APPENDIX A: COMMUNITY STAKEHOLDERS

COMMUNITY STAKEHOLDERS

This section presents community stakeholders which can be valuable for future safety-related engagement and outreach.

Organization	Website	Number & Email
WHEELS	https://www.wheelsbus.com/	925-828-0231 info@lavta.org
Dial-a-Ride	https://www.wheelsbus.com/	925-455-7510 info@lavta.org
Bike East Bay	https://bikeeastbay.org/	kristi@bikeeastbay.org
Trail Trekkers	http://trailtrekkers.weebly.com/	hikedirector@gmail.com
Valley Spokesmen Bicycle Club	https://www.valleyspokesmen.org	925-828-5299 webmaster@valleyspokesmen.org
Indians in Dublin, Ca	Facebook Link	Not available
Asian Pacific Islander American Public Affairs	https://www.apapa.org	916-928-9988 info@apapa.org
Integrity in Action	Dublin-integrity-in-action.org	info@dublinintegrityinaction.org
Chamber of Commerce	http://www.dublinchamberofcommerce.org	925-828-6200, Inge Houston, CEO/President, ceo@dublinchamberofcommerce.org
Innovation Tri-Valley	https://innovationtrivalley.org/	Lynn Naylor, CEO, lnaylor@innovationtrivalley.org
Dublin Senior Foundation	https://dublin.ca.gov/378/Dublin-Senior-Foundation	925-833-1866
Dublin Community Foundation	http://www.dublinfoundation.org/v	614-889-2001
New Life Church	http://www.newlifeinfo.com	925-355-9200
Muslim Community Center	https://mcceastbay.org/	925-485-1786 contact@mcceastbay.org

Organization	Website	Number & Email
Valley Christian Center	www.comediscovervcc.org	925-560-6202
Blazing Fire Church	https://blazingfire.org/home	925-264-9161 info@blazingfire.org
Dublin Art Collective	Facebook.com/DublinArtCa	
Sri Panchamukha Hanuman Temple	https://panchamukhahanuman.org/	510-926-7638 pmhtemple@gmail.com
Dublin Fighting Irish	http://www.dublinfightingirish.org	510-714-1439 irishyouthfootball@yahoo.com
Tri-Valley Convention and Visitor's Bureau	https://visittrivalley.com/	925-846-8910
Women's Club of Dublin/San Ramon	https://dsrwomensclub.org/	925-828-0231 dsrwcmail@gmail.com
Dublin Sister City Association	Facebook Link	925-899-4771
Dublin Partners in Education	www.dpie.org	925-828-2551 x8024
Dublin Lions Club	https://e-clubhouse.org/sites/dublinca/index.php	925-828-6636 steve6gd@yahoo.com
Girl Scouts	https://www.crossroadsgirlscouts.com/	800-447-4475 crossroadsgirlscouts@gmail.com
Boy Scouts of America	http://www.sfbac.org/about/ebscoutshop	925-785-4518 jalewis@bsamail.org
Dublin Historical Preservation Association	http://dhpa.org/	dhpaorg@gmail.com
Dublin 4-H	https://www.dublin4h.com/	925-462-4518 cnattu@gmail.com badami@gmail.com
Child Care Links	https://behively.org/	925-417-8733 hello@behively.org
BART	http://www.bart.gov	Kamala Parks, KParks2@bart.gov
Senior Support Programs of the Tri-Valley	https://cityservecares.org/seniors/	925-222-2273 mailto:mcare@cityservecares.org

Organization	Website	Number & Email
Alameda County Safe Routes to School	http://alamedacountysr2s.org/	info@alamedacountysr2s.org
Kaiser Permanente	https://healthy.kaiserpermanente.org/northern-california/facilities/dublin-medical-offices-and-cancer-center-339079	Ronald Wetter, Community & Governmental Relations Manager, ronald.wetter@kp.org
Zeiss Meditec	https://www.zeiss.com/corporate/us/innovation-and-technology/zeiss-innovation-center-in-dublin-california.html	Mark Boyd, Sr. Facilities Manager, mar.boyd@zeiss.com
Vagaro HQ	https://sales.vagaro.com/contact	Kerry Melchoir, Director of Operations, kerrymelchior@vagaro.com
TriNet HQ	https://www.trinet.com/contact-us	Jay Meyer, Director of Facilities, jay.meyer@trinet.com
Patelco Credit Union HQ	https://www.patelco.org/contact-us	Cara Houck, Community and Corporate Social Responsibility Specialist, chouck@patelco.org
AEye HQ	https://www.aeye.ai/contact/	Jennifer Deitsch, Communications Director
Ross Stores HQ	https://corp.rossstores.com/contact-us-corp/	Lynn Mayate, Corporate HR, lynn.mayate@ross.com
Graybar	https://www.graybar.com/contact-us	Kristian Reyes, Kristian.Reyes@graybar.com
Chabot Las Positas Community College District	http://districtazure.clpccd.org/	Julia Dozier, District Executive Director, jdozier@clpccd.org
Dublin San Ramon Services District	https://www.dsrsd.com/	Judy Zavadil, zavadil@dsrsd.com
Camp Parks	https://home.army.mil/parks/index.php/contact/public-affairs	Brian Lucid, Analyst, brian.m.lucid.civ@mail.mil
Tri-Valley Career Center	https://www.trivalleycareercenter.org/	Sarah Holtzclaw, Program Manager, sholtzclaw@clpccd.org 925-416-5100
Federal Corrections Institute	https://www.bop.gov/locations/institutions/dub/	mailto:DUB-ExecAssistant-S@bop.gov 625-833-7500
Alameda County (Courthouse, Office of Emergency Services, County Jail)	https://www.alameda.courts.ca.gov/location/dublin-east-county-hall-justice	925-227-6700

APPENDIX B:
COLLISION ANALYSIS MEMO

KITTELSON & ASSOCIATES
155 Grand Avenue, Suite 505
Oakland, CA 94612
P 510.839.1742

Technical Memorandum

October 11, 2022 Project# 26647

To: Sai Midididdi, TE; Pratyush Bhatia, PE, TE
City of Dublin

From: Kittelson & Associates, Inc.

RE: Dublin Local Roadway Safety Plan

TASK 3.2 – COLLISION ANALYSIS MEMO

This memorandum summarizes five years of collision data (2016 – 2020) and trends within the City of Dublin (City) as part of the Dublin Local Roadway Safety Plan (LRSP). It is organized into the following sections:

1. Executive Summary
2. Citywide Collision Patterns and Trends
    - All Road Users
    - Pedestrians
    - Bicyclists
    - Comparison with Strategic Highway Safety Plan
    - Recommended Emphasis Areas
3. Network Screening Findings
4. Next Steps

The data used for this analysis were compiled from SWITRS and Crossroads databases as detailed in Attachment A.

1 EXECUTIVE SUMMARY

The following presents a summary of findings from this report. All findings are explained in further detail throughout the remainder of the report.

1.1 Collision Patterns and Trends

1.1.1 ALL ROAD USERS

Descriptive analysis of reported collisions found the following:

- 1,455 collisions were reported (291 per year average), including 18 fatal/severe injury collisions (3.6 per year average).
- Intersection collisions are more frequent than segment collisions, representing 82% of reported collisions and 74% of fatal/severe injury collisions.
- *Rear end*, *broadside*, and *hit object* collisions are the most frequent collision types. Among fatal/severe injury collisions, the two most common types are *vehicle/pedestrian* and *hit object* collisions. Therefore, those four collision types were the focus of detailed analysis.

- *Unsafe speed*, *improper turning*, and *automobile right of way*[1] are the most frequently reported primary collision factors, together accounting for 54% of all reported collisions. *Driving/bicycling under the influence of alcohol or drug*, *unsafe speed*, and *improper turning* together account for 50% of fatal/severe injury collisions.

1.1.2 BICYCLE AND PEDESTRIAN COLLISIONS

Descriptive analysis of bicycle- and pedestrian-involved collisions found the following:

- 53 collisions (4% of reported) involved pedestrians, including 5 fatal/severe injury collisions (28% of fatal/severe injury citywide).
  - 4 of the fatal/severe injury collisions occurred in *dark* or *dusk* conditions.
- 56 collisions (4% of reported) involved bicyclists, including 2 severe injury collisions (11% of fatal/severe injury citywide).

1.1.3 COMPARISONS TO STATEWIDE AVERAGES

- The City has at least a 10% higher share of fatal and severe injury collisions than the statewide levels[2] for the following challenge areas:
  - Aging driver collisions (22% compared to 12%)
  - Pedestrian collisions (28% compared to 17%)
  - Intersection collisions (72% compared to 23%)

1.1.4 EMPHASIS AREA RECOMMENDATIONS

- **Pedestrian collisions:** These collisions account for 28% of all fatal/severe injury collisions as compared to 17% of all statewide fatal/severe injury collisions. Pedestrian collisions occurred mostly at intersections.
- **Nighttime safety:** A disproportionate share of fatal/severe injury collisions, including pedestrian collisions, occur in dusk/dawn or dark conditions.
- **Aging drivers:** These collisions account for 22% of all fatal/severe injury collisions as compared to 12% of all statewide fatal/severe injury collisions.
- **Signalized local/arterial intersections:** These intersections constitute the plurality of *rear end* and *broadside* collisions. *Hit object* collisions, which are the most frequent fatal/severe injury collision types, also primarily occur at signalized intersections.
- **Driver behavior:** Including impaired driving and aggressive driving.
  - *Impaired Driving* account for over 25% of all fatal/severe injury collisions in Dublin.
  - *Aggressive Driving* accounts for over 15% of all fatal/severe injury collisions in Dublin.

[1] This is a reported primary collision factor that indicates one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic. This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to conflicting traffic.

[2] California Strategic Highway Safety Plan 2020-2024: https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/shsp/2022-shsp-full-report-2020-2024-a11y.pdf

1.2 Network Screening Findings

- Intersection and roadway locations were evaluated based on five-year collision frequency and severity. A collision severity score was calculated and used to identify priority locations.
  - 15 priority intersections are identified.
  - 5 priority roadways are identified.

The identified priority locations based on collision severity score are presented in Table 1. The top scoring intersections and segments were reviewed to determine priority locations for safety improvements and upcoming HSIP applications. The final list of priority locations may change from the table below.

Table 1. Priority Intersections and Roadways based on Collision Severity Score

#	Location	Location Type	Collision Severity Score	Total No. Collisions	Fatal / Severe Injury Collisions	Other Injury Collisions	PDO Collisions
Priority Intersections							
1	Arnold Rd & Dublin Blvd	Sig. Int.	59.9	17	2	8	7
2	Dublin Blvd & Village Pkwy	Sig. Int.	49.4	43	1	15	27
3	Donlon Way & Dublin Blvd	Unsig. Int.	42.1	6	1	3	2
4	Amador Valley Blvd & San Ramon Rd	Sig. Int.	41.1	18	1	9	8
5	Regional St & Regional Common	Unsig. Int.	38.8	5	1	0	4
6	Winding Trail Ln & Rolling Hills Dr	Unsig. Int.	38.0	1	1	0	0
7	Lucania St & Brighton Dr	Unsig. Int.	38.0	1	1	0	0
8	Tyne Ct & Penn Dr	Unsig. Int.	38.0	1	1	0	0
9	Dublin Blvd & Dougherty Rd	Sig. Int.	37.2	65	0	22	43
10	San Ramon Rd & Shannon Ave	Sig. Int.	29.3	8	1	3	4
11	Dublin Ct & Dublin Blvd	Sig. Int.	27.3	13	1	1	11
12	Dublin Blvd & Tassajara Rd	Sig. Int.	25.8	34	0	16	18
13	Grafton St & Central Pkwy	Sig. Int.	24.3	3	1	0	2
14	Bent Tree Dr & Fallon Rd	Sig. Int.	23.9	1	1	0	0
15	Martinelli Way & Hacienda Dr	Sig. Int.	18.5	28	0	10	18
Priority Roadways							
1	Dougherty Rd (north of Willow Creek Dr to south of 8th St) – *0.75 mi*	Arterial	36.2	8	1	2	5
2	Fallon Rd (Signal Hill Dr to Gleason Dr) – *0.75 mi*	Arterial	35.5	4	1	1	2
3	Village Pkwy (northern city limits to north of Tamarack Dr) – *0.69 mi*	Collector	35.3	8	1	1	6
4	Amador Valley Blvd (Burton St to Dougherty Rd) – *0.75 mi*	Arterial	34.1	2	1	1	0

#	Location	Location Type	Collision Severity Score	Total No. Collisions	Fatal / Severe Injury Collisions	Other Injury Collisions	PDO Collisions
5	Tassajara Rd (northern city limits to Fallon Rd) – *0.50 mi*	Arterial	33.1	2	1	0	1

Note: Priority locations are based on collision severity scores and may change.

2 CITYWIDE COLLISION PATTERNS AND TRENDS

This section presents citywide collision patterns and trends. This analysis focuses on identifying behavioral and roadway patterns associated with injury and fatal collision outcomes. By analyzing reported collisions together, systemic trends and emphasis areas across locations can be identified. From these, countermeasures can be selected in subsequent project tasks. Analysis emphasis is given to fatal/severe injury collisions because these outcomes represent life-changing events. Preventing all collisions from occurring may not be a realistic goal, but an focus on safety should emphasize reducing the most severe outcomes that occur on roadways. Fatal and severe injury collisions are typically grouped together in this analysis because the difference between those outcomes is often a difference in emergency response time or the health conditions of the parties involved rather than the collision itself (the circumstances of such collisions are often similar and can therefore be analyzed together).

2.1 Collision Data

The database is comprised of the most recent five years of reported collisions available on the Statewide Integrated Traffic Records System (SWITRS) and the City's data in the Crossroads software, representing January 1, 2016, through December 31, 2020. These data sources were merged into a consolidated database that consists of 1,455 reported collisions. Methods and decisions relating to the merging of these databases are described in Attachment A.

Collision severity is coded according to the highest degree of injury experienced, and the data used for this analysis includes the following coded severity levels (listed in descending order):

- **Fatal:** death because of injuries sustained in the collision.
- **Severe Injury:** Injuries include, for example, broken bones, severe lacerations, or other injuries that go beyond the reporting officer's assessment of "other visible injuries."
- **Moderate Injury:** (Also referred to as *other visible injury*), an injury, other than those described above, that is evident to observers at the scene of the collision—for example, bruises or minor lacerations.
- **Minor Injury**: (Also referred to as *complaint of pain* or *suspected injury*). Internal or other non-visible injuries—for example, a person limps or seems incoherent.
- **Property damage only (PDO):** No injuries sustained

For simplicity in presentation, moderate injury and minor injury collisions are frequently collapsed into a single *other injury* category.

2.2 All Road Users

The findings in this section are organized as follows:

- Collision severity
- Collision location
- Collision type
- Primary collision factor
- Temporal trends
- Other factors

2.2.1 COLLISION SEVERITY

A total of reported 1,455 collisions are present in the compiled database. The collisions are from the period of January 1, 2016, through December 31, 2020.

A summary of collision severity and road user type is presented in Table 2. Pedestrians and bicyclists are each involved in 4% of reported collisions across all locations and severity levels but represent larger shares of injury and fatal collisions. Pedestrian and bicyclist trends are explored in more detail in subsequent sections.

Table 2: Road Users Involved and Collision Severity, Dublin, 2016-2020

Road Users Involved	Number of Fatal Collisions	Number of Severe Injury Collisions	Number of Moderate Injury Collisions	Number of Minor Injury Collisions	Number of Property Damage Collisions	Total Reported Fatal / Severe Injury Collisions (% of Column)	Total Reported Collisions (% of Column)
Pedestrian Involved	1	4	20	21	7	**5 (28%)**	**53 (4%)**
Bicycle Involved	-	2	24	22	8	**2 (11%)**	**56 (4%)**
Motor Vehicle Only or Vehicle-Fixed Object	1	10	111	293	932	**11 (61%)**	**1,347 (92%)**
Total Reported Collisions	**2**	**16**	**155**	**336**	**947**	**18 (100%)**	**1,455 (100%)**

Source: SWITRS, 2021; City of Dublin, 2021.
Note: There is one crash that is coded as both a pedestrian and bicyclist involved collision. Therefore, total reported collisions will not add up to the pedestrian, bicyclist, and motor vehicle collisions.

2.2.2 COLLISION LOCATION

Reported collisions are broken down by location and further broken down into type of intersection control and pedestrian, bicycle, and motorcycle collisions (Figure 1). The following trends are present:

- Most collisions (84%) occur at intersections.
  - Signalized intersections represent most collisions (58%) and the plurality of fatal/severe injury collisions (44%).
  - Just over one third of fatal/severe injury collisions occur at an intersection and involve a pedestrian or bicyclist (34%).
- Segment collisions, when they occur, are more likely severe than intersection collisions (2% of segment collisions are fatal/severe injury, compared to 1% of intersection collisions).

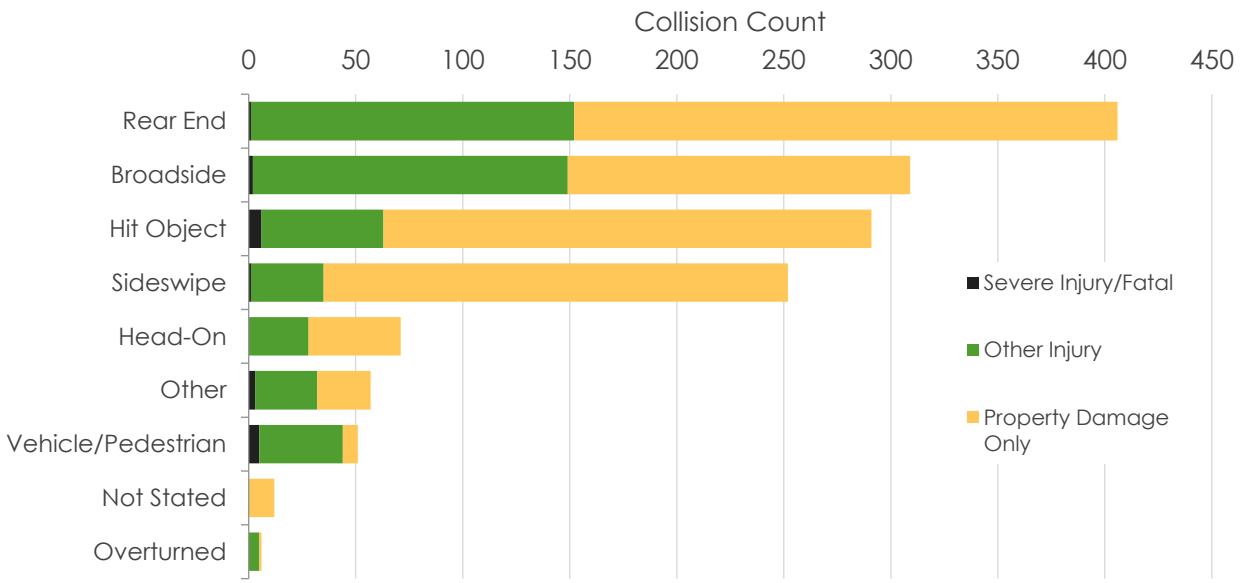
Figure 1: Reported Collisions by Location, Dublin, 2016-2020

2.2.3 COLLISION TYPE

Reported collision types indicate the movements most frequently resulting in collisions and severe outcomes. Figure 2 presents the distribution of collision types and severity levels.

- The three most frequent collision types are *rear end*, *broadside*, and *hit object*. These three collision types account for 69% of all reported collisions.
- The three most frequent collision types resulting in fatal or severe injury are *vehicle/pedestrian*, *other*, and *hit object*. *Vehicle/pedestrian* and *hit object* collisions together account for 69% of fatal/severe injury collisions.
- These four collision types—*rear end, broadside, hit object*, and *vehicle/pedestrian*, are focus collision types for this analysis given that they represent a substantial portion of collisions, injuries, and roadway deaths in the City.

Figure 2: Collisions by Type and Severity, Dublin, 2016-2020



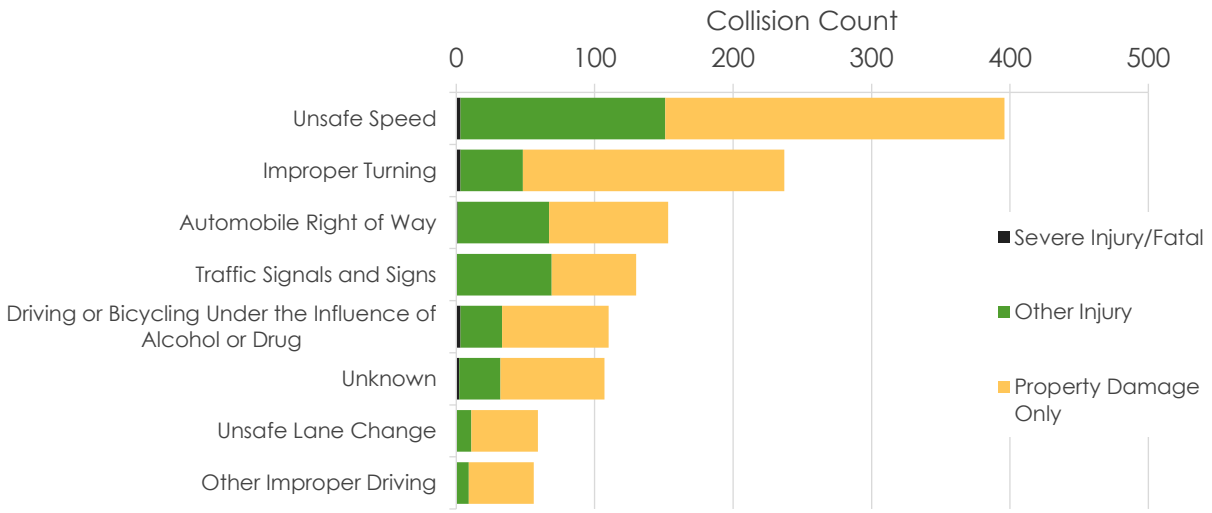
Source: SWITRS, 2021; City of Dublin, 2021.

2.2.4 PRIMARY COLLISION FACTOR

Reporting officers identify a primary collision factor (PCF) for each collision. There are a number of different PCFs from which an officer can select in filling out a report, corresponding to various California Vehicle Code (CVC) violations. It is up to the officer's judgment and information available at the scene for them to select the single factor they deem most relevant to the collision. Figure 3 presents collisions by reported PCF and severity.

- The three most frequent PCFs Citywide are *unsafe speed*, *improper turning*, and *automobile right of way*[3] . These three PCFs account for 54% of reported collisions.
- The most frequent PCFs that result in fatal or severe injury are *driving or bicycling under the influence of alcohol or drug*, *unsafe speed*, and *improper turning*. These three PCFs account for 50% of fatal/severe injury collisions.

Figure 3: Collisions by PCF and Severity, Dublin, 2016-2020



Source: SWITRS, 2021; City of Dublin, 2021.

2.2.4.1 Primary Collision Factor and Collision Type

For the focus collision types listed in the previous section – *rear end*, *broadside*, *hit object*, and *vehicle/pedestrian*—associated PCFs are further analyzed. Table 3 presents this cross tabulation. The table shows:

- *Rear end* collisions are most frequently associated with *unsafe speed* (72% of collisions).
- *Broadside* collisions are associated most frequently with *automobile right of way*[4] or *traffic signals and signs*[5] (32% and 33% respectively). These are likely associated with driveway access or intersections and are explored in more detail later.
- 68% of *hit object* collisions are caused by three PCFs: *improper turning*, *unsafe speed*, and *driving/bicycling under the influence*.
- 51% of *vehicle/pedestrian* collisions are attributed to either a pedestrian or a driver violation the other's right of way. More detailed trends are explored in Section 2.3.

[3] This is a reported PCF that indicates one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic. This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to conflicting traffic.

[4] This is a reported primary collision factor that indicates one of several California Vehicle Violation codes indicating a failure to yield right-of-way to conflicting traffic.

[5] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign or red signal indication).

- Three fatal or severe injury collisions involving bicyclists are recorded as *other* collision types. Bicyclist-involved collisions are analyzed and discussed in Section 2.4.

Table 3: Collision Type by PCF (PCFs Sum to 100%), Dublin, 2016 - 2020

Primary Collision Factor	Collision Type				
	Rear End (% of Column)	Broadside (% of Column)	Hit Object (% of Column)	Vehicle / Pedestrian (% of Column)	Other (% of Column)
Automobile Right of Way	1%	32%	0%	2%	19%
Driving or Bicycling Under the Influence of Alcohol or Drug	7%	2%	15%	0%	2%
Improper Turning	5%	9%	30%	0%	7%
Other Improper Driving	1%	1%	7%	10%	7%
Other Than Driver (or Pedestrian)	1%	1%	7%	0%	7%
Pedestrian Right of Way	0%	1%	0%	29%	4%
Pedestrian Violation	0%	0%	0%	22%	0%
Traffic Signals and Signs	0%	33%	1%	2%	4%
Unknown	3%	9%	6%	14%	14%
Unsafe Speed	72%	2%	23%	6%	11%
Unsafe Starting or Backing	7%	3%	1%	6%	11%
Wrong Side of Road	0%	2%	2%	0%	11%
Other PCFs	*3%*	*5%*	*8%*	9%	*3%*
Total Reported Collisions	**406 (100%)**	**309 (100%)**	**291 (100%)**	**51 (100%)**	**57 (100%)**

Source: SWITRS, 2021; City of Dublin, 2021.

Notes: The three highest PCFs for each collision type are highlighted in red. If there is a tie for the third highest, all tied PCFs are highlighted. Only focus collision types are shown and totaled in this table (three most frequent or three most frequent among fatal/severe injury). PCFs with less than 6% share across listed collision types are grouped into the "*Other PCFs*" category to improve legibility. Totals may not sum to 100% due to rounding.

2.2.4.2 Primary Collision Factor and Roadway Characteristics

The previous sections established focus collision types and their most frequent PCFs citywide. This section analyzes the frequency of location types for each collision type and PCF combination to provide greater detail on potential emphasis areas for the City. Location characteristics are further analyzed using intersection type and roadway functional class.

The following were analyzed:

- ***Rear end* collisions at intersections:** 28% of citywide collisions are *rear end,* the most frequent collision type (Table 4). 84% of *rear end* collisions occurred at an intersection.
- ***Broadside* collisions at intersections:** 21% of citywide collisions are *broadside,* the second most frequent collision type (Table 5). 84% of *broadside* collisions occurred at an intersection.
- ***Hit Object* collisions at intersections:** 33% of fatal/severe injury collisions are *hit object*, the most frequent collision type among fatal/severe injury (Table 6). 76% of *hit object* collisions occurred at an intersection.

- ***Vehicle/pedestrian*** collisions were the second most frequent collision type among fatal/severe injury collisions and are analyzed in detail in Section 2.3.

Rear end collisions are analyzed by intersection type and PCFs in Table 4. *Rear end* collisions at intersections most frequently occur at signals (74% of collisions) and with a reported PCF of *unsafe speed* (75%).

- Among *rear end* collisions at intersections, 137 (46%) occur at signalized intersections of arterials with locals/collectors and 81 (27%) occur at signalized arterial/arterial intersections.
- Most of these collisions have a reported PCF of *unsafe speed*.

Table 4: Rear End Collisions by Intersection Type, Intersecting Functional Class, and PCF, Dublin, 2016-2020

Intersection Type	Signalized			Unsignalized			Total
Intersecting Functional Class	Arterial + Arterial	Arterial + Local/Collector	Local/Collector + Local/Collector	Arterial + Arterial	Arterial + Local/Collector	Local/Collector + Local/Collector	
Driving or Bicycling Under the Influence of Alcohol or Drug	5	12	0	1	2	7	27
Improper Turning	2	2	1	0	2	10	17
Unsafe Speed	62	112	3	3	25	23	228
Unsafe Starting or Backing	12	11	0	1	0	2	26
Total	**81**	**137**	**4**	**5**	**29**	**42**	**298**

Source: SWITRS, 2021; City of Dublin, 2021.

Notes: Local roads were taken to include collector and residential roads. Collisions with an unknown intersecting functional class were omitted from this table (4 collisions). Collisions at an intersection with a freeway ramp were omitted from this table (4 collisions).

Broadside collisions are analyzed by intersection type and PCFs in Table 5. *Broadside* collisions at intersections most frequently occur at signals (79%) and with a reported PCF of *traffic signals and signs.*[6] Among *broadside* collisions at intersections, 126 (54%) occur at local/arterial signalized intersections.

Table 5: Broadside Collisions by Intersection Type, Intersecting Functional Class, and PCF, Dublin, 2016-2020

Intersection Type	Signalized			Unsignalized			Total
Intersecting Functional Class	Arterial + Arterial	Local + Arterial	Local + Local	Arterial + Arterial	Local + Arterial	Local + Local	
Automobile Right of Way[7]	13	30	1	0	17	17	78
Improper Turning	6	10	1	0	3	5	25
Traffic Signals and Signs[8]	23	72	3	0	2	2	102
Unknown	11	14	0	0	1	2	28
Total	**53**	**126**	**5**	**0**	**23**	**26**	**233**

Source: SWITRS, 2021; City of Dublin, 2021.

Notes: Local roads were taken to include collector and residential roads. Collisions with an unknown intersecting functional class were omitted from this table (4 collisions). Collisions at an intersection with a freeway ramp were omitted from this table (4 collisions).

[6] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign or red signal indication).

[7] This is a reported primary collision factor that indicates one of several California Vehicle Violation codes indicating a failure to yield right-of-way to conflicting traffic.

[8] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign or red signal indication).

Hit object collisions *are analyzed by intersection type and PCFs in* Table 6. *Hit object* collisions at intersections most frequently occur at signals (107 of 171 collisions, or 63%) and with a reported PCF of *improper turning*. Among *hit object* collisions at intersections, the most frequently occurring location and PCF combinations are *improper turning* at arterial/local signalized intersections (21%).

Table 6: Hit Object Collisions by Intersection Type, Intersecting Functional Class, and PCF, Dublin, 2016-2020

Intersection Type	Signalized			Unsignalized			Total
Intersecting Functional Class	Arterial + Arterial	Local + Arterial	Local + Local	Arterial + Arterial	Local + Arterial	Local + Local	
Driving or Bicycling Under the Influence of Alcohol or Drug	8	16	3	1	1	8	37
Improper Turning	7	36	3	1	3	22	72
Other Improper Driving	0	3	0	0	0	11	14
Unsafe Speed	7	22	2	1	4	12	48
Total	**22**	**77**	**8**	**3**	**8**	**53**	**171**

Source: SWITRS, 2021; City of Dublin, 2021.

Notes: Local roads were taken to include collector and residential roads. Collisions with an intersecting with a freeway ramp were omitted from this table (2 collisions).

2.2.5 TEMPORAL TRENDS

2.2.5.1 Year-Over-Year

On average, there are 291 reported collisions per year and 3.6 reported fatal/severe injury collisions per year between 2016 and 2020. Total reported collisions increase year-over-year from 2016 to 2019. In 2020, collisions dropped below previous years (Table 7). This trend holds true for other injury and PDO collisions, but severe injury collisions have the greatest number of collisions in 2020 while total collisions drop significantly.

Single-year trends are not necessarily indicative of improved or decreased safety performance given and may be sensitive to random fluctuations. Collision totals for 2020 may be provisional, given that the California Highway Patrol-maintained SWITRS database is updated over time and collision data can take over a year to process and include. Further, cities in the United States experienced a decrease in traffic volumes in 2020 due to the COVID-19 pandemic but an increase in traffic fatalities.[9] While 2020 totals appear lower than previous years, its data should not be directly compared or used in isolation as indication of roadway safety performance.

[9] https://www.nhtsa.gov/press-releases/2020-fatality-data-show-increased-traffic-fatalities-during-pandemic

Table 7: Collisions by Year, Dublin, 2016-2020

Year	Collision Count	Fatal	Severe Injury	Other Injury	PDO
2016	288	1	4	104	179
2017	294	0	2	101	191
2018	323	0	4	108	211
2019	346	1	1	125	219
2020	204	0	5	52	147
Total	**1,455**	**2**	**16**	**490**	**947**

Source: SWITRS, 2021; City of Dublin, 2021.

2.2.5.2 Time-of-Day and Day-of-Week

Collisions are further analyzed by time-of-day and day-of-week.

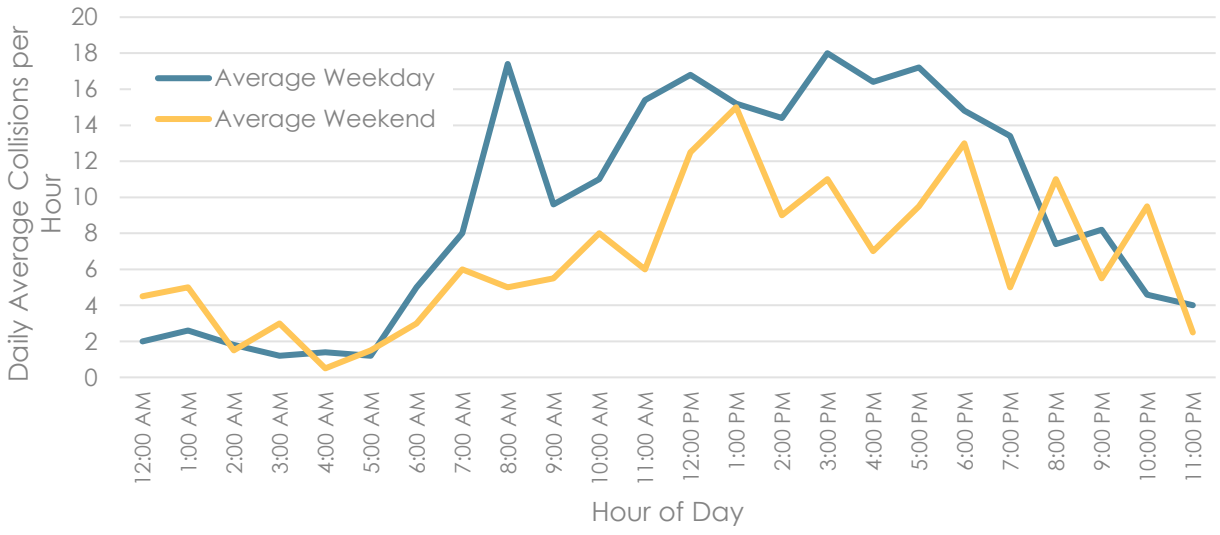
- The highest concentration of collisions occurs between Tuesday and Friday between 8 am and 6 pm (Table 8).
- One half of all fatal and severe injuries (9) occur between 8 pm and 2 am (Table 9).
- Trends are similar on weekdays and weekends but AM, midday, PM peaks are more noticeable on weekdays than weekends (Figure 4).

Table 8: Collisions by Time-of-Day and Day-of-Week, Dublin, 2016-2020

Hour of Day	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
12:00 AM – 12:59 AM	5	1	1	3	1	4	4
1:00 AM – 1:59 AM	4	2	2	3	4	2	6
2:00 AM – 2:59 AM	1	3		1	3	2	2
3:00 AM – 3:59 AM	2	1	1	1	1	2	4
4:00 AM – 4:59 AM	1	1	1	1	3	1	
5:00 AM – 5:59 AM	1	1		1	1	3	2
6:00 AM – 6:59 AM	1	7	4	4	6	4	5
7:00 AM – 7:59 AM	7	12	6	5	9	8	5
8:00 AM – 8:59 AM	7	8	16	27	15	21	3
9:00 AM – 9:59 AM	7	10	11	13	10	4	4
10:00 AM – 10:59 AM	5	11	8	10	15	11	11
11:00 AM – 11:59 AM	4	15	10	17	12	23	8
12:00 PM – 12:59 PM	12	16	18	22	13	15	13
1:00 PM – 1:59 PM	14	11	19	10	18	18	16
2:00 PM – 2:59 PM	8	11	14	17	15	15	10
3:00 PM – 3:59 PM	11	14	17	20	19	20	11
4:00 PM – 4:59 PM	5	9	17	24	15	17	9
5:00 PM – 5:59 PM	12	17	15	12	23	19	7
6:00 PM – 6:59 PM	13	12	27	14	7	14	13
7:00 PM – 7:59 PM	3	12	16	12	12	15	7
8:00 PM – 8:59 PM	12	4	10	7	6	10	10
9:00 PM – 9:59 PM	4	8	10	7	7	9	7
10:00 PM – 10:59 PM	13	3	1	8	6	5	6
11:00 PM – 11:59 PM	2		6	4	3	7	3

Source: SWITRS, 2021; City of Dublin, 2021.

Figure 4: Hourly Collisions by Weekday/Weekend, Dublin, 2016-2020



Source: SWITRS, 2021; City of Dublin, 2021.

Table 9: Fatal/Severe Injury Collisions by Time-of-Day and Day-of-Week, Dublin, 2016-2020

Hour of Day	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
12:00 AM – 12:59 AM		1					
1:00 AM – 1:59 AM	2				2		
2:00 AM – 2:59 AM							
3:00 AM – 3:59 AM							
4:00 AM – 4:59 AM							
5:00 AM – 5:59 AM							
6:00 AM – 6:59 AM							
7:00 AM – 7:59 AM				1			
8:00 AM – 8:59 AM				1			
9:00 AM – 9:59 AM							
10:00 AM – 10:59 AM							
11:00 AM – 11:59 AM							1
12:00 PM – 12:59 PM		1	1				
1:00 PM – 1:59 PM					1		
2:00 PM – 2:59 PM							
3:00 PM – 3:59 PM						1	1
4:00 PM – 4:59 PM							
5:00 PM – 5:59 PM							
6:00 PM – 6:59 PM				1			
7:00 PM – 7:59 PM							
8:00 PM – 8:59 PM							1
9:00 PM – 9:59 PM			1				1
10:00 PM – 10:59 PM		1					
11:00 PM – 11:59 PM							

Source: SWITRS, 2021; City of Dublin, 2021.

2.2.6 OTHER FACTORS

Along with driver contributing factors, collisions can also be related to environmental and behavioral factors that are present. Data allow us to examine trends relating to these factors, which include lighting, weather, road surface conditions and alcohol/drug involvement.

2.2.6.1 Lighting

Most collisions occur in *daylight* conditions (Table 10). For collisions that result in a fatality or severe collision, over half of the collisions occur during *dark* or *dusk* conditions.

Table 10: Collisions by Lighting, Dublin, 2016-2020

Lighting	Collision Count	Collision Share	Severe/Fatal Collision Count	Severe/Fatal Collision Share
Daylight	1,027	71%	8	44%
Dark – Street Lights	326	22%	7	39%
Dusk – Dawn	60	4%	2	11%
Dark – No Street Lights	25	2%	0	0%
Not Stated	15	1%	0	0%
Dark – Street Lights Not Functioning	2	0%	1	6%
Total	**1,455**	**100%**	**18**	**100%**

Source: SWITRS, 2021; City of Dublin, 2021.

2.2.6.2 Other

The following factors are also analyzed to determine relationship between the factors and the severity of collisions.

- **Weather**: No disproportionate relationship is found between all collisions and fatal/severe injury collisions by weather condition. 85% of collisions and 83% of fatal/severe injury collisions occur in *clear* conditions.
- **Road Surface**: No disproportionate relationship is found between all severities and fatal/severe injury collisions by road surface condition. 91% of collisions and 100% of fatal/severe injury collisions occur on *dry* road surfaces.
- **Alcohol/Drug Involvement**: Analysis shows a disproportionate relationship between all severities and fatal/severe injury collisions by alcohol/drug involvement. 10% of collisions and 19% of fatal/severe injuries involve alcohol/drugs.

2.3 Pedestrians

Of the 1,455 total reported collisions, there are 53 that involved pedestrians. Of these collisions, five (9%) result in a fatality or severe injury. Trends in pedestrian collisions are analyzed and discussed below, including:

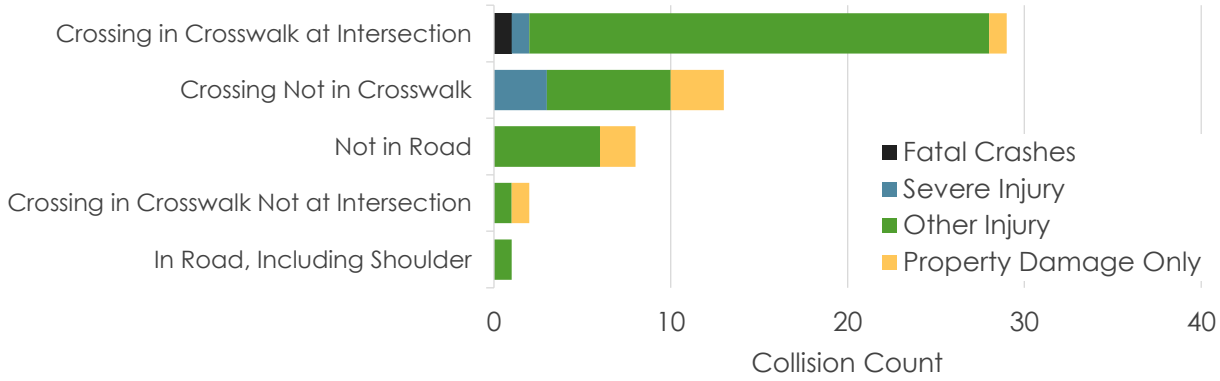
- Pedestrian action and location
- Time-of-day and day-of-week
- Lighting

2.3.1 PEDESTRIAN ACTION AND LOCATION

California collision data include *vehicle/pedestrian* collisions as a separate collision type. Therefore, we can use the supporting *pedestrian action* variable in the data to obtain the officer's assessment of where the collision occurred and what the pedestrian was doing before the collision (Figure 5).

- 50 *vehicle/pedestrian* collisions were within 250 feet of an intersection.
- 3 *vehicle/pedestrian* collisions occurred along a roadway segment.
- The most frequent pedestrian action was *crossing in crosswalk at intersection* (55% of pedestrian collisions).

Figure 5: Pedestrian Collisions by Pedestrian Action



Source: SWITRS, 2021; City of Dublin, 2021.

To better understand the nature of pedestrian-vehicle interactions, pedestrian collisions at intersections are isolated and analyzed by driver and PCF. There are 36 reported pedestrian collisions resulting injury (minor, moderate, or severe) or death that occur at an intersection. Table 11 breaks down pedestrian intersection collisions by control type, driver action, and cited PCF. The table indicates a somewhat even distribution of driver movements. The most frequently cited PCFs at signalized intersections indicate the presence of turning right-of-way conflicts at signalized intersections.

The following PCFs are most frequent:

- *Pedestrian right of way*: This PCF indicates that the pedestrian had the right-of-way.
- *Pedestrian violation*: This PCF indicates that the pedestrian violated the CVC.

Table 11: Injury and Fatal Pedestrian Collisions at Intersections: Location, Driver Movements, and PCF, Dublin, 2016-2020

PCF	Driver Movement Preceding Collision			Total
	Proceeding Straight	Making Right Turn	Making Left Turn	
Signalized Intersections				
Pedestrian Right of Way	2	5	5	12
Pedestrian Violation	3	2	1	6
Traffic Signals and Signs	1			1
Other Improper Driving			1	1
Improper Passing		1		1
Signalized Total	**6**	**8**	**7**	**21**
Unsignalized Intersections				
Unsafe speed	3			3
Unknown	2		1	3
Pedestrian violation	3			3
Pedestrian right of way		1	2	3
Not Stated	1	1		2
Improper turning		1		1
Unsignalized Total	**9**	**3**	**3**	**15**
Total	**15**	**11**	**10**	**36**

Source: SWITRS, 2021; City of Dublin, 2021.

Note: Driver movements (i.e., *backing, entering traffic, slowing/stopping, stopped in road, other*) associated with three or fewer total collisions are excluded from this table for legibility.

2.3.2 TIME-OF-DAY AND DAY-OF-WEEK

Collisions involving pedestrians are distributed throughout the week with concentrations during the morning and evening peak travel periods (Table 12). Fatal and severe injury collisions are distributed throughout the day, with 3 of the 5 collisions occurring between 6:00 PM and 2:00 AM.

Table 12: Pedestrian Collisions by Time-of-Day and Day-of-Week, Dublin, 2016-2020

	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
12:00 AM – 12:59 AM							1
1:00 AM – 1:59 AM							1
2:00 AM – 2:59 AM							
3:00 AM – 3:59 AM							
4:00 AM – 4:59 AM							
5:00 AM – 5:59 AM							
6:00 AM – 6:59 AM			1				
7:00 AM – 7:59 AM				1		1	
8:00 AM – 8:59 AM	2	3	2			2	
9:00 AM – 9:59 AM				1		2	
10:00 AM – 10:59 AM	1				2		
11:00 AM – 11:59 AM			1			1	
12:00 PM – 12:59 PM							1
1:00 PM – 1:59 PM				1			
2:00 PM – 2:59 PM		1	1	1	1		
3:00 PM – 3:59 PM		1				1	
4:00 PM – 4:59 PM			2			1	
5:00 PM – 5:59 PM		1	2		1		
6:00 PM – 6:59 PM							
7:00 PM – 7:59 PM			1	2			
8:00 PM – 8:59 PM			1	1			1
9:00 PM – 9:59 PM				1	1		2
10:00 PM – 10:59 PM		1					1
11:00 PM – 11:59 PM				1			1

Source: SWITRS, 2021; City of Dublin, 2021.

2.3.3 LIGHTING

Most pedestrian collisions occur during *daylight* conditions. However, most pedestrian collisions that result in fatality or severe injury, however, occur during *dark* or *dusk-dawn* conditions (Table 13). Collision shares should be interpreted with caution for fatal and severe injuries given that there are five reported fatal/severe injury pedestrian collisions.

Table 13: Pedestrian Collisions by Lighting, Dublin, 2016-2020

Lighting	Collision Count	Collision Share	Severe/Fatal Collision Count	Severe/Fatal Collision Share
Daylight	37	70%	1	20%
Dark - Street Lights	8	15%	1	20%
Dusk - Dawn	6	11%	2	40%
Dark - No Street Lights	1	2%	0	0%
Dark - Street Lights Not Functioning	1	2%	1	20%

Source: SWITRS, 2021; City of Dublin, 2021.

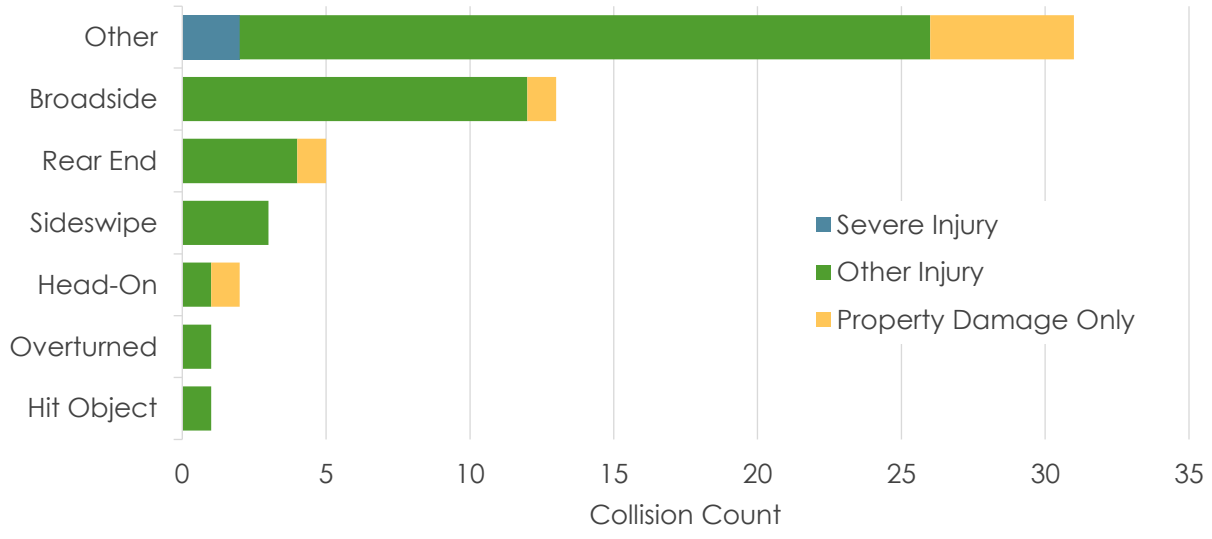
2.4 Bicyclists

Of the 1,455 total reported collisions, there are 56 that involved bicyclists. 2 of these (4%) result in severe injury. No fatal collisions involving a bicyclist are reported.

2.4.1 COLLISION TYPE AND SEVERITY

Most bicyclist collisions are categorized by collision type as *other* (55%). This is common for bicycle collisions because there is not a specific bicycle-related collision type for an officer to select. The next biggest share of collisions is categorized as *broadside* (23%) (Figure 6).

Figure 6: Bicyclist Collisions by Type and Severity, Dublin, 2016-2020



Source: SWITRS, 2021; City of Dublin, 2021.

2.4.2 TIME-OF-DAY AND DAY-OF-WEEK

Collisions involving bicyclists are distributed throughout the week and throughout the day (Table 14).

Table 14: Bicyclist Collisions by Time-of-Day and Day-of-Week, Dublin, 2016-2020

	Sun	Mon	Tues	Weds	Thurs	Fri	Sat
12:00 AM – 12:59 AM							
1:00 AM – 1:59 AM							
2:00 AM – 2:59 AM			1				
3:00 AM – 3:59 AM							
4:00 AM – 4:59 AM							
5:00 AM – 5:59 AM							
6:00 AM – 6:59 AM			1	2			
7:00 AM – 7:59 AM		3		1	1		
8:00 AM – 8:59 AM				1	1		2
9:00 AM – 9:59 AM			1	1	1		
10:00 AM – 10:59 AM	3				1		1
11:00 AM – 11:59 AM	2			2		1	
12:00 PM – 12:59 PM				1			
1:00 PM – 1:59 PM		1		1			
2:00 PM – 2:59 PM		1				1	
3:00 PM – 3:59 PM			1	2	1		
4:00 PM – 4:59 PM			1	2	1		1
5:00 PM – 5:59 PM						2	
6:00 PM – 6:59 PM	1		1		1		
7:00 PM – 7:59 PM		1	2	1	1		
8:00 PM – 8:59 PM				2	2		
9:00 PM – 9:59 PM							
10:00 PM – 10:59 PM							
11:00 PM – 11:59 PM							

Source: SWITRS, 2021; City of Dublin, 2021.

2.4.3 LIGHTING

Most collisions involving bicyclists happen during daylight conditions. Both bicyclist collisions that result in severe injury occurred during daylight conditions (Table 15).

Table 15: Bicyclist Collisions by Lighting, Dublin, 2016-2020

Lighting	Collision Count	Collision Share	Severe/Fatal Collision Count	Severe/Fatal Collision Share
Daylight	42	75%	2	100%
Dark - Street Lights	8	14%	0	0%
Dusk - Dawn	5	9%	0	0%
Dark - No Street Lights	1	2%	0	0%

Source: SWITRS, 2021; City of Dublin, 2021.

2.5 Comparison with Strategic Highway Safety Plan

The California 2020-2024 Strategic Highway Safety Plan is a statewide traffic safety plan that provides guidance to influence development of statewide goals, strategies, and performance measures for local agencies and stakeholders statewide.

The SHSP focuses on 16 challenges areas (the 10 bolded challenge areas are subsequently compared to Dublin collision history). The remaining are not compared because the data available for this project do not readily and reliably provide for these :

- **Aging Drivers (≥65 years old)**
- **Bicyclists**
- **Commercial Vehicles**
- Distracted Driving
- Driver Licensing
- Emergency Response
- Emerging Technologies
- **Impaired Driving**
- **Intersections**
- **Lane Departures**
- **Motorcyclists**
- Occupant Protection
- **Pedestrians**
- **Speed Management/ Aggressive Driving**
- Work Zones
- **Young Drivers (15-20 years old)**

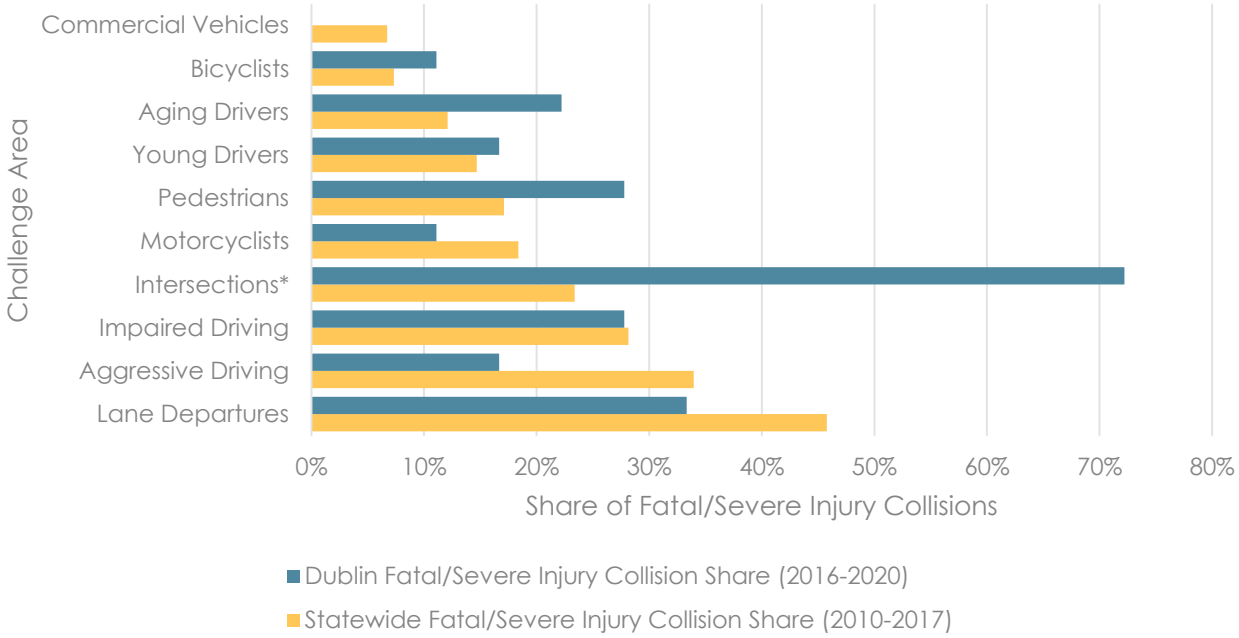
Figure 7 compares the share of fatal/severe injury collisions by challenge area between Dublin's 2016-2020 collision history and the statewide averages presented in the SHSP (based on 2010-2017 collision history).

The City has at least a 10% higher share of fatal and severe injury collisions than the statewide levels for the following challenge areas:

- Aging Drivers (22% compared to 12%)
- Pedestrians (28% compared to 17%)
- Intersections (72% compared to 23%)

Given the number of fatal/severe injury collisions in Dublin (18 over 5 years), only the intersection difference shows statistical significance when compared to statewide average. Nonetheless, the pedestrian and aging driver categories merit focus in LRSP emphasis area and goal development. The SHSP also classifies Intersections, Pedestrians, Bicyclists, Impaired Driving and Speed Management/Aggressive Driving as five of their high priority areas that would be similar to Dublin's LRSP emphasis area and goal development.

Figure 7: Dublin vs. Statewide Challenge Area Involvement, Fatal/Severe Injury Collisions



Source: SWITRS, 2021; City of Dublin, 2021; 2020-2024 SHSP

*Indicates difference is statistically significant at the 95% confidence level based on a difference of proportions t-test.

2.6 Recommended Emphasis Areas

Based on the analysis presented in Sections 2.2 through 2.5, recommended emphasis areas for the City include:

- **Pedestrian collisions:** These collisions account for 28% of all fatal/severe injury collisions as compared to 17% of all statewide fatal/severe injury collisions.
- **Nighttime safety:** A disproportionate share of fatal/severe injury collisions, including pedestrian collisions, occur in dusk/dawn or dark conditions.
- **Aging drivers:** These collisions account for 22% of all fatal/severe injury collisions as compared to 12% of all statewide fatal/severe injury collisions.
- **Signalized local/arterial intersections:** These intersections constitute the plurality of *rear end* and *broadside* collisions. *Hit object* collisions, which are the most frequent fatal/severe injury collision types, also primarily occur at signalized intersections.
- **Driver behavior:** Including impaired driving and aggressive driving.
    - *Impaired Driving* account for over 25% of all fatal/severe injury collisions in Dublin.
    - *Aggressive Driving* accounts for over 15% of all fatal/severe injury collisions in Dublin.

3 NETWORK SCREENING FINDINGS

Kittelson developed collision severity scores for two analysis scenarios; intersection collisions and roadway collisions. The collision severity scores will help the City identify priority locations for safety improvement projects.

3.1 Equivalent Property Damage Only (EPDO)

Kittelson used the equivalent property damage only (EPDO) score performance measure from the AASHTO *Highway Safety Manual*, which assigns weighting factors to collisions by severity relative to property damage only (PDO) collisions. The EPDO performance measure accounts for locations with the highest impact (e.g., locations with high severity collisions and/or high quantity of collisions) and closely aligns with Highway Safety Improvement Program (HSIP) funding. The EPDO calculation was performed for all public intersections and roadway segments, not including state highway facilities. The EPDO performance measure is described below. Moving forward throughout this document, the EPDO performance measure is referred to as a collision severity score.

The collision severity score assigns weight to individual collisions based on the collision severity and location of the collision (Table 16). Weights, provided by the 2020 *Caltrans' Local Roadway Safety Manual*, are based on the cost of property-damage-only (PDO) collisions, assigning each collision with a score relative to a PDO collision.

Table 16: Collision Weights by Severity and Location Type

Location Type	Collisions Weighting by Severity				
	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Signalized Intersection	119.55	119.55	10.70	6.08	1.00
Unsignalized Intersection	190.23	190.23	10.70	6.08	1.00
Roadway	164.66	164.66	10.70	6.08	1.00

Source: Caltrans, *Local Roadway Safety: A manual for California's Local Road Owners* (Version 1.5), 2020.

The weights prioritize fatal and severe injury collisions equally to recognize that a death versus a severe injury is often a function of the individual involved (i.e., age or physical fitness) or of emergency response time. Therefore, both outcomes represent locations where the region may equally value improvements. Collision weights vary by location due to the relative costs associated with the collision severity at the location types. Specifically, unsignalized intersections have a higher cost for fatal and severe collisions because fatal and severe collisions at these locations tend to result in more severely injured persons on average.

Intersection Methodology

Kittelson first identified signalized and unsignalized intersections in the City roadway network and then defined collisions as intersection or segment collisions. An intersection collision is defined as a collision that occurs within 250 feet of the intersection. These collisions were spatially joined and summarized in ArcGIS to show the total number of collisions by severity at each intersection. Where intersections were less than 500 feet from each other, collisions were assigned to the nearest of the two intersections. Collisions occurring

more than 250 feet from any intersection were separated to be used in the roadway segment analysis discussed below.

The collision severity score is calculated by multiplying each collision severity total by its associated weight and summing the results, using the following formula:

*Collision Severity Score = Fatal weight * # of fatal collisions + severe injury weight * # of severe injury collisions + moderate injury weight * # of moderate injury collisions + minor injury weight * # of minor injury weight collisions + property damage only collisions*

The collision severity score is annualized by dividing the score by the number of years (five) of collision data used in the analysis.

Roadway Methodology

After completing the intersection analysis, Kittelson used the collisions reported more than 250 feet from the nearest intersection to conduct a separate segment analysis. A Python script in ArcGIS allowed for splitting the Dublin roadway network into overlapping half-mile (0.5) segments, incrementing the segments by one quarter (0.25) of a mile. This methodology helps to identify portions of roadway with the greatest potential for safety improvements.

After splitting the network, the Python script spatially joined non-intersection collisions to each segment. Like the intersection methodology above, collisions were summarized by severity, and the totals were multiplied by the collision severity weights for roadway segments. The weighted collision severity scores of the collisions were totaled and annualized by the number of years of collision data (five) to generate an annualized collision severity score.

3.2 Results

3.2.1 NETWORK SCREENING RESULTS

This analysis scenario included total reported collision from the last 5 years of data. For intersection locations, the collision severity scores ranged from zero (no reported collisions during the 5 years) to 59.87. For the half-mile roadway segments, the collision severity scores ranged from zero to 36.16. Figure 8 and Figure 9 show the results of the collision severity scoring by percentiles for intersection locations and roadway segments, respectively. Intersections or segments are excluded from the figures if no collisions were reported at that location.

Figure 8. Intersection Collision Severity Scores

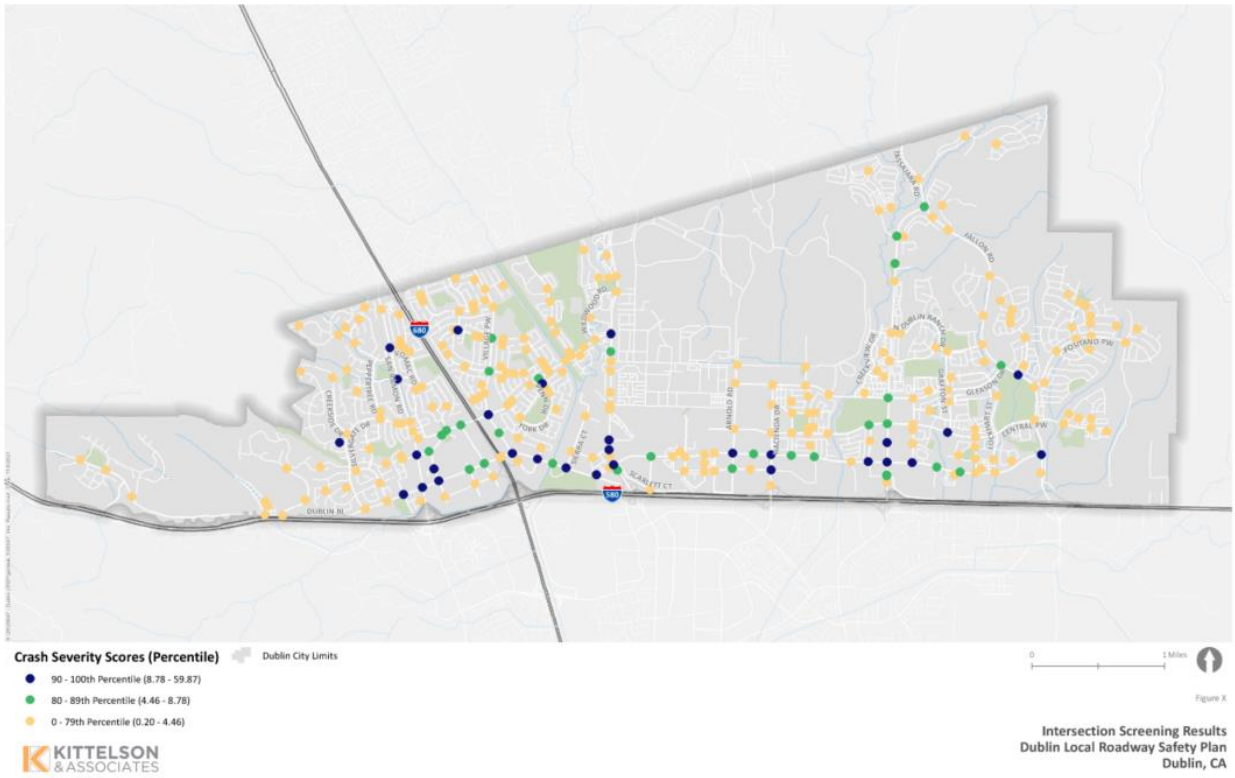
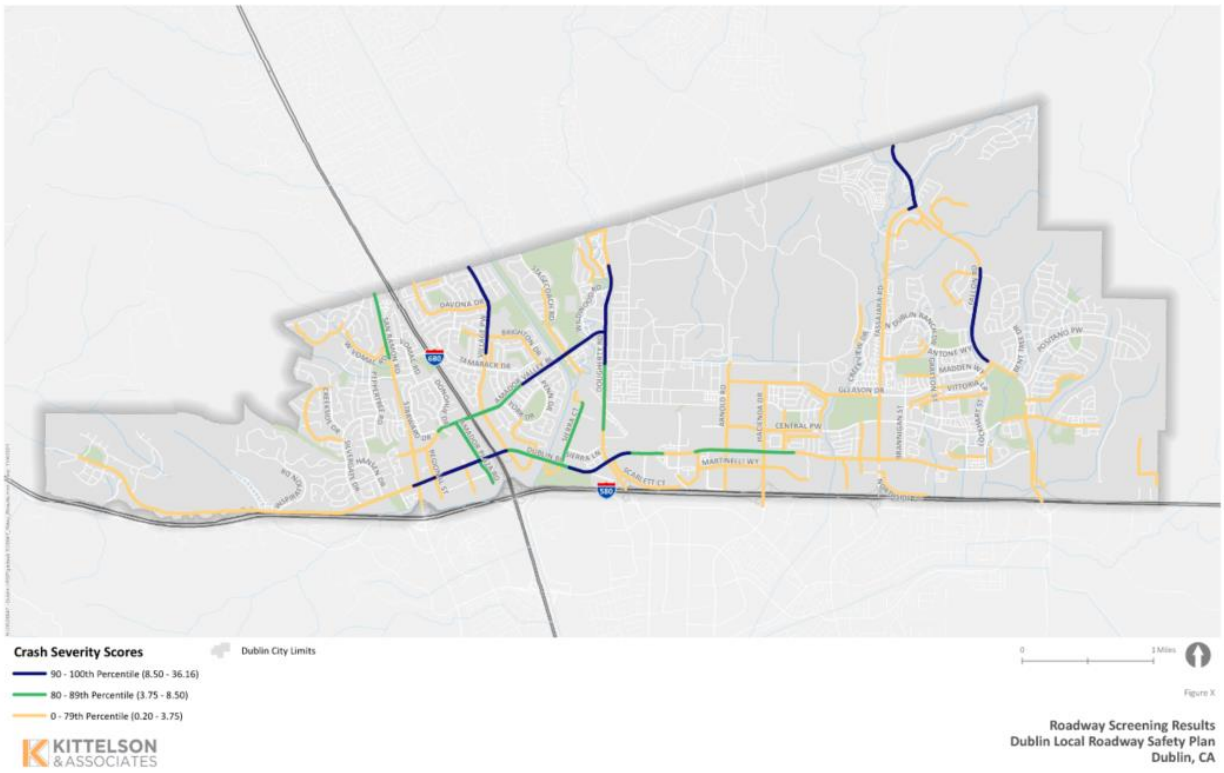


Figure 9. Roadway Collision Severity Scores



3.2.2 PRIORITY LOCATIONS

Kittelson identified priority intersections and segments using the annualized collision severity score for intersections and segments. The top 15 intersections (top 5th percentile) and 5 roadway segments (top 8th percentile) were identified. The resulting list of priority locations is provided in Table 17 and shown in Figure 10. The top scoring intersections and segments were reviewed to determine priority locations for safety improvements and upcoming HSIP applications. The final list of priority locations may change from the table below.

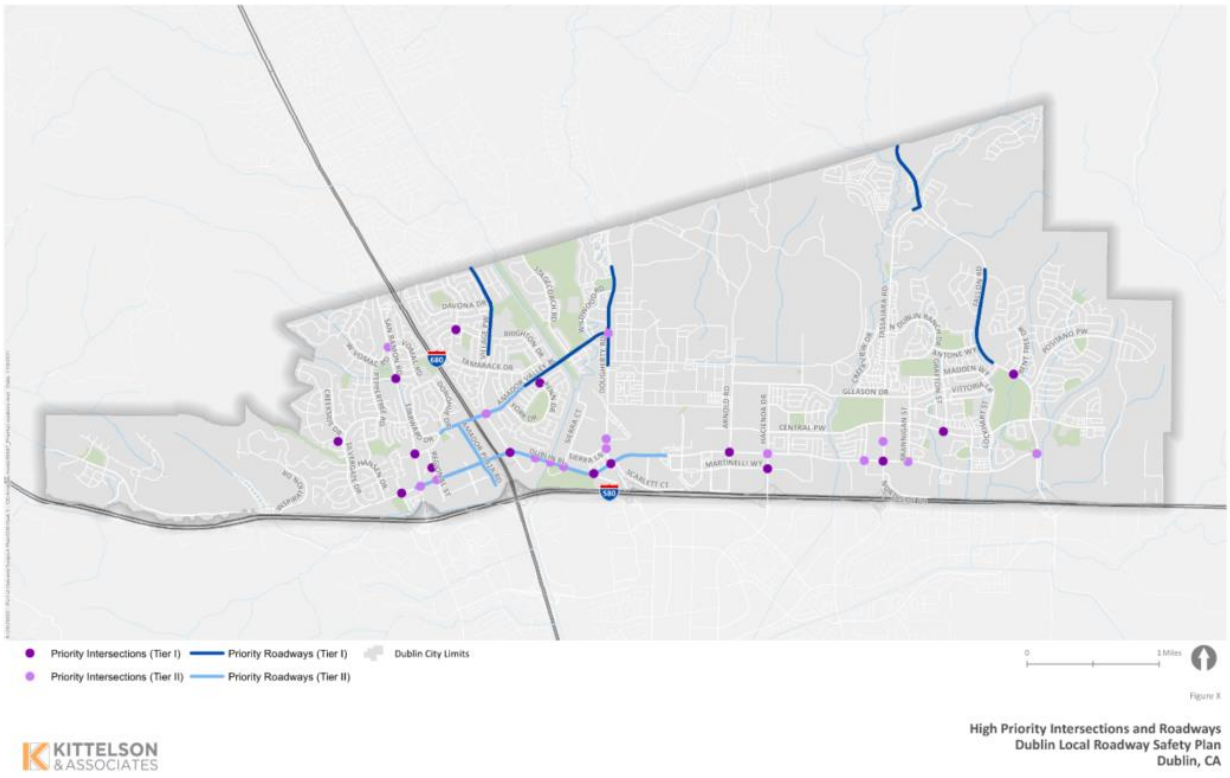
Table 17. Priority Intersections and Roadways

#	Location	Location Type	Collision Severity Score	Total No. Collisions	Fatal/Severe Injury Collisions	Other Injury Collisions	PDO Collisions
Priority Intersections							
1	Arnold Rd & Dublin Blvd	Signalized Intersection	59.9	17	2	8	7
2	Dublin Blvd & Village Pkwy	Signalized Intersection	49.4	43	1	15	27
3	Donlon Way & Dublin Blvd	Unsignalized Intersection	42.1	6	1	3	2
4	Amador Valley Blvd & San Ramon Rd	Signalized Intersection	41.1	18	1	9	8
5	Regional St & Regional Common	Unsignalized Intersection	38.8	5	1	0	4
6	Winding Trail Ln & Rolling Hills Dr	Unsignalized Intersection	38.0	1	1	0	0
7	Lucania St & Brighton Dr	Unsignalized Intersection	38.0	1	1	0	0
8	Tyne Ct & Penn Dr	Unsignalized Intersection	38.0	1	1	0	0
9	Dublin Blvd & Dougherty Rd	Signalized Intersection	37.2	65	0	22	43
10	San Ramon Rd & Shannon Ave	Signalized Intersection	29.3	8	1	3	4
11	Dublin Ct & Dublin Blvd	Signalized Intersection	27.3	13	1	1	11
12	Dublin Blvd & Tassajara Rd	Signalized Intersection	25.8	34	0	16	18
13	Grafton St & Central Pkwy	Signalized Intersection	24.3	3	1	0	2
14	Bent Tree Dr & Fallon Rd	Signalized Intersection	23.9	1	1	0	0
15	Martinelli Way & Hacienda Dr	Signalized Intersection	18.5	28	0	10	18
Priority Roadways							

#	Location	Location Type	Collision Severity Score	Total No. Collisions	Fatal/Severe Injury Collisions	Other Injury Collisions	PDO Collisions
1	Dougherty Rd (north of Willow Creek Dr to south of 8th St) – *0.75 mi*	Arterial	36.2	8	1	2	5
2	Fallon Rd (Signal Hill Dr to Gleason Dr) – *0.75 mi*	Arterial	35.5	4	1	1	2
3	Village Pkwy (northern city limits to north of Tamarack Dr) – *0.69 mi*	Collector	35.3	8	1	1	6
4	Amador Valley Blvd (Burton St to Dougherty Rd) – *0.75 mi*	Arterial	34.1	2	1	1	0
5	Tassajara Rd (northern city limits to Fallon Rd) – *0.50 mi*	Arterial	33.1	2	1	0	1

Note: Priority locations are based on collision severity scores and may change.

Figure 10. Priority Intersections and Roadways



4 NEXT STEPS

The findings presented above will be discussed, reviewed, and confirmed with City of Dublin staff. The findings will be used to develop countermeasure profiles for the most relevant safety treatments for the City based on identified collision risk and common collision patterns and trends. This analysis will also be used to determine the locations and projects most likely to provide the greatest potential collision reduction. Kittelson and the City will work together to identify locations for field observation and project development. Collectively, the information in this memorandum and follow-on recommendations from the next steps will be incorporated into the City's final LRSP.

Attachment A
Collision Database Review Memorandum

KITTELSON & ASSOCIATES
155 Grand Avenue, Suite 505
Oakland, CA 94612

TECHNICAL MEMORANDUM

October 7, 2021 Project# 26647

To: Sai Midididdi, TE
City of Dublin

From: Mike Alston, RSP; Erin Ferguson, PE; Grace Carsky; Jackson Lynch

RE: Dublin Local Roadway Safety Plan

TASK 3.2 – TECHNICAL COLLISION DATABASE REVIEW

This memorandum presents an overview of the collision data available for the City of Dublin (City) and a recommendation on the appropriate data source to use in the development of the Dublin Local Roadway Safety Plan (LRSP). It is organized into the following sections:

- Data Sources
- Database Findings
- Recommendations

Kittelson compared collisions provided by the City from its database in Crossroads software to collisions obtained from the public California Statewide Integrated Traffic Records System (SWITRS) database. Several discrepancies were found between the total number of collisions and recorded collision severity in the databases, so Kittelson consulted police reports provided by the City to check a sample of collisions from both databases and make a recommendation.

The findings and recommendations of this memorandum establish the approach to compile a consolidated collision database for the Dublin LRSP. That database will be used for the high-collision locations analysis (Task 3.2), the identification of safety goals and countermeasures (Task 4), and the identification of geographic priorities for future projects (Task 5).

Kittelson recommends using SWITRS collision records and recorded severities for the 2016-2020 period and augmenting with the 141 unique collisions from the Crossroads database to create a complete and consolidated dataset for the forthcoming LRSP analysis efforts.

DATA SOURCES

Kittelson obtained the most recently reported collision data from the City's Crossroads collision database, representing collisions occurring July 2015 through February 2021. Kittelson obtained collision dated from the SWITRS database for the same period (July 2015 through February 2021).

The five most recent available years of complete data (January 2016 to December 2020) will be used for the project's analysis and were therefore analyzed to compare databases.

Police reports for a sample of collisions were obtained from the City and compared to the matching records in each database.

DATABASE FINDINGS

The Crossroads database included 1,366 collisions between January 2016 and December 2020. The SWITRS database included 1,314 collisions during the same period (Figure 1). These collisions were categorized into different severities (Table 1). The total number of fatal and severe injury collisions was equal between the two data sources, but there were clear discrepancies between the level of other injury collisions and total collisions reported annually.

Figure 1. Total Number of Collisions, 2016-2020

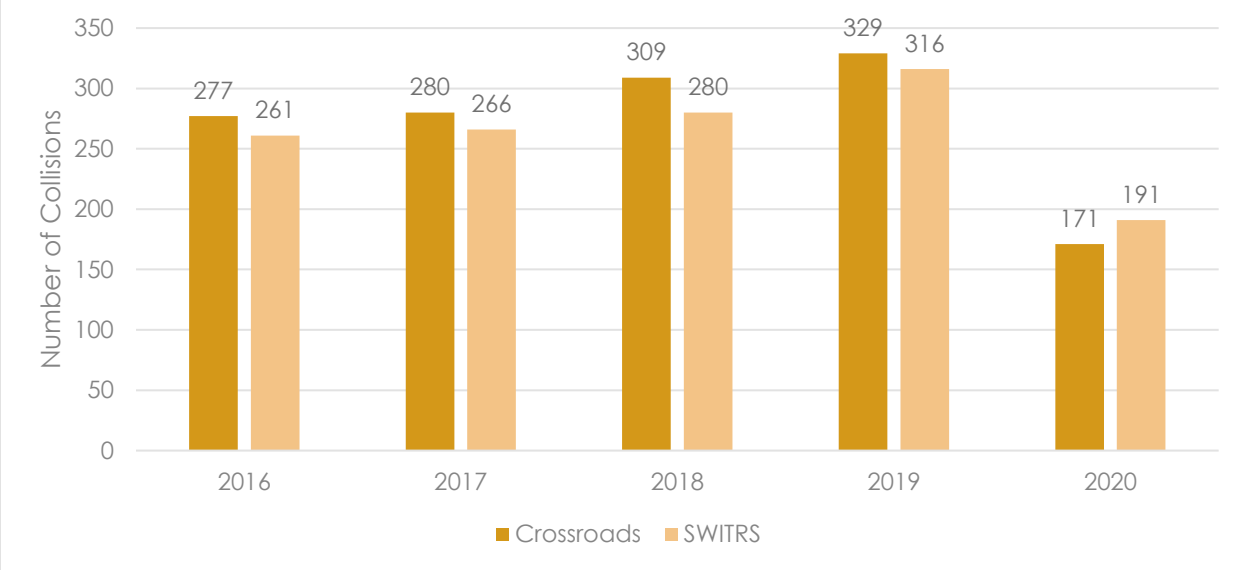


Table 1. Crossroads and SWITRS Collision Severities

	Crossroads	SWITRS
Fatal	2	2
Severe Injury	15	15
Other Visible Injury	277	141
Complaint of Pain	86	327
Property Damage Only	986	829
Total	**1,366**	**1,314**

Kittelson used collision time, date, and location to cross-reference collision reports between Crossroads and SWITRS. Each database contained unique collision records not present in the other database. Of the 1,366 Crossroads collisions, 141 were unique to the database and not included in the SWITRS database. Of the 1,314 SWITRS collisions, 89 were unique to the database.

1,225 collision records were in both databases, and 431 of these were coded with different collision severities between the two databases (Table 2). Most notable is the discrepancy of one collision coded as a severe injury collision in SWITRS and a property damage only (PDO) collision in Crossroads.

Table 2. Comparison Matrix of Crossroads and SWITRS Collision Severities – All Common Collisions

Crossroads Collision Severity	SWITRS Collision Severity: Fatal	Severe Injury	Other Injury	Complaint of Pain	PDO	*Total*
Fatal	**2**					*2*
Severe Injury		**14**				*14*
Other Visible Injury			**18**	246		*264*
Complaint of Pain			*75*	**1**	1	*77*
PDO		1	38	70	**759**	*868*
Total	*2*	*15*	*131*	*317*	*760*	***1,225***

Note: Bold numbers indicate the number of collisions that were recorded with the same collision severity in both the Crossroads and SWITRS databases.

Police reports for three collisions with different severities were obtained to check the police reports' recorded severity at the time of the event against the Crossroads and SWITRS databases. One report (D2003567) was selected due to the wide discrepancy between the severity reporting: Crossroads recorded the collision as PDO collision while SWITRS recorded the collision as a severe injury collision. The other two collisions were selected at random as representative other collision records with discrepancies: one where Crossroads recorded a higher level of severity and one where SWITRS recorded a higher level of severity. Table 3 presents the findings of the police report comparison.

Report D2003567 determined the collision to result in a severe injury, and Report D1900667 determined the collision to result as an other visible injury collision. However, both were entered as PDO collisions in Crossroads. The SWITRS database matched the severity of the police reports. Report D1602575 determined the collision to result as an other visible injury in the collision description, but neither database matched this coding. Crossroads did not match the police reports for any of the three reported collisions; SWITRS matched for two of the three.

Table 3. Comparison Matrix of Crossroads and SWITRS Collision Severities – Specific Collisions

Crossroads Report No.	SWITRS Case ID	Crossroads Severity	SWITRS Severity	Determined Severity
D2003567	9204895	Property Damage Only	Severe Injury	Severe Injury
D1602575	8131511	Complaint of Pain	Property Damage Only	Other Visible Injury
D1900667	8810265	Property Damage Only	Other Visible Injury	Other Visible Injury

RECOMMENDATIONS

After comparing the Crossroads and SWITRS databases against each other and verifying severity of a sample of collision records using police reports, Kittelson recommends using SWITRS collision records and recorded severities for the 2016-2020 period and augmenting with the 141 unique collisions from the Crossroads database to create a complete and consolidated dataset for the forthcoming LRSP analysis efforts.

This verification step also highlights the need for database maintenance. As the main source of information for city staff to review collision history, having accurate collision information is

important. The City could review their Crossroads data input methodologies and could consider regularly taking a sample of police reports and comparing those against data entered into the Crossroads database to verify accuracy of the Crossroads data.

APPENDIX C: COUNTERMEASURE TOOLBOX

ENGINEERING COUNTERMEASURES

This section presents engineering countermeasures – treatments to reduce crashes and improve safety on roadways – organized by treatment location type:

- Signalized intersections
- Unsignalized intersections
- Roadways

Treatments that are applicable to more than one location type are listed in all applicable categories.

SIGNALIZED INTERSECTIONS

This section presents recommended engineering countermeasures at signalized intersections in Dublin. Detailed description of each measure is provided further in the document.

Table 1: Summary of Signalized Intersection Countermeasures and Related Information

Countermeasure Name	CM ID*	Documented Crash Reduction Factor**	Federal Funding Eligibility through HSIP***	Cost Estimate[t]	Emphasis Area	Page Reference
Motor Vehicle Treatments						
Add intersection lighting	S01	40%	100%	$	Nighttime Safety, Signalized Local/Arterial Intersections	3
Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	15%	100%	$	Signalized Local/Arterial Intersections	4
Provide advanced dilemma-zone detection for high-speed approaches	S04	40%	100%	$ - $$	Nighttime Safety, Signalized Local/Arterial Intersections	5
Install left-turn lane and add turn phase	S06/S07	55%	90%	$ - $$$	Signalized Local/Arterial Intersections	6
Convert signal to mast arm (from pedestal-mounted)	S08	30%	100%	$ - $$$	Signalized Local/Arterial Intersections	7
Install raised median on approaches	S12	25%	90%	$ - $$$	Signalized Local/Arterial Intersections	8

Countermeasure Name	CM ID*	Documented Crash Reduction Factor**	Federal Funding Eligibility through HSIP***	Cost Estimate[ŧ]	Emphasis Area	Page Reference
Create directional median openings to allow (and restrict) left-turns and U-turns (signalized intersection)	S14	50%	90%	$ - $$	Pedestrian Crashes, Signalized Local/Arterial Intersections	9
Signalized intersection conspicuity treatments	Varies	Varies	Varies	$ - $$	Signalized Local/Arterial Intersections, Driver Behavior	13
No Right Turn on Red (RTOR)[1]	N/A	N/A	N/A	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	10
Centerline hardening[1]	N/A	N/A	N/A	N/A	Pedestrian Crashes	11
Convert intersection to roundabout (from signal)	S16	35-67%**	100%	$ - $$$	Signalized Local/Arterial Intersections	12
Pedestrian/Bicycle Treatments						
Install pedestrian countdown signal heads	S17PB	25%	100%	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	13
Install pedestrian crossing	S18PB	25%	100%	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	16
Install pedestrian scramble	S19PB	40%	100%	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	17
Install advance stop bar before crosswalk (Bicycle Box)	S20PB	15%	100%	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	18
Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	S21PB	60%	100%	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	19
Install painted safety zone	N/A	N/A	N/A	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	20
Install Protected Intersection Elements	N/A	N/A	N/A	$ - $$$	Pedestrian Crashes, Signalized Local/Arterial Intersections	21

*CM ID refers to the Countermeasure ID from the Caltrans *Local Roadway Safety Manual* (April 2020, LRSM). If a CM ID is not listed, the countermeasure is not listed in the LRSM. Local Roadway Safety - A Manual for California's Local Road Owners

**Documented crash reduction factors are derived either from the *LRSM* or the FHWA's *Proven Safety Countermeasures* resource, unless otherwise noted. An "N/A" indicates that a documented, research-backed crash reduction factor does not exist.

***Funding eligibility indicates the designated federal contribution level for approved HSIP projects in California associated with Caltrans HSIP Cycle 10. This is subject to change from one cycle to the next and should be confirmed with the state HSIP coordinator.

ŧ $ - $50,000 or less; $$ - $50,000 to $100,000; $$$ - $100,000 or more

MOTOR VEHICLE TREATMENTS

Add Intersection Lighting

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Nighttime	Nighttime Safety, Signalized Local/Arterial Intersections	40%	100%	$	Yes

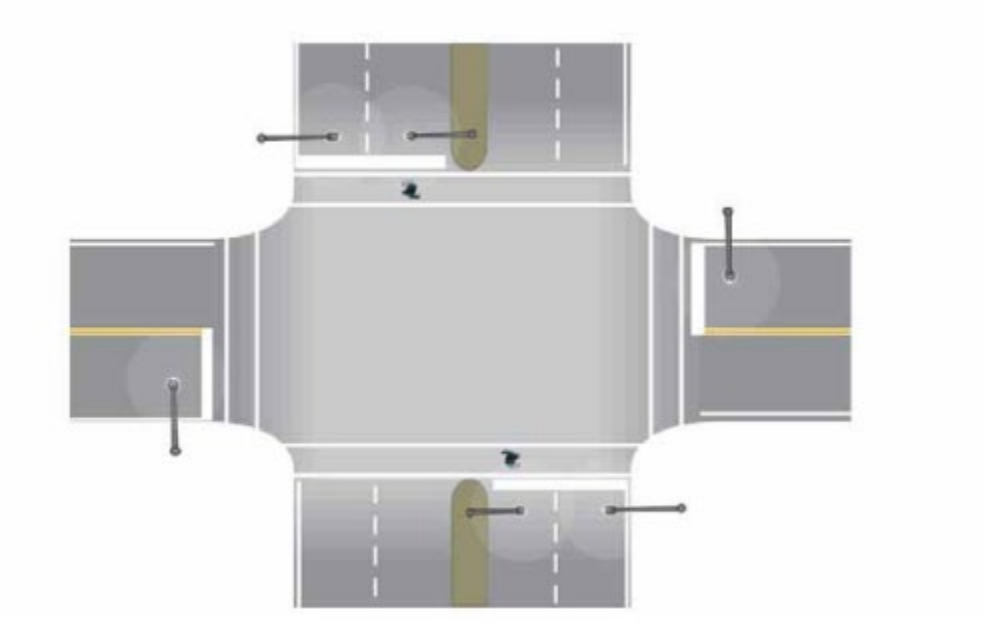
What is it?

Lighting may be improved at an intersection, its approaches, or a roadway segment to make drivers more aware of the surroundings at an intersection, enhance drivers' available sight distances, and improve the visibility of non-motorists at an intersection. In commercial areas or in downtown areas where there is more pedestrian activity, pedestrian-scale lighting may be placed over sidewalks to help pedestrians navigate the intersection safely. Intersection lighting improvements may be considered at intersections that have a disproportionate number of night-time crashes and do not currently provide lighting at the intersection or at its approaches.

What are some considerations for use?

These treatments may be considered when high frequencies of night-time crashes have occurred at a signalized intersection. Avoid placing the light source behind pedestrians at crossing locations (Figure 1).

Figure 1. Example of Intersection Lighting



Source: FHWA Informational Report on Lighting Design for Midblock Crosswalks

Improve Signal Hardware: Lenses, Back-Plates with Retroreflective Borders, Mounting, Size, and Number

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Rear-end, Broadside	Nighttime Safety, Signalized Local/Arterial Intersections	40%	100%	$	Y

What is it?

- **Lenses:** New lenses with LED lighting increases visibility of the traffic signal.
- **Back-plates with retroreflective borders**: This treatment warns drivers of the upcoming signalized intersections by making signal heads more visible in daytime and nighttime conditions. Signal hardware upgrades may be considered where crash patterns indicate visibility of the intersection or signal heads may benefit from enhancements.
- **Mounting**: Mounting assemblies include mast arms, span wires, and side-mounted vehicular signals. Upgrading the mounting assembly may improve the longevity of the signal hardware.
- **Size and Number**: Increasing the size and/or numbers may improve visibility of the signal.

What are some considerations for use?

This treatment may be considered when high frequencies of broadside, rear-end, or other conflicting movement crashes are occurring at a signalized intersection related to signal conspicuity.

Figure 2. Signal with Retroreflective Borders

Source: FHWA

Provide Advanced Dilemma-Zone Detection for High Speed Approaches

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Rear-end	Nighttime Safety, Signalized Local/Arterial Intersections	40%	100%	$ - $$	Y

What is it?

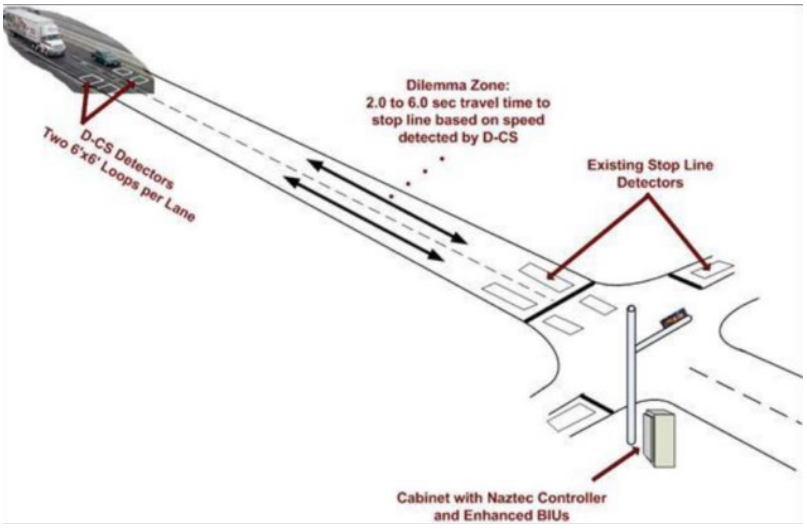
This treatment consists of adding new advance detection and signal hardware to detect vehicles that may approach the intersection in the "dilemma zone" of deciding whether to stop or proceed during a yellow phase. The detection system modifies the signal timing to reduce the numbers of drivers needing to make this decision and the potential for conflicts due to phase changes.

Providing advanced dilemma-zone detection can help reduce conflicts due to late-entering vehicles proceeding through the intersection or conflicts arising from hard-stopping vehicles due to the dilemma of whether to proceed or stop during the yellow phase of a signal. Advanced dilemma-zone detection can help reduce the frequency of red-light violations, crashes associated with phase changes, and may provide operational benefits.

What are some considerations for use?

This treatment may be considered when high frequencies of crashes involve hard-stopping vehicles resulting in rear-end crashes, or there is a pattern of crashes related to late-entering vehicles or vehicles running red lights.

Figure 3. Example Layout of Dilemma-Zone Detection



Source: FHWA

Install Left-Turn Lane and Add Turn Phase

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Crashes related to left-turning vehicles (broadside, rear-end, sideswipe)	Signalized Local/Arterial Intersections	55%	90%	$ - $$$	Y

What is it?

This treatment consists of adding a new protected left-turn phase to a signal where left-turns are currently permitted and, if no left-turn lane currently exists, adding a left-turn lane to allow left-turning vehicles to queue separately from through movement traffic. This treatment includes both adjustments to signal timing as well as new signal hardware to provide for the protected movement.

Protected left-tun phasing can help reduce rear-end or sideswipe crashes related to left-turn vehicle conflicts with oncoming traffic or vehicles behind them where permitted left-turns are allowed. This phasing removes the need for left-turning drivers to navigate through gaps in opposing through vehicles.

What are some considerations for use?

These treatments may be considered when high frequencies of crashes involving left-turning vehicles are occurring at a signalized intersection. Adding a protected phase will likely require new signal heads, may require a new mast arm and pole if the existing mast arm could not support the new signal heads, and may require roadway widening.

Figure 4. Example of Protected Left-Turn Lane and Phase

Source: Google Earth

Convert Signal to Mast Arm (from Pedestal-Mounted)

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Rear-end, broadside	Signalized Local/Arterial Intersections	30%	100%	$ - $$$	N

What is it?

Conversion of pedestal-mounted intersections to mast arms can improve visibility of the traffic signals. Providing better visibility of intersection signs and signals aids drivers' advance perception of the upcoming intersection.

What are some considerations for use?

These treatments may be considered when high frequencies of broadside, rear-end, night-time or other conflicting movement crashes are occurring at a signalized intersection that may be related to intersection and signal conspicuity.

Figure 5. Example of Mast Arm

Source: AA Roads

Install Raised Median on Approaches

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Broadside	Signalized Local/Arterial Intersections	25%	90%	$ - $$$	Y

What is it?

This treatment consists of adding new raised medians on the approaches to intersections to control and restrict movements from access points (e.g., driveways from commercial and retail areas) on the approach to a signalized intersection. Adding raised medians can help reduce conflicts by restricting access-related movements to the roadway on the approaches to an intersection. The raised medians prohibit left-turns into and out of driveways that may be located within the influence area of the intersection to reduce potential conflicts.

What are some considerations for use?

These treatments may be considered when high frequencies of crashes involve left-turning vehicles on the approach to any intersection are present or there is other evidence of access-related crashes on the intersection approaches. At signalized intersections, the addition of raised medians and median noses can be installed to create pedestrian refuge islands, providing an additional benefit to pedestrians and bicyclists crossing the intersection. However, implementation of these treatments will need to balance access to businesses where restrictions occurred with safety benefits in commercial and retail areas.

Figure 6. Example of Raised Median

Source: Kittelson

Create Directional Median Openings to Allow (and Restrict) Left-Turns and U-Turns

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Broadside, Rear-end, Pedestrian, Sideswipe (involving left turns)	Pedestrian Crashes, Signalized Local/Arterial Intersections	50%	90%	$ - $$	Y

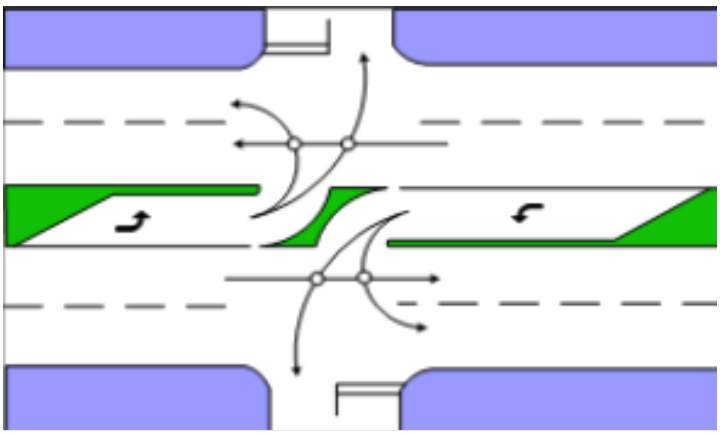
What is it?

This treatment may be used at signalized or unsignalized intersections and mid-block locations on roadways that have turning movement crashes near the intersection or at driveway access points. This treatment can improve access control at intersections and mid-block roadway segments. Application of this countermeasure should be based on current crash data and a clearly defined need to restrict or accommodate the movement. Raised medians next to left-turn lanes at intersections can offer a cost-effective means for reducing crashes and improving operations at higher volume intersections. The raised medians prohibit left turns into and out of driveways that may be located too close to the functional area of the intersection.

What are some considerations for use?

A clustering of similar turning movement-related crashes may indicate a candidate movement to restrict. Raised medians at intersections may be most effective in retrofit situations where high volumes of turning vehicles have degraded operations and safety, and where more extensive countermeasures would be too expensive because of limited right-of-way and the constraints of the built environment.

Figure 7. Diagram of a Directional Median Opening



Source: Texas A&M Transportation Institute

No Right Turn on Red (RTOR)

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	N/A	N/A	$	Y

What is it?

This treatment restricts motorists from turning right during the red light. In California, turning right on red is a default condition of the existing laws. Drivers in California are advised of this restriction with the posting of "No Turn on Red" signs (static or dynamic), according to the sign specifications for MUTCD R10-11 in California Manual on Uniform Traffic Control Devices (CA-MUTCD). Dynamic signs can be used to restrict right turns during certain times of day or during certain signal phases.

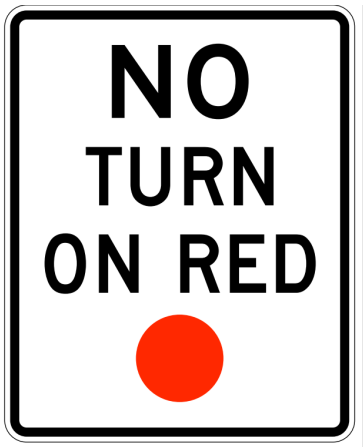
What are some considerations for use?

No RTOR treatments may be considered at signalized intersections, specifically at intersections with medium to high motor vehicle turning volumes and pedestrian volumes. This treatment may be considered at intersections with exclusive pedestrian phase, and school crossings.

Figure 8. Example of Dynamic No Right Turn Sign (can be included on red phase)

Source: Flickr 2018

Figure 9. MUTCD R10-11 Sign



Source: Traffic Signs

Centerline Hardening

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian and Bicycle	Pedestrian Crashes	N/A	N/A	N/A	Y

What is it?

The Basic Hardened Centerline treatment consists of five pieces of rubber curb and bollards and/or rubber speed bumps installed on the centerline and extending at maximum of six feet into the intersection. This is a turn calming treatment that addresses intersections with left and right turns.

The Complete Hardened Centerline treatment includes five pieces of rubber curb and bollards and/or rubber speed bumps, "No Parking" markings and slow turn wedge/box markings coupled with flexible plastic posts.

What are some considerations for use?

A Basic Hardened Centerline treatment is installed where one-way or two-way road meets at two-way road. A Complete Hardened Centerline treatment is installed where one-way road meets a two-way road.

Figure 10. Basic Centerline Hardening

Source: NYC.GOV

Source: Kittelson

Convert Intersection to Roundabout (from Signal)

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
All	Signalized Local/Arterial Intersections	35-67%	100%	$ - $$$	N

What is it?

This treatment consists of installing a roundabout as traffic control at an intersection. A roundabout is a type of circular intersection without traffic signals or stop signs, where drivers travel counterclockwise around a center island. When entering the roundabout, drivers yield to existing traffic, then enter the intersection and exit in their desired direction. Roundabouts are designed to eliminate left turns by requiring traffic to exit to the right of the circle. Roundabouts are installed to manage vehicular speeds through the intersection, improve safety at intersections by eliminating broadside and head-on crashes, and help traffic flow more efficiently.

What are some considerations for use?

This treatment may be considered at any intersection with a high frequency of reported crashes, traffic delays, complex geometry (more than four approach roads), frequent left-turns, and/or relatively balanced traffic flows.

Roundabouts work well for intersections with low-to-moderate traffic speeds, and lower traffic volumes. Per the NCHRP 672: Roundabout Informational Guide, the typical daily service volumes for four-leg roundabouts are as follows:

- Up to 15,000 veh/day for a mini-roundabout with desirable entry design speed of 15-20 mph,
- Up to 25,000 veh/day for a single-lane roundabout with desirable entry design speed of 20-25 mph, and,
- 25,000 – 45,000 veh/day for a multi-lane roundabout (2-lane entry) with desirable entry design speed of 25-30 mph.

Figure 11. Example of Roundabout

Source: Kittelson

CONSPICUITY TREATMENTS

Countermeasure	Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Install flashing beacons as advance warning (Signalized Intersection)	Rear-end, Broadside	Signalized Local/Arterial Intersections	30%	100%	$ - $$	Y
Install raised pavement markers and striping (Through Intersection)	Wet, Night, All	Nighttime Safety, Signalized Local/Arterial Intersections, Driver Behavior	10%	100%	$	Y

Install Flashing Beacons as Advance Warning

What is it?

Flashing beacons are highway traffic signals operates in a flashing mode. This treatment leads to increased driver awareness of an approaching signalized intersection and an increase in the driver's time to react. Driver awareness of both downstream intersections and traffic control devices is critical to intersection safety. Crashes often occur when the driver is unable to perceive an intersection, signal head or the back of a stopped queue in time to react. Advance flashing beacons can be used to supplement and improve driver attention to intersection control signs. Most advance warning flashing beacons can be powered by solar, thus reducing the issues relating to power source.

What are some considerations for use?

Flashing beacons should be used at signalized intersections with crashes that are a result of drivers being unaware of the intersection or are unable to see the traffic control device in time to comply.

Figure 12. Example of Flashing Beacons as Advance Warning

Source: Kittelson

Install Raised Pavement Markers and Striping

What is it?

Raised pavement markers and striping through the intersection can clarify the preferred path of travel through the intersection to help avoid potential conflicts. Providing more effective guidance through an intersection will minimize the likelihood of a vehicle leaving its appropriate lane and encroaching upon an adjacent lane. This treatment should be used where signalized intersection footprints are large, skewed, or have multiple turn lanes for a given movement.

What are some considerations for use?

Raised pavement markers and striping should be used where signalized intersection footprints are large, skewed, or have multiple turn lanes for a given movement. They are most effective at intersections where the lane designations are not clearly visible to approaching motorists and/or intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection.

Figure 13. Example of Raised Pavement Markers and Striping

Source: Traffic Works

PEDESTRIAN/BICYCLE TREATMENTS

Install Pedestrian Countdown Signal Heads

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	25%	100%	$	Y

What is it?

Pedestrian countdown signals contain a timer display and count down the number of seconds left to finish crossing the street. Countdown signals can reassure pedestrians who are in the crosswalk when the flashing "DON'T WALK" interval appears that they still have time to finish crossing. Countdown signals begin counting down either when the "WALK" or when the flashing "DON'T WALK" interval appears and stop at the beginning of the steady "DON'T WALK" interval. These signals also have been shown to encourage more pedestrians to use the pushbutton rather than cross illegally.

What are some considerations for use?

This treatment may be considered at signals that have signalized pedestrian crossing with "WALK"/"DON'T WALK" indicators and where there have been pedestrian crashes.

Figure 14. Example of Pedestrian Countdown Signal Head

Source: Maricopa Association of Governments

Install Pedestrian Crossing

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	25%	100%	$	Y

What is it?

This treatment alerts drivers and enhances pedestrian and bicycle safety at pedestrian crossings. Installing pedestrian crossings at intersections can improve pedestrian and bicycle safety by designating a dedicated portion of the roadway for pedestrian and bicycle crossing. This helps to reduce pedestrian-related crashes that occur within 50 feet of an intersection. The use of high-visibility crosswalk markings, pedestrian countdown signals, and appropriate signs can enhance pedestrian and bicycle safety at pedestrian crossings.

What are some considerations for use?

This treatment may be considered at signalized intersections with no marked crossing and pedestrian signal heads, where pedestrians are known to be crossing intersections that involve significant turning movements. They are especially important at intersections with (1) multiphase traffic signals, such as left-turn arrows and split phases, (2) school crossings, and (3) double-right or double-left turns. At signalized intersections, pedestrian crossings are often safer when the left turns have protected phases that do not overlap the pedestrian walk phase. Caltrans HSIP does not provide reimbursement for visibility enhancements to existing marked crosswalks at signalized intersections. However, such improvements (like restriping transverse lines as high-visibility crosswalks) still provide visibility benefit and are worth consideration.

Figure 15. Example of Pedestrian Crossing at a Signalized Intersection

Source: NACTO

Install Pedestrian Scramble

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	40%	100%	$	Y

What is it?

This treatment allows pedestrian movements in all directions simultaneously, including diagonally. This is a traffic signal operation that functions differently than a standard signal operation because it allows for an exclusive pedestrian phase, i.e., all pedestrians to cross in any direction while all vehicles are stopped.

What are some considerations for use?

Pedestrian scrambles may be implemented along with No Right Turn on Red treatment at intersections with high pedestrian volumes.

Figure 16. Example of Pedestrian Scramble

Source: Wall Street of the Rockies

Install Advance Stop Bar before Crosswalk (Bicycle Box)

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	15%	100%	$	Y

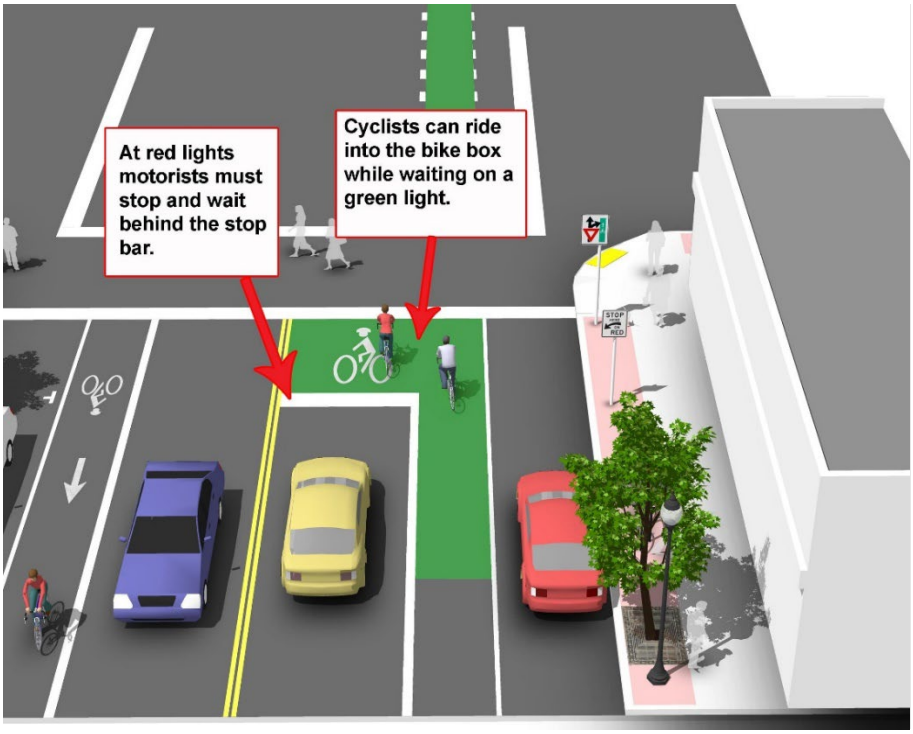
What is it?

Adding advance stop bar before the striped crosswalk has the opportunity to enhance both pedestrian and bicycle safety. Stopping cars well before the crosswalk provides a buffer between the vehicles and the crossing pedestrians. It also allows for a dedicated space for cyclists, making them more visible to drivers (This dedicated space is often referred to as a bike-box.)

What are some considerations for use?

This treatment should be used at signalized intersections with a marked crossing, where significant bicycle and/or pedestrians volumes are known to occur.

Figure 17. Diagram of Advance Stop Bar Before Crosswalk and Bike Box



Source: BikePGH

Modify Signal Phasing to Implement a Leading Pedestrian Interval (LPI)

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	60%	100%	$	Y

What is it?

LPIs provide pedestrians a head start when crossing at a signalized intersection. LPIs can be easily programmed into existing signals to give pedestrians the "Walk" signal a minimum of 3 to 7 seconds before motorists are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before motorists have priority to turn left at the intersection. LPIs can be provided automatically with each phase or provided only when actuated (actively or passively). LPIs increase visibility of crossing pedestrians and reduce conflicts between pedestrians and vehicles. This treatment increases the likelihood of motorists yielding to pedestrians.

What are some considerations for use?

LPIs may be considered at signalized intersections, specifically at intersections with medium to high motor vehicle turning volumes and pedestrian volumes. LPIs may be considered at locations with particularly high elderly populations, high crash history, or at school crosswalks.

Figure 18. Example of Leading Pedestrian Interval

Source: Go Active Long Beach

Painted Safety Zone

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	N/A	N/A	$	Y

What is it?

Painted safety zones provide a low-cost curb extension that improves pedestrian safety at intersection corners in three ways:

- Creating distance between turning vehicles and waiting pedestrians
- Slowing vehicle turning movements
- Improve visibility between drivers and crossing pedestrians

What are some considerations for use?

Painted safety zones do not extend the sidewalk or create a formal waiting area but do provide low-cost improvements wherever vehicles are turning across pedestrian or bicyclist paths. Verify vehicle turn templates for vehicles expected to make turns at the treatment intersection.

Figure 19: Example Painted Safety Zone

Source: SFMTA

Protected Intersection Elements

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes, Signalized Local/Arterial Intersections	N/A	N/A	$ - $$$	Y

What is it?

The elements that form what is commonly called a "protected intersection" combine to achieve the following design goals:

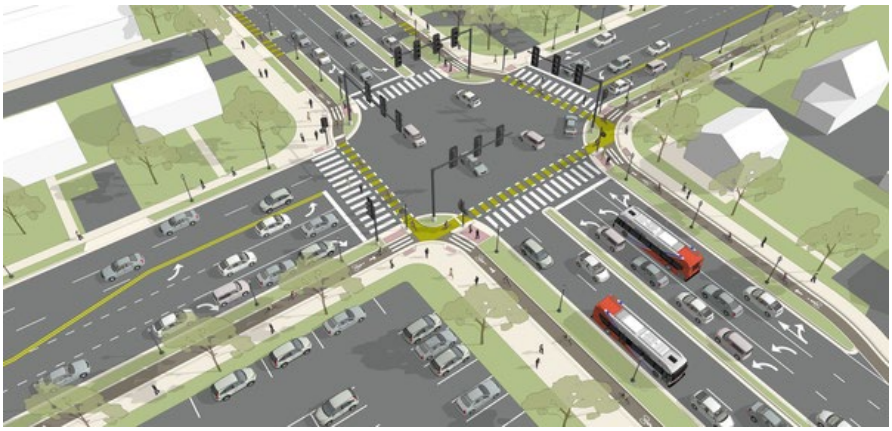
Protected Intersection Element	Design Outcome
Bicycle lane extension through intersections (see "A" in Figure 20b)	Improve bicyclist and pedestrian visibility to turning drivers
Bicycle signals and signal phasing, including Leading Bicycle/Pedestrian Interval (LBI/LPI)	Improve bicyclist and pedestrian visibility to turning drivers Separate modal movements in time by giving bicyclists and pedestrians a "head start" when the signal turns green
Curb extensions and curb radius reductions (see "B" in Figure 20b)	Shorten crossing distance for bicyclist and pedestrians Improve bicyclist and pedestrian visibility to turning drivers Reduce vehicle speeds
Two-stage bicycle turn box (see "C" in Figure 20b)	Simplify left-turn movement and reduce conflicts between bicyclists and motor vehicles
High visibility crosswalk markings (see "D" in Figure 20b)	Improve crossing conspicuity
No Turn on Red signs	Eliminate conflicts between turning motor vehicles and pedestrians/bicyclists

What are some considerations for use?

Protected intersection elements are applicable at both signalized and unsignalized intersections. Some elements are eligible for HSIP funding:

- S21PB: Leading pedestrian intervals
- R33PB: Install separated bicycle lanes (if bicycle lanes do not already exist in the location)

Figure 20: Example Protected Intersections



(a) Concept Visualization

(b) Paseo Padre Parkway/Walnut Avenue, Fremont, California.

Source: Kittelson & Associates, Inc; Google Earth

UNSIGNALIZED INTERSECTIONS

This section presents recommended engineering countermeasures at unsignalized intersections in Dublin.

Table 2: Summary of Unsignalized Intersection Countermeasures and Related Information

Countermeasure Name	CM ID*	Documented Crash Reduction Factor**	Federal Funding Eligibility through HSIP***	Cost Estimate[t]	Emphasis Area	Page Reference
Add intersection lighting	NS01	40%	100%	$	Nighttime Safety	3
Create directional median openings to allow (and restrict) left-turns and u-turns	NS15	50%	90%	$ - $$	Pedestrian Crashes	9
Install painted safety zone	N/A	N/A	N/A	$	Pedestrian Crashes, Signalized Local/Arterial Intersections	20
Install raised medians (refuge islands)	NS19PB	45%	90%	$	Pedestrian Crashes	24
Install pedestrian crossing at uncontrolled locations	Varies. See page references.	Varies. See page references.	Varies. See page references.	$ - $$$	Varies. See page references.	25
Non-Signalized Intersection Conspicuity Treatments	Varies. See page references.	Varies. See page references.	Varies. See page references.	$ - $$$	Varies. See page references.	26
Install transverse rumble strips on approaches	NS10	20%	90%	$	Driver Behavior	29
Install splitter islands on the minor road approaches	NS13	40%	90%	$	Driver Behavior	30

*CM ID refers to the Countermeasure ID from the Caltrans *Local Roadway Safety Manual (April 2020).*

**Documented crash reduction factors are derived either from the Caltrans *Local Roadway Safety Manual April 2020) or the* FHWA's *Proved Safety Countermeasures* resource, unless otherwise noted.

***Funding eligibility indicates the designated federal contribution level for approved HSIP projects in California associated with Caltrans HSIP Cycle 9. This is subject to change from one cycle to the next and should be confirmed with the state HSIP coordinator.

ŧ $ - $50,000 or less; $$ - $50,000 to $100,000; $$$ - $100,000 or more

Install Raised Medians (Refuge Islands)

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian & Bicycle	Pedestrian Crashes	45%	100%	$	Y

What is it?

A pedestrian refuge island is a median with a refuge area that is intended to help protect pedestrians who are crossing the roadway. A refuge island allows the pedestrians to focus on identifying adequate gap in traffic for one direction at a time. This treatment reduces the crossing distance for pedestrians and creates a place for refuge to allow multiple-stage crossings. Refuge island positions pedestrians in the sightline of drivers approaching the intersection. This treatment could also be used as a retrofit opportunity for roads that have medians that do not provide an adequate refuge.

What are some considerations for use?

Per the FHWA *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations*, refuge islands may be considered under the following roadway conditions: [1]

- Any ADT + 2 or 3 lanes (without a raised median) + any posted speed limit
- ADT ≥ 9,000 + 4 or more lanes (without a raised median) + any posted speed limit
- Any ADT + 4 or more lanes (without a raised median) + ≥ 35 mph posted speed limit

This treatment may be considered at locations with inadequate conspicuity/visibility of the crosswalk and/or crossing pedestrian, excessive vehicle speed, or lack of pedestrian separation from traffic during long crossings.

Figure 21. Example of Pedestrian Refuge Island

Source: NACTO

Figure 22. Example of Median (not a Refuge Island)

Source: Naples News

[1] Source: Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations (dot.gov)

Install Pedestrian Crossing at Uncontrolled Locations

Countermeasure	Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Signs and markings only	Pedestrian & Bicycle	Pedestrian Crashes	25%	100%	$	Y
With enhanced safety features	Pedestrian & Bicycle	Pedestrian Crashes	35%	100%	$ - $$$	Y

What is it?

Signs and markings only—Pavement markings delineate a portion of the roadway that is designated for pedestrian crossing. These markings will often be different for controlled versus uncontrolled locations. The use of high-visibility crossing patterns ("ladder" or "zebra" style) at uncontrolled crossings can increase both pedestrian and driver awareness to the increased exposure at the crossing.

With enhanced safety features—Enhanced safety features include flashing beacons, curb extensions, advanced "stop" or "yield" markings, and other safety features.

- **Flashing beacons** are added at crossings under the pedestrian sign. When a pedestrian crosses the street, the lights flash, alerting drivers to yield before the intersection.
- **Curb extensions** are an extension of the sidewalk zone or curb line into the roadway zone at intersections. Curb extensions are intended to increase safety, calm motorized traffic, and create additional space for pedestrians and the boulevard and furnishing zone.
- **Advance yield/stop line** include the stop bar or "sharks teeth" yield markings placed 20 to 50 feet in advance of a marked crosswalk to indicate where vehicles are required to stop.

What are some considerations for use?

Both these treatments should be used at non-signalized intersections without a marked crossing, where pedestrians are known to be crossing intersections that involve significant vehicular traffic. They are especially important at school crossings and intersections with right and/or left turns pockets.

Figure 23. Example of a High Visibility Pedestrian Crossing

Source: NACTO

Figure 24. Example of a Curb Extensions and Advanced Stop Bar

Source: Move Culver City

CONSPICUITY TREATMENTS

Countermeasure	Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Install/upgrade larger or additional stop signs or other intersection warning or regulatory signs	Rear-end, right-angle, or turning crashes related to lack of driver awareness	Driver Behavior	15%	100%	$	Y
Upgrade intersection pavement markings	Rear-end, right-angle, or turning crashes related to lack of driver awareness	Driver Behavior	25%	100%	$	Y
Install Pedestrian Signal or Pedestrian Hybrid Beacon	Pedestrian and Bicycle	Pedestrian Crashes	55%	100%	$$$	N

Install/Upgrade Larger or Additional Stop Signs or Other Intersection Warning/Regulatory Signs

What is it?

Installing larger warning or regulatory signs at or in advance of an intersection can increase the visibility of the intersection, thereby increasing the ability of approaching drivers to perceive the intersection. The effectiveness of this strategy is greatest when implementation involves a combination of regulatory and warning signs appropriate for the conditions on an unsignalized intersection approach.

What are some considerations for use?

Signs should be used at approaches to unsignalized intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection. A key to success in applying this strategy is to select a combination of regulatory and warning sign techniques appropriate for the conditions on a particular unsignalized intersection approach.

Figure 25. Example of Warning Signs

Source: ITE

Upgrade Intersection Pavement Markings

What is it?

Upgrades to intersection pavement markings include "Stop Ahead" markings and the addition of centerlines and stop bars for stop-controlled approaches. Providing visible stop bars and clearer delineation of lanes on minor road approaches to unsignalized intersections can help direct the attention of drivers to the presence of the intersection.

What are some considerations for use?

Upgraded intersection pavement markings should be used at unsignalized intersections that are not clearly visible to approaching motorists, particularly approaching motorists on the major road. The strategy is particularly appropriate for intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection. They are also effective at minor road approaches where conditions allow the stop bar to be seen by an approaching driver at a significant distance from the intersection.

Figure 26. Example of Upgraded Intersection Pavement Markings

Source: City of San Antonio Public Works Department

Install Pedestrian Signal (Including Pedestrian Hybrid Beacon [HAWK])

What is it?

A Pedestrian Hybrid Beacon (PHB) is a hybrid beacon used to control traffic and reverts to all dark until a pedestrian activates it via a push button or other form of detection. When activated, the beacon displays a sequence of flashing and solid lights that indicate when vehicles must stop and when pedestrians should cross. PHBs provide active warning to drivers when a pedestrian is in the crosswalk. PHBs have been shown to significantly increase driver yielding behavior at uncontrolled crosswalks, with motorist yielding rates exceeding 90% (FHWA, 2014).

What are some considerations for use?

Pedestrian Hybrid Beacons may be considered at locations with long pedestrian delay due to few available gaps in traffic, drivers not yielding to pedestrians in crosswalks, or noted conflicts at crossing locations.

Figure 27. Example of Pedestrian Hybrid Beacon

Source: FHWA

Install Transverse Rumble Strips or Optical Speed Bars on Approaches

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
All	Driver Behavior	20%[1]	90%[1]	$[1]	Y

1: Information presented relates to transverse rumble strips.

What is it?

Transverse rumble strips are installed in the travel lane for the purposes of providing an auditory and tactile sensation for each motorist approaching the intersection. They can be used at any stop or yield approach intersection, often in combination with advance signing to warn of the intersection ahead.

Optical speed bars are transverse bars are spaced progressively closer together at an increasing rate as the driver travels along the roadway. The intent is that the reduced spacing gives the driver the perception of acceleration, causing the driver to slow down.

What are some considerations for use?

Transverse rumble strips may generate noise generated by vehicles driving over them, so care must be taken to minimize disruption to nearby residences and businesses.

Figure 28. Example of Transverse Rumble Strips

Source: Vision Zero North Dakota

Figure 29. Example of Optical Speed Bars

Source: Speed Reduction Mitigation Strategies on Rural Highways at Two-Way Stop Control Intersections and Curves

Install Splitter Islands on the Minor Road Approaches

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Broadside, Rear-end	Driver Behavior	40%	90%	$	N

What is it?

This treatment consists of adding a raised median island at minor street intersection approaches. Raised splitter islands create a physical separation between vehicles turning onto the stop-controlled approach and vehicles stopped on that same approach. The splitter island also increases the visibility of the intersection, clarifies movements at the intersection, and provides a space for a secondary stop sign on the approach, if desired.

What are some considerations for use?

Splitter islands may be considered when high frequencies of crashes are related to conflicting movements resulting from movements onto or off minor street approaches. Splitter islands should also be designed to accommodate appropriate design vehicles while still being large enough to be visible to drivers and provide a refuge area for crossing pedestrians.

Figure 30. Example of Splitter Island on Minor Road Approach

Source: FHWA

ROADWAYS

This section presents recommended engineering countermeasures along roadways in Dublin.

Table 3: Summary of Roadway Intersection Countermeasures and Related Information

Countermeasure Name	CM ID*	Documented Crash Reduction Factor	Federal Funding Eligibility through HSIP***	Cost Estimate	Emphasis Area	Page Reference
Add lighting	R01	35%	100%	$	Nighttime Safety	32
Road diet (Reduce travel lanes from 4 to 3 and add a two way left-turn and bike lanes)	R14	30%	90%	$	Pedestrian Crashes	32
Corridor access management[1]	N/A	Varies.	N/A	$ - $$$	Pedestrian Crashes	34
Install edgeline rumble strips/stripes	R31	15%	100%	$-$$$	Driver Behavior	35
Install separated bike lanes	R33PB	45%	90%	$ - $$	Bicycle Crashes	36
Crosswalk visibility enhancements	Varies. See page reference.	Varies. See page reference.	Varies. See page reference.	$ - $$$	Varies. See page reference.	37
Roadway/intersection approach conspicuity treatments	Varies. See page reference.	Varies. See page reference.	Varies. See page reference.	$ - $$	Driver Behavior	39
Speed management treatments[1]	Varies. See page reference.	Varies. See page reference.	Varies. See page reference.	$	Driver Behavior	42

[1]Countermeasure not included in LRSM.

*CM ID refers to the Countermeasure ID from the Caltrans *Local Roadway Safety Manual (April 2020).*

**Documented crash reduction factors are derived either from the Caltrans *Local Roadway Safety Manual April 2020) or the* FHWA's *Proved Safety Countermeasures* resource, unless otherwise noted.

***Funding eligibility indicates the designated federal contribution level for approved HSIP projects in California associated with Caltrans HSIP Cycle 9. This is subject to change from one cycle to the next and should be confirmed with the state HSIP coordinator.

Add Segment Lighting

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Nighttime	Nighttime Safety	35%	100%	$	Y

What is it?

Providing roadway lighting improves the safety during nighttime conditions by (1) making drivers more aware of the surroundings, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances to perceive roadway characteristic in advance of the change, and (3) improving non-motorist's visibility and navigation. Segment lighting improvements may be considered at segments with patterns of rear-end, right-angle, turning or roadway departure crashes on the roadways may indicate that night-time drivers can be unaware of the roadway characteristics.

What are some considerations for use?

These treatments may be considered at locations with substantial patterns of nighttime crashes. Patterns of rear-end, right-angle, turning or roadway departure collisions on the roadways may indicate that night-time drivers can be unaware of the roadway characteristics.

Figure 31. Example of Roadway Segment Lighting

Source: Pensacola Voice

Road Diet

(reduce travel lanes from 4 to 3 and add a two way left-turn and bike lanes)

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Head-on, Hit object, Unsafe Speed	Pedestrian Crashes	30%	90%	$	N

What is it?

Road diets reduce the number of travel lanes on the roadway and provide space to implement pedestrian and bicyclist related treatments including adding bike lanes, and median crossing islands. The most common road diet configuration involves converting a four-lane roadway into three travel lanes (with one lane in each direction and a two-way left-turn lane), often supplemented with bike lanes. Figure 12 shows an example of road diet, i.e., reconfiguration of the roadway. Road Diets are intended to improve access management, increase pedestrian and bicyclist access, and enhance roadway safety.

What are some considerations for use?

Road diets may be considered for application at priority pedestrian and bicycle routes or in urban and suburban areas with multilane roadways.

This treatment may be considered when any of the following factors are observed on site:

- Presence of left-turning conflicts between bicyclists and motor vehicles; or
- Desire to better accommodate pedestrian and bicycle travel.

Figure 32. Example of Road-Diet (Roadway Cross-Section Before and After Reconfiguration)

Source: Victoria Transport Policy Institute

Corridor Access Management

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian and Bicycle, All	Pedestrian Crashes	Varies.	N/A	$ - $$$	Y

What is it?

Access management refers to the design, application, and control of entry and exit points along a roadway. This includes intersections with other roads and driveways that serve adjacent properties. Thoughtful access management along a corridor can simultaneously enhance safety for all modes, facilitate walking and biking, and reduce trip delay and congestion.

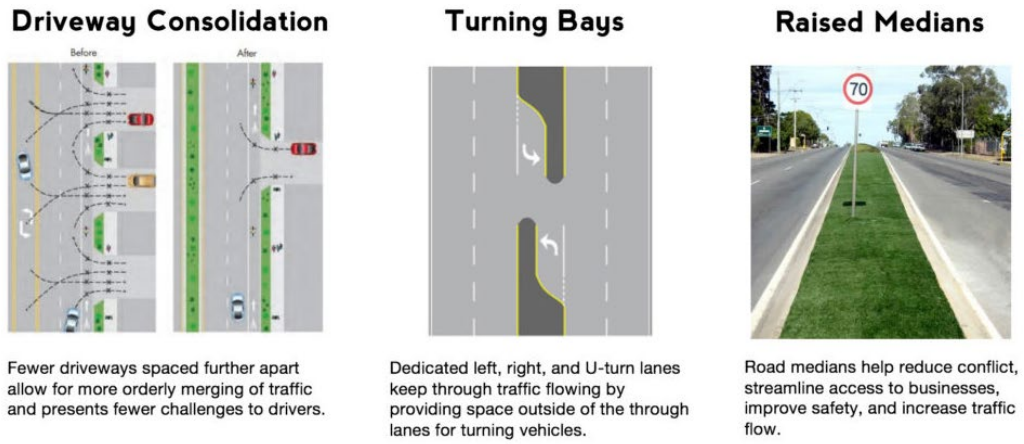
The following access management strategies can be used individually or in combination with one another:

- Reduce density through driveway closure, consolidation, or relocation.
- Manage spacing of intersection and access points. Limit allowable movements at driveways (such as right-in/ right-out only).
- Place driveways on an intersection approach corner rather than a receiving corner, which is expected to have fewer total crashes.
- Implement raised medians that preclude across-roadway movements.
- Utilize designs such as roundabouts or reduced left-turn conflicts (such as restricted crossing U-turn, median U-turns, etc.).
- Provide turn lanes (i.e., left-only, right-only, or interior two-way left).
- Use lower speed one-way or two-way off-arterial circulation roads.

What are some considerations for use?

Successful corridor access management involves balancing overall safety and mobility for all users along with the needs of adjacent land uses.

Figure 33. Access Management Strategies.



Source: FHWA

Install Edgeline Rumble Strips/Stripes

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Run-off Road, Hit Object	Driver Behavior	15%	100%	$ - $$$	Y

What is it?

Edgeline rumble strips alert drivers that are drifting out of their travel lane before they depart the roadway, providing the driver time to correct and stay in their lane. The Caltrans Local Roadway Safety Manual recommends installing rumble strips along an entire corridor, instead of just in certain spots. Rumble stripes –so called when the pavement marking is in the rumble strip—provide enhanced marking in wet or dark conditions.

What are some considerations for use?

Edgeline rumble strips may have special requirements when installing in locations with residential land uses related to noise. If bicyclists are expected to ride in proximity of the edgeline, stripes should be used to provide for bicyclist comfort and safety.

Figure 34. Example of Edgeline Rumble Strips

Source: FHWA

Install Separated Bike Lanes

Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Pedestrian, Bicycle	Driver Behavior	45%	90%	$ - $$	Y

What is it?

Separated bike lanes can range from painted buffers and flexible delineators to raised curbs, grade separation, and parking lanes. Separated bike lanes are the most appropriate in urban and suburban areas, on roadways with high volumes of bicycle traffic, or where a high number of bike-vehicle collisions have occurred.

What are some considerations for use?

The cost of the treatment can be low to high, depending on whether roadway widening, right of way, or environmental impacts are involved. Treatments should also include signage and markings directing cyclists to appropriate paths, and for motorized users to be aware of where bicyclists are traveling.

Figure 35. Example of Separated Bike Lane

Source: Kittelson & Associates, Inc.

CROSSWALK VISIBILITY ENHANCEMENTS

Countermeasure	Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Install/upgrade pedestrian crossing (with enhanced safety features)	Pedestrian and Bicycle	Pedestrian Crashes	35%	100%	$$ - $$$	Y
Install raised pedestrian crossing	Pedestrian and Bicycle	Pedestrian Crashes	35%	90%	$	Y

Install/Upgrade Pedestrian Crossing (with Enhanced Safety Features)

What is it?

This treatment should be used at roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multi-lane roads locations. Adding pedestrian crossings has the opportunity to greatly enhance pedestrian safety. The enhanced safety elements, which may include curb extensions, medians and pedestrian crossing islands, beacons, and lighting, combined with pavement markings delineating a portion of the roadway that is designated for pedestrian crossing.

What are some considerations for use?

When installing or upgrading a pedestrian crossing with enhanced safety features, care must be taken to warn drivers of the potential for pedestrians crossing the roadway and enhanced improvements added to the crossing increase the likelihood of pedestrians crossing in a safe manner. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including sign and markings directing pedestrians and cyclists on appropriate/legal travel paths and signs.

Figure 36. Example of Enhanced Mid-Block Crossing

Source: NACTO

Install Raised Pedestrian Crossing

What is it?

Raised crossings are a vertical traffic control measure that can reduce vehicle speeds, improve pedestrian visibility to approaching drivers, and improve pedestrian and bicyclist crossing safety by improving drivers yielding. The raised crossing encourages drivers to reduce their speed and provides improved delineation for the portion of the roadway that is designated for pedestrian crossing. Signs and markings directing pedestrians and cyclists on appropriate travel paths should be used in combination with this countermeasure.

What are some considerations for use?

In combination with installing a raised pedestrian crossing, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including sign and markings directing pedestrians and cyclists on appropriate/legal travel paths.

Figure 37. Example of Raised Pedestrian Crossing

Source: PedBikeSafe

ROADWAY DEPARTURE TREATMENTS

Countermeasure	Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Remove or relocate fixed objects outside of Clear Recovery Zone	Hit Object	Driver Behavior	35%	90%	$ - $$	Y
Install delineators, reflectors and/or object marker	All	Driver Behavior	15%	100%	$	Y
Install/upgrade signs with new fluorescent sheeting (regulatory or warning)	Head-on, Run-off Road, Sideswipe, Night	Nighttime Safety, Driver Behavior	15%	100%	$	Y

Remove or Relocate Fixed Objects Outside of Clear Recovery Zone

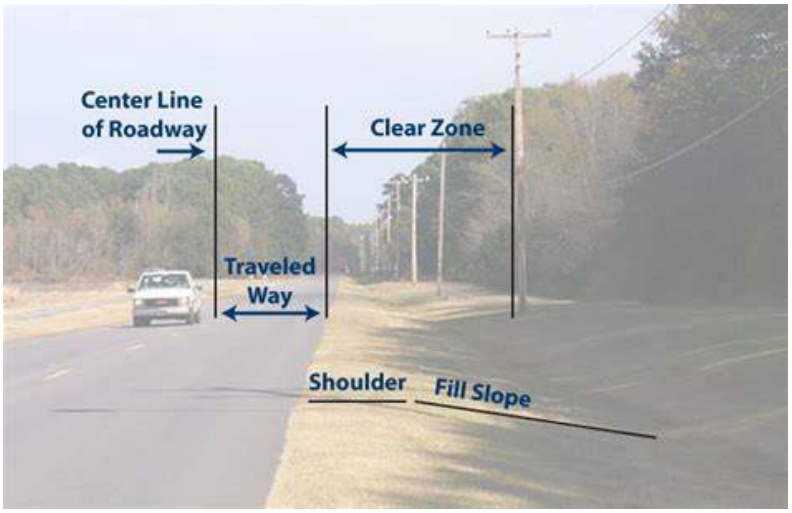
What is it?

Removing or relocating roadside fixed objects such as utility poles, drainage, trees, or other fixed objects provides a clear recovery zone that allows drivers to correct their path of travel when they leave the roadway. This treatment is particularly effective outside of curves, along lane drops and in traffic islands where fixed object crashes are more common. A clear recovery zone should be developed on more rural context roadways, as space is available.

What are some considerations for use?

A clear recovery zone should be developed on every roadway, as space is available. In situations where public right-of-way is limited, steps should be taken to request assistance from property owners, as appropriate.

Figure 38. Example of Clear Recovery Zone



Source: United States Army

Install Delineators, Reflectors and/or Object Marker

What is it?

This treatment consists of adding delineators, reflectors, or object markers on the approach and through a horizontal curve. Delineators, reflectors, and object markers provide drivers with a visual cue of the approaching horizontal curve and help drivers navigate safely through the curve.

What are some considerations for use?

Delineators, reflectors and object markers may be considered at any horizontal curve where visibility of the approaching curve is limited or providing guidance through the curve via delineation may provide safety benefits. These treatments may be considered when high frequencies of run-off-road crashes related to a horizontal curve are identified.

Figure 39. Example of Roadside Delineators

Source: Pathmark Traffic Products

Install/Upgrade Signs with New Fluorescent Sheeting (Regulatory or Warning)

What is it?

Installing and/or or upgrading signs with fluorescent sheeting provides drivers with a visual warning of the presence of a specific roadway feature or regulatory requirement that they may have missed with existing signs. This treatment is appropriate on roadway segments with a history of head-on, nighttime, non-intersection, run-off road, and sideswipe crashes.

What are some considerations for use?

New fluorescent sheeting should be installed in combination with additional treatments such as installing or adding chevrons, warning signs, delineators, markers, beacons, and relocating existing signs.

Figure 40. Example of Fluorescent Sign

Source: 3M

SPEED MANAGEMENT TREATMENTS

Countermeasure	Crash Types Addressed	Emphasis Areas Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate	Ideal for Systemic Application?
Install dynamic speed warning signs	All	Driver Behavior	30%	100%	$	Y
Variable speed limit	Winter crashes (October - March)	Driver Behavior	31.6%[3]	N/A	N/A	N
Appropriate speed limit for all users	All	Pedestrian Crashes, Driver Behavior	Varies.	N/A	N/A	Y

Install Dynamic Speed Warning Signs

What is it?

This treatment consists of installing dynamic speed feedback signs on the roadway. Speed feedback signs provide drivers with feedback about their speed in relationship to the posted speed limit.

What are some considerations for use?

Dynamic speed warning signs may be considered on roadways that have higher incidence of crashes due to excessive speeds, and on relatively sharp curves.

Figure 41. Example of Dynamic Speed Warning Signs

Source: Radar Sign

Appropriate Speed Limit for All Users

What is it?

Posted speed limits are often the same as the legislative statutory speed limit. Agencies with designated authorities to set speed limits, which include States, and sometimes local jurisdictions, can establish non-statutory speed limits or designate reduced speed zones, and a growing number are doing so. Based on international experience and implementation in the United States, the use of 20 mph speed zones or speed limits in urban core areas where vulnerable users share the road environment with motorists may result in further safety benefits. California Assembly Bill 43, passed in 2021, allows local jurisdictions to reduce speed limits in key areas.

What are some considerations for use?

When setting appropriate speed limits**,** agencies should consider a range of factors such as pedestrian and bicyclist activity, crash history, land use context, intersection spacing, driveway density, roadway geometry, roadside conditions, roadway functional classification, traffic volume, and observed speeds. To achieve desired speeds, agencies often implement other speed management strategies concurrently with setting speed limits, such as self-enforcing roadways, traffic calming, and speed safety cameras.

APPENDIX D:
STRATEGY TOOLBOX

STRATEGY TOOLBOX

This section presents available non-engineering solutions to improve safety on local roadways in Dublin. The strategies require a champion either among, or in coordination with, City staff. The Local Roadway Safety Plan includes recommendations for how these strategies may be implemented, in recognition that

EDUCATION STRATEGIES

To build a culture of safety, the public must have access to traffic safety information. Public education and collaboration help bridge gaps in knowledge that influence roadway user behavior. The following strategies provide opportunities to educate and learn from the community:

EDUCATION CAMPAIGNS

Roadway safety education programs help people develop safer driving habits, learn how to take alternative modes of transportation, and have a deeper understanding of municipal laws.

Key topics for education programs include:

- Roadway safety for children
- Young driver safety
- Vulnerable roadway user safety
- Dangers of impaired driving
- Dangers of distracted driving (e.g., using cell phones and text messaging while driving)

Several organizations offer specialized educational training programs:

- American Association of Retired Persons (AARP) resources and courses: https://www.aarp.org/auto/driver-safety/
- CarFit program sponsored by American Automobile Association (AAA), AARP, and the American Occupational Therapy Association (AOTA): https://www.car-fit.org/

Potential partners: Dublin Unified School District, California Department of Motor Vehicles, Alameda County Department of Public Health, local community organizations (e.g., Bike East Bay, Community for Independent Living), City of Dublin Public Information Office, Dublin Police Services

TRANSPORTATION SAFETY CAMPAIGN

Designed to dovetail with community education efforts, transportation safety campaigns use strategic marketing, advertising, and engagement to foster community awareness of a shared responsibility for roadway safety. Successful messaging reaches audiences using a variety of approaches. Campaigns should be created in partnership with various community stakeholders, including other planning organizations and jurisdictions.

This section presents ideas for a Dublin transportation safety campaign that can be tailored to accommodate limited staff, resources, and budget.

Campaign Tools

Branding: A logo, font standards, and color palette help create a recognizable brand for print and digital products. The City of Dublin already has well established brand standards.

Social Media Strategy & Schedule: A social media campaign is a great way to reach target audiences. Different demographics use different platforms, so careful implementation can help agencies reach new groups. Social media strategy should use graphics, text, and a post release schedule to create a storyline that Dublin residents can follow and participate in.

Multimedia: Strong campaigns engage audiences through many types of media and events.

- **Print**—Campaign events should have ready-to-share print materials to engage interested stakeholders who may not have time to stick around and learn more.
- **Radio and Video**—Radio and video spots can help spread the word about a safety campaign.
- **School Resources**—School-based programs can help teach young people that their actions as roadway users have consequences that impact others.

Safety Messaging

Safety messages and infographics on posters and in social media can be tailored to identified safety emphasis areas. These messages link behavioral elements to safety performance trends and educate drivers to be alert and aware to help reduce these collision types. Each safety message should come with a supporting statistic that underscores why this safety message is important, and the larger campaign should provide a timeframe for when to publicize each safety message. This plan provides the supporting statistics that could be used in a campaign.

Figure 1: Example Safety Communications Graphic Developed for Tigard, Oregon

Implementation and Partnerships

Successful campaigns use supportive partnerships with jurisdictions, organizations, and individuals to share the messages throughout the community. Partnerships can help ensure campaign branding, tone, and materials clearly and correctly communicate safety messaging.

Potential partners: Dublin Unified School District, California Department of Motor Vehicles, Alameda County Department of Public Health, local active transportation organizations, Department of Public Information

EQUITABLE ENFORCEMENT STRATEGIES

Even with engineering countermeasures in place, road users can fail to obey traffic laws and cause crashes of varying severity. Police enforcement has been traditionally used as a strategy to increase driver awareness, educate drivers on roadway violations, and reduce traffic crashes.

However, if enforcement strategies are to improve overall safety in a community, traffic laws must be applied equitably. Directed enforcement strategies should be undertaken with due caution to avoid inequitable enforcement activities and be rigorously evaluated to determine the strategy's intent and impact.

Dublin Police Services leadership has diligently worked to ensure members of the organization demonstrate a commitment to modeling practices that are contemporary and at the forefront of the policing profession and traffic enforcement operations.

Dublin Police Services recognizes and fully embraces equity and prioritizes all traffic safety concepts and efforts for people or communities that have been marginalized by poverty and discrimination.

SPEED MONITORING TRAILERS

Speed monitoring devices can be used to improve road user behavior and decisions. This strategy was chosen due its applicability to the safety emphasis areas of driver behavior, particularly aggressive driving.

Portable speed trailers visually display a driver's real-time speed compared to the speed limit and may be effective at reducing speeds and increasing awareness of local speed limits. Portable speed trailers are also deployed to areas of Dublin that warrant traffic calming measures. These devices are most effective when the trailer flashes "SLOW DOWN" or flashes a bright white light that mimics a photo speed camera or a blue and red light that mimics a police car when drivers are moving too fast. In some cases, back-up speed enforcement by officers may be needed when radar speed trailers are used.

Potential partners: Dublin Police Services and local community organizations

Figure 2: Example Speed Monitoring Trailer

Source: PEDSAFE

PROGRESSIVE TICKETING

Progressive ticketing can be used to improve road user behavior and decision-making. This strategy was chosen due its applicability to the safety emphasis areas of driver behavior, particularly aggressive driving.

Issuing tickets has traditionally been used as the strongest strategy of an enforcement program and is usually reserved for changing unsafe behaviors that other strategies failed to change or that pose a real threat to road user safety. There are three main steps in an effective progressive ticketing program:

1. **Education**—Establish community awareness of the problem. The public needs to understand drivers are speeding and the consequences of this speeding for road safety. Raising awareness about the problem will change some behaviors and create public support for the enforcement efforts to follow. This is done through proactive enforcement initiatives.
2. **Warning**—Announce what action will be taken and why. It is common practice to allow the public time to change behaviors before ticketing starts. Fliers, signs, newspaper stories and official warnings from officers can all serve as reminders.
3. **Ticketing**—After the warning period, if offenders continue their unsafe behaviors, officers issue tickets.

It is inevitable that these enforcement initiatives increase interactions between law enforcement officers and community residents. Dublin Police Services is aware of the impact these interactions could have on community members experiencing poverty and discrimination and recognizes those sensitive circumstances and addresses them with the utmost professionalism.

Potential partners: Dublin Police Services, City of Dublin, and Department of Public Information Office

SPEED ENFORCEMENT IN SCHOOL ZONES

Speed enforcement in school zones can be used to improve driver behavior and decision-making. This strategy was chosen due its applicability to the safety emphasis areas of driver behavior, particularly aggressive driving.

Strict enforcement of speed laws in school zones is one law enforcement tool that can improve safety for children walking and bicycling to school and drivers. Potential approaches include a zero-tolerance policy for speeders in school zones and an increase in fines for drivers who violate the posted school zone speed limit.

Potential partners: Dublin Police Services

HIGH VISIBILITY SATURATION PATROLS

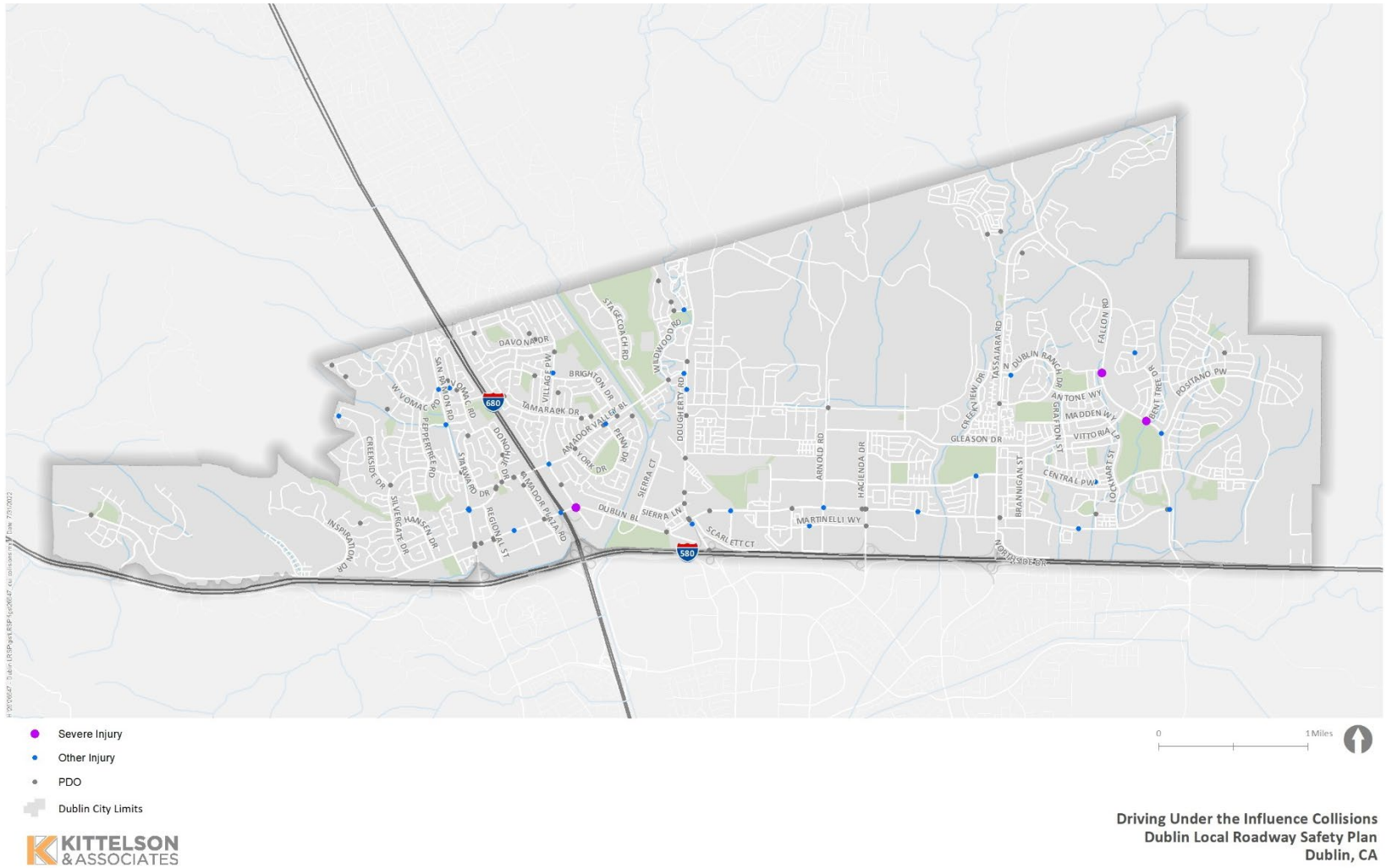
High visibility saturation patrols can be used to improve road user behavior and decision-making. This strategy was chosen due its applicability to the safety emphasis areas of driver behavior, particularly impaired driving.

A saturation patrol (also called a blanket patrol or dedicated driving while intoxicated (DWI) patrol) consists of many law enforcement officers patrolling a specific area, looking for drivers who may be impaired. These patrols usually take place at times and locations where impaired driving collisions commonly occur. Like publicized sobriety checkpoints, the primary purpose of publicized saturation patrols is to deter driving after drinking by increasing the perceived risk of arrest. The patrols can be paired with publicity around stepped-up enforcement efforts.

Figure 3 shows the location of Dublin collisions that involved the influence of drugs or alcohol.

Potential partners: Dublin Police Services, Department of Public Information Office

Figure 3: Driving Under the Influence Collisions



COLLISION VS. CITATION EVALUATION PROGRAMS

It is important to evaluate enforcement actions and to center social equity in doing so. Collision vs. citation evaluation programs are joint efforts between local government agencies and law enforcement to monitor and document the effectiveness of increased enforcement in lowering traffic collision rates at intersections.

In Dublin, a collision vs. citation evaluation strategy can assess whether enforcement strategies are effective and equitable. Disaggregating and evaluating collision and citation data by race and ethnicity will help promote an equitable approach to community safety and well-being.

FHWA and the US Department of Justice provide online resources for establishing a collision vs. citation program as part of a data-driven approach to traffic safety.

For more, see https://www.ojp.gov/library/publications/data-driven-approaches-crime-and-traffic-safety-ddacts-operational-guidelines.

Potential partner: Dublin Police Services

EVALUATING EDUCATION OR EQUITABLE ENFORCEMENT PROGRAMS

Quantifying campaign results can be difficult, but an execution and evaluation framework can help identify actions, recommendations, and opportunities for improvement. An evaluation framework will help track progress and aide future programs.

An evaluation framework can help capture how residents feel about a campaign, what resonated, and what opportunities for change exist. For example, the Fresno Council of Governments' transportation safety campaign *Safe Roads Save Lives* used a framework to help them understand whether audience behaviors changed, where the campaign was succeeding, and what aspects needed improvement (see Figure 4). Dublin could easily adapt this table to its programs.

Figure 4: Sample Evaluation Framework—Fresno's Safe Roads Save Lives Campaign

Part of Campaign	Evaluation Metrics	Evaluation Methods
Branding	• Brand/Campaign Recognition • Approval of Campaign Look/Style	• Intercept survey • Online survey
Social Media Strategy	• Intercept survey • Online survey	• Data counts • Tracking of jurisdiction, organizational, or individual participation
Print Materials	• Number of materials produced • Types of materials most requested • Location of material distribution • Language of materials requested	• Material inventory • Location tracking
Radio and Video Resources	• Creation of materials • Airtime	• Count of type of resource used • Survey of type of media where the resource was shared (e.g., genre of radio station, television program, etc.)
School Resources	• Number of participating schools • Types of resources used at each school	• School counts • Annuals surveys of schools
Overall Campaign	• Behavior change	• Before/after collision data • Survey of transportation stakeholders—law enforcement, jurisdictions, transportation advocates, etc.—on the efficacy of the campaign

Fresno Council of Governments Regional Safety Plan (2021), retrieved from https://www.fresnocog.org/project/2021-regional-safety-plan-local-road-safety-plan/.

EMERGENCY SERVICES

Whether a person survives a collision often depends on their access to medical care. Reaching a hospital within 60 minutes can significantly improve collision outcomes, and rural and remote areas or congestion can create additional delays for emergency response teams. Nearby hospitals (The San Ramon Regional Medical Center on Alcosta Bouelvard in San Ramon) (Stanford Health Care—ValleyCare on Santa Rita Road in Pleasanton) are regionally convenient but require of travel outside city limits.

The strategies in this section focus on partnerships with emergency medical services (EMS) that will improve regionwide response times and coordination by sharing real-time information.

PARTNER WITH LOCAL HOSPITALS OR OUTREACH GROUPS

At the collision site, bystanders are often the first people who can offer help. This is especially true in rural or remote areas. Organized through partnerships with local hospitals and outreach groups, public bystander training courses can help reduce severity outcomes. These courses educate community members on safe ways to help at the scene of a collision and can help people feel more comfortable giving aid in an emergency.

Potential partners: Alameda County Department of Public Health, Alameda County Fire Department

EMERGENCY SERVICES COORDINATION

Working with local hospitals and other stakeholders can help maximize efficiency with response times through evidence-based techniques, including

- Using registry data and EMS records to determine reasons for delay in transport for both ground and helicopter EMS
- Considering process improvement initiatives to increase EMS documentation and data collection
- Identifying equipment upgrades, training, or enhancements that would improve patient outcomes.

Potential partners: Alameda County Department of Public Health

COUNTY 911 TEAM COLLABORATION

Working with the local 911 team during project planning and design activities will help identify opportunities to improve EMS access and location identification. The 911 team will be key partners for enforcement strategies, EMS grant opportunities, and efforts to develop or modify a system that allows County 911 dispatchers to input reported roadway issues and send the information to the appropriate agency (i.e., the City, County, or other jurisdiction).

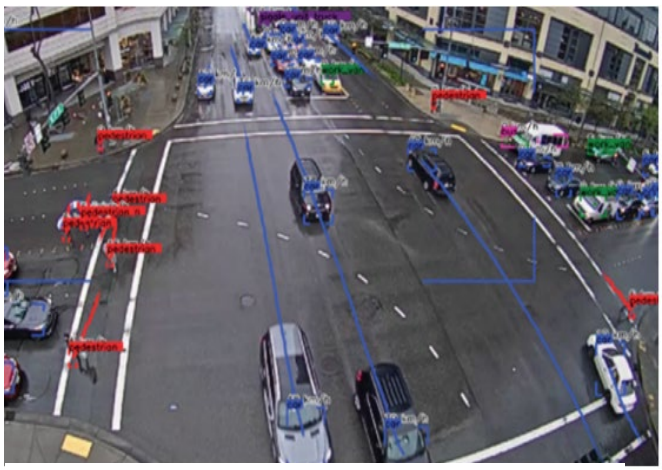
Potential partners: Alameda County Department of Public Health

EMERGING TECHNOLOGIES

New traffic safety technology—like artificial intelligence and deep learning—can enhance the benefits of Dublin's other engineering, education, enforcement, and emergency services efforts.

USE ARTIFICIAL INTELLIGENCE AND DEEP LEARNING

Artificial intelligence and deep learning on traffic video feeds (such as existing closed-circuit television, or CCTV, traffic cameras) can automatically analyze traffic flow for effective and immediate roadway safety diagnosis and conflict evaluation. Combining artificial intelligence and vehicle-to-everything (V2X) technology can predict vehicle and pedestrian intent and prevent conflicts that may result in collisions. Dublin could apply this technology to test effectiveness of countermeasures or to supplement collision data by identifying conflicts or near-misses on its roadways.



Video detection of road user trajectories can detect near-misses and conflicts. Photo source: National Operations Center of Excellence, https://bit.ly/3vuXfMG.

Example Application

The City of Bellevue, Washington, used a video-based network-wide conflict analysis to support a community Vision Zero project. This work used large-scale network screening to analyze video data from traffic surveillance cameras. Software analyzed traffic volumes, speeds, and near-misses at 40 intersections with varied population densities and land use.

This project helped Bellevue understand what factors impact its transportation network's safety and leverage that information to select improvements and evaluate outcomes.[1]

[1] City of Bellevue (2020). Video-based Network-wide Conflict Analysis to Support Vision Zero in Bellevue (WA). Retrieved from https://safety.transoftsolutions.com/city-of-bellevue/.

CROSSWALK MOTION SENSORS

Pedestrian user-friendly intelligent intersections, or PUFFIN crossings, are mid-block push-button applications used widely in the United Kingdom. PUFFIN crossings have a pedestrian signal and include sensors that detect pedestrians waiting to cross and within the crosswalk. Because the crosswalk detects crossing pedestrians, it can extend the signal to extend the phase if necessary. Studies in the United Kingdom showed pedestrian safety benefits with PUFFIN installation.[2] PUFFIN crossings may be useful at signalized crossings where older adults, children, or people with disabilities cross frequently. Tucson, Arizona, and Portland, Oregon, have implemented PUFFIN crossings that can extend the crossing phase. Alternative vendors exist that provide similar technological solutions.

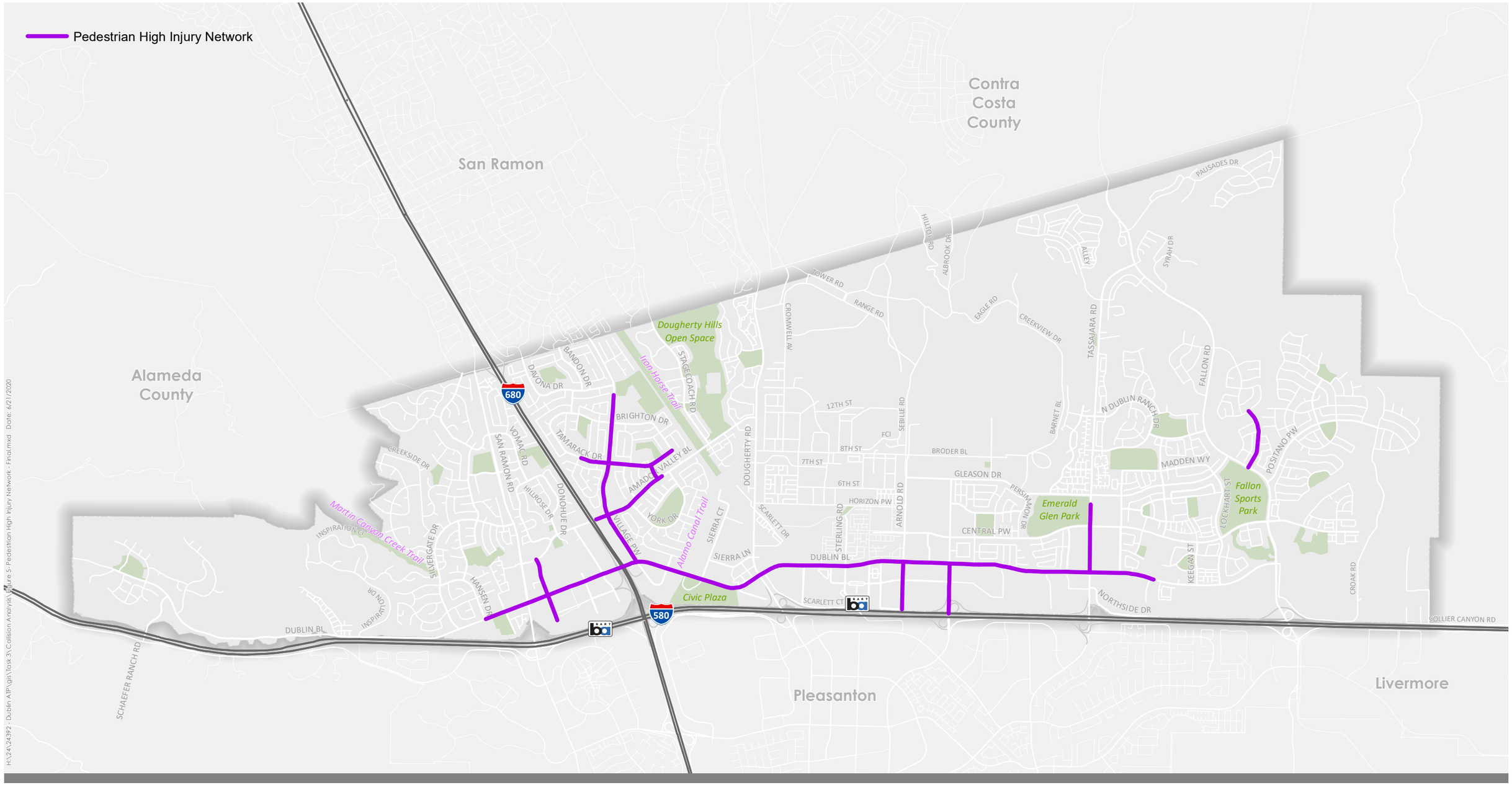
More information about PUFFIN crossings, visit http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=55.

Pedestrian sensor at a signalized crossing.

[2] Maxwell, A. and J. Kennedy. Study Compares Accident Frequency at Puffins and Crossings Using Farside Facilities. Traffic Engineering and Control, Vol. 51, No. 8, 2010, 317–321.

APPENDIX E:

BICYCLE AND PEDESTRIAN HIGH INJURY NETWORKS



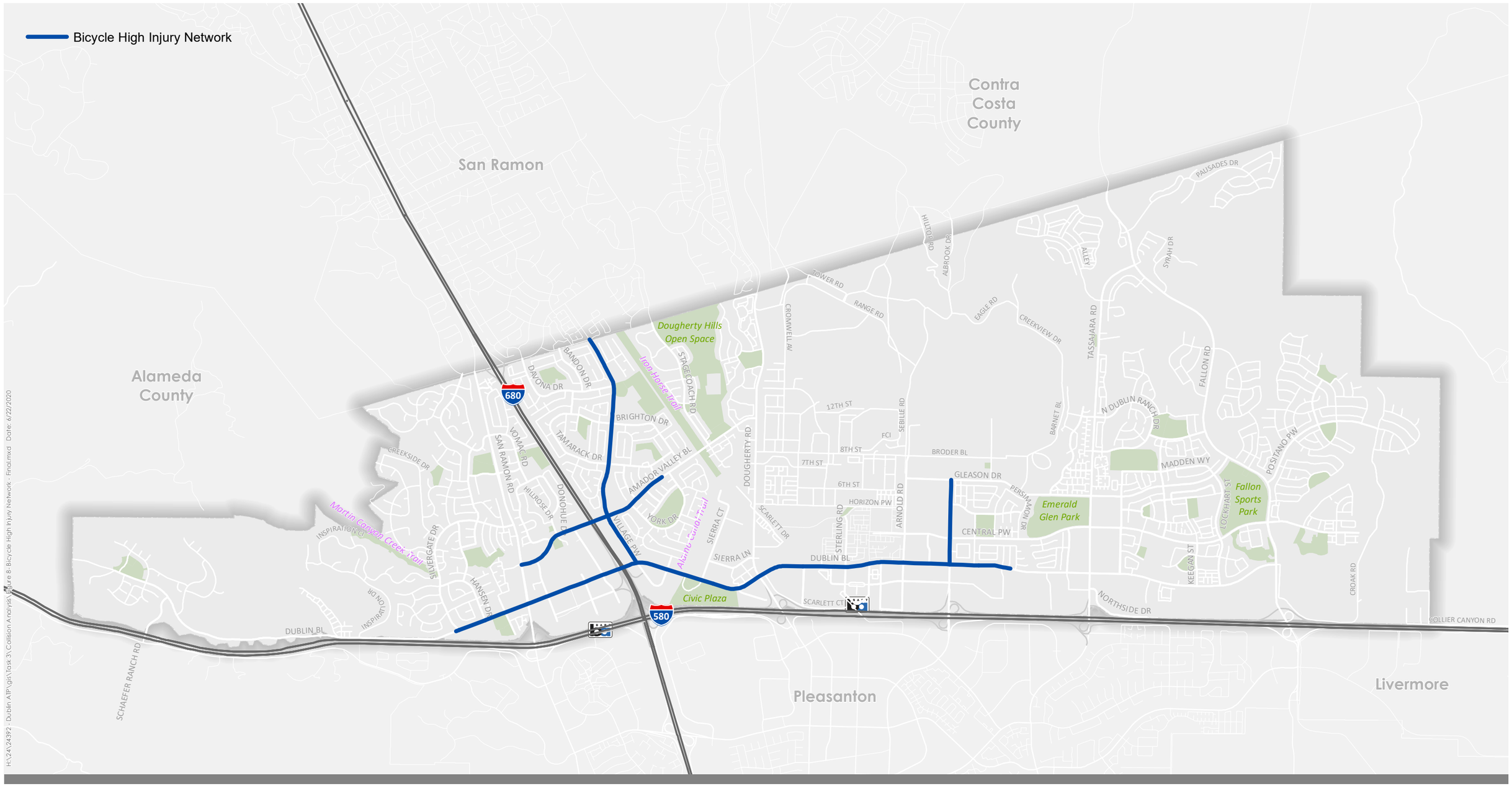
H:\24\24392 - Dublin ATP\gis\Task 3\Collision Analysis\Figure 5-Pedestrian High Injury Network - Final.mxd Date: 6/21/2020

DUBLIN
CALIFORNIA

KITTELSON & ASSOCIATES

Figure 5

Pedestrian High Injury Network
Dublin, California



H:\24\24392 - Dublin ATP\gis\Task 3\Collision Analysis\Figure 8 Bicycle High Injury Network - Final.mxd Date: 6/22/2020

DUBLIN
CALIFORNIA

KITTELSON & ASSOCIATES

Figure 8

Bicycle High Injury Network
Dublin, California

APPENDIX F: FUNDING

FUNDING

Both Federal and State agencies offer funding for regional and local transportation projects, policies, and programs.

FEDERAL FUNDING

Congestion Management & Air Quality (CMAQ)

Federal Highway Administration (FHWA)

The Congestion Mitigation and Air Quality Improvement (CMAQ) program provides flexible funding for State and local governments' transportation projects and programs to meet the requirements of the Clean Air Act (CAA) and its amendments. CMAQ money supports transportation projects that reduce mobile source emissions in areas designated by the U.S. Environmental Protection Agency (EPA) to be in nonattainment or maintenance of the national ambient air quality standards. See MTC's One Bay Area Grant (OBAG) program for how CMAQ funding is distributed within the nine-county Bay Area. OBAG disburses federal funds in accordance with MTC's regional transportation priorities and associated land-use and housing goals.

https://www.transportation.gov/sustainability/climate/federal-programs-directory-congestion-mitigation-and-air-quality-cmaq

Surface Transportation Block Grant (STBG) Program

FHWA

The Fixing America's Surface Transportation (FAST) Act converts the long-standing Surface Transportation Program (STP) into the Surface Transportation Block Grant Program (STBG). The STBG provides flexible funding address State and local transportation needs. Funding may be used to preserve and improve conditions and performance on the following: Federal-aid highway, bridge and tunnel projects on qualifying public roads; pedestrian and bicycle infrastructure; and transit capital projects, including intercity bus terminals. OBAG disburses federal funds in accordance with MTC's regional transportation priorities and associated land-use and housing goals.

https://www.fhwa.dot.gov/specialfunding/stp/

Land and Water Conservation Fund (LWCF)

National Park Service

The LWCF matches grants for states and local governments to acquire and develop public outdoor recreation areas and facilities. The LWCF has provided more than $16.7 billion to state and local governments to acquire new federal recreation lands. Projects can include open space acquisition, small city and neighborhood park development, and trail or greenway construction.

https://www.nps.gov/subjects/lwcf/index.htm

Rivers, Trails, and Conservation Assistance (RTCA) Program

National Park Service

The RTCA program supports community-led natural resource conservation and outdoor recreation projects nationwide. The National Park Service helps community groups, nonprofits, Tribes, and State and local governments design trails and parks, conserve and improve river access, protect special places, and create recreation opportunities.

https://www.nps.gov/orgs/rtca/index.htm

OTHER FEDERAL GRANTS

Because the continued existence of these grant programs is at the discretion of Congress, research the current state of funding before considering these sources.

Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Grant

United States Department of Transportation (USDOT)

The RAISE Discretionary Grant program provides a unique opportunity for USDOT to invest in roadway, rail, transit, and port projects that promise to achieve national objectives. Previously known as Better Utilizing Investments to Leverage Development (BUILD) and Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grants, the eligibility requirements of RAISE allow project sponsors at the state and local levels to obtain funding for multimodal, multi-jurisdictional projects that are more difficult to support through traditional department of transportation programs.

https://www.transportation.gov/RAISEgrants

Infrastructure for Rebuilding America (INFRA) Grant

USDOT

The INFRA Grants program funds transportation projects that focus on rebuilding existing infrastructure. To be eligible, projects must be on the National Highway System; a railway/highway grade separation project; a freight project that is rail or intermodal; or improve freight movement within an intermodal facility. Most governmental bodies (e.g., unit of local government, port authority, groups of jurisdictions) are eligible applicants. Minimum awards for large projects are $25 million and $5 million for small projects.

https://www.transportation.gov/grants/infra-grants-program

Infrastructure Jobs and Investment Act (IIJA)

USDOT

The bipartisan IIJA provides the basis for FHWA programs and activities through September 30, 2026. The IIJA makes a once-in-a-generation investment of $350 billion in highway programs and includes the largest dedicated bridge investment since the construction of the Interstate Highway System. New programs under the law focus on rehabilitating bridges in critical need of repair, reducing carbon emissions, increasing system resilience, removing barriers to connecting communities, and improving mobility and access to economic

opportunity. Many of the new programs include eligibility for local governments, Metropolitan Planning Organizations (MPOs), Tribes, and other public authorities.

One program, the Safe Streets for All (SS4A) Grant Program, has appropriated $5 billion over the next five years, with up to $1 billion available in fiscal year 2022. Funding is available for the following activities:

- Comprehensive safety action plans
- Planning, design, and development activities in support of an Action Plan (like this LRSP)
- Projects and strategies identified in an Action Plan (like this LRSP)

More information on the Bipartisan Infrastructure Law is available at https://www.fhwa.dot.gov/bipartisan-infrastructure-law/. A list of examples of SS4A funding-eligible activities is available at https://www.transportation.gov/grants/SS4A.

STATE FUNDING

Senate Bill 1 (SB 1)

SB1, the Road Repair and Accountability Act of 2017, is a long-term transportation reform and funding package. The bill includes new revenues that address a variety of transportation projects, such as roadway safety improvements, street repair, transit, and roadway and bridge construction. SB 1 provides more than $5 billion annually to transportation projects throughout California.

http://rebuildingca.ca.gov/

Highway Safety Improvement Program (HSIP)

Caltrans

The Highway Safety Improvement Program (HSIP) is one of the core federal-aid programs in the federal surface transportation act, Fixing America's Surface Transportation Act (FAST). HSIP aims to significantly reduce traffic fatalities and severe injuries on all public roads—including non-State-owned public roads and roads on Tribal land—by funding eligible projects such as crosswalk markings, rapid flashing beacons, curb extensions, speed feedback signs, guard rails, pedestrian refuge islands, slurry seal, and other pavement markings.

https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/highway-safety-improvement-program

Office of Traffic Safety (OTS) Grants

California Office of Traffic Safety

OTS strives to eliminate traffic deaths and injuries by granting funds to local and state public agencies for programs that enforce traffic laws, educate the public in traffic safety, and provide varied and effective means of reducing fatalities, injuries, and economic losses from collisions.

https://www.ots.ca.gov/grants/

Active Transportation Program (ATP) Grants

California Transportation Commission (CTC)

The ATP consolidates existing federal and state transportation programs, including the Transportation Alternatives Program (TAP), Bicycle Transportation Account (BTA), and State Safe Routes to School (SR2S), into a single discretionary grant program that focuses on making California a national leader in active transportation. The ATP aims to encourage active transportation by increasing the proportion of trips made by bicycle or on foot; increasing non-motorized user safety; reducing greenhouse gases; enhancing public health; and ensuring that disadvantaged communities share fully in program benefits.

https://catc.ca.gov/programs/active-transportation-program

State-Local Partnership Program (LPP)

CTC

Created by the Road Repair and Accountability Act of 2017 through SB1, the Local Partnership Program (LPP) annually appropriates $200 million from the Road Maintenance and Rehabilitation Account to local and regional transportation agencies that have passed sales tax measures, developer fees, or other imposed transportation fees. Funds are awarded for roadway maintenance and rehabilitation, sound walls, and other transportation improvement projects. LPP also funds local and regional agency projects that improve aging infrastructure, roadway conditions, active transportation, and health and safety. Consistent with the intent behind SB1, the CTC intends this program to balance the need to direct increased revenue to the State's highest transportation needs and the need to fairly distributing the economic impact of increased funding.

https://catc.ca.gov/programs/sb1/local-partnership-program

Sustainable Transportation Grant Program

Caltrans

The Sustainable Transportation Planning Grant Program was created to support the Caltrans mission: provide a safe, sustainable, integrated, and efficient transportation system to enhance California's economy and livability. Eligible planning projects must have a transportation nexus and ideally demonstrate that they directly benefit the multimodal transportation system. Sustainable Communities Grants will also improve public health, social equity, environmental justice, the environment, and provide other important community benefits.

https://dot.ca.gov/programs/transportation-planning/regional-planning/sustainable-transportation-planning-grants

State Highway Operation and Protection Program (SHOPP)

Caltrans

SHOPP is the "fix-it-first" program from the State Highway System (SHS). SHOPP funds repair and preservation, emergency repairs, safety improvements, and some highway operational improvements on the SHS. Although SHOPP is intended for projects on statutorily designated State-owned roads, highways (including the interstate system), and bridges, it can be used for associated bicycle and pedestrian facilities. Revenues for the SHOPP are generated by federal and State gas taxes and are fiscally constrained by the State Transportation Improvement Program Fund Estimate that is produced by Caltrans and adopted by the CTC.

https://dot.ca.gov/programs/financial-programming/state-highway-operation-protection-program-shopp-minor-program-shopp

State Transportation Improvement Program (STIP)

CTC

The STIP is a biennial, five-year plan adopted by the CTC for future allocations of certain State transportation funds for State highway improvements, intercity rail, and regional highway and transit improvements. State law requires the CTC to update the STIP biennially, on even-numbered years, with each new STIP adding two new years to prior programming commitments. CTC staff recommendations are based on the combined programming capacity for the Public Transportation Account (PTA) and State Highway Account (SHA) as identified in the fund estimate adopted by the CTC. To be included in the STIP that is adopted by the CTC, projects must first be nominated by the MTC in its Regional Transportation Improvement Program (RTIP), or by Caltrans in its Interregional Transportation Improvement Program (ITIP). https://catc.ca.gov/programs/state-transportation-improvement-program

Recreational Trails Program (RTP)

California Department of Parks and Recreation

RTP annually provides federal funds for recreational trails and trail-related projects. The RTP is administered at the federal level by the FHWA and at the state level by the California Department of Parks and Recreation (DPR) and the Department of Transportation (Caltrans) Active Transportation Program (ATP). Eligible non-motorized projects include acquisition of easements and fee simple title to property for recreational trails and recreational trail corridors; and development or rehabilitation of trails, trailside, and trailhead facilities.

https://www.parks.ca.gov/?page_id=24324

Affordable Housing and Sustainable Communities (AHSC) Program

California Strategic Growth Council

The AHSC program aims to reduce greenhouse gas emissions through projects that implement land-use, housing, transportation, and agricultural land preservation practices to support infill and compact development and that support related and coordinated public policy objectives. The AHSC program includes transportation focuses related to reducing air pollution, improving conditions in disadvantaged communities, supporting or improving public health, improving connectivity and access to jobs, increasing options for mobility, and increasing transit ridership. Funding for the AHSC Program is provided from the Greenhouse Gas Reduction Fund (GGRF), an account established to receive cap-and-trade auction proceeds.

https://sgc.ca.gov/programs/ahsc/

Transformative Climate Communities (TCC) Program

California Strategic Growth Council

Established by Assembly Bill 2722, the TCC program funds development and implementation of neighborhood-level transformative climate community plans that include multiple coordinated greenhouse gas emissions reduction projects that provide local economic, environmental, and health benefits to disadvantaged communities. The TCC Program helps realize the State's vision of vibrant communities and

landscapes and demonstrates how meaningful community engagement coupled with strategic investments in transportation, housing, food, energy, natural resources, and waste can reduce greenhouse gas emissions and pollution, advance social and health equity, and enhance economic opportunity and community resilience. The TCC Program funds both implementation and planning grants. While the program can fund a variety of projects, transportation-related projects can include developing active transportation and public transit projects; supporting transit ridership programs and transit passes for low-income riders; expanding first/last mile connections; building safe and accessible biking and walking routes; and encouraging education and planning activities to promote increased use of active transportation modes.

https://sgc.ca.gov/programs/tcc/

Environmental Enhancement and Mitigation (EEM) Grant Program

California Natural Resources Agency

The EEM program authorizes the California State Legislature to allocate up to $7 million each fiscal year from the Highway Users Tax Account. EEM projects must contribute to mitigation of the environmental effects of transportation facilities. The EEM Program does not generally fund commute-related trails or similar bicycle and pedestrian infrastructure. However, EEM does fund recreational and nature trails as part of storm water management or green infrastructure projects.

https://catc.ca.gov/programs/environmental-enhancement-mitigation

Urban Greening Grant Program

California Natural Resources Agency

Part of the California State Senate Bill 859, the Urban Greening Program is funded by the Greenhouse Gas Reduction Fund to support the development of green infrastructure projects that reduce greenhouse gas emissions and other benefits. To maximize economic, environmental, and public benefits, priority is given to projects in disadvantaged communities. The Urban Greening Program funds projects that reduce greenhouse gases by sequestering carbon, decreasing energy consumption, and reducing vehicle miles traveled while transforming the built environment into places that are more sustainable, enjoyable, and effective at creating healthy and vibrant communities. These projects will establish and enhance parks and open space by using natural solutions to improve air and water quality, reducing energy consumption, and creating more walkable and bikeable trails.

https://files.resources.ca.gov/grants/urban-greening/

Environmental Justice (EJ) Small Grants Program

California Environmental Protection Agency

EJ Small Grants provide funding to help eligible non-profit community organizations and federally-recognized Tribal governments address environmental justice issues in areas disproportionately affected by environmental pollution and hazards. EJ Small Grants are awarded on a competitive basis with a maximum amount $50,000 per grant. EJ Small Grants can be used for a variety of environmental purposes and to augment community engagement, health, trainings, and programmatic opportunities in underserved communities.

https://calepa.ca.gov/envjustice/funding/