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MEMORANDUM

September 27, 2022

To: Carrie Wilhelme
Organization: City of Tacoma
From: Michael Hintze AICP, Brian Almdale, Peter Garcia
Project: City of Tacoma Vision Zero

Re: Citywide Crash Analysis

Contents

Introduction

This document summarizes the results of the crash analysis conducted for the City of Tacoma as part of the Vision Zero plan development process. The crash analysis aims to systematically analyze fatal and serious injury (KSI) crashes that have occurred throughout the City of Tacoma using a data-driven approach that identifies systemic safety issues.

The general process began with data collection and consolidation, crash data contextualization, and a descriptive crash analysis. A series of high-level descriptive summary tables capture relationships between citywide crash data, infrastructure data, and contextual variables. These tables explore overall crash trends that are a useful guide for selection of variables warranting deeper analysis, development of new or changing existing policies, or the selection of countermeasures for project development.

Summary of Key Findings

This analysis is made up of three primary components: data consolidation, descriptive analysis, and a screen of the roadway network using the Safer Streets Priority Finder tool developed by Toole Design. The key findings from the descriptive analysis are summarized below.

Descriptive Analysis

- There were 384 KSI crashes that occurred over the five year study period. During that same period, an estimated 64 people were killed as a result of a traffic related crash.
- No discernable temporal pattern emerged looking at crash frequencies by year (2016-2020).

- Crashes involving more than one motor vehicle accounted for the largest share of KSI crashes (34 percent) and overall crashes (84 percent).
- Pedestrian crashes accounted for only 3 percent of crashes but 28 percent KSI crashes. In general, more vulnerable roadways users (pedestrians, bicyclists, and motorcyclists) were found to be overrepresented in KSI crashes.
- Crashes occurred most frequently at intersections compared to mid-block locations accounting for 78 percent of crashes and 70 percent of KSI crashes.
- Intersections with partial stop control (i.e., two-way stop) accounted for the largest share of KSI crashes (46 percent) followed by intersections with a traffic signal (38 percent). Intersections with a traffic signal had the highest number of KSI crashes per intersection (0.34).
- Streets with higher functional classification accounted for the largest share of KSI crashes, with 54 percent of KSI crashes having occurred along or at primary arterials and 18 percent along or at minor arterials.
- KSI crashes that occurred during dark lighting conditions (as reported by officer) were overrepresented with more than 45 percent of KSI crashes having occurred during dark lighting conditions whereas only 35 percent of overall crashes occurred during dark light condition. This overrepresentation is compounded when considering there are lower exposure rates during hours of the day with dark lighting conditions compared to daylight hours.
- Streets with a posted speed limit of 30mph or 35mph accounted for the strong majority of KSI crashes for intersection (46 percent and 30 percent respectively) and mid-block locations (23 percent and 43 percent respectively). For mid-block crashes, streets with a 25mph speed limit had a relatively high share of KSI crashes, which is likely related to 25mph streets representing the majority of Tacoma's street network.
- Intersections near commercial land uses had the highest number of KSI crashes per intersection.
- Proximity to transit was found to be associated with KSI crashes, which also may be related to land use and higher levels of exposure (primarily pedestrian).
- Crashes that involved a pedestrian who was struck by a motorist proceeding straight accounted for the largest share of KSI crashes (23 percent). Disregarding traffic control, inattention, failure to yield to the right of way, and alcohol appear to be the most common factors contributing to these types of crashes.
- Motor vehicle striking fixed object crash types had the second largest share of KSI crashes 13 percent) followed by angled crashes with both motorists proceeding straight (13 percent).

Analysis Methodology

This section of the memo describes the steps taken to assemble the working datasets, as well as the analytical framework used to develop the summary statistics. This memo presents descriptive statistics (frequencies and percentages) of crashes stratified by various attributes, injury severity, environmental conditions, behaviors, movement types, etc. The analyses reported here do not adjust for exposure rates; therefore, results should be interpreted carefully to understand why certain patterns may emerge. For example, in many communities pedestrian crashes are more common during daylight conditions than dark conditions. This does not mean that daylight conditions are more dangerous than dark conditions; rather, it reflects the fact that people are more likely to travel, and especially more likely to travel by walking, in light conditions than in dark conditions. Looking at relative crash severity within a category can help the reader understand these dynamics. In the aforementioned daylight/dark example, the percentage of crashes under each lighting condition that are severe versus non-severe provides a better indicator of how the environmental condition impacts safety than relative frequency of occurrence.

Crash data

Geocoded crash data is critical to understanding collision patterns. Police reports of collisions are the primary source for crash data. While this data is known to have problems with underreporting[1,2], it is often the most complete data source and provides necessary details for informing engineering treatments, such as the location of the collision and dynamics between the parties involved in the crash.

Crash data used in this analysis was provided to the consultant team through submitting a data request on the City of Tacoma's behalf to the Washington State Department of Transportation (WSDOT). Crash data was requested for all crashes that occurred within the city of Tacoma from 2016 through 2020 for all modes. For the purposes of this analysis, the consultant team coded cashes that involved at least one pedestrian as a pedestrian crash, bicycle crashes involved at least one bicyclist and no pedestrians, motor vehicle crashes did not involve any pedestrians or bicyclists, and a motor vehicle crash or motorcycle involving only one motor vehicle or motorcycle and no other modes as a solo motor vehicle or solo motorcycle crash.

The source of WSDOT's crash data and attributes is from the Police Traffic Collision Reports (PTCRs). WSDOT has conducted a data QC process and produced additional attributes derived from specific PTCR attributes (e.g., officer's narrative and diagram) and includes those specific attributes (in addition to PCTR's data) to support safety analysis and engineering[3]. For a full list of attributes that are recorded in PTCR data, please review the Washington State Police Traffic Collision Report Instruction Manual (updated January 2020)[4].

The crash data used in this analysis was reviewed and assessed by the consultant team for accuracy and consistency. Crashes were removed from this crash analysis if the crash occurred along limited access roadways, or segments of roadways, including I-5, SR-16, SR-705, and SR-509. (see Map 1).

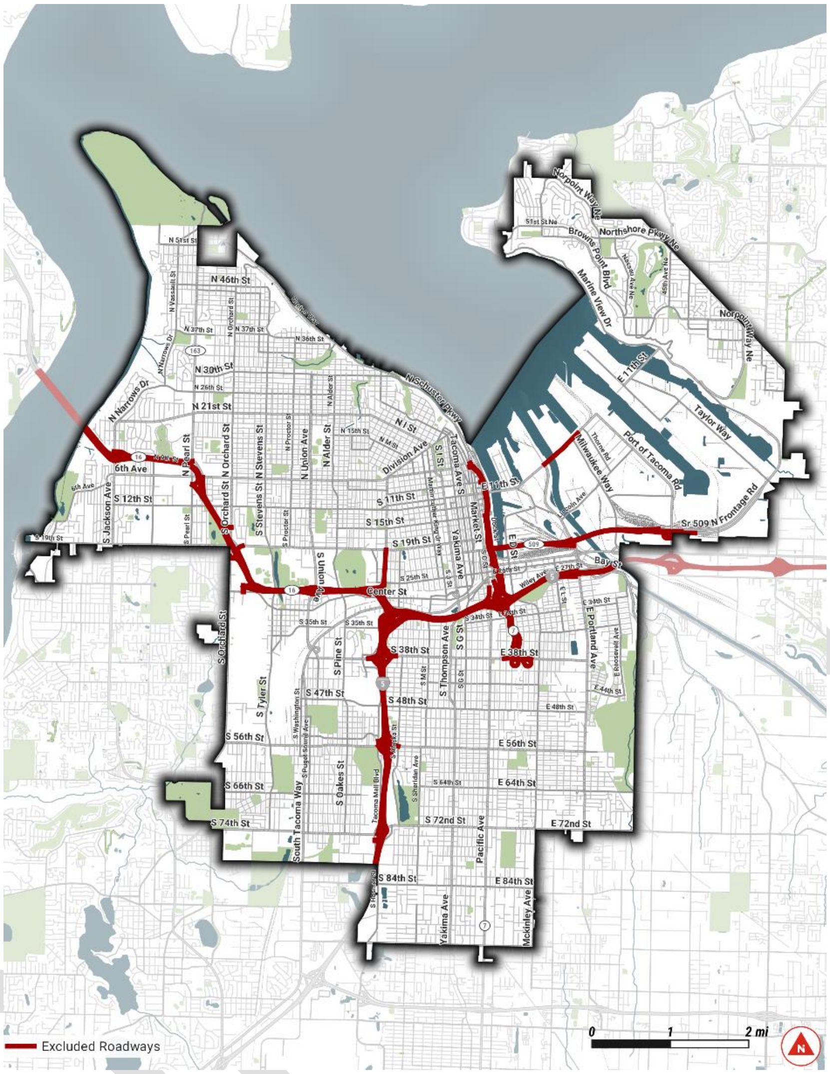
[1] Stutts, J., & Hunter, W. (1998). Police reporting of pedestrians and bicyclists treated in hospital emergency rooms. Transportation Research Record: Journal of the Transportation Research Board, (1635), 88-92.

[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

[3] https://www.wsdot.wa.gov/mapsdata/crash/crashdatafaq.htm

[4] https://www.wsp.wa.gov/wp-content/uploads/2020/01/2020-Police-Traffic-Collision-Instruction-Manual-Tenth-Edition.pdf

Map 1: Streets Excluded from Crash Analysis



Network Data Consolidation

The purpose of data consolidation is to allow the consultant team to analyze transportation system attributes at the location of each individual crash in the dataset. For crashes occurring at non-intersection locations (mid-block), the consultant team spatially joined attributes directly from nearby roadway data to the crashes. For intersection crashes, the consultant team built and populated a dataset of intersections throughout the city of Tacoma, aggregated attributes from roadway segments, and then joined intersection data to crashes within 150 feet of the intersection centroid. This allowed the consultant team to measure nuanced or complex concepts like the differential of speeds or number of lanes (functional class was used as a proxy) coming together at an intersection. The following sections describe the consolidation process and resultant variables.

Consolidated Street Centerline Dataset

To contextualize the crash data, the consultant team assembled and analyzed a spatial dataset using various roadway characteristic datasets. The City of Tacoma provided the consultant team with several GIS datasets used in this crash analysis to contextualize the crash data with roadway attributes not provided in the crash data. Table 1 summarizes the datasets consolidated to form the single centerline dataset.

Table 1: Consolidated Street Centerline Data

Dataset	Variable	Notes
City of Tacoma Centerline	Functional classification	Type of roadway functional classification. Functional classification was consolidated into six key classifications: alley/driveway, residential, minor collector, major collector, minor arterial, and primary arterial)
City of Tacoma Centerline	One-way	Type of one-way street.
City of Tacoma Centerline	Posted speed limit	Posted speed limit
City of Tacoma Transit Stops	Transit Stop	Number of transit stops along corridor
City of Tacoma Centerline	Long block length	Length of segment is > 660 feet

Consolidated Intersection Dataset

An intersection dataset was developed and derived from the street centerline data by the consultant team. Several roadway characteristic datasets were joined to the intersection dataset such as traffic control devices and crosswalk types. Most of the variables joined to the intersection dataset were either joined from the consolidated street centerline dataset or were derived from the centerline dataset.

Table 2: Consolidated Intersection Data

Dataset	Variable	Notes
City of Tacoma Centerline	Number of legs	Number of legs at intersection
City of Tacoma Street Signals	Traffic signals	Presence and type of signal at intersection
City of Tacoma Stop Signs	Stop Signs	Presence and type of stop control at intersection. Type (all-way or two-way/one-way) derived using the number of signs present at the intersection compared to number of legs at the intersection.
Derived from intersection dataset and City of Tacoma Street Signals	Distance to nearest signalized intersection	Euclidean distance to the nearest signalized intersection.
City of Tacoma Centerline	Posted speed limit	Posted speed limit per leg and highest and lowest posted speed limit present at the intersection.
City of Tacoma Centerline	Functional classification	Number of legs by functional classification, higher functional classification, and lowest functional classification. Functional classification was consolidated into six key classifications: alley/driveway, residential, minor collector, major collector, minor arterial, and primary arterial)
City of Tacoma Land Use	Primary Land Use	Prominent land use within 500 feet of the intersection.
City of Tacoma Transit Stops	Transit Stops	Number of transit stops within 250 feet of the intersections.

Descriptive Crash Analysis

This section provides summaries of reported crashes within the city of Tacoma using the officer-reported attributes and the contextualized attributes outlined in the previous section. The primary goal of this descriptive analysis is to identify high-risk factors that are associated with KSI crashes.

This section is organized into three sections. The first section describes general trends and temporal attributes such as crashes by year and crash frequency by injury type. The next section summarizes crashes on roadway and environmental attributes such as intersection control, posted speed limit, and lighting conditions. The final section summarizes crashes based on reported behaviors and WSDOT Target Zero[5] priorities, such as the movement types preceding the crash and violation types.

The priority of the Tacoma Vision Zero Action Plan is to focus on eliminating KSI crashes. Most tables in this section will include figures summarizing the number of crashes, KSI crashes, and Equivalent Property Damage Only (EPDO) scores. The EPDO scores weigh crashes according to the highest severity injury sustained in the crash by converting each crash to an equivalent number of Property Damage Only (PDO) crashes. For example, a crash that results in a possible injury is equivalent to approximately 10 PDO crashes, whereas a fatal crash is equivalent to approximately 231 PDO crashes. These EPDO factors are informed by the comprehensive societal costs of crashes and are scaled relative to PDO comprehensive crash cost estimates. The EPDO technique is utilized because normalizing crashes to a base unit in this way allows crashes to be easily compared. Additionally, subcategories of crashes can be compared based on the average EPDO score by crash factor to identify which factors resulted in higher severity injuries. Total EPDO scores are a measure of overall crash intensity and the average EPDO score per crash is a measurement of average crash intensity/severity. See Table 3 for the comprehensive crash costs for each crash severity provided by WSDOT.

Table 3: WSDOT Crash Costs Estimates

Crash Severity	EPDO Score	Comprehensive Crash Cost
Fatal (K)[6], Suspected Serious Injury (A)	231.31	$3,423,400
Suspected Minor Injury (B)	16.04	$237,400
Possible Injury (C)	9.61	$142,300
Property Damage Only (PDO)	1.0	$14,800

Victims

In addition to identifying the conditions under which crashes have occurred and the specifics of crashes, for the purposes of achieving Vision Zero it is critical to understand who is most affected by traffic safety problems in the City of Tacoma. The distribution of victims involved in a crash is compared both overall and specifically for fatal or serious injury outcomes for age groups and gender groups. **Note that these comparisons are based on the number of victims, not the number of crashes, therefore the total numbers are different than in other analyses within this report. Any given crash may injure multiple victims, at different levels of severity.**

[5] https://targetzero.com/

[6] Letters within the parenthesis refer to injury severity levels used by WSDOT (KABCO scale)

Age

Table 4 compares the victim age breakdown against the age breakdown of residents in the city of Tacoma. To compare these distributions, the percentage of victims and of KSI victims within a given age range is divided by the percentage share in the population overall. Values greater than 1 (red cells) indicate that a given age group is over-represented in the crash data. Values less than 1 (blue cells) indicate that age group is under-represented in the crash data.

Younger population cohorts are the most over-represented victims involved in crashes whereas the older population cohorts are the most under-represented victims involved in crashes. Victims aged between 20-24 are the most over-represented age cohort. When looking at crashes resulting in a killed or seriously injured victim, victims aged between 20-44 and 55-79 are overrepresented ,specifically the aging (75-79) and younger (20-24) populations are the most over-represented victims involved in KSI crashes.

Table 4: Victims by Age, 2016-2020

Age	Victims	KSI Victims	% of Victims	% of KSI Victims	Share of Population	Victims: Population Ratio	KSI Victims: Population Ratio
0 - 4	7	1	0%	0%	6%	0.00	0.05
5 - 9	22	6	0%	2%	6%	0.01	0.28
10 - 14	69	4	0%	1%	5%	0.05	0.22
15 - 19	1,891	15	7%	4%	6%	1.22	0.77
20 - 24	3,565	40	13%	12%	7%	1.82	1.61
25 - 29	3,402	40	13%	12%	9%	1.38	1.28
30 - 34	3,007	37	11%	11%	8%	1.36	1.32
35 - 39	2,662	31	10%	9%	8%	1.31	1.20
40 - 44	2,125	29	8%	9%	6%	1.30	1.40
45 - 49	1,998	23	7%	7%	6%	1.17	1.06
50 - 54	1,869	18	7%	5%	6%	1.14	0.86
55 - 59	1,839	26	7%	8%	6%	1.09	1.22
60 - 64	1,650	20	6%	6%	6%	1.10	1.06
65 - 69	1,067	17	4%	5%	4%	0.93	1.17
70 - 74	663	15	2%	4%	3%	0.75	1.33
75 - 79	432	12	2%	4%	2%	0.78	1.71
80 - 84	267	1	1%	0%	1%	0.67	0.20
85 +	158	3	1%	1%	2%	0.33	0.49
total	26,693	338	100%	100%	100%		

Mode

Table 5 summarize the number of victims by mode and injury severity. Drivers (of motor vehicles and motorcycles) are the most common victim type involved in overall crashes and KSI crashes throughout the city of Tacoma. This result is expected as driving is the most common mode of transportation in Tacoma. When comparing the percent share each victim is involved in crashes to the percent share of victims involved in KSI crashes (i.e., proportionality), pedestrians, bicyclists, and motorcyclists are over-represented in KSI crashes. This highlights the vulnerability of those modes to severe outcomes when involved in a crash.

Table 5: Victims by Mode, 2016-2020

Mode	# KSI Victims	% KSI Victims	# Victims	% Victims	KSI:Victim Proportionality
Motor Vehicle - Driver	110	33%	23,794	89%	0.37
Pedestrian	96	28%	867	3%	8.74
Motorcycle - Driver	50	15%	441	2%	8.95
Solo Motorist – Driver	35	10%	1,175	4%	2.35
Bicyclist	28	8%	354	1%	6.25
Solo-Motorcycle - Driver	17	5%	59	0%	22.76
Solo-Bicyclist	2	1%	3	0%	52.65
Total	***338***	***100%***	***26,693***	***100%***	***1.00***

Fatalities by Year

Table 6 summarizes the number of traffic related fatalities by year that occurred from 2016-2020. There have been on average 12.8 fatalities per year with little variation year-to-year, though 2017 had the fewest fatalities (7) and 2016 had the highest (17). Motorists involved in multi-vehicle crashes accounted for the largest shared of fatalities (24), followed pedestrians (19), and motorcycles (7).

Table 6: Fatalities by Mode, 2016-2020

Year	Pedestrian	Bicyclist	Motorcycle	Motorist	Solo-Bicyclist	Solo Motorist	Solo-Motorcycle	All Modes
2016	8	0	3	6	0	0	0	17
2017	1	0	0	2	0	5	0	8
2018	4	0	2	6	0	0	1	13
2019	5	1	0	5	0	2	0	13
2020[7]	1	0	2	5	1	4	0	13
Total	**19**	**1**	**7**	**24**	**1**	**11**	**1**	**64**

General Crash Trends

The following sections summarize the January 1st, 2016 through December 31st, 2020 crash data to provide insight into temporal patterns. Rows that are particularly insightful or are considered possible risk factors are highlighted in red.

Crashes by Year

Table 7 summarizes crash frequency for crashes by year. Aside from minor year-to-year fluctuations in KSI crashes, all injury crashes, and EPDO scores, crash frequencies are relatively evenly distributed during the analysis period showing little to no discernable pattern. No noticeable downward or upward trend is present. 2020 had the lowest crash frequency for all crashes (n=2,905), and 2017 had the highest KSI crashes (n=81). Crashes during 2020 tended to be more severe, with crashes having an average EPDO score of 10.0.

[7] Interpret crash frequencies for the year 2020 with caution. Travel patterns and behaviors changed as a result of the COVID-19 pandemic, which influenced crash frequencies and crash dynamics that this analysis cannot account for at the time this report was developed.

Table 7: Crashes by Year, All Modes, 2016-2020

Year	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
2016	73	19%	2.1%	31,044	20%	8.9	3,474	21%
2017	81	21%	2.3%	33,173	21%	9.5	3,498	21%
2018	77	20%	2.2%	32,648	21%	9.1	3,570	21%
2019	79	21%	2.3%	32,275	20%	9.5	3,405	20%
2020[8]	74	19%	2.5%	29,074	18%	10.0	2,905	17%
Total	**384**	**100%**	**2.3%**	**158,214**	**100%**	**9.4**	**16,852**	**100%**

Crash by Mode

Table 8 summarizes crash frequencies for each mode[9] and the location of crashes can be viewed in Map 2 through Map 5. This analysis confirmed a nationwide trend that found vulnerable roadway users (pedestrians, bicyclists, and motorcyclist) represent a smaller share of overall crashes but are overrepresented in KSI crashes. In the city of Tacoma, multi-motor vehicle crashes accounted for the largest share of all crashes (84 percent), KSI crashes (34 percent), and EPDO score (55 percent). While motor vehicle crashes had the highest percentage of KSI crashes of all modes, only one percent of all motor vehicle crashes resulted in a KSI. In contrast, pedestrian crashes only accounted for three percent of all crashes but represented 28 percent of all KSI crashes. Furthermore, 22 percent of pedestrian crashes resulted in a KSI, highlighting the vulnerability of pedestrians. Similarly, motorcycle crashes involved with a motor vehicle accounted for only three percent of all crashes but made up 13 percent of all KSI crashes and 21 percent of all motorcycle crashes resulted in a KSI. Pedestrian, bicyclist, and motorcyclists were disproportionality involved in KSI crashes, despite their low overall crash share, demonstrate the vulnerability of these roadway users. The average EPDO scores for these vulnerable modes further illustrate this finding. Pedestrian crashes had the highest average EPDO per crash at 58.9, followed by motorcycle crashes with 55.6 per crash, and bicyclists with an averaged EPDO of 40.8. In contrast, motor vehicle crashes had an average EPDO score of 6.1 per crash.

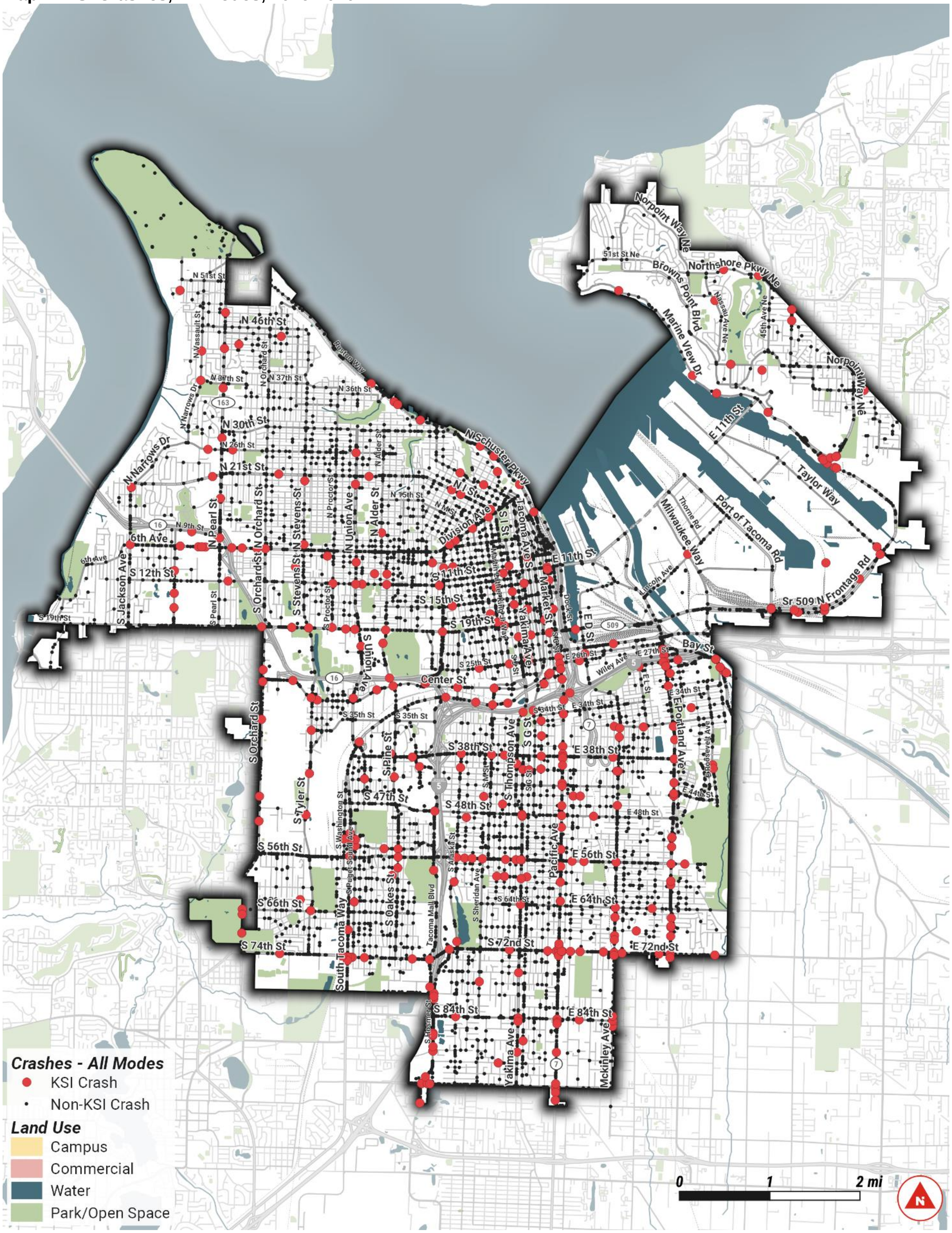
[8] Interpret crash frequencies for the year 2020 with caution. Travel patterns and behaviors changed as a result of the COVID-19 pandemic, which influenced crash frequencies and crash dynamics that this analysis cannot account for at the time this report was developed.

[9] Crash mode were assigned by the consultant team based on the unit types involved in the crash. Crashes that involved one or more pedestrians were coded as a pedestrian crash. Crashes with one or more bicyclist were coded as a bicycle crash. Crashes with one or more motor vehicles and no pedestrians or bicyclists were coded as a motor vehicle crash. Crashes with only one motor vehicle and no pedestrians or bicyclists was coded as solo motor vehicle.

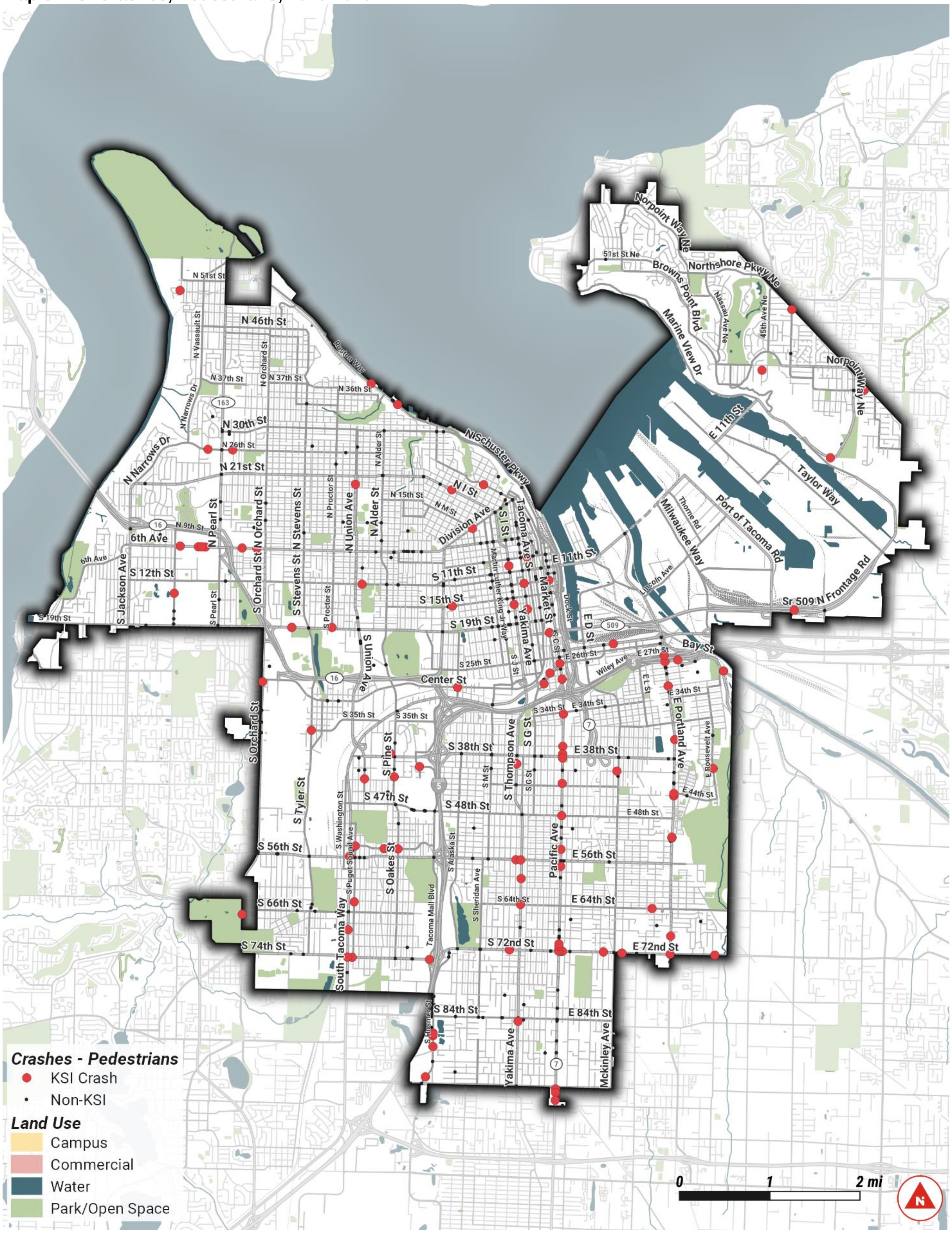
Table 8: Crashes by Injury Severity and Mode, 2016 - 2020

Mode	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
Motorist	132	34%	0.9%	86,915	55%	6.1	14,223	84%
Pedestrian	108	28%	21.7%	29,282	19%	58.9	497	3%
Motorcycle	51	13%	21.0%	13,519	9%	55.6	243	1%
Solo Motorist	46	12%	2.8%	15,363	10%	9.5	1,622	10%
Bicyclist	27	7%	13.6%	8,120	5%	40.8	199	1%
Solo-Motorcycle	17	4%	26.6%	4,306	3%	67.3	64	0%
Solo-Bicyclist	3	1%	75.0%	710	0%	177.5	4	0%
Total	**384**	**100%**	**2.3%**	**158,214**	**100%**	**9.4**	**16,852**	**100%**

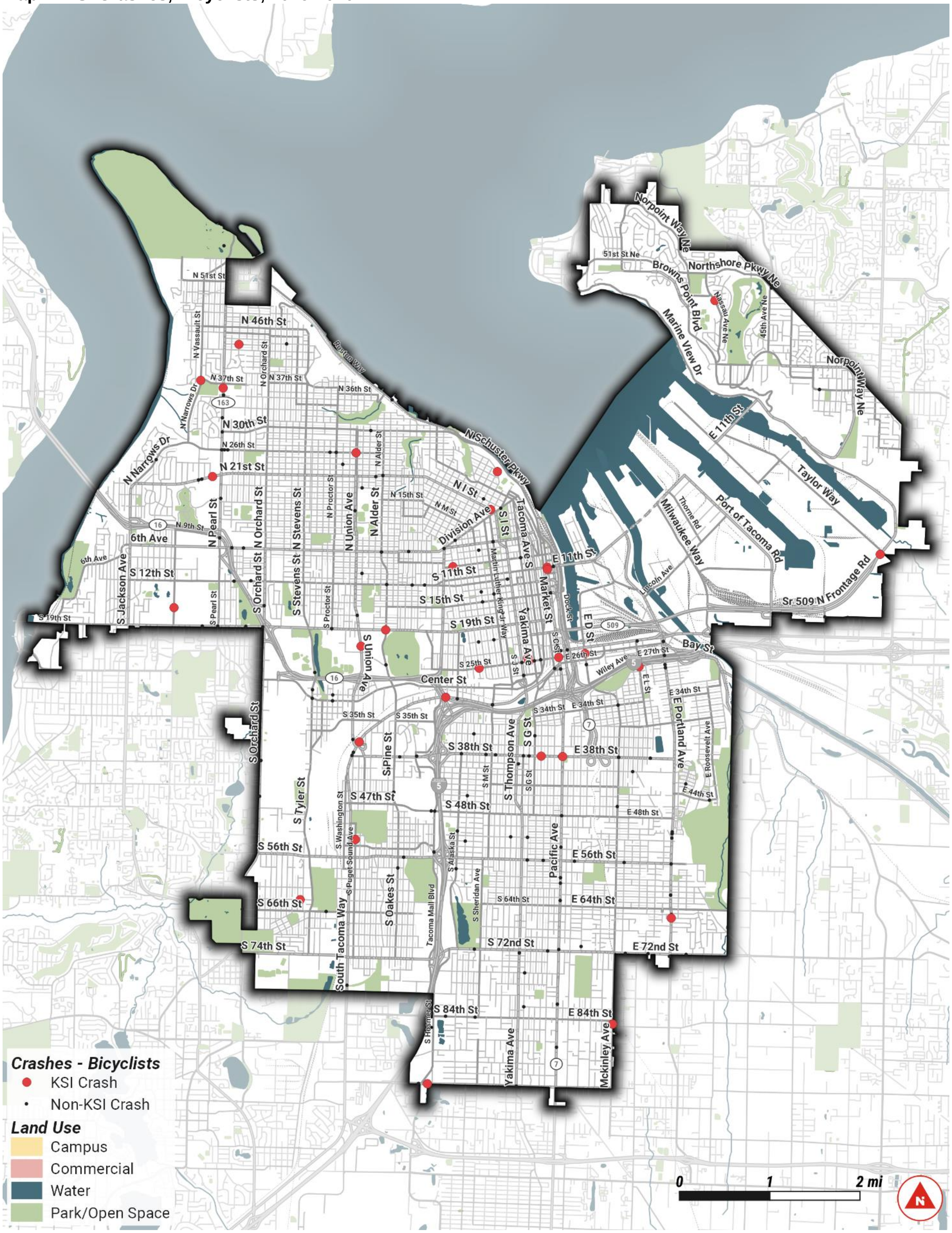
Map 2: KSI Crashes, All Modes, 2016-2020



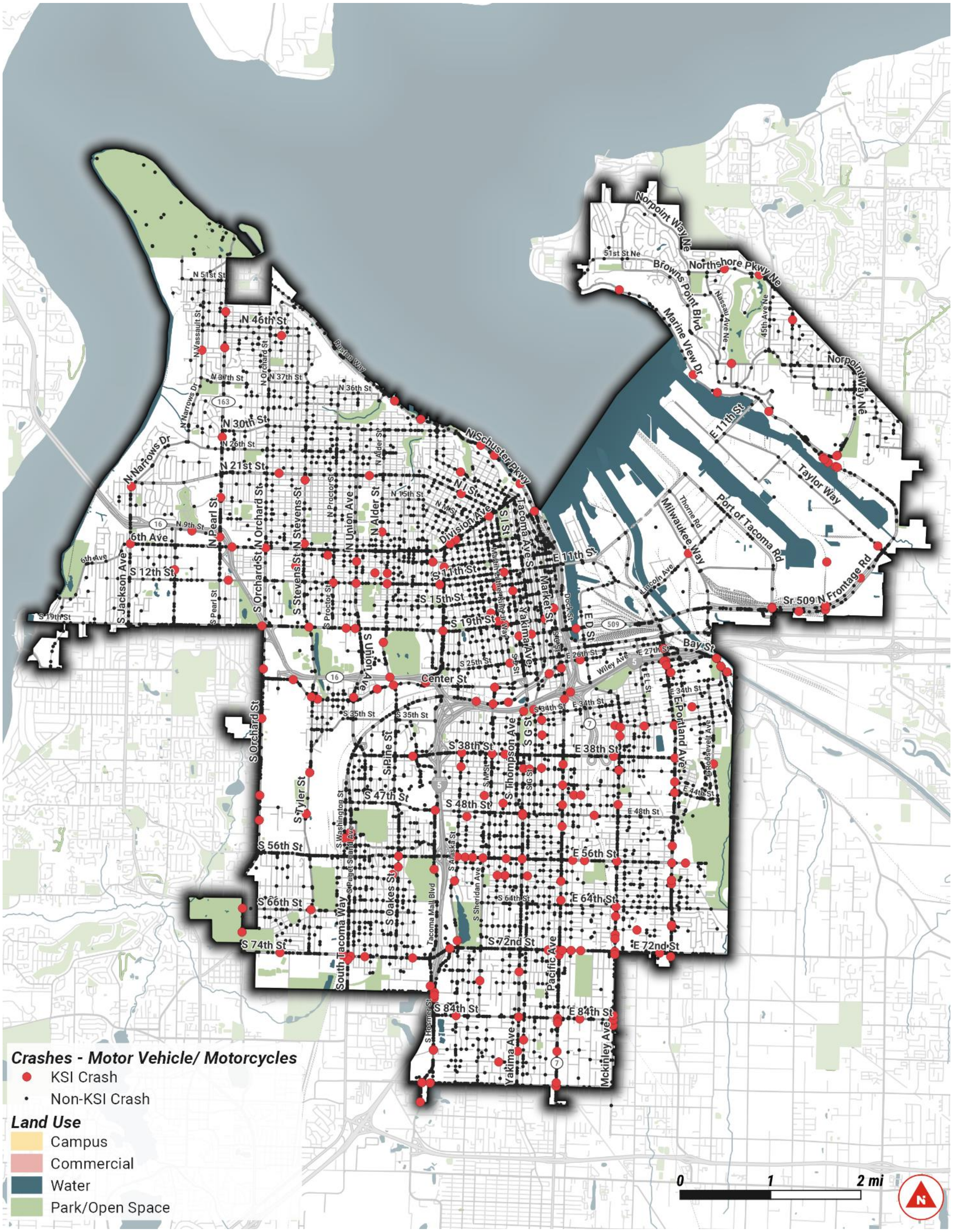
Map 3: KSI Crashes, Pedestrians, 2016-2020



Map 4: KSI Crashes, Bicyclists, 2016-2020



Map 5: KSI Crashes, Motorists, 2016-2020



Time of Day

Table 9 summarizes crash frequency for all modes by time of day. Most crashes occurred during the afternoon and evening periods. This is expected as these time periods generally have a higher share of the number of trips taken through a day. KSI crashes were generally concentrated around peak commute periods in the late afternoon and evening peak commuting hours. There are relatively high shares of KSI crashes that occurred between 9pm and 3am. Crashes tend to be most severe between 3-6pm and 6-9pm time periods, both time periods accounted for 21 percent of KSI crashes. What is notable, however, is the 6-9pm time periods accounted for the same amount of KSI crashes by percent as its previous time slot but with a 9% difference in total crashes.

Table 9: Crashes by Time of Day, All Modes, 2016 - 2020

Time of Day	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
12:00-2:59 AM	33	9%	3.2%	10,725	7%	10.4	1,036	6%
3:00-5:59 AM	15	4%	2.4%	5,576	4%	9.0	622	4%
6:00-8:59 AM	38	10%	2.2%	16,019	10%	9.3	1,726	10%
9:00-11:59 AM	26	7%	1.3%	15,326	10%	7.4	2,080	12%
12:00-2:59 PM	52	14%	1.7%	25,496	16%	8.2	3,114	18%
3:00-5:59 PM	82	21%	2.0%	36,776	23%	9.1	4,053	24%
6:00-8:59 PM	81	21%	3.1%	29,299	19%	11.3	2,593	15%
9:00-11:59 PM	57	15%	3.5%	18,997	12%	11.7	1,628	10%
Total	**384**	**100%**	**2.3%**	**158,214**	**100%**	**9.4**	**16,852**	**100%**

Table 10 summarizes the percent of KSI crashes for each mode and the average EPDO scores by time of day. There are several notable patterns that can be observed from this table. Pedestrian KSI crashes occurred most frequently during the peak hour PM commute hours and late evening (68 percent between 3pm to midnight). Higher pedestrian KSI crash frequencies during peak commute periods is likely associated with higher pedestrian exposure levels. However, the higher pedestrian KSI crash frequencies occurring in the late evening is notable as the number of trips being during the late evening is expected to be substantially lower than the volume of trips being made during the day. These severe outcomes during these late evening hours highlights pedestrian vulnerability when traveling at night. Additionally, the average crash intensity (average EPDO score) is highest during late evening hours and lowest throughout the day (slight peak between 9am-noon).

Bicyclist KSI crashes tend to occur during peak commute hours (6-9am and 3-6pm), though bicycle crashes during the early morning and late evening tend to be more severe which may be associated with dark hours or fewer bicycle crashes having occurred during 6-9am and 3-6pm .

Motorcycle crashes are heavily concentrated around the peak-hour commute period with nearly 40 percent of KSI crashes having occurred between 3-6pm. Like bicycle and pedestrian crashes, when a motorcyclist is involved in a crash, the outcome generally results in an injury or KSI as seen by the three modes' average EPDO scores throughout the day.

Motor vehicle crashes generally are less severe throughout the day compared to other modes (lower average EPDO score). KSI crashes typically occurred during the afternoon through the late evening with the fewest having occurred between 3-6am. The time periods that accounted for the two highest average EPDO scores was between 9pm-3am. Crashes during these time periods accounted for the majority (61 percent) of drug/alcohol involved motorist KSI crashes (10 percent of all KSI crashes regardless of mode involved someone under the influence of drugs or alcohol).

Table 10: Percent of KSI Crashes and Average EPDO Scores for Each Mode by Time of Day, 2016 - 2020

Time of Day	Pedestrian		Bicyclist		Motorcycle		Motorist	
	% KSI (n=108)	EPDO/ Crash	% KSI (n=30)	EPDO/ Crash	% KSI (n=68)	EPDO/ Crash	% KSI (n=178)	EPDO/ Crash
12:00-2:59 AM	4%	52.0	7%	118.3	9%	87.9	12%	7.7
3:00-5:59 AM	2%	56.5	13%	108.5	3%	59.3	4%	5.9
6:00-8:59 AM	8%	44.1	20%	58.8	6%	58.0	11%	6.6
9:00-11:59 AM	7%	62.5	3%	21.5	1%	26.2	9%	6.2
12:00-2:59 PM	11%	44.8	10%	26.6	19%	56.7	13%	6.0
3:00-5:59 PM	17%	43.2	23%	39.7	38%	63.6	17%	6.0
6:00-8:59 PM	28%	75.0	17%	40.5	21%	58.4	18%	6.9
9:00-11:59 PM	23%	95.4	7%	65.8	3%	28.2	16%	7.6
Total	***100%***	***58.9***	***100%***	***43.5***	***100%***	***58.1***	***100%***	***6.5***

Roadway and Environmental Characteristics

The following topics summarized in this section are related to roadway and environmental characteristics that were either reported by the responding officer or were joined by the consolidated GIS network datasets. Rows that are particularly insightful or are considered possible risk factors are highlighted in red.

Crash Location (Intersection vs. Mid-Block)

Table 11 summarizes crash frequencies by location type (intersection vs. mid-block). Most crashes (78 percent) and KSI crashes (70 percent) occurred at an intersection, while 22 percent of crashes and 30 percent of KSI crashes occurred mid-block. Two percent of intersection crashes were KSI crashes, and 3 percent of mid-block crashes were KSI crashes. Although intersections had the most crashes and highest EPDO score, mid-block crashes tended to be more intense on an individual basis. Mid-block crashes had an EPDO score of 11, which is slightly higher than intersection crash's 8.9 and may suggest that this difference is associated with higher travel speeds at the time of the crash.

Table 11: Crashes by Location Type, 2016 - 2020

Location Type	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
Intersection	269	70%	2.0%	117,823	74%	8.9	13,168	78%
Mid-Block	115	30%	3.1%	40,392	26%	11.0	3,684	22%
Total	**384**	**100%**	**2.3%**	**158,214**	**100%**	**9.4**	**16,852**	**100%**

Intersection Control Type

Table 12 summarizes crashes by location type and traffic control type (for intersections). Adding to what was reported in Table 11, intersection control plays a major role in crash dynamics and crash risk. It needs to be noted that traffic control types may be associated with traffic volumes (i.e., exposure), such as traffic signals. This does not mean that the presence of these traffic control devices are the primary factor that contributed to crashes, but simply these locations had a high crash frequency likely associated with higher traffic volumes (i.e., exposure levels) and a higher complexity of interactions between roadway users (i.e., motorists, bicyclists, and pedestrians having to negotiate space and yield to the right of way). Traffic signals are generally placed at busier intersections compared to all-way stop signs.

Partial stop[10] controlled intersections had the largest share of KSI crashes (46 percent), while signalized intersections had the highest overall crashes (38 percent). Both location types also had the largest shares of crashes with nearly 5,000 having occurred at partial stop controlled intersections and 5,776 at signalized intersections. Looking at crashes per intersection, signalized intersections have substantially more KSI crashes and overall crashes per location with a rate of 0.34 KSI crash per intersection 19.19 and overall crashes per intersection (301 intersections) compared to partial stop controlled intersection with 0.07 KSI crashes per intersection and 2.74 crashes per intersection (1,822 intersections). The difference in crash rates between the two location types is likely a function of differing levels of exposure, number of locations, and different types of interactions between roadway users.

Intersections with all-way stop control had only one KSI crash and very few overall crashes (n=18) compared to intersections with partial stop control. This is likely related to there being fewer locations and these locations generally have lower levels of exposure, whereas partial stop-controlled intersections are typically located at intersections between higher and lower functional classification roadways (e.g. primary arterial and residential).

[10] Stop controlled intersections where not every approach is stop controlled (e.g., two-way stop).

Table 12: Intersection Crashes by Intersection Control Type, 2016 - 2020

Intersection Control Type	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI/ IX[11]	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes	Crash/ IX
Partial Stop	123	46%	2.5%	0.07	49,395	42%	9.9	4,994	38%	2.74
Traffic Signal	101	38%	1.7%	0.34	49,293	42%	8.5	5,776	44%	19.19
Uncontrolled or Yield Controlled	32	12%	1.7%	0.01	13,594	12%	7.3	1,853	14%	0.55
Flashing Beacon	12	4%	2.3%	0.13	5,251	4%	10.0	527	4%	5.55
All-Way	1	0%	5.6%	0.08	289	0%	16.1	18	0%	1.38
Total	**269**	**100%**	**2.0%**		**117,823**	**100%**	**8.9**	**13,168**	**100%**	

Functional Classification

Table 13 summarizes crashes by functional classification. For crashes that occurred at an intersection, the highest functional classification was selected and assigned to the crash summarized in this table. In general, crashes occurred more frequently and were more severe at locations with a higher functional classification. Primary arterials accounted for 54 percent of crashes, 57 percent of KSI crashes, and 57 percent of EPDO scores despite only accounting for roughly 13 percent of the transportation systems roadway mileage. Additionally, primary arterials accounted for the majority share of overall crashes and KSI crashes on a per mile basis with 55.17 crashes per mile and 1.32 KSI crashes per mile. Minor arterials accounted for 18 percent of crashes, 20 percent of KSI crashes, 19 percent of EPDO scores. Minor arterials had the second highest rate of crashes per mile with 41.82 overall crashes per mile and 1.08 KSI crashes per mile.

[11] "IX" = shorthand for intersection

Table 13: Crashes by Functional Classification, 2016 - 2020

Functional Classification	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI/ Mile	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes	Crash/ Mile
Primary Arterial	219	57%	2.4%	1.32	90,719	57%	9.9	9,148	54%	55.17
Minor Arterial	76	20%	2.5%	1.06	30,551	19%	10.2	2,987	18%	41.49
Major Collector	46	12%	2.3%	0.65	18,514	12%	9.3	1,985	12%	28.04
Residential	36	9%	1.4%	0.05	16,287	10%	6.3	2,599	15%	3.70
Unknown	4	1%	3.6%	N/A	1,386	1%	12.4	112	1%	N/A
Minor collector	3	1%	14.3%	0.23	757	0%	36.1	21	0%	1.61
Total	***384***	***100%***	***2.3%***		***158,214***	***100%***	***9.4***	***16,852***	***100%***	

Table 14 summarizes intersection crashes (excludes mid-block crashes) by highest and lowest functional classifications present at the intersection. Consistent with the results displayed in Table 13, intersections with at least one primary arterial accounted for some of the largest shares of crashes and KSI crashes. Intersections at principal arterials with residential roadways had the largest share of KSI crashes (22 percent) followed by major collector and minor arterial (8 percent and 7 percent respectively). Of the intersections at primary arterials, residential roadways represented the largest group in terms of the number of locations (577 intersections) whereas locations at major collectors and other major collectors represented a combined total of 41 intersections. There appears to be a higher risk for a KSI crash to occur with primary arterial-minor arterial intersections (0.33 KSI crashes per location).

Table 14: Crashes by Highest and Lowest Functional Classification, Intersection Crashes, 2016-2020

Highest Functional Classification	Lowest Functional Classification	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI per IX	# Crashes	% Crashes	Crashes Per IX	# of IX
Primary Arterial	**Residential**	86	22%	3%	0.15	3,203	19%	5.55	577
Primary Arterial	**Major Collector**	29	8%	2%	0.27	1,293	8%	11.86	109
Primary Arterial	**Minor Arterial**	27	7%	2%	0.33	1,494	9%	18.22	82
Primary Arterial	**Primary Arterial**	20	5%	1%	0.29	1,397	8%	20.54	68
Minor Arterial	**Residential**	34	9%	2%	0.07	1,483	9%	2.90	512
Minor Arterial	**Major Collector**	11	3%	3%	0.24	384	2%	8.53	45
Minor Arterial	**Minor Arterial**	8	2%	1%	0.14	563	3%	9.71	58
Major Collector	**Residential**	20	5%	2%	0.04	1,106	7%	2.06	537
Major Collector	**Major Collector**	5	1%	2%	0.12	227	1%	5.54	41
Residential	**Residential**	28	7%	1%	0.01	1,991	12%	0.71	2790
Mid-Block		*116*	*30%*	*3%*		*3,711*	*22%*		
Total		***384***	***100%***	***2%***		***16,852***	***100%***		

Lighting Condition

Table 15 summarizes crashes by officer-reported lighting conditions. Most crashes occurred during daylight conditions, accounting for 63 percent of overall crashes. This is expected as trips most often occur during the day for commuting, recreation, or utility trips. However, 42 percent of KSI crashes happened during dark lighting conditions with the streetlights turned on. The share of KSI crashes were slightly higher (48 percent of crashes) during daylight conditions compared to 42 percent of crashes that happened during dark lighting conditions (higher share of trips made during daylight hours). Additionally, crashes during dark conditions with streetlights turned on are on average more severe than daylight crashes with 3.2 percent of crashes resulting in a KSI and an average EPDO score of 11.2 compared to 1.8 percent and 8.4 for daylight crashes. In general, the intensity of crashes was higher during dark lighting conditions (regardless of streetlight on, off, none). While daylight crashes accounted for the majority of overall crashes (63 percent), crashes that occurred during dark lighting conditions resulting in a KSI were overrepresented with roughly 35 percent of crashes having occurred during dark lighting conditions but roughly 45 percent of KSI crashes occurred during dark lighting conditions. This suggests that crashes that occurred during dark lighting conditions tend to have more severe outcomes, likely related to decreased visibility and delayed stopping or crash avoidance maneuvers.

Table 15: Crashes by Reported Lighting Condition, 2016 - 2020

Reported Lighting Condition	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
Daylight	186	48%	1.8%	89,047	56%	8.4	10,621	63%
Dark-Street Lights On	162	42%	3.2%	56,224	36%	11.2	5,023	30%
Dusk	17	4%	3.2%	6,252	4%	11.7	536	3%
Dark-No Street Lights	9	2%	3.8%	2,762	2%	11.6	238	1%
Dawn	5	1%	1.8%	2,239	1%	8.0	279	2%
Dark-Street Lights Off	3	1%	3.4%	1,044	1%	11.9	88	1%
Unknown	2	1%	3.6%	596	0%	10.6	56	0%
Other	0	0%	0.0%	11	0%	5.3	2	0%
Dark - Unknown Lighting	0	0%	0.0%	39	0%	4.3	9	0%
Total	***384***	***100%***	***2.3%***	***158,214***	***100%***	***9.4***	***16,852***	***100%***

Posted Speed Limit

Table 16 summarizes crashes by posted speed limit by lowest and highest posted speed limit present at each intersection for intersection crashes. Research has found roadways with higher speeds are positively associated with crash risk and crash severity. This analysis found intersections with a highest posted speed limit of 30mph accounted for the largest share of all crashes (46 percent) whereas intersections with a posted speed limit of 25mph accounted for only 20 percent of crashes despite accounting for 54 percent of the total number of intersections. Intersections with a highest posted speed limit of 30mph had the largest share of KSI crashes (46 percent) followed by intersections with a highest posted speed limit of 35mph (36 percent).

Table 16: Intersection Crashes by Highest Posted Speed Limit, 2016-2020

Highest Posted Speed Limit	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI per IX	# Crashes	% Crashes	Crashes Per IX	# of IX[12]
25	41	15%	1.6%	0.01	2,623	20%	0.87	3,024
30	123	46%	2.0%	0.09	6,117	46%	4.47	1,363
35	97	36%	2.4%	0.25	3,992	30%	10.24	383
40	4	1%	1.4%	0.10	283	2%	7.26	39
50	2	1%	1.5%	0.50	137	1%	34.25	4
60	2	1%	12.5%	0.67	16	0%	5.33	3
Total	**269**	**100%**	**2.0%**		**13,168**	**100%**		

Table 17 summarizes crashes by posted speed limit by lowest and highest posted speed limit present at each intersection for intersection crashes. When looking at the combinations of speed limits present at each intersection, speed limit combinations of 30/25mph accounted for the largest share of crashes (33 percent). Intersections with posted speed limit of 30mph/25mph and 35mph/25mph accounted for the largest shares of KSI crashes with 36 percent and 21 percent respectively. When looking at the number of crashes per intersection (for location types of more than 15 locations), intersections with a posted speed limit of 35mph/30mph had the largest number of crashes per intersection (26) and number of KSI crashes per intersection (0.50).

[12] IX = Intersection

Table 17: Crashes by Posted Speed Limit, Intersection Crashes, 2016-2020

Highest Speed Limit	Lowest Speed Limit	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI per IX	# Crashes	% Crashes	Crashes per IX	# of IX
30	25	96	36%	2.2%	0.08	4,358	33%	3.49	1246
30	30	27	10%	1.5%	0.23	1,759	13%	14.66	117
35	25	57	21%	3.0%	0.19	1,892	14%	6.39	294
35	30	28	10%	1.9%	0.50	1,456	11%	26.00	53
35	35	12	4%	1.9%	0.32	644	5%	16.95	36
25	25	41	15%	1.6%	0.01	2,623	20%	0.87	3020
40	30	3	1%	1.7%	0.27	177	1%	16.09	11
40	25	1	0%	2.0%	0.07	51	0%	3.64	14
40	40	0	0%	0.0%	-	37	0%	7.40	5
40	35	0	0%	0.0%	-	18	0%	2.00	9
50	25	2	1%	2.0%	1.00	98	1%	49.00	2
50	50	0	0%	0.0%	-	5	0%	5.00	1
50	40	0	0%	0.0%	-	34	0%	34.00	1
60	35	2	1%	16.7%	2.00	12	0%	12.00	1
60	40	0	0%	0.0%	-	4	0%	2.00	2
Total		***269***	***100%***	***2.0%***		***13,168***	***100%***		

Table 18 summarizes mid-block crashes (crashes more than 150' from an intersection) by posted speed limit. In general, mid-block crashes occurred at a higher rate per mile along streets with posted great limits greater than 25mph. Streets with a posted speed limit of 35 had the highest number of crashes (37 percent), KSI crashes (43 percent), crashes per mile of roadway (18.42), and KSI crashes per mile (0.68), while measuring at 74 street miles. Streets with a posted speed limit of 30 had the second highest number of crashes (31 percent), and number of KSI crashes (23 percent). Further investigation may be needed to find what other variables tied to roadways with posted speed limits of 35 and below contribute to their higher crash and KSI crash rates, such as whether these roadways tend to have more trip generators (schools, commercial land use, parks, etc.).

Table 18: Crashes by Posted Speed Limit, Mid-Block Crashes, 2016-2020

Speed Limit	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI/ Mile	# Crashes	% Crashes	Crashes/ Mile	Street Miles
25	17	15%	1.9%	0.02	881	24%	1.12	790
30	27	23%	2.3%	0.20	1,158	31%	8.66	134
35	50	43%	3.7%	0.68	1,363	37%	18.42	74
40	15	13%	6.6%	0.28	229	6%	4.35	53
50	6	5%	12.8%	1.19	47	1%	9.31	5
60	0	0%	0.0%	-	6	0%	0.16	37
Total	***115***	***100%***	***3.1%***		***3,684***	***100%***		

State Routes

Table 19 summarizes crash frequency by jurisdiction. **The figures summarized in this table will differ from the figures reported elsewhere in this memo. Access-controlled routes were removed from this analysis during the crash data preparation process.** The purpose of this table is to recognize those crashes that occur along City of Tacoma controlled streets, along access-controlled roadways (i.e. I-5, SR 16, etc.,), and along surface-level state routes (N Pearl St, Pacific Ave, and Marine View Dr). Tacoma roadways had a substantially lower crash rate on a per mile basis for all crashes and KSI crashes. This is likely related to these roadways making up the vast majority of the street network, whereas surface-level state routes and access-controlled state routes have a much lower share of network mileage. Access-controlled state routes had the highest number of crashes on a per mile basis by a large margin. This large margin is likely tied to the sheer volume of vehicles traveling along access-controlled corridors resulting in a higher frequency of crashes. Interestingly, access-controlled state routes had the lowest percent of crashes that resulted in a KSI (1 percent). Surface-level state routes had the second highest number of crashes per mile (178.3) and KSI crashes per mile (5.3). The top KSI crashes type along surface-level state routes include entering at angle (16 KSI), vehicle going straight hits pedestrian (15 KSI), fixed object (9), and motorist making left turn and motorists proceeding straight (7 KSI).

Table 19: Crashes by Roadway Jurisdiction, 2016-2020

Roadway Jurisdiction	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI/ Mile	# Crashes	% Crashes	Crashes/ Mile
Tacoma roadways	309	67%	2.2%	0.3	14,308	59%	13.8
Access-Controlled State Routes[13]	74	16%	1.0%	4.4	7,371	30%	436.2
Surface-Level State Route	75	16%	2.9%	5.3	2,544	11%	178.3
Total	**458**	**100%**	**1.9%**		**24,223**	**100%**	

Land Use

Primary Land Use – Intersection Crashes

Table 18 summarizes intersections crashes by primary land use[14]. Single family residential (SFR) land uses had the highest share of crashes (35 percent) and highest share of KSI crashes (35 percent), though had the lowest KSI crash per intersection (0.03) and second lowest crashes per intersection (1.37). This is not surprising as single family residential land use is the largest land use type in the city of Tacoma and is primarily on lower speed streets. In contrast, commercial land uses had substantially higher number of crashes per intersection (11.52) and KSI crashes per intersection (0.29). Intersections with neighborhood commercial had the second highest number of crashes per intersection (9.85) and KSI crashes per intersection (0.21). Intersections in general commercial land uses had both the highest crashes per intersection (11.52) and KSI crashes per intersection (0.29). Commercial land uses in general are common activity and trip generators, and as more people congregate to shop and run errands, the crash potential may also increase as a function of exposure.

[13] Crashes that occurred along access-controlled routes were removed from this analysis.

[14] Primary land use was assigned by measuring the land use composition around each intersection using a 500 foot buffer. The land use with the largest share of the 500 foot buffer was assigned the primary land use.

Table 20: Intersection Crashes by Primary Land Use, 2016 - 2020

Primary Land Use	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI/ Inter-section	# Crashes	% Crashes	Crashes/ Inter-section	# of IX
Single Family Residential	95	35%	2.1%	0.03	4,616	35%	1.37	3373
Neighborhood Commercial	29	11%	2.1%	0.21	1,369	10%	9.85	139
Multi-Family (Low Density)	28	10%	2.5%	0.14	1,110	8%	5.39	208
Downtown Regional Growth Center	24	9%	1.6%	0.07	1,533	12%	4.73	329
Crossroads Mixed-Use Center	21	8%	2.6%	0.03	805	6%	1.05	747
General Commercial	19	7%	2.5%	0.29	760	6%	11.52	64
Parks and Open Space	10	4%	3.1%	0.07	325	2%	2.26	145
Light Industrial	10	4%	2.3%	0.12	429	3%	5.11	81
Neighborhood Mixed-Use Center	8	3%	1.3%	0.07	639	5%	5.65	116
Heavy Industrial	8	3%	1.5%	0.07	527	4%	4.83	111
Major Institutional Campus	7	3%	2.2%	0.09	316	2%	4.05	76
Multi-Family (High Density)	6	2%	2.7%	0.07	223	2%	2.65	86
Tacoma Mall Regional Growth Center	4	1%	0.9%	0.05	448	3%	5.82	80
Shoreline	0	0%	0.0%	-	68	1%	2.00	40
Total	**269**	**100%**	**2.0%**		**13,168**	**100%**		***208***

Transit Stops

Table 19 summarizes intersection crashes within 250’ of a transit stop. While the number of crashes and KSI crashes is evenly split between intersections within and not within a transit stop, the two variables differ in crashes per intersection. The crashes per intersection for crashes that did not occur within 250’ of a transit stop was 1.42. In contrast, the crashes per intersection rate for crashes near a bus stop was 7.30. KSI crashes follow a similar pattern. The KSI crash rate for crashes that occurred near a bus stop was 0.16, substantially higher than crashes that were not near a bus stop (0.03). This suggests that crash exposure is higher in intersections near a bus stop. That is not to say that bus stops inherently have a higher crash risk. Rather, transit stops may be stationed in high-volume corridors and/or near activity centers that generate transit ridership, which in turn translates to higher crash frequency. Bus stop placement in relation to the nearest street crossing may also be a factor. Additionally, further analysis may reveal possible interaction types between parties involved in the crash that may be related to boarding/alighting operations or a multiple threat scenario or roadway users crossing the primary street.

Table 21: Intersection Crashes Within 250’ of Transit Stop, 2016 - 2020

Within 250’ of a bus stop	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	KSI/ Inter-section	# Crashes	% Crashes	Crashes/ Intersection	# of IX
Yes	138	51%	2%	0.16	6,493	49%	7.30	890
No	131	49%	2%	0.03	6,675	51%	1.42	4,705
Total	**269**	**100%**	***2%***		**13,168**	**100%**		***5,595***

Behaviors

The following section summarizes unit behaviors that occurred prior to the crash. These behaviors provide insight into the actions from the parties involved that may have contributed to the crash. Rows that are particularly insightful or are considered possible risk factors are highlighted in red.

Collision Description

Table 22 summarizes the top ten known (i.e., excludes blank crash types) officer reported crash types for crashes that resulted in a KSI. These crash types generally include the direction of travel in relation to both units involved (i.e. opposite direction), movements preceding the cash, as well as the commonly coded descriptive collision type (i.e. rear end). The raw officer reported collision descriptions is a relatively exhaustive list of possible collision types that are either very detailed or relatively vague. This analysis refined this variable to reduce the affect a highly stratified crash dataset may have on conducting a crash analysis. Some crash types were grouped into "fixed object" or "roadway departure" crashes and had the primary motor vehicle pre-crash movement added to the crash type.

Motorists traveling straight striking a pedestrian accounted for the largest share of KSI crashes (23 percent) but only 2 percent of all crashes. This highlights the overall vulnerability of pedestrians traveling in the city of Tacoma, with roughly 32 percent of pedestrian crashes with motorists traveling straight crashes resulting in a KSI. Roughly 66 percent of crashes and 61 percent of KSI crashes occurred at intersections. Most crashes occurred at two-way stop controlled intersections, which may suggest the pedestrian was attempting to cross a major road. Fixed object – going straight ahead crashes accounted for the second largest share of KSI crashes with 13 percent of KSI crashes and only 8 percent of overall crashes. Solo-motorcycle crashes and vehicle turning left hits pedestrian had the second and third highest percent of crashes resulting in a KSI with 28 percent and 12 percent, respectively. There were relatively few solo-motorcycle crashes that occurred in Tacoma, though when those crash types occurred, they generally had severe outcomes.

Table 22: Top 10 Known Crash Types for Crashes Resulting in a KSI, 2016- 2020

Collision Description	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
Vehicle going straight hits pedestrian	84	23%	32%	21,377	14%	80.4	266	2%
Fixed Object - Going Straight Ahead	49	13%	4%	15,142	10%	11.8	1,279	8%
Entering at angle - Going Straight Ahead - Going Straight Ahead	48	13%	1%	27,181	18%	8.4	3,242	19%
From opposite direction - one left turn - one straight	34	9%	2%	16,448	11%	9.4	1,750	10%
Solo-Motorcycle Crash	17	5%	27%	4,306	3%	68.3	63	0%
Entering at angle - Making Left Turn - Going Straight Ahead	16	4%	2%	7,819	5%	7.5	1,036	6%
Vehicle turning left hits pedestrian	16	4%	12%	5,080	3%	38.2	133	1%
From same direction - both going straight - one stopped - rear-end	15	4%	1%	13,893	9%	6.2	2,239	13%
From opposite direction - all others	10	3%	5%	3,019	2%	16.2	186	1%
From same direction - both going straight - both moving - rear-end	9	2%	1%	5,469	4%	7.1	770	5%

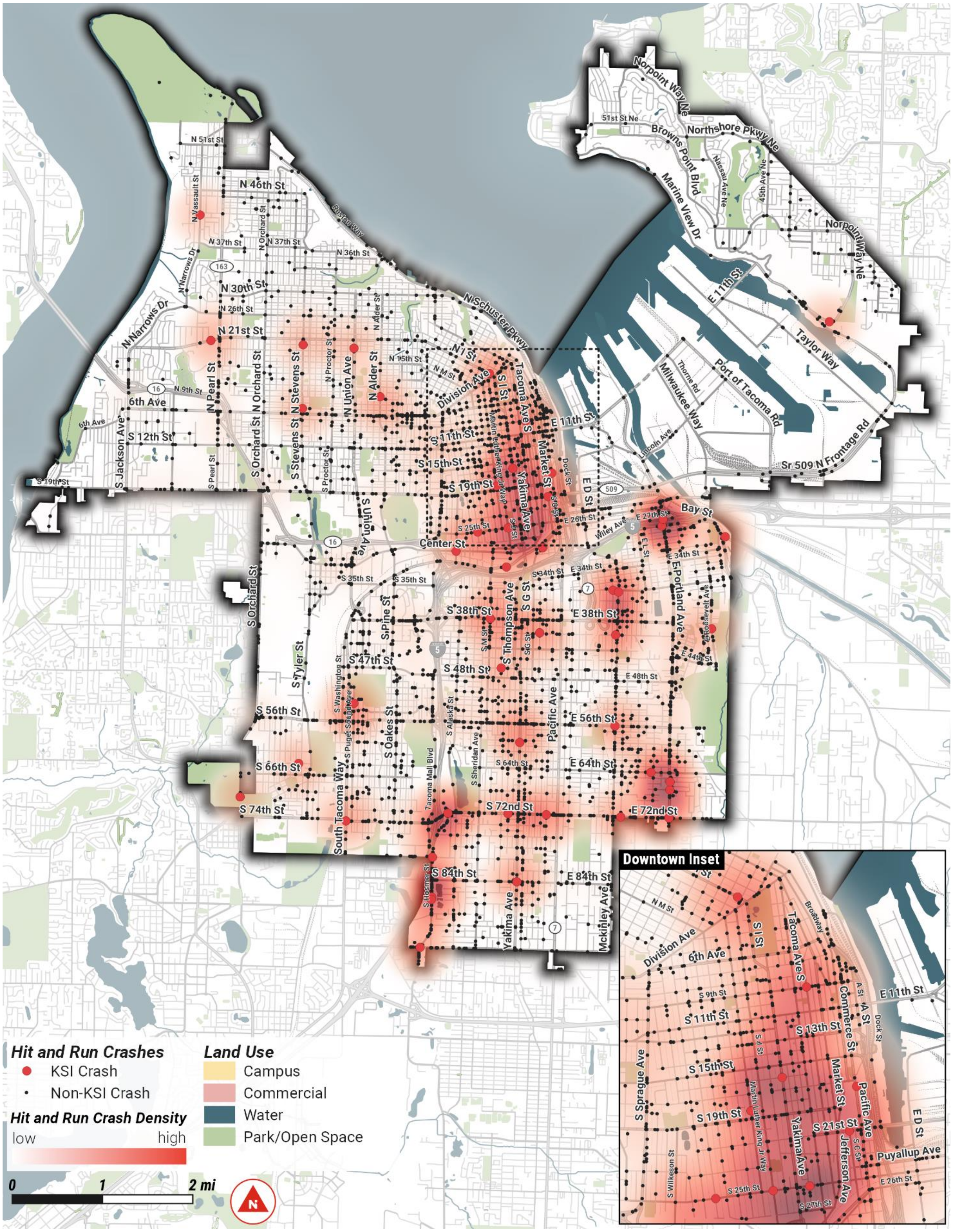
Hit and Run

Table 23 summarizes hit and run crashes by crash frequency and severity. Thirty percent of the reported crashes that occurred within the five year study period were reported as a hit and run crash. Additionally, nearly 15 percent of KSI crashes were a hit and run. Hit and run crash tend to be less severe with 1.1 percent of crashes resulting in a KSI outcome compared to 2.8 percent for non-hit and run crashes. Map 6 displays the location of all hit and run crashes. There appears to be a concentration of hit and run crashes within Downtown Tacoma, Portland Ave, and E 72nd St. The central and southern communities of Tacoma appear to have a higher frequency of crash and have more concentrated groupings of hit and run crashes compared to northwest and northeast Tacoma.

Table 23: Hit and Run Crashes, 2016- 2020

Hit and Run	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
Yes	55	14%	1.1%	25,671	16%	5.1	5,003	30%
No	329	86%	2.8%	132,543	84%	11.2	11,849	70%
Total	***384***	***100%***	***2.3%***	***158,214***	***100%***	***9.4***	***16,852***	***100%***

Map 6: Hit and Run Crashes, 2016- 2020



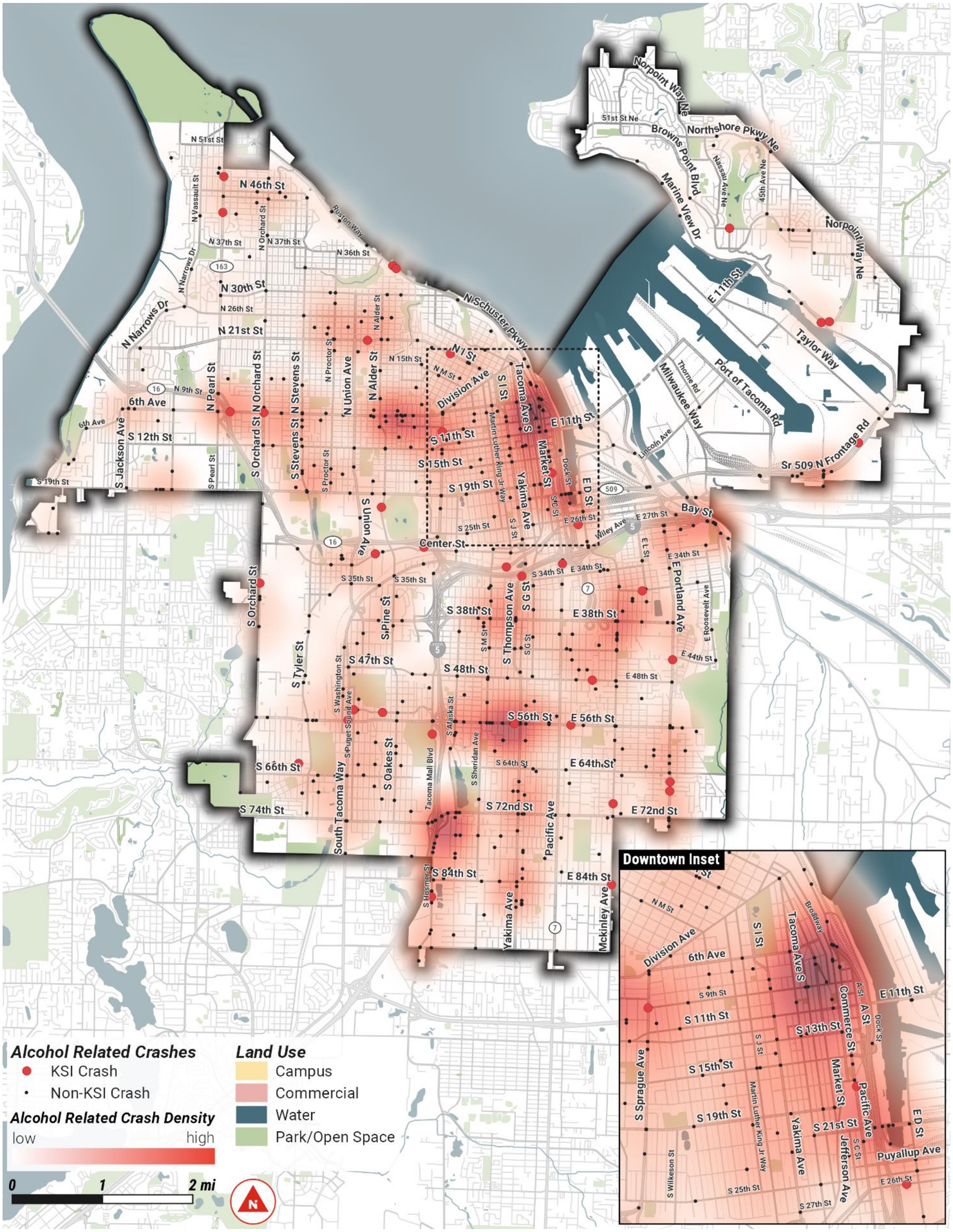
Alcohol Impairment

Table 24 summarizes crash frequency and severity for crashes with a reported alcohol impaired person. Crashes with an alcohol impaired person are disproportionately severe accounting for roughly 4 percent of crashes by 5 percent of KSI crashes and 7 percent of EPDO scores. The location and severity of these crashes can be viewed in Map 7. These crashes are relatively evenly distributed throughout the city with some minor concentrations visible near S 56th St and Yakima Ave, 6th Ave, and northern Downtown Tacoma.

Table 24: Crashes that Involved an Alcohol Impaired Person, 2016-2020

Involved Alcohol Impaired Person	# KSI Crashes	% KSI Crashes	% Crashes Resulting in KSI	EPDO Score	% EPDO Score	EPDO/ Crash	# Crashes	% Crashes
No	346	90%	2%	146,377	93%	9.1	16,145	96%
Yes	38	10%	5%	11,837	7%	16.7	707	4%
Total	**384**	**100%**	**2%**	**158,214**	**100%**	**9.4**	**16,852**	**100%**

Map 7: Crashes that Involved an Alcohol Impaired Person, 2016-2020



WSDOT Target Zero Primary Factors

Table 25 summarizes crashes for all the priorities in WSDOT's Target Zero plan[15]. The table includes the percent of statewide KSI crashes that had each of the Target Zero priority factors present. Note, not all priority factors included in the crash data were listed in the 2019 Target Zero Plan and bicycle and pedestrian KSI crashes were not disaggregated. Additionally, the 2019 Target Zero Plan used 2015-2017 crashes whereas the city of Tacoma used 2016-2020 crash data. The table highlights cells red where the Target Zero factor has a higher percent of KSI crashes in Tacoma than the statewide average, and cells blue where the factor has a lower share of KSI crashes. The most notable findings include the large difference in the share of KSI crashes for intersection related crashes (50 percent Tacoma; 32 percent statewide), unrestrained occupant (28 percent Tacoma; 12 percent statewide), and KSI crashes involving a pedestrian or bicyclist (36 percent Tacoma; 20 percent statewide). Other notable findings where the city of Tacoma had a lower share of KSI crashes compared to the statewide finding include speeding, distracted driving, lane departure, and impairment. Some of these factors may be challenging for a responding officer to decipher such as speeding and distracted driving, which may be a contributing factor in these underrepresented crash types.

[15] http://wtsc.wa.gov/wp-content/uploads/dlm_uploads/2019/10/TargetZero2019Lo-RES.pdf

Table 25: Target Zero Factors

Reported Target Zero Factors	# crashes	% crashes	# KSI Crashes	% KSI	Statewide % of KSI[16]
Intersection related[17]	9,952	58%	191	50%	32%
Pedestrian	497	3%	108	28%	(bike + pedestrian = 20%)
Unrestrained occupant	5,801	34%	104	27%	12%
Driver aged 65+	5,402	32%	96	25%	--
Lane departure	3,065	18%	73	19%	40%
Speeding	1,000	6%	55	14%	25%
Involved impaired Person	791	5%	53	14%	27%
Run off road	2,774	16%	53	14%	--
Distracted	730	4%	46	12%	30%
Driver aged 70+	1,440	8%	40	10%	10%
Alcohol impaired Involved Person	707	4%	38	10%	--
Driver aged 16-25	340	2%	35	9%	34%
Bicyclist	204	1%	30	8%	(bike + pedestrian = 20%)
Non-junction wrong way	291	2%	20	5%	--
Drug impaired Involved Person	18	0%	18	5%	--
Heavy vehicle	523	3%	15	4%	8%
Work zone related	95	1%	5	1%	1%
Wrong way vehicle	187	1%	3	1%	--
Drowsy driver	34	0%	2	1%	3%
Train	24	0%	1	0%	0%
School bus	69	0%	-	0%	0%
Wildlife	3	0%	-	0%	1%

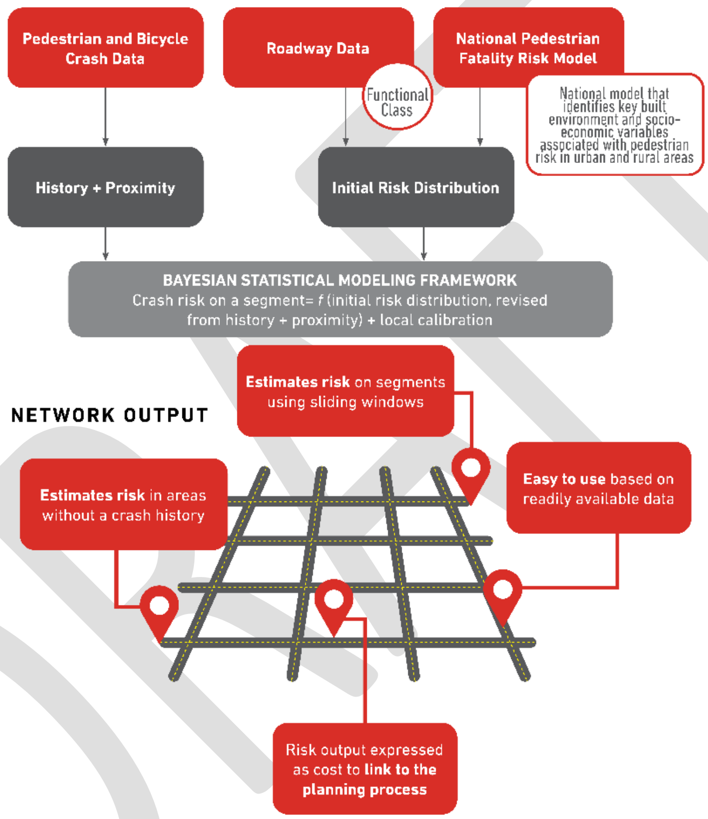
[16] Stats pulled directly from the 2019 WSDOT Target Zero Plan using 2015-2017 crash data. Compare the City of Tacoma crash analysis results with the statewide statistics with caution. Some Target Zero factors were split in the crash data but are aggregated in the Target Zero Plan.

[17] The WSDOT intersection related classification is defined differently than the approach used in this analysis. This analysis define a crash as an “intersection crash” if the crash occurred within 150 feet from the intersection centroid. WSDOT and WSP defines an “Intersection Related” by reviewing the crash narrative and diagram and using the data collectors judgment.

Safer Street Priority Finder (SSPF) Tool

SSPF Tool Background

Toole Design, in collaboration with the City of New Orleans, University of New Orleans Transportation Institute, and New Orleans Regional Transit Authority developed the Safer Streets Priority Finder Tool[18] (i.e., SSPF Tool). The SSPF Tool is a free, interactive, open-source resource available at the national scale that can help transportation practitioners identify a street network that is similar to a High Injury Network for bicyclists and pedestrians. The network goes further than a typical High Injury Network by not only taking into consideration areas where a disproportionate share of fatal and serious injury crashes have already occurred, but also areas that have factors present that are likely to contribute to future risk.



The SSPF produces two main outputs:

1. Sliding Windows Analysis (all modes) (typically how High Injury Networks are defined)
2. Safer Street Model: Estimated Future Societal Costs (bicycle and pedestrian crashes only)

The following sections will provide high level summaries for each analytical methodology and the results from each analysis. For more detailed information on the methodologies for each analysis, please see APPENDIX A, SSPF Technical Report, and/or https://www.saferstreetspriorityfinder.com/.

Sliding Windows Analysis

A sliding windows analysis helps us understand crashes throughout a transportation network and identify segments with the highest crash density, weighted by crash severity. The analysis is done by determining the number and severity of crashes in a half-mile “window” on a roadway and shifting that window along the roadway

[18] https://www.saferstreetspriorityfinder.com/tool/

1/10 mile at a time. Crashes are weighted by severity by multiplying the number of fatal and incapacitating injury (KSI) crashes by 3 and non-incapacitating injury crashes by 1 (non-injury crashes are not reflected). Each segment is scored and the result visualizes corridors with the highest density of crashes for bicyclists, pedestrians and motorists. Segments with thicker and darker lines represent portions of the roadway network that have a higher concentration of overall crashes and KSI crashes.

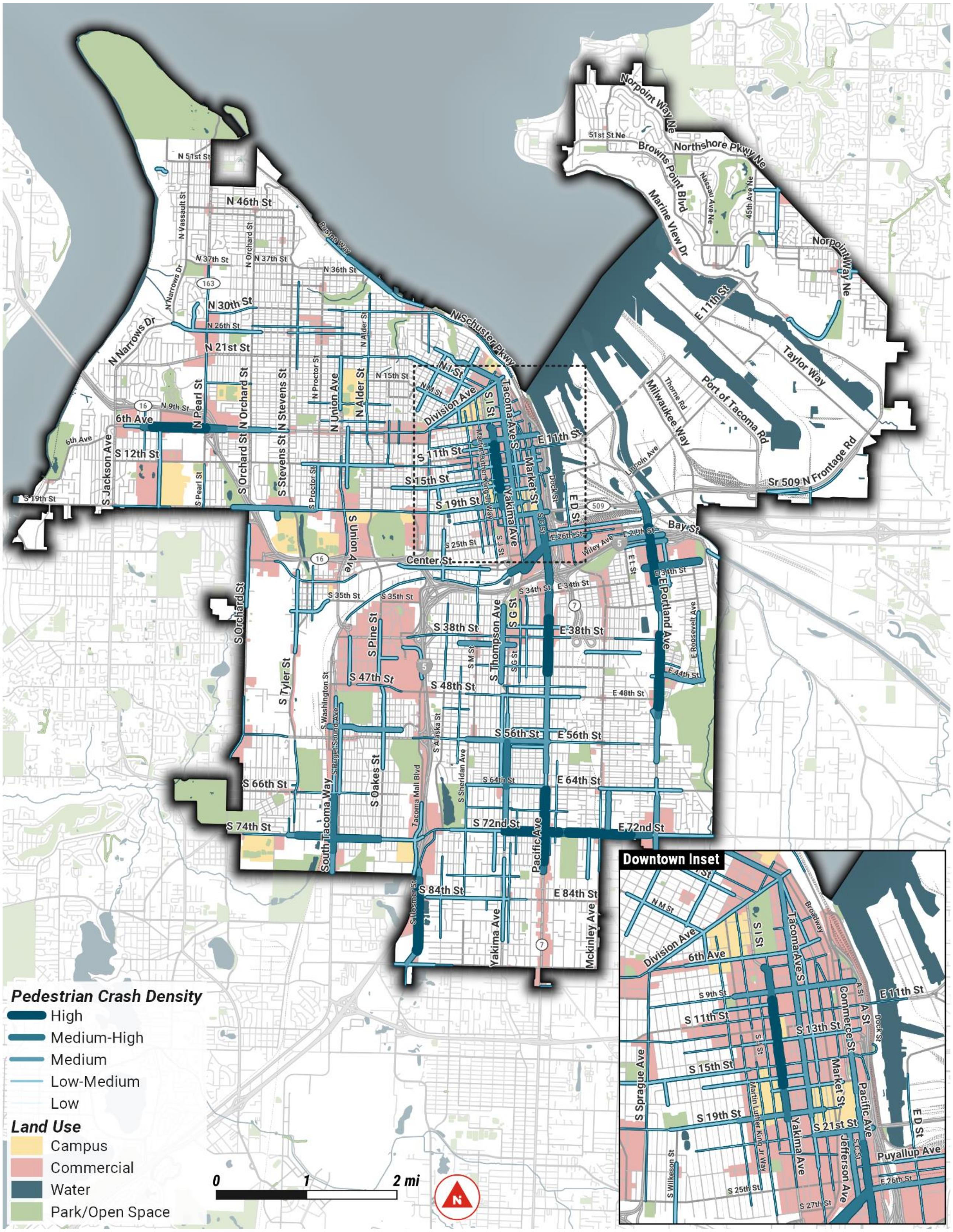
Key Output: corridors with highest concentration of crashes and KSI crashes using only historical crash data.

Pedestrian Sliding Windows Analysis Results

The results from this Sliding Windows Analysis confirms findings in the previous sections of this memo. Roadways with higher posted speed limits, busier streets (functional classification as proxy), and corridor along known pedestrian trip generating land uses have higher concentrations of more severe crashes. This can be seen along corridors in Tacoma's central business district/downtown where shorter blocks, higher intersection density, and a large number of activity centers generate a high propensity for pedestrian activity. 9th St provides an example of this, as it provides pedestrians with access to transit, civic and social services, as well as bars and restaurants. Roadway with longer blocks, higher speeds , and higher vehicle volumes include Pacific Ave, E Portland Ave, and S 72nd St. The following street had some of the highest scoring segments for pedestrian crashes:

- Pacific Ave
- E Portland Ave
- Yakima Ave
- 6th Ave
- E 72nd St

Map 8: Sliding Window Analysis, Pedestrian Crash Density

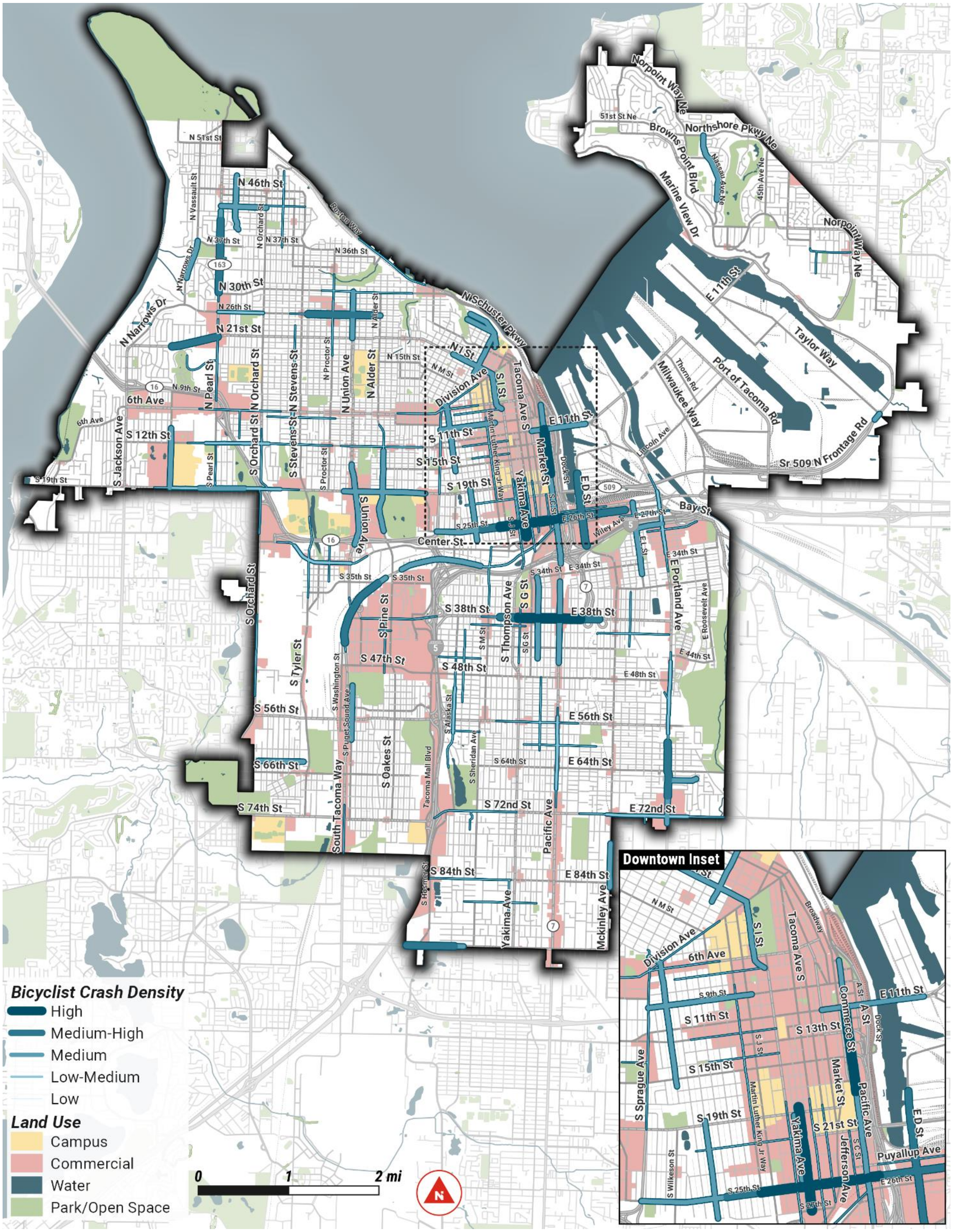


Bicyclist Sliding Windows Analysis Results

Similar to the pedestrian Sliding Windows Analysis results, bicycle crashes are most concentrated along major roadways and near trip generating/attracting land uses such as commercial/retail land and downtown Tacoma. The frequency of bicycle crashes is about half of the frequency of pedestrian crashes, which leads to there being fewer corridors that stand out as significant hot spots. Additionally, some corridors that may be known “risky corridors” for bicyclists may not appear as hot spots in this analysis due to the relatively small sample size in bike crash data. In other words, the absence of bicycle crashes does not indicate the absence of risk. The following streets had some of the highest scoring segments for bicycle crashes:

- S 38th St
- S 25th St
- E Portland Ave
- Pacific Ave

Map 9: Sliding Window Analysis, Bicyclist Crash Density



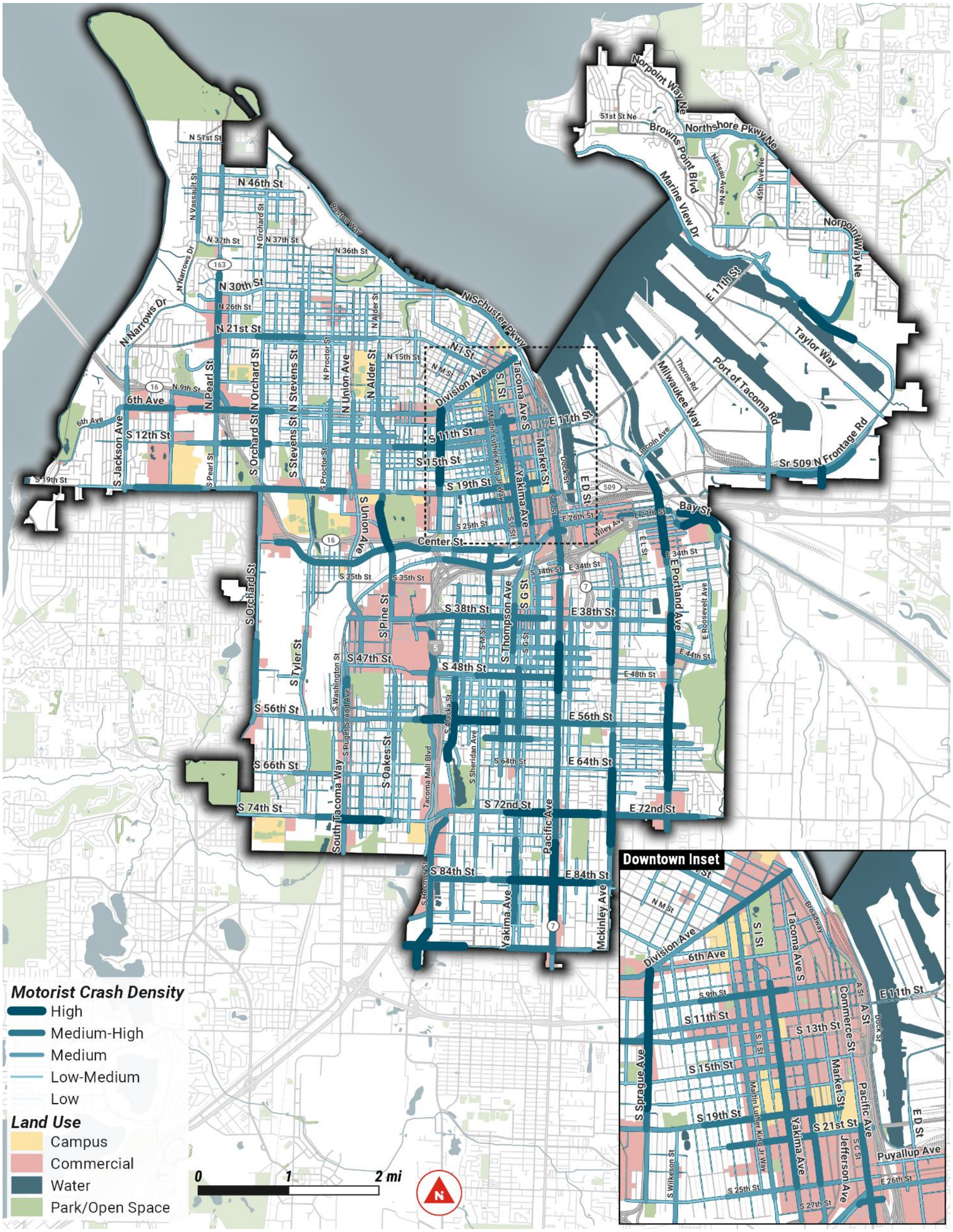
Motorist Sliding Windows Analysis Results

Similar to bicyclist and pedestrian sliding windows analysis, the highest scoring segments tend to be in areas where we can expect higher levels of activities. Unlike the pedestrian and bicyclist results, corridors that connect to the Interstate and the State Highways had a relatively high concentration of crashes[19]. Also dissimilar to the pedestrian and bicyclist results, all of the highest scoring motorist segments are outside of Downtown Tacoma, suggesting there are less severe crash outcomes for motorist crashes in Downtown. The following streets had the highest score for motor vehicle and motorcycle crashes:

- S 72nd St/S 74th St
- E Portland Ave
- Pacific Ave
- E 84th St
- S Alaska St
- McKinley Ave
- S Sprague Ave
- S Cedar St
- Bay St
- Marine View
- N Pearl St

[19] Note: crashes that occurred on the Interstate and State Highways (including on/off-ramps) have been removed from the analysis.

Map 10: Sliding Window Analysis, Motorist Crash Density



Safer Streets Model

The Safer Streets Model brings the segmented road network window segments (produced in the Sliding Windows Analysis) into a Bayesian statistical framework to estimate crash risk throughout the system. This framework incorporates external information about how many crashes might be expected (called a Bayesian prior), alongside the observed crash history.

The model estimates crash risk rates per mile for each road segment and each crash mode (pedestrian and bicyclist only) and severity. These values are then converted to crash cost estimates based on the costs assigned to each crash severity.

The Safer Streets Model is only available to model bicycle and pedestrian crashes. The model cannot estimate or model future motor vehicle or motorcycle crashes at this time.

Key Output: corridors with highest potential risk for bicycle and pedestrian crashes to occur in the future using both historical crash data and a statistical model.

Pedestrian Safer Street Model Results

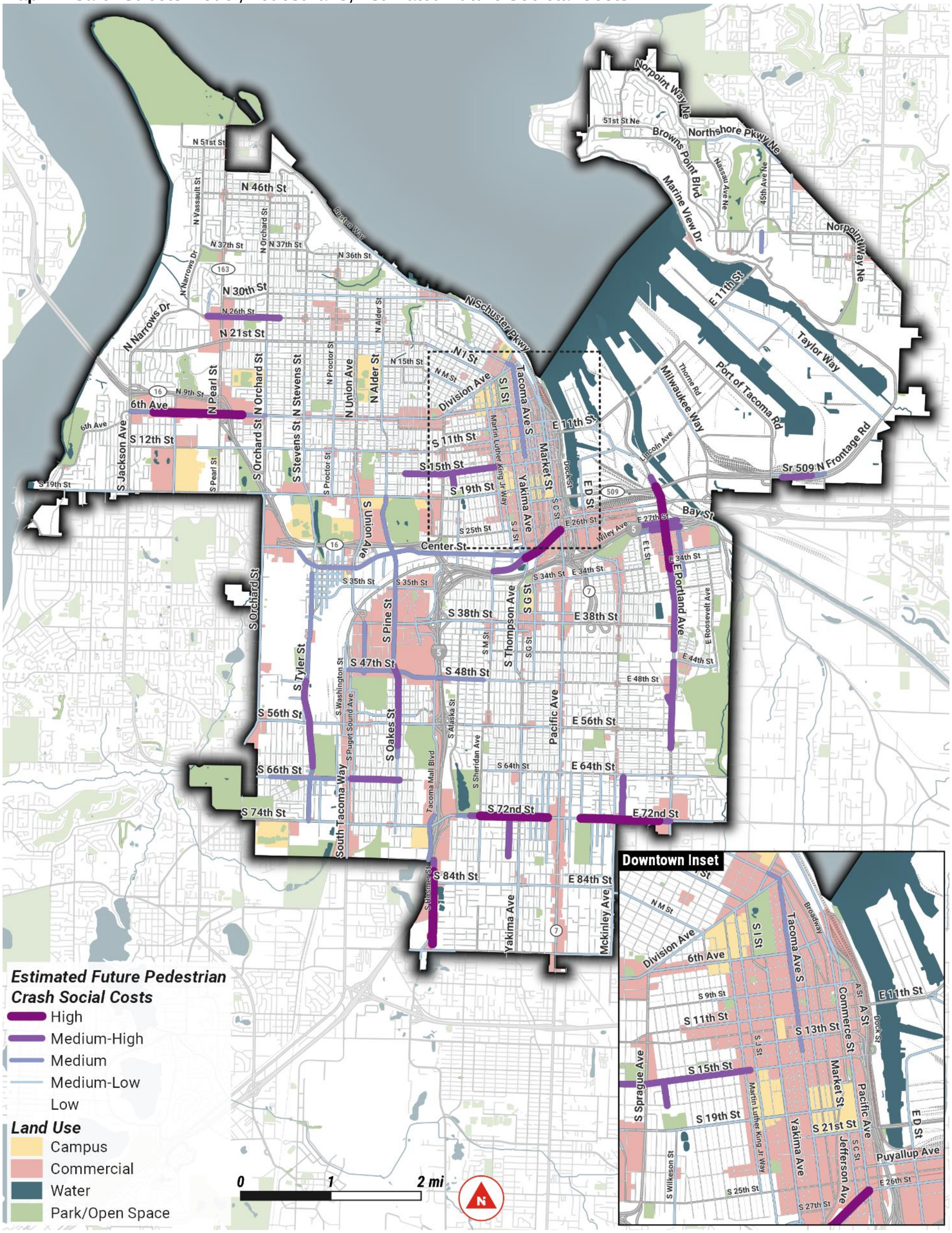
The Safer Streets Model for pedestrian crashes found some overlap between historical crash densities from the Sliding Windows Analysis and the modeled future pedestrian crashes. The following corridors were found to have a high estimate future pedestrian crash cost using the Safer Streets Model and have a high concentration of crashes found in the Sliding Windows Analysis:

Street Name	Safer Street Model	Sliding Window Analysis
S 72nd Ave	X	X
E Portland Ave	X	X
6th Ave	X	X
S Hosmer St	X	
South Tacoma Way	X	
Pacific Ave		X
Yakima Ave		X

One pattern that emerged from the Safer Streets Model involves streets that generally prioritize traffic throughput and run through automobile centric retail (such as drive-thru restaurants and big box retail). The design of those streets may contribute to higher crash potential between motorists and pedestrians. This can be seen in corridors like 72nd St and 6th Ave. 72nd St is a major arterial street that provides access to retail on its approach to Pacific Ave (another corridor with a high density of pedestrian crashes). 72nd St, especially on the west side of Pacific Ave, has a high driveway density. In turn, this translates to higher exposure and conflicts between pedestrians walking on the sidewalk and motorists approaching or leaving a driveway. 6th Ave in Tacoma's western edge follows these patterns. High driveway densities with wide radii (facilitating faster turning speeds, which increases crash intensity) and drive-thru restaurants on its eastbound side increase conflicts and crash risks between motorists and pedestrians.

This pattern may also suggest that larger roadways with higher vehicle volumes and speed, along corridors with automobile-centric land uses, may result in high pedestrian crash frequencies with more severe crash outcomes. For example, while Downtown Tacoma sees high-density pedestrian crash corridors, most have a relatively small pedestrian crash societal cost. Contrast this with corridors like Pacific Ave and 72nd St, as well as 6th Ave, which see a similar crash density but at a much higher societal cost.

Map 11: Safer Streets Model, Pedestrians, Estimated Future Societal Costs



Bicyclist Safer Street Model Results

The results from the Safer Streets Models, which estimates future bicyclist crash risk (represented by societal cost), found the following corridors to have the highest scoring segments for future bicycle crash risk and have a high concentration of crashes found in the Sliding Windows Analysis:

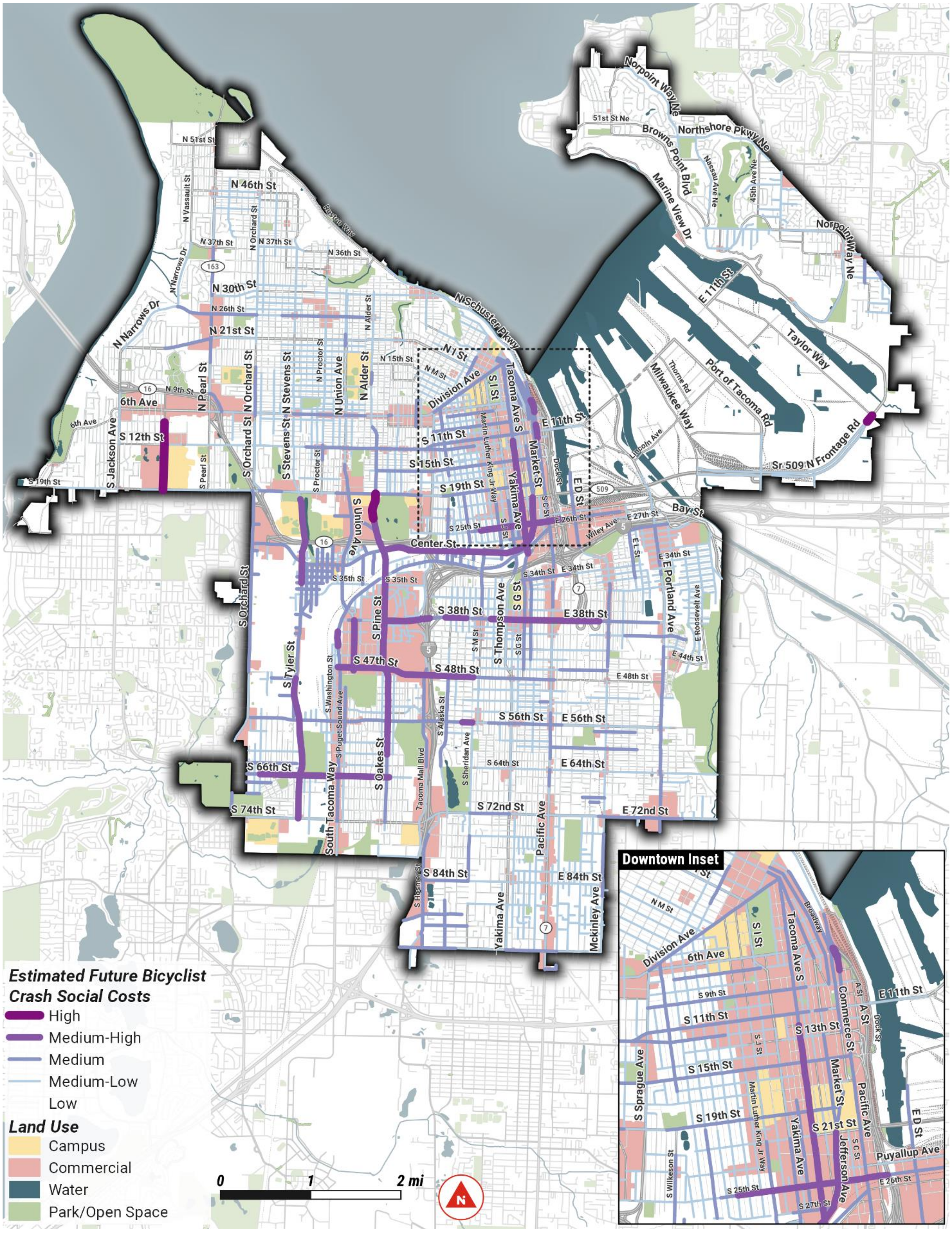
Street Name	Safer Street Model	Sliding Window Analysis
S Mildred St	X	
S Cedar St/S Pine St/ S Oak St	X	
Tacoma Ave S	X	
S 25th St	X	X
Center St	X	
E 38th St	X	X
S 48th St	X	
S 66th St	X	
E Portland Ave		X
Pacific Ave		X

Bike crash density patterns are somewhat similar to those found for pedestrian crashes in that they generally congregated on commercial and retail corridors. 25th St, for example, connects to transit/Amtrak station, breweries, and restaurants. Pacific Ave provides access to commercial and office land uses. Higher risk corridors tend to be along major arterials and collectors, with lower scores located along residential streets.

One significant trait that high societal cost scoring corridors had in common was that the corridors run long distances in between controlled intersections. For example, there is roughly a half-mile's distance between controlled intersections. Long distances between traffic signals or stop signs facilitate higher speeds, in turn increasing the intensity of a crash should one occur. This can be seen in other corridors like Mildred St and S Pine St. There are likely other design factors that contribute to higher speeds on these corridors.

One difference between existing crash densities and modeled bicyclist crash societal costs is that higher modeled societal costs occurred in corridors that did not run exclusively through retail land uses. Rather, higher risk corridors also were found on residential streets that operate at a higher functioning class, such as collector streets.

Map 12: Safer Streets Model, Bicyclists, Estimated Future Societal Costs



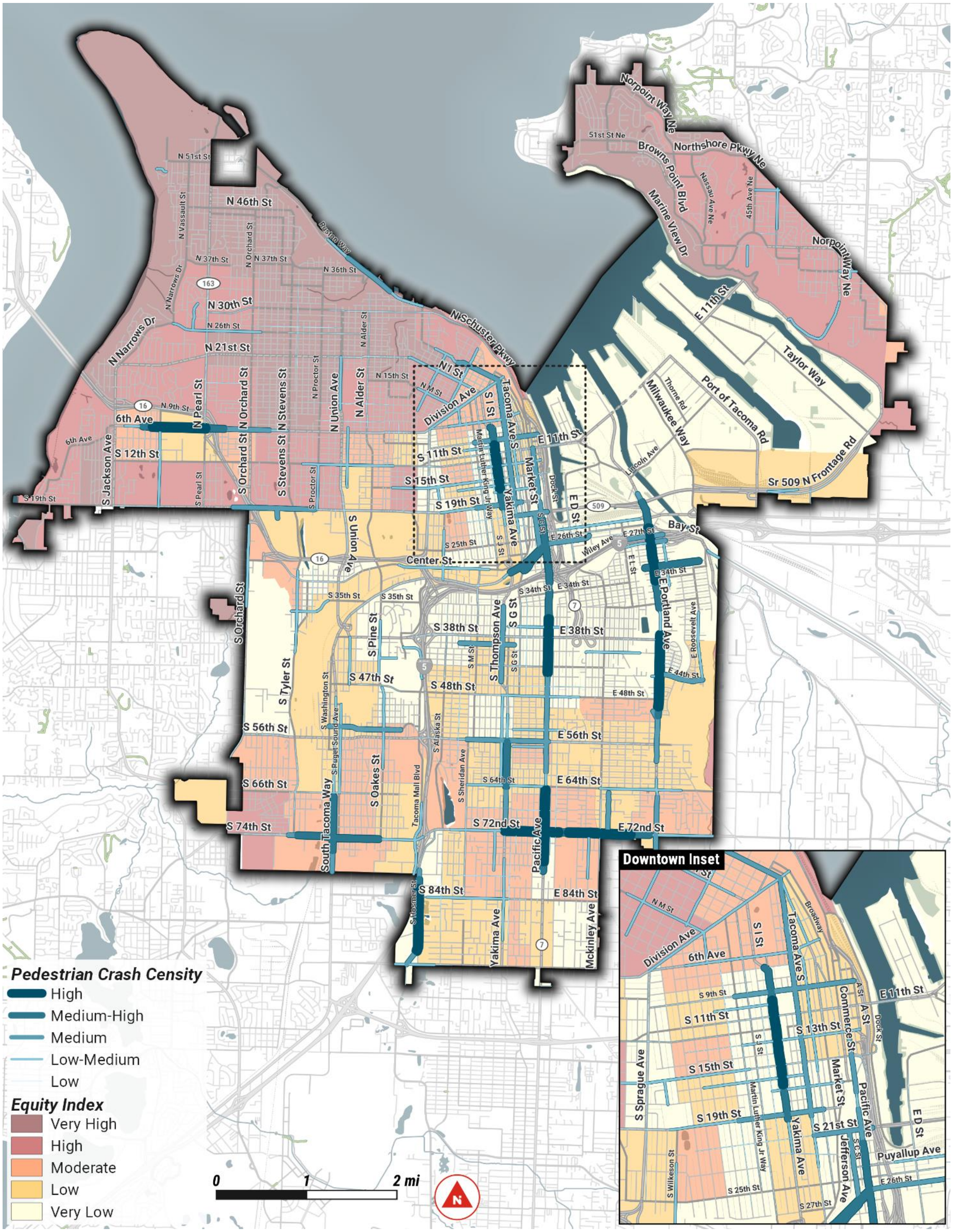
Equity

The City of Tacoma's Equity Index[20] was used in this analysis to assess the relationship between the results from the City's equity analysis and the location of historical crashes. The Equity Index displayed on the following maps indicate areas that have better opportunities to succeed and excel in life as having a darker share of red, and areas with fewer opportunities are displayed as a light yellow. The Equity Index displayed on these maps use a flipped color ramp to align with the City of Tacoma's intention to not reinforce historical representations of some communities as bad or negative using common colors that are associated as "bad", such as the color red.

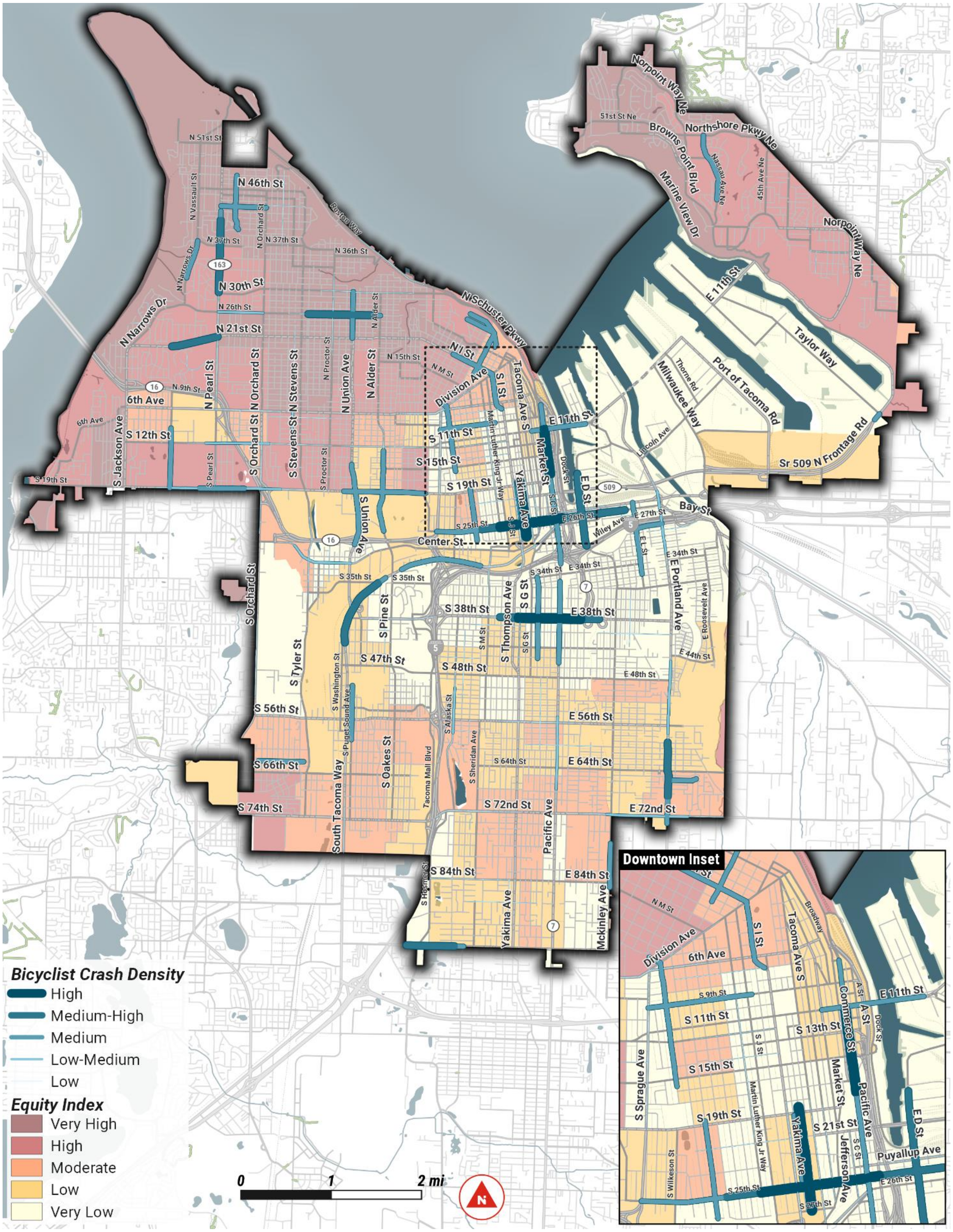
The results from each of the Sliding Windows Analysis were overlayed on top of the Equity Index. Across all modes, there are stark differences between corridors with high cash frequencies and the assigned Equity Index value. Areas with a lower Equity Index, which relates to lower opportunities, appear to have a strong association with crash density for each mode. This suggests communities with fewer opportunities to succeed have a disproportionate share of crashes and traffic related injuries.

[20] https://www.cityoftacoma.org/cms/One.aspx?portalId=169&pageId=175030

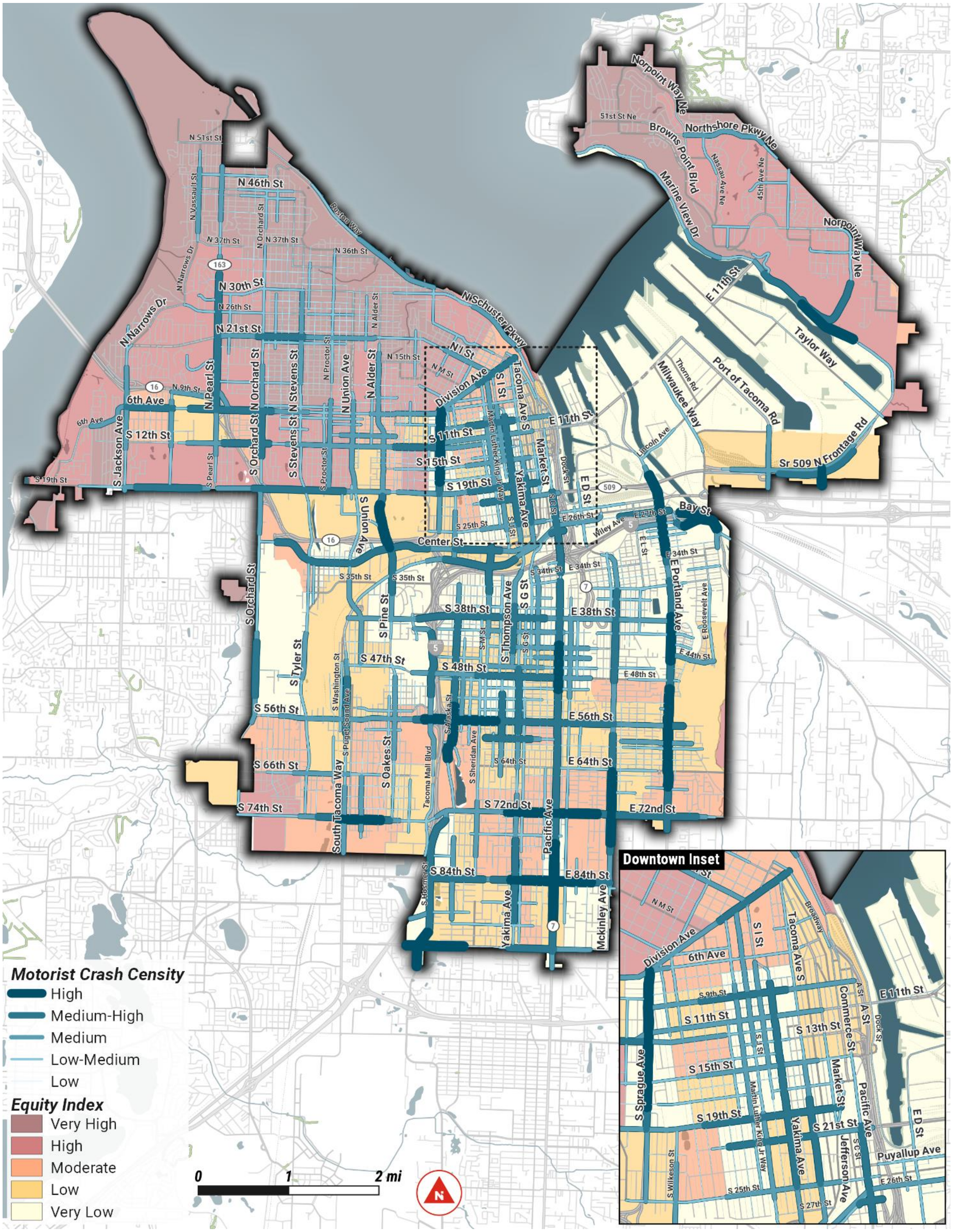
Map 13: Sliding Window Analysis and Equity Index, Pedestrian Crash Density



Map 14: Sliding Window Analysis and Equity Index, Bicyclist Crash Density



Map 15: Sliding Window Analysis and Equity Index, Motorist Crash Density



High Risk Network and High Crash Intersections

The outputs from the Sliding Windows Analysis and the Safer Street Model were used to develop a network that represents a series of corridors that have a high concentration of crashes that occurred in the past as well as corridors that have a higher estimated risk for crashes to occur in the future (for bicyclist and pedestrians only).

The Sliding Windows Analysis and Safer Street Model outputs were used to inform the development of the High Risk Network (HRN). The first step consisted of mapping the Sliding Windows Analysis results for each mode individually and iteratively filtering out the lower threshold required to be included in the HRN so as to eliminate streets that have a lower crash density. After the lower threshold was determined for each mode, the same process was used to iteratively filter out lower scoring segments from the Safer Street Model. These filtering processes to define the HRN require balancing both network coverage and network representation. The goal is to capture locations with historic crash issues and high risk for future crash to occur thus ensuring the final network captures the highest priority segments that can be systemically addressed through the identification and implementation of safety countermeasures.

In addition to developing the HRN, intersections were screened to identify locations that have a high concentration of crashes. High crash intersections were identified by selecting roughly the top 20 locations for bicyclists, pedestrians, and motorists by aggregating the EPDO values (see Table 3 for EPDO values for each injury severity).

Pedestrian High Risk Network

Table 26 summarizes the pedestrian HRN mileage along each street, Table 27 summarizes the pedestrian high crash intersections, and Map 16 displays the location of the HRN and top 19 intersections based on pedestrian EPDO scores. The HRN corridors are typically concentrated along many of the streets that have risk factors noted throughout this report, including streets with higher speeds and traffic volumes, near commercial land use, and with transit. The same can be said about the high crash intersections, many of which are located along the HRN.

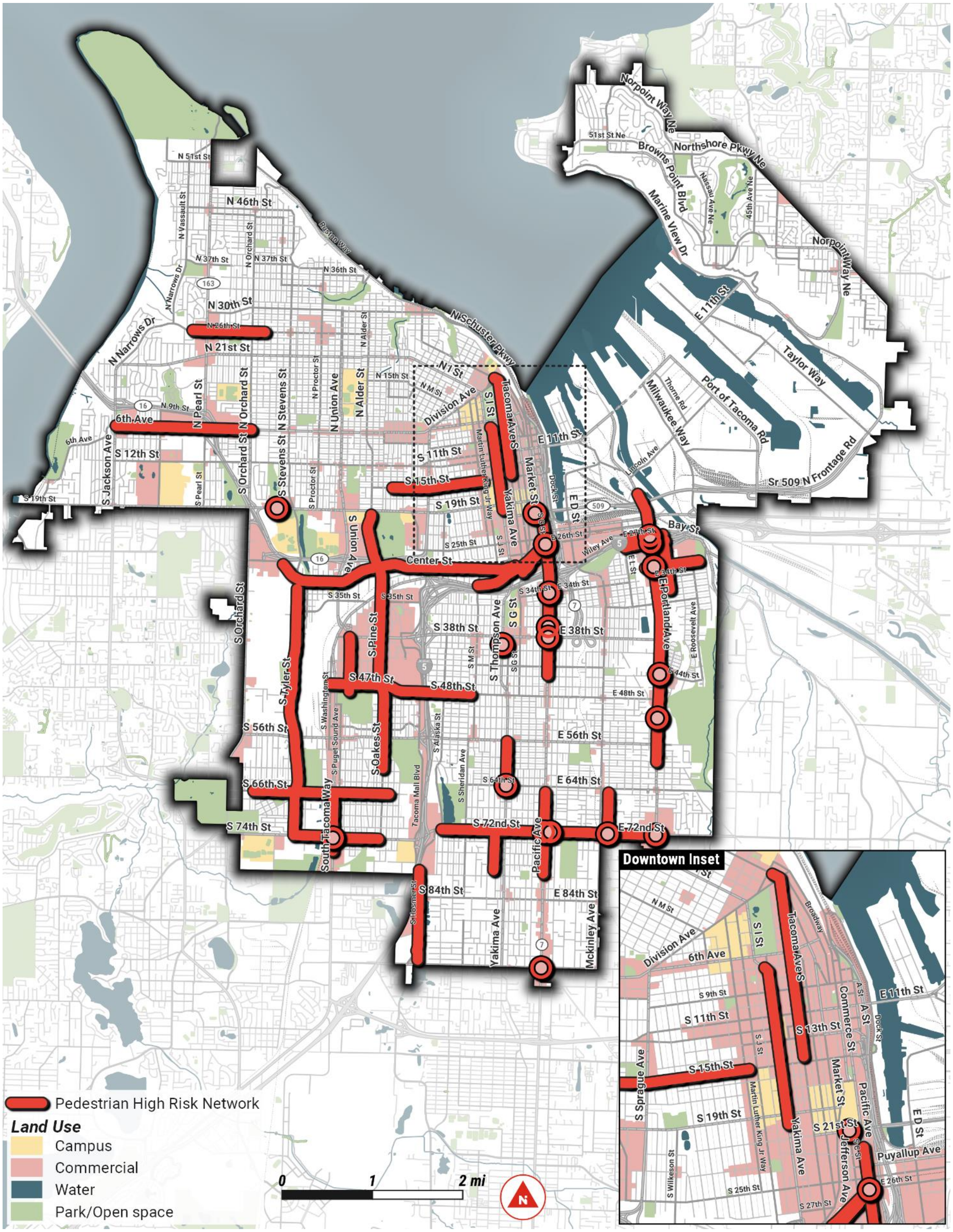
Table 26: Pedestrian HRN Street Mileage

Street Name	Mileage	% of Pedestrian
Portland	3.00	9%
Tyler	2.75	8%
Center	2.70	8%
Pacific	2.50	8%
72Nd	2.40	7%
6Th	1.50	5%
66Th	1.50	5%
South Tacoma	1.50	5%
Yakima	1.43	4%
Pine	1.30	4%
Tacoma	1.10	3%
15Th	1.00	3%
Oakes	1.00	3%
Hosmer	1.00	3%
74Th	0.90	3%
I	0.89	3%
26Th	0.80	2%
47Th	0.80	2%
48Th	0.77	2%
Cedar	0.60	2%
Warner	0.60	2%
32Nd	0.60	2%
R	0.55	2%
28Th	0.45	1%
27Th	0.44	1%
Delin	0.40	1%
Total	**32.48**	**100%**

Table 27: Top 19 Pedestrian High Crash Intersections

Intersection Name	EPDO
Pacific And 72nd	694
C And 21st	507
Portland And 32nd	505
72nd And I	488
39th And Thompson	472
Portland And 27th	472
South Tacoma Way And 74th	463
38th And Pacific	463
Portland And Pipeline	463
Clay Huntington And 19th	463
Portland And 44th	289
26th And Pacific	273
Pacific And 37th	257
Bell And 72nd	257
Yakima And 64th	257
28th And Portland	251
34th And Pacific	251
96th And Pacific	251
72nd And Portland	251

Map 16: Pedestrian High Risk Network



Bicyclist High Risk Network

Table 28 summarizes the bicyclist HRN mileage along each street, Table 29 summarizes the bicycle high crash intersections, and Map 17 displays the locations of both the HRN and the high crash intersections. Similar to the pedestrian HRN and high crash intersections, many of these segments and intersections are along streets where bicycle crash risk factors are present. Unlike the pedestrian HRN, bicycle HRN segments are slightly more concentrated toward central and northwest Tacoma, whereas pedestrian HRN segments have a stronger concentration in central to southern Tacoma.

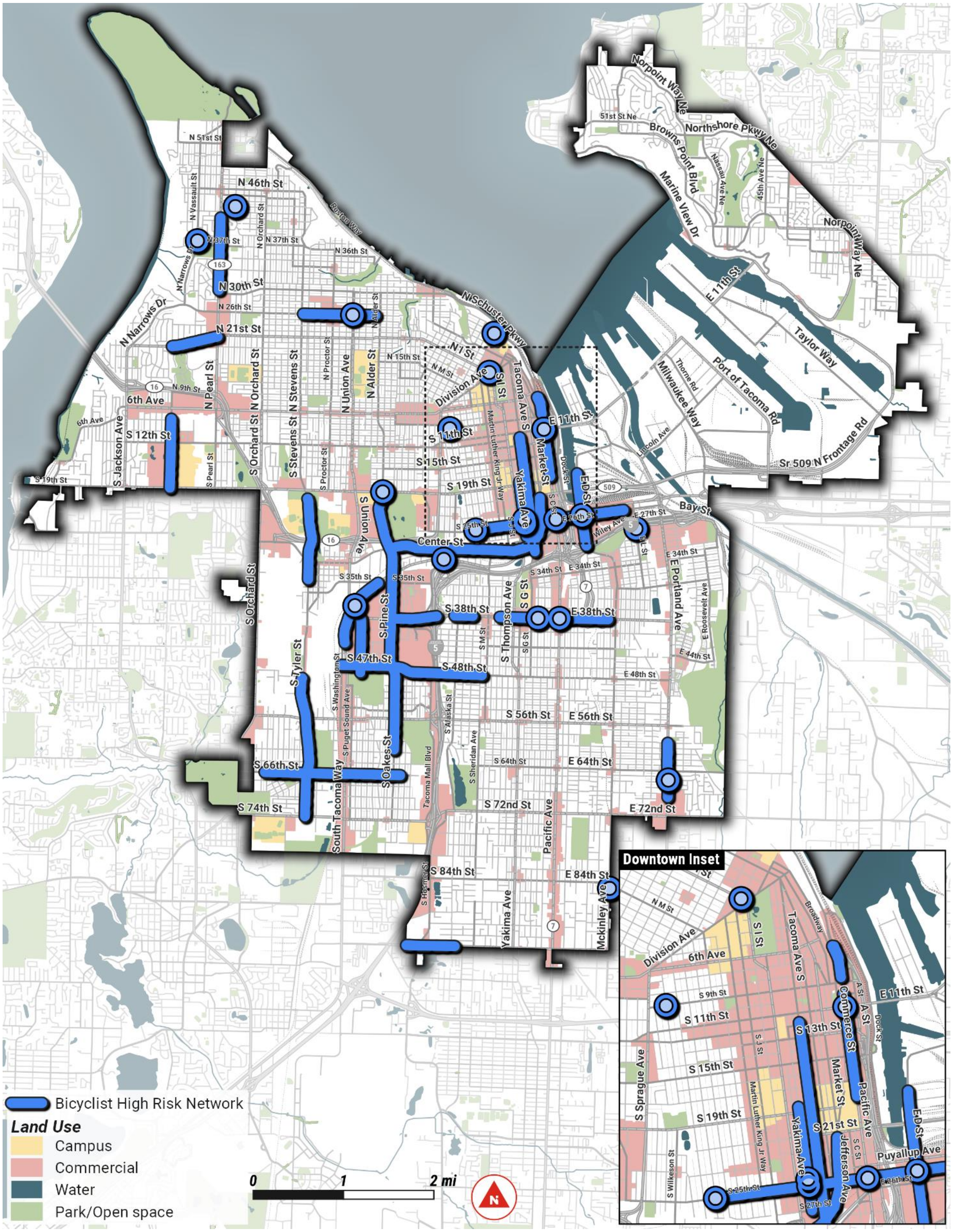
Table 28: Bicyclist HRN Street Mileage

Street Name	Mileage	% of Bike HRN
Tyler	2.45	11%
38Th	1.9	8%
25Th	1.6	7%
Center	1.6	7%
66Th	1.5	7%
Pine	1.3	6%
Tacoma	1.27	6%
Oakes	1	4%
Pacific	0.88	4%
D	0.81	4%
South Tacoma Way	0.8	3%
47Th	0.8	3%
Pearl	0.8	3%
26Th	0.8	3%
48Th	0.77	3%
Mildred	0.76	3%
G	0.61	3%
Portland	0.6	3%
Warner	0.6	3%
Cedar	0.6	3%
96Th	0.54	2%
Westgate	0.52	2%
Jefferson	0.5	2%
Total	**23.01**	**100%**

Table 29: Top 20 Bicyclist High Crash Intersections

Intersection Name	EPDO
11th And Pacific	463
25th And D	247
Tacoma And 38th	231
Vassault And 37th	231
19th And Cedar	231
25th And Cushman	231
25th And G	231
38th And Pacific	231
43rd And Winnifred	231
85th And Mckinley	231
9th And Grant	231
G And Court G	231
Hosmer And Sr 16	231
I And 2nd	231
L And 28th	231
Pacific And 25th	231
Portland And 66th	231
South Tacoma Way And 37th	231
Stadium And	231
Union And 26th	231

Map 17: Bicyclist High Risk Network



Motorist(including motorcycles) High Risk Network

Table 30 summarizes the motorist HRN mileage along each street. Table 31 summarizes the motorist high crash intersections, and Map 18 displays the location of the motorist HRN and high crash intersections. The motorist HRN is generally concentrated in central and southern Tacoma, with some segments located along Marine View Drive in northeast Tacoma. There appears to be a strong association between streets that connect to highways and presence on the HRN. This suggests that the volume, roadway design, and surrounding land uses influence crash frequencies and possible crash risk

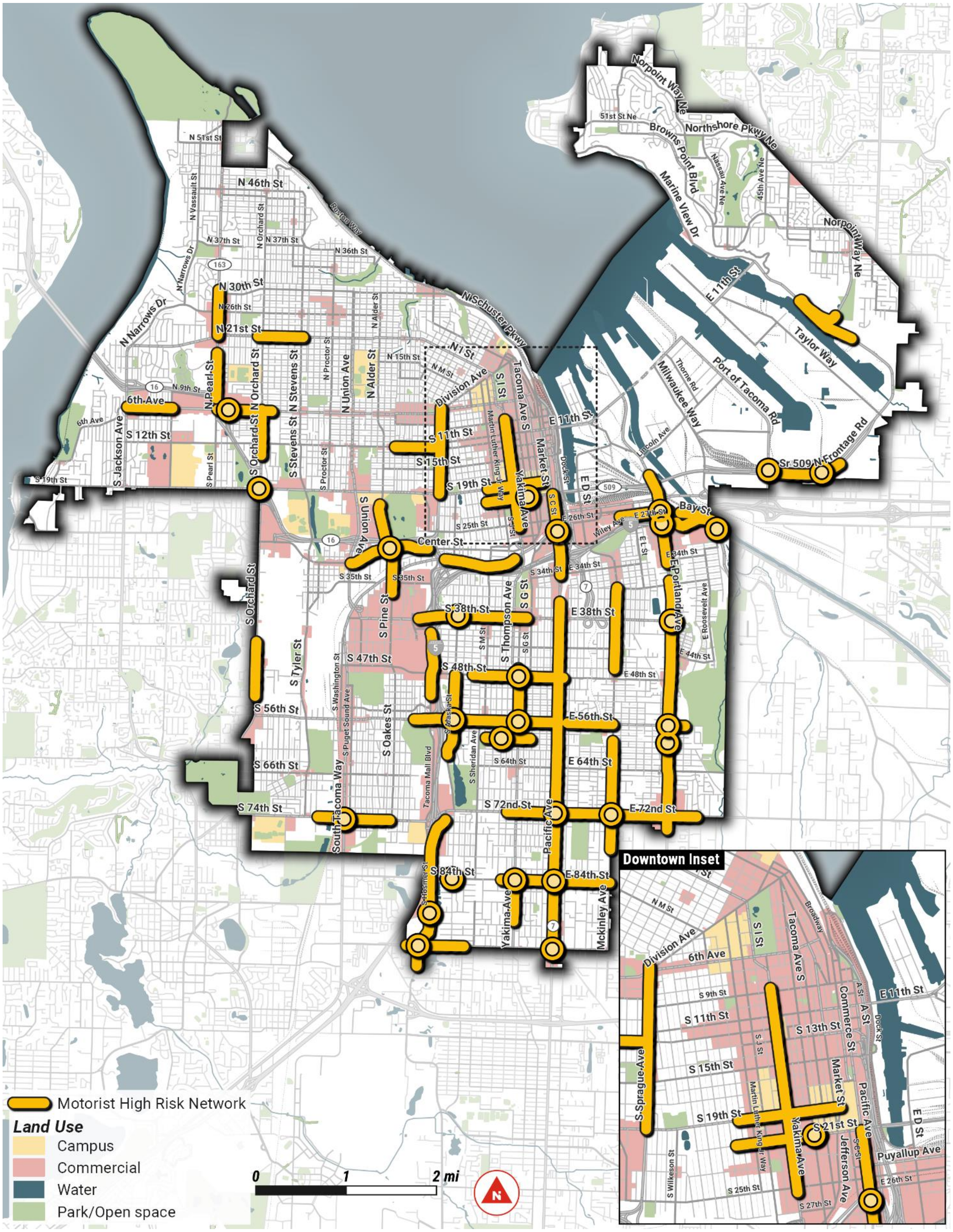
Table 30: Motorist HRN Street Mileage

Street Name	Mileage	% of Motorist
Portland	4.80	13%
56Th	3.76	10%
Yakima	2.30	6%
Mckinley	2.30	6%
72Nd	2.10	5%
Hosmer	2.10	5%
84Th	1.30	3%
38Th	1.20	3%
Orchard	1.20	3%
6Th	1.10	3%
Bay	1.10	3%
Pearl	1.00	3%
21St	1.00	3%
48Th	1.00	3%
Sprague	1.00	3%
Center	0.95	2%
Alaska	0.90	2%
South Tacoma Way	0.90	2%
74Th	0.80	2%
Tacoma Mall	0.80	2%
Marine View	0.70	2%
Sr 509 S Frontage	0.70	2%
96Th	0.70	2%
19Th	0.64	2%
26Th	0.60	2%
Norpoint	0.55	1%
12Th	0.50	1%
Pine	0.50	1%
Cedar	0.50	1%
59Th	0.50	1%
Steele	0.49	1%
Total	**38.40**	**100%**

Table 31: Top 27 Motorist High Crash Intersections

Intersection Name	EPDO
96th And Steele	1219
84th And Pacific	937
Yakima And 48th	772
Pacific And 27th	768
Portland And 26th	717
72nd And Mckinley	700
28th And Portland	680
Portland And 38th	669
Alexander And Sr 509 S	618
56th And Alaska	591
Pacific And 72nd	579
Center And Pine	571
Portland And 59th	535
Port Of Tacoma And Sr 509 N	520
Portland And 56th	511
90th And Hosmer	499
56th And Yakima	486
Yakima And 84th	481
J And 59th	479
96th And Pacific	479
Bay And Pioneer	476
Alaska And 84th	473
21st And Tacoma	464
South Tacoma Way And 74th	451
6th And Sr 16	451
Alaska And 38th	447
Orchard And 19th	437

Map 18: Motorist High Risk Network



High Risk Network – All Mode Summary

Table 32 summarizes the network mileage for each street that is included in the three modal HRNs. This table, and Map 19, help identify corridors that make up a large share of each individual mode HRN and identify where there are overlaps between the different mode-specific HRNs. In general, many of the longer HRN corridors tend to have larger shares of network mileage between the three mode-specific HRNs.

A full Intersection table is not included in this section as there were only five intersection that had overlap between the three modes. Only those five intersections are included in Table 33.

Table 32: All HRN Summary

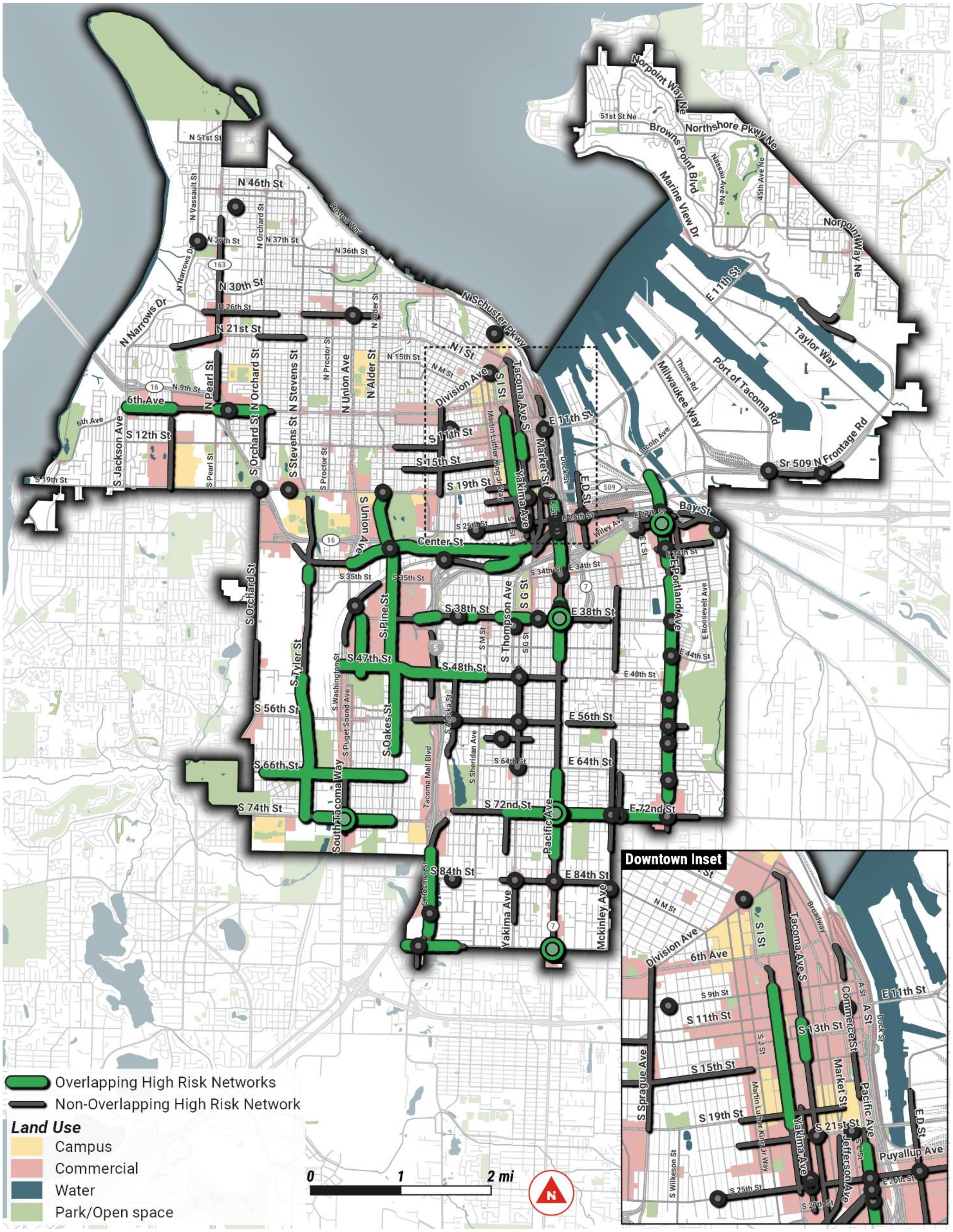
Street Name	Mileage	% of HRN	Pedestrian Mileage	Bike Mileage	Motorist Mileage
Pacific	5.98	8.6%	2.50	0.88	4.80
Portland	3.96	5.7%	3.00	0.60	3.76
Tyler	3.55	5.1%	2.75	2.45	
Yakima	2.93	4.2%	1.43		2.30
South Tacoma Way	2.80	4.0%	1.50	0.80	0.80
Center	2.80	4.0%	2.70	1.60	0.90
72nd	2.70	3.9%	2.40		2.10
38th	2.40	3.5%		1.90	1.20
56th	2.30	3.3%			2.30
Tacoma	2.17	3.1%	1.10	1.27	
26th	2.15	3.1%	0.80	0.80	0.55
Mckinley	2.10	3.0%			2.10
Pearl	1.80	2.6%		0.80	1.00
48th	1.67	2.4%	0.77	0.77	1.00
6th	1.60	2.3%	1.50		1.10
25th	1.60	2.3%		1.60	
66th	1.50	2.2%	1.50	1.50	
Hosmer	1.40	2.0%	1.00		1.30
Pine	1.30	1.9%	1.30	1.30	0.50
84th	1.20	1.7%			1.20
Orchard	1.10	1.6%			1.10
15th	1.00	1.4%	1.00		
Bay	1.00	1.4%			1.00
21st	1.00	1.4%			1.00
Oakes	1.00	1.4%	1.00	1.00	
Sprague	0.95	1.4%			0.95
Alaska	0.90	1.3%			0.90
74th	0.90	1.3%	0.90		0.80
I	0.89	1.3%	0.89		
D	0.81	1.2%		0.81	

Street Name	Mileage	% of HRN	Pedestrian Mileage	Bike Mileage	Motorist Mileage
47th	0.80	1.2%	0.80	0.80	
Mildred	0.76	1.1%		0.76	
Marine View	0.70	1.0%			0.70
Tacoma Mall	0.70	1.0%			0.70
Sr 509 S Frontage	0.70	1.0%			0.70
96th	0.64	0.9%		0.54	0.64
G	0.61	0.9%		0.61	
Warner	0.60	0.9%	0.60	0.60	
19th	0.60	0.9%			0.60
Cedar	0.60	0.9%	0.60	0.60	0.50
32nd	0.60	0.9%	0.60		
R	0.55	0.8%	0.55		
Westgate	0.52	0.7%		0.52	
Norpoint	0.50	0.7%			0.50
Jefferson	0.50	0.7%		0.50	
12th	0.50	0.7%			0.50
59th	0.49	0.7%			0.49
28th	0.45	0.6%	0.45		
27th	0.44	0.6%	0.44		
Steele	0.41	0.6%			0.41
Delin	0.40	0.6%	0.40		
Total	**69.53**	**100%**	**32.47**	**23.00**	**38.40**

Table 33: High Crash Intersections, Overlap Between Modes

Intersection Name	Pedestrian EPDO	Bike EPDO	Motorist EPDO	Total EPDO
Pacific And 72nd	694		579	1,273
28th And Portland	251		680	931
South Tacoma Way And 74th	463		451	914
96th And Pacific	251		479	730
38th And Pacific	463	231		694

Map 19: All Mode High Risk Network, Overlapping HRN Segments



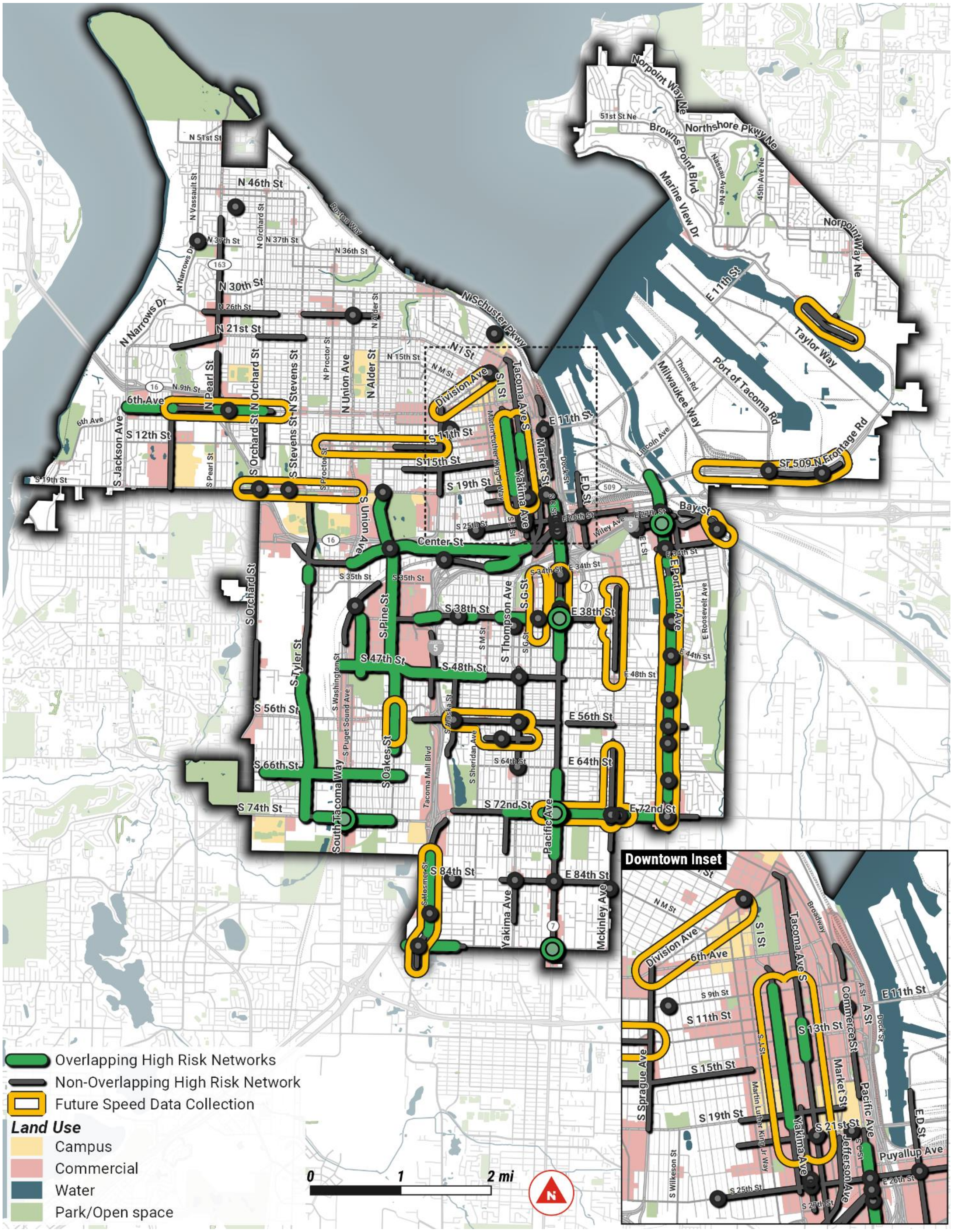
Speed Data Collection

As part of the Tacoma Vision Zero project, Toole Design assisted in identifying candidate corridors to collected vehicle speed data for in-depth analysis. The data collected along these corridors will help provide an understanding of existing speeds, differences between posted speed limit and observed speeds, and the extent to which the observed speeds exceed the target speed.

Several datasets were analyzed to identify and assess spatial patterns that emerged in the crash data and roadway data. Corridors with a higher sliding window value and spot locations with a higher concentration of KSI crashes were flagged and reviewed, specifically at locations that did not have a previous speed study conducted. All KSI crashes along these flagged corridors were reviewed to determine if any speed related factors were present and may have been a primary contributing factor to the crash. Reported crash types that were prioritized include crashes that involved the primary vehicle proceeding straight, fixed object, lane/roadway departure, and head-on crashes. In addition to the reported crash types, roadway/intersection characteristics were assessed to determine if speed was likely the primary factor contributing to the crash or if the intersection control (i.e., two-way stop at residential intersections) was the primary factor.

There is considerable overlap between the High Risk Network all mode summary displayed in Map 19 and the corridors that were recommended corridors to collect speed data (see Map 20). This may suggest a strong association between higher vehicles speeds and crash frequencies with severe outcomes along the High Risk Network.

Map 20: All Mode High Risk Network, Overlapping HRN Segments with Future Speed Data Collection Corridors



Study limitations

Temporal consistency limitations

The consultant team studied crashes that occurred over a period of five years, from 2016 through 2020. The compiled roadway data reflect current conditions. It can be assumed that some changes in roadway design and operations have occurred over the previous 5 years that cannot be accounted for. For example, if a crash occurred in 2016 and a segment narrowed from 4 lanes to 3 lanes in 2018, this analysis would link the 2016 crash with the present day 3-lane configuration. Additionally, some datasets did not have installation dates available for transportation elements that would have likely been installed within the last 5 years. This is mostly relevant for bike (bike facilities) and pedestrian infrastructure (RRFB).

Exposure data

Citywide volumes for motor vehicles along all streets, pedestrians, and bicyclists were not in a readily available format at the time of this analysis. Data on pedestrian and bicyclist volumes would help provide a better picture of crash risk for those two modes. Some proxies for exposure are noted in this analysis, such as land use, transit facilities, and functional classification.

Transportation Data for Future Study

Several datasets that would help identify or refine risk factors, but were not included citywide at the time of this analysis include:

- Number of travel lanes and turn lanes
- Street width
- Traffic signal phasing
- Transit frequency and boarding/alighting counts
- Location of fixed objects (raised medians, barriers, utility poles, etc.)
- Marked crosswalks and crosswalk enhancements

APPENDIX A - Safter Street Priority Finder Details

Tool Background

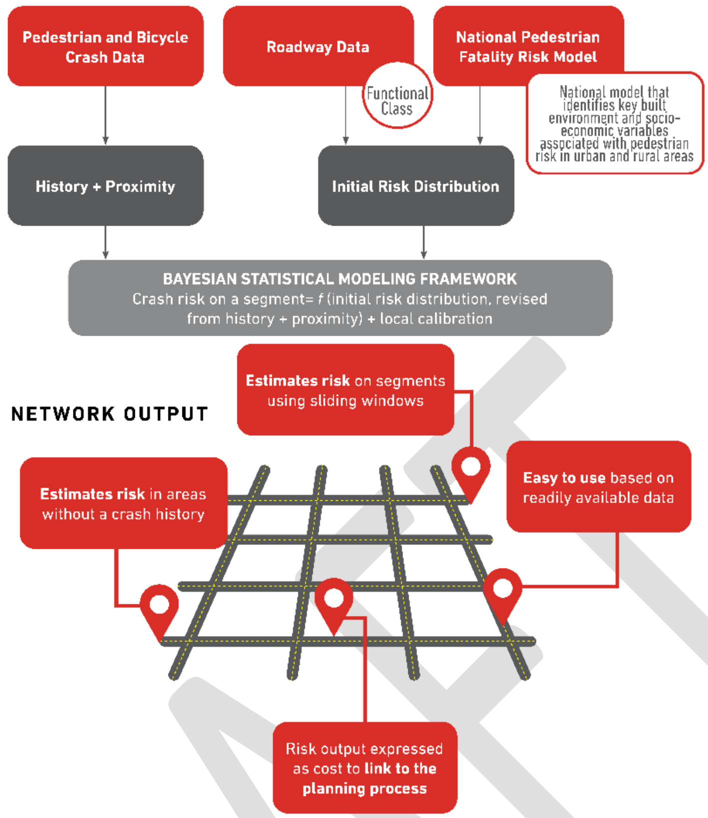
Toole Design, in collaboration with the City of New Orleans, University of New Orleans Transportation Institute, and New Orleans Regional Transit Authority developed the Safer Streets Priority Finder Tool[21] (i.e., SSPF Tool). The SSPF Tool is a free, interactive, open-source resource available at the national scale that can help transportation practitioners identify a street network that is similar to a High Injury Network for bicyclists and pedestrians. The network goes further than a typical High Injury Network by not only taking into consideration areas where a disproportionate share of fatal and serious injury crashes have already occurred, but also areas that have factors present that are likely to impact future risk.

The SSPF Tool is an expansion of a prior effort—the Pedestrian Fatality Risk Pilot[22] beta tool (i.e., Pilot Tool), developed by the USDOT. The Pilot Tool is based on a tract-level statistical model of pedestrian fatalities for the entire United States. As described in Mansfield, et al. (2018), this model takes into account various factors to predict pedestrian fatalities, including VMT density by functional classification, intersection density, employment density, residential population density, activity mix index, and sociodemographics.

The Pilot Tool model has been validated in the City of New Orleans, Lincoln Parish, LA, and Lowell, MA. The effort relied on Bayesian statistical modeling to translate expected outcomes from the Pilot Tool at the census tract level onto the street network itself. The statistical model also incorporated additional crash outcomes—including pedestrian severe injuries as well as bicyclist fatalities and severe injuries. In addition to screening for traffic safety problems across a network and enabling prioritization of opportunities for high-impact investment, the SSPF Tool provides users with the estimated comprehensive societal cost of estimated future crashes.

[21] https://www.saferstreetspriorityfinder.com/tool/

[22] See "Pedestrian Fatalities Pilot" section: https://www.transportation.gov/SafetyDataInitiative/Pilots
Technical report for the Pedestrian Fatalities Pilot can be viewed here: https://www.transportation.gov/sites/dot.gov/files/docs/mission/office-policy/transportation-policy/328686/effects-roadway-and-built-environment-characteristics-pedestrian-fatality-risk-mansfield-et-al.pdf
An interactive map of the Pedestrian Fatalities Pilot can be viewed here: https://maps.dot.gov/BTS/PedestrianFatalityModel/



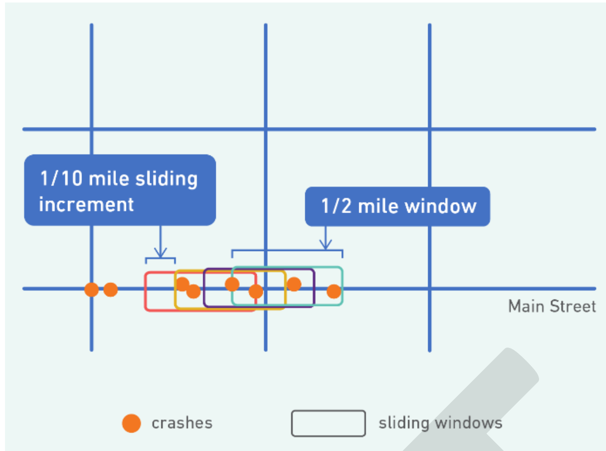
The SSPF produces two main outputs:

3. Sliding Windows Analysis (all modes)
4. Safer Street Model: Estimated Future Societal Costs (bicycle and pedestrian crashes only)

The following sections will discuss the Sliding Windows Analysis and the estimated future societal costs separately.

Sliding Windows Analysis

A sliding windows analysis helps us understand crashes throughout a transportation network and identify segments with the highest crash density, weighted by crash severity. The analysis is done by determining the number and severity of crashes in a half-mile “window” on a roadway and shifting that window along the roadway 1/10 mile at a time. Crashes are weighted by severity by multiplying the number of fatal and incapacitating injury crashes by 3 and non-incapacitating injury crashes by 1 (non-injury crashes are not reflected). Each segment is scored and the result visualizes the areas with the highest density of crashes for bicyclists, pedestrians and motorists.



The Sliding Windows score weights the most severe crashes more heavily than lower severity crashes. The Sliding Windows score is calculated by multiplying the number of Fatal (K) and Incapacitating Injury (A) crashes by 3, and multiplying the number of Non-Incapacitating Injury (B) crashes by 1. Once the weights are established and applied to the crashes, the total number of crashes are aggregated along a corridor while incorporating the crash severity weighting. Possible Injury (C) crashes and Property Damage Only (O) crashes are not reflected.

Safer Streets Model

The Safer Streets Model brings the segmented road network window segments (produced in the Sliding Windows Analysis) into a Bayesian statistical framework to estimate crash risk throughout the system. This framework allows us to incorporate external information about how many crashes we might expect to see (called a Bayesian prior), alongside the observed crash history.

The model estimates crash risk rates per mile for each road segment and each crash mode (pedestrian and bicyclist only at this time) and severity. These values are then converted to crash cost estimates based on the costs assigned to each crash severity.

Modeling Framework

A Bayesian model is used to estimate risk, informed by two key pieces of information (Bayesian priors) in addition to user-submitted crash data:

1. Estimate of the number of crashes within a Census tract, from the Pilot Tool model.
2. National average rate of fatal crashes per mile on a roadway based on its functional class, developed from national fatal crash data (Fatal Accident Reporting System, or FARS). Functional class is used as a proxy for roadway design elements that are associated with both the risk of crash occurring and the risk of a crash's outcome being severe (e.g., motor vehicle travel speeds, number of lanes, motor vehicle AADT, etc.)

For each tract in the City of Tacoma, the tool combines the estimated number of crashes with the actual, observed number of crashes in the tract. The model uses a Gamma-Poisson distribution based on this combined input to come up with an updated estimate of crashes for every tract.

For each window segment in the study area, the tool combines the national average crash rate with the observed number of crashes on each window segment to come up with an updated estimate of crash risk rate per mile.

Given the updated estimate of crashes in each tract, and the updated risk rate per mile for each window segment, the model then uses a Beta-Binomial distribution to allocate estimated crashes to window segments within each tract.

Observed number of crashes are the primary input, but these two additional inputs (priors) help us understand possible risk in areas where crashes haven't been observed yet. In other words, in areas with a lot of crashes, the model results may look very similar to the simple sliding window analysis. But in areas without a lot of crashes, the model results may identify some streets that could benefit from safety improvements even if crashes haven't happened there yet.