

# CITY SAFETY PLAN

FEBRUARY 2022

PREPARED FOR THE CITY OF CAMAS      PREPARED BY DKS ASSOCIATES



# Acknowledgements

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# INTRODUCTION

The City of Camas is located along the Columbia River and east of Vancouver, Washington. Camas is home to approximately 26,500 residents with more than 600 businesses within the city limits. The following 'At Risk Population Profile' provides key population and equity statistics based on 2021 data.<sup>1</sup>



<sup>1</sup> Source: ESRI Business Analysis Tool. <https://storymaps.arcgis.com/stories/52764a9948074c4b9d527a390aefdc67>

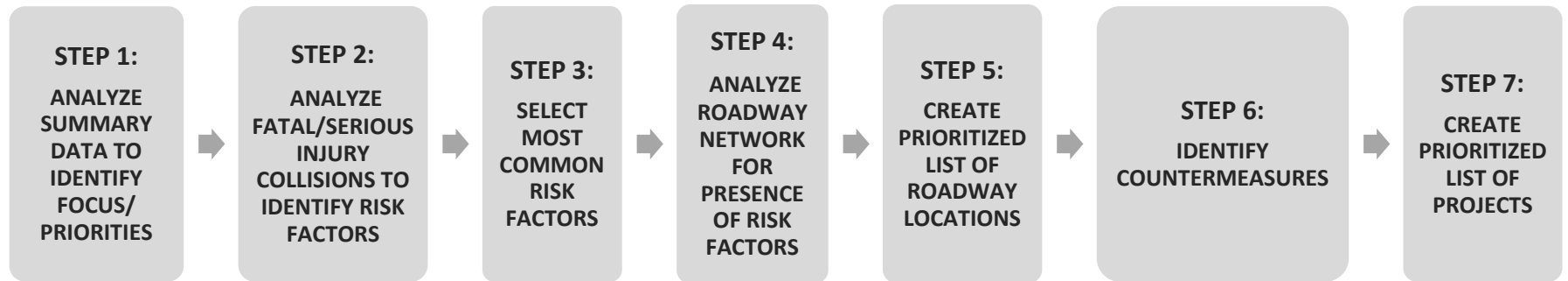
## CITY SAFETY PLAN PROCESS

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The purpose of the City Road Safety Plan is to analyze crash data from within the city in order to effectively identify trends, contributing factors, associated risk factors and deficiencies present in the city’s road network. Following this approach allows for the effective identification of appropriate, low cost countermeasures to be implemented for the purpose of crash reduction. The correlation of crash trends to the associated contributing factors, risk factors, and roadway deficiencies supports efficiency in identifying the need for crash reduction strategies as well as the implementation of specific infrastructure-based countermeasures for the purpose of reducing the risk of crashes resulting in serious injuries or fatalities.

The following plan includes a summary of existing safety conditions in Camas, identification of safety needs, and recommended treatments to address high-priority collision types and locations.

The sections below describe the process of collecting and analyzing available data and identifying safety needs from that analysis.



The data used and process followed are consistent with WSDOT’s guidelines from the 2022 City Safety Program. The recommended safety countermeasures are limited to infrastructure-based treatments eligible for one or more of the following grant programs:<sup>2</sup>

- WSDOT grant programs: City Safety, Safe Routes to School, Bicycle-Pedestrian, and Railway-Highway Grade Crossings
- Transportation Improvement Board (TIB) grants, including Complete Streets
- Several RTC grants

Appendix A, Safety Countermeasure Toolbox, includes a description of each treatment, when it should be used, estimated costs, and crash modification factor.

The sections below describe the process of collecting and analyzing available data and identifying safety needs from that analysis.

## STEP 1: ANALYZE SUMMARY DATA TO IDENTIFY FOCUS/PRIORITIES

The consultant support team worked with the City of Camas, Southwest Washington Regional Transportation Council (RTC), and WSDOT Transportation Data to acquire the following data sets.

- WSDOT database of all collisions on City of Camas streets, Jan 2016 - Dec 2020 (provided by Julie Brown, WSDOT Transportation Data)
- City of Camas Local Road Safety Plan Survey Responses (provided by Jim Hodges, City of Camas)
- City of Camas Citizen Feedback (provided by Jim Hodges, City of Camas)

The City and their consultant support reviewed the quality and accuracy of the data sets, communicated with WSDOT on discrepancies, and solicited and received the desired data from the State.

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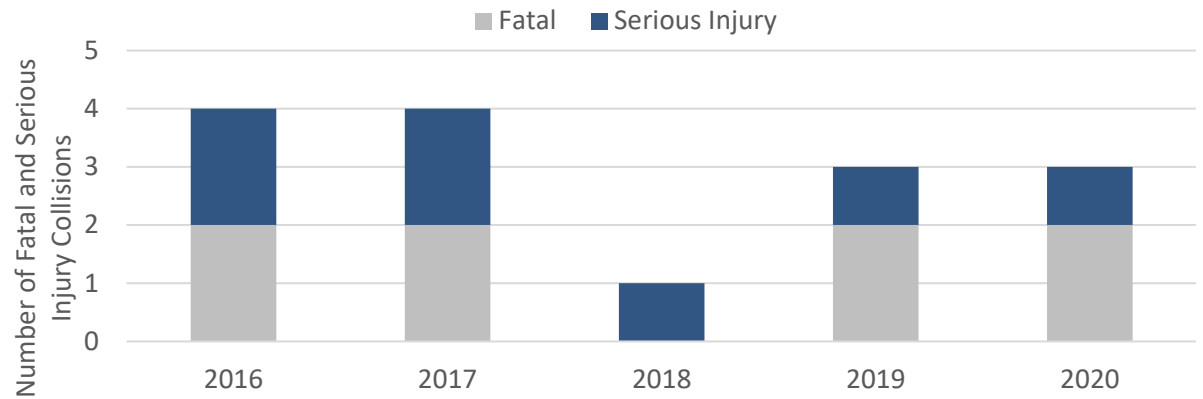
<sup>2</sup> Additional details regarding available grant programs are available in Appendix B, Grant Programs.

## DATA ANALYSIS OVERVIEW

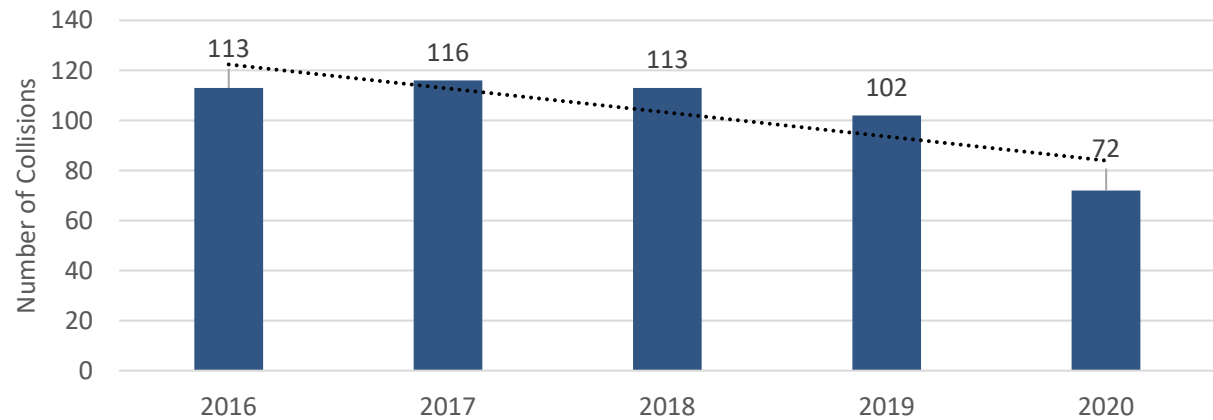
As illustrated in Figure 1, over the past five years, the number of fatal and serious injury collisions on city streets has ranged from one to four annually. The general trend since 2016 is a slight decrease.

The number of all reported collisions (regardless of severity) has ranged between 72 and 116, as shown in Figure 2. In the most recent year of data available, 2020, the city experienced 72 reported crashes (a 36% decline from 2016). The impacts of the COVID-19 pandemic response and associated travel patterns influenced crash frequency and severity in 2020.

Figure 3 shows the heat map of fatal and serious injury collisions over the five-year study period. Figure 4 provides a heat map of all reported collisions that occurred on City-owned streets in Camas during the study period.



**Figure 1. Fatal and Serious Injury Collisions in Camas, 2016-2020.**



**Figure 2. Total Collisions in Camas, 2016-2020.**

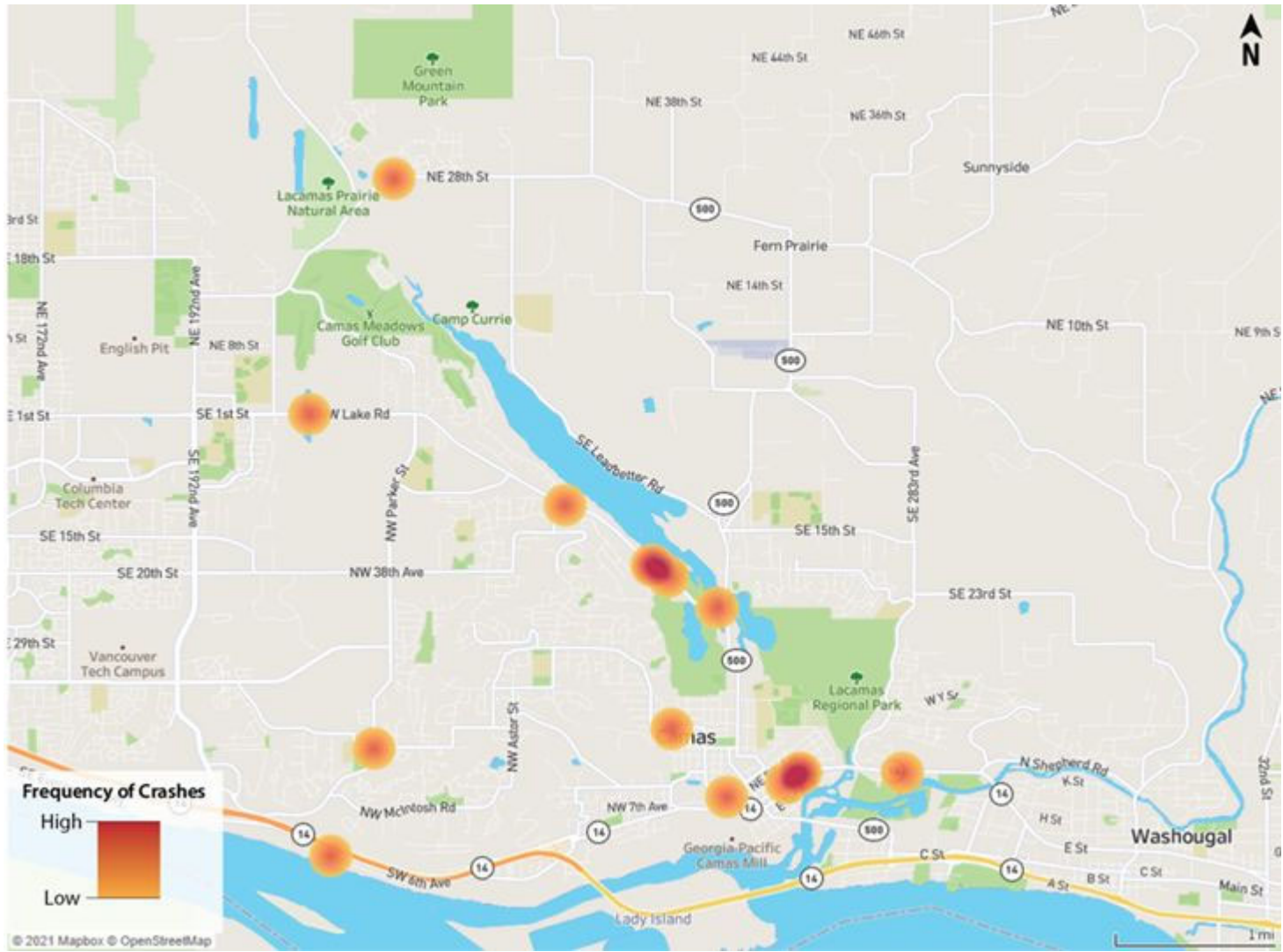


Figure 3. Heat Map of Fatal and Serious Injury Collisions in Camas, 2016-2020.



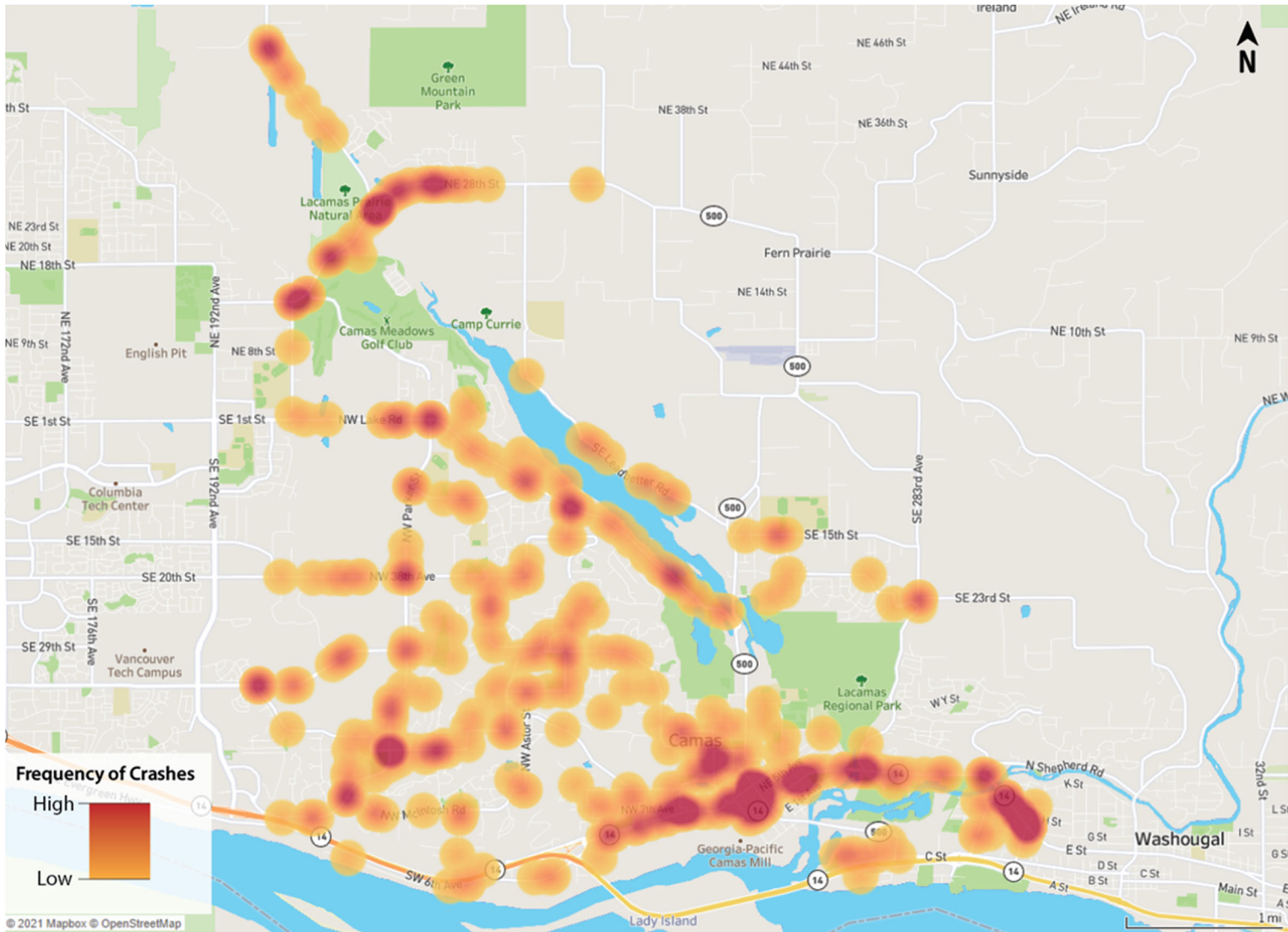


Figure 4. Heat Map of All Reported Collisions in Camas, 2016-2020.

## CITIZEN FEEDBACK

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Citizens of the city are an important source for traffic safety concerns. They have a vested interest in keeping travel safe for themselves and their families, and they bring their first-hand experiences. In particular, citizens sometimes identify issues occurring at night and on weekends that agency staff may not identify during typical daytime reviews.

The City of Camas provided a history of transportation safety-related citizen requests made over the past few years. Of the nine requests and 72 survey responses reviewed, most focused on the following topics:



### **Pedestrian Safety**

- Students walking to and from school, including safety on roads adjacent to the schools during drop-off and pick-up.
- Request for sidewalk infill along roads that currently do not have pedestrian facilities and for sidewalk maintenance at locations with potential trip hazards.
- Request for new bike lanes on roads that currently do not have them and to fill gaps to connect existing bike routes.
- Request for enhanced pedestrian crossings.
- Request for improved pedestrian and bicycle facilities near schools, neighborhoods, and trails.



### **High Vehicle Speeds**

- Request for change to posted speed limit, speed humps, and speed limit enforcement.



### **Sight Distance**

- Visibility issues at intersections due to parked cars.
- Visual restrictions due to on premise vegetation near intersections.
- Request for improvements at intersections with limited sight distance.



### **Roundabouts**

- Divided opinions regarding the implementation of roundabouts. There are citizens who are supporters and others who oppose the implementation of roundabouts in the city.

The following locations in the city were most commonly noted in citizen feedback:

Intersections:

- NW Brady Road and NW McIntosh Road
- NW Lake Road and NW Sierra Street

Corridors:

- NE 3rd Avenue
- NE 6th Avenue
- NW Lake Road
- NW Sierra Street
- NE Everett Street
- Crown Road
- NE Woodburn Drive

The *Engage Camas* survey solicited feedback on the community's highest priority safety concerns (see Figure 5). Vehicle speed, pedestrian safety, intersections, and lack of infrastructure were the most voted safety concerns from Camas residents.

What are the main roadway safety issues within Camas, Washington (Check all that apply):

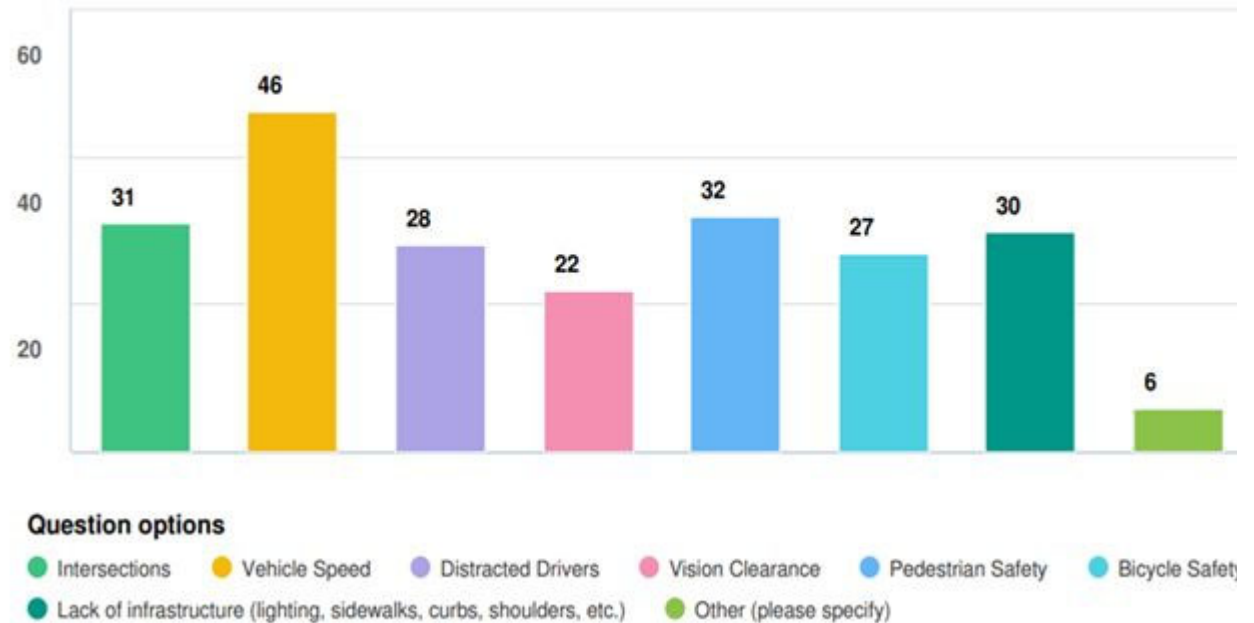
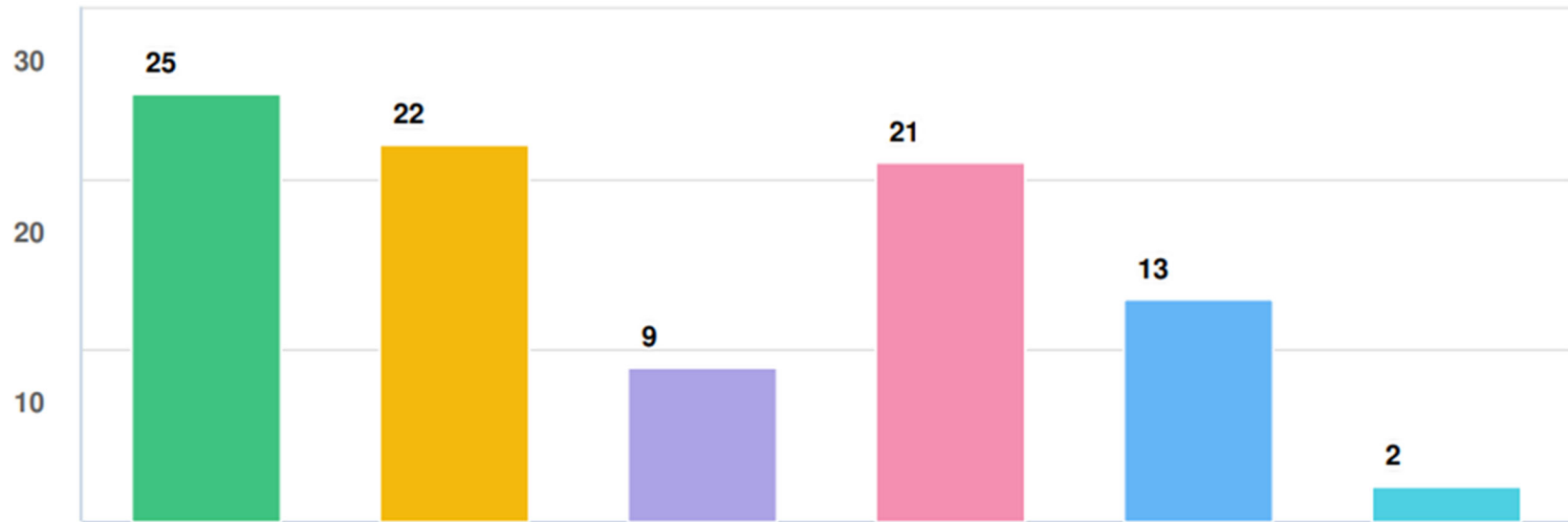


Figure 5. Camas Roadway Safety Issues Survey Results, 2021.

The *Engage Camas* survey also questioned residents on the roadway safety features that they would like the City to avoid. The results in Figure 6 display that speed bumps, stop cameras, and speed cameras are the least popular roadway safety features.

### Are there any roadway safety features you would like the City to avoid (check all that apply)?



#### Question options

- Speed Bumps
- Stop Cameras
- Left turn lane flashing yellow arrows
- Speed cameras
- Round-a-bouts
- Other (please specify)

Figure 6. Camas, Safety Features to Avoid, Survey Results, 2021

## STEP 2: ANALYZE FATAL/SERIOUS INJURY COLLISIONS TO IDENTIFY RISK FACTORS (COLLISION ATTRIBUTES)

The City studied each risk factor (collision attribute) to determine which would be most useful for future steps. Table 1 shows some of the most common attributes present in collisions that occur on City-owned streets in Camas.

**TABLE 1. MOST COMMON COLLISION ATTRIBUTES, CAMAS, 2016-2020**

Data Element	Collision Attribute	Total Collisions	Fatal Collisions (F)	Serious Injury Collisions (SI)	Percent of all Camas Collisions with this Attribute <sup>(1)</sup>	Percent of F&SI Camas Collisions with this Attribute <sup>(2)</sup>
<i>Citywide</i>	<i>Any</i>	<i>516</i>	<i>8</i>	<i>7</i>		
Collision Type	Roadway Departure	179	3	3	35%	40%
	Head-On	6	2	2	1%	27%
	Entering at Angle	97	2	1	19%	20%
Contributing Circumstance (For at least one vehicle)	Exceeding Reasonable Safe Speed or Exceeding Stated Speed Limit	56	3	2	11%	33%
	Alcohol-Impaired <sup>(3)</sup>	63	0	3	14%	20%
	Drug-Impaired <sup>(3)</sup>	3	0	0	1%	0%
	Inattention / Distraction	115	3	0	22%	20%
Motor Type Involved	Motorcycle	11	3	1	2%	27%
	Heavy Vehicle	88	0	2	17%	13%

Data Element	Collision Attribute	Total Collisions	Fatal Collisions (F)	Serious Injury Collisions (SI)	Percent of all Camas Collisions with this Attribute <sup>(1)</sup>	Percent of F&SI Camas Collisions with this Attribute <sup>(2)</sup>
Lighting Condition	Dark/Dusk/Dawn	49	0	1	9%	7%
Intersection	At Intersection or Intersection Related	224	3	2	43%	33%
	Signalized Intersection	40	0	0	8%	0%
	Unsignalized Intersection	184	3	2	37%	20%
Road User	Pedestrian Involved	6	0	0	1%	0%
	Cyclist Involved	13	0	0	3%	0%
Roadway Surface	Wet	132	1	3	26%	27%
	Ice	27	0	0	5%	0%
Age	Driver Age 16 to 25 Involved	227	3	3	44%	40%
	Driver Over Age 65 Involved	65	2	2	13%	27%
Restraint (Seat Belt) Usage	No Restraints Used	22	3	2	4%	33%

(1) For example, in Camas 35% of all collisions involved roadway departure.

(2) For example, in Camas 27% of all fatal and serious injury collisions were head-on crashes.

(3) As of this writing, WSDOT has identified an issue with 2020 impaired driving data and is looking into the details.

The City identified the following notable trends from this analysis:

- Intersections are the most common type of location for collisions (all severities) to occur (224 of 516; 43%)
- Roadway departure collisions were most likely to result in a fatality or serious injury, resulting in six of the 15 fatal and serious injury outcomes (40%).
- Young drivers (age 16 to 25) were involved in nearly half of all collisions (227 of 516; 44%).
- Of intersection crashes, the most common sub-type was Entering at an Angle
- Of intersection crashes, 82% (184 of 224) occurred at unsignalized intersections.

### STEP 3: SELECT MOST COMMON RISK FACTORS (COLLISION ATTRIBUTES)

Based on the findings of Step 1 and Step 2, the City identified the following collision attributes correlated with the highest frequency or severity of collisions. These collision attributes are the focus of the network analysis in Step 4:

1. Roadway Departure
2. Speeding
3. Unsignalized Intersections
4. Motorcycle
5. Wet Road Conditions

**Low-frequency, Severe-outcome Collision Attributes.** Several collision attributes were associated with a relatively high number of fatal and serious injury collisions, but a low overall frequency of those types or attributes. Therefore, evaluating these contributors for the entire city would not provide valuable location-specific information.

The following attributes were associated with a lower frequency of collisions, but a higher percentage of fatal and serious injury outcomes than most others:

- Head-on collisions (4 of 6 were fatal or serious injury collisions)
- Motorcycle-involved (4 of 11 were fatal or serious injury collisions)
- No Restraints Used (5 of 22 were fatal or serious injury collisions)

**Pedestrian and Bicycle Safety.** Only 19 of the 516 reported collisions during the study period involved a pedestrian or bicyclists, and none of those reported crashes resulted in a fatality or serious injury. To identify locations for potential infrastructure treatments under the WSDOT City Safety Program, at least one fatal or serious injury collision must be present in the database. However, citizen feedback included concerns for pedestrian safety, especially for students walking to and from school.

#### STEP 4: ANALYZE ROADWAY NETWORK FOR PRESENCE OF RISK FACTORS (COLLISION ATTRIBUTES)

Following WSDOT's recommended procedure,<sup>3</sup> the City applied the most common risk factors in fatal/serious injury crashes to the entire network using frequency of collisions based on the most common risk factors / collision attributes.

The City mapped crash frequency based on the seven most common risk factors in fatal and serious injury crashes. The maps in **Appendix C** illustrate the locations of crashes with these attributes.

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<sup>3</sup> WSDOT Local Road Safety Plans Guidance, [https://www.wsdot.wa.gov/sites/default/files/2014/02/27/LP\\_Local-Road-Safety-Plans.pdf](https://www.wsdot.wa.gov/sites/default/files/2014/02/27/LP_Local-Road-Safety-Plans.pdf)



## STEP 5: CREATE PRIORITIZED LIST OF ROADWAY LOCATIONS

The tables below identify intersections and corridors ranked by the number of risk factors / collision attributes identified. A location received a “point” for a risk factor if it experienced a relatively high frequency of crashes with that attribute compared to the rest of the city roadway network. An additional point was added if that location was identified as a citizen concern.

Note that these are not the recommended intersections for treatment. They are the first step in the process toward the final prioritization of safety projects in Step 7.

**TABLE 2. PRIORITIZED INTERSECTION SAFETY NEEDS BY NUMBER OF RISK FACTORS**

Intersection	Roadway Departure	Speeding	Unsignalized Intersection	Motorcycle Involved	Wet Road Surface	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
NW 16th Ave and NW Brady Rd <sup>4</sup>	-	✓	-	✓	✓	✓	✓	5
NE 6th Ave and NE Adams St	✓	✓	✓	-	-	✓	✓	5
NE Ingle Rd and NW Goodwin Rd	✓	-	✓	-	✓	-	✓	4
SE 23rd St and SE 283rd Ave	✓	✓	✓	-	✓	-	-	4

<sup>4</sup> Recently improved, including a new signal installation in 2018

Intersection	Roadway Departure	Speeding	Unsignalized Intersection	Motorcycle Involved	Wet Road Surface	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
NW Leadbetter Dr and NW Howard St	✓	✓	✓	-	✓	-	-	<b>4</b>
NW Parker St & NW 38th Ave <sup>5</sup>	✓	✓	-	-	✓	-	-	<b>3</b>
NE 6th Ave and NW 7th Ave	✓	-	✓	-	-	-	-	<b>3</b>
NE 3rd Ave and NE Hayes St	✓	-	✓	-	-	-	-	<b>3</b>

<sup>5</sup> Intersection was recently improved, and further treatments are planned for 2022-23.

**TABLE 3: PRIORITIZED CORRIDOR SAFETY NEEDS BY NUMBER OF RISK FACTORS**

Segment	Roadway Departure	Speeding	Motorcycle Involved	Wet Road Surface	At Least 1 Fatal or Serious Injury Crash	Citizen Request	Total
NE Goodwin Rd from NW Friberg-Strunk St to NE 222nd Ave	✓	✓	✓	✓	✓	✓	6
NW Lake Rd from NW Leadbetter Dr to NE Everett St	✓	✓	✓	✓	✓	✓	6
NE 3rd Ave from NE Garfield St to SE Crown Dr	✓	✓	✓	✓	✓	✓	6
SE Leadbetter Road from SE Everett St to NE 9th St	✓	✓	✓	✓	-	-	4

## STEPS 6 & 7: IDENTIFY COUNTERMEASURES AND DEVELOP A PRIORITIZED LIST OF PROJECTS

The City compared the list of prioritized intersections and corridors identified in Step 5 to recent and already-funded projects to identify the most pressing safety current needs, and then analyzed collision data and existing conditions at the locations shown in Table 4.

**TABLE 4: PRIORITIZED SAFETY STUDY LOCATIONS**

Location	Roadway Departure	Speeding	Unsignalized Intersection	Motorcycle Involved	Wet Road Surface	At Least 1 Fatal or Serious Injury Crash	Citizen Request
1. Intersection: NE 6th Ave and NE Adams St	✓	✓	✓	-	-	✓	✓
2. Intersection: NE Goodwin Rd and NW Alexandra Ln	✓	-	✓	-	-	-	-
3. Intersection: NW Drake St and NW 7th Ave	✓	-	✓	-	-	-	-
4. Intersection: NE 3rd Ave and NE Joy St	-	-	✓	-	-	✓	-
5. Segment: NE Goodwin Rd from NW Friberg-Strunk St to NE 222nd Ave	✓	✓	-	✓	✓	✓	✓
6. Segment: NW Lake Rd from NW Leadbetter Dr to NE Everett St	✓	✓	-	✓	✓	✓	✓

Upon completion of that analysis and identification of potential countermeasures, the City selected the priority spot location and systemic safety projects shown below.

**TABLE 5: SAFETY PROJECTS TO PURSUE**

Prioritized Location or Systemic Collision Type	Safety Project	Next Step
1. NW Lake Road from NW Leadbetter Drive to NE Everett Street	Horizontal Curve Signing, Profiled Pavement Marking, Shoulder Widening	Apply for 2022 WSDOT City Safety Program grant funding
2. Intersection: NE 6th Avenue and NE Adams Street	Intersection Improvement	Apply for 2022 WSDOT City Safety Program or future grant funding
3. Systemic Stop-controlled Intersections	Signing, Pavement Marking	Apply for 2022 WSDOT City Safety Program grant funding
4. Systemic Roadway Departure	4.1 Citywide MUTCD Curve Signing 4.2 Enhanced Curve Signing, Rumble Strips, Profiled Pavement Marking	Apply for 2022 WSDOT City Safety Program grant funding

The following sections detail existing conditions, countermeasures, and estimated project costs, monetary value of estimated safety benefits, and the estimated benefit/cost ratio of each recommended safety project.

## PRIORITY 1. NW LAKE ROAD FROM NW LEADBETTER DRIVE TO NE EVERETT STREET

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**Identified Safety Needs.** This segment of NW Lake Rd is a narrow, 2-lane, hilly, tree-lined roadway through the woods that connects lakeside residential properties to Heritage Park and NE Everett St (SR 500).

Collision history includes three head-on crashes (two fatal collisions and one serious injury collision) and another fatal roadway departure collision. Other common collision attributes include speeding, wet pavement, dark conditions, and motorcycle-involved.



**Figure 7. Horizontal Curve on NW Lake Road**

**Safety Treatments.** To address collisions along NW Lake Rd, most of which involve a motorist departing their lane and either running off the road or colliding with an oncoming vehicle, the City is considering the following treatments:

- **Horizontal Curve Signing.** Horizontal curve warning signs for each curve, as appropriate, including advance curve warning, advisory speed plaques, and chevron alignment signs. This provides additional information to drivers at curves and turns.
- **No Passing Zone Signs.** There is some evidence that the head-on collision involved illegal passing along the corridor. Adding No Passing Zone signs could supplement the existing double-yellow pavement marking.

- **Profiled Pavement Marking.** This treatment can address lane departure crashes by providing an auditory and tactile warning when driven on, alerting drivers drifting outside their travel lanes. Profiled pavement markings do not result in as much noise outside the vehicle as rumble strips.
- **Improving Shoulders.** Adding shoulders provides additional recovery area for drivers to return the roadway after departing the traveled way.
- **Install Illumination.** Identify gaps that create “dark spots” along the segment and fill in with new lighting.

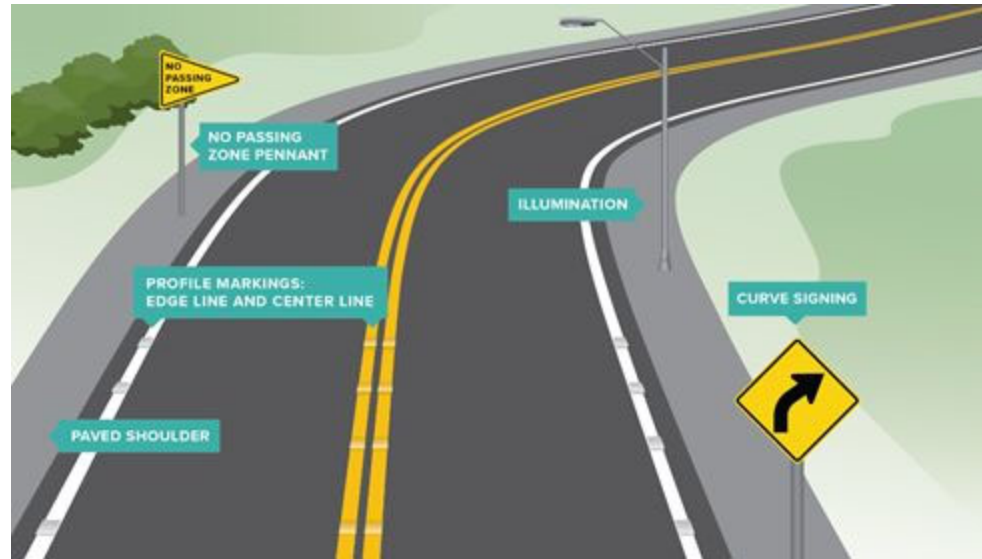


Figure 8. NW Lake Road Safety Treatments

**NW Lake Road from NW Leadbetter Drive to NE Everett Street**

	<p><u>Project Description</u> Provide horizontal curve signing, no passing zone signs, profiled pavement markings, and improved shoulders for the length of the segment.</p>	<p> <u>Cost Estimate</u> \$4,280,000</p>	<p> <u>Crash Reduction</u> <b>~25%</b></p>
		<p> <u>Benefit / Cost Ratio</u> 2.85</p>	<p>Combined reduction for all treatments along the segment <b>History:</b> 19 crashes observed from 2016-2020, including 3 fatal and 2 serious injury collisions. <b>Expected Benefit:</b> 0.96 fewer crashes per year</p>
		<p> <u>Time Frame</u> Long-term</p>	

## PRIORITY 2. NE 6TH AVENUE AND NE ADAMS STREET

**Identified Safety Needs.** Located in an industrial/commercial area of Camas, NE 6th Ave and NE Adams St has atypical traffic control. The northbound approach is free (through, left, and right) while the other three intersection legs are stop-controlled. This could introduce some confusion to drivers, though each Stop sign includes a “Cross Traffic Does Not Stop” plaque. Crash history at this location included two roadway departure crashes (both northbound left turns, occurred at night, and involved a driver under the influence) and one angle crash, also involving a northbound left-turning vehicle in conflict with an eastbound through motorist. Alongside reported collisions, citizens have expressed concerns about the safety of this intersection.



**Figure 9. NE Adams Street Northbound Approach at NE 6th Avenue**

To address the identified needs at this intersection, the City will consider the following safety countermeasures:

- **Roundabout.** See Figure 10 on the next page. The amount of pavement at this location makes it conducive to a roundabout installation. Roundabouts are a proven countermeasure to reduce the frequency and severity of intersection crashes by reducing operating speeds and flattening the angle of conflict. It will be important for this design to accommodate truck and transit vehicle movements.
- **Improved Intersection Lighting.** With crashes in dark conditions prominent, analyzing and improving lighting at the intersection supports safety at night.



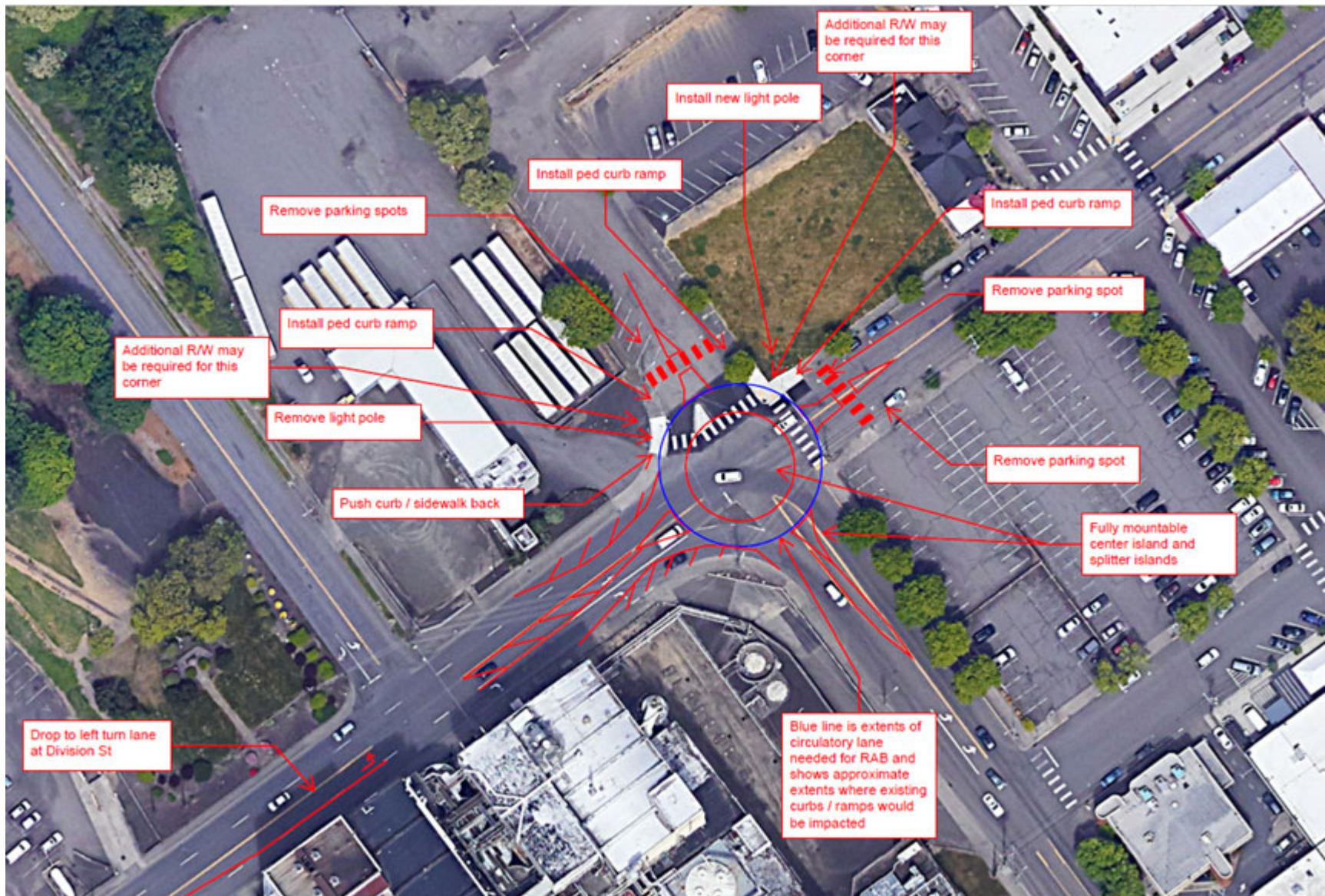


Figure 10. Conceptual Layout and Notes for a Roundabout at NE 6th Avenue and NE Adams Street

## NE 6th Avenue and NE Adams Street Safety Improvements



**Project Description**  
Install a roundabout at the intersection with associated lighting and pedestrian facilities.



**Cost Estimate**  
\$3,967,000



**Benefit / Cost Ratio**  
1.65



**Time Frame**  
Long-term



**Crash Reduction**

**~76%**

Combined reduction for all treatments at the intersection.

**History:** 3 crashes observed from 2016-2020, including 1 serious injury collision.

**Expected Benefit:** 0.45 fewer crashes per year

## PRIORITY 3. SYSTEMIC STOP-CONTROLLED INTERSECTIONS

In Camas, intersection and intersection-related collisions are the most common types to occur for all crash severities. 20% of fatal and serious injury collisions occurred at unsignalized intersections, and 37% of all collisions occurred at unsignalized intersections.

**Potential Safety Treatments.** Low-cost systemic safety countermeasures at unsignalized intersections consists primarily of signing and pavement marking. Treatments include doubled-up signs, additional pavement marking, fluorescent yellow sign sheeting, advance warning signs, oversize signs, and a between-lanes curbing on the side street.

To address the safety risks at intersections and the low cost of the recommended treatments, the City will consider a combination of these treatments at the following stop-controlled intersections:

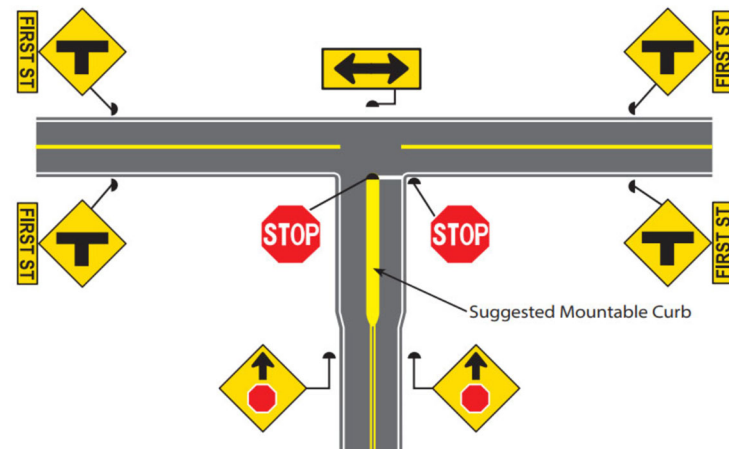


Figure 11. Low-Cost Intersection Treatments

- NE Goodwin Road and NW Alexandra Lane
- NE 3rd Avenue and NE Joy Street
- SE 23rd Street and SE 283rd Avenue
- NW Leadbetter Drive and NW Howard Street
- NE 6th Avenue and NW 7th Avenue
- NE 6th Avenue and NE Dallas Street
- NE 3rd Avenue and NE Hayes Street

- NE 6th Avenue and Division Street
- NW 14<sup>th</sup> Ave and Division Street
- NE 3rd Avenue and N Shepherd Road
- 3rd Avenue and Weir Street
- Camas Meadows Drive and Goodwin Road
- NW Lake Road and NW Sierra Street

### Example Intersection Locations

**NE Goodwin Rd and NW Alexandra Ln.** Located within a horizontal curve, this T-intersection has limited sight distance for all three approaches. Westbound Alexandra Ln takes a sharp reverse curve as it approaches the Stop sign. Southbound Goodwin Rd has a left curve that limits sight distance approaching Alexandra Lane. Northbound Goodwin Rd has a right curve just south of the Alexandra Ln intersection. Collision types include rear-ends and roadway departures. This intersection is also near a trailhead that attracts pedestrian traffic.



**Figure 12. Southbound Goodwin Road Approaching Alexandra Lane**

**NE 3rd Avenue and NE Joy Street.** This intersection serves residential neighborhoods and a nearby park. The eastbound Joy St approach has a downhill vertical curve for a full block approaching the intersection. Sight distance is limited by vegetation in all four corners. Westbound 3rd Ave has a horizontal curve in advance of the intersection.

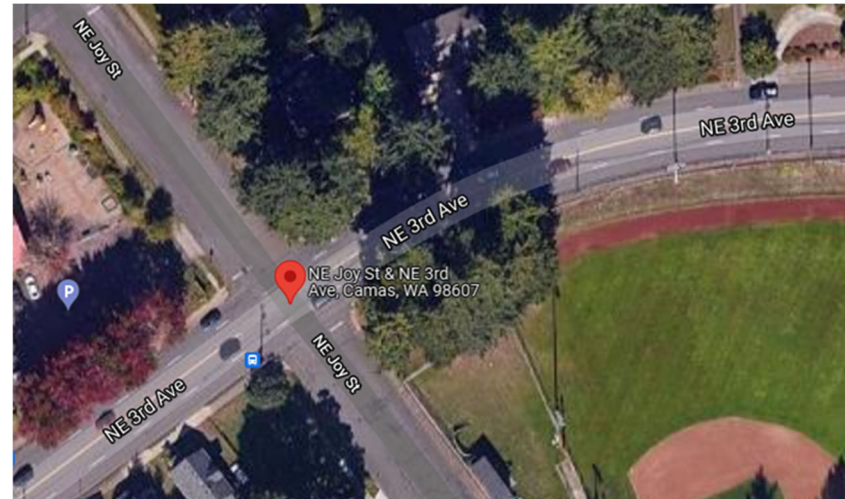


Figure 13. Aerial view of NE 3rd Avenue and NE Joy Street

**Camas: Systemic Stop-Controlled Intersection Safety Countermeasures**



**Project Description**

Install upgraded signing and pavement marking.



**Cost Estimate**

\$280,000



**Benefit / Cost Ratio**

42.41



**Time Frame**

Medium-term



**Crash Reduction**

**~38%**

**Combined reduction for the treatments described.**

**History:** 45 intersection collisions at the selected intersections from 2016-2020, including one fatal and one serious injury collision.

**Expected Benefit:** 3.39 fewer crashes per year

## PRIORITY 4. SYSTEMIC ROADWAY DEPARTURE

Roadway Departure collisions were the most common type to result in fatalities and serious injuries in Camas, with 40% of fatal and serious injury collisions during the study period including a vehicle departing its lane. Additionally, 35% of all collisions (regardless of severity) involved roadway departure. More specifically, 4 of the 15 fatal and serious injury collisions (27%) involved a vehicle crossing the centerline and striking another vehicle in a head-on collision. Figure 13 illustrates the frequency and density of roadway departure collisions.

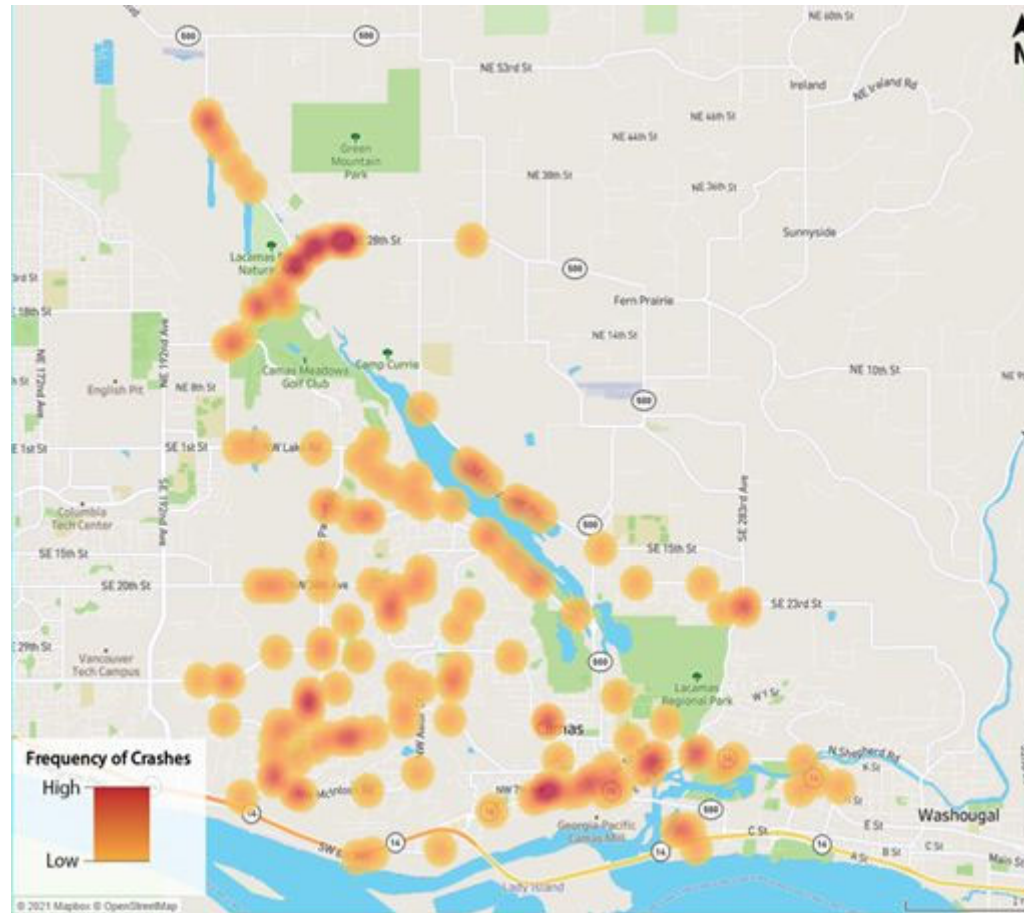


Figure 14. Roadway Departure Collisions, Camas, 2016-2020.

## 4.1 Citywide Horizontal Curve Safety Improvements

The City proposes horizontal curve safety improvements for two important reasons. First, motorists are more than three times as likely to be involved in a collision on a curve than a tangent section. Second, the most recent MUTCD (2009) included a legal requirement for every publicly-owned road with 1,000+ vehicles per day to meet horizontal curve requirements by December 31, 2019.






This safety project will provide current MUTCD standard curve warning signs at all horizontal curves on arterials and major collectors in the city limits (approximately 40 curves).

- Conduct a horizontal curve inventory study and posted speed limit study to assess existing conditions
  - Collect advisory speed data for each curve and turn
  - Collect operating speeds near each curve and turn, then analyze that data using current methodologies to determine the most appropriate posted speed limit.<sup>6</sup>
  - Calculate the difference between advisory speed and posted speed limit (per MUTCD)
- Design signing treatments
  - Determine the required (shall) and recommended (should) sign package for each curve per MUTCD Table 2C-5 (e.g., advanced warning sign, advisory speed plaque, chevrons, and/or one direction large arrow).
  - Confirm sign placement feasibility via field review
  - Produce plans, specifications, and estimates (PS&E) for curve signing
- Install horizontal curve warning signs

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<sup>6</sup> Experts have identified potential “too low” posted speed limits in La Center that have, as a result, reduced the horizontal curve warning sign requirements, since that requirement is tied directly to the posted speed limit per the MUTCD.

## Camas: Citywide Horizontal Curve Safety Improvements

	<u>Project Description</u> Provide current MUTCD standard curve warning signs or enhanced warning treatments at all horizontal curves and turns on arterials and major collectors	 <u>Cost Estimate</u> \$360,000	 <u>Crash Reduction</u> <b>15% Injury</b> <b>7% Property Damage Only</b> History: 108 curve crashes observed from 2016-2020. Expected Benefit: 2.06 fewer crashes per year
		 <u>Benefit / Cost Ratio</u> 29.66	
		 <u>Time Frame</u> Short-term	

### 4.2 Combined Roadway Departure Treatments Along Select Corridors

Low-cost roadway departure treatments focus primarily on keeping vehicles on the road and in their lane, and since motorists can depart the roadway at an infinite number of locations (versus the finite number of intersections in a jurisdiction), blanketing an entire corridor with roadway departure treatments can prevent future collisions, even at locations that have not experienced one in the past. The following treatments should be considered along select corridors.

- Enhanced Curve Safety Package.** On top of the minimum requirements, horizontal curve signing will be enhanced to provide additional warning for motorists: doubled-up signs, oversized signs fluorescent yellow sheeting, chevrons alignment signs, flexible delineators, flashers, speed feedback warning, and pavement marking. Additionally, High Friction Surface Treatment may be appropriate at select curves.
- Rumble Strips or Profiled Pavement Marking.** Provide visual, tactile, and auditory feedback to drivers - either via rumble strips or profiled pavement marking - depending on the surrounding land use.
- Nighttime Delineation.** Provide delineation via vertical delineators or products added to current appurtenances (e.g., guardrail) to improve visibility of roadway alignment in dark conditions.

- **Fixed Object Treatments.** For each fixed object within the right-of-way (with priority for those objects in the clear zone), address each using the following hierarchy per FHWA:
  - a. Remove the obstacle.
  - b. Redesign the obstacle so it can be safely traversed.
  - c. Relocate the obstacle to a point where it is less likely to be struck.
  - d. Reduce impact severity by using an appropriate breakaway device.
  - e. Shield the obstacle with a longitudinal traffic barrier designed for redirection or use a crash cushion.
  - f. Delineate the obstacle if the previous alternatives are not appropriate.

To address the roadway departure risks along segments, the City has identified the following priority corridors.

- NE Goodwin Rd from NW Friberg-Strunk St to NE 232nd Ave
- 3rd Ave from Franklin to Crown Road and from Adams Street to Dallas Street
- NW Lake Road from NW Friberg-Strunk Street to NE Everett Street
- NE Ingle Road from NE 199th Avenue to NE Goodwin Road
- Leadbetter Road from SE Everett Street to NE 9th Street
- Lewis and Clark Highway (SW 6th Avenue)
- NW Parker Street/SE Brady Road from Columbia Palisades Dr to NW Lake Road
- NW 6th Avenue from NE Adams St to western extent of Camas' city limits
- NW McIntosh Road from NW Brady Road to NW 11th Avenue



## Example Segment Locations

**NE Goodwin Road from NW Friberg-Strunk Street to NE 222<sup>nd</sup> Avenue.** This 1.3-mile segment runs along the north edge of the Camas City Limit and includes horizontal curves throughout. It is developing quickly and changing from rural to urban; Friberg-Strunk St is a signalized intersection. Collision attributes include roadway departure, speeding, wet roadway conditions, and motorcycle involvement.



Figure 15. Northbound NE Goodwin Rd near Camp Lacamas

**3rd Ave from Franklin to Crown Road & from Adams Street to Dallas Street.** State Route 500 starts at Dallas Street. The current section from Dallas Street to Franklin Street is a road diet that does not need improvements. A high-speed collision occurred recently east of Dallas Street. Improvements here could include lighting upgrades along with other systemic treatments.

### Camas: Systemic Roadway Departure Countermeasures along Select Corridors



Project Description  
Install enhanced safety treatments, profiled pavement markings, nighttime delineation, and/or fixed object treatments along these corridors.



Cost Estimate  
\$3,315,000



Benefit / Cost Ratio  
10.06



Time Frame  
Medium-term



Crash Reduction  
**~43%**

**Combined reduction for the treatments described.**

**History:** 135 roadway departure collisions along the select corridors from 2016-2020, including five fatal and 3 serious injury collisions.

**Expected Benefit:** 11.57 fewer crashes per year

## APPENDICES

**APPENDIX A: Safety Countermeasures Toolbox**

**APPENDIX B: Grant Programs**

**APPENDIX C: Collision Heat Maps**

# Appendix A Countermeasures Toolbox

## Signalized Intersections

### S1. Improve Intersection Lighting

A permanent source of artificial light applied to signalized intersections that have a disproportionate number of night-time crashes and do not currently provide sufficient lighting at the intersection or at its approaches.

#### Benefit-Cost

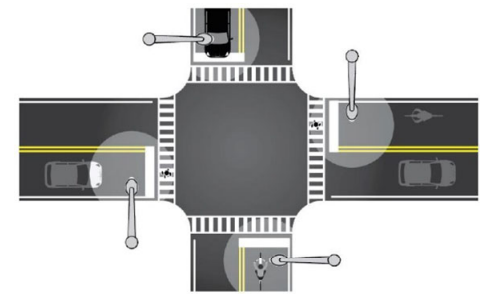
- » Implementation of this treatment reduces nighttime injury crashes by 38% and nighttime pedestrian crashes by 42%. (WSDOT)
- » 20 years of expected life
- » Estimated \$75,000
- » The provision of lighting involves both a fixed cost for lighting installation and an ongoing maintenance and power cost which results in a moderate to high cost.

Sources: CA-Local Roadway Safety Manual, FHWA, WSDOT

EXISTING CONDITION



IMPLEMENTATION



### S2. Improve Signal Hardware (lenses, back-plates, mounting, size, number of heads)

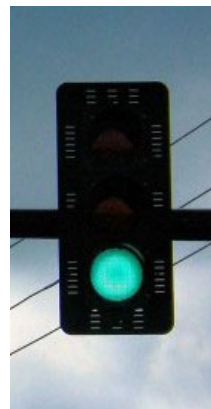
Applicable at signalized intersections with a high frequency of right-angle and rear-end crashes because drivers are unable to see traffic signals sufficiently in advance to safely negotiate the intersection being approached. Examples include increasing the size of indications from 8 in. to 12 in. and adding supplemental heads (e.g., side-mount, near-side mount).

#### Benefit-Cost

- » Implementation of this treatment can reduce crashes by 3-7% (WSDOT).
- » 10 years of expected life
- » Estimated \$40,000 per intersection
- » Cost varies based on size/number of signal heads.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



### S3. Improve Signal Timing (coordination, phasing, clearance intervals)

Effective at locations that have a crash history at multiple signalized intersections. Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations. This treatment addresses all types of crashes that occur on the approaches / influence area of the new signal timing. For projects coordination signals along a corridor, the crashes related to side-street movements should not be applied.

#### Benefit-Cost

- » Implementation of this treatment reduces all crashes by 16%, and particularly angle crashes by 32% (WSDOT).
- » 10 years of expected life
- » Estimated \$1,000 per intersection
- » Cost variation based on number of signal heads and number of movements.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



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### S4. Install Left-turn Lane and Add Turn Phase

Installed at signalized intersections that have a significant crash problem and the only alternative is to change the nature of the intersection itself. This treatment addresses all type of crashes and the measure can be very effective at intersection with complex geometry and intersection with frequent left-turn movements. A properly timed protected left-turn phase can also help reduce rear-end, broadside, and sideswipe crashes between left-turning vehicles and the through vehicles as well as vehicles behind them. This countermeasure only applies to crashes occurring on the approaches / influence area of the new left turn phases.

#### Benefit-Cost

- » Implementation of this treatment reduces all crashes by 35% and head on crashes by 69% (WSDOT).
- » 20 years of expected life
- » Estimated \$12,000 per intersection
- » If the existing traffic signal only requires a minor modification to allow for a protected left-turn phase, then the cost would also be low (installation is short because no actual construction). In-house signal maintainers can perform this operation once the proper signal phasing is determined so the cost is low.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## S5. Pavement Marking and RPMs through Intersection

Raised Pavement Markers (RPMs) and pavement marking installed in intersections where the lane designations are not clearly visible to approaching motorists. Can also be applied at intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection.

### Benefit-Cost

- » Implementation of this treatment reduces run off road, opposite direction and night crashes by 21% (WSDOT).
- » 10 years of expected life
- » Estimated \$2,000 per installation

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



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## S6. Improve Pavement Friction (High Friction Surface Treatment)

Improvement for signalized Intersections noted as having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than needed for roadway approach speeds. This treatment is intended to target locations where skidding and failure to stop is determined to be a problem in wet or dry conditions and the target vehicle is unable to stop due to insufficient skid resistance. In addition, treatment also addresses night crashes all other crashes. This treatment does not apply to standard chip-seal or open-graded maintenance projects for long segments of corridors or structure repaving projects intended to fix failed pavement.

### Benefit-Cost

- » Implementation of this treatment reduces crashes by 40% (WSDOT).
- » 10 years of expected life
- » Estimated \$5,000 per intersection for materials and equipment
- » Cost variation based on size of intersection and material (Estimated \$30/sq.yd.).

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## S7. Add Median Openings to Allow or Restrict Left-turns and U-turns

Install medians to reduce crashes related to turning maneuvers include angle, rear-end, pedestrian, and sideswipe (involving opposing left turns) type crashes. This treatment only applies to crashes occurring in the intersection/influence area of the new directional openings.

### Benefit-Cost

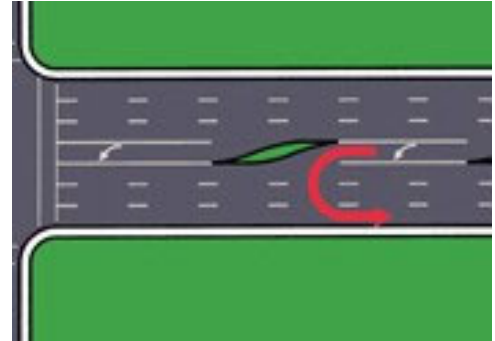
- » Implementation of this treatment reduces crashes by 51% (WSDOT).
- » 20 years of expected life
- » Estimated \$75,000 per installation
- » The cost of this strategy will depend on the treatment.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## S8. Install Right-turn Lane

Setting up right-turn lane may be appropriate in situations where there are an unusually high number of rear-end collisions on a single major road approach. The need for right turn lanes should be assessed on an individual approach basis. It is also important to ensure that the right-turn lanes are of sufficient length to allow vehicles to decelerate and “queue up” before turning, ideally without affecting the flow of through traffic. This treatment addresses rear-end crashes. When considering new right-turn lanes, potential impacts to non-motorized user should be considered and mitigated as appropriate.

### Benefit-Cost

- » Implementation of this treatment reduces crashes by up to 8% for all crashes and 17% for fatal/injury crashes (WSDOT).
- » 20 years of expected life
- » Estimated \$300,000 per right turn lane
- » Installing right turn lanes require substantial time for development and construction that can vary the cost.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## S9. Install Pedestrian Countdown Signal Heads

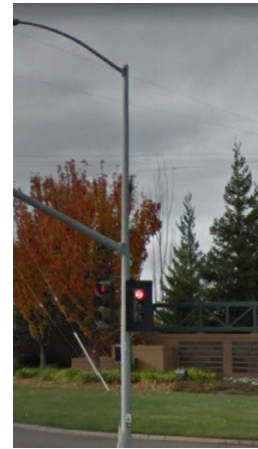
Install at signals that have signalized pedestrian crossing with WALK / DON'T WALK indications and where there have been pedestrian-vehicle crashes. The countermeasure addresses both pedestrian and bicycle collisions. This countermeasure only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new countdown heads.

### Benefit-Cost

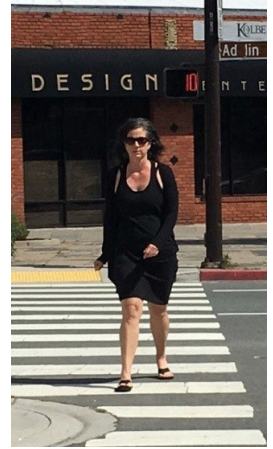
- » Implementation of this treatment reduces pedestrian crashes by 70% (WSDOT).
- » 20 years of expected life
- » Estimated \$1,500 per signal head (does not include push button or pole cost)
- » Costs and time of installation will vary based on the number of intersections included in this strategy and if it requires new signal controllers capable of accommodating the enhancement. This countermeasure can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## S10. Flashing Yellow Arrow Left Turn Signal

Flashing yellow arrow (FYA) traffic signals feature a flashing yellow arrow in addition to the standard red, yellow, and green arrows. When illuminated, the flashing yellow arrow allows waiting motorists to make a left-hand turn after yielding to oncoming traffic.

A national study demonstrated that drivers found flashing yellow left-turn arrows more understandable than traditional yield-on-green indications (green ball). Flashing yellow arrow treatment at signalized intersections can reduce the likelihood of left-turn crashes during permissive left-turn phasing. They can be used in either permissive-only or protected-permissive left-turn phasing schemes.

### Benefit-Cost

- » Implementation of this treatment reduces left turn crashes by 19% (WSDOT).
- » 10 years of expected life
- » Estimated \$200,000 per intersection (assuming 4 new installations)
- » Depending on the existing signal heads, signal controller, and signal cabinet, this treatment may require a controller replacement, which would increase the cost of installation.

EXISTING CONDITION



IMPLEMENTATION



Sources: FHWA, NACTO, Minnesota DOT

## S11. Leading Pedestrian Interval

A leading pedestrian interval (LPI) gives pedestrians the opportunity to enter the crosswalk at an intersection 3-7 seconds before vehicles are given a green indication. Using this “head start,” pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn right or left.

LPIs provide increased visibility of crossing pedestrians and increased likelihood of motorists yielding to pedestrians. This results in reduced conflicts between vehicles and pedestrians, improving intersection safety. LPI is particularly useful at signalized intersections with a high volume of turning movements.

### Benefit-Cost

- » Implementation of this treatment reduces pedestrian-vehicle crashes by 13-48% (FHWA, WSDOT, City of Seattle).
- » 10-20 years of expected life
- » Estimated \$200-10,000 (based on whether existing controller can accommodate the change)

Sources: FHWA, City of Seattle, WSDOT

### IMPLEMENTATION





# Countermeasures for Non-Signalized Intersections

## NS1. Add Intersection Lighting

Effective at unsignalized intersections that have a disproportionate number of nighttime crashes and do not currently have lighting. This treatment improves the safety of the intersection during nighttime by making drivers more aware of the surroundings at the intersection, enhancing driver's available sight distances and improving the visibility of non-motorists. This countermeasure only applies to nightcrashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.

### Benefit-Cost

- » Implementation of this treatment reduces nighttime injury crashes by 38% and nighttime pedestrian crashes by 42% (WSDOT).
- » 20 years of expected life
- » Estimated \$8,000 per intersection
- » Cost variation based on cost for lighting installation and an ongoing maintenance and powercost.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## NS2. Convert to All-way Stop Control

Applicable at unsignalized intersection locations (currently with two-way stop control or two-way yield control) with a crash history and have no controls on the major roadway approaches. The all-way stop control is suitable only at intersections with moderate and relatively balanced volume levels on the intersection approaches. This treatment addresses to all type of crashes and only applies to crashes occurring in the intersection and /or influence area of the new control. All-way stop warrant should be considered.

### Benefit-Cost

- » Implementation of this treatment reduces crashes by 18-75% (ODOT).
- » 10 years of expected life.
- » Estimated \$5,000 per intersection.
- » Cost variation based on numbers of locations.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



### NS3. Install Roundabout

Effective at intersections that have a high frequency of right-angle and left-turn type crashes, primarily at unsignalized intersections with moderate-volumes. This countermeasure only applies to crashes occurring in the intersection and/or influence area of the new control and is not eligible for use at existing all-way stop intersections.

#### Benefit-Cost

- » Implementation of this treatment at 2-way stop controlled intersection reduces crashes by 25% and fatal/injury crashes by 35% (WSDOT).
- » 20 years of expected life.
- » Estimated \$750,000 per intersection.
- » Cost variation based on the environmental process, right-of-way acquisition and implementation under an agency's long-term capital improvement program.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



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### NS4. Implement Unsignalized Intersection Signing and Marking Improvements

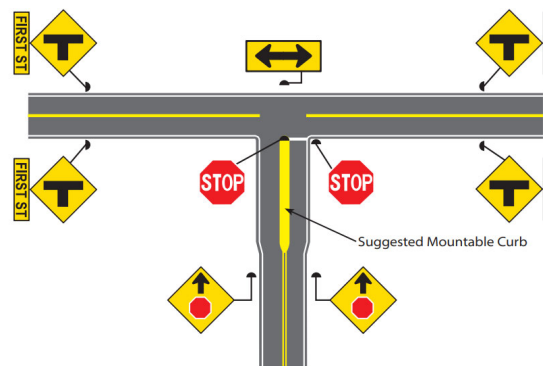
Target unsignalized intersections with patterns of rear-end, right-angle, or turning collisions related to lack of driver awareness of the presence of the intersection. The set of low-cost countermeasures is designed to increase drivers' alertness to the presence of the intersection and reduce potential conflicts with other entering vehicles. These treatments can include advanced intersection warning signs, oversized signs, doubled-up signs, stop ahead signs or painted on side street to supplement STOP sign.

#### Benefit-Cost

- » Implementation of this treatment reduces crashes by 25% (WSDOT).
- » 10 years of expected life.
- » Estimated \$700 per intersection.
- » Cost variation based on the number of signs.

Sources: CA-Local Roadway Safety Manual

IMPLEMENTATION



## NS5. Install Transverse Rumble Strips

Transverse rumble strips are installed in the travel lane for 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. This countermeasure applies to all crashes occurring on the approach / influence area of the new rumble strips.

### Benefit-Cost

- » Implementation of this treatment reduces all crashes by up to 6% and fatal/injury crashes by 7% (WSDOT).
- » 10 years of expected life.
- » Estimated \$5,000 per intersection.
- » Cost variation based on the length of the rumble strips.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## NS6. Install Raised Median

Used at Intersections noted as having turning movement crashes near the intersection as a result of insufficient access control. Application of this countermeasure should be based on current crash data and a clearly defined need to restrict or accommodate the movement. Angle crashes are addressed through this countermeasure. When agencies opt to install landscaping in conjunction with new raised medians, these locations must be excluded from their federally funded HSIP application scope. This countermeasure only applies to crashes occurring on the approaches / influence area of the new raised median.

### Benefit-Cost

- » Implementation of this treatment reduces all crashes by up to 39% and fatal/injury crashes by 44% (WSDOT).
- » 20 years of expected life.
- » Estimated \$200,000+ (depends on length, right-of-way, and surface treatment).
- » Cost variation based on the size of the new median.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## NS7. Install Right-turn Lane

Applicable when many collisions at unsignalized intersections are related to right-turn maneuvers. This countermeasure provides exclusive right-turn lanes, particularly on high-volume and high-speed major-road approaches to minimizing the collisions and applies to crashes occurring on the approaches / influence area of the new right-turn lanes.

### Benefit-Cost

- » Implementation of this treatment reduces all crashes by up to 8% and fatal/injury crashes by 17% (WSDOT).
- » 20 years of expected life.
- » Estimated \$200,000 per intersection.
- » Cost variation based on how wide the new right turn lane.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## NS8. Install Enhanced Pedestrian Crossing with

### Advanced Features

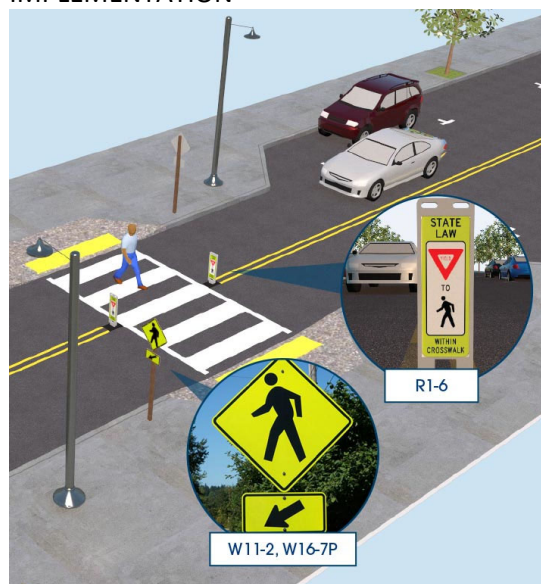
Applicable at non-signalized intersections without a marked crossing, where pedestrians are known to cross, that involve significant vehicular traffic. They are important at school crossings and intersections with right and/or left turns pockets. Rectangular rapid flashing beacons (RRFBs), overhead flashing beacons, curb extensions, advanced stop or yield lines and other safety features should be added to complement the standard crossing elements. This countermeasure reduced pedestrian crashes occurring in the crossing (influence area) with the new enhanced safety features.

### Benefit-Cost:

- » Implementation of this treatment reduces pedestrian crashes by 40% (WSDOT).
- » 20 years of expected life
- » Estimated \$ 50,000 per intersection
- » Cost variation based on the length of the pedestrian crossing and the amount of safety signs.

Sources: CA-Local Roadway Safety Manual

IMPLEMENTATION



## NS9. Install Pedestrian Crossing (signs and markings only)

Applicable when many collisions at unsignalized intersections are related to left-turn maneuvers. This countermeasure provides exclusive left-turn lanes, particularly on high-volume and high-speed major-road approaches to minimizing the collisions. This countermeasure applies to crashes occurring on the approaches /influence area of the new left- turn lanes, but is not eligible for use at existing all-way stop intersections.

### Benefit-Cost

- » Implementation of this treatment reduces pedestrian crashes by 40% (WSDOT).
- » 20 years of expected life
- » Estimated \$200,000 per intersection
- » Cost variation based on how wide the new left lane.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



# Countermeasures for Roadway Segments

## R1. Add Segment Lighting

Applied to night-time crashes. In particular, 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. This treatment addresses only to all night type crashes.

### Benefit-Cost

- » Implementation of this treatment reduces injury crashes by 28% (HSM).
- » 20 years of estimated life
- » Estimated \$8,000 per installation
- » Cost variation depending if lighting connected to signal box.

Sources: CA-Local Roadway Safety Manual, Highway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



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## R2. Remove or Relocate Fixed Objects

Applicable to known locations or roadway segments prone to collisions with fixed objects such as utility poles, drainage structures, trees, and other fixed objects, such as the outside of a curve, end of lane drops, and in traffic islands. This treatment addresses fixed object crashes that occur within the current clear zone.

### Benefit-Cost

- » Implementation on this treatment reduces run off road crashes by 38% (WSDOT).
- » 20 years of expected life
- » Varies. Up to estimated \$50,000 per deployment
- » Costs will generally be low, assuming that in most cases the objects to be removed are within the right-of-way.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



### R3. Install Guardrail

Guardrail is installed to reduce the severity of lane departure crashes. This treatment addresses fixed object and run-off road crashes. Its value in reducing collisions should only be applied to locations where past crash data or engineering judgement suggests the guardrail may result in a few or less severe crashes because the guardrail itself is a fixed object.

#### Benefit-Cost

- » Implementation on this treatment reduces run off road crashes by 7-34% (ODOT).
- » 20 years of expected life
- » Estimated \$50,000 per installation

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



### R4. Install Roadside Impact Attenuators

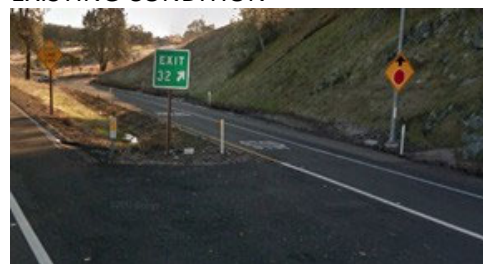
Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. This treatment addresses fixed object and run-off road that occur with the limits of the new attenuators. This countermeasure and corresponding collision reduction benefits should only be applied to locations where past crash data or engineering judgement applied to existing conditions suggests the upgraded attenuators may result in a few or less severe crashes.

#### Benefit-Cost

- » Implementation of this treatment reduces crashes by 25%.
- » 10 years of expected life
- » Estimated \$5,000 for steel railing, \$2,500 for traffic barrels
- » Costs depending on the scope of the project, type(s) used, and associated ongoing maintenance costs.

Sources: CA-Local Roadway Safety Manual

EXISTING CONDITION



IMPLEMENTATION



## R5. Add 2 ft Paved Shoulder

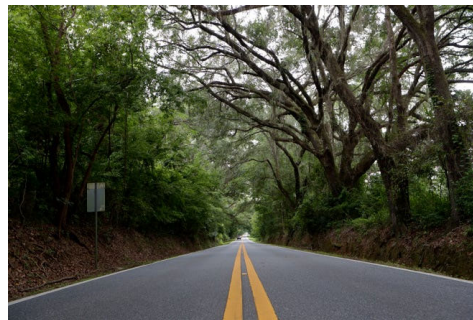
Installed in roadways that have a frequent incidence of vehicles leaving the travel lane resulting in an unsuccessful attempt to reenter the roadway. The probability of a safe recovery is increased if an errant vehicle is provided with an increased paved area in which to initiate such a recovery. This type of countermeasure addresses Fixed object, Run-off Road, and Sideswipe collisions.

### Benefit-Cost

- » Implementation on this treatment reduces crashes by 5-13% (ODOT).
- » 20 years of expected life.
- » Estimated \$150,000 (cost depends on need for right-of-way or if roadside modification is needed).
- » Shoulder widening costs would depend on whether new right-of-way is required and whether extensive roadside modification is needed. Since shoulder widening can be a relatively expensive treatment, one of the keys to creating a cost-effective project with at least a medium B/C ratio is targeting higher-hazard roadways.

Sources: CA-Local Roadway Safety Manual

### EXISTING CONDITION



### IMPLEMENTATION



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## R6. Add Unpaved Shoulder

Appropriate to roadways with a frequent incidence of vehicles leaving the travel lane resulting in an unsuccessful attempt to reenter the roadway. This countermeasure addressed all types of crashes. Unless shoulder widening requires additional right-of-way and environmental impacts, these treatments can be implemented in a relatively short timeframe. This countermeasure only applies to crashes occurring within the limits of the new shoulder.

### Benefit-Cost

- » Implementation on this treatment reduces crashes by 3-6% (ODOT).
- » 20 years of expected life
- » Estimated \$50,000 (varies)
- » The cost of adding a navigable non-paved shoulder would depend whether extensive roadside modification and shoulder stabilization are required.

Sources: CA-Local Roadway Safety Manual

### IMPLEMENTATION





## R7. Install Chevron Signs on Horizontal Curves

Set up on roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness. Ideally this type of safety countermeasure would be combined with other sign evaluations and upgrades (install warning signs, delineators, markers, beacons, and relocation of existing signs per MUTCD standards). This treatment can address all types of crashes; but, specifically, run-offroad crashes occurring near curves. This treatment only applies to crashes occurring within the influence area of the new signs (i.e. only through the curve).

### Benefit-Cost:

- » Implementation of this treatment reduces crashes by 64% (WSDOT).
- » 10 years of expected life.
- » Estimated \$1,000 per curve
- » Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low-cost improvements are usually funded through local funding by local maintenance crews. However, this treatment can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.

Sources: CA-Local Roadway Safety Manual

### IMPLEMENTATION



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## R8. Add Speed Feedback Signs

This type of treatment addresses all crashes caused by motorist traveling too fast, including horizontal curves. Before choosing this treatment, the agency needs to confirm the ability to provide power to the site (solar may be an option).

### Benefit-Cost

- » Implementation on this treatment reduces crashes by 46% (WSDOT).
- » 10 years of expected life
- » Estimated \$20,000-100,000
- » Cost varies by type of implementation.

Sources: CA-Local Roadway Safety Manual

### IMPLEMENTATION



## R9. Install Edge Line and Centerline Pavement Marking

Applicable on any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment. This treatment addresses all types, specifically impacts head-on and run-off road crashes. It only applies to crashes occurring within the limits of the new centerlines and/or edge lines. The treatment is not intended to be used for general maintenance activities (i.e. the replacement of existing striping) and must include upgraded safety features over the existing striping. For two lane roadways allowing passing, a striping audit must be done to ensure the passing limits meeting the MUTCD standards. Both the centerline and edge lines are expected to be upgraded.

### Benefit-Cost

- » Implementation on this treatment reduces run off road, opposite direction and nighttime crashes by 21% (WSDOT).
- » 10 years of expected life
- » Estimated \$4,000 (depends on number and length of segment, as well as striping material)
- » Costs for implementing this strategy are nominal and depend on the number and length of segment as well as the striping material (paint, thermoplastic, etc.). This countermeasure can be effectively implemented using a systemic approach with numerous and long locations.

Sources: CA-Local Roadway Safety Manual

### IMPLEMENTATION



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## R10. Install No Passing Zone

Installed on roadways that have a high percentage of head-on crashes suggesting that many head-on crashes may relate to failed passing maneuvers. No Passing Zones should be installed where drivers' "passing sight distance" is not available due to horizontal or vertical obstructions. This treatment addresses all types of crashes that occur when drivers cannot differentiate the centerline markings between passing and no-passing area. This treatment only applies to crashes occurring within the limits of the new or extended no-passing zones.

### Benefit-Cost

- » Implementation of this treatment reduces crashes by 45%.
- » 10 years of expected life
- » Estimated \$2,000 (varies)
- » When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This treatment can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding.

### IMPLEMENTATION



## R11. Install Centerline Rumble Strips/Stripes

Center Line rumble strips/stripes should be used on segments with a history of head-on crashes. This treatment addresses head-on and opposite-direction side-swipe crashes by alerting drivers who travel into the oncoming travel lane.

### Benefit-Cost

- » Implementation of this treatment reduces crashes by 20%.
- » 10 years of expected life
- » Estimated \$3,000 per mile
- » Costs for implementing this strategy are nominal and depend on the number and length of locations.

### IMPLEMENTATION



Sources: CA-Local Roadway Safety Manual

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## R12. Install Edge Line Rumble Strips/Stripes

Shoulder and edge line milled rumble strips/stripes should be used on roads with a history of roadway departure crashes. This treatment addresses run-off road crashes by providing an auditory and tactile warning when driven on, alerting drivers drifting outside their travel lanes.

### Benefit-Cost

- » Implementation of this treatment reduces opposite direction crashes by 40% and fatal/injury crashes by 8%.
- » 10 years of expected life
- » Estimated \$3,000 per mile
- » Costs for implementing this strategy are nominal and depend on the number and length of locations.

### IMPLEMENTATION



Sources: CA-Local Roadway Safety Manual

## R13. Rail Crossing Treatments

**Four Quadrant Gates** extend across all roadway lanes on both the approach and the departure side of the crossing. Unlike two-quadrant gate systems, four-quadrant gates provide additional visual constraints and inhibit most traffic movements over the crossing after the gates have been lowered. Safe guards are put in place to ensure vehicles are not trapped on the tracks.

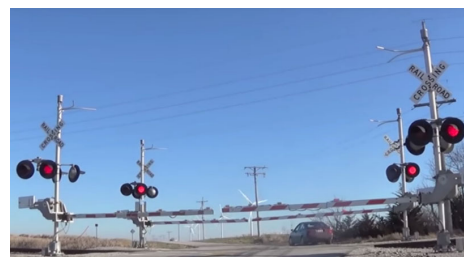
**Wayside Horns** can be used as an adjunct to train-activated crossing warning systems to provide audible warning of an approaching train for traffic on each approach to the highway-rail crossing. A wayside horn system consists of a horn or series of horns located at a public highway-rail crossing and directed at oncoming motorists. The wayside horn system simulates a train horn and sounds at a minimum of 15 seconds prior to the train's arrival at the highway-rail crossing, until the lead locomotive has traversed the crossing. It is typically used at locations where the train horn is not sounded.

### Benefit-Cost

- » Quantified benefits unknown.
- » 10 Years of expected life
- » Estimated \$700,000 for four quadrant gate system
- » Estimated \$500,000 for wayside horn system

Sources: FHWA, FRA

### IMPLEMENTATION



Four Quadrant Gate



Wayside Horn

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## R14. No Passing Zone Signs

A No Passing Zone, indicated by a solid yellow line on the left side of the driver's direction of travel, indicates a zone through which sight distance is restricted or where other conditions make overtaking and passing inappropriate. No Passing Zones are regulatory and legally enforceable.

In situations where head-on collision history is observed, a NO PASSING ZONE pennant can provide additional information to drivers at the beginning of the No Passing Zone, discouraging passing maneuvers. The NO PASSING ZONE sign is installed on the left side of the roadway.

Additionally, DO NOT PASS signs can be added as a supplement to No Passing Zone pavement markings to emphasize the restriction on passing. It can be installed at the beginning of, and at intervals within, the No Passing Zone.

### Benefit-Cost

- » Quantified benefits unknown.
- » 10 Years of expected life
- » Estimated \$200 per sign

Sources: FHWA

### IMPLEMENTATION



## Figure Links

S1a <https://www.aaroads.com/california/ca-238.html> S1b <https://www.aaroads.com/california/ca-262.html>  
S2a <https://safety.fhwa.dot.gov/provencountermeasures/lighting.cfm>  
S2b <http://wishtv.com/2016/02/16/new-traffic-signals-aim-to-reduce-crashes/>  
S3a <http://www.k-state.edu/roundabouts/ada/news/USNews.htm>  
S3b <https://parade.com/19072/marilynvossavant/what-would-traffic-light-synchronization-cost/>  
S4a <https://www.fhwa.dot.gov/publications/research/safety/09036/index.cfm>  
S4b <http://www.madriverunion.com/samoa-boulevard-traffic-light-system-changed-up/>  
S5a <https://dohanews.co/qatars-civil-defense-junction-is-now-a-proper-intersection/>  
S5b <http://www.gulf-times.com/story/461946/Ashghal-opens-signal-controlled-intersection-on-New-Rayyan-Road>  
S6a <http://www.cochraneagle.com/article/Cochrane-families-celebrate-cultural-diversity-20170803>  
S6b [https://rspcb.safety.fhwa.dot.gov/noteworthy/html/edccasestudy\\_ky.aspx](https://rspcb.safety.fhwa.dot.gov/noteworthy/html/edccasestudy_ky.aspx)  
S7a <https://bouldercolorado.gov/transportation/median-maintenance>  
S7b Unknown  
S8a Google Streetview  
S8b <https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/through-bike-lanes/>  
S9a Google Streetview  
S9b Google Streetview  
S10 <https://www.sacbee.com/news/local/article239121918.html>  
S11 [https://safety.fhwa.dot.gov/provencountermeasures/lead\\_ped\\_int.cfm](https://safety.fhwa.dot.gov/provencountermeasures/lead_ped_int.cfm)

NS1a Google Streetview  
NS1b Google Streetview  
NS2a Google Streetview  
NS2b <http://www.ite.org/uiig/types.asp>  
NS3a <https://www.flickr.com/photos/repowers/2933707788/>  
NS3b Google Streetview  
NS4a <https://alchemistsdiary.wordpress.com/2017/07/22/>  
NS4b [https://safety.fhwa.dot.gov/intersection/other\\_topics/fhwasa09020/fhwasa09020.pdf](https://safety.fhwa.dot.gov/intersection/other_topics/fhwasa09020/fhwasa09020.pdf)  
NS5a [http://www.cleveland.com/berea/index.ssf/2012/11/berea\\_changes\\_stop\\_sign\\_parkin.html](http://www.cleveland.com/berea/index.ssf/2012/11/berea_changes_stop_sign_parkin.html)  
NS5b <https://radiobintangsembilan.com/2016/03/07/hindari-kecelakaan-anak-sekolah-warga-minta-garis-kejut/>  
NS6a <http://www.jurist.org/hotline/2014/03/zachary-heiden-maine-panhandling.php>  
NS6b [https://www.edmonton.ca/transportation/on\\_your\\_streets/neighbourhood-traffic-concerns.aspx](https://www.edmonton.ca/transportation/on_your_streets/neighbourhood-traffic-concerns.aspx)  
NS7a Google Streetview  
NS7b <https://ux.stackexchange.com/questions/42867/how-does-the-projection-angle-of-road-arrows-change-drivers-expectations-of-the>  
NS8a [https://en.wikipedia.org/wiki/Uncontrolled\\_intersection](https://en.wikipedia.org/wiki/Uncontrolled_intersection)  
NS8b <https://safety.fhwa.dot.gov/provencountermeasures/crosswalk-visibility.cfm>  
NS9a Google Streetview  
NS9b <https://nacto.org/publication/urban-bikeway-design-guide/bicycle-boulevards/major-street-crossing/>

R1a <https://www.shutterstock.com/nb/video/clip-9830723-4k-driving-car-on-highway-roadway-night>  
R1b <https://www.wsdot.wa.gov/research/reports/fullreports/847.1.pdf>  
R2a Google Streetview  
R2b Google Streetview  
R3a Google Streetview  
R3b [https://www.reddit.com/r/funny/comments/4zcplq/a\\_local\\_plumbers\\_truck\\_decal/](https://www.reddit.com/r/funny/comments/4zcplq/a_local_plumbers_truck_decal/)  
R4a Unknown  
R4b <http://sllee.com/attenuators/Impact-Attenuators>  
R5a Unknown  
R5b [https://safety.fhwa.dot.gov/ped\\_bike/tools\\_solve/fhwasa11018/](https://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa11018/)  
R6b <https://www.fhwa.dot.gov/publications/research/safety/15030/009.cfm>

R7b [https://safety.fhwa.dot.gov/provencountermeasures/enhanced\\_delineation.cfm](https://safety.fhwa.dot.gov/provencountermeasures/enhanced_delineation.cfm)  
R8b <https://www.fhwa.dot.gov/publications/research/safety/15030/009.cfm>  
R9b <https://www.fhwa.dot.gov/publications/research/safety/15030/009.cfm>  
R10b <https://www.shutterstock.com/nb/search/double+yellow+lines>  
R11b [https://safety.fhwa.dot.gov/roadway\\_dept/pavement/rumble\\_strips/bike\\_ig/](https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/bike_ig/)  
R12b [https://safety.fhwa.dot.gov/roadway\\_dept/pavement/rumble\\_strips/bike\\_ig/](https://safety.fhwa.dot.gov/roadway_dept/pavement/rumble_strips/bike_ig/)  
R13a [https://cms.cityoftacoma.org/PublicWorks/RR\\_Crossing/Dome\\_OldTown/Option4\\_S\\_C\\_St\\_Poster\\_1of2.pdf](https://cms.cityoftacoma.org/PublicWorks/RR_Crossing/Dome_OldTown/Option4_S_C_St_Poster_1of2.pdf)  
R13b [https://safety.fhwa.dot.gov/hsip/xings/com\\_roaduser/fhwasa18040/](https://safety.fhwa.dot.gov/hsip/xings/com_roaduser/fhwasa18040/)  
R14a [https://safety.fhwa.dot.gov/older\\_users/fhwasa15088/ch4.cfm](https://safety.fhwa.dot.gov/older_users/fhwasa15088/ch4.cfm)  
R14b <https://driving-tests.org/road-signs/do-not-pass-sign/>

# Appendix B Grant Programs

Based on the projects included in the City Safety Plan, the City may be eligible to submit projects to the following grant programs.

## **WSDOT City Safety Program**

WSDOT Local Programs sends out a call for projects each even-numbered year. This program's funding is for projects enhancing safety on city streets by reducing the severity of crashes and utilizing transportation engineering improvements and countermeasures.

<https://wsdot.wa.gov/LocalPrograms/Traffic/CitySafetyProgram>

## **WSDOT Pedestrian and Bicycle Program**

WSDOT Active Transportation Program sends out a call for projects each even-numbered year. The Pedestrian and Bicycle Program objective is to improve the transportation system to enhance safety and mobility for people who choose to walk or bike.

<https://wsdot.wa.gov/LocalPrograms/ATP/funding.htm>

## **WSDOT Safe Routes to School Program**

WSDOT sends out calls early in even numbered years for project awards in the following biennium. The purpose of the Safe Routes to Schools program is to improve safety and mobility for children by enabling and encouraging them to walk and bicycle to school. Funding from this program is for projects within two-miles of primary, middle and high schools (K-12).

<https://wsdot.wa.gov/LocalPrograms/SafeRoutes/funding.htm>

## **WSDOT Railway-Highway Crossings Program**

Open call for projects depends on future federal funding and Washington State priorities. This program's funding is for projects enhancing safety at public grade crossings by reducing the severity of crashes and installing or upgrading protective mechanisms at railroad crossings.

<https://wsdot.wa.gov/localprograms/traffic/railway-crossings-program>

## **Transportation Improvement Board (TIB) Complete Streets**

The Complete Streets Award is a funding opportunity for local governments that have an adopted complete streets ordinance. Board approved nominators may nominate an agency for showing practice of planning and building streets to accommodate all users, including pedestrians, access to transit, cyclists, and motorists of all ages and abilities.

<http://www.tib.wa.gov/grants/grants.cfm?inav=3#other2>

## **Surface Transportation Block Grant (STBG) - Urban**

STBG – Urban is for jurisdictions above 5,000 population. The grant is approximately \$6 million per year, with grant applications due in July and grant awards in September. Previous funded projects include bringing urban roads and intersections up to urban standards. Projects need to have a balance of capacity, safety, and economic development to get funding.

<https://www.rtc.wa.gov/programs/tip/docs/tipcrit21.pdf>

## **STBG - Rural**

STBG – Rural is for smaller jurisdictions and rural areas awards approximately \$1 million every other year (even-numbered years). Selection occurs with applications due in July and grant awards in September. Criteria are less stringent than urban, but support capacity, safety, and economic development. It has funded downtown improvements in smaller cities and for arterial preservation/safety on county road arterials that access cities.

<https://www.rtc.wa.gov/programs/tip/call/>

## **Congestion Mitigation and Air Quality (CMAQ) Improvement Program**

This is available for projects that improve air quality. Available funding is approximately \$3 million per year, with applications due in July and September grant awards. CAQ has the same criteria as STBG-Urban, but air quality points are tripled. Mostly funded projects are signalized intersections and transit-related projects.

<https://www.rtc.wa.gov/programs/tip/call/>

## **Transportation Alternatives (TA)**

Approximately \$1.3 million available every odd year (2023, 2025, etc.). Grant application due in April with grant awards in July. Criteria and process is outlined in

<https://www.rtc.wa.gov/programs/tap/docs/taGuidebook.pdf>. Has funded pedestrian/bicycle improvements.



# APPENDIX C: COLLISION HEAT MAPS

Following WSDOT’s recommended procedure, the consultant support team applied the most common attributes present in fatal/serious injury collisions to the entire network by mapping collisions based on those attributes.

Figures C1 through C5 show the locations of crashes with these attributes.

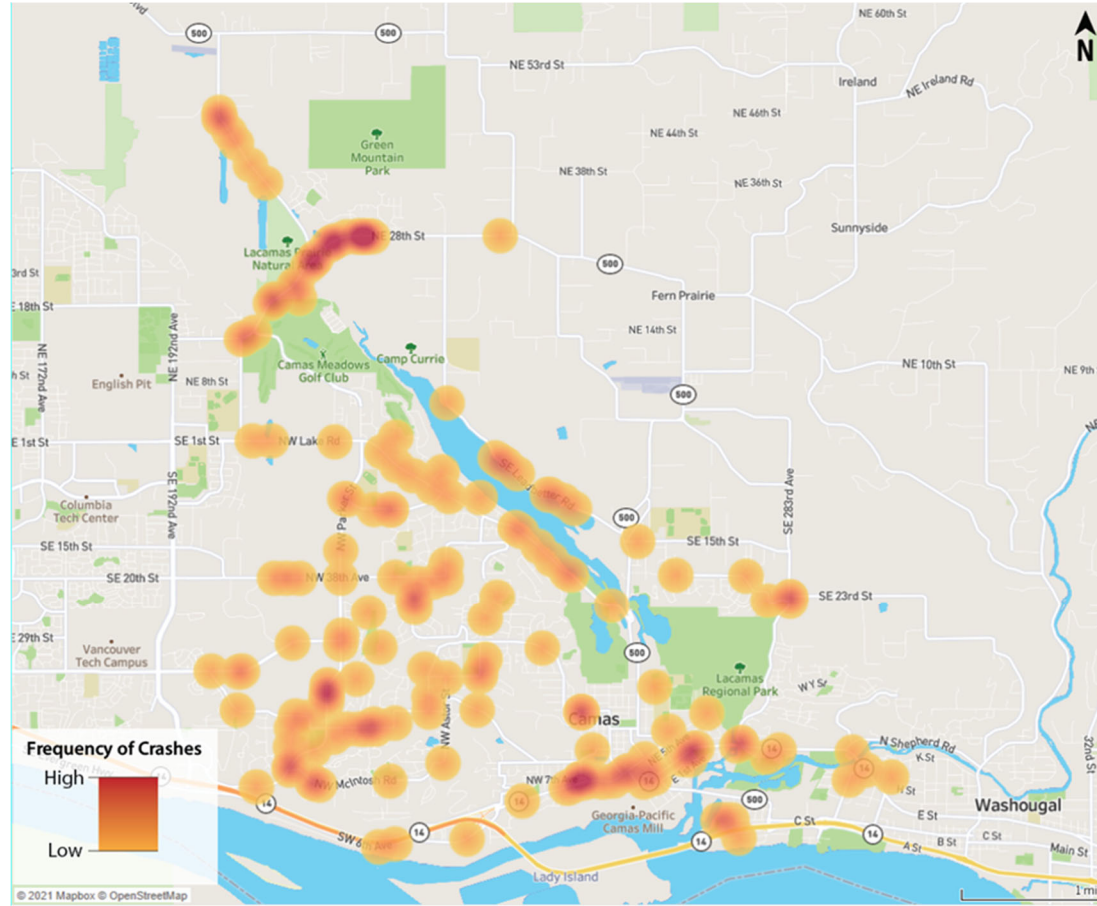


Figure C1. Roadway Departure Collisions, Camas, 2016-2020.

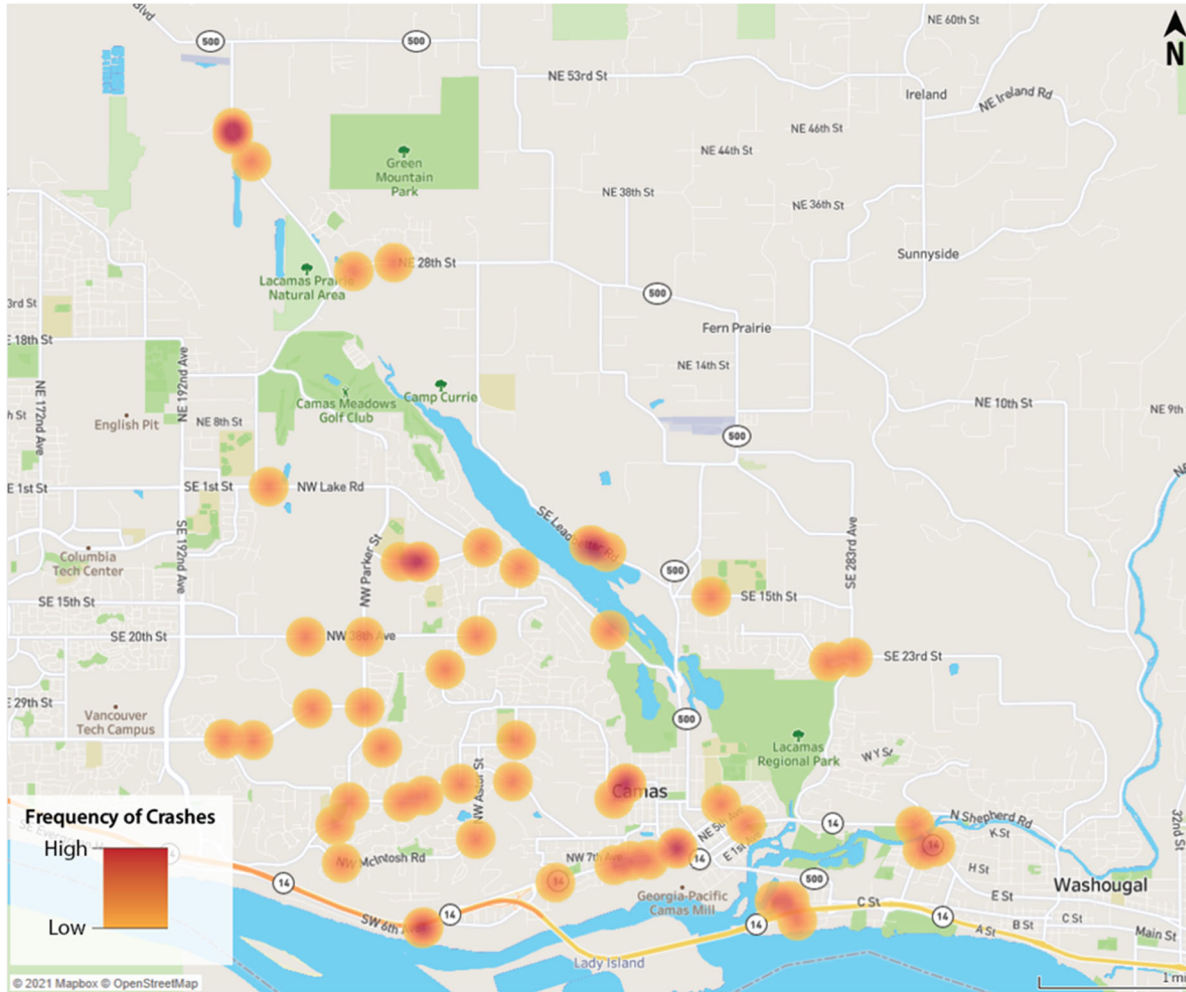


Figure C2. Speeding-related Collisions, Camas, 2016-2020.

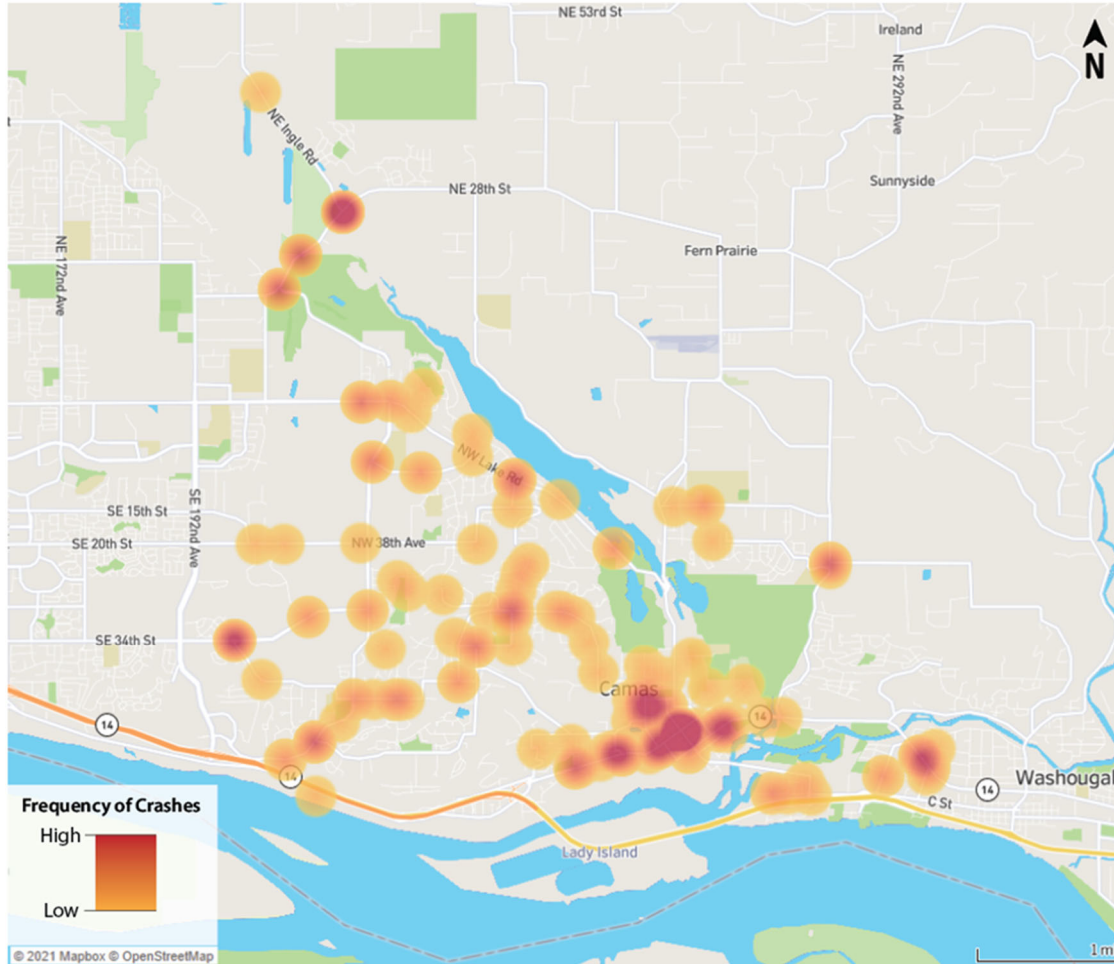


Figure C3. Unsignaled Intersection Collisions, Camas, 2016-2020.

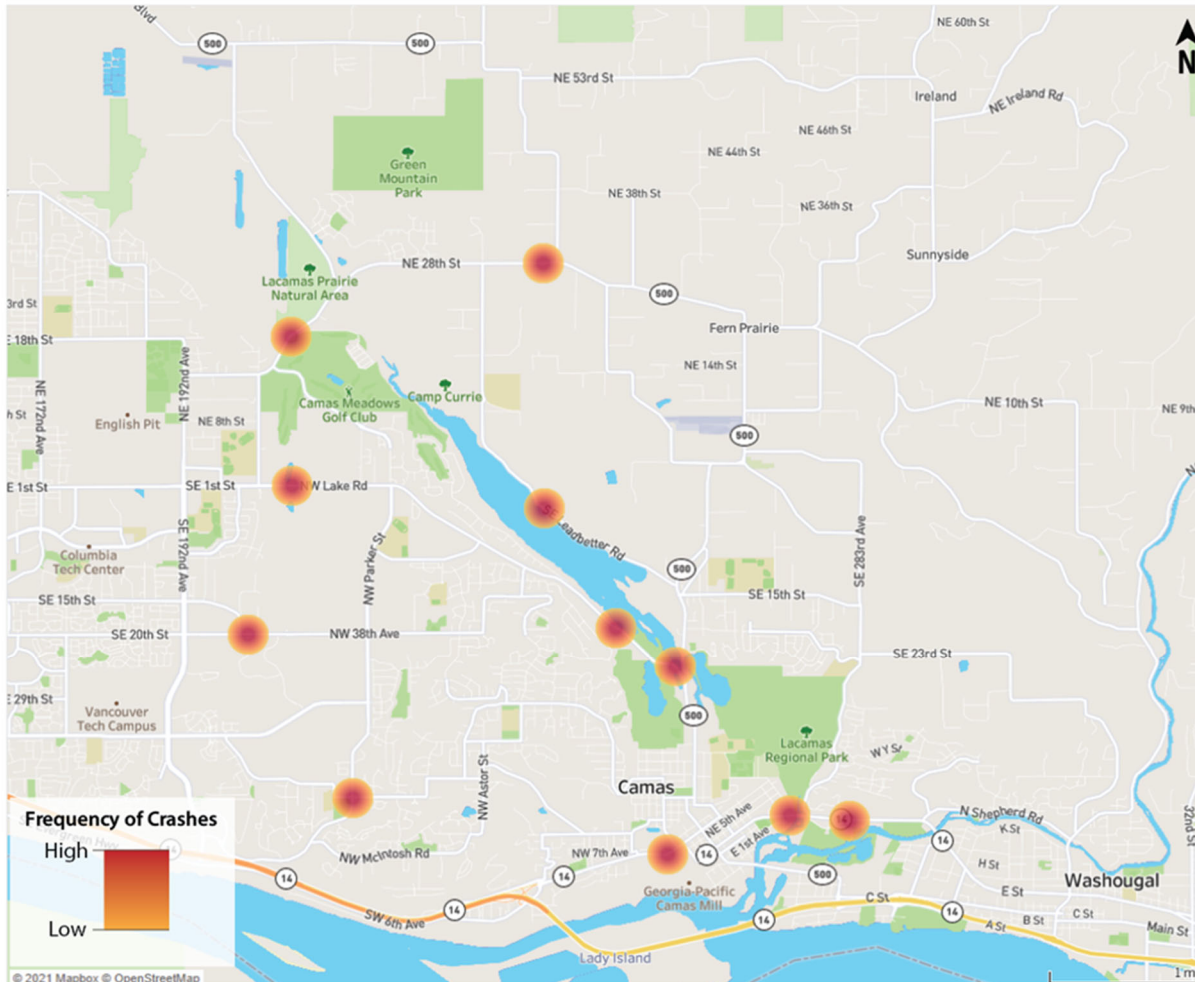


Figure C4. Motorcycle-involved Collisions, Camas, 2016-2020

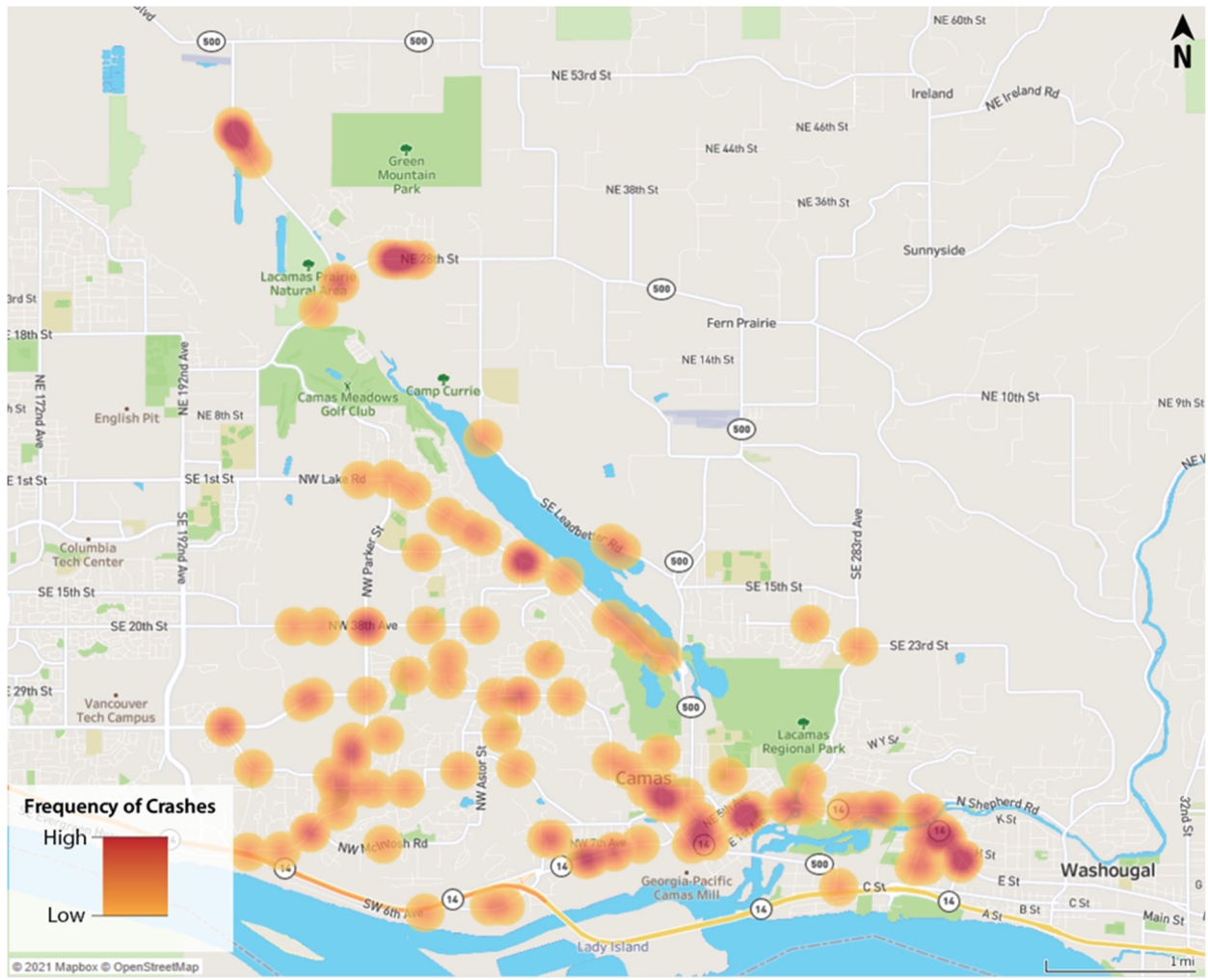


Figure C5. Collisions on Wet Roads, Camas, 2016-2020.