# 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*[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*.
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*. Prepared for ODOT by DKS Associates and IBI Group, March 2005

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* 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.

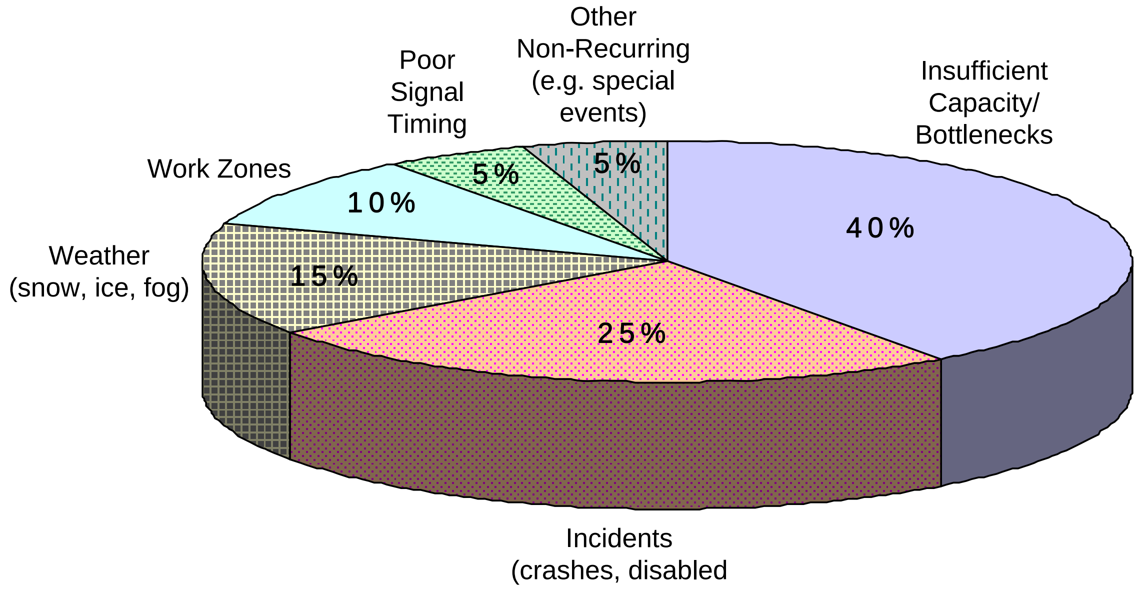


**Figure 9.1 Causes of Congestion**[2]

## 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.

[2] *Congestion Mitigation*. Office of Operations, Federal Highway Administration. http://www.ops.fhwa.dot.gov/congestionmitigation/congestionmitigation.htm. Accessed March 29, 2006.

In 2005, the Bend MPO, Oregon Department of Transportation (ODOT), City of Bend, City of Redmond, Deschutes County 911, and the Federal Highway Administration collectively developed the *Deschutes County ITS Plan* with input from other regional stakeholders. The mission of the 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:

- 2005 – 2009: 0 – 5 Year Plan (High Priority)
- 2010 – 2014: 6 – 10 Year Plan (Medium Priority)
- 2015 – 2025: 11 – 20 Year Plan (Low Priority)

Table 9.1 lists the projects that fall within the Bend MPO. A map illustrating the phased ITS infrastructure deployment locations for many of the ITS projects is located in Appendix H. 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 9.1[3].

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:

- Central management and operations of traffic signals
- 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

**Table 9.1 ITS Deployment Projects for Bend MPO**

| #/Title | Description (***stakeholders listed at end***) | Capital Cost |
|---|---|---|
| **2005 – 2009 (0 – 5 Year Plan, High Priority)** | | |
| **DC-TM-01:** Central Signal System | Install central traffic signal system, fiber optic communications, video monitoring, and count stations to allow traffic engineers the ability to monitor and change signal timings remotely and support future arterial management and advanced signal timing projects. (*ODOT, Bend, Redmond, Deschutes Co.*) | $1,422,000 |
| **DC-TM-02:** Hwy 97 Bus. (3rd St.) Safety & Efficiency Improvements | Deploy video monitoring cameras (pan-tilt-zoom), dynamic message signs, count stations, and advanced signal timing improvements. (*ODOT, Bend*) | $903,000 |

[3] *Oregon Statewide ITS Architecture and Operational Concept Plan*. Prepared for ODOT by DKS Associates, Aug. 31, 2006.

| #/Title | Description (***stakeholders listed at end***) | Capital Cost |
|---|---|---|
| **DC-TM-05:** Regional Traveler Information System | Develop an integrated system (coordinated with ODOT TTIP) to disseminate traveler information and install kiosks at key traveler points (Bend Parking Garage, truck stops, and rest areas). (*ODOT, Bend, Redmond, Deschutes Co.*) | $588,000 |
| **DC-TM-06:** Downtown Bend Parking Mgmt Sys. | Monitor parking garage occupancy to alert travelers if the garage is full and provide guidance to alternate available parking. (*Bend*) | $147,000 |
| **DC-TM-08:** Hwy 97(Bend Parkway) Safety & Efficiency Improvements | Deploy video monitoring cameras (pan-tilt-zoom) and automatic traffic recorders along the new Hwy 97 alignment. (*ODOT, Bend*) | $203,000 |
| **DC-TM-14:** ODOT Reg. 4 TOC Upgrade (Phase 1) | Expand/upgrade the existing TOC facility and equipment. Consider co-location with 911 center, EOC, or emergency response centers. (*ODOT*) | $95,000 |
| **DC-CO-02:** Communication Network | Expand the communication network to support additional field devices and connect operations centers to the regional communications network. (*ODOT, Bend, Redmond, Deschutes Co.*) | $105,000 |
| **DC-EM-01:** Info. Sharing Between Traffic Mgmt Systems & Emergency Service Providers | 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. (*ODOT, Bend, Redmond, Deschutes Co., Deschutes Co. 911*) | $550,000 |
| **DC-EM-02:** Coordinated Emergency Response - Radio System Link | Deploy a common communication interface between stakeholders responsible for emergency management. (*ODOT, Bend, Redmond, Deschutes Co., Deschutes Co. 911, US Forest Service*) | Funded by Reg. Comm. Consortium |
| **DC-MC-01:** Maintenance and Construction Coordination System | Deploy a construction activity information site that contains details about region-wide/statewide maintenance and construction activities by public agencies, and utility companies. (*ODOT, Bend, Redmond, Deschutes Co.*) | $100,000 |
| | ***Capital Cost for 2005 – 2009*** | ***$4,113,000*** |
| **2010 – 2014 (6 – 10 Year Plan, Medium Priority)** | | |
| **DC-TM-07:** Hwy 20/ Greenwood/Newport Safety & Efficiency Imp. | Deploy video monitoring cameras (pan-tilt-zoom), dynamic message signs, count stations, and advanced signal timing improvements. (*ODOT, Bend*) | $1,255,000 |
| **DC-TM-09:** Century Drive (to Mt. Bachelor) Safety & Efficiency Improvements | Deploy video, dynamic message signs, weather stations, dynamic speed limit signs, and speed photo enforcement on Century Drive between Bend and Mt. Bachelor. (*ODOT, Bend, Mt. Bachelor Inc.*) | $816,000 |
| **DC-TM-10:** Incident Response Program-Staff and Vehicles | Develop a multi-jurisdictional regional incident response program to support emergency mgmt agencies with incident mgmt. This program includes vehicles, personnel, and dispatch. (*ODOT, Bend, Redmond, Deschutes Co.*) | $728,000 |
| **DC-TM-13:** 27th/ Empire/Knott Safety & Efficiency Improvements | Deploy video monitoring cameras (pan-tilt-zoom), count stations, and advanced signal timing improvements. (*ODOT, Bend*) | $1,571,000 |
| **DC-TM-14:** ODOT Reg. 4 TOC Upgrade (Phase 2) | Expand/upgrade the existing TOC facility and equipment. Consider co-location with 911 center, EOC, or emergency response centers. (*ODOT*) | $95,000 |

| #/Title | Description (*stakeholders listed at end*) | Capital Cost |
|---|---|---|
| **DC-TM-15:** Special Event Management System (Phase 1) | Deploy traffic signal timing plans, portable dynamic message signs, parking management, and public transportation management at Deschutes County Fairgrounds and Expo Center. (*ODOT, Bend, Redmond, Deschutes Co.*) | $473,000 |
| **DC-TM-19:** Advanced Rail Warning System (Phase 1) | Deploy railroad crossing train detection and warning systems and transmit information for use by the TOC and emergency management agencies. (*ODOT, Bend, Redmond, Deschutes Co.*) | $186,000 |
| **DC-CO-01:** Document Communication Design Standards | Document design standards for communications to ensure standardization, compatibility, connectivity, and reliability between multiple jurisdictional agencies. (*ODOT*) | $75,000 |
| **DC-PTM-01:** AVL/CAD Transit Management System | Install an automated vehicle location (AVL) system on the Bend Transit District fleet and integrate transit vehicle locations with the existing computer aided dispatch (CAD) system. (*Bend Transit*) | $592,000 |
| **DC-PTM-02:** Maintenance Mgmt Sys. | Upgrade the existing dial-a-ride maintenance system to integrate AVL technology with maintenance diagnostics. (*Bend Transit*) | $36,000 |
| **DC-EM-03:** Real-Time Information to Mobile Data Devices | Provide real-time traffic information to emergency responder's mobile data devices. (*ODOT, Bend, Redmond, Deschutes Co., Deschutes Co. 911, Oregon State Police*) | $119,000 |
| **DC-EM-04:** Ambulance-Hospital Information System | Enable the exchange of real-time information (video, audio, and data) between first responders and hospitals through the St. Charles micro-wave comm. system. (*Bend, Redmond, Deschutes Co., St. Charles Hospital*) | Funded by St. Charles & Deschutes Co. |
| **DC-EM-05:** Traffic Adaptive Emergency Response | Deploy an integrated emergency response system that provides for pre-trip planning, en-route guidance, and dynamic route guidance for emergency vehicles. (*ODOT, Bend, Redmond, Deschutes Co., Deschutes Co. 911*) | $392,000 |
| **DC-EM-06:** Provide Traffic Management System Information at EOCs | Provide an interface between the TOC and/or other traffic mgmt systems and each of the EOCs to allow access to traffic control devices during emergency situations at the EOCs as well as to share information between agencies. (*ODOT, Bend, Redmond, Deschutes Co., Deschutes Co. 911*) | $76,000 |
| **DC-EM-08:** Traffic Signal Preemption by Vehicle ID | Implement preemption equipment to provide traffic signal preemption by specific vehicle ID. (*ODOT, Bend, Redmond, Deschutes Co.*) | $490,000 |
| **DC-EM-10:** Roundabout Preemption | Implement an emergency vehicle preemption system for roundabouts located on primary response routes. (*Bend*) | $600,000 |
| **DC-MC-03:** Roadway Automated Treatment | Deploy environmental sensors and automated treatment (de-icing) at the planned US 97/S. Century Drive interchange. (*ODOT*) | Funded with STIP |
| | ***Capital Cost for 2010 – 2014*** | ***$7,504,000*** |
| **2015 – 2025 (11 – 20 Year Plan, Low Priority)** | | |
| **DC-TM-17:** Reed Market Rd. Safety & Efficiency Improvements | Deploy video monitoring cameras (pan-tilt-zoom), count stations, and advanced signal timing improvements. (*ODOT, Bend*) | $527,000 |
| **DC-TM-18:** Expand the Incident Response Program - Plans | Develop plans to identify detour routes and manage traffic on Hwy 97 and Hwy 20 through Bend and Redmond to support the movement of north-south and east-west freight. The program will include incident signal timing plans, dynamic message signs, and congestion monitoring to support incident response. (*ODOT, Bend, Redmond, Deschutes Co.*) | $420,000 |

| #/Title | Description (***stakeholders listed at end***) | Capital Cost |
|---|---|---|
| **DC-TM-19:** Advanced Rail Warning System (Phase 2) | Deploy railroad crossing train detection and warning systems and transmit information for use by the TOC and emergency management agencies. (*ODOT, Bend, Redmond, Deschutes Co.*) | $160,000 |
| **DC-TM-19:** Advanced Rail Warning System (Phase 3) | Deploy railroad crossing train detection and warning systems and transmit information for use by the TOC and emergency management agencies. (*ODOT, Bend, Redmond, Deschutes Co.*) | $14,000 |
| **DC-TM-21:** TOCS Software Upgrade | Add additional functionality to the TOCS software to interface to the central signal system for traffic signal status information. (*ODOT*) | $240,000 |
| **DC-TM-24:** Vehicle Probes | Collect travel time/traffic congestion information using vehicles as probes. (*ODOT*) | $24,000 |
| **DC-TM-25:** Vehicle Navigation System | Deploy a system to transmit regional traveler information to in-vehicle navigation systems. (*ODOT*) | $32,000 |
| **DC-TM-26:** Adv. Vehicle Sys. – Mayday to TOCS | Provide for information flow from vehicle Mayday systems to the TOC (notification of airbag deployment). (*ODOT*) | $24,000 |
| **DC-TM-27:** Roundabout Surveillance | Deploy video (pan-tilt-zoom) in Bend at roundabouts to monitor traffic. (*Bend*) | $112,000 |
| **DC-TM-28:** City of Bend Data Collection Project | Deploy video traffic counting stations at bottleneck locations (e.g. Portland Street Bridge) to monitor traffic and collect volume data. (*Bend*) | $112,000 |
| **DC-PTM-03:** Real-Time Customer Information | Deploy real-time dynamic message signs at key transit locations. Information could also be disseminated via a phone system and the Internet. (*Bend Transit*) | $88,000 |
| **DC-PTM-04:** Transit Security System | Install video monitoring equipment on the transit vehicle fleet and at transit centers. (*Bend Transit*) | $105,000 |
| **DC-PTM-05:** Transit Signal Priority | Install transit signal priority equipment and software at key intersections on transit routes and on transit vehicles. (*Bend Transit, ODOT, Bend*) | $130,000 |
| **DC-PTM-06:** Automated Passenger Counting | Install an automated passenger counting system that electronically records boardings at each transit stop. (*Bend Transit*) | $105,000 |
| **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). (*Bend Transit, Bend*) | $25,000 |
| **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. (*ODOT, Bend, Redmond, Deschutes Co., Oregon State Police*) | $30,000 |
| **DC-EM-09:** Advanced Emergency Veh. Routing | Provide emergency vehicle priority between St. Charles Hospital and the Bend Airport. (*ODOT, Bend, Redmond, Deschutes Co.*) | $70,000 |
| **DC-IM-01:** Regional Data Management System | Implement a geospatial data management system for archiving data, collecting real-time data, and accessing data. (*ODOT, Bend, Redmond, Deschutes Co.*) | $540,000 |
| **DC-MC-04:** Portable Work Zone Equipment | Deploy moveable dynamic message signs and variable speed limit signs for use in work zones. (*ODOT, Bend, Redmond, Deschutes Co.*) | $342,000 |
| **DC-MC-05:** Maintenance Vehicle Tracking | Deploy GPS/AVL equipment in maintenance vehicles (e.g. snow plows). (*ODOT, Bend, Redmond, Deschutes Co.*) | $779,000 |

| #/Title | Description (***stakeholders listed at end***) | Capital Cost |
|---|---|---|
| **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. (*ODOT, Bend, Redmond, Deschutes Co.*) | $94,000 |
| **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. (*Bend*) | $35,000 |
| **DC-AVS-02:** Congestion Warning System | Deploy warning systems devices at entry points into urban areas to warn drivers of upcoming signals/queues. (*ODOT*) | $302,000 |
| **DC-AVS-03:** Intersection Collision Avoidance | Install short-range communications to transmit traffic controller information to in-vehicle collision avoidance systems. (*ODOT, Bend, Redmond*) | $1,400,000 |
| | ***Capital Cost for 2015 – 2025*** | ***$5,710,000*** |
| Source: *Deschutes County ITS Plan* | | |

### 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 benefits[4]:

- 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.

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

- 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 nontraversable 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 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 year[5].  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.

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

- 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.
- 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* includes a high-priority 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 ratio[6]. Coordinated signal timing projects in Oregon have yielded the following benefits:

[6] *National Traffic Signal Report Card, Executive Summary*. National Transportation Operations Coalition, 2005.

- 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. 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* 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.
- 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.

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[7] *Manual on Uniform Traffic Control Devices, 2003 Edition.* U.S. Department of Transportation, Federal Highway Administration, 2003.

- Periodically update signal timing. National guidelines recommend updating traffic signal timing every 3 to 5 years, or sooner, to accommodate growth and traffic pattern changes[8]. 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* includes the following projects that support traffic signal management and operations (see Table 10.1 for more details):

- Central signal system (Project DC-TM-01)
- Preemption/priority for emergency vehicles, transit, and roundabouts (Projects DC-EM-08, DC-EM-09, DC-EM-10, and DC-PTM-05)
- Advanced signal timing improvements on Hwy 97 Business (3rd), Hwy 20, Greenwood, Newport, 27th, Empire, Knott, and Reed Market (Projects DC-TM-02, DC-TM-07, DC-TM-13, and DC-TM-17)

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 2005 travel speeds too fast for roadway conditions contributed to approximately 13 percent of all crashes in the Bend area and were also a contributing factor in two of the area's four fatalities[9]. 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

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[8] *National Traffic Signal Report Card, Executive Summary*. National Transportation Operations Coalition, 2005.

[9] *2005 Oregon Traffic Crash Summary*. Oregon Department of Transportation, Transportation Data Section, Crash Analysis and Reporting Unit, June 2006.

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.

The *Deschutes County ITS Plan* includes speed management strategies within two of the projects. The Century Drive Safety and Efficiency Improvements project (DC-TM-09) includes 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* includes an advanced rail warning system project (DC-TM-19) 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 116:1 to 319:1 for fiscal years 2002 through 2005[1]. 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 average[11].

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

[10] *Value Engineering.* U.S. Department of Transportation, Federal Highway Administration. http://www.fhwa.dot.gov/ve/. Accessed March 19, 2007.

[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.

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 include aspects that help improve asset management such as remote monitoring and surveillance capabilities and automated systems (e.g. roadway treatment in winter, speed enforcement). The following *Deschutes County ITS Plan* projects focus specifically on asset management:

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