

# Performance Measures

The CMP is multimodal; it monitors limited-access and arterial roadways, interchanges, intersections, park-and-ride lots, bicycle parking at transit stations, pedestrian and bicycle transportation (as part of intersection monitoring), carpool and vanpool park-and-ride facilities, transit schedule adherence, and transit vehicle capacity.

The MPO staff collects data by facility type. For additional analysis, the CMP acquires data from other sources, such as the U.S. Census Bureau, the MBTA, and MassDOT. The data are matched to performance measures, many of which are associated with thresholds. Depending on the situation, selected performance measures are mapped, tabulated, or used as input for level-of-service analysis in order to estimate performance based on level of service (LOS), utilization rates, speed indices, crash rates, and other measures. Based on performance measures, congested locations are prioritized for recommendations for planning studies in the UPWP (Unified Planning Work Program), for project evaluation and prioritizing in the TIP (Transportation Improvement Program), and for the Needs Assessment in the LRTP (Long-Range Transportation Plan).

The following performance measures are used by the CMP, organized by facility type.

## Roadways, Intersections, and Interchanges

- **Average observed travel speed:** Travel speeds are associated with specific roadway segments and are calculated using travel times. The average observed travel speed is a good indicator of a deficiency in mobility in the roadway network and is used for determining solutions to mobility problems. Travel times are collected for limited-access, partially limited-access, and arterial roadways. Congestion is considered to occur when average observed travel speeds are less than 50 mph on limited-access roadways, equal to or less than 21 mph on partially limited-access arterials, or equal to or less than 14 mph on other arterials.
- **Speed index:** The speed index is the ratio of the observed speed to the posted speed limit. The posted speed limit is one of the factors that influence travel speeds on roadways. Therefore, in order to complement the average observed travel speeds, a speed index is used to account for the speed limit factor. The

index helps to determine whether a low observed speed is due to congestion or simply to a lower posted speed limit.

- **Delay:** This measure indicates if there is excessive travel delay at a particular intersection. The average delay was defined as the number of seconds for which travel speed is less than 5 mph. Delay is considered to occur when travel speed remains below 5 mph for more than three consecutive seconds. The amount of delay is used to define congestion. Delay can indicate how efficiently an intersection is operating, and can help determine if the intersection is in need of traffic operations or intelligent transportation systems (ITS) solutions. However, measuring delay is only one aspect of evaluating signalized intersections. The Highway Capacity Manual strongly recommends that any analysis of signalized intersections include both a capacity analysis and an LOS analysis in order to obtain a complete picture of existing intersection operations.<sup>1</sup> In other words, the CMP analysis should be viewed as a cursory assessment of signalized intersections; more data would need to be collected in order to determine the severity of problems for a specific traffic signal operation.
- **Traffic volume:** This is defined as the number of vehicles that pass through a given observation point during a given time period. Pedestrian and bicycle traffic volumes are also measured on non-limited-access roadways. Traffic volume is a factor that is considered in determining where there might be issues with safety and system preservation on the roadway network. The volume-to-capacity (V/C) ratio and many safety performance measures are dependent on the traffic volume variable.
- **Volume/capacity (V/C) ratio:** This measure is defined as the ratio of the traffic volume to capacity. Capacity is the maximum hourly rate at which vehicles can reasonably be expected to proceed through an intersection under prevailing roadway, traffic, and control conditions. A V/C ratio at or above 1.0 indicates that an intersection operates at or beyond its capacity. The V/C ratio is an indicator of where mobility might be an issue due to roadways having traffic volumes that exceed their capacity.
- **Level of service (LOS):** A measure describing operational conditions at an intersection, based on intersection delay, with LOS A representing the best conditions and LOS F the worst. Typically, a level of service of E or F is considered to indicate an unacceptable level of congestion.
- **Approach speed:** The average speed at which traffic approaches an interchange.

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<sup>1</sup> Transportation Research Board. *Highway Capacity Manual*. Washington, D.C., TRB, 2010.

- **Approach delay (intersections):** The total additional travel time experienced by a driver as a result of traffic control measures (for example, signals) and interaction with other users of an intersection.
- **Number of crashes:** The number of crashes that have occurred at a given location within a given time period. This can indicate where there are problems related to safety, incident response, and mobility. This variable is needed to calculate the crash rate.
- **Crash rate:** The crash rate for an intersection is expressed in crashes per million entering vehicles (MEV), and the crash rate for a roadway segment is expressed in crashes per million vehicle-miles traveled (MVMT). This measure is a better indicator than the number of crashes for analyzing dangerous locations on the roadway network. The crash rate evaluates the amount of incidents relative to the amount of traffic at a particular location.
- **Vehicle occupancy:** The number of persons in each vehicle; measured at selected locations.

## HOV Lanes and Parallel General-Purpose Lanes

- **Travel-time savings:** The average travel times for HOV lanes are compared to the average travel times for the adjacent general-purpose lanes during the hours of HOV lane operation. This allows the amount of time saved by HOV lane users to be calculated; it is a measure of the effectiveness of the HOV lanes.
- **Vehicle occupancy:** This measure allows the person-throughput of the HOV lanes to be calculated and compared with the person-throughput of the general-purpose lanes.

## Transit Service

- **On-time performance (schedule adherence):** Different thresholds for on-time performance are used for different modes of public transportation (bus, rapid transit, commuter rail, and ferry). They are described in detail in the Public Transit section of System Monitoring.
- **Passenger crowding (passengers per vehicle seat):** Passenger crowding is a measure of the ratio of passengers to the number of seats on the vehicle. For CMP purposes, MBTA thresholds for passenger crowding are used. They are described in detail in the Public Transportation section of System Monitoring .

## Park-and-Ride Facilities (MBTA and MassDOT Facilities)

- **Park-and-ride lot utilization:** The percent of parking spaces that are filled at the time of the last morning peak-period train, bus, or boat. (The peak period is defined by the MBTA; it varies depending on the transit line and station.) A park-and-ride lot is categorized as “full” if 85% or more of the spaces are used,

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“partially full” if between 50% and 84% of spaces are used, and “underutilized” if less than 50% of spaces are used.

- **Time a lot fills up:** For park-and-ride lots that fill up to 85% capacity or higher during the morning peak period on a typical weekday, the time at which a lot fills up is used as an additional performance measure. There is considered to be insufficient parking capacity if the lot fills completely before the departure time of the last peak-period train.
- **Bicycle parking availability and utilization:** The number of bicycle parking spaces (for example, bike racks) available and the percentage of them that are used at the time of the last peak-period train, bus, or boat. Bicycle parking at locations other than bike racks (for example, bikes locked to sign posts) is also measured, since this may indicate the need for proper bicycle parking facilities.

The connections between performance measures, CMP objectives, and MPO policies are shown in Table 1-1, and the data sources for the performance measures are listed in Table 3-1.

**TABLE 3-1  
CMP Performance Measures and Data Sources**

<b>Facility</b>	<b>Performance Measure</b>	<b>Data Source</b>
Roadways, Intersections, and Interchanges	Average observed travel speed	CTPS travel speed runs
	Speed index	CTPS travel speed runs
	Delay	CTPS travel speed runs
	Traffic volumes (all modes)	MassDOT and CTPS intersection site visits
	Volume/capacity (V/C) ratio	CTPS intersection site visits
	Level of service	CTPS intersection site visits
	Approach speed	CTPS travel speed runs
	Approach delay	CTPS intersection site visits
	Number of crashes	MassDOT crash data
	Crash rate	MassDOT crash data
	Vehicle occupancy	CTPS occupancy and traffic counts
HOV Lanes and Parallel General- Purpose Lanes	Travel time savings	CTPS travel speed runs
	Vehicle occupancy	CTPS occupancy and traffic counts
Transit Vehicles	On-time performance	CTPS ride checks, MBTA data
	Passenger crowding	CTPS ride checks, MBTA data
Park-and-Ride Facilities (MBTA and MassDOT)	Lot capacity and utilization	CTPS park-and-ride site visits, MassDOT data
	Time a lot fills up	CTPS park-and-ride site visits
	Bicycle parking capacity and utilization	CTPS park-and-ride site visits

## CONGESTION THRESHOLDS

Many CMP performance measures have associated thresholds that are used to identify when congestion is occurring, or to otherwise distinguish between undesirable outcomes and desirable outcomes. If the thresholds are surpassed, the transportation facility may be identified as a congested corridor

These thresholds are listed in Table 3-2.

**TABLE 3-2  
Congestion Thresholds**

Performance Measure	Threshold
Average observed travel speed	Indicators of congestion: < 50 mph (limited-access roadways) ≤ 21 mph (partially limited-access arterials) ≤ 14 mph (other arterials)
Speed index	< 0.70 indicates congestion
Delay	≥ 55 seconds (arterials) indicates congestion
Traffic volumes (all modes)	Depends on functional class roadway capacity
Volume/capacity (V/C) ratio	> 1.0 indicates congestion
Level of service	E or F indicates congestion
Approach speed	Varies
Approach delay (interchanges)	Varies
Number of crashes	No threshold
Crash rate	MassDOT Highway Division District average. Anything higher indicates problem areas
HOV travel time savings	One minute per mile is the minimum acceptable benefit
Vehicle occupancy	No threshold
On-time performance	Varies (see page 4-8 for more information)
Passenger crowding	Varies (see Table 4-9)
Park-and-ride lot utilization	Full: ≥ 85% Underutilized: < 50%
The time a lot fills up	There is insufficient parking capacity if the lot fills to 100% before the departure time of the last AM peak-period train.
Bicycle parking capacity and utilization	Full: ≥ 85% Underutilized: < 50%