# Chapter 3: Existing Conditions

## Overview

The Bend Metropolitan Planning Organization (BMPO) is the regional transportation planning organization for the City of Bend urban area. It is formed of local governments and is responsible for overseeing transportation related planning decisions such as the approval of federal transportation funding for the Bend region in order to meet current and future transportation needs. Other responsibilities include creating and maintaining a comprehensive Metropolitan Transportation Plan (MTP) for the MPO area. The Bend MPO area is slightly larger than the City of Bend Urban Growth Boundary (UGB) and includes areas that are anticipated to develop into urbanized areas over the next 20-year horizon.

The MTP is designed to serve as the Bend metropolitan area's long term transportation plan. It addresses all travel modes, including pedestrians, bicycles, public transit, motor vehicles, freight, water, air, and pipelines, in an effort to address the region's long term projected transportation needs associated with future population growth. Projects identified in the MTP must be within projected levels of available financial resources and must also meet federal and state planning requirements. The primary objective of the plan is to identity both short-term and long-term actions in order to maintain the efficient movement of people and goods.

This chapter summarizes existing transportation operations and infrastructure within the Bend MPO boundary. Note that only highway, arterial, and collector roadways are discussed within this MTP. Field inventories conducted in spring 2006 and existing City of Bend and Deschutes County inventories were used to map existing transportation facilities in an effort to establish base year conditions. This existing inventory provides a framework (basis of comparison) for future assessment of transportation performance and needs within the Bend urban area transportation network relative to desired policies and goals.

## Pedestrians

Figure 3-1 shows the existing sidewalk coverage along arterial and collector roadways in addition to existing trail inventory within the Bend MPO area. Network connectivity is typically carried out by means of collector and arterial roadways; therefore it is important to have sidewalk coverage along these roadways to provide pedestrians with continuous connections. The existing sidewalk and trail infrastructure was assembled using City of Bend inventory[1] and field observations. As can be seen, significant portions of the arterial and collector roadway network currently have sidewalks on at

[1] Paved and unpaved sidewalk GIS data provided by Bend MPO.

least one side of the roadway, particularly in the downtown area and near residential land uses. Downtown Bend currently has fairly dense sidewalk coverage and is made up of mostly commercial, industrial, and residential land use that is characterized by a variety of small specialty retail shops, store front businesses and a historic grid roadway network. This dense sidewalk coverage therefore provides easy access to these small local businesses.

As mentioned, the majority of local streets in medium to high density residential areas feature sidewalks, which provide connections to major roadways and surrounding neighborhoods. This is likely due to the fact that the City currently requires sidewalks to be constructed on both sides of the roadway in new residential areas[2].

Overall, there is an estimated 60 miles of sidewalk coverage throughout the study area which is equivalent to approximately one-quarter of major roadway frontages[3]. In general, sidewalks are provided near and around schools and parks as illustrated in Figure 3-1. Sidewalks promoting access to local parks provide the public comfortable access to outdoor recreational facilities. Additionally, sidewalks leading to and surrounding school frontages is essential to ensure students have a safe route to school. With respect to this, the City of Bend is currently conducting a Safe Routes to School study. This program is intended to ensure children, grades kindergarten through twelve, have safe walking and biking routes within two miles of their respective school facility. The program helps communities target and reduce the number of hazards imposed on children while on their route to school. At this time, two schools in the City of Bend have participated in the program. The Safe Routes to School program stems from two pieces of legislation passed in 2005 (SAFETEA-LU and House Bill 2742).

While there is a significant amount of sidewalk coverage on arterial and collector roadways throughout the study area, there are considerable sidewalk coverage gaps that could be more in-filled to provide greater and safer pedestrian connectivity. Coverage gaps were defined where there is discontinuous sidewalk coverage along a single side of the roadway segment. Sidewalk coverage gaps were determined by visual inspection with no empirical analysis used. Table 3-1 lists several collector and arterial roadway segments which contain several sidewalk gaps. These sidewalk gaps are furthermore highlighted in Figure 3-1. Sidewalk gaps total to an estimated 61 miles in length.

Of note, the City of Bend has planned to conduct an assessment of existing sidewalks to verify whether they comply with current American with Disabilities Act criteria[4].

[2] Bend Urban Area Transportation System Plan, City of Bend, page 32, Adopted October 11, 2000.

[3] *Ibid*

[4] *ADA Revised Draft Guidelines for Accessible Public Rights-Of-Way*, Department of Justice, November 2005.

**Figure 3-1: Existing Pedestrian Facilities**

**Table 3-1: Existing Sidewalk Deficiency Areas**

| Roadway | Limits | Functional Classification |
|---|---|---|
| Reed Market Road | 3rd Street to 27th Street | Major Arterial |
| Empire Avenue | O.B. Riley to Purcell Boulevard | Major Arterial |
| 27th Street | Bear Creek Road to Ferguson Road | Major Arterial |
| Bear Creek Road | Craven Road to east MPO boundary | Minor Arterial |
| Butler Market Road | Revere Avenue to east MPO boundary | Minor Arterial |
| Cooley Road | O.B. Riley to 18th Street | Minor Arterial |
| Boyd Acres Road | Ross Road to Empire Avenue | Minor Arterial |
| 15th Street | Knott Road to King Hezekiah Way | Minor Arterial |
| Knott Road | Highway 97 to Ferguson Road | Minor Arterial |
| Galveston Avenue | 14th Street to west MPO boundary | Minor Arterial |
| Century Drive | Mount Washington Drive to west MPO boundary | Minor Arterial |
| Baker Road | Brookswood Boulevard to Highway 97 | Minor Arterial |
| Brookswood Boulevard | Hollygrape Street to Parkwood Court | Minor Arterial |
| Brookswood Boulevard | South city limits to China Hat | Minor Arterial |
| 9th Street | Wilson Avenue to Reed Market Road | Minor Arterial |
| Neff Road | Eagle Road to east MPO boundary | Minor Arterial |
| Shelvin Park Road | McClain Drive to west MPO boundary | Minor Arterial |
| Brosterhous Road | Knott Road to Murphy Road | Major Collector |
| Brosterhous Road | American Lane to 3rd Street | Major Collector |
| American Lane | Brosterhous Road to Reed Market Road | Major Collector |
| O.B. Riley Road | North MPO boundary to Highway 20 | |
| Murphy Road | 3rd Street to Paulina Lane | Major Collector |
| Parrel Road | Grand Targhee Drive to Brosterhous Road | Major Collector |
| Ponderosa Street | Highway 97 to Poplar Street | Major Collector |
| Lodgepole Drive | Poplar Street to Mahogany Street | Major Collector |
| Country Club Drive | Knott Road to Murphy Road | Major Collector |
| Putnam Road | Mount Washington Drive to north MPO boundary | Major Collector |

| Roadway | Limits | Functional Classification |
|---|---|---|
| Chase Road | 3rd Street to east end of roadway | Major Collector |
| Pettigrew Road | Reed Market Road to Twin Knolls Drive | Major Collector |
| Brinson Boulevard | Boyd Acres Road to Butler Market Road | Major Collector |
| Archie Briggs Road | Mount Washington Drive to O.B. Riley Road | Major Collector |
| Awbrey Road | Wilmington Avenue to Saginaw Avenue | Major Collector |

## Pedestrian Collisions

When looking at pedestrian travel, it is important to consider the safety aspects of the pedestrian system. Careful attention must be directed towards pedestrian crossings and where they are subject to high vehicle volumes. Using City of Bend[5] records, locations of collisions involving pedestrians spanning the years 1995-2004 were identified and are illustrated in Figure 3-2. There were 80 collisions reported involving pedestrians during the 10-year span, yielding an average of 8 collisions per year. It appears that the majority of these collisions occurred on arterial roadways in the downtown area where pedestrian and traffic volumes are typically higher. Additionally, it appears that collisions occurred where sidewalks are currently present.

Interestingly, 56-percent of these crashes occurred at mid-block locations with the remaining 44-percent occurring at intersections. Of note, approximately 40-percent of the mid-block (23-percent of total collisions) collisions involving pedestrians occurred on 5-lane roadway segments. This may suggest the need for enhanced pedestrian crossings. Enhanced pedestrian crossings may include roadway lighting, signing, striping, textured crossings, medians, flashers, and curb extensions. Samples of enhanced pedestrian crossings within the study area are located at the intersections of Colorado Avenue/Arizona Avenue and Bond Street/Wall Street which both feature curb extensions and textured crossings.

[5] Pedestrian collision data provided by Bend MPO.

**Figure 3-2: Pedestrian Crashes**

## Bicycles

Figure 3-3 shows the existing and proposed bicycle facilities in the Bend MPO area. These facilities were compiled using Deschutes County records[6] in addition to field observations. The majority of the collectors and arterials in the study area provide on-street paved bike lanes. Bike lanes currently connect the north, south, east, and west city limits, providing cyclists a wide number of through route options. For the most part, bike lanes are provided on both sides of roadways totaling an estimated 83.5 miles in length[7]. In addition to the already large inventory of bikes lanes, the City of Bend has proposed many additional paved bike lanes to ensure adequate connectivity throughout the city. The proposed bike lanes are also shown in Figure 3-3 and add an estimated total of 36.7 miles to the bike system[8].

In addition to on-street bike lanes, the Bend MPO area features many paved and unpaved trails and walkways that are also displayed in Figure 3-3. As shown, trails are provided almost along the entire extent of the Deschutes River within the study area providing a scenic route for walkers and bicyclists. Additionally, trails are provided leading to many of Bend's hilltops. There are approximately 28 miles of public trail facilities in the study area[9]. These trails serve as recreational facilities for walkers and bikers.

Overall, the existing bike lane and trail system provides substantially adequate connections to and from neighborhoods and schools, parks, and retail centers. Cyclists desiring to travel through the study area can select from the many designated routes on the major roadways or can share the road with motor vehicles on the lower volume, neighborhood streets to reach appropriate destinations.

[6] Deschutes County GIS, Deschutes County GIS Service Center

[7] *Ibid*

[8] *Ibid*

[9] Bend Urban Area Transportation System Plan, Adopted October 11, 2000, page 32, City of Bend.

**Figure 3-3: Existing Bicycle Facilities**

## Transit

### Existing Transit Services

Transit service is provided throughout the study area by means of a Dial-A-Ride program. There is currently no fixed route public transportation system within the MPO boundary. The Dial-A-Ride program provides demand responsive transportation to the general public including seniors and those that are disabled. The 17-vehicle fleet, each wheelchair ready, offers service seven days a week with scheduled operating hours Monday through Friday from 7:15am to 7:15pm and Saturday and Sunday from 8:30am to 4:15pm. Single trips (per direction) are available for a fee of $1.25 to the general public, $1.00 for youths (ages 10-17), and $0.75 for honored citizens. Free service is provided for youths ages 10 and younger when accompanied by an adult[10]. Table 3-2 summarizes the Dial-A-Ride ridership for the 2005 calendar year, aggregated by rider type[11]. Rider type, as defined by Bend Dial-A-Ride is provided in Appendix C.

**Table 3-2: Bend Dial-A-Ride Ridership Summary (2005)**

| Rider Type | Total Riders |
|---|---|
| General Public | 15,038 |
| Youth | 4,460 |
| Disabled | 25,226 |
| Honored Citizen | 32,015 |
| Senior | 17,094 |
| Other | 7,137 |
| Low Income | 2,454 |
| Medicaid | 1,398 |
| **Overall** | **104,822** |

Note: Rider type based on Bend Dial-A-Ride classification. Each rider is classified as one rider type.

A total of 104,822 riders were transported via the Dial-A-Ride system in 2005. This is a significant increase since the opening to the general public in 2002, when a total of 88,738 passengers were transported. Prior to 2002, service was only provided to seniors and those that were disabled. Since offering service to the general public in 2002, there has been an average 5 percent increase in ridership per year. This is comparable to the average increase in population over the same time period for the City of Bend which was approximately 6 percent per year[12]. The average trip length per

[10] City of Bend Dial-A-Ride, http://www.ci.bend.or.us/depts/public_works/_dial_a_ride__public_transportation.html, accessed May 19, 2006.

[11] Email from Kathy Ostrom, City of Bend Dial-A-Ride, April 12, 2006.

[12] Economic Development for Central Oregon, http://www.edforco.org/, accessed June 7, 2006.

passenger on the system is just over 3 miles. Figure 3-4 illustrates the trend of increasing ridership on Bend's Dial-A-Ride system for the previous ten years.

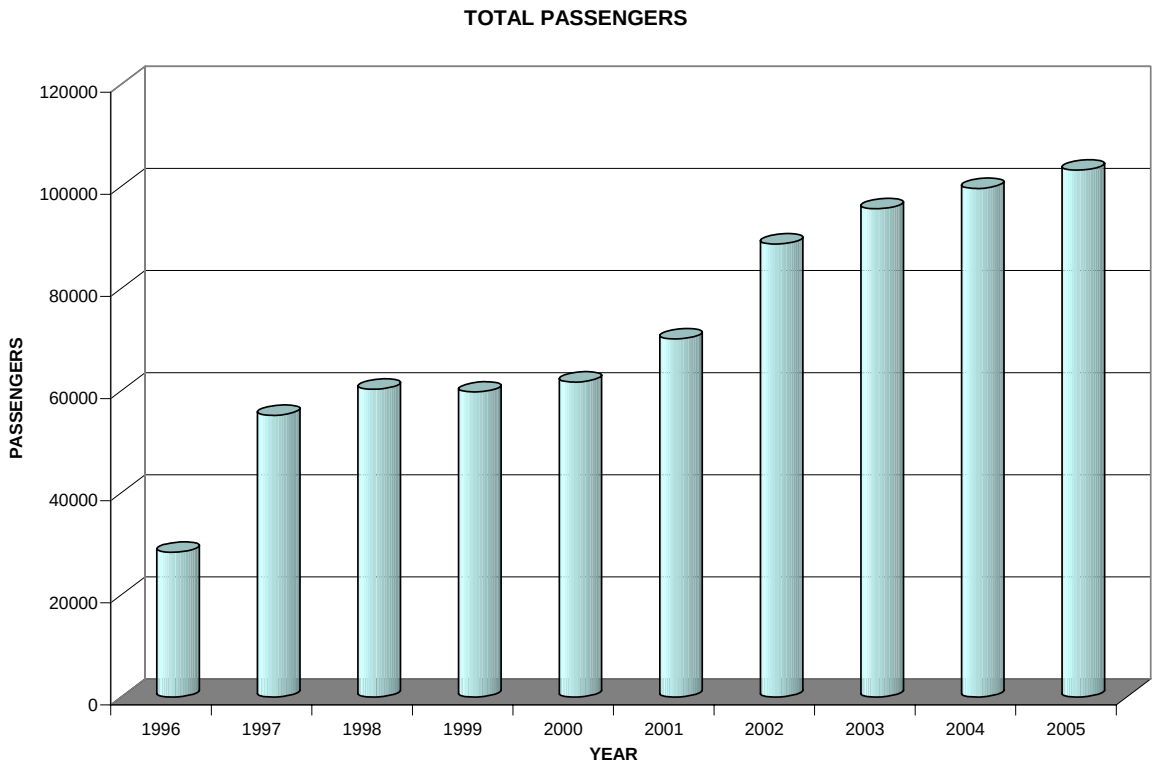



**Figure 3-4: Bend Dial-A-Ride – Total Annual Ridership**

Additionally, there are several commercial bus and airport taxi services within the study area. Porter Stage Lines offers daily scheduled bus service to and from Bend at 1315 NE 3rd Street (K Walker Enterprises Inc.). This station's operating hours are Monday through Friday 8:00am to 4:00pm and Saturday through Sunday from 8:30am to 2:00pm. Three Amtrak thruway buses currently pass through the study area. They are operated by Amtrak, Porter Stage Lines, and Valley Retriever Bus lines respectively. The nearest Amtrak station is in the city of Chemult, Oregon located approximately 65 miles south of Bend where Amtrak's Coast Starlight (Seattle-Portland-Los Angeles) passenger train passes through. Furthermore, People Mover offers bus service between Bend and John Day while C-A-C Transportation, Inc. provides daily shuttle service between Bend and Portland via the Central Oregon Breeze shuttle.

Transportation to Bend's Mount Bachelor ski resort is provided via Mount Bachelor's Super Shuttle. Service is provided between the ski resort and their park and ride located at Colorado Avenue and Simpson Avenue during the winter season.

## Planned Transit Services

A fixed-route transit feasibility study conducted in 1996 by the City of Bend found that fixed-route transit was feasible. However, when the option reached voting ballots in November 2000, the general public voted against the transit system. Voters again rejected the ballot for fixed route transit in the City of Bend in November 2004.

Recently, a Draft Service Plan[13] for fixed route transit in the City of Bend was completed as an update to the previous feasibility study. This plan investigated three fixed route alternatives and four service level options (operating frequency level). Based on the draft plan, an all day 30 minute operating service level was recommended for weekdays along with a 60 minute operating service level on Saturday, and no service Sunday. The recommended route alternative would require a minimum 6 fixed-route vehicles. Revision of this plan is currently in progress with the preferred fixed route service options anticipated to begin September, 2006.

[13] City of Bend Draft Service Plan, Nelson/Nygaard consulting associates, May 2006

# Motor Vehicles

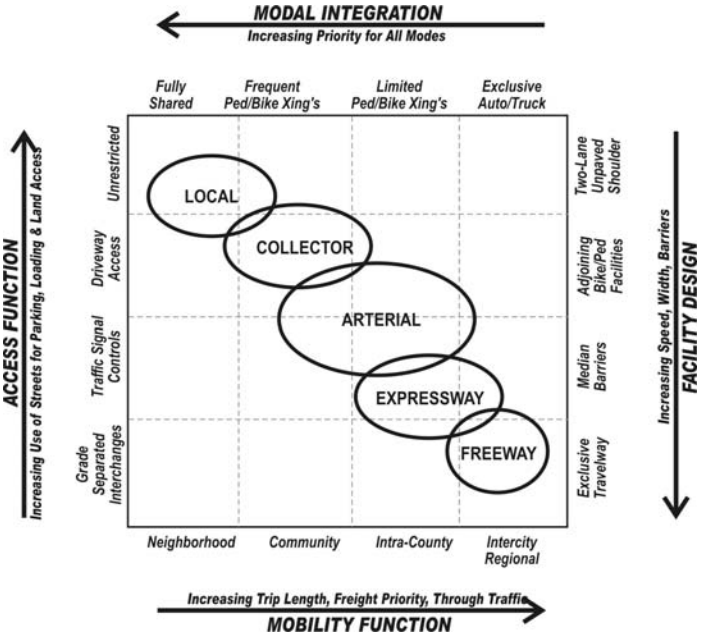
This section discusses the physical roadway infrastructure and motor vehicle travel characteristics within the study area. Summary of the existing roadway classifications set forth by the City of Bend and ODOT in addition to roadway characteristics, traffic operations, and traffic safety within the study area is included. These all play substantial roles in determining the existing conditions of the roadway network and help to target deficient areas. Key roadway characteristics such as speed limits, roadway cross-section, intersection control, and traffic volumes are addressed as these elements play key roles in defining the capacity and efficiency of the roadway network.

**Functional Classification**

The roadway functional classification system is designed to serve varying transport needs within the community. The schematic diagram shown below illustrates the competing functional nature of roadway facilities as it relates to access, mobility, multi-modal transport, and facility design. The diagram is useful to understand how competing objectives can have opposing effects. For example, as mobility is increased (bottom axis), the provision for non-motor vehicle modes (top axis) is decreased accordingly. Similarly, as access increases (left axis), the facility design (right axis) dictates slower speeds, narrower travel lanes, and non-exclusive facilities. The primary goal of selecting functional classes for particular roadways is to provide a suitable balance of these competing objectives.

The diagram shows that as roadway classes progress from local to collector to arterial to expressway (top left corner to bottom right corner) the following occurs:

- *Mobility Increases* – Longer trips between destinations, greater proportion of freight traffic movement, and a higher proportion of through traffic.
- *Integration of Pedestrian and Bicycle Decreases* – Provisions for adjoining sidewalks and bike facilities are required up through the arterial class, however, the frequency of intersection or mid-block crossings for non-motorized vehicles steadily decreases with higher functional classes. The expressway and freeway facilities typically do not allow pedestrian and bike facilities adjacent to the roadway and any crossings are grade-separated to enhance mobility and safety.



- *Access Decreases* – The shared uses for parking, loading, and direct land access is reduced. This occurs through parking regulation, access control and spacing standards (see opposite axis).
- *Facility Design Standards Increase* – Roadway design standards require increasingly wider, faster facilities leading to exclusive travel ways for autos and trucks only. The opposite end of the scale is the most basic two-lane roadway with unpaved shoulders.

The existing City of Bend functional classification system, as set forth in the City's Transportation System Plan (TSP)[14], is shown in Figure 3-5. Both ODOT and Deschutes County roadway classifications are additionally shown in the figure. Roadway classifications are summarized in tabular form in Appendix C. The classification system is intended to allow for the safe and efficient movement of people and goods while optimizing certain objectives as noted earlier. There are a total of nine roadway classifications defined in the Bend TSP (expressway, principal arterial, major arterial, minor arterial, frontage road, major collector, local street, industrial street, and alley). This classification system is intended to serve the city over the next 20-year horizon.

Bend for the most part consists of a series of minor arterials which are responsible for the connection between large trip generators such as commercial and residential areas and consist of two to four travel lanes. These arterials provide a balance between access, mobility, multi-modal transport, and facility design within the study area. The collector roadways are intended to provide access and circulation to nearby arterial roadways in a multi-modal fashion. The Highway 97 and Highway 20 expressways traveling north/south and east/west through the city are intended to carry large vehicle volumes both though the city and to urban areas. These facilities have limited access and higher speeds and interestingly contain some bike lanes and sidewalks.

Roadway ownership and maintenance responsibilities of the various roadways in the study area are carried out by the City of Bend's Public Works Department and Deschutes County, with the exception of Highway 97 and Highway 20. These facilities are state routes and are under the jurisdiction of the Oregon Department of Transportation (ODOT).

[14] Bend Urban Area Transportation System Plan, City of Bend, page 25, Adopted October 11, 2000.

**Figure 3-5: Existing Functional Classification**

## Roadway Characteristics

Field inventories and existing documentation were used to determine major roadway features within the study area. These features included posted speed limits, number of lanes per roadway segment, and intersection controls. Each of these features play key roles in defining roadway capacity and operating efficiency throughout the roadway network, which can influence travel path choices for drivers in Bend.

Figure 3-6 shows an illustration of posted speed limits on arterials and collectors within the Bend MPO boundary. The data were extracted from the City's existing inventory of speed limit signs. The majority of local roadways in Bend are posted at 20-25 miles per hour (mph). Major arterial roadways such as Reed Market Road and 27th Street have a speed limit ranging from 35-45 mph, while minor arterial roadways such as Newport Avenue, Butler Market Road, Mount Washington Drive, and Century Drive have a posted speed ranging from 25-45 mph. Collector roadways, including Portland Avenue and Parrell Road, have posted speeds ranging from 20-40 mph. Highway 97 as well as Highway 20 both have a posted speed limit of 55 mph outside of city limits. Within city limits, Highway 97 (Bend Parkway) maintains a 45 mph speed posting while Business 97 (3rd Street) and Highway 20 feature speed limits ranging between 35-45 mph.

Figure 3-7 shows the existing number of lanes on selected roadway segments in the study area. Highway 97, Highway 20, and Business 97 (3rd Street) maintain a cross-section of 4-5 travel lanes throughout the study area. For the most part, arterial roadways consist of 2-3 travel lanes featuring a shared center turn lane, while collector roadways maintain a two lane cross section. Local and County roads are 2 lane roadways.

**Figure 3-6: Existing Speed Limits**

**Figure 3-7: Existing Roadway Lanes**

**Motor Vehicle Volume**
The City of Bend maintains an active traffic counting program in which they conduct 24-hour directional traffic counts along selected roadway segments. This program began in 2003 with counts now being conducted yearly. These traffic counts are conducted on weekdays between the months of April through October. Figure 3-8 presents the bi-directional existing traffic volumes collected by the City of Bend during 2004-2005.

As expected, Highway 97, Business 97 (3rd Street), and Highway 20 carry the majority of traffic within the study area. Reed Market Road and 27th Street, both classified as major arterials, transport high levels of traffic throughout the day (20,000-30,000 vehicles). These two facilities join to connect downtown Bend and Highway 97 to high residential land uses. Arterial and collector roadways carry approximately 2,000-20,000 vehicles per day.

**Traffic Operations Performance Standards**
It is important to note that both Highway 97 and Highway 20 are classified as state facilities therefore they are subject to ODOT operational standards as set forth in the 1999 Oregon Highway Plan[15]. This plan states that these facilities must operate at a v/c ratio equal to or less than 0.80. The City of Bend additionally sets forth various intersection operational standards based on the type of intersection control. These standards are listed below and are based on measurements of v/c ratios and magnitude of delay[16].

- Two-Way Stop Control
    - Total delay for individual lane groups must be less than or equal to 50 seconds, and
    - Volume to capacity ratio for individual lane groups must be less than or equal to 1.0, and
    - 95th percentile queuing must be less than or equal to available storage length.
- All-Way Stop Control
    - Total delay for the intersection must be less than or equal to 80 seconds.
- Roundabout
    - Volume to capacity ratio for individual approaches must be less than or equal to 1.0.
- Signalized Intersection
    - Total delay for the intersection must be less than or equal to 80 seconds, and
    - Volume to capacity ratio for the intersection must be less than or equal to 1.0, and
    - 95th percentile queuing must be less than or equal to available storage length.

[15] Oregon Department of Transportation, Oregon Highway Plan, 1999.

[16] City of Bend, Street Policy No. 6, Section 6.3, Adopted May 7, 2003

**Figure 3-8: ADT**

## Traffic Operations

Level of Service (LOS), delay, and volume to capacity (v/c) ratios are typically used as measures of effectiveness for intersection operations. LOS is similar to a "report card" rating based upon average vehicle delay. Level of Service A, B, and C indicate conditions where traffic moves about without significant delays during periods of peak hour travel demand. Level of Service D and E are progressively worse peak hour operating conditions. Level of Service F represents conditions where average vehicle delay exceeds 80 seconds per entering vehicle at a signalized intersection and demand has exceeded capacity (v/c>1.0). This condition is typically evident in long queues and delays. Unsignalized intersections provide levels of service for major and minor street turning movements. For this reason, LOS E and even LOS F can occur for a specific turning movement; however, the majority of traffic may not be delayed (in cases where major street traffic is not required to stop). LOS E or F conditions at unsignalized intersections generally provide a basis to study intersections further in efforts to determine the availability of acceptable gaps, safety and traffic signal warrants.

A volume to capacity ratio (v/c) is the peak hour traffic volume at an intersection divided by the maximum volume that intersection can handle. For example, a v/c ratio equivalent to 0.80 indicates that peak hour traffic is using 80 percent of the intersections capacity. If traffic volumes exceed capacity, queues will form and will lengthen until demand subsides below the available capacity. When v/c is less than, but close to 1.0, intersection operation becomes unstable and small disruptions can cause traffic flow to break down.

Intersection turn movement counts conducted during peak periods by the City of Bend were used in addition to intersection volumes documented in recent traffic analysis reports[17] were used to determine the existing intersection capacity levels based on the *2000 Highway Capacity Manual* methodology for signalized and unsignalized intersections[18]. Analysis for modern roundabouts is based on the Federal Highway Administration's (FHWA) guidelines. Seasonal adjustments were applied to Highway 97 and Highway 20 traffic volumes to reflect 30th highest hourly volumes based on 2004 records gathered from ODOT's Automatic Traffic Recording (ATR) stations located on these facilities.

Study intersections and intersection control are highlighted in Figure 3-9. These intersections were selected based on consultation with Bend MPO staff. Study intersections are a representation of where traffic volumes are highest and where operations and capacity may be of concern. Table 3-3 summarizes the existing weekday peak hour intersection operational levels at the study intersections that either fail to meet operational requirements or are nearing capacity. Intersection operational levels for remaining study intersections are included in Appendix C.

[17] 1) Newport Bridge Conceptual Design, Kittelson & Associates , Inc., December 2004. 2) Juniper Ridge Master Plan, Kittelson & Associates, Inc., January, 2006. 3) Reed Market Corridor Study, Parametrix, June 2005. 4) US 97 & US 20 Refinement Plan, Kittelson & Associates, November 2005.

[18] *2000 Highway Capacity Manual*, Transportation Research Board, 2000.

**Figure 3-9: Study Intersections**

**Table 3-3: Existing Weekday PM Peak Hour Intersection Level of Service**

| *Intersection* | *Level of Service* | *Delay (sec./veh)* | *Volume / Capacity* |
|---|---|---|---|
| ***Unsignalized Intersections*** | | | |
| ***ODOT Jurisdiction*** | | | |
| Highway 97/Ponderosa Road – China Hat Road | **F/B** | **>100** | **0.88** |
| ***Bend Jurisdiction*** | | | |
| Empire Avenue/Boyd Acres Road (all-way stop) | **F** | **>100** | **>1.00** |
| Empire Avenue/18th Street | **F/B** | **>100** | **>1.00** |
| Reed Market Road/American Lane | **F/B** | **>100** | **>1.00** |
| ***Roundabout*** | | | |
| ***Bend Jurisdiction*** | | | |
| Reed Market Road/Brookswood Boulevard | C | 19.2 | 0.94 |
| ***Signalized Intersections*** | | | |
| ***ODOT Jurisdiction*** | | | |
| Highway 20/Greenwood Avenue | **D** | **51.8** | **0.93** |
| Highway 20/27th Street | **D** | **43.9** | **0.85** |
| Highway 97/Cooley Road | **C** | **25.1** | **0.86** |
| ***Bend Jurisdiction*** | | | |
| 3rd Street/Reed Market Road | D | 47.4 | 0.90 |
| 27th Street/Neff Road | **E** | **69.5** | **>1.00** |
| Reed Market Road/15th Street | D | 45.0 | 0.89 |
| Portland Avenue – Olney Avenue/Wall Street | D | 37.5 | 0.85 |
| Olney Avenue – Neff Road/8th Street | D | 43.3 | 0.88 |

Notes: Unsignalized Intersections:
A/A = Minor Street turn LOS/Major street turn LOS
V/C = Individual lane groups
Delay = Individual lane groups
Roundabouts:
V/C = Individual approach
Delay = Individual approach
Signalized and All-Way Stop Intersections:
Delay = Average vehicle delay in the peak hour for entire intersection in seconds.

Currently, four unsignalized study intersections (listed below) do not meet operational standards. Three of these intersections fall within City of Bend jurisdiction, while the intersection of Highway 97/Ponderosa Road-China Hat Road is under ODOT jurisdiction.

- Reed Market Road/American Lane
- Empire Boulevard/18th Street
- Empire Boulevard/Boyd Acres Road
- Highway 97/Ponderosa Road – China Hat Road

The northbound single lane approach at the intersection of Reed Market Road/American Lane suffers excessive delay (>100 seconds/vehicle) and has a v/c ratio of >1.0 which is greater than the maximum v/c ratio of 1.0 addressed as the City of Bend standard. This is due to minimal gaps on Reed Market Road during the PM peak hour which prohibits vehicles wishing to make a left turn onto Reed Market Road from doing so. The intersection of Empire Boulevard/18th Street also does not meet the city's standards with a v/c ratio >1.0 and delay of >100 seconds/vehicle on the southbound single lane approach. The all-way stop intersection of Empire Boulevard/Boyd Acres Road additionally does not currently meet city requirements yielding an average intersection delay of >100 seconds/vehicle, which is greater than the 80-second standard. The unsignalized intersection of Highway 97/Pondersa Road -China Hat Road yields a v/c ratio greater than the ODOT standard of 0.80 as set forth in the Oregon Highway Plan. The minor street consists of single lane stopped approaches which experience high levels of delay when attempting to access Highway 97, especially left turning vehicles. All remaining study unsignalized intersections meet specified operational criteria set forth by ODOT and the City of Bend.

All study intersection roundabouts are located within the City of Bend jurisdiction and currently meet city operational standards. The southbound approach at the roundabout located at Reed Market Road/Brookswood Boulevard is however nearing capacity.
One study signalized intersection under City of Bend jurisdiction and three signalized intersections under ODOT jurisdiction do not currently meet traffic signal operations criteria and are listed below.

- Highway 20/Greenwood Avenue
- Highway 20/27th Avenue
- Highway 20/Cooley Road
- Neff Road/27th Street

The intersection of Neff Road/27th Street currently has a v/c ratio of >1.0 which is greater than the City of Bend standard. Moreover, the ODOT maintained signalized intersections of Highway 20/Greenwood Avenue, Highway 20/27$^{th}$ Avenue, and Highway 20/Cooley Road currently have v/c ratios greater than the 0.80 standard. All remaining signalized intersections meet both ODOT and City of Bend operations criteria.

There are five signalized intersections that are nearing capacity as listed below, four of which fall under City of Bend jurisdiction and one under ODOT jurisdiction.

- 3rd Street/Reed Market Road
- Reed Market Road/15th Street
- Portland Avenue – Olney Avenue/Wall Street
- Olney Avenue – Neff Road/8th Street
- Highway 20/27th Street

Attention should be directed towards these intersections in order to maintain efficient operations and maximize throughput.

**Traffic Safety**

Collision data for the previous five years (2001-2005) was obtained from the Oregon Department of Transportation (ODOT) for selected corridors within the study area[19]. Analysis focused on the identification of existing high collision segments by fusing 2004 Average Daily Traffic (ADT) volumes conducted by the City of Bend and ODOT with the provided collision records and respective segment length. Equivalent collision rates per million vehicle miles traveled (MVMT) were then determined for each respective segment and used as the basis of identifying high collision segments within the study area. The use of MVMT reflects the level of exposure relevant to each roadway segment. Table 3-4 summarizes the average collision rates per MVMT over the previous five years.

[19] Oregon Department of Transportation, Collision data provided for 2001-2005. Note that 2005 collision data may be subject to change.

**Table 3-4: Bend Roadway Segment Collision Rates (2000-2005)**

| *Roadway Segment* | *Collision Type* | | | | *Collision Severity* | | | *Total* | *Rate (per MVMT)* | *ODOT 2004 Rate (per MVMT) similar facilities* |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Rear* | *Angle* | *Turn* | *Other* | *PDO* | *Injury* | *Fatal* | | | |
| **Reed Market Road** | | | | | | | | | | |
| Bond St. to Silver Lake Blvd. | 0 | 2 | 2 | 3 | 7 | 0 | 0 | 7 | 0.84 | 2.04 |
| Silver Lake Blvd. to American Ln. | 37 | 27 | 46 | 10 | 70 | 50 | 0 | 120 | **3.24** | 2.04 |
| American Ln. to SE 27th St. | 43 | 2 | 11 | 19 | 40 | 34 | 0 | 74 | **2.14** | 2.04 |
| **27th Street** | | | | | | | | | | |
| Butler Market Rd. to Conners Ave. | 8 | 4 | 12 | 4 | 18 | 10 | 0 | 28 | 1.06 | 2.04 |
| Conners Ave. to Copperfield Ave. | 34 | 15 | 27 | 13 | 54 | 35 | 0 | 89 | 1.81 | 2.04 |
| Copperfield Ave. to Reed Market Rd. | 8 | 1 | 5 | 1 | 2 | 13 | 0 | 15 | **2.09** | 2.04 |
| **Empire Avenue** | | | | | | | | | | |
| OB Riley Rd. to Boyd Acres Rd. | 17 | 5 | 22 | 2 | 26 | 20 | 0 | 46 | **2.77** | 2.04 |
| Boyd Acres Rd. to Purcell Blvd. | 0 | 3 | 7 | 3 | 11 | 2 | 0 | 13 | 1.09 | 2.04 |
| **Business 97 (3rd Street)** | | | | | | | | | | |
| Greenwood Ave. to Brosterhous Rd. | 82 | 31 | 89 | 27 | 128 | 100 | 1 | 229 | **2.84** | 2.04 |
| Brosterhous Rd. Hwy 97/3rd St. (south) | 22 | 21 | 54 | 15 | 61 | 50 | 1 | 112 | 1.29 | 2.04 |
| **Highway 97** | | | | | | | | | | |
| North MPO boundary to Nels Anderson Rd. | 80 | 5 | 18 | 22 | 63 | 62 | 0 | 125 | **1.54** | 0.76 |
| Nels Anderson Rd. to Greenwood Ave. | 36 | 2 | 19 | 26 | 51 | 32 | 0 | 83 | 0.46 | 0.76 |
| Greenwood Ave. to Reed Ln. | 30 | 1 | 7 | 17 | 25 | 30 | 0 | 55 | 0.46 | 0.76 |
| Reed Ln. to Hwy 97/3rd St. (south) | 73 | 16 | 29 | 9 | 69 | 57 | 1 | 127 | **2.24** | 0.76 |
| Hwy 97/3rd St. (south) to south MPO boundary | 2 | 7 | 5 | 2 | 5 | 11 | 0 | 16 | **0.92** | 0.76 |
| **Highway 20** | | | | | | | | | | |
| North MPO boundary to Hwy 20/Hwy 97 (north) | 8 | 0 | 2 | 3 | 5 | 8 | 0 | 13 | 0.27 | 0.76 |
| Hwy 20/Hwy 97 (north) to | 1 | 0 | 1 | 0 | 2 | 0 | 0 | 2 | 0.02 | 0.76 |

| Roadway Segment | Collision Type | | | | Collision Severity | | | Total | Rate (per MVMT) | ODOT 2004 Rate (per MVMT) similar facilities |
|---|---|---|---|---|---|---|---|---|---|---|
| | Rear | Angle | Turn | Other | PDO | Injury | Fatal | | | |
| Railroad track | | | | | | | | | | |
| Railroad track to Greenwood Ave. | 45 | 19 | 51 | 17 | 72 | 60 | 0 | 132 | **2.60** | 0.76 |
| 3rd St. to Pilot Butte Summit Dr. | 38 | 17 | 59 | 22 | 79 | 57 | 0 | 136 | **3.59** | 0.76 |
| Pilot Butte Summit Dr. to Purcell Blvd. | 41 | 3 | 13 | 12 | 32 | 36 | 0 | 68 | **1.83** | 0.76 |
| Purcell Blvd. to East MPO boundary | 17 | 3 | 12 | 4 | 24 | 12 | 0 | 36 | **1.54** | 0.76 |

Notes:
- Other types of collisions include backing, pedestrian, head-on, sideswipe, parking, fixed object, non-collision, and miscellaneous.
- Injury includes A, B, and C type injuries
- PDO = Property damage only
- MVMT = Million vehicle miles traveled

These measured collision rates were compared to those of similar facilities as indicated in ODOT's 2004 Oregon State Highway Crash Rate Tables[20]. The basis of comparison for similar facilities is based on urban city arterials and urban city expressways which had respective collision rates of 2.04 and 0.76 per MVMT in 2004.

It is important to note that the criterion for mandatory collision reporting was revised effective after December 31, 2003. Collisions before December 31, 2003 were required to be reported if they met the following:

- Death
- Bodily injury or damage to any one's property in excess of $1,000

The revision consisted of changing legally reportable collisions to ones in which met the following for the driver:

- Death
- Bodily Injury
- $1,500 damage to your vehicle
- $1,500 damage to any one's property
- If any vehicle is towed from the scene due to damage.

This revision poses less stringent guiding principles for collision reporting which would attribute to an expected decrease in reported collisions. This is supported by 2004

[20] 2004 State Highway Crash Rate Tables, Oregon Department of Transportation, Transportation Data Section, August, 2005.

ODOT collision records where collision rates decreased by 54-percent and 17-percent for urban city arterials and expressways respectively.

Table 3-4 indicates that five collector/arterial roadway segments and seven highway/expressway segments analyzed have collision rates higher than similar state facilities. It must be noted that collision data analyzed contain data for three years under the previous mandatory collision reporting criteria and two years data under the new collision reporting criteria which is anticipated to yield a lower total number of reported collisions than previous criteria.

Reed Market Road

The segment between Silver Lake Boulevard and American Lane has an average collision rate over one-and-a-half times that of similar facilities. The majority of collisions occurring on this segment were a result of turn movements which is a reflection of vehicles turning onto Reed Market Road from minor street approaches. A significant number of these collisions occurred at the intersection of Reed Market Road/American Lane. The single lane approach at American Lane suffers excessive delay during peak periods and it is likely that drivers attempt to turn onto Reed Market Road when there are insufficient gaps. The intersections of Reed Market Road/Division Street and Reed Market Road/3rd Street, also in this same segment, were additionally engaged in numerous collisions. With respect to the segment between American Lane and SE 27th Street, the majority of collisions occurred at the intersections of Reed Market Road/SE 15th Street and Reed Market Road/SE 27th Street.

27th Street

There is one segment on 27th Street that experienced a collision rate higher than the compared normal. This segment is between Copperfield Avenue and Reed Market Road. This section yields a higher crash rate when compared to similar facilities due to lower traffic volumes which in turn yields a lower level of exposure.

Empire Boulevard

Empire Boulevard between O.B. Riley Road and Boyd Acres Road also has a higher than average collision rate. This section passes through the Highway 97 and Highway 20 interchanges which both experience high levels of traffic during peak periods. These collisions consisted mainly of rear end and turning movement collisions. Of note, Bend Parkway (Highway 97) opened in 2001, the first year of the analysis period.

Business 97 (3rd Street)

There are two study segments on Business 97 (3rd Street) that hold higher collision rates than similar facilities. Both of these segments are located within downtown Bend where 3rd Street consists of a 5-lane cross section and contains many traffic signals. Collision trends reveal a large number of rear end and turn movement collisions which are typically expected with traffic signals and turn

movements from minor streets onto a busy principal arterial. Of note, there was one fatality recorded over the previous five years on 3rd Street.

Highway 97

There are two study segments on Highway 97 where average collision rates are respectively two and three times higher than average. The segment between the north city limits and Nels Anderson Road experienced a significant number of rear end collisions. The intersections of Highway 97 and Cooley Road and Robal Road are signalized where the majority of collisions along this segment occurred. Recently, a shopping mall was introduced on the west side of Highway 97 between Cooley Road and Robal Road which in turn generated higher traffic volumes within the area. This high collision rate is likely attributed to the increase in traffic volumes associated with the shopping mall. The segment between Reed Lane and 3rd Street also experienced a large amount of rear end collisions. Highway 97 has a posted speed of 45 mph within this section and traffic signals are located at 3rd Street, Pinebrook Boulevard, and Powers Road. Of importance, there was one fatality experienced within this section. The sections of Highway 97 north and south of this segment do not contain any traffic signals. With this, these traffic signals are probable sources to the large number of rear end collisions along this segment.

Highway 20

Four segments analyzed along Highway 20 yielded higher collision rates than similar facilities. Three are all located on the east section, stemming from Business 97 (3rd Street). The segment between Business 97 (3rd Street) and Pilot Butte Access maintains a 5-lane cross section and has a posted speed of 25-35 mph. Throughout this segment are a large number of busy cross streets which is likely the source for the majority of collisions being the result of turn movements. The remaining two sections of highway 20 have a 4-lane cross section and have a posted speed of 45 mph. The largest percentage of collisions along these segments are rear ends. This is likely due to that both of these segments contain moderately spaced traffic signals.

The majority of crashes occurring on the northern section of Highway between the railroad tracks and Greenwood Avenue occurred at the busy intersection of Highway 20/Greenwood Avenue. The majority of these collisions were the result of turning movements and rear-ends.

**Deschutes County High Crash Locations**

Deschutes County currently maintains a listing of high crash locations within the county. The County has identified a total of 16 intersections that they have designated as high crash locations in Bend which are shown in Figure 3-10.

**ODOT SPIS**

Furthermore, ODOT maintains a Safety Priority Index System (SPIS) that ranks high collision locations along state facilities. The system provides a weighted score based on

the severity, frequency, and rate of collisions over the previous three years. Locations are aggregated into 0.10-mile segments. Only segments experiencing three or more collisions or one fatality over the three year analysis period are considered to be a SPIS site. The most recent ODOT SPIS data indicate that 21 one-tenth of a mile segments along Highway 97 and Highway 20 made the SPIS list for the 2001-2003 analysis period[21].

[21] ODOT, http://www.oregon.gov/ODOT/TD/TDATA/gis/odotmaps.shtml#SPIS_SIP_Maps

**Figure 3-10: High Collision Locations**

## Truck Freight

The movement of raw and furnished goods plays a vital role in our economy. The majority of these goods are transported via motor carrier; therefore efficient truck mobility is crucial to economic survival. The designation of through truck routes provides for this efficient movement while at the same time maintaining neighborhood livability, public safety, and minimizing maintenance costs of the roadway system. ODOT[22] identifies Highway 97 (Bend Parkway) as a designated federal truck route and a state freight route. Highway 20 is designated a federal truck route through the entire study area. The following two sections of Highway 20 are designated state freight routes: 1) from the west study area limits to Empire Avenue and 2) from NE 11th Street to the east study area limits. These routes are identified in Figure 3-11. The surrounding arterial roadway system links these highways with nearby businesses located in the industrial and commercial zoning regimes. Table 3-5 summarizes available 2004 truck traffic as a percentage of ADT at several permanent ODOT ATR stations within the City of Bend.

**Table 3-5: Existing Truck Volumes**

| Route | Automatic Traffic Recorder Location | 2004 Average Daily Traffic | Truck ADT | Truck % |
|---|---|---|---|---|
| Highway 97 | south of Revere Avenue | 38,600 | 2,740 | 7.1 |
| Highway 97 | south of Empire Boulevard | 41,300 | 3,550 | 8.6 |
| Highway 97 | 0.9 miles south of Bend | 22,150 | 1795 | 8.1 |
| Highway 20 | 5 miles east of Bend | 2,750 | 650 | 23.5 |

[22] *1999 Oregon Highway Plan*, Oregon Department of Transportation, May 1999.

**Figure 3-11: Truck Routes/RR Crossings**

## Other Travel Modes

There are four other modes of transportation in Bend included in this MTP: rail, pipeline, air, and water. The Deschutes River flows through the center of bend and serves as a scenic and recreational waterway. There is no freight activity along this waterway within the study area therefore it will be left out of the remaining discussion. These remaining modes of transportation can all be seen in the previous Figure 3-11 with the exception of pipelines.

### Rail Freight

Burlington Northern Santa Fe (BNSF) and Union Pacific (UP) currently operate manifest trains through the City of Bend. The rail track, owned by BNSF, runs parallel to Highway 97 at the north city limits before veering east just south of Colorado Avenue towards the industrial zone. The rail track is regulated under the Federal Railroad Administrations (FRA) class 2, 3 and 4 track standards. In this, there are no weight or dimensional restrictions for freight movements through the study area.

BNSF and UP combined for an estimated 13 million gross ton miles being transported through the study area in 2002[23]. In 2005, BNSF was operating approximately 12-15 trains per 24 hours through the study area, while UP was operating one train daily in each direction. Additionally, BNSF operates a switch engine which transports freight to and from local businesses within the study area. The majority of freight being transported through the study area consists of various forest products, cement, diesel fuel, liquefied petroleum gas, wallboard, and other construction supplies[24].

With rail freight passing through the study area, attention needs to be directed towards the intersection of the rail track and the roadway. Railroad crossings were shown in Figure 3-11. Currently, there are a total of seventeen crossings. Of these, eleven are at-grade crossings featuring active traffic control devices (automatic gates). Of the remaining grade-separated crossings, three are over grade crossings where the railway travels over the roadway and two are under grade crossings where the roadway spans over the railway. For the most part, grade separated crossings are preferred so as to provide sufficient safety and eliminate large traffic delays. A review of the Reed Market Road at grade crossing over three consecutive weekdays yielded an average gate downtime of almost four minutes. Vehicle queues westbound on Reed Market extended back to 15th Street and beyond.

### Gas Pipelines

Gas Transmission Northwest Corporation (TransCanada) currently operates high-pressure natural gas pipelines that run near Bend city limits. This pipeline extends between Kingsgate, British Columbia and Malin, Oregon thus traversing a distance of 612 miles. The pipeline currently passes through the southeast corner of the city limits and consists of 36-inch and 42-inch diameter pipeline that is capable of delivering up to

[23] Email from Bob Melbo of ODOT Rail Division to Tyler Deke of Bend MPO, January, 2006.

[24] *Ibid*

1 billion cubic feet (BCF) of gas per day to the Pacific Northwest; however typical daily operations are in the range of 600-700 million cubic feet per day[25]. Cascade Natural Gas holds the role of distributing natural gas to the City of Bend through a series of 2-6 inch diameter piping. The maximum allowable operating pressure for the pipeline system is 911 pounds per square inch (psi).

**Airport**

The Bend Municipal Airport (Airport Identifier BDN) is located at 63136 Powell Butte Highway, approximately five miles northeast of city limits. It is a non-towered airport and classified as a Category 2 – Business or High Activity General Aviation Airport. In this, there is no scheduled passenger service to/from the airport. The existing single asphalt runway measures 75 feet in width and 5,005 feet in length serving approximately 42,000 annual aircraft operations (departures and arrivals) with an approximate average of 110 operations per day thus making it the 14th busiest airport in the state[26]. The existing asphalt runway has been noted to be in fair condition. Approximately 180 aircrafts in combination with 18 aviation type businesses are currently based at the airport. The airport was established in 1942 in response to World War II training efforts.

The Oregon Aviation Plan[27] found runway length/width and weather reporting to be key needs for this particular airport in order to preserve the airport system over the next twenty years. Recently, an automated weather observation system capable of announcing wind speed, wind direction, day versus night, current temperature and dew point, precipitation, cloud layers (up to three) and ceiling (up to 12,000 feet above ground level), density altitude, barometric pressure, visibility (1/4 mile to 10+ miles), and lightning strikes/activity within and beyond 10 miles[28]. Moreover, a new runway is anticipated to be completed in October 2007 which will replace the existing runway.

Pilot Butte Airport (Airport Identifier 8OR5) is a private use airstrip located south of Pilot Butte in the City of Bend. It consists of a 20 foot wide by 2400 foot asphalt runway.

[25] Phone conversation with Robert Latimer, TransCanada GTN & NBP System, May 9, 2006.

[26] Airport update #7, Bend Municipal Airport, April 18, 2006 (http://www.ci.bend.or.us)

[27] *Oregon Aviation Plan*, Oregon Department of Transportation, February 2000.

[28] Airport update #7, Bend Municipal Airport, April 18, 2006 (http://www.ci.bend.or.us)

## Land Use

Land use plays a large role in driving transportation choices. Consequently, land use within the City of Bend is a key ingredient to understanding current transportation patterns and roadway traffic volumes. Industrial and commercial land uses are found within the central core of the city along Highway 97 and Highway 20, while residential land uses make up most of urban and rural Bend. Bend's Zoning Ordinance (NS 1178) and Subdivision Ordinance (NS 1349) control and regulate the most appropriate use of land within the City.

Currently, the Bend Area General Plan (BAGP) is the key source for setting forth goals, objectives, and policies linking transportation and land use within the City of Bend. This document is intended to provide guidance to local, state, and federal agencies, neighborhood and community groups, and anyone interested in development with making appropriate land use decisions with regards to future development that will help meet the future needs of the state, community, and citizens. The plan consists of a package of goals, text, exhibits, policies, and illustrative maps in an effort to lay out where and how changes should happen in order to accommodate the rapid population and economic growth. Both the City's zoning and subdivision ordinance are designed in compliance with the goals, objectives and policies as stated in the BAGP and are intended to implement the general plan.

It should be noted that the BAGP is subject to changes over time and should be revised to reflect new information and attitudes towards future transportation and land use needs.

## Intelligent Transportation Systems

In efforts to further examine the existing transportation infrastructure in Bend, a review of existing Intelligent Transportation Systems (ITS) was carried out. These systems are intended to better manage the existing roadway system. The Deschutes County ITS Plan[29] was used as the basis for this section.

### ITS Systems

Bend currently houses several ITS systems including remote weather information systems (RWIS), automatic traffic recorders (ATR), video detection cameras, closed circuit television (CCTV) cameras, and an oversize vehicle closure telephone system. Figure 3-12 provides an overview of current ITS deployments within the City of Bend. These are all monitored and managed by the Bend Traffic Operations Center (TOC) which is currently suited to successfully carry out tasks in incident management, emergency management, traffic management, traveler information, winter operations, and maintenance operations.

[29] Deschutes County ITS Plan, DKS Associates, March 2005.

Six CCTV cameras are currently installed along Highway 97 (Bend Parkway). These cameras are used to monitor current traffic conditions and aid with incident, emergency, and traffic management strategies. Currently there are five ATR recorder stations within Bend city limits. These are all located on Highway 97 and Highway 20. Weather stations are used in an effort to aid travelers and maintenance crews of adverse weather conditions. There are two weather stations located in Bend in the northern part of the city. Typical measurements include air and pavement temperature, precipitation, wind speed and direction, and humidity. With the addition of new traffic signals and modifications, video detection systems are becoming more common. These units take the place of inductive loop detectors to allow for actuated traffic signal operations. A large sum of information reported from these field devices is broadcasted to the public via ODOT's Trip Check website.[30]

[30] Oregon Department of Transportation, Tripcheck, (http://www.tripcheck.com)

**Figure 3-12: ITS**