VISION ZERO SF

VISION ZERO HIGH INJURY NETWORK: 2022 UPDATE

A METHODOLOGY FOR SAN FRANCISCO, CALIFORNIA
NOVEMBER 2022

San Francisco Department of Public Health, Center for Data Science
in collaboration with the
San Francisco Municipal Transportation Agency

POPULATION HEALTH DIVISION
SAN FRANCISCO DEPARTMENT OF PUBLIC HEALTH

November 15, 2022 (v. 1.0)

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Executive Summary

This report describes the methodology applied in 2022 by the San Francisco Department of Public Health (SFDPH) to identify corridors with high concentrations of severe traffic injuries and fatalities in support of San Francisco's Vision Zero policy, in collaboration with the San Francisco Municipal Transportation Agency.

San Francisco adopted Vision Zero as City policy in 2014, with the goal of zero traffic deaths for all modes, including people in motor vehicles, walking, and cycling[1]. The 2022 Network update includes key data enhancements that provide the most comprehensive analysis San Francisco has had to date with respect to the location of severe and fatal injuries. It is our hope that this analysis helps the City be more targeted in its Vision Zero investments.

San Francisco is the first city in the country to use mapped hospital data along with police injury data to analyze spatial patterns of severe and fatal injuries in support of Vision Zero. These data were used to identify locations of unreported traffic injuries – people treated at Zuckerberg San Francisco General Hospital (ZSFG) with injuries not reported to the San Francisco Police Department (SFPD). In addition, when possible, injury severity of SFPD reported data were updated to reflect a more accurate injury outcome as determined by ZSFG medical staff.

Each block in the San Francisco's street network was transformed (i.e., "corridorized") into overlapping quarter mile sections. The highest scoring sections (i.e., most injuries per mile) along a street were selected using an injury per mile threshold to determine network eligibility. Natural start and end points were determined based on the threshold chosen.

Given the unprecedented changes that occurred due to the COVID-19 pandemic that started in early 2020, a decision was made to use 5 years of severe and fatal crash data instead of the 3 years used during the 2017 update. There is uncertainty about whether data from 2020 and 2021 are brief aberrations in crash patterns or if these data are current state indicators of longitudinal trends. The 2022 Vision Zero High Injury Network Update includes 5 years of severe injury and fatality collision data: 3 years (2017-2019) prior to the pandemic, and 2 years (2020-2021) during the pandemic to adjust for this uncertainty.

The updated Network (Figure 1 and Figure 2) continues to be focused exclusively on severe and fatal traffic-related injuries across all modes of travel using the comprehensive Transportation Injury Surveillance Dataset (TISS). TISS includes linked fatalities reported by the Office of the Medical Examiner, linked/unlinked patients suffering severe injuries at ZSFG due to a traffic crash, and linked/unlinked crash reports from SFPD where the victim was observed to have suffered a severe injury. This was done to better align the updated network with the goal of Vision Zero to eliminate all traffic fatalities and reduce severe injuries.

At a high level, the 2022 High Injury Network, which is based on five years of data between 2017-2021 revealed that the Network represents 12% of city street miles and captures 68% severe and fatal injuries (Table 1). The Network performs better when capturing fatalities; the 2022 Network captures 74% of fatalities that occurred between January and September 2022. Moreover, as summarized in Table 2, pedestrians are the highest proportion of severe and fatal injuries captured on the 2022 High Injury Network (70.5%) relative to other modes. Pedestrians and cyclists also represent a greater majority of all injuries captured on the 2022 High Injury Network.

Table 1. Mileage Summary Statistics*

	Miles of Network on City Streets*	Percent of City Streets*	Percent Capture of Severe & Fatal Injuries	Miles Overlap with 2017 VZ High Injury Network	Percent Overlap with 2017 VZ High Injury Network
2022 VZ High Injury Network	121.5	12.2%	68.2%	76.7	63.1%

*Does not include street miles from freeways, The Presidio, Fort Mason, and streets closed to vehicles.

Table 2. Injury Summary Statistics 2022 Vision Zero High Injury Network (SFPD and ZSFG, 2017-2021)*

Transportation Mode	Count of TISS *Severe or Fatal Injuries* by Mode on the 2022 Vision Zero High Injury Network	Count of TISS *Severe or Fatal Injuries* by Mode across San Francisco	Percent of TISS *Severe or Fatal Injuries* by Mode on 2022 Vision Zero High Injury Network	Count of *All SFPD Injuries* by Mode on the 2022 Vision Zero High Injury Network	Count of *All SFPD Injuries* by Mode across San Francisco	Percent of *All SFPD Injuries* by Mode on 2022 Vision Zero High Injury Network
Pedestrian	644	913	70.5%	2,397	3,893	61.6%
Cyclist	296	462	64.1%	1,553	2,491	62.3%
Motor Vehicle Occupant	579	845	68.5%	7,462	12,465	59.9%
Motorcyclist	226	343	65.9%			
Other	47	64	73.4%	291	433	67.2%
All Injuries	1,792	2,627	68.2%	11,703	19,282	60.7%

"TISS" includes all SFPD & ZSFG severe and fatal transportation injuries recorded in San Francisco between 2017-2021 (N=2,627); "SFPD" indicates all police reported transportation injuries between 2017-2021 (N=19,282)

*Does not include n=62 crashes on The Presidio, Fort Mason, and streets closed to vehicles; and/or intentional assault or self-harm crashes.

Geocoded injury data as pulled on 11/01/2022.

San Francisco Police Department (SFPD) collision reports, 2017-2021.
Zuckerberg San Francisco General Hospital (ZSFG) data linked to Emergency Medical Services data, 2017-2021.

Figure 1. Map of 2022 Vision Zero High Injury Network

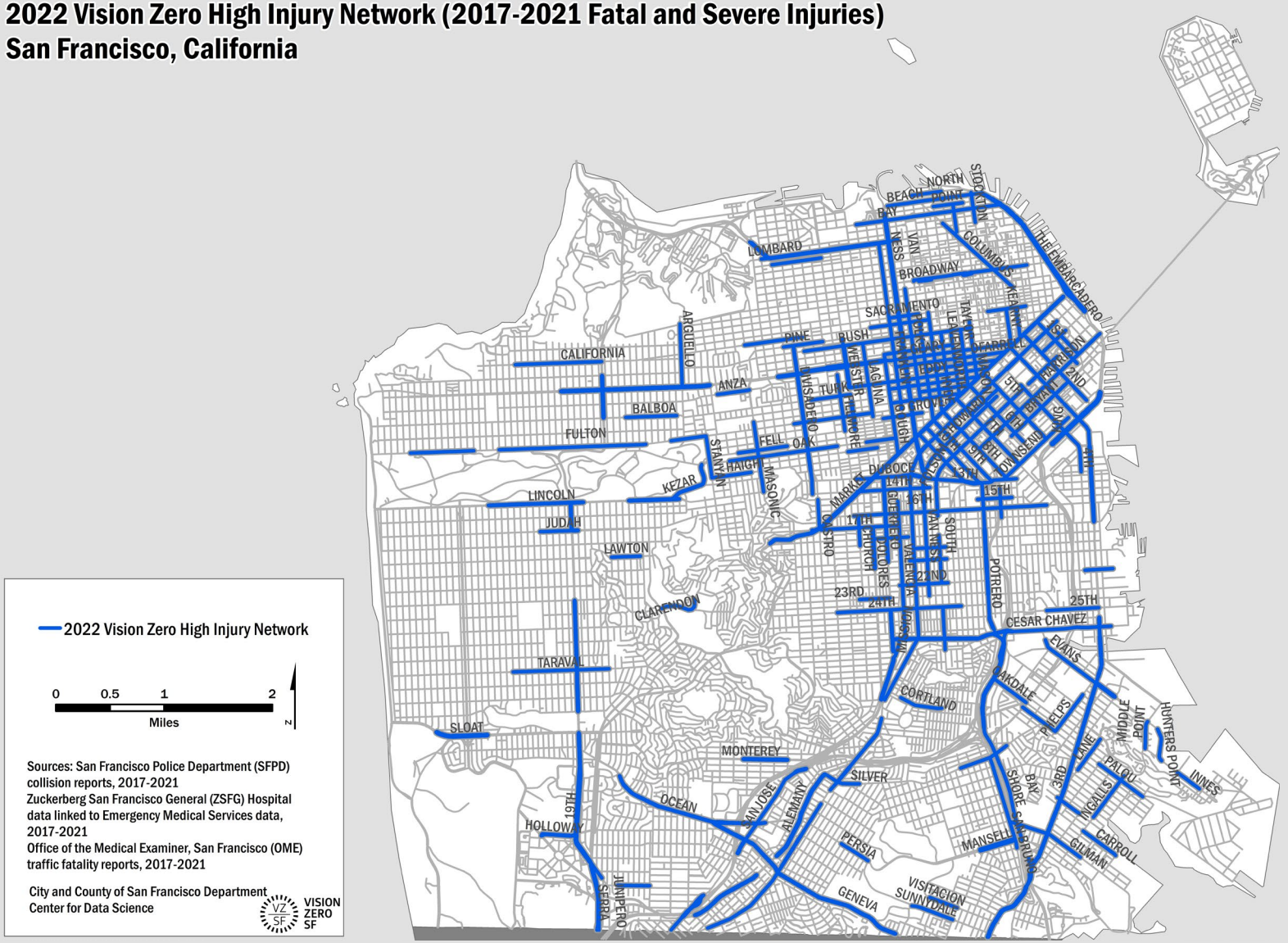
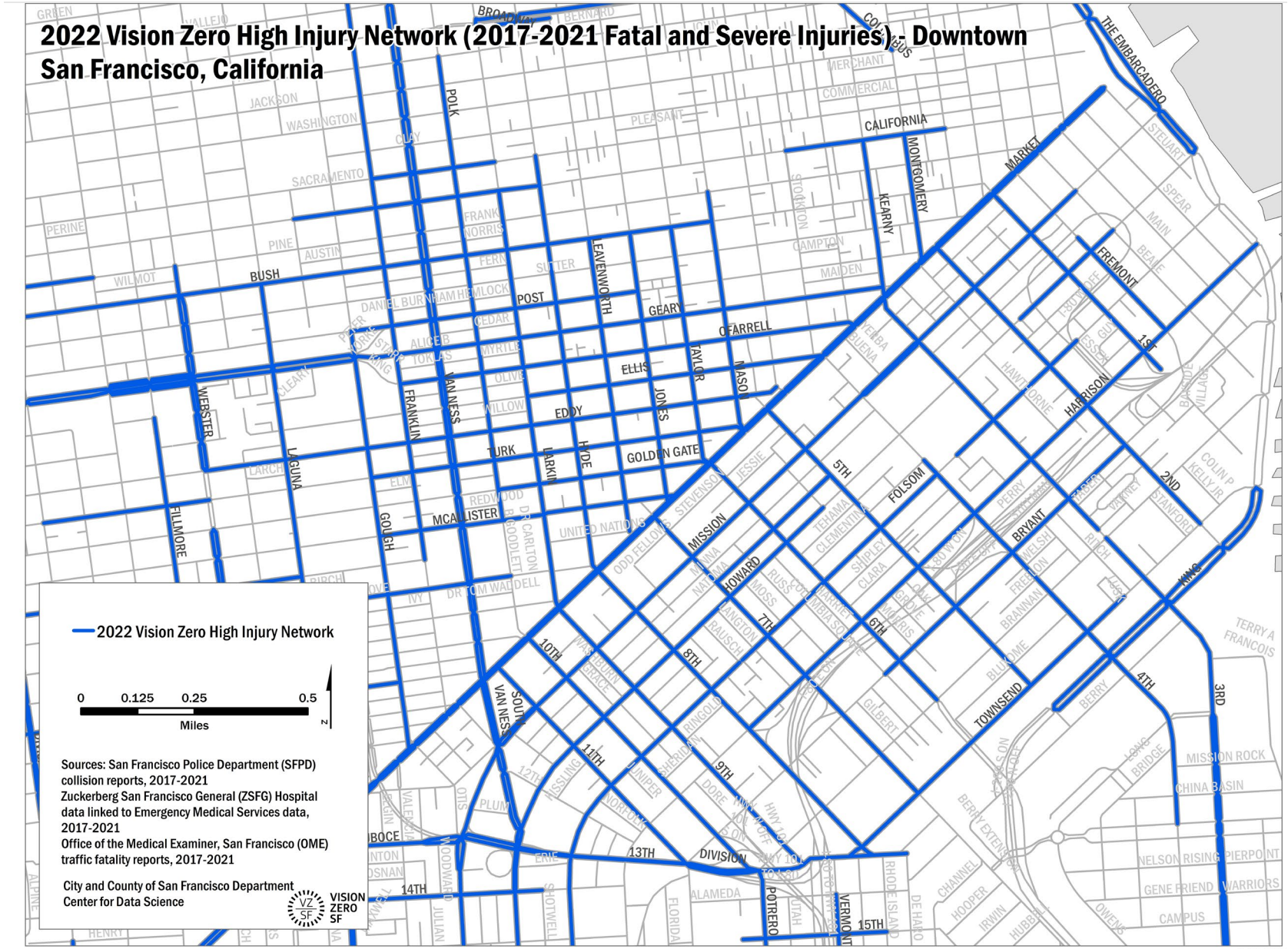


Figure 2. Downtown Map of 2022 Vision Zero High Injury Network



Recommended Citation

San Francisco Department of Public Health – Center for Data Science. 2022. *Vision Zero High Injury Network: 2022 Update – A Methodology for San Francisco, California.* San Francisco, CA. Available at: https://www.visionzerosf.org/wp-content/uploads/2022/11/2022_Vision_Zero_Network_Update_Methodology.pdf

Disclaimers

Data and Methods: This methodology is provided as public information as defined under San Francisco and California public records laws. The San Francisco Department of Public Health (SFDPH), the San Francisco Municipal Transportation Agency (SFMTA), and the San Francisco Police Department (SFPD) cannot limit or restrict the use of the data provided by this methodology by other parties in any way. Where this methodology or data are communicated, distributed, reproduced, mapped, or used in any other way, the user should: 1) acknowledge SFDPH's Center for Data Science (CDS) as the methodology's source (see Recommended Citation), and the SFDPH-Traffic Injury Surveillance System (TISS)/SFPD-TransBASE as the data source, and include the data time period; and 2) provide a reference to this documentation where applicable. However, users should not attribute their own analysis or interpretation of data to SFDPH, SFMTA, SFPD, or the City and County of San Francisco ("City" or "CCSF").

While the data presented in this report has been collected and/or produced for the use of the City, CCSF cannot guarantee its accuracy or completeness. Accordingly, CCSF, including SFDPH, SFMTA, and SFPD, make no representation as to the accuracy of the information or its suitability for any purpose, and disclaim any liability for omissions or errors that may be contained therein. As all data is associated with methodological assumptions and limitations, CCSF recommends that users review all documentation associated with this analysis prior to its interpretation or communication.

The Vision Zero High Injury Network ("Network"): The 2022 Vision Zero High Injury Network represents a snapshot in time (2017-2021) where severe and fatal injuries were most concentrated. It may not reflect current conditions or changes to the City's transportation system made since this point-in-time snapshot. Although prior crashes can be indicative of future crashes, the Vision Zero High Injury Network is not a prediction (probability) of future risk. The Network approach is in contrast to a risk-based analysis, which focuses on locations calculated to have an increased risk of injury as a result of a crash at a particular location by dividing the number of injuries or collisions by vehicle volumes at a given location to estimate risk of injury per vehicle at that location. The Vision Zero High Injury Network provides information regarding the streets where injuries, particularly severe and fatal, are concentrated in San Francisco based on injury counts; in other words, the High Injury Network Analysis is not an assessment of whether a street or a particular location is dangerous. The Vision Zero High Injury Network is derived from the more severe injury outcomes (count of severe or fatal injuries) based on an injury severity index, and may not include locations with counts of less severe injury collisions.

Hospital and emergency medical service records from which SFPD-unreported injury and reclassified injury collisions are derived are protected by the Health Insurance Portability and Accountability Act and state medical privacy laws, and thus the underlying records and data have strict confidentiality and privacy protections. As of November 2022, SFDPH is working in conjunction with SFDPH's Office of Compliance and Privacy Affairs, Zuckerberg San Francisco General Hospital ("ZSFG") and the SFMTA to determine to what extent SFDPH can share the data in compliance with federal and state privacy laws. Intersection and other small-area specific counts of severe/fatal injuries have thus been intentionally excluded from this document in order to protect privacy.

Only injuries and deaths with valid geographic information are mapped. All mappable injury data is represented on the simplified San Francisco street centerline model maintained by the Department of Public Works (SFDPW)[i]. Data on transportation-related injuries on streets in San Francisco that are reported to SFPD, or treated at ZSFG, are queried and aggregated on a yearly basis. Injuries and deaths occurring at complex intersections with multiple roadways are mapped onto a single point, and injuries and fatalities occurring on highways are excluded.

[i]City and County of San Francisco Department of Public Works/Bureau of Street-Use and Mapping. 2018. San Francisco Basemap Street Centerlines. San Francisco, CA. Available at: https://data.sfgov.org/Geographic-Locations-and-Boundaries/San-Francisco-Basemap-Street-Centerlines/7hfy-8sz8/data

SFDPH, SFMTA, and SFPD reserve the right to update this document if injury data is added, removed, or revised.

Background: 2010-2017

In 2014, San Francisco adopted Vision Zero as City policy – with a goal of *zero* traffic deaths for all modes, including people in motor vehicles, people walking, and people cycling by 2024. This document is a summary of the 2022 analysis to update the city's Vision Zero High Injury Network in support of San Francisco's Vision Zero policy.

Corridor-level analysis supports efficient and effective transportation injury prevention[2]. Prioritization based on high injury intersections alone typically identifies and addresses only a very small overall proportion of injuries. Because injuries, particularly severe and fatal, are relatively rare events at an individual intersection or location, there can be a high degree of variability at individual locations from year-to-year. However, when analyzing aggregated injury data over a few years, there are evident corridor patterns of injury that represent a larger share of injuries. The concentration of injury collisions along corridors often represents the aggregation of established environmental-level risk factors including traffic, pedestrian and cyclist volumes, and speeds as well as other corridor-specific conditions. Interventions targeting corridors can address the factors contributing to injuries at multiple blocks and intersections.

The original Pedestrian High Injury Corridors (PHIC) were created in 2011 in support of Mayor Gavin Newsom's Pedestrian Safety Executive Directive (2010) using traffic collision injury data obtained from the Statewide Integrated Traffic Records System (SWITRS) for years 2005-2009, the most current available at that time. In 2013 the PHIC was updated using SWITRS data for years 2007-2011 in coordination with SFMTA's WalkFirst, a pedestrian safety prioritization plan. At the request of the SFMTA's Livable Streets Program SFDPH created a Cyclist High Injury Corridors map in 2014 using SWITRS data from 2007-2011. A Vehicle High Injury Corridors map was created in 2014 using SWITRS data from 2008-2012 after San Francisco adopted Vision Zero. In 2015 all three corridor maps were combined and presented as the Vision Zero High Injury Network[3] as part of the first Vision Zero Two-Year Action Strategy.

Figure 3 is a map of the previous Vision Zero High Injury Network released in 2015.

The 2017 Vision Zero High Injury Network[4] update included using mapped hospital data along with police injury data from the Transportation Injury Surveillance System (TISS) to analyze spatial patterns of severe and fatal injuries for years 2013- 2015. TISS includes Emergency Medical Service (EMS) data from King-American Ambulance Company, American Medical Response, and San Francisco Fire Department Emergency Medical Services Agency, and was used to identify locations of unreported traffic injuries – people treated at the hospital with injuries not reported to SFPD. For the first time, severe transportation-related injuries identified in the hospital dataset were included in creating the network.

Figure 4 is a map of the previous Vision Zero High Injury Network released in 2017.

After a delay due to the 2020 COVID-19 pandemic, in 2022 SFDPH completed the linkage between ZSFG and SFPD datasets for 2017-2021. SFDPH convened a technical advisory group (TAC) composed of members from SFMTA, SFPD, SF Planning, SFDPW, and the SFCTA to advise on the refined methodological approach for the update to the Vision Zero High Injury Network as outlined in this document.

Figure 3. Map of 2015 Vision Zero High Injury Network [PREVIOUS NETWORK]

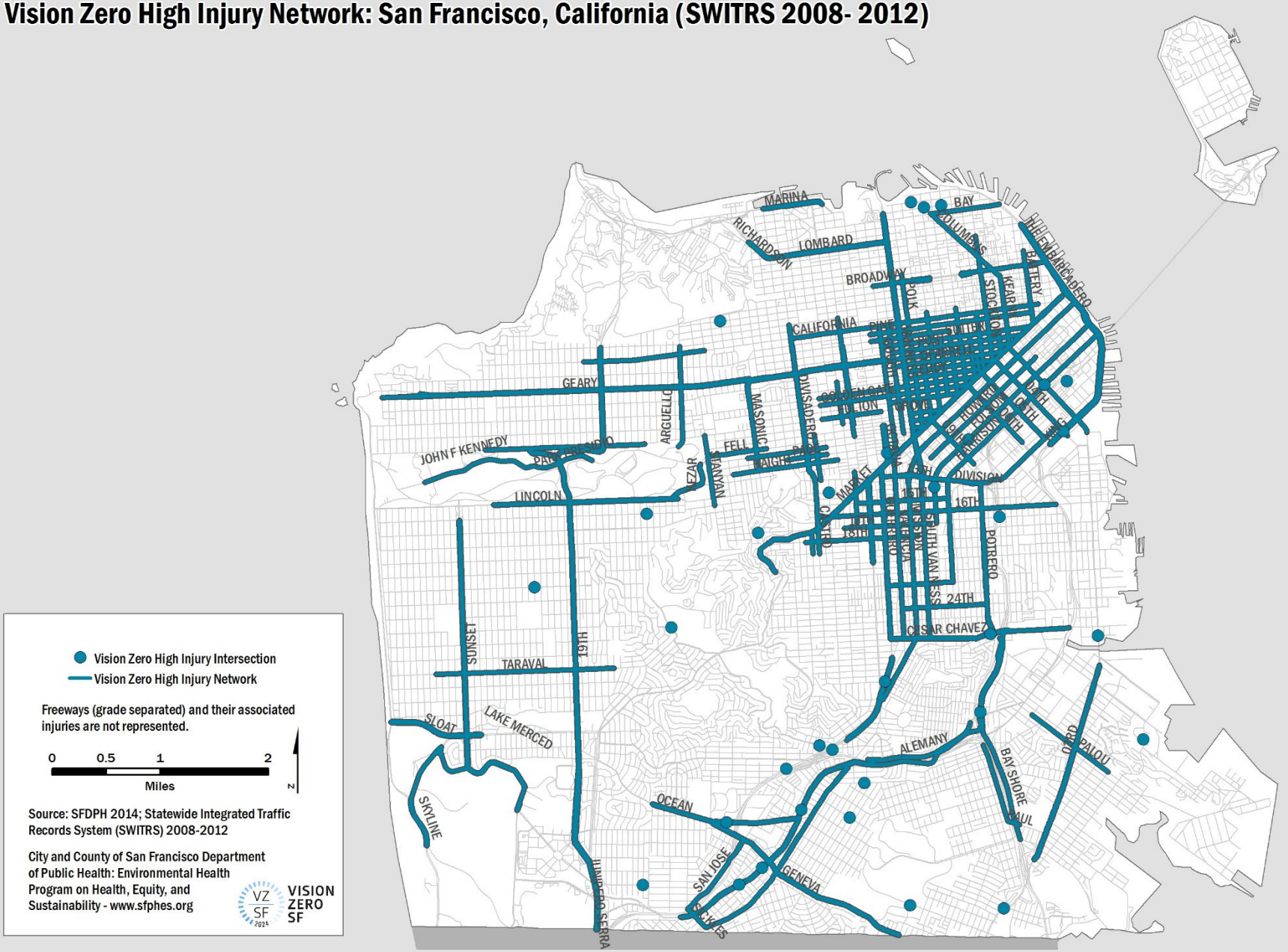
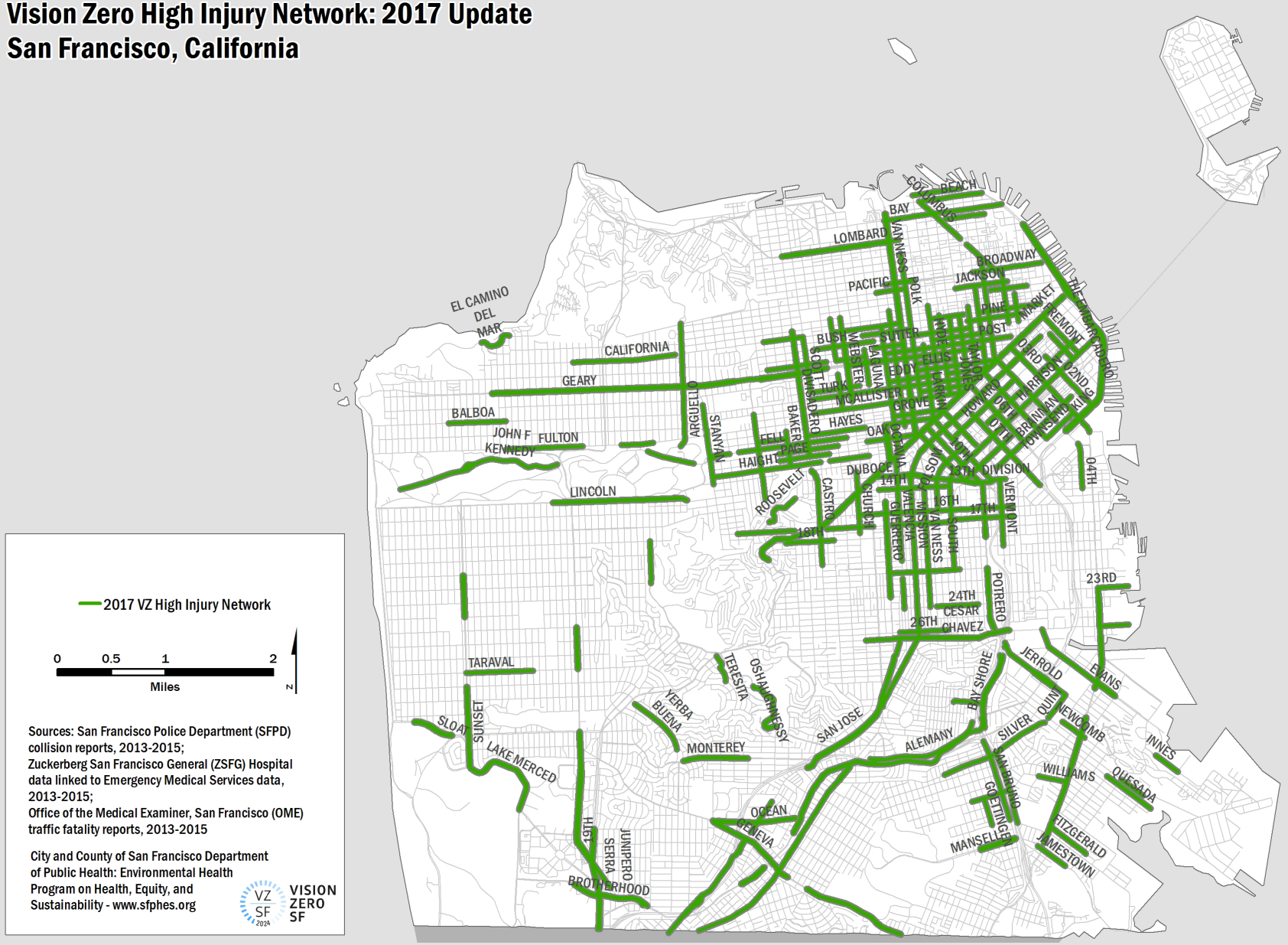


Figure 4. Map of 2017 Vision Zero High Injury Network [PREVIOUS NETWORK]



2022 Methodology

Continued use of the Transportation Injury Surveillance System

Since the creation of the original Vision Zero High Injury Network, the San Francisco Police Department (SFPD) has integrated crash reporting into TransBASE, a web platform for collision data, producing geospatial queries, data analysis of traffic collisions, and sharing collision reports. SFPD in conjunction with SFMTA and SFDPH have established data sharing to allow for inter-agency access to traffic collision data collected by this system. This allows for more timely access to SFPD collision report data.

SFDPH in conjunction with the Zuckerberg San Francisco General Hospital and Trauma Center (ZSFG), the only Level-One trauma center in San Francisco, have developed a comprehensive Transportation-related Injury Surveillance System (TISS) to conduct accurate, coordinated, and timely monitoring of transportation-related injuries and deaths. This system links existing transportation-related injury and fatality data collected by City and County of San Francisco agencies (including the SFPD collision reports, as well as hospitalization, emergency medical service, and Medical Examiner's Office (OME) data) into a comprehensive database to provide a more complete picture of transportation-related injuries occurring in the city. The creation of this data system has vastly expanded the City's access to data to better analyze the geographic distribution, causes, costs, and consequences of transportation-related injuries in San Francisco by utilizing detailed crash factor data in SFPD collision reports and health outcome data in ZSFG patient records.

The 2022 Vision Zero High Injury Network Update continues the four main improvements the occurred during the 2017 Vision Zero High Injury Update[2]:

- *Clinical Assessment of Injury Severity* - Utilizing hospitalization data from the TISS to **improve the accuracy of injury severity assessment** for SFPD-reported traffic injuries.
- *Inclusion of People Severely Injured and Treated at ZSFG but not in SFPD Data* - Utilizing the TISS data to **identify and geolocate ZSFG-only traffic injuries** in order to have a more comprehensive assessment of injury and injury locations.
- *Standardized Analytic Approach to Identifying Corridors* – Utilizing **improved geospatial analysis techniques** to better **identify concentration of linear patterns** of transportation-related severe and fatal injuries.
- *One Severe/Fatal Injury Network for All Transportation Modes* - Focusing on corridors with high numbers of persons killed and/or severely injured to **better align the network's purpose with the goal of Vision Zero to eliminate all traffic fatalities and reduce the most severe injuries.**

[2] https://www.sfdph.org/dph/files/EHSdocs/PHES/VisionZero/Vision_Zero_High_Injury_Network_Update.pdf

The **Vision Zero Rapid Response Protocol** was instituted in 2017. Rapid Response means SFMTA staff visit the site of the crash site within 24-48 hours after a traffic fatality to determine if any immediate-term repairs or site-specific improvements can be implemented. The Rapid Response program is not intended to supersede the SFPD's crash investigation, which consider a complex set of factors. Even before the primary cause of the crash is determined by investigators, Rapid Response seeks to identify any potential safety improvements that can be quickly installed or repaired.

This Vision Zero High Injury Network Update includes crash data from 2020 and 2021 during the height the coronavirus disease 2019 (COVID-19) pandemic. The San Francisco Department of Public Health issued its first Stay at Home Order on Tuesday, March 17, 2020. Due to the unprecedented social and economic disruption caused by the COVID-19 pandemic, there is uncertainty whether data from 2020 and 2021 are a temporary aberration in crash patterns or if the data from this period inform indicators of a longer-trend. Therefore, the 2022 Vision Zero High Injury Network Update includes 5 years of severe injury and fatality collision data: 3 years (2017-2019) prior to the pandemic and 2 years (2020-2021) during the pandemic to adjust for this uncertainty.

SFDPH is committed to evaluating how future post-pandemic crash data may alter the network and the potential necessity of updating the Vision Zero High Injury Network on a more frequent basis until trends in crash, traffic patterns, transit usage, and return to office work stabilize to a new normal.

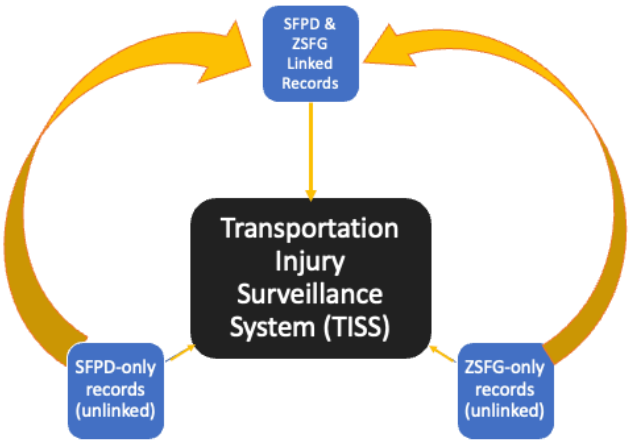
The 2022 Vision High Injury Network Update makes the following revisions:

- *Fatalities on Previous Network No Longer Automatically Qualify Corridor Section* – The Vision Zero Rapid Response Protocol has reshaped the way city agencies respond to traffic fatalities and **improved responsiveness of implementing changes to address the causes of one-off traffic fatalities.** Corridors no longer automatically qualify if they have had any fatal crash in the last 4 years (see pg. 23 for current corridor inclusion criteria).
- *Larger Sample Size of Severe and Fatal Injuries Over a 5-Year Period* – Uncertainty in changes to traffic crash patterns caused by the COVID-19 pandemic necessitates the **need for more data to cover the period before, during, and after the pandemic**. In addition, the five-year analysis horizon more closely matches what the SFMTA default analysis period is for site specific crash analysis.

Clinical Assessment of Injury Severity

As described above, both SFPD and ZSFG records were included in the 2022 High Injury Network Update. TISS uses LinkSolv[5] 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. Figure 5 details the possible outcomes of the linkage process between the SFPD and ZSFG datasets. 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.

Figure 5. TISS Dataset Linkage Outcomes



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[6]:

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[7], 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[8]. 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[9]. This definition of severe traffic-related injury is 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 as originally assessed by SFPD based on ZSFG data using the above criteria.

Table 3. Reclassification of SFPD Injury Severity based on ZSFG Data for Linked Records (N=7,493; 2017-2021)*

Linked/Reported Injury Extent	Count Extent of Injury	Percent
SFPD Categorized: Severe Injury	**1,165**	**15.5%**
Remained Severe (also severe per ZSFG record)	759	65.2%
Downgraded (not severe per ZSFG record)	406	34.8%
SFPD Categorized: Other Visible Injury	**2,248**	**30.0%**
Remained as Other Visible	1,779	79.1%
Upgraded to Severe per ZSFG record	469	20.9%
SFPD Categorized: Complaint of Pain	**4,080**	**54.5%**
Remained as Complaint of Pain	3,576	87.6%
Upgraded to Severe per ZSFG record	504	12.4%
Total	**7,493**	**100.0%**

*Includes n=62 crashes in The Presidio, Fort Mason, and streets closed to vehicles; and/or intentional assault or self-harm crashes.

Table 4. Reclassification of SFPD Injury Severity based on Hospital Data for Linked Records (N=7,493; 2017-2021)*

Injury Extent	Original SFPD Report	After Reclassification by linked ZSFG data	Percent Change
Severe Injury	1,165	1,732	48.7%
Non-severe Injury	6,328	5,761	-9.0%
Total		**7,493**	

*Includes n=62 crashes in The Presidio, Fort Mason, and streets closed to vehicles; and/or intentional assault or self-harm crashes.

After reclassification there was a net increase of 567 severe injuries among people injured with both SFPD and ZSFG records, for a total of 1,732 reported severe injuries in the linked dataset.

Inclusion of People Severely Injured and Treated at ZSFG but not in SFPD Data

Another advantage of utilizing data from TISS is the ability to include ZSFG data where a patient was injured in a transportation-related collision, but no SFPD report was filed. TISS utilizes data from emergency medical service providers King-American Ambulance Company, American Medical Response, and San Francisco Fire Department Emergency Medical Services Agency, to identify locations of unreported traffic injuries. From 2017-2021, TISS identified 650 severe injuries that were seen at ZSFG with location information mappable to a San Francisco city street, but *that were not linked to a SFPD collision report*.

Potential reasons why injury underreporting may be occurring in SFPD dataset include:

- An injured person chose not to report the collision to SFPD;
- SFPD did not respond to the scene of the injury or did not file a collision report;
- The collision was reported to another police agency (CHP, Sheriff, etc.);
- Linksolv was missing key variables and unable to complete a match.

Research findings from the 2013-2015 data linkage found transportation-injured ZSFG-treated patients lacking police reports were more often cyclists, male, Hispanic or Black, and less often occupants of motor vehicles compared to those with injuries captured only in police reports. Linking ZSFG and SFPD records capture injuries absent in police data, adding data on populations empirically vulnerable to injury. In addition, it improves injury severity assessment. Finally, linked data better informs and targets interventions serving injury-burdened populations and road users.[10]

Table 5 summarizes severe injuries that needed to be excluded from the dataset because they did not meet the case definition set out by the Vision Zero Fatality Protocol. These include severe injuries that occurred outside the public right of way in the City/County of San Francisco including crashes in the Presidio, Fort Mason, and private property; and crashes that included ICD-10 codes that indicated the crash was an intentional assault or self-harm (Y03.8XX, Y02.0XX, Y03.0XX, Y02.1XX, X82.0XX, X82.1XX, X82.2XX, X82.8XX, X81.0XX, X81.1XX). Also included are 4 SFPD crashes had no mappable location information.

Table 5. Severe Injuries Excluded from SFPD and ZSFG Dataset Due to Not Meeting the Vision Zero Fatality Protocol Definition (N=2,689; 2017-2021)

Exclusion Reason	Count Excluded	Percent
Outside CCSF Jurisdiction	**37**	**1.4%**
Intentional Assault/Self-Harm	**21**	**0.8%**
Unable to Geocode	**4**	**0.1%**
Total	**62**	**2.3%**

Table 6 summarizes all severe injuries and fatalities by data source and mode as a percent of total injuries (including fatalities). This is the final dataset that was mapped and used to generate the 2022 Vision Zero High Injury Network.

Table 6. Severe and Fatal Injuries by Data Source and Linkage Status (N=2,627; SFPD and ZSFG, 2017-2021)

Data Source	Count Injuries	Percent of Total Severe and Fatal Injuries *Across All Data Sources*	Percent of Severe and Fatal Injuries *Within Each Data Source*
ZSFG - Patient Record Not Matched to Police Report	**596**	**22.7%**	**100.0%**
Cyclist Severe Injury	169	6.4%	28.4%
Pedestrian Severe Injury	120	4.6%	20.2%
Vehicle Severe Injury	306	11.6%	51.3%
Other Severe Injury	1	0.1%	0.1%
SFPD and ZSFG - Patient Record Matched to Police Report	**1724**	**65.6%**	**100.0%**
Cyclist Severe Injury	239	9.1%	13.8%
Pedestrian Severe Injury	675	25.7%	39.2%
Vehicle Severe Injury	766	29.2%	44.4%
Other Severe Injury	44	1.7%	2.6%
SFPD - Police Report not Matched to Patient Record	**178**	**6.8%**	**100.0%**
Cyclist Severe Injury	44	1.7%	24.7%
Pedestrian Severe Injury	47	1.8%	26.4%
Vehicle Severe Injury	73	2.8%	41.0%
Other Severe Injury	14	0.5%	7.9%
OME – Office of the Medical Examiner Record (Fatalities)	**129**	**4.9%**	**100.0%**
Cyclist Fatality	10	0.4%	7.8%
Pedestrian Fatality	71	2.7%	55.0%
Vehicle Fatality	43	1.6%	33.3%
Other Fatality	5	0.2%	3.9%
Total	**2,627**	**100.0%**	**100.0%**

*Does not include n=62 crashes on The Presidio, Fort Mason, and streets closed to vehicles; and/or intentional assault or self-harm crashes.

Representing the header data sources from Table 6 above, but shown differently, Figure 6 below displays the proportion of severe and fatal injuries by data source. Without the addition of TISS data, 23% of traffic-related collisions that resulted in a severe injury where the individual(s) were transported to ZSFG would not be included in the analysis (Figure 6).

Using this new 2017-2021 dataset with a larger sample size of severe and fatal traffic-related injuries, both from underreporting and reclassification of existing data, the TAC decided to move forward with a Vision Zero High Injury Network that refocuses on addressing corridors with a high incidence of severe and fatal injuries. As demonstrated in Figure 7, vulnerable road users, pedestrians, and cyclists, still make up a majority of the dataset.

Figure 6. Percent of Severe and Fatal Injuries by Data Source (N=2,627; SFPD and ZSFG, 2017-2021)

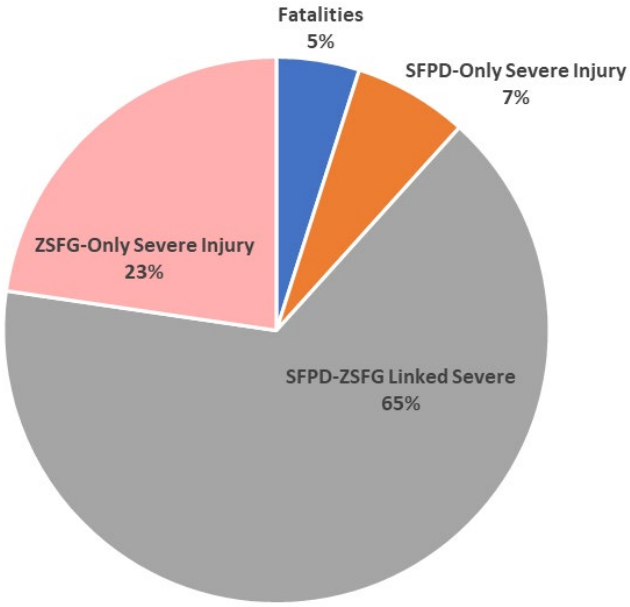
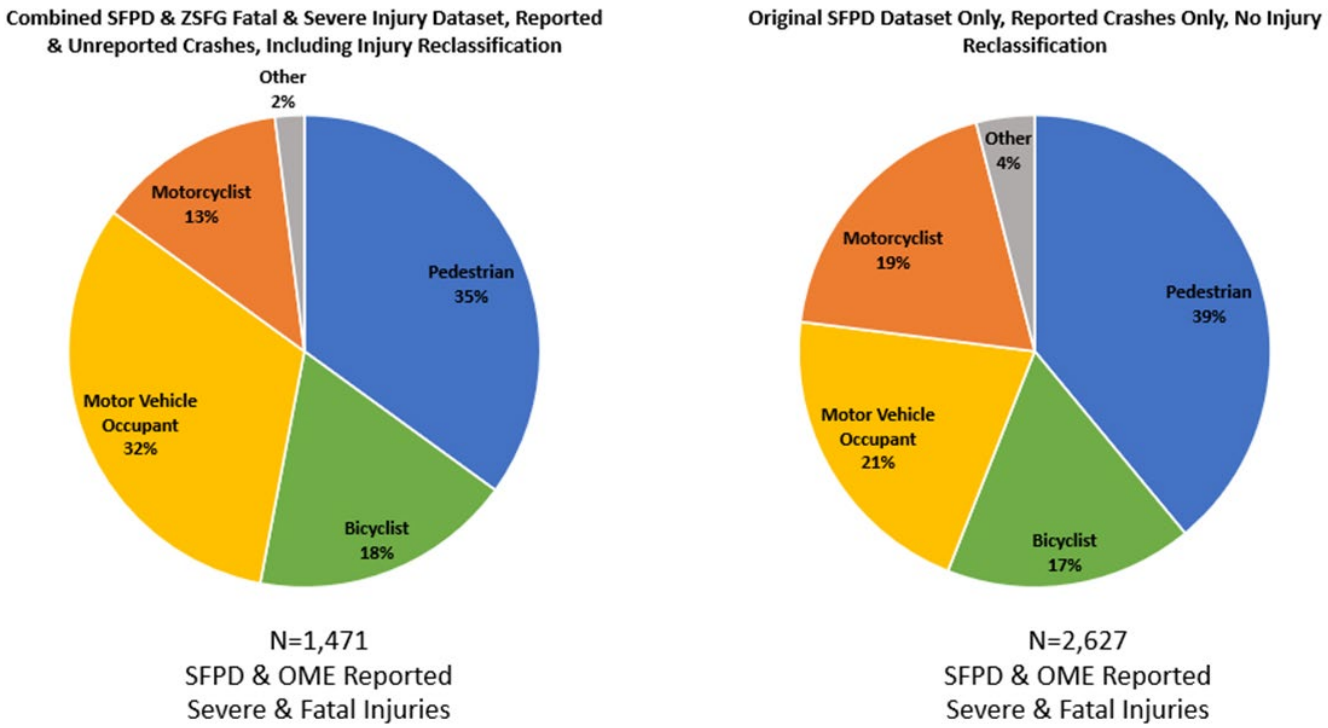


Figure 7. Comparison of Original SFPD & OME Dataset to TISS Dataset



Standardized Analytic Approach to Identifying Corridors

The 2022 High Injury Network incorporates improvements to the corridor calculations. Each street segment block was converted into ~0.25 mile overlapping "corridorized" sections using an ArcPy script (ArcGIS Desktop 10.8) to create a consistent unit of measurement and assess the concentration of linear patterns of injuries within a defined distance. With this method, the highest scoring (i.e. most injuries per mile) corridorized sections within a street can easily be identified and an appropriate threshold may be set to determine network eligibility. Natural start and end points are created based on the threshold chosen and corridorized sections will stay consistent over time for future evaluation purposes.

The street centerline geospatial model maintained by the Department of Public Works (SFDPW, 2017) was used for this analysis with freeways, private streets, and streets in Fort Mason and the Presidio excluded. The script begins by selecting an individual street segment block.

The script then selects the adjacent blocks on the same street. If the total is less than 0.25 miles the script the next set of adjacent blocks along the street are added until at least 0.25 miles of the street is selected. Streets that could not be converted into at least 0.25 miles were excluded from this analysis. This was done to drop out alleyways and short streets that may become over weighted when count of injuries are normalized per mile to account for minor variations in corridorized lengths. These streets and intersections will be included in other high injury analysis that include smaller geographic scales.

Figure 8. Selection of Street Block

Figure 9. Conversion of Blocks into ~0.25 Mile Corridors

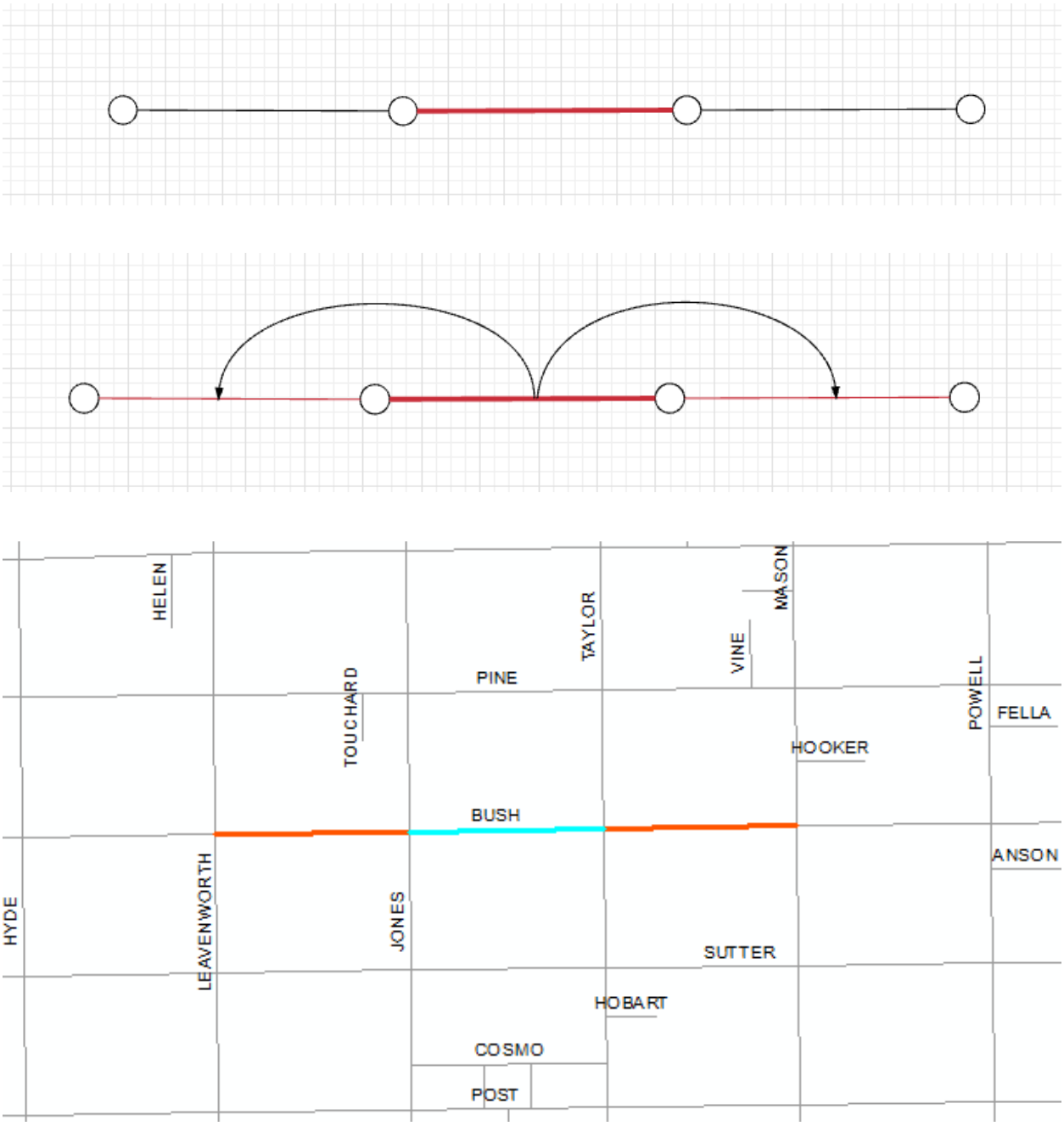
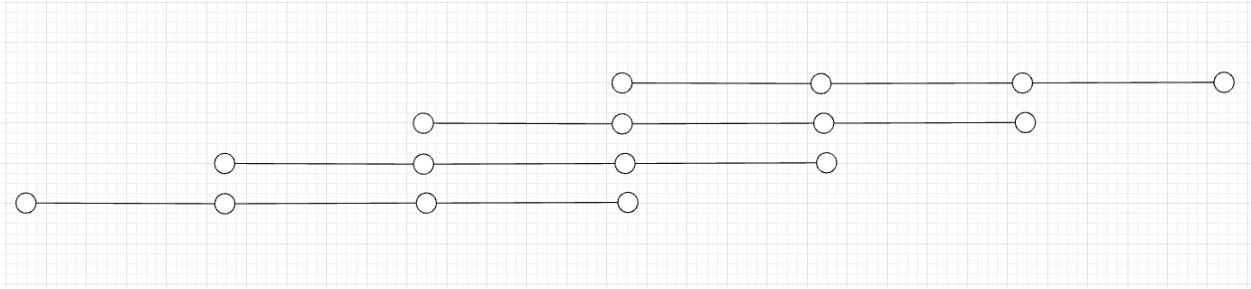


Figure 10. Iteration through All Blocks along Street

The script then moves on to the next block along the street and the process repeats until every block on that street has been converted into ~0.25 “corridorized” sections. The starting and ending points of each corridorized section overlaps part of the previous section. This process was repeated for every street block in San Francisco.



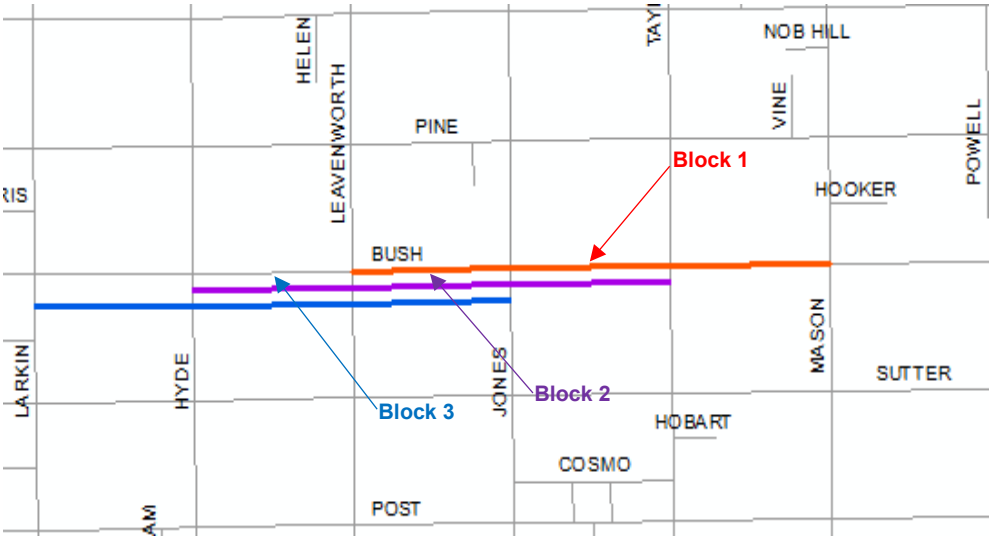


Table 7. Summary Statistics for Corridorized Street Segments

Statistic	Miles
Mean	0.33
Median	0.30
Minimum	0.25
Maximum	3.23*
Standard Deviation	0.12

*Upper Great Highway is represented as one long corridor in the SFPDW street centerline dataset.

Each corridorized section was then geometrically intersected with severe and fatal injuries to get a count of reported and unreported crashes occurring on that section. Injuries were restricted to only those that had the same primary street as the corridorized section given that the CHP 555 manual states the primary street is “…the [street] upon which the involved party most at fault was traveling.” All injuries not at an intersection were linearly referenced to the correct offset from an intersection based on the distance reported by the SFPD or an address if given by the EMS provider. Count of

injuries were then normalized to a per mile rate to account for minor variations in the lengths of corridorized sections.

Establishing a Cutoff Threshold for Network Eligibility

SFDPH with assistance from the TAC determined an appropriate severe and fatal injury per mile threshold for eligibility on the updated network. The objective was to effectively select corridors with the highest incidents of severe and fatal injuries. This was done to provide a map of the areas of the city with the most severe injury outcomes.

Severe and fatal injuries in San Francisco continue to follow a Pareto distribution where sections of streets with the highest number of severe and fatal injuries account for a disproportionate amount of the total number of severe and fatal injuries citywide. For example, roughly 9 percent of all severe and fatal injuries that occur in the city can be found in only 5 miles (0.5 percent of total miles) of city streets, yielding about 40 severe and fatal injuries per mile by corridorized section as shown in Table 8.

The number of street miles needed to capture the same percent of total severe and fatal injuries increases as one adds additional street mileage to the network. Moving from 9 percent to capturing 19 percent of total severe and fatal injuries (a 10 percent increase) requires roughly 14 miles of street (1.4 percent of total street miles) and yields about 30 severe or fatal injuries per mile. Capturing 70 percent of severe/fatal injuries would require roughly 130 miles of street network (13 percent of total street miles) and yield a capture rate of 10 severe/fatal injuries per mile. Each additional city street mile yields less injuries captured per mile.

Table 8. Distribution of Total Severe and Fatal Injuries Capture per Percent of City Street Miles (SFPD and ZSFG, 2017-2021)

Corridor Cutoff Thresholds	Percent Fatal and Severe Injuries Captured	Percent Street Miles Captured
>=40 killed or severely injured per mile	9%	<1%
35 killed or severely injured per mile	13%	<1%
30 killed or severely injured per mile	19%	1%
25 killed or severely injured per mile	27%	2%
20 killed or severely injured per mile	38%	4%
15 killed or severely injured per mile	52%	7%
10 killed or severely injured per mile*	**70%**	**13%**
<=5 killed or severely injured per mile	88%	25%

*Does not include manual review outlined below.

The TAC reviewed three alternative scenarios: 1) a pre-pandemic network using 3 years of TISS data from 2017 to 2019; 2) a network using 3 years of TISS data that mostly overlapped with the pandemic from 2019 to 2021; and 3) a 5-year network that covered periods of time both pre and post pandemic from 2017-2021. It was decided that using only pre-pandemic data was not adequately capturing changes that had occurred on city streets given the time lag in the dataset; however, using only the latest pandemic year data yielded a network that lacked corridors in areas of the city most impacted by the pandemic due to changes in employment and tourism. The compromise 5-year network covering both periods of time was chosen.

A cutoff was determined to be ≥10 severe and fatal injuries per mile along a corridorized section of street, regardless of mode. The TAC affirmed that this cutoff strikes a good balance between percent of injuries captured versus street miles captured, and accounts for the transition to a larger 5-year

period of crash data compared to the 3 years used in the 2017 update. Like 2017, the TAC continued with one multimodal Vision Zero High Injury Network to prioritize locating where severe and fatal injuries are concentrated regardless of transportation mode and better align with the policy goal of Vision Zero.

It is interesting to note that using the 5-year period of severe and fatal crash data from 2017-2021 yields fewer injuries captured per street mile of network than when compared to the 2017 update (2013-2015 ZSFG/SFPD). To reach the same 75% of severe and fatal crashes captured as identified in the 2017 network, the 2022 network would need to include 159.5 miles of street network or 16% of city streets. This may be indicative of changes in the geographic proximity of severe and fatal injuries occurring along linear street corridors, especially during the pandemic years of 2020 and 2021. In other words, severe injuries and fatalities from 2017-2021 may be more spread apart compared to the previous 2013-2015 TISS dataset.

Finally, a manual verification was conducted to assess if specific sections identified in the updated network were selected due to severe and fatal injury collisions occurring at one particular intersection along a given section, and to adjust corridors so they better overlapped with where clusters of injuries were occurring. After this review, the following street sections were removed from the network update with the concurrence from SFMTA staff:

- Portola Ave. from O'Shaugnessy Blvd. to Market St.
- Jamestown Ave. from Griffith St. to Harney Wy.

Table 9 shows the final total number of street miles and injuries captured after this manual review by the 2022 Vision Zero High Injury Network compared to the 2017 Vision Zero High Injury Network.

Table 9. Mileage Summary Statistics Comparison

	Miles of Network on City Streets*	Percent of City Streets*	Miles Overlap with 2017 VZ High Injury Network	Percent Overlap with 2017 VZ High Injury Network
2017 VZ High Injury Network	128.9	12.8%	---	---
2022 VZ High Injury Network	121.5	12.2%	76.7	63.1%

*Does not include street miles from freeways, The Presidio, Fort Mason, and streets closed to vehicles.

Table 10. Side by Side Injury Summary Statistics for 2022 and 2017 Vision Zero High Injury Networks*

	Count of *Severe or Fatal Injuries* on the 2022 Vision Zero High Injury Network	Count of *Severe or Fatal Injuries* on the 2017 Vision Zero High Injury Network	Count of TISS *Severe or Fatal Injuries* by Mode (across San Francisco)	Percent of *Severe or Fatal Injuries* Captured on 2022 Vision Zero High Injury Network	Percent of *Severe or Fatal Injuries* Captured on 2017 Vision Zero High Injury Network	Count of *All Injuries* on the 2022 Vision Zero High Injury Network	Count of *All Injuries* on the 2017 Vision Zero High Injury Network	Count of *All Injuries* by Mode (across San Francisco)	Percent of *All Injuries* Captured on 2022 Vision Zero High Injury Network	Percent of *All Injuries* Captured on 2017 Vision Zero High Injury Network
Pedestrian	644	566	913	70.5%	62.0%	2,397	2,328	3,893	61.6%	59.8%
Cyclist	296	256	462	64.1%	55.4%	1,553	1,582	2,491	62.3%	63.5%
Motor Vehicle Occupant	579	464	845	68.5%	54.9%	7,462	7,122	12,465	59.9%	57.1%
Motorcyclist	226	202	343	65.9%	58.9%					
Other	47	40	64	73.4%	62.5%	291	284	433	67.2%	65.5%
All Injuries	1,792	1,528	2,627	68.2%	58.2%	11,703	11,316	19,282	60.7%	58.7%

"TISS" includes all SFPD & ZSFG severe and fatal transportation injuries recorded in San Francisco between 2017-2021 (N=2,627); "SFPD" indicates all police reported transportation injuries between 2017-2021 (N=19,282)

*Does not include n=62 crashes on The Presidio, Fort Mason, and streets closed to vehicles; and/or intentional assault or self-harm crashes.

Geocoded injury data as pulled on 11/01/2022.

San Francisco Police Department (SFPD) collision reports, 2017-2021.
Zuckerberg San Francisco General Hospital (ZSFG) data linked to Emergency Medical Services data, 2017-2021.

In comparison to the 2017 Vision Zero High Injury Network, the 2022 Vision Zero High Injury Network captures a larger proportion of severe and fatal injuries than the 2017 Network captured (68% vs 58%, respectively) on city streets, and does so over a slightly smaller proportion of total city street miles (12% vs approx. 13%, respectively); however, the 2017 Network captures slightly more cyclist injuries overall, regardless of severity.

Future Updates

Given the unprecedented changes that occurred due to the COVID-19 pandemic, SFDPH will monitor SFPD and ZSFG traffic-related injuries on the 2022 Vision Zero High Injury Network over the upcoming year. SFDPH discussed with the TAC of potentially using a rolling 5-year time period with yearly future updates to the Vision High Injury Network. This update schedule might ensure better timeliness of the data and a better understand of how completed projects may be impacting the distribution of injuries along corridors.

More Information

Please contact Devan Morris (devan.morris@sfdph.org) or Seth Pardo (seth.pardo@sfdph.org) for more information regarding this methodology.

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