# APPENDIX

# APPENDIX A: Technical Memorandum #1: Risk Factor Identification

## Technical Memorandum #1

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CC: **ODOT Technical Advisory Committee** 

RE: Risk Factor Identification

### ODOT INTERSECTION SAFETY PLAN

#### Introduction

The 2021 Oregon Transportation Safety Plan (TSAP)<sup>1</sup> established a long-term vision of eliminating fatal and serious injuries on Oregon roadways by 2035. The TSAP noted that an estimated 36% of all fatal and injury crashes occurred at intersections between 2014-2018 (the most recent available at that time). As a result, one of the key action items identified by the TSAP is updating the Oregon Intersection Safety Implementation Plan, previously completed in 2012.

The objective of this Oregon Intersection Safety Implementation Plan Update is to develop a data-driven framework for conducting systemic intersection safety analyses that is in line with the Safe System Approach. The resulting framework will be used by local agencies and ODOT Regions to identify and implement low-cost systemic projects over multiple sites. It could also be used to complement crash historybased screening analyses (e.g., Safety Priority Index System (SPIS) analyses).

#### Safe System Approach

The plan update incorporates a Safe System Approach (SSA)-based framework, which approaches roadway safety with the notion that a Minimize Remove or Minimize Minimize conflict simplify road impact impact angles points user decisions speeds For all road users

Source: Understanding and Improving Safe System Intersection Performance, Austroads Research Report AP-R556-17

crash resulting in a fatal or serious injury on a roadway is unacceptable. It encourages proactively designing intersections to reduce crash risk in anticipation of human error. SSA intersection design principles include managing conflict points, motor vehicle speeds, potential crash angles, and movement complexity. While crashes are unavoidable, their severity can be mitigated through appropriate countermeasures focused on these design principles<sup>2</sup>. In accordance with the SSA, this project is focused on fatal and suspected serious injury (i.e., Injury A) crashes). SSA principles will inform other aspects of this plan, including risk factor selection, network screening, and countermeasure identification and prioritization methods.

Oregon Department of Transportation (ODOT) (2021). Oregon Transportation Safety Action Plan. https://www.oregon.gov/odot/Safety/Documents/2021\_Oregon\_TSAP.pdf.

<sup>&</sup>lt;sup>2</sup> FHWA (2021). A Safe System-Based Framework and Analytical Methodology for Assessing Intersections. Tech Brief: A Safe System-Based Framework and Analytical Methodology for Assessing Intersections (dot.gov).

#### **Systemic Safety**

Consistent with the SSA framework, this plan update approaches intersection safety through a proactive, data-driven systemic process that identifies intersections at highest risk for fatal and serious injury crashes. This approach complements the traditional "hot-spot" approach, which focuses on intersections with the highest historic crash rates (ODOT's SPIS is an example of a hot-spot screening approach, though it uses a combination of crash history and risk factors). The systemic approach is well suited for evaluating high-severity, low frequency crash types, such as severe intersection crashes. It considers that while the location of these crashes may appear random, the underlying contributing factors are predictable.

#### **Plan Outline**

The methodology for the ODOT Intersection Safety Implementation Plan Update is outlined in the five steps shown in Figure 1 and summarized below. These steps are in alignment with the systemic approach and the Oregon DOT Pedestrian and Bicycle Safety Implementation Plan<sup>3</sup>.

Figure 1. Intersection Safety Plan Update Process



- Step 1 (Confirm Study Network, Compile Available Data, and Identify Risk Factors): The study network and risk factors are identified using existing available data. This memorandum covers Step 1.
- **Step 2 (Screen Network)**: The network of study intersections will be screened using weighted risk factors identified in Step 1. A map of study intersections by ODOT region is provided in Appendix A. Step 2 will be discussed in Technical Memorandum #2.
- **Step 3 (Select Potential Countermeasures)**: The results of Step 2 inform the selection of potential treatment sites. Intersection safety countermeasures are then identified for each site. This project will include example treatments at a minimum of 15 sites spread across ODOT Regions.
- Step 4 (Prioritize & Implement Projects): The treatments identified in Step 3 are prioritized and then implemented. This project will develop a process for prioritizing and implementing projects based on results of Steps 1-3. This process will be applicable to ODOT Regions and local agencies.
- Step 5 (Evaluate Program and Project Impacts): After countermeasures have been implemented for a certain time, their effectiveness, and the overall program, can be evaluated and changes made to improve the plan's impact on fatal and serious injuries. This project will provide recommended methods for completing before-after evaluations of projects and the ODOT Intersection Safety Plan program.

#### Study Network

This plan is meant for use on all intersections on public streets in Oregon. For the purposes of this analysis, the plan includes intersections on public roadways maintained by the Oregon Department of Transportation (ODOT) for which data is available from ODOT. The available intersection data includes a

<sup>&</sup>lt;sup>3</sup> Oregon Department of Transportation (ODOT) (2021). Oregon Pedestrian and Bicycle Safety Implementation Plan. https://www.oregon.gov/odot/Engineering/Docs\_TrafficEng/Bike-Ped-Safety-Implementation-Plan.pdf.

signalized intersection dataset provided by ODOT, a stop-controlled intersection dataset provided by ODOT, and a roundabout dataset taken from the Kittelson roundabout database<sup>4</sup>.

These three datasets do not include all intersections on ODOT highway. However, the available dataset is assumed to be a representative sample of intersections on ODOT facilities.

#### Compile Available Data

Kittelson compiled available roadway, demographic, intersection, and crash data to prepare the analysis dataset. This section describes how the dataset was created.

#### **Data Sources**

Kittelson compiled available data from ODOT to develop the intersection dataset. ODOT directly provided signalized intersections and stop controlled intersections. Other relevant roadway, intersection, and demographic data was pulled from ODOT's publicly available TransGIS data or was provided directly by ODOT. Data for roundabout intersections was provided by Kittelson's Roundabouts Database.

#### **Intersection Dataset Preparation**

Kittelson merged the three datasets noted in the preceding section. The data was screened to remove intersections with less than 3 legs or intersections not on an ODOT facility. The final study intersection dataset used in the analysis consists of 4,908 intersections and includes:

- 1,219 signalized intersections
  - Urban: 1,171 intersections
  - Rural: 48 intersections
- 3,679 stop-controlled intersections
  - Urban: 1,464 intersectionsRural: 2,215 intersections
- 8 roundabouts
  - Urban: 6 intersections
  - Rural: 2 intersections

The intersection study sites are shown in Appendix A.

Kittelson created a combined dataset that integrates the study intersection data provided by ODOT with other intersection, roadway, and demographic data to describe the characteristics of the intersection and the approach roads for each study intersection. The variables for the final intersection dataset were obtained in one of two ways:

- 1. Calculated from ODOT's linear referencing system (LRS) data from ODOT's TransGIS; or,
- 2. Derived from other datasets provided by ODOT, which may have additional attributes beyond what is included in similar TransGIS datasets.

<sup>4</sup> https://roundabouts.kittelson.com/

Table 1 presents the intersection variables and their sources. Appendix B describes the data in more detail.

Table 1. Proposed Intersection Characteristics

Variable	Source
Location Ch	naracteristics
Area Type (Urban/ Rural)	Federal Aid Urban Boundary (FAUB) - ODOT TransGIS
Jurisdiction	ODOT TransGIS
Intersection C	Characteristics
Ramp Terminal	ODOT TransGIS; Google Earth
Approach	Information
Leg Count	Unsignalized Intersections: Calculated from ODOT TransGIS Data Signalized Intersections: Provided in ODOT Dataset
Posted Speed	ODOT TransGIS
Functional Classification	ODOT TransGIS
Number of Lanes	ODOT TransGIS
Median Type	ODOT TransGIS
Volume (AADT)	ODOT TransGIS
Heavy Vehicle Percentage	ODOT TransGIS
Bicycle Lane	ODOT TransGIS
Sidewalk	ODOT TransGIS
Right Turn Lane	ODOT TransGIS
Left Turn Lane	ODOT TransGIS
Demographi	c Information
Equity	ODOT Social Equity Index <sup>1</sup>

<sup>&</sup>lt;sup>1</sup> The ODOT Social Equity Index is based on 2014-2018 data from the American Community Survey (ACS). ODOT is in the process of updating the Social Equity Index with the most recently available data. More information about the Social Equity Index can be found at Oregon Social Equity Web App (arcgis.com).

After compiling available roadway data from ODOT for each intersection, Kittelson concatenated data from each approach and isolated the maximum and minimum for each variable. For example, an intersection with 4 approach legs with posted speeds of 55 miles-per hour (mph), 55 mph, 35 mph, and 25 mph would be assigned 55 mph as the maximum value and 25 mph as the minimum value for the posted speed variable.

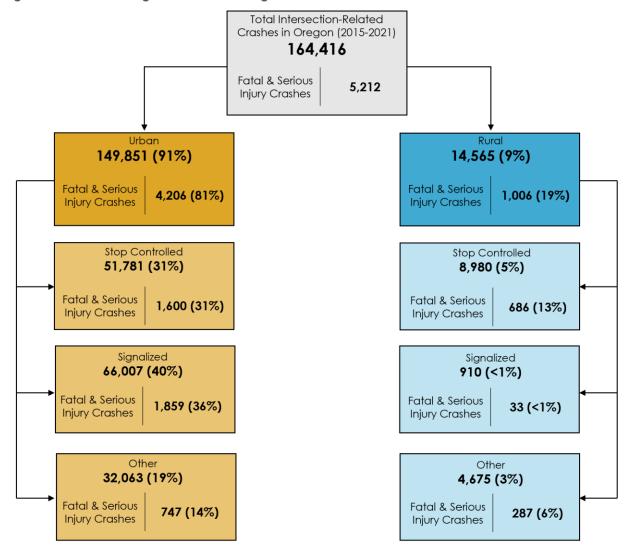
#### **Crash Data Overview**

ODOT provided crash data on Oregon roadways facilities between January 1, 2015, to December 31, 2021.

#### **All Intersections**

The distribution of all intersection crashes in Oregon by area type and traffic control is summarized in a crash tree diagram shown in Figure 2. Total fatal and serious injury crashes and the percentage per category of all fatal and serious injury crashes are also provided.

Figure 2. Crashes in Oregon - Crash Tree Diagram



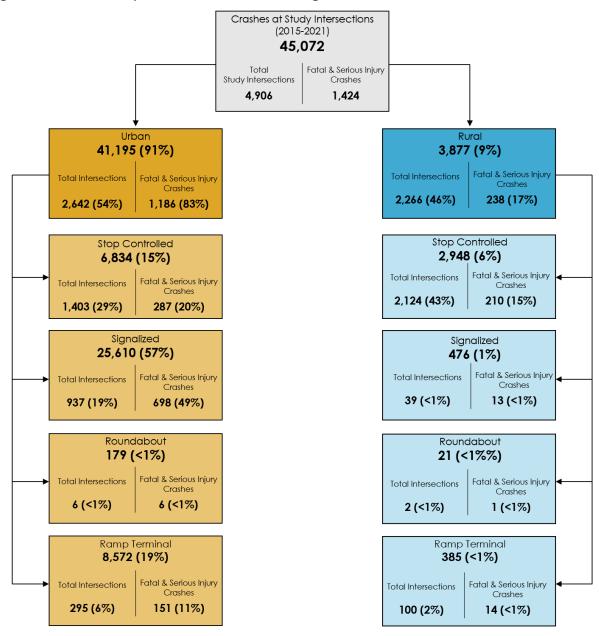
Urban intersections account for the vast majority, approximately 91%, of all intersection crashes, including 81% of all fatal and suspected serious injury crashes occurred in urban areas. However, crashes at rural intersections are more likely to result in a fatal or suspected serious injury, accounting for 19% of these crashes, despite accounting for 9% of crashes across all severities. Crashes at stop-controlled intersections also appear to have a higher propensity for being more severe; however, the crash data in urban areas is not fully conclusive on this point since the exact type of traffic control is described as "unknown" or some other form of control in the crash data for about 16% of all crashes.

#### **Study Intersections**

Figure 3 summarizes the distribution of intersection crashes on the study network of intersections spread across the state and provided by ODOT. Total fatal and serious injury crashes and the percentage per category of all fatal and serious injury crashes are also provided.

This subset of crashes was used for the crash risk factor analysis discussed in the Identify Risk Factors section. Crashes that occurred at ramp terminal intersections were also assigned a separate subgroup due to their unique characteristics. The ramp terminals included in the analysis are stop controlled or signalized.

Figure 3. Crashes at Study Intersections - Crash Tree Diagram



The percentage of total crashes by area type is consistent with the overall intersection crash dataset. The proportion of fatal and suspected serious injury crashes for each sub-category indicates most fatal and

suspected serious injury crashes (49%) occur at signalized intersections in urban areas. In rural areas, stop-controlled intersections make up most of the study intersections and show a higher percentage of fatal and suspected serious injury crashes compared to signalized, roundabout, or ramp terminal intersections.

Fatal and suspected serious injury crashes at roundabouts represent <1% of these types of crashes. Additionally, many of these crashes occurred at the intersections before a roundabout was constructed. Given the relatively low number of fatal and suspected serious injury crashes that occurred at the roundabouts, and that they're already considered an effective countermeasure at reducing these crashes<sup>5</sup>, the Kittelson team recommends not including roundabouts in the study network.

#### **Crash Summary**

Table 2 provides a summary of all intersection crashes in Oregon within the study period by year and severity.

Table 2. Intersection-Related Crashes in Oregon by Year and Severity

			Crash S	everity			F+A C	Crashes
Year	Fatal (F)	Suspected Serious Injury (A)	Suspected Minor Injury (B)	Possibly Possible Injury (C)	Property Damage Only (PDO)	Total	Total F+A Crashes	F+A Crashes %
2015	89	608	3,631	9,861	11,847	26,036	697	2.68%
2016	88	681	3,710	11,025	12,708	28,212	769	2.73%
2017	74	576	3,494	9,713	12,417	26,274	650	2.47%
2018	88	603	3,495	9,713	9,616	23,515	691	2.94%
2019	94	682	3,284	9,520	9,603	23,183	776	3.35%
2020	98	538	2,648	6,072	7,632	16,988	636	3.74%
2021	117	876	4,813	5,921	8,481	20,208	993	4.91%
Total	648	4,564	25,075	61,825	72,304	164,416	5,212	3.17%

Generally, the proportion of fatal and suspected serious injury crashes compared to all crashes in a given year ranges from approximately 2% to 5%. The number of fatal and suspected serious injury crashes recently peaked in 2021 at 993 compared to 636 to 776 crashes per year in the preceding years. They also represented about 5% of all intersection crashes in 2021, compared to approximately 2.6-3.7% in previous years.

Table 3 summarizes all intersection crashes in Oregon within the study period by crash type and severity.

<sup>&</sup>lt;sup>5</sup> Federal Highway Administration (FHWA) (2023). Roundabouts. https://highways.dot.gov/sites/fhwa.dot.gov/files/Roundabouts\_508.pdf.

Table 3. Intersection-Related Crashes in Oregon by Crash Type and Severity

	l		Cro	ısh Severi	ty		F+A Cı	ashes
Crash Type	Fatal	A	В	С	PDO	Total	Total F+A Crashes	F+A Crashes %
			Sing	le Vehicle	e (SV)			
Animal	1	3	10	20	145	179	4	<1%
Fixed Object	73	356	1,381	1,628	5,339	8,777	429	8.2%
Other	1	18	44	26	53	142	19	<1%
Overturn	8	62	226	114	129	539	70	1.6%
Parked Car	4	34	151	273	1,691	2,153	38	<1%
Train	1	5	15	25	50	96	6	<1%
Total SV	91	487	1,852	2,099	7,422	11,951	578	11%
			Mult	i-Vehicle	(MV)			
Angle	214	1,703	9,812	19,410	25,682	56,821	1,917	36.8%
Bicycle	26	221	1,814	1,335	0	3,396	247	4.7%
(O) One Left Turn, One Straight	81	828	4,052	6,036	6,615	17,612	909	17.4%
(O) One Stopped	2	20	87	264	821	1,194	22	<1%
(O) Both Straight	12	68	207	257	311	855	80	1.5%
(O) All Others	0	9	47	216	805	1,077	9	0.2%
Pedestrian	166	397	1,587	1,608	0	3,758	563	10.8%
(S) One Stopped	29	599	4,268	25,310	20,678	50,884	628	12.0%
(S) One Turn, One Straight	15	117	634	1,805	3,595	6,166	132	2.5%
(S) Both Straight	12	101	623	2,950	4,699	8,385	113	2.2%
(S) All Other	0	14	92	535	1,676	2,317	14	0.3%
Total (MV)	557	4,077	23,223	59,726	64,882	152,465	4,634	88.9%
Total (Overall)	648	4,564	25,075	61,825	72,304	164,416	5,212	100.0%

<sup>(</sup>O) – Vehicles from Opposite Direction

Crashes involving multiple vehicles account for most (89%) of fatal and suspected serious injury crashes. For crashes involving multiple vehicles, those that involve vehicles moving in the opposite direction are generally more severe than those moving in the same direction. Angle crashes and crashes between a left-turning vehicle and a vehicle going straight make up about 57% of all fatal and suspected serious injury crashes. Pedestrian crashes made up 3% of all crashes, but 11% of fatal and suspected serious injury crashes. Similarly, bicycle crashes accounted for about 2% of all crashes, but 5% of fatal and suspected serious injury crashes.

<sup>(</sup>S) – Vehicles from Same Direction

Based on the crash data within the study period, to have the greatest impact on fatal and suspected serious injury crashes, agencies could focus on reducing the likelihood and severity of angle, left-turning, and vulnerable roadway user crashes.

A summary of crash data at study intersections is provided in Appendix C. The crash trends on the study network are consistent with the crash trends shown here for all intersections in Oregon.

#### Identify Risk Factors

Kittelson assigned the intersection and roadway characteristics compiled in the previous step to each intersection-related crash on an ODOT facility. The resulting crash dataset was used in this step of the process to evaluate fatal and suspected serious injury crash trends based on these characteristics. These results are then used to identify common risk factors for fatal and suspected serious injury crashes, which could be used to screen a study network to identify locations for treatments.

#### **Crash Analysis**

Kittelson identified several potential risk factors based on research and similar studies. The potential risk factors that could be analyzed with the data available are shown below:

- Functional class
- Number of legs
- Number of lanes
- Posted speed
- Volume, including bicycle and pedestrian volumes
- Heavy vehicle percentage (HV%)
- Presence of left turn lanes
- Presence of right turn lanes
- Presence of a median
- Equity considerations
- Light conditions

Kittelson evaluated the relationship between each of the potential risk factors and fatal and suspected serious injury crashes at the study intersections. This evaluation was conducted through two analyses:

- Calculating a "risk ratio" in accordance with Federal Highway Administration (FHWA) guidance<sup>6</sup>. A risk ratio can be used to evaluate the severity of crashes associated with a particular intersection factor compared to the severity of all other crashes. Characteristics with a ratio of greater than 1.0 were flagged for further consideration.
- Analyzing whether a characteristic is over-represented in fatal and suspected serious injury crashes (e.g., a characteristic that is present at 10% of sites, but at 20% of fatal and suspected serious injury crashes would be flagged).

These calculations were performed by traffic control type (i.e., signal or stop-control) and area type (i.e., urban or rural) for each of the potential risk factors listed above. Ramp terminal intersections were analyzed separately from other intersections. Appendix D contains the complete analysis results.

<sup>6</sup> https://highways.dot.gov/safety/zero-deaths/applying-safety-data-and-analysis-performance-based-transportation-planning-2

#### **Proposed Risk Factors**

The Kittelson team reviewed risk factors with risk ratios exceeding 1.0 or that were overrepresented in fatal and suspected serious injury crashes. This review considered which metrics were met, general trends in the data, the sample size used in the analysis, professional judgment, and input from ODOT staff to identify the proposed risk factors. Table 4 summarizes the proposed risk factors. It identifies the traffic control and area type that the factor is relevant for. It also identifies whether the proposed risk factor is relevant to all intersections or only ramp terminal intersections or non-ramp terminal intersections.

In some cases, the sample size for a particular characteristic is too small to draw meaningful conclusions. When this occurs, trends from similar intersections are sometimes assumed to be relevant for the intersection type with the small sample size. This most commonly occurs with rural unsignalized intersections. In some of these cases, the trend seen at urban intersections may be assumed to also exist for their rural counterparts if it seems like a logical extension of the trend (e.g., higher speeds are likely to result in higher severities in urban and rural locations).

#### Correlation vs. Causation

The identified risk factors are generally correlated with fatal and suspected serious injury crashes. This does not necessarily mean that the presence of the characteristic is contributing to the risk. This may be particularly true of characteristics that are likely acting as proxies for other features of the intersection (e.g., the presence of a bike lane is likely a surrogate measure for bicyclist exposure as opposed to a feature that creates hazards for intersection users).

Turn lanes are another example where the relationship between the factor and crash risk is complex. Turn lanes have been shown to reduce certain crash types in specific situations and are included in ODOT's All Roads Transportation Safety (ARTS) program's crash reduction factor (CRF) list. Locations with turn lanes may have higher turning volumes or more complex movements<sup>7</sup>. It is also not known in the dataset where other countermeasures may exist, such as protected left-turn phasing, prohibiting right-turns-on-red (RTOR), or the specific design of the turn lane (e.g., a right-turn yield control slip lane compared to a more typical right-turn lane with stop or signal control and a tighter radius).

<sup>&</sup>lt;sup>7</sup> FHWA (2021). A Safe System-Based Framework and Analytical Methodology for Assessing Intersections. https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-06/fhwasa21008.pdf

Table 4. Identified Risk Factors

	Signa	lized	Stop Co	ntrolled
Risk Factor	Urban	Rural	Urban	Rural
Functional Classification <sup>1</sup>				
Principal Arterial	Χ	X	X	X
Minor Arterial	Χ			
Other Freeways and Expressways	R			
Posted Speed <sup>2</sup>				
35 - 50 mph	Χ	X	X	X
≥ 55 mph	Χ	Χ	Χ	Χ
Volume (AADT)				
AADT≥ 10,000				Χ
AADT between 10,000-25,000			X	
AADT > 25,000		Χ	Χ	
AADT between 25,000-40,000	X			
AADT ≥ 40,000	Χ			
Approach Characteristics				
Right Turn Lane Present <sup>5</sup>	R		NR	NR
Left Turn Lane Present <sup>5</sup>	X	X	X	X
Number of Through Lanes ≥ 3			Χ	Χ
Number of Through Lanes ≥ 4	X	X		
Equity				
Medium High or High Equity Disparity	X	X	X	X
Active Transportation				
Bicycle Volumes <sup>3</sup>	X	X	X	X
Pedestrian Volumes <sup>4</sup>	Χ	X	Χ	Χ

Risk factors designated with an "X" in the table apply to both ramp and non-ramp terminal intersections, whereas an "R" indicates the risk factor only applies to ramp terminal intersections and "NR" indicates the risk factor only applies to intersections not on a ramp terminal.

<sup>&</sup>lt;sup>1</sup> Functional classification is likely a surrogate for number of lanes, speed, and volume. Therefore, it should only be used when one or more of these datasets are missing.

<sup>&</sup>lt;sup>2</sup> Posted speed risk factors are separated into categories for weighting purposes. Risk factor weighting will be discussed in Technical Memo #2.

<sup>&</sup>lt;sup>3</sup> Bicycle volume data is not available from ODOT at a statewide scale, so the presence of a bicycle lane is used as a proxy to indicate whether an intersection should be prioritized for bicycle related treatments.

<sup>&</sup>lt;sup>4</sup> Pedestrian volume data is not available from ODOT at a statewide scale so the presence of a sidewalk lane is used as a proxy to indicate whether an intersection should be prioritized for pedestrian related treatments.

<sup>&</sup>lt;sup>5</sup> See discussion in "Correlation vs. Causation" subsection on previous page.

Risk ratios, proportion of intersections, and proportion of fatal and serious injury crashes for each of the identified risk factors are summarized in Table 5.

Table 5. Risk Factors - Risk Ratios, Intersection Data, and Crash Data

			Signo	ılized				Unsigr	nalized			
		Urban			Rural <sup>1</sup>			Urban			Rural <sup>1</sup>	
Risk Factor	Risk Ratio	% of Inters. <sup>2</sup>	% of F+A <sup>3</sup>	Risk Ratio	% of Inters.	% of F+A	Risk Ratio	% of Inters.	% of F+A	Risk Ratio	% of Inters.	% of F+A
Functional Classification												
Principal Arterial	1.01 (1.33)	85% (12%)	86% (12%)	3.67 (2.56)	82% (33%)	92% (50%)	1.13 (0.88)	69% (42%)	80% (73%)	1.10 (1.63)	50% (12%)	58% (50%)
Minor Arterial	1.05 (1.34)	11% (3%)	8% (3%)	-	-	-	-	-	-	-	-	-
Posted Speed												
Posted Speed between 35 – 50 mph	1.24 (1.05)	55% (30%)	66% (34%)	0.2645 (0*)	10% (33%)	15% (0%*)	1.55 (0.80)	26% (23%)	31% (20%)	0.47 (0.77)	14% (7%)	9% (25%)
Posted Speed ≥ 55 mph	0.91 (1.55)	4% (4%)	4% (6%)	0.66 (0*)	10% (0%*)	23% (0%*)	2.86 (1.36)	12% (10%)	32% (13%)	3.07 (2.43)	58% (13%)	86% (63%)
Volume (AADT)												
AADT ≥ 10,000	-	-	-	-	-	-	-	-	-	1.17 (0.94)	10% (1%*)	31% (50%*)
AADT between 10,000-25,000	-	-	-	-	-	-	1.08 (0.32)	48% (33%)	62% (33%)	-	-	-
AADT > 25,000	-	-	-	0.82 (0*)	5% (11%)	23% (0%)	1.03 (0*)	8% (1.6%)	13% (0%*)	-	-	-
AADT between 25,000-40,000	0.89 (0.83)	26% (24%)	36% (32%)	-	-	-	-	-	-	-	-	-
AADT ≥ 40,000	0.86 (1.32)	3% (5%)	5% (9%)	-	-	-	-	-	-	-	-	-
Approach Characteristics												

			Signo	alized					Unsigr	nalized		
		Urban			Rural <sup>1</sup>			Urban		Rural <sup>1</sup>		
Risk Factor	Risk Ratio	% of Inters. <sup>2</sup>	% of F+A <sup>3</sup>	Risk Ratio	% of Inters.	% of F+A	Risk Ratio	% of Inters.	% of F+A	Risk Ratio	% of Inters.	% of F+A
Right Turn Lane Present	(1.06)	(56%)	(65%)				2.14	9%	28%	1.52	6%	19%
Left Turn Lane Present	1.11 (0.88)	70% (59%)	80% (65%)	0.33* (2.91*)	74% (56%*)	62% (50%*)	2.09 (1.35)*	16% (21%)	41% (20%)	1.39 (4.5*)	9% (3%*)	30% (75%*)
Number of Lanes ≥ 3	-	-	-	-	-	-	1.24 (1.75)*	37% (18%)	52% (20%)	0.88 (0)*	55% (0)*	24% (0*)
Number of Lanes ≥ 4	1.11 (0.83)*	55% (45%)	68% (55%)	2.41 (0*)	67% (33%*)	91% (0%*)	-	-	-	-	-	-
Equity												
Medium High or High Equity Disparity <sup>4</sup>	1.11 (0.91)	53% (44%)	60% (46%)	1.11 (0.91)	53% (44%)	60% (46%)	0.79 (1.29)	51% (54%)	44% (35%)	0.79 (1.29)	51% (54%)	44% (35%)
Active Transportation												
Bicycle Volumes <sup>5</sup>	1.70 (0.87)	71% (68%)	79% (67%)	NA (NA)	56% (NA)	NA (NA)	2.86 (NA)	60% (56%)	83% (100%)	0 (NA)	19% (NA)	0% (NA)
Pedestrian Volumes <sup>6</sup>	0.61 (0.76)	90% (59%)	96% (71%)	NA* (NA)	77% (NA)	100% (NA)	0.60 (NA)	71% (100%)	88% (NA)	0.50 (NA)	23% (NA)	67% (NA)

XX% = intersections not at a ramp terminal

(XX%) = ramp terminal intersections

Due to the limited number of rural signalized intersections, the data from urban intersections is sometimes used to justify the inclusion of a risk factor for these intersections.

<sup>&</sup>lt;sup>2</sup>Percentage of intersections with the risk factor characteristics.

<sup>&</sup>lt;sup>3</sup>Percentage of all fatal and suspected serious injury crashes on study intersections.

<sup>&</sup>lt;sup>4</sup>Equity was evaluated based on control type only; results for urban and rural are the same within each control group.

<sup>&</sup>lt;sup>5</sup>Presence of a bicycle lane was assessed as a proxy for bicycle volumes. The fatal and serious injury crash percentages in this row represent the proportion of bicycle fatal and suspected serious injury crashes occurring at intersections with bicycle lanes. The results indicate these locations should be prioritized for bicycle-related treatments.

<sup>&</sup>lt;sup>6</sup>Presence of a sidewalk was assessed as a proxy for pedestrian volumes. The fatal and serious injury crash percentages in this row represent the proportion of pedestrian fatal and suspected serious injury crashes occurring at intersections with sidewalks. The results indicate these locations should be prioritized for pedestrian-related treatments.

<sup>\*</sup>Limited sample size for this subgroup of intersections based on available ODOT data. For risk factors that show a value of 0, there were no fatal or serious injury crashes at those intersections.

<sup>\*\*</sup> NA-There were no bicycle or pedestrian crashes at intersections with these intersection characteristics based on available data from ODOT.

The individual risk factors have different levels of correlation with fatal and suspected serious injury crashes. These correlations will be further explored in the next phase of the project in assigning weights to each risk factor.

#### Relationship to the Safe System Approach

The risk factors identified in Table 4 are aligned with the Safety System Approach (SSA). FHWA recently published a report that proposes a method to quantitatively assess an intersection from a SSA perspective<sup>8</sup>. This report notes that the key factors affecting the likelihood of a severe crash at an intersection are related to speed, crash angles, risk exposure, and complexity. These elements are captured in the risk factors above (i.e., speed (posted speed), risk exposure (traffic volumes), and complexity (number of lanes, number of legs, presence of turn lanes)).

Further, the report proposes an analytical method using traffic volumes, speed, and intersection geometry (e.g., number of lanes). This method is meant for use in analyzing individual intersections and requires more inputs than are available on the network-level. However, many of the inputs are represented in the risk factors, as noted previously.

#### Other Risk Factors

The risk factors previously discussed are useful for screening and prioritizing sites since data about them is available statewide and/or on ODOT highways. The literature review and analysis identified other factors worth considering when evaluating specific sites with more detailed data, including:

- Lighting Crashes under nighttime conditions tend to have risk ratios greater than 1.0 across all intersection types in urban and rural areas.
- **Left-turn Signal Phasing** Left-turn, opposite direction crashes accounted for about 18% of all fatal and suspected serious injury crashes. Identifying sites with permissive left-turn signal phasing could reduce the risk of these types of crashes.
- Pedestrian and Bicycle Crossing Treatments Pedestrian and bicycle crashes accounted for about 16% of all fatal and suspected serious injury crashes. Certain crossing treatments have been proven to reduce the risk of pedestrian and bicycle crashes at intersections. Understanding where these treatments do not exist could be useful for prioritizing sites for treatments.
- Intersection Skew Angle Intersection skew angle has been shown to be associated with crash risk at unsignalized intersections.

#### Next Steps

The Kittelson team will review this memorandum with ODOT staff. Following revisions to this memorandum, it will be presented to a group of local agency representatives.

Once these reviews are completed, the Kittelson team will use the final set of risk factors to screen intersections on the study network. The network screening process is expected to follow these steps:

- Each crash is assigned a score based on Equivalent Property Damage Only (EPDO) values to account for crash severity and frequency of crashes.
- The EPDO scores of crashes will be aggregated to develop a weight for each risk.

<sup>&</sup>lt;sup>8</sup> FHWA (2021). A Safe System-Based Framework and Analytical Methodology for Assessing Intersections. https://safety.fhwa.dot.gov/intersection/ssi/fhwasa21008.pdf.

- The weighted risk factor values will be used calculate a crash risk score for each study intersection within the study network.
- Based on crash risk scores, the project team will identify at least 3 sites in each ODOT Region for further evaluation.

#### **APPENDICES**

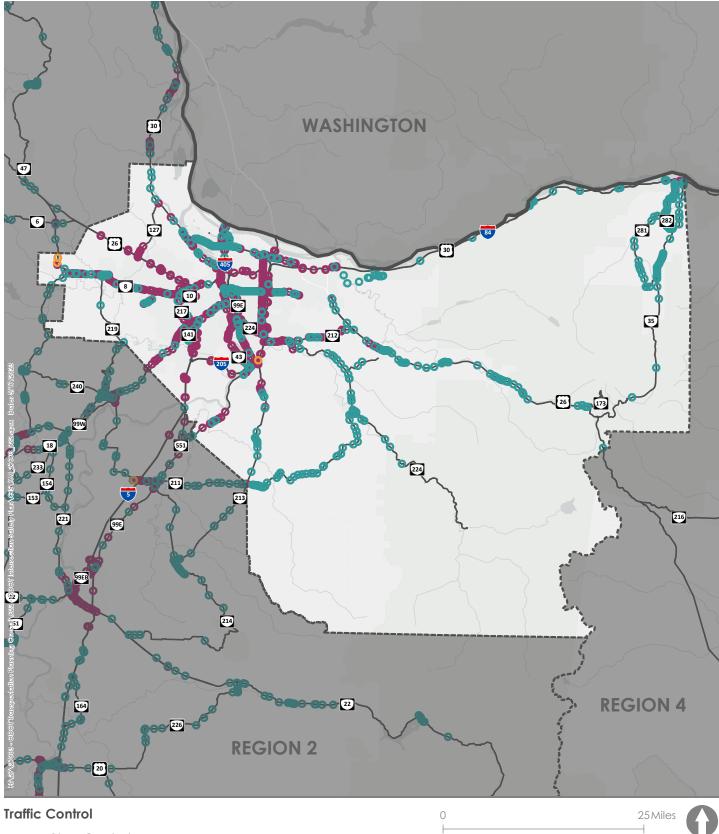
Appendix A: Study Sites

Appendix B: Intersection Dataset Data Dictionary

Appendix C: Crashes on Study Intersection Dataset

Appendix D: Risk Ratio Calculations

## APPENDIX A: STUDY SITES



- Stop Control
- Roundabouts
- Traffic Signal

Figure A.1

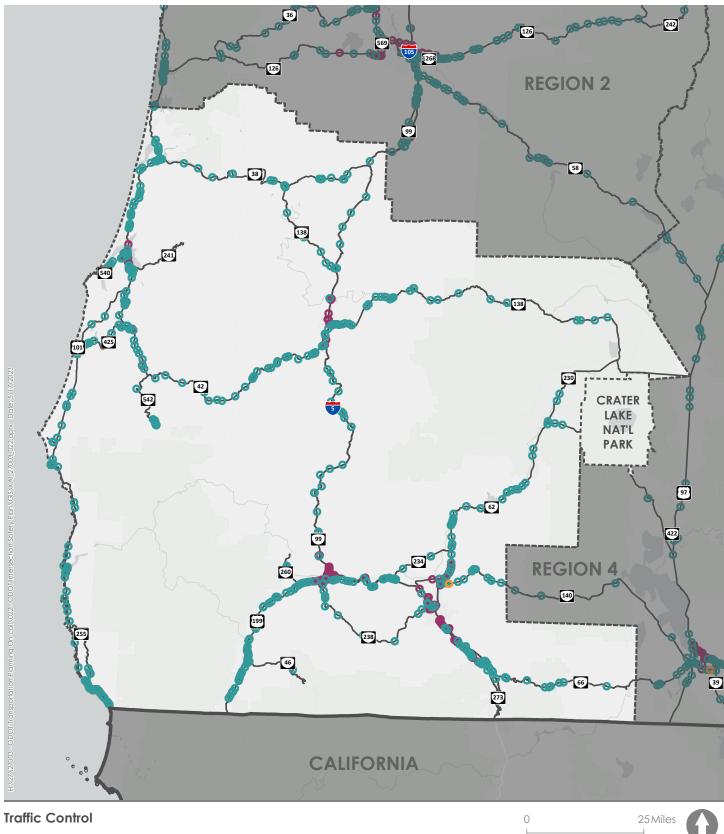




- Stop Control
- Roundabouts
- Traffic Signal 0

Figure A.2

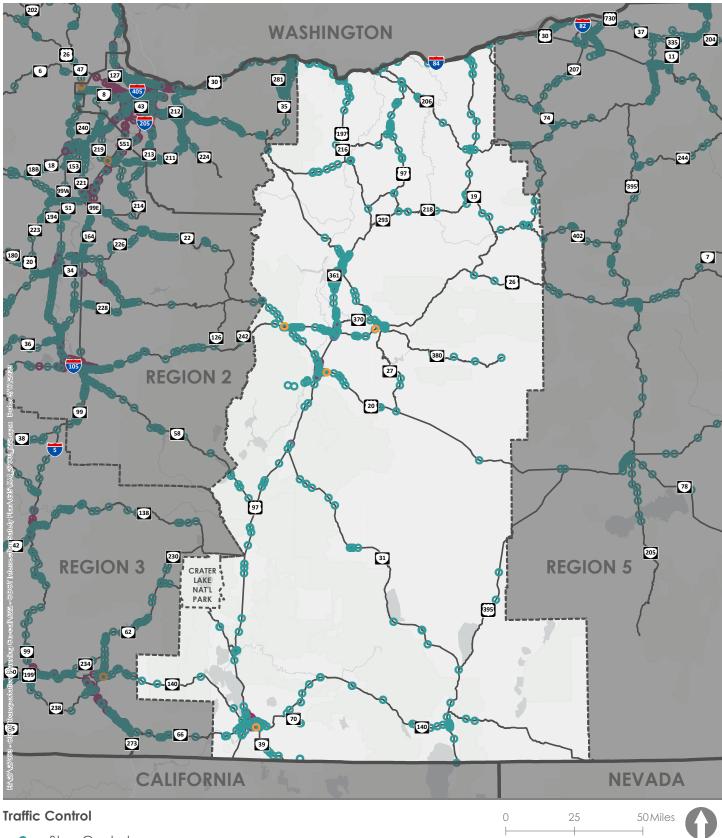




- Stop Control
- Roundabouts
- Traffic Signal 0





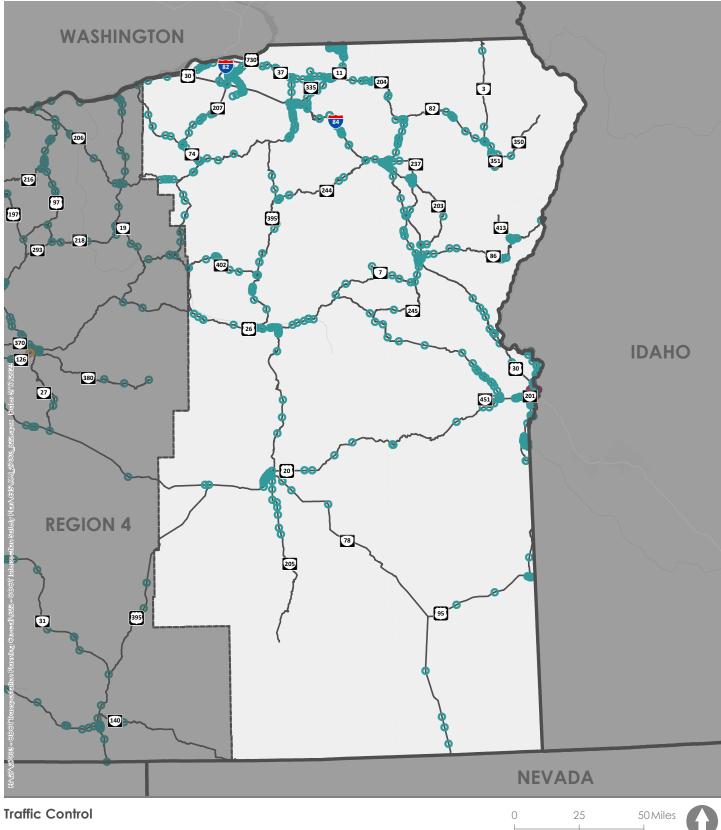


Stop Control

- . . . . .
- Roundabouts
- Traffic Signal







- Stop Control
- Roundabouts
- Traffic Signal 0





Figure A.5



# APPENDIX B: INTERSECTION DATASET DATA DICTIONARY

Appendix B - Intersection Dataset Data Dictionary

	n Dataset Data Dictionary	Data Saura	Notes
Field	Description	Data Source	Notes
Flag_Interchange	Flagged if Interchange	Signalized_Intersection_Attributes	
TSSU ID	Traffic Systems Services Unit ID	Signalized_Intersection_Attributes	
District	ODOT District	Signalized_Intersection_Attributes	
Highway	ODOT Highway Number	Signalized_Intersection_Attributes	
Mile_Point	ODOT Facility Mile Point	Signalized Intersection Attributes	
LRM	Linear Reference Method Key	Signalized_Intersection_Attributes	
	Intersection Name	Signalized_Intersection_Attributes	
Location_D			
Type	Standard Intersection or Roundabout	Draft_Stop_Control_Intersections	
Leg_Count	Number of Legs	Signalized_Intersection_Attributes	
LegName_Mj	Roadway Name - Major Roadway	Signalized_Intersection_Attributes	
LegName_Mn	Roadway Name - Minor Roadway	Signalized_Intersection_Attributes	
HV_Hj	Heavy Vehicle Percentage - Major Roadway	Signalized_Intersection_Attributes	
HV_Mn	Heavy Vehicle Percentage - Minor Roadway	Signalized_Intersection_Attributes	
AADT M	Average Annual Daily Traffic - Major Roadway	Signalized_Intersection_Attributes	
AADT_Mn	Average Annual Daily Traffic - Minor Roadway	Signalized_Intersection_Attributes	
FC_Mj	Functional Class - Major Roadway	Signalized_Intersection_Attributes	
FC_Mn	Functional Class - Minor Roadway	Signalized_Intersection_Attributes	
I C_/VIII	Roadway Facility Type, Defined by Number of	Signalized_intersection_, vinisores	
	Legs, Median, and Traffic Control - Major		
De selTere e Adi	3	Circumstand Intersection Attributes	
RoadType_Mj	Roadway Roaaway Facility Type, Definea by Number of	Signalized_Intersection_Attributes	
	Legs, Median, and Traffic Control - Minor		
RoadType_Mn	Roadway	Signalized_Intersection_Attributes	
Med_Mj	Median Type - Major Roadway	Signalized_Intersection_Attributes	
Med_Mn	Median Type - Minor Roadway	Signalized_Intersection_Attributes	
HWYNAME	Highway Name	Draft_Stop_Control_Intersections	
HWYNUMB	Highway Number	Draft_Stop_Control_Intersections	
ST_HWY_SFX	Highway Number Suffix	Draft_Stop_Control_Intersections	
RDWY_ID	1 or 2?	Draft_Stop_Control_Intersections	
MLGE TYP	Mileage Type	Draft_Stop_Control_Intersections	
OVLP_CD	Mileage Overlap Code	Draft_Stop_Control_Intersections	
MP	Mile Post	Draft_Stop_Control_Intersections	
		Draft_Stop_Control_Intersections	
STDSIGN_ID	Sign ID		
LEGEND	Sign Type	Draft_Stop_Control_Intersections	
bb	Intersection Name	Draft_Stop_Control_Intersections	
unitID	unitID	Draft_Stop_Control_Intersections	
descriptn	Inside an Incorporated City Boundary	Draft_Stop_Control_Intersections	
FAUB	Inside a Federal Aid Urban Boundary	ODOT's Federal Aid Urban Boundaries	
		Merged from Roundabouts, Signalized_Intersection_Attributes,	
Merge_SRC	Intersection Data Source Layer	Draft_Stop_Control_Intersections	
			Filtered out data on a mainline and used Google Earth to classity as
On_Ramp_Terminal	Ramp Terminal (Y/N)	ODOT Roadway Data	a ramp terminal
Number_of_Legs	Number of Legs	Aggregated from ODOT Data	
	Functional Classification (Concatenated for All		Any data without a FC assignment is attributed as Local - planarized
Functional_Classification	Legs)	Aggregated from ODOT Data	/ 35 foot radius spatial join
r or ionoria_orassinoanori	Number of Lanes at Each Leg (Concatenated	1931-04-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	,
Lanes	for All Legs, Null for Roundabouts)	ODOT's Lanes	25 foot radius spatial join
Posted_Speeds	Posted Speed	ODOT's Posted Speeds	25 foot radius spatial join
	•	ODOT Flow Map Data	, ,
AADTs		ODOT Flow Map Data ODOT's Social Equity Index	25 foot radius spatial join
Equity	Equity Score of Intersection Location	. ,	TV(D_OD_N_1 ((D1) 1010)
Bike_Lanes	Side of Road, Bike Lane or Shoulder	ODOT's Bike Lane Data	TYP_CD IN ('BL', 'SH') / 250 foot radius spatial join
Sidewalk	Side of Road, Width, Condition	ODOT's Sidewalk Data	NEED_STAT = 'IP' / 80 foot radius spatial join
Right_Turn_Lanes	Presence of Right Turn Lane, Lane Width	ODOT's Right Turn Lane Data	50 foot radius spatial join
Left_Turn_Lanes	Presence of Left Turn Lane, Lane Width	ODOT's Left Turn Lane Data	50 foot radius spatial join
Heavy_Vehicle_Percento	Heavy Vehicle Percentage	ODOT's Flow Map Data	35 foot radius spatial join
Median_Type	Median Type	ODOT's Median Data	35 foot radius spatial join
Jurisdiction	ODOT or Non-ODOT	ODOT's LRS vs. Ifher Roadways	25 foot radius spatial join
Crashes_Total	Total Number of Crashes	ODOT Statewide Crash Data (2015-2021)	
2.22.700_10101	Total Number of Crashes - Fatal or Severe		
Crashes_Fatal_Severe	(Type A)	ODOT Statewide Crash Data (2015-2021)	
Crashes_All_Injury	Total Number of Crashes - All Injuries (A-C)	ODOT Statewide Crash Data (2015-2021)	
0. 001 100_/ \li_11 1JO1 y			I

# APPENDIX C: CRASHES ON STUDY INTERSECTION DATASET

Table C.1. Crashes at Study Intersections by Year and Severity

			Crash	n Severity			F+A C	Crashes
Year	Fatal	Suspected Serious Injury (A)	Suspected Minor Injury (B)	Possibly Injury (C)	Property Damage Only (PDO)	Total	Total F+A Crashes	F+A Crashes %
2015	25	167	931	2,886	3,038	7,047	192	2.7%
2016	18	190	956	3,107	3,304	7,575	208	2.7%
2017	23	148	869	2,742	3,194	6,976	171	2.5%
2018	27	149	854	2,836	2,600	6,466	176	2.7%
2019	27	184	865	2,680	2,461	6,217	211	3.4%
2020	31	139	665	1,857	2,137	4,829	170	3.5%
2021	22	274	1,369	1,847	2,450	5,962	296	5.0%
Total	173	1,251	6,509	17,955	19,184	45,072	1,424	3.2%

Table C.2. Crashes at Study Intersections by Crash Type and Severity

			Crash Se	everity			F+A C	Crashes
Crash Type	Fatal	Suspected Serious Injury (A)	Suspected Minor Injury (B)	Possibly Injury (C)	Property Damage Only (PDO)	Total	Total F+A Crashes	F+A Crashes %
Animal	0	0	2	5	33	40	0	<1%
Fixed Object	9	65	214	250	896	1,434	74	5.2%
Other	0	4	11	10	41	66	4	6.1%
Overturn	1	12	56	24	35	128	13	10.2%
Parked Car	1	3	11	11	101	127	4	3.1%
Train	0	0	0	1	0	1	0	<1%
Total SV	11	84	294	301	1,106	1,796	95	5.3%
Angle	61	455	2,315	4,324	5,198	12,353	516	4.2%
Bicycle	8	35	301	233	0	577	43	7.5%
(O) One Left Turn, One Straight	27	262	1,244	1,860	1,978	5,371	289	5.4%
(O) One Stopped	1	7	22	78	240	348	8	2.3%
(O) All Others	0	1	13	56	248	318	1	0.3%
(O) Both Straight	4	13	39	44	54	154	17	11.0%
Pedestrian	40	114	404	347	0	905	154	17.0%
(S) One Stopped	8	219	1511	9,098	7426	18,262	227	1.2%
(S) One Turn, 1 Straight	6	25	151	490	953	1,625	31	1.9%
(S) All Other	0	6	33	221	603	863	6	0.7%
(S) Both Straight	7	30	182	903	1,378	2,500	37	1.5%
Total MV	162	1,167	6,215	17,654	18,078	43,276	1,329	3.1%
Total	173	1,251	6,509	17,955	19,184	45,072	1,424	3.2%

## APPENDIX D: RISK RATIO CALCULATIONS

#### Risk Factor: Speed (Not on a Ramp)

On_Ramp_Terminal	No
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Count of CRASH_ID	Column Labels											
Row Labels	FATAL	INJA II					Total Intersections			Risk Ratios	% of Intersections	% of KA Crashes
Draft_Stop_Control_Intersections	79				3584	9255	3528	497	8758			
Inside	41			2409	2547	6436	1403	287	6149			
0		4	15	40	43	102	27		98	0.88		1.39%
20		4	14	40	86	144	33			0.62		1.39%
25	1	11	126	296	413	847	217	12		0.29		4.18%
30	5	41	210	635	660	1551	275	46	1505	0.60	19.60%	16.03%
35	5	35	254	580	567	1441	321	40	1401	0.56	22.88%	13.94%
40	2	20	93	192	174	481	109	22	459	1.03	7.77%	7.67%
45	6	46	175	279	253	759	210	52	707	1.66	14.97%	18.12%
50	3	11	46	61	66	187	49	14	173	1.71	3.49%	4.88%
55	19	74	260	286	285	924	162	93	831	2.86	11.55%	32.40%
Outside	38	172	657	915	1037	2819	2125	210	2609			
0	1	1	3	1	6	12	21	2	10	2.25	0.99%	0.95%
20			1	5	8	14	20	0	14	0.00	0.94%	0.00%
25	1	2	29	53	87	172	250	3	169	0.22	11.76%	1.43%
30	1	3	23	52	83	162	167	4	158	0.32		1.90%
35		3	20	40	60	123	152	3	120	0.32		1.43%
40		6	26	61	69	162	117	6		0.48		2.86%
45	4	7	49	78	99	237	137	11	226	0.60	6.45%	5.24%
50	1		11	31	29	72	36	1	71	0.18		0.48%
55	28	147	467	578	566	1786	1121	175		2.89		83.33%
65	2		28	16	29	78	96			0.86		2.38%
70	_	ŭ			1	1	8			0.00		0.00%
Roundabouts	2	5	32	53	94	186	10		179	0.00	0.0070	0.007
Inside	2		31	45	84	166	7	. 6				
0	2		20	39	77	140	6		136	0.371428571	85.71%	66.67%
55	_	2	11	6	7	26	1	2		2.692307692		33.33%
Outside		1	1	8	10	20	2		19	2.00200.002	11.2070	00.007
0		1	1	8	10	20	2		19	#DIV/0!	100.00%	100.00%
SignalizedIntersection Attributes	75	633 3	538	10896	9511	24653	976			,,,,,,,,	100.0070	
Inside	74			10696	9338	24200	937	695				
0		15	85	272	215	587	21	15		0.89	2.24%	2.16%
20		6	44	103	137	290	34	6		0.72		0.86%
25	2		285	698	829	1851	132			0.72		5.61%
30	15		704	2514	2135	5498	199			0.90		20.86%
35	20		004	2988	2732	6920	247	196		0.98		28.20%
40	11		354	1044	825	2311	85			1.37		12.66%
45	18		713	2215	1783	4854	157	143		1.03		20.58%
50	2		116	346	290	786	27	34	752	1.53		4.89%
55	6		166	516	392	1103	35			0.91		4.17%
Outside	1	12	67	200	173	453	39	13		0.51	0.1470	7.17 /
0	•		2	_00	1/3	3	1	0		0.00	2.56%	0.00%
25		3	4	9	12		6			4.55		23.08%
30		5	12	38	39	94	16			2.39		38.46%
35		J	8	18	30	56	8	0		0.00		0.00%
45		1	10	21	19	50	3		50	0.66		7.69%
50		1	5	48	26	80	3 1	1	79	0.39		7.69%
55	1	2	26	46 66	26 46	141	4	-		0.39		23.08%
							. 4	3	136	0.00	10.20%	23.00%
Grand Total	150	1056 5	120	1/272	13190	34094						

#### Risk Factor: Speed (On a Ramp)

On\_Ramp\_Terminal Yes

Count of CRASH_ID	Column Labels											
Row Labels	FATAL	INJA	INJB	INJC	PDO	Grand Total	Total Intersection	Fatal + A	Non-Severe	Risk Ratios	% of Intersections	% of F+A
Draft_Stop_Control_Intersections	4		92			664	145					
Inside	2	13	67	220	249	551	60	15	536			
0	1	5	26	47	73	152	26	6	146	1.75		
20		1	1			2	1	1	1	19.61	1.67%	6.67%
25		2	9	87	76	174	2	2	172	0.33	3.33%	13.33%
30					1	1	1	0	1	0.00	1.67%	0.00%
35		1	7	16	11	35	10	1	34	1.05	16.67%	6.67%
40			2	10	16	28	5	0	28	0.00	8.33%	0.00%
45		3	12	39	49	103	9	3	100	1.09	15.00%	20.00%
55	1	1	10	21	23	56	6	2	54	1.36	10.00%	13.33%
Outside	2	6	25	36	44	113	85	8	105			
0		1	5	9	12	27	61	1	26	0.46	71.76%	12.50%
25				1	1	2	4	0	2	0.00	4.71%	0.00%
35			1	1	2	4	3	0	4	0.00	3.53%	0.00%
40		1	1	2	4	8	2	1	7	1.88	2.35%	12.50%
45	1		5	7	13	26	4	1	25	0.48	4.71%	12.50%
55	1	4	13	16	12	46	11	5	41	2.43	12.94%	62.50%
SignalizedIntersection_Attributes	13	176	989	3408	3252	7838	243	189	7649			
Inside	13	170	947	3312	3138	7580	234	183	7397			
0	7	81	463	1627	1605	3783	132	88	3695	0.93	56.41%	48.09%
20		2	8	16	33	59	1	2	57	1.41	0.43%	1.09%
25			3	9	17	29	2	0	29	0.00	0.85%	0.00%
30	1	18	119	401	340	879	19	19	860	0.88	8.12%	10.38%
35	1	25	153	526	486	1191	35	26	1165	0.89	14.96%	14.21%
40		5	39	136	112	292	10	5	287	0.70	4.27%	2.73%
45	1	14	86	301	271	673	19	15	658	0.92	8.12%	8.20%
50	2	15	36	169	151	373	7	17	356	1.98	2.99%	9.29%
55	1	10	40	127	123	301	9	11	290	1.55	3.85%	6.01%
Outside		6	42	96	114	258	9	6	252			
0		3	24	50	52	129	2	3	126	1.00	22.22%	50.00%
35		3	8	21	24	56	4	3	53	3.61	44.44%	50.00%
40			10	25	38	73	3	0	73	0.00	33.33%	0.00%
Grand Total	17	195	1081	3664	3545	8502		212	8290			

#### Risk Factor: Functional Class (Not on a Ramp)

On\_Ramp\_Terminal No

Count of CRASH_ID	Column Labels											
Row Labels	FATAL	INJA	INJB	INJC	PDO	<b>Grand Total</b>	<b>Total Intersections</b>	Fatal + A I	Non-Severe	Risk Ratios 9	% of Intersections % of I	F+A
Draft_Stop_Control_Intersections	79	418	1850	3324	3584	9255	3526	497	8758			
Inside	41	246	1193	2409	2547	6436	1403	287	6149			
Interstate					1	1	1	0	1	0.00	0.07% 0.0	.00%
Local		1	2	2	5	10	10	1	9	2.25	0.71% 0.3	35%
Major Collector		8	26	77	88	199	97	8	191	0.90	6.91% 2.7	79%
Minor Arterial	3	46	215	438	509	1211	322	49	1162	0.89	22.95% 17.0	.07%
Minor Collector			1	1	1	3	3	0	3	0.00	0.21% 0.0	.00%
Other Freeways and Expressways			3	2	3	8	5	0	8	0.00	0.36% 0.0	.00%
Other Principal Arterial	38	191	946	1889	1940	5004	965	229	4775	1.13	68.78% 79.7	79%
Outside	38	172	657	915	1037	2819	2123	210	2609			
Local			1	1	1	3	12	0	3	0.00	0.57% 0.0	.00%
Major Collector	1	14	31	38	63	147	381	15	132	1.40	17.95% 7.1	14%
Minor Arterial	13	57	251	391	373	1085	646	70	1015	0.80	30.43% 33.3	33%
Minor Collector	1	2	2		4	9	18	3	6	4.52	0.85% 1.4	43%
Other Principal Arterial	23	99	372	485	596	1575	1066	122	1453	1.10	50.21% 58.1	10%
Roundabouts	2	5	32	53	94	186	9	7	179			
Inside	2	4	31	45	84	166	7	6	160			
Minor Arterial				1	2	3	5	0	3	0.00	71.43% 0.0	.00%
Other Principal Arterial		2	11	6	7	26	1	2	24	2.69	14.29% 33.3	33%
·	2	2	20	38	75	137	1	4	133	0.42	14.29% 66.6	67%
Outside		1	1	8	10	20	2	1	19			
		1	1	8	10	20	2	1	19	#DIV/0!	100.00% 100.0	.00%
SignalizedIntersection_Attributes	75	633	3538	10896	9511	24653	976	708	23945			
Inside	74	621	3471	10696	9338	24200	937	695	23505			
Interstate		3	8	17	28	56	2	3	53	1.87	0.21% 0.4	43%
Local			1	4	3	8	1	0	8	0.00	0.11% 0.0	.00%
Major Collector			6	12	10	28	3	0	28	0.00	0.32% 0.0	.00%
Minor Arterial	3	54	319	738	788	1902	107	57	1845	1.05	11.42% 8.2	20%
Other Freeways and Expressways	4	31	170	634	499	1338	28	35	1303	0.91	2.99% 5.0	.04%
Other Principal Arterial	67	533	2967	9291	8010	20868	796	600	20268	1.01	84.95% 86.3	33%
Outside	1	12	67	200	173	453	39	13	440			
Minor Arterial		1	16	49	40	106	7	1	105	0.27	17.95% 7.6	69%
Other Principal Arterial	1	11	51	151	133	347	32	12	335	3.67		31%
Grand Total	156	1056	5420	14273	13189	34094	4511					

#### Risk Factor: Functional Class (On a Ramp)

On_Ramp_Terminal	Yes

Count of CRASH_ID	Column Labels											
Row Labels	FATAL	INJA	INJB	INJC	PDO	<b>Grand Total</b>	<b>Total Intersection F</b>	atal + A N	Ion-Severe	Risk Ratios %	of Intersections % of	of K+A Crashes
Draft_Stop_Control_Intersections	4	19	92	256	293	664	150	23	641			
Inside	2	13	67	220	249	551	61	15	536			
Interstate		2	16	29	47	94	28	2	92	0.75	45.90%	13.33%
Major Collector	1	1	1	5	7	15	1	2	13	5.50	1.64%	13.33%
Minor Arterial			3	4	13	20	5	0	20	0.00	8.20%	0.00%
Other Freeways and Expressways				3	1	4	1	0	4	0.00	1.64%	0.00%
Other Principal Arterial	1	10	47	179	181	418	26	11	407	0.88	42.62%	73.33%
Outside	2	6	25	36	44	113	89	8	105			
Interstate	2	2	11	21	25	61	72	4	57	0.85	80.90%	50.00%
Minor Arterial			3		6	9	6	0	9	0.00	6.74%	0.00%
Other Principal Arterial		4	11	15	13	43	11	4	39	1.63	12.36%	50.00%
SignalizedIntersection_Attributes	13	176	989	3408	3252	7838	243	189	7649			
Inside	13	170	947	3312	3138	7580	234	183	7397			
Interstate	9	99	566	2142	1993	4809	145	108	4701	0.83	61.97%	59.02%
Minor Arterial		5	22	60	69	156	6	5	151	1.34	2.56%	2.73%
Other Freeways and Expressways	2	46	253	838	770	1909	55	48	1861	1.06	23.50%	26.23%
Other Principal Arterial	2	20	106	272	306	706	28	22	684	1.33	11.97%	12.02%
Outside		6	42	96	114	258	9	6	252	0.96		
Interstate		3	32	78	96	209	6	3	206	0.59	66.67%	50.00%
Other Principal Arterial		3	10	18	18	49	3	3	46	2.56	33.33%	50.00%
Grand Total	17	195	1081	3664	3545	8502	393	212	8290			

#### Risk Factor: Volume (AADT - Not on a Ramp)

On\_Ramp\_Terminal No

Count of CRASH_ID	Column Labels												
Row Labels	FATAL	IN	IJΑ	INJB	INJC	PDO	<b>Grand Total</b>	<b>Total Intersections</b>	Fatal + A	Non-Severe	Risk Ratios	% of Intersections %	of K+A Crashes
Draft_Stop_Control_Intersections		79	418	1850	3324	3584	9255	3527	497	8758			
Inside	4	41	246	1193	2409	2547	6436	1403	287	6149			
<1,000			1	5	11	11	28	10	1	27	0.80	0.71%	0.35%
Between 1,000 and 10,000		6	65	313	602	745	1731	596	71	1660	0.89	42.48%	24.74%
Between 10,000-25,000	;	30	148	746	1458	1489	3871	676	178	3693	1.08	48.18%	62.02%
Between 25,000-40,000		5	29	119	311	265	729	113	34	695	1.05	8.05%	11.85%
>40,000			3	10	27	37	77	8	3	74	0.87	0.57%	1.05%
Outside	;	38	172	657	915	1037	2819	2124	210	2609			
<1,000		2	3	15	11	25	56	416	5	51	1.20	19.59%	2.38%
Between 1,000 and 10,000	2	27	112	442	633	754	1968	1486	139	1829	0.85	69.96%	66.19%
Between 10,000-25,000		8	54	187	243	232	724	212	62	662	1.21	9.98%	29.52%
Between 25,000-40,000		1	3	13	28	26	71	10	4	67	0.75	0.47%	1.90%
Roundabouts		2	5	32	53	94	186	9	7	179			
Inside		2	4	31	45	84	166	7	6	160			
<1,000		2	4	31	44	82	163	6	6	157	#DIV/0!	85.71%	100.00%
Between 1,000 and 10,000					1	2	3	1	0	3	0.00	14.29%	0.00%
Outside			1	1	8	10	20	2	1	19			
<1,000			1	1	8	10	20	2	1	19	#DIV/0!	100.00%	100.00%
SignalizedIntersection_Attributes	•	75	633	3538	10896	9511	24653	976	708	23945			
Inside	•	74	621	3471	10696	9338	24200	937	695	23505			
<1,000			1	2	18	19	40	1	1	39	0.87	0.11%	0.14%
Between 1,000 and 10,000		2	19	126	289	367	803	81	21	782	0.91	8.64%	3.02%
Between 10,000-25,000	;	35	348	1900	5292	4843	12418	581	383	12035	1.16	62.01%	55.11%
Between 25,000-40,000	;	33	217	1273	4356	3457	9336	244	250	9086	0.89	26.04%	35.97%
>40,000		4	36	170	741	652	1603	30	40	1563	0.86	3.20%	5.76%
Outside		1	12	67	200	173	453	39	13	440			
Between 1,000 and 10,000			5	9	24	41	79	17	5	74	2.96	43.59%	38.46%
Between 10,000-25,000		1	4	45	108	95	253	20	5	248	0.49	51.28%	38.46%
Between 25,000-40,000			3	13	68	37	121	2	3	118	0.82	5.13%	23.08%
Grand Total	1;	56 1	056	5420	14273	13189	34094	4512					

#### Risk Factor: Volume (AADT) (On a Ramp)

On_Ramp_Terminal	Yes	
Volume on At Least 3 Leas	(AII)	

Count of CRASH_ID	Column Labels							Total Intersections I	atal + A N	lon-Severe	Risk Ratios	% of Intersections %	of F+A Crashes
Row Labels	FATAL	1	NJA	INJB	INJC	PDO	<b>Grand Total</b>		0	0			
Draft_Stop_Control_Intersections		4	19	92	256	293	664	151	23	641			
Inside		2	13	67	220	249	551	61	15	536	0.38		
<1,000				3	6	8	17	8	0	17	0.00	13.1%	0.0%
Between 1,000 and 10,000		1	9	32	80	102	224	. 32	10	214	1.51	52.5%	66.7%
Between 10,000-25,000		1	4	31	134	138	308	20	5	303	0.32	32.8%	33.3%
>40,000				1		1	2	. 1	0	2	0.00	1.6%	0.0%
Outside		2	6	25	36	44	113	90	8	105	0.98		
<1,000			1	1	4	6	12	50	1	11	0.83	55.6%	12.5%
Between 1,000 and 10,000		2	1	15	19	29	66	39	3	63	0.97	43.3%	37.5%
Between 10,000-25,000			4	9	13	9	35	1	4	31	0.94	1.1%	50.0%
SignalizedIntersection_Attributes		13	176	989	3408	3252	7838	243	189	7649			
Inside		13	170	947	3312	3138	7580	234	183	7397			
Between 1,000 and 10,000		1	13	58	152	205	429	33	14	415	1.38	14.1%	7.7%
Between 10,000-25,000		7	87	470	1678	1644	3886	134	94	3792	1.00	57.3%	51.4%
Between 25,000-40,000		4	54	343	1223	1095	2719	55	58	2661	0.83	23.5%	31.7%
>40,000		1	16	76	259	194	546	12	17	529	1.32	5.1%	9.3%
Outside			6	42	96	114	258	9	6	252			
Between 1,000 and 10,000				6	9	12	27	3	0	27	0.00	33.3%	0.0%
Between 10,000-25,000			6	33	70	76	185	5	6	179	#DIV/0!	55.6%	100.0%
Between 25,000-40,000				3	17	26	46	1	0	46	0.00	11.1%	0.0%
Grand Total		17	195	1081	3664	3545	8502	394					

On\_Ramp\_Terminal

No

Risk Factor: Right-Turn Lanes (Not on a Ramp)

Count of CRASH_ID	Column Labels												
Row Labels	FATAL	INJA	INJB	INJC	PDO	<b>Grand Total</b>	Total Intersections	Fatal + A	Non-Sev	ere	Risk Ratios	% of Intersections %	of K+A Crashes
Draft_Stop_Control_Intersections	79	418	1850	3324	3584	9255	3527	497		8758			
Inside	41	246	1193	2409	2547	6436	1403	287		6149			
No RT Lane Present	28	179	963	2071	2209	5450	1279	207		5243	0.468123853	91.16%	72.13%
RT Lane Present	13	67	230	338	338	986	124	80		906	2.136186809	8.84%	27.87%
Outside	38	172	657	915	1037	2819	2124	210		2609			
No RT Lane Present	34	137	567	825	889	2452	1997	171		2281	0.656261764	94.02%	81.43%
RT Lane Present	4	35	90	90	148	367	127	39		328	1.523782208	5.98%	18.57%
Roundabouts	2	5	32	53	94	186	10	7		179			
Inside	2	4	31	45	84	166	7			160			
No RT Lane Present	2	4	31	45	84	166	7	6		160			
Outside		1	1	8	10	20	3	1		19			
No RT Lane Present		1	1	8	10	20	3	1		19			
SignalizedIntersection_Attributes	75	633	3538	10896	9511	24653	976	708		23945			
Inside	74	621	3471	10696	9338	24200	937	695		23505			
No RT Lane Present	42	351	1872	5734	5176	13175	581	393		12782	1.088964148	62.01%	56.55%
RT Lane Present	32	270	1599	4962	4162	11025	356	302		10723	0.918303878	37.99%	43.45%
Outside	1	12	67	200	173	453	39	13		440			
No RT Lane Present		5	27	67	78	177	25	5		172	0.974576271	64.10%	38.46%
RT Lane Present	1	7	40	133	95	276	14	8		268	1.026086957	35.90%	61.54%
Grand Total	156	1056	5420	14273	13189	34094	4503	1212		32882			

On\_Ramp\_Terminal Yes Risk Factor: Right-Turn Lanes (On a Ramp)

Count of CRASH_ID	Column Labels													
Row Labels	FATAL	IN	JA I	NJB	INJC	PDO	<b>Grand Total</b>	Total Intersections	Fatal + A	N	Non-Severe	Risk Ratios	% of Intersections %	of K+A Crashes
Draft_Stop_Control_Intersections	4	4	19	92	256	293	664	152	2	23	641			
Inside	2	2	13	67	220	249	551	61	1	15	536			
No RT Lane Present	2	2	11	58	184	210	465	56	1	13	452	1.202150538	91.8%	86.7%
RT Lane Present			2	9	36	39	86	5		2	84	0.831842576	8.2%	13.3%
Outside	:	2	6	25	36	44	113	91		8	105			
No RT Lane Present	•	1	2	11	18	25	57	87		3	54	0.589473684	95.6%	37.5%
RT Lane Present	•	1	4	14	18	19	56	4		5	51	1.696428571	4.4%	62.5%
SignalizedIntersection_Attributes	13	3 1	76	989	3408	3252	7838	243	18	39	7649			
Inside	13	31	70	947	3312	3138	7580	234	18	33	7397			
No RT Lane Present		5	59	316	1174	1196	2750	102	6	64	2686	0.94459893	43.6%	35.0%
RT Lane Present	8	8 1	11	631	2138	1942	4830	132	11	19	4711	1.058650362	56.4%	65.0%
Outside			6	42	96	114	258	9		6	252			
No RT Lane Present			5	33	64	70	172	5		5	167	2.5	55.6%	83.3%
RT Lane Present			1	9	32	44	86	4		1	85	0.4	44.4%	16.7%
Grand Total	17	7 1	95 ′	1081	3664	3545	8502	395	21	12	8290			

On\_Ramp\_Terminal No Risk Factor: Left-Turn Lanes (Not on a Ramp)

Count of CRASH_ID	Column Labels											
Row Labels	FATAL	INJA	INJB	INJC	PDO	<b>Grand Total</b>	Total Intersections	Fatal + A	Non-Severe	Risk Ratios	% of Intersections	% of K+A Crashes
Draft_Stop_Control_Intersections	79	418	1850	3324	3584	9255	3527	497	8758			
Inside	41	246	1193	2409	2547	6436	1403	287	6149			
LT Lane Present	22	97	382	561	570	1632	226	119	1513	2.09	16.11%	41.46%
No LT Lane Present	19	149	811	1848	1977	4804	. 1177	168	4636	0.48	83.89%	58.54%
Outside	38	3 172	657	915	1037	2819	2124	210	2609			
LT Lane Present	11	50	167	196	218	642	195	61	581	1.39	9.18%	29.05%
No LT Lane Present	27	122	490	719	819	2177	1929	149	2028	0.72	90.82%	70.95%
Roundabouts	2	2 5	32	53	94	186	10	7	179			
Inside	2	2 4	31	45	84	166	7	6	160			
LT Lane Present		2	2 11	6	7	26	1	2	24			
No LT Lane Present	2	2 2	20	39	77	140	6	4	136			
Outside		1	1	8	10	20	3	1	19			
No LT Lane Present		1	1	8	10	20	3	1	19			
SignalizedIntersection_Attributes	75	633	3538	10896	9511	24653	976	708	23945			
Inside	74	621	3471	10696	9338	24200	937	695	23505			
LT Lane Present	56	501	2707	8512	7187	18963	660	557	18406	1.11	70.44%	80.14%
No LT Lane Present	18	3 120	764	2184	2151	5237	277	138	5099	0.90	29.56%	19.86%
Outside	1	1 12	67	200	173	453	39	13	440			
LT Lane Present	1	7	53	177	138	376	29	8	368	0.33	74.36%	61.54%
No LT Lane Present		5	5 14	23	35	77	10	5	72	3.05	25.64%	38.46%
Grand Total	156	1056	5420	14273	13189	34094	4513	1212	32882			

On\_Ramp\_Terminal Yes Risk Factor: Left-Turn Lanes (On a Ramp)

Count of CRASH_ID	Column Labels															
Row Labels	FATAL	ı	NJA I	NJB	INJC	PDO	<b>Grand Total</b>	Total Intersections		Fatal + A	Nor	n-Severe	Risk Ratios	% of	Intersection: % of	K+A Crashes
Draft_Stop_Control_Intersections		4	19	92	256	293	664		152	2	23	641				
Inside		2	13	67	220	249	551		61	1	15	536				
LT Lane Present			3	13	30	40	86		13		3	83	1	.35	21.31%	20.00%
No LT Lane Present		2	10	54	190	209	465		48	1	12	453	C	.74	78.69%	80.00%
Outside		2	6	25	36	44	113		91		8	105				
LT Lane Present		2	4	13	16	10	45		3		6	39	4	.53	3.30%	75.00%
No LT Lane Present			2	12	20	34	68		88		2	66	C	.22	96.70%	25.00%
SignalizedIntersection_Attributes	1	13	176	989	3408	3252	7838		243	18	89	7649				
Inside	1	13	170	947	3312	3138	7580		234	18	83	7397				
LT Lane Present		6	112	671	2280	2033	5102		137	11	18	4984	C	.88	58.55%	64.48%
No LT Lane Present		7	58	276	1032	1105	2478		97	6	65	2413	1	.13	41.45%	35.52%
Outside			6	42	96	114	258		9		6	252				
LT Lane Present			3	12	24	27	66		5		3	63	2	.91	55.56%	50.00%
No LT Lane Present			3	30	72	87	192		4		3	189	C	.34	44.44%	50.00%
Grand Total		17	195	1081	3664	3545	8502		395	21	12	8290				

On\_Ramp\_Terminal

No

Risk Factor: Number of Lanes (Not on a Ramp)

Count of CRASH_ID	Column Labels											
Row Labels	FATAL			INJC			Total Intersectid	Fatal + A	Non-Severe	Risk Ratios	% of Intersections	% of K+A Crashe
Draft_Stop_Control_Intersections				3324		9255	3527	497				
Inside	41	246	1193	2409	2547	6436	1403	287	6149			
1		1	4	4	6	15	5	1	14	1.5	50 0.36%	0.35%
2	16	121	613	1267	1413	3430	882	137	3293	3.0	80 62.87%	47.74%
3	10	23	100	218	213	564	69	33	531	1.3	35 4.92%	11.50%
4	15	94	461	861	855	2286	432	109	2177	1.1	11 30.79%	37.98%
5		7	15	59	60	141	15	7	134	1.1	12 1.07%	2.44%
Outside	38	172	657	915	1037	2819	2124	210	2609			
1			2	4	3	9	1	0	9	0.0	0.05%	0.00%
2	31	153	564	779	892	2419	1886	184	2235	1.1	17 88.79%	87.62%
3	4	12	45	48	66	175	106	16	159	1.2	25 4.99%	7.62%
4	3	7	46	84	76	216	131	10	206	0.6	60 6.17%	4.76%
Roundabouts	2	5	32	53	94	186	9	7	179			
Inside	2	4	31	45	84	166	7	6	160			
0	2	2	20	38	75	137	5	4	133			
2		2	11	7	9	29	2	2	27			
Outside		1	1	8	10	20	2	1	19			
0		1	1	8	10	20	2	1	19			
SignalizedIntersection_Attributes	75	633	3538	10896	9511	24653	976	708	23945			
Inside	74	621	3471	10696	9338	24200	937	695	23505			
1			6	22	12	40	3	0	40	0.0	00 0.32%	0.00%
2	12	142	809	2371	2164	5498	294	154	5344	0.0	97 31.38%	22.16%
3	9	62	421	1241	1116	2849	128	71	2778	3.0	85 13.66%	10.22%
4	51	378	2053	6241	5379	14102	478	429	13673	1.1	15 51.01%	61.73%
5	1	29	139	631	496	1296	27	30	1266	3.0	80 2.88%	4.32%
6	1	10	43	190	171	415	7	11	404	0.0	92 0.75%	1.58%
Outside	1	12	67	200	173	453	39	13	440			
2		2	24	77	69	172	11	2	170	0.3	30 28.21%	18.18%
3		1	3	7	7	18	2	1	17	2.0	01 5.13%	9.09%
4	1	9	40	116	97	263	26	10	253	2.4	41 66.67%	90.91%
Grand Total	156	1056	5420	14273	13189	34094						

On\_Ramp\_Terminal Yes Risk Factor: Number of Lanes (On a Ramp)

Count of CRASH_ID	Column Labels												
Row Labels	FATAL	INJA	INJB	INJC	PDO	<b>Grand Total</b>	<b>Total Intersection F</b>	atal + A	No	on-Severe	Risk Ratios	% of Intersection: %	of K+A Crashes
Draft_Stop_Control_Intersections	4	19	92	256	293	664	152	2	23	641			
Inside	2	13	67	220	249	551	61	1	15	536			
1		5	19	21	38	83	11		5	78	2.82	18.03%	33.33%
2	1	6	36	171	185	399	39		7	392	0.33	63.93%	46.67%
3			3	10	6	19	4		0	19	0.00	6.56%	0.00%
4	1	1	6	17	17	42	6		2	40	1.86	9.84%	13.33%
5		1	3	1	3	8	1		1	7	4.85	1.64%	6.67%
Outside	2	6	25	36	44	113	86		8	105			
2	2	6	25	36	44	113	86		8	105	#DIV/0!		100.00%
SignalizedIntersection_Attributes	13	176	989	3408	3252	7838	243	18	39	7649			
Inside	13	170	947	3312	3138	7580	234	18	33	7397			
1	3	15	89	297	308	712	27	1	18	694	1.05	11.54%	9.84%
2		32	139	473	470	1114	57	3	32	1082	1.23	3 24.36%	17.49%
3	2	31	155	525	545	1258	44	3	33	1225	1.11	18.80%	18.03%
4	7	64	397	1471	1362	3301	81	7	71	3230	0.82	2 34.62%	38.80%
5	1	21	135	441	369	967	21	2	22	945	0.93	8.97%	12.02%
6		7	32	105	84	228	4		7	221	1.28	1.71%	3.83%
Outside		6	42	96	114	258	9		6	252			
2		3	29	55	58	145	4		3	142	0.78	3 44.44%	50.00%
3		3	6	15	15	39	2		3	36	5.62	22.22%	50.00%
4			7	26	41	74	3		0	74	0.00	33.33%	0.00%
Grand Total	17	195	1081	3664	3545	8502		21	12	8290			

On\_Ramp\_Terminal No FAUB (All)

Risk Factor: Medium High or High Equity Disparity (Not on a Ramp)

Count of CRASH_ID	Column Labels							Total Intersecti Fa	ıtal + A	Non-	Severe	Risk Ratios	% of Intersections	% of K+A Crashes
Row Labels	FATAL	IN.	JA I	NJB I	INJC	PDO	<b>Grand Total</b>		C	)	0			
Draft_Stop_Control_Intersections	7	79 4	18	1850	3324	3584	9255	3527	497	,	8758			
High_State		7	44	264	581	562	1458	362	51		1407	0.611512484	10.26%	10.26%
MedHigh_State	3	33 1	32	607	1074	1259	3105	1429	165	5	2940	0.984372272	40.52%	33.20%
LowMed_State	2	26 1	64	632	1063	1186	3071	1213	190	)	2881	1.246249193	34.39%	38.23%
Low_State	1	13	78	347	606	577	1621	523	91		1530	1.055563828	14.83%	18.31%
Roundabouts		2	5	32	53	94	186	9	7	,	179			
MedHigh_State				4	26	67	97	4	C	)	97	0	44.44%	0.00%
LowMed_State			3	12	15	19	49	4	3	3	46	2.096938776	44.44%	42.86%
Low_State		2	2	16	12	8	40	1	4	ļ	36	4.86666667	11.11%	57.14%
SignalizedIntersection_Attributes	7	75 6	33	3538	10896	9511	24653	976	708	3	23945			
High_State	1	19 1	63	828	2625	2167	5802	183	182	2	5620	1.124196717	18.75%	25.71%
MedHigh_State	2	27 2	213	1217	3747	3076	8280	333	240	)	8040	1.01405921	34.12%	33.90%
LowMed_State	1	18 1	62	970	2880	2723	6753	299	180	)	6573	0.903638787	30.64%	25.42%
Low_State	1	11	95	523	1644	1545	3818	161	106	6	3712	0.960875134	16.50%	14.97%
Grand Total	18	56 10	56	5420	14273	13189	34094		1212	2	32882			

On\_Ramp\_Terminal Yes FAUB (All)

Risk Factor: Medium High or High Equity Disparity (On a Ramp)

Count of CRASH_ID	Column Labels						Total Intersecti F	atal + A	Non-	-Severe	Risk Ratios	% of Intersection: %	of K+A Crashe
Row Labels	FATAL	INJ	NJB	INJC	PDO	<b>Grand Total</b>		0	)	0			
Draft_Stop_Control_Intersections		4 1	9 92	256	293	3 664	152	23	}	641			
High_State			5	7	' 18	3 30	12	0	)	30	0	7.89%	0.00%
MedHigh_State	•	1	7 32	53	3 71	1 164	70	8	}	156	1.62601626	46.05%	34.78%
LowMed_State	•	1 1	1 39	158	161	1 370	49	12	2	358	0.866830467	32.24%	52.17%
Low_State	:	2	1 16	38	3 43	3 100	21	3	3	97	0.846	13.82%	13.04%
SignalizedIntersection_Attributes	1;	3 17	989	3408	3252	2 7838	243	189	)	7649			
High_State	;	5 2	7 196	737	582	2 1547	37	32	2	1515	0.828857168	15.23%	16.93%
MedHigh_State		5	5 291	992	907	7 2245	71	55	;	2190	1.022554267	29.22%	29.10%
LowMed_State	(	6 7	1 347	1110	1093	3 2627	86	77	•	2550	1.363746669	35.39%	40.74%
Low_State		2 2	3 155	569	670	1419	49	25	5	1394	0.689574417	20.16%	13.23%
Grand Total	1:	7 19	5 1081	3664	3545	5 8502							

On\_Ramp\_Terminal No CRASH\_TYP1 BIKE

Risk Factor: Bike Volume (Not on a Ramp)

#### Filtered - Just Bike crashes

						Based on crash data							
Count of CRASH_ID	Column Labels					Total Intersections	Fatal + A	Non-S	Severe	Risk Ratios	%	of Intersection: % o	f K+A Crashes
Row Labels	FATAL	INJA	INJB	INJC G	Frand Total								
Draft_Stop_Control_Intersections		8	77	49	134			8	260				
Inside		6	70	45	121	1403		6	236				
Bike Lane Present		5	41	31	77	840		5	149		2.86	59.87%	83.33%
No Bike Lane		1	29	14	44	563		1	87		0.35	40.13%	16.67%
Outside		2	7	4	13	2124		2	24				
Bike Lane Present			2	1	3	400		0	6		0.00	18.83%	0.00%
No Bike Lane		2	5	3	10	1724		2	18	#DIV/0!		81.17%	100.00%
Roundabouts			2		2			0	4				
Inside			2		2			0	4				
Bike Lane Present			1		1			0	2				
No Bike Lane			1		1			0	2				
SignalizedIntersection_Attributes	7	21	177	149	354		:	28	680				
Inside	7	21	177	145	350	937	:	28	672				
Bike Lane Present	4	18	128	92	242	669	:	22	462		1.70	71.40%	78.57%
No Bike Lane	3	3	49	53	108	268		6	210		0.62	28.60%	21.43%
Outside				4	4	39		0	8				
Bike Lane Present				2	2	22		0	4	#DIV/0!		56.41%	#DIV/0!
No Bike Lane				2	2	17		0	4	#DIV/0!		43.59%	#DIV/0!
Grand Total	7	29	256	198	490								

 On\_Ramp\_Terminal
 Yes

 CRASH\_TYP1
 BIKE

Risk Factor: Bike Volume (On a Ramp)

#### Filtered to just bike crashes

Count of CRASH_ID Row Labels	Column Labels FATAL		INJA	INJB	INJC	Grand Total
Draft_Stop_Control_Intersections		1				1
Inside		1				1
Bike Lane Present		1				1
SignalizedIntersection_Attributes			6	45	35	86
Inside			6	45	35	86
Bike Lane Present			4	30	26	60
No Bike Lane			2	15	9	26
NO DIKE Lane			_	10	•	20

Total Inter: Fatal + A	Non-Severe	
	0	0
	1	1
61	1	1
34	1	1
	6	166
234	6	166
158	4	116
76	2	50
	7	167

Risk Ratios	% o	f Intersections% of K	(+A Crashes
#DIV/0!		55.74%	100.00%
	0.87 1.15	67.52% 32.48%	66.67% 33.33%

 On\_Ramp\_Terminal
 No

 CRASH\_TYP1
 PED

Risk Factor: Pedestrian Volume (Not on a Ramp)

Filtered by ped crashes

Count of CRASH_ID	Column Labels									Risk Ratios		% of Intersection: % of h	K+A Crashes
Row Labels	FATAL	Ш	NJA	INJB	INJC	<b>Grand Total</b>	Total Intersections Fat	al + A	Non-Severe				
Draft_Stop_Control_Intersections	3	8	19	71	57	155	3527	27	283	3			
Inside		6	18	61	55	140	1403	24	256	5			
No Sidewalk		2	1	7	1	11	405	3	19	)	1.68	28.87%	12.50%
Sidewalk Present		4	17	54	54	129	998	21	237	7	0.60	71.13%	87.50%
Outside		2	1	10	2	15	2124	3	27	7			
No Sidewalk		1		2		3	1628	1		5	2.00	76.65%	33.33%
Sidewalk Present		1	1	8	2	12	496	2	22	2	0.50	23.35%	66.67%
SignalizedIntersection_Attributes	:	29	84	300	238	651	976	113	1189	)			
Inside	:	29	82	296	236	643	937	111	1179	5			
No Sidewalk			5	8	5	18	93	5	3	l	1.64	9.93%	4.50%
Sidewalk Present	2	29	77	288	231	625	844	106	1144	1	0.61	90.07%	95.50%
Outside			2	4	2	8	39	2	14	ı			
No Sidewalk				1		1	9	0	2	2	0.00	23.08%	0.00%
Sidewalk Present			2	3	2	7	30	2	12	2 #DIV/0!		76.92%	100.00%
Grand Total	;	37	103	371	295	806		140	1472	2			

 On\_Ramp\_Terminal
 Yes

 CRASH\_TYP1
 PED

Risk Factor: Pedestrian Volume (On a Ramp)

Filtered by ped crashes

Count of CRASH_ID	Column Labels					
Row Labels	FATAL		INJA	INJB	INJC	<b>Grand Total</b>
Draft_Stop_Control_Intersections				1	2	3
Inside				1	2	3
Sidewalk Present				1	2	3
SignalizedIntersection_Attributes		3	11	33	47	94
Inside		3	11	33	47	94
No Sidewalk		1	3	12	6	22
Sidewalk Present		2	8	21	41	72
Grand Total		3	11	34	49	97

Total Intersections	Fatal + A	Non-Severe	Risk Ratios	% of Intersection:	% of K+A Crashes
251		0 6			
17	-	0 6			
17		0 6	#DIV/0!	100.00%	#DIV/0!
	1	4 174		0.00%	#DIV/0!
234	1	4 174			
97		4 40	1	1.31 41.45%	28.57%
137	1	0 134	C	0.76 58.55%	71.43%

## APPENDIX B: City of Salem Case Study

## echnical Memorandum

September 13, 2023 Project# 27003.022

Christi McDaniel-Wilson, State Traffic Safety Engineer, ODOT To:

Jiguang Zhao, Traffic Safety Engineer, ODOT

From: Katie Popp, Nick Foster, AICP, RSP1, Matt Braughton, RSP1, Pete Jenior, PE, PTOE

CC: **ODOT Technical Advisory Committee** 

RE: ODOT Intersection Safety Implementation Plan Update - City of Salem Case Study

## CITY OF SALEM CASE STUDY

The Oregon Intersection Safety Implementation Plan Update is intended to be implementable at the statewide, ODOT Region, and local agency levels. As such, the project team conducted a case study application of the characteristics-based analysis at the local agency level using City of Salem data. The case study demonstrates key considerations that ODOT Regions and local agencies may encounter when implementing the characteristics-based process developed as part of the Plan. The application of this project's methods and these considerations are discussed below.

## Study Network and Available Data

The City's GIS database includes most of the data required to conduct the intersection screening analysis using the characteristics-based process. Remaining data needs were fulfilled by data available from ODOT. A summary of the data sources for each screening factor is shown in Table 1.

Table 1. City of Salem Case Study Data Sources

Characteristic	Data Source	Considerations <sup>1</sup>
Intersection Type	City of Salem (COS_Intersections, COS_SignalizedIntersections, COS_StopSigns)	The COS_Intersections layer did not have traffic control type defined. Therefore, the COS_SignalizedIntersections were used to define signalized intersections and the COS_StopSigns were used to identify stop-controlled intersections. Intersections without a signal nearby or a stop sign were assumed to also be stop signs.
Functional Class	City of Salem (COS_FunctionalClass)	Joined functional class for all intersection approaches using a search radius of 50 feet.  Maximum functional class was used for the analysis.
AADT	ODOT 2021 AADT	Joined AADT for all intersection approaches using a search radius of 50 feet. Maximum AADT was used for the analysis.
On a Ramp Terminal	Kittelson – Manual Assignment	Determined manually via reviewing aerial photography (Google Earth).
Posted Speed	City of Salem (COS_Centerlines)	Joined posted speed for all intersection approaches using a search radius of 50 feet.  Maximum posted speed was used for the analysis.

Characteristic	Data Source	Considerations <sup>1</sup>
Left Turn Lane/ Right Turn Lane	City of Salem (COS_TurnLane)	The dataset provided by Salem includes point data for all striped arrows within the city. Intersections were assigned a turn lane if a turn lane arrow was present within a 100-foot radius around the intersection point. This process may sometimes incorrectly assign a turn lane to an intersection just downstream of another intersection's turn lane.
Number of Through Lanes	City of Salem (COS_Centerlines)	Joined number of through lanes for all intersection approaches using a search radius of 25 feet.  Maximum number of through lanes was used for the analysis.
Presence of a Bike Lane	City of Salem (COS_BikeRoutes)	Joined bicycle data for all intersection approaches using a search radius of 100 feet. Lines for bike routes were not consistent with the centerlines layer. Shared lane markings and Family Friendly Bikeways were included in the search.
Presence of a Sidewalk	City of Salem (COS_Sidewalks)	Determined by the presence of a sidewalk within six feet of an intersection. This distance was selected based on reviewing distance of intersection points to the outer edge of intersection where sidewalk lines were located. A distance less than 65' may not capture all intersections with a sidewalk in their vicinity, whereas a distance threshold too large may incorrectly assign presence of a sidewalk to an intersection without one.
Equity	City of Salem Equity Data (Census Tract Level)	Tracts that scored 15 points and above are scored the same as the Medium-High and High Equity Disparity levels defined by the ODOT Social Equity Index.
Federal Aid Urban Boundaries (FAUB)	Federal Aid Urban Boundaries Data	Not a screening characteristics but used to clarify intersections as urban or rural. All intersections in Salem's urban growth boundary are classified as Urban.

Search radius differed depending on the GIS layer that was used to join the data. Layers with larger search radii had linework that was generally farther away from the centerlines layer, which was used to create the intersections.

### **Data Screening**

The project team screened the COS\_Intersections layer and removed the following:

- Intersection nodes that were incorrectly defined as intersections. These incorrect nodes were locations where COS\_Centerlines merged, diverged, and crossed at locations other than intersections (e.g., at bridges).
- Intersection nodes with less than three legs (defined by the field WAY\_COUNT).

Overall, 3,745 stop controlled intersections and 232 signalized intersections in Salem were analyzed. There are 16 intersections at ramp terminals in Salem, nine which are on Interstate 5 (I-5), five on Salem Dallas Hwy (OR22), and two on North Santiam Hwy (OR99E). Therefore, intersections on a ramp terminal were excluded from the analysis due to the limited number of these types of intersections in Salem.

#### Comparison to ODOT Network Screening Methodology

#### **Bicycle Facilities**

In the screening characteristics identification process, the presence of a bicycle lane based on ODOT data was used as a surrogate for bike volumes. Shared facilities were not included in the ODOT data used to develop the screening characteristics. However, the project team determined that including these facilities would be appropriate at the local level because they are expected to have higher bicycle traffic similar to how a highway with bike lanes may have higher bike volumes than a highway without one. For Salem, shared bicycle facilities include Family Friendly Bikeways (FFB) and streets with shared lane markings.

#### One-Way Streets

Intersection data available from ODOT did not include directionality (e.g., one- or two-way) data for all intersection traffic control types. Therefore, directionality was not considered in the statewide ODOT network screening. At a local level, it may be more feasible to include directionality as an additional screening factor if an agency is searching for locations for a specific intersection treatment. The City of Salem could include this as an additional screening factor since they have directionality data.

#### **Data Coverage**

The City of Salem GIS database included most of the data items that could be used to conduct screening characteristics analysis. Salem's data included public roadways in the city except for most private roads and local streets/alleys in the dense residential areas. The ODOT AADT data covered most arterials and collectors in Salem. Because of this AADT coverage, and Salem having speed limit and number of lanes data, functional classification was not included in the final screening score<sup>1</sup>.

Some of the minor differences between data coverage include:

- Intersection Data The City of Salem has intersection, traffic signals, and stop signs datasets. Therefore, all signalized intersections and all stop-controlled intersections on arterials and collectors were included in the Salem analysis.
- Turn Lane Data Format The City of Salem has turn lanes in a point format at each painted turn lane arrow, whereas ODOT has turn lane data in a linear format representing the length of a turn lane.
- Bicycle Facility Data The City of Salem bicycle facility data is more detailed than the ODOT network screening data and contains more types (i.e., Family Friendly Bikeways, shared lane markings, cycle tracks, unpaved paths, and shared use paths). As discussed, shared facilities were included in the analysis in addition to separated bicycle facilities such as bike lanes, cycle tracks, and shared use paths.

#### Ramp Terminals

The City of Salem only has a few intersections at ramp terminals, so they were excluded from the screening analysis. At the local level, any intersection improvements at ramp terminals would likely be assessed on a case-by-case basis and would necessitate coordination with ODOT.

<sup>&</sup>lt;sup>1</sup> As discussed in Technical Memorandum #1, functional classification is likely a surrogate for number of lanes, speed, and volume. Therefore, it should only be used when one or more of these datasets are missing.

#### **Equity Index**

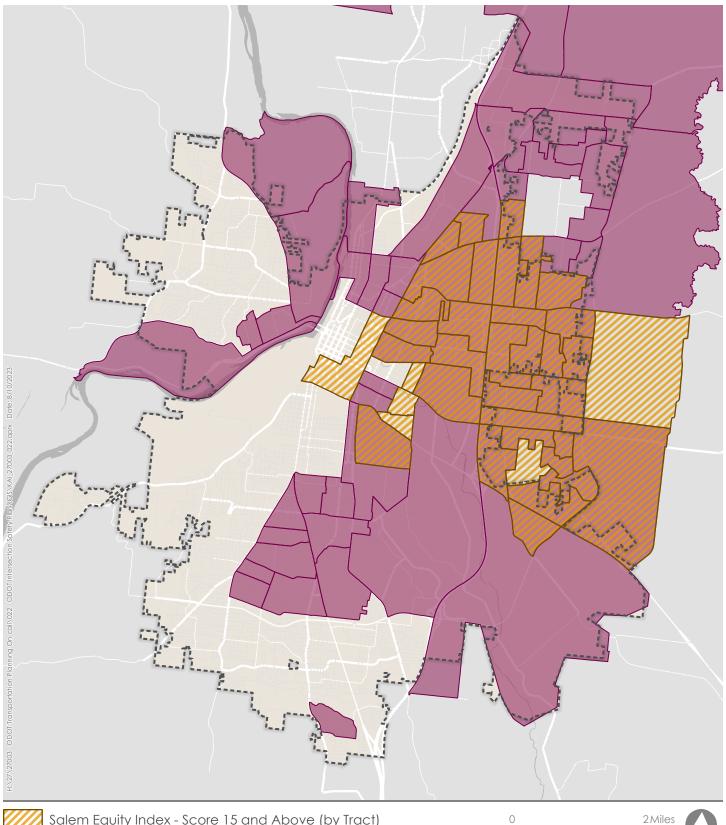
The City of Salem case study used Salem's city-specific equity index to identify areas with high equity disparity. The Salem equity index broadly uses the same population demographic factors as the ODOT Social Equity Index (SEI) from the American Community Survey (ACS) data to calculate the equity index <sup>2</sup>. The two indexes differ in the weighting of factors and the subsets of population groups included in the calculation (e.g., Salem's calculation includes a category for persons 65 years or older with a disability, whereas the SEI includes persons aged 20 to 64 to that have a disability). Additionally, the Salem index is at the Census Tract level, whereas the ODOT index evaluates at the Census Block Group level. Additionally, the Salem equity index uses a 25-point scoring system, whereas the ODOT screening uses a different scoring system that assigns equity based on categories like "High Equity Disparity". The project team along with the City of Salem determined that an equity score of 15 or greater would align with "medium-high" or "high" equity disparity defined by the ODOT Social Equity Index.

A comparison of the ODOT equity index versus the City of Salem equity index data coverage is shown in Figure 1. As displayed, census tracts scoring 15 or higher based on the Salem equity index results in lower coverage, which better targets areas of higher equity disparity. However, because Salem uses Census Tracts, the coverage also expands further beyond Block Groups used by ODOT, including some areas outside of the City boundary to the east.

### Characteristics-Based Analysis Results

Each intersection was scored using the screening characteristics weights defined in *Technical Memorandum #2: Network Screening*. The rural screening weights did not apply to intersections in the City of Salem dataset. The top scoring signalized intersections and stop controlled intersections are provided in Table 2. Intersections scoring in the top 10% of the analysis are displayed in Figure 2. A full list of intersections scoring in the top 10% of the analysis is in Appendix A.

<sup>&</sup>lt;sup>2</sup> The Salem Equity Tool (Beta Version) uses 2016-2020 ACS data and ODOT SEI uses 2017-2021 data.





ODOT Social Equity Index - High and Medium-High Equity Disparity (by Block Group)

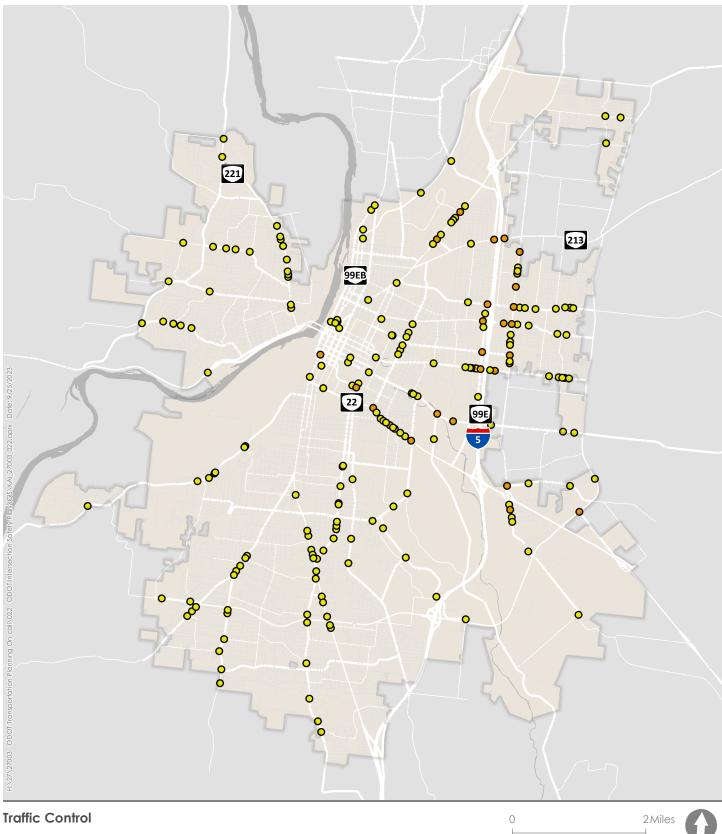
City of Salem



Figure 1

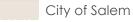
Table 2. Top-Scoring Intersections by Traffic Control Using Characteristics-Based Method

Intersection	Screening Score
Signalized	
25th St SE & Mission St SE	8.03
Cordon Rd SE & Gaffin Rd SE	7.05
Fisher Rd NE & Silverton Rd NE	7.03
Bill Frey Dr NE & Portland Rd NE	7.03
Airport Rd SE & State St	7.03
Hawthorne Av NE & Silverton Rd NE	7.03
Hawthorne Av NE & Sunnyview Rd NE	7.03
Geer Dr NE & State St	7.03
Carson Dr SE & Lancaster Dr SE	7.03
Lancaster Dr SE & Rickey St SE	7.03
Stop Controlled	
Hawthorne Av NE & Weston Ct NE	9.89
Boone Rd SE & Commercial St SE	9.33
12th St Cutoff SE & Oakhill Av SE	9.33
Barnes Av SE & Commercial St SE	9.33
Doaks Ferry Rd NW & Wallace Rd NW	9.33
Hines St SE & Mission St SE	9.05
21st St SE & Mission St SE	9.05
23rd St SE & Mission St SE	9.05
12th St SE & Mill St SE	8.89
Commercial St SE & Ratcliff Dr SE	8.84
Liberty Rd S & Marietta St SE	8.84
Hyacinth St NE & Mainline Dr NE	8.84
Front St NE & Front St NE (99E)	8.84
Liberty Rd S & Pembrook St SE	8.84
12th St SE & Vista Av SE	8.84



Traffic Signal

Stop Control





& ASSOCIATES

Figure 2

Characteristics-Based Screening Results Top 10% by Traffic Control (Excluding Ramps) City of Salem

There are several groupings of top 10% intersections along major corridors in Salem, including:

- A concentration of top 10% stop-controlled intersections on Mission Street, Center Street, 17th Street, Sunnyview Road, Liberty Road, Commercial Street, and OR 221.
- A concentration of top 10% signalized intersections on Mission Street, Hawthorne Avenue, and Lancaster Drive.

#### Key Takeaways – City of Salem Intersection Data

The project team reviewed the characteristics of the top 10% intersections in Salem to the characteristics of the top 10% of intersections in the ODOT network screening. Table 3 summarizes this comparison. Exhibits showing these comparisons are provided in Appendix B.

Observations from the comparison to the top 10% of the statewide ODOT network screening include:

- Signalized intersections:
  - There is a higher representation of intersections with AADT between 10,000 and 25,000, likely attributed to the limited number of roadways with greater than 25,000 AADT in the City of Salem.
  - Higher representation of principal arterials, interactions with four legs, and intersections with right-turn lanes.
  - o Posted speeds are generally lower in the Salem data compared to the ODOT data.
- Stop controlled intersections:
  - Higher representation of minor arterials, intersections with three legs, and intersections with right-turn lanes.
  - o Posted speeds are generally lower in the Salem data compared to the ODOT data.

Table 3. Common Characteristics in Characteristics-Based Top 10% for the City of Salem

	Urban Signals		Urban Stop Controlled	
Characteristic	Salem	ODOT	Salem	ODOT
Highest Functional Classification				
Local	4%	0%	<1%	0%
Minor Arterial	0%	4%	32%	10%
Major Collector	0%	0%	1%	<1%
Principal Arterial <sup>1</sup>	96%	92%	65%	88%
Other Freeways and Expressways	0%	4%	<1%	1%
AADT				
<1,000	0%	0%	0%	0%
Between 1,000 and 10,000	0%	<1%	31%	12%
Between 10,000 and 25,000	69%	29%	49%	74%
Between 25,000 and 40,000	27%	65%	18%	13%
>40,000	4%	5%	2%	<1%
Number of Legs				
3 Legs	23%	28%	75%	65%
4+ Legs	77%	72%	23%	31%
Number of Lanes				
1	0%	0%	0%	46%
2	4%	0%	8%	8%
3	4%	0%	37%	36%
4+	92%	100%	54%	12%
Turn Lanes				
Left-Turn Lane Present	100%	100%	19%	65%
Right-Turn Lane Present	46%	31%	64%	53%
Max Posted Speed				
20 mph	0%	0%	0%	0%
25 mph	0%	0%	7%	<1%
30 mph	4%	0%	10%	3%
35 mph	50%	29%	38%	31%
40 mph	31%	16%	22%	8%
45 mph	11%	45%	22%	22%
50 mph	0%	5%	1%	8%
55 mph (or greater) <sup>3</sup>	4%	5%	<1%	27%
Salem Equity Score ≥ 15	85%	100%2	62%	76%2
Bike Lane Present	100%	100%	94%	23%
Sidewalk Present	92%	100%	98%	66%

<sup>&</sup>lt;sup>1</sup>Roadways classified as "Parkway" in the Salem database were combined with Principal Arterials for comparison purposes.

<sup>&</sup>lt;sup>2</sup>ODOT Equity Index based on "Medium-High" or "High" Equity disparity.

<sup>&</sup>lt;sup>3</sup>Maximum speed in Salem was 55 MPH

## Example Application – Intersection Prioritization for Safety Countermeasures

The project team conducted an example application of the characteristic-based screening to support the City of Salem in identifying high-priority intersections for All Roads Transportation Safety Program (ARTS) applications. The screening scores can be used to prioritize intersections with similar characteristics, such as bicycle lane/ right-turn conflicts and lighting within those conflict zones.

The City of Salem identified green pavement markings (ODOT crash reduction factor (CRF) BP6) as a possible systemic intersection safety treatment at signalized intersections with bicycle lanes that cross over right-turn lanes). If there isn't a dedicated right-turn lane, green pavement markings can be applied through the intersection to highlight potential bicycle lane conflicts with right-turning vehicles. Additional lighting at these conflict points (ODOT CRF BP2) will also be considered if existing lighting is insufficient.

To identify potential intersections to prioritize for these treatments, the project team conducted the following steps using GIS software:

- Identified a sub-group of the study intersection dataset that includes signalized intersections with bike lane and right-turn conflicts by filtering the study intersections dataset with the following characteristics:
  - a. Signalized intersection
  - b. Bike lanes present on at least one leg
  - c. Right turn lane present on at least one leg
- 2. Sorted the sub-group (190 intersections) by the screening score.
- 3. Reviewed the following characteristics for each approach at intersections in the sub-group scoring in the top 50% of the screening analysis:
  - a. Presence of a bike lane and a dedicated right-turn lane conflict point (i.e., the point where right-turn traffic must cross the bike lane to enter the right-turn lane prior to the intersection)
  - b. Presence of a bike lane and a through-right turn lane conflict (i.e., the point where a right-turning vehicle turns across the path of people biking in the intersection)
  - c. Presence of lighting at each conflict point<sup>3</sup>

The project team reviewed characteristics of the 190 intersections in an Excel spreadsheet that will be provided to the City. The spreadsheet includes lighting and bicycle lane/right-turn conflict information for each approach. For example, the Cordon Road SE/Gaffin Road SE in Salem shown in Figure 3 demonstrates a scenario where green pavement markings could be added to the area where right-turning vehicles cross the bike lane (see the red box) on the northeast leg. The City can also apply green pavement markings through the intersection to highlight the potential conflict between right-turning vehicles and cyclists in the bike lane on Cordon Road. The intersection may also benefit from additional lighting on the northeast leg to illuminate the conflict point.

Kittelson & Associates, Inc.

<sup>&</sup>lt;sup>3</sup> City of Salem provided light pole data. Lighting was not used in the screening analysis since there ODOT does not maintain a comprehensive lighting database that could have been used to develop a score for the presence/absence of lighting.

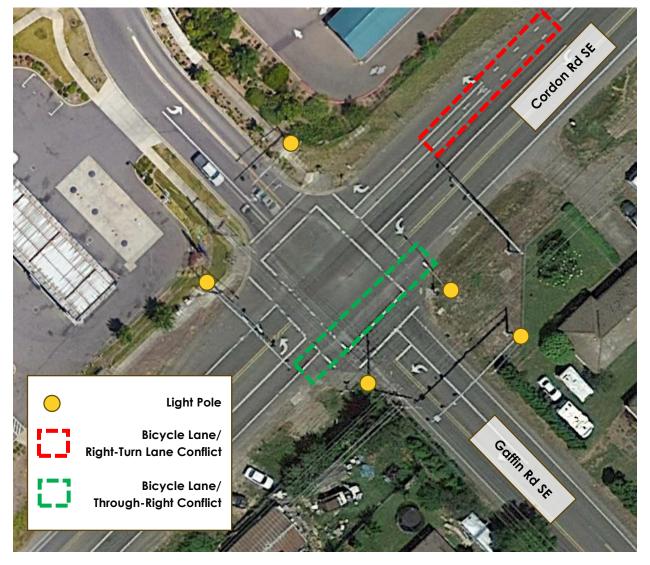


Figure 3. Cordon Road SE & Gaffin Rd SE in Salem, OR

As another example, the Center Street NE/Lancaster Drive NE intersection, shown in Figure 4, has bike lanes on all four approaches. The City can implement green pavement markings (CRF BP6) at the bicycle lane and dedicated right-turn conflict on the west leg. For the remaining legs, the City can apply green pavement markings through the intersection to highlight the potential conflict between right-turning vehicles and people biking. The intersection may benefit from additional lighting (CRF BP2) to illuminate conflicts on the northeast and southeast corners.

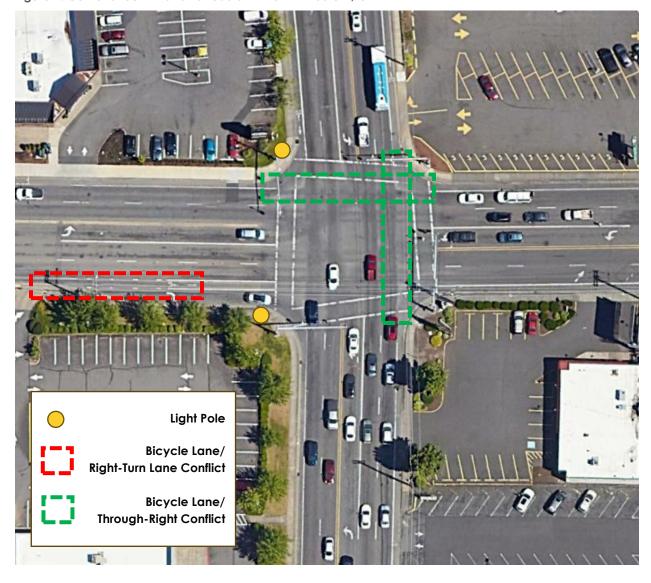


Figure 4. Center Street NE and Lancaster Drive NE in Salem, OR

#### Salem Next Steps

The project team provided the City with a spreadsheet that includes the 190 intersections in the sub-group with information about lighting and right-turn/bike lane conflict points. The City can use this spreadsheet to support their next ODOT ARTS application. To effectively incorporate this information into the application, the project team recommends the following next steps for the City:

- 1. Review the project team's findings and confirm the lighting assessment.
- 2. Develop cost estimates for each site based on the expected level of treatment and number of applicable approaches.
- 3. Determines which sites to move forward in the grant application based on anticipated budget and the grant funding request.
- 4. Calculate the cost-effectiveness index (CEI) for the selected sites and adjust the included sites as necessary to develop a competitive application.
- 5. Complete ARTS application.

## Considerations for Application of the Characteristics-Based Analysis Approach

#### Software and Staffing

- The characteristics-based screening requires knowledge of GIS software to spatially assign data to a single intersection layer.
  - o GIS capabilities may also include the ability to create and perform quality control on an intersection layer if the agency does not already have one.
  - The screening calculations can be completed within GIS software, or the results can be exported to a spreadsheet and calculated in spreadsheet software (e.g., Microsoft Excel).

#### **Data Availability**

- Some data management and preparation may be required to assign roadway characteristics to intersections.
  - Intersection traffic control may not be available in many cities. In smaller cities, the lack of traffic control data may be easily overcome by manually assigning signals, which are likely few. For larger cities, the time required to manually assign intersections may impact feasibility of conducting the network screening depending on available resources/ staffing. Open-source data sources like OpenStreetMap may be used to assist in identifying signalized intersection locations.
  - Many cities or counties may not have turn lanes, sidewalks, bicycle lanes, or other roadway characteristic data used in the screening process. The analysis can be completed without this data by omitting these factors from the overall score.
  - o If ODOT and/or local or regional average annual daily traffic (AADT) volume data is not sufficient, functional class can be used instead as a proxy for relative volume.
  - o Ramp terminal information would be important for regional analysis or larger metropolitan areas (e.g., Portland).
- An intersection dataset can be developed in GIS using spatial analysis tools to create nodes at roadway network intersections. This process requires quality control checks to remove locations associated with over- or undercrossing locations that may be calculated as an intersection.
- If a local agency does not have sufficient data to conduct the analysis, they should reach out to ODOT for technical assistance in assessing their data and steps necessary to obtain the needed data.
- If a local agency has its own equity index, additional considerations to translate a local equity index to comparative ranges from the ODOT Social Equity Index (medium-high and high) is necessary.

#### **Prioritization of Sites**

- If a city or county has identified a potential systemic treatment, the screening scores can provide an initial screening method to identify intersections that may benefit from the treatment.
  - o The project team used this method for the City of Salem case study application.
- Alternatively, a city or county can use the characteristics based analysis to screen a local jurisdiction network to identify treatments (systemic or hot spot) based on the scoring results.
- Other prioritization criteria (such as community input, crash history, or other community goals) may be integrated with the scoring to help prioritize locations that would achieve multiple goals within a jurisdiction.

## **APPENDIX**

Appendix A: Characteristics-Based Analysis - City of Salem Intersections Scoring in the Top 10%

Appendix B: Comparison of Salem Top 10% and ODOT Top 10%

## APPENDIX A: CHARACTERISTICS-BASED ANALYSIS - CITY OF SALEM INTERSECTIONS SCORING IN THE TOP 10%

Table 4. Characteristics-Based Analysis - City of Salem Intersections Scoring in the Top 10%

Intersection	Screening Score
Signalized	Screening Score
25th St Se & Mission St SE	8.03
Cordon Rd SE & Gaffin Rd SE	7.05
Fisher Rd Ne & Silverton Rd Ne	7.03
	7.03
Bill Frey Dr Ne & Portland Rd Ne	
Airport Rd Se & State St	7.03
Hawthorne Av Ne & Silverton Rd Ne	7.03
Hawthorne Av Ne & Sunnyview Rd Ne	7.03
Geer Dr Ne & State St	7.03
Carson Dr Se & Lancaster Dr Se	7.03
Lancaster Dr Se & Rickey St Se	7.03
22nd St Se & Mission St Se	6.99
17th St Se & Mission St Se	6.99
Center St Ne	6.95
D St Ne & Hawthorne Av Ne	6.95
Beverly Av Ne & Lancaster Dr Ne	6.95
Lancaster Dr Ne & Wolverine St Ne	6.95
Devonshire Av Ne & Lancaster Dr Ne	6.95
Commercial St Se & Ferry St Se	6.95
Lancaster Dr Ne & Sunnyview Rd Ne	6.95
Lana Av Ne & Portland Rd Ne	6.95
Center St Ne & Hawthorne Av Ne	6.95
Hawthorne Av Ne & Market St Ne	6.94
Lancaster Dr Ne & Market St Ne	6.94
12th St Se & Bellevue St Se	6.94
	Stop Controlled
Hawthorne Av Ne & Weston Ct Ne	9.89
Boone Rd Se & Commercial St Se	9.33
12th St Cutoff Se & Oakhill Av Se	9.33
Barnes Av Se & Commercial St Se	9.33
Doaks Ferry Rd Nw & Wallace Rd Nw	9.33
Hines St Se & Mission St Se	9.05
21st St Se & Mission St Se	9.05
23rd St Se & Mission St Se	9.05
12th St Se & Mill St Se	8.89
Commercial St Se & Ratcliff Dr Se	8.84
Liberty Rd S & Marietta St Se	8.84
Hyacinth St Ne & Mainline Dr Ne	8.84
Front Cp Ne & Front St Ne	8.84
Front Cp Ne & Front St Ne	8.84
Liberty Rd S & Pembrook St Se	8.84
12th St Se & Vista Av Se	8.84
49th Av Se & State St	8.8
	0.0

Silverton Rd Ne & Williams Av Ne	8.58
37th Av Ne & State St	8.57
Portland Rd Ne & Stortz Av Ne	8.57
Lancaster Dr Se & Saddle Club St Se	8.57
Commercial St Se & Winding Wy Se	8.24
Center St Ne & Norman Av Ne	8.08
Carolina Av Ne & Lancaster Dr Ne	8.08
Greentree Dr Ne & Sunnyview Rd Ne	8.08
Brown Rd Ne & Sunnyview Rd Ne	8.08
Icabod St Ne & Sunnyview Rd Ne	8.08
Earle Av Ne & Lancaster Dr Ne	8.08
41st Av Ne & Sunnyview Rd Ne	8.08
Center St Ne & Oregon Av Ne	8.08
Lancaster Dr Ne & Weathers St Ne	8.08
Carleton Wy Ne & Portland Rd Ne	8.08
Anita Dr Ne & Lancaster Dr Ne	8.08
Donald St Ne & Portland Rd Ne	8.08
36th Av Ne & Center St Ne	8.08
Neota St Ne & Swegle Rd Ne	8.08
Center St Ne & Illinois Av Ne	8.08
Freeway Ct Ne & Hawthorne Av Ne	8.08
Highway Av Ne & Portland Rd Ne	8.08
Judy Av Ne & Lancaster Dr Ne	8.08
Hollywood Dr Ne & Sunnyview Rd Ne	8.08
Center St Ne & Edina Ln Ne	8.08
Mousebird Av Nw & Orchard Heights Rd Nw	8.06
Skyline Rd S & Skyline Village Lp S	8.06
Airport Rd Se & Ryan Dr Se	8.06
Croisan Scenic Wy S & Kuebler Rd S	8.06
Doaks Ferry Rd Nw & Glen Creek Rd Nw	8.06
Holder Ln Se & Liberty Rd S	8.06
Davis Rd S & Liberty Rd S	8.06
Eola Dr Nw & Burley Hill Dr Nw	8.06
Skyline Rd S & Skyline Village Lp S	8.06
Burley Hill Dr Nw & Sunwood Dr Nw	8.06
25th St Se & Aviation Lp Se	8.02
Michigan City Ln Nw & Wallace Rd Nw	8
Lee St Se & Mission St Se	7.96
12th St Se & Cannon St Se	7.84
Liberty St Ne & Union St Ne	7.84
Capitol St Ne & Myrtle Av Ne	7.84
12th St Se & Cannon St Se	7.84
State St & Winter St Se	7.8
Lansing Av Ne & Sunnyview Rd Ne	7.8
Liberty St Se & Mill St Se	7.8
Commercial St Ne & Front Cp Ne	7.75
Liberty Rd S & Mize Rd Se	7.75
13th St Ne & Center St Ne	7.58
Church St Se & Mission St Se	7.58
Kimeron St Se & Liberty Rd S	7.57
Idylwood Dr Se & Sunnyside Rd Se	7.57
Barnes Av Se & Sunnyside Rd Se	7.57

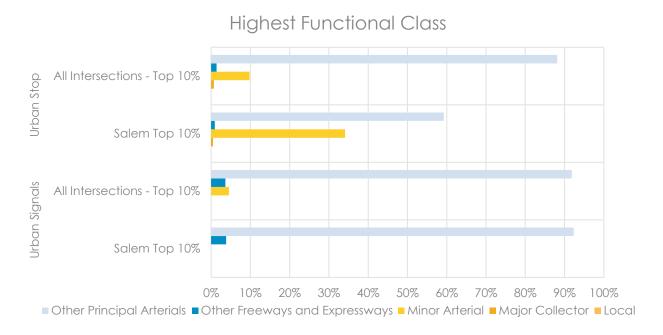
Boone Rd Se & Sunnyside Rd Se	7.57
Sunnyside Rd Se & Valleywood Lp Se	7.57
Bellevue St Se & University St Se	7.56
22nd St Se & Madrona Av Se	7.52
12th St Cutoff Se & Doris Av Se	7.52
Barnes Av Se & Commercial St Se	7.52
Madrona Av Se & Madrona Ct Se	7.52
Commercial St Se & Promontory PI Se	7.52
Portland Rd Ne & Wayside Tr Ne	7.52
12th St Cutoff Se & Ibsen St Se	7.52
Commercial St Se & Lansford Dr Se	7.52
Commercial St Se & Crowley Av Se	7.52
Commercial St Se & Royvonne Av Se	7.52
7th St Nw & Wallace Rd Nw	7.51
9th St Nw & Wallace Rd Nw	7.51
Hagers Grove Rd Se & Lancaster Dr Se	7.48
Caplinger Rd Se & Cordon Rd Se	7.48
Cranston St Se & Lancaster Dr Se	7.48
24th St Se & Mission St Se	7.24
Ford St Se & Mission St Se	7.24
20th St Se & Mission St Se	7.24
Ford St Se & Mission St Se	7.24
23rd St Ne & Recovery Dr Ne	7.08
Commercial St Se & Leslie St Se	7.08
Market St Ne & Tierra Dr Ne	7.08
Clay St Ne & Market St Ne	7.08
State St & Wander Wy Se	7.08
17th St Ne & Nebraska Av Ne	7.08
25th St Ne & State St	7.08
17th St Ne & Kansas Av Ne	7.08
17th St Ne & Kay St Ne	7.08
24th St Se & State St	7.08
17th St Ne & B St Ne	7.08
17th St Ne & A St Ne	7.08
17th St Ne & C St Ne	7.08
Hrubetz Rd Se & Liberty Rd S	7.03
12th St Se & Hillendale Dr Se	7.03
Fairview Av Se & Pringle Rd Se	7.03
Commercial St Se & Oakhill Av Se	7.03
12th St Se & Morningside St Se	7.03
12th St Se & Harris Av Se	7.03
Delmar Dr N & River Rd N	7.03
12th St Se & Shamrock Dr Se	7.03
Burley Hill Dr Nw & Satara Ct Nw	7.03
Commercial St Se & Ewald Av Se	7.03
12th St Se & Marshall Dr Se	7.03
Idylwood Dr Se & Liberty Rd S	7.03
Broadway St Ne & Shangri La Av Ne	7.03
River Rd N & Stark St N	7.03
Cypress St Ne & Lancaster Dr Ne	6.99
Cougar Ct Se & State St	6.99
Hawthorne Av Ne & Monroe Av Ne	6.99

Plateau St Ne & Swegle Rd Ne	6.99
Beach Av Ne & Portland Rd Ne	6.99
El Rancho Av Ne & Sunnyview Rd Ne	6.99
Center St Ne & Vinyard Av Ne	6.99
Future Dr Ne & Sunnyview Rd Ne	6.99
Alpine Lakes St Se & Rickey St Se	6.99
Lancaster Dr Ne & Manor Dr Ne	6.99
Eb Edgewater Rp & Wb Edgewater Rp	6.98
Church St Ne & Hood St Ne	6.97
49th Av Se & Macleay Rd Se	6.81
Division Cp Ne & Division St Ne	6.75
Mainline Dr Ne & Salem Py Ne	6.74
Pringle Rd Se & Tiburon Ct Se	6.57
Linwood St Nw & Orchard Heights Rd Nw	6.57
36th Av Se & Trelstad Av Se	6.54
13th St Se & State St	6.53
Court St Ne & Winter St Ne	6.53
Capitol St Ne & Nebraska Av Ne	6.49
Commercial St Se & Welcome Wy Se	6.49
Kimeroff Ln Se & Liberty Rd S	6.48
Cayuse Cr Se & Sunnyside Rd Se	6.48
Bliler Av Ne & Liberty St Ne	6.48
Lancaster Dr Se & Sylvia St Se	6.45
Cordon Rd Se & Old Macleay Rd Se	6.45
Commercial St Ne & Division Cp Ne	6.44
Liberty St Ne & Taylor St Ne	6.42
14th St Ne & D St Ne	6.31
14th St Ne & D St Ne	6.31
Country Club Dr S & River Rd S	6.26
Doaks Ferry Rd Nw & Eola Dr Nw  Orah grad Unighta Rd Nov & William gradus Av Nov	6.25
Orchard Heights Rd Nw & Wilmington Av Nw	6.25
Rees Hill Rd Se & Sunnyside Rd Se	6.25
Liberty Rd S & Radiance Av Se Croisan Scenic Wy S & Summercrest Dr S	6.25
River Rd S & Valley High St S	6.25 6.25
	6.25
Neahkahnie St Se & Sunnyside Rd Se Benson St S & River Rd S	6.25
Fairview Industrial Dr Se & Marietta St Se	6.25
Aumsville Hw Se & Joseph St Se	6.25
Golf Course Rd S & River Rd S	6.25
Bayne St Ne & Kale St Ne	6.25
Liberty Rd S & Mildred Ln Se	6.25
Maple Glen Ln S & River Rd S	6.25
River Rd S & Schurman Dr S	6.25
Orchard Heights Rd Nw & Titan Dr Nw	6.25
49th Av Ne & Kale St Ne	6.25
Croisan Creek Rd S & Kuebler Rd S	6.25
Eagle View Dr Nw & Eola Dr Nw	6.25
Eola Dr Nw & Mule Deer St Nw	6.25
Fairview Industrial Dr Se & Lindburg Rd Se	6.25
Acacia Dr S & River Rd S	6.25
Cascadia Industrial St Se & Reed Rd Se	6.25
Cascada indosmaror do a recoa na do	0.20

Orchard Heights Rd Nw & Snowbird St Nw	6.25
Pringle Rd Se & Suntree Dr Se	6.25
Eola Dr Nw & Gehlar Rd Nw	6.25
49th Av Ne & Hayesville Dr Ne	6.24
Center St Ne & Greencrest St Ne	6.21
Center St Ne & Sand Piper Av Ne	6.21
Center St Ne & Sphinx Ct Ne	6.21
Center St Ne & Wildflower St Ne	6.21
Center St Ne & Royalty Dr Ne	6.21
Wallace Rd Nw &	6.19
Creek Ct Nw & Wallace Rd Nw	6.19
Orchardview Av Nw & Wallace Rd Nw	6.19
Tulip Ln Nw & Wallace Rd Nw	6.19
Hope Av Nw & Wallace Rd Nw	6.19
Narcissus Ct Nw & Wallace Rd Nw	6.19
Lynda Ln Nw & Wallace Rd Nw	6.19
Narcissus Ct Nw & Wallace Rd Nw	6.19
Harritt Dr Nw & Wallace Rd Nw	6.19
Deering Dr Nw & Wallace Rd Nw	6.19

# APPENDIX B – COMPARISON OF SALEM TOP 10% AND ODOT TOP 10%

**Exhibit 1. Functional Class** 



**Exhibit 2. Number of Legs** 



**Exhibit 3. Number of Lanes** 

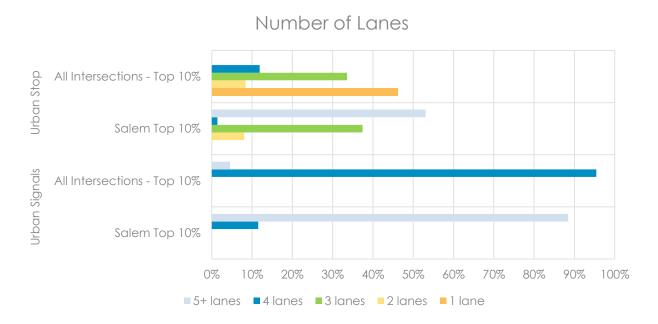


Exhibit 4. Right Turn Lane Presence

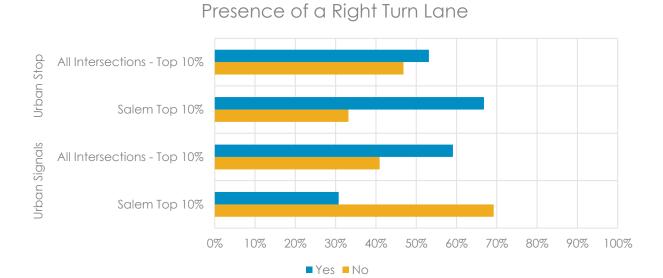


Exhibit 5. Left Turn Lane Presence



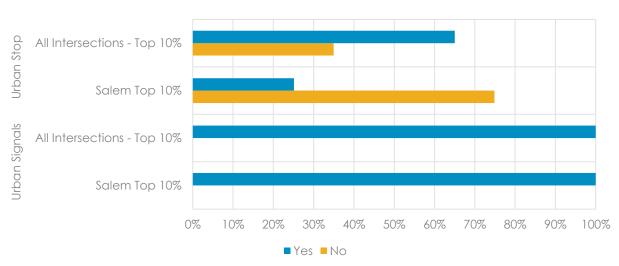
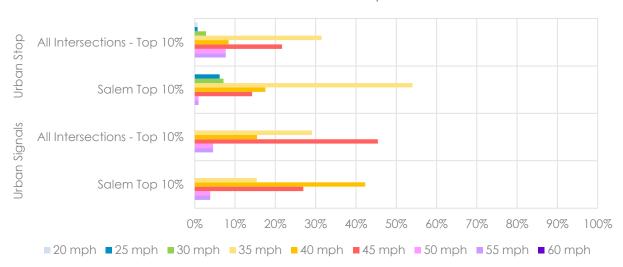


Exhibit 6. Maximum Posted Speed

## Maximum Posted Speed



**Exhibit 7. Equity Disparity** 



Exhibit 8. Bike Lane Presence

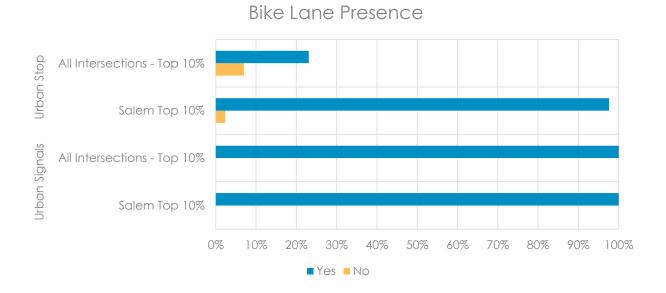


Exhibit 9. Sidewalk Presence

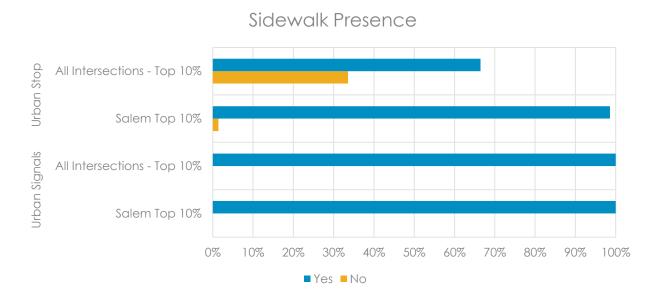
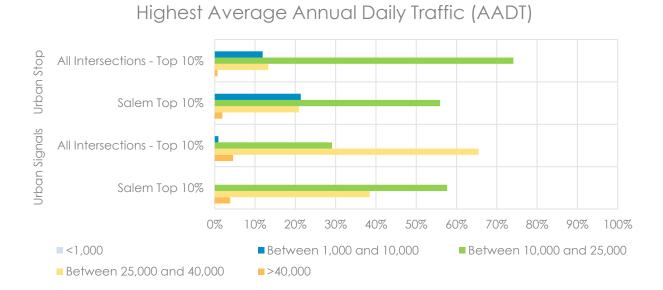


Exhibit 10. Average Annual Daily Traffic (AADT)



# APPENDIX C: Technical Memorandum #2: Network Screening

# Technical Memorandum

September 28, 2023

Project# 27003.022

To: Christi McDaniel-Wilson, State Traffic Safety Engineer, ODOT

Jiguang Zhao, Traffic Safety Engineer, ODOT

From: Katie Popp, Ashleigh Ludwig, PE, AICP, Nick Foster, AICP, RSP1, Matt Braughton, RSP1, Pete Jenior,

PE, PTOE, Kittelson & Associates, Inc.

Beth Wemple, PE, HDR

CC: ODOT Technical Advisory Committee

RE: ODOT Intersection Safety Implementation Plan Update – Network Screening

# ODOT INTERSECTION SAFETY IMPLEMENTATION PLAN UPDATE

#### Introduction

This memorandum documents the network screening analysis completed as part of the Oregon Department of Transportation (ODOT) Intersection Safety Implementation Plan Update. The plan update process is summarized in Figure 1 This memorandum documents the work completed for Step 2.

Figure 1. Intersection Safety Implementation Plan Update Process



The goal of the network screening step is to identify intersections on the study network, previously presented in Technical Memorandum (TM) #1, that have the greatest potential for safety benefit. This memorandum discusses the methodologies and assumptions used to identify these intersections based on two systemic screening methods:

- (1) Risk factor-based analysis
- (2) Safety performance function (SPF)-based analysis

The purpose of completing these two analyses is to compare their results and offer guidance on benefits/considerations related to each method so that ODOT Region and local agency staff can select the method that may be best suited to their data and goals.

The results of the risk factor-based analysis, along with input from ODOT Region staff, will be used to identify six intersections in each ODOT Region for the next step in the process. This next step will include identifying potential safety countermeasures for each intersection.

# Network Screening Methodologies and Results

The project team conducted the network screening analysis using 1) a risk factors-based approach and 2) a safety performance function (SPF)-based approach. This section presents the methodologies and results of each approach. **Both approaches focus on fatal and suspected serious injury (i.e., Injury A) crashes** in alignment with the project's Safe System Approach (SSA)-based framework.

The network screening analysis was conducted with 3- and 4- leg intersections, excluding ramps. The study intersection dataset consists of 4,503 intersections, including:

976 signalized intersections

Urban: 937 intersectionsRural: 39 intersections

■ 3,527 stop-controlled intersections

Urban: 1,403 intersectionsRural: 2,124 intersections

#### Method 1: Risk Factor-Based Approach

Technical Memorandum #1 identified risk factors that are correlated with fatal and suspected serious injury intersection crashes. These factors are based on ODOT crash and intersection data. The methodology used for this approach is similar to the network screening conducted for ODOT's Bicycle and Pedestrian Safety Implementation Plan.

#### **Risk Factor Weighting**

To use these risk factors to screen the study network, the project team weighted each risk factor to capture their relative correlation with fatal and suspected serious injury crashes. The weights were calculated using Equivalent Property Damage Only (EPDO) scores. These scores are calculated by converting each crash to a score based on its severity. Property damage only (PDO) crashes are assigned a value of 1, and every other severity is assigned a multiple of that based on ODOT's latest crash cost values, which are currently in draft form. Each risk factor is then assigned an "EPDO per crash" score based on the total EPDO scores of all crashes associated with that factor divided by the number of crashes. Table 1 summarizes the EPDO-based weights for each risk factor.

Table 1. Risk Factor Weights

	Signalized		Stop Co	ntrolled
Risk Factor	Urban	Rural	Urban	Rural
Functional Classification				
Arterial (Principal + Minor)	1.03	-	1.25	-
Arterial (Principal)	(1.12)	1.29 (3.59)	(1.24)	1.61 (2.37)
Arterial (Minor)	(1.19)	-	-	-
Other Freeways and Expressways	(1.06)			
Posted Speed				
35 mph	1.01 (1.00)	-	1.00 (1.31)	-
40 – 45 mph	1.09 (1.19)	-	1.49 (2.00)	-
45 – 50 mph	-	1.00	-	1.06 (1.22)
≥ 50 mph	1.11 (1.33)	-	2.04 (1.44)	-
≥ 55 mph	-	1.13	-	2.03 (3.05)
Volume (AADT)				
AADT ≥ 10,000	-	-	1.27 (1.03)	1.80 (2.78)
AADT ≥ 25,000	1.00	1.24 (1.00)	-	-
AADT between 25,000-40,000	(1.00)	-	-	-
AADT ≥ 40,000	(1.18)	-	-	-
Approach Characteristics				
Right Turn Lane Present <sup>3</sup>	(1.05)	-	1.81	2.10
Left Turn Lane Present <sup>3</sup>	1.70 (1.03)	1.10 (2.97)	1.09 (1.34)	1.95 (3.18)
Number of Through Lanes ≥ 3		-	1.33 (1.60)	1.51 (1.00)
Number of Through Lanes ≥ 4	1.04 (1.01)	1.46 (1.02)	-	-
Equity				
Medium High or High Equity Disparity	1.16 (1.03)	1.20 (1.16)	1.05 (1.00)	1.65 (2.16)
Active Transportation				
Bicycle Volumes <sup>4</sup>	1.03 (1.01)	1.27 (3.59)	1.31 (1.36)	1.00 (3.40)
Pedestrian Volumes <sup>5</sup>	1.01 (1.02)	1.44 (3.59)	1.03 (1.01)	1.13

<sup>&</sup>lt;sup>1</sup> Each cell provides two values, "Value Not on a Ramp | (Value on a Ramp)". Cells with one value only have risk factors for that intersection type.

<sup>&</sup>lt;sup>2</sup>Functional classification is likely a surrogate for number of lanes, speed, and volume. Therefore, it should only be used when one or more of these datasets are missing.

<sup>&</sup>lt;sup>3</sup>See discussion in "Correlation vs. Causation" subsection in Technical Memorandum #1.

<sup>&</sup>lt;sup>4</sup> Bicycle volume data is not available from ODOT at a statewide scale, so the presence of a bicycle lane is used as a proxy to indicate whether an intersection should be prioritized for bicycle related treatments.

<sup>&</sup>lt;sup>5</sup> Pedestrian volume data is not available from ODOT at a statewide scale so the presence of a sidewalk lane is used as a proxy to indicate whether an intersection should be prioritized for pedestrian related treatments.

This analysis did result in some risk factors changing from what was identified in *Technical Memorandum #1*. These changes reflect feedback from the Local Agency Advisory Committee (LAAC) and the results of the EPDO weighting exercise. They include:

- Combining Principal and Minor Arterials for urban intersections
- Altering the speed categories for urban intersections
- Combining AADT categories for signalized intersections

#### **Risk-Based Method Results**

The project team calculated a total risk factor score for each intersection using the weighted scores in Table 1. Intersections were evaluated using the following sub-categories:

- Non-ramp terminal intersections:
  - Urban Signalized
  - Urban Stop Controlled
  - Rural Signalized
  - Rural Stop Controlled
- Ramp terminal intersections

The sample of ramp terminal intersections is limited. Therefore, the project team focused its analysis on non-ramp terminal intersections. For the purposes of this analysis, the total risk factor-based score excludes functional class because that factor is only intended to be used when volume, speed, and/or number of lanes data is missing and that data is available on the study network.

Table 2 summarizes intersections in the top 10% by ODOT region and sub-category (excluding ramp terminal intersections).

Table 2. Intersections Scoring in the Top 10% by ODOT Region

Region	Urban Signalized	Urban Stop Controlled	Rural Signalized	Rural Stop Controlled	Total
1	59	40	0	41	140
2	30	53	1	70	154
3	21	31	7	46	105
4	6	12	0	31	49
5	3	8	0	28	39
Total	119	144	8	216	487

Region 2 has the most intersections in the top 10% of risk-based scoring, followed by Regions 1 and 3. Patterns in the results generally follow the character of each Region. Region 1 has over half of the urban signalized intersections in the top 10% of scores, likely associated with the high number of signalized intersections in its denser urban areas compared to other Regions. Rural intersections make up most of the identified intersections in Regions 4 and 5, while Regions 2 and 3 have a more even split between urban and rural intersections. Table 3 summarizes the top ten scoring intersections<sup>1</sup> in each sub-category (excluding ramp terminal intersections).

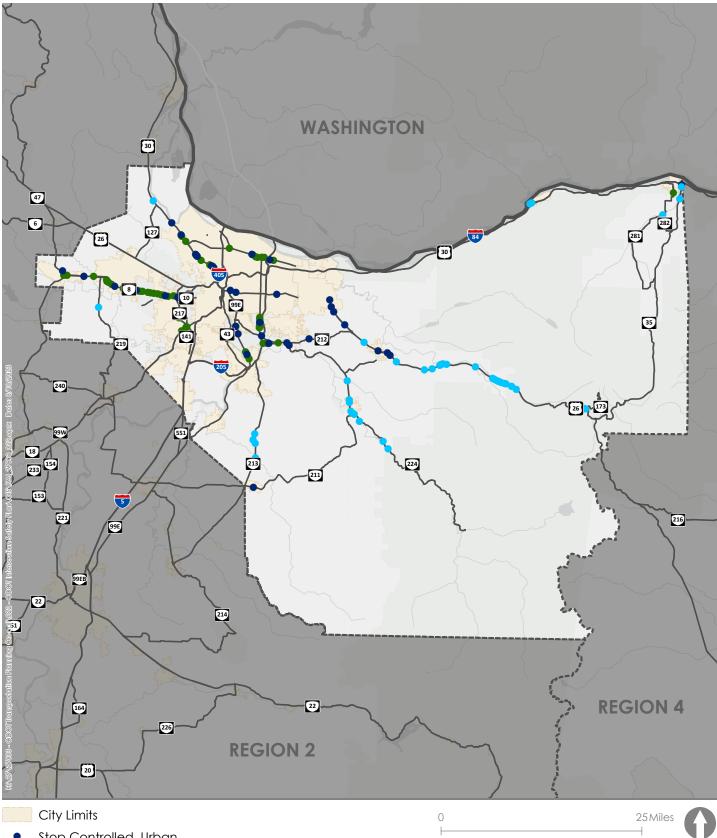
Figures 2 through 7 map the intersections scoring within the top 10% of risk factor scoring of their respective sub-categories. Appendix A contains the full list of top10% intersections.

 $<sup>^{</sup>m 1}$  Some sub-categories may show more than 10 intersections if there are multiple intersections with the same risk factor score.

Table 3. Top-Scoring Intersections in Each Sub-Category Using Risk Factor-Based Method

Intersection Name	Highway #	Mile Post	ODOT Region	Risk Factor Score
	Urban Signalize	d	kegion	JCOIE
McKenzie Highway @ Eugene Springfield Hwy (Or126)	015	6.23	2	8.05
S 6th @ Parkway	020	3.28	4	8.05
OR62 @ OR 140	022	6.03	3	8.05
OR2 @ Roberts Ck Rd/Carnes Rd (Kelly' S Corner)	035	75.72	3	8.05
OR22 @ Airport	072	7.92	2	8.05
OR22 @ Hawthorne	072	8.26	2	8.05
US97 @ Robal	004	134.6	4	8.03
OR62 @ Poplar Dr/Bullock Rd	022	0.89	3	8.03
US199 @ Allen Creek	025	1.24	3	8.03
US199 @ Dowell	025	2.05	3	8.03
OR8 @ Murray Blvd	029	4.58	1	8.03
OR8 @ 153rd Dr	029	4.9	1	8.03
OR8 @ 160th Ave	029	5.36	1	8.03
OR8 @ 170th Ave	029	5.84	1	8.03
OR8 @198th Ave	029	7.28	1	8.03
OR8 @ 205th Ave/Intel	029	7.54	1	8.03
OR8 @ 209th Ave	029	7.8	1	8.03
OR8 @ Cornelius Pass Rd	029	8.32	1	8.03
OR8 @ 229th Ave/67th Ave	029	8.81	1	8.03
OR8 @ 234th Ave/Century Blvd	029	9.06	1	8.03
OR8 @ Brookwood Ave	029	9.73	1	8.03
OR8 @ 17th Ave	029	14.15	1	8.03
OR8 @ Mountain View Ln	029	17.46	1	8.03
OR8 @ Quince St	029	17.88	1	8.03
Or213 @ Clack Town Ctr S	068	9.05	1	8.03
Salem Parkway @ Broadway	072	3.16	2	8.03
OR22 @ 17th	072	6.77	2	8.03
OR22 @ 25th	072	7.52	2	8.03
OR99E @ River Rd/Bluebird St	081	6.3	1	8.03
OR99E @ Jennings Ave	081	9.8	1	8.03
OR99E @ Glen Echo Ave	081	10.3	1	8.03
OR99E @ Gloucester St	081	10.75	1	8.03
OR99E @ Ward Dr	081	45.89	2	8.03
Portland Rd(OR99E) @ Hyacinth	081	46.49	2	8.03
Yeon Ave (US30) @ 26th Ave	092	2.25	1	8.03
Yeon Ave (US30) @ 29th Ave	092	2.68	1	8.03
Yeon Ave (US30) @ St Helens Rd/Kittridge Ave	092	3.92	1	8.03
St Helens Rd (US30) @ Bridge Ave N(Us30By)	092	7.32	1	8.03
Portland Hwy (US30BY) @ Cully Blvd	123	9.64	1	8.03
Portland Hwy (US30BY) @ 82nd Ave (068)	123	10.37	1	8.03

Intersection Name	Highway #	Mile Post	ODOT Region	Risk Factor Score
Killingsworth St @ Nb @ Columbia Pkwy Blvd	123	10.72	l l	8.03
OR141 @ Fairview Place/Eliander Ln	141	2.96	1	8.03
OR141 @ Wash Sq/Circle	141	3.08	1	8.03
OR210 @ Hall Blvd (Hwy141)	143	9.6	1	8.03
OR224 @ 130th Ave	171	6.94	1	8.03
US199 @ 238	272	0.03	3	8.03
OR281 @ Eliot Dr/Brookside Dr	281	1.17	1	8.03
Urb	an Stop Contro	lled		
Oneil Hwy @ The Dalles-California Hwy	004	118.52	4	10.93
Redwood Hwy @ Willow Ln	025	2.56	3	10.38
Warm Springs Hwy @ Ne Cedar St	053	117.42	4	10.38
McKenzie-Bend Hwy @ McKenzie-Bend Hwy	017	16.74	4	9.9
Redwood Hwy @ Neill Rd	025	6.35	3	9.9
Mt Hood Hwy @ Se Hillyard Rd	026	15.44	1	9.9
Oregon Coast Hwy @ Shamrock Rd	009	17.49	2	9.35
Mt Hood Hwy @ Mt Hood Hwy	026	14.58	1	9.35
Lower Columbia River Hwy @ Pittsburg Rd	092	29.10	2	9.33
Lower Columbia River Hwy @ Wyeth St	092	28.94	2	9.33
	Rural Signalized	1		
US 101 @ OR 38	009	211.58	3	6.61
US 101 @ 13th Street	009	211.91	3	6.61
US 101 @ Winchester	009	212.05	3	6.61
US 101 @ OR 42S	009	261.57	3	6.61
US 101 @ 11th Street	009	274.48	3	6.61
US 101 @ Moore St	009	328.48	3	6.61
US199 @ Lister St	025	28.63	3	6.61
US30 at Nehalem	092	61.47	2	6.61
Rur	al Stop Control	led		
The Dalles-California Hwy @ Madras-Prineville Hwy	360	0.09	4	11.66
The Dalles-California Hwy @ Sw Iris Ln	004	103.63	4	10.66
Coquille-Bandon Hwy @ Coos Bay-Roseburg Hwy	035	10.85	3	10.55
Florence-Eugene Hwy @ Perkins Peninsula Park Rd	062	49.75	2	10.53
Redwood Hwy @ Laurel Rd	025	27.75	3	9.56
Rogue River Loop Hwy @ Redwood Hwy	025	7.09	3	9.53
Redwood Hwy @ Lakeshore Dr	025	20.79	3	9.53
Wilsonville-Hubbard Hwy @ Keil Rd Ne	051	3.00	2	9.53
Willamina-Salem Hwy @ Salt Creek Rd	030	11.18	2	9.53
Clackamas Hwy @ Se Currin St	171	23.27	1	9.49

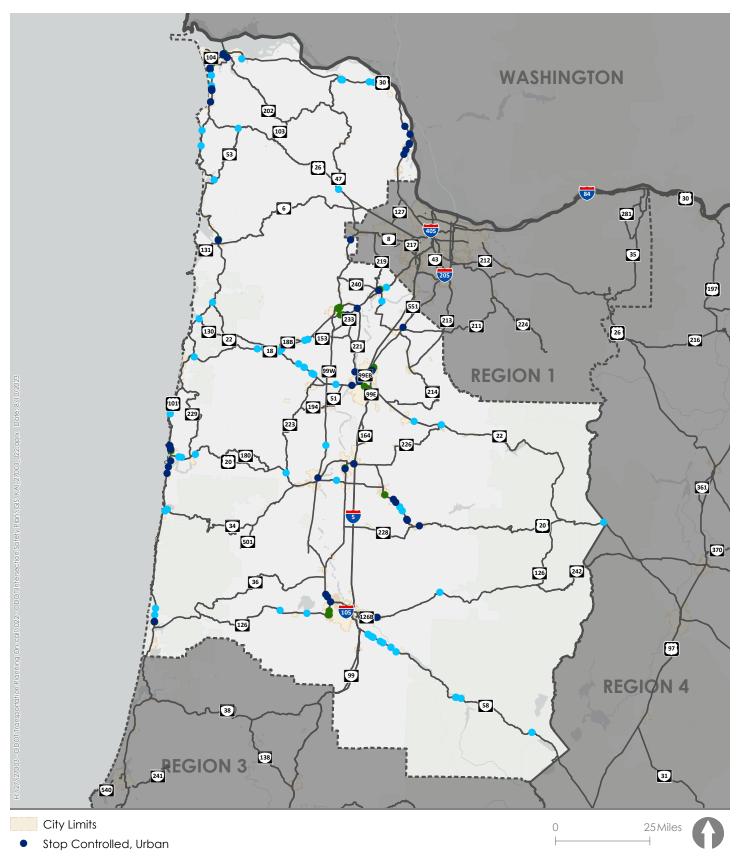


- Stop Controlled, Urban
- Stop Controlled, Rural
- Signalized, Urban







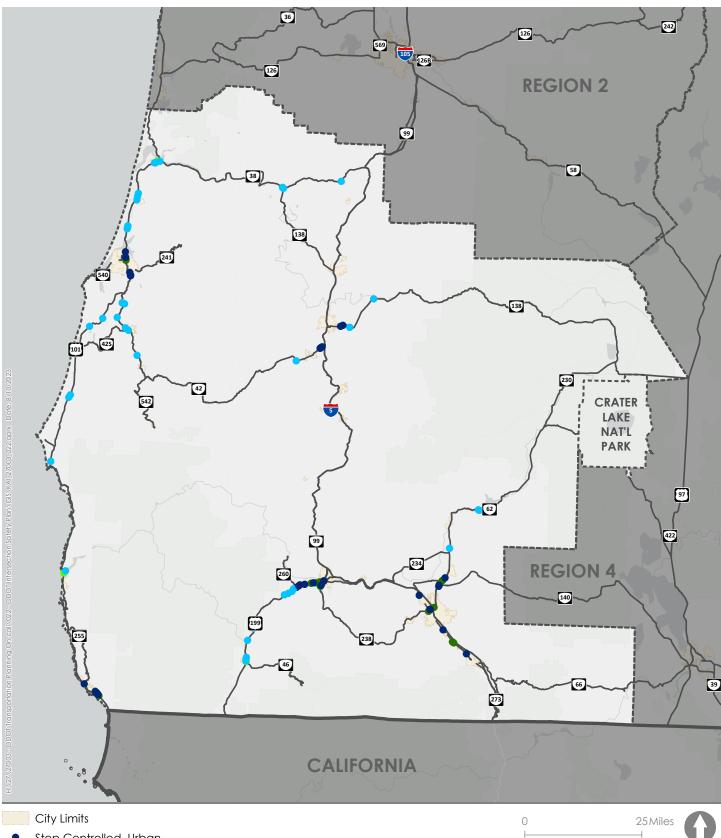


- Stop Controlled, Rural
- Signalized, Urban
- Signalized, Rural

Figure 3





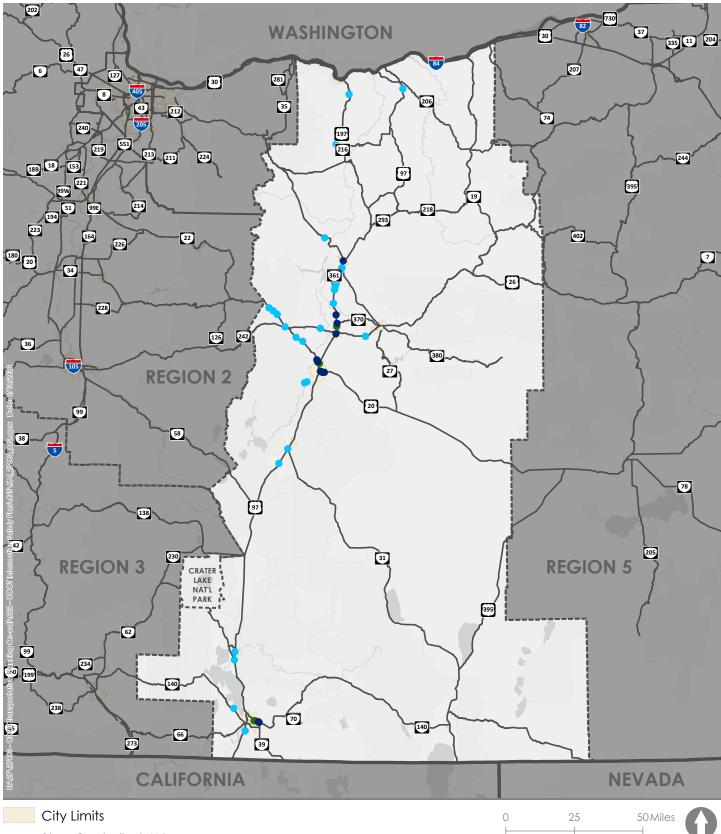


- Stop Controlled, Urban
- Stop Controlled, Rural
- Signalized, Urban
- Signalized, Rural



Risk-Based Screening Results
Top 10% by Category (Excluding Ramps)
ODOT Region 3



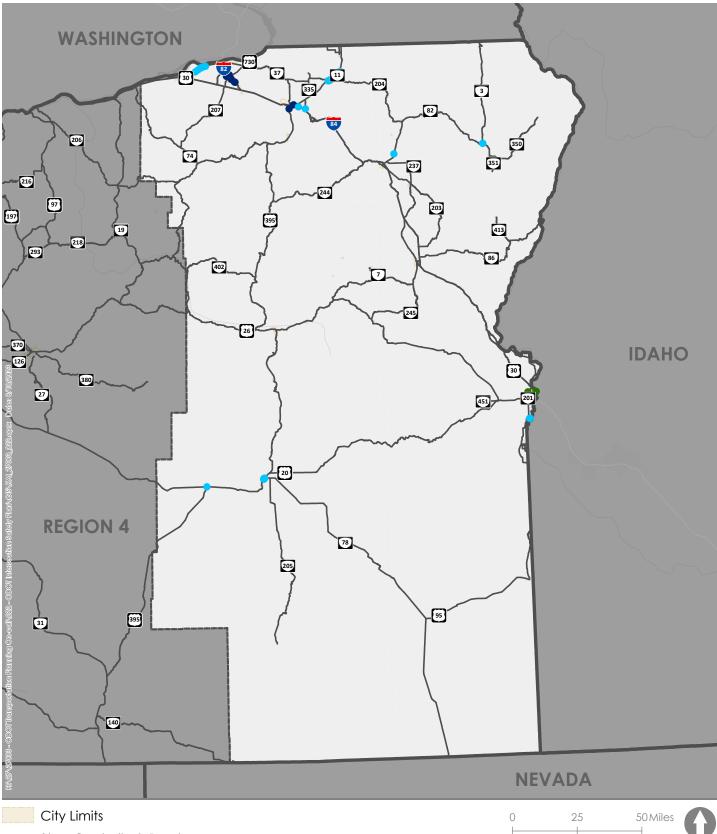


- Stop Controlled, Urban
- Stop Controlled, Rural
- Signalized, Urban







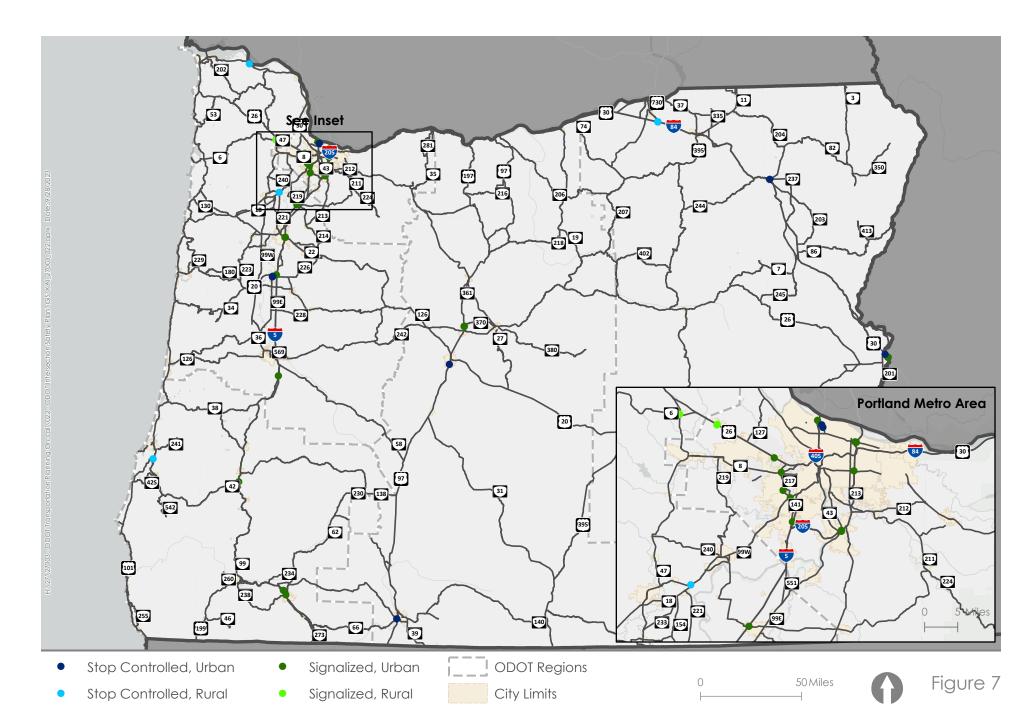


- Stop Controlled, Rural
- Signalized, Urban
- Stop Controlled, Urban











## Key Takeaways from Risk Factor-Based Screening

The project team reviewed the characteristics of the top 10% intersections compared to the representation of each characteristic within all intersection, by sub-category. A summary of the comparison is provided in Table 4

Table 4. Common Characteristics in Risk-Based Top 10% Intersections

	Urban Stop					Rural Stop		
	Urban S	Signals		rolled	Rural	Signals	Controlled	
Characteristic	Тор	All Int.	Тор	All Int.	Тор	All Int.	Тор	All Int.
	10%		10%		10%		10%	
Highest Functional Classification					'		'	
Local	0%	<1%	0%	1%	0%	0%	0%	<1%
Major Collector	0%	<1%	1%	7%	0%	0%	1%	19%
Minor Arterial	4%	11%	6%	10%	10%	18%	15%	30%
Other Freeways and	6%	3%	1%	<1%	0%	0%	0%	<1%
Expressways								
Principal Arterial	90%	85%	93%	69%	100%	82%	84%	50%
AADT								
< 1,000	0%	<1%	0%	<1%	0%	0%	1%	20%
Between 1,000 and 10,000	<1%	<1%	12%	42%	63%	44%	45%	70%
Between 10,000 and 25,000	29%	62%	74%	48%	37%	51%	52%	10%
Between 25,000 and 40,000	64%	26%	13%	8%	0%	5%	2%	<1%
>40,000	6%	3%	<1%	<1%	0%	0%	0%	0%
Number of Legs								
3 Legs	28%	14%	68%	60%	25%	10%	67%	69%
4 Legs	69%	83%	27%	39%	63%	90%	32%	31%
Lanes on Major Cross-Street								والمالية المالية
1	0%	1%	0%	<1%	0%	0%	0%	<1%
2	0%	30%	46%	65%	0%	28%	59%	68%
3	0%	15%	8%	4%	0%	5%	15%	5%
4	93%	50%	33%	15%	100%	67%	26%	14%
5+	7%	3%	0%	<1%	0%	0%	0%	<1%
Turn Lanes		707	. =~	1.407		7.40	~	007
Left-Turn Lane Present	100%	70%	65%	16%	100%	74%	67%	9%
Right-Turn Lane Present	54%	38%	53%	9%	25%	36%	46%	6%
Max Posted Speed	007	407	.107	007	007	007	.107	-107
20 mph	0%	4%	<1%	2%	0%	0%	<1%	<1%
25 mph	0%	14%	<1%	15%	0%	15%	6%	12%
30 mph	0%	21%	3%	20%	88%	41%	6%	8%
35 mph	29%	26%	31%	23%	12%	21%	8%	7%
40 mph	20%	9%	8%	8%	0%	0%	1%	6%
45 mph	41%	17%	22%	15%	0%	8%	<b>9%</b>	6%
50 mph	<b>4</b> %	3%	8%	3%	0%	3%	2%	2%
55+ mph	6% 100%	4%	27%	12%	0%	10%	63%	53%
High or Medium-High Equity	100%	53%	75%	14%	100%	62%	74%	51%
Disparity Bike Lane Present	100%	71%	92%	60%	100%	56%	2497	19%
Sidewalk Present	98%	90%	66%	71%	100%	77%	26% 28%	23%
Note: Bold numbers represent characteris								

Note: Bold numbers represent characteristics in the top 10% sites that exceed the proportion of intersections with that characteristic in the overall dataset.

#### Method 2: Safety Performance Function (SPF)-Based Approach

Safety Performance Functions (SPFs) can be used to estimate the long-term average cash frequency for a specific intersection type. Predicted crashes are calculated based on traffic control, number of legs, and traffic volume. The Empirical Bayes (EB) method is then applied to calculate the expected number of crashes based on predicted crashes and observed crashes from the study period. The AASHTO Highway Safety Manual (HSM) predictive methodology covers a range of roadway and intersection types<sup>2</sup>. Oregon has developed calibration factors for the Rural Two-Lane, Two-Way Roads; Rural Multilane Highways; and Urban/Suburban Arterials.

#### **SPF-Based Method Results**

Given the presence of Oregon calibration factors, the project team evaluated the following subcategories for non-ramp terminal intersections<sup>3</sup>:

- Urban Signalized
- Urban Stop Controlled
- Rural Signalized
- Rural Stop Controlled

Predicted and expected crash calculations using the SPF method are dependent on major approach AADT and minor approach AADT. Therefore, intersections with AADT information for only one leg were excluded from the analysis, resulting in a smaller overall sample size. A summary of the sample size for each sub-category is provided in Table 5.

Table 5. SPF-Based Approach Sub-Category Sample Sizes

Sub-Category	Sample Size
Urban Signalized	718
Urban Stop Controlled	528
Rural Signalized	21
Rural Stop Controlled	919
Total	2,186

Table 6Table 6 summarizes intersections in the top 10% by ODOT region and sub-category (excluding ramp terminal intersections). The intersections are ranked using the expected average fatal and injury crash frequency. This method is used since it highlights the intersections with the greatest number of fatal and injury crashes.

<sup>&</sup>lt;sup>2</sup> American Association of State Highway Officials (AASHTO). Highway Safety Manual Volume 2, 1st Edition. (2010).

 $<sup>^{3}</sup>$  ODOT has not yet calibrated the ramp terminal intersection predictive models.

Table 6. Intersections Scoring in the Top 10% of Fatal and Injury Crashes by ODOT Region

Region	Urban Signalized	Urban Stop Controlled	Rural Signalized	Rural Stop Controlled	Total
1	44	21	0	10	75
2	18	20	2	45	85
3	6	5	0	13	24
4	3	6	0	11	20
5	0	0	0	13	13
Total	71	52	2	92	217

Using the SPF-based approach, intersections scoring in the top 10% are more heavily concentrated in Regions 1 and 2, compared to the risk factor-based approach. Consistent with the risk-based scoring, patterns in the results generally follow the character of each Region, though Region 1 has a higher concentration of the urban locations, while the other Regions primarily have rural intersections in the top 10%. Table 7 summarizes the top ten scoring intersections<sup>4</sup> in each Region.

Figures 8 through 12 map the intersections scoring within the top 10% of risk factor scoring of their respective sub-categories. Appendix B contains the full list of top 10% intersections.

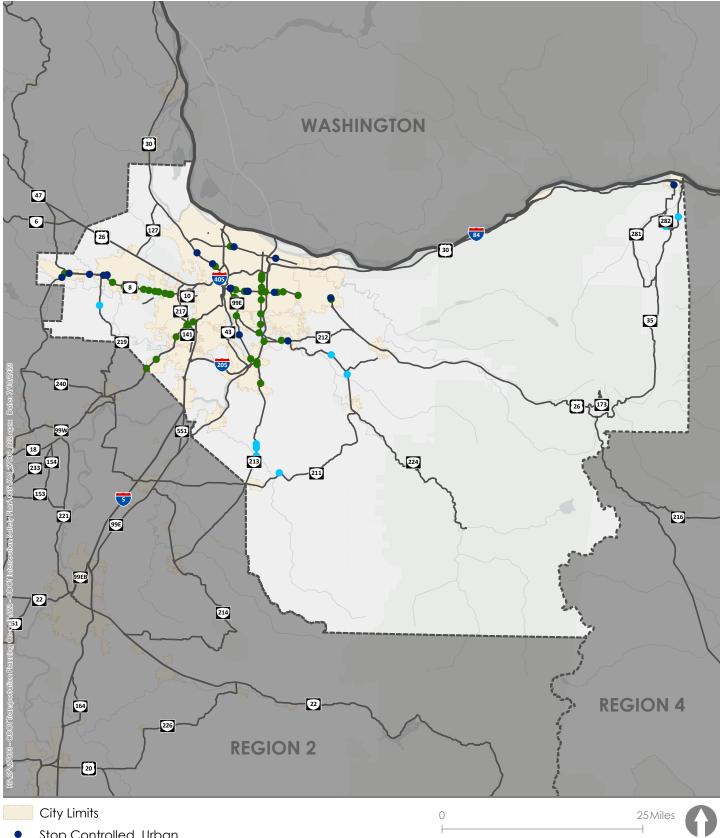
Table 7. Top-Scoring Intersections in Each ODOT Region (SPF Method)

Intersection Name	Highway #	Mile Post	Intersection Type	Expected Fatal/ Injury Crashes per Year
ODOT Region 1				
OR213 @ Beavercreek Rd	160	2.98	Urban Signalized	9.75
Powell Blvd @ 82nd Ave (OR213)	068	4.75	Urban Signalized	8.44
OR99W @ Tualatin Sherwood Rd/Roy Rodgers Rd	091	15.00	Urban Signalized	6.36
Powell Blvd (US26) @ 92nd Ave	026	5.59	Urban Signalized	6.22
OR22OR224 @ 135th Ave/Hubbard Rd	171	7.23	Urban Signalized	6.18
OR213 @ Johnson Creek Blvd	068	7.54	Urban Signalized	6.15
Powell Blvd (US26) @ 122nd Ave	026	7.21	Urban Signalized	5.81
OR8 @ 185th Ave	029	6.60	Urban Signalized	5.51
OR99E @ Milport Rd	081	5.20	Urban Signalized	5.51
82nd Ave @ Glisan St	068	2.75	Urban Signalized	5.48
ODOT Region 2				
(OR22) Center St @ Commercial	030	26.14	Urban Signalized	8.08
(OR22) Marion St @ Commercial	030	26.18	Urban Signalized	7.50
Portland Rd(OR99E) @ Hyacinth	081	46.49	Urban Signalized	6.08
OR22 @ Airport	072	7.92	Urban Signalized	5.57
OR22 @ 25th	072	7.52	Urban Signalized	5.00
Salem Parkway @ Hyacinth	072	1.54	Urban Signalized	4.68
Pioneer Parkway @ Q St	228	0.26	Urban Signalized	4.25
Salem Parkway (Trade St) @ Liberty	072	5.52	Urban Signalized	4.22
OR99W @ Sunset Blvd/Elwert Rd	091	16.67	Urban Signalized	4.22
OR214 @ Evergreen	140	37.02	Urban Signalized	4.08

<sup>&</sup>lt;sup>4</sup> Some ODOT Regions may show more than 10 intersections if there are multiple intersections with the same risk factor score.

Interraction Name	Highway #	Mile Post	Intersection Type	Expected Fatal/ Injury Crashes per Year
Intersection Name Salem Parkway @ Broadway	Highway # 072	3.16	Urban Signalized	4.08
ODOT Region 3			, and the second	
US199 @ Ringuette	025	0.62	Urban Signalized	4.49
OR62 @ OR 140	022	6.03	Urban Signalized	3.91
US199 @ 238	272	0.03	Urban Signalized	3.68
US199 @ beacon	482	1.00	Urban Signalized	3.56
OR238 @ Union	272	0.22	Urban Signalized	3.54
OR2 @ Roberts Ck Rd/Carnes Rd (Kelly' S Corner)	035	75.72	Urban Signalized	3.51
Oregon Coast Hwy @ Ranch Ln	009	229.27	Rural Stop Controlled	1.44
Redwood Hwy @ W Sixth St	025	26.42	Rural Stop Controlled	1.36
Redwood Hwy @ Reeves Creek Rd	025	24.59	Rural Stop Controlled	1.25
Crater Lake Hwy @ Mountain View Dr	022	12.86	Rural Stop Controlled	0.98
Crater Lake Hwy @ Indian Creek Ln	022	19.78	Rural Stop Controlled	0.98
ODOT Region 4				
US97 @ Veterans	004	121.98	Urban Signalized	4.75
US97 @ Cooley	004	134.11	Urban Signalized	4.06
US97 @ Powers The Dalles-California Hwy @ SW Highland	004	139.97	Urban Signalized Rural Stop	3.85
Ln	004	102.59	Controlled	1.40
Warm Springs Hwy @ NW Elm Ln	053	113.61	Rural Stop Controlled	1.13
Ochoco Hwy @ SW Reif Rd	041	7.84	Rural Stop Controlled	1.06
Ne Lafayette Ave @ McKenzie-Bend Hwy	017	20.87	Urban Stop Controlled	1.04
McKenzie Hwy @ McKenzie Hwy	015	97.46	Rural Stop Controlled	0.97
Mckenzie Hwy @ SW 67th St	015	108.04	Rural Stop Controlled	0.97
The Dalles-California Hwy @ SW Jericho Ln	004	104.93	Rural Stop Controlled	0.96
ODOT Region 5			Durral Chara	
Central Oregon Hwy @ Lincoln Dr	007	255.19	Rural Stop Controlled	0.97
N River St @ NE North St	010	65.09	Rural Stop Controlled	0.88
Central Oregon Hwy @ N Second St	007	266.25	Rural Stop Controlled	0.87
Central Oregon Hwy @ Central Oregon Hwy	007	129.12	Rural Stop Controlled	0.87
NW Second St @ Wallowa Lake Hwy	010	64.96	Rural Stop Controlled	0.84
Oregon-Washington Hwy @ Blue Mountain Station Rd	008	23.45	Rural Stop Controlled	0.83
Wallowa Lake Hwy @ NW Holmes St	010	64.64	Rural Stop Controlled	0.83

Intersection Name	Highway #	Mile Post	Intersection Type	Expected Fatal/ Injury Crashes per Year
Central Oregon Hwy @ E Adams \$t	007	131.65	Rural Stop Controlled	0.83
Umatilla-Mission Hwy @ Mission Rd	331	2.52	Rural Stop Controlled	0.82
Central Oregon Hwy @ E A St	007	131.76	Rural Stop Controlled	0.81



- Stop Controlled, Urban
- Stop Controlled, Rural
- Signalized, Urban

Figure 8



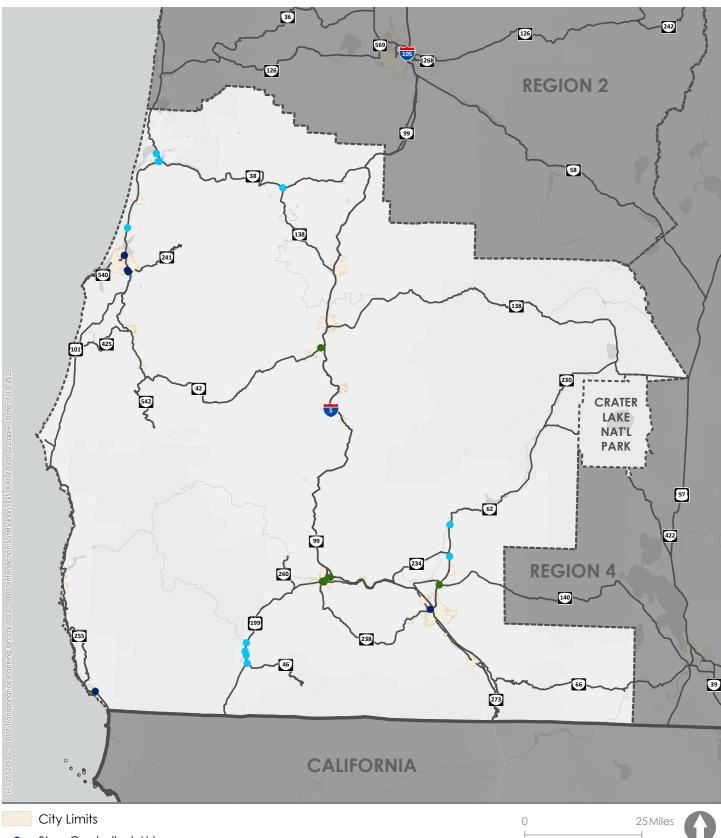


- Stop Controlled, Rural
- Signalized, Urban
- Signalized, Rural







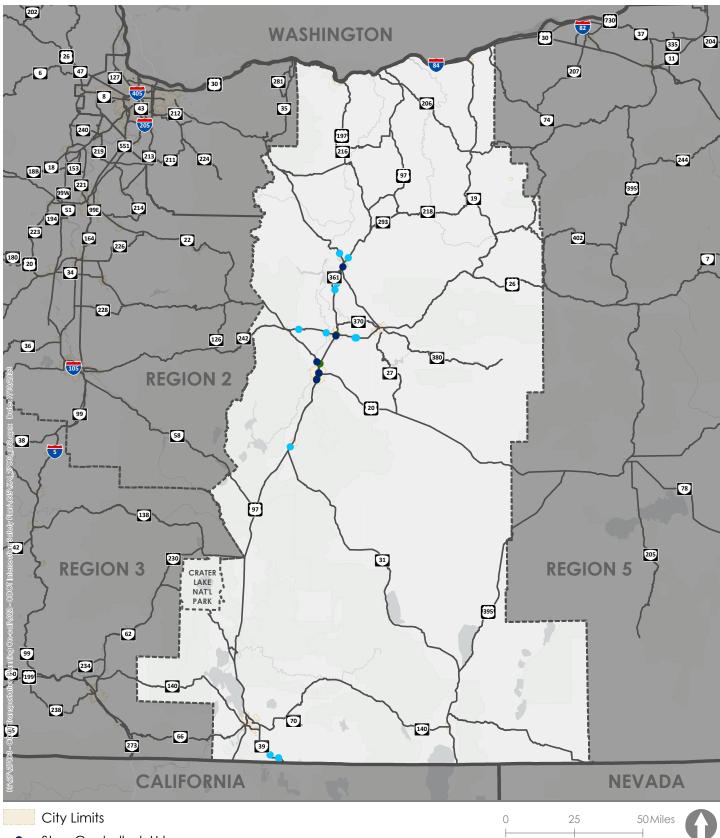


- Stop Controlled, Urban
- Stop Controlled, Rural
- Signalized, Urban



SPF-Based Screening Results
Top 10% by Category (Excluding Ramps)
ODOT Region 3





- Stop Controlled, Urban
- Stop Controlled, Rural
- Signalized, Urban









Figure 12





## Key Takeaways from Top 10% Intersections

The project team reviewed the characteristics of the top 10% intersections compared to the representation of each characteristic within all intersection, by sub-category. A summary of the comparison is provided in Table 8.

Table 8. Common Characteristics in SPF-Based Top 10%

	Urban Stop Rural Stop							l Stop
	Urban	Signals	Cont	rolled	Rural S	ignals <sup>1</sup>	Cont	rolled
Characteristic	Тор		Тор		Тор		Тор	All Int.
	10%	All Int.	10%	All Int.	10%	All Int.	10%	
Highest Functional Classificati	on							
Local	0%	<1%	0%	<1%	0%	0%	0%	<1%
Minor Collector	0%	<1%	2%	7%	0%	0%	0%	19%
Minor Arterial	1%	11%	8%	23%	100%	18%	37%	30%
Other Freeways and	14%	3%	0%	<1%	0%	0%	0%	<1%
Expressways								
Principal Arterial	85%	85%	90%	69%	0%	82%	63%	50%
AADT								
<1,000	0%	<1%	0%	<1%	0%	0%	0%	20%
Between 1,000 and 10,000	0%	9%	2%	42%	0%	44%	64%	70%
Between 10,000 and 25,000	14%	62%	67%	48%	100%	51%	36%	10%
Between 25,000 and 40,000	63%	26%	27%	8%	0%	5%	0%	<1%
>40,000	24%	3%	4%	1%	0%	0%	0%	0%
Number of Legs								
3 Legs	3%	14%	23%	60%	0%	10%	23%	69%
4 Legs	97%	83%	77%	39%	100%	90%	77%	31%
Lanes on Major Cross-Street								
1	3%	<1%	0%	<1%	0%	0%	0%	<1%
2	13%	30%	65%	65%	0%	28%	67%	68%
3	13%	15%	0%	4%	0%	5%	3%	5%
4	64%	50%	8%	15%	100%	67%	20%	14%
5+	8%	4%	0%	<1%	0%	0%	10%	<1%
Turn Lanes								
Left-Turn Lane Present	82%	70%	25%	16%	100%	74%	12%	9%
Right-Turn Lane Present	54%	38%	13%	9%	100%	36%	9%	6%
Max Posted Speed			1		1			
20 mph	0%	4%	0%	2%	0%	<1%	0%	<1%
25 mph	1%	14%	12%	15%	0%	15%	17%	12%
30 mph	22%	21%	29%	20%	0%	41%	8%	8%
35 mph	22%	26%	21%	23%	0%	21%	12%	7%
40 mph	6%	9%	10%	8%	0%	0%	4%	6%
45 mph	32%	17%	17%	15%	0%	8%	8%	6%
50 mph	6%	3%	6%	3%	0%	3%	3%	2%
55+ mph	8%	4%	6%	12%	100%	10%	47%	53%
High or Medium-High Equity	63%	53%	63%	51%	100%	62%	53%	53%
Disparity								
Bike Lane Present	81%	71%	62%	60%	50%	62%	33%	19%
Sidewalk Present Note: Rold numbers represent character	83%	90%	83%	71%	0%	77%	37%	23%

Note: Bold numbers represent characteristics in the top 10% sites that exceed the proportion of intersections with that characteristic in the overall dataset.

<sup>&</sup>lt;sup>1</sup>There were only two rural unsignalized intersections in the top 10%.

#### **Comparative Results**

Key findings from comparing results between the two methods include:

- The SPF-based screening tends to favor higher volume and 4-legged sites, since those are the primary inputs.
  - This results in higher concentrations of priority sites in more dense areas in Regions 1 and 2.
- The SPF-based screening uses a common unit (crashes/year) and so results can be compared across intersection sub-categories, while the risk-factor based results can only be compared within individual sub-categories.
- Speed and other intersection characteristics tend to have less influence on the results of the SPFbased screening, for instance:
  - Posted speeds on intersections in the top 10% tend to be lower in the SPF analysis compared to the risk-based analysis.
  - Most stop-controlled top 10% intersections in the risk factor-based analysis had left and/or right turn lanes, whereas most stop-controlled intersections in the top 10% of the SPF analysis did not have a turn lanes.
  - The SPF-based analysis tends to result in more sites with fewer number of lanes in urban areas as compared to the risk factor-based screening.
  - The SPF-based analysis tends to result in fewer sites with 3 legs compared to the risk-based analysis.
- Both had limitations with evaluating rural signalized intersections due to the small sample size of this intersection type.

#### Considerations in Selecting a Method

- The risk factor-based approach has the following advantages and considerations:
  - Can be scaled to match available data.
  - Places a greater emphasis on certain factors associated with fatal and suspected serious injury crashes (e.g., Speed).
  - Can be applied to a wider range of intersection types.
  - Results in a more geographically diverse set of prioritized sites.
  - Results cannot be compared across intersection sub-categories, as currently implemented.
  - Incorporates equity as a factor using the ODOT Social Equity Index.
- The SPF-based approach has the following advantages and considerations:
  - Results can be compared across all intersection types that can be analyzed.
  - Reporting results in terms of crashes/year is more readily understandable than risk factor scoring.
  - Considers a less diverse range of inputs.
  - Requires AADT information for major and minor streets.
  - Cannot be applied to as wide a range of intersection types as risk factor-based screening currently.

# Next Steps

The Kittelson team has reviewed this memorandum with ODOT staff and incorporated updates based on feedback from ODOT. This memorandum will be presented to the Local Agency Advisory Committee for review. Following revisions to the memorandum, the draft will be finalized.

Once these reviews are completed, the Kittelson team will proceed with identifying potential countermeasures for selected treatment sites. This includes:

- Identifying at least 30 sites for potential countermeasures (at least 6 per ODOT Region)
- Developing a sheet for each site describing potential countermeasures that can be used as an example for local agencies and ODOT Region staff

# **Appendices**

Appendix A: Risk-Based Approach - Table of Intersections Scoring in the Top 10% by Sub-Category

Appendix B: SPF Approach - Table of Intersections Scoring in the Top 10% by Sub-Category

# APPENDIX A

Table 9. Risk-Based Analysis - Intersections Scoring in the Top 10% by ODOT Region

ODOT	Intersection Name	Highway	Mile Post	Sub-Category	Risk
Region					Factor
4	THE DALLES-CALIFORNIA HWY @	360	0.09	Rural Stop	<b>Score</b> 11.66
7	MADRAS-PRINEVILLE HWY	300	0.07	Controlled	11.00
2	ONEIL HWY @ THE DALLES- CALIFORNIA HWY	004	118.52	Urban Stop Controlled	10.93
2	THE DALLES-CALIFORNIA HWY @ SW IRIS LN	004	103.63	Rural Stop Controlled	10.66
2	COQUILLE-BANDON HWY @ COOS BAY-ROSEBURG HWY	035	10.85	Rural Stop Controlled	10.55
2	FLORENCE-EUGENE HWY @ PERKINS PENINSULA PARK RD	062	49.75	Rural Stop Controlled	10.53
2	REDWOOD HWY @ WILLOW LN	025	2.56	Urban Stop Controlled	10.38
3	WARM SPRINGS HWY @ NE CEDAR ST	053	117.42	Urban Stop Controlled	10.38
3	MCKENZIE-BEND HWY @ MCKENZIE- BEND HWY	017	16.74	Urban Stop Controlled	9.9
3	REDWOOD HWY @ NEILL RD	025	6.35	Urban Stop Controlled	9.9
3	MT HOOD HWY @ SE HILLYARD RD	026	15.44	Urban Stop Controlled	9.9
3	REDWOOD HWY @ LAUREL RD	025	27.75	Rural Stop Controlled	9.56
3	ROGUE RIVER LOOP HWY @ REDWOOD HWY	025	7.09	Rural Stop Controlled	9.53
3	REDWOOD HWY @ LAKESHORE DR	025	20.79	Rural Stop Controlled	9.53
3	WILSONVILLE-HUBBARD HWY @ KEIL RD NE	051	3.00	Rural Stop Controlled	9.53
3	WILLAMINA-SALEM HWY @ SALT CREEK RD	030	11.18	Rural Stop Controlled	9.53
3	CLACKAMAS HWY @ SE CURRIN ST	171	23.27	Rural Stop Controlled	9.49
3	CASCADE HWY S @ S UNION HALL RD	160	9.14	Rural Stop Controlled	9.39
2	OREGON COAST HWY @ SHAMROCK RD	009	17.49	Urban Stop Controlled	9.35
2	MT HOOD HWY @ MT HOOD HWY	026	14.58	Urban Stop Controlled	9.35
2	LOWER COLUMBIA RIVER HWY @ PITTSBURG RD	092	29.10	Urban Stop Controlled	9.33
4	LOWER COLUMBIA RIVER HWY @ WYETH ST	092	28.94	Urban Stop Controlled	9.33
4	OREGON COAST HWY @ NE 31ST ST	009	138.73	Urban Stop Controlled	9.29

4	COOS BAY-ROSEBURG HWY @ GREEN ACRES LN	035	3.24	Rural Stop Controlled	9.24
4	WILLAMETTE HWY @ WALDO LAKE RD	018	58.94	Rural Stop Controlled	9.24
3	ATHENA-HOLDMAN HWY @ OREGON-WASHINGTON HWY	334	18.12	Rural Stop Controlled	9.24
3	OREGON COAST HWY @ LINTON LN	009	240.19	Urban Stop Controlled	9.12
3	OREGON COAST HWY @ TROY LN	009	240.31	Urban Stop Controlled	9.12
3	COOS BAY-ROSEBURG HWY @ COOS BAY-ROSEBURG HWY	035	76.07	Urban Stop Controlled	9.12
3	WILLAMINA-SALEM HWY @ FRONTAGE RD CONN	030	23.13	Urban Stop Controlled	9.12
3	SALEM-DAYTON HWY @ MICHIGAN CITY LN NW	150	17.57	Urban Stop Controlled	9.05
3	OREGON COAST HWY @ JUNE AVE SE	009	273.57	Rural Stop Controlled	9.04
3	SANTIAM HWY @ SANTIAM TERRACE RD	016	21.55	Rural Stop Controlled	8.94
3	NORTH SANTIAM HWY @ OLD MEHAMA RD	162	15.68	Rural Stop Controlled	8.94
1	BEAVERTON-HILLSDALE HWY @ SW MAPLE AVE	040	1.11	Urban Stop Controlled	8.89
1	CLACKAMAS HWY @ NW PARK AVE	171	21.36	Rural Stop Controlled	8.88
1	SUNRISE EXPRESSWAY HWY. HWY @ LAKE RD. CONN. NO. 2 HWY	171	4.03	Urban Stop Controlled	8.85
1	OREGON COAST HWY @ PATRIOT WAY	009	9.87	Urban Stop Controlled	8.85
1	FORT STEVENS HWY @ OREGON COAST HWY	009	9.48	Urban Stop Controlled	8.85
1	LOWER COLUMBIA RIVER HWY @ BENNETT RD	092	25.80	Urban Stop Controlled	8.85
1	MCKENZIE-BEND HWY @ COOLEY RD	017	17.49	Urban Stop Controlled	8.85
1	PACIFIC HWY W @ THEONA DR	091	118.24	Urban Stop Controlled	8.85
1	PACIFIC HWY W @ W ENID RD	091	116.74	Urban Stop Controlled	8.85
1	LOWER COLUMBIA RIVER HWY @ PACIFIC ST	092	31.61	Urban Stop Controlled	8.85
1	CASCADE HWY N @ SE KING RD	068	8.30	Urban Stop Controlled	8.8
1	SANTIAM HWY @ DALE ST SE	016	0.81	Urban Stop Controlled	8.8
1	SANTIAM HWY @ CENTER ST SE	016	0.83	Urban Stop Controlled	8.8
1	MCKENZIE HWY @ S 17TH ST	015	2.71	Urban Stop Controlled	8.8

W HANBY LN @ REDWOOD HWY	025	28.19	Rural Stop Controlled	8.74
OREGON COAST HWY @ W RANDOLPH LN	009	256.54	Rural Stop Controlled	8.73
OREGON COAST HWY @ N EIGHTH ST	009	222.01	Rural Stop Controlled	8.73
UMATILLA-STANFIELD HWY @ UMATILLA-STANFIELD HWY	054	8.43	Urban Stop Controlled	8.63
ROGUE VALLEY HWY @ SCENIC AVE	063	1.41	Urban Stop Controlled	8.61
REDWOOD HWY @ ROBINSON RD	025	5.50	Urban Stop Controlled	8.59
BEAVERTON-HILLSDALE HWY @ SW POPLAR LN	040	2.41	Urban Stop Controlled	8.58
PACIFIC HWY E @ SE MELDRUM AVE	081	10.14	Urban Stop Controlled	8.57
OREGON COAST HWY @ HIGHLANDS LN	009	17.03	Urban Stop Controlled	8.57
OREGON COAST HWY @ OREGON COAST HWY	009	358.52	Urban Stop Controlled	8.57
OREGON COAST HWY @ SE 62ND ST	009	143.80	Urban Stop Controlled	8.57
CLACKAMAS HWY @ SE 152ND DR	171	8.05	Urban Stop Controlled	8.57
TUALATIN VALLEY HWY @ SE 30TH AVE	029	10.78	Urban Stop Controlled	8.57
TUALATIN VALLEY HWY @ SE 73RD AVE	029	8.57	Urban Stop Controlled	8.57
TUALATIN VALLEY HWY @ SW 214TH AVE	029	8.05	Urban Stop Controlled	8.57
ROGUE VALLEY HWY @ ELM AVE	063	5.28	Urban Stop Controlled	8.57
PACIFIC HWY E @ SE RIVER RD	081	6.31	Urban Stop Controlled	8.57
LOWER COLUMBIA RIVER HWY @ NW 26TH AVE	092	2.43	Urban Stop Controlled	8.57
WOODBURN-ESTACADA HWY @ DIXON AVE	161	12.41	Urban Stop Controlled	8.56
MT HOOD HWY @ E SALMON RIVER RD	026	41.45	Rural Stop Controlled	8.42
CASCADE HWY S @ S ALDER CREEK LN	160	10.45	Rural Stop Controlled	8.42
THE DALLES-CALIFORNIA HWY @ CULVER HWY	361	11.62	Rural Stop Controlled	8.42
OREGON-WASHINGTON HWY @ BANISTER RD	800	17.52	Rural Stop Controlled	8.27
UMATILLA-STANFIELD HWY @ AIRPORT WAY	054	6.94	Urban Stop Controlled	8.26
UMATILLA-STANFIELD HWY @ UMATILLA-STANFIELD HWY	054	6.61	Urban Stop Controlled	8.26
	OREGON COAST HWY @ W RANDOLPH LN OREGON COAST HWY @ N EIGHTH ST UMATILLA-STANFIELD HWY @ UMATILLA-STANFIELD HWY ROGUE VALLEY HWY @ SCENIC AVE REDWOOD HWY @ ROBINSON RD  BEAVERTON-HILLSDALE HWY @ SW POPLAR LN PACIFIC HWY E @ SE MELDRUM AVE OREGON COAST HWY @ OREGON COAST HWY OREGON COAST HWY @ OREGON COAST HWY OREGON COAST HWY @ SE 62ND ST CLACKAMAS HWY @ SE 152ND DR  TUALATIN VALLEY HWY @ SE 30TH AVE TUALATIN VALLEY HWY @ SE 73RD AVE TUALATIN VALLEY HWY @ ELM AVE PACIFIC HWY E @ SE RIVER RD  LOWER COLUMBIA RIVER HWY @ NW 26TH AVE WOODBURN-ESTACADA HWY @ DIXON AVE MT HOOD HWY @ E SALMON RIVER RD CASCADE HWY S @ S ALDER CREEK LN THE DALLES-CALIFORNIA HWY @ CULVER HWY OREGON-WASHINGTON HWY @ BANISTER RD UMATILLA-STANFIELD HWY @ AIRPORT WAY UMATILLA-STANFIELD HWY @	OREGON COAST HWY @ W RANDOLPH LN OREGON COAST HWY @ N EIGHTH ST UMATILLA-STANFIELD HWY @ 054 UMATILLA-STANFIELD HWY POSCENIC 063 AVE REDWOOD HWY @ ROBINSON RD 025  BEAVERTON-HILLSDALE HWY @ SW POPLAR LN PACIFIC HWY E @ SE MELDRUM 081 AVE OREGON COAST HWY @ 009 HIGHLANDS LN OREGON COAST HWY @ OREGON 009 COAST HWY OREGON COAST HWY @ SE 62ND 009 ST CLACKAMAS HWY @ SE 152ND DR 171  TUALATIN VALLEY HWY @ SE 30TH 029 AVE TUALATIN VALLEY HWY @ SE 73RD 029 AVE TUALATIN VALLEY HWY @ SW 214TH 029 AVE ROGUE VALLEY HWY @ SE RIVER RD 081  LOWER COLUMBIA RIVER HWY @ 092 NW 26TH AVE WOODBURN-ESTACADA HWY @ 161 DIXON AVE MT HOOD HWY @ E SALMON RIVER 026 RD CASCADE HWY S @ S ALDER CREEK 160 LN THE DALLES-CALIFORNIA HWY @ 008 BANISTER RD UMATILLA-STANFIELD HWY @ 054 AIRPORT WAY UMATILLA-STANFIELD HWY @ 054	OREGON COAST HWY @ W RANDOLPH LN OREGON COAST HWY @ N EIGHTH ST UMATILLA-STANFIELD HWY @ 054 REDWOOD HWY @ SCENIC 063 1.41 AVE REDWOOD HWY @ ROBINSON RD 025 5.50  BEAVERTON-HILLSDALE HWY @ SW POPLAR LN PACIFIC HWY E @ SE MELDRUM 081 10.14 AVE OREGON COAST HWY @ 009 17.03 HIGHLANDS LN OREGON COAST HWY @ OREGON 09 358.52 COAST HWY OREGON COAST HWY @ SE 62ND 09 143.80 ST CLACKAMAS HWY @ SE 152ND DR 171 8.05  TUALATIN VALLEY HWY @ SE 30TH 029 10.78 AVE TUALATIN VALLEY HWY @ SE 73RD 029 8.57 AVE TUALATIN VALLEY HWY @ SE 73RD 029 7.70 AVE TO 7.03 AND	OREGON COAST HWY @ W RANDOLPH LN OREGON COAST HWY @ N EIGHTH OREGON COAST HWY @ N EIGHTH ST UMATILLA-STANFIELD HWY @ OS4 UMATILLA-STANFIELD HWY ROGUE VALLEY HWY @ SCENIC AVE REDWOOD HWY @ ROBINSON RD OREGON COAST HWY @ W OVE REDWOOD HWY @ ROBINSON RD OREGON COAST HWY @ W OVE REDWOOD HWY @ ROBINSON RD OVE REDWOOD HWY @ SE SE MELDRUM OVE OCONTROLLED OCON

0		000	02475	Hule and Chair	0.04
2	OREGON COAST HWY @ PITTUM LP	009	234.65	Urban Stop Controlled	8.24
2	Santiam HWY @ Harmony RD	016	24.50	Urban Stop Controlled	8.09
2	SANTIAM HWY @ DEW RD	016	24.16	Urban Stop Controlled	8.09
2	OREGON COAST HWY @ SW 97TH CT	009	145.60	Urban Stop Controlled	8.09
2	NORTH UMPQUA HWY @ NE DOUGLAS AVE	138	2.75	Urban Stop Controlled	8.09
2	NORTH UMPQUA HWY @ NE POMONA ST	138	2.18	Urban Stop Controlled	8.09
2	CENTRAL OREGON HWY @ PILOT BUTTE ACCESS RD	007	1.20	Urban Stop Controlled	8.08
2	CENTRAL OREGON HWY @ NE 11TH	007	1.11	Urban Stop Controlled	8.08
1	CENTRAL OREGON HWY @ NE AZURE DR	007	1.95	Urban Stop Controlled	8.08
1	REDWOOD HWY @ TUSSEY LN	025	0.32	Urban Stop Controlled	8.08
1	LOWER COLUMBIA RIVER HWY @ NW 108TH AVE	092	8.35	Urban Stop Controlled	8.08
1	SALEM-DAYTON HWY @ VEALL LN NW	150	20.46	Urban Stop Controlled	8.08
2	COOS BAY-ROSEBURG HWY @ EMILS WAY	035	75.53	Urban Stop Controlled	8.07
2	TUALATIN VALLEY HWY @ TUALATIN VALLEY HWY	029	15.36	Urban Stop Controlled	8.07
2	MCKENZIE HIGHWAY @ EUGENE SPRINGFIELD HWY (OR126)	015	6.23	Urban Signalized	8.05
2	S @ 6th @ Parkway	020	3.28	Urban Signalized	8.05
2	OR62 @ OR 140	022	6.03	Urban Signalized	8.05
1	OR2 @ ROBERTS CK RD/CARNES RD (KELLY' S CORNER)	035	75.72	Urban Signalized	8.05
1	OR22 @ Airport	072	7.92	Urban Signalized	8.05
1	OR22 @ Hawthorne	072	8.26	Urban Signalized	8.05
2	US97 @ Robal	004	134.60	Urban Signalized	8.03
2	OR62 EB @ POPLAR DR/BULLOCK RD	022	0.89	Urban Signalized	8.03
2	US199 @ Allen Creek	025	1.24	Urban Signalized	8.03
2	US199 @ Dowell	025	2.05	Urban Signalized	8.03
1	OR8 @ MURRAY BLVD	029	4.58	Urban Signalized	8.03
1	OR8 @ 153RD DR	029	4.90	Urban Signalized	8.03
1	OR8 @ 160TH AVE	029	5.36	Urban Signalized	8.03
1	OR8 @ 170TH AVE	029	5.84	Urban Signalized	8.03
1	OR8 @ 198TH AVE	029	7.28	Urban Signalized	8.03
1	OR8 @ 205TH AVE/INTEL	029	7.54	Urban Signalized	8.03
2	OR8 @ 209TH AVE	029	7.80	Urban Signalized	8.03
1	OR8 @ CORNELIUS PASS RD	029	8.32	Urban Signalized	8.03

1 1 1 1	OR8 @ 229TH AVE/67TH AVE OR8 @ 234TH AVE/CENTURY BLVD OR8 @ BROOKWOOD AVE OR8 @ 17TH AVE OR8 @ MOUNTAIN VIEW LN OR8 @ QUINCE ST	029 029 029 029 029	8.81 9.06 9.73 14.15	Urban Signalized Urban Signalized Urban Signalized	8.03 8.03 8.03
1 1 1	OR8 @ BROOKWOOD AVE OR8 @ 17TH AVE OR8 @ MOUNTAIN VIEW LN	029 029	9.73	Urban Signalized	
1	OR8 @ 17TH AVE OR8 @ MOUNTAIN VIEW LN	029		J	
1	OR8 @ MOUNTAIN VIEW LN			Urban Signalized	8.03
			17.46	Urban Signalized	8.03
1		029	17.88	Urban Signalized	8.03
1	OR213 @ CLACK TOWN CTR S	068	9.05	Urban Signalized	8.03
1	SALEM PARKWAY @ BROADWAY	072	3.16	Urban Signalized	8.03
1	OR22 @ 17th	072	6.77	Urban Signalized	8.03
1	OR22 @ 25th	072	7.52	Urban Signalized	8.03
2	OR99E @ RIVER RD/BLUEBIRD ST	081	6.30	Urban Signalized	8.03
1	OR99E @ JENNINGS AVE	081	9.80	Urban Signalized	8.03
1	OR99E @ GLEN ECHO AVE	081	10.30	Urban Signalized	8.03
1	OR99E @ GLOUCESTER ST	081	10.75	Urban Signalized	8.03
3	OR99E @ WARD DR	081	45.89	Urban Signalized	8.03
3	PORTLAND RD(OR99E) @ HYACINTH	081	46.49	Urban Signalized	8.03
3	Yeon Ave (US30) @ 26th Ave	092	2.25	Urban Signalized	8.03
3	Yeon Ave (US30) @ 29th Ave	092	2.68	Urban Signalized	8.03
1	(US30)YeonAve @ St Helens Rd/Kittridge Ave	092	3.92	Urban Signalized	8.03
5	(US30)St Helens Rd @ Bridge Ave N(US30BY)	092	7.32	Urban Signalized	8.03
5	(US30BY)Portland Hwy @ Cully Blvd	123	9.64	Urban Signalized	8.03
5	(US30BY)Portland Hwy @ 82nd Ave(068)	123	10.37	Urban Signalized	8.03
4	Killingsworth St NB @ Columbia Pkwy Blvd	123	10.72	Urban Signalized	8.03
4	OR141 @ FAIRVIEW PLACE/ELIANDER LN	141	2.96	Urban Signalized	8.03
4	OR141 @ WASH SQ/CIRCLE	141	3.08	Urban Signalized	8.03
3	OR210 @ HALL BLVD (HWY141)	143	9.60	Urban Signalized	8.03
2	OR224 @ 130TH AVE	171	6.94	Urban Signalized	8.03
3	US199 @ 238	272	0.03	Urban Signalized	8.03
3	OR281 @ ELIOT DR/BROOKSIDE DR	281	1.17	Urban Signalized	8.03
1	OREGON COAST HWY @ LORAIN LN	009	240.37	Urban Stop Controlled	8.03
3	COOS BAY-ROSEBURG HWY @ ART MILL LN	035	75.83	Urban Stop Controlled	8.03
2	CRATER LAKE HWY @ W DUTTON RD	022	8.03	Urban Stop Controlled	8.02
2	THE DALLES-CALIFORNIA HWY @ NW LOWER BRIDGE WAY	004	115.23	Urban Stop Controlled	8
1	CLACKAMAS HWY @ SE GOOSEHOLLOW DR	171	8.49	Urban Stop Controlled	8
1	OREGON COAST HWY @ NE 36TH ST	009	138.55	Urban Stop Controlled	7.96

3	OREGON COAST HWY @ NW 49TH ST	009	137.75	Urban Stop Controlled	7.96
2	MCKENZIE HIGHWAY @ 28TH ST	015	3.43	Urban Signalized	7.95
5	S @ 6th @ Summers	020	3.22	Urban Signalized	7.95
3	S @ 6th @ Hope	020	3.62	Urban Signalized	7.95
2	OR8 @ LOMBARD AVE	029	3.35	Urban Signalized	7.95
2	OR8 @ HOCKEN AVE	029	4.02	Urban Signalized	7.95
1	OR8 @ 178TH AVE	029	6.26	Urban Signalized	7.95
3	OR8 @ 185TH AVE	029	6.60	Urban Signalized	7.95
3	OR8 @ MINTER BRIDGE RD/CYPRESS ST	029	11.28	Urban Signalized	7.95
3	OR8 @ RIVER RD/13TH AVE	029	11.72	Urban Signalized	7.95
1	OR8 @ 11TH AVE	029	11.95	Urban Signalized	7.95
1	OR8 @ MAPLE ST	029	12.18	Urban Signalized	7.95
1	OR10 @ JAMIESON RD	040	1.90	Urban Signalized	7.95
1	OR213 @ OVERLAND ST	068	7.73	Urban Signalized	7.95
1	OR213 @ OTTY RD	068	7.92	Urban Signalized	7.95
4	OR213 @ KING RD	068	8.23	Urban Signalized	7.95
5	OR213 @ BOYER DR	068	8.41	Urban Signalized	7.95
1	OR213 @ CAUSEY RD	068	8.63	Urban Signalized	7.95
3	OR213 @ MONTEREY AVE	068	8.83	Urban Signalized	7.95
2	OR213 @ CLACK TOWN CTR N	068	8.91	Urban Signalized	7.95
2	OR99W @ HALL BLVD	091	8.82	Urban Signalized	7.95
2	OR99W @ GREENBURG RD/MAIN ST	091	8.94	Urban Signalized	7.95
2	OR99W @ WALNUT ST	091	9.64	Urban Signalized	7.95
1	OR99W at Elliott	091	22.45	Urban Signalized	7.95
2	(US30)St Helens Rd @ 105th Ave	092	8.15	Urban Signalized	7.95
2	(US30)St Helens Rd @ 107th Ave	092	8.30	Urban Signalized	7.95
2	Lombard St @ MLK Blvd (99E)	123	6.15	Urban Signalized	7.95
2	(US30BY)Portland Hwy @ 72nd Ave	123	9.87	Urban Signalized	7.95
2	Sandy Blvd @ 112th Ave	123	11.95	Urban Signalized	7.95
1	OR210 @ CASCADE AVE	143	9.06	Urban Signalized	7.95
2	WALLACE RD(OR221) @ TAGGERT	150	20.57	Urban Signalized	7.95
2	OR212 @ 82ND DR	171	5.05	Urban Signalized	7.95
3	OR212 @ EVELYN ST/102ND AVE	171	5.54	Urban Signalized	7.95
2	E. Idaho Avenue @ Goodfellow Lane	493	28.00	Urban Signalized	7.95
3	Idaho Avenue @ East Lane	493	28.17	Urban Signalized	7.95
2	OREGON COAST HWY @ OREGON COAST HWY	009	229.46	Rural Stop Controlled	7.88
2	HILLSBORO-SILVERTON HWY @ HILLSBORO-SILVERTON HWY	140	24.14	Rural Stop Controlled	7.88
2	NORTH SANTIAM HWY @ NORTH FORK RD SE	162	23.21	Rural Stop Controlled	7.88
2	WILLAMETTE HWY @ PHEASANT LN	018	6.39	Rural Stop Controlled	7.88

4	WILLAMETTE HWY @ BRABHAM RD	018	2.64	Rural Stop Controlled	7.88
2	WILLAMETTE HWY @ LOST CREEK RD	018	11.42	Rural Stop Controlled	7.88
4	WILLAMINA-SALEM HWY @ SALT CREEK RD	030	8.58	Rural Stop Controlled	7.88
3	NEHALEM HWY @ STALEYS CONN	047	45.41	Rural Stop Controlled	7.88
4	HISTORIC COLUMBIA RIVER HWY @ HISTORIC COLUMBIA RIVER HWY	100	31.28	Rural Stop Controlled	7.83
3	OREGON COAST HWY @ OREGON COAST HWY	009	327.90	Rural Stop Controlled	7.83
5	PACIFIC HWY W @ NW BUCHANAN AVE	091	82.95	Urban Stop Controlled	7.78
2	NEHALEM HWY @ NW PORTER RD	102	89.99	Urban Stop Controlled	7.78
3	OREGON COAST HWY @ SW SINGING TREE RD	009	128.48	Rural Stop Controlled	7.76
4	PACIFIC HWY W @ PACIFIC HWY W	091	115.83	Urban Stop Controlled	7.76
4	UMPQUA HWY @ ELKTON- SUTHERLIN HWY	045	36.44	Rural Stop Controlled	7.76
3	CENTRAL OREGON HWY @ CENTRAL OREGON HWY	007	2.65	Urban Stop Controlled	7.75
2	OREGON COAST HWY @ BEACH ACCESS RD	009	33.70	Rural Stop Controlled	7.73
2	HAWKS BEARD RD @ SANTIAM HWY	016	92.88	Rural Stop Controlled	7.73
2	SANTIAM HWY @ SW CAMP SHERMAN RD	016	90.91	Rural Stop Controlled	7.73
5	MCKENZIE HWY @ NW 101ST ST	015	105.63	Rural Stop Controlled	7.73
4	CENTRAL OREGON HWY @ LAKEVIEW-BURNS HWY	007	104.72	Rural Stop Controlled	7.73
1	SANTIAM HWY @ SW SUTTLE LAKE RD	016	87.33	Rural Stop Controlled	7.73
1	REDWOOD HWY @ EIGHT DOLLAR RD	025	24.02	Rural Stop Controlled	7.73
1	MIDLAND HWY @ THE DALLES- CALIFORNIA HWY	004	280.16	Rural Stop Controlled	7.73
3	THE DALLES-CALIFORNIA HWY @ CHILOQUIN HWY	004	249.08	Rural Stop Controlled	7.73
4	OREGON COAST HWY @ BAY BERRY DR	009	185.04	Rural Stop Controlled	7.73
3	DUNEWOOD DR @ OREGON COAST HWY	009	186.88	Rural Stop Controlled	7.73
1	NECANICUM HWY @ OREGON COAST HWY	046	19.03	Rural Stop Controlled	7.73
3	OREGON-WASHINGTON HWY @ SCHRIMPF RD	800	18.99	Rural Stop Controlled	7.73

3	PENDLETON-JOHN DAY HWY @ OREGON-WASHINGTON HWY	028	0.05	Urban Stop Controlled	7.62
3	THE DALLES-CALIFORNIA HWY @ SW DOVER LN	004	98.37	Rural Stop Controlled	7.61
3	MT HOOD HWY @ E. GOVERNMENT CAMP FRONTAGE RD	026	53.99	Rural Stop Controlled	7.59
3	TIMBERLINE HWY @ MT HOOD HWY	026	54.23	Rural Stop Controlled	7.59
3	CLACKAMAS HWY @ FARADAY FRONTAGE RD. #2 CONN	171	28.87	Rural Stop Controlled	7.59
4	CRATER LAKE HWY @ BUTTE FALLS HWY	022	14.57	Rural Stop Controlled	7.59
4	MT HOOD HWY @ SE 10TH AVE	026	1.25	Urban Stop Controlled	7.58
1	UMATILLA-STANFIELD HWY @ FEEDVILLE RD	054	8.82	Urban Stop Controlled	7.58
3	MCKENZIE-BEND HWY @ GIST RD	017	4.93	Rural Stop Controlled	7.58
3	HOOD RIVER HWY @ HOOD RIVER HWY	281	5.09	Rural Stop Controlled	7.58
4	REDWOOD HWY @ ROUND PRAIRIE RD	025	10.02	Rural Stop Controlled	7.58
4	REDWOOD HWY @ REDWOOD HWY	025	8.74	Rural Stop Controlled	7.58
3	HERMISTON HWY @ W MADRONA AVE	333	8.63	Urban Stop Controlled	7.56
4	HERMISTON HWY @ N MCNARY ST	333	6.93	Urban Stop Controlled	7.56
2	MT HOOD HWY @ SE 123RD AVE	026	7.25	Urban Stop Controlled	7.56
1	REDWOOD HWY @ MIDWAY AVE	025	4.44	Urban Stop Controlled	7.54
3	REDWOOD HWY @ APPLEGATE AVE	025	5.79	Urban Stop Controlled	7.54
1	SALMON RIVER HWY @ SALMON RIVER HWY	039	48.59	Urban Stop Controlled	7.54
3	1ST ST CONN. NO. 1 CONN @ HILLSBORO-SILVERTON HWY	140	20.73	Urban Stop Controlled	7.53
1	LOWER COLUMBIA RIVER HWY @ E DIVISION RD	092	27.15	Urban Stop Controlled	7.52
3	CLACKAMAS HWY @ SE 106TH AVE	171	5.78	Urban Stop Controlled	7.52
3	THE DALLES-CALIFORNIA HWY @ SW PUMICE AVE	004	122.26	Urban Stop Controlled	7.52
1	MT HOOD HWY @ MT HOOD HWY	026	25.12	Urban Stop Controlled	7.52
1	MT HOOD HWY @ UNIVERSITY AVE	026	23.65	Urban Stop Controlled	7.52
1	LOWER COLUMBIA RIVER HWY @ CANAAN RD	092	34.19	Urban Stop Controlled	7.52

1	CLACKAMAS-BORING HWY @ SE ROYER RD	174	2.85	Urban Stop Controlled	7.51
1	COOS RIVER HWY @ EDWARDS ST. (BUNKER HILL) CONN	241	0.12	Urban Stop Controlled	7.51
1	ROGUE VALLEY HWY @ ROGUE VALLEY HWY	063	17.80	Urban Stop Controlled	7.51
1	PACIFIC HWY E @ SE HOLLY AVE	081	7.33	Urban Stop Controlled	7.48
1	OREGON COAST HWY @ HIGHWAY	009	17.28	Urban Stop Controlled	7.48
2	OREGON COAST HWY @ OREGON COAST HWY	009	358.13	Urban Stop Controlled	7.48
3	OREGON COAST HWY @ FLORAL HILL DR	009	359.11	Urban Stop Controlled	7.48
3	CRATER LAKE HWY @ MERRY LN	022	5.94	Urban Stop Controlled	7.48
3	CRATER LAKE HWY @ GRAMERCY DR	022	5.77	Urban Stop Controlled	7.48
3	KLAMATH FALLS-LAKEVIEW HWY @ HILYARD AVE	020	5.19	Urban Stop Controlled	7.48
3	KLAMATH FALLS-LAKEVIEW HWY @ UNITY ST	020	4.94	Urban Stop Controlled	7.48
3	PACIFIC HWY E @ 38TH AVE NE	081	45.49	Urban Stop Controlled	7.48
3	PACIFIC HWY E @ BLOSSOM DR NE	081	45.37	Urban Stop Controlled	7.48
3	ALBANY-JUNCTION CITY HWY @ PACIFIC PL SW	058	3.95	Urban Stop Controlled	7.48
2	TUALATIN VALLEY HWY @ SW 142ND AVE	029	4.39	Urban Stop Controlled	7.48
2	OREGON COAST HWY @ 36TH ST	009	188.62	Urban Stop Controlled	7.48
2	OREGON COAST HWY @ 34TH ST	009	188.73	Urban Stop Controlled	7.48
2	OREGON COAST HWY @ WAKEMAN LN	009	17.48	Urban Stop Controlled	7.48
1	JACKSONVILLE HWY @ MAYFAIR LN	272	1.20	Urban Stop Controlled	7.48
2	ROGUE VALLEY HWY @ HAZEL ST	063	5.22	Urban Stop Controlled	7.48
4	ROGUE VALLEY HWY @ LYNN ST	063	5.16	Urban Stop Controlled	7.48
5	LOWER COLUMBIA RIVER HWY @ NW 57TH AVE	092	5.15	Urban Stop Controlled	7.48
1	LOWER COLUMBIA RIVER HWY @ NW 55TH AVE	092	5.01	Urban Stop Controlled	7.48
2	LOWER COLUMBIA RIVER HWY @ NW 56TH AVE	092	5.08	Urban Stop Controlled	7.48
2	LOWER COLUMBIA RIVER HWY @ NW SUFFOLK ST	092	2.05	Urban Stop Controlled	7.48

2	LOWER COLUMBIA RIVER HWY @ NW 60TH AVE	092	5.30	Urban Stop Controlled	7.48
3	LOWER COLUMBIA RIVER HWY @ NW SALTZMAN RD	092	5.23	Urban Stop Controlled	7.48
2	NORTHEAST PORTLAND FWY @ NE HOLMAN ST	123	9.08	Urban Stop Controlled	7.48
3	MCKENZIE HWY @ \$ 63RD ST	015	6.85	Urban Stop Controlled	7.48
3	SANTIAM HWY @ CLARK MILL RD	016	28.59	Urban Stop Controlled	7.48
3	OREGON COAST HWY @ LARSON RD	009	64.83	Urban Stop Controlled	7.48
3	PACIFIC HWY E @ PATRICK WAY	081	30.98	Urban Stop Controlled	7.48
3	OREGON COAST HWY @ OREGON COAST HWY	009	142.04	Urban Stop Controlled	7.47
3	PENDLETON-JOHN DAY HWY @ SOUTHGATE PL	028	2.67	Urban Stop Controlled	7.47
3	OREGON COAST HWY @ 10TH AVE	009	20.53	Urban Stop Controlled	7.47
4	MCKENZIE HWY @ S 18TH ST	015	2.78	Urban Stop Controlled	7.47
2	CASCADE HWY S @ S GLENN DR	160	9.93	Rural Stop Controlled	7.44
3	OREGON COAST HWY @ HAUSER RD. FRONTAGE RD. HWY	009	229.00	Rural Stop Controlled	7.44
2	OREGON COAST HWY @ ACCESS RD	009	228.88	Rural Stop Controlled	7.44
2	OCHOCO HWY @ SW STILLMAN RD	041	11.10	Rural Stop Controlled	7.43
4	REDWOOD HWY @ WILDERVILLE FRONTAGE RD	025	7.67	Rural Stop Controlled	7.43
4	SALMON RIVER HWY @ THREE RIVERS HWY	032	24.97	Rural Stop Controlled	7.43
3	CLACKAMAS HWY @ WOODBURN- ESTACADA HWY	161	33.49	Rural Stop Controlled	7.39
2	COOS BAY-ROSEBURG HWY @ W CENTRAL BLVD	035	9.97	Rural Stop Controlled	7.36
3	NEHALEM HWY @ FLORENCE AVE	102	0.22	Urban Stop Controlled	7.29
3	NEHALEM HWY @ SEVENTH ST	102	1.61	Urban Stop Controlled	7.29
2	NEHALEM HWY @ SIXTH ST	102	1.55	Urban Stop Controlled	7.29
2	MT HOOD HWY @ SE CHERRYVILLE DR	026	30.43	Rural Stop Controlled	7.29
2	MT HOOD HWY @ TICKLE CREEK FRONTAGE RD	026	21.62	Rural Stop Controlled	7.29
3	MT HOOD HWY @ MT. HOOD HWY	026	37.06	Rural Stop Controlled	7.29

1	MT HOOD HWY @ ALDER HEIGHTS DR. FRONTAGE RD	026	32.68	Rural Stop Controlled	7.29
2	MT HOOD HWY @ E CHERRYVILLE DR	026	32.47	Rural Stop Controlled	7.29
2	MT HOOD HWY @ MT HOOD HWY	026	31.41	Rural Stop Controlled	7.29
1	MT HOOD HWY @ E KIRKWOOD DR	026	33.36	Rural Stop Controlled	7.29
2	MT HOOD HWY @ E ALDER HEIGHTS	026	32.88	Rural Stop Controlled	7.29
2	MT HOOD HWY @ SE CANYON VALLEY RD	026	26.67	Rural Stop Controlled	7.29
2	LOWER COLUMBIA RIVER HWY @ ACCESS RD	092	50.30	Rural Stop Controlled	7.29
1	COOS BAY-ROSEBURG HWY @ CONFUSION HILL RD FRONT RD HWY	035	2.97	Rural Stop Controlled	7.29
4	CRATER LAKE HWY @ MCGREGOR FISHING ACCESS RD	022	29.35	Rural Stop Controlled	7.29
4	SANTIAM HWY @ INGRAM RD	016	20.29	Rural Stop Controlled	7.29
5	CORVALLIS-LEBANON HWY @ OAKVILLE RD	210	5.10	Rural Stop Controlled	7.29
5	WILLAMETTE HWY @ HILLTOP DR	018	7.19	Rural Stop Controlled	7.29
2	WILLAMETTE HWY @ KENSINGTON DR	018	3.65	Rural Stop Controlled	7.29
3	LOWER COLUMBIA RIVER HWY @ NW CHESTNUT LN	092	13.87	Rural Stop Controlled	7.29
2	WILLAMINA-SALEM HWY @ GREENWOOD RD N	030	18.61	Rural Stop Controlled	7.29
3	SHERMAN HWY @ SMITH LN	042	11.72	Rural Stop Controlled	7.29
2	OREGON-WASHINGTON HWY @ UPPER DRY CREEK RD	800	22.15	Rural Stop Controlled	7.29
2	CLACKAMAS HWY @ SE RIVER MILL RD	171	21.66	Rural Stop Controlled	7.29
2	PACIFIC HWY W @ NE CORRAL CREEK RD	091	20.69	Rural Stop Controlled	7.29
2	OREGON COAST HWY @ CARPENTERVILLE HWY	009	354.83	Urban Stop Controlled	7.28
4	ROGUE VALLEY HWY @ NORTHRIDGE TRL	063	10.58	Urban Stop Controlled	7.26
4	STANTON AVE @ OREGON COAST HWY	009	235.88	Urban Stop Controlled	7.26
2	TUALATIN VALLEY HWY @ SW DUDNEY AVE	029	21.57	Urban Stop Controlled	7.26
2	SALMON RIVER HWY @ SE KREDER RD	039	51.73	Urban Stop Controlled	7.26
4	NW 54TH ST @ OREGON COAST HWY	009	137.53	Urban Stop Controlled	7.24

4	SALEM-DAYTON HWY @ HOPE AVE NW	150	19.72	Urban Stop Controlled	7.24
4	LOWER COLUMBIA RIVER HWY @ SW TICHENOR ST	092	61.52	Rural Stop Controlled	7.24
4	LOWER COLUMBIA RIVER HWY @ SE TRUEHAAK ST	092	61.31	Rural Stop Controlled	7.24
3	OREGON COAST HWY @ SW MAPLE ST	009	156.18	Rural Stop Controlled	7.24
5	HISTORIC COLUMBIA RIVER HWY @ HISTORIC COLUMBIA RIVER HWY	026	101.82	Urban Stop Controlled	7.2
1	COOS BAY-ROSEBURG HWY @ NORTH BANK LN	035	6.75	Rural Stop Controlled	7.14
1	COOS BAY-ROSEBURG HWY @ REMOTE LN	035	37.70	Rural Stop Controlled	7.14
1	COOS BAY-ROSEBURG HWY @ OLD HWY 42 RD	035	17.83	Rural Stop Controlled	7.14
1	NORTH UMPQUA HWY @ WHISTLERS LN	138	13.01	Rural Stop Controlled	7.14
4	THE DALLES-CALIFORNIA HWY @ WILLIAMSON RIVER DR	004	252.06	Rural Stop Controlled	7.14
2	OREGON COAST HWY @ LITTLE NESTUCCA HWY	009	91.37	Rural Stop Controlled	7.14
3	OREGON COAST HWY @ HARLEM AVE SE	009	273.69	Rural Stop Controlled	7.09
2	OREGON COAST HWY @ OREGON COAST HWY	009	127.46	Rural Stop Controlled	7.09
2	OREGON COAST HWY @ NE CLARKE ST	009	127.38	Rural Stop Controlled	7.09
3	OREGON COAST HWY @ N 18TH ST	009	212.37	Rural Stop Controlled	7.09
3	OREGON COAST HWY @ N 15TH ST	009	212.14	Rural Stop Controlled	7.09
2	HAMBURG AVE @ OREGON COAST HWY	009	4.14	Urban Stop Controlled	7.08
5	MT HOOD HWY @ SE 24TH AVE	026	1.97	Urban Stop Controlled	7.08
5	NORTHEAST PORTLAND FWY @ NE 103RD AVE	123	11.50	Urban Stop Controlled	7.08
5	US101-US30 at Megler-Basin	009	3.80	Urban Signalized	7.05
5	US199 @ Hubbard	025	3.07	Urban Signalized	7.05
5	OR18 at Cumulus Ave	039	47.39	Urban Signalized	7.05
5	OR126 (11TH ST) @ BELTLINE HWY(OR569)	069	3.10	Urban Signalized	7.05
5	BELTLINE HWY(OR569) @ ROOSEVELT	069	4.24	Urban Signalized	7.04
2	SALEM PARKWAY @ HYACINTH	072	1.54	Urban Signalized	7.04
2	MT HOOD HWY @ SE HALEY RD	026	18.35	Urban Stop Controlled	7.04
1	SANTIAM HWY @ WATERLOO RD	016	18.67	Urban Stop Controlled	7.04

1	SANTIAM HWY @ OLD SANTIAM HWY	016	17.73	Urban Stop Controlled	7.04
2	MT HOOD HWY @ SE 267TH AVE	026	16.24	Urban Stop Controlled	7.04
4	LOWER COLUMBIA RIVER HWY @ NW RIVERVIEW DR	092	10.30	Urban Stop Controlled	7.04
4	MT HOOD HWY @ MT HOOD HWY	026	25.56	Urban Stop Controlled	7.04
2	US101 at Ensign	009	8.04	Urban Signalized	7.03
2	US101 at Wilson River Loop Rd	009	64.57	Urban Signalized	7.03
2	US101 at 25th	009	139.11	Urban Signalized	7.03
2	US101 at 35th	009	188.68	Urban Signalized	7.03
2	US101 @ LEWIS ST/CEDCO CASINO	009	236.28	Urban Signalized	7.03
2	US101 @ NEWMARK ST	009	236.49	Urban Signalized	7.03
2	US 101 @ Shopping Center	009	358.57	Urban Signalized	7.03
3	US 101 @ Hoffeldt	009	358.76	Urban Signalized	7.03
4	US 101 @ Benham	009	359.32	Urban Signalized	7.03
2	US20 @ WELDWOOD	016	15.10	Urban Signalized	7.03
1	S @ 6th @ Home Depot	020	4.78	Urban Signalized	7.03
1	OR 62 @ Antelope Rd	022	6.33	Urban Signalized	7.03
1	OR 62 @ G	022	7.15	Urban Signalized	7.03
4	OR 62 @ H	022	7.36	Urban Signalized	7.03
4	OR18 at Norton Ln	039	46.69	Urban Signalized	7.03
4	OR99E at 29th	058	3.69	Urban Signalized	7.03
4	OR99 @ CENTRAL/TABLE ROCK RD	063	5.33	Urban Signalized	7.03
2	OR 99 @ Colver/Suncrest	063	13.82	Urban Signalized	7.03
5	OR 99 @ W Valley View Rd	063	14.20	Urban Signalized	7.03
4	OR126 (11TH ST) @ DANEBO	069	2.83	Urban Signalized	7.03
1	OR99E @ CHEMAWA RD	081	44.46	Urban Signalized	7.03
1	OR99E @ KALE DR	081	45.01	Urban Signalized	7.03
1	OR99E @ HAYESVILLE RD	081	45.64	Urban Signalized	7.03
1	OR99W at Lafayette	091	35.48	Urban Signalized	7.03
1	OR99W at 27th	091	35.68	Urban Signalized	7.03
1	OR99W at McDaniel	091	36.06	Urban Signalized	7.03
2	(US30BY)Portland Hwy @ 60th Ave	123	9.20	Urban Signalized	7.03
4	OR 238 @ West Harbeck	272	0.90	Urban Signalized	7.03
2	OR 238 @ New Hope Rd	272	1.53	Urban Signalized	7.03
2	OR238(ROSSANLEY DR) @ SAGE RD	272	38.08	Urban Signalized	7.03
3	Olds Ferry Hwy. @ SW 4th. Avenue	455	27.77	Urban Signalized	7.03
5	6th @ Quince	0		Urban Signalized	7.03
2	COOS BAY-ROSEBURG HWY @ DELMAR LN	035	2.72	Rural Stop Controlled	6.99
1	COOS BAY-ROSEBURG HWY @ CHEHALIS LN	035	2.66	Rural Stop Controlled	6.99
2	MT HOOD HWY @ EASTSIDE RD	026	101.52	Rural Stop Controlled	6.99

5	MT HOOD HWY @ WHISKEY CREEK DR	026	99.86	Rural Stop Controlled	6.99
5	WILLAMINA-SALEM HWY @ BECK RD	030	6.87	Rural Stop Controlled	6.99
5	WILLAMINA-SALEM HWY @ OLD WALLACE BRIDGE RD	030	0.29	Rural Stop Controlled	6.99
4	LOWER COLUMBIA RIVER HWY @ VAN ST	092	61.00	Rural Stop Controlled	6.94
5	CASCADE HWY S @ S UNION MILLS RD	160	12.35	Rural Stop Controlled	6.91
1	MADRAS-PRINEVILLE HWY @ SW TAHOE LN	360	0.13	Rural Stop Controlled	6.78
2	WARM SPRINGS HWY @ NW AGENCY HOT SPRINGS RD	053	103.27	Rural Stop Controlled	6.76
2	OREGON-WASHINGTON HWY @ THIRD ST	800	16.43	Rural Stop Controlled	6.76
2	UMATILLA-MISSION HWY @ WILDHORSE BLVD	331	3.72	Rural Stop Controlled	6.76
4	THREE RIVERS HWY @ OREGON COAST HWY	032	0.00	Rural Stop Controlled	6.7
4	OREGON COAST HWY @ W BEAVER HILL RD	009	252.70	Rural Stop Controlled	6.63
2	OREGON COAST HWY @ SUNSET BLVD. CONN. NO. 4 HWY	009	29.47	Rural Stop Controlled	6.63
2	WILDWOOD DR. FRONTAGE RD @ OREGON COAST HWY	009	221.36	Rural Stop Controlled	6.63
2	SALMON RIVER HWY @ GRAND RONDE RD	039	21.18	Rural Stop Controlled	6.61
2	US 101 @ OR 38	009	211.58	Rural Signalized	6.61
5	US 101 @ 13th Street	009	211.91	Rural Signalized	6.61
5	US 101 @ Winchester	009	212.05	Rural Signalized	6.61
2	US 101 @ OR 42S	009	261.57	Rural Signalized	6.61
5	US 101 @ 11th Street	009	274.48	Rural Signalized	6.61
1	US 101 @ Moore St	009	328.48	Rural Signalized	6.61
2	US199 @ Lister St	025	28.63	Rural Signalized	6.61
2	US30 at Nehalem	092	61.47	Rural Signalized	6.61
2	THE DALLES-CALIFORNIA HWY @ SW FORD LN	004	101.29	Rural Stop Controlled	6.61
2	SW PARK LN @ THE DALLES- CALIFORNIA HWY	004	110.72	Rural Stop Controlled	6.61
2	THE DALLES-CALIFORNIA HWY @ SW GLIDE LN	004	101.81	Rural Stop Controlled	6.61
3	THE DALLES-CALIFORNIA HWY @ SW JERICHO LN	004	104.93	Rural Stop Controlled	6.61
3	THE DALLES-CALIFORNIA HWY @ SW HIGHLAND LN	004	102.59	Rural Stop Controlled	6.61
3	THE DALLES-CALIFORNIA HWY @ SW BEAR DR	004	100.07	Rural Stop Controlled	6.61
1	NORTH UMPQUA HWY @ STOCKS LN	138	4.38	Rural Stop Controlled	6.49

1	OREGON-WASHINGTON HWY @ WILDHORSE RD	800	16.84	Rural Stop Controlled	6.32
1	MT HOOD HWY @ E FAUBION LP	026	43.60	Rural Stop Controlled	6.32
1	MT HOOD HWY @ E FAUBION LP	026	42.85	Rural Stop Controlled	6.32
1	THE DALLES-CALIFORNIA HWY @ SHADYBROOK RD	004	32.99	Rural Stop Controlled	6.32
5	COQUILLE-BANDON HWY @ NORTH AVE SE	244	0.05	Rural Stop Controlled	6.24
5	WILLAMETTE HWY @ SPOT ST	018	34.47	Rural Stop Controlled	6.24
5	WILLAMETTE HWY @ W SECOND ST	018	34.31	Rural Stop Controlled	6.24
5	OREGON COAST HWY @ NEW LAKE LN	009	285.35	Rural Stop Controlled	6.19
5	OREGON COAST HWY @ BETHEL MOUNTAIN LN	009	284.62	Rural Stop Controlled	6.19
1	WILLAMETTE HWY @ PLAZA LP	018	4.18	Rural Stop Controlled	6.09
1	CENTRAL OREGON HWY @ CENTRAL OREGON HWY	007	131.05	Rural Stop Controlled	6.09
1	CENTRAL OREGON HWY @ S JUNTURA AVE	007	130.83	Rural Stop Controlled	6.09
2	CENTRAL OREGON HWY @ S MCGOWAN AVE	007	130.61	Rural Stop Controlled	6.09
1	CENTRAL OREGON HWY @ N FAIRVIEW AVE	007	131.16	Rural Stop Controlled	6.09
3	CENTRAL OREGON HWY @ W TAYLOR ST	007	130.68	Rural Stop Controlled	6.09
3	CENTRAL OREGON HWY @ CENTRAL OREGON HWY	007	130.95	Rural Stop Controlled	6.09
4	SUMPTER HWY @ WHITNEY HWY	071	25.23	Rural Stop Controlled	6.08
3	KINGS VALLEY HWY @ CORVALLIS- NEWPORT HWY	033	44.57	Rural Stop Controlled	6.08
3	PACIFIC HWY W @ CAMP ADAIR RD	091	73.75	Rural Stop Controlled	6.08
3	CLACKAMAS HWY @ FARADAY FRONTAGE RD. #1 CONN	171	24.78	Rural Stop Controlled	6.08
1	CLACKAMAS HWY @ NORTH FORK RD	171	30.92	Rural Stop Controlled	6.08
1	LOWER COLUMBIA RIVER HWY @ JOHN DAY RIVER RD	092	92.67	Rural Stop Controlled	6.08
2	CENTURY DRIVE HWY @ USFS 041 RD	372	7.59	Rural Stop Controlled	6.08
2	CENTURY DRIVE HWY @ CENTURY DRIVE HWY	372	6.54	Rural Stop Controlled	6.08
2	COOS BAY-ROSEBURG HWY @ HOOVER HILL RD	035	69.51	Rural Stop Controlled	6.08

2	LAKE OF THE WOODS HWY @ LAKE OF THE WOODS HWY	270	61.68	Rural Stop Controlled	6.08
2	FLORENCE-EUGENE HWY @ KNIGHT RD	062	42.29	Rural Stop Controlled	6.08
2	CORVALLIS-NEWPORT HWY @ FRONTAGE RD. CONN. NO. 2 CONN	033	7.49	Rural Stop Controlled	6.08
3	WALLOWA LAKE HWY @ MARKET LN	010	6.81	Rural Stop Controlled	6.08
3	THE DALLES-CALIFORNIA HWY @ EIGHTMILE RD	004	7.17	Rural Stop Controlled	6.08
5	MT HOOD HWY @ E ELM AVE	026	39.91	Rural Stop Controlled	6.02
3	E MOWICH LN @ MT HOOD HWY	026	40.46	Rural Stop Controlled	6.02
2	MT HOOD HWY @ E DEWEY RD	026	40.28	Rural Stop Controlled	6.02
3	MT HOOD HWY @ MT HOOD HWY	026	40.78	Rural Stop Controlled	6.02
2	MT HOOD HWY @ E VINE MAPLE DR	026	41.21	Rural Stop Controlled	6.02
5	MT HOOD HWY @ E GUMJUWAC RD	026	39.65	Rural Stop Controlled	6.02
5	SUNSET BEACH LN @ OREGON COAST HWY	009	13.45	Rural Stop Controlled	5.93
1	MCKENZIE-BEND HWY @ FRYREAR RD	017	7.87	Rural Stop Controlled	5.93
1	WILLAMETTE HWY @ WILLIAMSON LN	018	9.61	Rural Stop Controlled	5.93
1	WILLAMINA-SALEM HWY @ STARR RD	030	8.56	Rural Stop Controlled	5.93
1	UMPQUA HWY @ S CEDAR ST. CONN. NO. 1 CONN	045	50.24	Rural Stop Controlled	5.88
1	ENTERPRISE-LEWISTON HWY @ NW LOGAN ST	011	43.13	Rural Stop Controlled	5.88
1	ENTERPRISE-LEWISTON HWY @ WALLOWA LAKE HWY	010	65.02	Rural Stop Controlled	5.88
1	COLUMBIA RIVER HWY @ COLUMBIA RIVER HWY	002	175.31	Rural Stop Controlled	5.88
1	CENTRAL OREGON HWY @ CENTRAL OREGON HWY	007	266.31	Rural Stop Controlled	5.88
1	MCKENZIE HWY @ N PINE ST	015	92.29	Rural Stop Controlled	5.88
1	COLUMBIA RIVER HWY @ NE MAIN AVE	002	176.36	Rural Stop Controlled	5.81
1	CLACKAMAS HWY @ SE WILDCAT MOUNTAIN DR	171	18.95	Rural Stop Controlled	5.78
1	OREGON COAST HWY @ DELLMOOR LP	009	16.27	Rural Stop Controlled	5.78
1	LOWER COLUMBIA RIVER HWY @ PRICE RD	092	52.58	Rural Stop Controlled	5.78

4	LOWER COLUMBIA RIVER HWY @ HEATH RD	092	51.32	Rural Stop Controlled	5.78
3	THE DALLES-CALIFORNIA HWY @ THE DALLES-CALIFORNIA HWY	004	169.68	Rural Stop Controlled	5.78
4	THE DALLES-CALIFORNIA HWY @ HACKETT DR	004	175.86	Rural Stop Controlled	5.78
3	MCKENZIE HWY @ GOODPASTURE RD	015	25.63	Rural Stop Controlled	5.78
3	OTIS CONN. HWY @ SALMON RIVER HWY	039	1.31	Rural Stop Controlled	5.78
3	CORVALLIS-NEWPORT HWY @ FRUITVALE RD	033	3.10	Rural Stop Controlled	5.78
2	CORVALLIS-NEWPORT HWY @ NE VALLEY RIDGE LN	033	2.24	Rural Stop Controlled	5.78
2	COLUMBIA RIVER HWY @ SW THIRD ST	002	174.76	Rural Stop Controlled	5.78
2	COLUMBIA RIVER HWY @ W FOURTH RD	002	174.46	Rural Stop Controlled	5.78
1	WILLAMINA-SALEM HWY @ PERRYDALE RD	030	11.79	Rural Stop Controlled	5.78
1	OREGON-WASHINGTON HWY @ PAMBRUN RD	800	16.07	Rural Stop Controlled	5.78
1	SW SIMPSON RD @ HILLSBORO- SILVERTON HWY	140	3.84	Rural Stop Controlled	5.78
2	SALMON RIVER HWY @ SW GOPHER VALLEY RD	039	34.73	Rural Stop Controlled	5.78
5	SALMON RIVER HWY @ SW CALEB PAYNE RD	039	35.62	Rural Stop Controlled	5.78
2	HISTORIC COLUMBIA RIVER HWY @ SW SCHOOL ST	100	31.02	Rural Stop Controlled	5.73
2	UMPQUA HWY @ FIRST ST	045	36.27	Rural Stop Controlled	5.73
2	UMPQUA HWY @ SECOND ST	045	36.21	Rural Stop Controlled	5.73
2	CENTRAL OREGON HWY @ N SIXTH ST	007	265.99	Rural Stop Controlled	5.73
2	WINCHESTER AVE @ UMPQUA HWY	045	0.63	Rural Stop Controlled	5.73
2	ALSEA HWY @ NE CRESTLINE DR	027	0.48	Rural Stop Controlled	5.73
5	OREGON COAST HWY @ PARADISE POINT RD	009	299.82	Rural Stop Controlled	5.66
2	NECANICUM HWY @ SUNSET HWY	046	0.04	Rural Stop Controlled	5.63
2	OREGON COAST HWY @ OREGON COAST HWY	009	222.73	Rural Stop Controlled	5.63
5	SANTIAM HWY @ INDIAN FORD RD	016	94.91	Rural Stop Controlled	5.63
5	CRATER LAKE HWY @ TAKELMA DR	022	29.17	Rural Stop Controlled	5.63

1	COLUMBIA RIVER HWY @ PATERSON FERRY RD	002	171.89	Rural Stop Controlled	5.63
1	COLUMBIA RIVER HWY @ W EIGHTH RD	002	173.18	Rural Stop Controlled	5.63
2	SALMON RIVER HWY @ STEEL BRIDGE RD	039	28.21	Rural Stop Controlled	5.63
3	PENDLETON HWY @ PENDLETON HWY	067	6.01	Rural Stop Controlled	5.63
2	CLACKAMAS HWY @ SW WADE ST	171	23.00	Rural Stop Controlled	5.59
2	CLACKAMAS HWY @ CLACKAMAS HWY	171	22.81	Rural Stop Controlled	5.59
2	WILLAMETTE HWY @ GALE ST	018	35.80	Rural Stop Controlled	5.59
2	REDWOOD HWY @ W PALMER ST	025	28.56	Rural Stop Controlled	5.58
1	OREGON COAST HWY @ NE LANE ST	009	126.95	Rural Stop Controlled	5.58
2	NW HARNEY ST @ OREGON COAST HWY	009	126.98	Rural Stop Controlled	5.58
2	OREGON COAST HWY @ NE BECHILL ST	009	127.25	Rural Stop Controlled	5.58
2	OREGON COAST HWY @ NE AUSTIN ST	009	127.11	Rural Stop Controlled	5.58
2	OREGON COAST HWY @ NW VISTA ST	009	127.06	Rural Stop Controlled	5.58
2	OREGON COAST HWY @ NW SUNSET ST	009	127.10	Rural Stop Controlled	5.58

#### APPENDIX B

Table 10. SPF Analysis - Intersections Scoring in the Top 10% by ODOT Region

					Expected
ODOT			Mile		Fatal/ Injury
Region	Intersection Name	Highway	Post	Sub-Category	Crashes per
Ŭ					Year
1	OR213 @ BEAVERCREEK RD	160	2.98	Urban Signalized	9.75
1	POWELL BLVD @ 82ND AVE(OR213)	068	4.75	Urban Signalized	8.44
2	(OR22)CENTER ST @ COMMERCIAL	030	26.14	Urban Signalized	8.08
2	(OR22)MARION ST @ COMMERCIAL	030	26.18	Urban Signalized	7.50
1	OR99W @ TUALATIN SHERWOOD RD/ROY RODGERS RD	091	15.00	Urban Signalized	6.36
1	POWELL BLVD(US26) @ 92ND AVE	026	5.59	Urban Signalized	6.22
1	OR224 @ 135TH AVE/HUBBARD RD	171	7.23	Urban Signalized	6.18
1	OR213 @ JOHNSON CREEK BLVD	068	7.54	Urban Signalized	6.15
2	PORTLAND RD(OR99E) @ HYACINTH	081	46.49	Urban Signalized	6.08
1	POWELL BLVD(US26) @ 122ND AVE	026	7.21	Urban Signalized	5.81
2	OR22 @ Airport	072	7.92	Urban Signalized	5.57
1	OR8 @ 185TH AVE	029	6.60	Urban Signalized	5.51
1	OR99E @ MILPORT RD	081	5.20	Urban Signalized	5.51
1	82ND AVE @ GLISAN ST	068	2.75	Urban Signalized	5.48
1	OR8 @ QUINCE ST	029	17.88	Urban Signalized	5.22
1	82ND AVE @ DIVISION ST	068	4.24	Urban Signalized	5.19
1	OR8 @ MURRAY BLVD	029	4.58	Urban Signalized	5.17
1	OR8 @ CORNELIUS PASS RD	029	8.32	Urban Signalized	5.12
1	OR8 @ 160TH AVE	029	5.36	Urban Signalized	5.05
2	OR22 @ 25th	072	7.52	Urban Signalized	5.00
1	POWELL BLVD (US26) @ 39TH AVE(SE CESARCHAVEZ)	026	2.91	Urban Signalized	4.98
1	OR8 @ CEDAR HILLS BLVD	029	3.82	Urban Signalized	4.96
1	OR8 @ 198TH AVE	029	7.28	Urban Signalized	4.81
1	MCLOUGHLIN BLVD @ 17TH AVE	081	2.73	Urban Signalized	4.79
4	US97 @ Veterans	004	121.9 8	Urban Signalized	4.75
1	POWELL BLVD(US26) @ 21ST AVE	026	1.81	Urban Signalized	4.70
1	OR99W @ HALL BLVD	091	8.82	Urban Signalized	4.69
2	SALEM PARKWAY @ HYACINTH	072	1.54	Urban Signalized	4.68
1	OR212 @ 82ND DR	171	5.05	Urban Signalized	4.52
3	US199 @ Ringuette	025	0.62	Urban Signalized	4.49
1	OR8 @ BROOKWOOD AVE	029	9.73	Urban Signalized	4.45
1	82ND AVE @ FOSTER RD	068	5.76	Urban Signalized	4.39
1	OR8 @ 170TH AVE	029	5.84	Urban Signalized	4.36
2	PIONEER PARKWAY @ Q ST	228	0.26	Urban Signalized	4.25

1	OR213 @ CLACKAMAS RIVER DR/PRAIRIE SCHOONER WAY	160	0.14	Urban Signalized	4.24
2	SALEM PARKWAY (TRADE ST) @ LIBERTY	072	5.52	Urban Signalized	4.22
2	OR99W @ SUNSET BLVD/ELWERT RD	091	16.67	Urban Signalized	4.22
1	POWELL BLVD(US26) @ 136TH AVE	026	7.90	Urban Signalized	4.20
1	US26 @ PALMQUIST	026	14.75	Urban Signalized	4.14
1	OR99W @ GREENBURG RD/MAIN ST	091	8.94	Urban Signalized	4.11
1	OR99W @ 72ND AVE/FRED MEYER	091	8.02	Urban Signalized	4.11
2	OR214 at Evergreen	140	37.02	Urban Signalized	4.08
2	SALEM PARKWAY @ BROADWAY	072	3.16	Urban Signalized	4.08
1	OR213 @ REDLAND RD/ABERNETHY RD	160	0.48	Urban Signalized	4.07
4	US97 @ Cooley	004	134.1 1	Urban Signalized	4.06
2	SALEM PARKWAY (COMMERCIAL) @ UNION ST	072	4.79	Urban Signalized	3.94
3	OR62 @ OR 140	022	6.03	Urban Signalized	3.91
1	MCLOUGHLIN BLVD @ HAROLD ST	081	3.07	Urban Signalized	3.90
4	US97 @ Powers	004	139.9 7	Urban Signalized	3.85
1	POWELL BLVD(US26) @ 174TH AVE	026	9.87	Urban Signalized	3.84
1	OR99E @ ARLINGTON ST/RIVER RD	081	11.02	Urban Signalized	3.81
2	OR22 @ Hawthorne	072	8.26	Urban Signalized	3.81
1	POWELL BLVD(US26) @ MILWAUKIE AVE	026	1.32	Urban Signalized	3.79
2	OR99W at Springbrook	091	22.05	Urban Signalized	3.78
1	Lombard St @ MLK Blvd (99E)	123	6.15	Urban Signalized	3.72
1	OR8 @ MINTER BRIDGE RD/CYPRESS ST	029	11.28	Urban Signalized	3.70
3	US199 @ 238	272	0.03	Urban Signalized	3.68
1	OR213 @ MONTEREY AVE	068	8.83	Urban Signalized	3.66
1	82ND AVE @ STARK ST	068	3.25	Urban Signalized	3.66
1	82ND AVE @ BURNSIDE ST	068	3.00	Urban Signalized	3.64
2	EUGENE SPRINGFIELD HWY (OR126) @ 52ND ST	227	9.05	Urban Signalized	3.64
1	OR8 @ HOCKEN AVE	029	4.02	Urban Signalized	3.63
2	(OR22)MISSION @ 12TH	072	6.30	Urban Signalized	3.58
2	US20 at Waverly	016	0.49	Urban Signalized	3.58
1	OR224 @ JOHNSON RD	171	3.73	Urban Signalized	3.57
3	US199 @ beacon	482	1.00	Urban Signalized	3.56
3	OR238 @ Union	272	0.22	Urban Signalized	3.54
3	OR2 @ ROBERTS CK RD/CARNES RD (KELLY' S CORNER)	035	75.72	Urban Signalized	3.51
1	Yeon Ave (US30) @ Nicolai St	092	1.97	Urban Signalized	3.50
1	OR99W @ BEEF BEND RD	091	10.95	Urban Signalized	3.50
2	SALEM PARKWAY @ CHERRY	072	2.61	Urban Signalized	3.47
2	OR551 at Ehlen Rd	051	3.48	Rural Signalized	2.29
1	PACIFIC HWY E @ SE MAPLE ST	081	7.70	Urban Stop Controlled	2.19

2	OR551 at Arndt Rd	051	1.47	Rural Signalized	2.07
	TUALATIN VALLEY HWY @ SE NINTH AVE	029		_	
1			12.52	Urban Stop Controlled	1.70
2	LOWER COLUMBIA RIVER HWY @ BENNETT RD	092	25.80	Urban Stop Controlled	1.67
1	CLACKAMAS HWY @ SE WEITZ LN	171	18.37	Rural Stop Controlled	1.54
2	WILLAMINA-SALEM HWY @ PERRYDALE RD	030	11.79	Rural Stop Controlled	1.53
1	MT HOOD HWY @ SE 49TH AVE	026	3.39	Urban Stop Controlled	1.49
3	OREGON COAST HWY @ RANCH LN	009	229.2 7	Rural Stop Controlled	1.44
1	MT HOOD HWY @ SE 115TH AVE	026	6.83	Urban Stop Controlled	1.44
1	TUALATIN VALLEY HWY @ SE NINTH AVE	029	12.60	Urban Stop Controlled	1.43
4	THE DALLES-CALIFORNIA HWY @ SW HIGHLAND LN	004	102.5 9	Rural Stop Controlled	1.40
2	PACIFIC HWY W @ OLD FORT RD	091	67.90	Rural Stop Controlled	1.39
1	TUALATIN VALLEY HWY @ YEW ST	029	17.35	Urban Stop Controlled	1.37
3	REDWOOD HWY @ W SIXTH ST	025	26.42	Rural Stop Controlled	1.36
2	SUNSET BEACH LN @ OREGON COAST HWY	009	13.45	Rural Stop Controlled	1.34
1	SW SIMPSON RD @ HILLSBORO- SILVERTON HWY	140	3.84	Rural Stop Controlled	1.31
2	SALMON RIVER HWY @ GRAND RONDE RD	039	21.18	Rural Stop Controlled	1.27
2	WOODBURN-ESTACADA HWY @ S HWY 170 HWY	161	7.59	Rural Stop Controlled	1.26
3	REDWOOD HWY @ REEVES CREEK RD	025	24.59	Rural Stop Controlled	1.25
2	WOODBURN-ESTACADA HWY @ S MERIDIAN RD	161	3.78	Rural Stop Controlled	1.24
2	SANTIAM HWY @ SANTIAM HWY	016	8.53	Rural Stop Controlled	1.20
1	NORTHEAST PORTLAND FWY @ NE STAFFORD ST	123	6.65	Urban Stop Controlled	1.20
2	ALBANY-JUNCTION CITY HWY @ LASALLE ST	058	28.89	Rural Stop Controlled	1.20
2	WILSONVILLE-HUBBARD HWY @ KEIL RD NE	051	3.00	Rural Stop Controlled	1.14
4	WARM SPRINGS HWY @ NW ELM LN	053	113.6 1	Rural Stop Controlled	1.13
2	FLORENCE-EUGENE HWY @ PERKINS PENINSULA PARK RD	062	49.75	Rural Stop Controlled	1.13
2	OREGON COAST HWY @ NW VISTA ST	009	127.0 6	Rural Stop Controlled	1.10

•		010	0.44	5 101	
2	WILLAMETTE HWY @ BRABHAM RD	018	2.64	Rural Stop Controlled	1.10
1	CASCADE HWY S @ S MILK CREEK WAY	160	10.84	Rural Stop Controlled	1.08
2	OREGON COAST HWY @ KEENON DR	009	56.12	Rural Stop Controlled	1.07
2	OLD PACIFIC HWY @ OREGON COAST HWY	009	52.52	Rural Stop Controlled	1.06
4	OCHOCO HWY @ SW REIF RD	041	7.84	Rural Stop Controlled	1.06
2	SALMON RIVER HWY @ THREE RIVERS HWY	032	24.97	Rural Stop Controlled	1.06
2	OREGON COAST HWY @ W WASHINGTON ST	009	51.67	Rural Stop Controlled	1.05
2	ALSEA HWY @ NW CEDAR ST	027	0.16	Rural Stop Controlled	1.05
2	ALBANY-JUNCTION CITY HWY @ MAIN ST SE	058	1.80	Urban Stop Controlled	1.05
2	SALMON RIVER HWY @ SALMON RIVER HWY	039	48.59	Urban Stop Controlled	1.04
4	NE LAFAYETTE AVE @ MCKENZIE-BEND HWY	017	20.87	Urban Stop Controlled	1.04
2	OREGON COAST HWY @ NINTH ST	009	44.89	Rural Stop Controlled	1.04
1	MT HOOD HWY @ SE 45TH AVE	026	3.21	Urban Stop Controlled	1.04
1	CASCADE HWY S @ S DARNELL RD	160	11.35	Rural Stop Controlled	1.03
2	TUALATIN VALLEY HWY @ TUALATIN VALLEY HWY	029	25.37	Rural Stop Controlled	1.02
1	TUALATIN VALLEY HWY @ NW 334TH AVE	029	14.79	Urban Stop Controlled	1.01
2	SALEM-DAYTON HWY @ ZENA RD NW	150	14.98	Rural Stop Controlled	1.00
2	OREGON COAST HWY @ SW LEE ST	009	140.5 7	Urban Stop Controlled	0.99
2	LOWER COLUMBIA RIVER HWY @ 29TH ST	092	97.27	Urban Stop Controlled	0.98
2	NORTH SANTIAM HWY @ NW SEVENTH AVE	162	29.73	Rural Stop Controlled	0.98
1	MT HOOD HW CONN @ MT HOOD HWY	026	1.10	Urban Stop Controlled	0.98
3	CRATER LAKE HWY @ MOUNTAIN VIEW DR	022	12.86	Rural Stop Controlled	0.98
2	TUALATIN VALLEY HWY @ TUALATIN VALLEY HWY	151	0.00	Rural Stop Controlled	0.98
3	CRATER LAKE HWY @ INDIAN CREEK LN	022	19.78	Rural Stop Controlled	0.98
5	CENTRAL OREGON HWY @ LINCOLN DR	007	255.1 9	Rural Stop Controlled	0.97

4	MCKENZIE HWY @ MCKENZIE HWY	015	97.46	Rural Stop Controlled	0.97
4	MCKENZIE HWY @ SW 67TH ST	015	108.0 4	Rural Stop Controlled	0.97
4	THE DALLES-CALIFORNIA HWY @ SW JERICHO LN	004	104.9 3	Rural Stop Controlled	0.96
2	CORVALLIS-NEWPORT HWY @ NW HIGHWAY 20 HWY	033	5.59	Rural Stop Controlled	0.96
2	NORTH SANTIAM HWY @ NE FIFTH AVE	162	30.42	Rural Stop Controlled	0.95
2	OREGON COAST HWY @ S SECOND AVE	009	50.90	Rural Stop Controlled	0.95
4	BADGER RD @ THE DALLES-CALIFORNIA HWY	004	140.3 0	Urban Stop Controlled	0.95
2	OREGON COAST HWY @ W OCEAN LN	009	35.12	Rural Stop Controlled	0.94
1	CLACKAMAS HWY @ SE AMISIGGER RD	171	15.22	Rural Stop Controlled	0.92
1	ODELL HWY @ SUMMIT DR	282	1.82	Rural Stop Controlled	0.92
2	TUALATIN VALLEY HWY @ W LINCOLN ST	029	37.50	Rural Stop Controlled	0.92
2	HALSEY-SWEET HOME HWY @ FISHER RD	212	4.69	Rural Stop Controlled	0.90
4	OCHOCO HWY @ SW KISSLER RD	041	7.35	Rural Stop Controlled	0.90
2	CORVALLIS-NEWPORT HWY @ WOODS CREEK RD	033	47.99	Rural Stop Controlled	0.90
2	WILLAMETTE HWY @ WILLIAMSON LN	018	9.61	Rural Stop Controlled	0.90
2	SANTIAM HWY @ 22ND AVE	016	27.93	Urban Stop Controlled	0.89
5	N RIVER ST @ NE NORTH ST	010	65.09	Rural Stop Controlled	0.88
4	KLAMATH FALLS-MALIN HWY @ MALONE RD	050	16.01	Rural Stop Controlled	0.88
2	WOODBURN-ESTACADA HWY @ S BARLOW RD	161	5.15	Rural Stop Controlled	0.88
4	HUNTINGTON RD @ THE DALLES- CALIFORNIA HWY	004	167.9 9	Rural Stop Controlled	0.87
2	PACIFIC HWY W @ W THIRD AVE	091	109.6 3	Urban Stop Controlled	0.87
5	CENTRAL OREGON HWY @ N SECOND ST	007	266.2 5	Rural Stop Controlled	0.87
5	CENTRAL OREGON HWY @ CENTRAL OREGON HWY	007	129.1 2	Rural Stop Controlled	0.87
3	OREGON CAVES HWY @ N OLD STAGE RD	038	0.35	Rural Stop Controlled	0.87
3	UMPQUA HWY @ E RAILROAD AVE	045	0.24	Rural Stop Controlled	0.87

3	OREGON COAST HWY @ OREGON COAST HWY	009	358.1 3	Urban Stop Controlled	0.86
2	OREGON COAST HWY @ W THIRD ST	009	164.3 1	Rural Stop Controlled	0.86
4	MCKENZIE-BEND HWY @ MCKENZIE- BEND HWY	017	16.74	Urban Stop Controlled	0.86
1	HOOD RIVER HWY @ HOOD RIVER HWY	281	0.33	Urban Stop Controlled	0.86
1	LOWER COLUMBIA RIVER HWY @ NW 26TH AVE	092	2.43	Urban Stop Controlled	0.86
2	ALBANY-JUNCTION CITY HWY @ MADISON ST SE	058	1.93	Urban Stop Controlled	0.85
1	ODELL HWY @ EAGLE LP	282	2.23	Rural Stop Controlled	0.85
1	CASCADE HWY S @ S UNION MILLS RD	160	12.35	Rural Stop Controlled	0.85
3	ROGUE VALLEY HWY @ ELM AVE	063	5.28	Urban Stop Controlled	0.84
5	NW SECOND ST @ WALLOWA LAKE HWY	010	64.96	Rural Stop Controlled	0.84
2	ALBANY-JUNCTION CITY HWY @ MCMULLEN LN	058	29.66	Rural Stop Controlled	0.84
1	MT HOOD HWY @ GLASS DR	026	97.33	Rural Stop Controlled	0.84
5	OREGON-WASHINGTON HWY @ BLUE MOUNTAIN STATION RD	800	23.45	Rural Stop Controlled	0.83
5	WALLOWA LAKE HWY @ NW HOLMES ST	010	64.64	Rural Stop Controlled	0.83
5	CENTRAL OREGON HWY @ E ADAMS ST	007	131.6 5	Rural Stop Controlled	0.83
3	OREGON COAST HWY @ PITT ST	009	209.6 4	Rural Stop Controlled	0.82
2	OREGON COAST HWY @ N CLANCY RD	009	110.9 5	Urban Stop Controlled	0.82
5	UMATILLA-MISSION HWY @ MISSION RD	331	2.52	Rural Stop Controlled	0.82
2	LOWER COLUMBIA RIVER HWY @ MARSHLAND DISTRICT RD	092	65.99	Rural Stop Controlled	0.82
2	PACIFIC HWY W @ WHITESON RD CONN	091	41.95	Rural Stop Controlled	0.81
1	TUALATIN VALLEY HWY @ MAPLE ST	029	18.56	Urban Stop Controlled	0.81
2	OREGON COAST HWY @ OREGON COAST HWY	009	140.4 2	Urban Stop Controlled	0.81
5	CENTRAL OREGON HWY @ E A ST	007	131.7 6	Rural Stop Controlled	0.81
3	REDWOOD HWY @ REDWOOD HWY	025	27.31	Rural Stop Controlled	0.81
5	OREGON-WASHINGTON HWY @ ROTHROCK RD	800	9.06	Rural Stop Controlled	0.80

3	UMPQUA HWY @ UMPQUA HWY	045	0.33	Rural Stop Controlled	0.80
2	SW OCEANA ST @ OREGON COAST HWY	009	128.9 6	Rural Stop Controlled	0.79
3	UMPQUA HWY @ N FOURTH ST	045	0.46	Rural Stop Controlled	0.79
2	SALEM-DAYTON HWY @ HOPEWELL RD NW	150	12.46	Rural Stop Controlled	0.79
4	KLAMATH FALLS-MALIN HWY @ ANDERSON RD	050	12.36	Rural Stop Controlled	0.78
4	THE DALLES-CALIFORNIA HWY @ NE CLARK DR	004	89.18	Rural Stop Controlled	0.78
5	CENTRAL OREGON HWY @ KING AVE	007	260.6 7	Rural Stop Controlled	0.78
2	OREGON COAST HWY @ NE EIGHTH ST	009	139.9 9	Urban Stop Controlled	0.77
5	CENTRAL OREGON HWY @ E B ST	007	131.8 1	Rural Stop Controlled	0.77
1	WOODBURN-ESTACADA HWY @ S UNION MILLS RD	161	16.43	Rural Stop Controlled	0.77
3	UMPQUA HWY @ MAIN ST	045	36.32	Rural Stop Controlled	0.77
1	LOWER COLUMBIA RIVER HWY @ NW SALTZMAN RD	092	5.23	Urban Stop Controlled	0.76
2	SALMON RIVER HWY @ STEEL BRIDGE RD	039	28.21	Rural Stop Controlled	0.76
1	CLACKAMAS HWY @ SE 152ND DR	171	8.05	Urban Stop Controlled	0.76
2	ALBANY-JUNCTION CITY HWY @ W I ST	058	19.80	Rural Stop Controlled	0.75
2	TUALATIN VALLEY HWY @ MAIN ST	029	25.45	Rural Stop Controlled	0.75
2	LOWER COLUMBIA RIVER HWY @ SCANDINAVIAN RD	092	93.25	Rural Stop Controlled	0.75
2	PACIFIC HWY W @ PACIFIC HWY W	091	37.80	Urban Stop Controlled	0.75
2	OREGON COAST HWY @ SUNSET HWY	009	24.93	Rural Stop Controlled	0.75
1	TUALATIN VALLEY HWY @ SE FOURTH AVE	029	12.95	Urban Stop Controlled	0.75
2	PACIFIC HWY W @ W 11TH AVE	091	109.1 7	Urban Stop Controlled	0.75
3	UMPQUA HWY @ N THIRD ST	045	0.53	Rural Stop Controlled	0.75
4	CENTRAL OREGON HWY @ NE FOURTH ST	007	0.60	Urban Stop Controlled	0.75
2	HILLSBORO-SILVERTON HWY @ E CHARLES ST	140	46.12	Rural Stop Controlled	0.75
2	SALMON RIVER HWY @ SW HARMONY RD	039	30.63	Rural Stop Controlled	0.75

2	CORVALLIS-NEWPORT HWY @ MARYS RIVER ESTATES RD	033	48.48	Rural Stop Controlled	0.74
2	OREGON COAST HWY @ NW 15TH ST	009	139.5 4	Urban Stop Controlled	0.74
4	THE DALLES-CALIFORNIA HWY @ SW L ST	004	96.14	Urban Stop Controlled	0.74
1	MT HOOD HWY @ MT HOOD HWY	026	14.58	Urban Stop Controlled	0.73
1	NORTHEAST PORTLAND FWY @ NE 115TH AVE	123	12.11	Urban Stop Controlled	0.72
1	MT HOOD HWY CONN. NO. 1 CONN @ MT HOOD HWY CONN. NO. 1 CONN	081	1.62	Urban Stop Controlled	0.71
3	CAPE ARAGO HWY @ MEADE AVE	240	0.16	Urban Stop Controlled	0.70
4	THE DALLES-CALIFORNIA HWY @ SW PUMICE AVE	004	122.2 6	Urban Stop Controlled	0.70
2	OREGON COAST HWY @ 17TH ST	009	189.7 3	Urban Stop Controlled	0.69
2	OREGON COAST HWY @ FIFTH AVE	009	20.73	Urban Stop Controlled	0.69
2	SANTIAM HWY @ PRICE RD SE	016	1.31	Urban Stop Controlled	0.68
2	MONMOUTH-INDEPENDENCE HWY @ ATWATER ST N	043	0.30	Urban Stop Controlled	0.68
1	TUALATIN VALLEY HWY @ SE 73RD AVE	029	8.57	Urban Stop Controlled	0.65
1	BEAVERTON-HILLSDALE HWY @ SW POPLAR LN	040	2.41	Urban Stop Controlled	0.65
3	OREGON COAST HWY @ HARRIET RD	009	239.3 1	Urban Stop Controlled	0.65
3	OREGON COAST HWY @ E HALL AVE	009	238.7 4	Urban Stop Controlled	0.64
2	DALLAS-RICKREALL HWY @ N FIR VILLA RD	189	1.55	Urban Stop Controlled	0.64
2	YAMHILL-NEWBERG HWY @ W SHERIDAN ST	151	11.39	Urban Stop Controlled	0.63



#### Technical Memorandum

September 25, 2023 Project# 27003.022

To: Christi McDaniel-Wilson, State Traffic Safety Engineer, ODOT

Jiguang Zhao, Traffic Safety Engineer, ODOT

From: Katie Popp, Robert Olney, Nick Foster, AICP, RSP1, Matt Braughton, RSP1, Pete Jenior, PE, PTOE,

Kittelson & Associates, Inc.

Beth Wemple, PE, Olivia Polinsky, HDR

CC: ODOT Technical Advisory Committee

RE: ODOT Intersection Safety Implementation Plan Update – Countermeasure Selection, Prioritization,

and Case Study Example

### ODOT INTERSECTION SAFETY IMPLEMENTATION PLAN UPDATE

#### Introduction

The Oregon Department of Transportation (ODOT) Intersection Safety Implementation Plan Update process is summarized in Figure 1.

Figure 1. Intersection Safety Implementation Plan Update Process



This memorandum documents the work completed for Steps 3-5. It includes:

- Example potential countermeasures at 30 intersections of varying contexts and control types spread across Oregon (Step 3).
- Guidance for prioritizing and evaluating the effectiveness of systemic intersection safety projects and programs (Steps 4 & 5).
- An example application of Steps 1-4 using City of Salem data.
- A fact sheet describing the Safe System Approach (SSA) and how it relates to intersections.

ODOT and local agencies may use the guidance in this memorandum to identify systemic intersection safety projects after completing the first two steps, described in the previous memorandum. These projects can be submitted for ODOT's All Roads Transportation Safety (ARTS) funding or completed as part of a local agency or other safety program. The project and program evaluation can be used to evaluate the effectiveness of systemic projects, as well as program implementation and effectiveness.

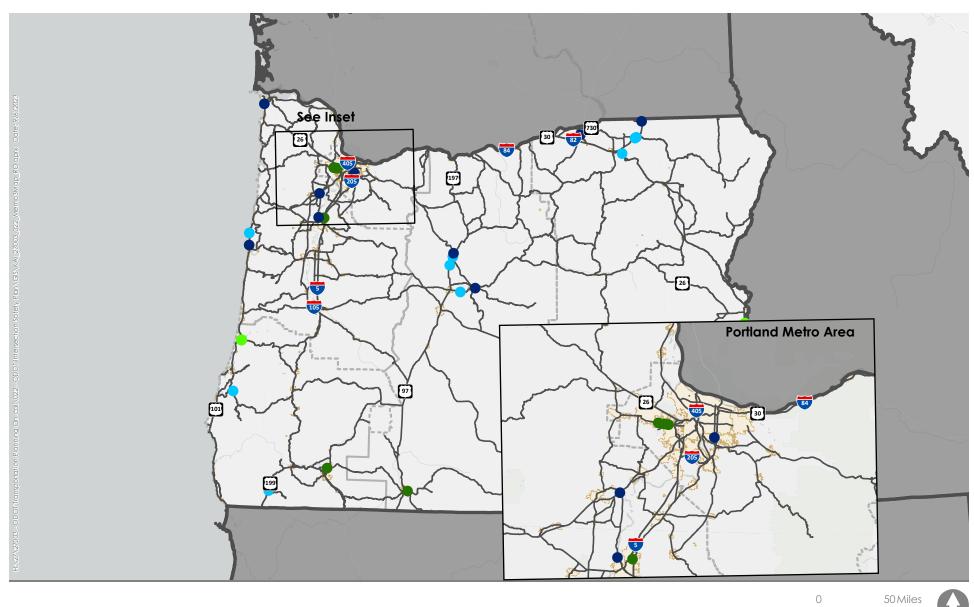
#### Selecting Potential Countermeasures

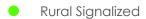
To complete Step 3, the project team worked with ODOT to select sites for further evaluation. After selecting the sites, the project team identified potential countermeasures for each site, along with their potential effect on Oregon climate goals and how they address Safe System Approach principles for intersections. The countermeasures shown are examples ODOT could consider at each location based on the intersection characteristics.

All countermeasures considered in this memorandum are taken from ODOT's approved list for the ARTS program. Countermeasures on this list are typically based on research, data analysis, and best practices. Study results for safety treatments can vary widely depending on the specific study context and the types of factors being addressed, so a range of potential effectiveness is sometimes provided for certain countermeasures. To have the greatest likelihood of reducing fatal and serious injury crashes, select safety countermeasures that treat the specific context of an intersection (e.g., geometric, traffic, crash, and land-use patterns).

#### Site Selection

In the previous memorandum, the project team identified candidate sites with the greatest network screening score. The project team worked with ODOT Region staff to identify 30 sites for further evaluation. These sites were generally selected from the highest-scoring sites in each ODOT Region, with the following objectives in mind: 1) The sites represent a range of land-use and geographic contexts; and 2) The sites represent a range of traffic control types. Figure 2 maps the selected sites, which are also shown in Table 1.





Rural Stop Controlled

Urban Signalized

Urban Stop Controlled









**Table 1. Example Intersections** 

ODOT	Intersection	ODOT LRM #	Milepost #	Туре
Region		00000100		
	OR 8 / SW Murray Boulevard	02900100	4.58	Urban Signalized
	OR 8 / SW 153rd Drive	02900100	4.9	Urban Signalized
1	OR 8 / SW 160th Avenue	02900100	5.36	Urban Signalized
	OR 8 / SW 170th Avenue	02900100	5.84	Urban Signalized
	OR 8 / SW 198th Avenue	02900100	7.28	Urban Signalized
	SE 82nd Avenue / SE King Road	06800100	8.3	Urban Stop Controlled
	US 101 / SW Singing Tree Road	00900100	128.48	Rural Stop Controlled
	OR 18 / Kreder Road	03900100	51.73	Urban Stop Controlled
2	Portland Road NE (OR 99E) / Hyacinth Street NE	08100100	46.49	Urban Signalized
	US 101 / NW 49th Street	00900100	137.75	Urban Stop Controlled
	OR 221 / Michigan City Lane NW	15000100	17.57	Urban Stop Controlled
	US 101 / Patriot Way	00900100	9.87	Urban Stop Controlled
	US 101 / OR 38	00900100	211.58	Rural Signalized
	US 101 / 13th Street	00900100	211.91	Rural Signalized
2	US 101 / Winchester Avenue	00900100	212.05	Rural Signalized
3	OR 42 / OR 42S	03500100	10.85	Rural Stop Controlled
	US 199 / Hanby Lane	02500100	28.19	Rural Stop Controlled
	OR 62 / OR 140	02200100	6.03	Urban Signalized
	US 97 / US 26	36000100	0.09	Rural Stop Controlled
	US 97 / SW Iris Lane	00400100	103.63	Rural Stop Controlled
4	US 26 / NE Cedar Street	05300100	117.42	Urban Stop Controlled
4	OR 39 / Crater Lake Parkway	02000100	3.28	Urban Signalized
	OR 380 / SE Juniper Canyon Road	38000100	1.35	Urban Stop Controlled
	OR 126 / SW Reif Road	04100100	7.84	Rural Stop Controlled
	US 26 / OR 201	00700100	265.97	Rural Signalized
	OR 11 / Banister Road	00800100	17.52	Rural Stop Controlled
Г	OR 11 / 3rd Street	00800100	16.43	Rural Stop Controlled
5	OR 331 / Wildhorse Boulevard	33100100	3.72	Rural Stop Controlled
	OR 207 / NE McNary Street	33300100	6.93	Urban Stop Controlled
	OR 11 / Crockett Road	00800100	33.53	Urban Stop Controlled

#### **Example Countermeasure Selection**

At each of the 30 sites, the project team considered potential countermeasures based on the ODOT ARTS list. These countermeasures come from the Hotspot, Intersection Systemic, and Bicycle and Pedestrian Systemic categories. They are divided into relative cost categories. Striping, signage, lighting and traffic signal improvements were generally considered low-cost; turn lane additions, surface, and adding small physical features were considered medium-cost; and larger intersection redesigns that would require substantial change to the site infrastructure were considered high-cost.

Generally, countermeasures in the "low" and "medium" cost categories may be suitable for systemic deployment across several sites through the Systemic category of ODOT's ARTS program or through a local agency safety program. Countermeasures in the "High" cost category are more likely to be implemented at only a few, or less, sites through a single project through the Hotspot category of ODOT's ARTS program, an

agency's capital improvement program (CIP), or through a larger federal grant program (e.g., Safe Streets and Roads for All [SS4A], Rebuilding American Infrastructure with Sustainability and Equity [RAISE]).

#### **Greenhouse Gas Emissions**

For consistency with state policy, the project team considered the potential impacts on greenhouse gas (GHG) emissions that countermeasures might have, either increasing or decreasing them through their impacts on traffic flow and vehicle idling (construction and production emissions were not considered here). Certain countermeasures may also promote more active transportation, thereby decreasing GHG emissions from vehicle use. Following draft guidance provided by ODOT, the project team identified how each countermeasure might impact GHG emissions based on its effect on traffic flow, idling, and active transportation. More information on ODOT's efforts to reduce GHG emissions can be found here: <a href="https://www.oregon.gov/odot/climate/pages/mitigation.aspx">https://www.oregon.gov/odot/climate/pages/mitigation.aspx</a>.

It is important to keep in mind that, while certain countermeasures may impact GHG emissions, intersection safety treatments that show the greatest potential to reduce fatal and serious injury crashes should be selected when using Highway Safety Improvement Program (HSIP) funds, which are the primary source of ARTS program funding. This holds true even in instances of potential conflict with objectives such as freight mobility or emissions reduction.

#### **Vulnerable Road Users**

As noted in Technical Memorandum #1, pedestrian crashes made up 3% of all intersection crashes from 2015 to 2021, but 11% of fatal and suspected serious injury crashes. Similarly, bicycle crashes accounted for about 2% of all crashes, but 5% of fatal and suspected serious injury crashes. Given these findings, the memo recommends agencies focus on vulnerable roadway user (VRU) crashes, as well as angle and left-turning crashes, to have the greatest impact on fatal and suspected serious injury crashes. For this reason, the project team included Bicycle and Pedestrian Systemic countermeasures in its review of the 30 example sites. The ODOT Highway Design Manual also encourages designers to make the safety of VRUs a primary focus. In addition to providing protection, physically or through separation in time, for VRUs, design can facilitate driver awareness of VRUs, reduce conflict points between motor vehicle traffic and VRUs, and manage speeds through these conflict points.

#### Safe System Approach

The Safe System Approach (SSA) is an FHWA framework for designing and analyzing the safety of road networks. It identifies five core features that together create a safe system that minimizes severe crashes: Safe Road Users, Safe Vehicles, Safe Speeds, Safe Roads, and Post-Crash Care. Three of these five principles — Safe Roads, Safe Road Users, and Safe Speeds — are all relevant to the countermeasures considered here. Therefore, the project team identified which principle(s) each countermeasure helped work towards. These were largely based on how each countermeasure addressed the defining characteristics of each intersection: complexity, speed, potential crash angles, and conflict points, as well as generally how aware road users would be of their surroundings.

Attachment "A" contains more information on the Safe System Approach and how it relates to intersection safety.

#### **Countermeasure Selection**

The process for selecting potential countermeasures at each of the 30 potential treatment sites identified in Step 4 included the following steps:

- Reviewing existing conditions of potential treatment site including traffic and roadway data, land-use context, crash history, pedestrian and bicycle facilities, and other site characteristics.
- Based on this review, determining potentially relevant countermeasures.
- Assessing the feasibility of countermeasure implementation upon reviewing aerial and street-level imagery.
- Documenting potential GHG effects and alignment with SSA principles.

Attachment "B" contains the results of this process for each of the 30 sites. The countermeasures shown in this attachment are examples ODOT could consider at each location based on the intersection's characteristics. They are meant to be illustrative as examples for how an agency could start this step. These representative sites require further evaluations before selecting countermeasures. Further investigation may determine that certain countermeasures are not applicable at a particular site based upon traffic or crash patterns or characteristics not observed during this evaluation.

#### Prioritize and Implement Projects

After selecting countermeasures, agencies must prioritize projects. In general, the process to refine and implement a systemic treatment involves the following activities, as identified in the Federal Highway Administration's (FHWA's) Systemic Safety Project Selection Tool and National Cooperative Highway Research Program (NCHRP) Research Report 893.

- Consider additional community priorities and programming needs
- Perform additional diagnostics
- Perform economic assessments
- Allocate funding and implement projects

#### **Consider Additional Community Priorities and Programming Needs**

Prior to finalizing the selected countermeasure(s), consider inputs not accounted for in the previous steps. These inputs could include other data not already accounted for (e.g., site specific count volumes), planned land-uses or transportation projects, geographic diversity, equity, ongoing maintenance costs and needs, planning studies (e.g., transportation system plans), safety studies (e.g., SPIS, road safety audits), and other community priorities and considerations. If not already considered, evaluate timing, funding eligibility, and other programmatic related considerations (e.g., need to obtain right-of-way, project development timing, environmental or other analyses needed, expected prioritization within a funding program). Some possible areas to explore include:

- Data Collection: Gather additional site-specific data that may not have been included in the initial assessment. This may include crash data, more detailed inventory data, speed studies, safety audits, detailed traffic volumes (including pedestrians and bicycles) during various times of day and days of the week, or video analytics. This data can help identify trends in user behavior or other site characteristics that can be used to further assess how to reduce the potential for serious crashes.
- Planned Land Uses and Transportation Projects: Review relevant planning studies and documents to consider any planned or anticipated land-use changes or transportation projects in the vicinity of the intersection. Consider how intersection improvements and the needs of various road users fit into overall

- visions from these plans. Aligning safety projects with these plans and developments may help improve network connectivity and avoid potential conflicts in the future.
- Demographics and Equity: Consider how safety improvements address equity concerns and prioritize areas that might have been historically underserved. This includes considering emphasis areas from ODOT's Transportation Safety Action Plan, such as vulnerable road users and the needs of aging drivers.
- Ongoing Maintenance Costs and Needs: Consider potential maintenance costs and requirements so that safety improvements remain effective and operational over time.
- Community Priorities and Considerations: Engage with the local community to understand their priorities, concerns, and experiences. This information can sometimes also be obtained by reviewing relevant safety plans and studies.
- Programmatic Related Considerations: Consider factors such as whether the safety treatment is the long-term goal or part of a bigger vision, the ability to leverage other opportunities, project scheduling (including coordination with other ongoing projects), funding eligibility (meeting the criteria for available grants or programs), the need to secure right-of-way, environmental impact assessments, and the expected prioritization within funding programs.

#### **Perform Additional Diagnostics**

If the prior steps have only included a desktop review, a field review of potential sites should be completed. These visits can reveal additional information about the potential feasibility of the selected countermeasure(s) and identify other items that could be addressed to reduce the potential of a crash occurring. The *Highway Safety Manual* recommends that a field review include traveling through the site from all directions and by all modes of travel to understand how each user experiences the site while making all possible movements. Similarly, viewing the site during different conditions (e.g., day and night) can also help understand how site characteristics and behaviors can change throughout the day. Other considerations during a review can include a more detailed review of site characteristics (e.g., sight distance, lighting conditions, signing and striping visibility), user behavior (e.g., hard braking, unique actions, traffic control compliance, near-misses, speeding), and evidence of past conflicts (e.g., tire or skid marks, broken glass, damaged roadside features).

#### **Perform Economic Assessments**

The ARTS program uses a benefit-cost analysis (BCA) methodology to prioritize most intersection projects, including Hotspot (i.e., a project targeted at a single location to address its fatal and serious injury crash history) and Systemic (i.e., low-cost countermeasures deployed across multiple locations) program projects. The exception is that pedestrian and bicycle systemic projects are evaluated using the Cost-Effectiveness Index (CEI).

#### **Benefit-Cost Analysis**

Under the BCA, countermeasures are assigned calculated benefits based on their crash reduction factors and the economic costs they may avoid by decreasing particular crash types and severities. The economic costs per crash are sourced from ODOT. The sum of these avoided costs (the project benefit) is weighed against the cost outlays of executing a project to arrive at a net societal economic gain/loss from the project. For example, if a particular project is expected to eliminate crashes that cost \$10 million over its lifetime, and the project costs \$2 million to complete, then the B/C ratio is 5.

#### **Cost-Effectiveness Index**

Systemic pedestrian and bicycle projects are prioritized using the CEI methodology. This methodology is being revamped for the upcoming ARTS cycle. The draft CEI methodology estimates the total reduced risk per \$1,000 spent on a project(s), known as the Risk Reduction Cost Ratio (RRC). This is calculated using a spreadsheet tool developed by ODOT. The tool calculates a risk score based on various site characteristics, such as recent crash history, AADT, crossing distance, speed limit, and sidewalk and bicycle facilities, among others.

Next, identified countermeasures are input into the tool, and their CRFs and site coverage are used to calculate a value that represents the total reduced risk (the benefit) of the proposed countermeasure (s). The cost of the proposed countermeasure project(s) is then estimated using a cost estimator worksheet. The total reduced risk is then divided by the total present value cost of the proposed project. This arrives at an RRC value, representing the reduced risk per \$1,000 of project cost.

The CEI methodology is useful for systemic projects, as it considers more than crash history in calculating the economic benefit of the project. It can also be used to find a combined value for multiple project sites and up to three simultaneous countermeasures. The CEI methodology can be used for pedestrian and bicycle focused projects at intersections (i.e., countermeasures from ARTS' Systemic Bike and Pedestrian Countermeasures list). However, BCA must be used for projects from the Systemic Intersection Countermeasures list.

#### **Evaluating Projects**

ODOT provides spreadsheets for ARTS funding applicants to use on its website. Jurisdictions use either the BCA or CEI spreadsheet to determine the economic value of the proposed countermeasure(s). Hotspot projects will evaluate the B/C ratio at the single location that is being treated by the project. Systemic projects will group together all intersections receiving the proposed countermeasure(s) and calculate a combined benefit cost ratio across all sites. This grouping is important to the systemic process since the goal is to prevent future crashes from occurring, including at sites that may not have a crash history. These groupings can occur at various levels depending on the applying agency (e.g., installing flashing yellow arrow signal heads at multiple signals in one city, installing beacons on stop signs at multiple locations across ODOT Region 5).

During this process, an agency may examine additional countermeasures or how projects are grouped to achieve a desirable B/C ratio or RRC (CEI method). As such, this and the previous step are sometimes repeated iteratively.

#### **Allocate Funding and Implement Projects**

ODOT allocates funding for systemic intersection safety projects through the ARTS program. Funds are allocated to each ODOT Region based on a five-year fatal and serious injury crash history. The Regions are encouraged to use at least half of the funds on systemic projects. Of their systemic funds, Regions are encouraged to dedicate about 35% to intersection projects.

#### Evaluate Project and Program Impacts

The final step includes evaluating and monitoring the systemic process based on the implemented treatments identified and prioritized in the previous steps. This includes project and program evaluations.

#### **Project Evaluation**

A common means for evaluating the effectiveness of a project is to analyze crashes before and after countermeasure implementation. This type of analysis is often called a simple, or naïve, before-after study and typically uses three to five years of data in the before and after periods. For a hotspot project, this may be completed for a single site. For systemic projects, the data across all sites need to be grouped together for the evaluation.

The primary shortcoming of the simple before-after study is that it does not account for randomness in crash data, which can be especially marked in low-occurring crash types, such as fatal and serious injury crashes or when evaluating only a single site. Crashes can appear to be random from year to year, so using expected crash frequency can help limit the impact of regression-to-mean movements on performance evaluations. According to the Highway Safety Manual, one method to provide a better statistical estimate of the effect of a treatment is to use safety performance functions (SPFs, mathematical models that predict long-term average crash frequency) in conjunction with observed crash data. ODOT has calibrated SPFs for many intersection types to Oregon conditions, allowing them to potentially be used in these analyses. When possible, these SPFs should be used in performing project evaluations.

#### **Program Evaluation and Monitoring**

Generally, program evaluation and monitoring focuses on one of two categories:

- Program Implementation This entails evaluating progress made in implementing the program and could include monitoring and evaluating the following:
  - Whether the process is being carried out (i.e., is the process being implemented as intended?).
  - o The level of funding being allocated to systemic intersection safety projects.
  - o The number of systemic intersection safety projects implemented.
  - o The time between when funding is allocated and when projects are implemented.
  - o Identifying implementation barriers and lessons learned (e.g., additional data needs, policy/funding challenges, training needs, additional coordination needed).
  - The percentage of locations in the Top 10% for characteristics-based scores (or other category) that have been treated.
  - Number of ARTS applications submitted for systemic intersection projects.
- Program Outcomes This includes evaluating the success of the program in achieving its goals (e.g., reducing intersection-related fatalities and injuries). Performance measures ODOT may consider using for this purpose include:
  - Number of intersection crash-related fatalities and serious injuries, including breakouts by:
    - Crash type
    - Intersection control type
    - Social Equity Index category
    - Roadway ownership (i.e., State vs. non-State), including breakouts by urban and rural context
    - Vulnerable users

 Number of fatal and serious injury intersection crashes, including breakouts by the same categories as those described for the number of fatalities and injuries

The results of these evaluation and monitoring activities can be used to track progress and outcomes and to refine the process as necessary to increase its effectiveness. Evaluating implementation can be started immediately after funding is allocated. Evaluating the outcomes of the program may take longer as it may take several years for there to be sufficient after data available and the benefits of implemented projects may not be able to be fully evaluated until three or more years after they are installed.

#### City of Salem Case Study

The Kittelson team has completed a sample application of this plan's methods using the City of Salem as a case study. The results of this work are provided as Attachment "C."

#### **Attachments**

Attachment A: Safe System Approach Fact Sheet

Attachment B: Example Countermeasure Selection Sites

Attachment C: City of Salem Case Study

Attachment A Safe System Approach Fact Sheet

#### Memo

Date:	Monday, August 14, 2023
Project:	Oregon Intersection Safety Implementation Plan
To:	Oregon Department of Transportation
From:	Olivia Polinsky and Beth Wemple, HDR

Subject: Safe System Approach Fact Sheet Draft

HDR has prepared a draft Safe System Approach (SSA) Fact sheet for Oregon Department of Transportation (ODOT) as a part of the Oregon Intersection Safety Implementation Plan. This fact sheet will provide an overview of the SSA concept and its applications, specifically as it applies to ODOT projects and initiatives. The intended audience of this document includes safety engineers and analysts from the five ODOT regions, as well as ODOT's local safety engineering partners from counties, cities, and Tribes.

Please review the following draft content. Subject to review, feedback, and remaining project budget we will evaluate the feasibility of moving this into an InDesign product as a final product.

#### What is the Safe System Approach?

The <u>Safe System Approach (SSA)</u> aims to eliminate fatal and serious injury crashes, focusing on human mistakes and vulnerabilities. The SSA establishes multiple layers of protection to prevent crashes from occurring and reduce crash severity when they do occur.

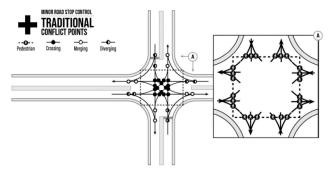


https://www.transportation.gov/NRSS/SafeSystem

SOURCE:

The SSA can be applied to enhance <u>intersection safety</u> by:

- Reducing the number of conflict points & improving (reducing) conflict angles - Vehicle to Vehicle AND Vehicle to Pedestrian/Bicycle
- Reducing speeds & improving visibility
- Separating different modes of transportation



SOURCE: FHWA - Report No. FHWA-SA-21-008 FHWA - Report No. FHWA-SA-21-013



SOURCE: ODOT Bicycle and Pedestrian Design Guide (Figure I-14)

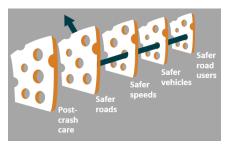
#### Why the Safe Systems Approach?

The SSA is a holistic approach that:

- 1. Anticipates human error
- 2. Reduces kinetic energy upon impact

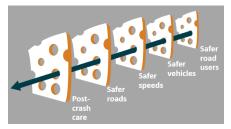
The five objectives of the SSA (safer people, safer vehicles, safer speeds, safer roads, and post-crash care) creates redundancy by incorporating safety considerations into all potential contributing factors of a crash.

The "Swiss Cheese Model" demonstrates this concept of redundancy – if one level fails, there's additional safety measures in place to protect people.



SOURCE: FHWA - The Safe System Approach Presentation (Jan. 4, 2023)

The only way for fatal or serious injury crashes to occur, is if ALL safety measures (SSA objectives) fail.



SOURCE: FHWA - The Safe System Approach Presentation (Jan. 4, 2023)

#### What does this mean for you?

How can you play a role in implementing the SSA?

The SSA can be applied to any and all project phases!

Things to consider in the work that you do:

- How can you separate modes of transportation (in terms of time and space)?
- How can you reduce conflict points and conflict angles?
- How can you reduce speeds?
- How can you reduce sight obstructions?

#### **ODOT Applications of the Safe Systems Approach**

#### <u>Blueprint for Urban Design (BUD)</u> - ODOT's Approach for Design in Oregon Communities

- Designs to accommodate ALL modes of transportation affecting ALL roadway users (see Table 1)
- Modal & cross-section considerations to help prioritize design criteria and guide separation of modes of transportation

Land Use Context	Motorist	Freight	Transit	Bicyclist	Pedestrian
Traditional Downtown/CBD	Low	Low	High	High	High
Urban Mix	Medium	Low	High	High	High
Commercial Corridor	High	High	High	Medium	Medium
Residential Corridor	Medium	Medium	Low	Medium	Medium
Suburban Fringe	High	High	Varies	Low	Low
Rural Community	Medium	Medium	Varies	High	High

High: Highest level facility should be considered and prioritized over other modal treatments.

Medium: Design elements should be considered: trade-offs may exist based on desired outcomes and user needs.

Low: Incorporate design elements as space permits.

Table 1: General Modal Consideration in Different Urban Contexts (BUD Table 2-3)



SOURCE: BUD Figure 3-1

#### **Speed Zoning Update** – ODOT Speed Zone Manual July 2022 Update

- Zoning update shifts focus in urban areas from 85<sup>th</sup> to 50<sup>th</sup> percentile speeds
- Considers location and context of roadway
- Reducing vehicle speeds improves safety for ALL modes (Speed reduction = kinetic energy reduction upon impact = lower severity)

SOURCE: <u>Vision Zero Network: Safety Over Speed</u> (BLACK ICONS REPRESENT FATALITIES)

#### Intersection Safety Implementation Plan - ODOT's Plan to Achieve Intersection Safety Goals Outlined in the SHSP

- Incorporates SSA principles
- Provides a proactive approach to reducing crash frequency and severity



#### **Additional Resources**

- Vision Zero: Demystifying the Safe System Approach
- ITE Technical Brief: Institutionalizing the Safe System Approach in Local Road Safety Plans
- Safe Systems: Guiding Principles & International Applications
- FHWA Implementing Safe System Principals on Highway 316 in Hastings, Minnesota
- Austroads: Safe System Assessment Framework
- Austroads: Towards Safe System Infrastructure

#### **Contact Information**

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## Attachment B Example Countermeasure Selection Sites

# Region 1

#### OR 8 / SW Murray Boulevard

#### Location

ODOT Region 1 ODOT LRM # 02900100 Milepost 4.58

#### **Intersection Type**

Urban | Signalized

#### Safety

Crashes, 2015-2021						
	Α	В	С	0		

SPIS 2021 Percentile: 95%-100%

0





OR 8 Eastbound Approach



OR 8 Westbound Approach



SW Murray Boulevard Northbound Approach



SW Murray Boulevard Southbound Approach

#### **Screening Elements Present**

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Left Turn Lane
- ► Thru Lanes ≥ 4

- Equity Disparity: High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
	Lo	ow-cost coun	termeasures	
Improve Signal Hardware: Lenses, Reflectorized Back plates, Size, and Number	12	20% for 2; 25% for 3-4; 30% for 5-6	- No effect	Safe Roads; Safe Road Users - Increases visibility
Add 3-inch yellow retroreflective sheeting to signal backplates	13	15	- No effect	Safe Roads; Safe Road Users - Increases visibility
Increase Signal Head Quantity - Additional Primary Head	15	28	- No effect	Safe Roads; Safe Road Users - Increases visibility
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	I6 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility
Install Adaptive Signal Timing of Urban Traffic Signals	113	17	- Improves traffic flow	Safe Roads; Safe Road Users - Reduced rear-end speeds
Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	114	8	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	116 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times
Prohibit Right-Turn-On-Red	129	9	- Increases idling - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Mitigates crash angles - Separates users in time
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Install Pedestrian Countdown Timer(s)	BP1 <sup>P</sup>	70	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity
Reduce Right Turn Permissive Conflicts (right turn arrow)	BP5 PB	20	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points
Prohibit Right-Turn-On-Red	BP25 PB	41	<ul><li>Increases idling</li><li>Promotes active</li><li>transportation</li></ul>	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time

Medium-Cost Countermeasures						
Right Turn Lane on Both Major Road Approaches: Signalized Intersection (3- or 4-leg)	H5	8	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)		
Channelized Right Turn Lane with Raised Median	H6 <sup>FI</sup>	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)		
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles		
Dual/Double Left Turn Lanes	H63 FI	29	- Reduces delay	Safe Roads - Reduces rear-end speeds		
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds		
	Hi	gh-Cost Coun	termeasures			
Median U-Turn Intersection Treatment	H1 FI	30	- Reduces delay - Requires modest out- of-direction travel	Safe Roads; Safe Road Users - Mitigates crash angles - Reduces complexity - Reduces conflict points		
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds		

Note: If no applicable crash type or injury type is specified, then countermeasure is applicable to all types. Crash types: A = Angle, RE = Rear-End, N = Nighttime, LT = Left Turning, WR = Wet Road, P = Pedestrian, B = Bike, PB = Ped/Bike, PBN = Ped/Bike Nighttime. Injury types: FI = Fatal/Injury, FA = Fatal/Serious Injury (A).

#### OR 8 / SW 153rd Drive

#### Location

ODOT Region 1 ODOT LRM # 02900100 Milepost 4.9

#### **Intersection Type**

Urban | Signalized

#### Safety

Crashes, 2015-2021							
Κ	Α	В	С	0			
_		10		- 1			

0 10 9 SPIS 2021 Percentile: 85%-90%





OR 8 Eastbound Approach



OR 8 Westbound Approach



SW 153<sup>rd</sup> Drive Southbound Approach

#### **Screening Elements Present**

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Left Turn Lane
- Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
	Low-	cost counter	measures	
Improve Signal Hardware: Lenses, Reflectorized Back plates, Size, and Number	12	20% for 2; 25% for 3-4; 30% for 5-6	- No effect	Safe Roads; Safe Road Users - Increases visibility
Add 3-inch yellow retroreflective sheeting to signal backplates	13	15	- No effect	Safe Roads; Safe Road Users - Increases visibility
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	I6 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility
Replace Urban Permissive or Protected/Permissive Left Turns to Protected Only	19 LT	99	- Increases delay	Safe Roads; Safe Road Users - Reduces complexity - Reduces conflict points
Install Adaptive Signal Timing of Urban Traffic Signals	113	17	- Improves traffic flow	Safe Roads; Safe Road Users - Reduced rear-end speeds
Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	114	8	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	I16 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times
Increase Triangle Sight Distance	117 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles
Prohibit Right-Turn-On-Red	129	9	- Increases idling - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Mitigates crash angles - Separates users in time
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	BP3 PB	37	- Promotes active transportation	Safe Roads; Safe Road Users - Separates users in time
Install No Pedestrian Phase Feature with Flashing Yellow Arrow	BP4 P	43	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time

Reduce Right Turn Permissive Conflicts (right turn arrow)	BP5 PB	20	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
Install Urban Green Bike Lanes at Conflict Points	BP6 B	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points
Install Bike Signal	BP21 <sup>B</sup>	45	- Increases delay - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Reduces complexity
Prohibit Right-Turn-On-Red	BP25 PB	41	<ul> <li>Increases idling</li> <li>Promotes active transportation</li> </ul>	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
	Mediun	n-Cost Count	termeasures	
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
	High-	Cost Counte	rmeasures	
Median U-Turn Intersection Treatment	H1 FI	30	- Reduces delay - Requires modest out-of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

# OR 8 / SW 160th Avenue

## Location

ODOT Region 1 ODOT LRM # 02900100 Milepost 5.36

# **Intersection Type**

Urban | Signalized

# Safety

Crashes, 2015-2021							
K	Α	В	С	0			
0	3	10	29	25			

SPIS 2021 Percentile: 80%-85%





OR 8 Eastbound Approach



OR 8 Westbound Approach



SW 160<sup>th</sup> Avenue Southbound Approach



SW 160<sup>th</sup> Avenue Northbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Left Turn Lane
- Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
		Low-cost	countermeasures	
Add 3-inch yellow retroreflective sheeting to signal backplates	13	15	- No effect	Safe Roads; Safe Road Users - Increases visibility
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	16 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility
Replace Urban Permissive or Protected/Permissive Left Turns to Protected Only	19 LT	99	- Increases delay	Safe Roads; Safe Road Users - Reduces complexity - Reduces conflict points
Install Adaptive Signal Timing of Urban Traffic Signals	113	17	- Improves traffic flow	Safe Roads; Safe Road Users - Reduced rear-end speeds
Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	114	8	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	116 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times
Increase Triangle Sight Distance	117 <sup>Fl</sup>	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles
Install Advance Warning Signs (Signal Ahead)	122 <sup>A</sup>	35	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Prohibit Right-Turn-On-Red	Right-Turn-On-Red 129 9		- Increases idling - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Mitigates crash angles - Separates users in time
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	BP3 PB	37	- Promotes active transportation	Safe Roads; Safe Road Users - Separates users in time

Install No Pedestrian Phase Feature with Flashing Yellow Arrow	BP4 P	43	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
Reduce Right Turn Permissive Conflicts (right turn arrow)	BP5 PB	20	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points
Install Bike Signal	BP21 <sup>B</sup>	45	- Increases delay - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Reduces complexity
Prohibit Right-Turn-On-Red	BP25 PB	41	- Increases idling - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
		Medium-Co	ost Countermeasures	
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Dual/Double Left Turn Lanes	H63 FI	29	- Reduces delay	Safe Roads - Reduces rear-end speeds
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
		High-Cost	Countermeasures	
Median U-Turn Intersection Treatment	H1 <sup>fi</sup>	30	- Reduces delay - Requires modest out- of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

## OR 8 / SW 170th Avenue

## Location

ODOT Region 1 ODOT LRM # 02900100 Milepost 5.84

## **Intersection Type**

Urban | Signalized

#### Safety

Crashes, 2015-2021

	0:00:00, 20:0 202:								
K	Α	В	U	0					
0	0	6	28	25					

SPIS 2021 Percentile: 95%-100%





OR 8 Eastbound Approach



OR 8 Westbound Approach



SW 170<sup>th</sup> Avenue Southbound Approach



SW 170<sup>th</sup> Avenue Northbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Left Turn Lane
- ► Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed					
Low-cost countermeasures									
Improve Signal Hardware: Lenses, Reflectorized Back plates, Size, and Number	12	20% for 2; 25% for 3-4; 30% for 5-6	- No effect	Safe Roads; Safe Road Users - Increases visibility					
Add 3-inch yellow retroreflective sheeting to signal backplates	13	15	- No effect	Safe Roads; Safe Road Users - Increases visibility					
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	I6 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility					
Install Adaptive Signal Timing of Urban Traffic Signals	113	17	- Improves traffic flow	Safe Roads; Safe Road Users - Reduced rear-end speeds					
Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	114	8	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles					
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	I16 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times					
Increase Triangle Sight Distance	117 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles					
Prohibit Right-Turn-On-Red	129	9	- Increases idling - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Mitigates crash angles - Separates users in time					
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity					
Install Pedestrian Countdown Timer(s)	BP1 P	70	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity					
Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	BP3 PB	37	- Promotes active transportation	Safe Roads; Safe Road Users - Separates users in time					
Reduce Right Turn Permissive Conflicts (right turn arrow)	BP5 PB	20	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time					

Install Urban Green Bike Lanes at Conflict	BP6 <sup>B</sup> 39		- Promotes active	Safe Roads; Safe Road Users
Points	BL9 ₽	39	transportation	- Increases visibility (for bicyclist) - Emphasizes potential conflict points
Install Rika Signal	BP21 <sup>B</sup>	45	- Increases delay - Promotes active	Safe Roads; Safe Road Users - Reduces conflict points
Install Bike Signal	DFZI	45	transportation	- Reduces complexity
			- Increases idling	Safe Roads; Safe Road Users
Prohibit Right-Turn-On-Red	BP25 PB	41	- Promotes active	- Reduces conflict points
		0.10	transportation	- Separates users in time
	меан	im-Cost Cou	ntermeasures	
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Dual/Double Left Turn Lanes	H63 <sup>FI</sup>	29	- Reduces delay	Safe Roads - Reduces rear-end speeds
Increase Pavement Friction by Installing High Friction Surface Treatment	18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
	High	n-Cost Count	ermeasures	
Median U-Turn Intersection Treatment	H1 FI	30	- Reduces delay - Requires modest out- of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

# OR 8 / SW 198th Avenue

## Location

ODOT Region 1 ODOT LRM # 02900100 Milepost 7.28

## **Intersection Type**

Urban | Signalized

## Safety

Crashes, 2015-2021							
Κ	Α	В	C	0			
0	4	11	36	35			

SPIS 2021 Percentile: 95%-100%





OR 8 Eastbound Approach



OR 8 Westbound Approach



SW 198<sup>th</sup> Avenue Southbound Approach



SW 198<sup>th</sup> Avenue Northbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Left Turn Lane
- ► Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
	Low-cost c	ountermeas	sures	
Add 3-inch yellow retroreflective sheeting to signal backplates	13	15	- No effect	Safe Roads; Safe Road Users - Increases visibility
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	I6 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility
Replace Urban Permissive or Protected/Permissive Left Turns to Protected Only	19 LT	99	- Increases delay	Safe Roads; Safe Road Users - Reduces complexity - Reduces conflict points
Install Adaptive Signal Timing of Urban Traffic Signals	113	17	- Improves traffic flow	Safe Roads; Safe Road Users - Reduced rear-end speeds
Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	114	8	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	I16 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times
Increase Triangle Sight Distance	11 <i>7</i> FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles
Prohibit Right-Turn-On-Red	129	9	- Increases idling - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Mitigates crash angles - Separates users in time
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	BP3 PB	37	- Promotes active transportation	Safe Roads; Safe Road Users - Separates users in time
Install No Pedestrian Phase Feature with Flashing Yellow Arrow	BP4 P	43	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
Reduce Right Turn Permissive Conflicts (right turn arrow)	BP5 PB	20	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time

Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points
Install Bike Signal	BP21 <sup>B</sup>	45	- Increases delay - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Reduces complexity
Prohibit Right-Turn-On-Red	BP25 PB	41	- Increases idling - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
$\sim$	ledium-Cost	Counterme	easures	
Channelized Right Turn Lane with Raised Median	H6 <sup>FI</sup>	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Dual/Double Left Turn Lanes	H63 <sup>FI</sup>	29	- Reduces delay	Safe Roads - Reduces rear-end speeds
Increase Pavement Friction by Installing High Friction Surface Treatment	18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
	High-Cost C	ountermea	isures	
Median U-Turn Intersection Treatment	H1 <sup>FI</sup>	30	- Reduces delay - Requires modest out-of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

# SE 82<sup>nd</sup> Avenue / SE King Road

### Location

ODOT Region 1 ODOT LRM # 06800100 Milepost 8.3

## **Intersection Type**

Urban | Stop Controlled

## Safety

Crashes, 2015-2021

C1 031 103, 20 10 202 1							
K	Α	В	C	0			
0	0	0	1	4			

SPIS 2021 Percentile: 95%-100%





SE 82<sup>nd</sup> Avenue Northbound Approach



SE 82<sup>nd</sup> Avenue Southbound Approach



SE King Road Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 35 mph
- Right Turn Lane
- ► Thru Lanes ≥ 3

- Equity Disparity: High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
		Low-cost of	countermeasures	
Increase Triangle Sight Distance	11 <i>7</i> FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Install Urban Green Bike Lanes at Conflict Points	BP6 B	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points
	N	ledium-Cos	t Countermeasures	
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles
Curb Extensions	133	30	- No effect	Safe Roads; Safe Speeds; Safe Road Users - Reduces speeds - Reduces crossing complexity

# Region 2

# US 101 / SW Singing Tree Road

## Location

ODOT Region 2 ODOT LRM # 00900100 Milepost 128.48

## **Intersection Type**

Rural | Stop Controlled

## Safety

Crashes, 2015-2021

K	Α	В	С	0
0	0	1	2	1

SPIS 2021 Percentile: N/A





US 101 Southbound Approach



US 101 Northbound Approach



Singing Tree Road Eastbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane

- Left Turn Lane
- Equity Disparity: Medium High
- ▶ Bicycle Activity (Bike Lane Present)\*

<sup>\*</sup> ODOT statewide data notes bike lanes at this location where wide shoulders exist.

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed					
	Low-cost countermeasures								
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Increase Triangle Sight Distance	117 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles					
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times					
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times					
Provide "Stop Ahead" pavement markings	130	31	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times					
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
	Mediur	m-Cost Count	ermeasures						
Install Rural Median Acceleration Lane	H28 <sup>FI</sup>	45	- Reduces delay	Safe Roads; Safe Speeds - Mitigates crash angles - Reduces conflict points - Separates users in space					

Increase Pavement Friction by Installing High Friction Surface Treatment	I18 <sup>WR</sup>	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds		
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users		
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles		
High-Cost Countermeasures						
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds		
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	<ul> <li>Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles</li> </ul>	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles		

# OR 18 / Kreder Road

## Location

ODOT Region 2 ODOT LRM # 03900100 Milepost 51.73

## **Intersection Type**

Urban | Stop Controlled

## Safety

(	Crashe	es, 201	<u>5-202 l</u>	
Κ	Α	В	C	0

SPIS 2021 Percentile: 95%-100%





OR 18 Eastbound Approach



OR 18 Westbound Approach



Kreder Road Northbound Approach

[Street view not available]

Kreder Road Southbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 55 mph
- Right Turn Lane

- Left Turn Lane
- Thru Lanes ≥ 3
- Equity Disparity: Medium High
- AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed				
Low-cost countermeasures								
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility				
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles				
Increase Triangle Sight Distance	I17 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles				
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times				
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles				
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times				
Install Transverse Rumble Strips on Stop Controlled Approach(es)	127 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles				
	Medium-Cost	Counterme	asures					
Right Turn Lane on Single Major Road Approach: Unsignalized Intersection (3- or 4- leg)	H2	14	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)				
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)				

Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
	High-Cost C	Countermeas	ures	
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 FI	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Urban Traffic Signal	H22 <sup>A</sup> /H23 <sup>RE</sup>	67/-143	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 15-30% of Total Entering Traffic)	H26 <sup>FI</sup>	25	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)	H27 <sup>FI</sup>	33	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles

# Portland Road NE (OR 99E) / Hyacinth Street NE

### Location

ODOT Region 2 ODOT LRM # 08100100 Milepost 46.49

#### **Intersection Type**

Urban | Signalized

#### Safety

Crashes, 2015-2021

Κ	Α	В	С	0
0	2	15	51	35

SPIS 2021 Percentile: 90%-95%





Portland Road NE Southbound Approach



Portland Road NE Northbound Approach



Hyacinth Street NE Westbound Approach



Hyacinth Street NE Eastbound Approach

- ► Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Left Turn Lane
- ► Thru Lanes ≥ 4

- ► Equity Disparity: High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed			
Low-cost countermeasures							
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	I6 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility			
Replace Urban Permissive or Protected/Permissive Left Turns to Protected Only	19 <sup>LT</sup>	99	- Increases delay	Safe Roads; Safe Road Users - Reduces complexity - Reduces conflict points			
Install Adaptive Signal Timing of Urban Traffic Signals	113	17	- Improves traffic flow	Safe Roads; Safe Road Users - Reduced rear-end speeds			
Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	114	8	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles			
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	116 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times			
Left Turning Traffic Calming Treatments (Left Turn Wedge), Posted Speeds < 35 MPH	119 <sup>LT</sup>	10	- No effect	Safe Speeds; Safe Road Users - Reduces speeds			
Left Turning Traffic Calming Treatments (Hardened Centerline), posted speeds <35 MPH	120 <sup>LT</sup>	10	- No effect	Safe Speeds; Safe Road Users - Reduces speeds			
Prohibit Right-Turn-On-Red	129	9	<ul><li>Increases idling</li><li>Promotes active transportation</li></ul>	Safe Roads; Safe Road Users - Reduces conflict points - Mitigates crash angles - Separates users in time			
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity			
Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	BP3 PB	37	<ul> <li>Promotes active transportation</li> </ul>	Safe Roads; Safe Road Users - Separates users in time			
Install No Pedestrian Phase Feature with Flashing Yellow Arrow	BP4 P	43	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time			
Reduce Right Turn Permissive Conflicts (right turn arrow)	BP5 PB	20	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time			

Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	Promotes active transportation     Increases idling	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points Safe Roads; Safe Road Users
Prohibit Right-Turn-On-Red	BP25 PB	41	- Promotes active transportation	- Reduces conflict points - Separates users in time
	Med	ium-Cost C	ountermeasures	
Right Turn Lane on Both Major Road Approaches: Signalized Intersection (3- or 4-leg)	Н5	8	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Channelized Right Turn Lane with Raised Median	H6 <sup>FI</sup>	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
	Hig	ih-Cost Cou	untermeasures	
Median U-Turn Intersection Treatment	H1 <sup>FI</sup>	30	- Reduces delay - Requires modest out- of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points

# US 101 / NW 49th Street

## Location

ODOT Region 2 ODOT LRM # 00900100 Milepost 137.75

## **Intersection Type**

Urban | Stop Controlled

#### Safety

(	Crashes, 2015-2021						
Κ	Α	В	$\cap$	0			
0	0	2	2	1			
_							

SPIS 2021 Percentile: 10%-15%





OR 101 Northbound Approach



OR 101 Southbound Approach



NW 49<sup>th</sup> Street Eastbound Approach

[Street view not available]

NE Lucky Gap Street Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane
- ► Thru Lanes ≥ 3

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed					
	Low-cost countermeasures								
Install Lighting at Intersection	H29 <sup>N,Fl</sup> / ] <sup>N,Fl</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Increase Triangle Sight Distance	117 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles					
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times					
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times					
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points					
	Мес	dium-Cost Co	untermeasures						
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds					

Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 FI	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)

# OR 221 / Michigan City Lane NW

# Location

ODOT Region 2 ODOT LRM # 15000100 Milepost 17.57

## **Intersection Type**

Urban | Stop Controlled

#### Safety

Crashes, 2015-2021

01 d31103/ 2010 2021							
Κ	Α	В	U	0			
1	0	0	2	0			

SPIS 2021 Percentile: N/A





OR 221 Northbound Approach



OR 221 Southbound Approach



Michigan City Lane NW Eastbound Approach



Michigan City Lane NW Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane
- Left Turn Lane

- ► Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed		
Low-cost countermeasures						
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Increase Triangle Sight Distance	11 <i>7</i> FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles		
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 <sup>A</sup>	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points		
	M	edium-Cost C	Countermeasures			
Right Turn Lane on Single Major Road Approach: Unsignalized Intersection (3- or 4-leg)	H2	14	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)		
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds		

Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles
	I	High-Cost Co	untermeasures	
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Urban Traffic Signal	H22 <sup>A</sup> /H23 <sup>RE</sup>	67/-143	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles

# US 101 / Patriot Way

## Location

ODOT Region 2 ODOT LRM # 00900100 Milepost 9.87

## **Intersection Type**

Urban | Stop Controlled

#### Safety

Crashes, 2015-2021

K	Α	В	С	0
0	1	3	1	2

SPIS 2021 Percentile: 70%-75%





US 101 Southbound Approach



US 101 Northbound Approach



Patriot Way Eastbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 55 mph
- Right Turn Lane
- Left Turn Lane

- Thru Lanes ≥ 3
- ▶ Bicycle Activity (Bike Lane Present)\*
- AADT ≥ 10,000

 $<sup>^{*}</sup>$ ODOT statewide data notes bike lanes at this location where wide shoulders exist.

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed		
Low-cost countermeasures						
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility		
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Increase retroreflectivity of Stop signs	I23 A	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	125 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Install Transverse Rumble Strips on Stop Controlled Approach(es)	I27 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility		
		Medium-Cos	t Countermeasures			
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds		
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users		
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles		

High-Cost Countermeasures						
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 FI	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)		
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds		
Install Urban Traffic Signal	H22 <sup>A</sup> /H23 <sup>RE</sup>	67/-143	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles		

# Region 3

# US 101 / OR 38

## Location

ODOT Region 3 ODOT LRM # 00900100 Milepost 211.58

## **Intersection Type**

Rural | Signalized

## Safety

Crashes, 2015-2021						
Κ	Α	В	C	0		
^	•	)	•	-		

SPIS 2021 Percentile: N/A





US 101 Northbound Approach



US 101 Southbound Approach



OR 38 Westbound Approach



Port Dock Road Eastbound Approach

- Functional Classification: Arterial
- Left Turn Lane
- ► Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed		
Low-cost countermeasures						
Protected Left Turn - Split Side Street Signal Phasing	110 <sup>LT</sup>	70	- May increase delay	Safe Roads; Safe Road Users - Reduces complexity - Reduces conflict points		
Change from permissive only to FYA - permissive only	112 <sup>LT</sup>	50	- No effect	Safe Roads; Safe Road Users - Reduces complexity		
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	I16 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times		
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity		
Install Pedestrian Countdown Timer(s)	BP1 P	70	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity		
	Ме	edium-Cost C	ountermeasures			
Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)	H4	4	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)		
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)		
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles		
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds		
	H	ligh-Cost Co	untermeasures			
Median U-Turn Intersection Treatment	H1 FI	30	- Reduces delay - Requires modest out- of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity		

				Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

# **US 101 / 13th Street**

# Location

ODOT Region 3 ODOT LRM # 00900100 Milepost 211.91

# **Intersection Type**

Rural | Signalized

# Safety

Crashes, 2015-2021

Κ	Α	В	$\cup$	0
0	0	0	0	1

SPIS 2021 Percentile: N/A





US 101 Northbound Approach



US 101 Southbound Approach



13<sup>th</sup> Street Eastbound Approach



13<sup>th</sup> Street Westbound Approach

- Functional Classification: Arterial
- Left Turn Lane
- Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
	Lov	v-cost coun	termeasures	
Install Lighting at Intersection	H29 <sup>N,Fl</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Protected Left Turn - Split Side Street Signal Phasing	110 rt	70	- May increase delay	Safe Roads; Safe Road Users - Reduces complexity - Reduces conflict points
Change from permissive only to FYA - permissive only	112 <sup>LT</sup>	50	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Install Pedestrian Countdown Timer(s)	BP1 P	70	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Install Bike Signal	BP21 B	45	- Increases delay - Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Reduces complexity
	Medi	um-Cost Co	untermeasures	
Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)	H4	4	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Right Turn Lane on Both Major Road Approaches: Signalized Intersection (3- or 4-leg)	H5	8	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles

Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
	High	n-Cost Coun	termeasures	
Median U-Turn Intersection Treatment	H1 FI	30	- Reduces delay - Requires modest out- of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

# **US 101 / Winchester Avenue**

# Location

ODOT Region 3 ODOT LRM # 00900100 Milepost 212.05

# **Intersection Type**

Rural | Signalized

# Safety

Crashes, 2015-2021						
Κ	Α	В	$\cap$	0		

SPIS 2021 Percentile: 50%-55%





US 101 Northbound Approach



US 101 Southbound Approach



Winchester Avenue Westbound Approach

[Street view not available]

Winchester Avenue Eastbound Approach

- Functional Classification: Arterial
- Left Turn Lane
- Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
	Lo	w-cost cou	ntermeasures	
Install Lighting at Intersection	H29 <sup>N,Fl</sup> /I1 <sup>N,Fl</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Protected Left Turn - Split Side Street Signal Phasing	110 LI	70	- May increase delay	Safe Roads; Safe Road Users - Reduces complexity - Reduces conflict points
Change from permissive only to FYA - permissive only	112 <sup>LT</sup>	50	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	I16 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Install Bike Signal	BP21 <sup>B</sup>	45	<ul> <li>Increases delay</li> <li>Promotes active transportation</li> </ul>	Safe Roads; Safe Road Users - Reduces conflict points - Reduces complexity
	Меа	lium-Cost C	ountermeasures	
Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)	H4	4	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Right Turn Lane on Both Major Road Approaches: Signalized Intersection (3- or 4-leg)	H5	8	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)

Channelized Right Turn Lane with Raised Median	H6 <sup>FI</sup>	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 <sup>A,RE</sup>	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
	Hig	gh-Cost Cou	untermeasures	
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Median U-Turn Intersection Treatment	H1 FI	30	- Reduces delay - Requires modest out-of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

# OR 42 / OR 42S

# Location

ODOT Region 3 ODOT LRM # 03500100 Milepost 10.85

# **Intersection Type**

Rural | Stop Controlled

### Safety

Crashes, 2015-2021					
K	Α	В	C	0	
0	0	5	0	3	

SPIS 2021 Percentile: N/A





OR 42 Northbound Approach



OR 42 Southbound Approach



OR 42S Eastbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane
- Left Turn Lane

- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
	Lov	v-cost count	ermeasures	
Install Lighting at Intersection	H29 <sup>N,Fl</sup> /I1 <sup>N,Fl</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Install Transverse Rumble Strips on Stop Controlled Approach(es)	I27 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Provide "Stop Ahead" pavement markings	130	31	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
	Medio	um-Cost Cou	ntermeasures	
Install Rural Median Acceleration Lane	H28 <sup>FI</sup>	45	- Reduces delay	Safe Roads; Safe Speeds - Mitigates crash angles - Separates users in space
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles

Leadell / fl. and are also Defined Divide and				- Increases awareness of other users
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles
	High	n-Cost Count	termeasures termeasures	
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles

# US 199 / Hanby Lane

# Location

ODOT Region 3 ODOT LRM # 02500100 Milepost 28.19

# **Intersection Type**

Rural | Stop Controlled

### Safety

Crashes, 2015-2021

1/	<b>A</b>	, D		
K	Α	B	ر	)
0	0	0	0	3

SPIS 2021 Percentile: N/A





US 199 Northbound Approach



US 199 Southbound Approach



Hanby Lane Eastbound Approach



Hanby Lane Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
		Low-cost co	untermeasures	
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Increase Triangle Sight Distance	117 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Install Transverse Rumble Strips on Stop Controlled Approach(es)	I27 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
	M	edium-Cost (	Countermeasures	
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds

Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles
	I	High-Cost Co	ountermeasures	
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 <sup>FI</sup>	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 15-30% of Total Entering Traffic)	H26 <sup>Fl</sup>	25	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)	H27 <sup>Fl</sup>	33	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles

# OR 62 / OR 140

# Location

ODOT Region 3 ODOT LRM # 02200100 Milepost 6.03

# **Intersection Type**

Urban | Signalized

# Safety

Crashes, 2015-2021							
(	Α	В	$\cup$	0			
2	2	5	38	32			

SPIS 2021 Percentile: 95%-100%





OR 62 Northbound Approach



OR 62 Southbound Approach



OR 140 Eastbound Approach



OR 140 Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 55mph
- Left Turn Lane
- Thru Lanes ≥ 4

- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed				
	Low-cost countermeasures							
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	I6 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility				
Install Actuated Advance Warning Dilemma Zone Protection System at High Speed Signals (Microwave Detection)	114	8	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles				
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	116 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times				
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity				
Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	BP3 PB	37	- Promotes active transportation	Safe Roads; Safe Road Users - Separates users in time				
Install No Pedestrian Phase Feature with Flashing Yellow Arrow	BP4 P	43	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time				
Reduce Right Turn Permissive Conflicts (right turn arrow)	BP5 PB	20	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time				
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points				
Install Bike Signal	BP21 <sup>B</sup>	45	<ul> <li>Increases delay</li> <li>Promotes active transportation</li> </ul>	Safe Roads; Safe Road Users - Reduces conflict points - Reduces complexity				
Medium-Cost Countermeasures								
Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)	H4	4	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)				
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)				

Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
	Hig	ih-Cost Cou	ntermeasures	
Median U-Turn Intersection Treatment	H1 FI	30	- Reduces delay - Requires modest out-of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

# Region 4

# US 97 / US 26

# Location

ODOT Region 4 ODOT LRM # 36000100 Milepost 97.3

# **Intersection Type**

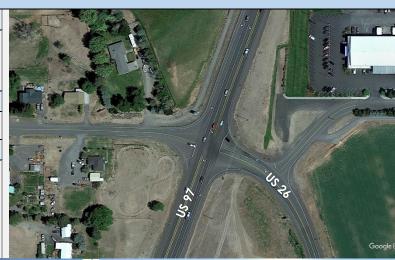
Rural | Stop Controlled

### Safety

Crashes, 2015-2021

Κ	Α	В	С	0
0	2	1	2	3

SPIS 2021 Percentile: N/A





US 97 Northbound Approach



US 97 Southbound Approach



SW Colfax Lane Eastbound approach



Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 55 mph
- Right Turn Lane
- Left Turn Lane

- Equity Disparity: Medium High
- ▶ Bicycle Activity (Bike Lane Present)\*
- ► AADT ≥ 10,000

 $<sup>^{\</sup>ast}$  ODOT statewide data notes bike lanes at this location where wide shoulders exist.

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed			
Low-cost countermeasures							
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility			
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Increase retroreflectivity of Stop signs	123 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Install Transverse Rumble Strips on Stop Controlled Approach(es)	127 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Provide "Stop Ahead" pavement markings	130	31	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility			
Medium-Cost Countermeasures							
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds			

Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles
	High	-Cost Counte	ermeasures	
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 <sup>FI</sup>	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles
Convert 4-Leg Intersection to Two 3- Leg Intersections (Minor St ADT is 15- 30% of Total Entering Traffic)	H26 <sup>FI</sup>	25	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles
Convert 4-Leg Intersection to Two 3- Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)	H27 <sup>Fl</sup>	33	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles

# US 97 / SW Iris Lane

# Location

ODOT Region 4 ODOT LRM # 00400100 Milepost 103.63

# **Intersection Type**

Rural | Stop Controlled

### Safety

Crashes, 2015-2021

K	Α	В	U	0			
0	1	0	0	1			

SPIS 2021 Percentile: N/A





US 97 Northbound Approach



US 97 Southbound Approach



SW Iris Lane Eastbound approach



SW Iris Lane Westbound approach

- Functional Classification: Arterial
- Max Posted Speed: 55 mph
- Right Turn Lane

- Left Turn Lane
- Equity Disparity: Medium High
- ► AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed			
	I	ow-cost cou	intermeasures				
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility			
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Increase retroreflectivity of Stop signs	123 A	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 <sup>^</sup>	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Install Transverse Rumble Strips on Stop Controlled Approach(es)	I27 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Provide "Stop Ahead" pavement markings	130	31	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility			
	Medium-Cost Countermeasures						
Right Turn Lane on Single Major Road Approach: Unsignalized Intersection (3- or 4-leg)	H2	14	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)			

Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)		
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds		
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users		
High-Cost Countermeasures						
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 FI	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)		
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds		
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	<ul> <li>Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles</li> </ul>	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles		

# US 26 / NE Cedar Street

### Location

ODOT Region 4 ODOT LRM # 05300100 Milepost 117.42

# **Intersection Type**

Urban | Stop Controlled

### Safety

Crashes, 2015-2021

0.0.0.00, 20.0 202.							
K	Α	В	C	0			
0	0	0	3	1			

SPIS 2021 Percentile: 20%-25%





US 26 Northbound Approach



US 26 Southbound Approach



NE Cedar Street Eastbound Approach



NE Cedar Street Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane
- Left Turn Lane

- Equity Disparity: High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
		Low-cost	countermeasures	
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Increase Triangle Sight Distance	117 <sup>FI</sup>	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Increase retroreflectivity of Stop signs	123 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	l25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points
		Medium-Co	ost Countermeasures	
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users

Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles
Curb Extensions	133	30	- No effect	Safe Roads; Safe Speeds; Safe Road Users - Reduces speeds - Reduces crossing complexity
		High-Cost	Countermeasures	
Install Roundabout from Minor Road Stop Control	H18 <sup>Fl</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Urban Traffic Signal	H22 <sup>A</sup> /H23 <sup>RE</sup>	67/-143	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles

# OR 39 / Crater Lake Parkway

# Location

ODOT Region 4 ODOT LRM # 02000100 Milepost 3.28

# **Intersection Type**

Urban | Signalized

### Safety

Crashes, 2015-2021

0.0.0.00, 20.0 202.							
Κ	Α	В	$\cup$	0			
0	2	8	22	23			

SPIS 2021 Percentile: 95%-100%





OR 39 Eastbound Approach



OR 39 Westbound Approach



Crater Lake Parkway Southbound Approach

- ► Functional Classification: Arterial
- Max Posted Speed: 50 mph
- Left Turn Lane
- Thru Lanes ≥ 4

- Equity Disparity: High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 25,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed					
Low-cost countermeasures									
Install Lighting at Intersection	H29 <sup>N,Fl</sup> / 1 <sup>N,Fl</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
Increase Signal Head Quantity - Additional Primary Head	15	28	- No effect	Safe Roads; Safe Road Users - Increases visibility					
Replace Incandescent Traffic Signal Bulbs with Light Emitting Diodes (LEDs)	16 RE	17	- No effect	Safe Roads; Safe Road Users - Increases visibility					
Install Adaptive Signal Timing of Urban Traffic Signals	113	17	- Improves traffic flow	Safe Roads; Safe Road Users - Reduced rear-end speeds					
Provide overhead lane-use signs	I31 RE	10	- No effect	Safe Roads; Safe Road Users - Reduces complexity					
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
Install Urban Leading Pedestrian or Bicycle Interval at Signalized Intersection	BP3 PB	37	- Promotes active transportation	Safe Roads; Safe Road Users - Separates users in time					
Install No Pedestrian Phase Feature with Flashing Yellow Arrow	BP4 P	43	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time					
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points					
Install Bike Signal	BP21 <sup>B</sup>	45	<ul> <li>Increases delay</li> <li>Promotes active transportation</li> </ul>	Safe Roads; Safe Road Users - Reduces conflict points - Reduces complexity					
		Medium-	Cost Countermeasures						
Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)	H4	4	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)					

Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds

# OR 380 / SE Juniper Canyon Road

# Location

ODOT Region 4 ODOT LRM # 38000100 Milepost 1.35

# **Intersection Type**

Urban | Stop Controlled

# Safety

Crashes, 2015-2021

Κ	Α	В	С	0
0	1	0	1	1

SPIS 2021 Percentile: 65%-70%





OR 380 Westbound Approach



OR 380 Eastbound Approach



SE Juniper Canyon Road Northbound Approach

- ► Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane

- Thru Lanes ≥ 3
- Equity Disparity: Medium High
- Bicycle Activity (Bike Lane Present)

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed					
Low-cost countermeasures									
Install Lighting at Intersection	H29 <sup>N,Fl</sup> /I1 <sup>N,Fl</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times					
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Provide Flashing Beacons at All-Way Stop Controlled Intersections	I24 <sup>A</sup>	28	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Install Transverse Rumble Strips on Stop Controlled Approach(es)	I27 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles					
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility					
	/	Medium-Cost	t Countermeasures						
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds					
		High-Cost C	Countermeasures						
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds					

# OR 126 / SW Reif Road

# Location

ODOT Region 4 ODOT LRM # 04100100 Milepost 7.84

# **Intersection Type**

Rural | Stop Controlled

# Safety

K	Α	В	С	0
0	0	0	3	1

SPIS 2021 Percentile: N/A





OR 126 Westbound Approach



OR 126 Eastbound Approach



SW Reif Road Northbound Approach



SW Reif Road Southbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 50 mph

- Equity Disparity: Medium High
- ► AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed			
Low-cost countermeasures							
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility			
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Increase Triangle Sight Distance	I17 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles			
Improve Intersection Warning with Markings and Signs	l21	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Increase retroreflectivity of Stop signs	I23 ^	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Install Transverse Rumble Strips on Stop Controlled Approach(es)	127 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Provide "Stop Ahead" pavement markings	130	31	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility			
	Mediu	m-Cost Cour	ntermeasures				

Right Turn Lane on Single Major Road Approach: Unsignalized Intersection (3- or 4-leg)	H2	14	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Right Turn Lane on Both Major Road Approaches: Unsignalized Intersection (3- or 4-leg)	НЗ	26	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Channelized Right Turn Lane with Raised Median	H6 <sup>FI</sup>	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Left Turn Lane on Single Major Road Approach: Rural, Unsignalized Intersection (3-leg)	Н9	44	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Left Turn Lane on Both Major Road Approaches: Rural, Unsignalized Intersection (4-leg)	H10	48	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Install Rural Median Acceleration Lane	H28 FI	45	- Reduces delay	Safe Roads; Safe Speeds - Mitigates crash angles - Separates users in space
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users

Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles				
	High-Cost Countermeasures							
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles				
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 15-30% of Total Entering Traffic)	H26 <sup>FI</sup>	25	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles				
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)	H27 <sup>Fl</sup>	33	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles				

# Region 5

#### US 26 / OR 201

#### Location

ODOT Region 5 ODOT LRM # 00700100 Milepost 265.97

#### **Intersection Type**

Rural | Signalized

#### Safety

Crashes,	2015-202

Κ	Α	В	U	0
0	0	0	0	2

SPIS 2021 Percentile: N/A





US 26 Eastbound Approach



US 26 Westbound Approach



OR 201 Northbound Approach

- Functional Classification: Arterial
- Left Turn Lane
- ► Thru Lanes ≥ 4

- Equity Disparity: Medium High
- ▶ Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
	Lo	w-cost cou	ntermeasures	
Install Actuated/Coordinated Flashing Beacons as Advance Warning for Signalized Intersections	116 RE	36	- No effect	Safe Roads; Safe Road Users - Mitigates crash angles - Increases reaction times
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Install No Pedestrian Phase Feature with Flashing Yellow Arrow	BP4 P	43	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces conflict points - Separates users in time
	Med	lium-Cost C	ountermeasures	
Right Turn Lane on Single Major Road Approaches: Signalized Intersection (3- or 4-leg)	H4	4	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Truck Priority System (Detection)	H62 A,RE	9	- Improves traffic flow	Safe Roads; Safe Road Users - Mitigates crash angles
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
	Hig	gh-Cost Cou	untermeasures	
Install Roundabout from Signalized Intersection	H19 <sup>FI</sup>	78	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

#### OR 11 / Banister Road

#### Location

ODOT Region 5 ODOT LRM # 00800100 Milepost 17.52

#### **Intersection Type**

Rural | Stop Controlled

#### Safety

Crashe	es, 201	5-2021	
			ī

0.000.000, 0.000.000							
Κ	Α	В	U	0			
0	0	2	0	1			

SPIS 2021 Percentile: 20%-25%





OR 11 Eastbound Approach



OR 11 Westbound Approach



Banister Road Northbound Approach

- ▶ Functional Classification: Arterial
- Max Posted Speed: 50 mph
- Right Turn Lane

- Left Turn Lane
- Equity Disparity: Medium High

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed			
Low-cost countermeasures							
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Install Transverse Rumble Strips on Stop Controlled Approach(es)	127 <sup>FA</sup>	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles			
Provide "Stop Ahead" pavement markings	130	31	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times			
		Medium-Cost	Countermeasures				
Increase Pavement Friction by Installing High Friction Surface Treatment	118 <sup>WR</sup>	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds			
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users			
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles			
		High-Cost C	Countermeasures				

Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles

#### OR 11 / 3rd Street

#### Location

ODOT Region 5 ODOT LRM # 00800100 Milepost 16.43

#### **Intersection Type**

Rural | Stop Controlled

#### Safety

Crashes	2015-202
Ciusiies,	2013-202

Κ	Α	В	U	0
0	0	0	0	1

SPIS 2021 Percentile: N/A





OR 11 Eastbound Approach



OR 11 Westbound Approach



3<sup>rd</sup> Street Southbound Approach

[Street view not available]

Brooks Road Northbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 50 mph
- Right Turn Lane

- Left Turn Lane
- Equity Disparity: Medium High

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed
		Low-cost of	countermeasures	
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Increase Triangle Sight Distance	117 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Install Transverse Rumble Strips on Stop Controlled Approach(es)	I27 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
		Medium-Cos	st Countermeasures	
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users

Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	l28	15	- No effect	Safe Roads - Mitigates crash angles
		High-Cost	Countermeasures	
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	- Increases delay for major street through vehicles, but may reduce delay for minor street and turning vehicles	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 15-30% of Total Entering Traffic)	H26 <sup>Fl</sup>	25	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles
Convert 4-Leg Intersection to Two 3-Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)	H27 <sup>Fl</sup>	33	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles

#### OR 331 / Wildhorse Boulevard

#### Location

ODOT Region 5 ODOT LRM # 33100100 Milepost 3.72

#### **Intersection Type**

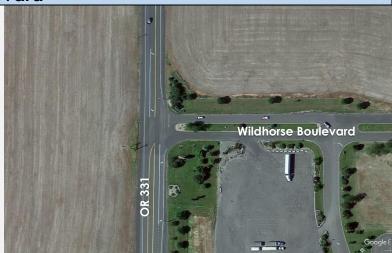
Rural | Stop Controlled

#### Safety

Cras	hes,	201	5-	-20	2

Κ	Α	В	С	0
0	0	0	0	1

SPIS 2021 Percentile: N/A





OR 331 Northbound Approach



OR 331 Southbound Approach



Wildhorse Boulevard Westbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 45 mph
- Right Turn Lane

- Left Turn Lane
- Equity Disparity: High

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed		
Low-cost countermeasures						
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility		
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Increase Triangle Sight Distance	I17 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles		
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Install Transverse Rumble Strips on Stop Controlled Approach(es)	127 FA	25	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Provide "Stop Ahead" pavement markings	130	31	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Install Wrong Way Driving Countermeasures: Signing, Pavement markings, Geometric Modifications, and ITS Technologies (see Table 3.1 in Wrong-	132	20%: for 2; 30%: for 3; 40%: for ≥ 4	- No effect	Safe Roads - Reduces complexity		

· · · · · · · · · · · · · · · · · · ·		I		
Way Driving Analysis and Recommendations Final Report)				
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility
	Medium	-Cost Count	ermeasures ermeasures	
Channelized Right Turn Lane with Raised Median	H6 <sup>FI</sup>	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Install Rural Median Acceleration Lane	H28 <sup>FI</sup>	45	- Reduces delay	Safe Roads; Safe Speeds - Mitigates crash angles - Separates users in space
Increase Pavement Friction by Installing High Friction Surface Treatment	I18 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
	High-C	Cost Counter	measures	
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 FI	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Rural Traffic Signal	H24 <sup>A</sup> /H25 <sup>RE</sup>	77/-58	- Increases delay for major street through vehicles, but may reduce delay for	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if

	minor street and turning	converting from TWSC)
	vehicles	- Mitigates crash angles

#### OR 207 / NE McNary Street

#### Location

ODOT Region 5 ODOT LRM # 33300100 Milepost 6.93

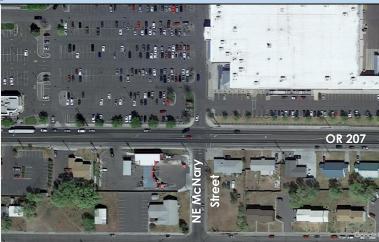
#### **Intersection Type**

Urban | Stop Controlled

#### Safety

Crashes, 2015-2021						
Κ	Α	В	C	0		
0	0	0	3	7		

SPIS 2021 Percentile: 25%-30%





OR 207 Eastbound Approach



OR 207 Westbound Approach



NE McNary Street Northbound Approach



NE McNary Street Southbound Approach

- Functional Classification: Arterial
- Right Turn Lane
- Left Turn Lane
- ► Thru Lanes ≥ 3

- Equity Disparity: High
- Bicycle Activity (Bike Lane Present)
- Pedestrian Activity (Sidewalk Present)
- ► AADT ≥ 10,000

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed		
	Low-cost countermeasures					
Increase Triangle Sight Distance	I17 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles		
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Increase retroreflectivity of Stop signs	I23 <sup>A</sup>	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	I25 <sup>A</sup>	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility		
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points		
	Med	lium-Cost Co	untermeasures			
Right Turn Lane on Single Major Road Approach: Unsignalized Intersection (3- or 4-leg)	H2	14	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)		
Right Turn Lane on Both Major Road Approaches: Unsignalized Intersection (3- or 4-leg)	НЗ	26	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)		
Channelized Right Turn Lane with Raised Median	H6 FI	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)		

Increase Pavement Friction by Installing High Friction Surface Treatment	I18 <sup>WR</sup>	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
Curb Extensions	133	30	- No effect	Safe Roads; Safe Speeds; Safe Road Users - Reduces speeds - Reduces crossing complexity
	Hig	ıh-Cost Coun	termeasures	
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds

#### OR 11 / Crockett Road

#### Location

ODOT Region 5 ODOT LRM # 00800100 Milepost 33.53

#### **Intersection Type**

Urban | Stop Controlled

#### Safety

Crashes, 2015-2021

		,		
K	Α	В	C	0
0	4	3	6	3

SPIS 2021 Percentile: 95%-100%





OR 11 Northbound Approach



OR 11 Southbound Approach



East Crockett Road Westbound Approach



Crockett Road Eastbound Approach

- Functional Classification: Arterial
- Max Posted Speed: 50 mph
- ► Thru Lanes ≥ 4

- Equity Disparity: Medium High
- ▶ Bicycle Activity (Bike Lane Present)\*
- ► AADT ≥ 10,000

<sup>\*</sup> ODOT statewide data notes bike lanes at this location where wide shoulders exist.

Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed		
	Low-cost countermeasures					
Install Lighting at Intersection	H29 <sup>N,FI</sup> /I1 <sup>N,FI</sup>	38	- No effect	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility		
Install Flashing Beacons as Advance Warning at Intersections (Not Coordinated with Signal Timing)	115	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Increase Triangle Sight Distance	117 FI	48	- No effect	Safe Roads; Safe Road Users - Increases time to process information - Increases visibility - May mitigate crash angles		
Improve Intersection Warning with Markings and Signs	121	20% for 1-2; 25% for 3-4; 30% for 5-7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Increase retroreflectivity of Stop signs	I23 ^	7	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles		
Provide Flashing Beacons at Minor Road Stop Controlled Intersections	l25 ^	13	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases reaction times		
Provide Intersection Lighting (Bike & Ped)	BP2 PBN,FI	42	- Promotes active transportation	Safe Roads; Safe Road Users - Reduces complexity - Increases visibility		
Install Urban Green Bike Lanes at Conflict Points	BP6 <sup>B</sup>	39	- Promotes active transportation	Safe Roads; Safe Road Users - Increases visibility (for bicyclist) - Emphasizes potential conflict points		
	Medium-Cost Countermeasures					
Right Turn Lane on Single Major Road Approach: Unsignalized Intersection (3- or 4-leg)	H2	14	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)		

Right Turn Lane on Both Major Road Approaches: Unsignalized Intersection (3- or 4-leg)	Н3	26	- Reduces congestion	Safe Roads - Reduces rear-end speeds - Reduces conflict points for major road (increases for minor)
Channelized Right Turn Lane with Raised Median	H6 <sup>FI</sup>	35	- Reduces congestion	Safe Roads - Reduces conflict points for major road (increases for minor)
Increase Pavement Friction by Installing High Friction Surface Treatment	118 WR	57	- No effect	Safe Roads - Reduces rear-end speeds - Reduces wet-weather crash speeds
Provide Actuated Flashing Beacons Triggered by Approaching Vehicles at Unsignalized Intersections	126	27	- No effect	Safe Roads; Safe Road Users - Reduces rear-end speeds - Mitigates crash angles - Increases awareness of other users
Install 6 ft. or greater Raised Divider on Stop Approach (Splitter Island)	128	15	- No effect	Safe Roads - Mitigates crash angles
	High	n-Cost Counte	ermeasures	
Median U-Turn Intersection Treatment	HI FI	30	- Reduces delay - Requires modest out-of-direction travel	Safe Roads - Mitigates crash angles - Reduces complexity Safe Road Users - Reduces conflict points
Channelized Left Turn Lane with Raised Median on All Approaches (3- or 4-leg)	H17 <sup>FI</sup>	27	- Reduces congestion	Safe Roads - Reduces complexity for major road (but may increase for minor road)
Install Roundabout from Minor Road Stop Control	H18 <sup>FI</sup>	82	- Improves traffic flow - Reduces congestion	Safe Roads; Safe Speeds; Safe Road Users - Reduces conflict points - Reduces complexity - Mitigates crash angles - Reduces speeds
Install Urban Traffic Signal	H22 <sup>A</sup> /H23 <sup>RE</sup>	67/-143	- Increases delay for major street through vehicles, but may reduce delay for minor	Safe Roads; Safe Speeds; Safe Road Users - Reduces complexity - Reduces speeds (if converting from TWSC) - Mitigates crash angles

			street and turning vehicles	
Convert 4-Leg Intersection to Two 3- Leg Intersections (Minor St ADT is 15- 30% of Total Entering Traffic)	H26 <sup>FI</sup>	25	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles
Convert 4-Leg Intersection to Two 3- Leg Intersections (Minor St ADT is 30% + of Total Entering Traffic)	H27 <sup>Fl</sup>	33	- Reduces delay	Safe Roads - Reduces conflict points - Mitigates crash angles

Attachment C City of Salem Case Study

# echnical Memorandum

September 13, 2023 Project# 27003.022

Christi McDaniel-Wilson, State Traffic Safety Engineer, ODOT To:

Jiguang Zhao, Traffic Safety Engineer, ODOT

From: Katie Popp, Nick Foster, AICP, RSP1, Matt Braughton, RSP1, Pete Jenior, PE, PTOE

CC: **ODOT Technical Advisory Committee** 

RE: ODOT Intersection Safety Implementation Plan Update - City of Salem Case Study

### CITY OF SALEM CASE STUDY

The Oregon Intersection Safety Implementation Plan Update is intended to be implementable at the statewide, ODOT Region, and local agency levels. As such, the project team conducted a case study application of the characteristics-based analysis at the local agency level using City of Salem data. The case study demonstrates key considerations that ODOT Regions and local agencies may encounter when implementing the characteristics-based process developed as part of the Plan. The application of this project's methods and these considerations are discussed below.

## Study Network and Available Data

The City's GIS database includes most of the data required to conduct the intersection screening analysis using the characteristics-based process. Remaining data needs were fulfilled by data available from ODOT. A summary of the data sources for each screening factor is shown in Table 1.

Table 1. City of Salem Case Study Data Sources

Characteristic	Data Source	Considerations <sup>1</sup>
Intersection Type	City of Salem (COS_Intersections, COS_SignalizedIntersections, COS_StopSigns)	The COS_Intersections layer did not have traffic control type defined. Therefore, the COS_SignalizedIntersections were used to define signalized intersections and the COS_StopSigns were used to identify stop-controlled intersections. Intersections without a signal nearby or a stop sign were assumed to also be stop signs.
Functional Class	City of Salem (COS_FunctionalClass)	Joined functional class for all intersection approaches using a search radius of 50 feet.  Maximum functional class was used for the analysis.
AADT	ODOT 2021 AADT	Joined AADT for all intersection approaches using a search radius of 50 feet. Maximum AADT was used for the analysis.
On a Ramp Terminal	Kittelson – Manual Assignment	Determined manually via reviewing aerial photography (Google Earth).
Posted Speed	City of Salem (COS_Centerlines)	Joined posted speed for all intersection approaches using a search radius of 50 feet.  Maximum posted speed was used for the analysis.

Characteristic	Data Source	Considerations <sup>1</sup>
Left Turn Lane/ Right Turn Lane	City of Salem (COS_TurnLane)	The dataset provided by Salem includes point data for all striped arrows within the city. Intersections were assigned a turn lane if a turn lane arrow was present within a 100-foot radius around the intersection point. This process may sometimes incorrectly assign a turn lane to an intersection just downstream of another intersection's turn lane.
Number of Through Lanes	City of Salem (COS_Centerlines)	Joined number of through lanes for all intersection approaches using a search radius of 25 feet.  Maximum number of through lanes was used for the analysis.
Presence of a Bike Lane	City of Salem (COS_BikeRoutes)	Joined bicycle data for all intersection approaches using a search radius of 100 feet. Lines for bike routes were not consistent with the centerlines layer. Shared lane markings and Family Friendly Bikeways were included in the search.
Presence of a Sidewalk	City of Salem (COS_Sidewalks)	Determined by the presence of a sidewalk within six feet of an intersection. This distance was selected based on reviewing distance of intersection points to the outer edge of intersection where sidewalk lines were located. A distance less than 65' may not capture all intersections with a sidewalk in their vicinity, whereas a distance threshold too large may incorrectly assign presence of a sidewalk to an intersection without one.
Equity	City of Salem Equity Data (Census Tract Level)	Tracts that scored 15 points and above are scored the same as the Medium-High and High Equity Disparity levels defined by the ODOT Social Equity Index.
Federal Aid Urban Boundaries (FAUB)	Federal Aid Urban Boundaries Data	Not a screening characteristics but used to clarify intersections as urban or rural. All intersections in Salem's urban growth boundary are classified as Urban.

Search radius differed depending on the GIS layer that was used to join the data. Layers with larger search radii had linework that was generally farther away from the centerlines layer, which was used to create the intersections.

#### **Data Screening**

The project team screened the COS\_Intersections layer and removed the following:

- Intersection nodes that were incorrectly defined as intersections. These incorrect nodes were locations where COS\_Centerlines merged, diverged, and crossed at locations other than intersections (e.g., at bridges).
- Intersection nodes with less than three legs (defined by the field WAY\_COUNT).

Overall, 3,745 stop controlled intersections and 232 signalized intersections in Salem were analyzed. There are 16 intersections at ramp terminals in Salem, nine which are on Interstate 5 (I-5), five on Salem Dallas Hwy (OR22), and two on North Santiam Hwy (OR99E). Therefore, intersections on a ramp terminal were excluded from the analysis due to the limited number of these types of intersections in Salem.

#### Comparison to ODOT Network Screening Methodology

#### **Bicycle Facilities**

In the screening characteristics identification process, the presence of a bicycle lane based on ODOT data was used as a surrogate for bike volumes. Shared facilities were not included in the ODOT data used to develop the screening characteristics. However, the project team determined that including these facilities would be appropriate at the local level because they are expected to have higher bicycle traffic similar to how a highway with bike lanes may have higher bike volumes than a highway without one. For Salem, shared bicycle facilities include Family Friendly Bikeways (FFB) and streets with shared lane markings.

#### One-Way Streets

Intersection data available from ODOT did not include directionality (e.g., one- or two-way) data for all intersection traffic control types. Therefore, directionality was not considered in the statewide ODOT network screening. At a local level, it may be more feasible to include directionality as an additional screening factor if an agency is searching for locations for a specific intersection treatment. The City of Salem could include this as an additional screening factor since they have directionality data.

#### **Data Coverage**

The City of Salem GIS database included most of the data items that could be used to conduct screening characteristics analysis. Salem's data included public roadways in the city except for most private roads and local streets/alleys in the dense residential areas. The ODOT AADT data covered most arterials and collectors in Salem. Because of this AADT coverage, and Salem having speed limit and number of lanes data, functional classification was not included in the final screening score<sup>1</sup>.

Some of the minor differences between data coverage include:

- Intersection Data The City of Salem has intersection, traffic signals, and stop signs datasets. Therefore, all signalized intersections and all stop-controlled intersections on arterials and collectors were included in the Salem analysis.
- Turn Lane Data Format The City of Salem has turn lanes in a point format at each painted turn lane arrow, whereas ODOT has turn lane data in a linear format representing the length of a turn lane.
- Bicycle Facility Data The City of Salem bicycle facility data is more detailed than the ODOT network screening data and contains more types (i.e., Family Friendly Bikeways, shared lane markings, cycle tracks, unpaved paths, and shared use paths). As discussed, shared facilities were included in the analysis in addition to separated bicycle facilities such as bike lanes, cycle tracks, and shared use paths.

#### Ramp Terminals

The City of Salem only has a few intersections at ramp terminals, so they were excluded from the screening analysis. At the local level, any intersection improvements at ramp terminals would likely be assessed on a case-by-case basis and would necessitate coordination with ODOT.

<sup>&</sup>lt;sup>1</sup> As discussed in Technical Memorandum #1, functional classification is likely a surrogate for number of lanes, speed, and volume. Therefore, it should only be used when one or more of these datasets are missing.

#### **Equity Index**

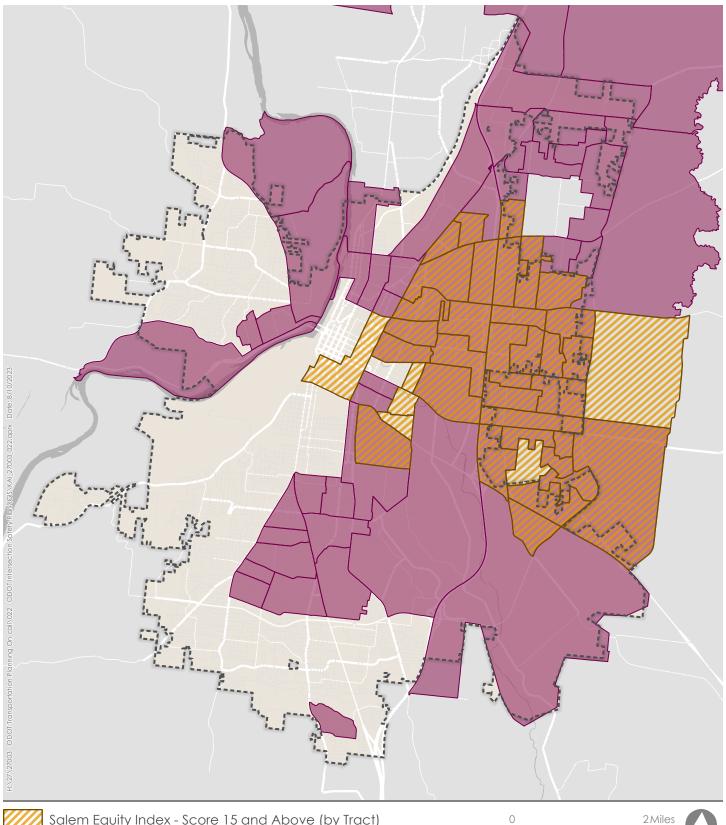
The City of Salem case study used Salem's city-specific equity index to identify areas with high equity disparity. The Salem equity index broadly uses the same population demographic factors as the ODOT Social Equity Index (SEI) from the American Community Survey (ACS) data to calculate the equity index <sup>2</sup>. The two indexes differ in the weighting of factors and the subsets of population groups included in the calculation (e.g., Salem's calculation includes a category for persons 65 years or older with a disability, whereas the SEI includes persons aged 20 to 64 to that have a disability). Additionally, the Salem index is at the Census Tract level, whereas the ODOT index evaluates at the Census Block Group level. Additionally, the Salem equity index uses a 25-point scoring system, whereas the ODOT screening uses a different scoring system that assigns equity based on categories like "High Equity Disparity". The project team along with the City of Salem determined that an equity score of 15 or greater would align with "medium-high" or "high" equity disparity defined by the ODOT Social Equity Index.

A comparison of the ODOT equity index versus the City of Salem equity index data coverage is shown in Figure 1. As displayed, census tracts scoring 15 or higher based on the Salem equity index results in lower coverage, which better targets areas of higher equity disparity. However, because Salem uses Census Tracts, the coverage also expands further beyond Block Groups used by ODOT, including some areas outside of the City boundary to the east.

#### Characteristics-Based Analysis Results

Each intersection was scored using the screening characteristics weights defined in *Technical Memorandum #2: Network Screening*. The rural screening weights did not apply to intersections in the City of Salem dataset. The top scoring signalized intersections and stop controlled intersections are provided in Table 2. Intersections scoring in the top 10% of the analysis are displayed in Figure 2. A full list of intersections scoring in the top 10% of the analysis is in Appendix A.

<sup>&</sup>lt;sup>2</sup> The Salem Equity Tool (Beta Version) uses 2016-2020 ACS data and ODOT SEI uses 2017-2021 data.





ODOT Social Equity Index - High and Medium-High Equity Disparity (by Block Group)

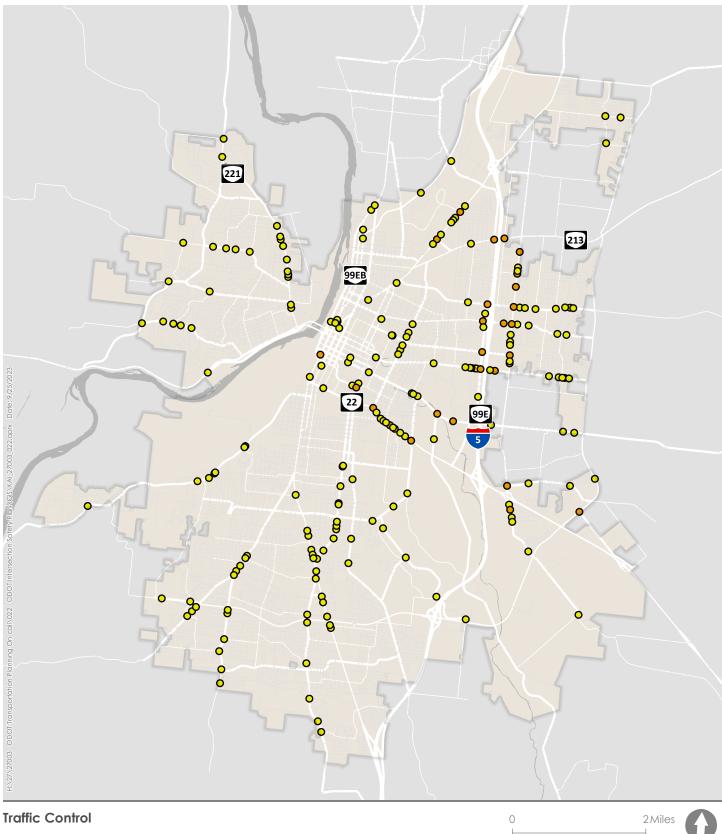
City of Salem



Figure 1

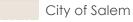
Table 2. Top-Scoring Intersections by Traffic Control Using Characteristics-Based Method

Intersection	Screening Score				
Signalized					
25th St SE & Mission St SE	8.03				
Cordon Rd SE & Gaffin Rd SE	7.05				
Fisher Rd NE & Silverton Rd NE	7.03				
Bill Frey Dr NE & Portland Rd NE	7.03				
Airport Rd SE & State St	7.03				
Hawthorne Av NE & Silverton Rd NE	7.03				
Hawthorne Av NE & Sunnyview Rd NE	7.03				
Geer Dr NE & State St	7.03				
Carson Dr SE & Lancaster Dr SE	7.03				
Lancaster Dr SE & Rickey St SE	7.03				
Stop Controlled					
Hawthorne Av NE & Weston Ct NE	9.89				
Boone Rd SE & Commercial St SE	9.33				
12th St Cutoff SE & Oakhill Av SE	9.33				
Barnes Av SE & Commercial St SE	9.33				
Doaks Ferry Rd NW & Wallace Rd NW	9.33				
Hines St SE & Mission St SE	9.05				
21st St SE & Mission St SE	9.05				
23rd St SE & Mission St SE	9.05				
12th St SE & Mill St SE	8.89				
Commercial St SE & Ratcliff Dr SE	8.84				
Liberty Rd S & Marietta St SE	8.84				
Hyacinth St NE & Mainline Dr NE	8.84				
Front St NE & Front St NE (99E)	8.84				
Liberty Rd S & Pembrook St SE	8.84				
12th St SE & Vista Av SE	8.84				



Traffic Signal

Stop Control





& ASSOCIATES

Figure 2

Characteristics-Based Screening Results Top 10% by Traffic Control (Excluding Ramps) City of Salem

There are several groupings of top 10% intersections along major corridors in Salem, including:

- A concentration of top 10% stop-controlled intersections on Mission Street, Center Street, 17th Street, Sunnyview Road, Liberty Road, Commercial Street, and OR 221.
- A concentration of top 10% signalized intersections on Mission Street, Hawthorne Avenue, and Lancaster Drive.

#### Key Takeaways – City of Salem Intersection Data

The project team reviewed the characteristics of the top 10% intersections in Salem to the characteristics of the top 10% of intersections in the ODOT network screening. Table 3 summarizes this comparison. Exhibits showing these comparisons are provided in Appendix B.

Observations from the comparison to the top 10% of the statewide ODOT network screening include:

- Signalized intersections:
  - There is a higher representation of intersections with AADT between 10,000 and 25,000, likely attributed to the limited number of roadways with greater than 25,000 AADT in the City of Salem.
  - Higher representation of principal arterials, interactions with four legs, and intersections with right-turn lanes.
  - o Posted speeds are generally lower in the Salem data compared to the ODOT data.
- Stop controlled intersections:
  - Higher representation of minor arterials, intersections with three legs, and intersections with right-turn lanes.
  - o Posted speeds are generally lower in the Salem data compared to the ODOT data.

Table 3. Common Characteristics in Characteristics-Based Top 10% for the City of Salem

	Urban Signals		Urban Stop Controlled	
Characteristic	Salem	ODOT	Salem	ODOT
Highest Functional Classification				
Local	4%	0%	<1%	0%
Minor Arterial	0%	4%	32%	10%
Major Collector	0%	0%	1%	<1%
Principal Arterial <sup>1</sup>	96%	92%	65%	88%
Other Freeways and Expressways	0%	4%	<1%	1%
AADT				
<1,000	0%	0%	0%	0%
Between 1,000 and 10,000	0%	<1%	31%	12%
Between 10,000 and 25,000	69%	29%	49%	74%
Between 25,000 and 40,000	27%	65%	18%	13%
>40,000	4%	5%	2%	<1%
Number of Legs				
3 Legs	23%	28%	75%	65%
4+ Legs	77%	72%	23%	31%
Number of Lanes				
1	0%	0%	0%	46%
2	4%	0%	8%	8%
3	4%	0%	37%	36%
4+	92%	100%	54%	12%
Turn Lanes				
Left-Turn Lane Present	100%	100%	19%	65%
Right-Turn Lane Present	46%	31%	64%	53%
Max Posted Speed				
20 mph	0%	0%	0%	0%
25 mph	0%	0%	7%	<1%
30 mph	4%	0%	10%	3%
35 mph	50%	29%	38%	31%
40 mph	31%	16%	22%	8%
45 mph	11%	45%	22%	22%
50 mph	0%	5%	1%	8%
55 mph (or greater) <sup>3</sup>	4%	5%	<1%	27%
Salem Equity Score ≥ 15	85%	100%2	62%	76% <sup>2</sup>
Bike Lane Present	100%	100%	94%	23%
Sidewalk Present	92%	100%	98%	66%

<sup>&</sup>lt;sup>1</sup>Roadways classified as "Parkway" in the Salem database were combined with Principal Arterials for comparison purposes.

<sup>&</sup>lt;sup>2</sup>ODOT Equity Index based on "Medium-High" or "High" Equity disparity.

<sup>&</sup>lt;sup>3</sup>Maximum speed in Salem was 55 MPH

# Example Application – Intersection Prioritization for Safety Countermeasures

The project team conducted an example application of the characteristic-based screening to support the City of Salem in identifying high-priority intersections for All Roads Transportation Safety Program (ARTS) applications. The screening scores can be used to prioritize intersections with similar characteristics, such as bicycle lane/ right-turn conflicts and lighting within those conflict zones.

The City of Salem identified green pavement markings (ODOT crash reduction factor (CRF) BP6) as a possible systemic intersection safety treatment at signalized intersections with bicycle lanes that cross over right-turn lanes). If there isn't a dedicated right-turn lane, green pavement markings can be applied through the intersection to highlight potential bicycle lane conflicts with right-turning vehicles. Additional lighting at these conflict points (ODOT CRF BP2) will also be considered if existing lighting is insufficient.

To identify potential intersections to prioritize for these treatments, the project team conducted the following steps using GIS software:

- Identified a sub-group of the study intersection dataset that includes signalized intersections with bike lane and right-turn conflicts by filtering the study intersections dataset with the following characteristics:
  - a. Signalized intersection
  - b. Bike lanes present on at least one leg
  - c. Right turn lane present on at least one leg
- 2. Sorted the sub-group (190 intersections) by the screening score.
- 3. Reviewed the following characteristics for each approach at intersections in the sub-group scoring in the top 50% of the screening analysis:
  - a. Presence of a bike lane and a dedicated right-turn lane conflict point (i.e., the point where right-turn traffic must cross the bike lane to enter the right-turn lane prior to the intersection)
  - b. Presence of a bike lane and a through-right turn lane conflict (i.e., the point where a right-turning vehicle turns across the path of people biking in the intersection)
  - c. Presence of lighting at each conflict point<sup>3</sup>

The project team reviewed characteristics of the 190 intersections in an Excel spreadsheet that will be provided to the City. The spreadsheet includes lighting and bicycle lane/right-turn conflict information for each approach. For example, the Cordon Road SE/Gaffin Road SE in Salem shown in Figure 3 demonstrates a scenario where green pavement markings could be added to the area where right-turning vehicles cross the bike lane (see the red box) on the northeast leg. The City can also apply green pavement markings through the intersection to highlight the potential conflict between right-turning vehicles and cyclists in the bike lane on Cordon Road. The intersection may also benefit from additional lighting on the northeast leg to illuminate the conflict point.

Kittelson & Associates, Inc.

<sup>&</sup>lt;sup>3</sup> City of Salem provided light pole data. Lighting was not used in the screening analysis since there ODOT does not maintain a comprehensive lighting database that could have been used to develop a score for the presence/absence of lighting.

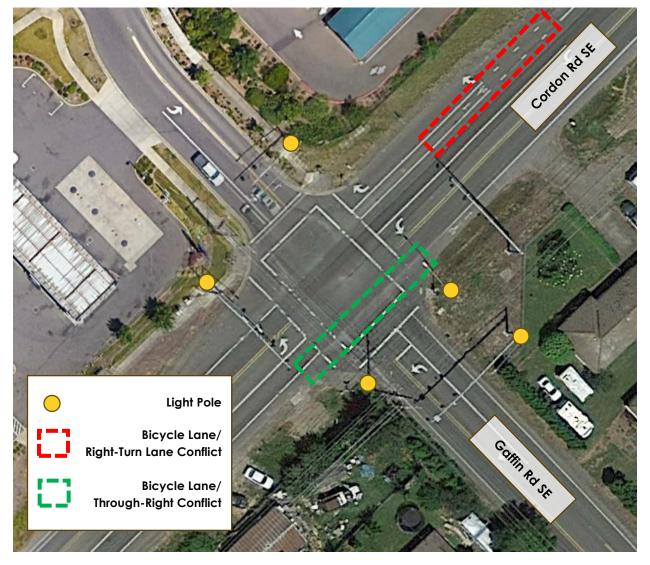


Figure 3. Cordon Road SE & Gaffin Rd SE in Salem, OR

As another example, the Center Street NE/Lancaster Drive NE intersection, shown in Figure 4, has bike lanes on all four approaches. The City can implement green pavement markings (CRF BP6) at the bicycle lane and dedicated right-turn conflict on the west leg. For the remaining legs, the City can apply green pavement markings through the intersection to highlight the potential conflict between right-turning vehicles and people biking. The intersection may benefit from additional lighting (CRF BP2) to illuminate conflicts on the northeast and southeast corners.

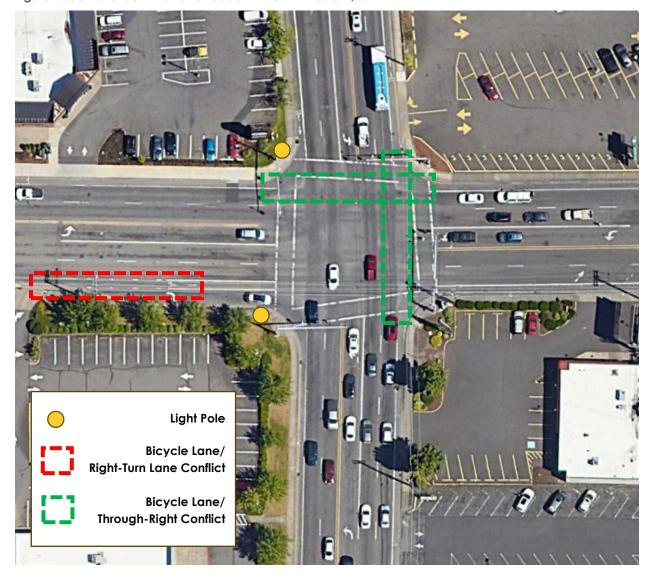


Figure 4. Center Street NE and Lancaster Drive NE in Salem, OR

#### Salem Next Steps

The project team provided the City with a spreadsheet that includes the 190 intersections in the sub-group with information about lighting and right-turn/bike lane conflict points. The City can use this spreadsheet to support their next ODOT ARTS application. To effectively incorporate this information into the application, the project team recommends the following next steps for the City:

- 1. Review the project team's findings and confirm the lighting assessment.
- 2. Develop cost estimates for each site based on the expected level of treatment and number of applicable approaches.
- 3. Determines which sites to move forward in the grant application based on anticipated budget and the grant funding request.
- 4. Calculate the cost-effectiveness index (CEI) for the selected sites and adjust the included sites as necessary to develop a competitive application.
- 5. Complete ARTS application.

# Considerations for Application of the Characteristics-Based Analysis Approach

#### Software and Staffing

- The characteristics-based screening requires knowledge of GIS software to spatially assign data to a single intersection layer.
  - o GIS capabilities may also include the ability to create and perform quality control on an intersection layer if the agency does not already have one.
  - The screening calculations can be completed within GIS software, or the results can be exported to a spreadsheet and calculated in spreadsheet software (e.g., Microsoft Excel).

#### **Data Availability**

- Some data management and preparation may be required to assign roadway characteristics to intersections.
  - Intersection traffic control may not be available in many cities. In smaller cities, the lack of traffic control data may be easily overcome by manually assigning signals, which are likely few. For larger cities, the time required to manually assign intersections may impact feasibility of conducting the network screening depending on available resources/ staffing. Open-source data sources like OpenStreetMap may be used to assist in identifying signalized intersection locations.
  - Many cities or counties may not have turn lanes, sidewalks, bicycle lanes, or other roadway characteristic data used in the screening process. The analysis can be completed without this data by omitting these factors from the overall score.
  - o If ODOT and/or local or regional average annual daily traffic (AADT) volume data is not sufficient, functional class can be used instead as a proxy for relative volume.
  - o Ramp terminal information would be important for regional analysis or larger metropolitan areas (e.g., Portland).
- An intersection dataset can be developed in GIS using spatial analysis tools to create nodes at roadway network intersections. This process requires quality control checks to remove locations associated with over- or undercrossing locations that may be calculated as an intersection.
- If a local agency does not have sufficient data to conduct the analysis, they should reach out to ODOT for technical assistance in assessing their data and steps necessary to obtain the needed data.
- If a local agency has its own equity index, additional considerations to translate a local equity index to comparative ranges from the ODOT Social Equity Index (medium-high and high) is necessary.

#### **Prioritization of Sites**

- If a city or county has identified a potential systemic treatment, the screening scores can provide an initial screening method to identify intersections that may benefit from the treatment.
  - o The project team used this method for the City of Salem case study application.
- Alternatively, a city or county can use the characteristics based analysis to screen a local jurisdiction network to identify treatments (systemic or hot spot) based on the scoring results.
- Other prioritization criteria (such as community input, crash history, or other community goals) may be integrated with the scoring to help prioritize locations that would achieve multiple goals within a jurisdiction.

# **APPENDIX**

Appendix A: Characteristics-Based Analysis - City of Salem Intersections Scoring in the Top 10%

Appendix B: Comparison of Salem Top 10% and ODOT Top 10%

# APPENDIX A: CHARACTERISTICS-BASED ANALYSIS - CITY OF SALEM INTERSECTIONS SCORING IN THE TOP 10%

Table 4. Characteristics-Based Analysis - City of Salem Intersections Scoring in the Top 10%

Intersection	Screening Score
Signalized	Screening Score
25th St Se & Mission St SE	8.03
Cordon Rd SE & Gaffin Rd SE	7.05
Fisher Rd Ne & Silverton Rd Ne	7.03
	7.03
Bill Frey Dr Ne & Portland Rd Ne	
Airport Rd Se & State St	7.03
Hawthorne Av Ne & Silverton Rd Ne	7.03
Hawthorne Av Ne & Sunnyview Rd Ne	7.03
Geer Dr Ne & State St	7.03
Carson Dr Se & Lancaster Dr Se	7.03
Lancaster Dr Se & Rickey St Se	7.03
22nd St Se & Mission St Se	6.99
17th St Se & Mission St Se	6.99
Center St Ne	6.95
D St Ne & Hawthorne Av Ne	6.95
Beverly Av Ne & Lancaster Dr Ne	6.95
Lancaster Dr Ne & Wolverine St Ne	6.95
Devonshire Av Ne & Lancaster Dr Ne	6.95
Commercial St Se & Ferry St Se	6.95
Lancaster Dr Ne & Sunnyview Rd Ne	6.95
Lana Av Ne & Portland Rd Ne	6.95
Center St Ne & Hawthorne Av Ne	6.95
Hawthorne Av Ne & Market St Ne	6.94
Lancaster Dr Ne & Market St Ne	6.94
12th St Se & Bellevue St Se	6.94
	Stop Controlled
Hawthorne Av Ne & Weston Ct Ne	9.89
Boone Rd Se & Commercial St Se	9.33
12th St Cutoff Se & Oakhill Av Se	9.33
Barnes Av Se & Commercial St Se	9.33
Doaks Ferry Rd Nw & Wallace Rd Nw	9.33
Hines St Se & Mission St Se	9.05
21st St Se & Mission St Se	9.05
23rd St Se & Mission St Se	9.05
12th St Se & Mill St Se	8.89
Commercial St Se & Ratcliff Dr Se	8.84
Liberty Rd S & Marietta St Se	8.84
Hyacinth St Ne & Mainline Dr Ne	8.84
Front Cp Ne & Front St Ne	8.84
Front Cp Ne & Front St Ne	8.84
Liberty Rd S & Pembrook St Se	8.84
12th St Se & Vista Av Se	8.84
49th Av Se & State St	8.8
	0.0

Silverton Rd Ne & Williams Av Ne	8.58
37th Av Ne & State St	8.57
Portland Rd Ne & Stortz Av Ne	8.57
Lancaster Dr Se & Saddle Club St Se	8.57
Commercial St Se & Winding Wy Se	8.24
Center St Ne & Norman Av Ne	8.08
Carolina Av Ne & Lancaster Dr Ne	8.08
Greentree Dr Ne & Sunnyview Rd Ne	8.08
Brown Rd Ne & Sunnyview Rd Ne	8.08
Icabod St Ne & Sunnyview Rd Ne	8.08
Earle Av Ne & Lancaster Dr Ne	8.08
41st Av Ne & Sunnyview Rd Ne	8.08
Center St Ne & Oregon Av Ne	8.08
Lancaster Dr Ne & Weathers St Ne	8.08
Carleton Wy Ne & Portland Rd Ne	8.08
Anita Dr Ne & Lancaster Dr Ne	8.08
Donald St Ne & Portland Rd Ne	8.08
36th Av Ne & Center St Ne	8.08
Neota St Ne & Swegle Rd Ne	8.08
Center St Ne & Illinois Av Ne	8.08
Freeway Ct Ne & Hawthorne Av Ne	8.08
Highway Av Ne & Portland Rd Ne	8.08
Judy Av Ne & Lancaster Dr Ne	8.08
Hollywood Dr Ne & Sunnyview Rd Ne	8.08
Center St Ne & Edina Ln Ne	8.08
Mousebird Av Nw & Orchard Heights Rd Nw	8.06
Skyline Rd S & Skyline Village Lp S	8.06
Airport Rd Se & Ryan Dr Se	8.06
Croisan Scenic Wy S & Kuebler Rd S	8.06
Doaks Ferry Rd Nw & Glen Creek Rd Nw	8.06
Holder Ln Se & Liberty Rd S	8.06
Davis Rd S & Liberty Rd S	8.06
Eola Dr Nw & Burley Hill Dr Nw	8.06
Skyline Rd S & Skyline Village Lp S	8.06
Burley Hill Dr Nw & Sunwood Dr Nw	8.06
25th St Se & Aviation Lp Se	8.02
Michigan City Ln Nw & Wallace Rd Nw	8
Lee St Se & Mission St Se	7.96
12th St Se & Cannon St Se	7.84
Liberty St Ne & Union St Ne	7.84
Capitol St Ne & Myrtle Av Ne	7.84
12th St Se & Cannon St Se	7.84
State St & Winter St Se	7.8
Lansing Av Ne & Sunnyview Rd Ne	7.8
Liberty St Se & Mill St Se	7.8
Commercial St Ne & Front Cp Ne	7.75
Liberty Rd S & Mize Rd Se	7.75
13th St Ne & Center St Ne	7.58
Church St Se & Mission St Se	7.58
Kimeron St Se & Liberty Rd S	7.57
Idylwood Dr Se & Sunnyside Rd Se	7.57
Barnes Av Se & Sunnyside Rd Se	7.57

Boone Rd Se & Sunnyside Rd Se	7.57
Sunnyside Rd Se & Valleywood Lp Se	7.57
Bellevue St Se & University St Se	7.56
22nd St Se & Madrona Av Se	7.52
12th St Cutoff Se & Doris Av Se	7.52
Barnes Av Se & Commercial St Se	7.52
Madrona Av Se & Madrona Ct Se	7.52
Commercial St Se & Promontory PI Se	7.52
Portland Rd Ne & Wayside Tr Ne	7.52
12th St Cutoff Se & Ibsen St Se	7.52
Commercial St Se & Lansford Dr Se	7.52
Commercial St Se & Crowley Av Se	7.52
Commercial St Se & Royvonne Av Se	7.52
7th St Nw & Wallace Rd Nw	7.51
9th St Nw & Wallace Rd Nw	7.51
Hagers Grove Rd Se & Lancaster Dr Se	7.48
Caplinger Rd Se & Cordon Rd Se	7.48
Cranston St Se & Lancaster Dr Se	7.48
24th St Se & Mission St Se	7.24
Ford St Se & Mission St Se	7.24
20th St Se & Mission St Se	7.24
Ford St Se & Mission St Se	7.24
23rd St Ne & Recovery Dr Ne	7.08
Commercial St Se & Leslie St Se	7.08
Market St Ne & Tierra Dr Ne	7.08
Clay St Ne & Market St Ne	7.08
State St & Wander Wy Se	7.08
17th St Ne & Nebraska Av Ne	7.08
25th St Ne & State St	7.08
17th St Ne & Kansas Av Ne	7.08
17th St Ne & Kay St Ne	7.08
24th St Se & State St	7.08
17th St Ne & B St Ne	7.08
17th St Ne & A St Ne	7.08
17th St Ne & C St Ne	7.08
Hrubetz Rd Se & Liberty Rd S	7.03
12th St Se & Hillendale Dr Se	7.03
Fairview Av Se & Pringle Rd Se	7.03
Commercial St Se & Oakhill Av Se	7.03
12th St Se & Morningside St Se	7.03
12th St Se & Harris Av Se	7.03
Delmar Dr N & River Rd N	7.03
12th St Se & Shamrock Dr Se	7.03
Burley Hill Dr Nw & Satara Ct Nw	7.03
Commercial St Se & Ewald Av Se	7.03
12th St Se & Marshall Dr Se	7.03
Idylwood Dr Se & Liberty Rd S	7.03
Broadway St Ne & Shangri La Av Ne	7.03
River Rd N & Stark St N	7.03
Cypress St Ne & Lancaster Dr Ne	6.99
Cougar Ct Se & State St	6.99
Hawthorne Av Ne & Monroe Av Ne	6.99

Plateau St Ne & Swegle Rd Ne	6.99
Beach Av Ne & Portland Rd Ne	6.99
El Rancho Av Ne & Sunnyview Rd Ne	6.99
Center St Ne & Vinyard Av Ne	6.99
Future Dr Ne & Sunnyview Rd Ne	6.99
Alpine Lakes St Se & Rickey St Se	6.99
Lancaster Dr Ne & Manor Dr Ne	6.99
Eb Edgewater Rp & Wb Edgewater Rp	6.98
Church St Ne & Hood St Ne	6.97
49th Av Se & Macleay Rd Se	6.81
Division Cp Ne & Division St Ne	6.75
Mainline Dr Ne & Salem Py Ne	6.74
Pringle Rd Se & Tiburon Ct Se	6.57
Linwood St Nw & Orchard Heights Rd Nw	6.57
36th Av Se & Trelstad Av Se	6.54
13th St Se & State St	6.53
Court St Ne & Winter St Ne	6.53
Capitol St Ne & Nebraska Av Ne	6.49
Commercial St Se & Welcome Wy Se	6.49
Kimeroff Ln Se & Liberty Rd S	6.48
Cayuse Cr Se & Sunnyside Rd Se	6.48
Bliler Av Ne & Liberty St Ne	6.48
Lancaster Dr Se & Sylvia St Se	6.45
Cordon Rd Se & Old Macleay Rd Se	6.45
Commercial St Ne & Division Cp Ne	6.44
Liberty St Ne & Taylor St Ne	6.42
14th St Ne & D St Ne	6.31
14th St Ne & D St Ne	6.31
Country Club Dr S & River Rd S	6.26
Doaks Ferry Rd Nw & Eola Dr Nw  Orah grad Unighta Rd Nov & William gradus Av Nov	6.25
Orchard Heights Rd Nw & Wilmington Av Nw	6.25
Rees Hill Rd Se & Sunnyside Rd Se	6.25
Liberty Rd S & Radiance Av Se Croisan Scenic Wy S & Summercrest Dr S	6.25
River Rd S & Valley High St S	6.25 6.25
	6.25
Neahkahnie St Se & Sunnyside Rd Se Benson St S & River Rd S	6.25
Fairview Industrial Dr Se & Marietta St Se	6.25
Aumsville Hw Se & Joseph St Se	6.25
Golf Course Rd S & River Rd S	6.25
Bayne St Ne & Kale St Ne	6.25
Liberty Rd S & Mildred Ln Se	6.25
Maple Glen Ln S & River Rd S	6.25
River Rd S & Schurman Dr S	6.25
Orchard Heights Rd Nw & Titan Dr Nw	6.25
49th Av Ne & Kale St Ne	6.25
Croisan Creek Rd S & Kuebler Rd S	6.25
Eagle View Dr Nw & Eola Dr Nw	6.25
Eola Dr Nw & Mule Deer St Nw	6.25
Fairview Industrial Dr Se & Lindburg Rd Se	6.25
Acacia Dr S & River Rd S	6.25
Cascadia Industrial St Se & Reed Rd Se	6.25
Cascada indosmaror do a recoa na do	0.20

Orchard Heights Rd Nw & Snowbird St Nw	6.25
Pringle Rd Se & Suntree Dr Se	6.25
Eola Dr Nw & Gehlar Rd Nw	6.25
49th Av Ne & Hayesville Dr Ne	6.24
Center St Ne & Greencrest St Ne	6.21
Center St Ne & Sand Piper Av Ne	6.21
Center St Ne & Sphinx Ct Ne	6.21
Center St Ne & Wildflower St Ne	6.21
Center St Ne & Royalty Dr Ne	6.21
Wallace Rd Nw &	6.19
Creek Ct Nw & Wallace Rd Nw	6.19
Orchardview Av Nw & Wallace Rd Nw	6.19
Tulip Ln Nw & Wallace Rd Nw	6.19
Hope Av Nw & Wallace Rd Nw	6.19
Narcissus Ct Nw & Wallace Rd Nw	6.19
Lynda Ln Nw & Wallace Rd Nw	6.19
Narcissus Ct Nw & Wallace Rd Nw	6.19
Harritt Dr Nw & Wallace Rd Nw	6.19
Deering Dr Nw & Wallace Rd Nw	6.19

# APPENDIX B – COMPARISON OF SALEM TOP 10% AND ODOT TOP 10%

**Exhibit 1. Functional Class** 



**Exhibit 2. Number of Legs** 



**Exhibit 3. Number of Lanes** 

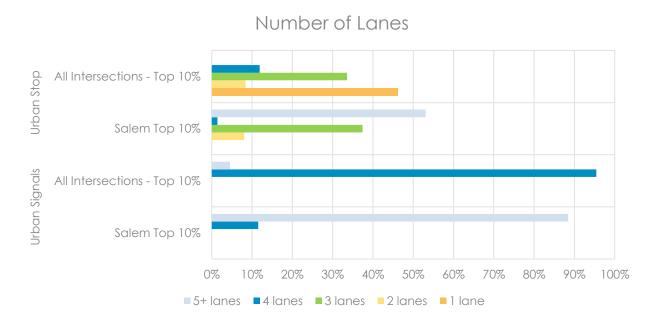


Exhibit 4. Right Turn Lane Presence

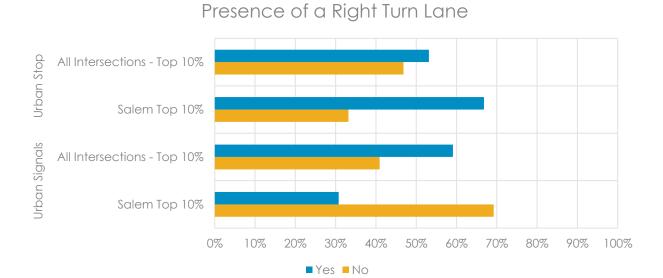


Exhibit 5. Left Turn Lane Presence



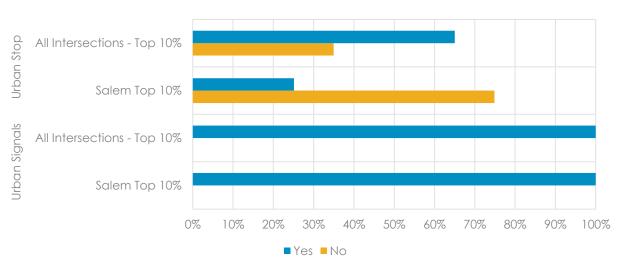
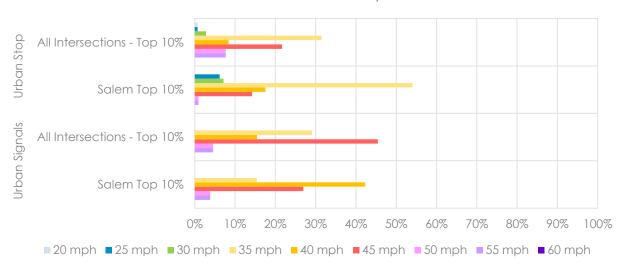


Exhibit 6. Maximum Posted Speed

#### Maximum Posted Speed



**Exhibit 7. Equity Disparity** 



Exhibit 8. Bike Lane Presence

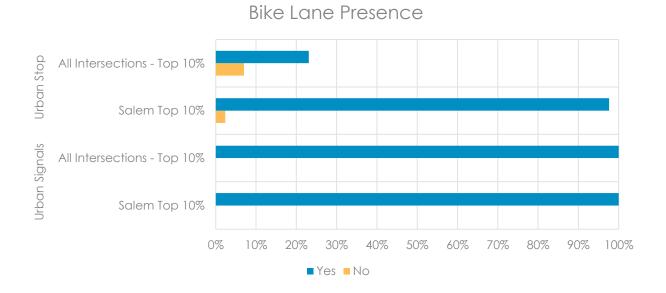


Exhibit 9. Sidewalk Presence

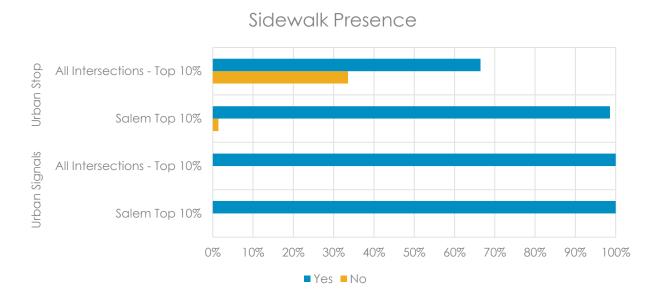
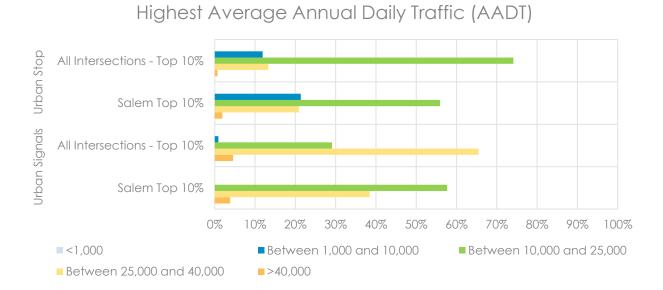


Exhibit 10. Average Annual Daily Traffic (AADT)



## APPENDIX E: Stakeholder Outreach Meeting Summaries and Presentation Slides

#### MEETING SUMMARY

June 1, 2023 Project# 27003.022

Project Name: ODOT Intersection Safety Plan Update: Local Agency Advisory

Committee Meeting #1

Meeting Location: Microsoft Teams

#### **Attendees**

Christi McDaniel-Wilson, ODOT

• Jiguang Zhao, ODOT

 Nick Foster, Kittelson and Associates (KAI)

• Ashleigh Ludwig, KAI

• Katie Popp, KAI

• Carl Lund, Marion County

• Clint Spencer, City of Hermiston

• James Philp, Jackson County

Jamie Jeffrey, City of Portland

John Fasana, Washington County

Julie Warncke, City of Salem

Angela Kargel, ODOT

Karl MacNair, City of Medford

Lani Radtke, Marion County

 Melissa Norman, Washington County

Mariana Montes, ODOT Region 2

 Nick Fortey, Federal Highways Oregon Division

Shyam Sharma, ODOT Region 1

Tiffany Slauter, ODOT Region 1

Stacy Shetler, Washington County

Logan Telles, City of Eugene

Paul Woods, City of Ontario

#### **Meeting Kickoff and Introductions**

Each LAAC participant introduced themselves and provided details on how their agency currently identifies safety projects. Responses are shown in Table 1.

Table 1. LAAC Participant Introductions and Responses

Name	Position and Agency	How does your agency currently identify intersection safety projects?	What's one thing you might want this plan to help you with?
Carl Lund	Marion County Traffic Engineer	Projects are identified based on fatal and serious injury crash locations.	Looking forward to exploring how the ODOT Intersection Safety Plan Update will support their agency.
Clint Spencer	Planning Director with City of Hermiston	Projects are identified based on fatalities, which lead to safety projects.	Looking forward to exploring how the ODOT Intersection Safety Plan Update will support their agency.
James Philp	County Engineer with Jackson County	Projects are identified based on crash reports and crash history.	Looking forward to exploring how the ODOT Intersection Safety Plan Update will support their agency.
Jamie Jeffrey	Interim City of Portland Traffic Engineer	Identifies projects that align with the Vision Zero policy and program with a focus on fatal and serious injury crashes. Projects are also identified from the Safe Routes to School (STRS) program.	Looking forward to exploring how the ODOT Intersection Safety Plan Update will support their agency.
John Fasana	Washington County Principal Traffic Engineer		
Julie Warncke	Transportation Planning Manager with City of Salem Public Works	Currently there's a focus on improving pedestrian crossings. Crossing improvement locations are identified from crowdsourced requests from the community. Those locations are then evaluated based on speed,	Hoping this plan will help expand their toolbox beyond pedestrian-related safety concerns to better include motor vehicle crashes.

Name	Position and Agency	How does your agency currently identify intersection safety projects?	What's one thing you might want this plan to help you with?
		volume, and pedestrian generators.	
Angela Kragel	ODOT State Traffic Services and Engineer	Projects identified through the ARTS program.	Looking forward to exploring how the ODOT Intersection Safety Plan Update will support their agency.
Karl MacNair	City of Medford Transportation Manager	Projects identified based on crash history and complaints from citizens.	Planning to apply for a Safe Streets and Roads for All (SS4A) grant for a safety action plan. Looking forward to seeing how the ODOT Intersection Safety Plan Update will support this work.
Lani Radtke	County Engineer – Marion County	Projects identified based on past fatal and serious injury history.	Hoping that the ODOT Intersection Safety Plan will support current efforts, including identifying grant opportunities, conducting a more thorough county-wide analysis to see where issues lie based on data, and updating their TSP (starting soon).
Melissa Norman	Washington County Traffic Engineer	Uses SPIS to identify safety projects.	Seeing a lot of correlation with uses for their TSAP.
Mariana Montes	Region 2 Traffic at ODOT	Heavily relies on hot spots and SPIS locations to identify intersection safety projects.	Wants this plan support efforts to capture intersections that may be missed through their existing identification processes.
Nick Fortey	Traffic Safety Engineer - FHWA Oregon Division	-	Looking for support in identifying and making safety investments and the safe systems approach.
Shyam Sharma	Region 1 Traffic at ODOT	Uses ARTS program to identify projects.	Wants to identify proactive safety solutions.

Name	Position and Agency	How does your agency currently identify intersection safety projects?	What's one thing you might want this plan to help you with?
and Tiffany Slauter			
Stacy Shetler	County Engineer, Washington County	Uses SPIS, TSAP, SRTS, and safe access to transit to identify projects. Identification depends on funding. Development reviews are safety-based. There's also a community-driven process for safety improvements.	What are the safety risks of diverting traffic to other locations that may not be as safe?  Treatments that may improve safety may have consequences someplace else.
Logan Telles	Runs Vision Zero program in City of Eugene	Uses fatal and serious crash data to identify safety projects.	Recent recipient of a SS4A grant and they're in the early stages of implementation. They also received SRTS grants.

#### **Meeting Discussion**

- Nick Foster (KAI) provided an overview of the project scope and schedule.
  - Questions
    - (Jamie Jeffrey) Will this change the CRF established by the ARTS program?
      - (Nick) We don't anticipate a comprehensive revision. We may add treatments that aren't on the list if any are identified. We may suggest an adjustment if we identify some that have new data available. We would work with ODOT on that.
    - (Jamie Jeffrey) What is the relationship between this project and the CRF list/ ARTS?
      - (Nick) The CRF list will be a source for potential countermeasures. The procedures in this plan can be used to nominate projects for ARTS funding. These processes will be further defined in later stages.
- Nick Foster (KAI) provided an overview of Tech Memo #1.
  - Nick reminded the group that we are looking at correlation, not necessarily causation.
  - We are focusing on factors associated with more severe crashes (i.e., fatal and suspected serious injury (Injury A) crashes).

- Functional classification is likely a surrogate for several other measures, so
  it is only recommended for use if you are missing some of the other factors
  (e.g., speed, volume).
- Turn lanes may also be a surrogate for other factors.
- Bicycle and pedestrian volume data is not available, but the presence of bike lanes and sidewalks are being used as surrogate measures for their activity.
- o In the next phase, the project team will weight these factors and use those weightings to screen the sample study network.
- Questions
  - (Jamie Jeffrey) We also have shared-use paths. Is there a distinction of how you would characterize these?
    - (Nick) You can give it points for both bicycle and pedestrian volumes in the scoring.
  - (Karl MacNair) Surprised not to see more of a breakout of different ranges of speed.
    - (Nick) The risk factors are based on available data. We are also trying to keep things relatively simple. If people want to see more nuance, we can revisit the breaks in posted speed.
  - (John Fasana) For rural areas, how do you distinguish between bikes riding on the shoulder and actual bike lanes in those areas?
    - (Nick) We are using ODOT's data which identifies ODOT's bike lanes separately. If your agency has shoulder data and you know they are used by bikes, you could use that instead.
  - (Logan Telles) We all know bike and pedestrian crashes are underreported. Is there a way to help elevate the bike/ped crashes with a weighting? In some previous ARTS applications, they know there is a risk but just haven't had a crash yet. Is there a way to help adjust for this and the underreporting?
    - (Nick) ODOT's <u>Bicycle and Pedestrian Safety Implementation</u> <u>Plan</u> is probably the better tool to address bike/pedestrian crashes.
    - Agencies can follow up with Christi or Angela if there are further questions about bicycle and pedestrian safety projects and implementation.
  - (Julie Warncke) In an urban setting, there aren't that many intersections with >55 mph posted speeds.
    - (Nick) We can look at breaking down the data further between 35-50 mph to help identify locations in urban settings.
  - (Jamie Jeffrey): They are trying to push speeds down in the City of Portland. There's a big difference in the number of streets on the

network that are 30, 35, 40, 45, 50 mph. Could we break this out even more?

• (Nick) Yes, we could look at that.

#### **Action Items/ Next Steps**

- The LAAC can continue to send comments or questions on the draft Tech Memo #1 to the project team.
- Next step is to screen study intersections.
- Next LAAC meeting will likely be the week of July 10th.

#### **Attachments**

1. Meeting #1 Presentation Slides



#### Agenda

- Introductions
- Project Scope & Schedule
- Overview of Tech Memo #1
- Discussion & Questions
- Next Steps & Near-term Actions



#### Introductions

- Name
- Agency
- How does your agency currently identify intersection safety projects?
- One thing you might want this plan to help you with

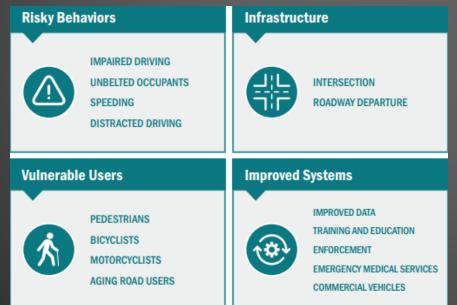


## Project Scope and Schedule



## **Project Background**

- Previous plan 2012
- Emphasis area from 2021 TSAP



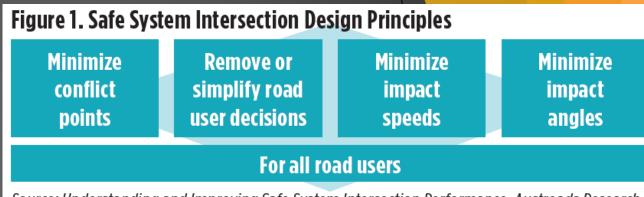
Oregon Intersection Safety Implementation Plan June 2012





### **Project Overview**

- Statewide
  - Local and State roads
- Signalized and unsignalized
- Agency priorities
- Updated analyses and countermeasures
- Implementation



Source: Understanding and Improving Safe System Intersection Performance, Austroads Research Report AP-R556-17



#### **Systemic Process Step 1:** Define Study Scope **Step 7**: Evaluate Program and Project Step 2: Compile Data **Impacts Step 6:** Refine and **Step 3:** Determine Risk Implement the Factors Treatment Plan **Step 4:** Identify Potential Treatment Step 5: Select Potential Sites Countermeasures



### **Project Objectives**

- This Plan Provides:
  - ► Framework for Conducting Systemic Intersection Safety Analyses
  - Risk Factors to Identify Locations for Treatments
  - ► Example Applications and Treatment Options
- This Plan *Does Not* Provide:
  - ► A Project List



## Project Scope & Schedule

Mar - May

June - July

July - Sep

Confirm Network, Compile Data, Identify Risk Factors



**Network Screening** 



Countermeasures & Prioritization



# Task 2 - Confirm Study Network and Compile Available Data (March – May)

- Identify potential risk factors
- LAAC Meeting #1
- Tech Memo #1

#### **RISK FACTOR SCREENING WEIGHTS: PEDESTRIANS**

	KISK FACTOR WEIGHTS	
Risk Factor	Urban	Rural
Principal Arterial	1.24	1.46
Number of Lanes (>= 4 Lanes)	1.55	1.73
High-Access Density	1.64	_
No Sidewalks (or Only One Side)	1.38	-
Posted Speed (>=35 mph)	1.83	1.63
Mixed Use Zoning	1.00	_
Other Zoning	_	1.45
Proximity to Schools (1 Mile)	1.03	1.17
Proximity to Transit Stops (1/4 Mile)	1.08	1.00
High Population over the Age of 64	1.00	_

Dick Eactor Woights



## Task 3 – Network Screening (June – July)

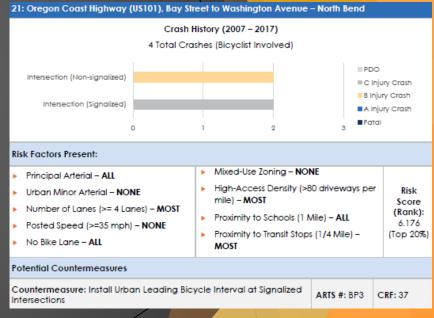
- Apply risk factors
- Example sites (3/Region)
- LAAC Meeting #2
- Tech Memo #2





# Task 4 – Countermeasures and Prioritization (July – September)

- Potential countermeasures at example sites
- Prioritization & evaluation processes
- LAAC meeting #3
- Final plan and presentation





## LAAC Roles & Responsibilities

- Attend meetings
- Review deliverables
  - Assess utility to your agency? What is useful? What needs to be improved?



## Tech Memo #1



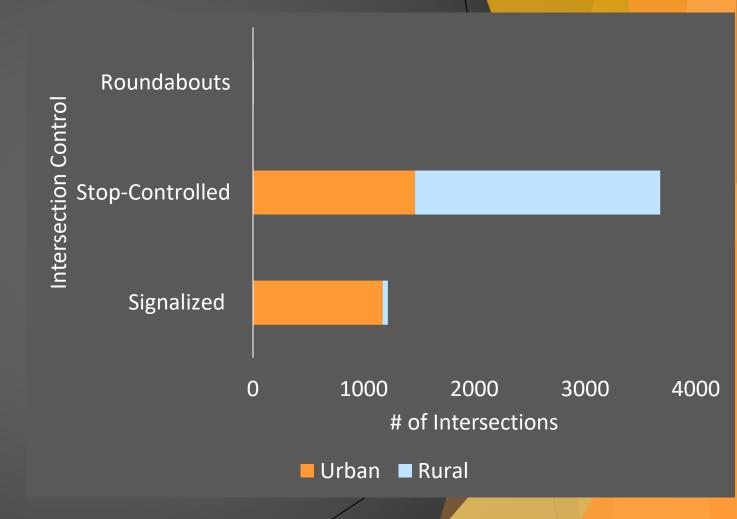
#### **Contents**

- Project Background
- Study Network
- Data Sources
- Crash Analysis
- ► Risk Factors



## **Study Network**

- Applicability PublicStreet Intersections
- Analysis Network –Sample Provided by ODOT
  - State Highway
    Intersections



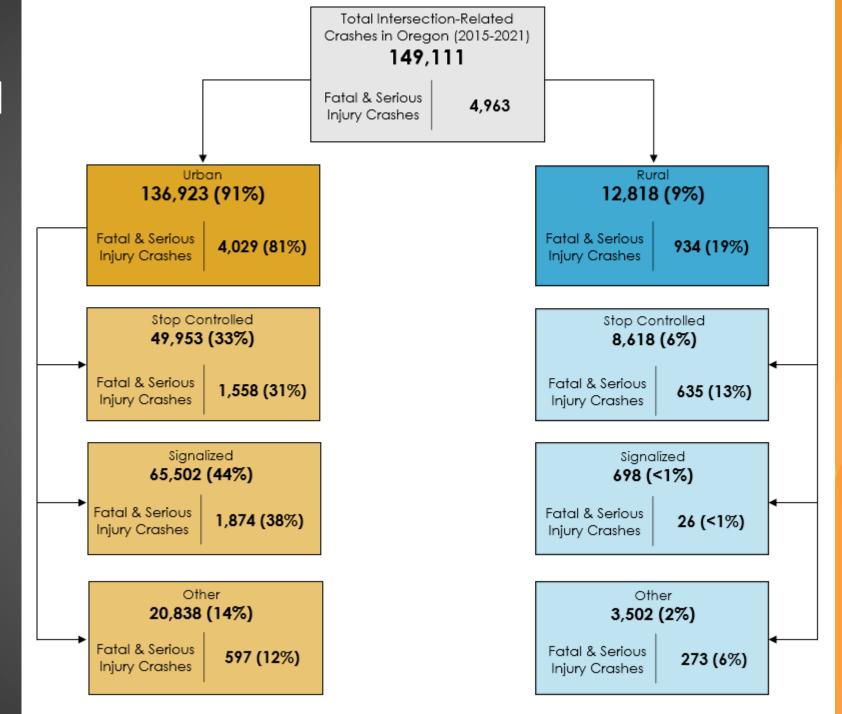


## **Data Analyzed**

Variable	Source	
Location Characteristics		
Area Type (Urban/ Rural) Federal Aid Urban Boundary (FAUB)		
Jurisdiction	ODOT TransGIS	
Intersection (	Characteristics	
Ramp Terminal ODOT TransGIS; Google Earth		
Approach I	nformation	
Leg Count	Unsignalized Intersections: Calculated Signalized Intersections: Provided by ODOT	
Posted Speed	ODOT TransGIS	
Functional Classification	ODOT TransGIS	
Number of Lanes	ODOT TransGIS	
Median Type	ODOT TransGIS	
Volume (AADT)	ODOT TransGIS	
Heavy Vehicle Percentage	ODOT TransGIS	
Bicycle Lane	ODOT TransGIS	
Sidewalk	ODOT TransGIS	
Right Turn Lane	ODOT TransGIS	
Left Turn Lane	ODOT TransGIS	
Demographi	Information	
Equity	ODOT Social Equity Index	

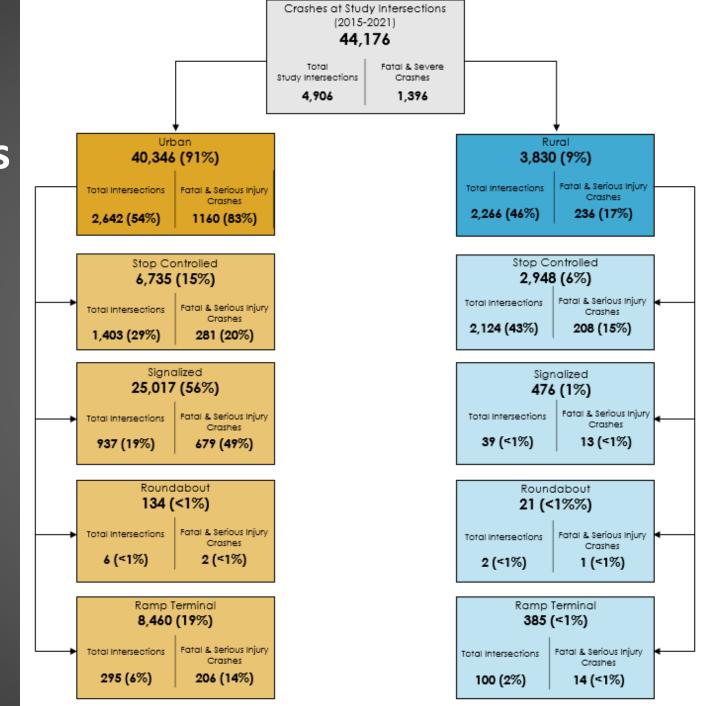


# Crash Data – All Intersections



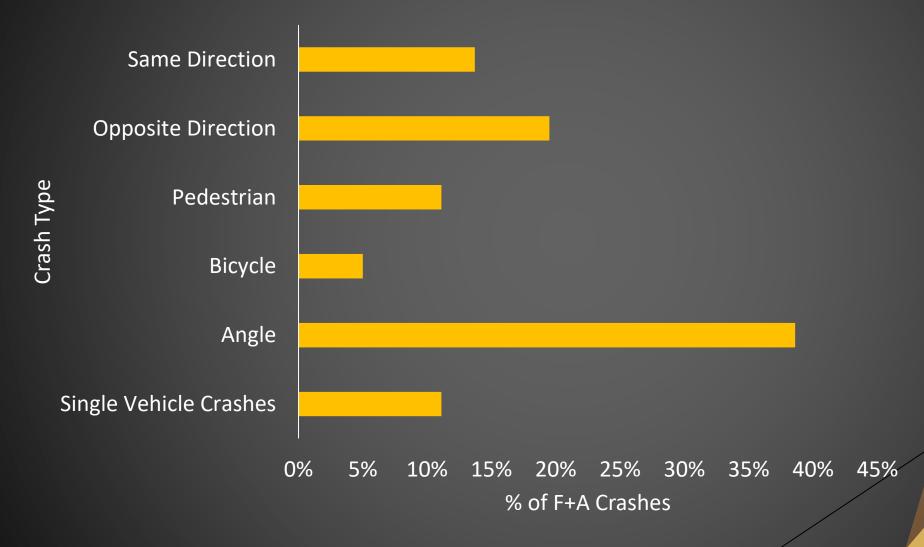


# Crash Data – Study Intersections





## **Crash Types**





# **Identifying Risk Factors**

- Severity Focused
  - ► Risk Ratio
  - F+A Crash
    Overrepresentation

	Signalized						
	Urban			Rural <sup>1</sup>			
Risk Factor	Risk Ratio	% of Inters. <sup>2</sup>	% of F+A³	Risk Ratio	% of Inters.	% of F+A	
Functional Classification							
Principal Arterial	1.01 (1.33)	85% (12%)	86% (12%)	3.67 (2.56)	82% (33%)	92% (50%)	

- Some Judgment Needed
- Correlation vs. Causation



# Proposed Risk Factors

	Signalized		Stop Controlled						
Risk Factor	Urban	Rural	Urban	Rural					
Functional Classification <sup>1</sup>									
Principal Arterial	X	X	X	X					
Minor Arterial	X								
Other Freeways and Expressways	R								
Posted Speed <sup>2</sup>									
35 - 50 mph	X	X	X	X					
≥ 55 mph	X	X	X	X					
Volume (AADT)									
AADT ≥ 10,000				X					
AADT between 10,000-25,000			X						
AADT > 25,000		X	Χ						
AADT between 25,000-40,000	X								
AADT ≥ 40,000	X								
Approach Characteristics									
Right Turn Lane Present <sup>5</sup>	R		NR	NR					
Left Turn Lane Present 5	X	X	X	X					
Number of Through Lanes ≥ 3			X	X					
Number of Through Lanes ≥ 4	X	X							
<b>Equity</b>									
Medium High or High Equity Disparity	X	X	X	X					
Active Transportation									
Bicycle Volumes <sup>3</sup>	X	X	X	X					
Pedestrian Volumes <sup>4</sup>	X	Χ	Χ	X					



# Discussion & Questions



## Questions

- Do these factors make sense?
  - Any unexpected results?
  - ► Any missing?
- Do you have data for these factors?



# Next Steps & Near-term Actions



# **Next Steps & Near-term Actions**

- Weight risk factors
- Screen study intersections
- ► Next LAAC meeting w/o July 10<sup>th</sup>



### MEETING SUMMARY

July 17, 2023 Project# 27003.022

Project Name: ODOT Intersection Safety Plan Update: Local Agency Advisory

Committee Meeting #2

Meeting Location: Microsoft Teams

#### **Attendees**

• Jiguang Zhao, ODOT

• Carl Lund, Marion County

• Jamie Jeffrey, City of Portland

• Julie Warncke, City of Salem

Karl MacNair, City of Medford

• Lani Radtke, Marion County

 Melissa Norman, Washington County Nick Fortey, FHWA

Shyam Sharma, ODOT Region 1

Logan Telles, City of Eugene

Colton Minton, Jackson County

Robin Lewis, City of Bend

• Nick Foster, Kittelson

Katie Popp, Kittelson

#### **Welcome and Meeting Overview**

- Nick Foster provided a refresher of the ODOT Intersection Safety Plan Update project objectives.
- LAAC Meeting #1 addressed Steps 1-3 of the systemic process. Today we are addressing Step 4: Identify Potential Treatment Sites.
- The information presented in this meeting is also discussed in Technical Memo #2.

### **Screening Results Work Session**

### RISK FACTOR BASED SCREENING RESULTS (METHOD #1)

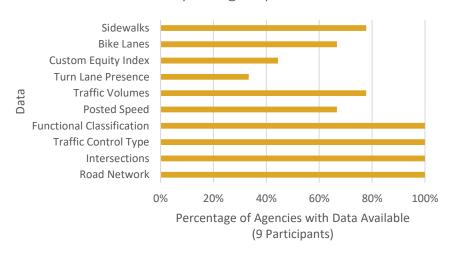
- Nick walked through the risk factor-based network screening methodology.
- The risk factors changed slightly from LAAC Meeting #2 based on LAAC feedback.
- The posted speed ranges are overlapping. Are these correct?
  - Yes, this is correct. The speed intervals differ for urban and rural intersections.
- Do you actually need bicycle and pedestrian volume data?
  - We are not using the volumes themselves; we're using presence of bicycle facilities and sidewalks as surrogate measures.

- What ODOT deals with is different than some local agencies, such as the City of Portland. Is there a need for some more granular change in the bicycle and pedestrian risk factors to represent different facility types?
  - o If you're just focused on bicycle and pedestrian factors, see <u>ODOT Bicycle</u> & Pedestrian Safety Implementation Plan.
  - o If you have your own dataset, you can go through the first part of the process and develop your own risk factors. Some larger agencies, such as the City of Portland, may have enough crash data and sites to do this.
- Note that for some of the risk factors, it's not these characteristics that may be causing crashes – they are potentially acting as surrogates for other items (e.g., turn lanes and turning volumes).

#### ATTENDEE QUESTIONS AND DISCUSSION

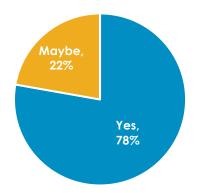
• (Poll #1) What data does your agency have available?



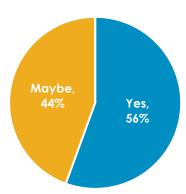


- Robin (City of Bend) Does not have volumes in the dataset yet, they're in their own files.
- (Poll #2) Do you think your agency could apply this process? Would you find this screening useful?

Do you think your agency could apply this process?

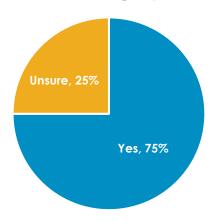


Would you find this screening useful?



- o What obstacles would prevent you from applying it?
  - Time (3 responses)
  - Workload
  - Ability to obtain grant funding for locations where no severe crashes have occurred.
  - Data availability
  - Staff skillset
  - Limitations for incorporating additional crash factors, such as DUI crashes.
- o What could make it more useful?
  - Tool for the calculation
  - Contracting a consultant to run the analysis periodically.
  - Reviewing results from a test case
  - Coordination with grant programs
  - Identifying a method that distinguishes high-scoring intersections (e.g., in smaller jurisdictions, all signals may score the same because of similar characteristics)
- (Poll #3) Does ranking/scoring sites within subgroups make sense or would you want to compare across sub-groups?

Does ranking/ scoring sites within subgroups make sense or would you want to compare across sub-groups?



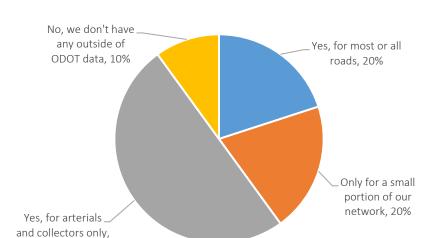
- Robin Lewis (City of Bend)
  - o Every signal in the city could potentially be flagged using this method.
  - o How can we differentiate signals with similar characteristics?
    - As your jurisdiction size gets smaller, it may be more difficult to distinguish sites when you have only a few of them. This will be explored in our City of Salem case study.
- Carl Lund (Marion County)
  - A lot of funding follows grant availability. Currently, it's easiest to identify locations with high crash numbers to apply for funding.

### CRASH PREDICTION MODEL SCREENING (METHOD #2)

- Nick provided an overview of the crash prediction model network screening methodology.
  - o This method is presented primarily for a comparison purpose.
  - From a data constraints perspective, it may not be practical to use these models because they are data-intensive (rely on volume).

#### ATTENDEE QUESTIONS AND DISCUSSION

(Poll #4) Does your agency have daily traffic volumes?



#### Does your agency have daily traffic volumes?

#### COMPARISON OF THE TWO METHODS

50%

 Nick compared the two methods and outlined potential benefits/ limitations of using one method instead of the other.

#### **OPEN DISCUSSION AND QUESTIONS**

- (Logan Telles) Crash prediction model
  - Did you undertake any accuracy validation to see if the predicted crashes align with actual crashes from the last 5 years?
  - (Nick) Models are based on national data, so the data that they're based on is not Oregon data. Different states have different data and different crash thresholds.
  - HSM recommends you calibrate the models to your local conditions.
     ODOT developed these calibration factors in 2011.
- (Jamie Jeffrey)
  - These are both helpful for different reasons. In Portland, Jamie can see maybe trying to use a bit of both.
  - Noticed that ODOT has a lot of intersections that have exactly the same score - Could we use one to develop a list and the other to tease out those specific intersections?
- (Logan Telles)
  - With the fatal crash predictions locally, a lot of fatal/ severe injury crashes are influenced by the use of drugs and alcohol and a large

- number of pedestrian crashes occur in locations with the unhoused. These factors are not incorporated in the crash prediction methodology.
- (Nick) Those factors could be considered as an additional consideration when you're identifying potential treatment sites.
- (Karl MacNair) This methodology seems helpful to use in an overall plan to identify projects. Are they a replacement or a supplement to using crash history?
  - (Nick) It's a supplementary/ complementary method. This systemic method is used to identify more sites for lower-cost treatments.
     Recommend using both hot spot and systemic method. In a city the size of Medford, using both methods would be useful.
  - (Karl) Medford is going to go a safety action plan in the relatively near future, this could be a helpful tool in that process.
- (Julie Warncke)
  - After going through this process and identifying an intersection treatment,
     will the intersection rank change?
  - (Nick) No. You will need to filter those out of dataset for future intersection screening.
  - o (Julie) Concerns about public perception
    - How do you show that the treatments are working?
    - There's a lot of pushback for adding turn lanes. Identifying turn lanes as a risk factor may indicate that turn lanes are bad, even though that's not the intention.
    - (Nick) A typical application of systemic safety includes multiple location deployments. An agency would analyze results of treatments in an aggregate manner. This will be explored more in the next phase of the project.

### **Action Items/ Next Steps**

- The LAAC can continue to send comments or questions on the draft Tech Memo #2 to the project team.
- Next step is to conduct the City of Salem case study and discuss prioritization and evaluation methods.
- Next LAAC meeting will likely be the week of September 4th (Labor Day week).

#### **Attachments**

1. Meeting #2 Presentation Slides



# Agenda

- ► Welcome/Overview
- Screening Results Worksession
  - ► Risk Factor Based Screening
  - Crash Prediction Model Screening
  - ► Method Comparison
- Discussion & Questions
- Next Steps & Near-term Actions



# **Project Objectives**

- This Plan Provides:
  - ► Framework for Conducting Systemic Intersection Safety Analyses
  - Risk Factors to Identify Locations for Treatments
  - ► Example Applications and Treatment Options
- This Plan *Does Not* Provide:
  - ► A Project List



# **Systemic Process**

**Step 7**: Evaluate Program and Project Impacts Step 1: Define Study Scope

Step 2: Compile Data

**Step 6:** Refine and Implement the Treatment Plan

**Step 3:** Determine Risk Factors

We are here

**Step 5**: Select Potential Countermeasures

**Step 4:** Identify Potential Treatmen Sites



# Project Scope & Schedule

Mar - May

June - July

July - Sep

Confirm Network, Compile Data, Identify Risk Factors



**Network Screening** 



Countermeasures & Prioritization



# Screening Results



# **Two Screening Methods**

### Risk Factor Screening

- Scoring based on risk factors (TM #1)
- Rank based on total scores in sub-groups
- Primary focus

### Safety Performance Function Screening

- Mathematical models using volumes, geometrics, control, and other features
- Predict the number of crashes



# Risk Factor Screening



# **Screening Process**

Join Data in GIS Software



Score Intersections for Each Risk Factor



Sum Scores & Rank



Review List & Identify Priority Sites



## Requirements

- Data
  - Roadway Network
  - Intersections (or ability to create)
  - ► Traffic Control Type (or ability to create)
  - One or More Risk Factors
- ► GIS Capabilities
- ► Interpret Results



# Risk Factor Weights

	Signalized		Stop Controlled						
Risk Factor	Urban	Rural	Urban	Rural					
Functional Classification									
Arterial (Principal + Minor)	1.03	-	1.25	-					
Arterial (Principal)	-	1.29		1.61					
Posted Speed									
35 mph	1.01	-	1.00	-					
40 – 45 mph	1.09	-	1.49	-					
45 – 50 mph	-	1.00	-	1.06					
≥ 50 mph	1.11	-	2.04	-					
≥ 55 mph	-	1.13	-	2.03					
Volume (AADT)									
AADT ≥ 10,000	-	-	1.27	1.80					
AADT ≥ 25,000	1.00	1.24	-	-					
Approach Characteristics									
Right Turn Lane Present	-	-	1.81	2.10					
Left Turn Lane Present	1.70	1.10	1.09	1.95					
Number of Through Lanes ≥ 3	-	-	1.33	1.51					
Number of Through Lanes ≥ 4	1.04	1.46	-	-					
Equity									
Medium High or High Equity Disparity	1.16	1.20	1.05	1.65					
Active Transportation									
Bicycle Volumes	1.03	1.27	1.31	1.00					
Pedestrian Volumes	1.01	1.44	1.03	1.13					



# What Risk Factors Does Your Agency Have Data For?



# Common Characteristics in Top 10% – Signals

### Urban

- Principal Arterials
- Volumes >25,000 ADT
- 4+ Lanes Major Street
- Left/Right Turn Lanes
- 40+ MPH
- Med-Hi/Hi Equity Disparity
- Multimodal Activity

### Rural\*

- Principal Arterials
- 4 Lanes Major Street
- Left Turn Lanes
- 30+ MPH
- Med-Hi/Hi Equity Disparity
- Multimodal Activity



<sup>\*</sup>Small sample size

# Common Characteristics in Top 10% – Stop Controlled

### Urban

- Principal Arterials
- Volumes >10,000 ADT
- 3+ Lanes Major Street
- Left/Right Turn Lanes
- 35+ MPH
- Med-Hi/Hi Equity Disparity
- Multimodal Activity

### Rural

- Principal Arterials
- Volumes >10,000 ADT
- Left Turn Lanes
- 55+ MPH
- Med-Hi/Hi Equity Disparity



# Do You Think Your Agency Could Apply This Process? Would You Find it Helpful?

If not, what obstacles would prevent you from applying it? What could make it more useful?



Does Ranking/Scoring Sites within Subgroups Make Sense or Would you Want to Compare Across All?



# Safety Performance Function Screening



## Requirements

- Data
  - Similar to risk factor screening + major/minor street AADT volumes
- ► GIS Capabilities
- Understanding of Models and Performance Measures



# **Screening Process**

Join Data in GIS Software



Calculate Predicted Crashes



Combine Predicted with Observed Crashes (Optional)



Calculate
Expected LongTerm Average
Crash Frequency



Does Your Agency Have Widespread Traffic Volume Data?



# Common Characteristics in Top 10% – Signals

### Urban

- Principal Arterials
- Volumes >25,000 ADT
- 4-Legs
- 4+ Lanes Major Street
- Left/Right Turn Lanes
- Med-Hi/Hi Equity Disparity

### Rural\*

Sample size too small



# Common Characteristics in Top 10% – Stop Controlled

### Urban

- Principal Arterials
- Volumes >10,000 ADT
- 4-Legs
- 30+ MPH
- Med-Hi/Hi Equity Disparity
- Multimodal Activity

### Rural

- Principal Arterials
- Volumes >10,000 ADT
- 4-Legs



# Comparison



# **Key Findings**

- Risk Factor Method
  - ► More Diverse Range of Sites
  - Speed, # of Lanes, and Other Factors Play a Greater Role
- > SPF Method
  - Higher volume, 4-Leg Sites



### **Considerations in Selecting a Method**

- Risk Factor Method
  - Less data intensive
  - Wider coverage
  - Places greater emphasis on selected factors
- SPF Method
  - Common, understood unit (crashes/year)
    - ► Easily feeds into benefit-cost analysis
  - Volume data required
  - Considers fewer inputs



## Discussion & Questions



# Next Steps & Near-term Actions



### **Next Steps & Near-term Actions**

- Example Applications
- Case Study How Does This Work for a Local Agency?
- Prioritization and Evaluation Methods
- ► Next LAAC meeting w/o September 4<sup>th</sup>



### MEETING SUMMARY

September 6, 2023 Project# 27003.022

Project Name: ODOT Intersection Safety Plan Update: Local Agency Advisory

Committee Meeting #3

Meeting Location: Microsoft Teams

#### **Attendees**

• Jiguang Zhao, ODOT

• Carl Lund, Marion County

• Julie Warncke, City of Salem

• Kevin Hottmann, City of Salem

Karl MacNair, City of Medford

 Melissa Norman, Washington County

Shyam Sharma, ODOT Region 1

Logan Telles, City of Eugene

Robin Lewis, City of Bend

• Clint Spencer, City of Hermiston

Mariana Montes, ODOT Region 2

James Philp, Jackson County

 Janelle Shanahan, Marion County

• Nick Foster, Kittelson

Katie Popp, Kittelson

Robert Olney, Kittelson

#### **Welcome and Meeting Overview**

- Nick provided a refresher of the systemic process.
- Steps 1-4 were addressed in LAAC Meeting #1 and Meeting #2. Today we are addressing the City of Salem Case Study and Steps 5-7: Countermeasure Selection and Prioritization, Implementation, and Evaluation.
- The information presented in this meeting is also discussed in Technical Memo #3 and the City of Salem Case Study Technical Memo.
- This is the final LAAC Meeting.

#### Countermeasure Selection and Prioritization

- Nick discussed how this plan aligns with ARTS countermeasure categories.
  - Hotspot projects are typically more expensive, implemented at a single site, and addressed through crash-based screening.
  - This plan focuses on systemic projects, which are lower cost and deployed across multiple sites.
- Nick walked through a summary of information provided in Technical Memo #3, including:
  - Example countermeasures

- Attachment B
- 30 sites selected in consultation with ODOT Region staff that scored high using the characteristics screening method.
- These are examples of potential countermeasures.
- Prioritization
  - Consider funding criteria of potential programs.
  - Additional diagnostics
    - Turning movement counts
    - Maintenance costs
    - Field visit
    - Overall funding eligibility and project readiness
  - Economic assessments
    - Benefit-cost analysis (BCA) at Hotspot sites
    - BCA for systemic intersection projects
    - Cost-effectiveness index (CEI) for bike/ped projects
- Questions/ comments about this process?
  - None

#### City of Salem Example Application

- Local agencies don't have to have the same dataset as ODOT to conduct the analysis.
- Differences in data between the City and ODOT:
  - Equity Salem has its own index, which was used for this analysis. It resulted in different, more focused coverage.
  - Bike facilities The City had data for shared-use paths and designed bikefriendly shared streets, which were also included in addition to bike lanes, which were all that were included in the ODOT dataset.
  - Traffic volumes used ODOT AADT data, which covered most arterials and collectors.
    - This data was used since it covers most intersections that would likely be prioritized. Those without counts are likely lower priorities.
    - If an agency doesn't have volume data and the ODOT volume data coverage is not sufficient, the agency could use functional class as a surrogate.
- Process followed:
  - City wanted to screen for locations to install green bike lane pavement markings and lighting at conflict points between right-turning vehicles and people biking at signalized intersections.
  - Kittelson filtered the data to sites that would be eligible for these treatments.

- Kittelson screened the filtered sites using the risk factor analysis method presented at the last LAAC meeting.
- Kittelson reviewed the sites scoring in the top 50% for potential countermeasure applicability.
- Next steps for the City:
  - Confirming desktop assessments
    - Conducting field visits and reviewing other data
  - Cost estimates
  - Draft set of sites
  - Calculate cost effectiveness index (CEI) and adjusting site mix as necessary for a competitive and appropriately sized application.
  - Completing ARTS application
- Key takeaways
  - Local jurisdictions can apply their own data to the analysis. The data doesn't have to be the same as the data used in the development of the risk factors.
  - Depending on data availability, cities/ counties can omit risk factors from overall calculations if you don't have data for everything. Use what you have available to prioritize sites.
  - o Reach out to ODOT if you have questions.
- Julie and Kevin from Salem shared that they found this process useful.
   Specifically, they've been getting questions from City Council about implementing green paint. They've been trying to figure out how to prioritize sites and develop a quality ARTS application, and this process gives them a defensible approach for selecting sites.
  - The biggest challenge they see is that staffing availability may limit opportunities to implement this methodology going forward.
  - o In the future, they may look for consultant help to apply it.
- Jiguang shared that the City of Salem application is promising, and he is hopeful that the process can be used more widely for safety screenings and selecting intersections for improvements.

#### **Poll Questions**

- 1. Do You Think Your Agency Could Apply This Process?
  - a. Yes 67%
  - b. Maybe 33%
  - c. No 0%
- 2. Would You Find This Screening Useful?
  - a. Yes -75%
  - b. Maybe 25%
  - c. No 0%

- 3. What Obstacles Would Prevent You from Applying it?
  - a. Staffing availability/staff resources (6 responses)
  - b. Data (2 responses)
- 4. What Could Make it More Useful?
  - a. Support with data entry
  - b. Pre-formatted data rules
  - c. Use it as a larger planning effort
  - d. ODOT and consultant support
  - e. Training
  - f. Periodic reminders of methodology
  - g. Make it a broader approach (across jurisdictions/ municipalities)

#### **Performance Monitoring**

- The memo describes useful strategies for local jurisdictions to evaluate projects/ programs related to:
  - Before-after studies
  - Implementation monitoring
  - Outcome monitoring
- Information on ODOT's calibrated SPFs can be found here: <a href="https://www.oregon.gov/odot/Programs/ResearchDocuments/HSM.pdf">https://www.oregon.gov/odot/Programs/ResearchDocuments/HSM.pdf</a>
- If any cities or regions are interested in doing before/ after studies, let Jiguang or Christi know. ODOT may be able to provide some assistance or answer questions.

#### **Discussion & Questions**

From your perspective, what other challenges do you face in identifying or applying for systemic safety projects?

- Julie Warncke
  - Using federal funding for low-cost systemic treatments can be inefficient.
     Other challenges:
    - Lead time This year's application is for 2027-2030
      - Conditions might change between when we apply and when we get to implementation.
- Melissa Norman
  - o Agrees with Julie's statements.
  - Another challenge crash data:
    - Planning for next 4-5 years using data from several years ago
    - Use of older data doesn't align with goals/concerns of local elected officials.
  - o It can sometimes be difficult to show how low-cost treatments improve safety to the public or elected officials because they don't see large scale results.

- o The process for implementing safety projects is slow, which can impact public perception of how funds are spent and the results of those projects.
- Working on a before-after study of curve related improvements in Washington County to see how their results match the ODOT CRF.

#### **Action Items/ Next Steps**

- Project team is in the process of revising memos and writing the final report.
- Reach out to Christi or Jiguang to provide any feedback or questions on how to implement the project, technical support, etc.
- This is the final LAAC meeting.
- The LAAC can continue to send comments or questions on the draft Tech Memo #3 or the City of Salem Case Study application to the project team by Friday, 9/8.

#### **Attachments**

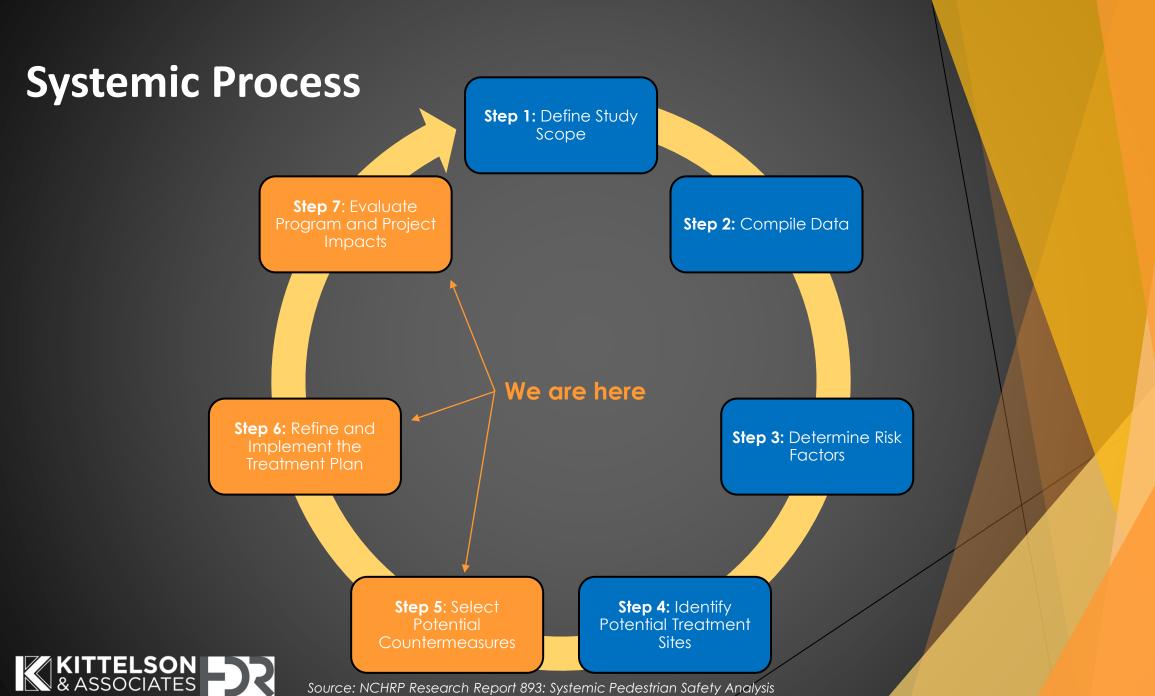
1. Meeting #3 Presentation Slides



### Agenda

- Welcome/Overview
- Countermeasure Selection and Prioritization
- City of Salem Example Application
- Performance Monitoring
- Discussion & Questions
- Next Steps





### Project Scope & Schedule

Mar - May

June - July

July - Sep

Confirm Network, Compile Data, Identify Risk Factors



**Network Screening** 



Countermeasures & Prioritization



# Countermeasure Selection and Prioritization



# ARTS Countermeasures Categories (Applicable to Intersections)

Hotspot (Single Site Projects)



SPIS or other Crash-Based Screening



**Hotspot Countermeasures (H#)** 

Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure	
Hotspot		Left Turn Lane on Single Major Road Approach: Rural, Signalized Intersection (3-leg)	

Systemic Projects (Multiple Sites)



**Characteristics-Based Screening** 



Systemic Intersection Countermeasures (I#)

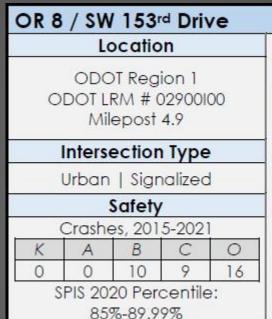
Systemic Bike & Ped Countermeasures (BP#)

Hotspot or Systemic Application Type	Countermeasure Number	Countermeasure
Intersection Systemic	13	Add 3-inch yellow retroreflective sheeting to signal backplates



### **Example Countermeasures**

be considered





Potential Countermeasure	ARTS #	CRF (%)	Potential GHG Effect(s)	SSA Principle(s) Addressed				
Low-cost countermeasures								
Improve Signal Hardware: Lenses,		20% for 2;		Safa Daada, Safa Daad Haara				
Reflectorized Back plates, Size, and	12	25% for 3-4;	- No effect	Safe Roads; Safe Road Users - Increases Visibility				
Number		30% for 5-6						



### **Prioritization – Next Steps**

- Additional community priorities/programming needs
- Additional diagnostics
- Economic assessments
  - BCA vs. CEI
- Allocate funding/apply for funding

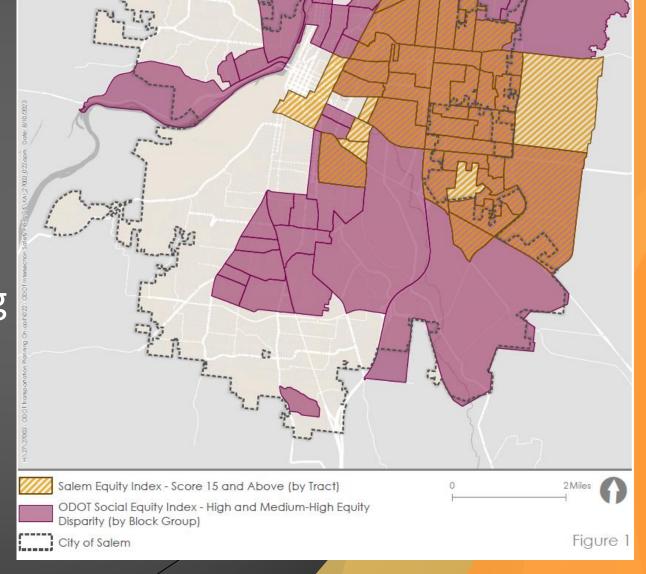


# City of Salem Example



### Data Availability – Differences from ODOT

- Bicycle network
- Traffic volume coverage
  - ► Used ODOT data
- ► Intersections some cleaning
- Ramp terminals excluded
- Equity index





# Screening for Systemic Countermeasures

- Filter intersections by:
  - Signals
  - ▶ Bike lane
  - ► Right-turn lane
- Screen using risk factor analysis

#### BP6: Install Urban Green Bike Lanes at Conflict Points

**Description**: Green bike lanes are green-colored pavement placed on the roadway to enhance visibility of a bicycle lane.



#### ODOT CRF Value:

39%

Reduction in Bicycle Crashes at All Severities (Including PDO's)

#### Range of Effectiveness:

39%

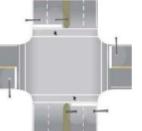
#### Safety Effects:

It helps to bring awareness of the presence of potential bicyclists in locations where drivers may not be expecting them.

#### BP2: Provide Intersection Illumination (Bike & Ped)

**Description**: A permanent source of artificial light installed at an intersection that provides greater visibility of the intersection and its potential multi-modal users.





#### Images from FHWA

#### ODOT CRF Value:

42%

Reduction in Nighttime Pedestrian and Bicycle Crashes at All Injury Severities (Excluding PDO's)

#### Range of Effectiveness:

42%



### **Site Review**

- Review top 50% for applicability
  - Aerial and street-level imagery
- Used lighting GIS data, but could use photos/field visit





### **Next Steps**

- Confirm assessments
- Cost estimates
- Draft set of sites
- Calculate CEI & adjust sites as needed
- ARTS application



Save As



#### OREGON DEPARTMENT OF TRANSPORTATION Highway Safety Improvement Program (HSIP) COST ESTIMATION WORKSHEET

See Instructions

All costs related to the proposed project must be accounted for on this worksheet, including costs covered by other types of funding. List funding amounts from other sources in the "Non-Eligible Costs" section.

List estimated costs for the various activities listed below, as applicable to proposed project. Round all costs up to the nearest hundred dollars. For each activity listed below, write a description of the items included. Please list the items separated by a comma (,) as space is limited.

Project Name:

**Project Description:** 



### **Key Takeaways (Data)**

- Some GIS capabilities required
- Considerations/Potential Challenges
  - Intersection control
  - ► Missing information omission vs. surrogates
  - ► Ramp terminals not likely relevant for systemic screening
  - Can create an intersection dataset if one does not exist
- Reach out to ODOT for assistance



### **Key Takeaways (Application)**

- ► Risk factor screening useful for systemic treatments
  - ► Can identify countermeasure first or screen first and then identify countermeasure
  - Crash history still important for Systemic Intersection ARTS applications



## Q&A/Discussion



### **Poll Questions**

- ▶ Do You Think Your Agency Could Apply This Process? Would You Find it Helpful?
  - ► If not, what obstacles would prevent you from applying it? What could make it more useful?



# Performance Monitoring



### **Project/Program Evaluation**

- Before-after study
  - Group systemic/similar projects
  - Use ODOT-calibrated safety performance functions (SPFs), if possible
- Implementation Monitoring
  - Is the program being implemented?
- Outcomes
  - Crashes by focus area(s)



## Discussion & Questions



# Next Steps



### **Next Steps**

- Memo revisions
- Final report
- ► ARTS applications!

