

TECHNICAL MEMORANDUM

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Project #31171.0

To: Project Management Team

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Project: Bend Transportation Safety Action Plan Update

Subject: Final Tech Memo #2: Safety Analysis Framework

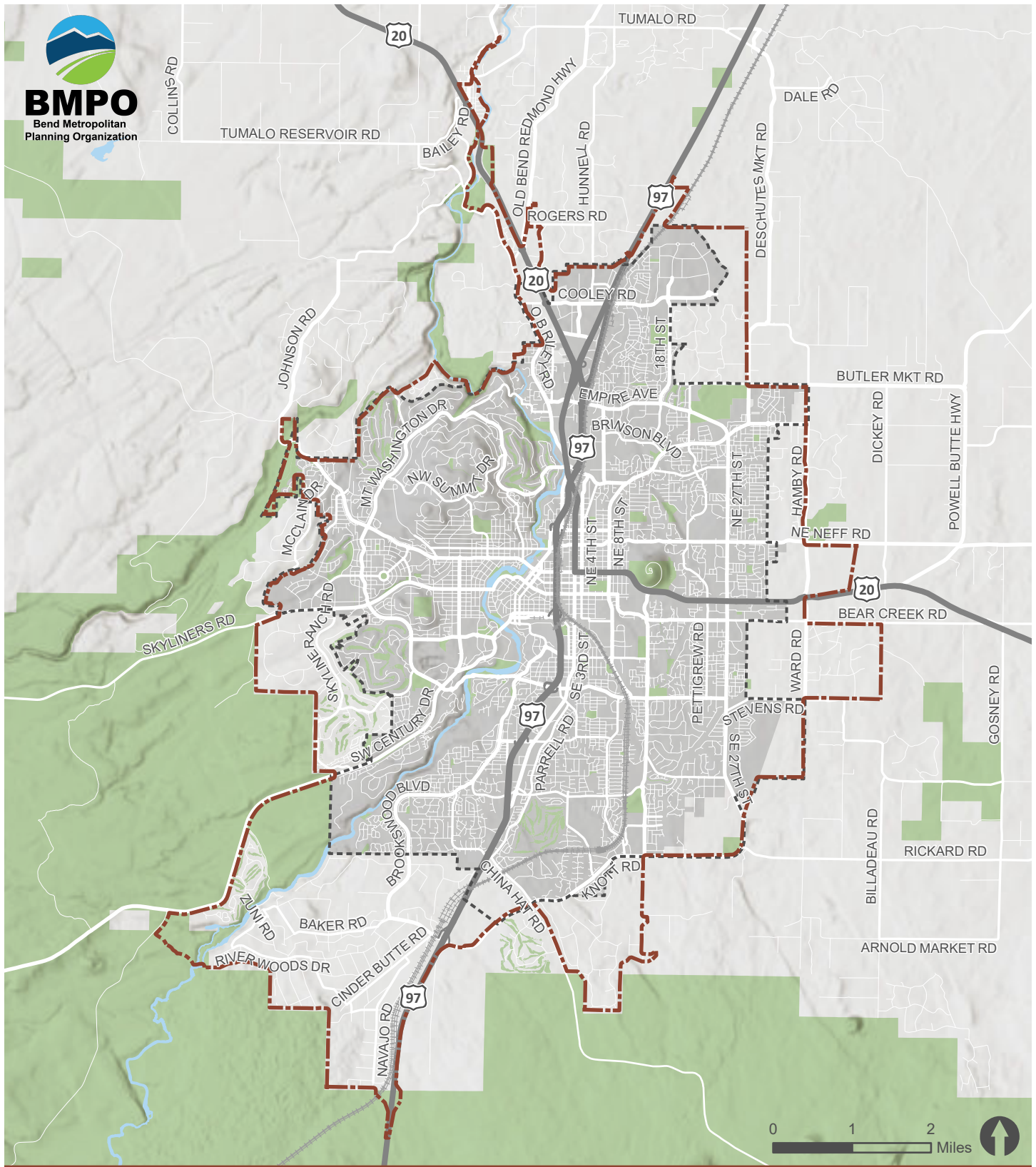
Background

This memorandum presents the proposed safety analysis framework for the Bend Metropolitan Planning Organization (MPO) Transportation Safety Action Plan (TSAP) Update. Since the adoption of the first TSAP in 2019, the MPO is now updating the plan to assess progress in reducing fatal and serious injury crashes across its transportation network and to realign safety priorities as needed. The framework presented herein outlines the proposed safety analysis methodology for the TSAP that will support a prioritized list of projects, programs, and policies to reduce crash frequency and severity within the study area, shown in Figure 1. The study area includes all public roadways within the Bend Metropolitan Planning Organization (BMPO) boundary.

Comprehensive Approach to Safety

A comprehensive approach to transportation safety acknowledges that policy, planning, programming, and projects are multidisciplinary. Recognizing this, the United States Department of Transportation (USDOT) has adopted the **Safe System Approach** to guide its roadway safety efforts based on six principles and five objectives, shown in the graphic to the right. The six Safe System Approach principles, shown on the outside ring of the graphic, encompass the fundamental beliefs upon which the approach is built. The five Safe System Approach objectives, shown in the middle ring of the figure to the right, are conduits through which the approach is implemented (Reference 1 – USDOT Safe System Approach).





- Bend MPO Boundary
- Bend Urban Growth Boundary
- City of Bend
- National Forest, Park, or Golf Course

Figure 1 - Study Area

Bend MPO TSAP

To achieve a multidisciplinary plan, input will be gathered by a variety of community interests throughout the plan development process:

- **Project Management Team (PMT)** – The PMT includes key staff from the BMPO, City of Bend, and the Oregon Department of Transportation (ODOT) who meet regularly to provide technical input during key steps.
- **Project Advisory Committee (PAC)** – The PAC represents a wide range of interests (i.e., Deschutes County, City of Bend, Bend La Pine Schools, Federal Highway Administration, Central Oregon Intergovernmental Council, Commute Options, Deschutes County Bicycle and Pedestrian Advisory Committee, Bend Park and Recreation District, community members, Cascades East Transit, health services, law enforcement, Oregon State University Cascades, fire and emergency medical services, and ODOT). This group will meet three times at key project milestones to provide input on the existing conditions analysis and the TSAP’s policy, program, and project recommendations. This group will also discuss and identify non-engineering solutions to further support crash reductions through a multidisciplinary approach.
- **BMPO Policy Board** – The PMT will engage with the governing body of the BMPO, BMPO Policy Board, three times during the project to provide updates and solicit guidance. The PMT will request that the BMPO Policy Board make a public commitment to the TSAP goal of zero transportation-related fatalities and serious injuries and a near-term benchmark to make progress toward the goal.
- **Bend City Council** – The PMT will engage with the governing body of the City, the Bend City Council, three times during the project to provide updates and solicit guidance. The PMT will request that the Bend City Council make a public commitment to the TSAP goal of zero transportation-related fatalities and serious injuries and a near-term benchmark to make progress toward the goal.
- **Community Engagement** – The planning process will include two rounds of public outreach at key milestones to inform transportation safety needs and develop associated recommendations. BMPO staff may also conduct additional outreach activities with interested parties or the general public to share project information and solicit feedback.

Analysis Framework

The process, analysis tools, and methods that will be used to update the BMPO TSAP are organized into the four key phases that are summarized in Table 1. Details on each phase, its purpose, and desired outcomes are described after Table 1.

Table 1. TSAP Update Process

Phase	Steps
#1: Due-Diligence	- Review inventory of existing data - Evaluate potential analysis tools and methods
#2: Network Screening	- Identify reference populations - Establish data-driven emphasis areas - Establish thresholds for comparison - Identify sites for study within emphasis areas
#3: Countermeasure Development & Prioritization	- Diagnose identified sites - Identify contributing factors to crashes - Identify potential countermeasures - Calculate planning level project costs - Rank by relative priority and ease of implementation - Identify non-infrastructure countermeasures
#4: TSAP Implementation	- Develop performance measures - Develop a regular update program

PHASE #1 – DUE-DILIGENCE

This first phase of the analysis framework will assess the availability and quality of existing crash and transportation network data and determine the best method for performing a Network Screening (Phase #2) with that data. Crash, traffic volume, and roadway inventory data are typically needed to conduct an objective safety analysis, but the most critical data are reported crashes that are geospatially tied to the physical BMPO roadway network. Other helpful data includes specific roadway characteristics like traffic control, number of travel lanes, speed limits and 85th percentile speeds, the presence of pedestrian and bicycle facilities, transit centers, routes, and stops, school zones and routes, and streetlights. This secondary information is not necessary to complete the Network Screening but can be useful for detailed analyses and site diagnoses.

The data that will be used in the crash analysis for the BMPO TSAP Update include:

- Reported Crash Data (January 1, 2019 to December 31, 2023) – provided by ODOT
- BMPO Road Network – provided by the City of Bend and Deschutes County
- Sidewalk Network, Bicycle Facilities, Low Stress Network, Crosswalks, Paths and Trails, Primary Transit Corridors, Speed Limits, Intersection Traffic Control (as available), Mobility Hubs, Existing Land Use (Zoning), Future Land Use (Comprehensive Plan) – provided by the City of Bend
- Traffic Volumes (as available) – provided by ODOT and the City of Bend
- Equity-Related Population Data – provided by the BMPO and the City of Bend

Real-time data for fatal crashes are available from the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS). These data fall outside of the study period of ODOT's reported crashes and will not be incorporated into the five-year crash analysis to prevent skewed results. However, for the fatal crashes on FARS reported in years more recent than 2023,

their locations and characteristics will be compared to the five-year crash analysis results in Phase #2 to validate continued patterns or discover new trends.

PHASE #2 – NETWORK SCREENING

This second phase of the analysis framework will screen the BMPO roadway network to identify sites and patterns where there is potential to reduce crash frequency and/or severity. Network screening methods that will be applied to the BMPO TSAP Update are described in detail in Chapter 4 of the Highway Safety Manual (HSM) and generally include the following steps (Reference 2 – HSM):

1. **Establish Emphasis Areas:** safety trends (e.g., time of day, seasonal variability, driver age, crash types, crash causes, crash locations, speeding, pedestrian and bicycle crashes, roadway classifications, etc.) that the City of Bend will want to address with systemic treatments and multidisciplinary actions. All public roads within the BMPO will be included in the crash pattern analysis. A separate crash pattern analysis will be conducted that focuses exclusively on local roads, with State Highways excluded.
2. **Identify Reference Populations:** study area characteristics that, when organized into groups, help develop the most cost-effective projects to reduce crashes. These can include area types (e.g., urban, rural, suburban), traffic control (e.g., signalized, unsignalized, roundabout, etc.), number of approaches (e.g., three-leg or four-leg intersection), cross-section (e.g., number of through lanes and turning lanes), functional classification, and traffic volumes.
3. **Select Performance Measures:** a quantitative “score” is applied to crash data across all sites. The HSM identifies 13 performance measures that can be used in network screenings. Based on available data and consistent with the 2019 Bend TSAP, the BMPO TSAP Update will apply the Equivalent Property Damage Only (EPDO) crash frequency performance measure to evaluate the study area. The EPDO crash frequency performance measure assigns a weighting to a crash based on its severity. Consistent with ODOT’s Safety Priority Index System (SPIS), Fatal and Suspected Serious Injury (A) crashes receive a weight of ‘100,’ Suspected Minor (B) and Possible (C) injury crashes receive a weight of ‘10,’ and Property Damage Only (O) crashes receive a weight of ‘1.’ To account for crash concentrations, the analysis also assesses intersection crashes and street segment crashes separately by identifying crashes within a specified boundary of an intersection and by using a sliding window along streets. Therefore, the greater the crash severity and/or the higher the crash frequency, the higher the score that a location will likely receive.
4. **Screen and Evaluate Results:** Geographic Information System (GIS) tools are used to perform the network screenings and identify the BMPO’s High Injury Network (HIN). Roadways and intersections are ranked across the BMPO based on their EPDO score and the potential that crash frequency and/or severity could be reduced at these sites. Ten sites overall will be selected in coordination with the PMT as priority for future improvement. Concepts will be developed for five of those locations, based on PMT direction, to further identify possible improvements and support future funding applications or project development activities. In some situations, top-ranked sites based on score may not be selected as a priority—such as if another project is already planned at that location or if State Highway sites rank higher than local sites, but this project will target the local system. All public and private roads within the BMPO will be included in the network screening. The analysis will also highlight local streets that appear on the overall HIN, enabling the BMPO to prioritize them for targeted improvements.

PHASE #3 – COUNTERMEASURE DEVELOPMENT

The third phase of the analysis framework will identify factors contributing to fatal and serious injury crashes and develop countermeasures to reduce them. The following sections provide a general overview of the process the Consultant Team will use to develop these countermeasures.

Identify Contributing Factors at Top Sites

Diagnosis will include desktop reviews for the top-ranked sites identified in Phase #2. For each site, diagnosis will include a review of the following three elements, as available:

1. Crash and volume data trends;
2. Site history (e.g., construction, traffic control modifications, etc.); and,
3. Field conditions using aerial imagery.

The Consultant will work with the PMT to identify up to 10 sites to be diagnosed to determine factors contributing to crashes, and countermeasures will be identified to address those contributing factors.

Identify Infrastructure Countermeasures

The factors contributing to crashes, as identified through desktop analysis, are linked to countermeasures that can help reduce both the frequency and severity of these crashes. This step will require considering a range of countermeasures, then narrowing the options to those that have a documented ability through empirical study to reduce a specific crash type. This step uses Crash Modification Factors (CMFs) and/or Crash Reduction Factors (CRFs) in the HSM, ODOT's CRF Manual (Reference 3 – CRF Manual), and the Federal Highway Administration's (FHWA) CMF Clearinghouse (Reference 4 – CMF Clearinghouse) to identify potential solutions.

In addition to developing countermeasures for PMT's top 10 locations, the Consultant Team will also recommend low-cost systemic treatments from the sources above that can be applied at a broad scale to address the Emphasis Areas identified in Phase #2.

Identify Non-Infrastructure Countermeasures

As documented earlier in this memorandum, engineering (infrastructure) countermeasures are only one component of a comprehensive safety program. The PAC includes multidisciplinary stakeholders that will provide input during a designated PAC meeting on potential non-infrastructure countermeasures that should be considered to address the Emphasis Areas identified in Phase #2.

Prioritize Infrastructure Countermeasures

The goal of prioritizing countermeasures is to select projects that will most effectively reduce crash frequency and severity while minimizing costs. Chapters 7 and 8 of the HSM describe several methods for ranking projects, with benefit-cost analysis being a commonly used ranking method. Therefore, ranking requires that monetary costs and benefits be identified for each project. Improvement concepts and planning level project cost estimates will be prepared for five of the ten selected sites. The

CMFs/CRFs associated with identified countermeasures will be used to estimate benefits in terms of crash reductions, when available.

Coordination with Other Agencies and Partners

Additional transportation safety projects that are not identified in the TSAP update projects—such as those in the 2019 TSAP that have yet to be implemented, new projects ODOT has identified for its system, or projects identified through other means—will be carried forward into the TSAP document as agreed to by the PMT to provide a complete safety project list.

PHASE #4 – IMPLEMENTATION

In this phase, the City of Bend will implement TSAP Update recommendations by integrating them into projects, programs, and policies. Effective implementation extends beyond the prioritized list of infrastructure and non-infrastructure strategies. The TSAP Update may include recommendations in the following areas to enhance long-term safety performance:

- **Capital Improvement Program (CIP):** Update criteria and methods to incorporate safety performance.
- **Development Review:** Revise processes to integrate safety considerations.
- **Roadway Standards:** Update standards and standard details based on TSAP Update findings.
- **Performance Tracking:** Establish measures and excel log to monitor progress toward safety goals.
- **Education and Enforcement:** Identify new programs to improve outreach and compliance.
- **Policy Development:** Define needs that align with the BMPO's long-term vision.
- **Data Collection:** Address gaps to reduce statistical bias in future TSAP updates.
- **Public Health Integration:** Explore connections that support state and future BMPO and City goals.
- **Plan Maintenance:** Recommend methods and frequency for TSAP updates to ensure a proactive, current transportation safety management program.
- **Funding:** Ensure adequate financial resources to support implementation and establish a process to track funding allocations as part of executing the recommendations.
- **Emergency Services:** Identify strategies to improve crash response time, including technology enhancements that enable EMS to reach crash sites faster.

Next Steps

The consultant will refine the safety analysis framework based on PMT feedback and initiate the Existing Conditions analysis using the agreed-upon methodology outlined in this memorandum.

References

1. U.S. Department of Transportation. Principles of a Safe System Approach.
<https://www.transportation.gov/NRSS/SafeSystem>
2. American Association of State Highway and Transportation Officials (AASHTO). Highway Safety Manual. 2010.
3. Oregon Department of Transportation (ODOT). Crash Reduction Factor Manual. 2024.
4. Federal Highway Administration (FHWA). CMF Clearinghouse.
<https://cmfclearinghouse.fhwa.dot.gov/>