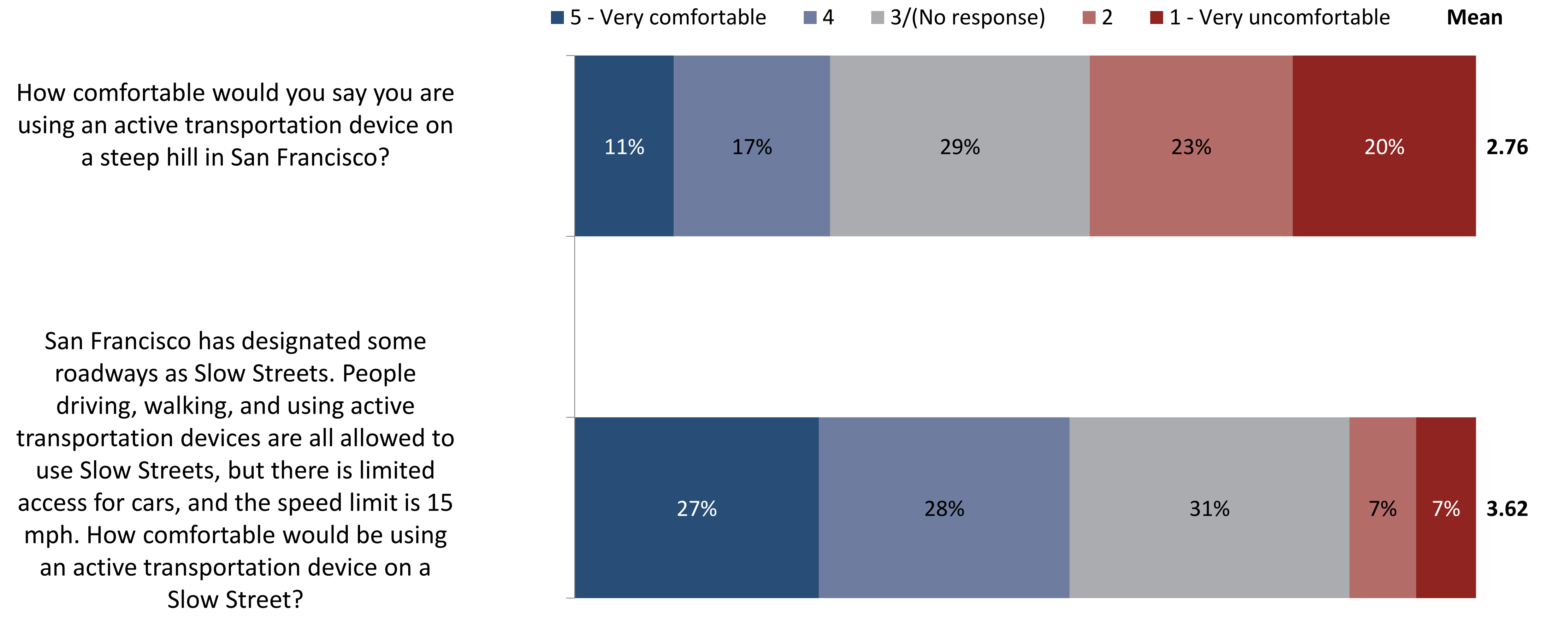
A street completely closed off to cars.



Q21-29. There are a number of different types of facilities in San Francisco's Active Transportation Network.
Please look at each of the following pictures and rate how comfortable you think you would be using each.

Stated Comfort in Other Environments

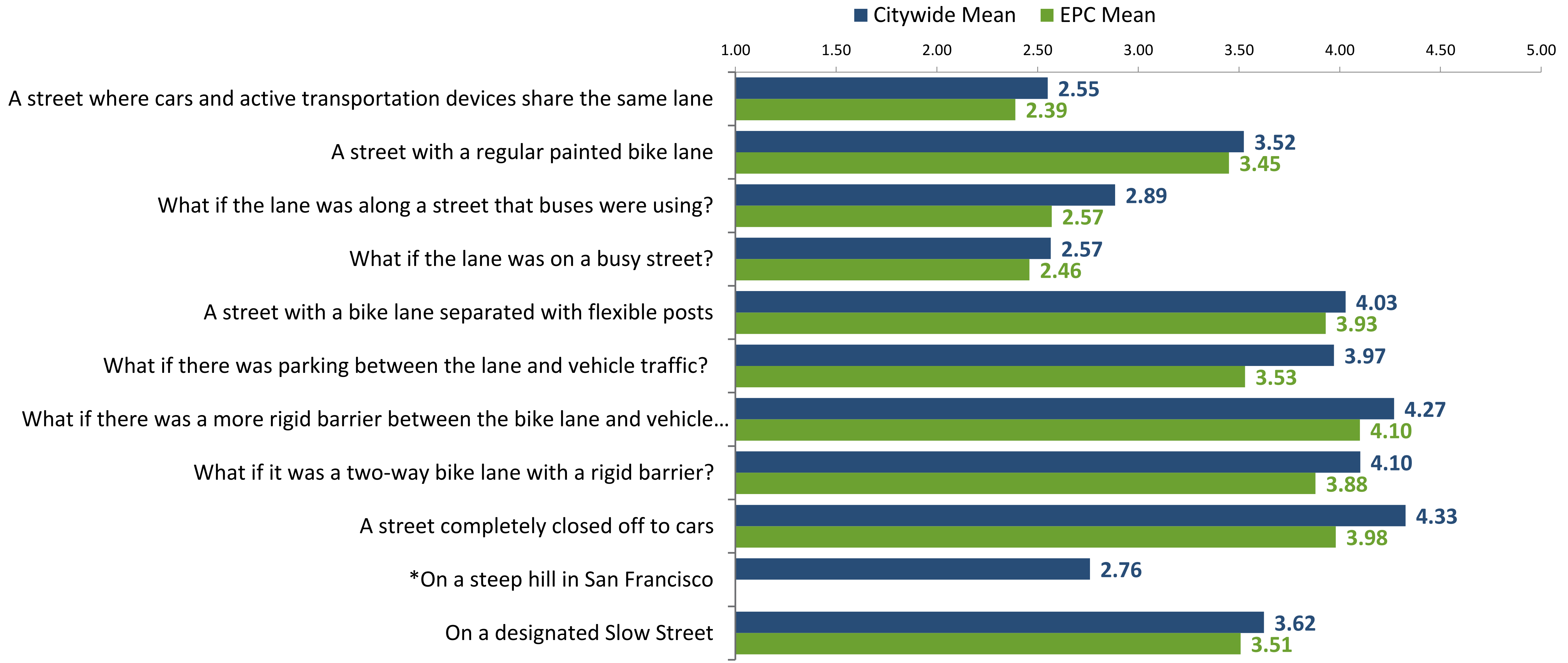
Many are uncomfortable using active transportation devices on steep hills.



Q30/31.

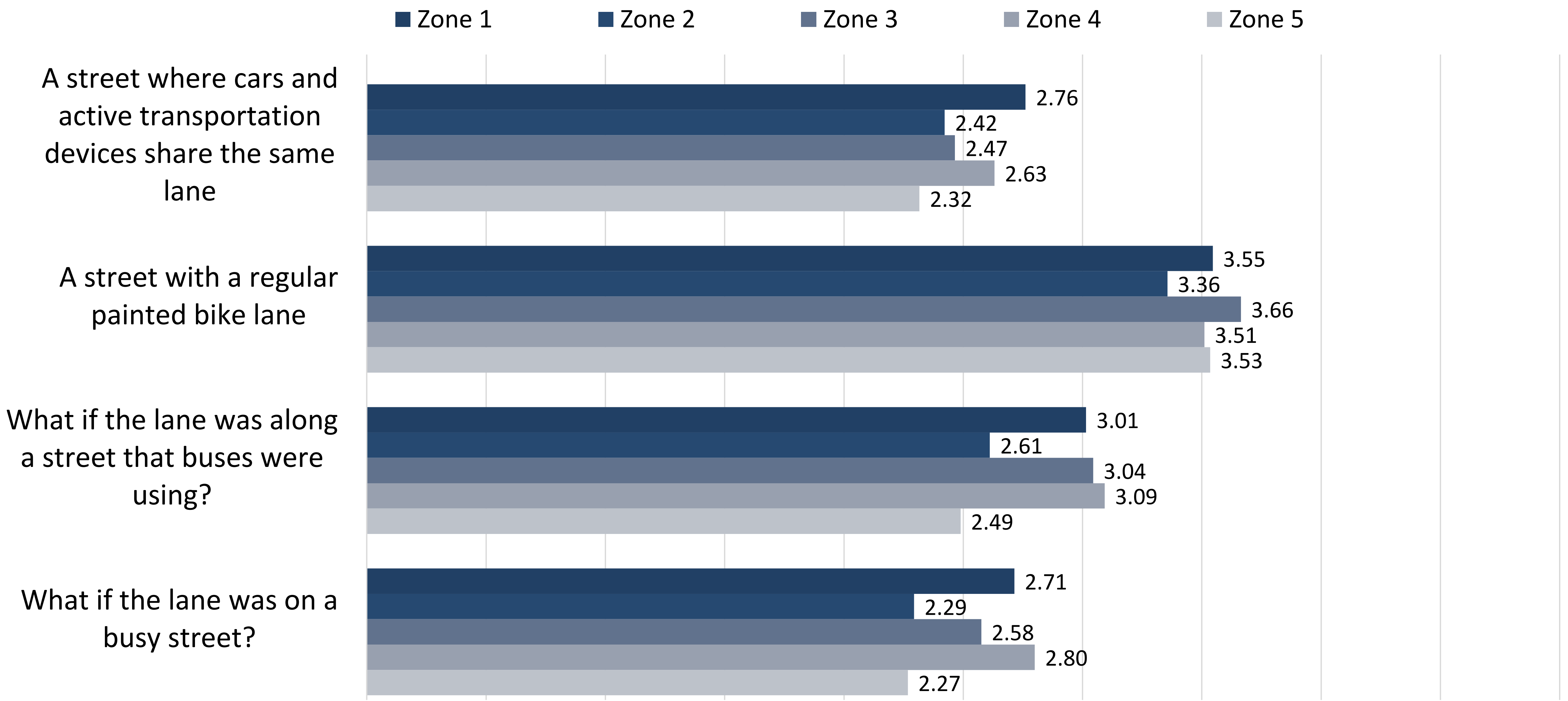
Comfort In Network Facilities: Citywide vs. EPC Respondents

EPC respondents were slightly less comfortable than citywide residents in every type of ATN facility tested, but thresholds for changing comfort levels follow similar patterns.

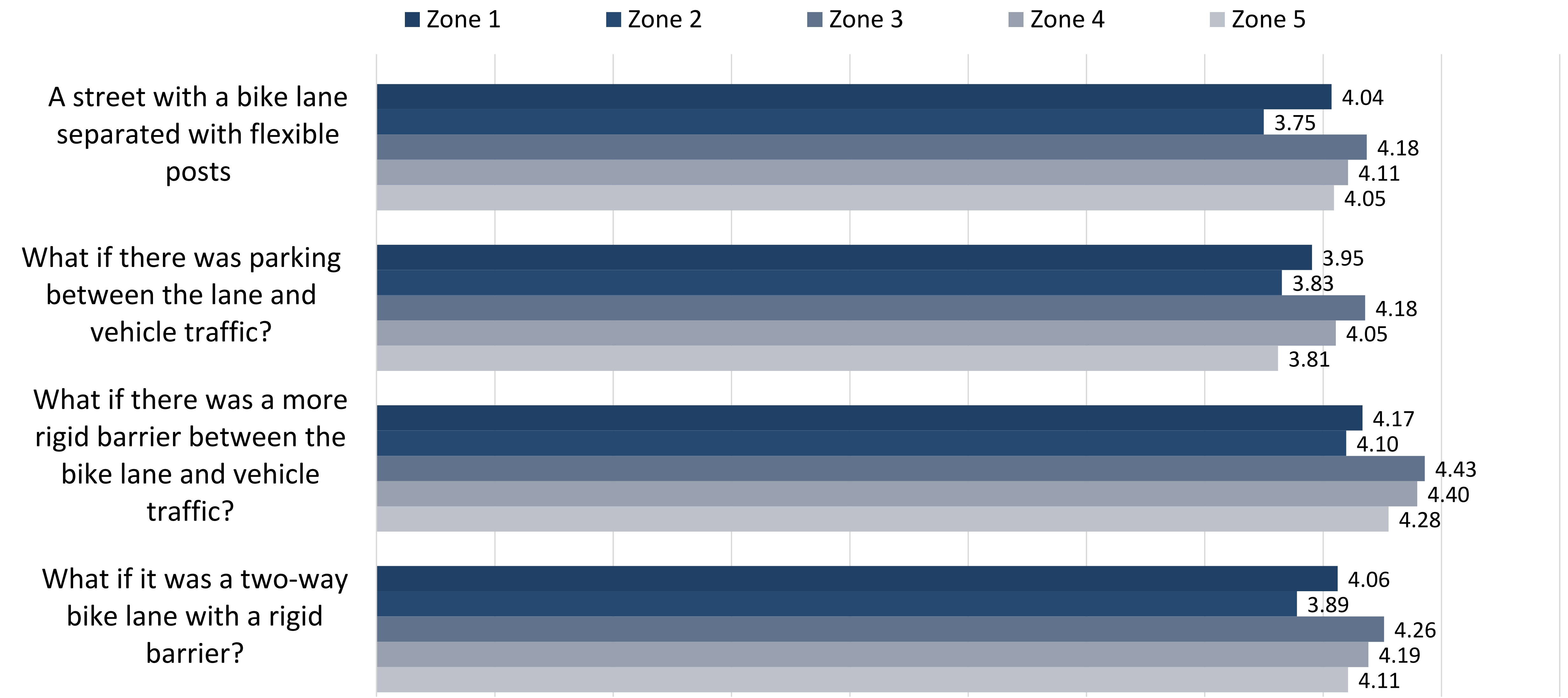


**asked only on online web panel*

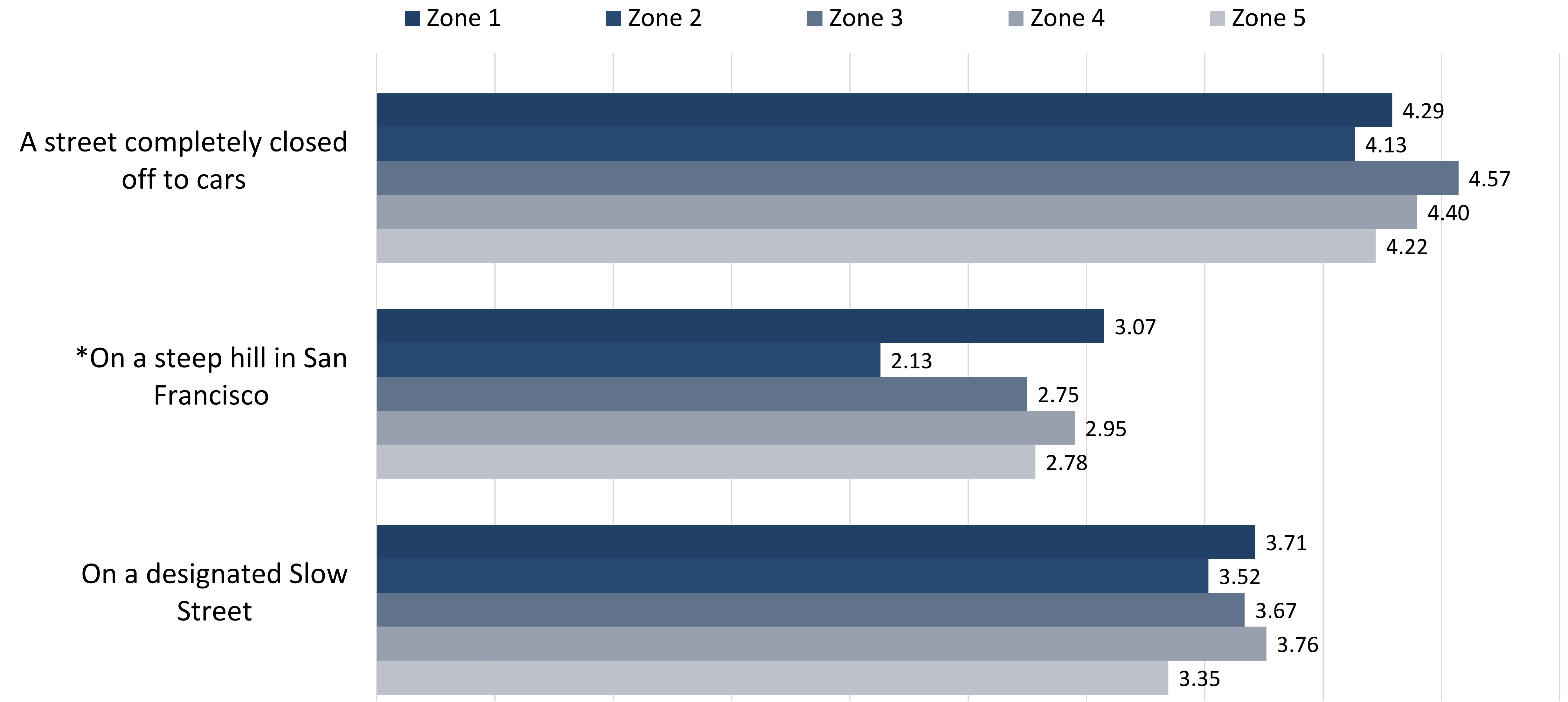
Comfort In Network Facilities by Zone



Comfort In Network Facilities by Zone



Comfort In Network Facilities by Zone



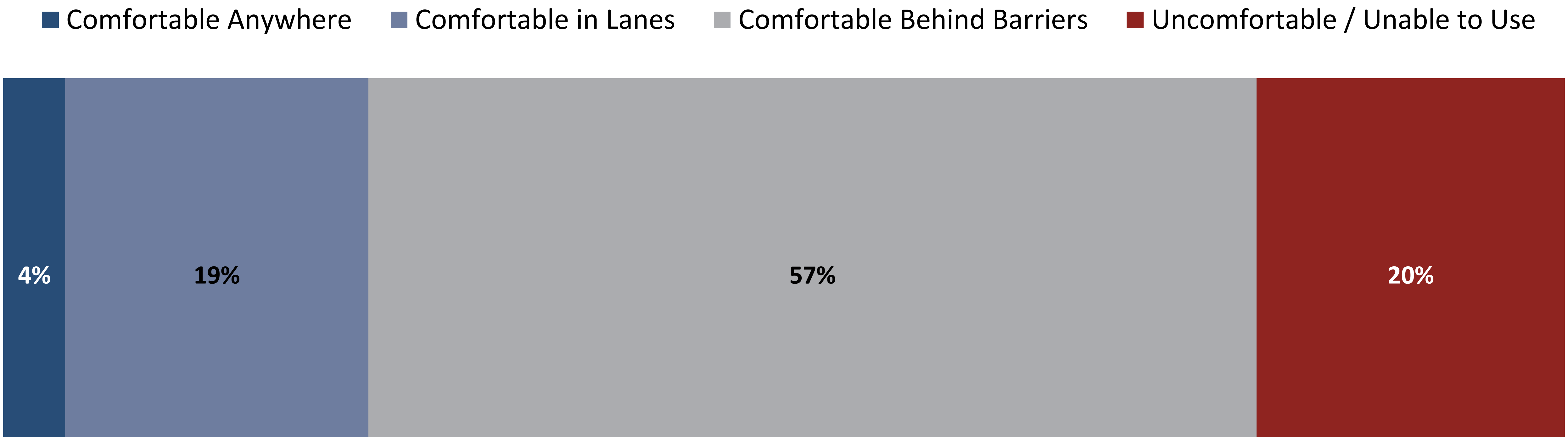
*asked only on online web panel

Active Transportation Network Comfort Index (ATNCI)

Active Transportation Network Comfort Index (ATNCI)

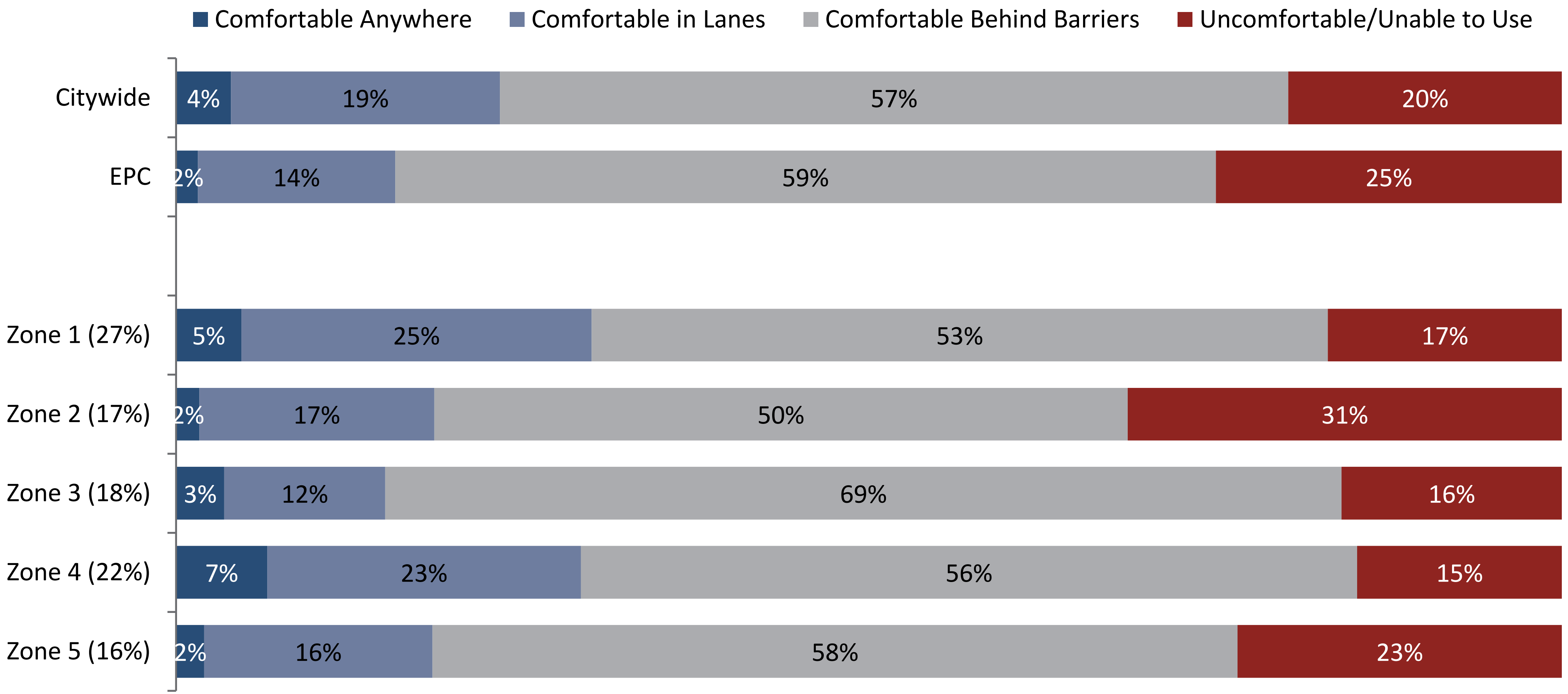
EMC research

Comfortable anywhere: *Very comfortable on streets without lanes*
Comfortable in lanes: *Very comfortable as long as there are striped lanes*
Comfortable behind barriers: *Only comfortable with a physical barrier*
Uncomfortable/Unable to use: *Not comfortable in any environment, or unable to use ATN*



ATNCI by Geography

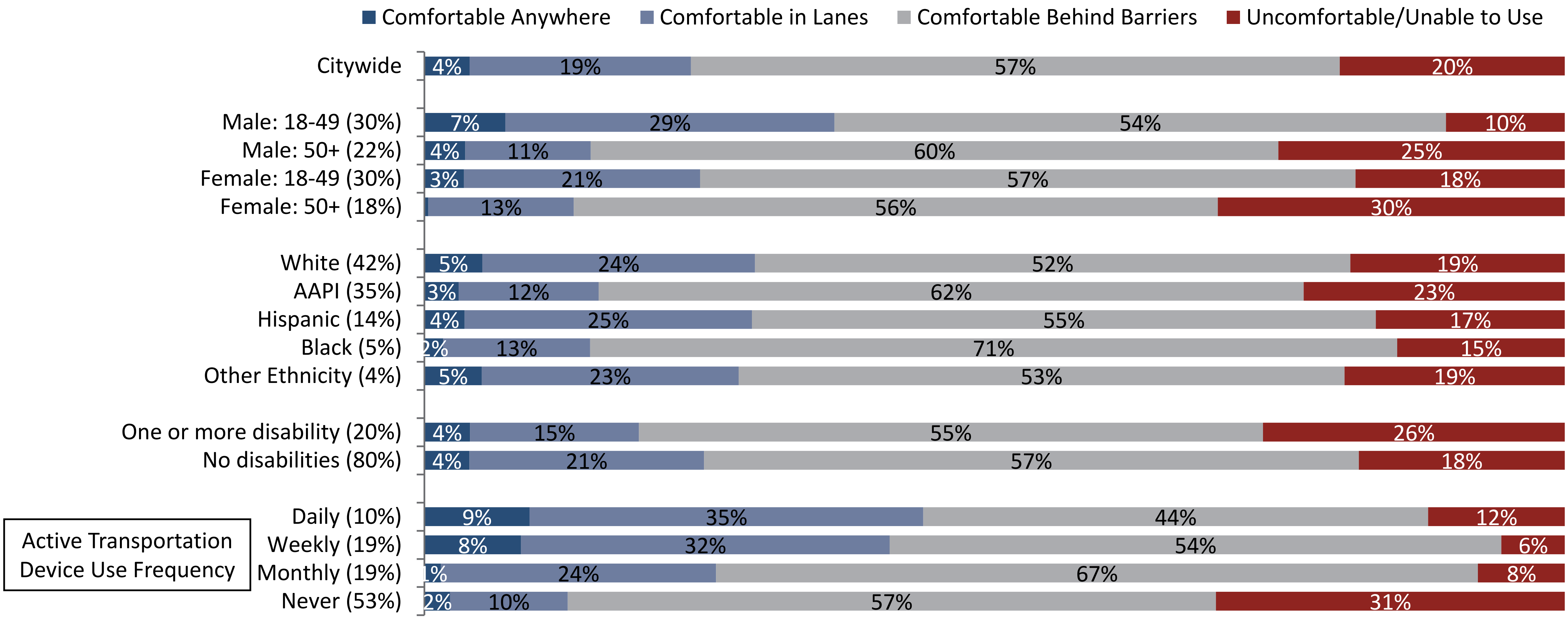
Northwest and Southeast residents are more likely to be uncomfortable or unable to use the ATN, as were respondents in the EPC interviews.



ATNCI by Subgroups

EMC research

Younger men are the most comfortable in shared facilities with and without striped lanes, along with more frequent users of active transportation devices.

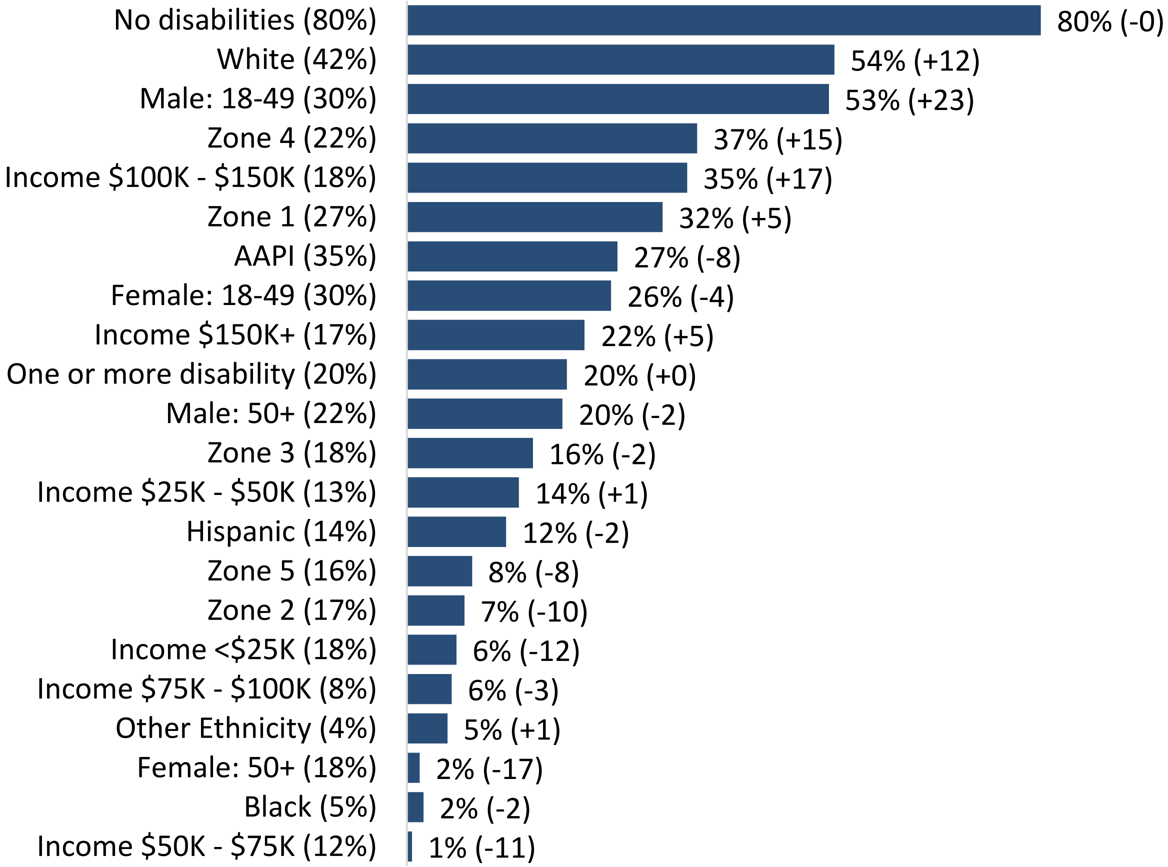


Top ATNCI Demos

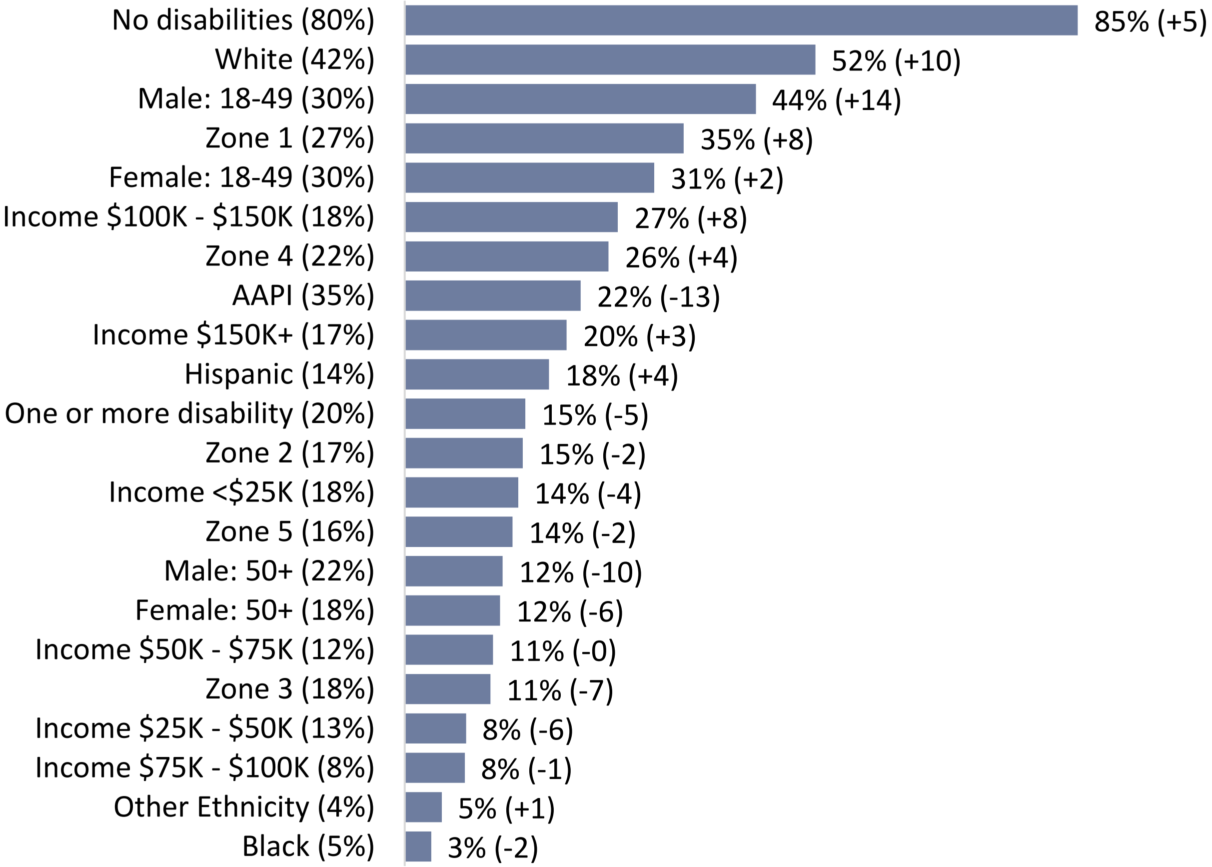
EMC research

White men under 50 are strongly represented in both “Comfortable Anywhere” and “Comfortable in Lanes”

Top “Comfortable Anywhere” Demos



Top “Comfortable in Lanes” Demos

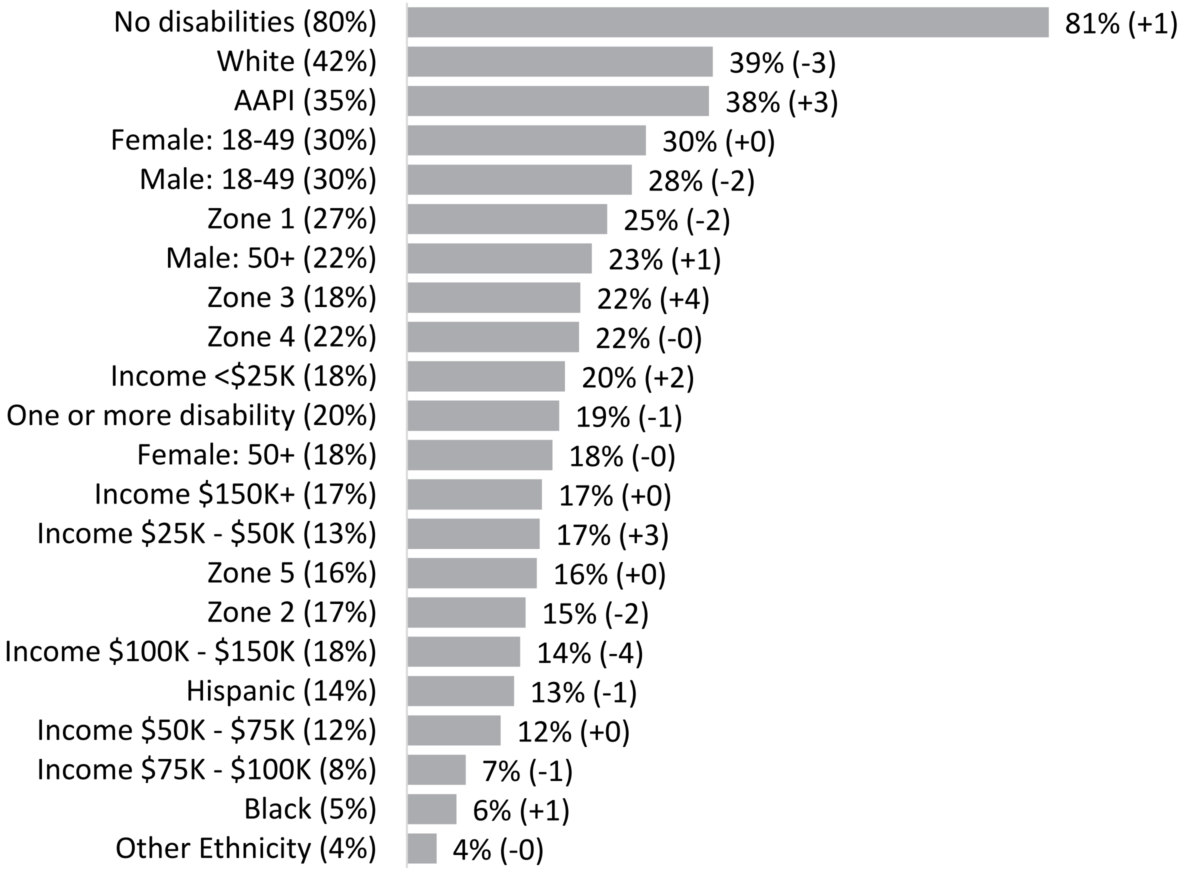


Top ATNCI Demos

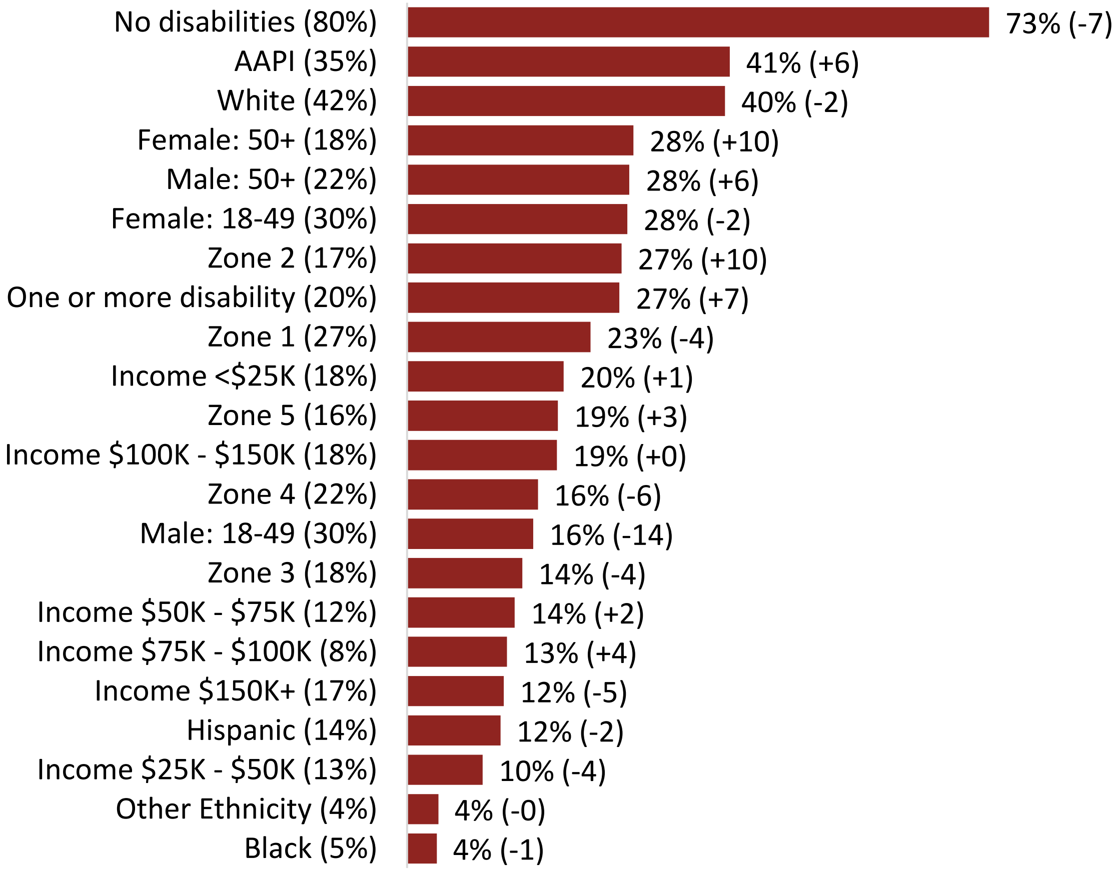
EMC research

Women over 50, those in the Marina and Richmond Districts, and AAPI residents are more likely to be the least comfortable or able to use the ATN.

Top "Comfortable Behind Barriers" Demos



Top "Uncomfortable/Unable to Use" Demos



Conclusions

- While nearly half of San Franciscans use active transportation devices regularly, many are not particularly comfortable in many of the types of active transportation facilities they may encounter traveling around the City. In particular, facilities where users have little to no physical protection from vehicles are the most uncomfortable.
- Uses for the Active Transportation Network vary across different parts of the City. Many of those interviewed in the Equity Priority Communities, as well as residents in the downtown/SOMA area, were primarily using the Network for commute and errand trips, while those in the central and western parts of the city used it more for social and exercise purposes.
- Reduction of barriers to active transportation devices could include things like additional protected facilities, along with better safe parking access and reduction in the cost of ownership or usage of the necessary devices.

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SFMTA Active Communities Plan
Resident Preference Survey
Equity Priority Community
Interviews Supplement

DRAFT

Data and Methodology Notes

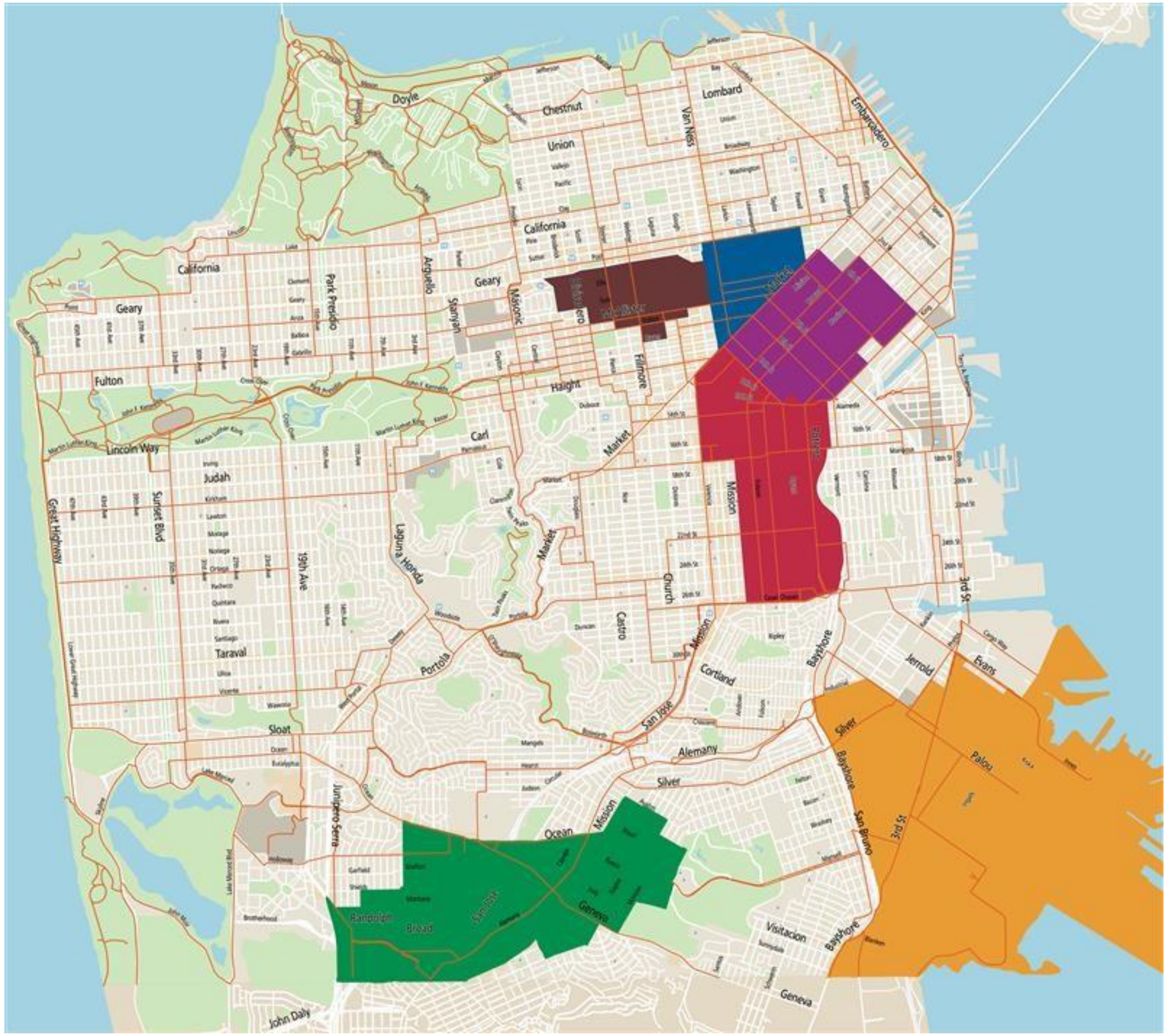
- This deck is meant to supplement the overall Resident Preference Survey report with additional information from the Equity Priority Community Interviews.

- The intercept interviews conducted in the Equity Priority Communities were not designed to be a truly random, representative sample of each individual EPC. Therefore, **it is important that the data from the collective and individual EPCs be represented as only the opinions and behaviors of this particular set of survey respondents**, and not assumed to be projectable across broader populations living or traveling in the EPCs.

- 600 intercept interviews were conducted April 4 – May 1, 2023 across six identified Equity Priority Communities (EPCs). These interviews were specifically targeted to populations underrepresented in the online surveys due to language and demographic characteristics, and reflected demographics largely present in the EPCs.
  - 100 interviews were conducted in each of the following EPCs: Western Addition, Tenderloin, Excelsior, Bayview/Hunters Point, SOMA, and Mission
  - Intercept surveys conducted in English, Spanish, Chinese and Tagalog by professional interviewers

Please note that due to rounding, some percentages may not add up to exactly 100%.

Equity Priority Communities



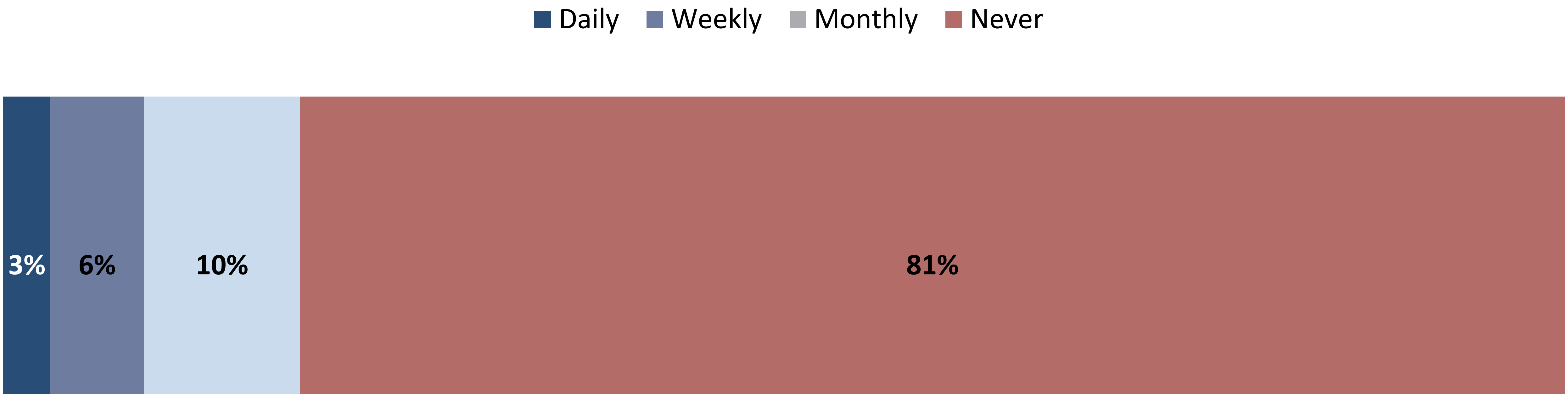
Equity Priority Community	Intercept Interviews
Western Addition	100
Tenderloin	100
Excelsior	100
Bayview/Hunter's Point	100
SOMA	100
Mission	100

SOMA EPC:
Intercept Interviews

SOMA EPC: Active Transportation Device Usage

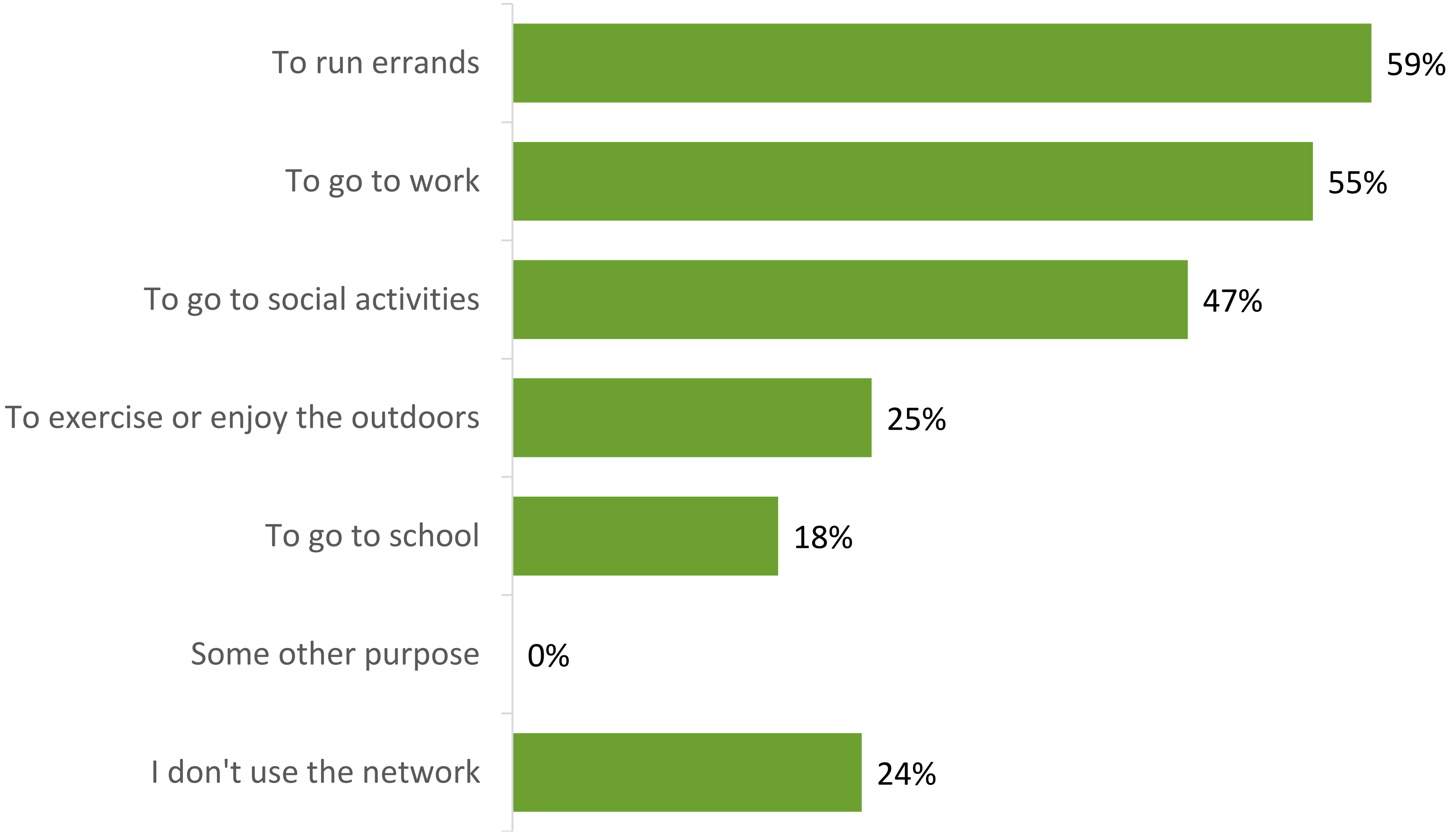
8-in-10 of those interviewed in the SOMA EPC never used Active Transportation Devices

Daily: *Daily user of at least one active transportation device (bike, scooter, skateboard/one-wheel, or assisted mobility device)*
Weekly: *Weekly user of at least one active transportation device*
Monthly: *Monthly user of at least one active transportation device*
Never: *Never uses an active transportation device*



SOMA EPC: Active Transportation Network Uses

While many interviewed in the SOMA EPC said they use the network for functional travel, like running errands or commuting, about a quarter interviewed said they did not use the ATN at all.



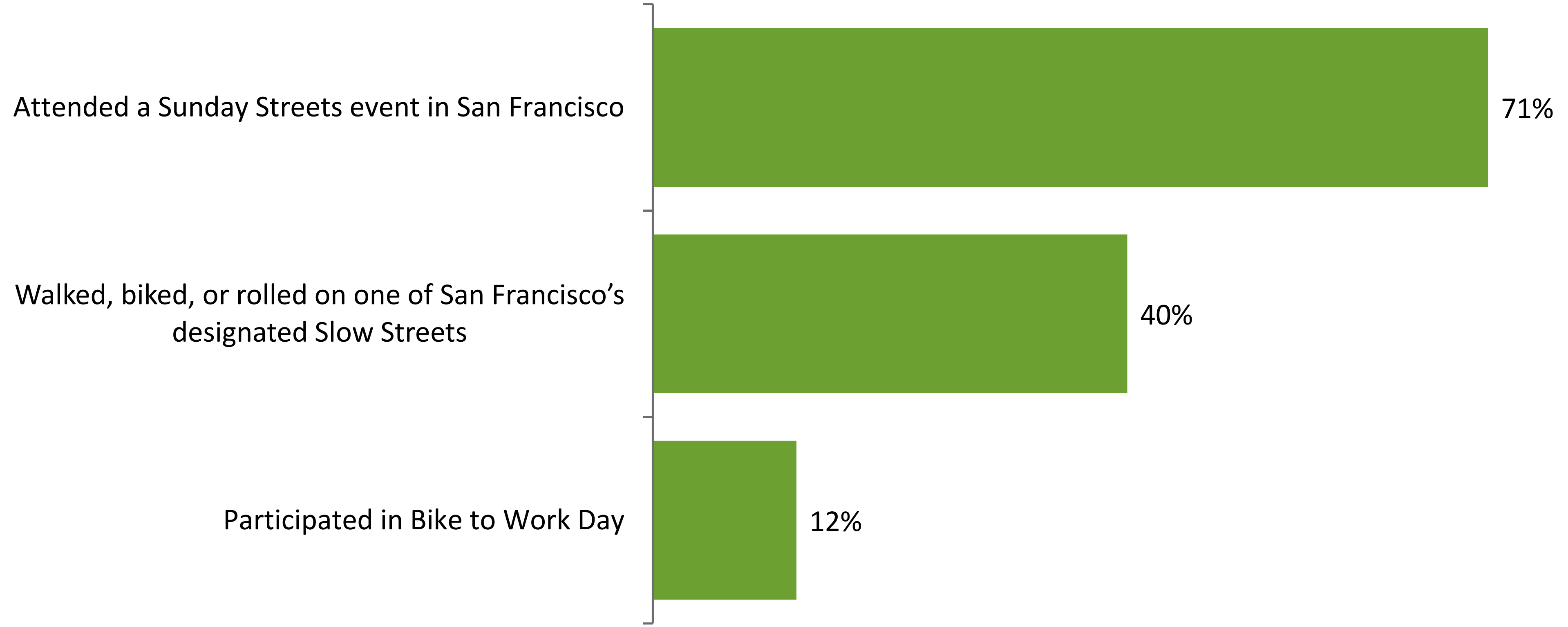
Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

SOMA EPC: Active Transportation Program Participation

EMC research

Seven in ten interviewed in the SOMA EPC had attended a Sunday Streets event; just one tenth had participated in BTWD.

Which of the following have you done?
(multiple responses accepted)

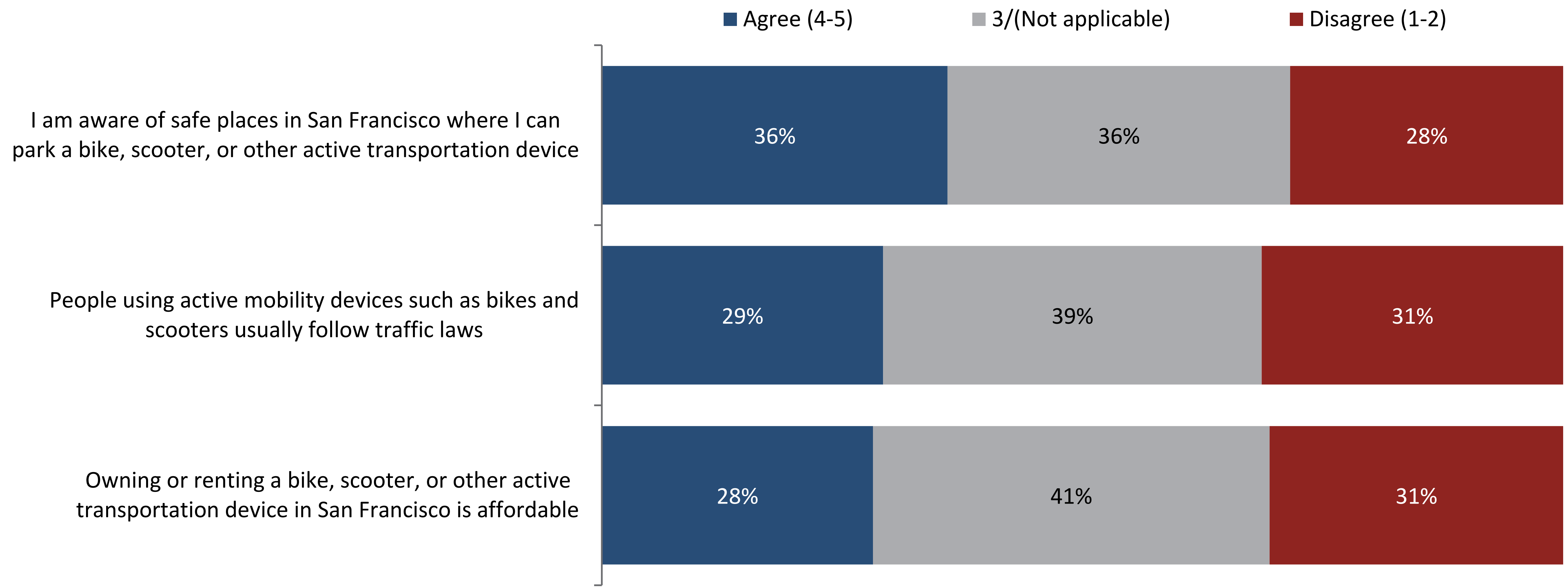


Q32.

SOMA EPC: Active Transportation Perceptions

EMC research

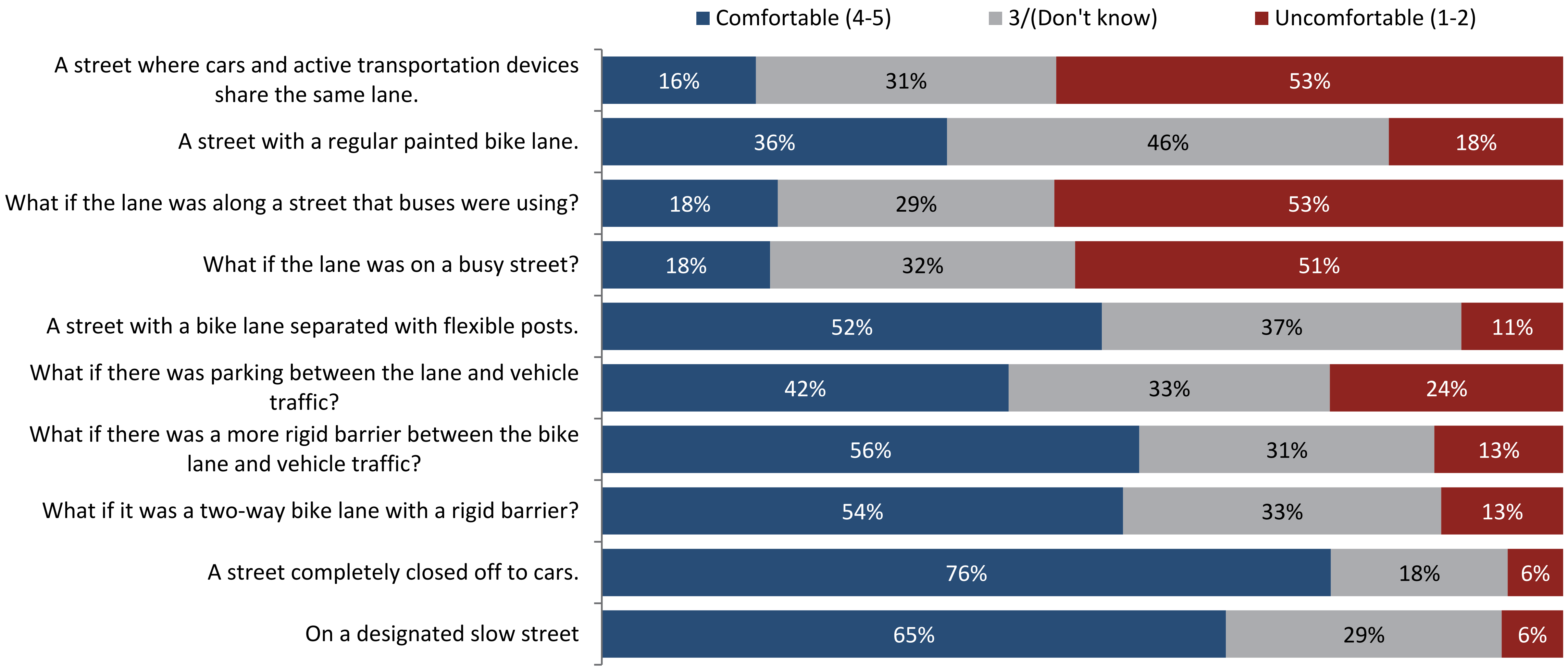
Many of the SOMA EPC respondents were not aware of safe parking areas, and one in three did not feel the costs of owning or renting a device was affordable. Of those interviewed in the SOMA EPC, 9% had had all of part of a bike or scooter stolen.



*** % usage calculated from respondents who ever use each device**

SOMA EPC: Facility Comfort Levels

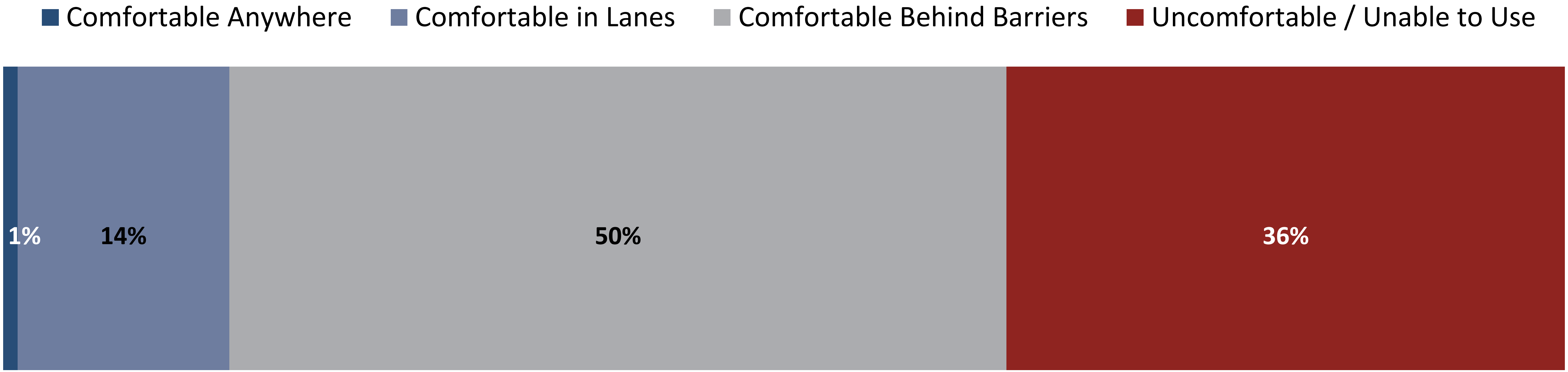
Many interviewed in the SOMA EPC weren't comfortable in shared facilities or bike lanes on busy streets.



SOMA EPC: Active Transportation Network Comfort Index (ATNCI)

Nearly none of those interviewed in the SOMA EPC are comfortable in all types of active transportation facilities.

Comfortable anywhere: *Very comfortable on streets without lanes*
Comfortable in lanes: *Very comfortable as long as there are striped lanes*
Comfortable behind barriers: *Only comfortable with a physical barrier*
Uncomfortable/Unable to use: *Not comfortable in any environment, or unable to use ATN*

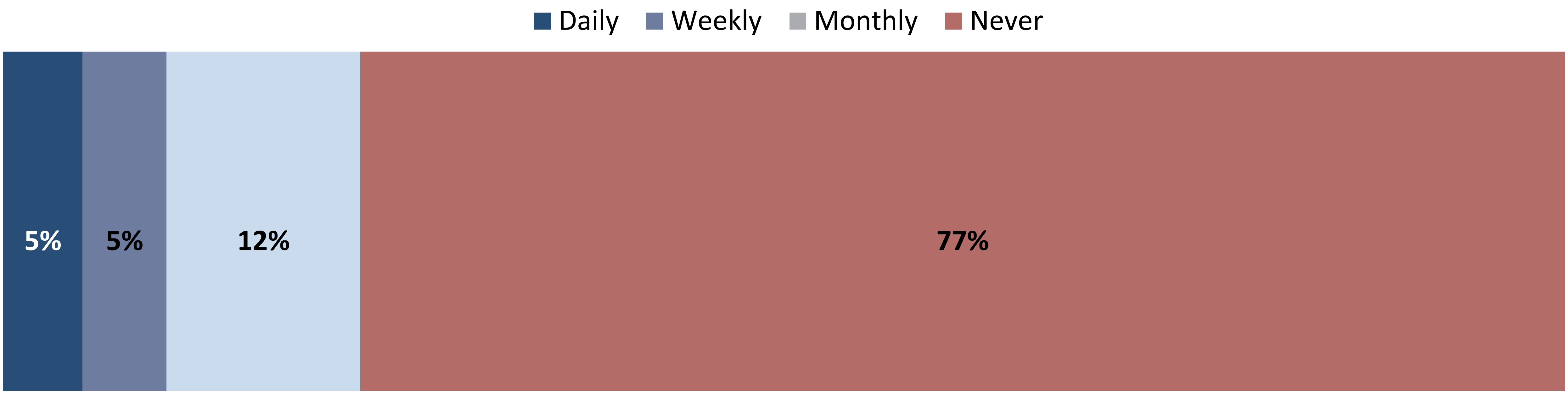


Mission EPC:
Intercept Interviews

Mission EPC: Active Transportation Device Usage

One in ten interviewed in the Mission EPC used active transportation devices at least weekly.

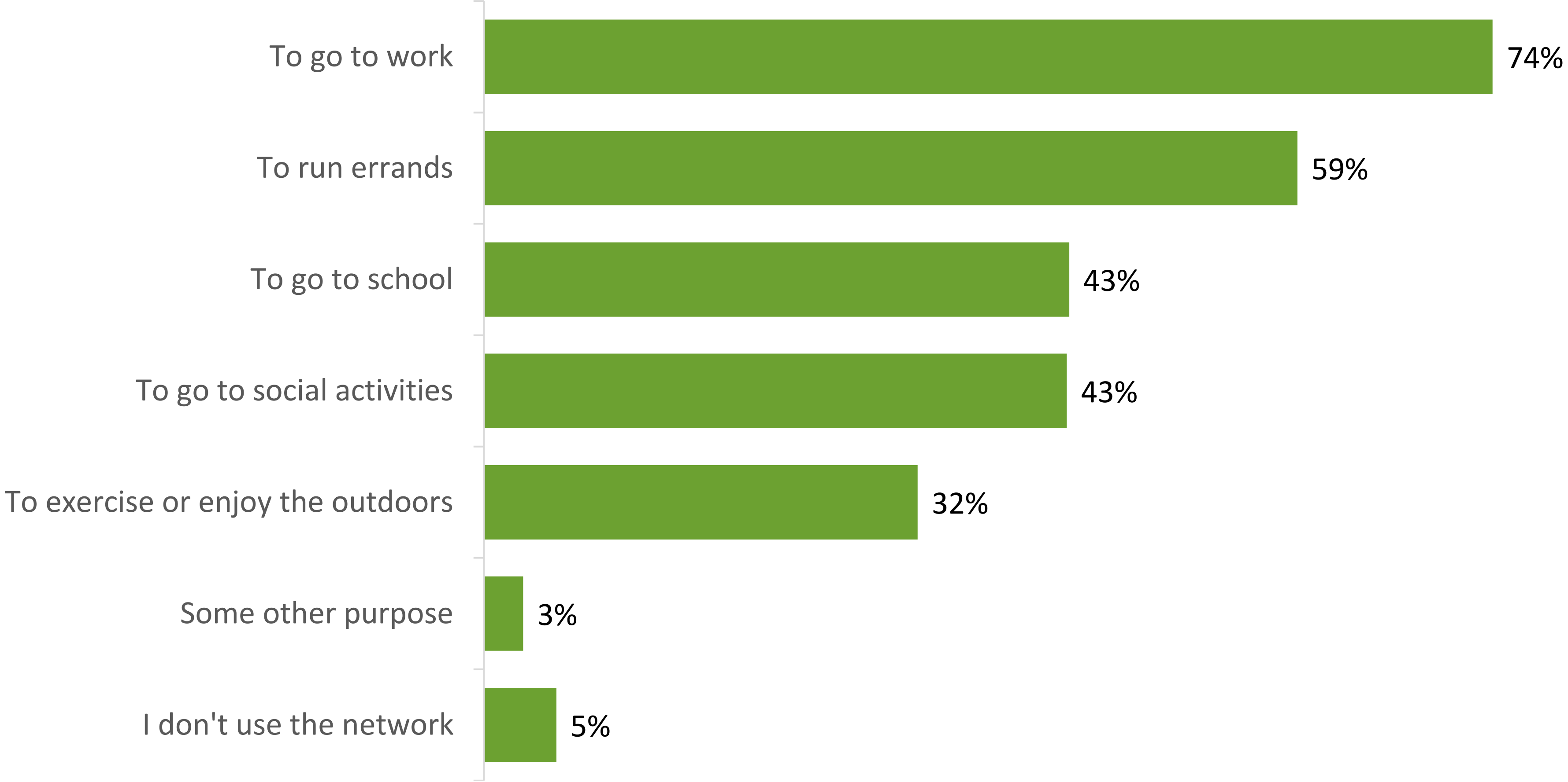
Daily: *Daily user of at least one active transportation device (bike, scooter, skateboard/one-wheel, or assisted mobility device)*
Weekly: *Weekly user of at least one active transportation device*
Monthly: *Monthly user of at least one active transportation device*
Never: *Never uses an active transportation device*



Mission EPC: Active Transportation Network Uses

EMC research

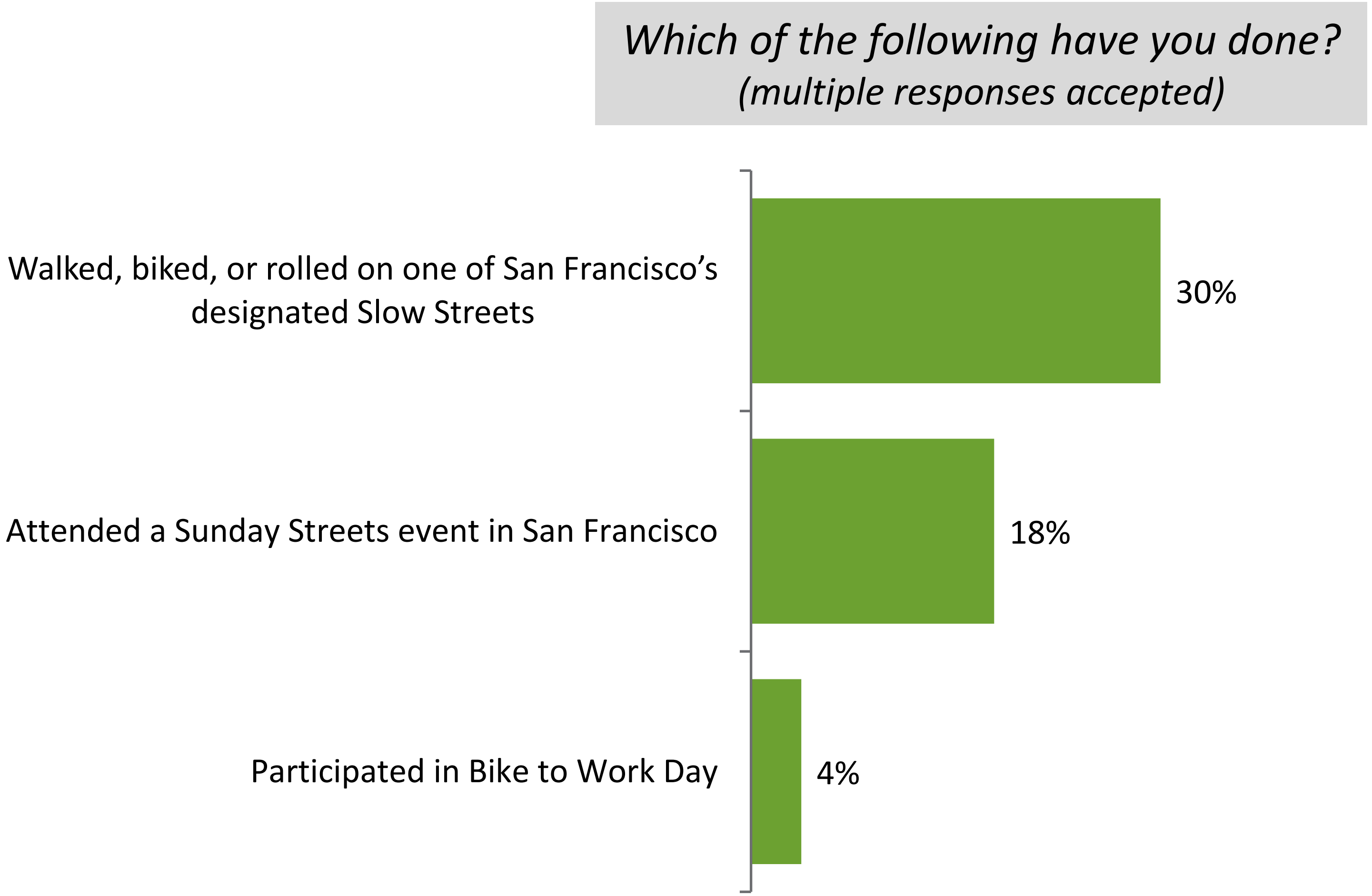
Three-quarters of those interviewed in the Mission EPC used the ATN for commuting, with many also using the network for running errands.



Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Mission EPC: Active Transportation Program Participation

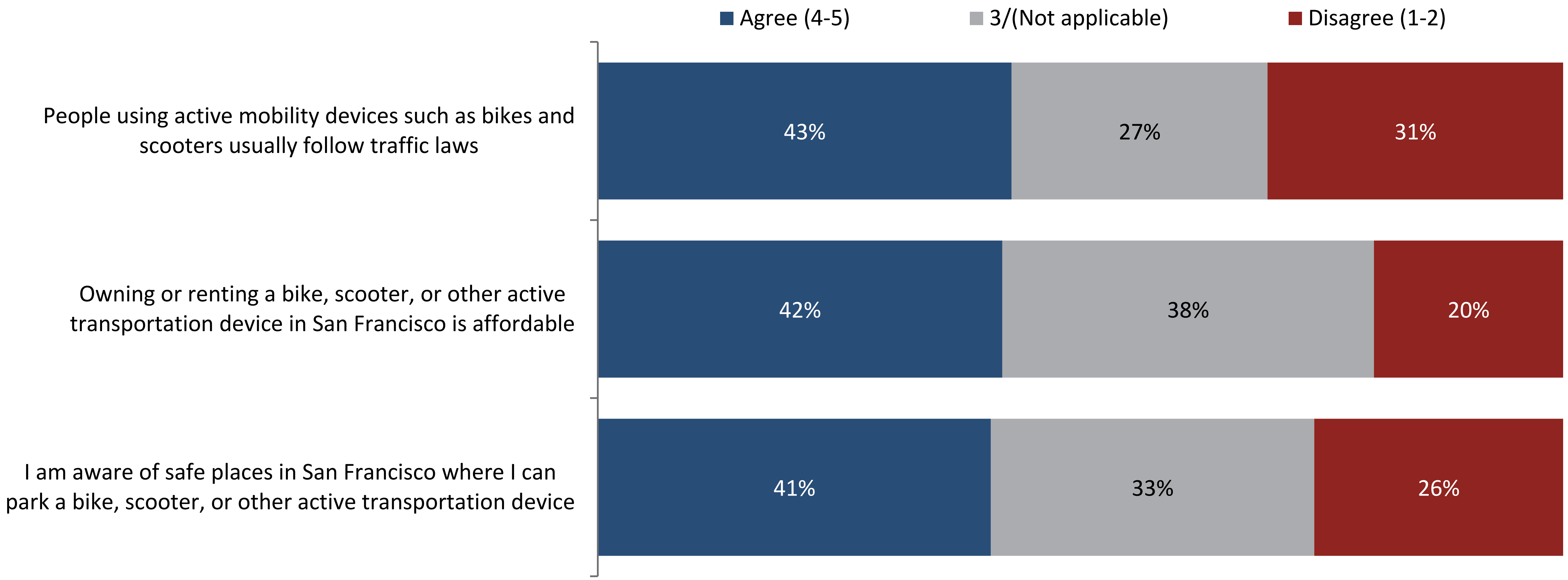
Three in ten Mission EPC respondents had used Slow Streets for active transportation, and nearly none had participated in Bike to Work Day.



Q32.

Mission EPC: Active Transportation Perceptions

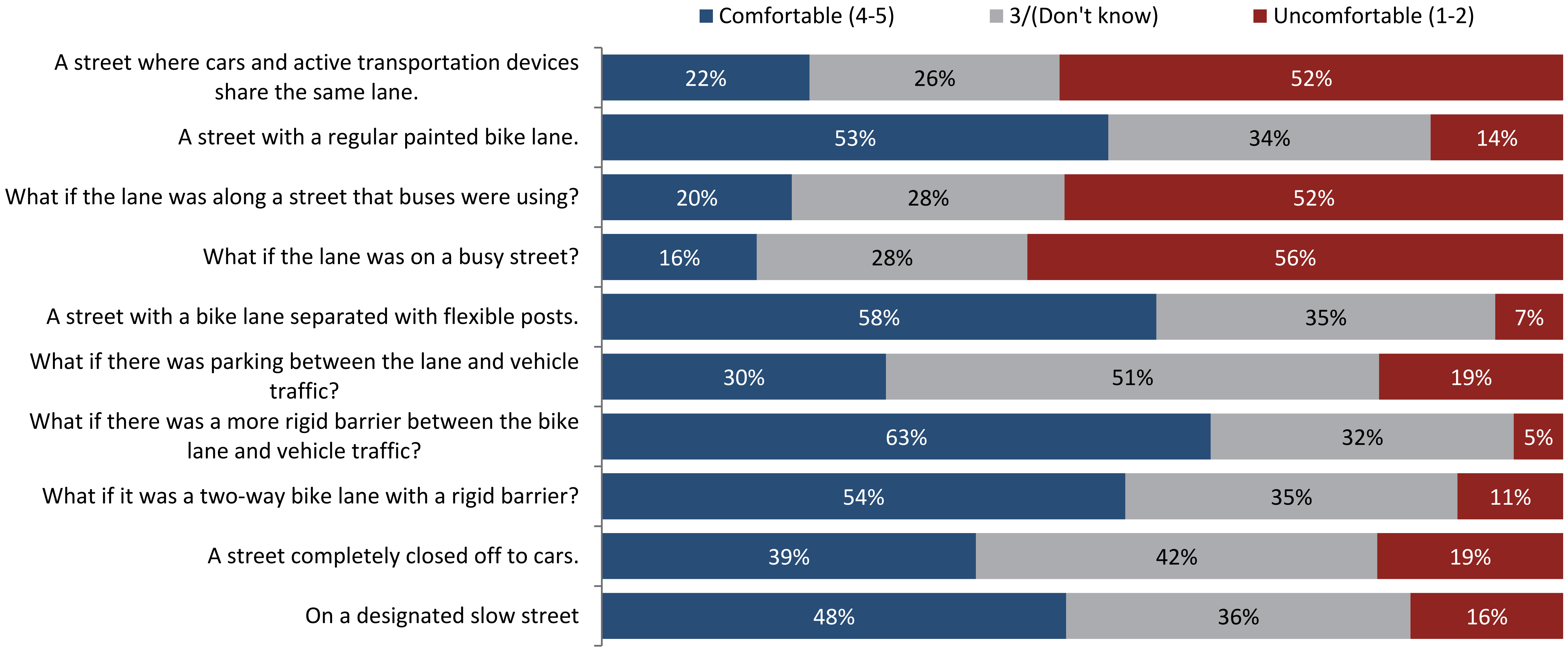
Less than half of Mission EPC respondents felt owning or renting an active transportation device was affordable, or that they knew where they could park safely.



* % usage calculated from respondents who ever use each device

Mission EPC: Facility Comfort Levels

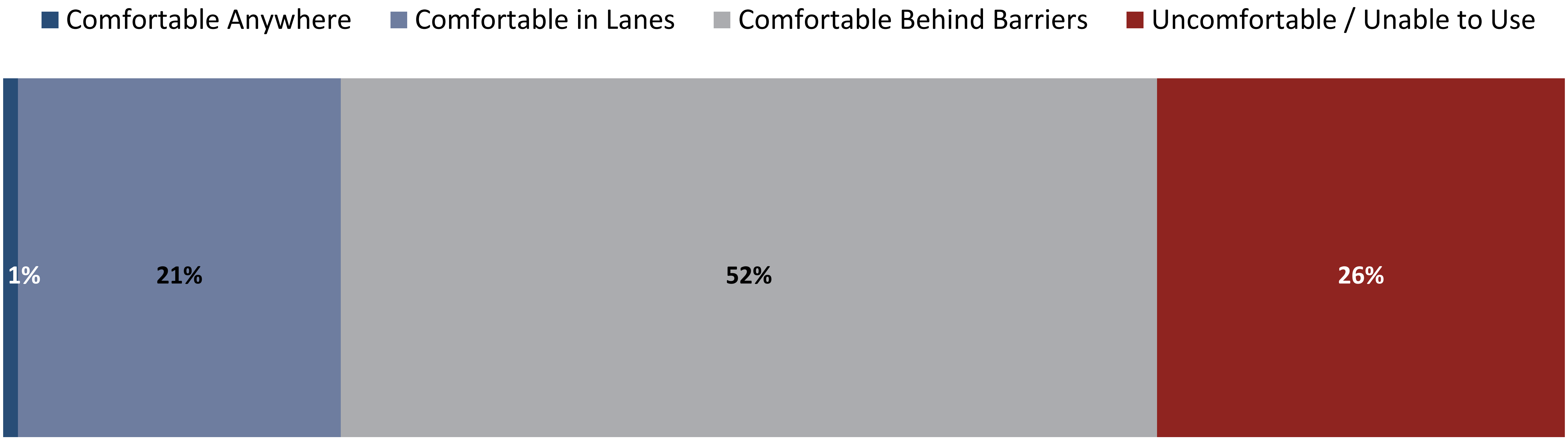
Many interviewed in the Mission EPC weren't comfortable in shared facilities or bike lanes on busy streets.



Mission EPC: Active Transportation Network Comfort Index (ATNCI)

Nearly none of those interviewed in the Mission EPC are comfortable in all types of active transportation facilities.

Comfortable anywhere: *Very comfortable on streets without lanes*
Comfortable in lanes: *Very comfortable as long as there are striped lanes*
Comfortable behind barriers: *Only comfortable with a physical barrier*
Uncomfortable/Unable to use: *Not comfortable in any environment, or unable to use ATN*

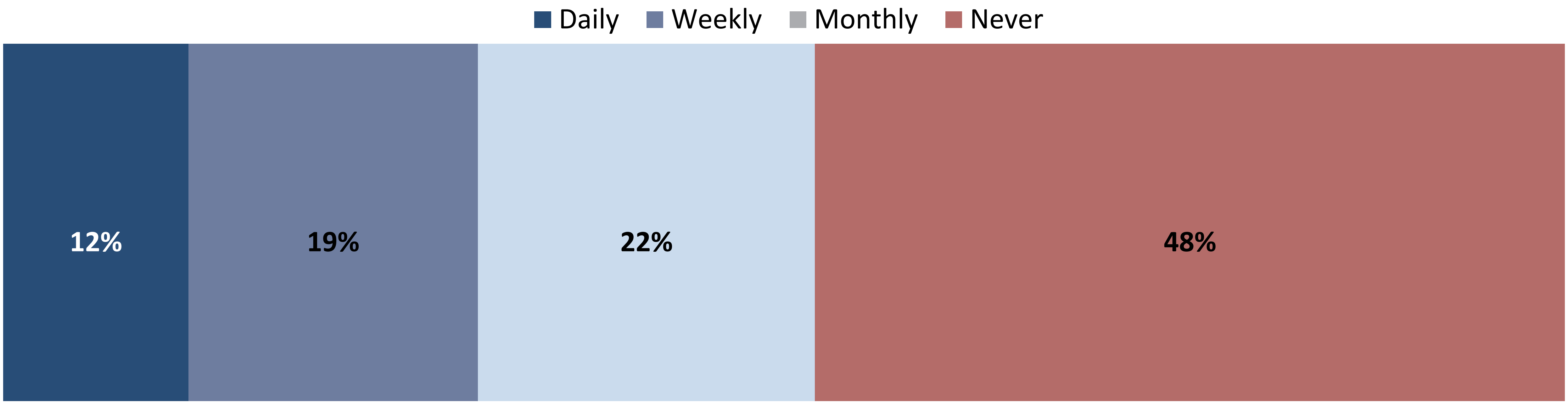


Excelsior EPC:
Intercept Interviews

Excelsior EPC: Active Transportation Device Usage

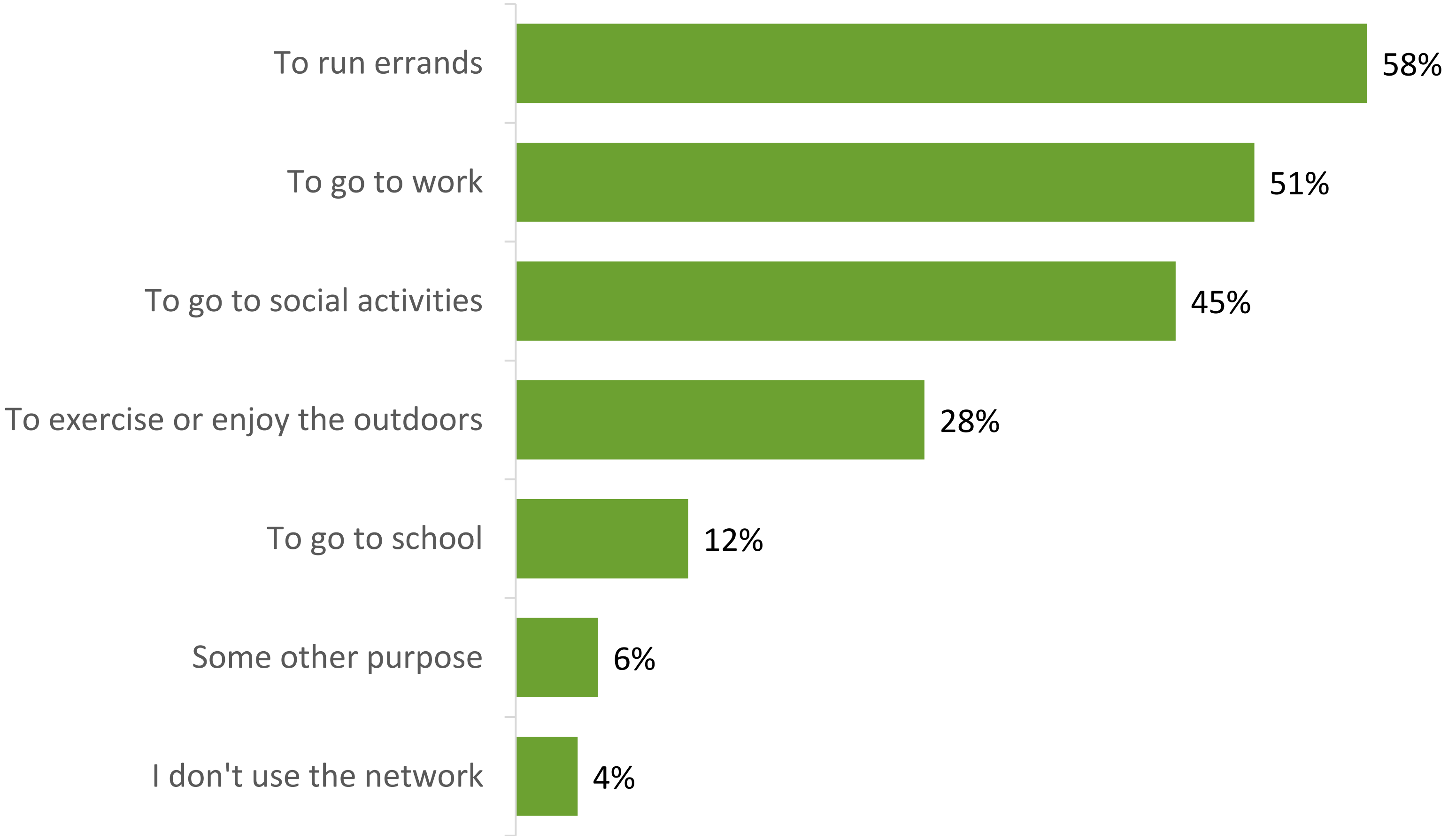
Around half of those interviewed in the Excelsior EPC used the ATN, with 3-in-10 stating they used it at least once a week.

Daily: *Daily user of at least one active transportation device (bike, scooter, skateboard/one-wheel, or assisted mobility device)*
Weekly: *Weekly user of at least one active transportation device*
Monthly: *Monthly user of at least one active transportation device*
Never: *Never uses an active transportation device*



Excelsior EPC: Active Transportation Network Uses

Excelsior EPC respondents used the network most frequently to run errands, and about half used it to commute.

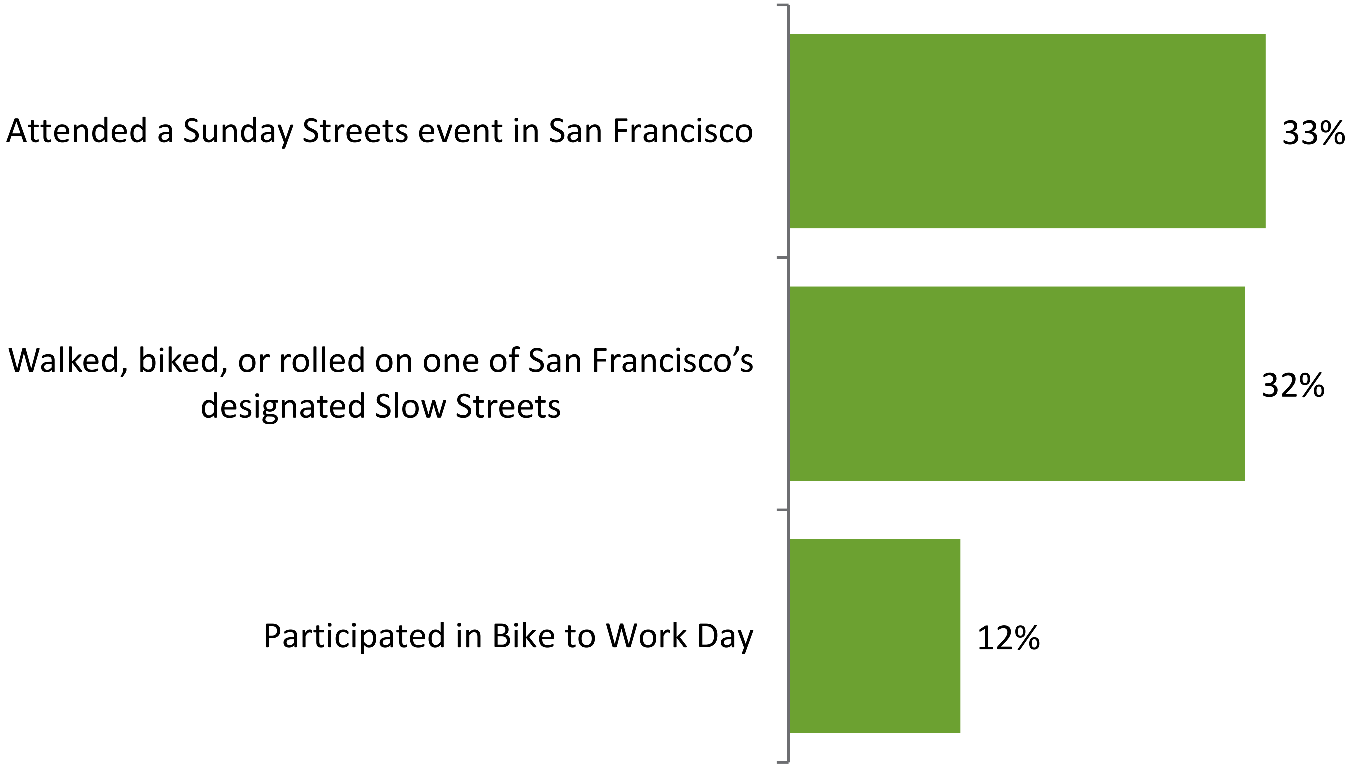


Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Excelsior EPC: Active Transportation Program Participation

One-third of respondents in the Excelsior EPC have used slow streets for active transportation or attended a Sunday Streets event.

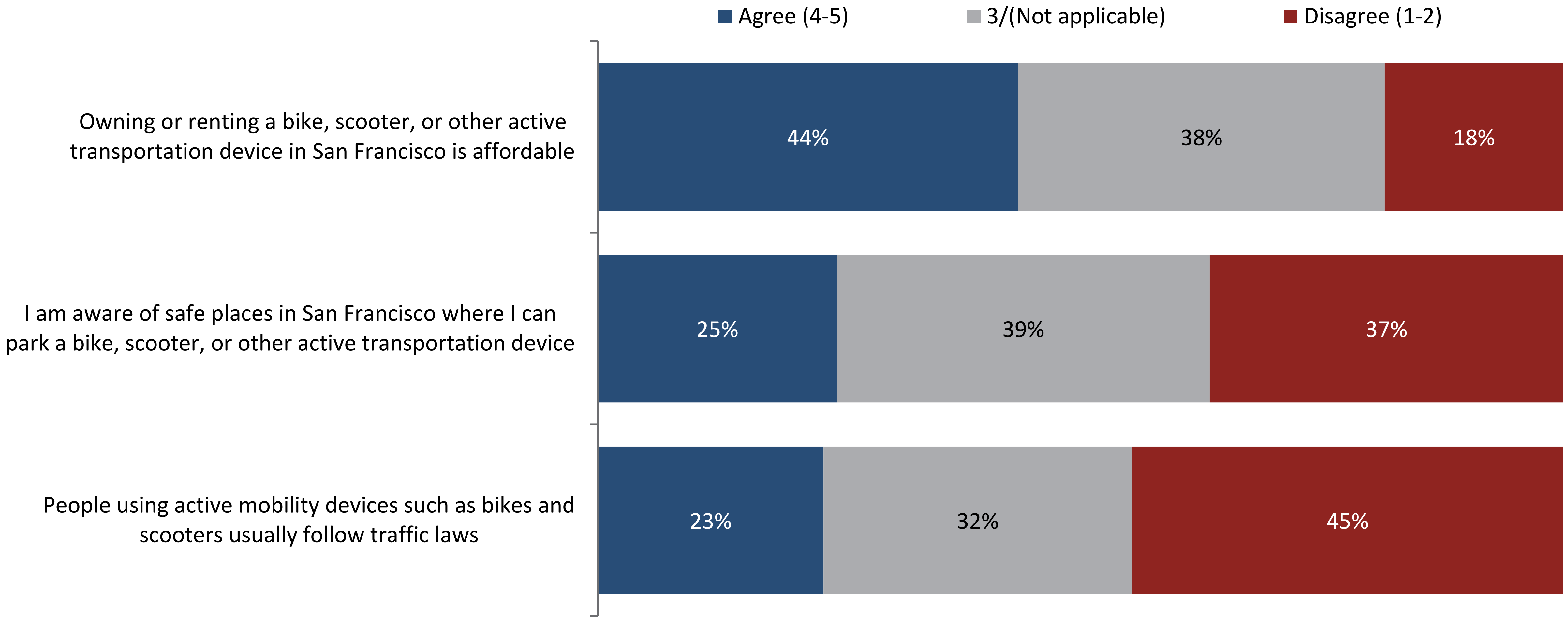
Which of the following have you done?
(multiple responses accepted)



Q32.

Excelsior EPC: Active Transportation Perceptions

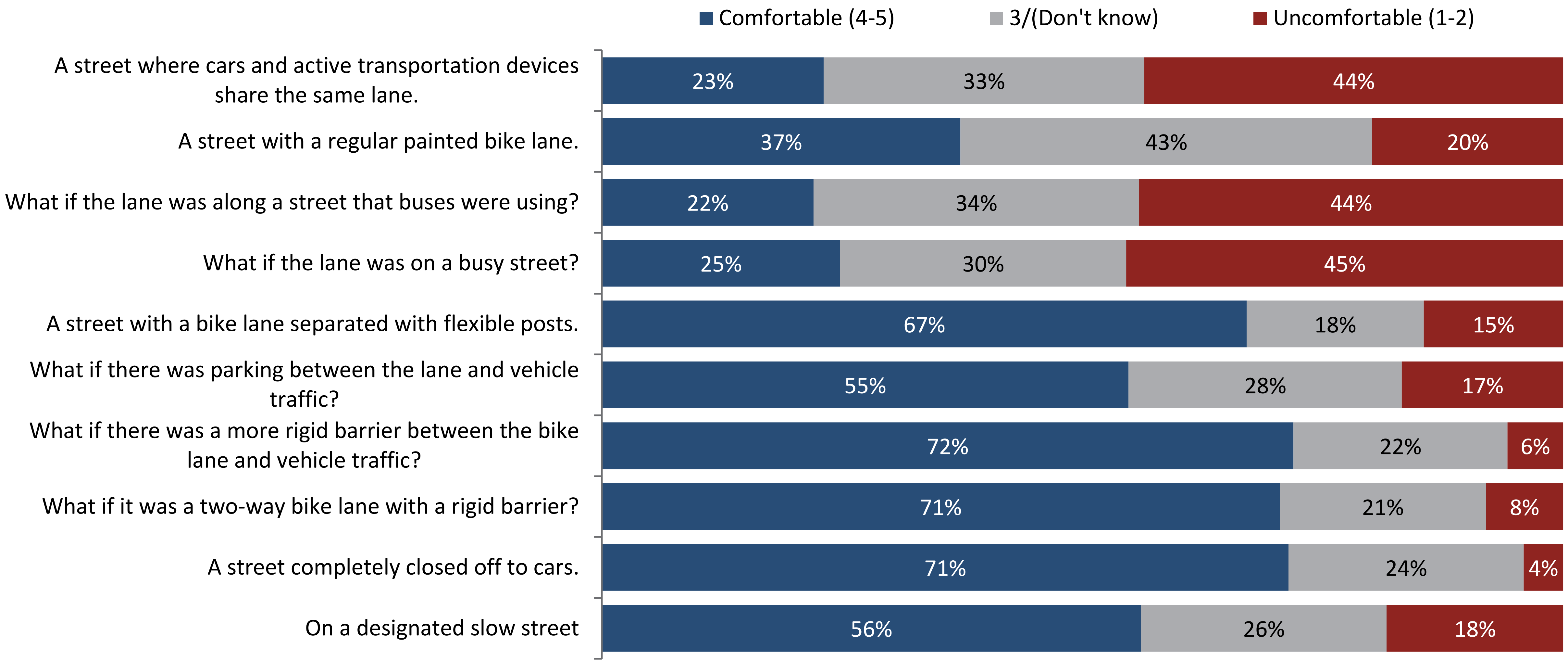
Nearly half of those interviewed in the Excelsior agree that owning or renting an active transportation device is affordable, but many are not aware of safe parking areas.



* % usage calculated from respondents who ever use each device

Excelsior EPC: Facility Comfort Levels

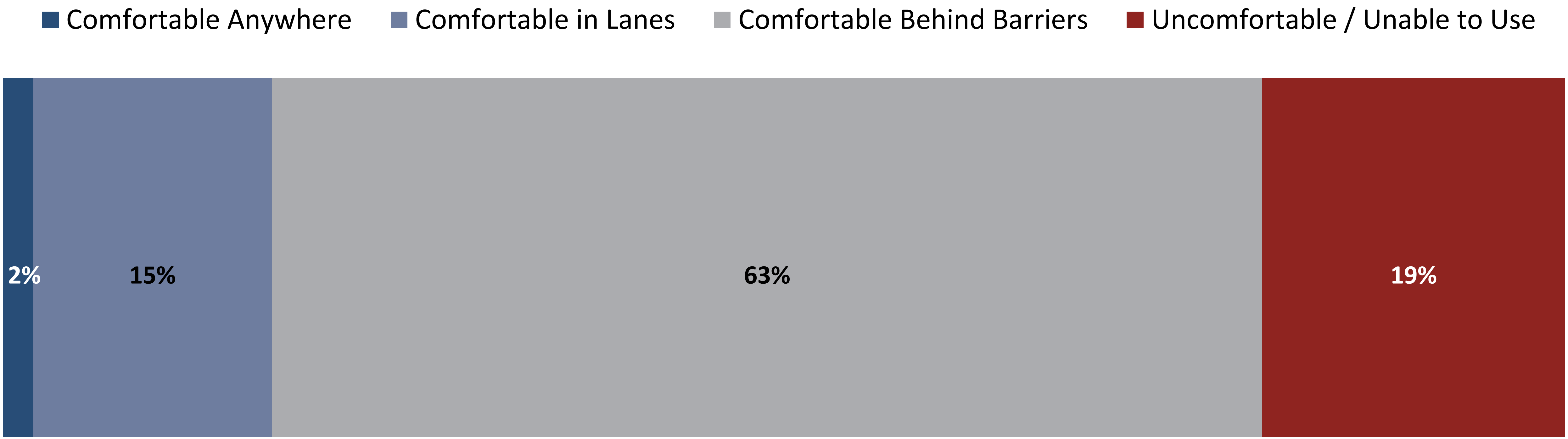
Those interviewed in the Excelsior EPC were generally much more comfortable in protected facilities.



Excelsior EPC: Active Transportation Network Comfort Index (ATNCI)

Most of those interviewed in the Excelsior EPC were only comfortable using the Active Transportation Network with barriers.

Comfortable anywhere: *Very comfortable on streets without lanes*
Comfortable in lanes: *Very comfortable as long as there are striped lanes*
Comfortable behind barriers: *Only comfortable with a physical barrier*
Uncomfortable/Unable to use: *Not comfortable in any environment, or unable to use ATN*

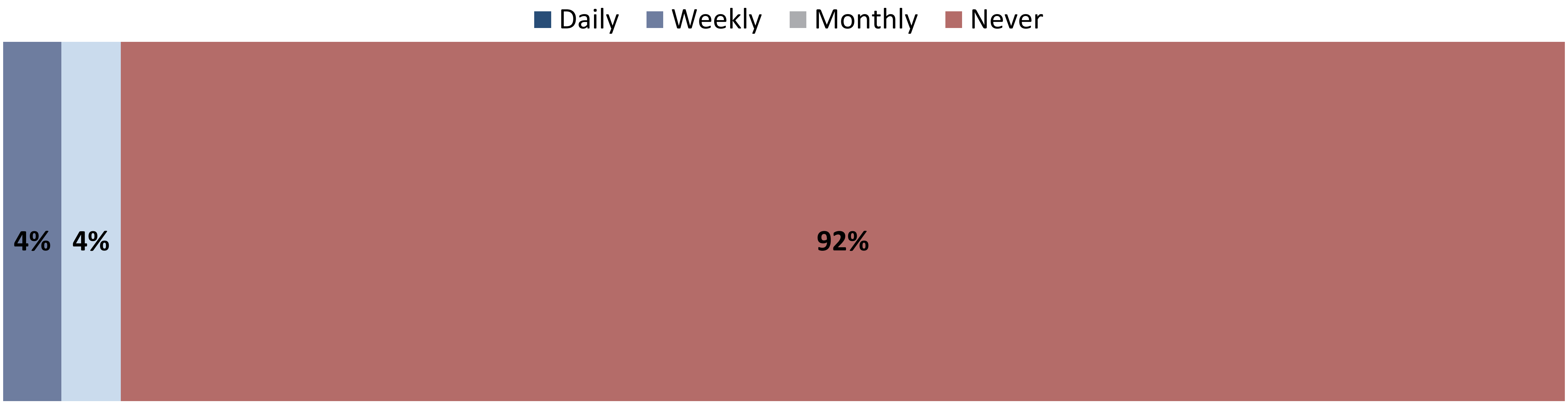


Bayview/Hunters Point EPC: Intercept Interviews

Bayview/Hunters Point EPC: Active Transportation Device Usage

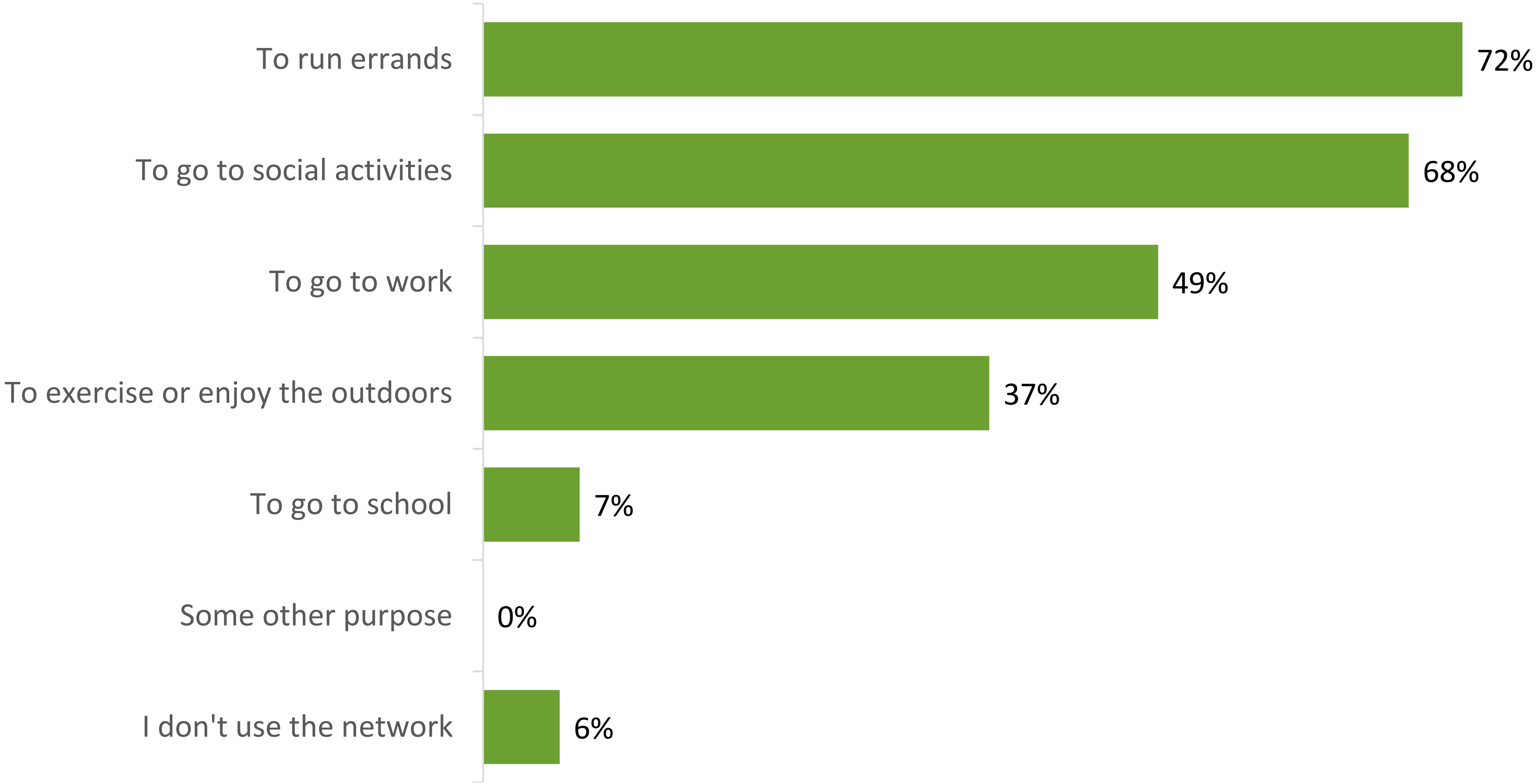
Most of those interviewed in the Bayview/Hunters Point EPC did not use active transportation devices at all.

Daily: *Daily user of at least one active transportation device (bike, scooter, skateboard/one-wheel, or assisted mobility device)*
Weekly: *Weekly user of at least one active transportation device*
Monthly: *Monthly user of at least one active transportation device*
Never: *Never uses an active transportation device*



Bayview/Hunters Point EPC: Active Transportation Network Uses

For those interviewed in the Bayview/Hunters Point EPC that used the ATN, most were using it for errands and social activities.



Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Bayview Hunters Point EPC: Active Transportation Program Participation

Few of those interviewed in the Bayview/Hunters Point EPC participate in the active transportation programs tested.

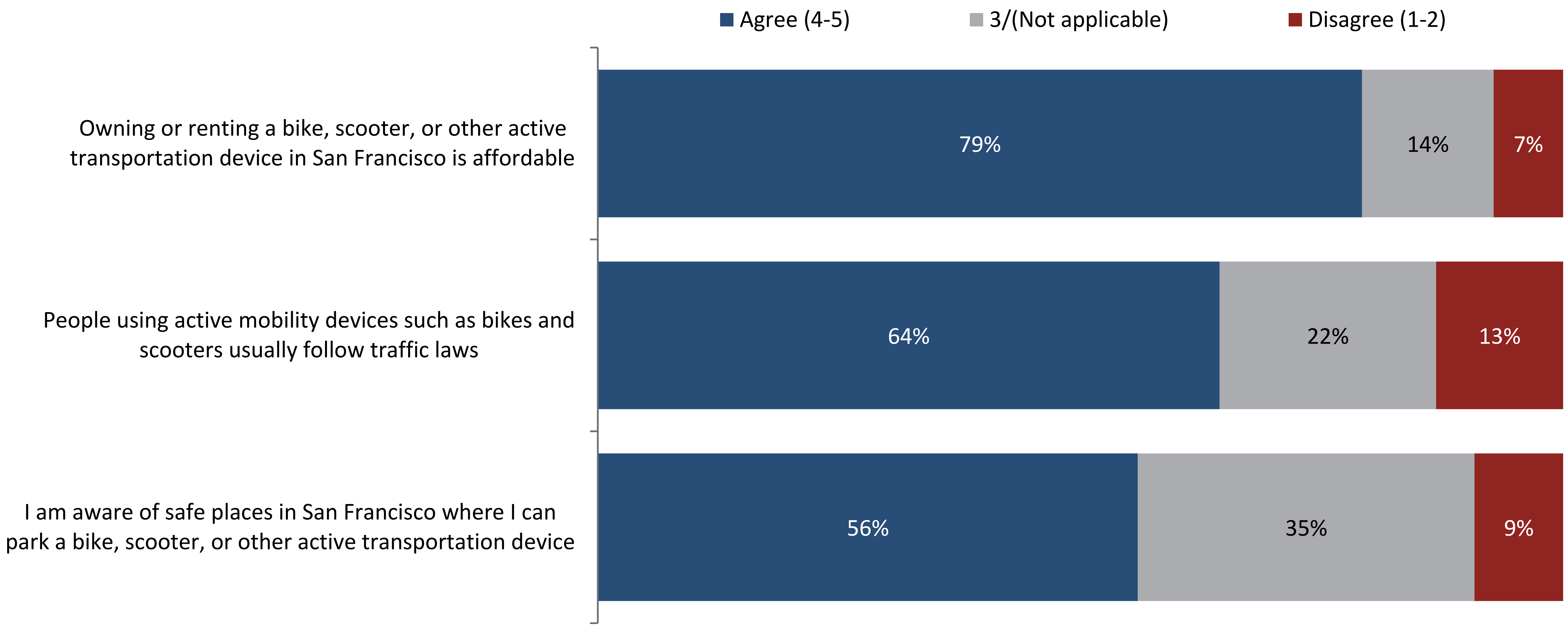
Which of the following have you done?
(multiple responses accepted)

Q32.

Bayview/Hunters Point EPC: Active Transportation Perceptions

EMC research

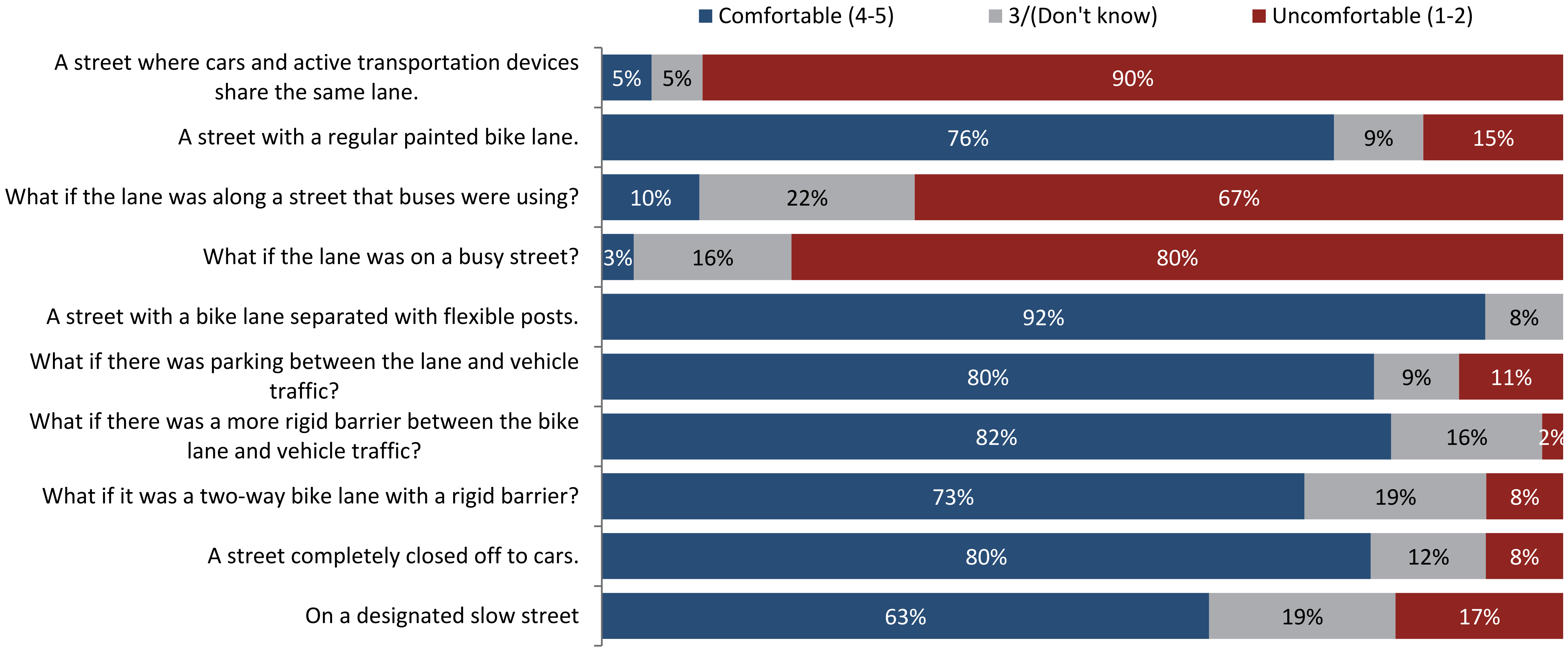
Bayview/Hunters Point EPC respondents generally felt that owning an active transportation device was affordable, and over half knew of safe places to park.



* % usage calculated from respondents who ever use each device

Bayview/Hunters Point EPC: Facility Comfort Levels

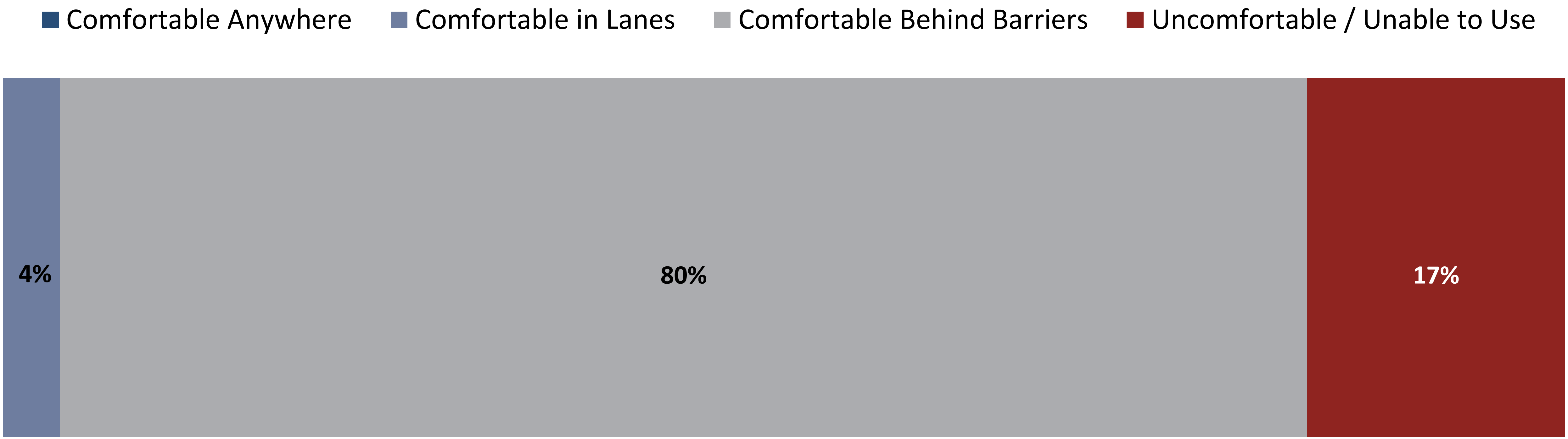
The addition of barrier protection made a big difference to those interviewed in the Bayview-Hunters Point EPC.



Bayview/Hunters Point EPC: Active Transportation Network Comfort Index (ATNCI)

Four in five of those interviewed in the Bayview-Hunters Point EPC are only comfortable in facilities with barriers.

<u>Comfortable anywhere:</u> *Very comfortable on streets without lanes*
<u>Comfortable in lanes:</u> *Very comfortable as long as there are striped lanes*
<u>Comfortable behind barriers:</u> *Only comfortable with a physical barrier*
<u>Uncomfortable/Unable to use:</u> *Not comfortable in any environment, or unable to use ATN*

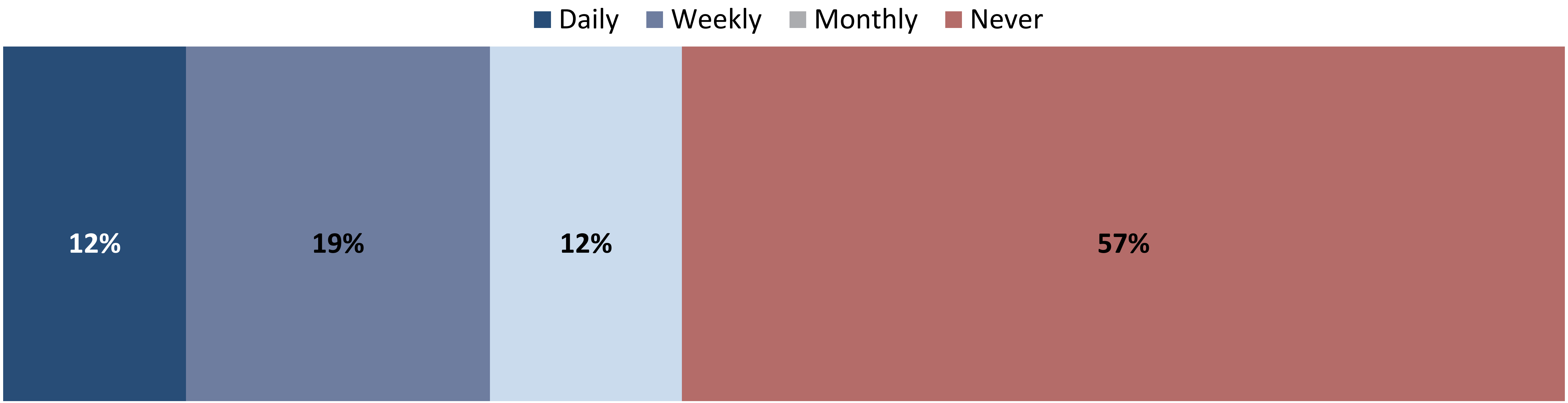


Tenderloin EPC:
Intercept Interviews

Tenderloin EPC: Active Transportation Device Usage

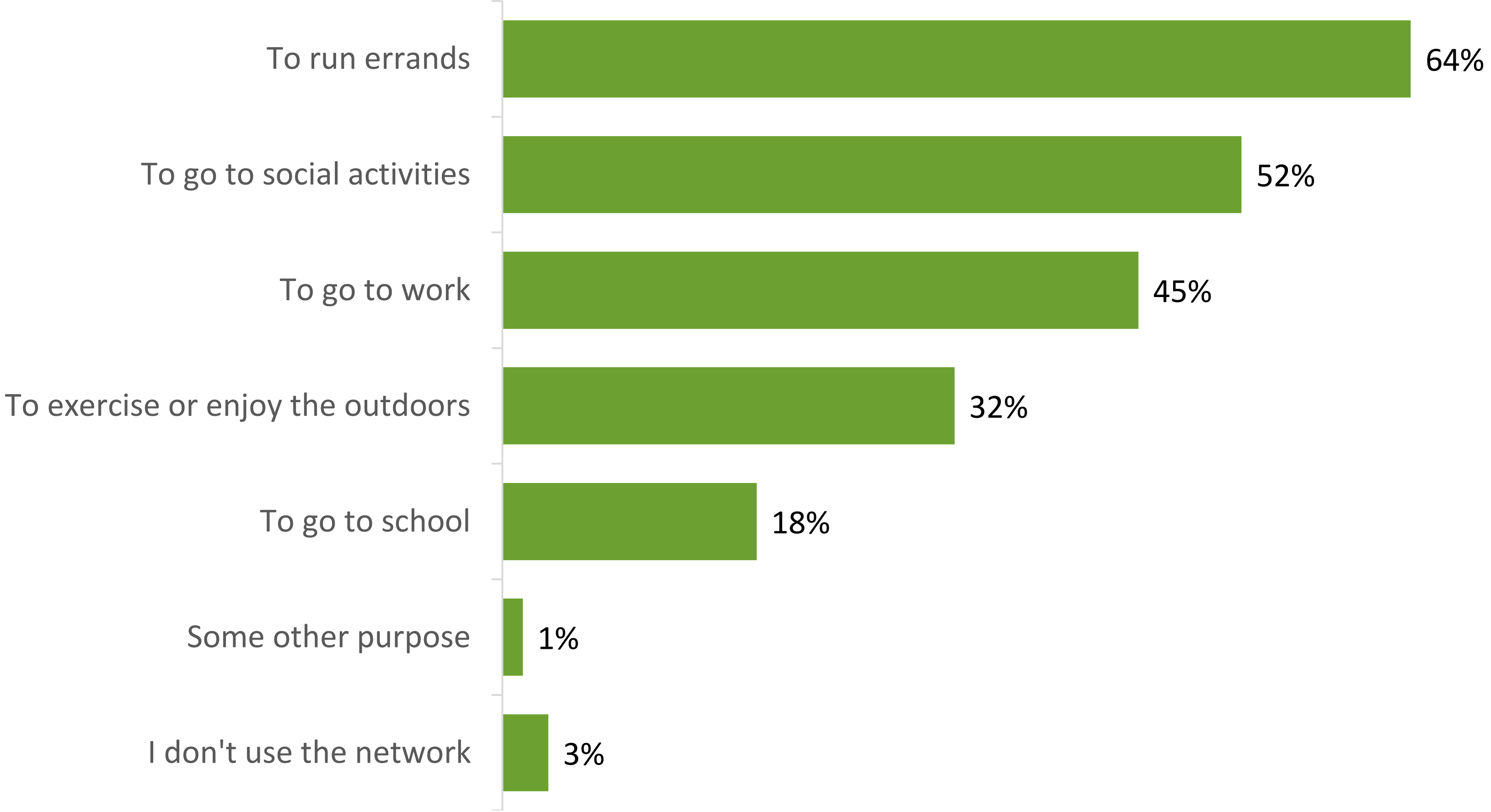
Over four in ten of those interviewed in the Tenderloin EPC used active transportation devices regularly.

Daily: *Daily user of at least one active transportation device (bike, scooter, skateboard/one-wheel, or assisted mobility device)*
Weekly: *Weekly user of at least one active transportation device*
Monthly: *Monthly user of at least one active transportation device*
Never: *Never uses an active transportation device*



Tenderloin EPC: Active Transportation Network Uses

Tenderloin EPC respondents used the network most frequently to run errands, and about half used it for social activities.



Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Tenderloin EPC: Active Transportation Program Participation

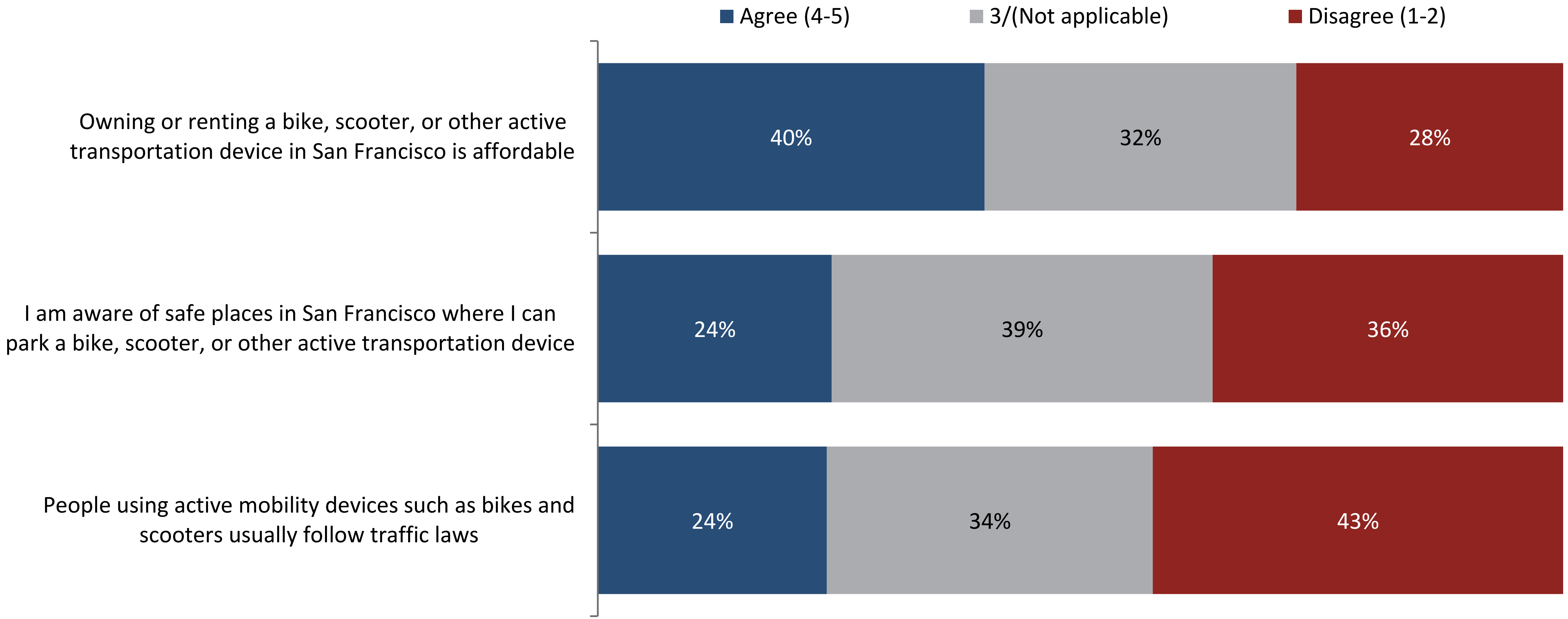
One-third of respondents in the Tenderloin EPC have used slow streets for active transportation or attended a Sunday Streets event.

Which of the following have you done?
(multiple responses accepted)

Q32.

Tenderloin EPC: Active Transportation Perceptions

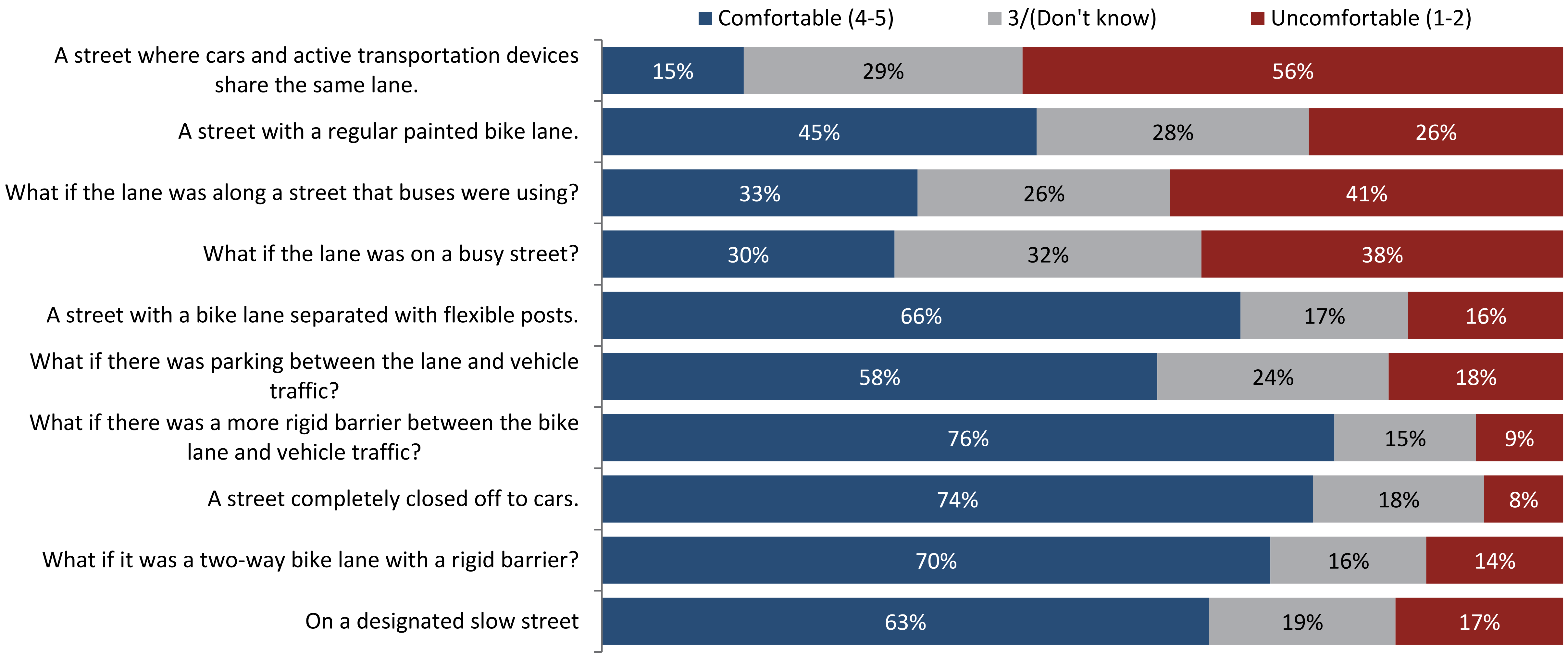
Tenderloin EPC respondents had limited awareness of safe places to park active transportation devices.



* % usage calculated from respondents who ever use each device

Tenderloin EPC: Facility Comfort Levels

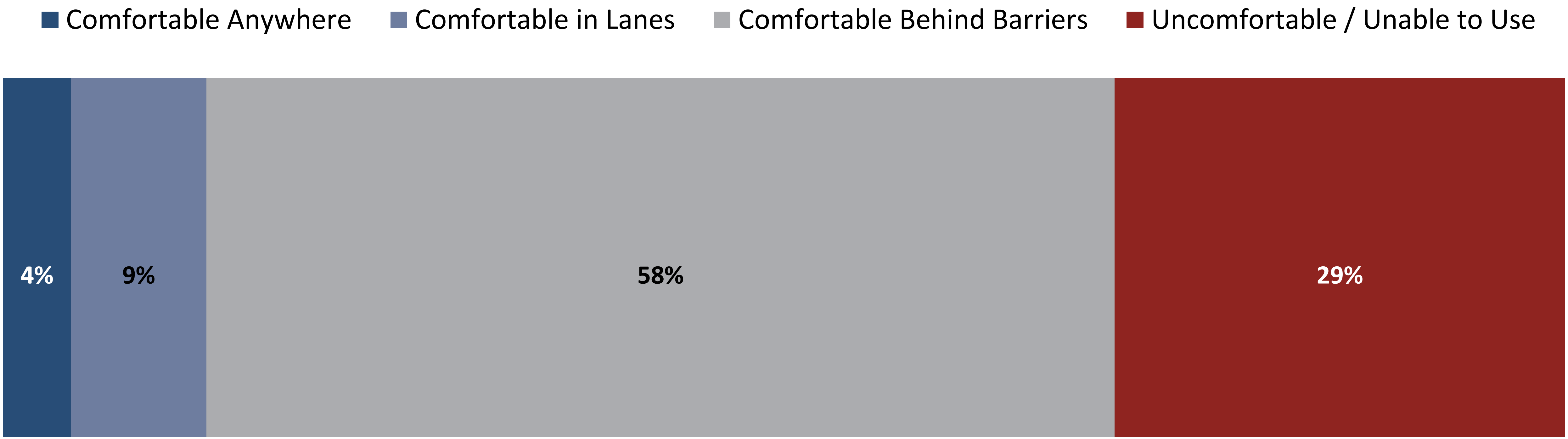
Those interviewed in the Tenderloin EPC were generally much more comfortable in protected facilities.



Tenderloin EPC: Active Transportation Network Comfort Index (ATNCI)

Most of those interviewed in the Tenderloin EPC were only comfortable using the Active Transportation Network with barriers.

Comfortable anywhere: *Very comfortable on streets without lanes*
Comfortable in lanes: *Very comfortable as long as there are striped lanes*
Comfortable behind barriers: *Only comfortable with a physical barrier*
Uncomfortable/Unable to use: *Not comfortable in any environment, or unable to use ATN*

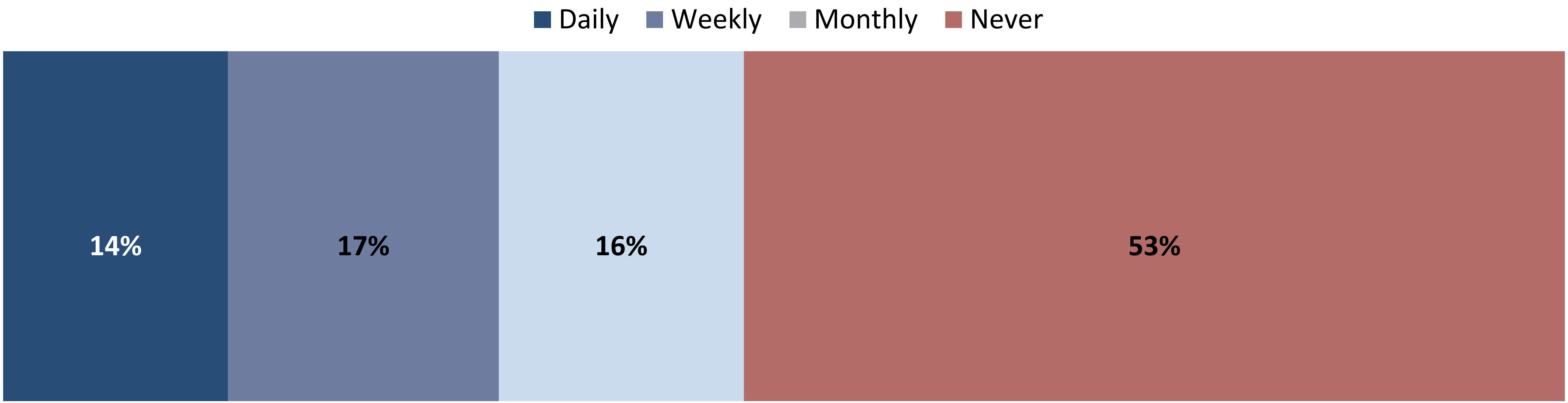


Western Addition EPC: Intercept Interviews

Western Addition EPC: Active Transportation Device Usage

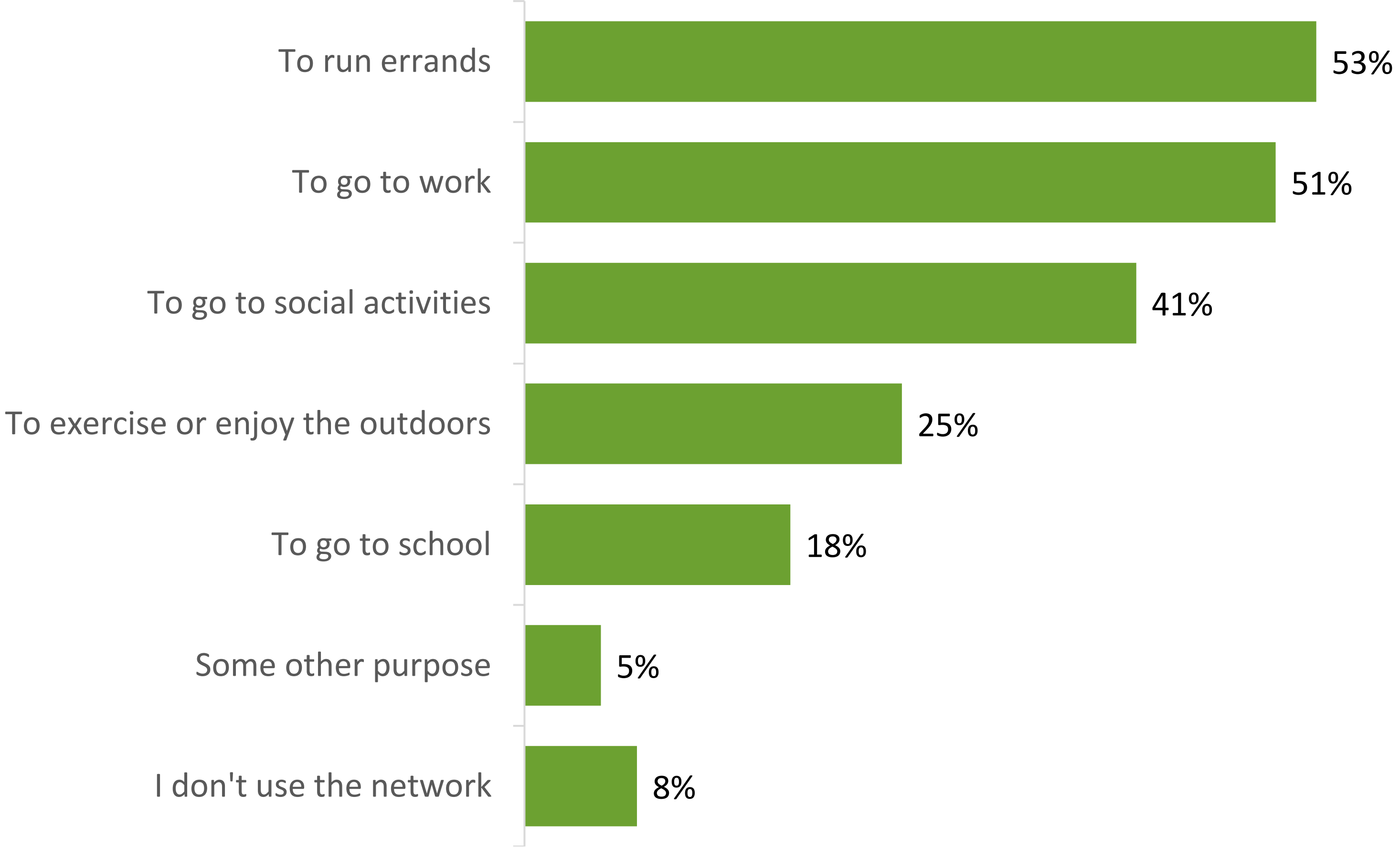
Over three in ten of those interviewed in the Western Addition EPC used active transportation devices weekly.

Daily: *Daily user of at least one active transportation device (bike, scooter, skateboard/one-wheel, or assisted mobility device)*
Weekly: *Weekly user of at least one active transportation device*
Monthly: *Monthly user of at least one active transportation device*
Never: *Never uses an active transportation device*



Western Addition EPC: Active Transportation Network Uses

About half of Western Addition EPC respondents used the network to run errands or commute.

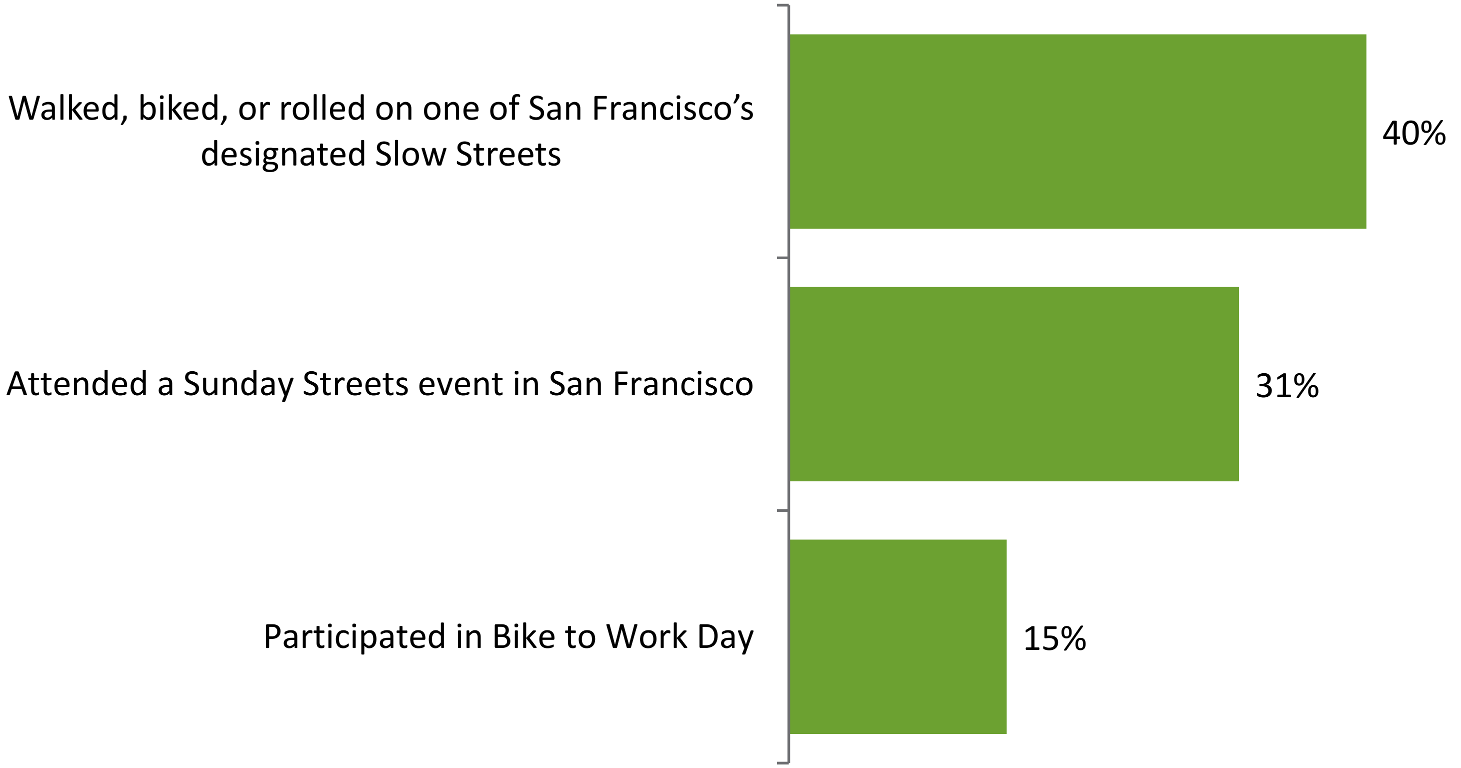


Q15. For which of the following reasons do you use San Francisco's Active Transportation Network?

Western Addition EPC: Active Transportation Program Participation

Four in ten of those interviewed in the Western Addition EPC had used slow streets, and a third had participated in a Sunday Streets event.

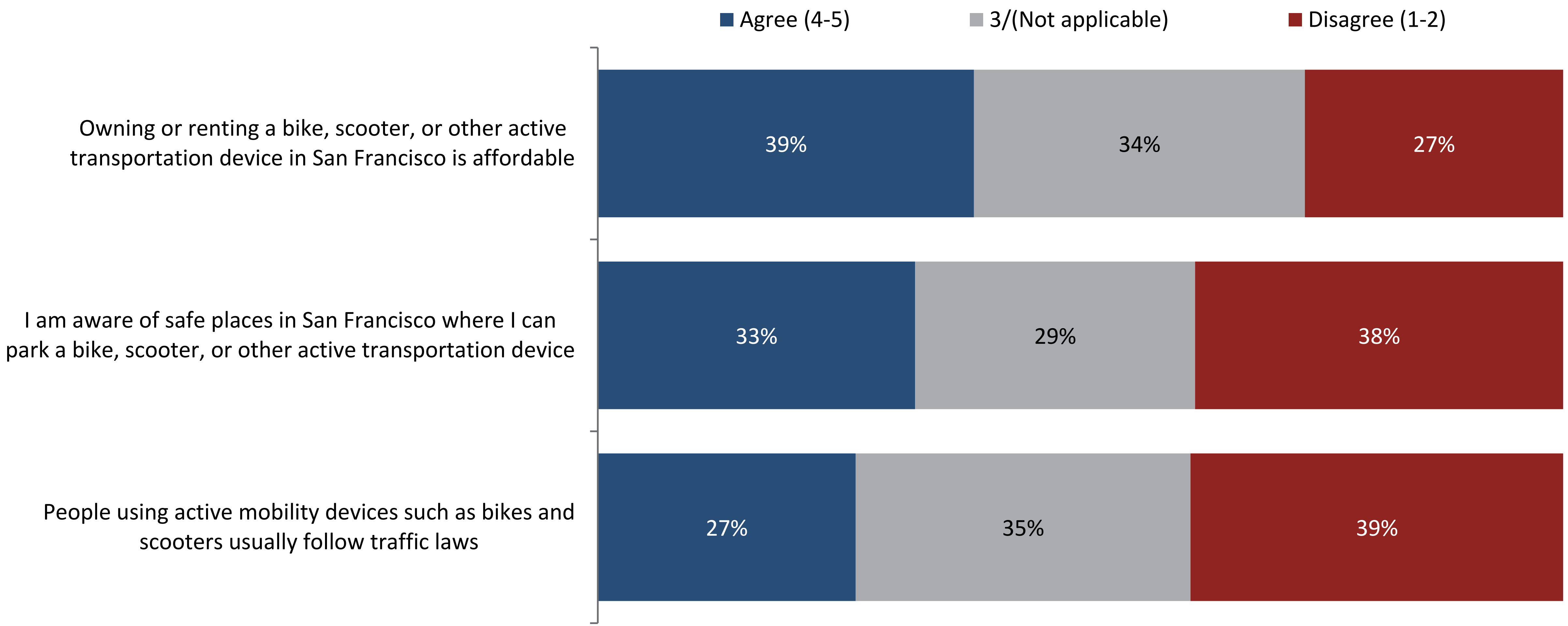
Which of the following have you done?
(multiple responses accepted)



Q32.

Western Addition EPC: Active Transportation Perceptions

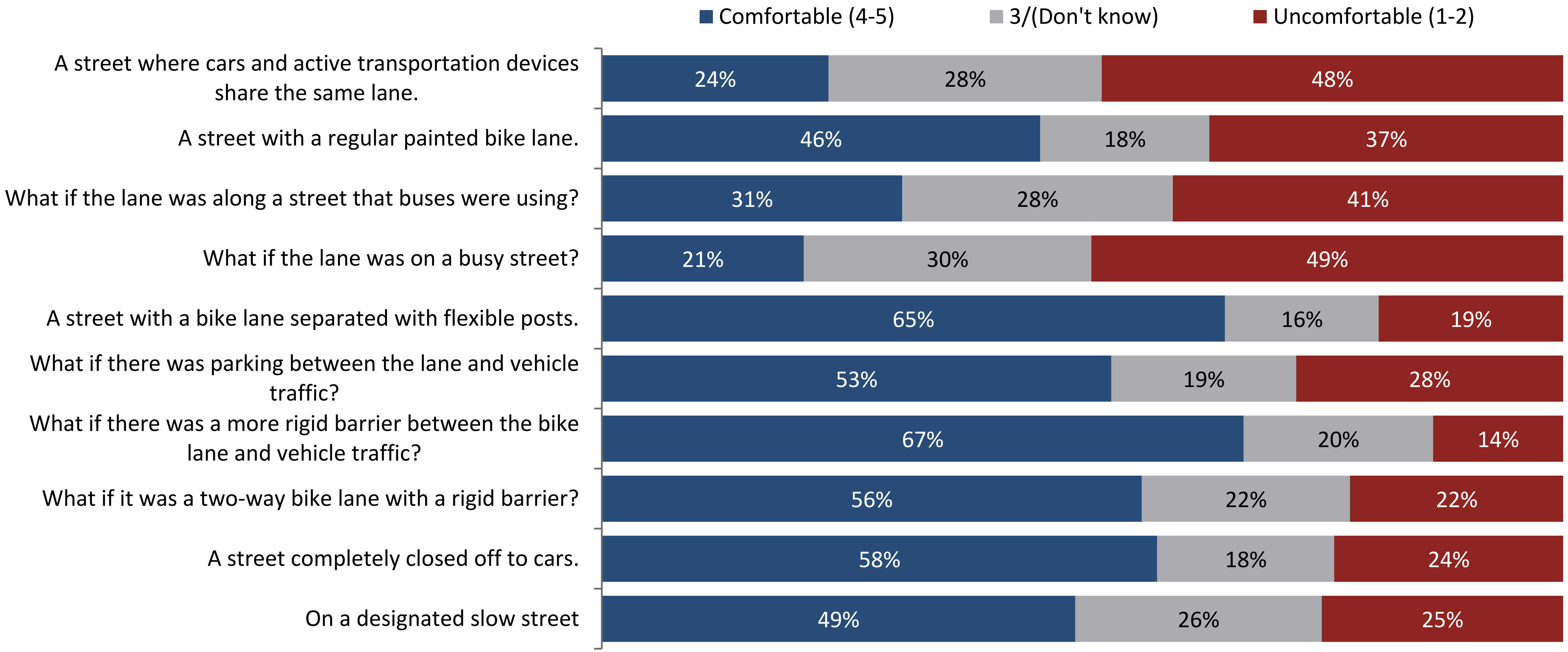
One-third of Western Addition EPC respondents were aware of safe places to park active transportation devices.



* % usage calculated from respondents who ever use each device

Western Addition EPC: Facility Comfort Levels

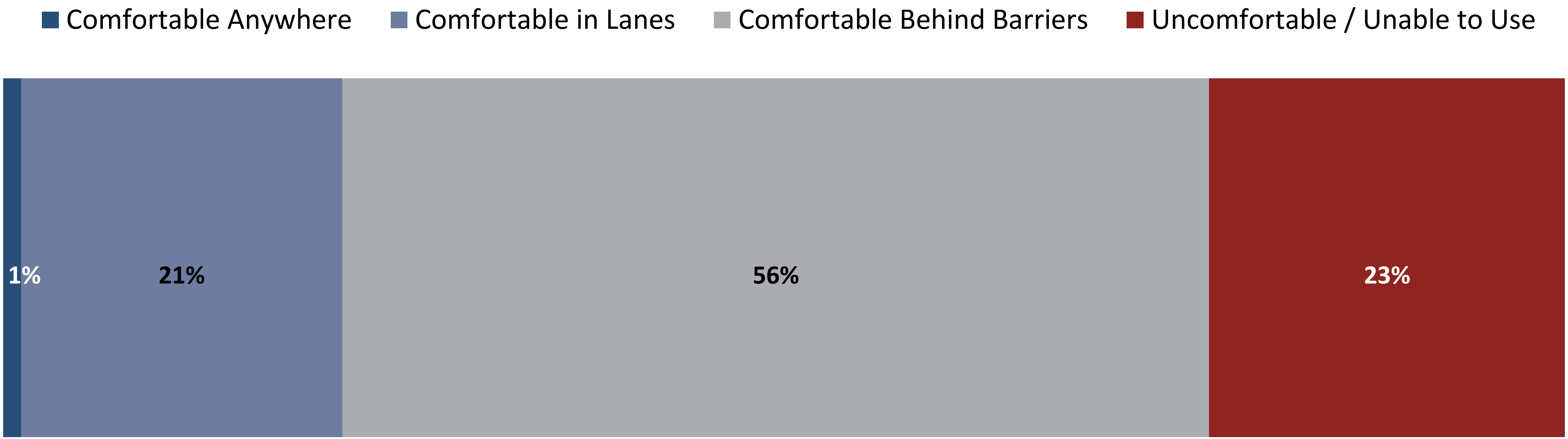
Adding barriers increased comfort for those interviewed in the Western Addition EPC.



Western Addition EPC: Active Transportation Network Comfort Index (ATNCI)

Just over half of those interviewed in the Western Addition EPC were only comfortable using the Active Transportation Network with barriers.

Comfortable anywhere: *Very comfortable on streets without lanes*
Comfortable in lanes: *Very comfortable as long as there are striped lanes*
Comfortable behind barriers: *Only comfortable with a physical barrier*
Uncomfortable/Unable to use: *Not comfortable in any environment, or unable to use ATN*



Draft Bicycle Comfort Index (BCI) Methodology

January 31, 2023

Purpose and Goals

Toole Design is supporting the SFMTA to update the agency's 2017 Bicycle Comfort Index (BCI) methodology and map. The updated BCI score will meet the SFMTA's implementation needs by:

- Capturing a variety of quantitative and qualitative factors that impact comfort, customized for the San Francisco context
- Applying a nuanced, defensible methodology that can be regularly updated and easily maintained
- Allowing the SFMTA to test and measure the impact of different design interventions on levels of comfort

Defining Bicycle Comfort

San Francisco's bicycle network is made up of five facility types (protected bikeway, bicycle lane, bicycle route, off-street multi-use path, and slow streets). But these categories do not capture how people experience these facilities while biking and rolling. The Bicycle Comfort Index evaluates San Francisco's street network using quantitative indicators of comfort. San Francisco's 2023 BCI builds upon and expands the nationally standardized Bicycle Level of Traffic Stress (LTS). LTS considers prevailing speed, ADT, number of lanes, lane width, facility type, and facility width. This iteration of San Francisco's BCI takes the LTS model a step further to consider other factors that influence perceptions of comfort, such as the type of vertical delineation along a bike lane, pavement quality, elevation, and surrounding land use conditions.

Proposed BCI Framework

Toole Design worked with the SFMTA staff to develop a BCI framework that tells a nuanced story about bicycle (and micromobility) comfort in San Francisco. The project team developed a framework for calculating BCI that is inspired by the questions: *"Of all the factors that influence comfort, which factors does SFMTA have influence over? Which factors fall outside of SFMTA's sphere of influence?"* With these questions in mind, the BCI is broken down into three "subscores". The subscores are generally organized to distinguish between those factors that the SFMTA can feasibly impact to improve comfort (such as type of bicycle facility), and factors that the SFMTA cannot influence (such as slope/elevation). In this way, **the BCI score will support the SFMTA staff to identify and invest in physical infrastructure or pursue policies that influence bicyclist comfort.**

Figure 1 illustrates the proposed BCI framework, including the ten inputs that make up each of the three subscores.

Figure 1: San Francisco 2023 BCI Draft Framework: 1 Composite Score, 3 Subscores, 10 Inputs

BCI Composite Score

Context Subscore

- Land Use
- Pavement Quality
- Reported Behavioral Violations
- Slope

Traffic Subscore

- Level of Traffic Stress (LTS)

  7 Sub-Inputs: Bike Class, Bike Lane Width (Assumed), Posted Speed, Intersection Control, Traffic Volume (ADT), Number of Lanes, Direction of Lanes
- Transit Presence
- Parking Time Limit

Bicycle Infrastructure Subscore

- Bicycle Facility Type

  4 Sub-Inputs: Bike Class, Buffer, Barrier Type, and Slow Streets
- Intersection Facility Type
- Green Wave Bicycle Streets

Three Subscores

Subscore #1: Context

The Context Subscore is made up of four (4) inputs. Table 1 shows how they mathematically contribute to the subscore and interact with one another. Table 1 also shows how they are weighted relative to one another. Segments can receive a maximum Context Subscore of 50.

Table 1: Context Subscore Inputs

Input	Mathematical Formulas	Point Range	Relative Weight in Subscore
Land Use	Additive	30 (16 to 46)	Highest
Pavement Quality	Additive	12 (-8 to 4)	Middle
Reported Behavioral Violations	Additive	8 (-8 to 0)	Lowest
Slope	Multiplier	NA	NA

The interaction between the four inputs can be described by the following formula:

(Land Use + Pavement Quality + Behavioral Violations) * Slope

Table 2 illustrates how different combinations of inputs can produce different Context Subscores. The examples described below are examples only and are not associated with specific real-world locations in San Francisco.

Table 2: Examples Context Subscores and Corresponding Input Scenarios

Context Subscore	Example Input Scenarios		
0 (Lowest possible score)	Commercial land use with poor pavement quality and many reported behavioral violations	Residential land use with an impassable slope	Public land use with poor pavement quality, many reported behavioral violations, and an uncomfortable slope
10 (Low)	Industrial land use with many reported behavioral violations	Public land use with poor pavement quality and many reported behavioral violations	Residential land use with a very uncomfortable slope
20 (Low-Mid)	Public land use poor pavement quality	Industrial land use with good pavement quality	Residential land use with an uncomfortable slope
30 (High-Mid)	Residential land use with poor pavement quality issues and a noticeable slope	Public land use with good pavement quality and many reported behavioral violations	Public land use with fair pavement quality and very few reported behavioral violations
40 (High)	Residential land use with poor pavement quality	Residential land use with several reported behavioral violations	Residential land use with good pavement quality and a noticeable slope
50 (Highest possible score)	Residential land use with good pavement quality and no slope	*(no other combinations produce this score)*	*(no other combinations produce this score)*

Subscore #2: Traffic

The Traffic Subscore is made up of three (3) inputs. Table 3 shows how they mathematically contribute to the subscore and interact with one another. Table 3 also shows how they are weighted relative to one another. Segments can receive a maximum Traffic Subscore of 50.

Table 3: Traffic Subscore Inputs

Input	Mathematical Formulas	Point Range	Relative Weight in Subscore
Level of Bike Traffic Stress (LTS)*	Additive	30 (20 to 50)	Highest
Parking Time Limit	Additive	12 (-12 to 0)	Middle
Transit Presence	Additive	8 (-8 to 0)	Lowest

*LTS is made up of a further seven inputs: Bike Facility Classification, Bike Lane Width, Prevailing Speed (Posted Speed Limit where Prevailing is not available), Intersection Control, Traffic Volume (ADT), Number of Lanes, and Direction of Lanes

The interaction between the three inputs can be described by the following formula:

LTS + Curbside Turnover + Transit Presence

Table 4 illustrates how different combinations of inputs can produce different Traffic Subscores. The examples described below are examples only and are not associated with specific real-world locations in San Francisco.

Table 4: Examples Traffic Subscores and Corresponding Input Scenarios

Traffic Subscore	Example Input Scenarios		
0 (Lowest possible score)	LTS 4 on a Transit corridor with extremely frequent Curbside Turnover	*(No other combinations for a zero score)*	*(No other combinations for a zero score)*
10 (Low)	LTS 4 on a Transit corridor	LTS 4 with very frequent Curbside Turnover	LTS 3 on a Transit corridor with extremely frequent Curbside Turnover
20 (Low-Mid)	LTS 4 without Transit and extremely infrequent Curbside Turnover	LTS 3 on a Transit corridor	LTS 2 on a Transit corridor with extremely frequent Curbside Turnover
30 (High-Mid)	LTS 2 with very frequent Curbside Turnover	LTS 2 on a Transit corridor	LTS 3 without Transit and extremely infrequent Curbside Turnover
40 (High)	LTS 1 on a Transit corridor	LTS 1 with very frequent Curbside Turnover	LTS 2 without Transit and extremely infrequent Curbside Turnover
50 (Highest possible score)	LTS 1 without Transit and extremely infrequent Curbside Turnover	*(No other combinations produce this score)*	*(No other combinations produce thus score)*

Traffic Subscores are used to moderate the comfort impact of different bicycle facility types under the Bicycle Infrastructure Subscore. To that end:

- Heavy Traffic Conditions (shown in orange) = Traffic Subscore of 10 or below out of 50
- Neutral Traffic Conditions = Traffic Subscore of 11 – 39 out of 50
- Light Traffic Conditions (shown in green) = Traffic Subscore of 40 or above out of 50

Subscore #3: Bicycle Infrastructure

The Bicycle Infrastructure Subscore is made up of three (3) inputs. Table 5 shows how they mathematically contribute to the subscore and interact with one another. Table 5 also shows how they are weighted relative to one another. Segments can receive a maximum Bicycle Infrastructure Subscore of 50.

Table 5: Bicycle Infrastructure Subscore Inputs

Input	Mathematical Formulas	Point Range	Relative Weight in Subscore
Bike Facility Type	Additive, Conditional	35 (5 to 40)	Highest
Intersection Bike Facility Type	Additive, Conditional	10 (0 to 10)	Middle
Green Wave Signal Streets	Additive, Bonus	5 (0 to 5)	Lowest

The interaction between the three inputs can be described by the following formula:

Bicycle Facility Type + Intersection Bike Facility Type + Green Wave

This subscore accounts for the fact that no facility exists in isolation from the surrounding traffic context. The same facility type may be either appropriate and comfortable OR inappropriate and uncomfortable, depending on the traffic context. For example, a Class II Bike Lane with a buffer may be appropriate and comfortable on quiet street with low volumes and speeds. That same facility is inappropriate and may be uncomfortable on a busy street with high volumes and speeds. **Therefore, the number of points allocated to each facility type is modified by the surrounding traffic.** Table 6 shows the number of points allocated to each bicycle facility type, depending on the traffic conditions. More specifically, it shows the number of points allocated depending on the Traffic Subscore. Table 7 shows the number of points allocated to each Intersection Facility Type, depending on the Traffic Subscore.

Table 6: Point Allocation per Bicycle Facility Type, Modified by Traffic Context

	Heavy Traffic	**Neutral Traffic**	**Light Traffic**
Traffic Subscore Range	**0-10**	**11-39**	**40-50**
Bicycle Facility Type			
Class III – Bike Route	5	10	10
Class II – Bike Lane no buffer	10	16	20
Class IV – SBL with “CURB”	10	16	20
Class II – Bike with buffer	16	20	25
Class IV – SBL with “SAFE-HIT POST”	20	23	30
Class IV – SBL with “CONCRETE” or “CONCRETE ISLAND”	25	27	35
Class IV – SBL with “K-RAIL”	35	30	40
Class IV – SBL with “BACK-IN ANGLED PARKING” or “PARKING”	35	35	40
Slow Street	20	35	40
Class I – Bike Path	40	40	40

Table 7: Point Allocation per Intersection Facility Type, Modified by Traffic Context

	Heavy Traffic	Neutral Traffic	Light Traffic
Traffic Subscore Range	**0-10**	**11-39**	**40-50**
Intersection Facility Type			
“Intersection sharrow” or “Mixing zone”	0	2	2
“Crossbike”	4	5	6
“Two-stage left” or “Jughandle” or “Bike Box” or “Bike Signal”	7	8	10
“Bike channel” or “Protected corner” or “Protected intersection”	10	10	10

Table 8 illustrates how different combinations of inputs can produce different Traffic Subscores. The examples described below are examples only and are not associated with specific real-world locations in San Francisco.

Table 8: Examples Bicycle Infrastructure Subscores and Corresponding Input Scenarios

Infrastructure Subscore	Example Input Scenarios		
0 (Lowest possible score)	“Heavy Traffic Condition” – Bike Route with a Sharrow	“Heavy Traffic Condition” – No facilities	Neutral Traffic Condition” – marked Crossbike
10 (Low)	“Heavy Traffic Condition” – Bike Lane without a Buffer	“Heavy Traffic Condition” – Bike Route with a marked Crossbike	“Neutral Traffic Condition” – Bike Route with a Sharrow
20 (Low-Mid)	“Heavy Traffic Condition” – Buffered Bike Lane with a marked Crossbike	“Neutral Traffic Condition” – Buffered Bike Lane with a marked Crossbike	“Light Traffic Condition” – Bike Lane without a Buffer
30 (High-Mid)	“Heavy Traffic Condition” – Concrete-protected SBL with a Two-Stage Left	“Neutral Traffic Condition” – K Rail-protected SBL	“Light Traffic Condition” – Safe Hit Posts-protected SBL
40 (High)	“Heavy Traffic Condition” – Bike Path	“Heavy Traffic Condition” – Green Wave Street with Parking-protected SBL	“Neutral Traffic Condition” – Slow Street with a marked Crossbike
50 (Highest possible score)	Any Traffic Condition – Bike Path with a protected intersection	“Light Traffic Condition” – Concrete-protected SBL with a Two-Stage Left	“Neutral Traffic Condition” – Green Wave Street with Parking-protected SBL and a Bike Box

Final BCI Score

The BCI score is the summation of all three subscores, weighted equally with their 50-point ranges, and has a total point potential of 150 points. The total equation for a segment's BCI is below.

((Land Use + Behavioral Violations + Pavement Quality) * Slope))
+ (LTS + Transit Presence + Curbside Turnover)
+ (Bike Facility Type + Intersection Bike Facility Type + Green Wave)

Every segment in San Francisco's street network will receive a BCI score between 0 and 150. The scoring range will be broken into even or proportional buckets. The draft methodology breaks the BCI range into five equal buckets. The final scoring breakdown and naming convention will be determined in coordination with SFMTA staff and the BCI Working Group. Table 9 provides example input and subscore scenarios that can produce scores in each of the five buckets.

Table 9: BCI Score point ranges and possible input scenarios to achieve each score

BCI Score	Example Subscores	Example Input Scenarios
121-150	Highest Context Subscore + High Traffic Subscore + High Bike Infrastructure Subscore	Residential land use with fair pavement quality, LTS 1 on a Transit corridor, and Safe Hit Posts-protected SBL with a Bike Signal
91-120	Highest Context Subscore + High-Mid Traffic Subscore + High-Mid Bike Infrastructure Subscore	Residential land use with good pavement quality, LTS 2 with frequent Curbside Turnover, and Green Wave Street with a Buffered Bike Lane and Protected Intersection
61-90	High-Mid Context Subscore + High-Mid Traffic Subscore + Low-Mid Bike Infrastructure Subscore	Public land use with good pavement quality and many reported behavioral violations, LTS 3 without Transit and extremely infrequent Curbside Turnover, and Buffered Bike Lane with a marked Crossbike
31-60	Lowest Context Subscore + Lowest Traffic Subscore + High Bike Infrastructure Subscore	Public land use with poor pavement quality and many reported behavioral violations, LTS 4 on a Transit corridor with extremely frequent Curbside Turnover, and K Rail-protected SBL with a Protected Corner
0-30	Low Context Subscore + Lowest Traffic Subscore + Lowest Bike Infrastructure Subscore	Residential land use with good pavement quality and a very uncomfortable slope, LTS 3 on a Transit corridor with extremely frequent Curbside Turnover, and Bike Route with a marked Crossbike

Mathematical Formulas

The draft BCI formula is designed to be a mathematical description of real-world interactions between the various factors that influence comfort. To capture the nuance of real-world interactions and interdependence, the formula uses weighting, multipliers, conditional formulas, and bonus points:

Additive Points and Weighting

Under the draft methodology, many inputs are additive (ie. they are assigned points, and those points are simply added together). To add nuance to additive inputs, each input is weighted according to how much it influences comfort in the real world, relative to other inputs. Weighting is achieved by assigning different inputs with different potential point ranges. For example, the Traffic Subscore is the summation of LTS + Transit Presence + Parking Time Limit. Each input is assigned a weighted point range: LTS = 30 Point Range (From 20 to 50), Transit Presence = 12 Point Range (From -12 to 0), Parking Time Limit = 8 Point Range (From -8 to 0). The variation in the point ranges produces varied weighting. In this case, LTS has the largest possible point range and is therefore is weighted most heavily. Point allocation, and therefor weighting, can be adjusted in coordination with SFMTA staff and the BCI working group.

Multiplier

Under the Context Subscore, "Slope" is treated as a multiplier

In contrast to land use, pavement quality, and behavioral violations, slope is un-changeable. Slope impacts comfort independent of the other three inputs. Slope is therefore multiplied with, rather than added to, the summation of the other three inputs. Therefore, severe, or impassable slope (>8%) can override any comfort provided by the other three inputs. Ranging from 0% to 100%, this multiplier input can only reduce the summation of the previous context inputs.

Conditional Performance

Under the Bicycle Infrastructure Subscore, "Facility Type" and "Intersection Type" are both treated as conditional, depending on the surrounding traffic conditions.

This BCI accounts for the fact that no facility exists in isolation from the surrounding traffic context. The same facility type may be either appropriate and comfortable OR inappropriate and uncomfortable, depending on the traffic context. For example, a Class II Bike Lane with a buffer may be appropriate and comfortable on quiet street with low volumes and speeds. That same facility is inappropriate and may be uncomfortable on a busy street with high volumes and speeds. Therefore, the number of points allocated to each facility type is modified by the surrounding traffic

Bonus Points

Under the Bicycle Infrastructure Subscore, "Green Wave Streets" are treated as bonus points.

The proposed BCI model allows street segments to receive the highest possible Bicycle Infrastructure Subscore (50 out of 50 points), without even considering the presence of Green Wave Streets. Segments can receive a maximum of 40 points for Bicycle Facility, and a maximum 10 points for intersection type. Under that scenario, the presence or absence of Green Wave signals is moot. However, if a segment has a combined Facility Type + Intersection Type score of 45, the presence of Green Wave signals can contribute up to 5 bonus points for a total of 50 points. Note that the maximum subscore possible is capped at 50. If a segment has a combined Facility Type + Intersection Type score of 48, the presence of Green Wave signals will bring the facility to 50 points, but will not result in points beyond 50.

Assumptions and Limitations

Due to data availability or form, simplification of the methodology, and/or other reasons, this BCI is limited in its ability to exactly express the expected or true comfort on every facility. Some of these limitations include:

- **Impact of Land Use:** Under the proposed methodology, Commercial, Mixed Use, and Industrial land uses are all considered “uncomfortable” for bicyclists. However, commercial areas can contribute to a sense of personal safety or comfort due to "eyes on the street", placemaking, or streetscaping. Similarly, industrial areas can feel comfortable when traffic volumes and speeds are low. This BCI methodology does not account for these possible positive impacts. The Residence Preference Survey will help calibrate and adjust the methodology as it relates to this assumption/ limitation. For segments that have different land uses on each side of the street, the "more comfortable" (higher point earning) land use is assumed to take precedence (e.g., a segment with commercial on one side and residential on the other will be classified as residential).
- **Reported Behavioral Violations:** By nature of publicly reported data, this 311 source may skew frequency in the raw data to poorer areas of San Francisco or generally have different patterns in differently reporting neighborhoods, falsely showing an increase in one area over another.
- **Parking Time Limit (Proxy for Curbside Turnover):** The methodology does not adjust the comfort impact of parking turnover for different facility types. For example, parking turnover will have the same impact on the Traffic Comfort Score at locations with bike lanes, parking protected bike lanes, and separated bike paths. We know that parking-protected bike lanes and Class I paths may not feel the full effect of curbside turnover, but this nuance is not captured by the model.
- **Bike Lane Width and Buffer Width:** Discrete data for these potential inputs is not readily available. Bike Lanes are assumed to be 6 feet wide and the Buffer input is used as a binary (either present or not present). Therefore, this BCI is not able to further distinguish between facilities with wide buffers and narrow buffers or allocate points to wide bike lanes that could accommodate side-by-side riding.
- **Speed Limits:** Posted speed limit data is older than the implementation of the Slow Streets Program and Slow Streets segments. Therefore, all Slow Streets segments are assumed to have a speed limit of 15 mph to match with the intention of the program.
- **Temporal Changes/Differences:** This BCI does not account for changes in context, traffic, etc. throughout the day, throughout the week, and throughout the year. Different times of day, days of the week, and seasons may affect the performance or data (e.g., ADT near schools will decrease in the summer months), but this BCI is stagnant in time.
- **Different Users:** This BCI does not account for different comfort levels experienced by different user types (e.g., e-bikes may not experience steep slope as uncomfortable). This BCI will be used in tandem with the cross-tabulated findings from the Residence Preference Survey to tell the story of how different demographics feel about different contexts/ facility types.