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Chapter 3.3 – Traffic Impact Analysis[1]

3.3.01 Overview

The primary audience of these guidelines is internal to ODOT: Development Review Planners, Region Access Management Engineers, Traffic Analysts and other ODOT staff who review local government development proposals and/or state highway approach applications. Traffic Impact Analysis reports (TIAs) are used to identify the impacts of development proposals or new or changed approaches on state transportation facilities and to propose mitigation measures when needed as conditions of development approval.

This Section may also provide guidance to those involved in the preparation of TIA reports or Traffic Impact Studies (TIS) for development projects that affect state highways, either directly or indirectly. Assignment of ODOT reviewing responsibilities will vary by Region, except that a TIA submitted as part of an Approach Permit application will be reviewed by the RAME or a licensed Oregon Professional Engineer (PE).

Guidelines do not set policy, but rather attempt to explain how agency business practices can be carried out effectively and in a manner consistent with formal ODOT policies and procedures, state laws and administrative rules.

The following discussion provides general information and ODOT accepted best practices applicable to typical TIA reports, but does not include substantive technical content. The Analysis Procedures Manual[2] is the technical resource that should be relied upon in the development of TIAs.

Although this guidelines document is developed by and for the ODOT Development Review Committee and staff, this section may have broader application because TIAs are used in a variety of situations. Staff who review TIAs have requested that this section go beyond the subset of TIA issues that apply directly to development review to include access management and other issues. In so doing, it is believed that the development of TIAs can be more efficient, with fewer surprises later in the development process.

This approach will also help to ensure that the various issues likely to arise in the development process will, to the extent practicable, be assessed based upon the same data sets and time frames and upon consistent assumptions. However, it is understood that in some cases the site plan review will not occur for years after the zone change review so new data and timeframes will sometimes be required.

[1] 734-051-1070 (77): - “Traffic Impact Analysis” means a report prepared by a professional engineer that analyzes existing and future roadway conditions.
[2] http://www.oregon.gov/ODOT/TD/TP/Pages/APM.aspx

Technical Considerations:

When a TIA is developed for a proposal that includes new traffic control or modification to existing traffic signals, consult the Region Traffic Engineer early in the TIA scoping process. Proposed changes to or the addition of traffic control devices must be reviewed and approved by the Region Traffic Engineer or State Traffic Engineer prior to establishing ODOT concurrence with a traffic study's recommendations.

It is inadvisable to create a condition of approval specifically calling for a future signal where there is a range of possible solutions that could be effective at that later date. Include the Region Traffic Engineer on the application review team where signalization is proposed. The Traffic Manual is an additional resource:

http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/pages/traffic_manual.aspx

The Analysis Procedures Manual (APM) provides detailed technical support for many of the analysis procedures used in the development of TIAs. APM procedures must be followed unless otherwise agreed to by the department.

Every development proposal presents a unique set of issues to address, so professional judgment must be used along with the information in this chapter. Where ODOT is requiring, or takes the lead in developing the traffic analysis, variations from the APM must be approved by the department.

What the TIA Provides:

In the traffic analysis scoping process participants establish the purpose of the study, define a study area, agree to a methodology, appropriate peak hour (30th highest peak hour is a standard; variations relate to local conditions), and identify critical issues to be addressed. The basic outputs will include:

- Existing Site Conditions including the operational and geometric characteristics of roadways within the study area and how the highway area is performing relative to OHP Mobility Performance Targets or alternate mobility targets already in effect at the location;
- Existing or potential safety hazards or operation concerns, including patterns and trends and potential changes related to recent or planned improvements;
- Impacts of the Proposed Development on traffic facilities and services, and which facilities are inadequate to meet transportation needs;
- A comparison of the operational and safety characteristics of the transportation system for each time period to the standards and thresholds set in the applicable approval criteria. For example, identification of v/c ratios for all state intersections during each time period and analysis year and including the v/c ratios with and without the proposed development;

- Traffic flow diagrams to illustrate existing and projected traffic volumes and the appropriate design hour turning movements at each study intersection and site approach location;
- The completed TIA will provide the basis and rationale for any mitigation recommendations for the development application and/or approach permit. Mitigation alternatives can include geometric improvements, alternative approach configurations, installation of traffic control devices, Transportation Demand Management strategies, and other measures;
- For land use proposals subject to the TPR, a TIA will usually be necessary to determine whether a development proposal that includes a plan amendment will have a "significant effect" on a transportation facility as spelled out in TPR, section 0060 (OAR 660-012) and as discussed in detail in Chapter 3.2 of these guidelines;
- Other information required by local government code, the access management rules or other regulating agency or which the applicant agreed to provide during the scoping process.

3.3.02 When a TIA May Be Required

ODOT development review planners may recommend that a TIA be developed for a development application, but the ability to require a TIA is limited:

- ODOT only has authority to require a developer or other private applicant to develop traffic analysis for highway approach change of use and other permit applications only under certain circumstances.
- Local government may also require a TIA for certain types or scales of development proposals if it is enabled in their development codes.
- Applications for plan and zoning amendments[3] that create a "significant effect" under TPR section 0060 must provide information that is best discovered in traffic impact analysis, but it is up to the local government to request or require it.

Consequently, requiring a TIA is not an option in many cases.

Circumstances under which ODOT is more likely to ask that the local government request or require a TIA include:

- When the proposed development is within a quarter mile of the terminal of an interchange ramp;
- When the local development code requires that there are "adequate facilities" to serve the proposed development (often applies to "change of use" applications);
- When ODOT preliminary review identifies operational or safety issues related to increased traffic or highway access at the development site; and/or

[3] As used here, "plan and zoning amendments" comprise "an amendment to a functional plan, an acknowledged comprehensive plan, or a land use regulation (including a zoning map)," pursuant to OAR 6600-012-0060 (1).

- When an approach to the state highway will be the development's only, or primary, access to the roadway network.

Table 3.3.1 - TIA Thresholds and Analysis Areas

	Transportation Planning Rules	Local Land Use (Will vary by jurisdiction)	ODOT approach permit
Traffic Impact Analysis Required (Unless Waived)	When greater than existing provides. OHP (Policy 1F.5) >1000 ADT >400 ADT - <1000 ADT (Hwy Sec/ADT)	Example: 20 peak hour trips and/or 200 ADT at subject site or intersection	Public Approach if agreed to in coordination with local jurisdiction Request for Deviation from the spacing, sight distance and channelization standards per OAR 734-051-4020 Whenever site trips relative to highway ADT exceed thresholds in (OAR 734-051 3030(4)(b)[4] May be used to affirm whether a Change of Use of a Highway Approach (COU) has occurred.
Analysis Area	The analysis area is the area significantly affected (i.e. affected intersections), within reason. For example, in rural areas without street networks, a measurable effect can be felt far beyond the local area.	Examples: Within 1 Mile radius of the subject property; or Area including all arterials and collectors experiencing peak hour increase of XX trips.	(Not regulatory – based on past practice) Area including all intersections where traffic is increased by 50 peak hour trips; 300 ADT; and/or 10% TEV[5] increase (most likely to occur on low volume and/or rural roads)

In some cases, ODOT staff may work to persuade an applicant that it is in their best interest to have traffic analysis information in their applications even if there is not a specific requirement to do so. Remember that land use applicants have a responsibility (supported strongly by case law in Oregon) to provide adequate information to

[4] Rule section included in Highway Approach Permitting section below.
[5] Total Entering Vehicles

demonstrate that they satisfy all local land use criteria, and that maintaining adequate transportation facilities is a general requirement of all local plans and most codes.

The information that comes from good analysis will be valuable in all three elements of land development applications considered here: plan and zoning amendments, site development review and approach permitting. Development review planners work closely with ODOT access management staff and local planners to recognize when analysis is needed and coordinate the scoping of a TIA to ensure that it answers questions for all three review processes as needed.

Local Land Use Review

In basic development review, ODOT's role is as a party to a local land use decision that will be based upon the local development code. The local jurisdiction may require a TIA as part of a land use application. If it does not, the development review planner may recommend that a TIA be required, but unless the local code enables a TIA requirement or requires applicants to demonstrate that transportation facilities are adequate[6] to serve the type of proposal under review, a decision to require traffic analysis will be at the will of the local jurisdiction.

Where local development codes do require traffic impact analysis, the traffic volume or other type of thresholds that trigger a TIA requirement will often be different from the thresholds used in the access management rules. Where an application hits one threshold and not the other, the jurisdiction with authority related to that threshold will be the one requiring the TIA.

If the TIA shows that the transportation system is inadequate to accommodate a proposed land use action, then the TIA also identifies and recommends improvements to mitigate conditions so that adequacy can be achieved and that the local jurisdiction may then require as condition(s) of approval for the application.

Plan and Code Amendments[7]

When a land use proposal includes a request for a plan amendment or zoning map amendment[8], the issue of "significant effects" on transportation facilities arises pursuant to the Transportation Planning Rule (OAR 660-012-0060) and a TIA may be useful to identify whether a significant effect is indicated and the extent of it. If the local jurisdiction chooses to use the provisions in OAR 660-012-0060(11) (partial mitigation) to meet the TPR 0060 requirements, the proposal is required to include *"(a)nalysis and projections of the extent to which the proposed amendment in combination with proposed mitigating actions would fall short of being consistent with the function, capacity, and performance standards of transportation facilities"* which would likely require some level of formal traffic study. The TPR does not specifically require that a

[6] Discussed further in section 3.3.03, below
[7] See also Chapter 3.2, Transportation Planning Rule (TPR) Reviews
[8] As listed in OAR 660-012-0060(1) ". . .an amendment to a functional plan, an acknowledged comprehensive plan, or a land use regulation (including a zoning map) . . ."

TIA be developed to meet the requirements of the rule, so the decision to require traffic analysis is still a local one. However, where ODOT believes it is likely that there is a significant effect, it is in everyone's interest to develop a TIA to analyze the likely impacts through an agreed upon scope and methodology.

Highway Approach Permitting

In highway approach permitting TIAs are useful in a variety of types of decisions, but only required under certain circumstances:

- TIAs may be developed in cooperation with local governments for public approaches (in a process that is outside of the permitting process that applies to private approaches).
- Whether or not a private approach is subject to "change of use" review[9] may be determined in several ways that may include a TIA, but the rule does not specify that the applicant has to develop the TIA. In fact, the decision whether there is a change of use of the approach is determined before an application is required. It is unlikely that ODOT would ask for a TIA before deciding that an application will be required.

"Change of use" means a change to the use of an existing highway access, as opposed to the same term as used in land use planning that refers to a change to the type of land use. If a development activity creates a change of use of an approach, the affected approaches to the state facility are reviewed under "moving in the direction of" standards. That is, any conditions of the existing accesses that are not consistent with current spacing, sight distance and channelization standards can be remedied by ODOT / Applicant agreement to measures to reduce the inconsistencies in a meaningful way. If agreement cannot be reached, the applicant has the option to apply for a permit under the standard review process that applies to new approaches, wherein a TIA may be required.

ODOT's direct authority to require a TIA is related to trip volumes from the site and highway configuration and traffic levels, and is enabled and limited by OAR 734-051-3030(4):

- TIAs are required for deviations from standards unless waived by the department.
- TIAs <u>may</u> be required for other applications under certain circumstances related to site trip volumes and highway ADT:

  OAR 734-051-3030(4) (b) ***Except where the criteria in subsections (A) and (B) of this section, below, are met*** *for the highway segment where an approach permit is sought,* ***the department may require a person applying for an approach permit to submit a traffic impact analysis***[10] *in conjunction with the application for an approach permit.*

[9] 734-051-3020-Change of Use of a Private Connection
[10] Emphases added

(A) The average daily volume of trips at the property is determined to be four hundred (400) or fewer trips; or

(B) The average daily volume of trips at the property is determined to be more than four hundred (400) but fewer than one thousand one (1001) trips and:

(i) The highway is a two-lane highway with average annual daily trip volume of five thousand (5,000) or fewer motor vehicles;

(ii) The highway is a three-lane highway with average annual daily trip volume of fifteen thousand (15,000) or fewer motor vehicles;

(iii) The highway is a four-lane highway with average annual daily trip volume of ten thousand (10,000) or fewer motor vehicles; or

(iv)The highway is a five-lane highway with average annual daily trip volume of twenty-five thousand (25,000) or fewer motor vehicles.

Circumstances in highway approach permitting under which a TIA requirement may be waived by ODOT:

- When a request for a spacing deviation does not present any safety or operations concerns as set out in OAR 734-051-4020(3); and/or
- The applicant proposes and the department approves channelization to address the channelization standard set forth in OAR 734-051-4020(2)(b); and/or
- The department determines that a request for a sight distance deviation can be approved without a TIA.
- Region Access Management Engineer is familiar enough with the traffic conditions in the area to make a determination that the proposed development will not result in any significant safety or operations concerns.
- The local jurisdiction is requiring a TIA that is adequate in scope to address ODOT's concerns.

Staff needs to review explanations and background in the Highway Division technical bulletins on safety and operations concerns, channelization, and sight distance when deciding whether a TIA is needed and for what purpose[11].

3.3.03 Adequacy of State Transportation Facilities

State transportation facilities are "adequate" if they meet the minimum requirements set forth in the Oregon Highway Plan. The overriding highway plan policy is "To maintain and improve the safe and efficient movement of people and goods and contribute to the health of Oregon's local, regional, and statewide economies and livability of its communities." The individual OHP policies do not directly address safety or efficiency; the individual policies generally address system management issues.

[11] http://www.oregon.gov/ODOT/HWY/TECHSERV/Pages/technicalguidance.aspx#Bulletins

The OHP policy that most directly addresses "efficiency" is Policy 1F, the Highway Mobility Policy, which addresses highway capacity as a performance measure. For long-range studies, such as those required for zone changes and plan amendments, the adequacy of transportation facilities is often determined relative to the amount of remaining capacity there will be on the transportation system at the end of the applicable planning period (e.g. the horizon year for the applicable local transportation system plan).

Amendments to Policy 1F in 2011 changed the way volume to capacity ratios are applied in planning. The v/c Tables 6 and 7 in the Policy are now generally considered "targets" rather than standards. The highway mobility targets are used in three distinct ways:

- Transportation System Planning: Mobility targets identify state highway mobility performance expectations and provide a measure by which the existing and future performance of the highway system can be evaluated. Plan development may necessitate adopting methodologies and targets that deviate from adopted mobility targets in order to balance regional and local performance expectations. For purposes of compliance with OAR 660-012, the Transportation Planning Rule, mobility targets are considered standards.
- Local Plan Amendments and Development Review: Mobility targets are used to review amendments to comprehensive plans and land use regulations pursuant to the Transportation Planning Rule (TPR) to assess whether the proposed changes are consistent with the planned function, capacity and performance standards of state highway facilities. Unless the Oregon Transportation Commission has adopted an alternative mobility target that applies to the impacted facility, the mobility targets in Tables 6 and 7 are considered standards for purposes of determining compliance with OAR 660-012-0060.
- Operations: Mobility targets are used to assist in making traffic operations decisions such as managing access and traffic control systems to maintain acceptable highway performance.

3.3.04 TIA Scope of Work

The scope of work for a traffic impact analysis sets out the work that needs to be accomplished to deliver the analysis and report. The scope identifies the types of information needed to meet the requirements for the type(s) of criteria being addressed and includes assumptions and methods of analysis to be applied. A TIA scope of work may address criteria for TPR section 0060 compliance, local site development review, and/or highway approach permitting.

If possible, a TIA scope required for any one of these decision processes should also call for adequate analysis to inform good decisions in the other areas, but without requiring unnecessary time or expense for applicants.

Depending upon which entity requires or requests that a TIA be developed, ODOT staff may or may not participate in scoping. For an approach permit the RAME's have a key

role; for a land use application that does not include a new approach to a state highway, ODOT may ask or be asked to have an active role. ODOT staff may sometimes be encouraged to participate to help a local agency work through the technical details of scoping and reviewing a TIA. The agency definitely has an interest in any traffic study that considers conditions on state facilities.

The elements of a scope of work include but may not be limited to:

- A description of the proposed development including at a minimum: current and proposed land uses, property acreage and building sizes, intended location(s) of access to public right of way, site plan illustration, on-site circulation plan and vicinity map and development schedule including anticipated dates for completion of all phases.
- Analysis Study Area description including locations of affected intersections and public and private connections to public right of way and facilities supporting other modes, with illustration(s) of the study area,
- Set Assumptions[12]:
    - Plan Horizon
    - Planned Transportation Improvements
        - Highway
        - Local
        - Other modes
    - Analyzed Peak Hour and Mobility Target(s) That Apply
- Describe Required Traffic Data:
    - Traffic Count Standards and Locations
    - Site Trip Generation, Distribution and Assignment
- Describe of Analysis Procedures
    - Capacity Analysis
    - Queue Length Analysis
- Describe Analysis Requirements
    - Intersection Sight Distance
    - Right and Left Turn Criteria
    - Traffic Signal Installation and Modifications
    - Access Management
- Describe Analysis Outputs

[12] See also the Analysis Procedures Manual (linked earlier in the chapter),and Best Practices for Traffic Impact Analysis: http://www.oregon.gov/ODOT/TD/TP_RES/docs/reports/bestpracticesfortraffic.pdf

  - Existing Conditions
  - Traffic Volumes and Operations – Future Year
    - With proposed development
    - Without proposed development
  - Analysis Variable Inputs
- Conclusions and Recommendations
- Caveats (for example, "Signal timing adjustments will not be considered as mitigation").

Identifying an Analysis Study Area

The size of the area to be studied may vary based on the particular purpose of the study and the extent of the development and resulting traffic impacts. For example, when a TIA is being performed to identify effects and solutions related to plan or zoning amendments (OAR 660-012-0060) there may be a large area considered for a "significant effect determination" or to consider mitigating effects with off-site improvements or improvements for other modes, but for a state highway approach permit, the focus is narrower, looking at primarily local approach issues related to a state highway facility.

As a rule of thumb, the study and analysis area should typically include:

- Both sides of the highway along the entire frontage of the property(ies) involved;
- All state highways and major city and county streets which directly serve the proposed development or land use change, as well as any interchange ramps in the area;
- Nearest existing improvements for transit, bicycles and pedestrians.
- All proposed approaches on the state highway system;
- Any private approach intersection where the proposed development can be expected to add vehicle trips in a single day of more than the threshold volumes identified in OAR 734-051-3030(4) (b) or the threshold(s) set in the local development code, and
- Any road segment or intersection where the additional traffic created by the proposed development is greater than 10 percent of the current traffic volume for road segments or the current entering volume for the intersection.

Engineering judgment and awareness of local planning criteria come into play when defining a workable analysis area. For example, large development projects in rural areas can cause measurable traffic for hundreds of miles. A relatively small development can generate a significant percent increase in volume on a lightly traveled highway without an adverse effect on the highway. No specific formula will result in a sensible study area for all cases. Base the TIA study area upon the extent of the direct

impacts of the proposed development on transportation facilities and on areas around the facilities most at risk of failure or unsafe conditions due to the projected traffic impacts.

Identify Future Year(s) for Analysis:

Table 3.3.2 - Future Year Analysis: Suggested Time Lines

Proposed Development Daily Trip Generation	Single-Phase Development Horizon Years	Multi-Phased Development Horizon Years
Up to 999 ADT	Year of Opening	Year of Each Phase Opening
1,000 - 2,999 ADT	Year of Opening and at 5 Years	Year of Each Phase Opening and 5 Years Beyond Buildout
3,000 – 4,999	Year of Opening and 10 Years	Year of Each Phase Opening and 10 Years Beyond Buildout
5,000 or More	Year of Opening and Year of Planning Horizon for the Transportation System Plan or 15 Years, Whichever is Greater	Year of Each Phase Opening and Year of Planning Horizon for the Transportation System Plan or 15 Years, Whichever is Greater
Plan Amendments and Zone Changes[13]	Year of Planning Horizon for Transportation System Plan or 15 Years, Whichever is Greater	Year of Planning Horizon for Transportation System Plan or 15 Years, Whichever is Greater

[13] This is policy – ***OHP Action 1F.2. . .*** When evaluating highway mobility for amendments to transportation system plans, acknowledged comprehensive plans and land use regulations, use the planning horizons in adopted local and regional transportation system plans or a planning horizon of 15 years from the proposed date of amendment adoption, whichever is greater. To determine the effect an amendment to a transportation system plan, acknowledged comprehensive plan or land use regulation has on a state facility, the capacity analysis shall include the forecasted growth of traffic on the state highway due to regional and intercity travel and to full development according to the applicable acknowledged comprehensive plan over the planning period.

3.3.05 TIA Deliverables

Components of TIA Reports

The APM should be consulted for guidance on technical procedures that are common to planning and project analysis as well as analysis for a TIA. The general outline of a TIA document will include most or all of the following elements:

1. Executive Summary
2. Introduction
3. Existing Area Conditions
    a. Traffic Volumes – Year of Opening without the Development
    b. Traffic Operations – Year of Opening without the Development
    c. Roadway characteristics
4. Site Trip Generation, Distribution and Assignment
    a. Traffic Volumes – Year of Opening with the Development
    b. Traffic Operations – Year of Opening with the Development
    c. Traffic Volumes – Future Year without the Development
    d. Traffic Operations – Future Year without the Development
    e. Traffic Volumes – Future Year with the Development
    f. Traffic Operations – Future Year with the Development
5. Technical Analysis
    a. Capacity Analysis
    b. Peak Hour Factors and Design Hour Factor
    c. Signalized Intersections
    d. Unsignalized Intersections
    e. Roundabouts
    f. Capacity Analysis Documentation Requirements
    g. Queue Length Analysis
    h. Intersection Sight Distance
    i. Right/Left Turn Lane Warrants
    j. Signal Warrants, if a signal is proposed
    k. Transportation Demand Management
    l. Turning Conflict Analysis
    m. Access Management

n. Crash Analysis

o. Multi-Modal Analysis

p. System / Off-system Analysis

6. Mitigation Alternatives

7. Conclusions and Recommendations

8. Appendices including all data sheets

9. A Mitigation Schedule (See Appendix 12) is a practical way to summarize mitigation measures that will be used to reduce development impacts on the transportation system.

Each of these elements is discussed further in the subsections that follow.

Executive Summary

Executive summaries are particularly useful on larger, more complex applications to provide a general overview of the report. An executive summary concisely describes the purpose of the report and the study objectives, and provides a description of the site location, the study area, the proposed development and/or land use action, and the principal findings, recommendations and conclusions of the report. Executive summaries should be written to be understood by local government decision makers and other interested parties who are not planners or engineers.

Introduction

The introduction to a TIA includes a brief description of the proposal including the site location, map (township, range, section) and tax lot information, existing and proposed land uses and development intensities (e.g. number of units, square feet, whether the site is raw land or already has development, etc.), and the anticipated timing of development phases where applicable. In addition, the written description should be accompanied by a vicinity map, plat map with tax map identification (township, range, section and tax lot numbers), and a site plan. Site plans should be drawn to scale and show the proposed site approaches, approaches to adjacent properties and to properties across the highway from the subject site, building locations, parking lot layout, and internal circulation routes. This information is standard material required for typical land use applications.

Existing Area Conditions

An **existing conditions analysis** identifies site conditions and the operational and geometric characteristics of roadways within the study area for the current year. In addition to detecting existing transportation system deficiencies, the existing conditions analysis provides a baseline for comparison to the proposed development's traffic impacts found later in the TIA.

Figure 3.3.1 - EXAMPLE Existing Transportation Facilities in the Immediate Study Area[14]

Roadway	Roadway classification by Jurisdiction	Number of Lanes	Posted Speed (mph)	Sidewalks	Bicycle Lanes	On-Street Parking	Transit Facilities
I-5	Interstate Highway (ODOT)	7-8	55	No	No	No	No
SW Nyberg Road	Arterial east of T-S Road Washington County	6	30	Yes	Yes	No	No
	Minor Collector west of T-s Road (Tualatin)	2	30	Yes	No	No	No
Tualatin-Sherwood Road	Arterial (Washington County)	5	35	Yes	No	No	No
SW Martinazzi Ave	Minor Arterial north of T-S Rd. (Tualatin)	3	NP	Yes	No	No	Yes
	Major Arterial south of T-S rd. (Tualatin)	5	35	Yes	No	No	Yes

Note: ODOT has jurisdictional control over SW Nyberg Road within the vicinity of the northbound and southbound 1-5 ramp terminals
Note: This example does not include a column for mobility standard (LOS or v/c); it is recommended that the applicable mobility standard be included.

Information provided in a study of existing conditions includes:

Existing Area Conditions:

- Study area description:
  - Area of potentially significant traffic impact;
  - Existing street network;
  - Existing traffic volumes and conditions;

[14] As used in this chapter, a Figure is an illustration, i.e. an illustrative table from a sample document, as opposed to the Tables which are tables of information developed specifically for this chapter. This distinction was established for this chapter in the process of the 2006 complete guidelines update.

- Availability of public transit , bike and pedestrian facilities and other alternatives;
- Existing transportation system management programs;
- Local policy and regulations;
- Documented crash locations and crash type(s), as pertinent; and
- Known operational problems (e.g., long queues, high percentage of truck traffic, sight distance issues); and
- Any unique geometric characteristics.

- Study area land use(s):
  - Existing land uses;
  - Existing zoning and comprehensive plan designations;
  - Anticipated/ planned future development; and
  - Proposed zoning or plan amendments.

Figure 3.3.2 - EXAMPLE (Study Year) Existing Conditions and Operations Study

Site Number	Intersection	Minimum Operating Standard	Weekday PM Peak Hour		Saturday Midday Peak Hour	
			LOS	v/c	LOS	v/c
1	SW Boones Ferry Road / SW Tualatin Road	0.99	B	0.61	Not Analyzed	Not Analyzed
2	SW Boones Ferry Road / SW Martinazzi Ave	0.99	C	0.91	B	0.62
3	SW Nyberg Road / SW Martinazzi Ave	0.99	B	0.44	B	0.35

Note: LOS and v/c reported for the highest delay of critical movement

Some information, such as a description of the subject property, location, and surrounding land uses that were discussed in the Introduction are covered in more detail in this section.

A physical description of each roadway in the study area helps assess currently available transportation infrastructure. At a minimum, this includes: roadway names; roadway classifications; jurisdiction with road authority; posted speeds; roadway cross-section dimensions; number of lanes; transit services; presence of bike lanes, sidewalks, and on-street parking.

Existing lane configurations and traffic control devices are shown on a diagram of the study area (for example: the number of through lanes and turn lanes and types of traffic control, etc.), for each intersection approach to be analyzed. The amount of available vehicle storage in the left and right turn lanes can also be provided in this diagram.

Traffic flow diagrams are included in the report to illustrate existing traffic volumes and the appropriate design hour turning movements at each study intersection and site approach location. Refer to the APM for examples of traffic flow diagrams.

In general, ODOT requires the use of the 30th highest hourly volume (30 HV) of the year as the design hour volume. Alternatives to the 30th highest annual hour may be considered and established through the adoption of alternative mobility target(s), as provided in OHP Policy 1F and using the process set out in operational notice PB-02: http://transnet.odot.state.or.us/tdd/TransPlan/Web%20Components/pblt_opnotices.aspx?PageView=Shared).[15]

Note that alternative mobility targets may only be adopted through a long range planning process, such as a TSP update or other policy or facility plan; this is not an option for conditioning land use or site development approval.

In large urban areas, the design hour volume may be closely approximated by using the weekday peak hour volume from the peak month of the year. The weekday peak hour typically occurs during the work-related commute period, usually between 7-9 a.m. or 4-6 p.m. Seasonal factors can be applied to the counts obtained to model conditions during the peak month of the year.

The choice of peak hour volumes can vary based upon existing conditions or specifics of the development proposal. One example is a proposal for a church where Sunday morning traffic levels will be of more interest than weekday morning peak hours. In any case, **a description of the assumptions used** is a necessary part of the traffic study report.

In rural or recreational areas, the time of the design hour volume may be less predictable. An example is a coastal community where summer weekend peaks are far higher than weekday or off-season weekend traffic levels, so a decision has to be made to identify the appropriate peak hour traffic volumes for the study.

Complete procedures for determining the design hour volume in both urban and rural areas can be found in the APM. Also, see the APM for guidance on count location, type and duration.

An **analysis of existing study area intersection operations** during the time periods specified in the scope of work must be provided based on the information described above. The results need to be clearly presented in tables or figures (see Figure 3.3.2).

Many local jurisdictions measure **intersection operational performance** by Level of Service (LOS) or delay. ODOT measures the performance of the highway using volume

[15] Operational Notices are policies related to ODOT internal practices. Consult with an ODOT planner if you have questions about the operational notice PB-02.

to capacity ratios (v/c/). The TIA will report the performance of each intersection analyzed using the measuring criteria preferred by the jurisdiction with authority over the intersection. Having both LOS and v/c data helps to get a more accurate picture of how well an intersection functions. For example, for a minor approach to a major roadway that is not signalized, the v/c may be well within standards while the LOS (delay) is unacceptable.

For plan and zoning amendments, the TPR (OAR 660-012-0060(2)(e)) allows consideration of mitigation impacts at a broader or system-wide level under certain circumstances by:

> *Providing improvements that would benefit modes other than the significantly affected mode, improvements to facilities other than the significantly affected facility, or improvements at other locations, if the provider of the significantly affected facility provides a written statement that the system-wide benefits are sufficient to balance the significant effect, even though the improvements would not result in consistency for all performance standards.*

A TIA for an application that proposes using 0060(2)(e) measures to provide adequate facilities needs to include analysis at a scale that will identify appropriate measures and validate their application in the particular case.

Figure 3.3.3 - EXAMPLE: 2001 Existing Intersection Capacity Analysis

Intersection	Signalized Intersection*		Unsignalized Intersection			Level of Service
	v/c	Average Delay (sec)	Critical Movement	Movement v/c	Movement Delay (sec)	
Hwy 213 @ Hwy 211	0.45	26.3				C
Hwy 213 @ Barnards Rd			EBLT	0.02	17.7	C
Site Access @ Barnards Rd						
Hwy 213 @ Macksburg Rd			EB	0.87	77.5	F

*In region 3 the critical movement direction and critical movement v/c are also included for signalized intersections

It is also important to identify **existing or potential safety issues** in the analysis area. Traffic crash data from ODOT's Crash Analysis and Reporting Unit is used to identify patterns and trends. Five years of the most current crash data should be used for a TIA. Recent or upcoming improvement projects that change transportation infrastructure should be accounted for in evaluating hazardous locations. See the APM for crash and safety analysis procedures

Note that the safety (and operational) issues that can be considered in a decision to deny or require mitigation measures for a State Highway Approach Permit are limited in the access management rules to the list of issues in section 4020(3), as follows:

> *(3) Safety and Operations Concerns. The department has the burden of proving safety and highway operations concerns that it relies upon in requiring mitigation or in denying an application based on those concerns. The department may deny an application where the applicant is unable to provide adequate improvements to mitigate documented safety or highway operations concerns; safety and highway operations concerns that the department may consider are limited to (a) through (f), below:*
>
> *(a) Regular queuing on the highway that impedes turning movements associated with the proposed approach. Regular queuing will be evaluated based on the ninety-fifth (95th) percentile queue on the highway during the highway peak hour, as determined by field observation or traffic analysis in accordance with ODOT's Analysis Procedures Manual; or*
>
> *(b) Overlapping left turn movements or competing use of a center turn lane from a connection located on the opposite side of the highway; or*
>
> *(c) Location of the proposed approach within a highway segment with a crash rate that is twenty (20) percent or higher than the statewide average for similar highways; or*
>
> *(d) Location of the proposed approach within a highway segment listed in the top five percent of locations identified by the Safety Priority Index System developed by the department; or*
>
> *(e) The proposed approach is on a district or regional highway with a posted speed of 50 miles per hour or higher and the distance to the nearest public approach is less than the stopping sight distance on the highway, calculated in accordance with the 2004 AASHTO Policy on Geometric Design of Highways and Streets; or*
>
> *(f) Insufficient distance for weave movements made by vehicles exiting the proposed approach across multiple lanes in the vicinity of:*
>
> *(A) Signalized intersections; or*
>
> *(B) Roads classified as collectors or arterials in an acknowledged transportation system plan or comprehensive plan, or classified as such by the Federal Highway Administration; or*
>
> *(C) On-ramps or off-ramps.*

Figure 3.3.4 - EXAMPLE Intersection Crash History (Start Date to End Date)

Intersection	Collision Type						Total Crashes	Estimated Annual Average Daily Traffic	Crash Rate (crashes per million entering vehicles)
	Angle	Turning	Rear End	Fixed Object	Bike / Ped	Other			
SW Boones Ferry Rd / SW Tualatin Road	-	-	4	-	2	-	6	24.800	0.08
SW Nyberg Rd / SW Martinazzi Ave	-	4	4	-	-	-	8	16,950	0.43
1-5 SB Ramp Terminal / SW Nyberg Rd	1	20	24	-	2	1	48	50,900	0.86

Identification of **existing or potential traffic operational problems** is based on thorough field observations of the subject intersection(s)**.** Items of concern include, but are not limited to, excessive queuing and/or delay, location and spacing of adjacent intersections and driveways, sight distance and deficiencies related to geometry, meeting criteria for signals or turn lanes, etc. See the excerpt from Division 51 above for the types of operational issues that can be considered in reviewing a State Highway Approach Permit. Finally, for land use proposals subject to the TPR, **committed and planned transportation improvements** in the area, (both ODOT and local government) that affect or are affected by the development proposal need to be identified. This will include projects identified on the "financially constrained" list in adopted local and regional transportation system plans as well as corridor plans or projects from ODOT's Statewide Transportation Improvement Program (STIP) or the local jurisdiction's Capital Improvement Program (CIP).

Authorized users can find local transportation plans, refinement plans and ODOT facility plans in the area on the Transportation Planning Data Base (TPOD): http://www.arcgis.com/home/item.html?id=79682fc8ba934163b18964bf5cd081f3

Traffic Volumes – Year of Opening without the Development

These traffic volumes are typically referred to as the **background traffic** and represent the non-site traffic during the anticipated year of opening for the development. The background traffic consists of the existing traffic plus the traffic generated by nearby "in-process" developments (currently approved but not yet operational) and projected regional growth affecting the analysis area.

There are several methods for projecting the background traffic. The three most common methods are described briefly below. The method used to develop the background traffic volumes should be approved by the Region Access Management Engineer or his/her designee.

Transportation Models

The output from urban travel demand models may be used to estimate future traffic growth. Transportation models use current and projected land use and transportation network data to estimate current and future travel demand. The data is obtained from many different sources, including census data, state employment data, O-D[16] surveys, household travel surveys, traffic counts and field surveys.

Figure 3.3.5 - EXAMPLE Historical Traffic Counts

Count Location	2008	2009	2010	2011	2012
SW Nyberg Road (west of SW 65th Ave)	21,837	20,764	21,733	21,506	21,351
SW Tualatin-Sherwood Road (east of SW Boones Ferry Road)	40,469	38,813	39,671	41,137	40,591

Models that may be used in transportation impact analysis include MPO models, County models, and Small Urban Area models. A map showing locations of Oregon models is available at: http://www.oregon.gov/ODOT/TD/TP/pages/tools.aspx#modeling. The form used to request ODOT model runs is also available at this link.

Traffic Models are not detailed at the site level and are not intended for direct application to individual development project analysis without post-processing. However, model data do have value in development review by providing best available information on background trips under the current conditions (assuming input data is current) and for future years projected from those same "current" conditions. Models can also be used for traffic analysis, particularly for system-wide performance which may be needed in TPR reviews.

Figure 3.3.6 - EXAMPLE 2014 Background Daily Traffic Profile

Roadway	Segment	Estimated Daily Volume	
		2012 Existing	2014 Background
SW Lower Boones Ferry Rd	East of SW Upper Boones Ferry Rd	13,200	13,600
SW Tualatin Sherwood Rd	West of SW Boones Ferry Rd	30,800	31,800
SW Nyberg Rd	East of SW Tualatin-Sherwood Rd & west of 1-5 Southbound Ramp Terminal	51,900	52,900

Models are most suitable for use in urban areas over long time frames. The traffic analyst referencing model data needs to understand the origin of the inputs and the design parameters and limitations of the model. The transportation analysis zone (TAZ)

[16] O-D stands for origin-destination survey, conducted to identify where drivers at a survey station are destined. It's used frequently in model development and other studies. For example it can be used to determine the percentage of through versus local trips. A couple of the more common methods include roadside interviews/post card handouts or license plate surveys. Bluetooth is a more recent technique.

containing a proposed development should be investigated closely to ensure the appropriate land use was assumed in the model[17]. If a plan or zone amendment is proposed that will change allowed land uses to something that will perform differently from the land uses assumed in the model, the model may be relied upon for future year baseline projections, but projections are also needed that include the impacts of the proposed land use changes.

Transportation models of the current time period may be compared with a future year to arrive at an annual growth rate. The growth rate is then applied to the counted traffic volumes over the number of years into the future appropriate for that proposal. Because the models are typically developed in conjunction with a transportation system plan and comprehensive plan, this method can provide a reliable forecast for growing urban areas. Significant changes to the transportation network, such as the addition of a new arterial or new travel lanes, are also captured well by a model.

Note: Nearly all computerized system level traffic assignments require that further post-processing take place prior to their being used for transportation project planning and design. Model numbers represent employment and households, and only indirectly represent trips, so modeled volumes have to be compared on a relative basis. The recommended methodology for refining trip assignments obtained from computerized transportation models is provided in Chapter 17 of the APM (http://www.oregon.gov/ODOT/TD/TP/Pages/APM.aspx). Guidelines for the use of

Figure 3.3.7 - EXAMPLE Existing Daily Traffic Volumes on Select Roadway Segments

Roadway	Segment	Estimated Daily Volume
SW Lower Boones Ferry Road	East of SW Upper Boones Ferry Road	13,200
SW Martinazzi Ave	South of SW Boones Ferry Rd. and north of SW Nyberg Rd.	13,700
SW Nyberg Road	West of SW Tualatin-Sherwood Rd. and east of SW Martinazzi Ave.	9,000
SW Tualatin-Sherwood Road	East of SW Martinazzi Ave and west of SW Nyberg Road	44,600

models to evaluate land use changes are provided in the Modeling Procedures Manual for Land Use Changes, available at: http://www.oregon.gov/ODOT/TD/TP/pages/reports.aspx .

TIA Level Cumulative Analysis: This methodology is most suitable for smaller urban areas or for 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 estimated traffic generated by all approved but not yet opened developments in a study area to existing traffic volumes. Long-term forecasts should also include the

[17] Note that if the model is to be used to forecast future background volumes, the “appropriate land use” in the TAZ should not include the proposed project.

effects of future developments on undeveloped lands. An additional amount may be added to account for increases in through trips. This methodology is outlined in the APM.

If a cumulative analysis is conducted, a table listing the anticipated developments and corresponding trip generation rates must be provided.

Historical Trends: This method is most suitable for rural areas with stable growth rates. This methodology is based on the Future Volume Table, available on the TPAU website and described in the APM, which is based on regression analysis of traffic counts covering, typically, the past 20 years. When projecting future traffic demands based on this methodology it is usually assumed that site traffic is included in these projections. Professional judgment is needed to verify whether site traffic would be over- or under-estimated using this method. (For example, a particularly large use such as a destination resort may not fit the past 20-year trend.)

When background traffic volumes for the year of opening have been determined, updated traffic flow diagrams reflecting this condition must be provided.

Figure 3.3.8 - EXAMPLE Estimated Developer Preferred Site Plan Trip Generation

	ITE Code	Size (sq. ft.)	Weekday PM Peak Hour			Saturday Midday Peak Hour		
			Total	In	Out	Total	In	Out
Existing Site								
Existing Site Driveways[1]			945	435	510	970	490	480
Less Existing Library	590	22,123	(160)	(75)	(85)	(150)	(80)	(70)
Less Existing Civic Uses	715	+/- 10,000	(50)	(10)	(40)	-	-	-
Total Existing Retail			735	350	385	820	410	410
Future Site								
Shopping Center	820	299,000	1,325	650	675	1,750	910	840
Less Existing retail Driveway Counts	-	-	(735)	(350)	(385)	(820)	(410)	(410)
Subtotal	-	-	590	300	290	930	500	430
Pass-by Trips (weekday 34%, Sat. 26%)	-	-	(200)	(100)	(100)	(190)	(95)	(95)
Office	710	39,000	60	10	50	15	10	5
New Net Trips			450	210	240	725	400	325

Figure 3.3.9 - EXAMPLE 2014 Total Daily Traffic Profile (Preferred Development)

Roadway	Segment	Estimated Daily Volume		
		2012 Existing	2014 Background	2014 Total
SW Lower Boones Ferry Rd	East of SW Upper Boones Ferry Rd.	13,200	13,600	13,900
SW Boones Ferry Rd.	East of SW Martinazzi Ave	28,100	28,800	29,600
SW Martinazzi Ave	South of SW Boones Ferry Rd & north of SW Nyberg Rd.	13,700	14,100	14,400

Traffic Operations – Year of Opening without the Development

When background traffic volumes for the year of opening have been established, an operational analysis of study area intersections is conducted. This analysis should incorporate any transportation system improvements anticipated to be completed by the represented year. Results should be clearly presented in tables or figures and the performance of each intersection analyzed should be reported using the operational criteria preferred by the jurisdiction having authority over that intersection.

Figure 3.3.10 - EXAMPLE (Planned Year of Opening) Background Traffic Conditions

(Site) Number	Intersection	Minimum Operating Standard	Weekday PM Peak Hour		Saturday Midday Peak Hour	
			LOS	v/c	LOS	v/c
Signalized Intersections						
2	SW Boones Ferry Rd / SW Tualatin Rd.	0.99	B	0.75	Not Analyzed	Not Analyzed
3	SW Boones Ferry Rd / SW Martinazzi Ave	0.99	D	0.96	B	0.63
12	I-5 NB Ramp Terminal / SW Nyberg Rd.	0.85	B	0.60	B	0.54
Unsignalized Intersections[18]						
4	SW Martinazzi Ave / North Site Driveway	E	C	0.12	B	0.11
11	SW Nyberg / Right-In-Right-Out Site Driveway	0.99	A	0.01	A	0.02
All-Way Stop Controlled Intersections						
20	SW Sagert Street / SW Martinazzi Ave	D	F	N/A	Not Analyzed	Not Analyzed

[18] LOS and v/c reported for the highest delay or critical movement

Figure 3.3.11 - EXAMPLE 2003 Background Intersection Capacity Analysis

Intersection	Signalized Intersection*		Unsignalized Intersection			Level of Service
	v/c	Average Delay (sec)	Critical Movement	Movement v/c	Movement Delay (sec)	
Hwy 213 @ Hwy 211	0.48	26.7				C
Hwy 213 @ Barnards Rd			EBLT	0.02	18.6	C
Site Access @ Barnards Rd						
Hwy 213 @ Macksburg Rd			EB	1.02	118.5	F
Hwy 213 @ Union Mills Rd			WB	0.85	76.1	F

*In region 3 the critical movement direction and critical movement v/c are also included for signalized intersections

3.3.06 Site Trip Generation, Distribution and Assignment

Site trip generation, distribution and assignment provide information about how many new trips can be expected to be created by the proposed development and where they will occur on the surrounding transportation system. **Generation, distribution and assignment should be agreed upon with ODOT staff before proceeding with the TIA.**

Trip Generation

An estimate of the amount of trips originating from and destined to a proposed development, and a description of the method used to make the estimate are essential in evaluating that development's impacts to the transportation system. A few of the more common methods used to make these estimates are described below.

Institute of Transportation Engineers (ITE) Trip Generation Manual: This published document contains information provided by engineering and planning professionals in the United States and Canada about the trip generation characteristics of a variety of land uses. The Manual is updated periodically, so the most recent edition should be used. The data for a specific land use in this manual can often be applied to a proposed development if the uses are reasonably similar. If the appropriate land use is not listed in Trip Generation, the size of the proposed development is not within the range of data points presented, or if the trip rates are not considered to be similar to location conditions, local trip rates may need to be developed. Development of local trip rates should follow the methodology contained in the most recent edition of ITE Trip Generation Handbook.

Local Data: Sometimes ODOT or a local jurisdiction will have information about the trip generation characteristics for certain land uses. This information may be more appropriate for use than that from the ITE manual, which typically does not account for local conditions. Remember that the details of a specific development often change from the proposal submitted with the zone change application to something else at the time of site plan review. For example, the zone change may specify "Shopping Center" then change to a "Free-Standing Discount Store" at the site development stage, with both allowed under the new commercial zoning designation.

Data from Similar Sites: Data collected from existing sites found to be reasonably similar to that proposed are occasionally approved when no other information source is available or believed to be appropriate for the subject land use.

Estimates for Site Specific Characteristics: Trip generation can be estimated by closely examining the operating characteristics of the proposed development when there is no documented information available, and no similar sites can be found. To do this, information such as the number of employees, visitors, and deliveries must be known, as well as the time of day they are expected to be entering and leaving the site.

Site Trip Generation, Distribution and Assignment

Site trip generation, distribution and assignment provides information about how many new trips can be expected to be created by the proposed development and where they will occur on the surrounding transportation system. **Generation, distribution and assignment should be agreed upon with ODOT staff before proceeding with the TIA.**

Analysis When Proposal Does Not Include Specific Land Uses: Applications for comprehensive plan map and zoning amendments are often submitted without identifying a specific land use development proposal. The parties must agree on a scenario for potential uses of the land that considers the most intense allowed uses tempered by site conditions specific to the development site.

- The “worst case” is the most intense use allowable under the current zoning (future year condition without the project) and/or the proposed zoning (future year condition with the project).
- The worst case is tempered by a determination of what is “reasonable,” based upon mitigating factors such as access and the physical and size constraints of the subject property.
- Rely on the local comprehensive plan Economic Development or analogous element to determine what is reasonable. Factors used in the adopted plan to establish trends can include the size and level of growth activity in the market area, population, and sometimes job, growth, and recent and planned economic development projects.

- ODOT will typically accept local government assumptions related to development trends that are based on local research and/or policy and that are adopted into plans and ordinances,

A 2005 Land Use Board of Appeals decision offers some direction on the level of review that can be required. The basis for analysis of the difference in traffic impact between an existing zoning district and a proposed new zone, as required by OAR 660-012-060 is considered in *Mason v. City of Corvallis and Pahlisch Homes, 49 OR LUBA 199 (2005).* The city rezoned a recently annexed parcel and amended the comprehensive plan. Petitioner objected because the city did not assume in its analysis of the traffic that the entire parcel could be developed into the most intense land uses allowed under the proposed new zoning. That decision says in part (emphasis added):

> "*Petitioner is correct that the focus of OAR 660-012-0060(1) is on **allowed** land uses rather than **proposed** land uses. Petitioner is also correct that the local government must generally assume the most traffic-intensive uses allowed under the amended and unamended plan and zoning, in conducting a comparison of traffic impacts under 660-012-0060(2)(d). . . (it is) not necessarily error to assume something other than the most traffic-intensive uses, as long as the assumptions are consistent and the uses compared provide a meaningful comparison of the traffic impacts between the existing and proposed plan and zoning. . . (F)or example . . . a local government "would clearly err if it assumed without adequate justification that the most traffic-intensive uses would develop under existing zoning but the least traffic-intensive uses would develop under the proposed zoning."*

In *Griffiths v. City of Corvallis and Group Mackenzie, 50 Or LUBA 588 (2005)* LUBA was more specific about saying that the comparison between potential uses in the old zone vs. new zone should be based on the most intensive uses allowed in the zone, not the current uses, or the "likely" uses.

For example, if a 20-acre site were proposed to be re-zoned from industrial use to commercial use, but no specific type of size of commercial development had been identified in the application, assume that the property will develop to the highest trip generating potential under the new zoning. Assign high trip generating uses such as retail, a fueling station, and fast food with drive-through window to the property in quantities appropriate for the size of the site. Consider whether the high trip-generating uses are appropriate to the site, given its location and surrounding land uses when assigning the potential land use mix to the site. "Allowed" uses are presumably those uses that are permitted outright by the zoning designation. Conditional uses are not permitted outright and are typically subject to additional analysis and conditions at the time of conditional use review and approval.

Also, develop trip generation assumptions for property that will remain undeveloped when a zone change is being requested and a specific development is identified in the application that does not result in full buildout of the property. This provides realistic projections of the long term transportation impacts of the comprehensive plan/zoning change.

A table should be included in the TIA report that shows the daily trips generated, as well as the hourly trips generated for all time periods analyzed.[19] Both entering and exiting volumes need to be displayed for the hourly periods. Include weekend trip generation for some land uses, particularly for those uses that will generate a significant number of trips on the weekend. Show trip generation for each proposed use included in the development.

Explain any variations or adjustments that are required to account for local conditions. All assumptions for adjustments must be documented and discussed in the report. Further discussion on trip generation adjustments can be found below.

Figure 3.3.12 - EXAMPLE Site Trip Generation

Land Use	ITE Code	Size	Daily Trips	Peak Hour Trips		
				Total	Inbound	Outbound
Single-Family Detached	210	124 Dwelling Units	1265	130	85	45

<u>Trip Generation Adjustments</u>: The forecast trip generation from the ITE Trip Generation Manual for the proposed development may be adjusted under certain circumstances. A few types of adjustments are described below.

1. **Pass-by Trips**: Pass-by trips are made as intermediate stops on the way from an origin to a primary destination without a route diversion. They are attracted from traffic passing the site on an adjacent roadway that offers direct access. Reductions in trip generation on the adjacent system accounting for pass-by trips may be allowed based on the factors below.

- Type of development
- Existing traffic composition
- Existing population distribution
- Location(s) of competing developments

Pass-by trip proportions within the total street volume need to be realistic. The number of pass-by trips should not exceed 15 percent (15%) of the adjacent street traffic volume

[19] Traffic Impact Analysis reports typically evaluate the time of day when the peak site traffic, combined with adjacent street traffic, is greatest such as during the AM and PM commute and/or weekend peak. This is commonly defined as the peak hour of adjacent street traffic. However, if a TIA is required as part of an ODOT approach permit, trip generation should also be reported for the peak AM/PM and weekend peak of the generator so that a change of use determination can be performed by ODOT per OAR 734-051-3020.

(street volume prior to site development) during the peak hour per ITE Transportation Impact Analyses for Site Development.

Note: While this assumption may reduce the trips distributed to the transportation system, the full site traffic generation is still based on the site approach(es) and land use assumptions. Recognizing the existence of pass-by trips does not reduce the driveway entering and exiting turning volumes.

2. **Diverted Link Trips**: Diverted linked trips are trips that are attracted from the traffic on roadways within the vicinity of the site but that require a diversion from that roadway to gain access. Diverted linked trips will add traffic to the streets adjacent to a site, but might not add traffic to the area's major travel routes.

3. **Internal Trips**: Where multi-use developments are proposed that offer the potential for interaction among the individual uses (such as a mix of office, retail, and multi-family housing), a reduction in the vehicle trip generation between the overall development and the external street system can be applied to account for internal, or captured, trips. These captured trips are made entirely within the site by either walking or driving between buildings using the internal street system or pathways. Internal trips, if present, must be subtracted before pass-by trip or diverted link reductions are applied.

4. **Mode Split.** Mode split is the process of estimating the number of travelers from the development that are anticipated to use modes other than automobiles in the site impact analysis. If this percentage is low, the step can be skipped. As transit and other non-motorized alternatives become available, mode split analysis may be required. If transit or ridesharing is anticipated to be a factor, data from similar developments within the area should be used to refine the mode split estimates.

The most recent Trip Generation Handbook, ITE, should be consulted for a complete explanation of when and how to use these and other trip generation refining factors. **The Region Access Management Engineer or his/her designee should review and approve all proposed trip generation adjustments before proceeding with the TIA.**

The non-automobile portion of the project's traffic should be deducted from the trip generation estimates. Data must be presented to support any significant use of alternative modes. Note that the TPR section 660-012-0060(6) allows, and in some cases requires, local governments to give a specific amount of credit for potential reduction in vehicle trips for uses located in mixed-use, pedestrian-friendly centers and neighborhoods. The complete TPR can be found in Division 12 of the following, on the web at: http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_660/660_tofc.html

3.3.07 Trip Distribution

The purpose of trip distribution is to analyze the trip-making characteristics of the proposed development and off-site areas. The level of effort involved in this step is a function of the intensity and type of development, adjacent land uses, and the time of day being evaluated.

A complete TIA report includes a trip distribution diagram to illustrate the percentage of trips in and out of the site through all study area intersections. Project-generated trips and pass-by trips should have separate trip distributions.

In cases where ODOT is the lead review agency, ODOT must approve of the trip distribution methodology used in the study. A common method of determining trip distribution is to analyze existing area travel patterns. However, when using this method care must be taken to consider the types of trips associated with the proposed land use and how site generated trips are likely to interact with surrounding land uses.

The *Analogy, Transportation Model* and *Surrogate Data* methods described below are methods of establishing trip distribution acceptable to ODOT and recognized by the Institute of Transportation Engineers.

Analogy Method: The analogy method uses traffic information from a similar, existing development to predict trip distribution for the proposed development. This can be accomplished by various methods including driver surveys, license plate origin-destination studies, and driveway turning movement counts. The gathered information can then be applied to the location of the proposed development. Judgment needs to be exercised with this method to account for other influencing factors such as population distribution, location and competing attractions. This method is generally acceptable for small to mid-size developments.

Travel Demand Model: A travel demand model can be effective in estimating traffic distribution patterns. Because travel demand models are typically developed in conjunction with a transportation system plan and comprehensive plan, they can provide a reliable forecast for growing urban areas. The transportation analysis zone (TAZ) containing the proposed development should be investigated closely to ensure land uses, development densities, and trip making characteristics are modeled consistent with existing conditions. TAZ's may need to be split along with other necessary network adjustments. Post processing of the model trip assignment for use in projecting trip distribution is necessary, and should follow the guidance in the APM. This method is preferable for large developments.

As a variation of this alternative, the travel demand model can be used to perform a “select zone” run to determine the distribution of the proposed development’s traffic. The results then can be used to manually assign the project’s trips to study intersections and roadways based on the select zone results.

Surrogate Data: Surrogate data involves using one piece of information and applying it to another. An example is using employment as a surrogate for residential trips. Generally, residential use will serve as a good surrogate for office, retail, and entertainment trips. This method can accurately estimate trip distribution when used

cautiously and for appropriate land uses. This method requires an extensive database of usable socioeconomic and demographic information for various regions of the city.

Trip Assignment

Trip Assignment is the process that estimates the volume of traffic that will use certain routes on the existing roadway system. Trip assignments can be developed with the aid of a computer model or by manual calculations. The most common method is to manually calculate the actual volumes of trips on each study area intersection movement using trip generation estimates and a previously established trip distribution diagram.

Prior to using the model trip assignment for planning or project analysis, post processing will be necessary. The recommended methodology is found in the APM. A complete TIA includes traffic flow diagrams illustrating the site traffic volumes on study intersection movements during each time period analyzed.

Traffic Volumes – Year of Opening with the Development

With background traffic volumes estimated and site generated trips assigned to the transportation system, “total” traffic volumes during the anticipated opening year of the development can be calculated by adding the two together. Again, an updated traffic flow diagram must be provided for each time period analyzed showing these new volumes on each study intersection movement. .

Traffic Operations – Year of Opening with the Development

This analysis should incorporate any transportation system improvements anticipated to be completed by the represented horizon year. For purposes of comprehensive plan and zone changes, the categories of planned improvements that can be taken into consideration to mitigate future impacts are set out in the TPR, OAR 660-012-0060. Improvements anticipated to be constructed as mitigation for the proposed development are <u>not</u> considered in this part of the analysis.

Results should be clearly presented in tables or figures and the performance of each intersection analyzed should be reported using the measuring criteria preferred by the jurisdiction having authority over that intersection.

Figure 3.3.13 - EXAMPLE Total Traffic Study Intersection Capacity Analysis

Intersection	Signalized Intersection*		Unsignalized Intersection			Level of Service
	v/c	Average Delay (sec)	Critical Movement	Movement v/c	Movement Delay (sec)	
Hwy 213 @ Hwy 211	0.49	26.8				C
Hwy 213 @ Barnards Rd			EBLT	0.15	23.1	C
Site Access @ Barnards Rd			SB	0.04	9.2	A
Hwy 213 @ Macksburg Rd			EB	1.16	171.5	F
Hwy 213 @ Union Mills Rd			WB	0.95	105.7	F

Traffic Volumes – Future Year without the Development

Local code, statewide planning regulations, or the rules in Division 51 may require analyses of future years beyond the year of opening of the proposed development. The future years to be analyzed are established in the scope of work and may depend upon the level of trip generation, phasing of the development, or whether or not a zone change/plan amendment is proposed. Table 3.3.2 above shows recommended thresholds for determining years of analysis based on current practice in access management.

Background traffic volumes for future year analysis should be developed using one of the methods previously described in the section, *Traffic Volumes – Year of Opening without the Development*. In the future year forecasts, transportation improvements that appear in a fiscally constrained transportation system plan can be assumed to be in place, as applicable. The estimated background traffic volumes for the future years must be displayed on traffic flow diagrams.

Traffic Operations – Future Year without the Development

This analysis incorporates any transportation system improvements anticipated to be completed by the represented year. For purposes of comprehensive plan and zone changes, the categories of planned improvements that can be taken into consideration to mitigate future impacts are set out in the TPR, OAR 660-012-0060. This does not include improvements anticipated to be constructed as mitigation for the proposed development. Results should be clearly presented in tables or figures and the performance of each intersection analyzed should be reported using the measuring criteria (LOS or v/c) preferred by the jurisdiction having authority over that intersection and/or the decision process. It is helpful to have both measurements whenever possible.

Figure 3.3.14 - EXAMPLE Background Traffic; Intersection Capacity Analysis

Intersection	Signalized Intersection*		Unsignalized Intersection			Level of Service (LOS)
	v/c	Average Delay (sec)	Critical Movement	Movement v/c	Movement Delay (sec)	
Hwy 213 @ Hwy 211	0.55	27.5				C
Hwy 213 @ Barnards Rd			EBLT	0.11	26.3	D
Site Access @ Barnards Rd						
Hwy 213 @ Macksburg Rd			EB	1.59	368.2	F
Hwy 213 @ Union Mills Rd			WB	1.43	300.2	F

Traffic Volumes – Future Year with the Development

Future year traffic volumes from the site should be based on the described methods of trip generation, distribution, and assignment. For most land uses, trip generation will not change substantially from year of opening to the future year, so the proposed project generated volumes obtained for the year of opening may be used for the future year. If area land uses, transit usage, transportation infrastructure, or other factors are expected to change, then the estimates of future traffic generation may need to be adjusted as well.

The future year total traffic hourly and ADT volumes must be shown in traffic flow diagrams.

Traffic Operations – Future Year with the Development

This analysis incorporates any transportation system improvements anticipated to be completed by the represented year. This does not include improvements anticipated to be constructed as mitigation for the proposed development. Again, results should be clearly presented in tables or figures and the performance of each intersection analyzed should be reported using the measuring criteria preferred by the jurisdiction having authority over that intersection.

Figure 3.3.15 - EXAMPLE 2014 Total Traffic Operations (Preferred Development Plan)

Number	Interconnection	Minimum Operating Standard	Weekday PM Peak Hour		Saturday Midday Peak Hour	
			LOS	v/c/	LOS	v/c
Signalized Intersections						
2	SW Boones Ferry Rd / SW Tualatin Rd.	0.99	B	0.63	Not Analyzed	Not Analyzed
3	SW Boones Ferry Rd / SW Martinazzi Ave	0.99	D	0.97	B	0.68
12	I-5 NB Ramp Terminal / SW Nyberg Rd.	0.85	C	0.71	E	0.88
Unsignalized Intersections						
4	SW Martinazzi Ave / North Site Driveway	E	C	0.24	C	0.19
All-Way Stop Controlled Intersections						
20	SW Sagert Street / SW Martinazzi Ave	D	F	N/A	Not Analyzed	Not Analyzed

Note: LOS and v/c reported for the highest delay of critical movement

3.3.08 Mitigation Alternatives

The operational and safety characteristics of the transportation system for each time period are compared to the standards and thresholds set in the applicable approval criteria. Failure to comply with any applicable criteria can now be identified.

If the analysis finds the transportation system is inadequate to support the development, the applicant must identify mitigation so the development can meet local approval criteria. Mitigation alternatives can include geometric improvements, alternative approach configurations, installation of traffic control devices, Transportation Demand Management strategies, and other measures. In addition, the TPR has been amended to allow system improvements outside of the immediate impact area of a development site, including improvements serving modes other than highway, under some circumstances.

Any mitigation considered for the proposed project must be included in a revised traffic operational and safety analysis. This analysis must show whether the mitigation is sufficient to meet the local approval criteria for any time period in which it had failed to meet the criteria in the earlier analysis. In addition, the feasibility of implementing any recommended mitigation must be examined and addressed in the TIA. This will typically include considerations such as availability of necessary right-of-way, design standards, Oregon Highway Plan policies, Oregon Administrative Rules and statutes, and consistency with local transportation system plans.

Where access to a state highway is proposed, OAR 734-051-3070 provides a description of types of mitigation measure applicable under ODOT's authority.

Figure 3.3.16 - EXAMPLE Key Intersection Mitigation (Year of Opening)
Total Traffic Conditions

Mitigation	Weekday PM Peak Hour			Saturday Midday Peak Hour		
	Delay	LOS	v/c	Delay	LOS	v/c
Traffic Signal	10.3	B	0.55	7.2	A	0.42
Permissive left-turn phasing assumed for all approaches						

Report Conclusions and Recommendations

A report's conclusions summarize existing and future conditions, discuss the development's impacts, identify any operational or safety deficiencies, recommend mitigation if needed, and describe the effectiveness of the mitigation proposed.

The TIA should clearly state whether the proposed development with any necessary mitigation measures would comply with all operational and safety standards in the applicable approval criteria. A "Mitigation Schedule" (*See* Appendix 12), is a tool for summarizing the recommended and/or agreed upon mitigation measures that was developed by development review and access management staff. It is recommended as a way to convey general information about needed mitigation measures to local decision makers and to ODOT staff who are not trained as traffic analysts.

3.3.09 TIA Appendices

The traffic count data sheets and the capacity analysis worksheets are a necessary part of a complete TIA and are typically included with other relevant information as an Appendix. Additional information that is typically appended includes:

- Trip Generation and Volume Development Calculations;
- Queuing Analysis Worksheets;
- Crash Data;
- Analysis output sheets;
- Traffic Signal Warrant Worksheets;
- Turn Lane Warrant Worksheets;
- ODOT's staff letter setting out or accepting the scope of work;
- Software input sheets for verification of defaults and input parameters (electronic files of inputs are highly desirable).

Technical Analysis

This section provides additional information for those responsible for reviewing TIA reports for ODOT, as well as for those responsible for conducting the technical analysis for a TIA report scoped by ODOT. Below are sections on several types of analyses to be considered in a typical TIA, as well as descriptions of methodologies generally

acceptable to ODOT. The analysis needs for each development proposal must be determined individually. Furthermore, analysis methodologies and parameters other than those identified below may only be used with approval from the Region Access Management Engineer or his/her designee.

Capacity Analysis

Volume to capacity (v/c) ratios are used as the measure of mobility on state facilities. A complete transportation impact analysis lists the v/c ratios for all intersections during each time period and analysis year and clearly shows the v/c ratios with and without the proposed development.

The v/c ratios from the TIA must be compared to OHP Policy 1F, *Highway Mobility Standards,* and the v/c ratios provided in OHP Tables 6 (general) and 7 (Metro), as amended. In situations where an interchange and interstate freeway needs to be modified, it is necessary to coordinate with FHWA and the developer to work out any issues relative to OHP versus HDM standards. The v/c ratios from the OHP tables establish the mobility targets for the various classifications of state highways and the target ratios should not be exceeded. OHP Policy 1F provides a process by which alternative mobility standards may be adopted, as has occurred in the Metro area and is proposed in other areas. Where an alternative mobility standard has been adopted by a local jurisdiction and by the OTC, that standard supersedes Table 6.

Figure 3.3.17 - EXAMPLE: Total Traffic Study Intersection Capacity Analysis

Intersection	Signalized Intersection*		Unsignalized Intersection			Level of Service
	v/c	Average Delay (sec)	Critical Movement	Movement v/c	Movement Delay (sec)	
Hwy 213 @ Hwy 211	0.56	27.5				C
Hwy 213 @ Barnards Rd			EBLT	0.28	35.0	E
Site Access @ Barnards Rd			SB	0.04	9.3	A
Hwy 213 @ Macksburg Rd			EB	1.021.83	118477.0.5	F
Hwy 213 @ Union Mills Rd			WB	0.851.65	401.076.1	F

The performance of each ODOT intersection analyzed should be reported using the measuring criteria listed in the two Mobility Standard White Papers in Appendix 8 of these guidelines. If a development proposal's impacts will degrade the performance of a state highway to a degree that the v/c standards would be exceeded, mitigation must be implemented to bring v/c ratios back to or below the standard for the facility.

Local jurisdictions can adopt operational standards for state highways that are more conservative than those from the *1999 Oregon Highway Plan*, and some have. While ODOT does not consider local standards when evaluating system adequacy, the local

jurisdiction can use them to require mitigation on state facilities. Of course, as the owner of the facilities, ODOT must approve any proposed mitigation.

In situations where the mobility targets are already exceeded prior to the addition of the proposed development's traffic, where transportation improvements are not planned that would bring performance levels back to the mobility standard, the standard is to avoid further degradation of the facility, pursuant to OHP Action 1F.6.

For further explanation of ODOT's policies on implementing mobility standards during the review of development and approach permit applications, see the white papers titled, "Highway Performance and the 1999 Mobility Standards," (2001) and "Application of Oregon Highway Plan Mobility Standards" (2004) that are attached in Appendix 8. An Operational Notice, PB-02, setting up best practices for alternative mobility standards can be found here: http://transnet.odot.state.or.us/tdd/TransPlan/Web%20Components/pblt_opnotices.aspx?PageView=Shared [20]

Capacity analysis of signalized intersections, unsignalized intersections, rural two-lane highways, arterials, multilane highways, freeways, and weaving sections in the study area should follow the established methodology of the APM. Capacity analysis is based on actual measured values, standard default values listed in the HCM, or other department-approved input values. Default values selected for use in the analysis should remain constant through each analysis year and each alternative as applicable[21]. The calculations may be done by hand or with the use of computer software.

Application of computer software should closely follow an ODOT approved analysis methodology. The appropriate use of computer software such as HCS or the current version of Synchro for capacity analysis is discussed in the APM. For additional information on accepted analysis methods, use the resources located at http://www.oregon.gov/ODOT/TD/TP/Pages/Tools.aspx.

A complete listing of input and output parameters must be included in the report, typically in a technical appendix and on a CD. A printout from a computerized analysis program should list all parameters necessary for the reviewer to make a determination that the analysis is accurate and complete. Printouts should indicate the number of lanes, lane configurations, saturation flow rate and adjustments, volumes and adjustments, intersection traffic control and timing data as applicable, approach v/c ratios. Copies of the field saturation flow study sheets, lost time measurements, or other capacity analysis inputs should be attached to the report and also conveyed electronically to reviewers.

[20] Operational Notices are policies related to ODOT internal practices. Consult with an ODOT planner if you have questions about the operational notice PB-02.
[21] The APM recommends using peak hour factors based on traffic counts for the existing conditions analysis and then using default values for future conditions. All other defaults should remain constant.

Peak Hour Factors

The transportation system must be designed to accommodate the 15-minute peaking in the peak hour. In areas near capacity, the 15-minute flow can cause up to several hours of congested flow. The congestion that results from the 15-minute flow must be accounted for in the analysis of the transportation system.

The 1999 OHP v/c ratio Tables 6 and 7 originally intended peak hour factors to be used. The analysis that determined the v/c ratio standards used PHFs as an input. To remain consistent with the OHP, any analysis that uses the OHP v/c ratios need to use a PHF except where an alternative mobility target modifies the procedure for using a peak hour factor.

Peak 15 minute deficiencies do not necessarily result in the need for additional lanes at significant cost and right of way impacts. Minor mitigation resulting in lesser impacts may be sufficient, such as transportation demand management (TDM) strategies and acceptable operational improvements.

Peak hour factors should be obtained and applied according to the guidelines in the APM.

Signalized Intersections

Signalized intersections are evaluated with the methodology of the current Highway Capacity Manual (HCM), and as determined within the scope agreed to by ODOT staff. Results from an Interchange Capacity Utilization (ICU) analysis can be considered “ballpark” numbers, and can indicate whether further analysis is needed. Analysis of signalized intersections follows an approved method with the standard default input values or with locally measured values. ODOT default values for use with signalized intersection analysis are contained in the APM.

Methods and default values selected for use in the analysis should be consistent through each analysis year and each alternative. Other solutions short of signalization must be analyzed as required for traffic signal justification analysis.

For future signals, left turns should be assumed to be phased as recommended in the current ODOT Traffic Signal Policy and Guidelines.

Computer software used should closely follow an ODOT-approved analysis methodology. The appropriate use of computer software such as HCS or Synchro for capacity analysis can be further explored using resources available on the web page of ODOT’s Transportation Planning Analysis Unit (see link above). Summary output sheets for the capacity analysis must be attached to the traffic study.

These software applications are included here only as examples, not as recommended applications. Any software shown to be consistent with HCM methodology may be used.

Unsignalized Intersections

Two-way and four-way stop-controlled intersections may be evaluated with the methodology of the current HCM or other department-approved methods. As with other default input values of the HCM analysis method, revisions to the acceptable gap times and follow-up times should only be done after conducting a thorough field investigation study. In addition, v/c and LOS should be analyzed for access from a minor roadway to a major roadway.

Roundabouts

Where a roundabout is proposed as mitigation in Development Review there are several important planning issues:

- A roundabout cannot be used to rationalize adding a new approach to a state highway facility, particularly opposite a freeway ramp terminal, where the approach would not otherwise be approved.
- Where a roundabout is considered to mitigate development impacts, the analysis supporting the roundabout should also consider other possible solutions.

The State Transportation Engineer has been delegated the authority to approve the installation of roundabouts. Requests for roundabout approval are made through the Region Traffic Engineer in collaboration with the Technical Services Roadway Manager. Requests must be supported by an Intersection Traffic Control Study as explained in the ODOT Traffic Manual. The investigation addresses the Considerations described below. (*See also* Section 6-26 of the Highway Design Manual: http://www.oregon.gov/ODOT/HWY/ENGSERVICES/pages/hwy_manuals.aspx)

The Department has developed a list of considerations that should be addressed in the Engineering Investigation that is submitted for proposed roundabout locations[22]. These considerations should not be interpreted as roundabout warrants nor should they be considered pass/fail criteria for installation of a roundabout. Rather, they have been identified as important considerations to take into account when proposing roundabout intersections on state highways.

- Freight Mobility needs should be sufficiently defined and addressed prior to Conceptual Approval.

- Motorized user mobility needs must be balanced with the mobility needs of non-motorized road users. The ability for bicyclists and pedestrians to safely move through the roundabout intersection is equally important as the mobility needs of motorized vehicles. Bicyclists should be given the option to use either the circulating roadway with other vehicles or the pedestrian crossings outside the

[22] This paragraph and the bulleted list that follows it were copied from the June 2014 DRAFT Highway Design Manual Chapter 8.6 Modern Roundabouts, Section 8.6.3. Consult the HDM as adopted to be sure of the considerations in place at the time of development review.

circulatory roadway. Special design considerations should be given for the pedestrian crossings at the entrances and exits on all legs of the roundabout where vehicles are either decelerating to enter the roundabout or accelerating to exit the roundabout. Multi-lane roundabouts, like other multi-lane intersections, have potential for "multiple threat" conflicts between vehicles and pedestrians, particularly vision impaired pedestrians. The Public Rights-Of-Way Accessibility Guide (PROWAG) has identified the need for pedestrian-activated crossing capability at multi-lane roundabouts. Although not explicitly required at this time, rulemaking is proposed and it is prudent to design a multi-lane roundabout for easy installation of the necessary equipment in the future. Crosswalk placement, striping, installing conduit as well as identifying and reserving necessary equipment locations even though final installation of all the equipment is not necessary at this time, is good design practice and can save money in the future. Additional information can be obtained by reviewing the PROWAG document available from the FHWA Civil Rights website under Programs/ADA/Section 504.

- Roundabout design should consider the needs and desires of the local community including speed management and aesthetics.

- Intersection safety performance should be a primary consideration when pursuing a roundabout for intersection control. Predicted reductions in fatal and serious injury crashes should be compared with other types of intersection control such as traffic signals or other alternatives supported by crash modification factors (CMF) from the AASHTO Highway Safety Manual.

- Roundabout entrance geometry, circulating geometry and exit geometry should be designed to allow the design vehicle to traverse the roundabout in a reasonable and expected manner commensurate with best design practices as shown in NCHRP Report 672 and the ODOT Highway Design Manual. This design should utilize a representative template of the design vehicle and the vehicle path should be demonstrated through the use of computer generated path simulation software,

- Roundabouts should meet acceptable v/c ratios for the appropriate Design Life. (See the Design Life subsection for possible exceptions to this consideration.)

- Roundabouts proposed for the state highways with posted speeds higher than 35 mph will require special design considerations (e.g. longer splitter islands, landscaping, reversing curves approaching the roundabout) to transition the roadside environment from higher to lower speeds approaching the roundabout intersection.

- For Roundabouts with more than 4 approach legs, special design considerations should be made for the layout of the approach legs.

- Roundabout proposals should address how roundabout operations would impact the corridor immediately upstream and downstream from the roundabout intersection. (If the proposed roundabout is in a location where exiting vehicles would be interrupted by queues from signals, railroads, draw bridges, ramp meters, or by operational problems created by left turns or accesses, these problems should be addressed by the Engineering Investigation.

The State Traffic Engineer makes the decision to approve a particular intersection for roundabout control (Concept approval). The State Roadway Engineer will make the final decision on the approval of the geometric design.

Analysis of roundabout operations is outlined in the APM.

3.3.10 Capacity Analysis Documentation Requirements

The input data and output results of capacity analysis work are a necessary part of a complete TIA and are typically included in an appendix, with all documentation available electronically. In a summary description of each intersection, document the following:

- lane configurations,
- stop-controlled approaches (for unsignalized intersections),
- cycle length (for signalized intersections),
- assumed ideal saturation flow rates and all adjustment factors,
- traffic volumes,
- peak hour factor,
- lost time, and
- v/c ratios for each approach and the entire intersection.

The HCM allows and encourages field measurements of traffic flow parameters such as ideal saturation flow rate and lost time. ODOT will accept substitution of field measured values only when accompanied by appropriate worksheets showing data collected and calculations made. See the two Mobility Standards White Papers attached in Appendix 8 for more details.

Queue Length Analysis

Intersection operations analysis needs to include the effects of queuing and blocking. Estimates of queue lengths should be based on the anticipated arrival patterns, duration of interruptions, and the ability of the intersection to recover from momentary heavy arrival rates. The average queue length and the 95th percentile queue lengths should be shown in the report. The 95th percentile queue length is used for design purposes. Average vehicle storage length to be used in the analysis is 25 feet per vehicle unless a local study indicates otherwise

A queue analysis should be conducted in the TIA that contrasts the background queues versus the total traffic queues after development for all movements. In this analysis, the TIA should provide the length of storage lanes and distance from other intersections or rail crossing. The queue analysis should consider three different types of queues:

- Overflow - The storage lane for a turn movement exceeds capacity creating an overflowing queue onto the through lanes.
- Spillback - Queue from a downstream intersection uses up all the capacity in a roadway segment between two signalized intersections where the queue spills back onto the upstream intersection.
- Storage Blocking – through traffic queues extend upstream past the opening of a storage lane preventing vehicles from accessing the lane.

If traffic from the proposed development adds to or creates an overflowing storage lane and/or spills back into another intersection or rail crossing, the TIA should explore whether there are potential mitigation measures to fix overflow or spillback problems. The same goes for storage blocking queues.

In cases where a TIA includes a queue analysis for an Interstate or Expressway off-ramp, vehicles should have enough stopping sight distance (determined from the recent AASHTO *A Policy on Geometric Design of Highways and Streets*) to decelerate from the beginning of the off-ramp to stop at the end of the 95th-percentile queue. If the total traffic does not allow reasonable stopping sight distance, the TIA should state what if any mitigation measure(s) would reduce the queue on the off-ramp.

Any methodology used to determine queue lengths must be approved by the Region Access Management Engineer or his/her designee. Note that queue lengths subject to over-capacity conditions can only be adequately assessed through the use of simulation software. Simulation software should be used to calculate 95th percentile queues when operational conditions are greater than 0.70 v/c and must be used if the v/c exceeds standards. All simulations must be calibrated in accordance with the APM. The APM provides further detail on determining appropriate queue lengths.

Figure 3.3.18 - EXAMPLE Estimated 95th Percentile Queuing Analysis

Intersection	Movement	Estimated 95th Percentile Queue (ft.) Weekday PM Peak Hour Total Traffic	Storage Length
I-5 SB Ramp Terminal / SW Nyberg Road	SB LT	575	700'
	SB TH/RT	425	700'
I-5 NB Ramp Terminal / SW Nyberg Rd.	NB TH/LT	750	1,270
	NB RT	300	1,270
SW Nyberg Rd / Signalized Site Driveway	WB LT	225	225
	WB TH	525	525
	WB RT	150	325
	SB LT	250	250
	SB TH/RT	200	250
	EB LT	150	225
	EB TH/RT	275	700
	NB RT	275	275
	NB TH/LT	150	225

Intersection Sight Distance

Adequate intersection sight distance should be verified for all study intersections and highway approaches. Stop controlled intersection sight distance should meet the standards of OAR 734-051 and the most recent AASHTO *A Policy on Geometric Design of Highways and Streets*. See also the Highway Design Manual Chapter 5. Intersection sight distance will vary depending which of the following types of at-grade intersections is under consideration:

- No control, but allowing vehicles to adjust speed;
- Yield control;
- Minor street stop control; and,
- Signal control where all legs of the intersection are either required to stop by a stop sign or the intersection is controlled by a signal.

Another measure of sight distance is stopping sight distance. Intersection sight distance is the standard for location of approaches to the highway; stopping sight distance is a lower standard that may be used in some cases, but not without approval of the RAME.

Sight distance standards are discussed in OAR 734-051-4020 and the standard Tables can be opened here: http://arcweb.sos.state.or.us/pages/rules/oars_700/oar_734/_table/734-051-4020.pdf . Additional Technical information is available: http://www.oregon.gov/ODOT/HWY/TECHSERV/docs/tech_bulletins/AM13-06b.pdf.

Right/Left Turn Lane Warrants

Proposed right or left turn lanes at unsignalized intersections and private approach roads must meet the installation criteria in the Highway Design Manual (HDM).

Locations that meet the HDM criteria for a right or left turn lane should be noted in the traffic study and installation of a turn lane may be recommended as mitigation for project traffic impacts. Meeting the criteria does not mean a turn lane has to be installed. Engineering judgment must be used to determine if an installation would be unsafe or impractical, particularly considering bicycle and pedestrian safety. The ODOT Traffic Manual provides further guidance on the use of right and left turn lanes (*see* http://www.oregon.gov/ODOT/HWY/TRAFFIC-ROADWAY/pages/traffic_manual.aspx). The APM also provides guidance on turn lanes.

At signalized intersections, the need for a right turn lane or left turn lane is based on a consideration of the intersection's v/c ratio, delay for the turn movement, desired phasing, and through vehicle speeds. Further guidance can be found in the ODOT Traffic Manual.

Intersection Traffic Control Study

Analysis and recommendations related to traffic signals must follow ODOT's Traffic Signal Policy and Guidelines. Modification or installation of a traffic signal must be based on documentation that satisfies the requirements of OAR 734-020 at http://arcweb.sos.state.or.us/pages/rules/oars_700/oar_734/734_tofc.html. If the proposed signal installation/modifications are within 500 ft of a rail crossing, contact the Rail Division Crossing Safety Section to determine additional analysis requirements.

If a new signal is being proposed, the traffic impact study shall provide a traffic signal investigation that:

- Clearly indicates the need for a traffic signal;
- Assesses the ability of existing, planned, and proposed public roads to accommodate the traffic away from the state facility;
- Describes in detail how a specific development will affect study area intersections; and,
- Provides documentation of traffic volumes and document whether appropriate signal warrants are met.
- Applies right turn discounting where applicable, consistent with APM methodology. http://www.oregon.gov/odot/hwy/traffic-roadway/docs/pdf/traffic_manual_09.pdf
- Green and yellow time for the through phases may be used in the progression band;
- System cycle length must be adequate to accommodate pedestrian crossing times;
- The progressed band speed can be no more than 5 mph below the existing posted speed in off-peak hours or more than 10 mph below the existing posted speed in the

peak hours, unless lower speeds are approved by the State Traffic Engineer. Progression speeds should never be set higher than posted speed.

Complete time-space diagrams are required for each of the analysis scenarios, including the existing coordination system. The diagrams indicate the offsets, phasing, and split times for each of the signals in the system.

It must be shown that the proposed signal system is capable of maintaining a progression bandwidth as large as that required, or as presently exists, for through traffic on the state highway at the most critical intersection within the roadway segment. The carrying capacity of the progression bandwidth should be estimated with the equation below:

Bandwidth Capacity (veh/hr). = (Bandwidth (sec –4)x(Adj. Sat. Flow Rate)C

The hourly bandwidth capacity should be calculated for both directions of progression and then compared with the corresponding hourly demand at the most critical intersection. See the APM for further details on this calculation. The Signal Progression Calculator may be used to help estimate bandwidth:
http://cms.oregon.gov/ODOT/TD/TP/Pages/Tools.aspx

Transportation Demand Management

Goal 4 of the 1999 Oregon Highway Plan is "To optimize the overall efficiency and utility of the state highway system through the use of alternative modes and travel demand management strategies". In addition, the TPR allows a significant effect on a highway segment to me mitigated in part by improvements to other modes in the plan amendment area.

Techniques to reduce a development's vehicle trip generation should be evaluated and recommended as part of the traffic study where appropriate. These techniques are referred to as "Transportation Demand Management" (TDM). Some TDM techniques to reduce vehicle trips during peak hours are listed below.

- Quality transit service to place of trip origins. Reliance on transit to mitigate a significant effect is only appropriate where transit service is currently available (see Chapter 3.2);
- Accommodations for bicycles such as bike lanes, bike boulevard treatments, bike parking;
- Ride-sharing and vanpool programs;
- Carpool incentives, such as preferred parking;
- Modified work schedules;
- Mixed uses connected by a quality pedestrian environment;
- Internal shuttle transportation in a major development;
- Reduction in parking availability or substantial increase in parking prices;

- Direct pedestrian connections to other nearby pedestrian facilities; and
- Trip-reduction ordinances.

These TDM techniques can be effective, alone or in combination, under a variety of conditions. For example, an increase in parking prices is most effective in reducing peak hour vehicle trips when accompanied by quality carpool, transit, or other alternative modes that provide good service to commuters and travelers.

Enforcement of TDM agreements is an issue where the measure requires long term commitment to maintaining a service or participation by private parties. Conditions of approval requiring TDM measure need to be very clear about expectations and about consequences if commitments are not followed through. For instance, a different mitigation measure might be required as a default where an agreed-upon rideshare program is not in place within a certain period of time. Any reliance on TDM for mitigation should be approved by either the participating ODOT planner or the Region TDM specialist.

In the case of transit, ODOT defers to the local transit authority to determine if the land use proposal has a significant effect per the TPR, and whether adopted transit service standards are met.

Transportation System Management

Transportation System Management (TSM) measures provide low cost mitigation for operational issues related to land use changes. Transportation system management measures maximize system efficiency by managing traffic through the use of traffic control devices such as ramp meters, median barriers and access management controls, closure or consolidation of accesses to properties along congested corridors and re-routing traffic to other facilities. TSM is also used to protect and improve transit infrastructure and service, through scheduling and routing efficiency, existing TDM infrastructure, service and committed improvements, existing bicycle and pedestrian infrastructure and service, and improvements to minimize conflicts with other modes.

Turning Conflict Analysis

When a proposed development adds ingress and/or egress trips onto or from the highway from an unsignalized, existing or proposed, public/private approach, a turning conflict analysis should be conducted to ensure that there are no turning conflicts with other approaches on the highway. The analysis should also establish v/c and LOS for the intersection. Turning diagrams should be drawn that include the proper intersection geometry, the distances of any queues, and the proper turning radius for the design vehicle. For additional information see:
http://www.oregon.gov/ODOT/HWY/TECHSERV/docs/tech_bulletins/AM13-04b.pdf

Access Management

When developed in conjunction with an application for a Highway Approach Permit, the TIA should document the manner in which a proposed site approach meets the

minimum spacing criteria of OAR 734-051 or fits into an access management plan already adopted by ODOT. The approach permit application will be subject to the approval criteria of OAR 734-051-3020 or 4020, et.al. If a deviation to the spacing standards will be requested, the TIA must establish the basis for granting the deviation.

Of particular interest to ODOT are the possible need for median control and any driveway conflicts with nearby intersections. If the driveway is in an Interchange Management Area, special considerations apply as defined in the 1999 OHP and Division 51. For additional information on access management requirements see Technical Bulletins at:
http://www.oregon.gov/ODOT/HWY/TECHSERV/Pages/technicalguidance.aspx , and the "TIA Requirements for Access Management" bulletin at:
http://www.oregon.gov/ODOT/HWY/TECHSERV/docs/tech_bulletins/AM13-07b.pdf

Mitigation Approval

Mitigation approval typically involves all of the members of the Development Review Team (Traffic Analysts, Planners, and Permit Specialists) as well as consultation with additional ODOT staff as necessary. Depending on the type and location of the mitigation proposed, approval may be required from sources such as the Region Traffic Engineer, State Traffic Engineer, Region Access Management Engineer, Roadway Engineering, or Right-of-Way, and other local stakeholders. For example, in cases where the installation of a traffic control device is proposed, the ODOT Traffic Manual provides a complete discussion of the State Traffic Engineer's authority and requirements for installation. Care should be taken to ensure that all needed approvals have been or can be obtained prior to making recommended mitigation plans into conditions of approval.

In situations where the mitigation proposed would be on a state highway routed over city right-of-way, coordination with the local jurisdiction will be required as well.

The legal considerations to keep in mind when determining how much and what types of mitigation are appropriate are discussed in Chapter 2.

Planning Conclusions and Recommendations

Traffic Impact Study Review Findings: A typical memorandum of findings begins with a brief description of the proposal and all affected state facilities. This is followed by an evaluation of the proposed development's impacts on the transportation system, a detailed description of any inadequate conditions, and an assessment of the ability to comply with the approval criteria. Based on these findings, recommendations should be made regarding necessary mitigation, if any, and whether to recommend that the local jurisdiction approve or deny the proposed action.

If there is a disagreement about any aspect of the TIA, such as an assumption, calculation, assessment of conditions, or recommended mitigation, a thorough explanation of the discrepancy should be provided along with a detailed justification for ODOT's position on the matter.

ODOT staff conclusions resulting from the review of a TIA should be written in a memorandum addressed to the ODOT staff person(s) responsible for corresponding with the local jurisdiction and/or applicant. The memorandum should be written in a clear and professional manner so it can be enclosed with the letter to the local jurisdiction to be submitted as part of the local decision record, if desired.