



# City of Bend

## Multimodal Traffic Safety Study 2012-2014

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*The purpose of this multimodal traffic safety study is to determine the most significant causes, types and characteristics of crashes in the city and identify how best to mitigate for these crashes given very limited resources.*

### **Goals:**

***Reduce crashes and community costs***

### **Objectives:**

- ***Conduct public outreach about safety program***
- ***Develop a list of highest priority traffic safety projects***
- ***Focus on injury crashes***
- ***Create on-going monitoring and safety assessment methodology***

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SUMMARY

The city has very limited staff resources to mitigate for multimodal crashes. Significant staff reduction in recent years has caused the transportation division and the Traffic Safety Advisory Committee to re-evaluate the crash program. With consulting services from Kittelson & Associates, staff reviewed current trends and practices. The national Highway Safety Manual, first published in 2010, has established a new methodology for addressing safety. This new methodology is data-driven and allows efficient resource allocation for improved transportation safety. The city is one of the first communities to implement this new approach to safety.

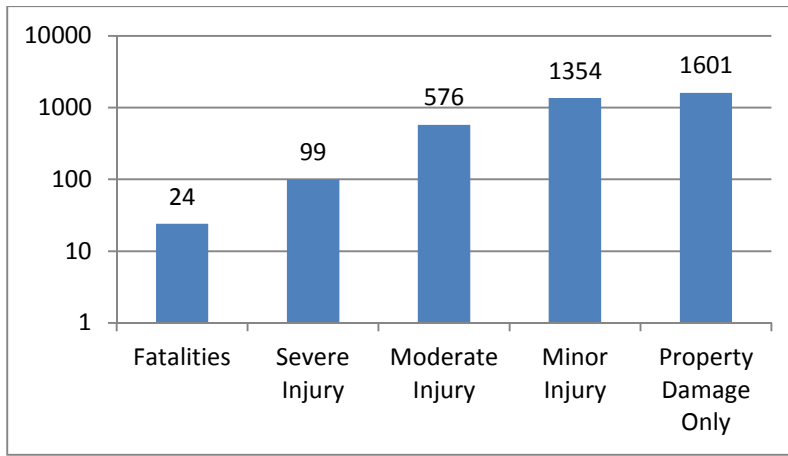


FIGURE 1. CRASHES BY SEVERITY  
SOURCE: ODOT 2006-2010

As shown in Figure 1, crashes in the city from 2006 to 2010 included:

- 3,654 reported crashes – about 700 per year,
- 2,029 injury crashes,
- 1,601 property damage only crashes, and
- 24 fatalities.

Comprehensive Economic Impacts of Crashes			
Crash Severity	Property Damage Only (PDO)	Fatal & Severe Injury	Moderate and Minor Injury
Reported Crashes	1601	123	1930
Comprehensive Economic Value Assigned per Crash Severity	\$15,000	\$840,000	\$47,900
Economic Impacts	\$24,015,000	\$103,320,000	\$92,447,000
Five Year 06-10 Comprehensive Economic Value of Crashes \$219,782,000			

TABLE 1. 5-YEAR TOTAL ECONOMIC IMPACTS OF CRASHES IN BEND  
SOURCE: ODOT 2006-2010

The total economic cost of property damage, fatality and injury crashes for the 5-Year window was \$219,782,000 (Table 1). Reported crashes cost our community roughly \$44 million a year. Costs associated with crashes range from initial services such as emergency response and public works clean-

up to insurance costs, property repairs, and ultimately the costs to individuals and families. The community loses significant resources that are not typically accounted for or discussed. Loss of life permanently changes a family. Loss of income and medical costs are the largest financial losses associated with a crash.

Figure 2 provides a breakdown of the crashes by roadway functional classification. These crashes occurred on roadways under the jurisdiction of the city of Bend and did not include crashes on ODOT's Hwy 20 (3<sup>rd</sup> Street from Greenwood Avenue northward, Greenwood Avenue from 3<sup>rd</sup> Street eastward). Using the data from Figure 2, the city determined that a focus on Collector and Arterial (including Principal Arterial) crash reduction would have a greater impact on the community as they represented more than 85% of the total reported crashes.

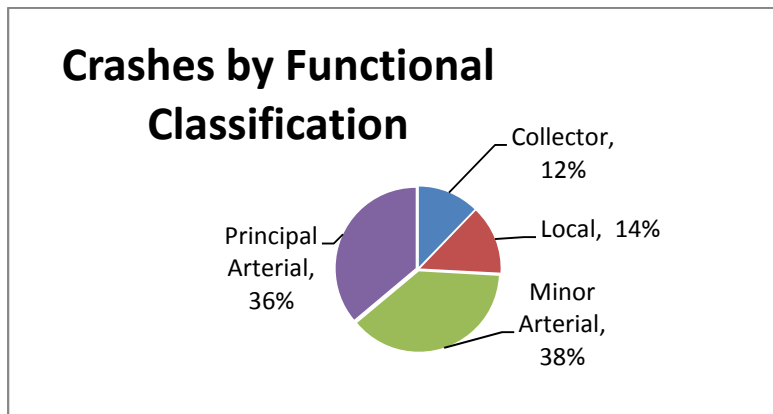


FIGURE 2. CRASHES BY ROADWAY FUNCTIONAL CLASSIFICATION  
SOURCE: ODOT 2006-2010

#### ALCOHOL AND SPEED RELATED CRASHES:

Between 2006 and 2010, there were 315 alcohol or drug related crashes. Of these types of crashes 144 resulted in a fatality or an injury.

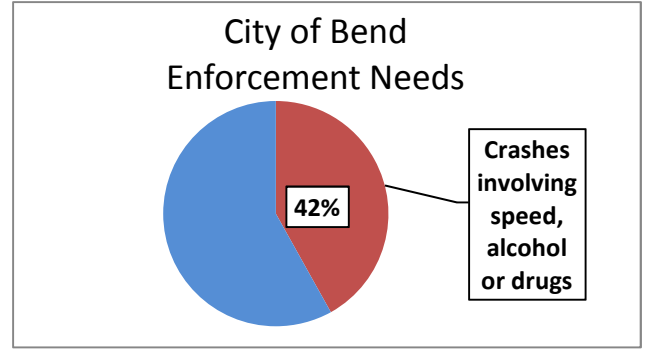
During the same time period, there were 1216 types of crashes related to speeds. Of these crashes, 325 resulted in a fatality or injury, and 103 resulted in a crash with a fixed object.

46% of alcohol or drug related crashes result in **death or injury**.

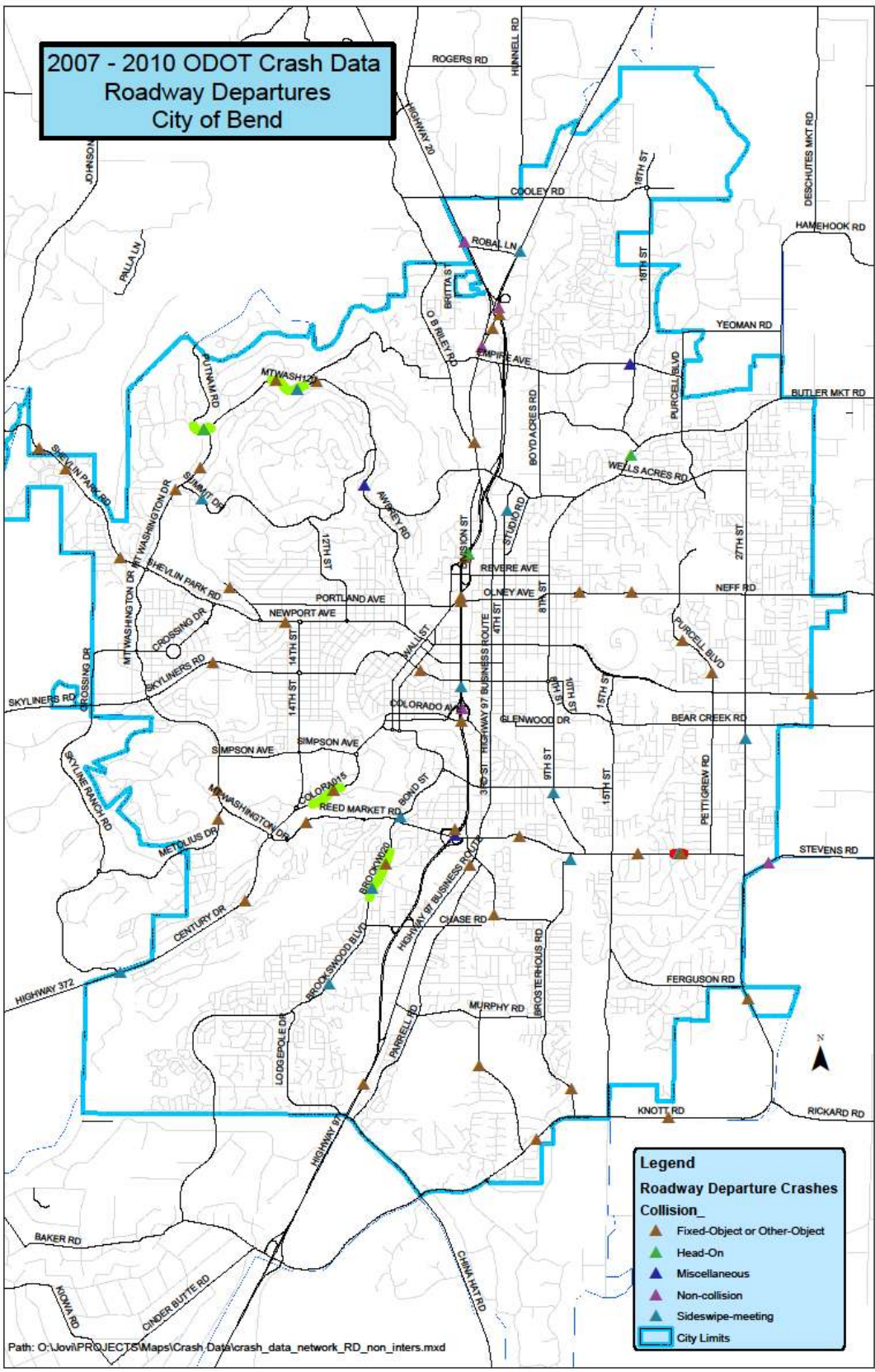
Figure 3 identifies 42% of all crashes in Bend involved speeding or driving while under the influence of alcohol or drugs. Currently approximately 100 hours per week are provided to the community in the form of a police traffic team. These 100 hours are not dedicated to enforcement patrolling, however. These hours are also used for incident response, court preparation and appearances, training and, finally, also on enforcement patrolling. Additional police personnel are needed to impact speeding and DUII issues within our community. Enforcement is limited to "chance encounters" in most cases. This is also the case for DUII enforcement.

FIGURE 3. SPEED, ALCOHOL OR DRUG INVOLVEMENT

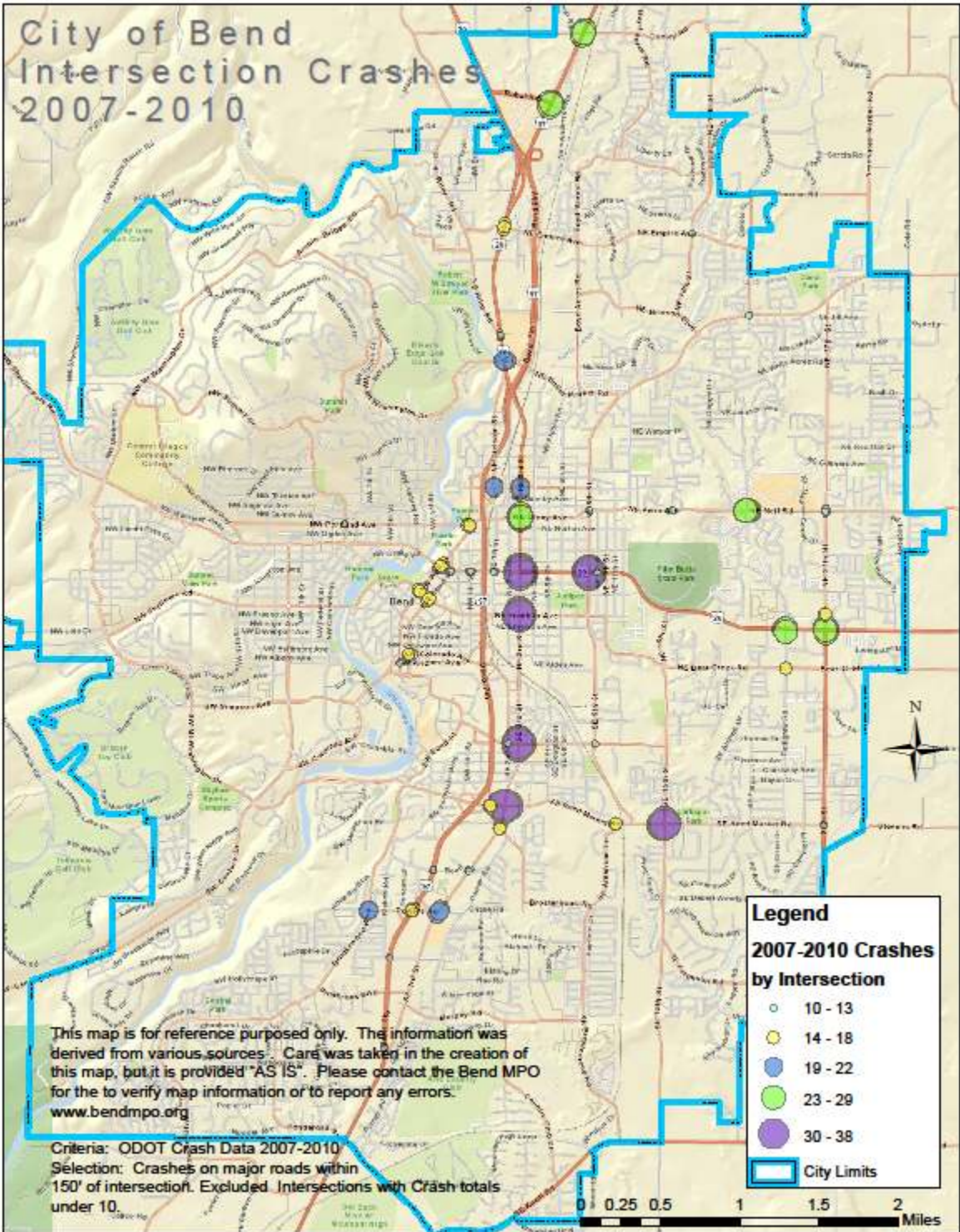
Source: ODOT 2006-2010



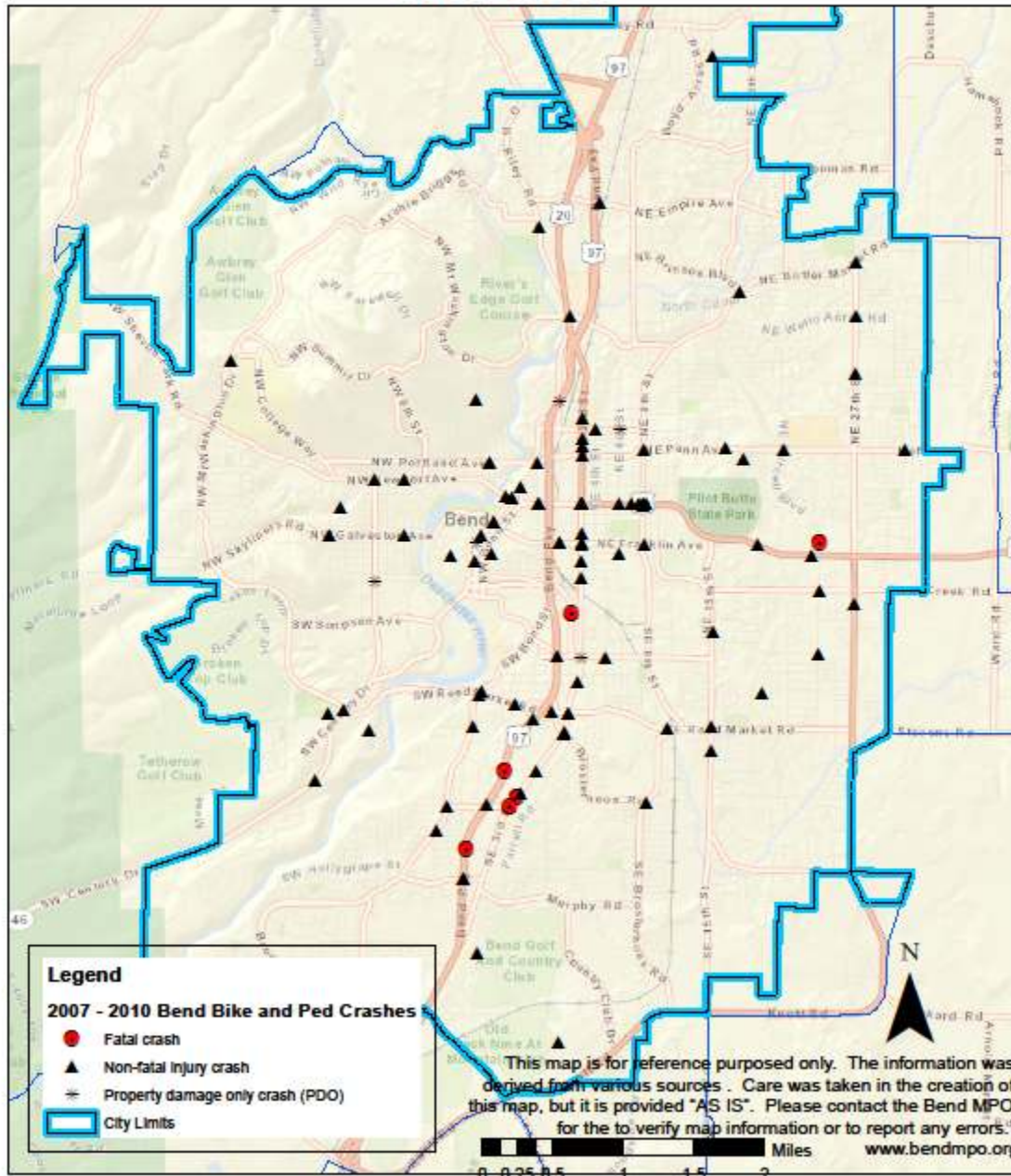
**2007 - 2010 ODOT Crash Data  
Roadway Departures  
City of Bend**



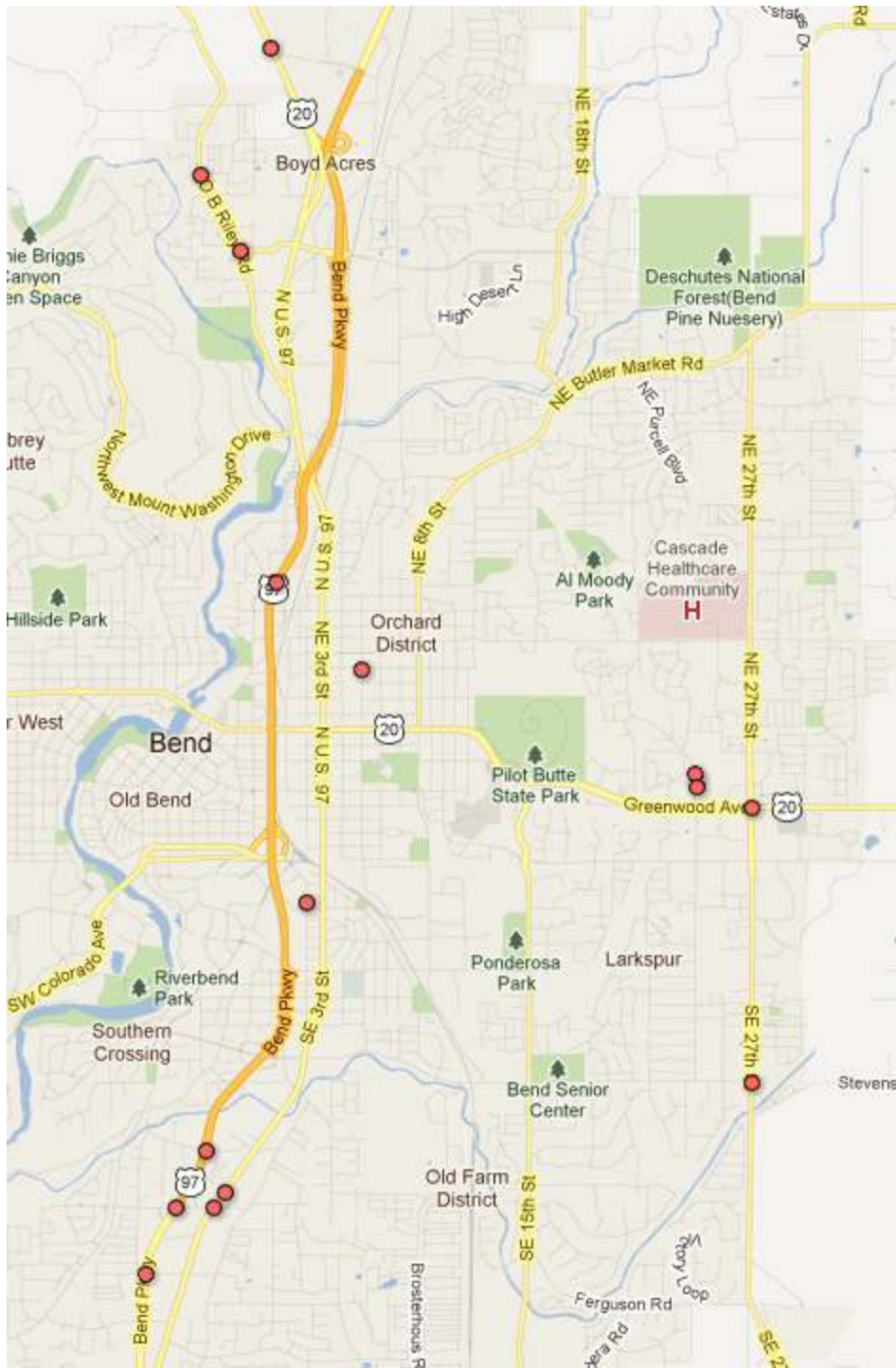
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# City of Bend Bike and Pedestrian Crashes 2007-2010







MAP: FATAL CRASHES 2007 TO 2010

## METHODOLOGY

The city outlined a safety management program meeting the core requirements of the Highway Safety Manual.

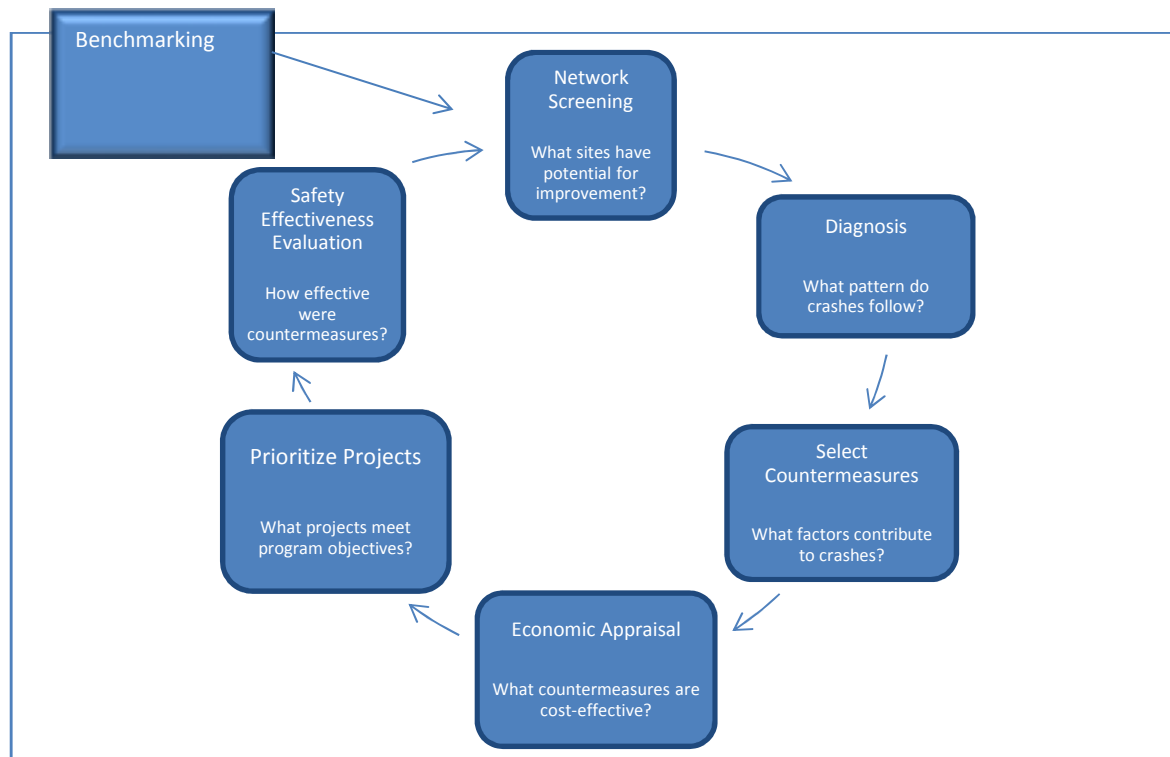


FIGURE 4. CITY OF BEND TRAFFIC SAFETY MANAGEMENT PROGRAM

The program is cyclical as shown in Figure 4 and can be repeated periodically. The Project Prioritization phase of the cycle could be performed to coincide with CIP planning work with the goal of implementing projects that would reduce crashes. During the Safety Effectiveness Evaluation phase, the city will determine how successful certain types of mitigations were on crash reduction and adjust the program accordingly.

The first step of this year's cycle added a Benchmarking phase. Benchmarking allowed us to look at other communities and see where Bend stood – “were we a safer community or a less safe community than others of comparable size in Oregon?” What we found shaped the development of our program's countermeasures to include enforcement

*Bend has a higher amount of fatalities compared to other communities.*

*Bend 24*

*Vs.*

*Corvallis 2*

***Bend had a higher amount of speeding and DUII types of crashes than the comparison communities.***

as well as education with our engineering countermeasures. For instance, Bend has a higher amount of speeding and DUII types of crashes, as compared to other comparable Oregon cities. We also found that we had a higher amount of fatal crashes, with a total of 24 fatalities between 2006 and 2010. One comparison community, Corvallis, had 2 fatalities during the same time period.

During the Benchmarking Phase, the city identified specific crash characteristics that appeared out of the norm when compared to three other Oregon communities (Springfield, Medford, Corvallis). These five crash characteristics became the program’s 2012-2014 focus areas and are strategically prioritized for crash reduction in Bend:

- Fatal and injury crashes,
- Alcohol-involved crashes,

- Speed-involved crashes,
- Pedestrian and bicyclist crashes,
- Roadway Departure crashes.

As detailed in the Technical Memorandum entitled, “*Benchmarking and Identification of Focus Areas,*” provided in Appendix 2, other communities in Oregon had much fewer fatal crashes and much fewer crashes noting alcohol and speed as contributing factors. Because one third of the fatal crashes in Bend involved a pedestrian or a bicyclist, reducing crashes for those users became a focus area. Roadway Departure crashes are high throughout Deschutes County and ODOT Region 4, which includes Bend compared to other counties and ODOT regions.

TABLE 2 FOCUS AREA CRASH CAUSATION		
Source: ODOT 2006-2010		
Roadway Departure	Bicyclist	Pedestrian
201 Crashes	58 Crashes	25 Crashes
Contributing Factors	Contributing Factors	Contributing Factors
Alcohol	Wrong Way Riding	Multilane roadway crossings
Speed	Night time visibility	Non-exclusive “WALK” phase of signal
Fixed Object	Right turn hook	Night time visibility

The next three phases would be performed each time the cycle was repeated: Network Screening phase, Diagnosis phase and Project Ranking phase. The process to develop the program and a more detailed

description of each phase are provided in the Technical Memorandum entitled, "Transportation Safety Framework Plan," which is provided in Appendix 1.

The 2012-2014 Traffic Safety Program used statistical data analyses to screen the network to identify high crash locations within each of these focus areas. These locations are intersections or roadway segments with a high number of crashes or a higher number of crashes than expected. The Network Screening process followed the Highway Safety Manual Methodology. A detailed explanation of the process is provided in Appendix 3 in a technical memorandum entitled, "*Network Screening*." This network screening resulted in 20 locations identified for further study. A 21<sup>st</sup> location was added during the next steps when an additional crash occurred during the analysis period at one of the roadway departure locations mapped in network screening. This location was on Mt. Washington Drive just east of Archie Briggs Road.

The network screening process was used to identify a subset of all crash locations throughout the community that staff could focus on for crash reduction.

For each of these 21 locations, staff identified crash patterns using crash diagramming. Countermeasures were identified with the goal of eliminating specific patterns of crashes at each location. Each countermeasure has an identified effectiveness rating. The effectiveness rating is listed in terms of Crash Reduction Factor (CRF) which is the percentage of the crashes predicted to be eliminated based on the implementation of the countermeasure. CRFs published in the Highway Safety Manual were utilized whenever available. CRFs ranged from nearly fool proof (almost all crashes would be eliminated) to somewhat effective. Additional countermeasures, such as enforcement and/or education are needed to alter behavior (crashes with a causation of speed, DUII, Red Light Running, dark clothing, etc.) for those crash patterns/types that have a low CRF.

Appendix 4 provides the crash diagrams, engineering cost estimates, and calculation sheets used to tabulate the economic benefits of the countermeasures. Table 3 summarizes the detailed data provided in Appendix 4. Table 3 shows each of these locations, the crash trend summary, identified countermeasures, countermeasure cost and the estimated potential economic impact due to crash reduction.

TABLE 3. CAPITAL IMPROVEMENT PROGRAM (CIP) PROJECT LIST

<b>Table 3. CIP Project List (alphabetical order, not ranked)</b>				
<b>Project Location</b>	<b>Crash Trend</b>	<b>Countermeasures</b>	<b>Counter-measure Cost</b>	<b>Countermeasure Economic Impact via Crash Reduction</b>
1 <sup>st</sup> Street at Greenwood Avenue <sup>1</sup>	NB EB angle crashes	<b>Curb extensions south side</b>	\$ 44,376	\$ 22,000
2 <sup>nd</sup> Street at Wilson Avenue	Sidestreet crossing (poor visibility)	<b>Improve visibility by do not block intersection</b>	\$ 18,480	\$ 150,000
27 <sup>th</sup> Street at Butler Market Road	System: Permitted Left turn crashes;  System: Red Light Running;  EB Thru v. EB right Rear End;  System: T-intersection run off the road	<b>Protected Only Phasing</b>  <b>Signal Timing and Phasing</b>  <b>Add Bike Lane</b>  <b>Improve warning signage</b>	\$ 56,560	\$ 200,000
27 <sup>th</sup> Street at Reed Market Road  (Implement with GO Bond project)	System: Permitted Left turn crashes  System: T-intersection run off the road	<b>Protected Only Phasing</b>  <b>Improve warning signage</b>	\$ 96,740	\$ 1,802,000

<sup>1</sup> Not proposed for ranking due to low Benefit-Cost Ratio

<b>Project Location</b>	<b>Crash Trend</b>	<b>Countermeasures</b>	<b>Counter-measure Cost</b>	<b>Countermeasure Economic Impact via Crash Reduction</b>
3 <sup>rd</sup> Street at Franklin Avenue	<b>System: right turn hook with BIKE</b>  <b>System: Red Light Running</b>	<b>Dutch Bike Crossings</b>  <b>Signal Timing and Phasing</b>	\$ 259,256	\$ 998,000
3 <sup>rd</sup> Street at Brosterhous Road	<b>System: Red Light Running</b>  <b>System: Left hook with pedestrian</b>	<b>Signal Timing and Phasing</b>  <b>Protected only phasing</b>	\$469,000	\$ 228,000
3 <sup>rd</sup> Street at Powers Road	<b>System: Red Light Running</b>  <b>System: Right Turn on Red Hit Ped</b>  <b>Left hook with Ped</b>	<b>Signal Timing and Phasing</b>	\$ 65,856	\$ 834,000
3 <sup>rd</sup> Street at Reed Market Road (seek implementation with GO Bond project)	<b>System: Red Light Running</b>  <b>System: Right hook with Ped</b>  <b>System: Right hook with BIKE</b>	<b>Signal Timing and Phasing</b>  <b>Leading Ped Phase</b>  <b>Dutch Bike Crossings</b>	\$ 183,538	\$ 1,350,000
Arizona Avenue at Wall Street	<b>System: Red Light Running</b>	<b>Signal Timing and Phasing and Signal Head visibility</b>	\$ 83,266	\$ 229,000

<b>Project Location</b>	<b>Crash Trend</b>	<b>Countermeasures</b>	<b>Counter-measure Cost</b>	<b>Countermeasure Economic Impact via Crash Reduction</b>
Awbrey Road at Portland Avenue	<b>Sidestreet crossing hit mainline bike</b>  <b>System: Rear end in shared Left-Thru</b>	<b>Mini roundabout</b>	\$ 98,883	\$ 283,000
Bear Creek Road at Pettigrew Road	<b>Stop sign run NB &amp; WB</b>	<b>Enhance visibility of stops</b>	\$ 6,820	\$ 657,000
Bond Street at Colorado Avenue	<b>System: Red Light Running</b>	<b>Signal Timing and Phasing and Signal Head visibility</b>	\$ 58,776	\$ 238,000
Bond Street at Reed Market <sup>2</sup>	<b>No crash trend</b>	<b>No countermeasure</b>	N/A	N/A
Brookwood Boulevard at Pinebrook Boulevard <sup>3</sup>	<b>Sidestreet left out</b>	<b>New roundabout at Murphy (100' south) will change patterns</b>	N/A	N/A
Country Club Road at Murphy Road	<b>Stop sign run NB</b>	<b>Enhance visibility of stop</b>	\$ 6,160	\$ 444,000
Division Street at Revere Avenue	<b>System: permitted lefts</b>  <b>System: Rear End in shared Left-Thru</b>  <b>System: Red Light Running</b>	<b>Protected Only Phasing</b>  <b>Road Diet</b>  <b>Signal Timing and Phasing</b>	\$ 144,259	\$ 1,393,000

<sup>2</sup> Not proposed for ranking due to no crash trend/no available countermeasure

<sup>3</sup> Not proposed for ranking due to short-term roadway network changes 100' south

<b>Project Location</b>	<b>Crash Trend</b>	<b>Countermeasures</b>	<b>Counter-measure Cost</b>	<b>Countermeasure Economic Impact via Crash Reduction</b>
Firerock Lane at OB Riley <sup>4</sup> Road	No crash trend	No countermeasure	N/A	N/A
Greenwood Avenue at Hill Street	Pedestrian/Bicycle crossing safety	Add curb extensions, advance stop bars, illumination	\$ 167,655	\$ 70,000
Franklin Avenue at Wall Street	System: right turn on red crossing BIKE;  System: right hook of peds  Pedestrian compliance to Don't Walk	Eliminate southbound right turn lane  Leading pedestrian phase  Wait Audible Message	\$ 80,663	\$ 101,000
Mt. Washington at Archie Briggs Road	Roadway Departure	Curve warning signs, guard rail	\$ 182,160	\$ 349,000
Neff Road at Purcell Boulevard	System: right turn on red crossing BIKE  Rear End northbound (mis-understanding of single lane approach)  Permitted Left Turn crashes	No RTOR  Provide bike lanes, clearly sign and stripe single lane approach  Protected Only Phasing	\$ 100,390	\$ 848,000
<b>Totals</b>			<b>\$ 2,123,838</b>	<b>\$ 10,196,000</b>

<sup>4</sup> Not proposed for ranking due to no crash trend/no countermeasure available



As noted in the table 3 footnotes, some locations did not have crash trends, or the crash trend might be altered by a nearby eminent project, or the predicted benefit cost ratio was negative.

Some projects can be grouped together for cost savings. These include the 3<sup>rd</sup> Street signalized corridor, Bear Creek/Purcell paired with the Country Club/Murphy stop sign improvements, and the Arizona/Wall Street signal paired with the Bond/Colorado Signal. Each of these project pairings has similar countermeasures, so design and construction efficiency should be achieved when combined.

As noted in Table 3 above, allocating approximately \$2,123,838 to the CIP program for engineering fixes has an estimated economic benefit of \$10,196,000. As further discussed below, there is an additional \$16 million in economic impacts that could be further reduced by implementing education and enforcement countermeasures as well.

### **A Broad Based Safety Program is Necessary**

#### **The case for increased enforcement, education and changes to standards and specifications:**

As noted earlier, many crashes are caused by unsafe behaviors and choices of drivers. DUII, excessive speed, and red light running each need increased enforcement in the community. Engineering countermeasures can only go so far to reduce those crashes. Therefore, enforcement and education is critical.

Unsafe behaviors and choices of pedestrians and bicyclists also contributed to crashes. Chief among these were dark clothing, lack of headlights/reflectors at night, and wrong way riding. Engineering countermeasures can help wrong way riding where a lack of safe roadway crossings or bike facilities encourage wrong way riding. However, the vast majority of these crashes will need to be tackled through education and enforcement.

As noted during the crash identification phase, engineering solutions could be identified for many of the crash types. This means that our previous system designs have built in conflicts which result in built in crash risk. The Safety Program therefore also recommends changes to the City's standards and specifications to implement state of the art and technology solutions so that crash risk is prevented through design. Table 4 summarizes each aspect of the 3E (Education, Enforcement, Engineering) approach that makes up the foundation of the Transportation Division's Safety Program.

TABLE 4. SUMMARY OF 2012-2014 CRASH REDUCTION PROGRAM ELEMENTS

<b>Table 4.</b>		
<b>Summary of 2012-2014 Crash Reduction Program Elements</b>		
<b>Education</b>	<b>Enforcement</b>	<b>Engineering</b>
Continue current education programs	Focus on high crash locations	Design and Construct CIP Project List
Supplement existing programs with focus on: <ul style="list-style-type: none"> <li>• Biking (visibility at night, risk of vehicles turning across their path of travel, wrong way riding)</li> <li>• Walking (visibility at night, risk of vehicles turning across their path of travel on "WALK," multiple approach lane risk during roadway crossings)</li> <li>• Driving (speeding, DUII, red light running, turning across a bicyclists path of travel, yielding to people walking)</li> </ul>	Focus on high crash causations: <ul style="list-style-type: none"> <li>• Speeding</li> <li>• DUII</li> <li>• Red Light Running</li> <li>• Failure to Yield to bicyclists and pedestrians</li> </ul>	Perform city-wide Curve Warning Assessment and Mitigation
	Continue Bike Diversion Program	Perform city-wide Roadside Hazard Identification and Mitigation
	Investigate Pedestrian Diversion Program	Update Standards and Specifications to reflect state of the art and technology usage to reduce crash risks
	Find ways to support more funding for traffic enforcement	Implement multi-modal count program to support future crash analysis efforts

# APPENDIX 1

## TECHNICAL MEMORANDUM

[Bend Arterial and Collector Safety Project Program Development](#)

[Transportation Safety Framework Plan](#)

<http://bendoregon.gov/modules/showdocument.aspx?documentid=10377>

## APPENDIX 2

### TECHNICAL MEMORANDUM

[City of Bend Arterial and Collector Safety Project Program Development](#)

[Phase B Memorandum: Benchmarking and Identification of Focus Areas](#)

<http://bendoregon.gov/modules/showdocument.aspx?documentid=10376>

## APPENDIX 3

### TECHNICAL MEMORANDUM

[Bend Arterial and Collector Safety Project Program Development](#)

[Network Screening](#)

<http://bendoregon.gov/modules/showdocument.aspx?documentid=10375>

## APPENDIX 4

### TECHNICAL MEMORANDUM

Bend Arterial and Collector Safety Project Program Development

Diagnosis and Project Ranking

<http://bendoregon.gov/modules/showdocument.aspx?documentid=10374>