

Chapter 9: Transportation Systems Management

Introduction

The Oregon Transportation Planning Rule defines transportation systems management (TSM) as the use of “techniques for increasing the efficiency, safety, capacity or level of service of a transportation facility without increasing its size.” Examples of TSM include physical roadway improvements (e.g. access management and channelization), operational improvements (e.g. traffic signal coordination and ramp metering), and the use of intelligent transportation systems.

This chapter includes goals and policies, forecasts and future needs, and strategies for applying transportation systems management to the Bend MPO. Intelligent transportation systems (ITS) play a large role in TSM and a separate planning effort was undertaken as part of the *Deschutes County ITS Plan Update*¹ to develop a 20-year deployment plan of ITS projects that improve the operations and management of the transportation network in Deschutes County with a focus on the Cities of Bend and Redmond. In addition to ITS other TSM strategies discussed in this chapter include access management, parking management, traffic signal management and operations, speed management, geometric improvements, value engineering, systems engineering, and asset management.

TSM Policies

The policies for transportation system management were developed based on a review of existing policies in other state, regional, and local plans such as the *Oregon Transportation Plan*, *Deschutes County Transportation System Plan*, *Deschutes County ITS Plan*, and *City of Bend Transportation System Plan*. These policies will help guide the future development and management of the transportation system.

1. Support the access management policies of the Oregon Department of Transportation along state highways.
2. Work with member jurisdictions and agencies to adopt legislation that protects the integrity of regional roadways by managing public and private accesses.
3. Work with member jurisdictions and agencies to develop parking regulations that support land use and travel demand and that also encourage the use of alternate modes.
4. Work with member jurisdictions and agencies to implement a comprehensive intelligent transportation system program per the *Deschutes County ITS Plan Update*.
5. Support efforts of member jurisdictions and agencies to update traffic signal and traffic signal control system hardware and software and implement signal timing strategies to optimize system efficiency for all modes.

¹ *Deschutes County ITS Plan Update*. Prepared for ODOT by DKS Associates and IBI Group, June 2011

6. Support efforts of member jurisdictions and agencies to remove traffic signals where an engineering study (based on *MUTCD* guidelines) demonstrates they are no longer warranted based on land use changes that have resulted in decreased travel demand.
7. Support efforts of member jurisdictions and agencies to install new traffic signals where an engineering study (based on *MUTCD* guidelines) shows they are warranted to support land use changes that have resulted in increased travel demand.
8. Work with member jurisdictions and agencies to investigate the feasibility of utilizing automated speed and red light enforcement at high accident locations to improve safety and reduce the manpower needed by law enforcement and adopt legislation as needed.
9. Support efforts of member jurisdictions and agencies to utilize traffic calming techniques to reduce travel speeds and cut-through traffic on roadways where traffic conditions do not match the roadway's intended design.
10. Encourage member jurisdictions and agencies to consider geometric improvements to enhance efficiency and provide safety for motorists, pedestrians, and bicycles.
11. Encourage member jurisdictions and agencies to consider using value engineering or systems engineering to deliver transportation projects more efficiently and cost-effectively.
12. Promote new technologies and strategies to effectively manage transportation assets including roadway pavement, bridges, right-of-way, public transportation facilities, traffic signals, ITS field devices, and other infrastructure to maximize functionality and prolong the lifetime of the transportation system.

Forecasts and Future Needs

Traffic congestion coupled with a large expected growth in population and travel demand (see Motor Vehicle chapter) impacts the mobility of travelers and freight throughout the Bend MPO. Congestion results in travel delay, reduced productivity, and a frustrated driving public. Over half of congestion is caused by non-recurring events as shown in Figure 9.1. TSM strategies are needed to reduce non-recurring congestion, and its negative impacts, to optimize systems operations and maximize the available capacity of the existing transportation infrastructure. During the development of the *Deschutes County ITS Plan Update* an extensive needs assessment was conducted through stakeholder interviews, questionnaires, and a workshop to identify regional needs in the following areas of interest:

- Travel and Traffic Management
- Public Transportation Management
- Emergency Management
- Information Management
- Maintenance and Construction Management

Although these needs were ultimately used to develop a phased implementation of ITS projects, the user needs identified were very broad and may also be addressed by TSM strategies other than ITS.

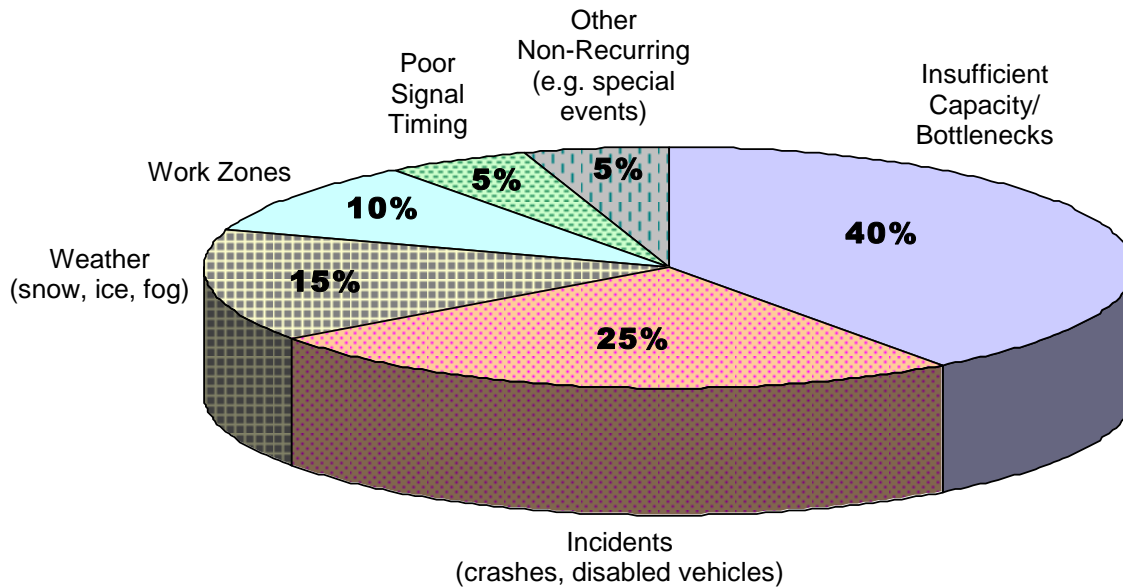


Figure 9.1 Causes of Congestion²

TSM Strategies

This section includes an overview of the strategies that may be used in the Bend MPO to support the transportation system management goals and policies listed earlier in this chapter. These strategies are discussed in the following management/operational areas: intelligent transportation systems, access management, parking management, traffic signal management and operations, speed management, geometric improvements, value engineering and systems engineering, and asset management.

Intelligent Transportation Systems

ITS involves the application of advanced technologies and proven management techniques to relieve congestion, enhance safety, provide services to travelers, and assist transportation system operators in implementing suitable traffic management strategies. ITS focuses on increasing the efficiency of existing transportation infrastructure, which enhances the overall system performance and reduces the need to add capacity (e.g., travel lanes). Efficiency is achieved by providing services and information to travelers so they can (and will) make better travel decisions and to transportation system operators so they can better manage the system. ITS technologies are used by agencies in the Bend MPO today and plans are in place to expand the use of ITS applications in the future.

In 2011, the Bend MPO, Oregon Department of Transportation (ODOT), Deschutes County, City of Bend, City of Redmond, Deschutes County 911, the Oregon State Police, and the Federal Highway Administration collectively developed the *Deschutes County ITS Plan Update* with input from other regional stakeholders. The mission of the

² *Congestion Mitigation*. Office of Operations, Federal Highway Administration. <http://www.ops.fhwa.dot.gov/aboutus/opstory.htm>. Accessed June 26, 2014.

plan is “to improve the safety, security and movement of goods, people, and services for all modes of the transportation network by using advanced technologies, establishing agency coordination, utilizing existing system capacity and infrastructure, and providing real time traveler information.” The outcome of the plan is a phased 20-year deployment plan of ITS projects, a regional ITS architecture, and regional operational concept that all meet federal ITS requirements. Additionally, this effort is consistent with plans put together statewide and in other regions of Oregon to ensure that ITS strategies are integrated and complementary.

Benefits of ITS

ITS projects are aimed at improving the safety and operational efficiency of the existing transportation infrastructure by:

- Reducing vehicle delays related to recurrent and non-recurrent congestion
- Reducing collisions and incident response times
- Providing travelers with real-time information to make informed route and mode choice decisions.

Quantifiable benefits resulting from intelligent transportation systems include:

- Reduced vehicle delays
- Reduced number of collisions
- Improved air quality
- Reduced fuel consumption
- Improved travel times

Other accrued benefits, which are more difficult to quantify, include improved travel time reliability, reduced driver frustration, and reduced driver anxiety from having real-time travel information. Additionally, improved efficiency due to coordinated and cooperative agency actions can produce long term savings, particularly in relation to coordinating regional projects and a coordinated regional response to incidents. ITS deployments around the state of Oregon have yielded many of these; some of these benefits are highlighted herein.

ODOT Region 2 Incident Management Program

- 15-percent reduction in average incident duration
- 35-percent reduction in vehicle-hours incident delay

Traveler Information

- 7- to 12-percent reduction in travel time
- Up to 33-percent reduction in emissions

ITS Projects for Bend MPO

A list of ITS projects was developed to meet the regional needs and then phased based on a scoring exercise (criteria included items such as safety, congestion mitigation, and key traveler decision points), cost, expected benefits, technical and institutional feasibility, relativity to other planned projects, input from the Steering Committee, and equitable distribution. The resulting deployment plan includes the following phases:

- 2014 – 2018: 0 – 5 Year Plan (Short-term)
- 2019+: 5+ Year Plan (Long-term)

Table 9.1 lists the projects that fall within the Bend MPO and are anticipated to be feasible within projected funding levels. Table 9.2 lists additional aspirational projects that have been identified in the Deschutes County ITS Plan, but are not anticipated to be achievable under projected funding sources. A map illustrating the phased ITS infrastructure deployment locations for many of the ITS projects is located in Appendix E. Many of the projects will be implemented by multiple jurisdictions and several projects will deploy systems that will be shared beyond the Bend MPO. ODOT plans to pursue a number of statewide ITS initiatives that may be applied to the Bend area and will support some of the projects included in Table 9.1³.

The ITS projects included in Table 9.1 utilize the following general strategies to improve the operational efficiency and management of the Bend area transportation network:

- Corridor management on key corridors that includes traffic signal coordination, remote monitoring, and traveler information dissemination
- Rail warning systems
- Parking management
- Transit system management
- Multi-jurisdictional programs for traffic management, incident response, emergency management, and maintenance and construction management
- Regional traveler information dissemination

³ *Oregon Statewide ITS Architecture and Operational Concept Plan*. Prepared for ODOT by DKS Associates, May 2012.

Table 9.1 ITS Deployment Projects for Bend MPO

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
2014 – 2018 (0 – 5 Year Plan, Short-term)		
DC-TM-02A: Region 4 TOC to 3 rd St RWIS	<ul style="list-style-type: none"> ● Install fiber optic cable along 3rd Street/The Dalles-California Highway between Region 4 TOC and Division Street, use existing conduit between OB Riley Road and the RWIS near the Bend Parkway ● Upgrade traffic signal controllers at: <ol style="list-style-type: none"> 1. 3rd Street/The Dalles-California Highway/NE Bed River Mall Drive 2. 3rd Street/The Dalles-California Highway/OB Riley Road 3. 3rd Street/The Dalles-California Highway/Mt Washington Drive/Butler Market Road 4. 3rd Street/The Dalles-California Highway/Division Street ● Connect to existing cameras as 3rd Street/The Dalles-California Highway/Mt Washington Drive/Butler Market Road (<i>ODOT, Bend</i>) 	\$330,000 to \$710,000
DC-TM-02B: Bend Pkwy and 3 rd St: Reed Market Rd to Murphy Rd (Stage 1)	<ul style="list-style-type: none"> ● Subscribe to leased services between ODOT Region 4 TOC and communications hub TBD between Reed Market Road and Murphy Road ● Install VDSL in existing conduit and existing aerial route along 3rd Street/The Dalles-California Highway between Reed Market Road and Power Road ● Install fiber optic cable in existing conduit along Powers Road between 3rd Street/The Dalles-California Highway Bend Parkway ● Install fiber optic cable in existing conduit along Bend Parkway between Powers Road and Murphy Road ● Upgrade traffic signal controllers at: <ol style="list-style-type: none"> 1. Bend Parkway/Powers Road 2. Bend Parkway/Pinebrook Boulevard 3. Bend Parkway/3rd Street/The Dalles-California Highway ● Install PTZ cameras at <ol style="list-style-type: none"> 1. Bend Parkway/Powers Road 2. Bend Parkway/3rd Street/The Dalles-California Highway 	\$140,000 to \$160,000
DC-TM-19A: Advanced Rail Warning System - Reed Market Road	Bend (Reed Market Road at 3rd Street, Railroad crossing, and 15th Street). Includes transmitting advanced crossing occupancy information to the public via message signs or in-vehicle navigation systems. (<i>ODOT, Bend, Redmond, Deschutes County, 911 Center</i>)	\$310,000
DC-TM-28: City of Bend Traffic Data Collection	Deploy video traffic counting stations at bottleneck locations (e.g. Portland Street Bridge) to monitor traffic and collect traffic volume data. (<i>Bend</i>)	\$110,000

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-TM-29: Revere Ave and Wall St to 3rd St and Greenwood Ave (Hwy 20)	<ul style="list-style-type: none"> ● Subscribe to leased services between ODOT Region 4 TOC and new communications hub at NW Revere Avenue/NW Wall Street ● Install fiber optic cable: <ol style="list-style-type: none"> 1. Use existing conduit along Revere Avenue between NE Wall Street and 3rd Street/The Dalles-California Highway 2. On existing aerial route along 3rd Street/The Dalles-California Highway between Revere Avenue and Greenwood Avenue ● Connect to existing interconnect to: <ol style="list-style-type: none"> 1. NE Wall Street/NW Portland Avenue/NW Olney Avenue 2. 3rd Street/The Dalles-California Highway/Franklin Avenue ● Upgrade traffic signal controllers at: <ol style="list-style-type: none"> 1. NW Revere Avenue/NW Wall Street/Bend Parkway southbound ramps 2. NW Revere Avenue/NE Division Street/Bend Parkway northbound ramps 3. 3rd Street/The Dalles-California Highway/Olney Avenue ● Install PTZ cameras at: <ol style="list-style-type: none"> 1. 3rd Street/The Dalles-California Highway/Olney Avenue 2. 3rd Street/The Dalles-California Highway/Greenwood Avenue (<i>ODOT, Bend</i>) 	\$370,000 to \$550,000
DC-PTM-01: Automated Vehicle Location (AVL)/Computer Aided Dispatch (CAD) Transit Management System	Install an automated vehicle location (AVL) system on the CET fleet and replace existing computer aided dispatch (CAD) system. (<i>CET</i>)	\$590,000
DC-PTM-03: Real-Time Customer Information	<p>Disseminate transit traveler info to internet and personal user devices.</p> <p>Deploy real-time dynamic message signs at key locations such as transit centers and bus stops where multiple routes pass through, and at stops with large bus headways. (<i>CET.</i>)</p>	\$90,000
DC-PTM-06: Automated Passenger Counting	Install an automated passenger counting system that electronically records boardings and alightings at each transit stop (<i>CET</i>)	\$110,000
DC-EM-01A: Coordinated Emergency Response - Radio System Link	Provide a two-way information flow (i.e.. CCTV camera images, congestion flow map, emergency calls) between transportation management systems and the 911 and emergency dispatch centers. This project will integrate the transportation information with existing computer aided dispatch systems and the emergency data with traffic management systems. (Oregon Interoperability Service (OIS) is currently underway). (<i>ODOT, Bend, Redmond, Deschutes County, Deschutes County 911, US Forest Service</i>)	\$550,000
DC-EM-02: Coordinated Emergency Response - Radio System Link	Deploy a common communication interface between stakeholders responsible for emergency management. This project supports coordinated emergency response for evacuation routes and disaster response. (<i>ODOT, Bend, Redmond, Deschutes County, Deschutes County 911, US Forest Service</i>)	Funded by Reg. Comm. Consortium
DC-MC-02: Work Zone Management and Safety Monitoring Systems	Deploy work zone safety enhancements and management techniques including variable speed limits, incident detection and management, lane merge controls, travel time estimates and queue detection with electronic feedback signs. (<i>ODOT</i>)	Funded with construction projects

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-PP-06: Roundabout Preemption (previously DC-EM-10)	Implement an emergency vehicle preemption system for roundabouts located on primary response routes. <ul style="list-style-type: none"> Priority at Reed Market Road/SE 15th Street (where the existing signal will be reconstructed as a roundabout with an upcoming City Project) is high (<i>Bend</i>) 	\$600,000
DC-PP-07: Automatic Vehicle Location Equipment Pilot Project (snowplows)	Test the use of automatic vehicle location devices on snowplows in District 10.	\$20,000
Capital Cost for 2014 – 2018		\$3,220,000 to \$3,800,000
2019 + (5+ Year Plan, Long-term)		
DC-TM-02D: Hwy 97 Business (3rd Street) - Travel Time Performance Measurements	This project will deploy devices to measure travel times for traveler information and performance measurement assessment. (<i>ODOT, Bend</i>)	\$335,000
DC-TM-07A: Hwy 20/Greenwood from 15th St to Purcell Blvd	<ul style="list-style-type: none"> Subscribe to leased services between ODOT Region 4 TOC and new communications hub at Greenwood Avenue/SE 15th Street Install fiber optic cable along Greenwood Avenue between 15th Street and Purcell Boulevard Upgrade traffic signal controller at Greenwood Avenue/15th Street Possible inter-agency communications with Bend Area Transit, Bend Police, and City of Bend Public Works (<i>ODOT, Bend</i>) 	\$185,000 to \$315,000
DC-TM-07D: Hwy 20/Greenwood/Newport - Travel Time Performance Measurements	This project will deploy devices to measure travel times for traveler information and performance measurement assessment. (<i>ODOT, Bend</i>)	\$270,000
DC-TM-08E: Hwy 97 (Bend Parkway) - Travel Time Performance Measurements	This project will deploy devices to measure travel times for traveler information and performance measurement assessment. (<i>ODOT, Bend</i>)	\$210,000
DC-TM-09: Century Drive (to Mt. Bachelor) Safety and Efficiency Improvements	This project will deploy video, electronic message signs, weather stations, dynamic speed limit signs, and speed photo enforcement on Century Drive between Bend and Mt. Bachelor (<i>ODOT, Bend, Mt. Bachelor Inc.</i>)	\$820,000
DC-TM-10: Incident Response Program - Staff and Vehicles	Develop a multi-jurisdictional regional incident response program to support emergency management agencies with incident management on state, county, and city roadways. This program includes vehicles, personnel, and dispatch. This program will coordinate with ODOT maintenance crew incident responders to maximize efficiency and pool resources. (<i>ODOT, Bend, Redmond, Deschutes County</i>)	\$960,000
DC-TM-11B: Hwy 97 (Bend to Redmond) Safety and Efficiency Improvements	This project will deploy video to support incident management and traveler information. (<i>ODOT</i>)	\$130,000
DC-TM-12A: Hwy 97 (South of Bend) Safety and Efficiency Improvements	This project will deploy a video, electronic message signs, and weather stations. (<i>ODOT</i>) – PARTIALLY COMPLETE	Funded with STIP

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-TM-12B: Hwy 97 (South of Bend) Safety and Efficiency Improvements	This project will deploy a variable speed limit system. (ODOT)	\$60,000
DC-TM-13A: 27 th /Empire/Knott Safety and Efficiency Improvements	This project will deploy video monitoring cameras with pan-tilt-zoom control, count stations, and advanced signal timing improvements. (Signal timing improvements on 27 th Street completed in 2011). (ODOT, Bend)	\$440,000
DC-TM-14: ODOT Region 4 TOC Upgrade	Expand/upgrade the existing TOC facility and equipment. (ODOT)	\$95,000
DC-TM-19B: Advanced Rail Warning System - Bend and Redmond locations	Bend (County Club Rd, Olney Ave, Revere Ave, Wilson Avenue), Redmond (Airport Way, Sisters Ave, Antler Ave) (ODOT, Bend, Redmond, Deschutes County, 911 Center)	\$190,000
DC-TM-34: Franklin Avenue: 3rd Street to Bond Street	<ul style="list-style-type: none"> ● Install fiber optic cable on Franklin Avenue between 3rd Street and NW Wall Street ● Possible inter-agency communications with Bend City Hall (Bend) 	\$100,000 to \$800,000
DC-TM-35: 27th Street Corridor Upgrade	<ul style="list-style-type: none"> ● Install fiber optic cable in existing conduit along 27th Street between Bear Creek Road and Neff Road ● Install fiber optic cable in existing conduit along Neff Road between 27th Street and Purcell Boulevard (may need to install conduit between Medical Center Drive and Purcell Boulevard). (Bend) 	\$170,000 to \$270,000
DC-TM-36: Wall Street: Greenwood Avenue to Portland Ave/Olney Ave	<ul style="list-style-type: none"> ● Install fiber optic cable along NW Wall Street between NW Portland Ave/NW Olney Ave and Greenwood Ave (Bend) 	\$130,000 to \$400,000
DC-TM-37: Remaining 170 to 2070 upgrades	<ul style="list-style-type: none"> ● Upgrade traffic signal controllers at: <ol style="list-style-type: none"> 1. NE Butler Market Road/NE Boyd Acres Road 2. NE 8th Street/NE Penn Avenue (Bend) 	\$30,000 to \$70,000
DC-TM-38: Wall Street: Revere Avenue to Portland Ave/Olney Ave	<ul style="list-style-type: none"> ● Install fiber optic cable in existing conduit along NW Wall Street between NW Revere Avenue and NW Portland Avenue/NW Olney Avenue ● Upgrade traffic signal controller at NW Wall Street/NW Portland Avenue/NW Olney Avenue (Bend) 	\$45,000 to \$50,000
DC-TM-40: Count Stations - Bridges	<p>Install count stations at several of the bridge over the Deschutes River:</p> <ul style="list-style-type: none"> ● Reed Market Road ● Colorado Avenue ● Columbia Street ● Galveston Avenue ● Newport Avenue ● Mt Washington Drive ● Archie Briggs Road <p>Count stations should collect the following data: vehicle volumes, vehicle classifications, and vehicle speeds. (Bend)</p>	\$150,000

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-TM-41: Count Stations - City Outskirts	Install count stations that support locations near Bend city limits in the travel demand model: <ul style="list-style-type: none"> ● Powell Butte Highway ● Century Drive ● Shevlin Park Road ● Skyliners Road ● Cline Falls Highway ● Old Bend-Redmond Highway ● Knott Road <p>Count stations should collect the following data: vehicle volumes, vehicle classifications, and vehicle speeds. (<i>Bend</i>)</p>	\$150,000
DC-PTM-02: Maintenance Management System	Upgrade the existing fleet maintenance system to expand functionality and meet FTA requirements. (<i>CET</i>)	\$40,000
DC-PTM-07: Electronic Fare System linked to Smart Cards	Install an electronic fare collection system that includes Smart Card support (linked to Bend Parking Garage Smart Cards). (<i>CET, Bend</i>)	\$25,000
DC-EM-03: Real-Time Information to mobile data devices	Provide real-time traffic information to emergency responders' mobile data devices. (<i>ODOT, Bend, Redmond, Deschutes County, Deschutes County 911, Oregon State Police</i>)	\$120,000
DC-EM-06: Provide Traffic Management System Information at EOCs	Provide an interface between the TOC and/or other traffic management systems and each of the emergency operations centers to allow access to traffic control devices during emergency situations at the EOCs as well as to share information between agencies. This would include workstations, monitors, and a communications interface at EOCs. (<i>ODOT, Bend, Redmond, Deschutes County, Deschutes County 911</i>)	\$80,000
DC-IM-01: Regional Data Management System	Implement a data management system for archiving data, collecting real-time data, and accessing data. The system should have geospatial capabilities and data should include at a minimum traffic counts, speed data, accidents (vehicles, pedestrians, and bicycles), traffic enforcement data, incident information, and transit information. (<i>ODOT, Deschutes County, Bend, Redmond</i>)	\$540,000
DC-MC-03: Roadway Automated Treatment	Includes environmental sensors and automated treatment (de-icing) at the planned US 97/S. Century Drive interchange. (<i>ODOT</i>)	Funded with STIP
Capital Cost for 2018+		\$7,585,000 to \$8,830,000

Source: *Deschutes County ITS Plan Update*

Table 9.2 ITS Aspirational Projects (Beyond Projected Funding Levels) for Bend MPO

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
No Implementation Target Identified (Beyond Projected Funding Levels)		
DC-TM-02C: Bend Pkwy and 3rd St: Reed Market Rd to Murphy Rd (Stage 2)	<ul style="list-style-type: none"> ● Install fiber optic cable in existing conduit and existing aerial route along 3rd Street/The Dalles-California Highway between Reed Market Road and Powers Road ● Install fiber optic cable in existing conduit along Powers Road between 3rd Street/The Dalles-California Highway Bend Parkway ● Install fiber optic cable in existing conduit along Bend Parkway between Powers Road and Murphy Road ● Salvage removed VDSL equipment from 3rd Street/The Dalles-California Highway, Powers Road, and Bend Parkway for use on State Highway 372/Colorado-Arizona Couplet (ODOT, Bend) 	\$240,000 to \$360,000
DC-TM-02E: Hwy 97 Business (3rd Street) - Dynamic Message Signs	This project will deploy dynamic message signs. (ODOT, Bend)	\$315,000
DC-TM-06: Downtown Bend Parking Management System	This project would monitor parking garage occupancy to alert travelers if the garage is full and provide guidance to alternate available parking. (Bend))	\$150,000
DC-TM-07B: Hwy 20/Greenwood Ave from 3rd St to 8th St	<ul style="list-style-type: none"> ● Install wireless along NE Greenwood Avenue between 3rd Street/The Dalles-California Highway and 8th Street ● Upgrade traffic signal controller at NE Greenwood Avenue/8th Street ● Install PTZ camera at NE Greenwood Avenue/8th Street (ODOT, Bend) 	\$50,000 to \$445,000
DC-TM-07C: Hwy 20/Greenwood from Purcell to 27th Ave	<ul style="list-style-type: none"> ● Install fiber optic cable in existing conduit along Greenwood Avenue between Purcell Boulevard and 27th Street ● Connect to existing interconnect along 27th Street ● Install PTZ cameras at: <ol style="list-style-type: none"> 1. Greenwood Avenue/15th Street 2. Greenwood Avenue/Purcell Blvd 3. Greenwood Avenue/27th Street (ODOT, Bend)	\$100,000 to 150,000
DC-TM-07E: Hwy 20/Greenwood - Dynamic Message Signs	This project will deploy dynamic message signs. (ODOT, Bend)	\$150,000
DC-TM-08A: Bend Pkwy from Hwy 372/Colorado Ave to Reed Market Rd	<ul style="list-style-type: none"> ● Install fiber optic cable along Bend Parkway between Colorado Avenue/State Highway 372 and Reed Market Road ● Install PTZ camera on Bend Parkway north of Reed Market Road ● Connect to existing PTZ camera near Colorado Avenue/State Highway 372 (ODOT, Bend) 	\$380,000 to \$580,000
DC-TM-08B: VMS: Bend Parkway northbound at Empire	<ul style="list-style-type: none"> ● Install variable message sign on Bend Parkway northbound at Empire Boulevard (ODOT, Bend) 	\$250,000 to \$350,000
DC-TM-08C: Bend Parkway: Revere Avenue to Franklin Avenue	<ul style="list-style-type: none"> ● Install fiber optic cable along Bend Parkway between hub at Revere Avenue/Wall Street and Franklin Avenue (ODOT, Bend) 	\$290,000 to \$590,000

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-TM-08D: Bend Parkway: Empire Avenue to Cooley Road	<ul style="list-style-type: none"> ● Install fiber optic cable along Bend Parkway between Empire Ave and Cooley Ave ● Connect to existing interconnect along Robal Road ● Upgrade traffic signal controller at Robal Road/Berg Lane (<i>ODOT, Bend</i>) 	\$400,000 to \$1,500,000
DC-TM-11C: Hwy 97 (Bend to Redmond) Safety and Efficiency Improvements	This project will deploy electronic message signs to support incident management and traveler information. (<i>ODOT</i>)	\$320,000
DC-TM-11D: VMS: The Dalles-California Highway northbound at Cooley	<ul style="list-style-type: none"> ● Install variable message sign on The Dalles-California-Highway northbound at Cooley Road ● On hold pending US 97 Bend North Corridor EIS (<i>ODOT, Bend</i>) 	\$250,000 to \$350,000
DC-TM-12C: Hwy 97 (South of Bend) Safety and Efficiency Improvements	This project will deploy video monitoring camera(s) with pan-tilt-zoom control near the ODOT weigh in motion station south of Bend. (<i>ODOT</i>)	\$30,000
DC-TM-13B: Northeast Ring: 27th to Empire	<ul style="list-style-type: none"> ● Install fiber optic cable along NE 27th Street between NE Neff Road and NE Butler Market Road ● Install fiber optic cable along Empire Avenue between Region 4 TOC and NE Purcell Boulevard ● Install fiber optic cable along future Empire Avenue extension between NE Purcell Boulevard and NE 27th Street ● Install fiber optic cable along NE Purcell Boulevard between Empire Avenue and NE Butler Market Road traffic signal ● Project provides a redundant path back to the ODOT Region 4 TOC and communications for future traffic signals (<i>ODOT, Bend</i>) 	\$850,000 to \$3,300,000
DC-TM-16: Hwy 20 (Bend to Sisters) Safety and Efficiency Improvements	Hwy 20 (Bend to Sisters) Safety and Efficiency Improvements (<i>ODOT</i>)	\$1,030,000
DC-TM-17A: Reed Market Road from Bend Pkwy to 3rd St	<ul style="list-style-type: none"> ● Install fiber optic cable along Reed Market Road between Bend Parkway southbound ramps traffic signal and 3rd Street/The Dalles-California Highway ● Upgrade traffic signal controller at Reed Market Road/Bend Parkway southbound ramps ● Connect to existing interconnect along 3rd Street/The Dalles-California Highway to Wilson Avenue ● Install PTZ camera on Bend Parkway south of Reed Market Road ● Install wireless communications to PTZ camera (<i>ODOT, Bend</i>) 	\$190,000 to \$440,000
DC-TM-17B: Reed Market Road: 3rd Street to 27th Street	<ul style="list-style-type: none"> ● Install fiber optic cable along Reed Market Road between 3rd Street and 27th Street ● Consider combining with Reed Market Road project Key #14210 ● Project provides a redundant path and communications to traffic signals at: <ol style="list-style-type: none"> 1. Reed Market Road/SE 9th Street 2. Reed Market Road/SE 27th Street 3. Reed Market Road/SE 15th Street (<i>Bend</i>)	\$590,000 to \$1,060,000
DC-TM-17C: Reed Market Road - Travel Time Performance Measurements	This project will deploy devices to measure travel times for traveler information and performance measurement assessment. (<i>ODOT, Bend</i>)	\$40,000

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-TM-18: Expand the Incident Response Program - Plans	This project supports incident management in Deschutes County and includes identification of detour routes, management of traffic on Highway 97 and Highway 20 through Bend and Redmond to support the movement of north-south and east-west freight through Oregon. The program will include incident signal timing plans, electronic message signs, and congestion monitoring to support the incident responders and management of the roadway network during incidents. (<i>ODOT, Bend, Redmond, Deschutes County</i>)	\$420,000
DC-TM-19C: Advanced Rail Warning System - Additional Bend and Redmond locations	Bend (China Hat Road, Brosterhous Rd, Cooley Rd), Redmond (Hemlock Ave, King Way) (<i>ODOT, Bend, Redmond, Deschutes County, 911 Center</i>)	\$130,000
DC-TM-19D: Advanced Rail Warning System - Message signs and in-vehicle communications	Transmit advanced crossing occupancy information to the public via message signs or in-vehicle navigation systems (assumes 12 VMS signs and 12 local transmission devices for in-vehicle navigation). (<i>ODOT, Bend, Redmond, Deschutes County, 911 Center</i>)	\$1,350,000
DC-TM-30: State Highway 372/Colorado-Arizona Couplet	<ul style="list-style-type: none"> ● Install fiber optic cable between Bend Parkway and traffic signal at Colorado Avenue/State Highway 372/Bend Parkway southbound ramps ● Install VDSL on existing twisted pair to traffic signals along Colorado-Arizona Couplet ● Upgrade traffic signal controllers at: <ol style="list-style-type: none"> 1. NW Colorado Avenue/State Highway 372/Bend Parkway southbound ramps 2. NW Colorado Avenue/State Highway 372/NW Bond Street 3. NW Colorado Avenue/State Highway 372/NW Wall Street 4. NW Colorado Avenue/State Highway 372/SW Industrial Way 5. NW Arizona Avenue/State Highway 372/NW Wall Street 6. NW Arizona Avenue/State Highway 372/NW Bond Street (<i>ODOT, Bend</i>) 	\$100,000 to \$150,000
DC-TM-31: VMS: McKenzie-Bend Highway westbound at Cooley	<ul style="list-style-type: none"> ● Install variable message sign on McKenzie-Bend Highway westbound at Cooley (<i>ODOT, Bend</i>) 	\$250,000 to \$350,000
DC-TM-32: Communications to Remote Traffic Signals	<ul style="list-style-type: none"> ● Install communications to: <ol style="list-style-type: none"> 1. Existing traffic signal at NE Butler Market Road/NE Boyd Acres Road 2. Existing traffic signal at NE 8th Street/NE Penn Avenue 3. Possible future traffic signal at NE Butler Market Road/NE 4th Street 4. Possible future traffic signal at SE Wilson Avenue/SE 9th Street. (<i>Bend</i>) 	\$70,000 to \$200,000

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-TM-33: Wall Street and Bond Street Wireless	<ul style="list-style-type: none"> ● Install wireless on NW Wall Street and NW Bond Street between Greenwood Avenue and Franklin Avenue ● Upgrade traffic signal controllers at: <ol style="list-style-type: none"> 1. NW Wall Street/Greenwood Avenue 2. NW Wall Street/NW Oregon Avenue 3. NW Wall Street/Franklin Avenue 4. NW Bond Street/Greenwood Avenue 5. NW Bond Street/NW Oregon Avenue 6. NW Bond Street/Franklin Avenue ● Possible inter-agency communications with Bend City Hall (<i>Bend</i>) 	\$140,000 to \$670,000
DC-TM-42: Speed Photo Enforcement	Install speed photo enforcement at the following locations: <ul style="list-style-type: none"> ● Mt Washington Drive, south of Simpson ● Empire Avenue, east of Boyd Acres ● Brookwood Boulevard, south of Powers Road (<i>Bend</i>) 	\$420,000
DC-TM-45: Red Light Cameras	Install red light cameras at the following locations: <ul style="list-style-type: none"> ● 3rd Street/Reed Market Road ● 3rd Street/Franklin ● 3rd Street/Greenwood ● 3rd Street/Empire ● Powers Road/US 97 (<i>Bend</i>) 	\$700,000
DC-EM-01B: Deschutes County 911 Communications	<ul style="list-style-type: none"> ● Install fiber optic cable along 3rd Street/The Dalles-California Highway and Jamison Road or McKenzie-Bend Highway between Empire Avenue and Deschutes County 911 facility ● Connect to Deschutes County 911 ● Connect to existing PTZ camera near Bend Parkway/Highway 20 interchange ● Possible inter-agency communications with Bend Fire Department, Deschutes County Sherriff, and Oregon State Police (<i>Deschutes County</i>) 	\$240,000 to \$870,000
DC-EM-05: Traffic Adaptive Emergency Response	Deploy an integrated emergency response system that provides for pre-trip planning, en-route guidance (static route plan), and dynamic route guidance (traffic-adaptive route plan) for emergency vehicles. (<i>ODOT, Bend, Redmond, Deschutes County, Deschutes County 911</i>)	\$390,000
DC-EM-07: Responder Video System	Provide emergency responders with video cell phones and develop a link to the TOC to link video to other agencies. (<i>ODOT, Bend, Redmond, Deschutes Co., OSP</i>)	\$30,000
DC-EM-09: Advanced Emergency Vehicle Routing	Provide emergency vehicle priority between St. Charles Hospital and the Bend Airport. (<i>ODOT, Bend, Redmond, Deschutes County</i>)	\$70,000
DC-IM-01: Regional Data Management System	Implement a data management system for archiving data, collecting real-time data, and accessing data. The system should have geospatial capabilities and data should include at a minimum traffic counts, speed data, accidents (vehicles, pedestrians, and bicycles), traffic enforcement data, incident information, and transit information. (<i>ODOT, Bend, Redmond, Deschutes County</i>)	\$540,000
DC-MC-04: Portable Construction Zone Equipment	Deploy moveable dynamic message signs and variable speed limit signs for use in work zones. (<i>ODOT, Bend, Redmond, Deschutes County</i>)	\$340,000

#/Title	Description (<i>stakeholders listed at end</i>)	Capital Cost
DC-MC-05: Maintenance Vehicle Tracking	Deploy GPS/AVL equipment in maintenance vehicles (e.g. snow plows). Provide route information for coordinating maintenance between agencies. Additional functionality could include environmental sensors (e.g. road temperature) (<i>ODOT, Bend, Redmond, Deschutes County</i>)	\$780,000
DC-MC-06: Automated Maintenance Logging System	Implement a system to automate coding of maintenance needs (e.g. potholes, wildlife removal, damaged signs) from vehicles. (<i>ODOT, Bend, Redmond, Deschutes County</i>)	\$100,000
DC-MC-07: Portable Sidewalk Closure Message System	Develop and deploy a sidewalk closure audible message system to re-route pedestrians and meet ADA requirements. (<i>Bend</i>)	\$35,000
DC-PP-01: Road Weather Conditions (previously DC-AVS-01)	Install short-range communications equipment at weather stations to transmit road conditions (pavement temperature) to vehicles. (<i>ODOT, Deschutes County</i>)	\$410,000
DC-PP-02: Congestion Warning System (previously DC-AVS-02)	Deploy warning systems devices at entry points into urban areas to warn drivers of upcoming signals/queues. (<i>ODOT</i>)	\$300,000
DC-PP-03: Intersection Collision Avoidance (previously DC-AVS-03)	Install short-range communications to transmit traffic controller information to in-vehicle collision avoidance systems. (<i>ODOT, Bend, Redmond</i>)	\$1,400,000
DC-PP-04: Wildlife Detection (previously DC-AVS-04)	Deploy wildlife detection equipment and short-range communications to transmit warnings to in-vehicle systems. (<i>ODOT, Deschutes County</i>)	\$340,000
DC-PP-05: Ambulance-Hospital Information System (previously DC-EM-04)	Enable the exchange of real-time information (video, audio, and data) between first responders and hospitals through the regional communication network (St. Charles microwave communication system). (<i>St. Charles Hospital, Deschutes County, Bend, Redmond</i>)	Funded by St. Charles and Deschutes County
Capital Cost for Aspirational Projects		\$14,180,000 to \$21,155,000

Source: *Deschutes County ITS Plan Update*

Access Management

The two main functions of a roadway are to:

- 1) provide access to adjacent properties, and
- 2) provide mobility to travelers.

Access management is the practice of balancing access and mobility based on a roadway's functional classification while also preserving the safety and efficiency of the transportation system. For instance, few access points are provided along interstate freeways to provide for high-speed travel while numerous access points are provided on local streets as entry points to residential properties. Research has shown that effective access management can provide the following benefits⁴:

- Up to 50-percent reduction of crashes
- 23- to 45-percent increase in roadway capacity
- 40- to 60-percent reduction in travel time and delay

Jurisdictions within the Bend MPO should adopt access management standards and develop access management plans along arterial and collector roadways that include some of the following strategies:

- Regulate access spacing minimums based on functional classification: between public roadways, between private approaches, and between public roadways and private approaches.
- Regulate spacing between traffic signals.
- Limit the number of approaches per property frontage based on development type and size.
- Regulate the width, apron size, radii, and vertical geometry of approaches based on development type.
- Limit access to the lower functionally classified roadway for properties that abut more than one roadway.
- Require developers to provide site designs with adequate internal circulation.
- Provide incentives for adjacent properties to share access points and provide circulation between properties.
- Develop guidelines for the use of median treatments: continuous two-way left turn lanes and non-traversable medians

At a minimum ODOT's access management policies should be met along state highways. More stringent standards may be developed if deemed applicable by the local jurisdiction.

Access management plans for implementation along specific corridors should include both short-term and long-term strategies. Since strict adherence to the adopted access management standards may adversely affect or limit access to existing land uses (particularly businesses), it is extremely important to work individually with each property owner to meet their access needs. The short-term access management plan should include strategies for improving approach locations and circulation for the

⁴ *Access Management Manual*. Transportation Research Board, National Academy of Sciences, 2003.

existing properties along a corridor while also working towards the adopted access management standards, improved safety, and better efficiency. The long-term access management plan should include strategies for access and circulation that may be applied if and when new development or redevelopment occurs in the future so that the plan may be used to gradually improve safety and roadway operations as opportunities arise.

Parking Management

Parking, whether on-street (curbside) or off-street (parking lots and garages), is an important aspect of the transportation system because motorists must physically store their vehicles somewhere in between trips. The management of parking can have significant impacts on the safety and efficiency of the transportation network. Although on-street parking often provides convenient access to adjacent land uses it is responsible for approximately one out of every five non-freeway accidents in cities every year⁵. It also reduces the capacity of the roadway by approximately one-third because the act of parking a vehicle and the presence of vehicle passengers in the roadway before and after parking physically restricts other vehicular movements, particularly in the lane adjacent to the on-street parking. When located too close to an intersection on-street parking may also reduce intersection sight distance.

Effective parking management can help balance mobility and safety with parking demand. The following parking management strategies should be considered for the Bend MPO:

- Allow or prohibit on-street parking based on functional classification.
- In core urban areas develop parking zoning as appropriate: short-term, long-term, no parking, no stopping or standing, loading, taxi, bus, permits, and public agency.
- Establish a minimum distance from intersections for no-parking zones based on functional classification and traffic control (e.g. stop control vs. traffic signal).
- Prohibit on-street parking adjacent to bicycle lanes where possible to reduce conflicts. Use parking bays or other designs from the *Oregon Bicycle and Pedestrian Plan* when both bicycle lanes and on-street parking need to be accommodated.
- Establish off-street parking requirements for private developments.
- Provide incentives for shared parking at commercial and retail developments.
- Establish thresholds for constructing public agency managed off-street parking facilities.
- Adhere to adopted access management standards for the location and design of approaches to off-street parking facilities.

Parking may also be managed using the following transportation demand management strategies, which are aimed at altering travel behavior by reducing the demand on the roadway network particularly during peak periods:

- Reduce the availability of long-term parking in downtown and other core urban areas.

⁵ *Traffic Engineering Handbook, 5th ed.* Institute of Transportation Engineers, 1999.

- Develop pricing strategies that charge the true cost of parking or that vary by time of day (e.g. higher prices during peak periods).
- Develop parking fines that discourage violation of parking time limits.
- Expand parking enforcement activities.
- Provide incentives for constructing park and ride facilities outside the core urban area for use with employer ride-share programs or a public transportation system.

The *Deschutes County ITS Plan Update* includes a Long-term timeframe project for a downtown Bend parking management system (DC-TM-06) that monitors occupancy in the parking garage, alerts travelers if the garage is full, and provides guidance to alternate available parking.

Traffic Signal Management and Operations

Approximately 60 traffic signals are used to control vehicular and pedestrian traffic in the Bend MPO and as many as 10 may be installed during the next 20 years. Traffic signals are primarily used to control the movement of traffic in an orderly manner at intersections with high volumes of vehicular traffic. They may also be used at locations with high pedestrian volumes, at school crossings, or at locations with crash histories that may benefit from a traffic signal. The management and operation of traffic signals greatly impacts the efficiency of the transportation network. It is estimated that poor signal timing accounts for five to ten percent of all traffic delay, but the good news is that traffic signal timing optimization projects typically have a 40:1 benefit-to-cost ratio⁶. Coordinated signal timing projects in Oregon have yielded the following benefits:

- 10- to 40-percent reduction in stops
- 15- to 45-percent reduction in delay
- 5- to 25-percent reduction in travel time
- Up to 15-percent increase in corridor travel speeds
- Up to 15-percent reduction in fuel consumption

To optimize system efficiency the Bend MPO should implement the following traffic signal management and operations strategies:

- Remove unnecessary traffic signals. Changes in land use, reduced travel demand, or geometric improvements may eliminate the need for a traffic signal that was once warranted. An engineering study should be conducted based on *MUTCD*⁷ guidelines to determine whether a traffic signal should be removed and the appropriate traffic control that should be used in its place.
- Install new traffic signals when warranted. Intersections should be evaluated using the *MUTCD* traffic signal warrants to determine if and when new traffic signals should be installed. Most often new traffic signals will be warranted due to changes in land use that result in increased travel demand.
- Utilize traffic signal hardware and software that support desired functionality.

⁶ *National Traffic Signal Report Card, Executive Summary*. National Transportation Operations Coalition, 2012.

⁷ *Manual on Uniform Traffic Control Devices, 2009 Edition*. U.S. Department of Transportation, Federal Highway Administration, 2009.

Advances in technology in the past few years have led to the availability of traffic signal hardware and software with more options available than ever before. The *Deschutes County ITS Plan Update* identified the following key features of a traffic signal system that will help optimize traffic signal operations in the Bend MPO: remote control and monitoring capability, controller error processing, and report generation. The recent completion of the Central Signal System Project in Bend addressed these key features.

- Implement traffic signal preemption/priority. “Preemption” causes a traffic signal to switch from normal operations to a special mode to allow passage of a vehicle class (e.g. emergency vehicles, trains) and “priority” is the preferential treatment of a vehicle class (e.g. transit) by a traffic signal that may occur if it does not disrupt normal operations. Preemption is currently used at the majority of the traffic signals in the Bend MPO for emergency vehicles (except police) but there is room for enhancements. Preemption techniques should be used in the Bend MPO to enhance emergency vehicle operations and priority techniques should be used to enhance transit operations.
- Implement coordinated signal timing where applicable. Various signal timing methods are available for optimizing the operations of closely spaced traffic signals. Traditional time-of-day coordination uses pre-set timing plans that are activated at certain times of the day (e.g. AM peak, midday, PM peak). Traffic responsive coordination uses real-time traffic volumes to select pre-set timing plans based on volume thresholds. Traffic adaptive coordination uses advanced signal controller technology to adjust signal timings in real-time based on real-time traffic volumes. Although traffic responsive and adaptive coordination are relatively new, all methods strive to provide continuous green time to heavy volumes on the mainline while also serving side street traffic in a timely manner.
- Periodically update signal timing. National guidelines recommend updating traffic signal timing regularly to accommodate growth and traffic pattern changes⁸. This includes updating timings for both coordinated and isolated traffic signals.
- Investigate the use of automated stop enforcement. Technology is available to detect when vehicles run a red light, to document this violation using cameras, and to automatically issue a ticket to offenders. The Bend MPO should evaluate the effectiveness of automated stop enforcement in other metropolitan areas in Oregon (e.g. Beaverton, Medford) and determine its applicability to Bend. The use of automated stop enforcement in Bend would require the adoption of supporting legislation.

The *Deschutes County ITS Plan Update* includes the following projects that support traffic signal management and operations (see Table 9.1 for more details):

- Preemption/priority for emergency vehicles, transit, and roundabouts (Projects DC-EM-01B and DC-EM-09)
- Advanced signal timing improvements on Hwy 97 Business (3rd), Hwy 20, Greenwood, Newport, 27th, Empire, Knott, and Reed Market (Projects DC-TM-02A, DC-TM-02B, DC-TM-07A, DC-TM-07C, DC-TM-13B, and DC-TM-17A, DC-TM-17B)

⁸ *National Traffic Signal Report Card, Executive Summary*. National Transportation Operations Coalition, 2012.

Additional projects or programs may be needed to review warrants for removing or installing traffic signals and for performing periodic traffic signal timing updates.

Speed Management

Uniform travel speeds consistent with a roadway's design provide for the safest and most efficient transportation system operation. Posted speeds are used to supply guidance to drivers in unfamiliar locations, discourage unreasonable driving behavior, and provide law enforcement with a means to identify excessive speeds. In 2012 travel speeds too fast for roadway conditions contributed to approximately 12 percent of all crashes in the Bend area and were also a contributing factor in one of the area's three fatalities⁹. Speeding traffic can also erode the livability of neighborhood streets. The following speed management strategies should be considered for use in the Bend MPO to reduce speed-related crashes:

- **Driver Feedback Speed Signs**: Driver feedback speed signs provide drivers with the speed limit (static information) and the driver's actual speed (real-time information) based on radar detection or other measurement methods. These signs have proven effective in reducing speeds because often drivers are not aware they are speeding until they see their actual speed. Driver feedback speed signs can be installed permanently or can be moved around on a temporary basis using trailers.
- **Variable Speed Limit Systems**: Variable speed limit systems use sensors to monitor real-time traffic conditions (e.g. prevailing travel speeds and volumes) and/or weather conditions and post appropriate enforceable speeds on dynamic message signs. Speeds may also be set manually based on other factors such as work zone activity. ODOT has successfully been using variable speed limit signs throughout Oregon to reduce travel speeds in work zones during lane restrictions and working hours.
- **Automated Speed Enforcement**: Technology is available to detect vehicles traveling faster than the posted speed and to automatically issue a ticket to offenders. The Bend MPO should evaluate the effectiveness of automated speed enforcement in other areas of Oregon and determine its applicability to Bend. The use of automated speed enforcement in Bend would require the adoption of supporting legislation.
- **Traffic Calming**: Numerous traffic calming techniques are available and have proven effective in reducing travel speeds and cut-through traffic on collectors and local roadways. Techniques include speed humps, traffic circles, traffic barriers, narrowed travel lanes/roadway cross-sections, wider sidewalks, curb extensions, pedestrian refuge islands, planted medians, turn restrictions, or a combination of these techniques. Area wide traffic calming treatments are often needed to ensure traffic problems on one roadway are not shifted to an adjacent roadway. The use of traffic calming elements in the design of new roadways can minimize the need for future enhancements.

⁹ 2012 Oregon Traffic Crash Summary. Oregon Department of Transportation, Transportation Data Section, Crash Analysis and Reporting Unit, September 2013.

The *Deschutes County ITS Plan Update* includes speed management strategies within three of the projects. The Speed Photo Enforcement project (DC-TM-42) incorporates speed photo enforcement on Mt Washington Drive, Empire Avenue, and Brookwood Boulevard, and the Century Drive Safety and Efficiency Improvements project (DC-TM-09) includes both variable speed limit signs and speed photo enforcement on Century Drive and the Portable Work Zone Equipment project (DC-MC-04) includes the use of variable speed limit signs in work zones.

Geometric Improvements

Often geometric improvements can be a cost-effective means of improving the safety and efficiency of the existing transportation system. Changing traffic conditions and piecemeal development often impact the operation of existing roadways and intersections. The Bend MPO should consider the use of the following strategies for improving geometric design based on site specific engineering evaluations:

- Realign roadways to enhance sight distance and reduce skew at intersections.
- Trim vegetation to enhance sight distance.
- Provide channelization for left turn movements, right turn movements, and bus movements. Channelization may be provided using striping, medians, islands, and pullouts.
- Consider lane use restrictions during peak periods. For example, the prohibition of left turns when suitable alternate routes are available may improve safety and reduce travel delay at some intersections.
- Re-stripe travel lane widths.
- Add or enhance destination signing at activity centers and intersections.
- Improve or remove modal crossings (e.g. at-grade rail crossings).

Geometric improvements are included in a number of projects in the Motor Vehicles chapter and the *Deschutes County ITS Plan Update* includes four advanced rail warning system project (DC-TM-19A, DC-TM-19B, DC-TM-19C, and DC-TM-19D) to deploy railroad crossing train detection and warning systems.

Value Engineering and Systems Engineering

Both value engineering and systems engineering are methodical processes used during project development and design to ensure the final product effectively meets user needs in a cost-efficient means. Value engineering is "the systematic application of recognized techniques by a multi-disciplined team which identifies the function of a product or service; establishes a worth for that function; generates alternatives through the use of creative thinking; and provides the needed functions, reliably, at the lowest overall cost."¹⁰ The FHWA requires a value engineering assessment on all federal-aid transportation projects with a cost greater than \$25 million and have found that value engineering provided a return on investment ranging from 80:1 to 146:1 for fiscal years

¹⁰ *Value Engineering*. U.S. Department of Transportation, Federal Highway Administration. <http://www.fhwa.dot.gov/ve/>. Accessed July 3, 2014.

2009 through 2012¹¹. Systems engineering is an offshoot of value engineering that focuses on projects that include technology. The FHWA requires a systems engineering analysis commensurate with the project scope for all ITS projects that use federal funds. Research has shown that projects that utilize systems engineering improve overall project cost performance (actual cost versus planned cost) whereas the actual costs on projects that do not use a systems engineering approach are 50 percent over planned costs on average¹¹.

The following strategies should be used for efficient and cost-effective transportation project delivery in the Bend MPO:

- Use value engineering or systems engineering per FHWA guidelines on all federal-aid projects.
- Develop thresholds (e.g. overall project cost) and criteria for determining when to use a full value engineering or systems engineering approach on a project.
- Develop scaled-back value engineering and systems engineering approaches for smaller projects.
- Utilize the “ITS Systems Engineering and Architecture Compliance Checklist” that ODOT developed for use on ITS projects deployed in Oregon.

Asset Management

“Asset management is a systematic process of maintaining, upgrading, and operating physical assets cost-effectively. It combines engineering principles with sound business practices and economic theory, and it provides tools to facilitate a more organized, logical approach to decision-making.¹²” Although not a new concept, asset management has become increasingly important because today’s transportation system is characterized by a combination of aging infrastructure and new technologies, high system user demand, tight budgets, limited agency resources, and public accountability. The Bend MPO should utilize the following asset management strategies to maximize the functionality and prolong the life of the MPO’s assets:

- Perform preventative maintenance to prolong the life of existing infrastructure.
- Use life-cycle cost analysis to determine the useful life span of infrastructure based on all associated costs (initial, operations, maintenance) and salvage values.
- Utilize tools used at the state and federal level such as FHWA’s Highway Economic Requirements System (HERS) software.
- Develop asset management programs for major infrastructure such as pavement, bridges, traffic signals, and ITS field devices.

Many of the projects included in the Deschutes County ITS Plan Update include aspects that help improve asset management such as remote monitoring and surveillance capabilities and automated systems (e.g. roadway treatment in winter, speed

¹¹ Eric Honour, “Understanding the Value of Systems Engineering”, 2004.

¹² *Asset Management: Advancing the State of the Art into the 21st Century Through Public-Private Dialogue*. Federal Highway Administration and the American Association of State Highway and Transportation Officials, 1996.

enforcement). The following *Deschutes County ITS Plan Update* projects focus specifically on asset management:

- Maintenance Vehicle Tracking (DC-MC-05)
- Automated Maintenance Logging System (DC-MC-06)
- AVL/CAD Transit Management System (DC-PTM-01)