

Chapter 4, Page 4-40, 4.6.3 Urban Transportation Demand Models

Added:

Latent Demand

An effect that may be observed from model results is where the Future Build volume is significantly greater than the future No Build volume, for the same year. This can occur where the Future No Build demand has exceeded capacity, and a portion has shifted to avoid congestion. The shifted demand is called latent demand. Demand can shift in a variety of ways, for example to other routes, modes, destinations, or time periods. Once the facility is at capacity, peak hour volumes no longer increase over time, while latent demand may continue to increase. When a Build alternative alleviates the congestion, a portion of the shifted demand may return, which is reflected by an increase in the Future Build volume.

Chapter 5, Pages 5-2,4, 5.2 Crash Analysis

As Reads:

5.2 Crash Analysis

Crash analysis typically involves the identification of the problem areas on facilities experiencing an above-average frequency of crashes or reoccurring crash patterns and an investigation of conditions that may contribute to the problem identified. This analysis should not be confused with the operational analysis that would be done separately by Region Traffic staff.

5.2.1 Calculating Crash Rates

Because the total number of crashes experienced on a segment of roadway is typically proportional to the number of vehicles using that segment, rates are often calculated to allow for comparisons of different facilities. The most common basis for comparison is to calculate the number of crashes experienced per million users. Specifically, for roadway segments, the number of crashes per million vehicle miles of travel (MVM) is calculated and for intersections, the number of crashes per million entering vehicles (MEV). The corresponding formulas for these calculations are shown in Table 5-1.

Table 5-1 Equations for Crash Rate Calculations

Description	Expression	Formula
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Segment Crash Rate (crashes per million vehicle miles of travel, MVM)	Annual number of crashes times one million, divided by the annual vehicle-miles of travel.	$\frac{\text{Annual number of crashes} \times 10^6}{(\text{AADT}) \times (365 \text{ days/year}) \times (\text{segment length in miles})}$
Intersection Crash Rate (crashes per million entering vehicles, MEV)	Annual number of crashes times one million, divided by the annual volume of entering traffic.	$\frac{\text{Annual number of crashes} \times 10^6}{(\text{AADT}) \times (365 \text{ days/year})}$

Note that care should be taken when calculating crash rates for sections that are less than one mile. The resulting rate for a short section can appear to be much higher than is actually the case. Evaluate crash rates for short sections by trying small changes in the number of crashes. If the changes in crash rate are dramatic then either this type of crash rate should not be used or its use should be accompanied with a warning. Whenever possible crash rates for short sections should be normalized (or lengthen the section) to a full one-mile section without including features that will significantly influence the outcome, e.g., a major intersection hosting a high concentration of crashes. These rates can also be calculated using only specified types of crashes such as fatalities, crashes resulting in injuries, or crashes resulting in property damage only.

Crash rates are commonly used to determine if the frequency of crashes experienced at a given intersection or segment of roadway is above average. ODOT does not have an established standard intersection crash rate to compare with as a baseline. The Safety Priority Index System (SPIS) provides an alternative method of ranking for intersections and segments of roadways on State Highways. SPIS incorporates crash rate, frequency and severity components to provide a single index to compare a roadway or intersection.

The top 5% SPIS ranking requires the Region Traffic offices to conduct a safety investigation each year to determine if there is an appropriate safety improvement fix to the problem. You can determine your SPIS ranking at the following intranet website <http://intranet.odot.state.or.us/tstrafmgt/PSMS/SPIS/spis.htm> or contact the appropriate Region Traffic Office for assistance. The Traffic-Roadway Section is contracting with Oregon State University and Portland State University to develop a Safety Investigations Manual. The Manual should be available in the Fall of 2009.

The ODOT CAR Unit publishes an annual document called the *Oregon State Highway Crash Rate Tables*. In this document crash rates for given segments of all state highways are calculated and listed for each of the last five years. In addition to this a variety of summaries of crash rates for state highways considering fatalities and different highway types, as well as information about the data used in the crash rate calculations, is provided.

Of particular interest is Table II, which shows comparative five-year crash rates for freeways and non-freeways on the state highway system, by urban and rural area and by

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primary and secondary designation. This table is often used in crash analysis to compare the segment crash rate calculated for a study highway to the statewide average rate shown in the table for a comparable highway type. In the selection of the appropriate highway type for comparison, the analyst must determine whether the study highway segment is classified as a freeway or non-freeway, is located within an urban or rural area and is on the primary or secondary highway system (a listing of primary and secondary highways is included after Table IV). Note that the category “State Highway System” provided alongside the primary and secondary system categories in Table II is merely a combination of the primary and secondary highway systems and should not be used for most crash rate comparisons.

When comparing a statewide average rate to a segment crash rate for a study highway, simply exceeding the statewide average rate should not be interpreted as proof that a section is hazardous. A segment crash rate that exceeds the statewide average crash rate should merely be considered as an indication that further investigation is necessary. It should also be stated that cost effective improvements to increase safety could still be identified even with a segment crash rate lower than the statewide average.

5.2.2 Identifying Crash Patterns

The commonly used procedure to identify crash patterns is categorizing crashes by characteristics such as types, time of day, weather conditions and locations. In this form it may be easier for the analyst to identify crash trends such as a high number of a certain type of crash or a location or movement that experiences a disproportionate amount of the total crashes.

Caution should be exercised when identifying actual crash locations from reported data. Crashes may be reported at the nearest integer milepoint even if they occurred hundreds of feet away, i.e., a crash reported at milepoint 12 even though it actually occurred at milepoint 12.34. This can be evidenced by clusters of crashes reported at even milepoints. Crash data should be checked for discrepancies such as where a crash occurred on a curve, but the reported milepoint is located on a straightaway section.

The analysis should also include a discussion of the details of crashes, particularly those that local residents will remember such as involving a fatality, bicyclists or pedestrians, or multiple cars. There should also be a discussion of major crash types and whether they are typical for the section, i.e., rear-end crashes at signalized intersections, sideswipe/overtaking crashes in areas with narrow lanes, or head-on and opposing sideswipe crashes where no median exists. In addition, it should be noted if there are concerns with particular types of crashes. For example, property-damage-only and minor injury rear-end crashes at signalized intersections are somewhat expected, however, if major injury (or fatal) crashes are occurring that may imply there is a problem with high speeds, which opens a whole realm of other things to consider such as driver expectancy and signal visibility. Table 5-2 lists some typical crash types, and

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associates them with common causes and potential countermeasures. Keep in mind that this list is not exhaustive, and is only provided as an example.

Changed To:

5.2 Crash Analysis

Crash analysis typically involves the identification of the problem areas on facilities experiencing an above-average frequency of crashes or reoccurring crash patterns and an investigation of conditions that may contribute to the problem identified. If an analyst generally understands crash trends within a study, the analyst can use the information in the analysis and recommendations. This analysis should not be confused with the operational analysis that would be done separately by Region Traffic staff.

5.2.1 Calculating Crash Rates

Crash rates are commonly used to determine if the frequency of crashes experienced at a given intersection or segment of roadway is above average. Because the total number of crashes experienced on a segment or intersection of roadway(s) is typically proportional to the number of vehicles using that facility, rates are often calculated to allow for comparisons of different facilities. The most common basis for comparison is to calculate the number of crashes experienced per million users. Specifically, for roadway segments, the number of crashes per million vehicle miles of travel (MVM) is calculated and for intersections, the number of crashes per million entering vehicles (MEV). These rates can also be calculated using only specific crash types such as fatalities, fatal, injury or property damage only crashes. The corresponding formulas for these calculations are shown in Table 5-1.

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Note that care should be taken when calculating crash rates for segments that are less than one mile. The resulting rate for a short section can appear to be much higher than is actually the case. Evaluate crash rates for short sections by trying small changes in the number of crashes. If the changes in crash rate are dramatic then either this type of crash rate should not be used or its use should be accompanied with a warning. Whenever

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possible crash rates for short sections should be normalized (or lengthen the section) to a full one-mile section without including features that will significantly influence the outcome, e.g., a major intersection hosting a high concentration of crashes.

For reporting crash rates on state highways, ODOT uses the segment crash rate. ODOT does not have an established standard intersection crash rate to compare with as a baseline. The ODOT CAR Unit publishes an annual document called the *Oregon State Highway Crash Rate Tables*. In this document crash rates for given segments of all state highways are calculated and listed for each of the last five years. In addition to this a variety of summaries of crash rates for state highways considering fatalities and different highway types, as well as information about the data used in the crash rate calculations, is provided.

Of particular interest is Table II, which shows comparative five-year crash rates for freeways and non-freeways on the state highway system, by urban and rural area and by primary and secondary designation. This table is often used in crash analysis to compare the segment crash rate calculated for a study highway to the statewide average rate shown in the table for a comparable highway type. In the selection of the appropriate highway type for comparison, the analyst must determine whether the study highway segment is classified as a freeway or non-freeway, is located within an urban or rural area and is on the primary or secondary highway system (a listing of primary and secondary highways is included after Table IV). Note that the category “State Highway System” provided alongside the primary and secondary system categories in Table II is merely a combination of the primary and secondary highway systems and should not be used for most crash rate comparisons.

When comparing a statewide average rate to a segment crash rate for a study highway, simply exceeding the statewide average rate should not be interpreted as proof that a section is hazardous. A segment crash rate that exceeds the statewide average crash rate should merely be considered as an indication that further investigation is necessary. It should also be stated that cost effective improvements to increase safety could still be identified even with a segment crash rate lower than the statewide average.

When an intersection crash rate may be appropriate to report, a rule of thumb is that intersections with a crash rate of 1.0 or greater is generally considered to be an indication that further investigation is warranted. . This is not to say whether a location is “bad” if over or “okay” if under 1.0. It should also be stated that cost effective improvements to increase safety could still be identified even with an intersection crash rate lower than the statewide average.

Another analysis tool that ODOT uses is the Safety Priority Index System (SPIS) which provides an alternative method of ranking for intersections and segments of roadways on State Highways. SPIS incorporates crash rate, frequency and severity components to provide a single index to compare a roadway or intersection.

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The top 5% SPIS ranking requires the Region Traffic offices to conduct a safety investigation each year to determine if there is an appropriate safety improvement fix to the problem. The SPIS ranking can be determined by contacting the appropriate Region Traffic Office for assistance or at the following intranet website <http://intranet.odot.state.or.us/tstrafmgt/PSMS/SPIS/spis.htm>. The Traffic-Roadway Section is contracting with Oregon State University and Portland State University to develop a Safety Investigations Manual which is planned to be available in Fall of 2009.

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The commonly used procedure to identify crash patterns is categorizing crashes by characteristics such as types, time of day, weather conditions and locations. In this form it may be easier for the analyst to identify crash trends such as a high number of a certain type of crash or a location or movement that experiences a disproportionate amount of the total crashes.

Caution should be exercised when identifying actual crash locations from reported data. Crashes may be reported at the nearest integer milepoint even if they occurred hundreds of feet away, i.e., a crash reported at milepoint 12 even though it actually occurred at milepoint 12.34. This can be evidenced by clusters of crashes reported at even milepoints. Crash data should be checked for discrepancies such as where a crash occurred on a curve, but the reported milepoint is located on a straightaway section.

5.2.3 What Data to Report

An analysis report should contain summarized information about crashes within the study area. The summary should contain trends, crash rates and a general discussion of the crashes. If on the state highway the report should contain the segment crash rate and reference to the most recent SPIS data.

Chapter 7, Page 34, 7.3.8 Software and Tools Available for Analysis

As Reads:

Traffix

Traffix is a computer program that calculates level of service at signalized and unsignalized intersections based on the *HCM* or other available methods such as Circular

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212¹ and SIGCAP. This program is frequently used for evaluating the impacts of proposed developments because it facilitates the process of trip distribution and assignment over a street network making it easier to test multiple development scenarios and different mitigation measures.

Changed to:

Traffix

Traffix is a computer program that calculates level of service at isolated signalized and unsignalized intersections based on the HCM methods. There is no interaction between the intersections, similar to the Highway Capacity Software (next software covered). This program is frequently used for evaluating the impacts of proposed developments. It facilitates the process of trip distribution and assignment over a street network making it easier to test multiple development scenarios and different mitigation measures. The Traffix program uses Zones, Gates, Paths, Routes, and Attractions to simulate an existing network and the addition of a potential development. The program can be used to develop both existing and future traffic volumes for several alternatives, evaluate potential signal timing (but not progression), and generate Level of Service and HCM reports for intersections (signalized and unsignalized). A Traffix file can be converted over to a Synchro file (some details don't transfer), saving time creating new files and inputting different volume scenarios.

Local jurisdictions often use Traffix to track various development proposals and to keep an inventory of their network. Traffix is often used for TIAs and similar analysis work. This tool is also used when working with cumulative analysis of small communities and small regional projects. Traffix may be a better tool for analysis in an area with several new developments or experiencing unusually fast growth that out paces historical growth rates.

There are some limitations of Traffix. Traffix does not use ODOT's accepted analysis procedure for roundabouts. The electronic file, along with the input and output file, will need to be provided. Screen prints may also be required to show various inputs. Traffix queue lengths must not be used for unsignalized intersections and may only be used for isolated signalized intersections where no simulation is being performed. Gates may be needed between attractions to show trips occurring between attractions. In a model based forecast, volumes should be post processed and are not considered to be when using a factor or multiplier in this program.

Chapter 7, Page 54, 7.5 Estimating Vehicle Queue Lengths

Added:

¹ *Transportation Research Circular 212: Interim Materials on Highway Capacity*, Washington, DC, TRB, 1980.

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A queue blockage or spillback condition is considered a problem when the duration exceeds 5 percent of the peak hour.

Chapter 8, Page 8-4, 8.3 SimTraffic

Added:

A queue blockage or spillback condition is considered a problem when the duration exceeds 5 percent of the peak hour.

Chapter 9, Page 9-3, 9.2 Standards for Determining Needs

Added:

It should be noted that for ramp terminals, the HDM mainline maximum v/c ration is the standard that applies. There is no equivalent ramp terminal v/c ratio in the OHP as there is in the HDM.

Chapter 10, Pages 10-22,23,24, 10.6.2 Progression Analysis

As Reads:

Traffic Signal Progression Analysis

Oregon Administrative Rule (OAR) 734-020-048 stipulates when a progression analysis is required for new or revised traffic signal systems. A traffic signal progression analysis is required if the proposed location is within ½ mile of an existing or possible future traffic signal. The roadway segment analyzed, to the extent possible, shall include all traffic signals in the existing or future traffic signal system.

Objectives of Signal Progression Analysis

For planning analysis, the goal is to maximize the progression bandwidth while maintaining optimum system performance (v/c ratios, queue lengths, cycle length, splits, etc.). For operational analysis, including signal design, final roadway design and Traffic Impact Studies, as noted in the above OAR section, the following objectives are applicable.

- Demonstrate acceptable existing and future traffic signal system operation during commute peak hours for cycle lengths and travel speeds approved by the State Traffic Engineer, or designated representative (e.g., Traffic Operations Section).

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- Provide for a progressed traffic band speed no more than 5 mph below the existing posted speed for both directions of travel during the off-peak periods and no more than 10 mph below the existing posted speed during peak periods. Approval by the State Traffic Engineer, or designated representative, shall be required where speeds deviate more than the above.
- Demonstrate sufficient vehicle storage is available at all locations within the traffic signal system without encroaching on the functional boundaries of adjacent lanes and signalized intersections. The functional boundary of an intersection shall be determined using procedures specified by the ODOT Access Management Unit.
- Provide a common cycle length with adequate pedestrian crossing times at all signalized intersections.
- Provide a progression bandwidth as large as that required, or as presently exists, for through traffic on the state highway at the most critical intersection within the roadway segment. The most critical intersection is the intersection carrying the highest through volume per lane on the state highway.

Available Analysis Tools

A traffic signal progression analysis for all new or revised traffic signal systems on state highways shall be performed using methods, models, computer software, data sources, roadway segment length and assumptions approved by the State Traffic Engineer, or designated representative. The computer software capable of performing these types of analyses include:

Changed To:

10.6.2 Progression Analysis

Traffic Signal Progression Analysis

This section pertains to planning analyses as provided for traffic signal engineering investigations, corridor studies, and other planning efforts. Oregon Administrative Rule (OAR) 734-020-0480 stipulates that a progression analysis is required for the approval of new or revised traffic signal systems if the proposed location is within ½ mile of an existing or possible future traffic signal. The roadway segment analyzed, to the extent possible, shall include all traffic signals in the existing or future traffic signal system. The purpose of a planning progression analysis is to ensure that a new signal or revised traffic signal will function acceptably with other nearby signals.

At the start of a project, ODOT traffic operations staff will determine whether the analyst 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

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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;
- Side Street Phase Lengths (Splits);
- Phase Sequence (Lead/Lag Left Turns);
- Intersection Offsets; and,
- Link Speed or Progression Speed

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 intersection v/c ratio and minimizing queue lengths. 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.

Requirements for Signal Progression Analysis

For planning analysis, the following requirements must be met:

- Demonstrate acceptable existing and future traffic signal system operation during commute peak hours
- Provide for a progressed traffic band speed within 5 mph of the existing posted speed for both directions of travel during the off-peak periods and within 10 mph of the existing posted speed during peak periods. Approval by the State Traffic Engineer, or designated representative, shall be required where speeds deviate more than the above.
- Demonstrate sufficient vehicle storage is available at all locations within the traffic signal system without encroaching on the functional boundaries of adjacent lanes and signalized intersections. The functional boundary of an intersection shall be determined using procedures specified by the ODOT Access Management Unit.
- Provide a common cycle length with adequate pedestrian crossing times at all signalized intersections.

The analysis must demonstrate that the additional or revised signal still allows the signal system to have a progression bandwidth as large as that required, or as presently exists, for through traffic on the state highway at the most critical intersection within the roadway segment. The most critical intersection is the intersection carrying the highest through volume per lane on the state highway. Unless directed otherwise by ODOT traffic signal operations staff, the analysis should use optimized timing settings. The carrying capacity of the progression bandwidth should be estimated with the following equation:

$$\text{Bandwidth Capacity (veh/cycle)} = \frac{(\text{Bandwidth(sec)} - 4) \times (\text{Adj. Sat. Flow Rate})}{1}$$

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3600

This capacity should be compared with the average platoon size expected to arrive at the most critical intersection for both directions of travel. The average platoon size may be found by the following simplified calculation.

$$\text{Average Platoon Size} = \frac{C * V}{3600}$$

Where: C = cycle length
V = volume (adjusted for PHF)

Complete time-space diagrams are required for each of the analysis scenarios, including the existing coordinated system. They should indicate the offsets, phasing, and split times for each of the signals in the system. If using Synchro, the bandwidth shall be reported for the maximum green times or the 90th percentile arrival rates. The reported bandwidth may include green and yellow clearance times. An example time-space diagram is shown in Figure 7-3.

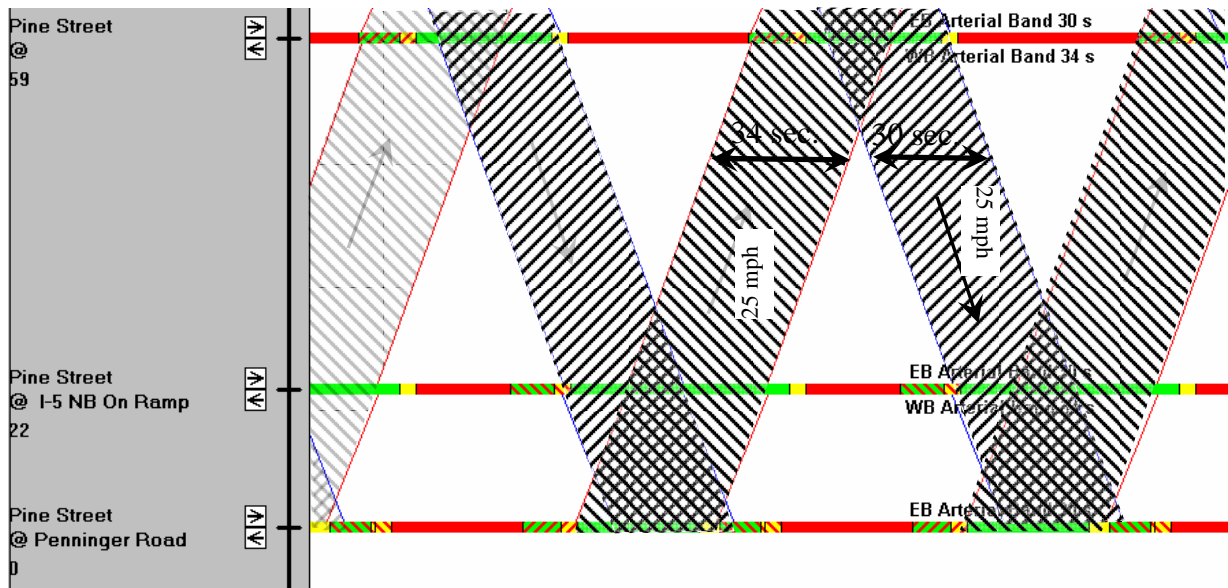
If the analysis shows that the proposed signal will not meet the requirements of OAR 734-020-480, other alternatives should be evaluated. These may include:

- Moving the new/revised intersection;
- Reducing phases on one or more signals;
- Providing additional lanes to reduce side street green or increase mainline capacity
- Decrease side street demands through TDM measures or construction of alternative routes.

Figure 10-8 Illustration of Bandwidths on a Time-Space Diagram

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Available Analysis Tools

To implement the requirements of OAR 734-020-480, analysts may use the coordinated system software program of their choice. Hand calculations and time-space diagrams are also acceptable. A few of the computer software programs capable of performing these types of analyses include:

Appendix A, Page A-1,2, Resources

Added:

[Circular 212 - Critical Movement Analysis and Unsignalized intersections](#)

[Development Review Guidelines](#)

[Traffic Engineering Handbook, ITE](#)

[ITE Trip Generation Handbooks](#)

Website

Added:

- [Appendix G - Example Tech Memos](#)

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- G.1 Fern Valley Interchange Existing Conditions Tech Memo (Report) (Figures)
- G.2 Constitution Area Refinement Study Future No-Build Tech Memo (Report) (Figures)
- G.3 Grandview - Nels Anderson Traffic Analysis Technical Memo (Report) (Figures)