Best Practices for Traffic Impact Studies

Final Report

SPR 614

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16. Abstract

For many years there have been concerns that some traffic engineers may approach traffic impact studies with an eye toward assisting developers expedite their development approval rather than delivering an unbiased evaluation of the impact of the development on the surrounding traffic system. Without unbiased studies, agencies are not able to make wise decisions to preserve the capacity of the infrastructure. Alternately, some agencies may also misinterpret the data from traffic impact analyses, resulting in overcharging of developers by imposing requirements for transportation improvements and conditions that are simply not warranted.

The goals of this research project were to examine decisions being made from traffic impact studies and to develop a set of best practices to supplement existing guidelines for developing and reviewing traffic impact studies. The research project selected and analyzed 12 case studies to compare post development traffic conditions to the traffic impact study forecasts of post implementation traffic conditions. Results of these comparisons were mixed. Best practices were identified for the following areas: land use code selection and application; pass-by trip reduction assumptions; seasonal variations; evaluation of other modes; analysis software; regional demand model verse growth rates; future year analysis; and safety.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

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This report does not constitute a standard, specification, or regulation.

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Abbreviations and Acronyms

AADT	average annual daily traffic
ADT	average daily traffic
ATR	automatic traffic recorder
DHV	design hour volume
DRG	Development Review Guidelines
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
ITE	Institute of Transportation Engineers
MPO	Metropolitan Planning Organization
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
TDM	Transportation Demand Management
TIA	traffic impact analysis ***or*** transportation impact analysis
TIS	traffic impact study
TPAU	Transportation Planning Analysis Unit
TPR	Transportation Planning Rule
TSP	Transportation System Plan
v/c	volume to capacity

1 Introduction

Chapter 3, Section 3 ("Traffic Impact Studies") of the 2005 Development Review Guidelines (DRG) provides guidance on the preparation of traffic impact studies (TISs). This recommended best practices document supplements the TIS section of the DRG by identifying key technical issues to consider in the scoping and preparation of TISs and recommends best practices for TIS development.

1.1 Traffic Impact Studies

TISs are used by the Oregon Department of Transportation (ODOT) and staff of other transportation agencies to forecast future system effects from proposed development projects and to predict the useful life of a transportation project against a future expected land use scenario. When impacts are not accurately projected through the traffic analysis process, the best decisions may not be made. Poor decisions can result in traffic congestion, safety issues, or unnecessary improvements.

> *The Importance of Traffic Analysis*
>
> When impacts are not accurately projected through the traffic analysis process, the best decisions may not be made. Poor decisions can result in traffic congestion, safety issues, or unnecessary improvements.

TIS analysis requires consideration of a number of key variables used to project future operations after a proposed improvement is implemented. Examples of variables include forecasted trip generation, trip distribution, future traffic conditions, and capacity and performance of roadway improvements. The assumptions made about key variables may affect the implementation of land use and transportation plans, positively or negatively.

Credible and accurate TISs are important for community development and livability. TISs with either overly conservative or aggressive estimates can create problems. For individual projects, overly conservative TISs may result in wasted resources for improvements that are not needed. The cumulative effect of overly conservative TISs may be perceived as an agency antigrowth bias to the development community. The other extreme occurs when assumptions made about the basic variables allow the applicant (also referred to as the developer) to underestimate projected impacts from development, or over-assume available capacity. Outcomes from this situation can include unanticipated congestion and safety problems, inappropriate or "throw-away" mitigation, and a "chasing the last trip" phenomenon, meaning the traffic effects of approved and built projects become the burden of future development. In the case of a modernization project, a 20-year design life volume may be reached much sooner than the projected 20 years, with the result that system improvements are consumed at an accelerated rate. An accurate TIS that represents the applicant's intentions provides all parties with the proper information to make quality decisions.

Organizational issues or conflicts of interest that may or may not affect the analysis outcomes are best discussed during scoping and managed accordingly by the relevant parties in advance of conducting the analysis.

1.2 Rationale

The purpose of this Recommended Best Practices document is to:

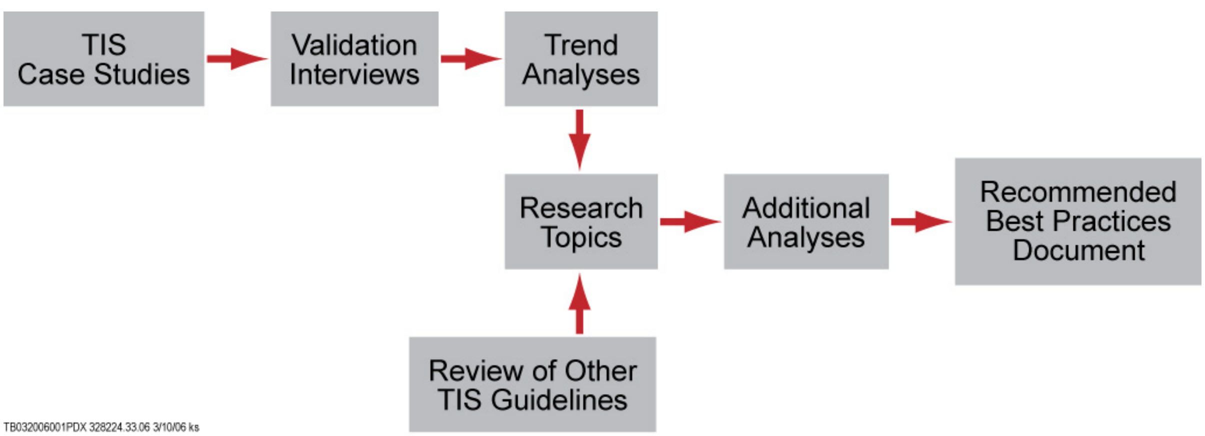
- Ensure that critical transportation and development issues are considered in the scoping process and addressed in TISs
- Provide a recommended best practice for preparers and reviewers
- Promote increased understanding of key issues to consider in TISs

This document does not outline ODOT's requirements for preparing TISs. The ODOT TIS section of the DRG (Chapter 3, Section 3) provides specific elements to include in TISs. The recommended best practices provided in this document supplement the DRG TIS requirements and help to assure that consistent and proper best practices are applied for land use actions proposed on or adjacent to ODOT facilities or that will have a significant effect on ODOT facilities. For the purposes of this document, the term TIS also applies to traffic impact analysis or transportation impact analysis (TIA) studies. The use of this document should not be limited to TISs prepared for ODOT. This document is equally applicable to TISs prepared for local jurisdictions and local transportation agencies.

1.3 Process

The process that led to the development of this Recommended Best Practices document is illustrated in Exhibit 1.

EXHIBIT 1. Recommended Best Practices Development Process



1.3.1 TIS Case Studies

Twelve case study TISs that projected future system impacts for private development proposals were evaluated (Appendix A and Appendix B). These projects primarily consisted of large, private commercial developments located on or near ODOT facilities ranging in years from 1991 to 2004. The case studies represented urban, urban fringe, and rural areas. At least one case study site was located in each ODOT region. One case study sheet was completed for each of the 12 case study sites. The sections for the case study sheets were as follows:

- Project Information: Basic information about the project
- Summary of TIS: Key findings, as reported in the TIS
- TIS Scope and Approach: Parameters used for the TIS analysis
- Assessment of Findings: Predicted conditions in the TIS compared with the actual (2005) conditions

1.3.2 Validation Interviews

A jurisdictional interview was conducted to capture qualitative contextual information for each case study site (Appendix A). A list of general, open-ended questions was used for all case study sites. Additional site-specific questions were used to clarify the context of the case study site and TIS. The desired information focused on reasons for deviation from the plan, and secondary and indirect impacts resulting from the development approval.

1.3.3 Trend Analyses

The quantitative and qualitative results of the case studies and validation interviews were evaluated to identify similarities and differences among the reviewed TISs (Appendix B). Criteria where TIS predictions were most consistent with actual conditions were:

- Interviewee Level of Satisfaction
- Site Built as Planned

Criteria where TIS predictions were partially consistent with actual conditions were:

- Intersection Operations
- Total Intersection Traffic
- Daily Trips Predicted
- Trip Distribution
- Intersection Traffic Growth

Criteria where TIS predictions were least consistent with actual conditions were:

- Peak Hour Trips Predicted
- Individual Turning Movements

1.3.4 Review of Other TIS Guidelines

An Internet search located 55 other TIS guidelines, although search results indicated that many jurisdictions either do not have TIS guidelines or these guidelines are not posted on the Internet. The methods and processes of these 55 other TIS guidelines were reviewed (Appendix C). Of the reviewed guidelines, 20 percent were State Department of Transportation agencies other than ODOT, 20 percent were counties, and 60 percent were cities. The review identified no unique TIS guidelines, although minor unique elements occurred in some of the researched guidelines.

1.3.5 Research Topics

Based on the case study analysis, TIS trends analyses, and review of other TIS guidelines, research topics were identified for this Recommended Best Practices document (Appendix D).

1.4 Relationship to Existing ODOT Guidelines

Chapter 3, Section 3 of the 2005 DRG gives guidance for the preparation of TISs. This document complements the DRG by providing guidelines for the selection of key topics to address in the TIS scoping process, and by outlining recommended best practices for use in TISs.

> *Use of This Document*
>
> This document complements the DRG by providing guidelines for the selection of key topics to address in the TIS scoping process, and by outlining recommended best practices for use in TISs. The use of this document should not be limited to ODOT TISs. This document is equally applicable to TISs for local jurisdictions and transportation agencies.

The authority of ODOT to require a TIS is outlined in DRG Chapter 3, Section 3.02. The following regulations apply to TISs and this Recommended Best Practices document. These regulations are summarized in more detail in the DRG:

- **Transportation Planning Rule (TPR) (Oregon Administrative Rule [OAR] 660-012):** Provides the regulatory framework to integrate land use and transportation planning. The TPR requires local governments to provide notice and coordinate with ODOT on potential comprehensive plan, zoning, and ordinance changes related to land use that may have a significant effect on transportation facilities.
- **Division 51 (OAR 734-051):** Establishes procedures and criteria to govern highway approaches, access control, spacing standards, medians, and restriction of turning movements in compliance with statewide planning goals.
- **Development Review Guidelines (Chapter 5 of the Access Management Manual):** Provides information to help ODOT staff respond to land use and development proposals that affect state transportation facilities.

Exhibit 2 illustrates the relationship of state law, local regulations, and ODOT standards to TIS development. This Recommended Best Practices document is intended to support TIS preparers and reviewers.

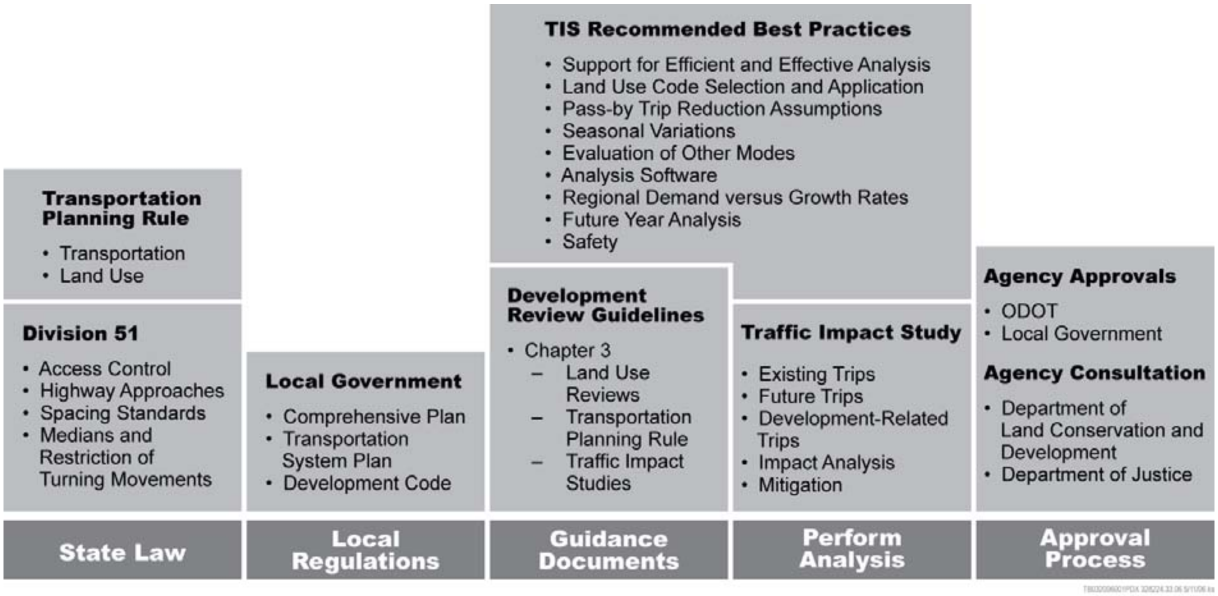
1.5 Best Practices Document Overview

Subsequent sections of this document are organized as follows:

- **Section 2—Scoping**: Defines the recommended approach to developing a scope of work for TISs. Describes how best to tailor the TIS work plan to the proposed development.
- **Section 3—Recommended Best Practices Use**: Identifies key variables that should be covered in the TIS.
  - **Land Use Code Selection and Application**: Explains land use code selection, independent variable selection, and estimation of trip generation methods.

  - **Pass-By Trip Reduction Assumptions**: Discusses when and how to apply pass-by trip reductions. Provides criteria for when and how to apply Institute of Transportation Engineers (ITE) manual rates. Discusses local survey methods.
  - **Seasonal Variations**: Provides additional explanation of ODOT's TIS guidelines.
  - **Evaluation of Other Modes**: Provides background to consider operational and safety implications for bicycle and pedestrian, transit, and trucks. The analysis needs to be tailored to the proposed development and setting.
  - **Analysis Software**: Introduces the analysis that the Federal Highway Administration (FHWA) conducted on traffic analysis tools, including a primer, methods for selecting the appropriate tool, and guidelines for applying microsimulation modeling software.
  - **Regional Demand Model versus Growth Rates**: Amplifies three methods used to determine future background traffic volumes—regional models, cumulative analysis, and growth trends. ODOT's DRG addresses each method in detail.
  - **Future Year Analysis**: Elaborates on the ODOT Development Review Guidelines and provides alternative information.
  - **Safety**: Provides background for considering safety when analyzing the traffic impacts of proposed development.
- Section 4—Summary
- Appendix A—Case Study Summary Sheets
- Appendix B—Trends Analysis Memorandum and Case Study Analysis Methodology
- Appendix C—List of Reviewed TIS Guidelines
- Appendix D—Research Topic Findings Technical Memorandum
- Appendix E—Examples of Guidance Letters and Scoping Checklists

EXHIBIT 2. TIS Recommended Best Practice Relationship



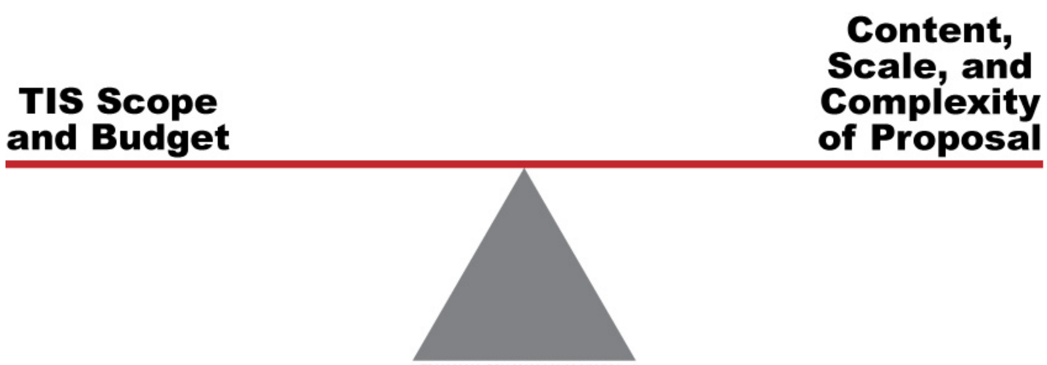
2 Scoping

ODOT, the local jurisdiction, and the applicant should discuss and agree on the scope, analysis methods, and assumptions prior to initiating the TIS. Consultation with ODOT and other affected transportation agencies will be needed to establish a suitable scope and level of detail for each development proposal project. Initiating a pre-application scoping meeting with ODOT is strongly encouraged, because the scoping stage is the best opportunity to identify critical issues and requirements for TISs, ensure timely review of the TIS, and avoid approval delays related to the transportation analysis.

> *TIS Scoping*
>
> The effectiveness of the final TIS is directly related to the quality of initial scoping. ODOT, applicable local jurisdictions, and the applicant should discuss and agree on the scope, analysis methods, and assumptions in a pre-application scoping meeting prior to initiating the TIS.

As stated in the DRG, the purpose of creating a scope of work for TISs is to define the study area boundaries, establish the analysis requirements, and convey specific concerns to be addressed in the TIS. The scope of work should be created with the goal of identifying the proposed development's impacts on the transportation system, as well as the potential improvements necessary to mitigate capacity, operation, and safety impacts of the development. The effectiveness of the final TIS in evaluating impacts and associated mitigation options is directly related to the quality of initial scoping. In developing a TIS, the scope and related budget should be balanced with the context, scale, and complexity of the proposed development (Exhibit 3).

EXHIBIT 3. Need for Balancing in TIS Development



> *No Statewide TIS Scoping Checklist*
>
> ODOT has not developed a statewide scoping checklist. In place of a checklist, this document should be consulted for general guidance on scoping elements.

ODOT has not developed a statewide scoping checklist because a checklist that is representative of all potential scenarios for locations throughout the state is not feasible. Two examples of scoping checklists are provided in Appendix E of this document. Appendix E also provides examples of scoping guidance letters developed by ODOT. The scoping checklists and guidance letters in Appendix E are examples and are not intended to be all-encompassing or applicable to every situation. In place of a statewide checklist, this Recommended Best Practices document should be consulted for general guidance on scoping elements.

The initial TIS scoping meeting should identify study issues, needs, assumptions, procedures, available sources of data, past and related studies, report requirements, and other topics relevant to prepare the TIS. Items that should be considered in the scoping meeting are as follows:

- Proposed land uses
- Existing land uses
- Study area limits
- Number of project phases
- Horizon year of buildout or years for multiphase projects related to the proposal
- Full buildout of uses already planned per existing zoning
- Background traffic data assumptions and methods for projecting growth
- Other developments currently approved or underway
- Modal considerations
- Traffic counts needed
- Study intersections
- Trip generation method and sources
- Trip reduction factors
- Trip distribution methodology
- Analysis software
- Committed and programmed roadway improvements
- Safety data resources
- Potential safety hazards
- Number, locations, capacity, and safety issues related to access points
- Potential mitigation opportunities

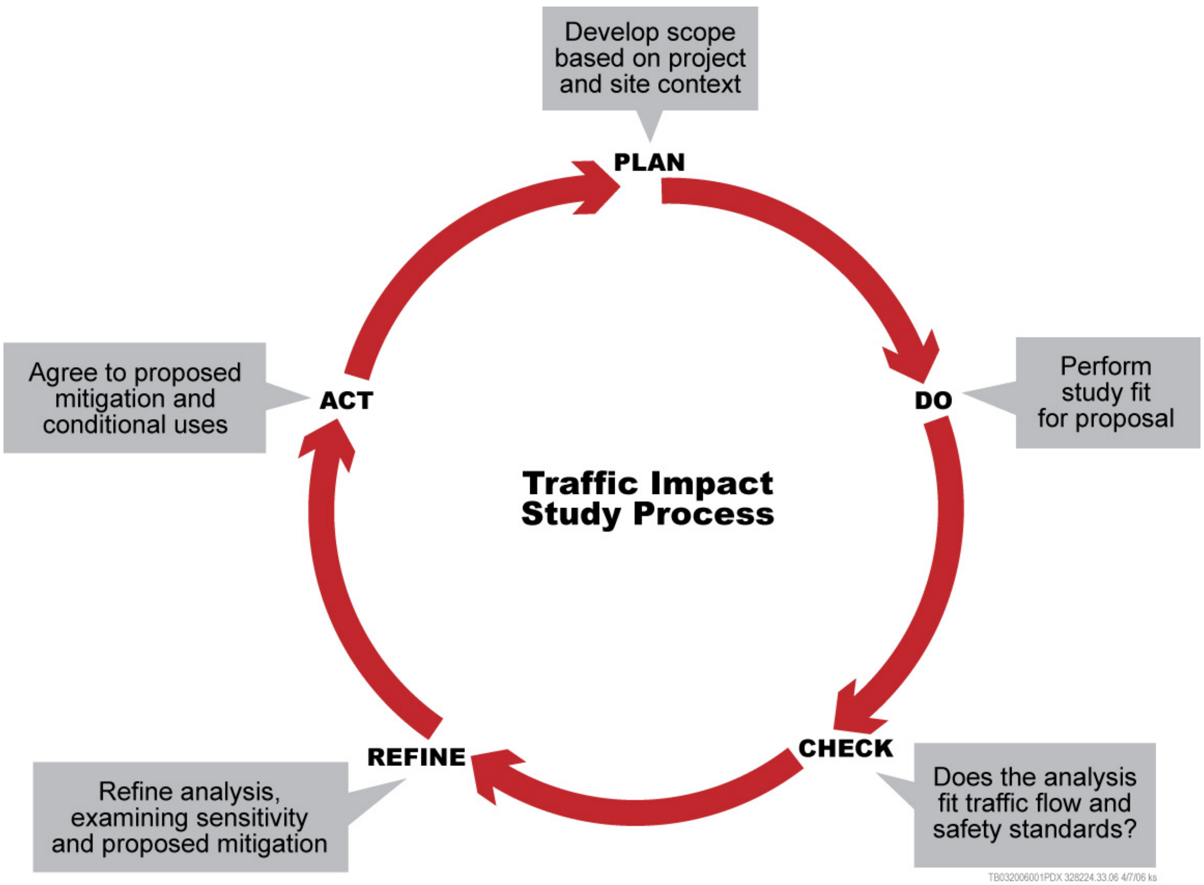
In addition to discussing the above items, ODOT or the local jurisdiction should provide available relevant data at or after the scoping meeting, including:

- Traffic counts—traffic counts should be no more than 1 year old from the date the report is prepared. Counts between 1 and 3 years old must be factored to the current year. If the proposed project is located in a high growth area, the collection of new traffic counts is recommended.
- Traffic signal phasing
- Traffic signal timing

- Improvement plans and programs
- Transportation and comprehensive plan information
- Data on planned or approved developments within the study area
- Safety data
- Relevant agency policies
- Other information directly relevant to the required study

Exhibit 4 summarizes the TIS development process. During TIS development, the preparers and reviewers should scope the planned project based on site context, perform the TIS fit for development proposal, check the analysis against what was reasonably expected as an outcome, refine the analysis examining sensitivity and proposed mitigation, and agree to proposed mitigation and conditional uses to be recommended to achieve approval.

EXHIBIT 4. TIS Development Process



3 Recommended Best Practices Use

This section recommends best practices for TIS development. These recommended best practices should be considered in the scoping process, the development of TISs, and the review of TISs. Recommended best practice guidelines have been developed for the following topics:

- Land Use Code Selection and Application
- Pass-By Trip Reduction Assumptions
- Seasonal Variations
- Evaluation of Other Modes
- Analysis Software
- Regional Demand Model versus Growth Rates
- Future Year Analysis
- Safety

The following sections provide detailed information on these key topics.

3.1 Land Use Code Selection and Application

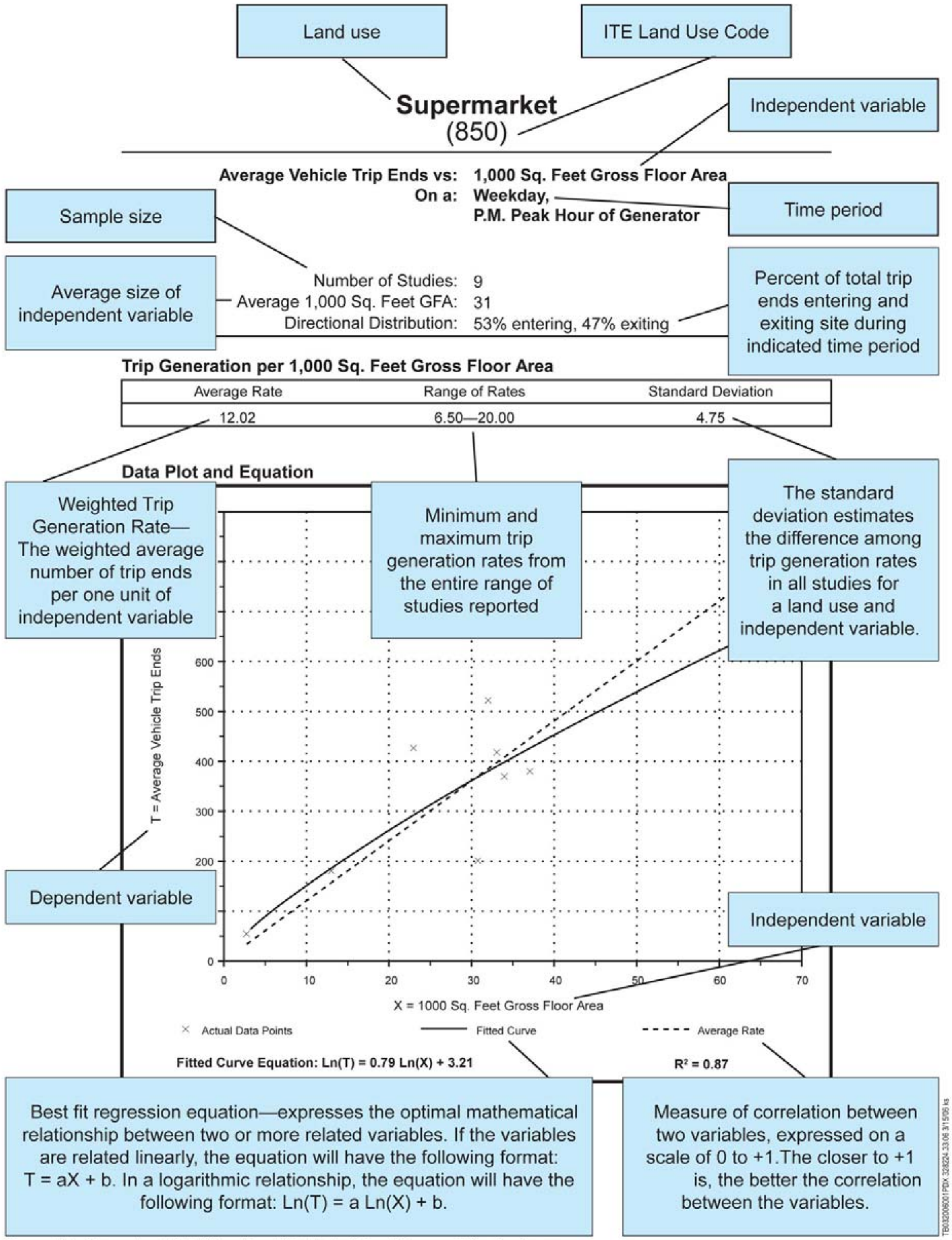
The estimated amount of traffic associated with a proposed development is a critical factor. This estimate is based on the land uses of the development. Where a travel demand model is available, the use of this model should be considered and discussed during the scoping meeting to predict trip generation.

When a travel demand model is unavailable, the most commonly accepted data source is ITE's *Trip Generation*, an informational report of estimated trip generation by land use codes. Exhibit 5 identifies the elements of a sample *Trip Generation* page. A trip generation prediction should be developed using the following sequential process:

- Land Use Code Selection: Because there are more than 150 land use categories in *Trip Generation*, the appropriate code must be identified. In many cases, there is more than one potential applicable code.
- Independent Variable Selection: There is more than one independent variable for many of the land use codes, so a decision must be made about the appropriate variable.
- Independent Variable Application: For most land use codes, an average rate or fitted curve can be used.

> *Land Use Code Selection and Application*
>
> The following should be discussed and determined during the scoping process:
>
> 1. Land use code
> 2. Independent variable
> 3. Weighted average rate or fitted curve

EXHIBIT 5. Trip Generation Sample Data Page



Source: *Trip Generation*, 7th Edition, *User's Guide*. Institute of Transportation Engineers.

The selection of the ITE land use code, independent variable, weighted average rate, or fitted curve should be determined during the scoping process with input from ODOT and other affected parties or agencies. The guidance presented in sections 3.1.1 through 3.1.3 applies to those developing trip generation prediction approaches.

3.1.1 ITE Land Use Code Selection

ITE land use code selection is the first step in predicting trip generation. To determine which land use code is appropriate for the TIS, the proposed development's mix of potential land uses should be determined. When selecting a land use code, consider the following:

- Multiple land use codes may be applicable to the proposed project.
- There may not be any one land use code that is directly applicable to the proposed project. The definitions for several of the land use codes overlap and may not specifically describe the land use for the proposed development.
- The proposed project may match the definition of a land use code. However, the characteristics of the proposed development may not match the independent variable provided in *Trip Generation*.

The method used to develop trip generation predictions can have a significant effect on the predicted number of trips. Based on the items listed above, the preparer should determine if an alternative method to *Trip Generation* is warranted to predict trip generation. Other methods are described in Section 3.1.4.

Example

The TIS for a proposed project of 603,000 square feet documented the planned land uses as "a mix of office and industrial flex-space." *Trip Generation* states, "The distinction between light industrial and manufacturing is sometimes vague. General heavy industrial (land use 120), industrial park (land use 130), and manufacturing (land use 140) are related uses." Depending on the selected land use code, the predicted trip rate varies between 460 and 838 peak hour trips (Exhibit 6). The TIS used the fitted curve equation for the industrial park land use code (130) to predict p.m. peak hour trip generation. The TIS predicted that 499 p.m. peak hour trips would be generated.

EXHIBIT 6. Trip Rate Comparison by ITE Land Use Code

ITE Land Use (Code)	Fitted Curve Equation (X=603)	Predicted p.m. Peak Hour Trip Generation
Industrial Park (130)	Trips = 0.729(X) + 59.621	499
Light Industrial (110)	Trips = 1.422(X) – 125.200	732
Manufacturing (140)	Trips = 0.771(X) – 5.154	460
Office Park (750)	Trips = 1.213(X) + 106.215	838
Business Park (770)	Ln(Trips) = 0.915Ln(X) + 0.782	765

As illustrated in Exhibit 6, with a predicted trip generation range of 384 trips between the potentially applicable land use codes, land use code selection can have a significant effect on the predicted number of trips and is a critical factor in TIS development. Where there is sufficient information to determine roughly how much of the project will fall into more than one ITE land use category, a combination of several predictors may be used.

3.1.2 Independent Variable Selection

For each land use, *Trip Generation* includes at least one independent variable that is expected to be a predictor for the variation in the number of trip ends generated by a land use. According to the ITE *Trip Generation Handbook* (a companion guide to *Trip Generation*), the preferred independent variable has the following characteristics:

- Appears to be a "cause" for the variation in trip ends generated by a land use—is most directly causal for the variation in trip ends generated by the land use.
- Can be obtained through primary measurement and not derived from secondary data (for example, the use of building square feet over the number of employees, which is derived as a function of the building size).
- Produces a rate or equation with the "best fit" of data: the standard deviation and r^2 values indicate which independent variable best fits the data. Standard deviations less than or equal to 110 percent of the weighted average rate, and r^2 values 0.75 or greater, are both indicative of good fits with the data. When two variables have similar measures of "best fit," the variable with more data points plotted (larger sample size) should be favored.
- Can be reliably forecast for applications.
- Is related to the land use type and not solely to the characteristics of site tenants.

Considering the above characteristics, the preparer should select the appropriate independent variable. An alternative method to *Trip Generation* may be warranted to predict trip generation if the independent variable(s) in *Trip Generation* are not appropriate. Chapter 4 of *Trip Generation Handbook* should be consulted for guidance. Where methods other than those laid out in *Trip Generation* are used, the method must be agreed to at the scoping stage, if possible. All data, assumptions, and analysis methods must be clearly documented in the TIS.

3.1.3 Independent Variable Application: Weighted Average Rate vs. Fitted Curve

If an independent variable in *Trip Generation* can be used, the preparer should consider the selection of the weighted average rate or the fitted curve. Most of the graphs in *Trip Generation* include two lines: the weighted average rate and the fitted curve (regression equation), a curve that best fits the data points.

> *Independent Variable Application*
>
> If an independent variable in *Trip Generation* can be used, the preparer should consider the selection of the weighted average rate or the fitted curve.

The weighted average rate assumes a linear relationship between trip ends and the independent variable. The weighted average rate expresses the average predicted number of trips to be generated by the proposed land use based on the applicable independent variable.

The regression equation for the fitted curve is provided at the bottom of the page in *Trip Generation*. The better this line fits with the points, the more accurate the equation. An r^2 value also is provided. This value is an estimate of the accuracy of the fit of data points, and is the percent variance in the number of trips explained by the variance in the independent variable.

According to *Trip Generation Handbook*, the regression equation should be used when all of the following conditions are met:

- A regression equation is provided in *Trip Generation*.

- The independent variable is within range of data.
- Either (1) the data plot has at least 20 points ***or*** (2) r^2 is greater than or equal to 0.75, the equation falls within the data cluster in the plot, and standard deviation is greater than 110 percent of the weighted average rate (calculation: standard deviation divided by weighted average rate is less than or equal to 1.1).

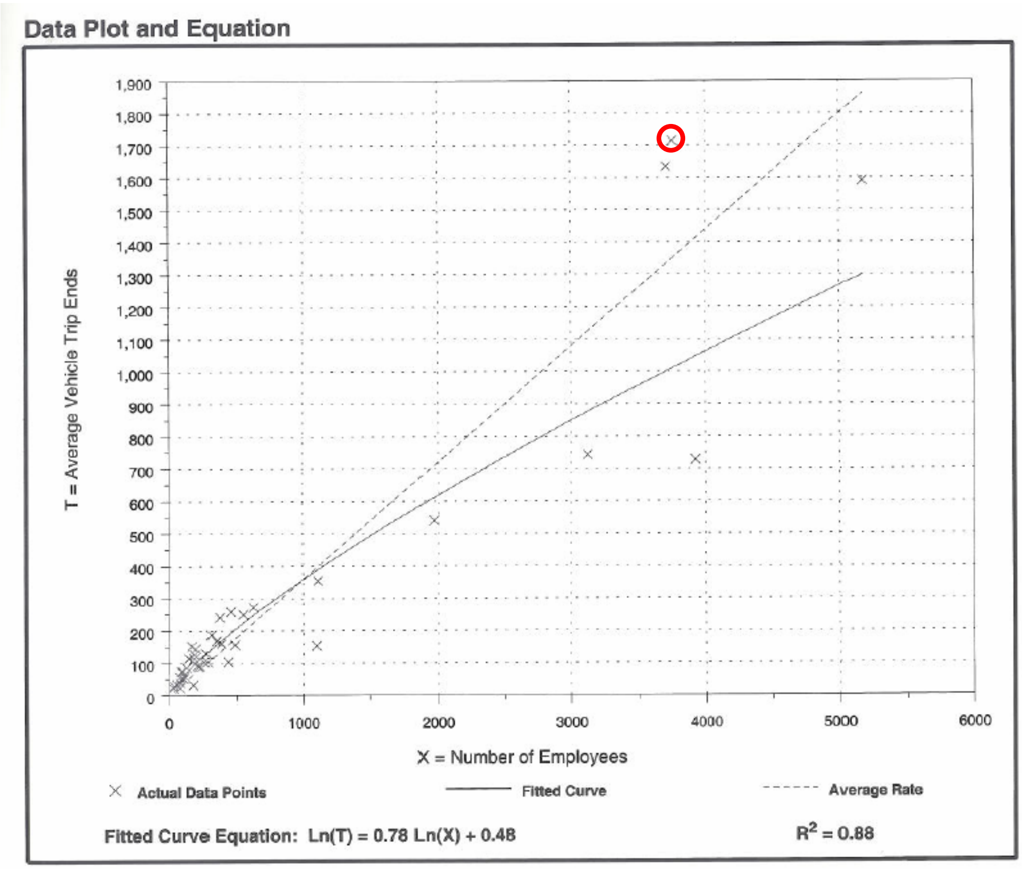
The weighted average rate should be used when all of the following conditions are met:

- At least three data points exist.
- The independent variable is within the range of the plotted data.
- The standard deviation is less than or equal to 110 percent of the weighted average rate.
- The r^2 is greater than or equal to 0.75, or no regression equation is given.
- The weighted average rate falls within the data plot cluster.

Caution should be exercised for data plots with a high r^2 value and outlier data points. Exhibit 7 illustrates a data plot from *Trip Generation*. Although there is a high r^2 value for this data plot, there are several outlier data points. These outlier data points could be the trip rate generated by the project under study.

For example, a site with 3,600 employees might have a projection of 1,000 or 1,350 trip ends, depending on the curve used. However, there was an actual site with 1,700 trip ends, shown with the circle. If the site under study was the circle, then the predicted number of trip ends would turn out to be much lower than actual using the weighted average or the fitted curve technique. Additional guidance from ODOT and other affected agencies is necessary to address this situation.

EXHIBIT 7. Trip Rate Comparison by Fitted Curve and Average Rate



Example

A TIS predicted peak hour trip generation by using the average rate for the industrial park land use (ITE code 130). This method predicted 519 peak hour trips (Exhibit 8). If the fitted curve was used rather than the average rate, the predicted trip rate would be 499. By land use and independent variable application, the predicted peak hour trip generation varies between 460 and 905.

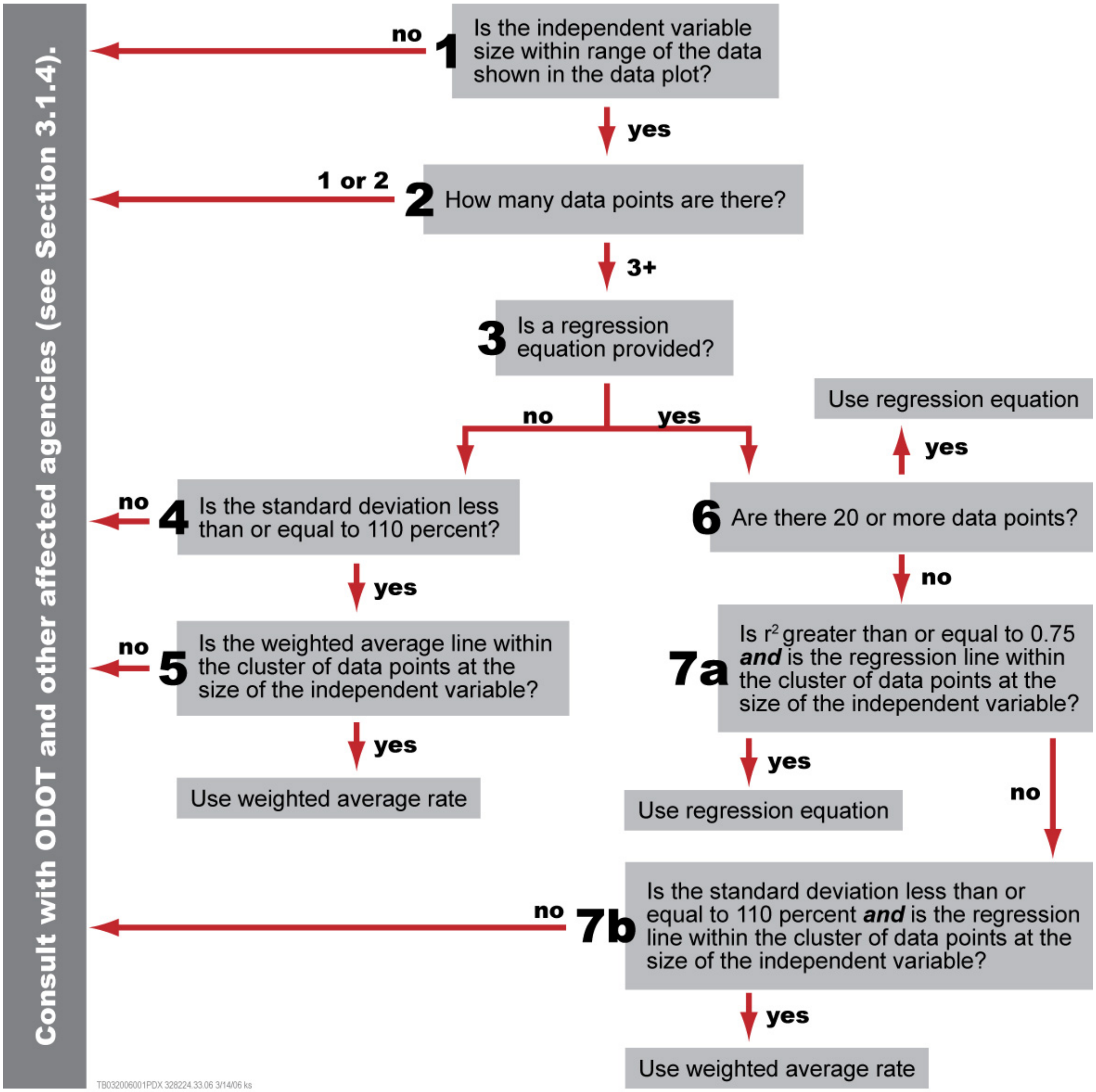
EXHIBIT 8. Trip Rate Comparison by Fitted Curve and Average Rate

ITE Land Use (Code)	Fitted Curve Equation (X = 603)	Fitted Curve Trip Generation	Average Rate	Average Rate Trip Generation
Industrial Park (130)	Trips = 0.729(X) + 59.621	499	0.86	519
Light Industrial (110)	Trips = 1.422(X) – 125.200	732	1.08	651
Manufacturing (140)	Trips = 0.771(X) – 5.154	460	0.86	519
Office Park (750)	Trips = 1.213(X) +106.215	838	1.50	905
Business Park (770)	Ln(Trips) = 0.915Ln(X) + 0.782	765	1.29	778

As illustrated in Exhibit 8, with a predicted trip generation range of 451 trips between land use and independent variable application (fitted curve versus weighted average rate), land use code selection and independent variable application can have a significant effect on the predicted number of trips and be a critical factor in TISs.

Exhibit 9 summarizes the process for independent variable application.

EXHIBIT 9. Independent Variable Application Summary



3.1.4 Use of Other Data

TIS preparers and reviewers may conclude that ITE's *Trip Generation* is not adequate to predict trip generation. This may occur if:

> *Use of Other Data for Predicting Trip Generation*
>
> ITE's *Trip Generation* may not be adequate to predict trip generation. TIS preparers and reviewers should follow the guidelines in this section to determine the applicability of *Trip Generation* for predicting trip generation.

- The study site or land use is not compatible with any ITE land use code definitions.
- Characteristics of the proposed project do not match the independent variable.
- Less than three data points are within the range of data provided in *Trip Generation*.
- The independent variable does not fall within the range of data.
- Neither the weighted average rate line nor fitted curve line fall within the data cluster at the size of the proposed development.
- The proposed development project will be served by significant public transportation or where there is an extensive transportation demand management program.

If any of the above scenarios is applicable to the TIS in question, other data should be gathered to predict trip generation; refer to Chapter 4 of *Trip Generation Handbook* for guidance. The use of other data should be approved by ODOT and other affected agencies. Other data may include one or a combination of the following sources:

- **Local Data:** ODOT or the local jurisdiction may have information about the trip generation characteristics for certain land uses.
- **Data from Similar Sites:** If no other information sources are available or believed to be appropriate for the project's proposed land use(s), data may be collected from existing sites in the local area. If no sites are available for data collection, sites elsewhere in Oregon may be used, and outside Oregon as a last resort.
- **Estimates for Site Specific Characteristics:** Trip generation may be estimated by evaluating the operating characteristics of the proposed project. To do this, information such as the number of employees and visitors must be known and the time of day expected to enter and leave the site.
- **Other Site Studies:** Other site studies (for example, previous traffic studies) that have been conducted for various reasons may be applicable for the purpose of estimating trip generation for the proposed project.

3.1.5 Trip Type

Consideration of trip type is important for assessing the impacts of local versus regional trips. The TIS should consider trip type to predict trip generation because trip generation is affected by the type of trip. Development projects geared to a regional customer base would be expected to generate more trips than a project geared to a local or neighborhood customer base. Regional development projects generally generate more trips, which could adversely affect the transportation system and require additional mitigation. To evaluate trip type, the following characteristics of the proposed project should be considered:

- Distance to similar land uses
- Size of the proposed project relative to the area
- Variety of land uses or business proposed
- Uniqueness of the proposed land use
- Anecdotal evidence and professional judgment of similar land use trip generation

3.2 Pass-By Trip Reduction Assumptions

Not all of the trips generated at access driveways represent new trips added to the adjacent street network. The trips made by traffic already using the street network and entering site access driveways should not be considered new trips generated by the development. These pass-by trips are made as intermediate stops on the way from an origin to a primary trip destination without a route diversion. For example, drivers may stop at the store on the way home from work, and do so without changing their normal route.

Since trip generation rates and equations are based on driveway volumes, an appropriate pass-by factor should be considered for many commercial land uses. Used correctly, pass-by trip assumptions reduce the predicted trip generation; however, depending on the assumptions used, predicted pass-by trips can vary significantly, so these adjustments must be applied carefully.

> *Pass-By Trip Reduction Assumptions*
>
> Caution should be exercised to ensure aspects of pass-by trip characteristics are handled appropriately. Pass-by trip reductions should be discussed with ODOT or the local jurisdiction. Reductions must be supported by adequate documentation in the TIS.

Pass-by trips are closely linked to the size of the development and the volume of traffic on the adjacent street that can deliver the pass-by trip. The precise correlation of pass-by trip percentages by land use is difficult to determine because of the limited amount of pass-by data available and the variability of site characteristics. Therefore, caution should be exercised to ensure aspects of pass-by trip characteristics are based on appropriate assumptions.

Reductions for pass-by traffic should be discussed with ODOT or the local jurisdiction when defining the scope of the TIS. The pass-by factors applied in the TIS must be supported by adequate documentation. Three options are available for developing pass-by trip generation percentages:

- Using the guidance and data in *Trip Generation Handbook*
- Conducting a local pass-by trip survey
- Developing a conservative estimate based on anecdotal evidence and professional experience

Sections 3.2.1 through 3.2.3 describe the three options. Section 3.2.4 describes the application of a 10 percent reduction in pass-by trips, as described in the TPR.

3.2.1 Using Guidance and Data in *Trip Generation Handbook*

Trip Generation Handbook contains average pass-by trip percentages by land use. The geographic distribution of the sites is limited, and little or no data have been collected for most land uses. Regression equations are only provided for ITE Land Use Code 820 (Shopping Center), but the r^2 values for all of the data plots are less than 0.50. Therefore, the regression equations for code 820 in *Trip Generation Handbook* should not be used to develop pass-by trip rate percentages—only the average rates should be considered.

The range of average pass-by trip percentages in *Trip Generation Handbook* can be considered a starting point if both of the following criteria are met:

- The sample consists of three or more data points.
- The independent variable unit of measurement is within the range of the data points provided.

The average pass-by trip percentages for several commercial land uses are summarized in Exhibit 10. The highlighted rows are land use codes with a sample size of three or more. The unhighlighted rows are provided for reference, but because the sample size is less than three, should not be used to develop pass-by trip percentages.

EXHIBIT 10. ITE Pass-By Trip Percentages by Land Use

ITE Code	Land Use	Average	Sample Size	Range
815	Free-Standing Discount Store	17%	22	1% to 39%
816	Hardware/Paint Store	26%	2	21% to 30%
820	Shopping Center	34%	100	8% to 89%
831	Quality Restaurant	44%	4	26% to 62%
832	High-Turnover (Sit-Down) Restaurant	43%	12	23% to 63%
834	Fast Food Restaurant with Drive-Through	50%	18	25% to 71%
843	Automobile Parts Sales	43%	1	---
844	Gasoline/Service Station	42%	9	20% to 62%
845	Gasoline/Service Station with Market	56%	9	46% to 72%
848	Tire Store	28%	3	23% to 36%
850	Supermarket	36%	12	19% to 57%
851	Convenience Market (24 Hours)	61%	19	28% to 87%
853	Convenience Store with Gasoline Pumps	66%	15	48% to 87%
854	Discount Supermarket	23%	10	18% to 35%
862	Home Improvement Superstore	48%	3	44% to 54%
863	Electronics Superstore	40%	1	---
880	Pharmacy/Drugstore	53%	6	30% to 65%
881	Pharmacy/Drugstore with Drive-Through	49%	3	41% to 58%
890	Furniture Store	53%	3	42% to 69%
912	Drive-in Bank	47%	6	15% to 64%

The scoping process should start with the average percentage, and adjustments should be made as necessary. Adjustments should acknowledge the significant range in pass-by trip percentage for many of the land use codes (provided in Exhibit 10). An adjustment to the average pass-by trip percentage is recommended and should be considered based on the following criteria:

- Size of the proposed development—larger developments will likely generate more pass-by trips.
- Volume of traffic on adjacent streets—developments adjacent to streets with high traffic volumes will likely generate more pass-by trips.
- Location of the proposed development relative to the street—site location, site orientation, parking, and signage relative to the street can affect pass-by trip rates.
- Location of existing and proposed points of access and intersecting roadways—the ease of use to access the site can affect the pass-by trips.
- Roadway network patterns—these can affect site access and the pass-by trip rate. For example, higher traffic distribution in one direction could affect service-oriented land uses, such as a coffee shop.
- Characteristics of passing traffic—passing traffic could positively or negatively affect pass-by trip rates. For example, the presence of high volumes of regional or local could positively or negatively affect pass-by trip rates.
- Specific types and distribution of businesses proposed for the site being analyzed—certain land uses will generate higher pass-by trips than other land uses.
- Nearby developments and land uses, as approved or allowed by current zoning—similar land uses, developments, and future potential land uses can positively or negatively affect pass-by trip rates.
- Population distribution—distance to the site and population distribution can affect pass-by trip rates.

Example

Exhibit 11 illustrates the impact of TIS pass-by trip reduction assumptions on trip generation for three proposed projects. The “Base (No Pass-By)” column lists the number of new trips predicted in the TIS without any pass-by trip reduction. The “Base with ITE” column lists the number of new trips generated using the recommended rates in *Trip Generation Handbook*. The “TIS” column lists the number of new trips generated using the pass-by trip reduction assumptions in the TIS study. The three TISs used a more conservative reduction than the ITE recommended reduction percentages (21 percent versus 30 percent).

EXHIBIT 11. Pass-By Trip Rate Assumptions

TIS No.	***Base (No Pass-By)***	***With Pass-By***	
		Base with ITE	***TIS***
TIS 1	705	388	675
TIS 2	2,685	1,743	1,651
TIS 3	546	360	436

As illustrated, applying a pass-by trip rate reduction significantly reduces the predicted number of new trips generated, and the pass-by trip rate has a significant effect on the predicted total number of new trips generated. Correctly applying pass-by rate reductions will improve accuracy.

3.2.2 Conducting a Local Pass-By Trip Survey

A trip count survey is an alternative method for developing a pass-by trip percentage. If relevant local data are to be used, surveys should be conducted at similar developments, during the same analysis periods as the TIS, and for streets with similar adjacent street volumes. When conducting a survey, the following factors should be considered:

- **Site Selection**: Sites should be chosen that have land uses and adjacent street volumes similar to the proposed development.
- **Sample Size:** *Trip Generation Handbook* includes a minimum number of sample sizes for pass-by trip count surveys by the maximum error in the mean (Exhibit 12). Caution in using this guidance is recommended because the data require an estimate of the percent of pass-by trips. This can be estimated by using the data in Exhibit 10. An alternative sample size may be developed in the scoping process.

EXHIBIT 12. Minimum Sample Size for Pass-By Trip Surveys (95 Percent Confidence Level)

Maximum Error in Mean	Estimated Percent Pass-By Trips						
	20%	30%	40%	50%	60%	70%	Unknown
10%	61	81	92	96	92	81	96
15%	27	36	41	43	41	36	43

- **Survey Location on Site:** Surveys should be conducted on all sides of the site proposed to have direct access onto the road system.
- **Analysis Period:** The same time period that will be studied in the TIS should be used.

3.2.3 Developing a Conservative Estimate

If a pass-by percentage using *Trip Generation Handbook* data or a local survey is not developed, then a conservative pass-by percentage should be determined based on anecdotal evidence and professional experience. This percentage should be discussed in the scoping meeting and approved by ODOT. The methodology used to develop this percentage should be documented in the TIS. In developing a pass-by trip percentage, the following should be considered:

- Roadway network patterns
- Existing traffic patterns
- Population distribution
- Characteristics of passing traffic
- Specific businesses proposed for development
- Nearby developments and land uses

3.2.4 Pass-By Trip Application

The TPR (OAR 660-012-0060(6)) allows for a 10 percent reduction in vehicle trips for uses located in “mixed-use, pedestrian friendly centers, and neighborhoods.” The 10 percent reduction is not allowed if the proposed land uses will rely solely on automobile trips, such as gas stations, car washes, storage facilities, and motels. If this vehicle trip reduction may apply to the proposed development, the preparer should review OAR 660-012-0060(6) to determine the applicability of this rule to the proposed project prior to discussing with ODOT or the local jurisdiction. The application of this trip reduction would be the year of project opening. This reduction may not be applied to existing traffic conditions.

A reduction for pass-by trips, as discussed earlier in this section, is not allowed for developments that use the 10 percent reduction in the TPR. The TIS may only apply the 10 percent reduction for "mixed-use, pedestrian friendly centers, and neighborhoods," as defined in the TPR, ***or*** apply a pass-by trip reduction as explained earlier in this section. The applicability of these pass-by reductions should be discussed in the scoping meeting with ODOT or the local jurisdiction.

3.3 Seasonal Variations

Variations in traffic use and seasonal effects should be taken into account when compiling traffic volumes from manual counts. Seasonal factors developed from permanent counters called automatic traffic recorders (ATRs), ATR characteristic tables, or seasonal trend tables should be applied to manual traffic counts to more accurately reflect traffic conditions.

3.3.1 Baseline Traffic Counts

Manual traffic counts used for TIS analysis should represent typical activity for the site and the study area. Steps should be taken to avoid collecting manual traffic counts during special events, holidays, construction periods, bad weather, or any other times when conditions at the site or in its vicinity may affect average traffic conditions. Additional guidance on manual traffic counts is located in the TIS section of the DRG.

3.3.2 Design Hour Volumes and Seasonal Factors

Manual traffic counts cannot be used for design or operational analysis "as is." These counts should be adjusted to account for variations in traffic volumes. ODOT's road network ranges from multilane freeways to two-lane rural highways. Travel behavior differs among various types of road facilities and truck volume patterns can vary considerably from car volume patterns.

Design Hour Volumes and Seasonal Factors

The peak hour from a manual count is converted to the 30th highest hourly volume by applying a seasonal factor. Seasonal factors are necessary to reflect the different seasonal travel patterns around the state. ODOT has developed guidance for applying a seasonal factor to manual traffic counts.

To account for these variations, design hour volumes (DHV) are used. To apply DHVs, the peak hour from a manual count is converted to the 30th highest hourly volume by applying a seasonal factor. Seasonal factors are necessary to reflect the different seasonal travel patterns around the state. Travel in urban areas that experience heavy recreational movements follow different travel patterns than those in areas without such movements. Empirical data suggest that the 30th highest hour in a large urban area usually occurs on a weekday in the peak month of the year and typically ranges from 9 to 12 percent of the average annual daily traffic (AADT). On a recreational route, the 30th highest hour typically occurs on a summer weekend and ranges from 11 to 25 percent of the AADT.

ODOT's Transportation Planning Analysis Unit (TPAU) has developed guidelines for applying a seasonal factor to manual traffic counts. Seasonal changes in total volume have been tracked for many years with ATRs, which are used to determine the AADT. This information is used to develop seasonal factors that apply to manual counts using one of the following three methods, as summarized below: onsite ATR, ATR characteristic table, or seasonal trend table. The methods should be applied sequentially, starting with the first method, until the appropriate method to be used is determined.

Onsite ATR Method

This method is used when there are no major intersections between a permanent ATR station and the project area, and the ATR is close enough that the traffic characteristics are comparable. This method is described in the ODOT *Developing Design Hour Volumes* training manual.

ATR Characteristic Table Method

This method is used to predict travel patterns based on general characteristics of ATR location and data. It is used when there is no ATR in the project area. The characteristic table is an electronic file that provides information for ATRs with similar characteristics for several categories. Characteristic categories are as follows:

- Seasonal traffic trends (11 different types)
- Area type (urbanized, urban fringe, small urban, small urban fringe, rural populated, or rural)
- Number of lanes
- Weekly traffic trends (weekday, weekend, or steady)

Characteristic ATRs should be within 10 percent of the AADT for the project area to be comparable. This method is described in the ODOT *Developing Design Hour Volumes* training manual.

Seasonal Trend Table Method

This method is used when there is no ATR close by and when the characteristic tables do not apply to the project area. The table contains factors developed by averaging all current monthly ATR factors for each of the 11 seasonal trend groupings:

- Recreation summer and winter
- Recreation winter
- Recreation summer
- Interstate
- Interstate urbanized
- Coastal destination
- Coastal destination route
- Commuter
- Summer
- Summer less than 2,500 average daily traffic (ADT)
- Agriculture

The guide suggests that averaging multiple seasonal trends may yield more appropriate factors than using a single trend. The seasonal trends that can be averaged and the seasonal trend method are located in the ODOT *Developing Design Hour Volumes* training manual.

3.4 Evaluation of Other Modes

Most TISs focus on automobile traffic only. The evaluation of other modes, including bicycle, pedestrian, transit, and trucks are important and should be evaluated in TISs where appropriate. This section gives guidance for bicycle, pedestrian, transit, and truck analysis.

3.4.1 Bicycle and Pedestrian Analysis

The TIS should document existing and planned pedestrian and bicycle facilities in the study area. The appropriate level of pedestrian and bicycle impact analysis in the TIS should be determined in the scoping meeting. The following questions should be considered:

- Are pedestrian and bicycle needs safely accommodated?
- Will the proposed development maintain or improve safety for pedestrians and bicyclists?
- Will the proposed development's access points increase potential conflicts with pedestrians and bicycles?
- Will site-generated traffic adversely affect pedestrians and bicycles?
- Will site-generated traffic adversely affect existing and planned pedestrian and bicycle facilities?
- How will proposed mitigation affect pedestrians and bicyclists?

At a minimum, the TIS should indicate that the proposed project will maintain or improve existing conditions for pedestrians and bicyclists. The TIS should identify any existing and planned bicycle or pedestrian facilities that are in the project area and identify facilities that would be modified or adversely affected by the proposed development.

An adverse pedestrian or bicycle effect would occur if the project were to result in unsafe conditions for pedestrians, including unsafe increases in pedestrian and bicycle or bicycle and motor vehicle conflicts. The TIS should document all analysis of bicycle and pedestrian needs, including adverse effect and proposed mitigation. Consultation with ODOT and other relevant parties during TIS preparation will be useful in assessing adverse effect. Other relevant parties could include the local school district, local bicycle or pedestrian coordinator, local transportation planner, or bicycle and pedestrian committees.

> *Bicycle and Pedestrian Analysis*
>
> Bicycle and pedestrian TIS analysis should:
>
> 1. Identify existing and planned bicycle and pedestrian facilities.
> 2. Maintain or improve existing conditions for bicyclists and pedestrians.
> 3. Identify facilities that will be modified or adversely affected by the proposed development.

To determine adverse effects on pedestrian and bicycle facilities, the following criteria should be evaluated:

- Road width
- Road design
- Acceptable grade
- Alignment where sidewalk crosses driveway
- Driveway widths
- Connection of street sidewalk and parking areas to building entrances
- Connections between adjacent developments/uses
- Access to adjacent and nearby pedestrian and bicycle facilities
- Traffic speed
- Traffic control operation and timing favorable to safe pedestrian crossing
- Whether right-turns-on-red should be prohibited to protect bikes and pedestrians
- Other items: sight lines, lighting, pavement condition, signing, curb extensions and pedestrian refuge medians

3.4.2 Transit Analysis

Recommended best practices for transit analysis are not provided in this document. In general, there is no reliable way of assessing trip reduction based on the presence of fixed transit service.

As general guidance, the mode split of the proposed development should be considered. *Trip Generation* states, “Data were primarily collected at suburban locations having little or no transit service, nearby pedestrian amenities, or travel demand management (TDM) programs.” Therefore, if a proposed project will be located in an area with frequent and reliable fixed transit service, the TIS should use an alternative or supplemental source to *Trip Generation* when predicting the proposed development’s trip generation and trip reductions for the presence of transit service.

Transit Analysis

Use the following general guidance for transit analysis in TISs:

1. *Site Access by Only Private Automobile* (no fixed, well-established transit service): Consult *Trip Generation*.
2. *Well-Established Transit Service at the Site* (and the proposed development is not automobile oriented): Use an alternative or supplemental source to *Trip Generation*.

3.4.3 Truck Trip Generation

Because trucks can affect safety, queuing, circulation, and access, the impacts of trucks should be evaluated in TISs. Truck trip generation analysis is often only evaluated for industrial land uses, but should be considered for all land uses. The TIS preparer should consult the Highway Capacity Manual to identify potential truck effects. At a minimum, the existing percentage of truck trips in the project area should be determined and cited in the TIS.

To estimate truck trip generation and the effect of trucks in the project study area, the following questions should be considered in the TIS:

- What is the existing percentage of trucks in the study area?
- Are there any existing truck safety issues in the study area? Will the proposed development sustain or improve these conditions?
- How will the specific land uses and businesses for the proposed development affect truck trip generation?
- When will the peak hour of truck trip generation occur?
- How will trucks be routed and circulated onsite and offsite?

Truck Trip Generation

Truck trip generation analysis should be evaluated for all proposed land uses. Recommended guidance follows:

1. At a minimum, the existing percentage of truck trips in the project area should be cited in the TIS.
2. More complex should also assess truck safety, and operations.
3. The most complex projects should assess truck distribution.

- How will queuing at driveways and intersections be affected by truck trip generation?
- Will truck trip generation adversely impact site access?
- Will there be sufficient truck turning radius?
- Will a separate truck access point be needed to minimize conflicts between trucks and other vehicles?
- Will deceleration lanes at the site access point be needed to maintain safety?
- How will trucks affect access, circulation, and operations at the proposed development's access points? For the entire study area?

In addition to addressing the above questions, the TIS should define what constitutes a truck and define a truck trip.

Larger developments may generate significant and regular truck trips, which will typically be directly related to land uses and the characteristics of the existing street system. The proposed development's potential truck trip generation should be discussed in the scoping meeting. If evaluated, the TIS should determine the following:

- Development's truck trip generation
- Development's peak hour of truck trip generation
- Accommodations necessary to support the predicted truck trip generation

Reliable truck trip generation data sources are limited. *Trip Generation* and *Trip Generation Handbook* provide information on truck trip generation.

The data plots in *Trip Generation* include truck trip generation estimates for all land uses, although the percentage of trucks in the data is not cited. The independent variable that provides the best estimate for all vehicle trip generation may not be the best for estimating truck trip generation. For example, the independent variables for industrial use may include acres, employees, and square footage, but these are not reliable variables for estimating truck trip generation. Therefore, *Trip Generation* is not recommended as a single source for predicting truck trip generation.

> *Truck Trip Generation Recommendations*
>
> 1. *Trip Generation* and *Trip Generation Handbook* are not recommended sources for predicting truck trip generation.
> 2. Manual techniques should be used to develop conservative truck trip generation rates.
> 3. The methodology should be approved by ODOT and/or the local jurisdiction.

Trip Generation Handbook provides truck trip generation rate data, but for only a few land uses. In Appendix A of *Trip Generation Handbook*, conclusions from truck trip generation studies are summarized. Appendix A provides truck trip generation information, but states that the data do not comprise recommended practices, procedures, or guidelines because existing data sources are old, there are general categories of land use that do not match ITE land use codes, and there is broad variation in observed truck trip rates.

Since *Trip Generation* and *Trip Generation Handbook* are not recommended as single sources to predict truck trip generation, manual techniques for developing conservative truck trip generation rates should be applied. Estimated rates should be approved by ODOT, and the methodology to develop rates should be documented in the TIS.

3.5 Analysis Software

As summarized in the TIS section of the DRG, application of traffic analysis software should follow an ODOT-approved analysis methodology. This methodology should be discussed with ODOT in the scoping meeting and their approval obtained.

> *Analysis Software*
>
> ODOT has not developed specific requirements for analysis tools and software. The Highway Capacity Manual and Synchro may be appropriate for many studies, but for larger TISs, the use of simulation tools should be considered.

There are no specific requirements for analysis tools and software. The use of analytical models such as Highway Capacity Manual methodologies or Synchro may be appropriate for many studies. On larger TISs, simulation tools may be needed to fully evaluate impacts.

ODOT's traffic analysis guidelines include general guidance for appropriate software use. As a supplemental source, FHWA's Traffic Analysis Tools provides guidance, recommendations, and examples on the selection and use of traffic analysis tools. "Traffic analysis tools" is a collective term used to describe a variety of software-based analytical procedures and methodologies that support different aspects of traffic and transportation analysis. Traffic analysis tools include methodologies such as sketch-planning, travel demand modeling, traffic signal optimization, and traffic simulation. The Traffic Analysis Toolbox currently contains three volumes:

- *Volume I: Traffic Analysis Tools Primer* presents a high-level overview of the different types of traffic analysis tools and their role in transportation analyses.
- *Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools* identifies key criteria and circumstances to consider when selecting the most appropriate type of traffic analysis tool for the analysis at hand.
- *Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software* provides a recommended process for using traffic microsimulation software in traffic analyses.

3.6 Regional Demand Model versus Growth Rates

Predicting future traffic is difficult, especially in high growth areas. A key input for TIS analysis is the expected future background traffic, without the proposed project. The method or combination of methods used in the TIS to project background traffic should be determined during the scoping meeting.

The TIS section of the DRG and ODOT Transportation System Plan (TSP) guidelines describe three common methods for predicting future traffic, as summarized below:

Common Methods for Projecting Background Traffic

1. *Regional Travel Demand Models:* The best tool for forecasting over long timeframes.
2. *Cumulative Analysis:* Most suitable for smaller urban areas or a portion of a large urban area and for short periods of time.
3. *Growth Trends:* Most suitable for rural areas with stable growth rates.

- **Regional Travel Demand Models***:* These are the best tools for forecasting over long timeframes. Because models are typically developed in conjunction with land use plans, this method can provide a reliable forecast for urban areas. MPO models are available for the areas of the state located within a Metropolitan Planning Organization (MPO) (Portland Metro, Eugene-Springfield, Salem-Keizer, Medford, Bend, and Corvallis areas). TPAU and other jurisdictions may have a model that could be used in other areas. The TPAU website and the local jurisdiction should be contacted to determine the availability of a model. ODOT prefers models to be used if available for the future horizon year analysis.
- **Cumulative Analysis:** This method is most suitable for smaller urban areas, or a portion of a large urban area (if a travel demand model is not available), where there is useful local information about future projects. This method projects future traffic volume by adding the estimated traffic generated by all approved, but not yet opened, developments in the study area. Long-term forecasts should also include the effects of future developments on undeveloped lands. This method requires a listing in the TIS of the anticipated developments and corresponding trip generation rates. This information should be provided by ODOT or the local jurisdiction during or after the scoping meeting. ODOT approval is recommended for the estimated future traffic volumes anticipated from future planned or zoned development, and the method used by the local jurisdiction to determine these volumes.
- **Growth Trends:** Most suitable for rural areas with stable growth rates, this methodology involves estimating growth rates based on regression analysis from historical data. The approach for using historical growth trend data should be discussed during the scoping

meeting. Growth rates or historical data should be obtained by ODOT or the local jurisdiction. Approval from ODOT of the growth trend to be used for future years is recommended.

3.7 Future Year Analysis

Both short-term and long-term evaluations of future traffic impacts may be appropriate. Short-term analysis (for example, 0 to 5 years after the proposed project is built) is used to investigate the immediate impact of the proposed development on the existing roadway network. The intent of a long-term planning assessment is to evaluate implications of the proposed project on long-term cumulative impacts of development, and in relation to planned transportation system improvements.

The DRG contains a table of suggested timelines for future year analysis that was developed with help from the Region Access Management Engineers. During the scoping meeting, the planning period for the analysis should be discussed and an agreement between the developer, ODOT, and the local jurisdiction should be reached. In developing a planning horizon year, the following questions should be considered:

- How many trips are predicted?
- How many phases are planned?
- What is the analysis year for the local TSP?
- Does the local TSP plan beyond fifteen (15) years? If not, then 15 years is ODOT's preferred minimum analysis period for large or complex projects.
- What is the capacity of affected state facilities? Is capacity currently exceeded? Is capacity expected to be exceeded before the end of the local TSP plan period?

At a minimum, the TIS should address existing conditions (the current year) plus the anticipated opening year of the proposed development. If the development is to be implemented in multiple phases, an analysis for the anticipated time of buildout of each phase is suggested. Depending on the complexity of the project, additional horizon years, ranging from 5 to 20 years, may be deemed appropriate during scoping. A 15-year analysis is required by the OHP for proposals that include comprehensive plan or zoning amendments. When evaluating long-range impacts, traffic projections may be available from the local jurisdiction, the local jurisdiction's TSP, or its MPO.

Future Year Analysis

At a minimum, the TIS should address:

1. Existing conditions
2. Opening year
3. Future phases
4. Additional years as requested by ODOT and/or the local jurisdiction

Examples of future year analysis timelines are provided in Exhibits 13 and 14. Exhibit 13 is adapted from Table 3.3.1 of the DRG. This timeline is based on peak hour trip generation and plan amendment or zoning changes. Exhibit 14 is an example of an alternative methodology for developing planning horizon years based on development size and peak hour trip generation.

EXHIBIT 13. Future Year Analysis Timelines (Adapted from Table 3.3.1 in the DRG)

Proposed Development Daily Trip Generation	Single-Phase Development Horizon Years	Multiphase Development Horizon Years
Up to 99 peak hour trips	Year of opening	Year of each phase opening
100 to 299 peak hour trips	Year of opening and at 5 years	Year of each phase opening and 5 years beyond buildout
300 to 499 peak hour trips	Year of opening and 10 years	Year of each phase opening and 10 years beyond buildout
500 peak hour trips or more	Year of opening and year of planning horizon for the TSP or 15 years, whichever is greater	Year of each phase opening and year of planning horizon for the TSP or 15 years, whichever is greater
Plan amendments and zone changes	Year of planning horizon for TSP or 15 years, whichever is greater	Year of planning horizon for TSP or 15 years, whichever is greater

EXHIBIT 14. Future Year Analysis Timeline—Arizona Department of Transportation

Analysis Category	Development Characteristic	Study Horizons	Minimum Study Area on the State Highway[1]
I	Small development	Opening year	Site access driveways, and adjacent signalized intersections and unsignalized intersections
IIa	Moderate, single phase 500-1,000 peak hour trips	Opening year and 5 years after opening	Site access driveways, all state highways, signalized intersections, and unsignalized intersections within 0.25 mile
IIb	Large, single phase >1,000 peak hour trips	Opening year, 5 years after opening, 10 years after opening	Site access driveways, all state highways, signalized intersections, and major unsignalized intersections within 1 mile
IIc	Moderate or large, multiphase	Opening year of each phase, 5 years after opening, 15 years after opening	Site access driveways, all state highways, signalized intersections, and major unsignalized street intersections within 1 mile

[1] These minimum study area distances are examples. TIS scoping should determine the appropriate distance for analysis, which will depend on many factors, including the proposed project land use, the transportation network in the project vicinity, trip distribution, trip assignment, and trip generation.

3.8 Safety

Safety is an important consideration for transportation planning and design, but elements of safety analysis are often ignored in TISs. Safety evaluations of roadways are needed to determine the expected safety performance and to identify modifications that will maintain or improve existing safety conditions before the opening day of any new development project.

The appropriate safety analyses for each TIS should be determined in the scoping meeting. Developments that should be anticipated to result in significant safety impacts are those that will generate significant vehicular traffic and increase its interaction with pedestrians and bicyclists in the site vicinity. In addition, developments with several designated access locations have the potential for broader safety impacts and therefore should require more detailed onsite and offsite safety analyses.

Safety analyses should not be confined to the development site; safety analyses should be carried out for the entire study area. The following questions should be considered to evaluate safety in the study area:

- Is the number of access points the minimum necessary to serve the project?
- Are proposed access points a sufficient distance from intersections and other approaches to minimize conflicts?
- Do proposed access points meet the access spacing standards in Division 51?
- Should left turns be restricted by signs, channelized driveways, or a raised median?
- Have opportunities for other methods of minimizing points of access (shared driveways, frontage roads, rear service driveways, or access from a side street) been utilized to the extent practicable?
- Is sight distance adequate for all movements between the proposed approach and off-site facilities?
- Is the design sensitive to pedestrian and bicyclist needs?
- Will the driveway and parking area adequately accommodate trucks?

A field study is recommended to identify safety characteristics that contribute to existing safety conflicts, and to determine which alternative treatment(s) should be implemented to correct any existing and predicted safety problems. The TIS should take proactive steps to analyze specific safety elements, including:

- **Crash History:** Crash records obtained from ODOT or other jurisdictional agencies (typically the most recent 3 to 5 years, to be determined during scoping) should be analyzed to determine the presence of crash patterns, and to determine what measures will be taken to correct the safety problem. The proposed project should not aggravate existing safety conditions.

> *Safety Analysis in TISs*
>
> The TIS should take proactive steps to analyze specific safety elements. A field study is recommended to identify safety characteristics that contribute to existing safety conflicts and to address any existing safety issues.

- **Conflict Analysis:** Where crash data are not available or the data are insufficient for analysis, an analysis should be performed to determine the critical movement for each intersection and conflict points based on predicted traffic volumes, conflicts with cross-traffic, conflicts with other modes, and left-turn maneuvers.
- **Intersection Sight Distance:** Each intersection and access point should be evaluated for adequate sight distance.

- **Safe Stopping Distance:** Each intersection and access point should be evaluated for safe stopping distance.
- **Vehicle–Pedestrian Conflicts:** Pedestrian needs and vehicle–pedestrian conflicts should be evaluated.
- **Vehicle–Bicyclist Conflicts:** Bicyclist needs and vehicle–bicyclist conflicts should be evaluated.
- **Access Conflicts:** Access points and throat depths should be evaluated for safety issues. Poorly designed or poorly located access points and throat depths adversely affect safety and reduce the capacity of the roadway.
- **Signal Warrants:** Each intersection and access point should be evaluated for signal warrants.
- **Auxiliary Lanes:** To maintain capacity and improve safety, auxiliary lanes should be considered.
- **Queuing and Storage:** At each intersection and access point, queuing and storage depths should be evaluated. Inadequate storage and queue depths adversely affect safety and reduce the capacity of the roadway.
- **Horizontal and Vertical Geometry:** Geometric deficiencies should be identified. The potential for increased accidents should be evaluated in the context of projected traffic volume and roadway characteristics.
- **Truck Movements:** Existing truck traffic and movements and the predicted truck trip generation and movements should be evaluated for safety issues.

4 Summary

This document supplements the traffic impact studies section of the DRG by providing guidelines on key topics. The purpose of this document is to:

- Ensure that critical transportation and development issues are considered in the scoping process and addressed in TISs rather than simply estimating future travel demand and presuming the system can absorb the incremental consumption of capacity
- Provide a recommended best practice for preparers and reviewers, particularly to improve the accuracy of trip generation prediction of proposed development
- Promote increased understanding of key issues to consider in TISs within the context of operating and maintaining a safe transportation system

This document is intended to inform the scoping process, specifically to aid in the decisions on assumptions, and to guide TIS preparers and reviewers by providing recommended best practices for the following topics:

- Land Use Code Selection and Application
- Pass-By Trip Reduction Assumptions
- Seasonal Variations
- Evaluation of Other Modes
- Analysis Software
- Regional Demand Model versus Growth Rates
- Future Year Analysis
- Safety

The recommended best practices in this document should be considered in the scoping process, the development of TISs, and the review of TISs. Recommended guidelines assure consistent and proper best practices are applied to (1) land use actions proposed on or adjacent to ODOT facilities, and (2) land use actions that will have a significant effect on ODOT facilities.

APPENDIX A

Case Study Summary Sheets

Barger Crossing Shopping Center, Eugene

Project Information

Project Type:	Retail Shopping Center
ODOT Region:	1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐
Location:	2155 Cubit Street, Eugene
Number of Driveways:	5
Size of Development:	15 acres; 137,360 square feet
Year of Study:	1996
Consulting Engineer:	JRH Transportation Engineering (Eugene)
Facilities Analyzed:	Four intersections in the site vicinity: • Barger Drive/Beltline Highway northbound ramps • Barger Drive/Beltline Highway southbound ramps • Echo Hollow Street and Cubit Street/Barger Drive • Cubit Street/Wagner Street

Summary of TIS

The TIS analyzed the development of 137,360 square feet of retail space. The study concluded the development could be built while maintaining acceptable levels of service in the site vicinity after the geometric improvements to the Beltline Highway/Barger Drive interchange and the Barger Drive/Echo Hollow Street intersection were completed. As part of the proposed development, Cubit Street would be extended south to connect with Barger Drive at the intersection with Echo Hollow Street, and a new road (Wagner Street) would be built to connect with the residential land to the east. These improvements were completed as proposed. A Bi-Mart was proposed as part of the development but was not built; several small businesses are now at this location. East of Cubit Street, there are two small businesses that were not identified in the TIS. The TIS predicted 824 Saturday midday peak hour trips generated by the development.

Overall Assessment from TIS Review

- Except for two smaller business (oil change business, coffee shack) located at the development and a large retailer (Bi-Mart) being replaced by several small business, the development was built as planned in the TIS.
- The TIS underpredicted the number of trips generated during the analyzed peak hour (weekday PM). Actual weekday PM peak hour trip generation is 57% higher than the predicted number of trips generated.
- Actual total intersection traffic at three of the four studied intersections is approximately 23% lower than predicted traffic counts; the fourth intersection is 12% higher than predicted (Cubit Street/Wagner Street).
- Gary McNeel, City of Eugene, indicated that he had some concern about the TIS when it was submitted to the City of Eugene. The specific concern was that the TIS may have not adequately predicted the number of trips generated, but a new TIS was not requested by the City of Eugene.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	1996 (post development) and 2015
Background Growth Assumptions/Rate:	The Eugene area transportation model was used to project growth rates; trips generated from the development were assigned to the road network.
Other Transportation Projects Identified:	Beltline Highway improvements, Barger Drive/Beltline Highway interchange improvements, and Barger Drive/Echo Hollow Road intersection improvements
Trip Generation Approach:	Based on ITE's *Trip Generation* (5th edition) for the selected land use (Code 820, Shopping Center—average trip rate of 6.02 trips per 1,000 square feet for the PM peak hour)
Analysis Periods:	Weekday PM Peak Hour
Other Developments Identified:	☒ Yes, 85-acre residential area to the north of the shopping center. ☐ No
Other Developments Analyzed:	☒ Yes, 85-acre residential area to the north of the shopping center. ☐ No
Trip Distribution/ Assignment Approach:	Estimated based on examination of Lane Council of Governments (LCOG) Eugene Area Transportation System Model results
Analysis Tools/Software:	SIGCAP
LOS MOEs:	Peak Hour V/C, LOS

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
• 137,360 square feet of retail/commercial space • 12.67 acres west of Cubit Street • 2.33 acres east of Cubit Street	Site is completely built as assumed, although there are two new small businesses that were not analyzed in the TIS.
Comments: While the site is completely built, the TIS assumed two large retailers (Bi-Mart and Waremart). Waremart is now Winco Foods and the location of the proposed Bi-Mart is now several small businesses. East of Cubit Street there is an oil change business and a small coffee shack that were not analyzed in the TIS.	
Traffic Growth (1995 to 2005)	
• Barger Drive/Cubit Street: 95% • Barger Drive/Beltline Highway northbound ramps: -12% • Barger Drive/Beltline Highway southbound ramps: -2%.	• 52% • -30% • -24%
Comments: Intersection traffic growth decreased at the Beltline Highway ramps due to the grade separation of the intersections; existing traffic counts in the TIS did not take into account the geometric improvements to the Barger Drive/Beltline Highway intersection (predicted 1996 and 2015 traffic volumes were adjusted to 2005 conditions).	
Other Developments	
85-acre residential development north of the shopping center	This development was built as predicted in the TIS.
Comments: The TIS used the predicted trip generation for the 85-acre development; this development was identified and analyzed in the Barger Crossing TIS.	
Other Transportation Projects	
• Beltline Road/Beltline Highway improvements • Barger Drive/Beltline Highway interchange grade separation • Barger Drive/Echo Hollow Road intersection improvements	These transportation projects were built as predicted.
Comments: The Barger Drive/Beltline Highway intersection is now grade separated. This transportation project was identified and assumed in the TIS.	
Trip Generation	
• 824 weekday PM peak hour trips (412 in, 412 out) • 8,862 average weekday trips	• 1,293 trips (695 in, 598 out; does not include coffee shack and oil change business) • 16,038 trips (including coffee shack and oil change business)
Comments: The peak hour was 5 to 6 PM. Using ITE's *Trip Generation*, the estimated number of trips generated during the weekday PM peak hour by the two small businesses (15 trips total) was removed from the actual total trip generation because the trip generation of these businesses were not analyzed in the TIS. Actual trip generation is 57% higher than the predicted trip generation. The actual proportion of in trips (54%) is slightly higher than the predicted proportion of in trips (50%). Increased urban development in the site vicinity may explain the difference between the predicted and actual number of trips generated.	

Trip Distribution	
• Barger Drive west of Cubit Street: 51% • Barger Drive east of Cubit Street: 39% • Echo Hollow Street: 8% • Cubit Street: 2%	• 55% • 16% • 26% • 3%
Comments: Actual trip distribution is generally consistent with the predicted trip distribution for Cubit Street north of the site and Barger Drive west of Cubit Street. The trip distribution for Echo Hollow Street is more than three times higher than the predicted trip distribution.	
Total Intersection Traffic	
• Cubit Street/Barger Drive: 3,535 • Cubit Street/Wagner Street: 626 • Barger Drive/Beltline Highway northbound ramps: 3,112 • Barger Drive/Beltline Highway southbound Ramps: 3,477	• 2,751 • 711 • 2,460 • 2,691
Comments: Actual intersection volumes at the two Beltline Highway ramp intersections and Barger Drive/Cubit Street are approximately 23% lower than predicted intersection volumes. Actual intersection volumes are 12% higher than predicted intersection traffic at the Cubit Street/Wagner Street intersection.	
Individual Turning Movements	
• Barger Drive left-turn to Cubit Street: 288 • Cubit Street right-turn to Barger Drive: 271 • Barger Drive right-turn to Cubit Street: 294 • Cubit Street left-turn to Barger Drive: 208 • Cubit Street southbound through at Barger Drive: 45	• 455 • 357 • 133 • 129 • 203
Comments: Actual turning movement volumes for three of the five selected turning movements are approximately 25% to 35% higher than predicted; one movement is more than 300% higher than predicted. The fifth turning movement is approximately 55% lower than the predicted turning movement volume.	
Intersection Operations	
1996 and (2015): • Beltline Highway ramps: B (D) • Cubit Street/Barger Drive: C (E)	Actual LOS is consistent with predicted LOS at selected intersections; the selected intersections perform between 1995 and 2015 conditions (Beltline Highway ramps: C; Cubit Street/Barger Drive: D).
Comments: LOS conclusions are based on a jurisdictional interview and field observations, not empirical data.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

Clackamas Crossing, Clackamas County

Project Information

Project Type:	Retail Center
ODOT Region:	1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Location:	SE 82nd Avenue/SE Johnson Creek Boulevard, Clackamas County
Number of Driveways:	5
Size of Development:	324,465 gross square feet of retail space
Year of Study:	1993
Consulting Engineer:	Kittleson & Associates, Inc. (Portland)
Facilities Analyzed:	Eleven total intersections, including four intersections on SE Johnson Creek Boulevard, six intersections on SE 82nd Avenue, and one intersection on SE Price-Fuller Road.

Summary of TIS

The TIS analyzed the development of 274,000 square feet of shopping center (156,000 square feet), home improvement store (104,000 square feet), and restaurant space (14,000 square feet). The development was built as proposed in the TIS. The TIS concluded weekday PM peak hour and Saturday midday peak hour LOS deficiencies with the proposed development at the SE 82nd Avenue/SE Johnson Creek Boulevard intersection. Mitigation of this intersection was recommended by providing an eastbound exclusive right-turn lane. A signal was also warranted at the SE 82nd Avenue/SE Overland Street intersection. These improvements were implemented as proposed. Year 2010 planning level forecasted traffic volumes identified the need for additional turning lanes at the SE 82nd Avenue/Johnson Creek Boulevard intersection but were not implemented as part of the development. The TIS predicted 2,531 Saturday midday peak hour trips generated by the development.

Overall Assessment from TIS Review

- The development was built as assumed in the TIS (the movie theater that was at the site prior to the development was recently redeveloped into a sporting goods store).
- The TIS overpredicted the number of trips generated during the analyzed peak hour (Saturday midday). The Saturday midday peak hour trip generation is 49% of the predicted trip generation.
- Actual total intersection traffic is 81% to 97% of predicted traffic volumes.
- Joe Merek, Clackamas County, was satisfied with the results of the TIS and found the analysis to be effective. The TIS analyzed four access scenarios and recommended a north driveway/access point from SE Johnson Creek Boulevard. The driveway, however, would not meet ODOT access spacing standards. Differing opinions between ODOT and Clackamas County about this driveway strained relations between the two agencies for several years. The development also removed east-west connections at the site which worsened traffic on nearby east-west roads. These negative consequences, however, did not occur as a result of the TIS, but rather Clackamas County decisions made prior to the development being built.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	1994 (post development) and 2010 (planning level analysis only)
Background Growth Assumptions/Rate:	Background traffic volumes for 1994 conditions were determined by applying a 1.5% growth factor to existing traffic volumes.
Other Transportation Projects Identified:	No known funded transportation improvements. Planned improvements included SE Otty Road upgrade and intersection improvements, SE Price-Fuller Road widening, and I-205 northbound on-ramp improvements at SE Johnson Creek Boulevard.
Trip Generation Approach:	Based on ITE's *Trip Generation* (5th edition) for four anticipated land uses (Code 820, Shopping Center; Code 815, Discount Store; Code 834, Fast Food Restaurant with Drive-Through; Code 832, High Turnover Sit-Down Restaurant). A 10% internal capture trip reduction was assumed for the home improvement and restaurant land uses. The following pass-by trip generation reductions were assumed: Home Improvement Center (20%), Shopping Center (40%), Fast Food Restaurant with Drive-Through (60%), and High-Turnover Sit-Down Restaurant (30%).
Analysis Periods:	Weekday PM Peak Hour and Saturday Midday Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the TIS, although the planning-level 2010 analysis used forecasted 2010 traffic volumes.
Trip Distribution/ Assignment Approach:	Examination of the anticipated market area relative to the existing street circulation system and a review of the existing traffic volumes and circulation patterns
Analysis Tools/Software:	Not documented in the TIS
LOS MOEs:	Peak Hour V/C, Reserve Capacity, Delay

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
324,465 square feet of retail space	Completely built as proposed, although the movie theater building (built prior to the development) was redeveloped as a sporting goods store
Comments: The development was completely built as proposed in the TIS.	
Traffic Growth (1994 to 2005)	
• SE 82nd Avenue/SE Johnson Creek Boulevard: 11% • SE 82nd Avenue/SE Overland Street: 28%	• 6% • 26%
Comments: The actual traffic growth at the two selected intersections was slightly less (2% and 5%) than predicted.	
Other Developments	
No other developments analyzed	Many redevelopment and infill projects in the area
Comments: Interviewee indicated several infill commercial developments and redevelopments in the area along SE Johnson Creek Boulevard and SE 82nd Avenue that have cumulatively decreased traffic operations in the area.	
Other Transportation Projects	
No known funded transportation improvements. Planned improvements include Otty Road upgrade and intersection improvements, Price-Fuller Road widening, and I-205 northbound on-ramp improvement at Johnson Creek Boulevard.	Only the Otty Road upgrade was completed as proposed. The construction of Bob Schumacher Road east of I-205 has decreased traffic volumes on SE 82nd Avenue.
Comments: The improvements identified in the TIS were not analyzed under future conditions because the projects were not funded.	
Trip Generation	
2,531 Saturday midday peak hour trips (1,189 in, 1,189 out)	1,233 trips (690 in, 543 out)
Comments: The Saturday midday peak hour was 1 to 2 PM. Actual trip generation is 49% of the predicted trip generation. The actual proportion of in trips (56%) is higher than the predicted proportion (50%) of in trips.	
Trip Distribution	
• 20% SE 82nd Avenue north of site • 25% SE 82nd Avenue south of site • 20% SE Johnson Creek Boulevard west of SE 82nd Avenue • 35% SE Johnson Creek Boulevard east of site	Based on limited driveway data: • 28% SE 82nd Avenue north of site • 28% SE 82nd Avenue south of site • 44% SE Johnson Creek Boulevard east of site
Comments: Based on limited driveway data, trip distribution is generally consistent with the predicted trip distribution.	

Total Intersection Traffic	
• SE 82nd Avenue/SE Johnson Creek Boulevard: 6,037 • SE 82nd Avenue/SE Clackamas Street: 3,652 • SE 82nd Avenue/SE Overland Street: 3,905	• 4,906 • 3,538 • 3,268
Comments: Actual total intersection traffic is 81% to 97% of predicted intersection traffic volumes.	
Individual Turning Movements	
• Northbound right turn at SE Overland Street: 141 • Northbound right turn at SE Clackamas Street: 71 • Southbound left turn at SE Overland Street: 277 • SE Overland Street westbound left turn: 283	• 89 • 15 • 104 • 127
Comments: The selected actual individual turning movement volumes are 21% to 63% of predicted turning movement volumes.	
Intersection Operations	
• SE 82nd Avenue/SE Johnson Creek Boulevard: E • SE 82nd Avenue/SE Overland Street: B	Actual LOS is consistent with predicted LOS at selected intersections.
Comments: Actual LOS conclusions are based on a jurisdictional interview and field observations, not empirical data.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

COSTCO/KING BUSINESS CENTER, MEDFORD

Project Information

Project Type:	Retail Shopping Center
ODOT Region:	1 ☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐
Location:	3639 Crater Lake Highway, Medford
Number of Driveways:	3
Size of Development:	12.6 acres; 117,850 square feet of retail
Year of Study:	1991
Consulting Engineer:	Carl Buttke, Inc. (Irvine, CA)
Facilities Analyzed:	Intersections along Crater Lake Highway (OR 62) at: • Delta Waters Road • Elliot Road • Cardinal Avenue • Commerce Road • Coker Butte Road

Summary of TIS

The TIS analyzed the development of an 117,850 square foot Costco building. The TIS concluded the development could be built and a signal could be installed at the Crater Lake Highway/Cardinal Avenue intersection without degrading the level of service on the Crater Lake Highway. The TIS also analyzed the long-term buildout of the King Business Center, a 120-acre commercial and industrial development. The study concluded the Cardinal Avenue/Crater Lake Highway signal could continue to function with the Costco development at an acceptable LOS without degrading traffic on the Crater Lake Highway. The TIS predicted 416 weekday PM peak hour trips generated.

Overall Assessment from TIS Review

- The development was built as assumed in the TIS, but a fueling facility was built at the site in 1999, 8 years after the TIS was completed.
- The TIS underpredicted the number of trips generated during the analyzed peak hour (weekday PM). The TIS predicted 416 weekday PM peak hour trip; actual trip generation was 1,098. A fueling facility was built at the site in 1999. ITE's *Trip Generation* estimates 170 trips for this land use, for a net actual trip generation of 928 (number of trips generated by the Costco site without the fueling facility). Therefore, the actual weekday PM peak hour trip generation is 123% higher than predicted.
- The actual intersection volume is approximately 85% of the predicted volumes at all three intersections.
- Alex Georgevitch, City of Medford, was not at the City when this TIS was submitted; however, this and other retail developments on the Crater Lake Highway have led to significant traffic problems throughout the day. The interviewee concluded this TIS adequately assessed the King Business Center development since the Costco development was one of the first commercial developments in the King Business Center and future land uses had not been confirmed for this development and other developments in the Crater Lake Highway corridor.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	1992 (post development) and 2015 (King Business Center buildout)
Background Growth Assumptions/Rate:	Review of traffic growth of previous 3 years concluded 9% growth rate; therefore a 3% growth rate was used for 1992 (full development).
Other Transportation Projects Identified:	Signalization of Crater Lake Highway/Delta Waters Road intersection
Trip Generation Approach:	Manual turning movement for the weekday PM peak hour at the Eugene Costco; assumed to be similar store size and market area as Medford. A 20% pass-by trip generation reduction was assumed for the site.
Analysis Periods:	Weekday PM Peak Hour
Other Developments Identified:	☒ Yes, King Business Center retail and industrial development (120 acres) ☐ No
Other Developments Analyzed:	☒ Yes, 2015 analysis included development of all of King Business Center ☐ No
Trip Distribution/ Assignment Approach:	Based on the service area identified in the Costco market analysis provided by Costco
Analysis Tools/Software:	PASSER II-87, NCAP
LOS MOEs:	Peak Hour V/C, LOS, Delay

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
117,850 square feet of retail	Completely built as planned
Comments: The development was built as planned in the TIS; however, a fueling facility was added to the site in 1999.	
Traffic Growth (1993 to 2005)	
• Cardinal Avenue/Crater Lake Highway: 27% • Coker Butte Road/Crater Lake Highway: 40% • Commerce Drive/Crater Lake Highway: 39%	• 10% • 18% • 18%
Comments: The actual traffic growth rate at selected intersections is approximately half the predicted traffic growth rate (predicted 2015 traffic volumes were adjusted to 2005 conditions).	
Other Developments	
King Business Center: 120-acre development of light industrial, general industrial, and commercial development (Costco is part of the King Business Center development.)	Significant amount of new commercial development along the Crater Lake Highway since 1992
Comments: 2015 analysis included a total of 718,000 square feet of shopping center land uses.	
Other Transportation Projects	
Signalization of Delta Waters Road/Crater Lake Highway intersection	Delta Waters Road signalization, access management, access control, and other improvements to the Crater Lake Highway
Comments: There have been many small transportation improvements in the area to reduce congestion. ODOT has also completed several corridor and access management studies in the area.	
Trip Generation	
• 416 PM weekday trips (214 in, 202 out) and 170 (85 in, 85 out) • 7,520 average daily trips	• 928 trips (542 in, 386 out) trips generated without the fueling facility (170 total trips) • 10,751 trips, without the fueling facility (2,023 total trips)
Comments: The actual trip generation is 123% higher than the predicted trip generation. The proportion of in trips (58%) is higher than the predicted proportion (51%) of in trips. The development's peak trip generation was noon to 1 PM (1,161 trips without the fueling facility). Actual daily trip generation is 43% higher than the predicted daily trip generation. The peak hour of the Crater Lake Highway was 4 to 5 PM. The regional population growth in southern Oregon may explain the increased actual trip generation since Costco generally has a regional customer base.	
Trip Distribution	
• Crater Lake Highway to/from the north: 20% • Crater Lake Highway to/from the south: 80%	Driveway counts and turning movements indicate the split is closer to 35% and 65%, respectively.
Comments: Actual trip distribution between north and south on the Crater Lake Highway is more balanced than predicted. Increased urban development to the north may explain the difference in trip distribution.	

Total Intersection Traffic	
• Cardinal Avenue/Crater Lake Highway: 3,912 • Coker Butte Road/Crater Lake Highway: 3,835 • Commerce Drive/Crater Lake Highway: 3,824	• 3,399 • 3,243 • 3,250
Comments: The actual intersection volume is approximately 85% of the predicted volumes at all three intersections.	
Individual Turning Movements	
• Crater Lake Highway left-turn to Cardinal Avenue: 33 • Crater Lake Highway right-turn to Cardinal Avenue: 100 • Cardinal Avenue right-turn to Crater Lake Highway: 70 • Cardinal Avenue left-turn to Crater Lake Highway: 192	• 198 • 185 • 89 • 510
Comments: Actual traffic volumes are 26% to 500% higher than predicted traffic volumes. The Cardinal Avenue left-turn movement to Crater Lake Highway is 500% more than predicted, likely because of increased urban development to the north of the site. The lane configuration of this approach was changed in 1999 from dedicated right-turn lane to a dual left- and right-turn lane.	
Intersection Operations	
2015 LOS: • Cardinal Avenue/Crater Lake Highway: B • Coker Butte Road/Crater Lake Highway: B • Delta Waters Road/Crater Lake Highway: D	Interview confirmed LOS at Cardinal Avenue/Crater Lake Highway is worse than predicted, at LOS C or D during the PM peak hour
Comments: Field observations and jurisdictional interview confirmed the LOS at the selected intersections to be worse than the predicted LOS by at least one grade, especially at the Cardinal Avenue/Crater Lake Highway intersection.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

FIRST BAPTIST CHURCH, EUGENE

Project Information

Project Type:	Church
ODOT Region:	1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐
Location:	3550 Fox Meadow Road, Eugene
Number of Driveways:	3
Size of Development:	115,000 square feet; 1,800-seat church
Year of Study:	2001
Consulting Engineer:	JRH Transportation Engineering (Eugene)
Facilities Analyzed:	Four intersections identified by the City of Eugene Transportation Division: • Country Farm Road/Coburg Road • Fox Meadow Road/Coburg Road • Game Farm Road/Fox Meadow Road • Game Farm Road/Coburg Road

Summary of TIS

The TIS analyzed the development of a 1,800-seat church. The TIS recommended no mitigation measures since no significant traffic impacts to the roadway system were identified. The project proposed to build a new north-south street connection between Coburg Road and Country Farm Road that would create direct access points for the church. This street was built and is named Fox Meadow Road. The predicted number of trips generated during the weekday PM peak hour by the development was 76.

Overall Assessment from TIS Review

- The site was built as assumed in the TIS.
- The TIS overpredicted the number of trips generated during the analyzed peak hour (weekday PM). The actual number of trips generated during the weekday PM peak hour is 30% of the predicted number of trips generated.
- The actual intersection traffic volume is 7% less than the predicted traffic volume at the main access road (Fox Meadow Road) to the site. Actual turning movement volumes to and from Fox Meadow Road are between 13% and 40% of the predicted turning movement volumes.
- Gary McNeel, City of Eugene, was satisfied with the results of the TIS and found the study and its analysis to be effective.

Vicinity Aerial Map

Note: Aerial photo was taken when the development was under construction.

TIS Scope and Approach

Analysis Horizon Year:	2002 (post development) and 2007
Background Growth Assumptions/Rate:	A 3% annual growth factor was applied to existing volumes. This rate is above the general historical growth rate of the Eugene area.
Other Transportation Projects Identified:	No transportation projects were identified in the TIS.
Trip Generation Approach:	Based on ITE's *Trip Generation* (6th edition) for the anticipated land use (Code 560, Church—average trip rate of 0.66 trips per 1,000 square feet during the weekday PM peak hour)
Analysis Periods:	Weekday PM Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the TIS.
Trip Distribution/ Assignment Approach:	Based on survey given to church attendees of residence location (by zip code) and mode of transportation.
Analysis Tools/Software:	HCS-3.2
LOS MOEs:	Peak-Hour V/C, LOS, Delay
Saturation Flow Rate:	No signalized intersections

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
115,000 square foot building; 1,800-seat church	Completely built as assumed in the TIS
Comments: A future phase of the development will build residential units and senior housing, but this was not assumed or analyzed in the TIS.	
Traffic Growth (2002 to 2005)	
• Coburg Road/Country Farm Road: 25% • Coburg Road/Fox Meadow Road: 25%	• 67% • 16%
Comments: Actual traffic growth is higher than the predicted traffic growth at the Coburg Road/Country Farm Road intersection. New residential development west of Country Farm Road and the extension of Lakeview Drive to Country Farm Road has resulted in increased traffic at the Coburg Road/Country Farm Road intersection. Actual traffic growth is about half the predicted traffic growth at the Coburg Road/Fox Meadow Road intersection (predicted 2007 traffic volumes were adjusted to 2005 conditions).	
Other Developments	
No other developments analyzed	New small subdivisions to the west of the site (west of Country Farm Road)
Comments: New residential development west of Country Farm Road and the extension of Lakeview Drive to Country Farm Road has resulted in increased traffic at the Coburg Road/Country Farm Road intersection (see “Total Intersection Traffic” below).	
Other Transportation Projects	
No transportation projects were identified. Improvements to Coburg Road were completed in conjunction with the development.	Extension of Lakeview Drive to the east to Country Farm Road
Comments: The extension of Lakeview Drive to Country Farm Road resulted in an increase in traffic at the Country Farm Road/Coburg Road intersection (see “Total Intersection Traffic” below).	
Trip Generation	
• 76 weekday PM peak hour trips (41 in, 35 out) • 1,048 average weekday trips	• 23 trips (8 in, 15 out) • 358 trips
Comments: The peak hour was 5 to 6 PM. The actual trip generation is 30% of the predicted trip generation. The proportion of in trips (35%) is lower than the predicted proportion (54%) of in trips. The development’s peak hour was between 2 and 3 PM (45 total trips). Actual weekday trip generation is 34% of the predicted weekday trip generation.	
Trip Distribution	
• 76% to/from the south on Coburg Road • 15% to/from Game Farm Road • 9% to/from the north on Coburg Road	Turning movement counts at the Coburg Road/Fox Meadow Road intersections indicates a higher proportion of vehicles to/from the north on Coburg Road and a lower proportion to/from the south on Coburg Road than predicted.
Comments: The actual trip distribution discussed is based on peak hour turning movements at the Coburg Road/Fox Meadow Road intersection. The number of out trips from the site (six total) to Coburg Road were insignificant and no conclusions could be made.	

Total Intersection Traffic	
• Coburg Road/Country Farm Road: 753 • Coburg Road/Fox Meadow Road: 798	• 1,012 • 741
Comments: The extension of Lakeview Drive to Country Farm Road and new development west of Country Farm Road likely explains the increase in traffic volumes at the Coburg Road/Country Farm Road intersection.	
Individual Turning Movements	
• Coburg Road left-turn to Fox Meadow Road: 29 • Fox Meadow Road right-turn to Coburg Road: 13 • Fox Meadow Road left-turn to Coburg Road: 5 • Country Farm Road right-turn to Coburg Road: 96	• 4 • 5 • 1 • 144
Comments: Actual turning movements volumes are lower than predicted (<40% of predicted traffic), except for the right-turn from Country Farm Road to Coburg Road (50% more than predicted, due to the extension of Lakeview Drive north of the Coburg Road/Country Farm Road intersection).	
Intersection Operations	
• Coburg Road: A (2007) • Country Farm Road: B (2007) • Camp Harlow Road: B (2007)	Actual LOS is consistent with predicted LOS at selected intersections.
Comments: Actual LOS conclusions are based on a jurisdictional interview and field observations, not empirical data.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

FIVE OAKS WEST, HILLSBORO

Project Information

Project Type:	Industrial Park
ODOT Region:	1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Location:	6200 NW Casper Place, Hillsboro
Number of Driveways:	4
Size of Development:	62.58 acres; 672,780 square feet
Year of Study:	1998
Consulting Engineer:	Group Mackenzie (Portland)
Facilities Analyzed:	Five intersections requested by the City of Hillsboro: • Helvetia Road/Jacobson Road • Helvetia Road/US 26 westbound ramps • Shute Road/US 26 eastbound ramps • Jacobson Road/Pinefarm Place • Jacobson Road/Casper Place

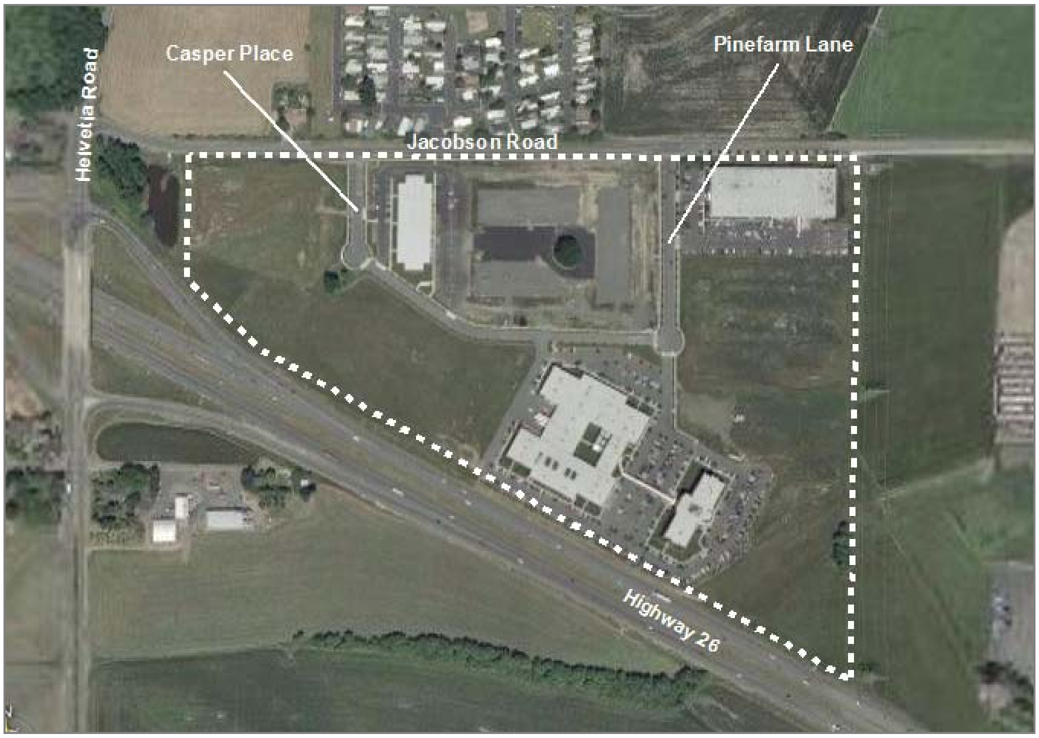
Summary of TIS

The TIS analyzed the development of 602,780 square feet of industrial park and office space. In total, 10 of the 14 buildings have not been built. The existing leased space is approximately 30% of what was predicted and analyzed for 2003 in the TIS. The following was proposed or recommended in the TIS: (1) a new western access road (Casper Place); (2) Pinefarm Lane and Casper Place at Jacobson Road to be striped with separate left- and right-turn lanes; (3) a right-turn lane on Jacobson Road at Casper Place; (4) a left-turn lane on Jacobson Road at Casper Place and Pinefarm Lane; and (5) signalization of the Jacobson Road/Pinefarm Lane intersection. These improvements were implemented, except for the separate striped turn lanes at Pinefarm Lane, the left-turn from Jacobson Road to Casper Place, and the signalization of the Jacobson Road/Pinefarm Lane intersection. The predicted weekday PM peak hour trip generation was 482.

Overall Assessment from TIS Review

- The site was assumed to be completely built and leased by 2003. However, only about 30% of the development is currently built and leased. Existing (2005) traffic data were adjusted to assume full buildout.
- If the development were fully built, the predicted trip generation and actual trip generation would be consistent for the analyzed peak hour (weekday PM) (actual trip generation would be 96% of the predicted).
- If the development were fully built, actual traffic volumes at selected intersections would be approximately 62% of the predicted intersection traffic volumes.
- Wink Brooks, City of Hillsboro, was pleased with the TIS and its analysis and found the study to be effective. Even though the development is currently only 30% built, the interviewee stated that full development by 2003 was a reasonable assumption at the time of analysis (1998).

Vicinity Aerial Map



TIS Scope and Approach

Analysis Horizon Year:	2003 (post development, 5-year projection) and 2018 (20-year projection)
Background Growth Assumptions/Rate:	2.0%—Washington County EMME-2 models; in process growth, background growth, and site traffic analyzed
Other Transportation Projects Identified:	Striping and signalization at Shute Road/US 26 eastbound ramps intersection
Trip Generation Approach:	Based on ITE's *Trip Generation* (6th edition) for the anticipated land use (Code 130, Industrial Park—using the fitted curve equation for peak hour of adjacent street traffic, one hour, between 4 and 6 PM: Ln[Trips] = 0.854 Ln[1,000 square feet of gross floor area] + 0.712)
Analysis Periods:	Weekday AM and PM Peak Hour
Other Developments Identified:	☒ Yes, seven City of Hillsboro approved developments ☐ No
Other Developments Analyzed:	☒ Yes, seven City of Hillsboro approved developments considered in the "In Process" analysis ☐ No
Trip Distribution/ Assignment Approach:	Evaluation of existing traffic patterns in the study area; different assignments for AM and PM peak hour, based on field observations.
Analysis Tools/Software:	HCS
LOS MOEs:	Peak Hour V/C, Reserve Capacity, Delay
Saturation Flow Rate:	1700

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
672,780 square feet (14 buildings) of industrial park space. The entire site was assumed to be completed in five years (2003).	Only 4 of 14 buildings are built. In total, approximately 30% of the development has been built.
Comments: Only approximately 30% of the leasable space cited in the TIS is currently built and leased due to the regional economic recession and high commercial vacancy rate.	
Traffic Growth (1998 to 2005)	
• Jacobson Road/Helvetia Road: 143% • Jacobson Road/Pinefarm Lane: 241%	If fully built: • 32% • 24%
Comments: If fully built, actual traffic growth at selected intersections would be 32% and 24% of the predicted traffic growth (predicted 2003 traffic volumes were adjusted to 2005 conditions).	
Other Developments	
No specific developments; anticipated long-term development growth rates were included in analysis.	None in site vicinity.
Comments: There are no new developments in the site vicinity, but there has been significant development approximately 1 mile to the southeast of the site near the Cornelius Pass Road/US 26 interchange.	
Other Transportation Projects	
Striping and signalization at the Shute Road/US 26 eastbound ramps interchange	Striping, signalization, metering lights, and on-ramp widening at the Shute Road/US 26 interchange
Comments: A jurisdictional interview indicated no new transportation projects in the vicinity other than minor improvements (striping, metering lights, signalization, on-ramp widening) at the Shute Road/US 26 interchange.	
Trip Generation	
507 weekday PM peak hour trips (105 in, 402 out)	151 trips (approximately 30% built and leased); 489 trips if 100% built and leased (94 in, 394 out).
Comments: The peak hour was 3 to 4 PM. If fully built and leased, the actual trip generation would be 96% of the predicted trip generation. The actual proportion of in trips (19%) is consistent with the predicted proportion (21%) of in trips.	
Trip Distribution	
• To/from west on Jacobson Road: 75% • To/from east on Jacobson Road: 25%	• 30% west • 70% east
Comments: Actual trip distribution west on Jacobson Road (30%) towards the Shute Road/US 26 interchange is significantly less than the predicted trip distribution (75%). Increased urban development to the west, new roads, and improvements to the Cornelius Pass Road/US 26 interchange may explain the existing trip distribution.	

Total Intersection Traffic	
• Jacobson Road/Helvetia Road: 2,076 • Jacobson Road/Pinefarm Lane: 1,176	If fully built: • 1,178 • 805
Comments: Total intersection traffic if fully built would be 57% to 68% of the predicted intersection traffic. While the development's trip generation would be consistent with the predicted trip generation, lower background traffic volumes would result in lower intersection volumes.	
Individual Turning Movements	
• Pinefarm Lane left-turn to Jacobson Road: 186 • Jacobson Road left-turn to Helvetia Road: 482 • Helvetia Road right-turn to Jacobson Road: 839 • Jacobson Road right-turn to Pinefarm Place: 49	If fully built: • 135 • 262 • 267 • 19
Comments: If fully built, traffic volumes for selected turning movements would be 32% to 73% of the predicted traffic volumes.	
Intersection Operations	
• Helvetia Road/Jacobson Road: F • Jacobson Road/Casper Place: E • Jacobson Road/Pinefarm Place: F (all 2003)	Actual intersection operations perform better than predicted, especially at the Jacobson Road/Casper Place intersection because the site is not fully built and leased.
Comments: Actual LOS conclusions are based on a jurisdiction interview and field observations, not empirical data. Actual intersection operations perform better than predicted because the site is not fully built and leased.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

HOME DEPOT, THE DALLES

Project Information

Project Type:	Retail Center
ODOT Region:	1 ☐ 2 ☐ 3 ☐ 4 ☒ 5 ☐
Location:	3600 W 6th Street, The Dalles
Number of Driveways:	3
Size of Development:	130,000 square foot home improvement building; 32,000 square feet of general retail
Year of Study:	2003
Consulting Engineer:	Kittleson & Associates, Inc. (Portland)
Facilities Analyzed:	Eleven intersections in the site vicinity selected based on a review of the transportation system and direction by the City of The Dalles and Wasco County

Summary of TIS

The TIS analyzed the development of a Home Depot building (130,000 square feet) and 32,000 square feet of general retail. The analysis concluded that with the proposed development, all 11 study area intersections would operate at acceptable levels, and no mitigation was necessary. The development proposed to construct near full street improvements on Chenowith Loop Road and half street improvements on 6th Street; these improvements were completed as proposed. The predicted trip generation was 1,120 trips during the Saturday midday peak.

Overall Assessment from TIS Review

- The site is not fully built out as assumed in the TIS. The TIS assumed retail buildings on W 6th Street in addition to Home Depot. Only the Home Depot has been built, which accounted for 63% of the predicted trips generated in the TIS.
- The TIS overpredicted the number of trips generated during the analyzed peak hour (Saturday midday). Saturday midday peak hour trip generation for Home Depot was predicted to be 705; actual trip generation is 278 trips. The retail buildings at the site were assumed to be completely built by 2004 in the TIS.
- Actual intersection traffic at the 6th Street/Home Depot driveway is 53% of the predicted traffic volume (Home Depot generated trips only).
- Dan Durow, City of The Dalles, was satisfied with the results of the TIS and found it to be effective.

Vicinity Aerial Map

Note: Aerial photo was taken prior to development being built.

TIS Scope and Approach

Analysis Horizon Year:	2004 (post development) and 2009
Background Growth Assumptions/Rate:	A 1% annual growth factor was applied to existing traffic volumes.
Other Transportation Projects Identified:	Half-street improvements (sidewalks and pavement widening) at the northwest quadrant of the 6th Street/Hostetler Road intersection
Trip Generation Approach:	Based on ITE's *Trip Generation* (6th edition) for planned land uses (Code 862, Home Improvement Superstore; Code 820, Shopping Center). The average rate of 5.40 trips per 1,000 square feet of gross floor area was used. A 5% pass-by trip reduction was assumed for the site.
Analysis Periods:	Weekday PM Peak Hour and Saturday Midday Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the TIS.
Trip Distribution/ Assignment Approach:	An examination of transportation facilities within the site vicinity, existing peak hour directional travel characteristics, an understanding of the surrounding roadway network, and a market analysis prepared by Home Depot
Analysis Tools/Software:	Traffix 7.5
LOS MOEs:	Peak-Hour V/C, LOS, Delay

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
130,000 square foot home improvement building and 32,000 square feet of general retail	The home improvement building (Home Depot) has been built; none of the retail buildings have been built.
Comments: Retail pads along 6th Street in front of Home Depot are vacant, but are zoned for general retail use.	
Traffic Growth	
Predicted to increase by 95% at 6th Street/Home Depot Driveway (was not previously a driveway).	Increased by 53%
Comments: Home Depot driveway (main entrance) is one of the three approaches at this intersection.	
Other Developments	
No other developments were predicted or identified.	None in site vicinity.
Comments: Field observations and interview concluded no new developments in the site vicinity.	
Other Transportation Projects	
Street improvements at the northwest quadrant of the Hostetler Road/6th Street intersection.	The identified project was completed. There are no other projects in the site vicinity.
Comments: Field observations and interview concluded no other transportation improvements in the site vicinity.	
Trip Generation	
705 Saturday midday peak hour trips (372 in, 334 out), adjusting for nonbuilt land uses (Home Depot trips only).	278 trips (128 in, 150 out); Home Depot trips only
Comments: The peak hour was noon to 1 PM. Actual trip generation is 39% of the predicted trip generation. The proportion of in trips (46%) is lower than the predicted proportion (53%) of in trips.	
Trip Distribution	
• Chenowith Interchange Road and 6th Street from the north: 30% • 6th Street from the south: 30%; • W 10th Street from the south: 15% • W 10th Street from the north: 10% • Hostetler Street east of I-84: 10% • W 7th Sreet, Pomona Street, and Snipes Street: 5%	Actual trip distribution is consistent with predicted trip distribution at selected intersections.
Comments: There have been no significant developments in the area. Since the TIS was completed in late 2003, the existing trip distribution would be consistent with the predicted trip distribution.	
Total Intersection Traffic	
• 6th Street/Home Depot Driveway: 896	• 705
Comments: Actual intersection traffic is approximately 79% of the predicted traffic volume at the main driveway intersection.	

Individual Turning Movements	
• 6th Street left-turn to Home Depot: 175 • 6th Street right-turn to Home Depot: 57 • Home Depot Driveway left-turn to 6th Street: 57 • Home Depot Driveway right-turn to 6th Street: 137	• 80 • 28 • 11 • 92
Comments: Actual traffic volumes range between 20% and 67% of predicted traffic volumes. Main driveway traffic volumes are less than predicted, but through movements at the 6th Street/Main Street intersection are 5% more than predicted.	
Intersection Operations	
• 6th Street/Chenowith Loop Road: C • 6th Street/Hostetler Street: D • 6th Street/Home Depot Driveway: E	Field observation and interview confirmed no traffic issues in the area, but no LOS conclusions could be made.
Comments: No conclusions on the existing LOS at the selected intersections could be made by the interviewee (Dan Durow, City of The Dalles).	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

JERRY'S HOME IMPROVEMENT CENTER, EUGENE

Project Information

Project Type:	Retail Center
ODOT Region:	1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐
Location:	2600 Highway 99, Eugene
Number of Driveways:	2
Size of Development:	Expansion of an existing building from 80,000 square feet to 160,000 square feet
Year of Study:	1994
Consulting Engineer:	Branch Engineering (Eugene)
Facilities Analyzed:	Two intersections: • Highway 99/Jerry's Main Driveway • Highway 99/Theona Drive

Summary of TIS

The TIS analyzed the expansion of Jerry's Home Improvement Center from 80,000 square feet to 160,000 square feet. The TIS concluded that with the proposed improvements, the expansion could occur while maintaining acceptable levels of service in the site vicinity. Proposed improvements included closing the existing Theona Drive driveway and moving it 250 feet to the west, widening Theona Drive to provide a three-lane cross-section with separate left- and right-turn channelization, improving the grade at the main intersection to match the grade of Highway 99, and installing a raised median on Highway 99 to restrict left-turn movements from Jerry's Main Driveway to Highway 99 northbound. All of these improvements were completed as proposed. The TIS predicted a total of 942 Saturday midday peak hour trips generated by the site.

Overall Assessment from TIS Review

- The existing home improvement building was expanded and improved as assumed in the TIS.
- The TIS slightly overpredicted the number of trips generated during the analyzed peak hour (Saturday midday). Actual Saturday midday peak hour trip generation is 16% lower than the predicted trip generation.
- Total intersection volume is 15% lower than predicted at the Highway 99/Jerry's Main Driveway intersection. Actual turning movement traffic volumes to and from Theona Drive are 20% to 178% higher than predicted.
- Gary McNeel, City of Eugene, was not at the City of Eugene when the TIS was submitted, but did indicate certain issues could have been addressed that were not addressed in the TIS (such as signage, reducing the posted speed limit, signal timing, and turning movement queuing at the access points).

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	1994 (post expansion), 2000
Background Growth Assumptions/Rate:	2%—Based on historical traffic data of traffic on Highway 99 in the site vicinity
Other Transportation Projects Identified:	None
Trip Generation Approach:	Based on ITE's *Trip Generation* (5th edition) for the existing land use (Code 812, Building Materials and Lumber Store—average rate of 5.89 trips per 1,000 square feet gross floor area, then multiplied existing trips by 1.33 [assumed a 33% increase in traffic])
Analysis Periods:	Saturday Midday Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the TIS.
Trip Distribution/ Assignment Approach:	Based on existing traffic counts from Lane County, ODOT, and field work
Analysis Tools/Software:	UNSIG10
LOS MOEs:	Peak Hour LOS
Saturation Flow Rate:	1900

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
Expansion of existing 80,000 square foot building to 160,000 square feet	Expansion and improvements were completed as planned.
Comments: The expansion doubled the square footage of the building and improved access to the site, onsite access, and internal traffic circulation.	
Traffic Growth (1994 to 2005)	
• Highway 99/Theona Drive: 27% • Highway 99/Jerry's Main Driveway: 32%	• 24% • 12%
Comments: Actual traffic growth at Highway 99/Theona Drive is generally consistent with the predicted traffic growth (predicted 2000 traffic volumes were adjusted to 2005 conditions).	
Other Developments	
No developments were identified in the TIS.	None in site vicinity.
Comments: Field observation and interview confirmed that there are no new developments in the site vicinity.	
Other Transportation Projects	
No transportation projects were identified in the TIS.	None in site vicinity.
Comments: Field observations and interview confirmed no new transportation improvements in the site vicinity.	
Trip Generation	
942 Saturday midday peak hour trips (498 in, 444 out trips)	794 trips (391 in, 403 out)
Comments: The Saturday midday peak hour was 1 to 2 PM. Actual trip generation is 84% of the predicted trip generation. The actual proportion of in trips (49%) is slightly lower than the predicted proportion (53%) of in trips.	
Trip Distribution	
• To/from south on Highway 99: 85% • To/from north on Highway 99: 15%	• 77% • 23%
Comments: The actual trip distribution to/from the south (77%) is slightly lower than the predicted trip distribution (85%).	
Total Intersection Traffic	
• Highway 99/Theona Drive: 1,606 • Highway 99/Jerry's Main Driveway: 2,320	• 1,573 • 1,972
Comments: The predicted intersection traffic volume is 2% lower than the actual traffic volume at Highway 99/Theona Drive. The total volume at the main driveway intersection is 15% lower than the predicted intersection volume.	

Individual Turning Movements	
• Theona Drive left-turn to Highway 99: 84 • Highway 99 right-turn to Theona Drive: 32 • Jerry's Main Driveway right-turn to Highway 99: 402	• 101 • 89 • 288
Comments: The left-turn movement from Theona Drive to Highway 99 and the right-turn movement from Highway 99 to Theona Drive are 20% and 178% higher than the predicted turning movement volumes. The right turn from the main driveway is 72% of the predicted turning movement volume.	
Intersection Operations	
• Highway 99 northbound left turn at Theona Drive: A • Northbound left turn at Jerry's Main Driveway: D • Theona Drive left turn to Highway 99: E • Theona Drive right turn to Highway 99: A	Predicted LOS is consistent with actual LOS at both intersections.
Comments: Actual LOS conclusions are based on a jurisdictional interview and field observations, not empirical data.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

Oregon Community Credit Union, Eugene

Project Information

Project Type:	Corporate Headquarters and General Office Building
ODOT Region:	1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐
Location:	2880 Chad Drive, Eugene
Number of Driveways:	1
Size of Development:	101,000 square foot building
Year of Study:	2000
Consulting Engineer:	Balzhiser & Hubbard Engineers (Eugene)
Facilities Analyzed:	Three intersections identified by City of Eugene staff: • Beltline Highway westbound ramps/Coburg Road • Beltline Highway eastbound ramps/Coburg Road • Chad Drive/Coburg Road

Summary of TIS

The TIS analyzed the development of a 101,000 square foot office building. The TIS assumed there would be 48,000 square feet of general office space and 53,000 square feet for Oregon Community Credit Union's (OCCU) corporate headquarters; however, the entire building is occupied by OCCU. Other than this item, the development was built as proposed in the TIS. The TIS concluded the development could be constructed while maintaining near-term acceptable levels of service and safety; no mitigation was required. Background traffic was assumed to grow at a faster rate (4% between 2001 and 2004) than the citywide average until 2004 because of the amount of nearby undeveloped property. Using ITE's *Trip Generation*, and adjusting to assume 100% occupied by OCCU, a total of 141 PM peak hour trips were predicted to be generated by the development.

Overall Assessment from TIS Review

- The development was built as proposed; however, the TIS assumed OCCU would occupy 53% of the building and 47% would be general office space; 100% of the building is occupied by OCCU.
- The TIS overpredicted the number of trips generated during the analyzed peak hour (weekday PM). The actual weekday PM peak hour trip generation is 61% of the predicted trip generation.
- Actual intersection volumes at the three selected intersections for analysis are approximately 13% lower than predicted intersection volumes.
- Gary McNeel, City of Eugene, was satisfied with the results of the TIS and found the study and its analysis to be effective.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	2001 (post development) and 2006
Background Growth Assumptions/Rate:	2001-2004: 4% per year; 2004-2006: 3% per year, based on existing and assumed trends with City of Eugene concurrence
Other Transportation Projects Identified:	None
Trip Generation Approach:	Based on ITE's *Trip Generation* (6th edition) for anticipated land uses (Code 714, Corporate Headquarters Building—average rate of 1.39 trips per 1,000 square feet, weekday PM peak hour; Code 710, General Office Building— average rate of 1.49 trips per 1,000 square feet, weekday PM peak hour)
Analysis Periods:	Weekday PM Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the TIS.
Trip Distribution/ Assignment Approach:	Based on existing travel patterns of the surrounding area and traffic data for the study intersections.
Analysis Tools/Software:	SIG/Cinema
LOS MOEs:	Peak Hour V/C, LOS, Delay

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
101,000 square foot building (53,000 square feet occupied by OCCU and 48,000 square feet of general office space)	Completely built, but 100% occupied by OCCU
Comments: OCCU occupies the entire building. If this was assumed in the TIS, the predicted trip generation would be 141 trips, not 146.	
Traffic Growth (2000 to 2005)	
• Chad Drive/Coburg Road: 25% • Coburg Road/Beltline Highway Eastbound ramps: 23% • Coburg Road/Beltline Highway Westbound ramps: 23%	• 4% • 2% • 3%
Comments: Actual traffic growth at selected intersections is approximately 3%, which is less than the predicted traffic growth of approximately 24%.	
Other Developments	
No other developments were predicted or identified.	The Costco fueling facility and Summer Oaks Crescent PUD to the north of the site and Chad Drive
Comments: No future developments were analyzed in the TIS.	
Other Transportation Projects	
No transportation projects were predicted or identified.	Signalization of Costco's main driveway on Chad Drive
Comments: No transportation projects were analyzed in the TIS.	
Trip Generation	
141 weekday PM peak hour trips (15 in, 126 out), assuming the Corporate Headquarters ITE Code was used for the entire building	86 trips (6 in, 80 out)
Comments: The peak hour was 5 to 6 PM. Actual trip generation is 61% of the predicted trip generation. The actual proportion of out trips (93%) is slightly higher than the predicted proportion (89%) of out trips.	
Trip Distribution	
• Beltline Highway: 40% • North of Chad Drive: 20% • Coburg Road south of Beltline Highway: 40%	Based on a jurisdictional interview, actual trip distribution is consistent with predicted trip distribution.
Comments: No conclusions can be made with existing traffic counts since there is only one exit from the site (Chad Drive to Coburg Road). However, the interviewee stated the actual trip distribution is likely consistent with the predicted trip distribution.	

Total Intersection Traffic	
• Beltline Highway westbound ramps/Coburg Road: 4,047 • Beltline Highway eastbound ramps/Coburg Road: 3,673 • Chad Drive/Coburg Road: 3,069	• 3,370 • 3,059 • 2,573
Comments: Actual total intersection volumes are approximately 83% of the predicted total intersection volumes.	
Individual Turning Movements	
• Coburg Road left-turn to Chad Drive: 63 • Coburg Road right-turn to Chad Drive: 367 • Chad Drive left-turn to Coburg Road: 1,090 • Chad Drive right-turn to Coburg Road: 80	• 57 • 254 • 858 • 100
Comments: Three of the four selected turning movements are between 69% and 90% of predicted volumes. The Chad Drive right turn to Coburg Road is 25% higher than the predicted turning movement volume.	
Intersection Operations	
• Beltline Highway eastbound ramps/Coburg Road: F • Beltline Highway westbound ramps/Coburg Road: F • Chad Drive/Coburg Road: C	Actual LOS is consistent with the predicted LOS at the selected intersections.
Comments: Actual LOS conclusions are based on a jurisdictional interview and field observations, not empirical data.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

PILOT TRAVEL CENTER, STANFIELD

Project Information

Project Type:	Travel and Truck Service Center
ODOT Region:	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☒
Location:	2115 Highway 395, Stanfield
Number of Driveways:	2
Size of Development:	18.22 acres
Year of Study:	1995
Consulting Engineer:	JRH Transportation Engineering (Eugene)
Facilities Analyzed:	Two intersections: • Umatilla-Stanfield Highway (Highway 395)/I-84 eastbound ramps • Umatilla-Stanfield Highway (Highway 395)/I-84 westbound ramps

Summary of TIS

The TIS analyzed the development of a gas station and convenience store at the I-84/US 395 interchange. The TIS concluded the development could be built while maintaining acceptable levels of service at the I-84 ramp terminals and at the two site access points. As part of the development, one access for cars and one access for trucks were recommended for improved level of service and safety. Left-turn lanes were recommended at both site driveways and a right-turn deceleration lane was recommended at the truck access driveway. All of these improvements were implemented as proposed. The TIS predicted a total of 275 weekday PM peak hour trips generated.

Overall Assessment from TIS Review

- The development was built as assumed in the TIS, but two fast-food restaurants were later constructed at the site and the truck access driveway was moved to the north to increase the distance between the northern and southern access points.
- The TIS underpredicted the number of trips generated during the analyzed peak hour (weekday PM). Using the ITE's *Trip Generation* to subtract the number of trips generated by the two existing fast-food restaurants, the actual weekday PM peak hour trip generation was approximately 54% higher than the predicted number of trips generated.
- Actual intersection traffic at the I-84 westbound ramps is 80% and 104% of predicted at the I-84 eastbound ramps.
- Scott Morris, City of Stanfield, was satisfied with the results of the TIS and found the study and its analysis to be effective. However, the interviewee stated that ODOT was the main commenter on the TIS and the City of Stanfield accepted ODOT's comments.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	1995 (post development) and 2015
Background Growth Assumptions/Rate:	A 3.1% annual growth factor was applied to existing volumes.
Other Transportation Projects Identified:	None
Trip Generation Approach:	Based on ITE's *Trip Generation* (5th edition) for the anticipated land use (Code 844, Gasoline/Service Station). 80% of trips on I-84 were assumed to be pass-by trips, but new trips on Highway 395.
Analysis Periods:	Weekday AM and PM Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the TIS.
Trip Distribution/ Assignment Approach:	Distributed in proportion to existing (1995) traffic volumes in the vicinity by using peak-hour manual traffic counts to estimate the proportion of trips and direction.
Analysis Tools/Software:	UNSIG10
LOS MOEs:	LOS, Reserve Capacity

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
18.22 acre travel center with a gas station and convenience store	The development was built as planned, but two fast-food restaurants have since been developed at the site, and the truck access driveway has been moved to the north.
Comments: There is a Subway restaurant and a McDonald's restaurant with a drive-through window that are connected to the original convenience store. These restaurants were not analyzed in the TIS. The truck access driveway was moved to the north to increase the spacing between the two access points and to improve safety.	
Traffic Growth (1995 to 2005)	
• Highway 395/I-84 westbound ramps: 77% • Highway 395/I-84 eastbound ramps: 70%	• 55% • 99%
Comments: Actual traffic growth was 22% less than predicted at the westbound ramps and 29% more than predicted at the eastbound ramps.	
Other Developments	
No developments were identified in the TIS.	None in site vicinity.
Comments: There are no new developments in the site vicinity.	
Other Transportation Projects	
No other transportation projects were identified in the TIS.	None in site vicinity.
Comments: There have been no new transportation projects in the site vicinity.	
Trip Generation	
275 weekday PM peak hour trips (140 in, 135 out)	423 trips (187 in, 236 out), assuming the McDonald's and Subway trips are removed from the actual trip generation
Comments: The peak hour was noon to 1 PM. After subtracting the number of trips generated by the two restaurants, actual trip generation is 54% more than the predicted trip generation. The proportion of in trips (44%) is lower than the predicted proportion of in trips (51%).	
Trip Distribution	
• To/from the north: 25% • To/from the south (including I-84): 75%	Actual trip distribution is consistent with the predicted trip distribution.
Comments: Based on limited data, actual trip distribution is unknown, but because predicted and actual traffic counts are similar, trip distribution is assumed to be consistent with the predicted trip distribution.	
Total Intersection Traffic	
• Highway 395/I-84 westbound ramps: 909 • Highway 395/I-84 eastbound ramps: 528	• 730 • 551
Comments: Actual intersection traffic at the westbound ramps is 80% of predicted traffic and 104% of predicted traffic at the eastbound ramps.	

Individual Turning Movements	
• I-84 eastbound offramp left-turn to Highway 395: 73 • I-84 westbound offramp right-turn to Highway 395: 323 • Highway 395 left-turn to I-84 eastbound onramp: 300 • Highway 395 right-turn to I-84 westbound onramp: 72 • Highway 395 southbound through at westbound I-84 ramps: 349	• 61 • 269 • 275 • 51 • 191
Comments: Actual turning movement volumes are between 71% and 91% of the predicted volumes for selected turning movements, except the Highway 395 southbound through movement at the I-84 westbound ramps, which is 55% less than predicted.	
Intersection Operations	
1995 and (2015) LOS: • Highway 395/I-84 westbound ramps: A (C) • Highway 395/I-84 eastbound ramps: B (D)	Actual LOS is consistent with the predicted LOS (between 1995 and 2105 conditions) at the two selected intersections.
Comments: Actual LOS conclusions are based on a jurisdictional interview and field observations, not empirical data.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

TUALATIN BUSINESS CENTER, TUALATIN

Project Information

Project Type:	Office and Industrial/Warehouse Complex
ODOT Region:	1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐
Location:	SW 63rd Avenue at Rosewood Street, Tualatin
Number of Driveways:	5
Size of Development:	6 acres; 116,000 square feet
Year of Study:	1999
Consulting Engineer:	DKS Associates (Portland)
Facilities Analyzed:	Eight intersections along Lower Boones Ferry Road and Upper Boones Ferry Road identified based on estimated increment of traffic added and discussions with city staff

Summary of TIS

The TIS analyzed the development of 116,000 square feet of office and industrial/warehouse space. Mitigation measures were not recommended since no significant traffic impacts to the roadway system were identified in the TIS. The development proposed to extend Rosewood Street to the west to connect with SW 65th Avenue and to include full street improvements along the property frontage on SW 63rd Avenue and Rosewood Street. These improvements were implemented as proposed. The predicted number of trips generated during the PM peak hour was 126.

Overall Assessment from TIS Review

- The development was built as assumed in the TIS.
- The predicted trip generation and actual trip generation are generally consistent for the analyzed peak hour (weekday PM). Actual weekday PM peak hour trip generation for the development is 84% of the predicted trip generation.
- Actual total intersection volumes at selected intersections are approximately 10% less than the predicted traffic volumes.
- Doug Rux, City of Tualatin, was satisfied with the TIS and found its analysis to be effective.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	2002 (post development, complete buildout)
Background Growth Assumptions/Rate:	A 2% annual growth factor was applied to 1999 volumes based on a 2002 project completion date.
Other Transportation Projects Identified:	None
Trip Generation Approach:	Based on the ITE's *Trip Generation* (6th edition) for anticipated land uses. Future tenant usage was assumed to be 63% manufacturing (ITE Land Use Code 140), 17% office (Code 710), and 20% warehouse (Code 150).
Analysis Periods:	Weekday PM Peak Hour and Saturday Midday Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the TIS.
Trip Distribution/ Assignment Approach:	Based on vehicle turning movements observed at study area intersections
Analysis Tools/Software:	Traffix
LOS MOEs:	Peak-Hour V/C, LOS, Delay
Saturation Flow Rate:	1900

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
116,000 square feet of manufacturing, office, and warehouse space	Completely built out as assumed
Comments: The phase of development analyzed in the TIS was completely built.	
Traffic Growth (1999 to 2005)	
• Lower Boones Ferry Road/SW 65th Avenue: 5% • Lower Boones Ferry Road/SW 63rd Avenue: 7%	• 1% • -1%
Comments: The decrease in total intersection traffic at Lower Boones Ferry Road/SW 63rd Avenue is negligible. Predicted 2002 traffic volumes were adjusted to 2005 conditions.	
Other Developments	
No other developments analyzed	Fitness facility south of Lower Boones Ferry Road and the Bridgeport Village development west of I-5
Comments: A jurisdictional interview identified these developments; other new developments have been approved in the area but have not been built.	
Other Transportation Projects	
No transportation projects were listed in short-term capital improvement lists or Regional Transportation Plans within the study area.	None in the site vicinity.
Comments: Field observations and a jurisdictional interview concluded no new transportation projects in the site vicinity. Transportation improvements have been made west of I-5 for the Bridgeport Village development (0.5 mile from site).	
Trip Generation	
• 126 weekday PM peak hour trips (32 in, 94 out) • 800 average weekday trips	• 106 trips (16 in, 90 out) • 877 trips
Comments: The peak hour was 4 to 5 PM. Actual trip generation is 84% of the predicted trip generation. The proportion of in trips (15%) is lower than the predicted proportion (25%) of in trips. The development’s peak hour trip generation was noon to 1 PM (132 trips). The actual weekday trip generation is 91% of the predicted weekday trip generation.	
Trip Distribution	
• To/from the north on I-5: 45% • To/from the south on I-5: 25% • To/from the east on Lower Boones Ferry Road: 15% • To/from west of I-5: 15%	1999 traffic data is similar to 2002 predicted and existing traffic counts. Therefore, predicted trip distribution is assumed to be consistent with the actual trip distribution at the selected intersections.
Comments: Based on available data, actual trip distribution is unknown since access is limited to Lower Boones Ferry Road; isolating site traffic and turning movements is not possible.	

Total Intersection Traffic	
• Lower Boones Ferry Road/SW 65th Avenue: 4,333 • Lower Boones Ferry Road/SW 63rd Avenue: 2,910	• 3,949 • 2,525
Comments: Predicted intersection volumes are approximately 10% more than the actual intersection volumes.	
Individual Turning Movements	
• Lower Boones Ferry Road left-turn to SW 65th Avenue: 353 • Lower Boones Ferry Road left-turn to SW 63rd Avenue: 90 • SW 65th Avenue right-turn to Lower Boones Ferry Road: 410 • SW 63rd Avenue right-turn to Lower Boones Ferry Road: 115 • SW 65th Avenue southbound through at Lower Boones Ferry Road: 60	• 297 • 92 • 349 • 52 • 39
Comments: Actual turning movement volumes are less than the predicted traffic (45% to 86% of predicted traffic) except for the Lower Boones Ferry Road left-turn to SW 63rd Avenue where the actual traffic is approximately the same as the predicted traffic volume.	
Intersection Operations	
• Lower Boones Ferry Road/SW 65th Avenue: E • Lower Boones Ferry Road/SW 63rd Avenue: B/F (all 2002).	Actual LOS is consistent with predicted LOS at selected intersections.
Comments: Actual LOS conclusions are based on a jurisdictional interview and field observations, not empirical data.	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

Two Rivers Correctional Facility, Umatilla

Project Information

Project Type:	Correctional Facility
ODOT Region:	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☒
Location:	82911 McNary Beach Access Road, Umatilla
Number of Driveways:	1
Size of Development:	Approximately 200 acres; 1,600-bed prison
Year of Study:	1997
Consulting Engineer:	Kittleson & Associates, Inc. (Portland)
Facilities Analyzed:	13 intersections identified through discussions with the City of Umatilla, Umatilla County, ODOT, and Oregon Department of Corrections. There are eight intersections on US 730 and five intersections on US 395.

Summary of TIS

The TIS analyzed the development of a 1,600-bed correctional facility. The development was built as proposed in the TIS. The LOSs for the minor approaches at three study intersections were predicted to operate at unacceptable levels under post-development conditions, but the major street movements at these intersections were predicted to operate at acceptable levels. Since traffic volumes at these intersections were too low to warrant a signal, no mitigation was recommended or implemented. A warrant for a left-turn lane was met at US 730/McNary Beach Access Road and for right-turn lanes on US 730 and McNary Beach Access Road at the US 730/McNary Beach Access Road intersection. These mitigation items were implemented as proposed. The TIS predicted the development would generate 205 weekday PM peak hour trips.

Overall Assessment from TIS Review

- The development was built as assumed in the TIS, but the facility recently expanded from approximately 1,600 to 1,800 beds.
- The TIS overpredicted the number of trips generated during the analyzed peak hour (weekday PM). The actual weekday PM peak hour trip generation is 54% of the predicted trip generation.
- The average annual traffic growth was predicted to be 5% from 1997 to 2002 and 3% from 2002 to 2007. Since the development was completed, the average traffic growth at selected intersections was approximately 8% (annual average growth rate of approximately 1%).
- Larry Clucas, City of Umatilla, was not at the City when this TIS was submitted; however, there are no existing significant traffic problems in the site vicinity.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	2000 (post development) and 2017
Background Growth Assumptions/Rate:	5% annual growth rate from 1997 to 2002 and 3% from 2002 to 2007
Other Transportation Projects Identified:	None in site vicinity.
Trip Generation Approach:	Based on empirical data from two State of Oregon prisons of vehicular activity generated by staff and visitors. Because the ITE's *Trip Generation* contained limited data for prisons, it was not used for trip generation.
Analysis Periods:	Weekday AM and PM Peak Hour
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the site vicinity.
Other Developments Analyzed:	☐ Yes ☒ No, there were no other developments analyzed in the site vicinity.
Trip Distribution/ Assignment Approach:	Based on existing traffic patterns, population density, and traffic analysis judgment
Analysis Tools/Software:	Traffix, SIGCAP
LOS MOEs:	Peak Hour V/C, LOS, Delay
Saturation Flow Rate:	Analysis used SIGCAP

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
Approximately 200 acres, 1,600-bed prison	The development was built as planned, but additional beds were recently added to the facility.
Comments: The site was initially built as planned, but approximately 200 additional beds were recently added to the facility. The facility now has approximately 1,800 beds.	
Traffic Growth (1997 to 2005)	
• US 730/I-82 southbound ramps: 55% • US 730/I-82 northbound ramps: 58% • US 730/US 395: 59%	• 4% • 6% • 13%
Comments: The annual traffic growth was predicted to be 5% from 1997 to 2002 and 3% from 2002 to 2007. The actual average traffic growth at selected intersections was approximately 8% (annual traffic growth of approximately 1%).	
Other Developments	
No other developments were predicted or identified in the site vicinity.	There were no new developments in the site vicinity.
Comments: Field observations and interview concluded no new developments in the site vicinity.	
Other Transportation Projects	
No transportation projects were predicted or identified in the site vicinity.	There were no transportation projects in the site vicinity.
Comments: Field observations and interview concluded no new transportation improvements in the site vicinity.	
Trip Generation	
• 205 weekday PM peak hour trips (5 in, 200 out trips) • 1,400 to 1,600 trips per day	• 110 trips (3 in, 107 out) • 782 trips
Comments: The peak hour was 3 to 4 PM. Actual trip generation is 54% of the predicted trip generation. The predicted proportion of out trips (97%) is the same as the actual proportion (97%) of out trips. The actual daily trip generation is 56% of the predicted daily trip generation.	
Trip Distribution	
• West of US 395 (including I-82): 60% • US 395: 30% • Willamette Avenue: 3% • East of McNary Beach Access Road: 7%	Based on available data, actual trip distribution cannot be determined.
Comments: No trip distribution conclusions can be made with existing traffic counts. There is only one exit from the site (McNary Beach Access Road to US 730); therefore, actual trip distribution cannot be determined with available data.	

Total Intersection Traffic	
• US 730/I-82 southbound ramps: 2,024 • US 730/I-82 northbound ramps: 1,916 • US 730/US 395: 2,361	• 1,246 • 1,136 • 1,277
Comments: Actual intersection volumes are approximately 60% of the predicted intersection volumes, likely because the actual average annual traffic growth rate is lower than the predicted average annual traffic growth rate.	
Individual Turning Movements	
• US 395 right-turn to US 730: 307 • US 730 left-turn to US 395: 265 • I-84 northbound offramp right-turn to US 730: 48 • I-84 southbound offramp left-turn to US 730: 265 • US 395 eastbound through at US 730: 349	• 151 • 153 • 53 • 193 • 191
Comments: Three of the five selected turning movements are between 50% and 75% of predicted volumes.	
Intersection Operations	
• US 730/I-82 southbound ramps: C • US 730/I-82 northbound ramps: F • US 730/US 395: C	Field observation and interview confirmed no traffic issues in the area, but no intersection operation conclusions could be made.
Comments: No intersection operation conclusions at the selected intersections could be made by the interviewee (Larry Clucas, City of Umatilla).	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

WAL-MART, COTTAGE GROVE

Project Information

Project Type:	Retail Shopping Center
ODOT Region:	1 ☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐
Location:	901 Row River Road, Cottage Grove
Number of Driveways:	3
Size of Development:	75,000 square feet (Phase I); 105,000 square feet (Phase II)
Year of Study:	1994
Consulting Engineer:	JRH Transportation Engineering (Eugene)
Facilities Analyzed:	Six intersections identified by City of Cottage Grove staff

Summary of TIS

The TIS analyzed the development of a 75,000 square foot Wal-Mart store (Phase I) and assumed a 30,000 square foot expansion of the store (Phase II) by 2004; however, a Land Use Board of Appeals (LUBA) court decision limits the development to 75,000 square feet. Therefore, only Phase I has been built and Wal-Mart cannot expand at this site. The TIS concluded that the Row River Road/I-5 northbound ramps intersection met signal warrants and a signal should be installed with the development; a signal was installed at this intersection. The TIS also recommended street improvements (sidewalks, curbs, gutters) to Row River Road. A jurisdictional interview concluded these improvements were completed as part of an Urban Renewal District project, and not as part of the Wal-Mart development.

Overall Assessment from TIS Review

- Phase I of the development was built as assumed in the TIS. Phase II was analyzed in the TIS and assumed to be completed by 2004, but was not built.
- The TIS overpredicted the number of trips generated during the analyzed peak hour (weekday PM). The actual weekday PM peak hour trip generation is approximately 81% of predicted trip generation.
- Actual traffic volumes at selected intersections are approximately 30% less than the predicted intersection volumes.
- Howard Schesser, City of Cottage Grove, was not at the City when this TIS was submitted; however, there are no existing significant traffic problems in the site vicinity.

Vicinity Aerial Map

TIS Scope and Approach

Analysis Horizon Year:	1994 (post development of Phase I) and 2004 (post development of Phase II)
Background Growth Assumptions/Rate:	Annual growth rates based on historical data. Ramp connections to I-5: 3.875%; Highway 99 north of Cottage Grove Connector: 1.9%; all other roadways: 1.6%
Other Transportation Projects Identified:	None
Trip Generation Approach:	Based on ITE's *Trip Generation* (5th edition) for the anticipated land use (Code 820, Shopping Center—using the fitted curve equation for weekday PM peak hour of adjacent street traffic: Ln[Trips] = 0.637Ln[1,000 square feet gross area] + 3.553). It was assumed that 20% of trips generated would be pass-by trips.
Analysis Periods:	Weekday PM Peak Hour; TIS acknowledged peak hour traffic generated "may be on a Saturday...counts are not available to verify this assumption."
Other Developments Identified:	☐ Yes ☒ No, there were no other developments identified in the TIS.
Other Developments Analyzed:	☐ Yes ☒ No there were no other developments analyzed in the TIS.
Trip Distribution/ Assignment Approach:	Estimated the percentage of local trips versus regional trips and analyzed the distribution of local traffic of residential areas. Trip assignment was based on the shortest path on major roads.
Analysis Tools/Software:	UNSIG10, SIGCAP
LOS MOEs:	Peak-Hour LOS, Delay, Maximum Queue

Assessment of Findings

Predicted	Actual
Leasable Space/Land Use Assumptions	
75,000 square feet (Phase I); 105,000 square feet (Phase II)	Only Phase I has been built.
Comments: A LUBA decision limited the development to 75,000 square feet (Phase I only). Wal-Mart cannot expand at this site.	
Traffic Growth (1993 to 2005)	
• Cottage Grove Connector/I-5 southbound ramps: 30% • Row River Road/I-5 northbound ramps: 46% • Whiteaker Road/Thornton Road: 59%	• 3% • 13% • 28%
Comments: Actual traffic growth is approximately 50% of the predicted traffic growth (predicted 1993 traffic volumes were adjusted to 2005 conditions). The average predicted increase at the three selected intersections was 45%; the actual average increase was 15%. Actual traffic growth is lower than the predicted traffic growth despite the medical facility and senior citizen facility being built (see below).	
Other Developments	
No other developments were identified in the TIS.	Medical facility and senior citizen facility to the northeast of Wal-Mart, near I-5, off Row River Road (total of 70,800 square feet)
Comments: The medical facility and senior citizen facility were completed in 2002.	
Other Transportation Projects	
No transportation projects were identified in the TIS.	Road improvements to Row River Road and improvements at the Row River Road/I-5 northbound ramps intersection
Comments: Row River Road improvements were completed as part of an Urban Renewal District. The intersection at I-5 northbound ramps was moved further to the east.	
Trip Generation	
• 546 weekday PM peak hour trips (273 in, 273 out) • 4,528 average weekday trips	• 448 trips (223 in, 225 out) • 4,700 trips
Comments: The peak hour was 5 to 6 PM. Actual trip generation is 82% of the predicted trip generation. The proportion of in trips (50%) is the same as the predicted proportion (50%) of in trips. Actual weekday trip generation is 4% higher than the predicted weekday trip generation. Actual and predicted trips are for Phase I only (75,000 square feet).	
Trip Distribution	
• 30% regional, 70% local • 25% to/from the south • 75% to/from the north	Actual trip distribution using existing traffic count data cannot be determined.
Comments: Actual trip distribution cannot be determined with available data. Interviewee could not make an estimate of existing trip distribution.	

Total Intersection Traffic	
• Cottage Grove Connector/I-5 southbound ramps: 2,197 • Row River Road/I-5 northbound ramps: 1,463 • Whiteaker Road/Thornton Road: 923	• 1,738 • 1,133 • 740
Comments: Actual intersection volumes are approximately 80% of the predicted intersection volumes. The medical facility and senior citizen facility were predicted to add 185 PM peak hour trips to the road network. This development's TIS and the Wal-Mart TIS overpredicted total intersection traffic volumes since actual intersection traffic volumes are lower than the predicted volumes in both TISs.	
Individual Turning Movements	
• Whiteaker Road left-turn to Thornton Road: 185 • Thornton Road right-turn to Whiteaker Road: 207 • I-5 southbound off-ramp left-turn to Cottage Grove Connector: 182 • Row River Road eastbound through at I-5 northbound ramps: 404	• 160 • 170 • 301 • 353
Comments: Actual turning movement volumes are approximately 85% of predicted volumes for three of the four selected turning movements. The I-5 southbound on-ramp left turn to Cottage Grove Connector is approximately 65% higher than the predicted volume.	
Intersection Operations	
• Whitaker Road/Thornton Road: A • Row River Road/Thornton Road: B • Row River Road/I-5 northbound ramps: B	Field observation and interview confirmed no traffic issues in the area, but no intersection operation conclusions could be made.
Comments: No intersection operation conclusions at the selected intersections could be made by the interviewee (Howard Schesser, City of Cottage Grove).	

Supporting Resources

Location Map and Site Plan	Interview Summary	Site Photos
Aerial Photo	Site Video Scan	Original Traffic Counts

APPENDIX B

Trends Analysis Memorandum and Case Study Analysis Methodology

TIA Research Project: Trend Analysis Memorandum and Case Study Analysis Methodology

PREPARED FOR: Project Technical Advisory Committee:
Mark Joerger/ODOT, Project Manager
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DATE: January 30, 2006

Introduction

Traffic impact studies (TISs) are used by Oregon Department of Transportation (ODOT) and local transportation agency staff to forecast future system impacts from proposed development projects and to predict the useful life of a transportation project against a future expected land use scenario. When impacts are not accurately projected through the traffic analysis process, the best decisions may not be made by local or state transportation agencies, which can lead to localized congestion resulting in safety issues or costly, ill-timed mitigation.

Traffic impact studies require the manipulation of a number of variables to project the future functioning of a proposed improvement. Examples include forecasted trip generation, trip distribution, future traffic conditions, and capacity and performance of roadway improvements. Assumptions made about the basic variables can, in the case of development review, allow the applicant's traffic engineer to underestimate projected impacts from development or overassume available capacity. Outcomes from this situation can include unanticipated congestion and safety problems, identification of inappropriate or "throwaway" mitigation, and a "chasing-the-last-trip" phenomenon where the impacts of past projects become the burden of later development. In the case of a modernization project, a 20-year design life volume may be reached much sooner than the projected 20 years, such that the system improvement is consumed at an accelerated rate.

The overall objective of this research project is to develop a Best Practice methodology for conducting TISs. To do this, CH2M HILL examined the predictions and analysis from twelve Oregon TISs that projected future system impacts for private development proposals. The TISs were selected by the Technical Advisory Committee consisting of ODOT, local government representatives, and FHWA. The research of the 12 case study TISs analyzed key variables used in traffic analyses and assessed the performance of the variables in predicting the future. The implementation of mitigation measures was also evaluated.

Ultimately, a Best Practices document will be developed that will cover the purpose of TISs, critical variables for analysis, a menu of assumptions to be applied, and tools for conducting the analysis. These elements will comprise a guideline of what, why, and how to conduct a TIS for application to a variety of development configurations and locations.

As an intermediate step, this case study evaluation was undertaken to provide input for the Best Practices document. The purpose of this memorandum is to: (1) summarize the methodology to develop the case study sheets, and (2) document trends identified in the analysis of the case study data.

Case Study Evaluation Methodology Summary

One case study sheet was developed that summarized the analysis for each of the 12 case study sites. This sheet has been designed to succinctly communicate relevant quantitative and qualitative data pertaining to the site. In particular, the sheet documents the predicted conditions identified in the TIS, and the actual (existing) conditions based on quantitative data, site visits, and interviews. The following sections summarize the methods used to analyze the data being reported in the summary sheets for each of the 12 case study sites to identify actual conditions. The complete methodology used to create these summary sheets is included as Attachment A.

Selection of Case Study Sites

Thirty TISs were received from ODOT and reviewed by CH2M HILL. These projects primarily consisted of large, private commercial developments located on or near ODOT facilities ranging in years from 1991 to 2004. The following screening criteria were used to narrow the list of projects:

- *Horizon Year of Traffic Projections:* Studies without at least one horizon year before 2010 were eliminated from consideration since future projections could not be accurately compared to existing (2005) traffic counts.
- *Number of Driveways:* Project sites with a limited number of driveways were desirable to reduce data collection costs and the complexity of travel patterns.
- *Expansion Projects:* Projects that were considered expansion or improvement projects were eliminated from consideration in most cases because of the difficulty in identifying trips resulting from the expansion.
- *Conflict of Interest:* Any studies with conflicts of interest between the study, the respective study’s consultants, and the contractor were eliminated from consideration.

Project sites were reviewed to assure they reflected diversity in geography (at least one from each ODOT region), scale, project type, and project consultant.

The 12 projects that were recommended as project case study sites are presented in Table 1 and reflect a mix of development types. Efforts were taken to select at least one project from each ODOT region; the list of case studies includes at least one project from each ODOT region.

TABLE 1. RECOMMENDED PROJECT SITES

Project Name	Location	Prepared by
Pilot Travel Center	Stanfield	JRH Transportation Engineering
Two Rivers Correctional Facility	Umatilla	Kittelson & Associates
Jerry's Home Improvement Center	Eugene	Branch Engineering
Barger Crossing Shopping Center	Eugene	JRH Transportation Engineering
Oregon Community Credit Union	Eugene	Balzhiser & Hubbard
First Baptist Church PUD	Eugene	JRH Transportation Engineering
Costco/King Business Center	Medford	Carl Buttke, Inc.
Wal-Mart	Cottage Grove	JRH Transportation Engineering
Home Depot	The Dalles	Kittelson & Associates
Tualatin Business Center	Tualatin	DKS Associates
Clackamas Crossing Shopping Center	Clackamas County	Kittelson & Associates
Five Oaks West	Hillsboro	Group Mackenzie

Data Collection

Each case study site was visited to observe existing site conditions and compare them with the information reported in the TIS. Field observations also verified the implementation of the proposed mitigation.

Traffic data were also collected to assess the predictions from the TIS. New intersection turning movement counts were collected when existing counts newer than 2003 were unavailable from the state or local jurisdiction. New driveway tube counts were collected for the access driveways at each site to determine peak hour and daily trip generation.

A jurisdictional interview was conducted to capture qualitative contextual information for each case study site. A list of general, open-ended questions was used for all case study sites. Additional site-specific questions were used to clarify the context of the case study site and TIS. The desired information focused on reasons for deviation from the plan and secondary and indirect impacts resulting from the development approval.

Case Study Sheets

One case study sheet was completed for each of the 12 case study sites. The sections for the case study sheets were as follows:

- Project Information—basic information about the project
- Summary of TIS—key findings, as reported in the TIS
- TIS Scope and Approach—parameters used for the TIS analysis
- Assessment of Findings—the predicted conditions in the TIS and the actual (2005) conditions

To assess the findings from the TISs, a set of criteria was developed: the criteria are listed below, and a complete description of the methodology is provided in Section C of Attachment A.

- *Leasable/Land Use Assumptions:* The leasable space or land use assumptions for the case study development
- *Traffic Growth:* The percent change in total intersection traffic volume between predevelopment and actual conditions for the intersections analyzed in the TIS
- *Other Developments:* Other planned or approved developments in the vicinity of the case study development site
- *Other Transportation Projects***:** Transportation projects or improvements in the vicinity of the case study development not associated with the case study development
- *Trip Generation:* The development's peak hour trip generation and daily trip generation
- *Trip Distribution:* Estimated travel direction proportion, in percent, of the total number of trips originating at or destined for the case study site
- *Total Intersection Traffic:* Total intersection traffic volumes at the intersections analyzed in the TIS compared to actual total intersection traffic volumes
- *Selected Individual Turning Movements:* The total traffic volume of selected turning movements. Two to four through, left-turn, or right-turn movements with the highest traffic volumes to and from the site were selected for analysis.
- *Intersection Operations:* The operational conditions (level of service [LOS]) of intersections analyzed in the TIS. While ODOT analyzes operations based on volume/capacity (v/c), for case study analysis, LOS was used because jurisdictions either provided the existing LOS, or operations were estimated in the field. Also, most of the TISs used LOS, not v/c, as the operation standard.

Trends Analysis of Case Studies

Quantitative and qualitative results of the case study evaluations were conducted using the criteria described above. The purpose of the trends analysis was to illustrate similarities and differences among the TISs investigated. Figures 1 and 2 are summaries of the qualitative and quantitative TIS analyses, respectively.

Quantitative TIS Case Study Results

The Quantitative TIS Case Study Results sheet (Figure 1) is a comparison of the TIS predictions with actual conditions. Most of the criteria could be assessed using a quantitative assessment. For example, a comparison of the intersection traffic growth versus actual was developed by tabulating predicted growth rates from the TISs against the actual observed growth rates. The other criteria were evaluated in similar fashion, and the complete details are provided in Attachment A.

Qualitative TIS Case Study Results

The next step was to conduct the qualitative analysis. This analysis was done for two reasons:

- Some of the evaluation criteria could only be evaluated qualitatively; no comparative data were available or appropriate. For example, the "Interviewee Level of Satisfaction" column is the interviewee's opinion of the TIS.
- A consistent way of comparing the quantitative criteria was needed.

The qualitative assessment was completed using a constructed scale as shown in Table 2. Symbols were used to summarize the assessment for each criterion. In most cases, the assigned symbol was based on the quantitative assessment. For example, an intersection traffic growth prediction that was within 4 percent of the actual traffic growth was assigned two green solid circles. Attachment A includes specific definitions for the application of symbols for each criterion.

TABLE 2. QUALITATIVE TIS CASE STUDY RESULTS KEY

Symbol Description	Symbol	General Description
Two Green Solid Circles	●●	Actual results are consistent with TIS prediction.
One Green Open Circle	○	Actual results are consistent with TIS prediction, but do not match exactly.
One Black Triangle	▲	Actual results do not match TIS prediction, but are not all inconsistent.
One Orange Open Square	□	Actual results are inconsistent with TIS prediction.
Two Red Open Squares	□□	TIS prediction is much more conservative than actual results.
Two Red Solid Squares	■■	TIS prediction is much more optimistic than actual results.
No Symbol		TIS prediction cannot be evaluated based on available data.

FIGURE 1. QUANITATIVE TIS CASE STUDY RESULTS SHEET

Case Study Site	Intersection Traffic Growth vs. Actual	Trips Predicted (Peak Hour) vs. Actual			Trips Predicted (Daily) vs. Actual			Total Intersection Traffic vs. Actual	Selected Individual Turning Movements vs. Actual (Predicted/Actual)		
	Average Annual Intersection Traffic Growth Rate (Predicted vs. Actual)	Predicted	Actual	% Difference between Predicted and Actual Trips	Predicted	Actual	% Difference between Predicted and Actual Trips	% Difference between Predicted and Actual Intersection Volumes	Left	Right	Through
Pilot Travel Center (Stanfield)	6.7% vs. 5.5%	275	423	35% lower than actual	Not Predicted in TIA Report			-4%, +25%	73/61 300/275	323/269 72/51	362/273
Two Rivers Correctional Facility (Umatilla)	6.4% vs. -0.9%	205	110	86% higher than actual	1,500	782	92% higher than actual	+62%, +69%, +85%	265/153 265/193	307/151 48/53	349/191
Jerry's Home Improvement (Eugene)	2.9% vs. 1.8%	942	794	19% higher than actual	Not Predicted in TIA Report			-2%, +18%	84/101	402/288 32/89	
Barger Crossing Shopping Center (Eugene)	2.5% vs. -0.1%	824	1,293	36% lower than actual	8,862	16,038	45% lower than actual	-12%, +27%, +28%, +29%	288/455 208/129	271/357 294/133	45/203
Oregon Community Credit Union (Eugene)	4.2% vs. 0.5%	141	86	64% higher than actual	Not Predicted in TIA Report			+19%, +20%, +20%	63/57 1090/858	367/254 80/100	
First Baptist Church PUD (Eugene)	4.9% vs. 8.1%	76	23	230% higher than actual	1,048	358	193% higher than actual	-26%, +8%	29/4 5/1	13/5 96/144	
Costco/ King Business Center (Medford)	2.9% vs. 1.6%	416	928	55% lower than actual	7,520	10,751	30% lower than actual	+15%, +18%, +18%	33/198 192/510	100/185 70/89	
Home Depot (The Dalles)	NA*	705	278	154% higher than actual	Not Predicted in TIA Report			+27%	175/80 57/11	57/28 137/92	
Tualatin Business Center (Tualatin)	1.8% vs. 0.0%	126	106	19% higher than actual	800	877	9% lower than actual	+10%, +15%	353/297 90/92	410/349 115/52	60/39
Clackamas Crossing (Clackamas County)	2.8% vs. 1.0%	2,531	1,233	105% higher than actual	Not Predicted in TIA Report			+3%, +19%, +23%	277/104 283/127	141/89 71/15	
Five Oaks West (Hillsboro)	24.1% vs. 9.9%	507	489	4% higher than actual	Not Predicted in TIA Report			+46%, +76%	186/135 482/262	49/19 839/267	
Wal-Mart (Cottage Grove)	3.5% vs 1.1%	546	448	22% higher than actual	4,528	4,700	4% lower than actual	+25%, +26%, +29%	185/160 182/301	207/170	404/353

* Could not be calculated based on available data

FIGURE 2. QUALITATIVE TIS CASE STUDY RESULTS SHEET

Case Study Site	Site Built as Planned vs. Actual	Intersection Traffic Growth vs. Actual	Trips Predicted (Peak Hour) vs. Actual	Trips Predicted (Daily) vs. Actual	Trip Distribution vs. Actual	Total Intersection Traffic vs. Actual	Individual Turning Movements vs. Actual	Intersection Operations vs. Actual	Interviewee Level of Satisfaction
Pilot Travel Center (Stanfield)	○	▲	▲		○	○	▲	●●	●●
Two Rivers Correctional Facility (Umatilla)	●●	□	□□	□□		□□	□□		
Jerry's Home Improvement (Eugene)	●●	●●	○		○	○	□	●●	■■
Barger Crossing Shopping Center (Eugene)	▲	□	□	□	□	▲	■■	□	■■
Oregon Community Credit Union (Eugene)	○	▲	□□			○	▲	●●	○
First Baptist Church PUD (Eugene)	●●	□	□□	□□	□	○	□□	●●	●●
Costco/King Business Center (Medford)	○	○	■■	▲	▲	○	■■	□	
Home Depot (The Dalles)	▲	□□	□□			▲	□□		●●
Tualatin Business Center (Tualatin)	●●	□	○	○		○	□		●●
Clackamas Crossing (Clackamas County)	●●	○	□□		▲	○	■■	●●	○
Five Oaks West (Hillsboro)	□□	□□	●●		□□	□□	□□	□□	●●
Wal-Mart (Cottage Grove)	▲	▲	○	●●		▲	▲		
OVERALL	○	▲	□	▲	▲	▲	□	▲	○

KEY	
●●	Actual results are consistent with TIS prediction
○	Actual results are consistent with TIS prediction but do not match exactly
▲	Actual results do not match TIS prediction but are not all inconsistent
□	Actual results are inconsistent with TIS prediction
□□	TIS prediction is much more conservative than actual results
■■	TIS prediction is much more optimistic than actual results
	TIS prediction cannot be evaluated based on available data

Findings for TIS Case Study Results

This section summarizes the general themes identified from the qualitative and quantitative results (Figures 1 and 2) for each criterion analyzed in the case study sheets. A discussion of each criterion is provided below. Each criterion section is divided into three subsections: Findings, Conclusions, and Best Practice Implications. The Findings section lists the specific trend(s) or theme(s) from the TIS case study results sheet; these are summarized in the Conclusions section. The Best Practices Implications section identifies potential language or guidance for the Best Practices document.

To analyze general themes and trends in the qualitative and quantitative TIS case study result sheets, the case study sites were divided into five categories based on the general existing land use (Table 3), and three categories based on the general location of the case study site (Table 4).

TABLE 3. CASE STUDIES BY LAND USE

RETAIL
Barger Crossing Shopping Center (Eugene)
Clackamas Crossing (Clackamas County)
Costco/King Business Center (Medford)
Home Depot (The Dalles)
Jerry's Home Improvement (Eugene)
Wal-Mart (Cottage Grove)
INDUSTRIAL/MANUFACTURING/OFFICE
Five Oaks West (Hillsboro)
Oregon Community Credit Union (Eugene)
Tualatin Business Center (Tualatin)
PRISON
Two Rivers Correctional Facility (Umatilla)
TRAVEL CENTER
Pilot Travel Center (Stanfield)
CHURCH
First Baptist Church PUD (Eugene)

TABLE 4. CASE STUIDES BY LOCATION

URBAN
Barger Crossing Shopping Center (Eugene)
Clackamas Crossing (Clackamas County)
Costco/King Business Center (Medford)
Oregon Community Credit Union (Eugene)
Tualatin Business Center (Tualatin)
MEDIUM SIZED TOWN OR URBAN FRINGE
First Baptist Church PUD (Eugene)
Five Oaks West (Hillsboro)
Home Depot (The Dalles)
Jerry's Home Improvement (Eugene)
Wal-Mart (Cottage Grove)
RURAL
Two Rivers Correctional Facility (Umatilla)
Pilot Travel Center (Stanfield)

To improve readability, the identification numbers in Table 5 were used rather than citing the development name.

TABLE 5. CASE STUDY SITE IDENTIFICATION NUMBERS

ID No.	Development	Location
1	Pilot Travel Center	Stanfield
2	Two Rivers Correctional Facility	Umatilla
3	Jerry's Home Improvement Center	Eugene
4	Barger Crossing Shopping Center	Eugene
5	Oregon Community Credit Union	Eugene
6	First Baptist Church PUD	Eugene
7	Costco/King Business Center	Medford
8	Home Depot	The Dalles
9	Tualatin Business Center	Tualatin
10	Clackamas Crossing Shopping Center	Clackamas County
11	Five Oaks West	Hillsboro
12	Wal-Mart	Cottage Grove

Leasable Space/Land Use Assumptions

Description

These assumptions are the leasable space or land use assumptions for the case study development as documented in the TIS compared to the actual building size or land uses identified from the site visit and jurisdictional interview.

Findings

1. Eight of the 12 sites (1, 2, 3, 5, 6, 7, 9, and 10) were built as planned in the TIS.
2. Three (4, 8, and 12) of the four sites not built as planned were retail sites. Site 12 (Wal-Mart) was not expanded as predicted in the TIS; site 8 (Home Depot) did not include retail buildings as predicted in the TIS; and site 4 (Barger Crossing) included land uses that were not assumed in the TIS.
3. The one site (11) that was not built as planned in the TIS was underdeveloped. This site (Five Oaks West) did not anticipate an economic recession and similarly zoned land in the area.

Conclusions

1. Two-thirds of the sites were built as planned in the TIS with no changes in the first 5 years.
2. Of the four sites not built as planned, three were retail sites. These sites either included land uses not assumed in the TIS, or the TIS included land uses not actually built with the development.
3. One site was underdeveloped because of the economic assumptions for full buildout in the TIS; the TIS did not account for or predict excess commercial and leasable space in the site vicinity.

Potential Best Practices Implications

1. Because retail sites can have several land uses, consider requiring retail sites to specifically cite all known land uses, apply the appropriate Institute of Transportation Engineers (ITE) land use code for the identified land uses, and apply conservative assumptions for unknown land uses.
2. Consider local and economic conditions when predicting site buildout in a TIS; also consider the availability and demand for similarly zoned land in the vicinity of the proposed development when predicting site buildout in a TIS.

Intersection Traffic Growth

Description

Intersection traffic growth is the predicted 2005 intersection traffic volume divided by the predevelopment (existing conditions in the TIS) intersection traffic volume (converted into percent change) compared to the actual intersection traffic volume divided by the predevelopment (existing conditions in the TIS) intersection traffic volume (converted into percent change).

Findings

1. The three sites (3, 7, and 10) with predicted intersection traffic growth within 20 percent of the actual intersection traffic growth were retail sites. The predicted land uses at each of these sites were consistent with the actual land uses.
2. Two TISs (8 and 11) overpredicted by more than 50 percent intersection traffic growth. This occurred because these TISs overpredicted site development.
3. There were no identifiable trends in intersection traffic growth for the other seven sites.

Conclusions

1. The predicted site development in a TIS has a strong effect on intersection traffic growth.
2. The sites most accurate in predicting total intersection traffic growth were retail sites.

Potential Best Practices Implications

1. Consider requiring conservative predicted intersection volume analysis (that is, a range of potential intersection traffic volumes with different land use assumptions) when all land uses have not been identified for a development.

Peak Hour Trip Generation

Description

Peak hour trip generation is the development's predicted peak hour trip generation as documented in the TIS compared to the development's actual peak hour trip generation.

Findings

1. The predicted peak hour trip generation for six TISs (2, 5, 6, 7, 8, and 10) were not within 50 percent of actual peak hour trip generation. Five sites overpredicted, and one underpredicted peak hour trip generation.
2. The predicted peak hour trip generation for four TISs (3, 9, 11, and 12) were within 20 percent of the actual peak hour trip generation; two of these sites were office and two were retail.
3. The predicted peak hour trip generation for four (4, 7, 8, and 10) of the six retail sites were off by more than 35 percent.

Conclusions

1. In many cases, the TISs used conservative trip generation assumptions that overpredicted peak hour trip generation by more than 50 percent.
2. The most accurate peak hour trip generation land use was office/industrial; no determination as to why this occurred could be made with such a small sample size.
3. The least accurate peak hour trip generation land use was retail. This was expected since retail sites can have many land uses and not all land uses were known for the retail case study sites.

Potential Best Practice Implications

1. Provide guidance for determining a range of peak hour trip generation rate predictions, possibly using more than one ITE land use code, when not all of a development's land uses are known.
2. Provide guidance on ITE land use code selection, and consider requiring agency approval.
3. Provide guidance on the use of the ITE fitted curve equation or average rate for trip generation analysis.

Daily Trip Generation

Description

Daily trip generation is the development's predicted daily trip generation as documented in the TIS compared to the development's actual daily trip generation. Predicted and actual daily trip generation data were available for 6 of the 12 sites.

Findings

1. Two TISs (2 and 6) overpredicted daily trip generation by more than 50 percent. The sites were built as planned and were one land use (prison and church); therefore, the trip generation analysis was likely conservative.
2. Two retail sites (4 and 7) analyzed daily trip generation, and both underpredicted daily trip generation by more than 20 percent.
3. There were no identifiable trends in trip generation for the other two TISs (9 and 12); 6 of the 12 TISs did not analyze daily trip generation.

Conclusion

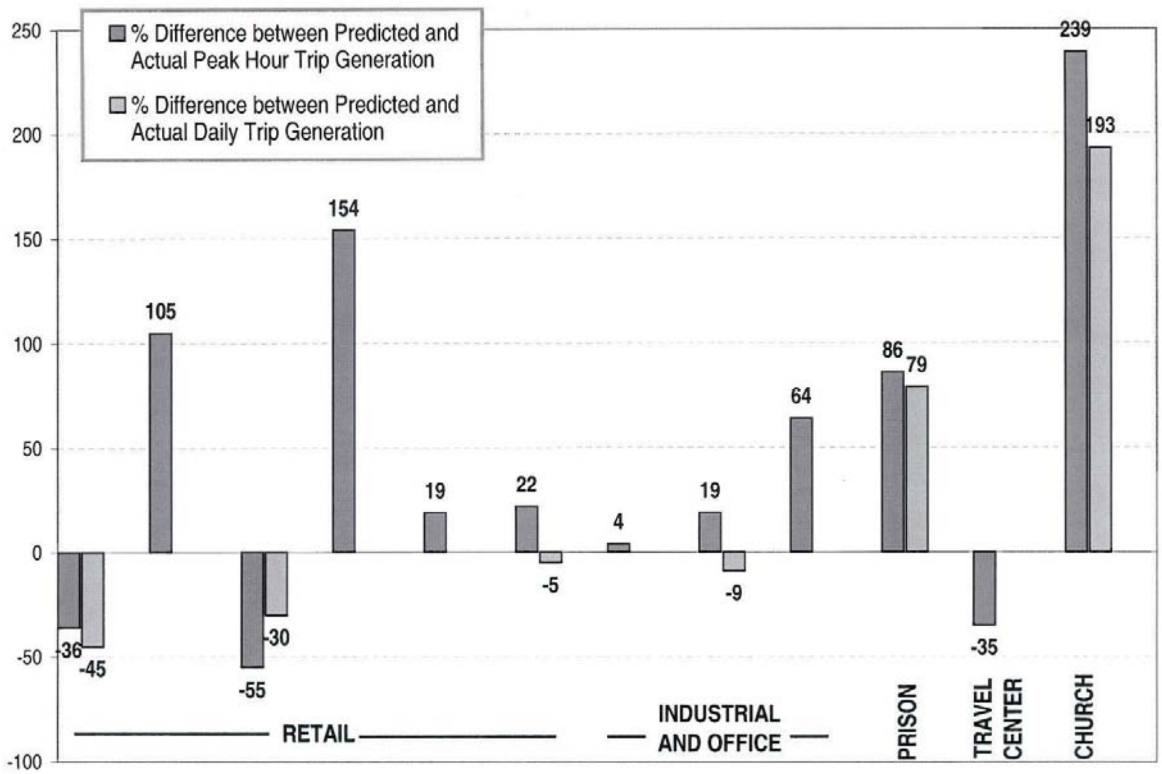
1. In many cases, the TISs had conservative trip generation analysis that resulted in daily trip generation predictions higher than actual daily trip generation.

Potential Best Practice Implication

1. Consider requiring daily trip generation analysis for certain land uses, locations, or for all developments.

Figures 3 is a graphical summary of peak hour and daily trip generation by land use.

FIGURE 3. PERCENT DIFFERENCE IN TRIP GENERATION (PREDICTED VS. ACTUAL) BY CASE STUDY LAND USE



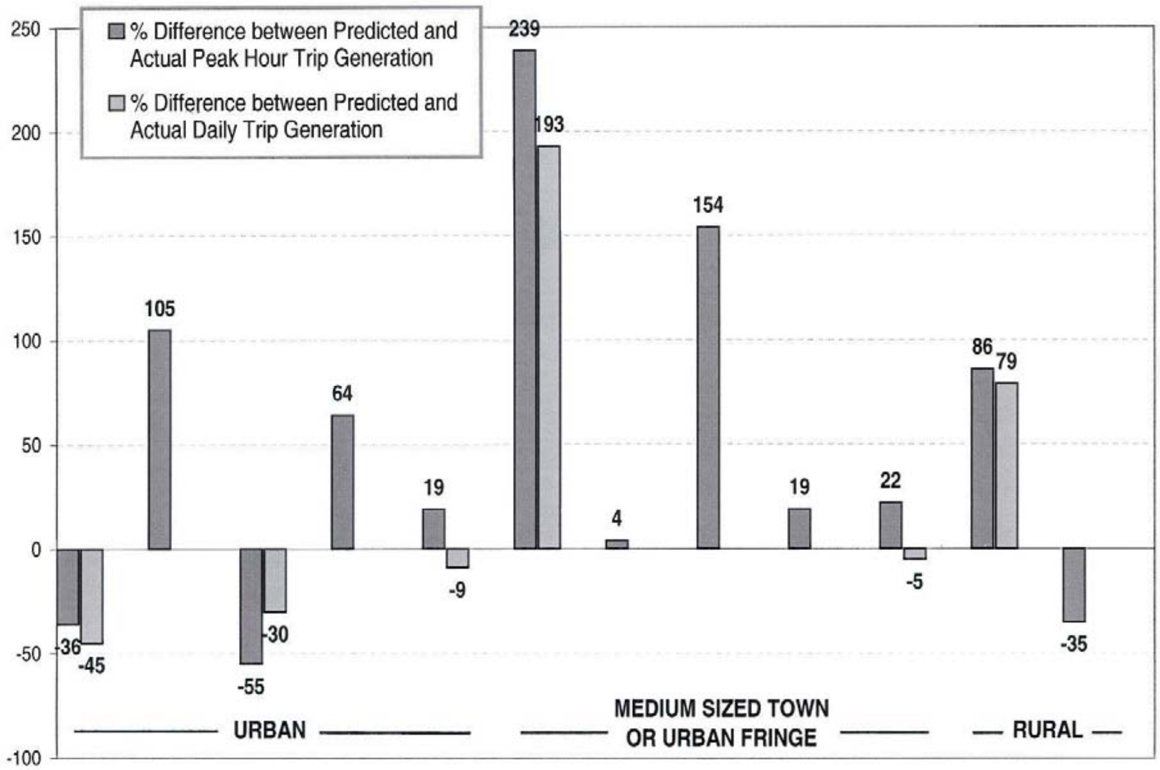
The Figure 3 findings are as follows:

1. The predicted peak hour trip generation was higher than the actual peak hour trip generation for all three industrial/office sites (5, 9, and 11).
2. The actual daily trip generation was higher than the predicted daily trip generation for four (4, 7, 9, and 12) of the six sites where data were available.

In general, there are no other identifiable trends between land uses for daily or peak hour trip generation for the case study sites.

Figures 4 is a graphical summary of peak hour and daily trip generation by location.

FIGURE 4. PERCENT DIFFERENCE IN TRIP GENERATION (PREDICTED VS. ACTUAL) BY CASE STUDY LOCATION



The Figure 4 findings are as follows:

1. The actual daily trip generation was higher than the predicted daily trip generation for all three urban sites (4, 7, and 9) where data were available.
2. The predicted peak hour trip generation was higher than the actual peak hour trip generation for all five medium-sized town or urban fringe sites (3, 6, 8, 11, and 12).

Trip Distribution

Description

Trip distribution is the estimated travel direction proportion, in percent, of the total number of trips originating at or destined for the case study site. Predicted and actual trip distribution data were available for 7 of the 12 sites.

Findings

1. Two TISs (1 and 3) predicted trip distribution within 20 percent of the actual trip distribution. Access control, no infrastructure improvements, and stagnant growth in the site vicinity may explain why trip distribution was within 20 percent of the actual trip distribution.
2. The variance for three TISs (4, 6, and 11) was more than 35 percent between predicted and actual trip distribution because development in the vicinity of the sites was not predicted. For example, the Five Oaks development did not predict growth to the east of the site at the US 26 and Cornelius Pass interchange.

3. Two TISs (7 and 10), representing two of the four retail sites with trip distribution data available, predicted trip distribution within 20 to 34 percent of the actual trip distribution.

Conclusions

1. The future trip distribution for areas predicted to be similar to existing conditions (that is, low average growth rate, no roadway improvements) would likely be similar to existing conditions.

2. Development not predicted in the TIS can have a significant effect on trip distribution, especially if the site is not built as predicted in the TIS.

Potential Best Practices Implications

1. Provide guidance on determining planned infrastructure improvements, planned or approved developments, and annual growth rate when predicting trip distribution.

2. Provide guidance on considering the impact of access control on a development's trip distribution.

Total Intersection Traffic

Description

These totals are the predicted total traffic volumes for the intersections analyzed in the TIS compared to the actual total traffic volume for the same intersections.

Findings

1. Total intersection traffic predictions for seven TISs (1, 3, 5, 6, 7, 9, and 10) were within 20 percent or less of the actual total intersection traffic. No trends could be identified on the type of development (land use) or location.

2. Two TISs (2 and 11) overpredicted total intersection traffic by more than 50 percent. These sites are in areas where traffic growth was predicted but did not occur; the actual total intersection traffic volumes were lower than predicted.

Conclusions

1. The predicted total intersection traffic for a majority of the TISs were consistent (within 20 percent) of the actual total intersection traffic.

2. TIS traffic growth assumptions affect total intersection traffic volumes.

Potential Best Practices Implication

1. Provide a detailed process for agency approval of growth rates to be used for traffic analysis.

Selected Individual Turning Movements

Description

These movements are the predicted traffic volumes for selected turning movements as documented in the TIS and compared to the actual traffic volumes for the same selected turning movement volumes.

Findings

1. No TISs predicted individual turning movement volumes within 20 percent of actual turning movement volumes.

2. Four TISs (2, 6, 8, and 11) overpredicted individual turning movements by more than 50 percent. Turning movement volumes were lower than predicted for three of the sites (2, 8, and 11) because the predicted annual growth rate was higher than the actual annual growth rate. The turning movement volumes for the fourth site were affected by an actual trip generation that was higher than predicted.

3. Three TISs (4, 7, and 10) underpredicted individual turning movement volumes by 50 percent or more. Additional land uses and buildings were added to two of the sites (4 and 7). An oil change facility and coffee shack were built at site 4, and a fueling facility was built at site 7 several years after the initial development opened. These land use changes could have affected turning movement volumes. No determination could be made for the large difference between actual and predicted turning movement volumes for site 10.

Conclusions

1. Turning movement volumes are affected by trip generation and the predicted annual traffic growth rate used in the TIS.

2. Land use changes to the site after approval of the TIS affects turning movement volumes.

Potential Best Practices Implications

1. Suggest more analysis of turning movement volumes since intersection LOS and mitigation are influenced by the predicted turning movement volumes.

2. Provide a process for agency approval of growth rates to be used in TIS analysis.

3. Consider additional traffic impact analysis for expansions of existing developments.

Intersection Operations

Description

These operations are the predicted intersection operations (LOS) for the horizon year closest to 2005 as documented in the TIS and compared to the actual (existing) LOS, based on field observations from the site visit and jurisdiction interview. Predicted and actual intersection operations data were available for 8 of the 12 sites.

Findings

1. The predicted LOSs at five sites (1, 3, 5, 6, and 10) were consistent with the actual LOS estimates for all analyzed intersections. These five sites also were built as planned in the TIS and intersection traffic was within 20 percent of the actual intersection volume.

2. For two sites (4 and 7), the actual LOS for a majority of the analyzed intersection were worse than the TIS prediction. This may have occurred because of additional site development not included in the TIS. For example, an oil change facility and

coffee shack were built at site 4 and a fueling facility at site 7 several years after the initial development opened.

3. For one site (11), the actual LOS estimates for all three analyzed intersections were better than predicted because the development was approximately 30 percent built.

Conclusions

1. When a development was built as planned, the predicted LOS analysis was consistent with the actual LOS.
2. The study intersection LOS is affected by the site being built as planned in the TIS.
3. Land uses not analyzed in the TISs affected intersection LOS in the site vicinity.

Potential Best Practices Implications

1. Provide LOS standards and guidance for study intersection LOS analysis.
2. Include statements of continual agency development monitoring to assure the development was built as planned in the approved TIS.
3. Consider requiring additional TISs for land uses not analyzed in the approved TIS.

Overall Summary of Case Study Trends

The following is a summary of the nine criteria analyzed from the case study sheets.

- The criteria where the TIS predictions were most consistent with actual conditions were:
  1. Interviewee Level of Satisfaction
  2. Site Built as Planned
- The criteria where the TIS predictions were partially consistent with actual conditions were:
  3. Intersection Operations
  4. Total Intersection Traffic
  5. Daily Trips Predicted
  6. Trip Distribution
  7. Intersection Traffic Growth
- The criteria where the TIS predictions were least consistent with actual conditions were:
  8. Peak Hour Trips Predicted
  9. Individual Turning Movements

Attachment A

TIS Research Project—Case Study Analysis Methodology

Purpose

The purpose of this document is to record the methods used to develop the individual case studies. Conducting this research the same way for each site makes it possible to compare similarities from one site to another.

The organizational structure of this document includes detailed information on data collection, the case study summary sheets, the information used to evaluate the case studies, and the criteria used to compare the predicted results, both quantitatively and qualitatively.

A. Selection of Case Study Sites

- A1. Case Study Sites

B. Data Collection

- B1. Site Visit
- B2. Existing Traffic Counts
- B3. Jurisdiction Telephone Interviews

C. Information Used to Evaluate the Case Studies

- C1. Leasable/Land Use Assumptions
- C2. Intersection Traffic Growth
- C3. Other Developments
- C4. Other Transportation Projects
- C5. Trip Generation
- C6. Trip Distribution
- C7. Total Intersection Traffic
- C8. Selected Individual Turning Movements
- C9. Intersection Operations

D. Qualitative Summary Sheet

- D1. Site Built as Planned versus Actual
- D2. Intersection Traffic Growth versus Actual
- D3. Trips Predicted (Peak Hour) versus Actual
- D4. Trips Predicted (Daily) versus Actual
- D5. Trip Distribution versus Actual
- D6. Total Intersection Traffic versus Actual
- D7. Selected Individual Turning Movements versus Actual
- D8. Intersection Operations versus Actual
- D9. Interviewee Level of Satisfaction

E. Quantitative Summary Sheets

- E1. Intersection Traffic Growth versus Actual
- E2. Trips Predicted (Peak Hour) versus Actual
- E3. Trips Predicted (Daily) versus Actual
- E4. Total Intersection Traffic versus Actual
- E5. Selected Individual Turning Movements versus Actual

A. Selection of Case Study Sites

Thirty traffic impact studies (TIS) were received from Oregon Department of Transportation (ODOT) and reviewed by CH2M HILL. These projects primarily consisted of large, private commercial developments located on or near ODOT facilities ranging in years from 1991 to 2004. Table A-1 summarizes information about each study and includes pertinent information with regards to preliminary evaluation. The following screening criteria were used to narrow the list of projects:

- *Horizon Year of Traffic Projections:* Studies without at least one horizon year before 2010 were eliminated from consideration since future projections could not be accurately compared to existing traffic counts.
- *Number of Driveways:* Project sites with a limited number of driveways were desirable to reduce data collection costs and the complexity of travel patterns.
- *Expansion Projects:* Projects that were considered expansion or improvement projects were eliminated from consideration in most cases due to the difficulty in identifying trips resulting from the expansion.

- *Conflict of Interest:* Any studies with conflicts of interest between the study, the respective study's consultants, and the contractor were eliminated from consideration.

Project sites were reviewed to assure they reflect diversity in geography (at least one from each ODOT region), scale, project type, and project consultant.

Projects that were recommended for elimination are identified with a ~~strikethrough~~ in Table A-1. The eliminated projects are coded with a shade based on the reason for removal. Table A-2 provides a key for these shades and summarizes the results of Table A-1.

TABLE A-1. INITIAL LIST OF PROJECT SITES

ID No	Project Name	Location	Adjacent Roadway Type—Name	ODOT Region	Size of Development (acres)	Type of Development	# of Driveways	Report Year	Horizon Years	Prepared by
~~1~~	~~Baker City Shopping Center~~	~~Baker City~~	~~District Hwy 7~~	~~5~~	~~3.7~~	~~Retail Center~~	~~2~~	~~1999~~	~~????~~	~~Lancaster Engineering~~
~~2~~	~~DC 37 Cook Site~~	~~Hermiston~~	~~OR 54 (US 395)~~	~~5~~	~~27.5~~	~~Distribution Center~~	~~1~~	~~1995~~	~~2014~~	~~Bovay Northwest~~
3	Pilot Travel Center	Stanfield	US 395, I-84	5	18.0	Truck Stop	2	1995	1995, 2015	JRH Transp. Engineering
~~4~~	~~Wal-Mart~~	~~Ontario~~	~~I-84~~	~~5~~	~~4.6~~	~~Retail Center~~	~~5~~	~~2001~~	~~2005, 2010, 2020~~	~~Keller Associates~~
5	Two Rivers Correctional Facility	Umatilla	McNary Beach Access Road	5	1,600 beds	Prison	1	1997	2000, 2017	Kittelson & Associates
~~6~~	~~Pendleton Retail Center~~	~~Pendleton~~	~~I-84~~	~~5~~	~~68.0~~	~~Retail Center~~	~~2~~	~~1994~~	~~2014~~	~~Kittelson & Associates~~
~~7~~	~~Klamath Falls Commercial Dev.~~	~~Klamath Falls~~	~~OR 39~~	~~3~~	~~5.2~~	~~Retail Center~~	~~1/2~~	~~2001~~	~~2002, 2017~~	~~Kittelson & Associates~~
~~8~~	~~Hines-New Best Western Site~~	~~Hines~~	~~US 20~~	~~5~~	~~under 5 acres~~	~~Truck Stop + Motel~~	~~4~~	~~1997~~	~~1997, 2017~~	~~David Evans & Associates~~
9	Jerry's Home Improvement Center	Eugene	OR 99	2	1.8	Retail Center	2	1994	1994, 2000	Branch Engineering
~~10~~	~~Biggs Junction Pilot Travel Center~~	~~Biggs Junction~~	~~I-84, US 97~~	~~5~~	~~6.2~~	~~Truck Stop~~	~~5~~	~~2001~~	~~2002~~	~~Kittelson & Associates~~
11	Barger Crossing Shopping Center	Eugene	(SH) Beltline Road	2	15.0	Retail Center	4	1996	1996, 2015	JRH Transportation Engineering
~~12~~	~~Fairway Loop Development~~	~~Eugene~~	~~I-105~~	~~2~~	~~4.8~~	~~Two office buildings 12 residential units~~	~~3~~	~~1999~~	~~2000, 2020~~	~~Access Engineering~~

ID No	Project Name	Location	Adjacent Roadway Type—Name	ODOT Region	Size of Development (acres)	Type of Development	# of Driveways	Report Year	Horizon Years	Prepared by
~~13~~	~~Costco Wholesale - Gas Station~~	~~Eugene~~	~~(SH) Beltline Rd.~~	~~2~~	~~0.4~~	~~Gas station addition to Retail Center~~	~~2~~	~~1999~~	~~2000~~	~~Barghausen Consulting~~
~~14~~	~~Summer Oaks~~	~~Eugene~~	~~(SH) Beltline Rd.~~	~~2~~	~~20.0~~	~~Office and Light Industrial~~	~~6~~	~~2000~~	~~2001, 2006, 2016~~	~~Balzhiser & Hubbard~~
15	Oregon Community Credit Union	Eugene	(SH) Beltline Rd.	2	2.3	Office Building	1	2000	2001, 2006	Balzhiser & Hubbard
~~16~~	~~Summer Oaks Crescent Center PUD~~	~~Eugene~~	~~Crescent Ave. (local arterial)~~	~~2~~	~~4.3~~	~~Mixed commercial~~	~~2~~	~~2001~~	~~2007~~	~~JRH Transportation Engineering~~
17	First Baptist Church PUD	Eugene	Coburg Rd. (local arterial)	2	2.6	Church	2	2001	2002/ 2007	JRH Transportation Engineering
~~18~~	~~Crescent Village PUD~~	~~Eugene~~	~~Crescent Ave. (local arterial)~~	~~2~~	~~39.0~~	~~Mixed uses~~	~~NA~~	~~2003~~	~~2010~~	~~JRH Transportation Engineering~~
~~19~~	~~Wal-Mart Expansion~~	~~Eugene~~	~~W. 11th Ave. and Commerce St.~~	~~2~~	~~20.5~~	~~Retail Center Expansion~~	~~2~~	~~2004~~	~~2015~~	~~PacLand~~
~~20~~	~~Old Mill Site~~	~~Bend~~	~~numerous local~~	~~4~~	~~270.0~~	~~Mixed uses~~	~~8~~	~~1999~~	~~2004/ 2019~~	~~Kittelson & Associates~~
21	Costco/King Business Center	Medford	OR 62- Crater Lake Hwy	3	2.7	Retail Center	2	1991	1992/ 2015	Carl Buttke, Inc.
~~22~~	~~Green District Industrial Area~~	~~Douglas County~~	~~I-5 and OR 99~~	~~3~~	~~295.0~~	~~Industrial Area~~	~~7~~	~~1995~~	~~2015~~	~~Lancaster Engineering~~
23	Wal-Mart	Cottage Grove	I-5 and OR 99	2	?	Retail Center	3	1994	1994/ 2004	JRH Transportation Engineering
~~24~~	~~Speedway Industrial Rezone~~	~~Roseburg~~	~~I-5 OR 99 OR 42~~	4	~~15.0~~	~~Industrial Area~~	~~1~~	~~1997~~	~~2015~~	~~Lancaster Engineering~~
25	Home Depot	The Dalles	Chenowith Loop Rd. and 6th Street	4	3.0	Retail Center	3/4	2003	2004/ 2009	Kittelson & Associates
26	Tualatin Business Center	Tualatin	I-5	1	2.7	Office and Light Industrial	6	1999	2002	DKS Associates

ID No	Project Name	Location	Adjacent Roadway Type—Name	ODOT Region	Size of Development (acres)	Type of Development	# of Driveways	Report Year	Horizon Years	Prepared by
27	Clackamas Crossing Center	Clackamas County	Hwy. 213 (SE 82nd), I-205	1	7.4	Retail Center	4	1993	1994/2010	Kittelson & Associates
~~28~~	~~Winmar Southshore Phase II~~	~~Gresham~~	~~US 30 (Sandy Blvd.), I-84~~	~~1~~	~~107.0~~	~~Industrial Area~~	~~3~~	~~1998~~	~~2000/2005~~	~~Kittelson & Associates~~
29	Five Oaks West	Hillsboro	US 26	1	62.6	Industrial Area	1	1998	2003/2018	Group Mackenzie
~~30~~	~~Home Depot~~	~~Beaverton~~	~~Hwy 217~~	~~1~~	~~3.8~~	~~Retail Center~~	~~1~~	~~1998~~	~~2000/2015~~	~~Kittelson & Associates~~

TABLE A-2. REASON FOR RECOMMENDED ELIMINATION

Reason	Projects Eliminated (ID Numbers)
Project's horizon years too far in the future (after 2010)	1, 2, 6, 18, 22, 24
Number of driveways and access points	4, 7, 8, 10, 12, 14, 20, 23, 30
Expansion Projects (difficult to separate trips)	13, 17,19
Potential conflict of interest (consultant)	28 (Winmar)

A1. Case Study Sites

The 12 projects that were recommended as project case study sites are presented in Table A-3. Efforts were taken to select at least one project from each ODOT region; the list of case studies includes at least one project from each ODOT region. The projects also reflect a mix of development types.

TABLE A-3. CASE STUDY SITES

ID No	Project Name	Location	Prepared by
3	Pilot Travel Center	Stanfield	JRH Transportation Engineering
5	Two Rivers Correctional Facility	Umatilla	Kittelson & Associates
9	Jerry's Home Improvement Center	Eugene	Branch Engineering
11	Barger Crossing Shopping Center	Eugene	JRH Transportation Engineering
15	Oregon Community Credit Union	Eugene	Balzhiser & Hubbard
17	First Baptist Church PUD	Eugene	JRH Transportation Engineering
21	Costco/King Business Center	Medford	Carl Buttke, Inc.
23	Wal-Mart	Cottage Grove	JRH Transportation Engineering
25	Home Depot	The Dalles	Kittelson & Associates
26	Tualatin Business Center	Tualatin	DKS Associates
27	Clackamas Crossing Shopping Center	Clackamas County	Kittelson & Associates
29	Five Oaks West	Hillsboro	Group Mackenzie

B. Data Collection

B1. Site Visit

Each case study site was visited to observe existing site conditions and to compare them with approved development plans as reported in the TIS. Office preparation included noting the following site attributes for observation and record:

- Existing lane configurations
- Access points and driveways
- Site development and land uses

- Adjacent land uses
- Intersection operations
- Traffic operations
- Trip distribution
- Travel patterns

Field observations verified the implementation of the proposed mitigation identified in the TIS. Other notable observations were made regarding the following:

- Function of transportation network
- Other identified transportation projects underway
- Verification of other unrelated planned developments identified in the TIS

A short site scan video of approximately 15 seconds of each site was recorded and digital photographs were taken at each site to complete field site visit documentation.

B2. Existing Traffic Counts

ODOT and the jurisdiction in which each individual case study was located were contacted to obtain current intersection turning movement counts. These turning movement counts were used if the data were no older than 2003. Where counts were unavailable, new intersection turning movement counts were collected to match the analyzed peak hours in the corresponding TIS. These peak hours were either the weekday p.m. peak hour (4 to 6 p.m.) or the Saturday midday peak hour (noon to 2 p.m.).

Twenty-four-hour driveway tube counts were collected for all nondelivery truck access points at each case study site. The day of the week was selected to correspond to the peak hour analyzed in the TIS (that is, if the TIS analyzed the weekday p.m. peak hour, driveway tube counts were obtained for the weekday p.m. peak hour). If there was more than one peak hour analyzed in the TIS, the peak hour with the highest trip generation was selected from the new counts for comparison. The sum of all driveway tube counts for each site was used to determine the peak hour of trip generation.

All new individual turning count data collection and driveway and access tube counts were collected between July 2005 and September 2005.

B3. Jurisdiction Telephone Interviews

The purpose of the jurisdictional telephone interview was to capture qualitative contextual information for each case study site. Each jurisdiction in which the case study was located was contacted to determine the appropriate person with site specific knowledge to interview from among the following roles: Traffic Engineer, Public Works Director, Planning Director, or Transportation Planner. If necessary, more than one person was interviewed. Interviews were conducted over the telephone and took approximately 15 to 60 minutes in length, depending on the interviewee’s knowledge of the TIS, the development, existing traffic operation, or land use conditions in the vicinity of the case study site.

Interview questions were open-ended and applied generically to all case study sites. Additional site-specific questions were developed to clarify the context of the case study site and TIS. The general questions were:

- Are you familiar with this project? Are you familiar with this developer or this traffic engineer?
- Were you with your agency when the original application was made? If not, were you familiar with this project at the time of approval, and in what capacity?
- Has the city made changes to their development or traffic impact study requirements that would have changed the conditions of development from what was allowed? If yes, why were the changes made? Was the development built as planned? If not, what changed? Were there political considerations that changed the implementation of any mitigation issues?
- Are there any critical traffic issues in the vicinity (either related to the development or otherwise)?
- Were there any particular issues related to the approval of the traffic impact study?
- Have you had any particular experience related to this specific developer or type of project that required special consideration on this traffic impact study?
- In the TIS, the use of travel demand models was reported as [X]. In retrospect, was that appropriate given the available models and the scope of the study? If the study were repeated today, would another approach be used or recommended? More specifically, would it be appropriate to rerun a regional travel demand model considering the changes in land use from the project?
- The traffic impact study noted that it was assumed that [developments X and Y were built] or [a future growth rate of Z percent was expected]. Will this still occur? If not, why not?
- Have there been any large developments that were not identified by the traffic impact study (that is, other future development)?
- Did the developer make all the improvements assumed in the study?
- Are all the improvements assumed to be done by others (state, county, city, or other development) have been completed? If not, why not?
- Are there unintended consequences of this development, either positive or negative, that we have missed that you would like to comment on?

Interview summary notes were taken by the project team and a summary of each case study interview was developed.

C. Information Used to Evaluate the Case Studies

This section summarizes assessment used on the case study sheets for the 12 case study sites. Each TIS was used to develop a case study sheet. The main titles of the sections on the case study sheets were: Project Information, Summary of TIS, TIS Scope and Approach, and Assessment of Findings. This section outlines the methodology for each criterion in the Assessment of Findings section of the case study summary sheets.

Note: If the case study's TIS did not analyze year 2005, the traffic volumes in the TIS for the horizon year closest to 2005 were adjusted to 2005 volumes using algebraic interpolation or extrapolation. For example, if the predicted growth rate in the TIS was 3 percent, and the closest horizon year analyzed in the TIS was 2003, the traffic volumes were increased by 3 percent to obtain 2004 volumes, then 2004 volumes were increased by 3 percent to obtain 2005 conditions.

C1. Leasable Space/ Land Use Assumptions

Measure

The leasable space or land use assumptions for the case study development.

Method

Predicted: The leasable space or land use assumptions for the case study development as documented in the TIS.

Actual: The actual building size or land uses identified from the site visit or jurisdictional interview.

C2. Traffic Growth

Measure

The percent change in total intersection traffic volume between predevelopment and actual conditions for the intersections analyzed in the TIS.

Method

Predicted: The predicted 2005 intersection traffic volume divided by the predevelopment (existing conditions in the TIS) intersection traffic volume, then converted into percent change.

Actual: The actual intersection traffic volume (Section B2) divided by the predevelopment (existing conditions in the TIS) intersection traffic volume, then converted into percent change.

C3. Other Developments

Measure

Other planned or approved developments in the vicinity of the case study development site.

Method

Predicted: Other planned or approved developments identified in the TIS and included in the post development or horizon year traffic analysis.

Actual: All approved or built developments in the site vicinity identified during the site visit (Section B1) or jurisdiction telephone interview (Section B3).

C4. Other Transportation Projects

Measure

Transportation projects or improvements in the vicinity of the case study development not associated with the case study development.

Method

Predicted: The transportation projects or improvements identified in the TIS not associated with the case study development.

Actual: All transportation projects or improvements in the site vicinity not associated with the case study development identified during the site visit (Section B1) or jurisdiction telephone interview (Section B3).

C5. Trip Generation

Measure

The development's peak hour trip generation and daily trip generation.

Method

Predicted: The development's predicted peak hour trip generation as documented in the TIS and the predicted daily trip generation, if documented in the TIS.

Actual: Existing driveway counts (from Section B2) were summed to determine the peak hour of trip generation for the development. In some cases, the development's peak hour of trip generation was not the same as the peak hour of the adjacent street. If this occurred, the development's peak hour of trip generation was documented on the case study summary sheet, but the development's trip generation during the adjacent street's peak hour was used for analysis in order to analyze the peak traffic volumes of the adjacent streets. The actual trip generation was compared to the predicted trip generation and the predicted proportion of in and out trips.

C6. Trip Distribution

Measure

Estimated travel direction proportion, in percent, of the total number of trips originating at or destined for the case study site.

Method

Predicted: The predicted trip distribution cited in the TIS for the year closest to 2005.

Actual: If sufficient turning movement data were available (from existing traffic counts, Section B2), trip distribution was calculated based on turning movements to and from the case study site. If no quantitative trip distribution conclusions could be made based on available data, a qualitative assessment summary was provided based on available data or jurisdictions interview (Section B3) or no conclusions on actual trip distribution were made on the case study summary sheet.

C7. Total Intersection Traffic

Measure

Total intersection traffic volumes at the intersections analyzed in the TIS compared to actual total intersection traffic volumes.

Method

Predicted: The predicted total traffic volumes for the intersections analyzed in the TIS study.

Actual: The actual total traffic volume (Section B2) for the intersections analyzed in the TIS study.

C8. Selected Individual Turning Movements

Measure

The total traffic volume of selected turning movements. Two to four through, left-turn, or right-turn movements with the highest traffic volumes to and from the site were selected for analysis.

Method

Predicted: The predicted traffic volumes for the selected turning movements as documented in the TIS.

Actual: The actual traffic volume (Section B2) for the selected turning movements.

C9. Intersection Operations

Measure

The operational conditions (level of service) of intersections analyzed in the TIS.

Method

Predicted: The predicted intersection operations (level of service [LOS]) for the horizon year closest to 2005 as documented in the TIS.

Actual: The project team used the intersections of one case study site to test the value of performing quantitative intersection operational analysis. Based on the labor and effort expended, very little additional benefit was provided to the overall analysis. Therefore, this level of analysis was dropped in favor of qualitative information based on site observation and interviews. The relative current intersection operational characteristics were based on field observations from the site visit (Section B1) to derive anecdotal evidence of relative gaps and frequency of conflicting movements. In addition, during the jurisdiction interview (Section B3), local jurisdictional representatives were asked to estimate the current LOS. If the interviewee was not able to estimate the existing LOS, because of the limited time for field observation, no conclusions were noted in the case study summary sheet. While ODOT analyzes operations based on volume to capacity (v/c), LOS was used for case study analysis because jurisdictions either provided the existing LOS, or operations were estimated in the field. Also, most of the TISs used LOS, not v/c, as the operation standard.

D. Qualitative Summary Sheet

The qualitative summary sheet contains symbols to illustrate the case study assessment findings (Section C). The following key (Table D-1) of symbols was developed to summarize the findings. See each of the following sections for specific definitions for the application of color and symbol per category.

TABLE D-1. QUALITATIVE SUMMARY SHEET KEY

Symbol Description	Symbol	General Description
Two Green Solid Circles	●●	Actual results are consistent with TIS prediction.
One Green Open Circle	○	Actual results are consistent with TIS prediction, but do not match exactly.
One Black Triangle	▲	Actual results do not match TIS prediction, but are not all inconsistent.
One Orange Open Square	□	Actual results are inconsistent with TIS prediction.
Two Red Open Squares	□□	TIS prediction is much more conservative than actual results.
Two Red Solid Squares	■■	TIS prediction is much more optimistic than actual results.
No Symbol		TIS prediction cannot be evaluated based on available data.

The remainder of this section summarizes how the rankings were developed for each symbol. For all criterions, if no conclusions could be made based on available data, then no symbol was assigned to the summary sheet.

D1. Site Built as Planned versus Actual

Measure

The proposed site plan in the TIS compared to actual site conditions (from Section C1).

Method

Using the results from Section C1, the following symbol was assigned to the summary sheet:

> Two Green Solid Circles: The site was built as planned in the TIS with no changes before the last horizon year analyzed in the TIS.
>
> One Green Open Circle: The site was built as planned in the TIS with no changes to the site in the first 5 years. For example, the Medford Costco was built as planned; however, a fueling facility was added 7 years after the Costco opened.
>
> One Black Triangle: The site was built as planned in the TIS, but with some key changes. For example, the first phase of the Cottage Grove Wal-Mart was built as planned in the TIS, but was assumed to be expanded to 150,000 square feet by 2002 in the TIS.
>
> One Orange Square: The actual site is inconsistent with the TIS's site prediction. No site was assigned this symbol; however, an example would be a site with the same predicted land uses and square footage but the actual number of access driveways and locations are inconsistent with the predicted number and location.

Two Open Red Squares: The site was not built as planned in the TIS (overdeveloped).

Two Solid Red Squares: The site was not built as planned in the TIS (underdeveloped). Five Oaks West is an example and was assigned this symbol since it was only 30 percent built.

D2. Intersection Traffic Growth versus Actual

Measure

The percent change in the total intersection traffic volume at the analyzed intersections in the TIS between predevelopment and existing conditions (from Section C2).

Method

Using the results from Section C2, the following symbol was assigned to the summary sheet:

Two Green Solid Circles: The predicted intersection traffic growth was within 4 percent or less of actual intersection traffic growth.

One Green Open Circle: The predicted intersection traffic growth was within 5 to 19 percent of the actual intersection traffic growth.

One Black Triangle: The predicted intersection traffic growth was within 20 to 34 percent of the actual intersection traffic growth.

One Orange Square: The predicted intersection traffic growth was within 35 to 49 percent of the actual intersection traffic growth.

Two Open Red Squares: The predicted intersection traffic growth was 50 percent or more of the actual intersection traffic growth (underpredicted).

Two Solid Red Squares: The predicted intersection traffic growth was 50 percent or more of the actual intersection traffic growth (overpredicted).

D3. Trips Predicted (Peak Hour) versus Actual

Measure

The development's peak hour trip generation (from Section C5).

Method

Using the results from Section C5, the following symbol was assigned to the summary sheet:

Two Green Solid Circles: The predicted peak hour trip generation was within 4 percent or less of the actual trip generation.

One Green Open Circle: The predicted peak hour trip generation was within 5 to 19 percent of the actual trip generation.

One Black Triangle: The predicted peak hour trip generation was within 20 to 34 percent of the actual trip generation.

One Orange Square: The predicted peak hour trip generation was within 35 to 49 percent of the actual trip generation.

Two Open Red Squares: The predicted peak hour trip generation was 50 percent or more of the actual trip generation (underpredicted).

Two Solid Red Squares: The predicted peak hour trip generation was 50 percent or more of the actual trip generation (overpredicted).

D4. Trips Predicted (Daily) versus Actual

Measure

The development's daily trip generation, if cited in the TIS (from Section C5).

Method

Using the results from Section C5, the following symbol was assigned to the summary sheet:

Two Green Solid Circles: The predicted daily trip generation was within 4 percent or less of the actual trip generation.

One Green Open Circle: The predicted daily trip generation was within 5 to 19 percent of the actual trip generation.

One Black Triangle: The predicted daily trip generation was within 20 to 34 percent of the actual trip generation.

One Orange Square: The predicted daily trip generation was within 35 to 49 percent of the actual trip generation.

Two Open Red Squares: The predicted daily trip generation was 50 percent or more of the actual trip generation (underpredicted).

Two Solid Red Squares: The predicted daily trip generation was 50 percent or more of the actual trip generation (overpredicted).

D5. Trip Distribution versus Actual

Measure

Estimated direction of travel, in percent, of the total number of trips originating at or destined for the case study site (from Section C6).

Method

Using the results from Section C6, the following symbol was assigned to the summary sheet if quantitative data were available:

Two Green Solid Circles: Predicted trip distribution was within 4 percent or less of the actual trip distribution.

One Green Open Circle: Predicted trip distribution was within 5 to 19 percent of the actual trip distribution.

One Black Triangle: Predicted daily trip distribution was within 20 to 34 percent of the actual trip distribution.

One Orange Square: Predicted daily trip distribution was within 35 to 49 percent of the actual trip distribution.

Two Open Red Squares: Predicted trip distribution was 50 percent or more of the actual trip distribution (underpredicted).

Two Solid Red Squares: Predicted daily trip distribution was 50 percent or more of the actual trip distribution (overpredicted).

Note: If only qualitative (interviewee's comments and field observations) data were available, the actual trip distribution was estimated (Section C6) and a symbol was assigned using this same method above.

D6. Total Intersection Traffic versus Actual

Measure

Total intersection traffic volume (sum) at the intersections analyzed in the TIS compared to actual intersection traffic volume (from Section C7).

Method

Using the results from Section C7, the following symbol was assigned to the summary sheet:

Two Green Solid Circles: Predicted total intersection traffic was 4 percent or less of the actual total intersection traffic.

One Green Open Circle: Predicted total intersection traffic was within 5 to 19 percent of the actual total intersection traffic.

One Black Triangle: Predicted total intersection traffic was within 20 to 34 percent of the actual total intersection traffic.

One Orange Square: Predicted total intersection traffic was within 35 to 49 percent of the actual total intersection traffic.

Two Open Red Squares: Predicted total intersection traffic was 50 percent or more of the actual total intersection traffic (underpredicted).

Two Solid Red Squares: Predicted total intersection traffic was 50 percent or more of the actual total intersection traffic (overpredicted).

D7. Selected Individual Turning Movements versus Actual

Measure

The predicted total intersection volume at selected turning movements compared to the actual selected turning movement volumes (from Section C8).

Method

Using the results from Section B8, the following symbol was assigned to the summary sheet:

Two Green Solid Circles: Predicted selected turning movement volumes were 4 percent or less of the actual selected turning movement volumes.

One Green Open Circle: Predicted selected turning movement volumes were within 5 to 19 percent of the actual selected turning movement volumes.

One Black Triangle: Predicted selected turning movement volumes were within 20 to 34 percent of the actual selected turning movement volumes.

One Orange Square: Predicted selected turning movement volumes were within 35 to 49 percent of the actual selected turning movement volumes.

Two Open Red Squares: Predicted selected turning movement volumes were 50 percent or more of the actual selected turning movement volumes (underpredicted).

Two Solid Red Squares: Predicted selected turning movement volumes were 50 percent or more of the actual selected turning movement volumes (overpredicted).

D8. Intersection Operations versus Actual

Measure

The operational conditions (LOS) within an intersection (from Section C9).

Method

Using the results from Section C9 above, the following symbol was assigned to the summary sheet:

Two Green Solid Circles: Actual intersection operations for all analyzed intersections are consistent with the TIS prediction.

One Green Open Circle: Actual intersection operations for most of the analyzed intersections are consistent with the TIS prediction.

One Black Triangle: Actual intersection operations for half of the analyzed intersections are consistent with the TIS prediction.

One Orange Square: Actual intersection operations for most of the analyzed intersections are inconsistent with the TIS prediction. Note: the interviewee for Barger Crossing Shopping Center identified intersection operational problems at all four of the development's access points. These access points were not analyzed in the TIS; therefore, to reflect this, this symbol was assigned for intersection operations for this site.

Two Open Red Squares: Actual intersection operations for all of the analyzed intersections are inconsistent with the TIS prediction (underpredicted).

Two Solid Red Squares: Actual intersection operations for all of the analyzed intersections are inconsistent with the TIS prediction (overpredicted).

D9. Interviewee Level of Satisfaction

Measure

Interviewee's level of satisfaction and opinion of the TIS (qualitative assessment, from Section B3).

Method

Using the comments from the jurisdiction interview (Section B3), the following symbol was assigned to the summary sheet:

> Two Green Solid Circles: The interviewee was satisfied with the TIS; the interviewee could not identify any areas where the TIS could have been improved.
>
> One Green Open Circle: The interviewee was satisfied with the TIS, but identified some areas where the TIS could have been improved.
>
> One Black Triangle: The interviewee had a neutral opinion with the TIS; the interviewee was neither satisfied nor unsatisfied with the TIS.
>
> One Orange Square: The interviewee was unsatisfied with the TIS; the interviewee identified many areas where the TIS could have been improved.
>
> Two Open Red Squares: The interviewee was unsatisfied with the TIS; the interviewee identified many areas where the TIS could have been improved and the TIS underpredicted its overall impact.
>
> Two Solid Red Squares: The interviewee was unsatisfied with the TIS; the interviewee identified many problems or areas where the TIS could have been improved and the TIS overpredicted its overall impact.

E. Quantitative Summary Sheet

The quantitative summary sheet displays the data results from Section C.

E1. Intersection Traffic Growth versus Actual

Measure

The average annual traffic growth rate of all the intersections analyzed in the TIS.

Method

Predicted: The difference between the predicted 2005 intersection traffic volume and the predevelopment (existing year in the TIS) intersection traffic volume, divided by the predevelopment (existing year in the TIS) intersection traffic volume, and then divided by the number of years of growth (the number of years between the existing year in the TIS and 2005).

Actual: The difference between the actual 2005 intersection traffic volume and the predevelopment (existing year in the TIS) intersection traffic volume, divided by the predevelopment (existing year in the TIS) intersection traffic volume, and then divided by the number of years of growth (the number of years between the existing year in the TIS and 2005).

E2. Trips Predicted (Peak Hour) versus Actual

The quantitative results from Section C5.

E3. Trips Predicted (Daily) versus Actual

The quantitative results from Section C5.

E4. Total Intersection Traffic versus Actual

The quantitative results from Section C7.

E5. Selected Individual Turning Movements versus Actual

The quantitative results from Section C8.

APPENDIX C

List of Reviewed TIS Guidelines

Existing TIS Guidelines Reviewed

Note

The below links were accurate at the time this study was completed (May 2006). However, the internet addresses and the content of these guidelines may change over time.

Arizona

- Arizona Department of Transportation (ADOT)
- Chandler
- Maricopa County
- Peoria
- Tempe
- Tucson

California

- California Department of Transportation (CalTrans)
- Los Angeles
- Los Angeles County
- Pasadena
- Riverside County
- Sacramento County
- San Bernardino County
- Stockton

Colorado

- Arapahoe County
- Grand Junction
- Loveland

Delaware

- Delaware Department of Transportation (DelDOT)

Florida

- Altamonte Springs

- Citrus County

Georgia

- Athens-Clarke County

Idaho

- Lewiston

Illinois

- Champaign

Indiana

- Indiana Department of Transportation (INDOT)
- Indianapolis

Kansas

- Lawrence

Louisiana

- Baton Rouge

Maryland

- Maryland Department of Transportation (MDOT)
- Prince George's County

Missouri

- Kansas City

Nevada

- Henderson

New Mexico

- New Mexico Department of Transportation (NMDOT)
- Albuquerque

North Carolina

- Chapel Hill

Ohio

- Ohio Department of Transportation (ODOT)
- Columbus

Oregon

- Bend
- Grants Pass
- Milwaukie
- Marion County
- Oregon City

Tennessee

- Knoxville

Texas

- Harris County
- Round Rock
- San Antonio

Utah

- Utah Department of Transportation (UDOT)

Virginia

- Bedford County
- Falls Church
- Smithfield

Washington

- Washington State Department of Transportation (WSDOT)
- Clark County
- Kent
- Kirkland

West Virginia

- West Virginia Department of Transportation (WVDOT)

Wisconsin

- Middleton

APPENDIX D

Research Topic Findings Technical Memorandum

TIA Research Project: Research Topic Findings

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DATE: February 6, 2006

I. Introduction

Traffic impact studies (TISs) are used by the Oregon Department of Transportation (ODOT) and local transportation agency staff to forecast future system impacts from proposed development projects and to predict the useful life of a transportation project against a future expected land use scenario. When impacts are not accurately projected through the traffic analysis process, the best decisions may not be made by local or state transportation agencies, which can lead to localized congestion resulting in safety issues or costly, ill-timed mitigation.

Effective TISs require the manipulation of a number of variables to project the future functioning of a proposed improvement. Examples of variables include forecasted trip generation, trip distribution, future traffic conditions, and capacity and performance of roadway improvements. The assumptions made about the key variables have the potential to affect the implementation of land use and transportation plans.

Credible and accurate TISs are important for community development and livability. There are two extreme, problematic conditions that inaccurate TISs can create: overly conservative estimates and aggressive estimates. For individual projects, overly conservative TISs may result in wasted resources for improvements that are not needed. The cumulative effect of overly conservative TISs may be a perception of an impediment to development, eventually causing delay in the rate of development. The other extreme occurs when assumptions made about the basic variables allow the applicant to underestimate projected impacts from development or overassume available capacity. Outcomes from this situation can include unanticipated congestion and safety problems, identification of inappropriate or "throwaway" mitigation, and a "chasing the last trip" phenomenon where the impacts of past projects become the burden of later development. In the case of a modernization project, a 20-year design life volume may be reached much sooner than the projected 20 years, such that the system improvement is consumed at an accelerated rate.

II. Document Purpose

The purpose of this memorandum is to: (1) define the topics for further research and the analysis approach, (2) summarize topic findings, and (3) identify the Best Practice development implications. The remaining sections of this document are organized as follows:

- Methodology Summary
- Selection and Application of Institute of Transportation Engineers (ITE) Land Use Code
- Pass-by Trip Reduction Assumptions
- Seasonal Adjustments
- Inclusion of Alternative Modes, Including Trucks
- Analysis Software
- Regional Demand Model versus Growth Rates
- Level of Accuracy in Guidelines
- Planning Horizon Years
- Safety
- References

III. Methodology Summary

The overall objective of this research project is to develop a Best Practice methodology for conducting TISs. To do this, CH2M HILL examined the predictions and analysis from 12 Oregon TISs that projected future system impacts for private development proposals. The TISs were selected by a Technical Advisory Committee (TAC) consisting of a private sector traffic engineer, ODOT, local government, and Federal Highway Administration (FHWA) representatives. The research of the 12 case study TISs analyzed key variables used in traffic analyses and assessed the performance of the variables in predicting the future from an "after the fact," post-implementation perspective. The implementation of mitigation measures was also evaluated. The results of the case studies were used to identify potential topics for further study and investigation to refine current practices being used by ODOT and local government. The result of the further investigation is instructive to the TAC and project team in the identification of Best Practices and recommendations for the guidance in TISs.

Ultimately, a Best Practices document will be developed that will provide educational guidance and tools for conducting the TIS. As an intermediate step, research was conducted to investigate and assess the specific Best Practice elements to be included in that guide. Research topics were developed by the TAC at the November 2005 meeting. Then, investigation was conducted to scan the case study TISs, other TIS guidelines found through an Internet search, and existing research studies. The purpose of these investigations was to identify implications for Best Practice development. Research topic findings were summarized to the TAC at the January 2006 meeting. Based on these findings, the TAC developed Best Practice implications for each topic, providing guidance to the development of the Best Practices document.

An analysis approach was developed for each of the topics and discussed with the TAC during the November 2005 meeting. The approaches were tailored to the individual topics. In general, the approaches considered the use of secondary literature (research conducted previously or by others), existing ODOT TIS practices, the TIS guidelines and practices of other jurisdictions—55 sources were identified—or further analysis of the 12 case studies.

IV. Selection and Application of Institute of Transportation Engineers (ITE) Land Use Code

A. Definition and Approach

TOPIC: The selection and application of (1) the appropriate land use code from the ITE manual for the proposed development, and (2) the comparison of fitted curve versus the average rate for the selected land use code.

RESEARCH: Using selected case study sites for industrial and commercial developments, a three-step investigation was conducted. First, it was determined whether other ITE land use codes could have been used. Next, a quantitative analysis of the difference in trip generation between land use codes was conducted. Finally, the difference in trip generation for the fitted curve and average rate of these land use codes was calculated. Also, the team conducted a review of other TIS guidelines for examples of where site prediction and monitoring language was included.

B. Research Findings

Using the project's case studies, a quantitative analysis of the difference in trip generation predictions for different ITE land use codes was conducted. Also, the differences between predictions using average rates versus fitted curve equations were evaluated. Other TIS guidelines were also reviewed.

Example: Five Oaks West, Hillsboro

This TIS documented the development's land uses as "a mix of office and industrial flex-space" and used the average rate for the industrial park land use (ITE code 130) for trip generation analysis. The resulting prediction was 555 daily trips. If the fitted curve were used instead, the predicted trip rate would be 482 (see Exhibit 1).

The other variable is the selection of the ITE land use code. ITE's *Trip Generation* states "…the distinction between light industrial and manufacturing is sometimes vague. General heavy industrial (land use 120), industrial park (land use 130), and manufacturing (land use 140) are related uses" (ITE, 2003). Depending on the selected code and fitted or average rate, the predicted trip rate varies between 446 and 910 daily trips. As a comparison, the actual trip rate (adjusting for a full buildout of the site) was observed as 489 trips.

EXHIBIT 1. *Five Oaks West Trip Rate Comparison*

ITE Land Use (Code)	Fitted	Average
Industrial Park (130)	482	555
Light Industrial (110)	700	591
Manufacturing (140)	455	446
Office Park (750)	812	910
Business Park (770)	801	892

Example: Barger Crossing Shopping Center, Eugene

This TIS used one land use code for all 137,000 square feet of leasable space. Two tenants identified in the TIS were a "fast food operator" and a "service station." These identified tenants were analyzed using the shopping center land use code.

In Exhibit 2, Scenario 1 illustrates the weekday p.m. peak hour trip generation analyzed in the TIS. Scenario 2 illustrates the weekday p.m. peak hour trip generation if the identified fast food restaurant and service station were considered as independent uses from the shopping center code. The actual weekday p.m. peak trip generation was 1,293: 12 percent higher than Scenario 2, and 45 percent higher than the reported trip generation (Scenario 1, as reported in the TIS).

EXHIBIT 2. *Barger Crossing Shopping Center Trip Generation Comparison (Average Rate)*

Scenario	ITE Land Use (Code)	Trip Generation	Total
Scenario 1	Shopping Center (820)	824	824
	Shopping Center (820)	786	
Scenario 2	Fast Food Restaurant with Drive Through Window (834)	143	1,158
	Service Station with Convenience Store (845)	229	

Other TIS Guidelines

The findings of other TIS guidelines were as follows:

- There was little to no guidance on site prediction. Most of the guidelines only required studies to state the ITE land use code that was used.
- Most required a more detailed description of site location and description (inventory of existing conditions) than site prediction justification.
- Two other guidelines stated that monitoring and additional mitigation could be needed if (1) the TIS included trip reductions for pass-by trips or other adjustments and (2) the actual trip generation was greater than predicted in the TIS.

C. Best Practice Development

Based on these findings, the Best Practices document could include the following:

- Identify a range of approaches—low, medium, and high land use intensity—based on complexity of existing urbanization of land uses to develop and predict trip

generation (for example, using different ITE land use codes). The thresholds could be based on existing or future demand from current transportation plans.
- Provide educational guidance on the uncertainty in predicting trip generation, including a list of items to consider when reviewing code selection and application.
- Provide educational guidance on the consideration of trip type (local versus regional) and the effect on trip generation.

V. Pass-by Trip Reduction Assumptions

A. Definition and Approach

TOPIC: Assessments of pass-by trip reductions in TISs, the degree of inter-connectivity of adjacent sites and the associated impact on trip generation.

RESEARCH: The pass-by trip reduction for the case studies was documented, literature sources were scanned for research on pass-by trip reductions for TISs, and guidance for applying pass-by trip reductions from other TIS guidelines were reviewed.

B. Research Findings

Pass-by trip reduction assumptions reduce the predicted new trip generation and may not accurately predict a development's actual new trip generation because they are based on rough assumptions and limited empirical data. In addition, new trip generation can vary greatly depending on the assumptions in the TIS about site and surrounding land use, and local and regional travel patterns.

ITE Recommended Percentages

Recommended allowable pass-by trip reduction percentages are outlined in the ITE *Trip Generation Handbook* (2004).

Other TIS Guidelines

When other TIS guidelines addressed pass-by trip reduction, the guidance was stated in one of the following four ways:

- Use the latest edition of ITE's *Trip Generation*. An example is from the Washington State Department of Transportation's (WSDOT's) guidelines*:* "Adjustments to trip generation made for pass-by or mixed-use traffic volumes shall follow the methodology outlined in the latest edition of the ITE Trip Generation Manual."
- Apply a reduction threshold (that is, no more than X percent without agency approval). An example is from the CalTrans guidelines*:* "Pass-by trips are only considered for retail oriented development. Reductions greater than 15% require consultation and acceptance by CalTrans. The justification for exceeding a 15% reduction should be discussed in the TIS."
- State that pass-by trip reductions should be discussed and approved by the agency or jurisdiction. An example is from the Oregon City guidelines*:* "The applicant's engineer shall not use any pass-by or internal trip reductions without prior approval of the method or data sources by the City Engineer."

- State that agency or jurisdiction pass-by trip reduction percentages should be used. An example is from the City of Los Angeles TIS guidelines: "Any claim for pass-by trip credits must use the trip reduction rates [in the guidelines]. The pass-by trip reduction rates shall be used for traffic analysis for land development projects in the City of Los Angeles."

Examples: Case Study Assumptions

Exhibit 3 illustrates the impact of pass-by trip reduction assumptions on trip generation for the four case study sites that applied pass-by trip reductions. The "Actual" column shows the observed number of trips during the peak hour. The "Base (No Pass-by)" column lists the number of new trips predicted in the TIS without any pass-by trip reduction. The "Base with ITE" column is the number of new trips generated using the recommended rates in the ITE Handbook. The "TIS" column is the number of new trips generated using the pass-by trip reduction assumptions in the TIS. With a small sample, the TISs used a more conservative reduction (29 percent versus 37 percent) than the ITE recommended values. Both of these are comparable to the actual reduction from the base (no pass-by) trip rates (34 percent).

EXHIBIT 3. *Case Study Pass-by Trip Rate Assumptions*

Development	Actual	Base (No Pass-by)	With Pass-by	
			Base with ITE	TIS
Home Depot, The Dalles	278	705	388	675
Clackamas Crossing, Clackamas County	1,233	2,685	1,743	1,651
Wal-Mart, Cottage Grove	448	546	360	436

C. Best Practice Development

Based on these findings, the Best Practices document could include educational guidance on to develop pass-by trip rate reductions and illustrate the effect of pass-by trip reduction on trip generation. One approach could be to use examples of different pass-by reductions for low, medium, and high land use intensities.

VI. Seasonal Adjustments

A. Definition and Approach

TOPIC: The consideration of the seasonal adjustments in traffic volumes in areas with known seasonal variations.

RESEARCH: Case studies were reviewed to determine if use of seasonal adjustment factors were used. ODOT guidance for adjusting traffic counts based on seasonal changes in traffic volumes was reviewed and summarized. Examples of seasonal variation in traffic volumes were developed.

B. Research Findings

None of the case study TISs documented that traffic counts were seasonally adjusted.

ODOT's Transportation Planning Analysis Unit (TPAU) has developed a training manual for applying a seasonal factor to manual traffic counts. Automatic traffic recorders (ATR) from around the state are used to determine the average annual daily traffic (AADT). This information is used to develop seasonal adjustments to apply to manual counts through one of the three methods summarized below.

Onsite ATR Method

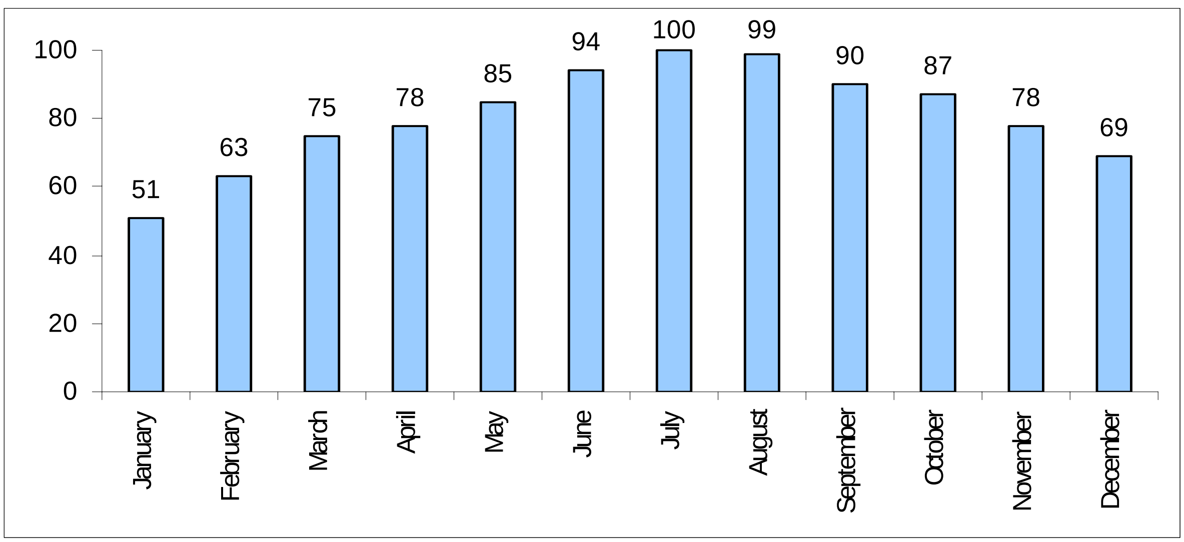
This method is used when there are no major intersections between the ATR and the project area, and the ATR is within reasonable distance that the traffic characteristics are comparable. This method is described in the ODOT *Developing Design Hour Volumes* training manual (ODOT, 2006).

ATR Characteristic Table Method

This method provides general characteristics for each ATR and is used when there is no ATR in the project area. The characteristic table is an electronic file that provides information for ATRs with similar characteristics for several categories. Characteristic categories include: seasonal traffic trend (11 different types), area type (urbanized, urban fringe, small urban, small urban fringe, rural populated, or rural), number of lanes, and weekly traffic trend (weekday, weekend, or steady). Characteristic AADT should be within 10 percent of the AADT for the project area to be comparable. This method is described in the ODOT *Developing Design Hour Volumes* training manual (ODOT, 2006).

Exhibit 4 illustrates an example of seasonal variation in traffic volumes at ATR 23-014, on Interstate 84 near Umatilla (this ATR would be used for the Stanfield Travel Center case study site).

EXHIBIT 4. *Seasonal Variation Example: Percent of Peak Month Average Weekday Traffic for ATR 23-014*



Seasonal Trend Table Method

This method is used when there is not an ATR close by or in an area representative of the project area. The table contains factors developed by averaging all current monthly ATR factors for each of the 11 seasonal trend groupings: recreation summer or winter, recreation winter, recreation summer, interstate urbanized, interstate, coastal destination, coastal destination route, commuter, summer, summer <2500 ADT, and agriculture. Multiple seasonal trends could also be averaged, which may yield more appropriate factors than using a single trend. The seasonal trends that can be averaged and the seasonal trend method are located in the ODOT *Developing Design Hour Volumes* training manual (ODOT, 2006).

Additional information of these methods is located at ODOT's transportation analysis webpage.

C. Best Practice Development

The Best Practices discussion could expand upon existing guidelines by addressing the need to consider the appropriate seasonal variations in locations where variation is significant. At the same time, the guidance could address the issues related to over-designing facilities for unusual travel patterns (for example, holidays or special events). A related issue to be addressed is the approach for using a design hourly volume (for example, 30th highest hour) versus seasonal adjustments to an average traffic day.

VII. Inclusion of Alternative Modes, Including Trucks

A. Definition and Approach

TOPIC: The use of truck data and alternative modes for trip generation, traffic impacts (queuing and conflicts), safety, and operations (turning movements, circulation, and conflicts).

RESEARCH: Other TIS guidelines were reviewed to identify any discussions of the analysis of trucks and alternative modes.

B. Research Findings

A review of other TIS guidelines concluded the following:

- Less than 10 percent required transit, pedestrian, or bicycle impact analysis.
- Less than 5 percent mention considering truck trip generation; however, no guidance was provided.
- ODOT's existing guidelines considers mode split in trip generation, but there is no reference to considering or analyzing truck trip generation. There is no reference to consider truck, pedestrian, or bicycle impacts.

No research could be located on the inclusion and analysis of alternative modes (transit, bicycle, and pedestrian) in TISs.

In general, truck trip generation data sources are limited. The trip generation data provided in *Trip Generation* are total vehicle rates, including trucks (ITE, 2003). However, specific truck trip generation rates are only provided for a few land uses and are based on limited data. Appendix A of the ITE *Trip Generation Handbook* (2004) provides information about predicting truck trip generation based on a limited pool of studies, but states it is "not recommended practices, procedures, or guidelines" for estimating truck trip generation.

The National Cooperative Highway Research Program's (NCHRP) Truck Trip Generation Data report (Synthesis 298) identified available truck trip generation data resources and provided an assessment of the current state of practice. The report concluded the following:

- There are little data on truck trip generation rates for transportation engineering applications reported in literature.
- Efforts to compile truck trip generation data were focused on collecting data from a few highly specialized land use categories.
- Industrial productivity relationships have a strong impact on truck trip generation (but ITE independent variables for industrial land uses are number of employees or size).
- The economic activities that generate truck activity are highly variable, making it difficult to apply truck trip generation rates outside of the localized area where the data were collected.
- Truck trip volumes and routes are needed for certain land uses that are not usually considered in freight studies, but for which truck traffic and access is important (shopping centers).

C. Best Practice Development

The Best Practices document could include the following:

- A discussion on how the TIS should assess truck trip generation impacts to safety, queuing, circulation, and access for industrial uses.

- A discussion on when and how the TIS should estimate the impact to alternative modes (transit, pedestrian, or bicycle) and why impact to these modes is important.

VIII. Analysis Software

A. Definition and Approach

TOPIC: The use and selection of the traffic analysis tools and software for TISs. The specific concern is that developers could use the traffic analysis tool that best suits their needs and interests or choose a software program unfamiliar to the reviewing agency or jurisdiction.

RESEARCH: Potential resources or software applicable to TISs were identified.

B. Research Findings

The findings were as follows:

- The 12 case studies used 7 different analysis software packages: SIGCAP, PASSER II-87, NCAP, HCS, Traffix, UNSIG10, and SIG/Cinema.
- ODOT traffic analysis guidelines have only general information on models.
- FHWA's Traffic Analysis Tools provides guidance, recommendations, and examples on the selection and use of traffic analysis tools. "Traffic analysis tools" is a collective term used to describe a variety of software-based analytical procedures and methodologies that support different aspects of traffic and transportation analyses. Traffic analysis tools include methodologies such as sketch-planning, travel demand

modeling, traffic signal optimization, and traffic simulation. The Traffic Analysis Tools Program was formulated by FHWA in an attempt to strike a balance between efforts to develop new, improved tools in support of traffic operations analysis and efforts to facilitate the deployment and use of existing tools. Currently, there are three volumes in the Traffic Analysis Toolbox:

- *Volume I:* Traffic Analysis Tools Primer—presents a high-level overview of the different types of traffic analysis tools and their role in transportation analyses (FHWA, 2004a).
- *Volume II:* Decision Support Methodology for Selecting Traffic Analysis Tools—identifies key criteria and circumstances to consider when selecting the most appropriate type of traffic analysis tool for the analysis at hand (FHWA, 2004b).
- *Volume III:* Guidelines for Applying Traffic Microsimulation Modeling Software—provides a recommended process for using traffic microsimulation software in traffic analyses (FHWA, 2004c).

C. Best Practice Development

ODOT's traffic analysis guidelines include general guidance for the appropriate software use. Additional guidance specific to TISs will be included in the Best Practices document.

IX. Regional Demand Model versus Growth Rates

A. Definition and Approach

TOPIC: The consideration of both regional demand models and growth rates in assessing traffic impact.

RESEARCH: Other TIS guidelines were reviewed to determine the recommended methodologies for predicting future traffic growth.

B. Research Findings

Case Studies

Of the 12 case studies, 10 used growth rates and regression analysis and 2 used a model. Models were used at Barger Crossing in Eugene and Five Oaks West in Hillsboro, both located in large urban areas where a model was available.

Other TIS Guidelines

A review of other TIS guidelines concluded the following:

- 35 percent had no guidance on the methodology.
- Urban areas generally allowed for use of a model or growth rates, or a combination of both. For instance, Chapel Hill, North Carolina, required extrapolation from historical traffic counts to current counts for the opening year's horizon year and the use of the region's model for the long-term horizon year.
- 100 percent required growth rates in rural areas, likely because models in most rural areas are not available.

- Less than 10 percent required use of a model if available (CalTrans is one example). These guidelines allowed for the use of growth rates (with agency or jurisdiction approval) if no model was available.
- State DOTs generally required use of the growth rate method, regardless of the location.

ODOT Guidelines

ODOT's guidelines are the most detailed and comprehensive of all reviewed guidelines. The three most common methods for adjusting traffic counts for seasonal variation, outlined in ODOT's guidelines are as follows:

- *Transportation Models:* These are most suitable for use in urban areas and for long time frames. Transportation models could be compared with a future year to arrive at an annual growth rate, and applied to existing traffic volumes. Because models are typically developed in conjunction with a plan, this method can provide a reliable forecast for urban areas.

- *Cumulative Analysis:* This methodology is most suitable for smaller urban areas, or a portion of a large urban area, and for short time frames where there is good local information about future projects. This method projects future traffic volume by adding the estimated traffic generated by all approved, but not yet opened, developments in the study area. Long-term forecasts should also include the effects of future developments on undeveloped lands. This method requires a table listing the anticipated developments and corresponding trip generation rates.

- *Growth Trends:* Most suitable for rural areas with stable growth rates, this methodology involves estimating growth rates based on regression analysis covering typically the past 20 years. It is usually assumed when projecting future traffic demands that site traffic is included in the projections.

C. Best Practice Development

The Best Practices document will summarize the methods for adjusting traffic counts and include guidance on when to use which method.

X. Level of Accuracy in Guidelines

A. Definition and Approach

TOPIC: The level of accuracy of traffic analysis results (number of significant digits), taking into consideration the potential range of error (sensitivity testing).

RESEARCH: An evaluation of the accuracy of level-of-service (LOS) models was conducted, and the case study TISs were reviewed to determine the stated or implied level of accuracy.

B. Research Findings

A majority of other TIS guidelines provided no guidance on the level of accuracy for reporting analysis findings. However, most TISs imply accuracy by providing examples in the TIS guidelines. The examples in ODOT's guidelines are that volume-to-capacity (v/c) ratios are reported to the nearest hundredth (0.01) and delays are reported to the nearest tenth (0.1) of a second.

A review of other TIS guidelines concluded the following:

- Most require documentation of calculations, but none provide guidance on accuracy or a sensitivity analysis.
- LOS is the standard in most TIS guidelines (v/c and delay calculations are generally described in an appendix). LOS grades range from 10 to 25 seconds, but delay is reported to the nearest 0.1 of a second.
- One reviewed TIS guideline provided specific guidance on level of accuracy: the City of Los Angeles requires v/c to the nearest one-thousandth (0.001).

C. Best Practice Development

The TAC agreed to delete this topic because the topic is technically complex and outside the scope of this project. Therefore, this topic will not be discussed in the Best Practice guidance.

XI. Planning Horizon Years

A. Definition and Approach

TOPIC: The appropriate horizon years for planning and traffic analysis, taking into consideration that uncertainty increases over time.

RESEARCH: Existing TIS guidelines and case study TISs were assessed to identify trends in horizon year analysis.

B. Research Findings

ODOT Guidelines

Existing ODOT guidelines provide thresholds for determining the year of future year analysis, based upon Access Management program practice.

Other TIS Guidelines

A review of other TIS guidelines concluded the following:

- 100 percent required opening year analysis.
- 50 percent only required opening year analysis. The other 50 percent require analysis after each development phase. This is less common with state DOTs.
- Less than 10 percent require future horizon year to match local plan, model year, or traffic forecasts.
- Less than 5 percent had a categorized set of analysis requirements. Exhibit 5 is an example of these requirements, from Arizona DOT (ADOT).

EXHIBIT 5. *Categorized Horizon Year Analysis Example (Arizona Department of Transportation)*

Analysis Category	Development Characteristic	Study Horizons
I	Small Development	Opening Year
IIa	Moderate, single phase 500–1000 peak hour trips	Opening year and 5 years after opening
IIb	Large, single phase >1000 peak hour trips	Opening year, 5 years after opening, 10 years after opening
IIc	Moderate or large, multiphase	Opening year of each phase, 5 years after opening, 15 years after opening

Case Studies

Of the 12 case study sites, 11 analyzed one additional future horizon year after the opening year. On average, the future horizon was 13 years after the opening year.

C. Best Practice Development

The Best Practices document will provide educational guidance on why a planning horizon year analysis is important and include guidance for a categorized horizon year analysis, similar to the ADOT example.

XII. Safety

A. Definition and Approach

TOPIC: The consideration of safety in TISs, since safety analysis is often generalized or ignored in TISs.

RESEARCH: Other TIS guidelines were reviewed for safety elements, language, or guidance.

B. Research Findings

Other TIS Guidelines

A review of other TIS guidelines concluded the following:

- Over 50 percent require safety analysis, but provided little to no detail on what safety elements should be reviewed or analyzed.
- Among DOTs, a review of previous 3 years of safety data was most common.
- WSDOT requires a comprehensive safety analysis. Required safety analysis elements include:
  - Accident History
  - Conflict Analysis
  - Horizontal and Vertical Geometry
  - Traffic Control
  - Pedestrian and Bicycle Conflicts

Literature Research

- Other than emphasizing roadway capacity and operational issues, TIS analyses can also provide an opportunity to review safety features prior to final development approval. TISs can serve to advise decisionmakers of any potential safety concerns and help to guide the development of a project (Pringle, 2002).

- The performance of a roadway with respect to safety is as important as the operational performance. There is opportunity to incorporate a process for a Safety Impact Study (SIS) without comprising the existing developmental process. A SIS will not duplicate effort because currently no such activity takes place in any part of the development process (Skene, Malone, and Solodo, 2004).

C. Best Practice Development

The Best Practices document will expand upon existing safety guidelines and include discussion that TISs should make a proactive step to analyze specific safety elements (accident history, conflict analysis, traffic control, bicycle and pedestrian conflicts, etc.).

XIII. References

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Appendix E

Examples of Guidance Letters and Scoping Checklists

Appendix 7
Traffic Impact Analysis: TIS – Scope R2

Oregon
Theodore R. Kulongoski, Governor

Department of Transportation
Region 2 Tech Center
455 Airport Road SE Building A
Salem, Oregon 97301-5397
Telephone (503) 986-2990
Fax (503) 986-2839

Date: **May 8, 2006** **File:**

Subject: **Traffic Impact Analysis Scope of Work**
Project Name
Adjacent Highway Name – Route Number (Highway Number)
Milepost/Milepost Range
City Name
County Name

Attn:

The purpose of this letter is to define the scope of work for a Traffic Impact Analysis (TIA), which evaluates the impact for the proposed .

The Oregon Department of Transportation (ODOT) and ________, along with the Developer previously met and discussed the need and general scope of a traffic impact analysis for this project. The affected jurisdictions agreed that ODOT would be the lead agency regarding the traffic study coordination. Therefore, any questions or comments will be coordinated through this office.

Scope of Work:

I. General:

Executive Summary:
Provide a description of the development, site location and study area (including a site map). Briefly describe the purpose of the analysis, principal findings, recommendations and conclusions.

Analysis Study Area:

Provide a text description (including tax-lot descriptions) of the proposed development; and a graphic showing the intersections and accesses, identified by highway milepost, to be evaluated as part of this analysis.

II. Traffic Data:

Traffic Counts

Full federal manual classification counts shall be made at all study area intersections. For all major intersections, the count must be at least 14-hours long, with 15-minute breakdowns during the A.M. and P.M. peak hours. For all minor intersections and approaches, the count must be at least 3-hours long, made during the afternoon peak, with 15-minute breakdowns.

Raw traffic volumes will not be accepted for use in traffic analysis. All traffic volumes shall be seasonally adjusted to represent 30th Highest Hour Volumes (30HV) for Current Year, Year of Opening, and Future Year "*background traffic*" conditions. For guidance, please refer to the *Developing Design Hour Volumes* document.
http://www.oregon.gov/ODOT/TD/TP/Analysis.shtml

Site Trip Generation, Distribution and Assignment:

Site trip generation shall utilize the most current edition of the Institute of Transportation Engineers (ITE) Trip Generation Manual to estimate daily and peak hour trip volumes originating from and destined to the proposed development.

This analysis should use available transportation models in conjunction with the City of *"Name"*, as well as current Transportation System and Comprehensive Plans to estimate traffic distribution patterns. Approved computer models, such as Traffix, or manual calculations may also be used for determining trip assignments for site-generated traffic volumes on roadways within the study area.

All assumptions, adjustments and variables shall be approved by Region Traffic in advance. Trip distribution and assignment will be shown on a vicinity map, as percentages and trips at significant intersections within the vicinity of the development. This information shall be documented and discussed in the TIA, or in the appendix.

Analysis Procedures:

Capacity Analysis:

Capacity analysis of signalized intersections, unsignalized intersections, and roadway segments shall follow the established methodologies of the current Highway Capacity Manual (HCM2000). For signalized intersections, the overall intersection V/C shall be reported. For unsignalized intersections, the highest approach V/C shall be reported, along with an indication of its corresponding movement.

Refer to **Table 3.3.7** in the Development Review Guidelines; it lists ODOT's default parameters for use in signalized intersection analysis. If the parameters used in the analysis are outside those listed in **Table 3.3.7**, documentation shall be supplied as justification. If multiple intersections are analyzed, the traffic volumes shall be balanced between intersection nodes. All intersection capacity analyses shall include heavy vehicles percentages by approach, as determined from manual counts.
http://www.oregon.gov/ODOT/TD/TP/DRG.shtml

Project level mobility results (V/C) from the TIA will be compared against the Highway Design Manual mobility requirements (Table 10-1, 20 Year Design Mobility Standards). Planning level mobility results (V/C) from the TIA will be compared against Highway Mobility Standards (Policy 1F) and the Maximum V/C Ratios provided in Table 6 of the 1999 Oregon Highway Plan (OHP), August 2005 Amendments.
http://www.oregon.gov/ODOT/TD/TP/orhwyplan.shtml#1999_Oregon_Highway_Plan

Application of Computer software shall closely follow ODOT-approved analysis methodologies. HCS2000 and Synchro/SimTraffic are examples of accepted analysis software. For further guidance, contact TPAU. All electronic files used in this analysis shall be provided via CD-ROM or ODOT's FTP site. For details, contact the Region Traffic office.
ftp://ftp.odot.state.or.us/

Queue Length Analysis:

Intersection operation analysis shall include the effects of queuing and blocking. Average queue lengths and 95th Percentile queue lengths shall be reported for all study area intersections. The 95th Percentile queuing shall be used for design purposes, and will be reported to the next nearest 25 foot increment. Any methodology used to determine queue length shall be approved in advance by either TPAU or the Region, and documented in the TIA or appendix.

III. Analysis Requirements:

Intersection Sight Distance:

Adequate intersection sight distance shall be verified for all proposed intersections and highway approaches as required in ODOT's 2005 Highway Design Manual. For guidance, please contact the Region Access Management Engineer.
http://egov.oregon.gov/ODOT/HWY/ENGSERVICES/hwy_manuals.shtml

Right & Left Turn Lane Criteria:

Proposed right or left turn lanes at unsignalized intersections and private approach roads shall meet installation criteria contained in the current Highway Design Manual (HDM). For turn lane evaluation procedures, refer to:
http://www.oregon.gov/ODOT/TD/TP/Analysis.shtml

Traffic Signal Installations & Modifications:

Analysis and recommendations related to new and/or modified traffic signals shall follow ODOT's Traffic Signal Policy and Guidelines, and all subsequent revisions. These documents can found on the web at:
http://www.oregon.gov/ODOT/HWY/TRAFFIC/publications.shtml

New signal proposals for Day of Opening shall show, but are not limited to, the following:

- A clear indication of need for a traffic signal; only after other enhancements to nearby signals are shown to be insufficient to mitigate the new highway related impacts resulting from the proposed development.
- An assessment of the ability of existing, planned, and proposed public roads to accommodated development traffic at another location.
- A detailed description how the proposed development will affect existing and proposed study area intersections.
- Documentation of traffic volumes and signal warrant satisfaction; if a new signal is determined to be the correct solution.

Clearly show how one or more of the eight warrants identified in the Millennium Edition of the Manual on Uniform Traffic Control Devices (MUTCD), Chapter 4C, Sections 1 through 9 are met, consistent with the requirements of OAR 734-020-0490. Traffic signal spacing requirements shall conform to the 1999 Oregon Highway Plan. Progression analysis shall meet the requirements of OAR 743-020-480.

If applicable; complete time-space diagrams for each of the analysis scenarios, including the existing coordinated system shall be provided. They will demonstrate the proposed signal system is capable of maintaining adequate progression band widths for through traffic on the State Highway on the most critical roadway segments within the study area.

Any recommendations for traffic signals to be installed as part of future mitigation should meet preliminary signal warrants (MUTCD Warrant #1, Case A & B). All future proposed signals shall still need to meet the need and warrants as described. For guidance, please contact TPAU or the Region, or refer to the Preliminary Signal Warrant Guidelines.
http://www.oregon.gov/ODOT/TD/TP/Analysis.shtml

NOTE: It is ultimately up to State Traffic Engineer to approve <u>all</u> signal installations, modifications and deviations. Just because an intersection may meet the MUTCD Warrants does not insure it will be approved by the State Traffic Engineer.

<u>Access Management:</u>
Demonstrate how the proposed access, or accesses meet the minimum spacing criteria of OAR 734-051; or how it coincides with the current access management plan/strategy.

IV. <u>Analysis Output:</u>

<u>Existing Conditions:</u>

Identify current year site conditions at the proposed development location. This includes, but is not limited to the following:

- A description of the site location, zoning, existing use(s), and proposed use(s) of subject property.
- A description of surrounding land uses.
- A graphic identifying existing lane configurations and traffic control devices at the study area intersections.
- A graphic showing existing 30HV traffic; reported as AM (7-9 a.m.) and PM (4-6 p.m.) Peak Hour Volumes (PHV), and also as average daily traffic (ADT). Also include in this graphic a list of heavy vehicle percentages by approach.
- An analysis of existing intersection operations, reported in terms of both Volume to Capacity (V/C) and Level of Service (LOS).
- An analysis of at least 3-years worth of crash data; including information on all SPIS sites within or adjacent to the study area.

Traffic Volumes & Operations – Year of Opening; with & without Proposed Development:

An analysis shall be made of all study area intersections in the Year of Opening, for both "*background traffic*" and "*total traffic*" conditions. "*Total traffic*" conditions are considered "*background traffic*" volumes plus site generated trips. This analysis should provide the following:

- A graphic showing Year of Opening "*background traffic*" and "*total traffic*" volumes.
- A graphic or table showing V/C and LOS analysis results for both "*background traffic*" and "*total traffic*" volumes.
- A graphic or table itemizing storage length requirements for all approaches, rounded to the next nearest 25 foot increment.
- If applicable, a discussion of progression performance along the analysis corridor.

Traffic Volumes & Operations – Future Year; with & without Proposed Development:

An analysis shall be made of all study area intersections for a XX-year horizon, for both "*background traffic*" and "*total traffic*" conditions. This analysis should provide the following:

- A graphic showing Year of Opening "*background traffic*" and "*total traffic*" volumes.
- A graphic or table showing V/C and LOS analysis results for both "*background traffic*" and "*total traffic*" volumes.
- A graphic or table itemizing storage length requirements for all approaches, rounded to the next nearest 25 foot increment.
- If applicable, a discussion of progression performance along the analysis corridor.

Planned transportation system improvements anticipated within the XX-year horizon shall be incorporated into the Future Year analysis. Do not incorporate improvements that are proposed as mitigation for the development. For guidance, please refer to the Transportation Planning Rule (TPR): OAR 660-012-0060.
http://egov.oregon.gov/ODOT/TD/TP/TPR.shtml

Analysis Variable Inputs:

A summary of traffic analysis variable inputs shall be provided in an appendix. In Synchro, the ***Int: Lanes, Volumes, Timings*** report is the output source for this information. TIA's submitted without an input summary will not be accepted by the Department.

<u>Conclusions and Recommendations:</u>

Summarize existing and future conditions and discuss the proposed development's impacts. Identify any operational or safety deficiencies and recommend mitigation along with the effectiveness of the mitigation. Summarize how the proposed development complies with all operational and safety standards in the applicable approval criteria.

Note: Signal timing adjustments will not be considered as mitigation.

Sincerely,

Name
Title

cc:

Traffic Impact Analysis: TIS-TIA Guidance R1

ODOT Guidelines for Requiring and Requesting Traffic Impact Studies for Development Review

OAR 734 Division 51 Access Management Rule

Oregon Administrative Rule Chapter 734, Division 51, Access Management Rule gives ODOT the authority to regulate access to State highway facilities. OAR 734-051-070 establishes when ODOT may require a TIS and when ODOT shall require a TIS for applicants proposing access to a State highway.

- ODOT **may require** a TIS for proposed developments generating vehicle trips that equal or exceed 600 daily trips or 100 hourly trips; and
- **Shall require** a TIS for proposed developments or land use actions where the on-site review indicates that operational or safety problems exist or are anticipated.

OAR 660-012-0060 Transportation Planning Rule

For comprehensive plan and zone change amendments local governments must make findings that a proposed amendment complies with the Transportation Planning Rule OAR 660-012-0060. There must be substantial evidence in the record to either make the finding of "no significant effect" on the transportation system, or if there is significant effect "assurance that allowed land uses are consistent with the identified function, capacity, and level of service of the transportation facility". In order to determine whether or not there will be a significant impact on the State transportation system, **ODOT may request** a TIS. The **local jurisdiction may require** the applicant to prepare a TIS to produce substantial evidence in the record.

TPR 660-012-0060 Plan and Land Use Regulation Amendments

(1) Amendments to functional plans, acknowledged comprehensive plans, and land use regulations which significantly affect a transportation facility shall assure that allowed land uses are consistent with the identified function, capacity and performance standards (v/c ratio) of the facility. This shall be accomplished by either:

a. **Limiting allowed land uses to be consistent with the planned function, capacity, and performance standards of the transportation facility;**
b. Amending the TSP to provide transportation facilities adequate to support the proposed land uses consistent with the requirements of this division;
c. Altering land use designations, densities, or design requirements to reduce demand for automobile travel and meet travel needs through other modes, or
d. Amending the TSP to modify the planned function, capacity and performance standards, as needed, to accept greater motor vehicle congestion to promote mixed use, pedestrian friendly development where multimodal travel choices are provided.

(2) A plan or land use regulation amendment significantly affects a transportation facility if it:

a. Changes the function classification of an existing or planned transportation facility;
b. Changes standards implementing a functional classification system;
c. Allows types or levels of land uses which would result in levels of travel or access which are inconsistent with the functional classification of a transportation facility;
d. Would reduce the performance standards of the facility below the minimum acceptable level identified in the TSP.

Interchange Management Areas

According to the Oregon Highway Plan 1999, freeways and interchanges are the highest classification of State highway facilities. When a proposed development is within a quarter mile of the terminal of an interchange ramp, ODOT **may request** the local jurisdiction require a TIS.

"Conditional Use" Land Use Applications

Typically, the local zoning code requires that applicant's demonstrate adequacy of public facilities at year of buildout for "conditional use" approval. A TIS may be necessary for the local government to make findings that there are adequate transportation facilities based on substantial evidence. Local governments typically defer to ODOT for determining whether or not State transportation facilities are adequate to serve the "conditional use". Therefore, ODOT **may request** the local government require a TIS so that the impacts on State highway facilities can be evaluated.

Operational or Safety Problems

ODOT **may request** the local government require a TIS when our preliminary review indicates that traffic generation from the proposed development may be impacting a State highway intersection where operational or safety problems exist or are anticipated.

State highway is the proposed development's primary access to the roadway network

ODOT **may request** the local government require a TIS when large amounts of the site generated traffic must use an intersection with the State highway to access the roadway network even when direct access to the highway is not proposed.

ODOT Region 1 TIS Requirements

1. When an applicant has been required to prepare a Transportation Impact Study (TIS) and a State highway facility may be impacted, the applicant is advised to contact the ODOT Transportation Analyst as early in the process as possible to scope the TIS.

2. Unlike most local jurisdictions that use the Level of Service (LOS) letter grades to measure highway performance, the Oregon Highway Plan (OHP) 1999 adopted the volume–to-capacity ratio (v/c) as the mobility standard for State highways. The v/c ratio is defined as the peak hour traffic volume (vehicles/hour) on a highway section divided by the maximum capacity of the highway section. An intersection with a v/c of 1.0 is operating at capacity. A v/c of less than 1.0 indicates that there is additional capacity at the intersection and a v/c exceeding 1.0 indicates that the intersection is operating over capacity. Mobility standards for State highways can be found in Tables 6 and 7 (as amended) of the OHP.

3. If the analysis area includes a signalized State highway intersection, the applicant must use ODOT's existing or planned signal timing for the intersection. For this information, applicants are advised to contact the ODOT Signal Manager.

4. Transportation Planning Rule OAR 660-012-0060 Compliance Analysis for Zone Changes or Comprehensive Plan Amendments must address the following:

   a. A TIS (prepared by a transportation engineer registered in Oregon) shall compare the land use with the highest trip generation rate allowed outright under the proposed zoning with the land use with the highest trip generation rate allowed outright under the existing zoning (this is commonly referred to as a “worst case” traffic analysis)*. The analysis should utilize the current edition of Institute of Transportation Engineers (ITE) *Trip Generation* manual, unless otherwise directed. If the applicant chooses to perform the analysis using a trip generation rate determined by any means other than from ITE *Trip Generation*, the proposed trip generation rate must meet ODOT concurrence.

   b. The analysis should apply the highway mobility standard (volume-to-capacity ratio) identified in the OHP over a planning horizon of the adopted local transportation system plan or 15 years from the proposed date of amendment adoption, whichever is greater (OHP Action 1F2).

   c. In situations where the highway facility is operating above the OHP mobility standard and transportation improvements are not planned within the planning horizon to bring performance to standard, the performance standard is to avoid further degradation. If the proposed zone change or comprehensive plan amendment increases the volume-to-capacity ratio further, it will significantly affect the facility (OHP Action 1F6).

   *It is particularly important that the applicant’s transportation engineer provide ODOT the opportunity to review and concur with the mix of land uses and square footage they propose to use for the “reasonable worst case” traffic analysis for both existing and proposed zoning prior to commencing the traffic analysis.

Standards for Traffic Impact Analysis
Administrative Rule R-9.8650

Traffic Impact Analysis/Traffic Impact Study Format

Address ____ **Date**_________

Land Use Application #________________ **Building Permit #**____________________

Project Description: **Project Name** ____

Map/Tax Lot # __________________ Land Use ___________________________

Site Size (s.f.) ____________________ Horizon Year __________________________

Existing Access(es)- # and width____

Analysis Period:

Weekday PM Peak ______

Weekday AM Peak ______

Weekday Noon Peak ______

Saturday 2PM Peak ______

Other ______

Trip Generation Requirements
____
____

Trip Distribution Requirements ______________
____

Scope of Analysis or Study (Software required, background traffic growth factors, etc.)
____
____

Intersections to be analyzed:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________

Accident Study/Collision Diagram Required:

____
____
____
____
____

Traffic Signal Warrant Analysis Required? Yes _____ No ____
____

Special Requirements of Study (Truck turning radius diagrams, internal circulation analysis, driveway stacking and operations, movement restrictions, median treatment)
____

APPENDIX A

INITIAL MEETING CHECKLIST

Suggestion: Use this Appendix as a worksheet to ensure that no important elements are overlooked. Cross out the items that do not apply.

Date:________________________________ Time: _____________
Location: ____

People Attending
Name, Organization, and Telephone Numbers
1)____
2)____
3)____
4)____
5)____

Study Preparer
Preparer's Name and Title:____
Organization:____
Address & Telephone Number:____

Reviewer(s)
Reviewer's Name & Title:____
Organization & Telephone Number:___________________________________
Reviewer's Name & Title:____
Organization & Telephone Number:___________________________________

Applicant
Applicant's Name, Address, & Telephone Number:______________________________
____

Proposed Development
Name: ____
Location: ____
Location within area:

CBD	Rural
Urban (Non-CBD)	Freeway Interchange
Suburban (Non-CBD)	Other (Specify)
Suburban CBD	__________________

Land Use Type:

ITE Code #: ____________________________
Other:__________________________________
Description:____
____
____
Proposed number of development units:____
____

Zoning
Existing:____
Comprehensive plan recommendation:____
Requested: ____

Findings of the Preliminary Study:
____
____
____
____
____
____
____

Study Type:
Complete_________________________ Traffic operations________________________
None ____

Study Area
Boundaries:____
____
____
Additional intersections to be analyzed:____
____
____

Horizon Year(s)
____

Analysis Time Period(s)
____

Future Off-Site Developments

Source of Trip Generation Rates

Reductions in Trip Generation Rates
None
Pass-by trips
Internal trips (mixed-use developments)
Transit use
Other

Horizon Year Roadway Network Improvements

Methodology & Assumptions
Non-site traffic estimates:

Site-trip generation:

Trip distribution method:

Traffic assignment method:

Traffic growth rate:

Special Features (from preliminary study or prior experience)

Accident locations:____

____

Sight distance: ____

____

____

Queuing: ____

____

____

Access location & configuration:___________________________________

____

____

Traffic control:____

____

Signal system location & progression needs:___________________________

____

____

On-site parking needs: ____

____

____

Data Sources: ____

____

____

____

Base maps: ____

____

Prior study reports:____

____

Access policy and jurisdiction:______________________________________

____

Review process: ____

____

____

Requirements:____

____

____

Miscellaneous

==

SIGNATURES

Study Preparer

Reviewers

Applicant

SCOPING FOR TRAFFIC STUDY

This Memorandum of Understanding (MOU) acknowledges Los Angeles Department of Transportation (LADOT) requirements of traffic impact analysis for the following project:

Project Name: ______________________________

Project Address: ______________________________

Project Description: ______________________________

____

Geographic Distribution: N _____ % S _____ % E _____ % W _____ % (Attach graphic illustrating project trip distribution percent ages at the studied intersections)

Trip Generation Rate(s): ITE 7th Edition / Other ______________________________

Land Use ________		Land Use ________		Land Use ________		
in	out	in	out	in	out	
_____	_____	_____	_____	_____	_____	AM Trips
_____	_____	_____	_____	_____	_____	PM Trips

Project Buildout Year: __________ Ambient or CMP Growth Rate: _______ % Per Yr.

Related Projects: (To be researched by the consul tant and approval by LADOT)

Study Intersections

(Subject to revision after CMP requirement, related projects, trip generation and distribution are determined)

1. ______________________________ 6. ______________________________
2. ______________________________ 7. ______________________________
3. ______________________________ 8. ______________________________
4. ______________________________ 9. ______________________________
5. ______________________________ 10. ______________________________

Trip Credits: (Exact amount of credit subject to approval by LADOT)

	yes	no
Transportation Demand Management (TDM)..	☐	☐
Existing Active Land Use	☐	☐
Previous Land Use	☐	☐
Internal Trip	☐	☐
Pass-By Trip	☐	☐

This analysis must follow latest LADOT Traffic Study guidelines.

	Consultant	Developer
Name	______________________	______________________
Address	______________________	______________________ Phone No.
	______________________	______________________

Approved by: ______________________ ______________________

Consultant's Representative Date LADOT Representative Date

s:\letters\scope
4/2002

Glossary

Access management: Methods that regulate physical access to streets, roads, and highways from public roads and private driveways. Requires balancing access to developed land while ensuring movement of traffic in a safe and efficient manner.

Average daily traffic (ADT): The average number of vehicles passing a certain point each day on a highway, road, or street.

Background traffic: Predicted traffic volumes without unapproved developments.

Capacity: Maximum volume of traffic that the roadway section is able to carry on a sustained basis.

Design hour volume (DHV): The peak hour volume used for design, measured in vehicles per hour (vph).

Development Review Guidelines (DRG): An ODOT handbook that compiles information to help ODOT staff respond to local land use and development proposals that affect state transportation facilities.

Division 51: The short name given to Oregon Administrative Rule 734, Division 51. The purpose of Division 51 is to provide a safe and efficient transportation system.

Fitted curve line: A curve that divides data points so that the sum of the distance between all data points above the curve line and the curve line equals the sum of the distance between all data points below the curve line and the curve line.

Highway Capacity Manual (HCM): A manual published by the Transportation Research Board as a means of standardizing the techniques used to evaluate the quality of service provided by various transportation facilities.

Horizon year: A future year to which the traffic analysis is directed.

Independent variable: A physical, measurable, and predictable unit describing the study site or generator that can be used to predict the value of the dependent variable (trip ends).

Institute of Transportation Engineers (ITE): An international educational and scientific association of transportation professionals. ITE facilitates the application of technology and scientific principles to research, planning, functional design, implementation, operation, policy development, and management for all transportation modes.

Metropolitan Planning Organization (MPO): A planning body in an urbanized area of more than 50,000 people that has responsibility for developing transportation plans for that area. In Oregon, there are six MPOs (Portland Metro, Eugene-Springfield, Salem-Keizer, Medford, Bend, and Corvallis).

Mitigation: Actions taken to minimize or offset negative effects of proposed projects or actions.

Oregon Administrative Rule (OAR): A rule written by a government agency intended to clarify the intent of an adopted law.

Peak hour: Hour of the day with the most traffic, usually during morning and evening commute times.

Regression: A form of statistical modeling that evaluates the relationship between one variable (termed the dependent variable) and one or more other variables (termed the independent variables).

R-squared (r^2): Also known as the coefficient of determination, r^2 is the percent of the variance in the number of trips associated with the variance in the size of the independent variable. For example, if the r^2 value is 0.70, then 70 percent of the variance in the number of trips is accounted for by the variance in the size of the independent variable. As r^2 approaches 1.0, the better the data fit.

Standard deviation: A measure of how widely dispersed data points are around the calculated average. The less the dispersion, the better the approximation.

Synchro: A traffic analysis software program.

Transportation Demand Management (TDM): Actions and policies that encourage people to modify their travel behavior so that the roadway system has reduced peak hour or single-occupancy vehicle traffic. Examples of TDM include rideshare programs, discounted transit passes, pricing strategies, and flexible work hours.

Transportation Planning Rule (TPR): This rule interprets Oregon Statewide Planning Goal 12 (Transportation), which is to provide and encourage the development of a safe, convenient, and economic transportation system. The rule requires the preparation and coordination of Transportation System Plans by the state, the Metropolitan Planning Organization in the area, and local governments.

Transportation System Plan (TSP): A plan required by Oregon law (Transportation Planning Rule—OAR Chapter 660 Division 12) that establishes a system of facilities and services to meet local transportation need. A TSP serves as the long-range transportation plan and must be consistent with the *Oregon Transportation Plan*.

Trip distribution: Estimated travel direction proportion, in percent, of the total number of trips originating at or destined for the case study site.

Trip generation: The development's actual or predicted trip generation.

Volume-to-capacity ratio (v/c ratio): A measure of roadway congestion, calculated by dividing the number of vehicles passing through a section of highway during the peak hour by the capacity of the section.

Weighted average rate: Calculated by dividing the sum of all trips or trip ends by the sum of all independent variable units where paired data are available.