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Technical Memorandum

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RE: TPR Modeling and Analysis Guides Update

Tech Memo #10: Performance Measure and Performance Standard Application Guidance

This memorandum provides a toolbox of performance measures and potential threshold considerations for inclusion in ODOT's Analysis Procedures Manual (APM). These measures and thresholds together can serve as performance standards for local jurisdictions per OAR 660-012-0215. Local jurisdictions within metropolitan areas must adopt at least two standards that address recent Oregon Administrative Rules (OARs) changes related to DLCD's Climate-Friendly and Equitable Communities (CFEC) rulemaking process.

Performance measures and standards are adopted metrics used to review comprehensive plan and land use regulation amendments, analyze transportation impacts as part of development review and review Metro functional plan amendments. In addition, measures and standards can identify deficiencies, recognize significant effects, understand impacts, and develop mitigations to address impacts to elements of the transportation system. Historically, performance measures and standards have been heavily focused on motorized vehicle capacity, with level-of-service and volume-to-capacity ratio being the most common metrics used.

When selecting performance measures and standards, jurisdictions should consider their transportation system goals, desired outcomes, data availability, and the level of effort their staff can put into reporting and/or reviewing these measures and standards.

This document provides a list of potential performance measures and thresholds which can be used to meet the OAR performance standard requirements. The measures included are listed by the identification number referenced in Technical Memorandum #9, where a broader set of potential measures identified in prior research were presented and screened to determine those that would most likely serve as useful candidates in this toolbox.

For each measure, the toolkit includes the following information:

- **Definition** – A brief description of the measure.
- **Scale** – The scales the measure can be applied to such as to a facility, sub-area or jurisdiction.
- **Strengths and Limitations** – Strengths and limitations of the metric that should be considered when considering selecting it as a performance standard or measure.
- **Data** – Describes the data needed to analyze or calculate the performance measure or standard.
- **Analytical Methods** – Describes the method for calculating the performance measure or standard and provides references to more detailed guidance in the APM or other guidance document.
- **Threshold Considerations** – Identifies potential ranges or approaches to establishing a threshold that could be established as the standard for the performance measure.
- **Mitigations and Outcomes Considerations** – Identifies the types of mitigations that could help meet the standard if it's not being met and describes the outcomes that are likely to occur over time.

PERFORMANCE MEASURES AND STANDARDS

OAR 660-012-0215(3) requires cities and counties within metropolitan areas and Metro to adopt at least two transportation performance standards (comprised of a performance measure and associated threshold). At least one of the transportation performance standards must support increasing transportation options and avoiding principal reliance on the automobile. Additionally, the performance standards must evaluate at least two of the following objectives for the transportation system, for any or all modes of transportation:

- Reducing climate pollution – creating feasible transportation options that reduce carbon emissions
- Equity – consideration for existing or proposed transportation-related disparities and barriers experienced by historically marginalized communities
- Safety – providing a transportation system that reduces injuries and fatalities, and one that people feel comfortable using
- Network connectivity – modal networks that provide route options to users and minimize out-of-direction travel
- Accessibility – the ease of reaching (and interacting with) destinations or activities distributed in space

- Efficiency - the maximization of transportation services at the lowest possible cost
- Reliability - dependably provides users with a consistent range of predictable travel times
- Mobility - the ability to move freely and easily.

Technical Memorandum #9 identified multiple performance measures that could be combined with an established threshold and serve as a performance standard that meet the OAR objectives. The performance measures were evaluated based on the following criteria:

- Does the measure support the performance targets in OAR 660-012-0910?
- Can the measure document incremental changes or impacts resulting from a development or transportation improvement and be compared to a threshold?
- Can the measure be used at different scales to compare scenarios or alternatives?
- Is the measure reasonably simple to analyze?
- Is the measure easy for both the public and practitioners to understand?
- Are ODOT and local agencies (alone or working collectively toward shared goals) able to impact these outcomes?
- Can the measure be reviewed using an equity lens?

For each evaluation criteria, the rating method was yes (+1) or no (0). The evaluation criteria were not weighted. Table 1 and Table 2below show the recommended performance measures for inclusion in a toolbox of the best measures for local jurisdictions to reference when selecting performance standards to adopt.

Table 1 shows the measures that support increasing transportation options and avoiding principal reliance on the automobile. Table 2 shows the measures focused on the automobile. Both tables include the OAR 660-012-0215(3) objectives that the potential performance standards have a primary impact upon as well as existing references in the APM.

Table 1 Recommended Performance Measures for the Toolbox – Support Increasing Transportation Options

TM #9 ID	Performance Measure	OAR 660-012-0215(3) Objectives with Primary Impact	Existing APM Reference
2	Accessibility to key destinations	Accessibility, Equity	ODOT APM 9.5
3	Accessibility to employment	Accessibility, Equity	ODOT APM 9.5
4	Accessibility to transit	Accessibility, Equity	ODOT APM 9.5.2
11[1]	Bicycle level of traffic stress (BLTS)	Accessibility	ODOT APM 14.4 and 9.8.2
12[1]	Pedestrian level of traffic stress (PLTS)	Accessibility	ODOT APM 14.4 and 9.8.2
16	System completeness	Network Connectivity, Accessibility	ODOT APM 9.8.1
27	Bicycle crash risk	Safety	Not in APM at this time
28	Pedestrian crash risk	Safety	Not in APM at this time
33[2]	Walking and bicycling facility condition	Accessibility	Not in APM at this time
34[3]	Pedestrian crossing spacing	Network Connectivity, Accessibility	Not in APM but ODOT HDM Table 3-9 includes spacing ranges by context

1. Measure 32 (percent of collector and arterial streets in priority areas with bicycle and pedestrian facilities that are rated with a LTS 1 or 2) and Measure 35 (percent of jurisdiction able to be reached by BLTS 1 routes) from Technical Memorandum #9 were combined into Measure 11 and Measure 12 because they are more related to threshold-setting, instead of being completed new metrics. The base metrics for Measure 32 and Measure 35 are BLTS and PLTS, respectively.
2. Measure 33 was modified to be called "walking and bicycling facility condition" to match the wording of the other performance measures described in this memorandum. The original measure from Technical Memorandum #9 was "percent of priority corridors with walking and bicycling facilities in fair or better condition" and this will be included in the potential thresholds.
3. Measure 34 was modified to be called "pedestrian crossing spacing" to match the wording of the other performance measures described in this memorandum. The original measure from Technical Memorandum #9 was "Percent of corridors or priority areas meeting target crossing spacing" and this will be included in the potential thresholds.

Table 2 Recommended Performance Measures for the Toolbox – Automobile-Focused Options

TM #9 ID	Performance Measure	OAR 660-012-0215(3) Objectives with Primary Impact	Existing APM Reference
1	ADT/capacity	Efficiency, Mobility	ADT/capacity in ODOT APM 9.2.5
9	Hours of congestion/Duration of congestion	Efficiency, Reliability, Mobility	ODOT APM 9.2.5
10	Level of service	Efficiency, Reliability, Mobility	ODOT APM 9.4
15	Queuing	Mobility, Safety	ODOT APM 9.2.5
17	Existing and predicted total crashes	Safety	ODOT APM 9.6.5
19	Travel speed	Efficiency, Mobility	ODOT APM 3.5.2
23	Vehicle hours traveled (VHT)	Reducing Climate Pollution	Not in APM at this time
29	Household-based vehicle miles traveled (VMT) per capita	Reducing Climate Pollution	VMT in ODOT APM 9.2.5
30	Volume-to-capacity ratio (V/C) at Intersections	Efficiency, Mobility	ODOT APM 9.2.1
31	V/C for roadway links	Efficiency, Mobility	ODOT APM 9.2.1

Selecting Performance Standards

OAR 660-012-0215(3) requires cities, counties, and Metro to adopt at least two transportation performance standards. At least one of the transportation performance standards must support increasing transportation options and avoiding principal reliance on the automobile. Additionally, the performance standards must evaluate at least two of the objectives identified in OAR 660-012-0215(6) and identified in Table 1 and Table 2.

When selecting measures to adopt as standards, local jurisdictions should consider applying the following evaluation criteria (criteria are organized in priority order, although the most important criteria for selecting standards may differ between local agencies):

1. Does the measure help support progress for at least one of the OAR 660-012-0215(6) objectives? If so, which ones?
2. Does the measure support increasing transportation options and avoiding principal reliance on the automobile? (One of the two measures must meet this criterion.)
3. Can your jurisdiction support the staff time or consultant time to report on the measure or review the measure for transportation projects and land use and development applications?
    a. Does your jurisdiction have the data available to support the measure? If not, are they able/willing to collect the necessary data to support the measure?
4. Does the measure support progress towards the TSP goals and objectives?
    a. If so, which ones? Greater consideration could be given to measures that address multiple goals.
5. What will the thresholds be for the standard and will they create outcomes desired by the community?
    a. E.g., would the standard encourage core or fringe development?
6. What standards do partner and neighboring agencies use and is there a benefit in coordinating standards?
7. How will the two or more selected standards work together? Per OAR 660-012-0215(3), updated Transportation System Plans "must clearly establish how to apply the multiple performance standards to a proposal that meets some, but not all, of the transportation performance standards."

MEASURES FOCUSED ON INCREASING TRANSPORTATION OPTIONS

2. Accessibility to Key Destinations

Definition

The number of key destinations within a certain travel time or distance, by different modes.

- **Key Destinations** are defined locally. Jurisdictions may have a previously developed a database of key destinations that can be considered. The TPR (Rule 0360) defines Key Destinations as those listed below (but not limited to these) as well as other destinations determined locally that are expected to attract a higher than average rate of pedestrian, bicycle, or transit trips. The agency needs to complete an exercise to identify key destinations.
  - (a) Climate-friendly areas (CFAs)
  - (b) Pedestrian-oriented commercial areas outside of CFAs
  - (c) Transit stations, stops, and terminals
  - (d) Retail and service establishments, including grocery stores
  - (e) Child-care facilities, schools, and colleges
  - (f) Parks, recreation centers, paths, trails, and open spaces
  - (g) Farmers markets
  - (h) Libraries, government offices, community centers, arts facilities, post offices, social service centers, and other civic destinations
  - (i) Medical or dental clinics and hospitals
  - (j) Major employers
  - (k) Gyms and health clubs
  - (l) Major sports or performance venues
  - (m) Other key destinations determined locally

Scale

This measure can be applied at a variety of scales. Typically, the measure is used to evaluate proposed impacts of projects on travel from a specific location or set of destinations. For example, the number of key destinations within a 30-minute bicycle ride from an apartment building or sub-area might be compared between existing conditions and a future scenario with the addition of a bridge across a freeway or set of network improvements.

Strengths and Limitations

For this measure, strengths include:

- Can effectively compare the transportation system between modes.

For this measure, limitations include:

- Identifying key destinations may be subjective or require extensive manual effort or public outreach.
- Developing a complete and usable network can be time consuming.
- Assessing the transit network using scheduling and routing data may be cumbersome.
- Transit service frequency and span of operations should be considered with respect to transit accessibility.

Data

Data collection for this measure is a medium to high level of effort, although it is lower if there is a travel demand model available. To calculate accessibility to key destinations, several data sets are needed.

- **Transportation network data** should be developed such that a network analysis can be completed in GIS or a similar geospatial program. This involves confirming that roadway segments are connected, incorporate pedestrian and bicycle facilities and include attributes that may impede travel such as one way links. Transit network and scheduling data can be collected for many agencies using the General Transit Feed Specification (GTFS).
- **Traveler behavior** may inform the development of thresholds. For example, if data is available that indicate that people in the community are willing to walk ½ mile to reach a transit stop or other destinations, that may be an effective threshold to determine a pedestrian walkshed. If travel behavior data is not available for a specific community, using default values may be a good alternative.

Analytical Methods

The methods of calculating accessibility to key destinations are discussed in the **APM Section 9.5.1 (Accessibility for Motorized Vehicles, Pedestrians and Bicyclists)**. This section includes discussion of the different models that may be used and how the outputs could support land use and development planning.

Threshold Considerations

Thresholds may vary greatly based on the existing conditions of the area that is being analyzed. In general, agencies should seek to support increasing accessibility to key destinations so that they are able to be reached within a certain time or distance as the transportation system evolves.

Common travel times used as thresholds for accessibility are often 20 to 30 minutes, for all modes. Common distances used as thresholds to define walking and bicycling are 1 mile and 5 miles, respectively.

Thresholds may be set from multiple perspectives:

- Accessibility to key destinations from a particularly important origin. For example, assessing the number of key destinations that can be reached within a 20-minute bicycle ride from a dense residential area, and then setting a relevant target for the future.
- Travel shed from key destinations. For example, assessing the portion of households that are within a 30-minute transit trip of a specific destination, such as a library, or within a 30-minute transit trip from any key destination, and then setting a relevant target.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Added connections for pedestrians and bicyclists, such as accessways between cul-de-sacs, filling sidewalks gaps, and installing new bicycle lanes
- Signal retiming
- Increased frequency of transit
- Expanded transit coverage
- Increased mixed-use development with key destinations, employment, and transit hubs located in closer proximity to residential nodes

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Improved safety for pedestrians and bicyclists
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

3. Accessibility to Employment

Definition

The number of jobs that can be reached within a certain travel time, cost or distance, by different modes.

Scale

This measure can be applied at a variety of scales. Typically, the measure is used to evaluate proposed impacts of projects on travel from a given location or set of destinations. For example, the number of jobs within a 30-minute bicycle ride from an apartment building or sub-area might be compared between existing conditions and the addition of a bridge across a freeway or set of network improvements.

Strengths and Limitations

For this measure, strengths include:

- Can effectively compare the transportation system between modes.

For this measure, limitations include:

- Developing a complete and usable network can be time consuming.
- Assessing the transit network using scheduling and routing data may be cumbersome.
- Transit service frequency and span of operations should be considered with respect to transit accessibility.

Data

Data collection for this measure is a medium to high level of effort, although it is lower if a travel demand model is available. To calculate accessibility to employment, several data sets are needed.

- **Employment data** should be available from the Oregon Employment Department, local sources, or through census data.
- **Transportation network data** should be developed such that a network analysis can be completed in GIS or a similar geospatial program. This involves confirming that roadway segments are connected, incorporate

pedestrian and bicycle facilities and include attributes that may impede travel such as one way links. Transit network and scheduling data can be collected for many agencies using the General Transit Feed Specification (GTFS).

- **Traveler behavior** may inform the development of thresholds. For example, if data is available that indicate that people in the community are willing to walk ½ mile to reach a transit stop or other destinations, that may be an effective threshold to determine a pedestrian walkshed. If travel behavior data is not available for a specific community, using default values may be a good alternative.

Analytical Methods

The methods of calculating accessibility to employment are discussed in the **APM Section 9.5.1 (Accessibility for Motorized Vehicles, Pedestrians and Bicyclists)**. This section includes discussion of the different models that may be used and how the outputs could support land use and development planning.

Threshold Considerations

Thresholds may vary greatly based on the existing conditions of the area that is being analyzed. In general, agencies should seek to support increasing accessibility to employment so that more jobs are able to be reached within a certain time or distance as the transportation system evolves. Common travel times used as the analysis factors are often 20 to 30 minutes, for all modes.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Added connections for pedestrians and bicyclists, such as accessways between cul-de-sacs, filling sidewalks gaps, and installing new bicycle lanes
- Signal retiming
- Increased frequency of transit
- Expanded transit coverage
- Increased mixed-used development with key destinations, employment, and transit hubs located in closer proximity to residential nodes

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity

- Improved safety for pedestrians and bicyclists
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

4. Accessibility to Transit

Definition

The number or percent of a population (e.g., weighting households by size), jobs, or households living within a defined distance or travel time from a transit stop. The specific definition or combination of these items (population, jobs or households) may be selected and applied. Transit stops should be considered for all transit modes including bus, bus rapid transit, commuter rail, streetcar, and light rail.

Scale

This measure can be applied at a variety of scales. Typically, the measure is used to evaluate proposed impacts of projects on travel from an area's transit stop network. For example, the number of jobs within ¼ mile from a sub-area's transit stop network might be compared between existing conditions and the addition of a bridge across a freeway or set of network improvements.

Strengths and Limitations

For this measure, strengths include:

- Can compare transit system alternatives.

For this measure, limitations include:

- Developing a complete and usable network can be time consuming.
- Assessing the transit network using scheduling and routing data may be cumbersome.
- Transit service frequency and span of operations should be considered with respect to transit accessibility.

Data

Data collection for this measure is a medium to high level of effort, although it is lower if a travel demand model or other routable inventoried street network (e.g., GIS) is available. To calculate accessibility to transit, several data sets are needed.

- **Transportation network data** should be developed such that a network analysis can be completed in GIS or a similar geospatial program. This involves confirming that roadway segments are connected, incorporate pedestrian and bicycle facilities and include attributes that may impede travel such as one way links. Transit network and scheduling data can be collected for many agencies using the General Transit Feed Specification (GTFS).
- **Traveler behavior** may inform the development of thresholds. For example, if data is available that indicate that people in the community are willing to walk ½ mile to reach a transit stop or other destinations, that may be an effective threshold to determine a pedestrian walkshed. If travel behavior data is not available for a specific community, using default values may be a good alternative.

Analytical Methods

The methods of calculating accessibility to transit are discussed in the **APM Section 9.5.2 (Accessibility for Transit Riders)**. This section includes discussion of the different models that may be used to model transit.

Threshold Considerations

Thresholds will vary greatly based on the existing conditions of the area that is being analyzed. In general, agencies should be working to increase accessibility with more housing and employment able to be reached within a certain time or distance of transit stops as the transportation system evolves. Common travel times used as the analysis factors are often 20 to 30 minutes, for all modes. Common distances used as analysis factors for walking and bicycling to/from transit stops are ¼ mile and 1 mile, respectively. Depending on the region of application and the transit network that is provided, consideration may be given to high-capacity transit versus other service levels.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Added connections for pedestrians and bicyclists, such as accessways between cul-de-sacs, filling sidewalks gaps, and installing new bicycle lanes
- Signal retiming
- Increased frequency of transit
- Expanded transit coverage
- Increased mixed-used development with key destinations, employment, and transit hubs located in closer proximity to residential nodes

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Improved safety for pedestrians and bicyclists
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

11. Bicycle Level of Traffic Stress (BLTS)

Definition

Bicycle Level of Traffic Stress (BLTS) classifies points and segments on routes into different categories of stress ranging from 1 (low stress) to 4 (high stress) based on factors that correlate to the comfort and safety of the bicyclist using that facility.

Scale

"Well suited for high-level plans such as corridor and transportation system plans (TSP). This method can also be used in detailed refinement-level plans and projects as a screening or flagging tool," (APM 14.4).

Strengths and Limitations

For this measure, strengths include:

- Direct connection to roadway characteristics.

- Most data points tend to be readily available in local jurisdiction or statewide datasets for most roads.

For this measure, limitations include:

- Not sensitive to land use changes and changes to bicycle trip volumes.
- Data collection may require extensive manual review of aerial photos.

Data

Data collection for this measure is a medium to high level of effort, dependent on what inventory data is available. "Traffic counts/daily volumes are not required except for higher-speed rural applications," (APM 14.4).

- Bicycle facility: Bicycle facilities should distinguish between >= 7' buffered bicycle lane, 5.5-7' bicycle lane, 4-5.5' bicycle lane, <4' bicycle lane, frequent blockage of bicycle lane, shared lane, no facility, separated facility.
- Speed: Posted speed is typically available and can be used in this methodology. If there are identified areas where prevailing operating speed is known to be higher than posted speed, this could impact the results.
- Auto lanes per direction: The number of auto lanes per direction is typically available from ODOT or the local jurisdiction.
- Parking lane: The parking lane should distinguish the presence of the parking lane and if a bicycle lane is also available the combined width of the bicycle lane and the parking lane.
- Volume: Volumes for segments should be assessed in alignment with the APM Section 3.4 (Vehicle Count Surveys) section. In general, the following are found:
    - State Highways have AADT and hourly volumes available from ODOT's website.
    - Arterials and major collectors may have estimated daily volumes available through local transportation plans or count programs.
    - The functional classification may be used in place of volume as a criterion in several conditions: (1) On mixed traffic segments in suburban or urban areas and (2) for unsignalized intersection crossings without a median refuge.

- Functional Class: ODOT maintains networks of functionally classified roadways[1]. Roadways that are not included in ODOT's functionally classified network are considered local roadways.

Analytical Methods

The methods of calculating BLTS are discussed in the **APM Section 14.4 (Bicycle Level of Traffic Stress)**. The methodology is modified from work originally documented by Mineta Transportation Institute. Analytical methods are available for segments, intersection approaches, and intersection crossings.

In addition to **APM Section 14.4 (Bicycle Level of Traffic Stress)**, BLTS is also discussed in **APM Section 9.8.2 (Bicycle or Pedestrian Level of Traffic Stress).** This section discusses the use of BLTS as a performance standard.

Threshold Considerations

The following describes several potential ways a threshold could be established that is more detailed than a generic BLTS 1 or 2 standard applied to all or specific facilities by functional classification.

- "A BLTS 2 is often used as the target as it will typically appeal to the majority of the potential bicycle-riding population and maximize the available bicycle mode share," (APM 14.4.2).
- "When evaluating networks near schools (within ¼ mile), the desirable level of traffic stress is BLTS 1 because BLTS 1 is targeted at 10-year olds (5th grade) or parents of younger children. Elementary school-age children should be able to travel between homes and schools without having to cross arterial streets (BLTS 3 and 4). Ideally, elementary schools and their related attendance boundaries should be placed to allow at least a few BLTS 1 routes. Middle school and high school placement should not be limited to only BLTS 1 routes; however routes should be no more than BLTS 2 because older students can use these without difficulty," (APM 14.4.2).
- Percent of collector and arterials streets in priority areas with bicycle and pedestrian facilities that are rated with a BLTS 1 or BLTS 2
- Percent of jurisdiction able to be reached by BLTS 1 routes

[1] https://www.oregon.gov/odot/data/pages/functional-class.aspx

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Added facilities for bicyclists
- Enhanced bicycle facilities with increased buffer
- Reduced posted speed limit
- Reduced vehicular travel lanes
- Reorganized roadway space with parking as a buffer between bicyclists and vehicular travel lanes

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Improved safety for bicyclists
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

12. Pedestrian Level of Traffic Stress (PLTS)

Definition

Pedestrian Level of Traffic Stress (PLTS) classifies points and segments on routes into different categories of stress ranging from 1 (low stress) to 4 (high stress) based on factors that correlate to the comfort and safety of the pedestrian using that facility.

Scale

"Well suited for high-level plans such as corridor and transportation system plans (TSP). This method can also be used in detailed refinement-level plans and projects as a screening or flagging tool," (APM 14.4).

Pedestrian LTS is used to evaluate segments and intersection crossings.

Strengths and Limitations

For this measure, strengths include:

- Considers pedestrian comfort and safety, which may encourage increased pedestrian trips.
- Data collection overlaps with Bicycle LTS allowing both to be completed in tandem.

For this measure, limitations include:

- Some data are not typically readily available for all roadways, notably: sidewalk condition and width, buffer type and width, parking width, and presence of illumination.
- Not sensitive to pedestrian volumes.
- Data collection may require extensive manual review of aerial imagery, field visits, and other means.

Data

Data collection for this measure is a medium to high level of effort, dependent on what inventory data is available. "Traffic counts/daily volumes are not required except for higher-speed rural applications," (APM 14.4).

Segment Analysis:

- Sidewalk condition and width
- Buffer type and width
- Bicycle lane width
- Parking width
- Number of lanes and posted speed
- Illumination presence
- General land use

Crossing Analysis:

- Functional class
- Number of lanes
- Posted ppeed
- Roadway average daily traffic (optional)
- Sidewalk ramps
- Median refuge
- Illumination presence
- Signalized intersection

Most data is available for state highway segments, through ODOT's databases.

Data can be collected through aerial review or field review on a site-by-site basis. Data may be more challenging to collect systemwide, without conducting substantial manual review.

If analysis is intended to be completed across the network and data is not available in a local database, use the best available data and consider using assumptions to calculate an interim PLTS. For example, use the functional classification or land use context to approximate conditions of unavailable data. If data becomes available later, the analysis can be updated.

Analytical Methods

The methods of calculating PLTS are discussed in the **APM Section 14.5 (Pedestrian Level of Traffic Stress)**. As noted, this methodology was created to be a companion to the BLTS methodology. Analytical methods are available for segments and intersection crossings.

In addition to **APM Section 14.5 (Pedestrian Level of Traffic Stress)**, PLTS is also discussed in **APM Section 9.8.2 (Bicycle or Pedestrian Level of Traffic Stress [LTS]).** This section discusses the use of BLTS as a performance measure.

Threshold Considerations

APM Section 15.4.3 (PLTS Targets) identifies several considerations for developing thresholds.

- PLTS 2 is generally a reasonable minimum target. Most pedestrians will find PLTS 2 acceptable.
- PLTS 1 is a good target for routes heavily used by children, including routes within a ¼ mile of schools. The area immediately adjacent to elementary schools should contain no PLTS 3 or PLTS 4 segments or intersection crossing.
- PLTS 1 is the preferred target for areas around middle and high schools; however, PLTS 2 facilities are generally acceptable.
- PLTS 1 is the preferred target for land uses including: downtown central business districts, medical facilities, areas near assisted living/retirement centers, and within ¼ mile of transit stops.
- Different land uses have different needs for the pedestrian network, for example, a large study area may have multiple targets for different portions of the area.

Mitigations and Outcomes Considerations

When applying this measure as a performance standard, potential mitigations could include:

- Additional of or improvement to facilities for pedestrians
- Reconstructed pedestrian facilities to improve the condition and/or increase width
- Updated pedestrian facilities with increased buffer
- Reduced posted speed limit
- Reduced vehicular travel lanes
- Reorganized roadway space to provide parking as a buffer between pedestrians and vehicular travel lanes
- Added illumination, including pedestrian-scale illumination
- New or improved pedestrian crossings
- New or improved sidewalk ramps

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Improved safety for pedestrians
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

16. System Completeness

Definition

The percent of planned facilities that are built within a specified network.

Scale

System completeness is most often reviewed at the system-wide level but can be viewed at a facility level as well. The data collection for measuring existing system completeness is done at a facility level.

Strengths and Limitations

For this measure, strengths include:

- Easily understood by the public.
- The planned system that is used as the basis for this measure will be highly dependent on the local agency. Their TSP needs to be up-to-date and have been vetted through a public engagement process.

For this measure, limitations include:

- While it may not be likely, the planned system could change whenever a TSP update or new plan document is created. Tracking over time could be impacted by these changes or show less progress depending on the changes.

Data

Data collection for this measure is a medium to high level of effort, dependent on what inventory data is available. System completeness heavily relies on inventory data. Ideally, facility characteristics can be collected by block or roadway segment and stored as geospatial data accessible for review, calculation, and visualization in programs such as ArcGIS. The following facility characteristics are needed for different planned modal networks being assessed:

- Facility type
- Location
- Other characteristics determined for the complete system, such as number of roadway lanes, bicycle facility type, or connected pedestrian network

The planned future system must also be provided to create the comparison between what currently exists versus what is proposed. These planned networks would ideally be contained within a geospatial program such as ArcGIS.

Analytical Methods

The methods of calculating system completeness are discussed in the **APM Section 9.8.1 (Network Connectivity and System Completeness)**. As noted, this method is a simple percentage calculation based on planned and existing facility elements. The planned system will be determined by a local agency's transportation system plan, which must meet the requirements contained within several sections in OAR 660-012. System completeness is evaluated for each mode.

Threshold Considerations

For system completeness, the target is to reach a 100 percent complete transportation network. But the reality of reaching that goal will vary greatly based on the existing conditions of the area that is being analyzed. In addition, the planned “complete” system may change over time, especially when Transportation System Plans (TSPs) or other planning documents are created or updated. A threshold could be based on maintaining or increasing the system completeness of an area.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Added facilities for pedestrians and bicyclists
- Expanded transit coverage
- Added turn lanes and through lanes up to the planned system design standards
- New connections for all modes, such as new roadways, bicycle lanes, or multi-use paths

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Improved safety for pedestrians and bicyclists
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

27. Bicycle Crash Risk

Definition

A risk score for a roadway section based on bicyclist behavior, roadway features, and other contextual factors such as land use.

Scale

Bicycle crash risk is calculated at the facility level but can be aggregated to a system-wide review. For example, ODOT has calculated bicycle crash risk for all highways and then divided the highway segments into quintiles to identify the top 20 percent with the highest bicycle crash risks for both urban and rural contexts. See the Vulnerable Road User Assessment from November 2023 for more information.

Strengths and Limitations

For this measure, strengths include:

- The needed data is likely already available, or, if not, assumptions can be used to fill gaps.
- As of 2020, ODOT has calculated the bicycle crash risks for all state highways.

For this measure, limitations include:

- Risk factors include land use factors that may increase bicycle activity but may result in conflation with increasing crash risk. For example, proximity to schools or to transit stops may increase bicycle activity level, which could lead to more frequent crashes, though the increase to the risk of crashes may not be directly affected (or decrease).

Data

Data collection for this measure is a medium to high level of effort, dependent on what inventory data is available. For ODOT's statewide systemic safety analysis completed in 2020, the bicycle risk factors used included:

- Principal arterial
- Minor arterials
- Number of lanes (>= 4 Lanes)
- Posted speed (>=35mph)
- No presence of a bicycle lane
- High-access density
- Mixed use zoning
- Proximity to schools (one mile)
- Proximity to transit stops (1/4 mile)

- High population over the age of 64 (threshold was set to 16.8 percent)

While vehicle volume is not explicitly identified in the analysis referenced above, it remains a risk factor regarding bicyclist safety. See ODOT Report SPR 779: Risk Factors for Pedestrian and Bicycle Crashes.

Analytical Methods

As part of the Oregon Pedestrian and Bicycle Safety Implementation Plan, ODOT implemented the NCHRP Research Report 893 methodology in 2020. This methodology uses risk factors to complete a systemic safety analysis aimed at identifying high risk locations for pedestrian and bicycle crashes along the state highway system. Systemic safety, as opposed to the traditional review of crash history, allows practitioners to proactively identify high risk sites for potential safety improvements based on risk factors that often correlate to locations with a low frequency of bicycle crashes, though the crashes that do occur tend to cause severe injuries or fatalities. Crash risk is a measure used by ODOT to assess bicycle and pedestrian safety.

To calculate bicycle crash risks, apply the following steps:

1. Collect data for the analysis roadway segments. If data is not available, apply reasonable assumptions to fill data gaps. For example, if posted speed data is not readily available in a geospatial format, posted speed could be assumed based on roadway classification (e.g., 25 mph for local roadways, 30 mph for collectors). Analysis segments should be separated every time a risk factor characteristic changes for the facility (e.g., when the posted speed changes from less than 35 mph to more than 35 mph).
2. Determine for each analysis segment whether a specific bicycle risk factor is present.
3. Add the risk factor weightings together for each analysis segment (weightings shown below are based on either urban or rural contexts). If a risk factor is present, the risk factor weight is added. If a risk factor is not present, then the risk factor weight is 0. If the risk factor is not applicable (i.e. shown as "-" in Figure 1, then do not include that risk factor in the analysis.

Figure 1 Bicycle Risk Factor Screenings Weights

RISK FACTOR SCREENING WEIGHTS: BICYCLISTS

	Risk Factor Weights	
Risk Factor	**Urban**	**Rural**
Principal Arterial	1.13	1.39
Minor Arterials	1.07	—
Number of Lanes (>= 4 Lanes)	1.08	—
Posted Speed (>=35 mph)	1.11	1.09
No Bike Lane	1.06	—
High-Access Density	1.02	—
Mixed Use Zoning	1.00	—
Proximity to Schools (1 Mile)	1.01	1.00
Proximity to Transit Stops (1/4 Mile)	1.03	1.03
High Population over the Age of 64	1.00	1.00

Source: Oregon Pedestrian and Bicycle Safety Implementation Plan

Threshold Considerations

For this performance measure, the target should be set such that a reduced bicycle risk factor is achieved. A threshold could be based on maintaining or decreasing the risk factor of a facility. A jurisdiction could also base a threshold off existing conditions. If the risk factors of all facilities or of facilities of a specific roadway classification or higher are calculated, the risk factor value that separates the top 20 percent from the top 40 percent, or a similar binning process, could be used to determine when a safety-based action is triggered.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations to reduce the calculated crash risk could include:

- Added facilities for bicyclists
- Reduced posted speed limit
- Reduced vehicular travel lanes
- Access management to reduce high-access density

Additional strategies to mitigate high crash risks but that don't impact the calculated crash risk include driver and bicyclist safety courses and signage among many other strategies that may be identified in a Transportation Safety Action Plan.

These types of mitigations could support the following outcomes:

- Increased multimodal reliability
- Improved safety for bicyclists
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing safety in areas with underserved populations

28. Pedestrian Crash Risk

Definition

A risk score for a roadway section based on pedestrian behavior, roadway features, and other contextual factors such as land use.

Scale

Pedestrian crash risk is calculated at the facility level but can be aggregated to a system-wide review. For example, ODOT has calculated pedestrian crash risk for all highways and then divided the highway segments into quintiles to identify the top 20 percent with the highest pedestrian crash risks based on both urban and rural contexts. See the Oregon Bicycle & Pedestrian Safety Implementation Plan from November 2020 for more information.

Strengths and Limitations

For this measure, strengths include:

- The needed data is likely already available or can use assumptions to fill gaps.
- In 2020, ODOT calculated the pedestrian crash risks for all state highways

For this measure, limitations include:

- Risk factors include land use factors that may increase pedestrian activity but may result in conflation with increasing crash risk. For example, proximity to schools or to transit stops may increase pedestrian activity level, which could lead to more frequent crashes, though the increase to the risk of crashes may not be directly affected (or decrease).

Data

Data collection for this measure is a medium to high level of effort, dependent on what inventory data is available. For ODOT's statewide systemic safety analysis completed in 2020, the pedestrian risk factors used included:

- Principal arterial
- Number of lanes (>= four lanes)
- High-access density
- No sidewalks (or only one side)
- Posted speed (>= 35 mph)
- Mixed use zoning
- Other zoning[2]
- Proximity to schools (one mile)
- Proximity to transit stops (1/4 mile)
- High population over the age of 64 (threshold of 16.8 percent)

While vehicle volume is not explicitly identified in the analysis referenced above, it remains a risk factor regarding pedestrian safety. See ODOT Report SPR 779: Risk Factors for Pedestrian and Bicycle Crashes.

Analytical Methods

As part of the Oregon Pedestrian and Bicycle Safety Implementation Plan, ODOT implemented the NCHRP Research Report 893 methodology in 2020. This methodology uses risk factors to complete a systemic safety analysis aimed at identifying high risk locations for pedestrian and bicycle crashes along the state highway system. Systemic safety, opposed to the traditional review of crash history, allows practitioners to proactively identify high risk sites for potential safety improvements based on risk factors that often correlate to locations with low frequency but high severity crashes. Crash risk is a measure used by ODOT to assess bicycle and pedestrian safety.

[2] "Other" zoning includes all zoning classifications within the Oregon Spatial Data Library (OSDL) except for residential, commercial, industrial, mixed-use, and farm-use zoning. Examples of "Other" zoning including forest/federal lands, coastline, parks, and rangeland.

To calculate pedestrian crash risks, apply the following steps:

1. Collect data for the analysis roadway segments. If data is not available, apply assumptions to fill data gaps. For example, if posted speed data is not readily available in a geospatial format, posted speed could be assumed based on roadway classification (e.g., 25 mph for local roadways, 30 mph for collectors). Analysis segments should be separated every time a risk factor characteristic changes for the facility (e.g., when the posted speed changes from less than 35mph to more than 35 mph).
2. Determine for each analysis segment whether the pedestrian risk factor is present.
3. Add the risk factor weightings together for each analysis segment (weightings shown below based on urban or rural contexts). If a risk factor is present, the risk factor weight is added. If it is not present, then the risk factor weight is 0. If the risk factor is not applicable (e.g., shown as "-" in Figure 2, then do not include that risk factor in the analysis.

Figure 2 Pedestrian Risk Factor Screenings Weights

RISK FACTOR SCREENING WEIGHTS: PEDESTRIANS

	Risk Factor Weights	
Risk Factor	**Urban**	**Rural**
Principal Arterial	1.24	1.46
Number of Lanes (>= 4 Lanes)	1.55	1.73
High-Access Density	1.64	—
No Sidewalks (or Only One Side)	1.38	—
Posted Speed (>=35 mph)	1.83	1.63
Mixed Use Zoning	1.00	—
Other Zoning	—	1.45
Proximity to Schools (1 Mile)	1.03	1.17
Proximity to Transit Stops (1/4 Mile)	1.08	1.00
High Population over the Age of 64	1.00	—

Source: Oregon Pedestrian and Bicycle Safety Implementation Plan

Threshold Considerations

For this measure, the target is to reach a reduced risk factor. A threshold could be based on maintaining or decreasing the risk factor of a facility. A jurisdiction could also base a threshold off existing conditions. If the risk factors of all facilities or of facilities of a specific roadway classification or higher are calculated, the risk factor value that separates the top 20 percent from the top 40 percent, or a similar binning process, could be used to determine when a safety-based action is triggered.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations to reduce the calculated crash risk could include:

- Added facilities for pedestrians
- Reduced posted speed limit
- Reduced vehicular travel lanes
- Access management to reduce high-access density

Additional strategies to mitigate high crash risks but that don't impact the calculated crash risk include driver and pedestrian safety courses and signage among many other strategies that may be identified in a Transportation Safety Action Plan.

These types of mitigations could support the following outcomes:

- Increased multimodal reliability
- Improved safety for pedestrians
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing safety in areas with underserved populations

33. Walking and Bicycling Facility Condition

Definition

A visual high-level classification of facility condition, ranging from good to very poor.

Scale

Walking and bicycling facility condition is collected at the facility level but can be aggregated to a system-wide review.

Strengths and Limitations

For this measure, strengths include:

- Once collected, the data for facility condition is easy to work with in programs such as ArcGIS.
- Facility condition data can be used in other metrics, such as PLTS and system completeness.

For this measure, limitations include:

- This measure involves a time-intensive data process. There are some products on the market that are targeting the collection of facility condition data, but they are not currently common. For most applications of this metric, personnel time is used to either review facility condition in person or via aerial imagery review.

Data

Data collection for this measure is a medium to high level of effort, dependent on what inventory data is available. Walking and bicycling facility condition is a characteristic that can be collected by block or roadway segment and stored as geospatial data accessible for review, calculation, and visualization in programs such as ArcGIS. The following roadway or facility characteristics are needed for all analysis roadway segments:

- Location (to determine number of roadside miles)
- Walking facility type and condition
- Bicycling facility type and condition

Analytical Methods

The methods of collecting walking and bicycling facility condition are discussed in the **APM Section 14.5.4 (PLTS Criteria)**. As noted, criteria and pictures for each category (good, fair, poor, very poor, no facility) are based off the Good-Fair-Poor (GFP) Pavement Condition Rating Manual for Bicycle and Pedestrian Facilities and the Pavement Distress Survey Manual developed by ODOT's Pavement Services Unit.

As part of the Oregon Pedestrian and Bicycle Performance Measure Recommendation report from September 2021, ODOT created a methodology for the percent of ODOT priority pedestrian and bicycle corridors with walking and bicycling facilities in fair or better condition. To calculate a similar percent of walking and bicycling facilities with fair or better condition, apply the following steps:

1. Confirm the corridors where the facility condition will be reviewed. For example, ODOT is interested in the walking and bicycling facility condition on their designated priority pedestrian and bicycle corridors.
2. Gather existing data for the analysis roadway segments. If data is not available, collect walking and bicycling facility condition data to fill the gaps.
3. In GIS or another geospatial program, conduct the following steps:
    a. **Setup**: Establish spatial correlation between the analysis roadway segments and walking and bicycling facilities if not already linked.
    b. **Target Roadside Miles:** Measure the total roadside miles located on the analysis roadways that should have walking and bicycling facilities, including bicycle lane, shared lane, shoulder bikeways, and sidewalk.
    c. **Fair or Better Condition Roadside Miles:** Measure roadway miles of walking and bicycling facilities in fair or better condition,
    d. **Percent Analysis:** Calculate the percentage of walking and bicycling facility roadside miles with fair or better condition using the equation presented below.

$$\begin{array}{l}\mathit{Percent\ Analysis}\\ \mathit{Roadways\ with}\\ \mathit{Walking\ and}\\ \mathit{Bicycling\ Facilities}\\ \mathit{of\ Fair\ or\ Better}\end{array} = \frac{\begin{array}{c}(Roadside\ Miles\ with\ Walking\ Facilities\ of\ Fair\ or\ Better\\ +\ Roadside\ Miles\ with\ Bicycle\ Facilities\ of\ Fair\ or\ Better)\end{array}}{\begin{array}{c}(Target\ Roadside\ Miles\ for\ Walking\ Facilities\\ +\ Target\ Roadside\ Miles\ for\ Bicycle\ Facilities)\end{array}}$$

Threshold Considerations

For walking and bicycling facility condition, the target is to reach a 100 percent complete network of priority walking and bicycling facilities with fair or better condition. But the reality of reaching that goal will vary greatly based on the existing conditions of the area that is being analyzed. In addition, the planned walking and bicycling network of priority corridors may change over time, especially when Transportation System Plans (TSPs) or other planning documents are created or updated. A threshold could be based on maintaining or increasing the percent of priority corridors with walking and bicycling facilities in fair or better condition.

Mitigations and Outcomes Considerations

When applying this measure as a performance standard, potential mitigations could include:

- Added facilities for pedestrians and bicyclists
- Reconstructed pedestrian and bicycle facilities to improve the condition

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Improved safety for pedestrians and bicyclists
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

34. Pedestrian Crossing Spacing

Definition

The distance between marked pedestrian crossings along a corridor or roadway segment.

Scale

Pedestrian crossing spacing is calculated at the facility level but can be aggregated to a system-wide review.

Strengths and Limitations

For this measure, strengths include:

- Once collected, the data for pedestrian crossing spacing is easy to work with in programs such as ArcGIS.
- Different target crossing spacings can be set based on land use and context of the corridors.

For this measure, limitations include:

- Calculating percent of analysis roadway segments meeting target crossing spacing may require multiple iterations per report if different target crossing spacings are established (i.e. instead of using a single target for the whole study area).
- While jurisdictions may have pedestrian crossing data, it may be in different formats that require additional analysis steps to join into a single dataset. For example, ODOT's pedestrian crossing data includes both point and line files.

Data

Data collection for this measure is a medium to high level of effort, dependent on what inventory data is available. Pedestrian crossing location data can be stored as geospatial data accessible for review, calculation, and visualization in programs such as ArcGIS. The following roadway or facility characteristics are needed for all analysis roadway segments:

- Location (to determine number of centerline miles)
- Marked pedestrian crossing locations

Analytical Methods

Table 300-4 of ODOT's **Highway Design Manual (HDM)**, includes recommended pedestrian crossing spacing ranges by urban context, as shown below.

Figure 3 ODOT HDM Target Crossing Spacing

Urban Context	Target Spacing (ft.)
Traditional Downtown/ CBD	250-550
Urban Mix	250-550
Commercial Corridor	500-1,000
Residential Corridor	500-1,000
Suburban Fringe	750-1,500
Rural Community	250-750

Source: ODOT Highway Design Manual

As part of the Oregon Pedestrian and Bicycle Performance Measure Recommendation report from September 2021, ODOT created a methodology for the percent of ODOT priority pedestrian and bicycle corridors meeting target crossing spacing. To calculate a similar percent of walking and bicycling facilities meeting a **750-foot target crossing spacing**[3], apply the following steps:

1. Confirm the corridors where pedestrian crossing spacing will be reviewed. For example, ODOT is interested in knowing pedestrian crossing spacing on their designated priority pedestrian and bicycle corridors.
2. Gather existing data for the analysis roadway segments. If data is not available, collect marked pedestrian crossing location data to fill the gaps.
3. In GIS or another geospatial program, conduct the following steps:
    a. Determine the marked crossings along each high priority corridor and locate marked crossings on the linear referencing method (LRM) system for the roadway geospatial data. Consider what type of crossings will be included in the analysis. For example, will all marked crossings be included? Or only marked crossings that include enhancements like signal control, pedestrian refuge, or beacons?
    b. Create a 375-foot buffer on the highway in the area around marked crossings. The buffer distance should be half of the target crossing spacing, as two crossings with adjacent 375-ft buffers will have 750-ft spacing between them.
    c. Establish which marked crossings serve the priority corridors by referencing the LRM keys and milepoints for both data sets.
    d. Clip out the priority corridor segments that are covered by the marked crossing buffer area.
    e. Calculate the percentage using the equation presented below.

$$\begin{matrix}\textit{Percent Analysis}\\ \textit{Roadways Meeting}\\ \textit{Target Crossing}\\ \textit{Spacing}\end{matrix} = \frac{\begin{matrix}\textit{Centerline Miles Covered by Marked Crossing}\\ \textit{Buffer Area on Analysis Roadway}\end{matrix}}{\textit{Centerline Analysis Roadway Miles}}$$

[3] The buffer distance used in Step 3b is half of the target crossing spacing. The Oregon Pedestrian and Bicycle Performance Measure Recommendation report used a target spacing of 750 feet for all priority corridors since it fell within the target spacing for most ODOT Highway Design Manual recommendations for target spacing by urban context. An agency using this methodology can select a different target spacing for all priority corridors or select different target spacings for different corridors and then adjust the buffer distance accordingly.

Threshold Considerations

For pedestrian crossing spacing, the target is to reach a 100 percent complete network of priority corridors or priority areas meeting target crossing spacings. But the reality of reaching that goal will vary greatly based on the existing conditions of the area that is being analyzed. In addition, the planned walking and bicycling network of priority corridors may change over time, especially when Transportation System Plans (TSPs) or other planning documents are created or updated. A threshold could be based on maintaining or increasing the percentage of priority corridors or priority area meeting target crossing spacings.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- New or improved pedestrian crossings, which may include ramps

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Improved safety for pedestrians
- Decreased reliance on the automobile and reduced climate pollution
- Ability to focus on equity by increasing accessibility in areas with underserved populations

MEASURES FOCUSED ON AUTOMOBILES

1. Average Daily Traffic to Capacity Ratio (ADT/C)

Definition

The ratio of average daily traffic volume to the peak hour capacity of a facility.

Scale

This measure is well suited for a high-level planning assessment of congestion on segments or intersection approaches. This measure may be applied at the roadway segment level based on how the regional travel demand model is segmented.

Strengths and Limitations

For this measure, strengths include:

- This metric can be forecast using a travel demand model or the ODOT Highway Economic Requirements System – State Version (HERS-ST).
- Effective at measuring impacts of treatments to increase capacity or reduce demand (volume of traffic).

For this measure, limitations include:

- Model outputs can be used incorrectly if practitioners do not review whether they are based on total roadway trip estimates per direction or lane estimates per direction.
- This may not be the best indicator for areas that see high seasonal fluctuations, such as coastal or recreational destinations. For those locations, roadways may fall within an acceptable ADT/C during some months of the year, but real-life conditions during other portions of the year may experience congestion.

Data

Data collection for this measure is a low to medium level of effort. To calculate ADT/C two data points are needed: ADT and peak hour capacity.

ADT: Volumes for segments should be assessed in alignment with the APM Section 3.4 (Vehicle Count Surveys) section. In general, the following are found:

- ADT may be calculated for different time periods depending on the agency requirements. ADT may be calculated over the course of a full year, effectively using Annual Average Daily Traffic (AADT), ADT may be calculated over a peak season, or another period may be used.
- State highways have readily available AADT and peak hourly volumes through ODOT.
- Arterials and major collectors may have estimated daily volumes available through local transportation plans or count programs.

Capacity: Peak capacity is calculated according to HCM methods. The data input for these methods can include typically systemwide adjustment values based on seasonality or roadway characteristics.

Analytical Methods

The methods of calculating ADT/C are discussed in the **APM Section 9.2.5 (Supplemental Vehicle Mobility Measures)**. As noted, this methodology was developed as part of studies prepared by FHWA and is the 24-hour volume divided by the peak one hour capacity which could be based on existing measured conditions or forecast conditions

Capacity is assessed using HCM or other supported methods. The APM includes methods for calculating capacity for different facilities:

- **APM Section 11.3 (Capacity-Related Inputs)** – Freeways and Multilane Highways
- **APM Section 12.3 (Unsignalized Intersection Capacity)** – Unsignalized Intersections

Threshold Considerations

The APM includes Exhibit 9-3 for recommended ADT/C threshold levels, as shown below. Agencies can determine the appropriate congestion level for specific facilities or areas under their jurisdiction based on roadway classifications, land use, or other factors or transportation system goals.

Figure 4 Exhibit 9-3 from the ODOT Analysis Procedures Manual

Level	Condition	Description	Lower ADT/C	Upper ADT/C
1	Uncongested	No decrease in speeds during the peak hour.	0.00	6.75
2	Uncongested to Moderately		6.75	8.25
3	Moderately Congested	Speeds decrease slightly during portions of the peak hour.	8.25	9.25
4	Moderately to Congested		9.25	9.75
5	Congested	Speeds decrease significantly during portions of the peak hour.	9.75	10.75
6	Congested to Very		10.75	12.25
7	Very Congested	Speeds decrease substantially for substantial portions of the peak hour.	12.25	13.75
8	Very to Extremely		13.75	15.25
9	Extremely Congested	Speeds decrease substantially for more than the peak hour.	15.25	24.00

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Signal retiming, at individual intersections or along a corridor
- Added turn lanes or through lanes
- Providing or increasing capacity on alternative routes
- Congestion pricing
- Travel demand management

These types of mitigations could support the following outcomes:

- Increased vehicular efficiency, reliability, and mobility
- Increased safety risks for pedestrians and bicyclists
- Increased reliance on the automobile

9. Hours of Congestion/Duration of Congestion

Definition

The number of hours within a defined period, most often within the morning and afternoon peak periods on non-holiday weekdays, where a facility's congestion target is exceeded.

Scale

Hours of congestion (HOC) can be applied at different scales, using different methods. Most often, HOC is calculated for uninterrupted highway segments though it is possible to measure hours of congestion on interrupted flow facilities.

Strengths and Limitations

For this measure, strengths include:

- There is flexibility to define "congestion" in different ways (e.g., v/c above a specified threshold, travel speed below a threshold, ADT/C above a threshold) depending on what the goal of the performance metric is.
- This metric can be forecast using a travel demand model, if a daily volume profile can be developed from the available data.

For this measure, limitations include:

- Measured or forecasted data must include multiple of hours of the day.
- Accounting for peak spreading and multiple hours of analysis increases the complexity and time required for analysis.

Data

Data collection for this measure is a low to medium level of effort. The data needed to calculate HOC depends on how "congested" is defined. Likely data needs include:

- **Geometric Data** (lane numbers and arrangements, cross-section elements, turn lane storage lengths, etc.) should be verified for consistency with previous work efforts, reviewed through aerial imagery, and confirmed through a site visit. Available as-built data may also be used to verify existing roadway geometry. A full list of geometric data that is typically collected is provided in **APM Section 3.3.1 (Geometric Data)**.

- **Operational Data** (such as posted speeds, intersection control, parking, right-turn on red) should be field verified and supplemented by available GIS data, aerials, and photos. A full list of data that is typically collected is provided in **APM Section 3.3.2 (Operational Data)**.
- **Vehicle Volumes** based on collected counts or forecasted volumes.

Analytical Methods

The methods of calculating hours of congestion or duration of congestion are discussed in the **APM Section 9.2.5 (Supplemental Vehicle Mobility Measures) and APM Chapter 8**. **APM Chapter 8** discusses how to forecast hours of congestion or duration of congestion, with consideration of peak spreading.

Threshold Considerations

Thresholds will vary based on the existing conditions of the roadway system that is being analyzed. In general, agencies should be working to maintain a similar level of congestion as existing or as reasonably forecast for the future. Thresholds should consider roadway classifications, including whether an HOC threshold is useful (i.e. may not be appropriate to apply to local streets). For example, in Metro's 2023 Regional Transportation Plan (adopted by Metro Council on November 20, 2023), two HOC thresholds are set. For throughways with controlled access, the average speed shall not be below 35 mph for more than 4 hours per day. For throughways with traffic signals, the average speed shall not be below 20 mph for more than 4 hours per day. All other facilities do not have an HOC-based standard applied to them.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Added through lanes
- Increased ramp metering
- Congestion pricing
- Travel demand management

These types of mitigations could support the following outcomes:

- Increased vehicular efficiency, reliability, and mobility
- Increased reliance on the automobile

10. Level of Service (LOS)

Definition

An A to F rating scale of motorized mobility (typically as a function of delay or density) of a facility, segment, intersection, or approach during a specified analysis period. LOS "A" represents conditions where traffic moves without substantial delays. LOS "F" represents conditions where average per-vehicle delay has become excessive, and demand has exceeded capacity.

Scale

LOS can be applied at different scales, using different methods. Most often, LOS is calculated for intersections or highway segments.

Strengths and Limitations

For this measure, strengths include:

- Simple to understand output.
- Easy to communicate to the public because it is a measure of the user's experience based on average per-vehicle delay, measured in seconds.

For this measure, limitations include:

- Tends to not be representative of the complex balance of modal and other priorities, such as safety or accessibility.
- In very congested conditions, this measure loses granularity. When an intersection is already at LOS "F", worsening congestion does not get assigned a lower grade to indicate further degradation of the intersection.

Data

Data collection for this measure is a low to medium level of effort. To calculate LOS, several types of data are needed.

- **Geometric Data** (e.g., lane assignments, cross-section elements, turn lane storage lengths) should be verified for consistency with previous work efforts, reviewed through aerial imagery, and confirmed through a site visit. Available as-built data may also be used to verify existing roadway geometry. A full list of geometric data that is typically collected is provided in **APM Section 3.3.1 (Geometric Data)**.

- **Operational Data** (such as posted speeds, intersection control, parking, right-turn on red) should be field verified and supplemented by available GIS data, aerials, and photos. A full list of data that is typically collected is provided in **APM Section 3.3.2 (Operational Data)**.
- **Vehicle Volumes** based on collected counts or forecasted volumes.

Analytical Methods

The methods of calculating LOS are discussed in the **APM Section 9.4.1 (Motorized Level of Service)**. As noted, the methodology is specified in the HCM.

Threshold Considerations

As discussed in **APM Section 9.4.1 (Motorized Level of Service)**, the HCM provides detailed considerations for thresholds based on each facility type, as shown below:

- Basic freeway segments – Chapter 12[4]
- Two lane highways – Chapter 15
- Signalized intersections – Chapter 19
- Unsignalized intersections – Chapters 20-22

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Signal retiming, at individual intersections or for a corridor
- Added turn lanes or through lanes

These types of mitigations could support the following outcomes:

- Increased vehicular efficiency, reliability, and mobility
- Increased safety risks for pedestrians and bicyclists
- Increased reliance on the automobile

[4] Chapter references are for the HCM 7th Edition

15. Queuing

Definition

The extent of vehicles queued on intersection approach lanes, including entrance and exit ramps, during a specified analysis period such as a peak hour.

Scale

This metric is most often applied at specific locations such as intersection approaches and highway exit ramps.

Strengths and Limitations

For this measure, strengths include:

- Easily understood by the public.
- Used already by some jurisdictions to evaluate turn lanes for concurrence with proposed developments and plan amendments.

For this measure, limitations include:

- Highly detailed. Often measured for only the peak hour (morning and afternoon) and therefore does not provide a good idea of overall system performance through a peak period or a day.
- In congested areas, the 95^{th} percentile queue may need to be calculated using a calibrated microsimulation model to account for impacts of adjacent intersections. This increases the data requirements, complexity, and time required to implement the measure.

Data

Data collection for this measure is a low to medium level of effort. To calculate queuing, several types of data are needed.

- **Geometric Data** (e.g., lane assignments, cross-section elements, turn lane storage lengths) should be verified for consistency with previous work efforts, reviewed through aerial imagery, and confirmed through a site visit. Available as-built data may also be used to verify existing roadway

geometry. A full list of geometric data that is typically collected is provided in **APM Section 3.3.1 (Geometric Data)**.
- **Operational Data** (such as posted speeds, intersection control, parking, right-turn on red) should be field verified and supplemented by available GIS data, aerials, and photos. A full list of data that is typically collected is provided in **APM Section 3.3.2 (Operational Data)**.
- **Vehicle Volumes** based on collected counts or forecasted volumes.

Analytical Methods

The use of queuing as a performance measure is discussed in the **APM Section 9.2.5 (Supplemental Vehicle Mobility Measures)**. This section references several other sections in the APM for methods of calculating queue length. Methods described in the APM include:

- ODOT-developed queuing estimation methods (APM Section 12.5)
- Highway Capacity Manual (HCM) methods as implemented by software and non-HCM methods such as microsimulation (APM Section 13.5)
- Microsimulation (APM Chapter 15)

In addition to methodologies currently described in the APM, data sources of probe data may be used to estimate queue lengths. This approach is beneficial for estimating queue lengths across the system but may be less accurate depending on the sample size. Field observations of queuing may also be used at specific locations.

Threshold Considerations

When an agency is setting a threshold, consider several components of a threshold:

- The analysis period may be for a peak hour, a peak period, or full day.
- The criteria being measured may be the length of a certain percentile queue (such as the average or 95th percentile) or the number of cycles where the queue extends beyond a certain point (e.g., the available storage of a left-turn lane).
- For many thresholds, selecting the correct queuing percentile is critical. Typically, a 95th percentile queue is used, but in some cases, it may be appropriate to use the average or maximum queue length.

If the performance measure is intended to be applied at a scale other than a specific intersection approach, consider options for aggregating the measure.

For example, an agency may choose to identify the number of intersections where at least one queue meets the threshold.

Table 3: Example Queuing Thresholds by Scale

Specific Location	Corridor	Region
95th percentile queue length (feet) for an intersection approach during the peak hour Percentage of signal cycles during the peak hour where the queue length blocks the turn lane	Percentage of approaches at signals on a corridor that have a peak hour 95th percentile queue that blocks a turn lane Number of intersections blocked by peak hour 95th percentile queues	Percentage of signals in the region that have an approach with a peak hour 95th percentile queue that blocks a turn lane.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Signal retiming, at individual intersections or for a corridor
- Signal modification, such as protected left turn phasing or flashing yellow arrows
- Added turn lanes
- Lengthening available turn lane storage

These types of mitigations could support the following outcomes:

- Increased vehicular efficiency, reliability, and mobility
- Increased safety risks for pedestrians and bicyclists
- Increased reliance on the automobile

17. Existing and Predicted Total Crashes

Definition

Number, severity, and location of all reported crashes within a specified time frame.

Scale

Reported and predicted total crashes are reviewed or calculated at the facility/intersection level but can be aggregated to a system-wide review.

Strengths and Limitations

For this measure, strengths include:

- The needed data is likely already available.
- Easily understood by the public.

For this measure, limitations include:

- Predictive methods are detailed and more time-intensive than reporting existing crashes.
- Crashes for some future situations are not able to be predicted with the same level of accuracy due to gaps in research and data.

Data

Data collection may rely on existing databases, although data collection needs will likely vary depending on the type of facility or crash type being analyzed. As discussed in the **APM Section 4.4 (Predictive Methods)**, the following data types are needed to calculate predicted total crashes:

- Crash frequency by severity, collision type, and pedestrian and bicyclist involvement (if using the Empirical Bayes Method)
- AADT traffic volumes for major and minor roads
- Pedestrian and bicyclist volumes or estimates
- Traffic control information
- Geometric design and roadway details

- Data requirements vary by predictive model and are discussed in APM Section 4.4.6. Complete Highway Safety Manual (HSM) Part C data requirements can be found in HSM Part C, Sections 10.4, 11.4, and 12.4
- Per **APM Section 4.4 (Predictive Methods)**, "Predictive methods do not require observed crash data to derive quantitative safety evaluations, and therefore can be used with future scenarios or design alternatives that do not yet exist."

Analytical Methods

Reported crash documentation does not require a methodology for calculation.

The methods of calculating predicted total crashes are discussed in the **APM Section 4.4 (Predictive Methods)**. As noted, this methodology is based on the HSM.

In addition to **APM Section 4.4 (Predictive Methods)**, predicted total crashes are also discussed in **APM Section 9.6.5 (Expected or Predicted Crash Frequency).**

Threshold Considerations

For this measure, many jurisdictions have a target to reach near or towards zero fatalities/serious injuries on the transportation system. A threshold could be based on decreasing the predicted total crashes relative to the existing total crashes for a facility or area.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Reduced posted speed limit
- Reduced vehicular travel lanes
- New or improved pedestrian crossings
- Intersection control modifications
- Signal retiming
- New or updated signage, striping, or markings
- See ODOT's ARTS crash reduction factor (CRF) list for other potential mitigations and associated crash reduction factors that can be used for analysis
- Additionally, the CRF Clearinghouse includes a range of crash modification factors that can be used for analysis

These types of mitigations could support the following outcomes:

- Increased multimodal reliability
- Improved safety for all modes

19. Travel Speed

Definition

Average or a percentile speed for a network segment or between origin-destination pairs, during a specific time period.

Scale

Travel speed is measured or calculated at the facility segment level but can be aggregated to a system-wide review.

Strengths and Limitations

For this measure, strengths include:

- Easily understood by the public.
- Can be measured through use of road tubes (on free-flow non-congested segments) or can be obtained from probe data.
- RITIS data is available statewide for many segments, through ODOT. RITIS data may be used to assess average speed for specific, predefined segments.

For this measure, limitations include:

- Increased vehicular speeds can have an impact of safety performance, especially on a multimodal corridor. There is a need to balance vehicular mobility and safety outcomes.
- Context is important when using travel speed as a performance measure. For example, small differences in travel speed in a long segment or corridor can indicate a large benefit; small differences in a short segment or corridor may reflect an amount of time saved that may not be apparent to system users.

Data

Data collection for this measure is a low to medium level of effort. To document and/or calculate travel speed, several types of data may be needed.

- Measured speeds from road tubes with vehicle classifying counters
- Probe data

Analytical Methods

The methods of measuring or calculating travel speed are discussed in the **APM Section 3.5.2 (Speed)**. As shown throughout the APM, travel speed can be used as a singular metric but can also be incorporated into other metrics, such as hours of congestion. Travel speed may also be calculated using travel demand models or simulation tools. If models are used to determine travel speed, calibration and post-processing may be required to acquire relevant results.

Threshold Considerations

Thresholds will vary based on existing conditions and posted speed of the roadway system that is being analyzed. In general, agencies should be working to maintain a similar level of congestion as existing or as reasonably forecast for the future. Thresholds should consider roadway classifications, including whether a travel speed threshold is useful (i.e. may not be appropriate to apply to local streets). For example, in Metro's 2023 Regional Transportation Plan (adopted by Metro Council on November 20, 2023), two travel speed thresholds are set. For throughways with controlled access, the average speed shall not be below 35 mph for more than 4 hours per day. For throughways with traffic signals, the average speed shall not be below 20 mph for more than 4 hours per day. All other facilities do not have a travel speed-based standard applied to them.

Agencies may also consider an upper limit threshold to inform the use of travel speed as a measure for monitoring safety conditions.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Signal retiming, at individual intersections or for a corridor
- Added turn lanes or through lanes

When applying this measure as a standard, focused on managing speeds for safety considerations, potential mitigations could include speed management treatments like medians, curb extensions, and horizontal deflection.

These types of mitigations could support the following outcomes:

- Increased vehicular efficiency, reliability, and mobility
- Increased safety risks for pedestrians and bicyclists
- Increased reliance on the automobile

23. Vehicle Hours Traveled (VHT)

Definition

The hours traveled by all vehicles in a specific area during a specified time period. Note that a variation of this measure (vehicle hours traveled per capita) considers population.

Scale

Vehicle hours traveled is typically calculated for an area or system-wide view.

Strengths and Limitations

For this measure, strengths include:

- Is effective for evaluating projects that involve changes in trip lengths.
- Can be aggregated to the regional level.
- Can be used to understand time required to complete a full trip, rather than evaluate delay at a given intersection.
- VHT may resonate with the public and decision makers as people tend to think about their travel times, rather than their travel distances.
- If using real world measurements, this metric is not dependent on a traffic model or assumptions about traffic characteristics (like arrival rate) to calculate existing conditions.
- If using a travel demand model, the metric can be output by most, if not all, modeling software packages.

For this measure, limitations include:

- Accuracy of VHT is highly dependent on the penetration rate of probe vehicles or other data used to estimate traveled speed. A CalTrans report[5] estimates that a penetration rate of seven percent is enough to obtain reliable and accurate estimates of VHT.
- VHT is also dependent on estimating daily volume and volume profiles throughout the system.

Data

Data collection for this measure is a low to medium level of effort. To calculate Vehicle Hours Traveled using data observations, two datapoints are needed:

- Hourly volumes
- Hourly speeds

Vehicle Hours Traveled may also be calculated using the Traffic Demand Model.

Analytical Methods

USDOT's Volpe Center calculates vehicle hours traveled using the method summarized below.

1. Allocate daily car and truck travel on each segment, by hour of the day and direction.
2. Calculate hourly speeds for each segment, using probe data.
3. Calculate VHT for cars and trucks during each hour of the day, by dividing the hourly vehicle miles traveled by the hourly average speed.

Volumes for segments should be assessed in alignment with the **APM Section 3.4 (Vehicle Count Surveys)** section. In general, the following are found:

- State highways have readily available AADT and hourly volumes through ODOT.
- Arterials and major collectors may have estimated daily volumes available through local transportation plans or count programs.

[5] Gan, Qijian, Gabriel Gomes, and Alexandre Bayen (2016). From LOS to VMT, VHT, and Beyond through Data Fusion: Application to Integrated Corridor Management. University of California Center for Economic Competitiveness in Transportation.

Where hourly volumes are not available, a volume profile needs to be developed to disaggregate the daily volume to segments by direction and hour of the day. When developing a volume profile for the region or corridor, consider characteristics that may impact some segments differently than others. For example, consider directional commuting patterns, differences in weekend traffic in recreational areas, or different functional classifications.

Hourly speeds should be assessed in alignment with **APM Section 3.5.2 (Speed)** section. This section describes several methods to assess speed. *INRIX link level speed data is the most effective method included in the APM for determining speed for use in calculating system level VHT. If VHT is being compared between time periods, for example if the agency is calculating VHT annually as a performance measure, ensure that similar segmentation and network is used for the analysis.*

The VHT metric can also be generated by a travel demand model.

Threshold Considerations

Vehicle hours of delay under free flow conditions can be used as a baseline for threshold setting.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Signal retiming, at individual intersections or for a corridor
- Added turn lanes or through lanes
- Increased network connectivity
- Congestion pricing
- Travel demand management

These types of mitigations could support the following outcomes:

- Increased vehicular efficiency, reliability, and mobility
- Increased reliance on the automobile

29. Household-based Vehicle Miles Traveled per Capita (VMT/capita)

Definition

The number of miles traveled by household-based light vehicles within a specified time period and study area, per the study area's population. This accounts for all travel generated by a household, regardless of trip purpose (e.g., travel from work to a store would be included).

Scale

This can be applied at the regional, jurisdiction, subarea or transportation analysis zone (TAZ) levels with the travel demand model. The Transportation Planning Rules (TPR) calls for household-based VMT per capita to be measured at the jurisdictional (city or county) level for the respective population within the Urban Growth Boundary.

Strengths and Limitations

For this measure, strengths include:

- Demonstrates how project study area residents' vehicle travel levels vary based on land use mixes, densities, and based on the availability of travel options.

For this measure, limitations include:

- Useful as a target or to identify land use and transportation actions that help decrease local residents' household VMT/capita at the jurisdictional scale per OAR 660-012-0160.
- Population growth and zoning allocation are outside the purview of some transportation agencies, including ODOT, therefore changes in this measure may not be solely attributed to actions implemented by the agency.

Data

Data collection for this measure is a medium to high level of effort, although it is lower is a travel demand model is available.

Analytical Methods

The methods of calculating household-based VMT/capita are discussed in the **APM Section 9.2.5 (Supplemental Vehicle Mobility Measures)**.

The measure is an output from the travel demand model. VMT/capita is calculated as the VMT from trips generated by households residing within the study area TAZs (within a jurisdiction) divided by the total population in the study area. This calculation excludes trips that pass through the jurisdiction (external-external) and trips that start outside the jurisdiction and end within the jurisdiction (external-internal). This calculation includes non-home-based trips made by people residing within the jurisdiction, even if those trips occur outside the jurisdiction. This methodology is being developed and will be detailed in ODOT's APM once complete.

Threshold Considerations

For application of the VMT per capita performance measure at the jurisdictional level in a TSP per Rule 0160, the threshold is defined in the TPR as no increase in per capita VMT in the horizon year relative to the base year. Use of different definitions of VMT per capita is possible, and thresholds for those uses are dependent on the scale and application.

A threshold for a standard could show a VMT per capita reduction with a land use or plan amendment. Application of VMT per capita to site development projects in the Oregon planning context may be difficult given the aggregation level required to measure change in VMT per capita.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Increased pricing for parking and/or tolling
- Increased frequency of transit
- Expanded transit coverage, or improved walking access to transit stops
- New connections for modes, such as a pedestrian overcrossing or new roadway
- Increased mixed-used development with key destinations, employment, and transit hubs located in closer proximity to residential nodes

These types of mitigations could support the following outcomes:

- Increased multimodal mobility and network connectivity
- Decreased reliance on the automobile and reduced climate pollution

30 & 31. Volume-to-Capacity Ratio (V/C) at Intersections & Roadway links

Definition

The ratio of traffic volume to the capacity of an intersection during a specified analysis period.

Scale

V/C ratio is calculated for intersections or roadway segments.

Strengths and Limitations

For this measure, strengths include:

- Simple to understand output, though not as straightforward as LOS
- V/C can be more consistently evaluated than other measures, such as per vehicle delay; this can support transportation analyses processes that depend on consistent results, including development review.

For this measure, limitations include:

- Tends to not be representative of the complex balance of priorities.

Data

Data collection for this measure is a low to medium level of effort. To calculate v/c, several types of data are needed.

- **Geometric Data** (e.g., lane numbers and arrangements, cross-section elements, turn lane storage lengths) should be verified for consistency with previous work efforts, reviewed through aerial photography, and confirmed through a site visit. Available as-built data may also be used to verify existing roadway geometry. A full list of geometric data that is typically collected is provided in **APM Section 3.3.1 (Geometric Data)**.

- **Operational Data** (such as signal timing plans, posted speeds, intersection control, parking, right-turn on red) should be field verified and supplemented by available GIS data, aerials, and photos. A full list of data that is typically collected is provided in **APM Section 3.3.2 (Operational Data)**.
- **Vehicle Volumes** based on collected counts or forecasted volumes.

Analytical Methods

The methods of calculating v/c at intersections are discussed in the **APM Section 9.2.5 (Volume to Capacity Ratio)**. As noted, the methodology is specified in the HCM.

Threshold Considerations

Many local agencies in Oregon have used v/c ratio as a performance standard. Thresholds often are set for different roadway classifications and land use contexts. The v/c ratio is the only standard currently used by ODOT as described in the Oregon Highway Plan (OHP). For example, the OHP Policy 1F Table 7 currently includes targets for v/c ratio ranging from 0.99 to 1.1, depending on the facility and time of day.

Mitigations and Outcomes Considerations

When applying this measure as a standard, potential mitigations could include:

- Signal retiming, at individual intersections or for a corridor
- Added turn lanes or through lanes
- Travel demand management

These types of mitigations could support the following outcomes:

- Increased vehicular efficiency, reliability, and mobility
- Increased safety risks for pedestrians and bicyclists
- Increased reliance on the automobile