Application of Oregon Highway Plan Mobility Standards

Introduction

Purpose

The purpose of this white paper is to clarify application of the 1999 Oregon Highway Plan (OHP) highway mobility standards for both ODOT staff and consultants.

Caution

This paper is a clarification of current practice, in order to give further guidance to those involved in the preparation of Traffic Impact Study (TIS) reports and to ODOT staff who are responsible for reviewing them. The following discussions provide general information to be applied to typical TIS reports, but is not intended to be exhaustive. Because every development proposal presents a unique set of problems to address, professional judgement must be used along with the information in this paper. Agreement with ODOT should be obtained during the scoping process, prior to proceeding with any analysis that deviates from these parameters.

ODOT Development Review Guidelines

All TIS's need to follow the ODOT Development Review Guidelines, which address the use of a PHF and other analysis parameters (such as from Table 3.3.7 of the Guidelines that lists peak hour factors, minimum lost time per phase, and ideal saturation flow rates). Many of the defaults and suggestions in the Guidelines also can be applied to planning products and project development work.[1] Changes will be made to the Development Review Guidelines to reflect clarifications made in this paper.

Background

Concern was expressed by both ODOT staff and consultants about the lack of clarity on the proper application of the Oregon Highway Plan (OHP) mobility standards (OHP Policy 1F). In response to this concern, the issues raised were discussed within the ODOT Planning and Traffic Management Sections, and this paper was developed. Region input was provided by the Region Access Management Engineers.

Continued on next page

[1] The ODOT Development Review Guidelines are available in hardcopy from the ODOT Planning Section or on the Internet at the following link: https://www.oregon.gov/ODOT/Planning/Pages/Guidance.aspx

Introduction, Continued

Contents

This paper covers the following topics:

OHP Table 7

Amendment to OHP Table 7

Table 7 in the OHP was revised by OHP Amendment 00-04 on December 13, 2000. The revised Table 7 is found in the document "Amendment to 1999 Oregon Highway Plan Alternate Highway Mobility Standards Metro Area"[2].

First and Second Hour Standards

The December 2000 OHP amendment eliminated the two-hour volume to capacity (v/c) ratios. Separate v/c ratio standards are specified for each of the one-hour periods. The existing first bullet under OHP Table 7 was a leftover from the original Table 7 and is proposed to be stricken from the OHP with the next revision. Each of the hours needs to be analyzed separately, using an appropriate PHF, with the results compared to the respective v/c ratios provided in Table 7.

[2] Alternate Mobility Standards for RVMPO & Metro, and other Oregon Highway Plan amendments, can be found on the Internet at the following link: https://www.oregon.gov/ODOT/Planning/Pages/OHP-Registry.aspx

Peak Hour Factors (PHF)

Congestion

- The transportation system must be designed to accommodate the 15-minute peaking in the peak hour. In areas near capacity, the 15-minute flow can cause up to several hours of congested flow. The congestion that results from the 15-minute flow must be accounted for in the analysis of the transportation system.
- Peak 15 minute deficiencies do not necessarily result in additional lanes and significant cost and right of way impacts. Minor mitigation resulting in lesser impacts may be sufficient, such as transportation demand management (TDM) strategies and acceptable operational improvements. If TDM strategies are contained in an adopted plan, a different PHF (to reflect spreading of the demand) may be used for future analysis if agreed to by ODOT during the scoping process.
- Guidance on the application of PHF's is contained in the ODOT Development Review Guidelines.

Development of OHP Tables 6 and 7

The 1999 OHP v/c ratio Tables 6 and 7 originally intended peak hour factors to be used. The analysis that determined the v/c ratio standards used PHF's as an input. To remain consistent with the OHP, any analysis that uses the OHP v/c ratios need to use a PHF.

OHP Tables 6 and 7 Clarification Language

The second bullet under OHP Table 6 (also for a new first bullet for the revised Table 7) needs to have clarification language added. The clarification should read as follows:

Current Language

- *"For the purposes of this policy, the peak hour shall be the 30th highest annual hour. This approximates weekday peak hour traffic in larger urban areas."*

Proposed Language

- ***"For the purpose of this policy, the maximum volume-to-capacity ratio for peak operating conditions shall be evaluated using the highest 15-minute period of the 30th highest annual hour. Weekday peak hour traffic can be used to approximate the 30th highest hour in larger urban areas."***

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Peak Hour Factors (PHF), Continued

Existing PHF's

- Existing year analyses need to use PHF's derived from the count information
- For areas with pronounced peaking characteristics such as industrial sites and schools, other peak 15 minute periods may need examination as well.

Existing PHF - Method 1

The preferred analysis method in most cases uses an intersection PHF to estimate peak 15 minute period equivalent hourly flow rates from the peak 60-minute period volumes. The peak 15 minute period with the highest intersection total entering volume (TEV) should be used to determine the PHF. The intersection PHF is calculated as follows.

Step	Action
1.	Determine the peak 15 minute period that has the highest intersection total entering volume (TEV).
2.	Calculate the intersection PHF based on the time period determined in Step 1, by dividing the TEV peak 60 minute volume by four times the TEV occurring during the peak 15 minutes.
3.	In the analysis, apply the intersection PHF from Step 2 to each movement peak 60 minute volume.

Existing PHF - Method 2

As an option, in cases where unusual peaking occurs on individual approaches, approach PHFs can be determined from the traffic count volumes. The peak 15 minute period with the highest intersection TEV should be used to determine the PHFs. PHFs are calculated for each approach as follows. If an approach PHF is calculated to exceed 1, entering a value of 1.00 will ensure a slightly conservative analysis.

Step	Action
1.	Determine the peak 15 minute period that has the highest intersection total entering volume (TEV).
2.	Calculate the PHF for each approach based on the time period determined in Step 1, by dividing the approach peak 60 minute volume by four times the approach peak 15 minute volume.
3.	In the analysis, apply the approach PHFs from Step 2 to the approach peak 60 minute volumes (usually calculated by the analysis software).

Peak Hour Factors (PHF), Continued

Existing PHF - Method 3

As an additional option in cases where unusual peaking occurs on individual approaches, the traffic count volumes for all movements that occur during the single peak 15 minute period can be used directly in software that multiplies the peak 15 minute period volumes by a factor of four. If this method is used, both the actual 60-minute period hourly volumes and the equivalent peak 15 minute hourly flow rates should be shown on the Existing Traffic flow diagrams, and clearly labeled to avoid confusion.

Step	Action
1.	Determine the peak 15 minute period that has the highest intersection total entering volume (TEV).
2.	For the time period determined in Step 1, enter the peak 15 minute volumes directly in the software.
3.	Select software analysis procedure based on the peak 15 minute period.
4.	On the flow diagrams show and clearly label both the actual 60-minute period hourly volumes and the equivalent peak 15 minute hourly flow rates, to avoid confusion.

Future PHFs

The future year analyses use the PHF defaults in Table 3.3.7 (see below) of the ODOT Development Review Guidelines unless better information is available. For areas with aggressive TDM strategies contained in an adopted plan, a different PHF (to reflect spreading of the demand) may be used for future analysis if agreed to by ODOT during the scoping process. For areas with pronounced peaking characteristics such as industrial sites and schools, PHF's lower than those shown in Table 3.3.7 should be used.

Signalized Intersections

Intersection V/C Ratio

For signalized intersections, the OHP v/c ratio is based on the overall intersection v/c ratio, not the movement v/c ratio as explained in Action 1F of the OHP. The intersection v/c ratio is also known as the critical v/c ratio, or X_c in the Highway Capacity Manual (HCM). The intersection v/c ratio is not generally affected by the approach green times (except in cases with shared left turns). See HCM equation 16-8 below.

$$Xc = \sum\left(\frac{v}{s}\right)_{ci}\left(\frac{C}{C-L}\right) \qquad (16\text{-}8)$$

where

Xc = critical v/c ratio for intersection;

$\sum\left(\frac{v}{s}\right)_{ci}$ = summation of flow ratios for all critical lane groups i;

C = cycle length(s); and

L = total lost time per cycle, computed as lost time, tL, for critical path of movement(s).

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Signalized Intersections, Continued

Analysis Procedures Regarding Signal Timing

Capacity analysis of signalized intersections should be performed in accordance with the methods and default parameters listed in chapter three of ODOT's Development Review Guidelines, Traffic Impact Studies. ODOT has established the following criteria for traffic impact studies in regards to the timing chosen for the capacity analysis of signalized intersections. ODOT reserves the right to reject any operational improvements that in its judgment would compromise the safety and efficiency of the facility.

Phase splits

A maximum split of at least 13 seconds should be used. Clear documentation of the selected maximum splits for each phase must be provided in the traffic impact study. The total side street splits should not be greater than the highway splits. Except in cases where the analyst is directed otherwise by ODOT staff, the splits should be optimized so as to yield the lowest overall intersection v/c ratio. This optimization should be done for each capacity analysis.

Non-Coordinated Signals

Cycle lengths and phase splits should be optimized to meet an ideal level of service, queuing, and/or volume to capacity ratio for a non-coordinated traffic signal intersection. Unless directed to do so by ODOT staff, the use of the existing timing is not required. The cycle length for the analysis should not exceed 60 seconds for a two-staged traffic signal, 90 seconds for a three-staged traffic signal (e.g. protected highway left turns and permissive side streets left turns), or 120 seconds for a four- or more staged traffic signal. The signal cycle length should cover the pedestrian clearance time for all crosswalks. For information on pedestrian crossings, see *ODOT Traffic Signal Policy and Guidelines.*[3]

Continued on next page

[3] ODOT Traffic Signal Policy and Guidelines are available at:
https://www.oregon.gov/ODOT/Engineering/Pages/Signals.aspx

Signalized Intersections, Continued

Analysis Procedures Regarding Signal Timing (continued)

Signals in Coordinated Signal System

At the initial scoping meeting for the traffic impact study, ODOT staff will determine whether the analysts should use the existing signal timings for all analysis scenarios or develop optimized timings for the coordinated system. If the existing timings are to be used in the analysis, Region traffic shall provide timing files, timing sheets, or Synchro files of the existing settings. If optimized timings are to be developed, those settings are subject to approval by ODOT; and those conditions become the baseline for all comparisons.

The following settings should be optimized for each analysis scenario when the analyst is asked to use optimum coordination settings.

- Cycle length
- Phase length,
- Phase sequence (lead/lag left turns)
- Intersection offsets

The optimum settings must meet the criteria established in OAR 734-020-0480 as it relates to progression analysis while also attempting to find the lowest v/c ratio for each intersection. This OAR only applies when modifications are proposed to a signal which would affect the settings of the coordination plans. Examples of these modifications are changes in cycle length, decreased green time for mainline, additional phases, longer crosswalks, and intersection relocation.

Saturation Flow Rates[4]

The passenger cars per hour of green per lane specified in the ODOT Development Review Guidelines is the ideal (unadjusted) saturation flow for a through travel lane. This value is adjusted downward by many factors (lane width, parking, bus blockage, area type, etc.) to arrive at the adjusted saturation flow.

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[4] Saturation flow rate data are collected on an ongoing basis.

Signalized Intersections, Continued

Field Measurements of Saturation Flow Rates

- Saturation flow rates for signalized intersections should be based on field measurements in accordance with Appendix H in Chapter 16 of the Highway Capacity Manual.
- The adjusted saturation flow is equivalent to a saturation flow field study calculated volume. In other words, if a field study is performed at the critical intersection(s) the resulting saturation flow volume is not adjusted by any of the factors above. All factors should be set to 1.00. Alternatively, the ideal saturation flow could be back-calculated from the field saturation flow and other known saturation flow factors.

Where Field Measurements are not Conducted

Where field measurements are not conducted, the unadjusted ideal saturation flow rate, before adjustment, is determined as follows:

- Outside of Metropolitan Planning Organization (MPO) urban areas, 1800 passenger cars per hour of green per lane (pcphgl) shall be used
- Inside MPO urban growth boundaries, 1900 pcphgl may be used, unless one or more of the following conditions are present, in which case 1800 pcphgl shall be used:
    - On-street Parking
    - Greater than 5% trucks
    - Roadways intersect at severe skew angle (i.e. greater than 20 degrees off perpendicular.
    - One or more approach(es), with a combined volume in excess of 5 vph, are present downstream of the intersection within the functional area, or upstream within the length of the standing queue.
    - Poor signal spacing or observed queue spillbacks between signals during the peak hour, or
    - Less than 12 foot travel lanes

Software

Any methodology or software that is applied in accordance with the operational method of the most recent edition of the Highway Capacity Manual will be accepted for signalized intersection v/c ratios. SIGCAP 2 is used in planning for relative comparisons between alternatives, not for evaluating the critical v/c ratio to compare to the OHP mobility standard, because it does not utilize a peak hour factor.

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Signalized Intersections, Continued

Future Signals

For future signals, left turns should be assumed to be protected if the criteria for protected left turn phasing contained in the current ODOT Traffic Signal Policy and Guidelines[5] will be met.

Scoping a TIS

It is important to work closely with the Region Traffic Engineer or a designee to scope a TIS involving signalized intersections, to ensure the correct parameters are used and to avoid unnecessary revisions. Any variance from parameters found in this document or the Development Review Guidelines must be agreed to in writing prior to completion of analysis.

[5]Can be found on the Internet at the following link: https://www.oregon.gov/ODOT/Engineering/Pages/Signals.aspx

Mobility Standards for No Build and Build Alternatives

TIS

Traffic Impact Studies (TIS) use the v/c ratios in the OHP as the mobility standard for existing and future no-build and build conditions. In situations where an interchange and interstate freeway needs to be modified, it is necessary to coordinate with FHWA and the developer to work out any issues relative to OHP versus HDM standards.

Project Development & Refinement Studies

No Build Conditions

All no-build alternative work for existing and future conditions will use the OHP v/c ratio as shown in Tables 6 and 7 in the OHP. Both Tables 6 and 7 in the OHP have been amended. The revisions are found in the "Amendment to 1999 Oregon Highway Plan Alternate Highway Mobility Standards South Medford Interchange And Metro Area"[6]. This applies to project development, corridor/refinement studies and Transportation System Plans.

Build Conditions

Since the ODOT Highway Design Manual (HDM) has been published, all future build alternative work needs to follow the HDM v/c ratios (HDM Table 10-1). The HDM v/c ratio will apply to project development work and refinement studies. The clarifications in this white paper also apply to the HDM v/c ratios.

[6] Alternate Mobility Standards for RVMPO & Metro, and other Oregon Highway Plan amendments, can be found on the Internet at the following link: https://www.oregon.gov/ODOT/Planning/Pages/OHP-Registry.aspx

Revised Development Review Guidelines Table 3.3.7

Default Signal Parameters

Table 3.3.7: ODOT Default Parameters for Use With Signalized Intersection Analysis Methodologies	
Total Lost Time	4 seconds per phase minimum for typical intersections, more for large or complex intersections.
Peak Hour Factor	For future year analysis: • 0.85 for local and collector street approaches • 0.90 for minor arterial approaches, • 0.95 for major arterial approaches, unless better information is available, such as for a school or industrial use.

Ideal Saturation Flow Rate	Field measurement should be consistent with methodology laid out in the HCM. Saturation flow rate worksheets must be included in the documentation.
	Where field measurements are not done,
	• Outside of MPO urban areas, 1800 passenger cars per hour of green per lane (pcphgl) shall be used
	• Inside MPO urban growth boundaries, 1900 passenger cars per hour of green per lane (pcphgl) may be used, unless one or more of the following conditions are present, in which case 1800 pcphgl shall be used
	  • Parking
	  • Greater than 5% trucks
	  • Other than ninety degree intersection skew angle
	  • One or more approach(es), with a combined volume in excess of 5 vph, are present downstream of the intersection within the functional area, or upstream within the length of the standing queue
	  • Poor signal spacing or observed queue spillbacks between signals during the peak hour, or
	  • Less than 12 foot travel lanes