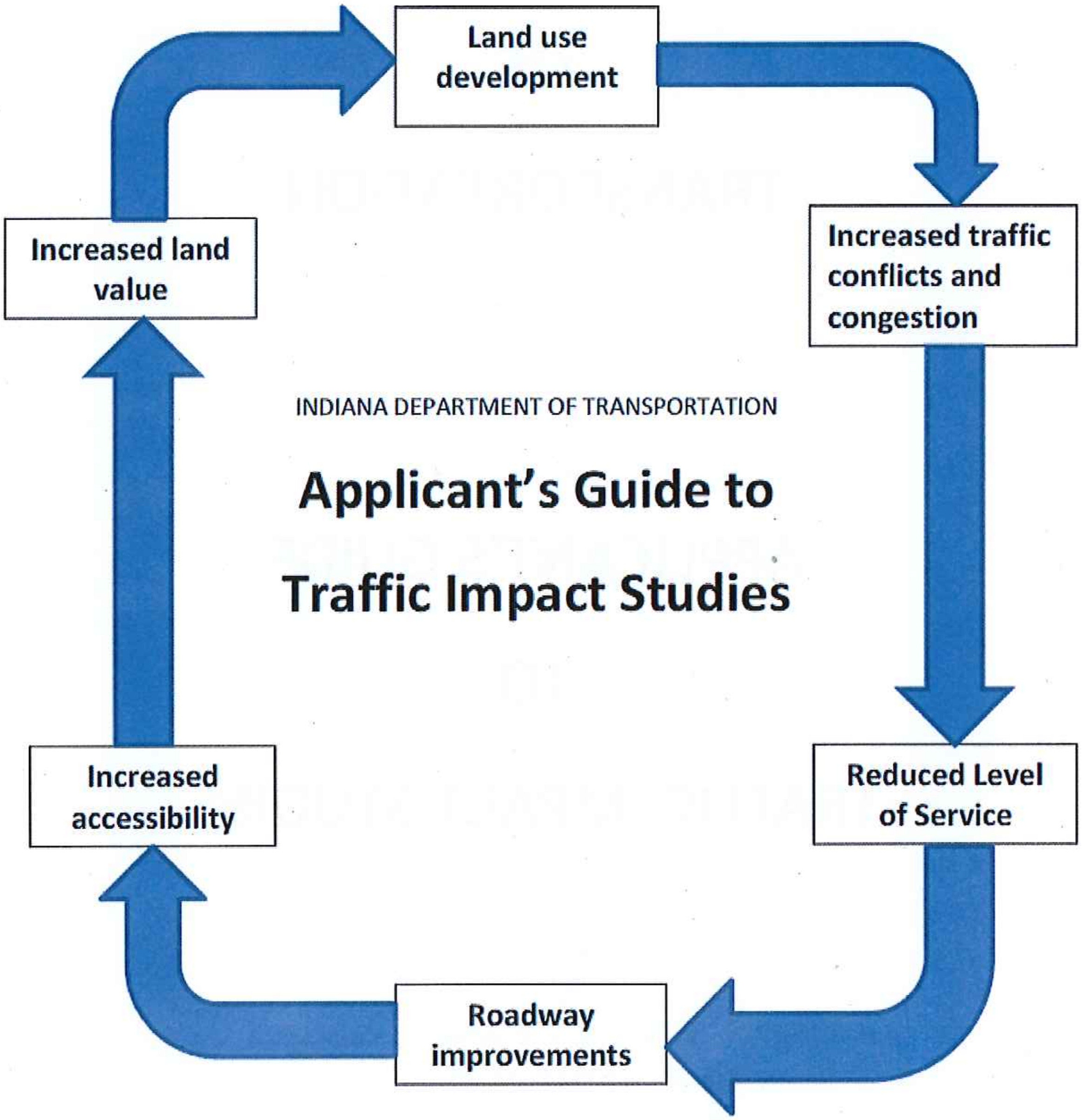
INDIANA DEPARTMENT OF TRANSPORTATION

Applicant's Guide to Traffic Impact Studies



May 2015

INDIANA DEPARTMENT

OF

TRANSPORTATION

APPLICANT'S GUIDE

TO

TRAFFIC IMPACT STUDIES

Approved: ______________________

Deputy Commissioner of Operations

Date: 6/5/15

Approved: ______________________

Deputy Commissioner of Engineering and Asset Management

Date: 6/12/2015

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Chapter 1 INTRODUCTION

1.1 THE INDOT APPLICANT'SGUIDE TO TRAFFIC IMPACT ANALYSIS

The Applicant's Guide is intended to be a stand-alone document for those with experience in TIA. There are other references that provide good guidance on the requirements and standard practice related to Traffic Impact Analysis (TIA). Foremost among them are

- *Transportation Impact Analyses for Site Development: An ITE Recommended Practice.* (2nd edition), Institute of Transportation Engineers, 2010.
- *Access management guide.* AECOM Transportation for Indiana Department of Transportation, 2009.
- *Indiana Design Manual.* Indiana Department of Transportation, 2011.

This Applicant's Guide will not attempt to replicate what those resources contain. However, the Guide will make frequent reference to them, as their contents are applied to issues facing INDOT and local public agencies in Indiana.

The Applicant's Guide is so named because the culmination of the TIA is the issuance of an access permit by the Indiana Department of Transportation or the appropriate local authority. Article 7, Rule 1, Sections 1 and 2 of the Indiana Administrative Code provide the basis for the state permit and a definition of "applicant":

> **105 IAC 7-1-1 Purpose of rule.** Authority: IC 9-21-19-2.
>
> The Indiana department of highways is authorized to determine and establish such requirements and restrictions for driveway approaches as may be necessary to provide for the drainage of the highway, preservation of the highway and the safety and convenience of traffic on the highway. A written permit application shall be considered by the department and, if in accordance with properly established regulations and requirements, a permit shall be granted subject to appropriate conditions and provisions contained therein. All work on the permit shall be performed to the satisfaction of the department.
>
> **105 IAC 7-1-2 Definitions.** Authority: IC 8-23-2-6.

(2) "Applicant" means: (A) a person; (B) a partnership; (C) a company; (D) a corporation; (E) an association; or (F) an agency; making application for a permit to perform work on an approach.

(4) "Approach" means a way or place improved for vehicular or pedestrian traffic on the highway right-of-way that joins the pavement edge of the highway with a driveway or pedestrian walkway.

The applicant is the owner of the property seeking access to the roadway(s) in question. The owner may be represented by an engineering consultant. Because the consulting engineer must be licensed and qualified to undertake a TIA, this Applicant's Guide does not prescribe specific methods or tell the engineer how to do his/her job. Rather, the Applicant's Guide provides a framework in which the two parties can communicate and operate efficiently, with a minimum of delay, leading to a result that enhances the value of the development while preserving or improving the safety and efficiency of the public roadways.

The guide is a product of SPR-3605 "Updated Methods for Traffic Impact Analysis". The study was conducted by the Joint Transportation Research Program (JTRP) in the School of Civil Engineering at Purdue University in conjunction with the Indiana Department of Transportation (INDOT) and the Federal Highway Administration (FHWA). The purpose of this study was to review the Applicant's and Reviewer's Guides that were published in 1992 and make changes that would bring them in line with the methods and conditions that have emerged since then.

The 1992 guides established a standardized procedure for requesting, preparing and/or reviewing a traffic impact study for a proposed development that would affect state highways. Use of the 1992 Guides have greatly reduced the frequency with which INDOT was not involved in the transportation aspects of a site's development until permits were requested for access to state routes. This can occur too late in the development's construction for any traffic-related problem to be remedied as effectively and economically as they could have been in the planning stage.

1.2 PURPOSE OF THE APPLICANT'S GUIDE

Traffic Impact Analysis (TIA) is a specialized study of the impact that a given type and intensity of land use has on the nearby transportation system. TIA makes it possible for mitigating measures to be taken in advance "in order to maintain a satisfactory level of service, an acceptable level of safety and the appropriate access provisions for a proposed development." [Bochner 1989 in ITE 2010] The main purposes of traffic impact analysis are:

1. To determine whether access to the proposed development will adversely affect traffic operations and safety near the site. "Near the site" can mean within the study area as defined in Section 5.1 of this guide or as agreed upon at the initial meeting (Chapter 5).
2. To identify transportation improvements required to maintain satisfactory operational conditions. This will include provision of the Americans with Disabilities Act, as addressed in the *INDOT Design Manual*.
3. To provide decision makers with a basis for assessing the transportation implications of approving proposed zoning changes and development applications.
4. To provide a basis for estimating the cost of proposed mitigating measures. A traffic impact study can be used to determine the "fair share" of the improvement cost to be paid by the developer.

This guide is intended to establish a standard framework for traffic impact analysis within Indiana, increasing consistency in study requests, preparation and review. A standardized procedure will enable the TIA study preparer to present the study findings and recommendations in a systematic manner consistent with the reviewer's expectations. The guide is not intended to make things more complicated and time-consuming. On the contrary, with a standard framework, the time involved in the process will decrease for both parties.

The Applicant's Guide allows enough flexibility to the study preparer to use innovative methods based on sound engineering judgment and the conditions at a specific site. However, this should be done with the prior consent of the study reviewer(s).

1.3 THE RESEARCH PROJECT TEAM

Scott Burress, Shuo Li (Project Administrator), Dwane Myers, James Poturalski, Steve Smith, and Bill Smith of INDOT, and Karen Stippich of FHWA, served as members of the Study

Advisory Committee (SAC). Transportation and planning professionals who accepted our invitations to attend SAC meetings and who provided valuable perspectives were: John Ayers (Hendricks County and Indiana Association of County Highway Engineers and Supervisors), Jodi Dickey (City of Fishers), Larry Lee (City of Lebanon and Indiana Street Commissioners Association), Mike McBride (City of Carmel and Indiana Association of City Engineers), and Hardik Shah (American Structurepoint, Inc. and Indiana Section of the Institute of Transportation Engineers).

This report is dedicated to Stephen C. Smith of INDOT's Division of Planning & Asset Management, Technical Planning Section, who passed away on 30 May 2013, as this report was being completed. Steve was the motivator for the 1991 Traffic Impact Analysis Project HPR-2039, which put Indiana among the leaders in TIA. Among his many responsibilities and accomplishments, he maintained a keen interest in TIA and led the development of INDOT's Access Management Study, Documents, and Draft Policies.

Chapter 2 PREPARER AND REVIEWER QUALIFICATIONS

2.1 PREPARER QUALIFICATIONS

Regulations exist governing who may conduct engineering work in Indiana. In order for a professional engineer to stamp and certify plans for a public project in Indiana, he/she must be licensed in Indiana. Traffic impact studies should be prepared by a transportation professional with training and experience in traffic engineering and transportation planning. It must be prepared by or under the supervision of a professional engineer licensed in Indiana with experience in traffic engineering operations. The study should contain a statement of certification as follows:

> I certify that this Traffic Impact Analysis report has been prepared by me or under my immediate supervision and that I have experience and training in the field of traffic and transportation engineering.

(signed)
John O. Smith, P.E.
Indiana Registration 12345
Consulting Firm, Inc.

2.2 REVIEWER QUALIFICATION

The traffic impact study shall be reviewed by one or more of the professional staff members of the Indiana Department of Transportation or of any other participating agency (City, County, etc.) who collectively have training and experience in traffic impact study methodology, land use planning and traffic engineering, including traffic safety and operations.

2.3 ETHICS AND OBJECTIVITY

A Traffic Impact Analysis often requires the analyst to make assumptions and judgments regarding a variety of values, e.g., trip generation rates, internal capture rates, and pass-by trip percentages. These and other judgments should be justified clearly in the report. Although study preparers and study reviewers might have different objectives and perspectives, they should adhere to established engineering ethics (similar to the Canon of Engineering Ethics) and conduct all analyses and reviews objectively and professionally.

Chapter 3 STUDY PROCEDURE

Typically a traffic impact study (TIS) should be considered in conjunction with an application for approval of any of the following [ITE 2010]:

- zoning changes
- subdivision/platting
- site plan
- building permit
- driveway (access) permit
- comprehensive plan amendments requested by the developer

However, INDOT gets involved in the traffic impact analysis procedure only when:

(a) access permits are requested for driveway access to state highways,

(b) installation of traffic signals on a state highway may be called for, or

(c) modifications to state highway facilities may be needed.

The traffic impact analysis (TIA) process will consist of one, two, three, or four steps, depending on the type of development under consideration. The possible steps in a traffic impact study procedure are discussed below and shown in flow diagram form in Figure 3.1.

- Step 1. A preliminary notification will be required of all proposed developments meeting certain "preliminary warrants". These are presented in Chapter 4 of this guide. If any of the development's predictor variables exceeds the preliminary threshold values, the developer must provide INDOT with the information that comprises a "preliminary notification" (see Chapter 4) and request that an "initial meeting" with INDOT be scheduled (see Step 2). If the development under consideration does not exceed the preliminary warrants, the applicant should nevertheless consult as early as possible with INDOT (or the LPA) regarding the location of the requested access. Driveway placement should anticipate any future development in the vicinity that may necessitate a frontage road, a new intersection, etc. No further action is required and the TIA procedure stops here.

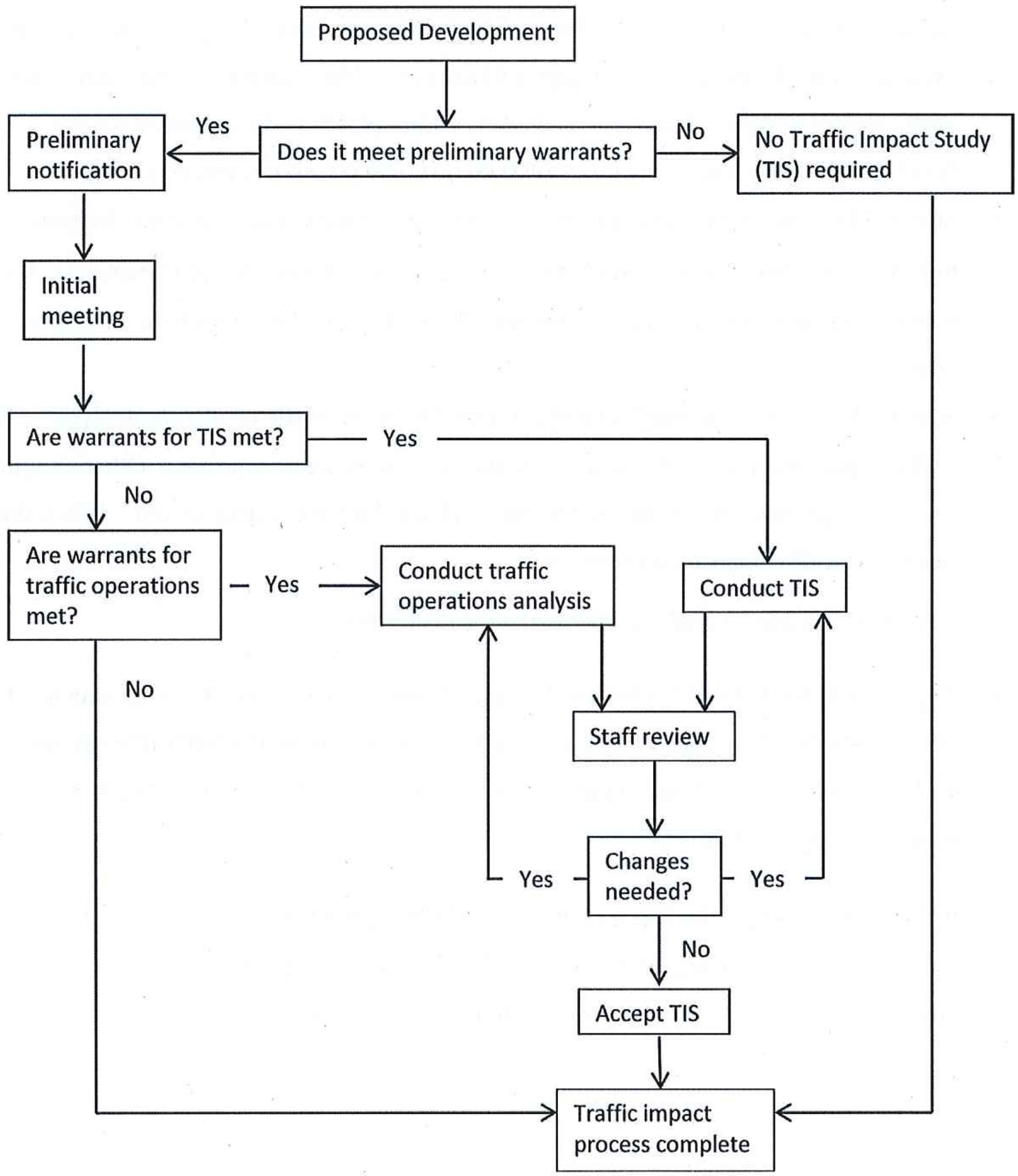


Figure 3.1 Flowchart Showing the Traffic Impact Study Procedure

- Step 2. At a mutually convenient time approximately 2-3 weeks after the preliminary notification has been received, representatives of the developer and INDOT should have the initial meeting. Based on additional information gathered since the preliminary notification, the two parties decide if a more detailed Traffic Impact Study is necessary. (See Chapters 5 and 6 for guidance.) From the findings of the preliminary study, it will be decided if the "Warrants for a Complete TIA" (Chapter 6) are met. If the warrants are met, then a detailed traffic impact analysis (discussed in Chapters 8 through 15) will be required for the development. If the warrants are not satisfied, go to Step 3; otherwise, go to Step 4.

- Step 3. This step involves determining whether the warrants of an operations analysis are met. If the warrants are met, an operations analysis must be conducted (Chapter 7). If the warrants for operations analysis are not met, the study procedure stops here. Otherwise, go to Step 4.
- Step 4. This involves the staff review (Chapter 16) of the traffic operations analysis or the traffic impact analysis. If the study is satisfactory, the process stops here. Otherwise, the revisions suggested have to be incorporated and sent back for further review. This is the last step of the traffic impact study process.

Two steps in Figure 3.1 should be described and clarified.

- Are warrants for TIS met? This involves a preliminary estimate of the traffic generated by the site, which will be added to the existing traffic to determine if a full traffic operations analysis is warranted. If such an analysis is warranted, the "Yes" path will be followed, leading to Conduct TIS.
- If the Staff Review of the TIS indicates that Changes [are] needed, the need for Conduct traffic operations analysis can be confirmed and a study of capacity and level of service for proposed traffic control and geometric features will be conducted.

Chapter 4 PRELIMINARY NOTIFICATION

A preliminary notification to INDOT will be required of all developments seeking access to a state highway that meet the preliminary threshold values for traffic impact analysis.

4.1 PRELIMINARY WARRANTS OR THRESHOLDS

ITE's Recommended Practice *Transportation Impact Analyses for Site Development* [ITE 2010] offers the following guidance on threshold values:

> A quantitative threshold for requiring a site transportation impact study should be established by each agency based on local needs, issues and policies. The threshold level may vary among agencies in response to local conditions and priorities. *In lieu of other locally preferred thresholds*, it is suggested that a transportation impact study be conducted whenever a proposed development will generate 100 or more added (new) trips during the adjacent roadways' peak hour or the development's peak hour. ... It should be noted, however, that many jurisdictions in more densely populated areas tend to use lower thresholds for initiating a transportation impact analysis. These thresholds fall in the range of 30 to 100 peak-hour trips.

The number of new peak hour trips may be difficult to predict. If the expected number of trips cannot be established directly, Table 4.1 can be used to set approximate upper bounds on land use intensities that are equivalent to threshold values of 100 and 500 peak hour trips. Table 4.1 is Table 2-2 in ITE's Recommended Practice [ITE 2010]. The preliminary warrants are based on certain predictor variables associated with the proposed development at full "build-out", such as number of residential units, gross floor area, etc. Developments having land use intensity greater than the threshold values qualify for the preliminary notification action.

Special generators with high trip generation rates, such as parking garages, banks (both drive-in and walk-in) , fast food restaurants, and service stations with convenience stores, will require a preliminary notification, unless a waiver (for roads not under INDOT jurisdiction) is obtained from the local public transportation agency (city, county, etc.) concerned. The reviewer(s) will decide whether or not a waiver is justified, based on experience and engineering judgment.

Table 4.1 Land Use Intensity Thresholds Based Upon Weekday Trip Generation Characteristics

Land Use	≤ 100 Peak Hour Trips	≤ 500 Peak Hour Trips
Residential		
Single-Family Home	95 units	565 units
Apartment	150 units	880 units
Condominium/Townhouse	190 units	1,320 units
Mobile Home Park	170 units	N/A
Shopping Center (GLA)	6,000 sq. ft.	70,000 sq. ft.
Fast-Food Restaurant with Drive-In (GFA)	3,000 sq. ft.	N/A
Gas Station with Convenience Store (Fueling Positions)	7 fueling positions	N/A
Bank with Drive-In (GFA)	3,900 sq. ft.	N/A
General Office (GFA)	67,000 sq. ft.	376,000 sq. ft.
Medical/Dentist Office (GFA)	31,000 sq. ft.	N/A
Research and Development Facility (GFA)	73,000 sq. ft.	518,000 sq. ft.
Light Industrial/Warehousing (GFA)	180,000 sq. ft.	460,000 sq. ft.
Manufacturing Plant (GFA)	149,000 sq. ft.	661,000 sq. ft.
Park-and-ride Lot with Bus Service	170 parking spaces	655 parking spaces

Note: GFA = gross floor area

For mixed-use developments, for developments that cannot be grouped under one of the land use categories given in Table 4.1, or for those discussed in the previous paragraph, the estimated trip generation rates should be determined using the latest available edition of the ITE Trip Generation Manual. [ITE 2012] If the development under consideration will produce more than 50 street peak period major direction vehicle trips, then the preliminary warrants are satisfied. For developments that generate a significant percentage of truck traffic, the truck trips should be converted to equivalent vehicle trips.

4.2 PRELIMINARY NOTIFICATION CONTENTS

The preliminary notification should include:

- the type of development
- the complete site plan, with the site's requested access points
- the nearest signalized intersections in each direction, and other signalized intersections within 2 miles of the site or part of signal progression
- a market study (if applicable)
- trip generation values and the method (s) used to compute them

The preliminary notification need not be a detailed analysis of the present and future conditions. No elaborate data collection effort or computer modeling is necessary for the notification. It is intended to provide an approximate description of existing and anticipated traffic conditions and is supposed to provide a foundation on which to base discussion during the initial meeting. INDOT and/or the local transportation agency may be contacted for any existing traffic data that are available to help prepare such a description.

The preliminary notification should be submitted along with the petition for an access permit. If the development under consideration does not exceed the preliminary warrants, the applicant should nevertheless consult as early as possible with INDOT (or LPA) regarding the location of the requested access. Driveway placement should anticipate any future development in the vicinity that may necessitate a frontage road, a new intersection, etc. No further action is required and the TIA procedure stops here.

Chapter 5 INITIAL OR SCOPING MEETING

If the values for a proposed development exceed the preliminary warrants (Table 4.1), an "initial meeting" or "scoping meeting" between the developer's representative and INDOT personnel should be scheduled. Depending on the nature of the development, the type of information to be discussed at the meeting, and the way in which an INDOT jurisdiction (normally, the District) has organized its functions, it may be sufficient to have the INDOT District Permit Manager attend the initial meeting. In some cases, the Permit Manager may also invite ...

- Representatives of affected LPAs
- District Traffic Engineer
- District Technical Services Director
- District Construction Director
- INDOT Central Office counterparts of the District personnel

For brevity, the developer's representative will hereinafter be called the Traffic Impact Study "preparer" or "applicant", and the INDOT personnel will be referred to as the "reviewers".

If any local jurisdiction may be affected by the development, a representative of that LPA should be invited to the Initial Meeting. This is not only good practice when a project seeks access to a state highway, it also creates a cooperative relationship with LPAs that may have future projects with direct access to local roads that may affect nearby state roads.

The discussions in the initial meeting between the preparer and the reviewers will be based on the information contained in the preliminary notification. The initial meeting will serve the following purposes:

1) To decide whether a detailed traffic impact study or traffic operations analysis is required for the proposed development.
2) If further studies are required, the meeting will help the study preparer to understand the reviewer's expectations.
3) To discuss critical issues like extent of the study, study area, horizon years, time periods to be analyzed, data sources and availability, etc.

4) To ensure that all relevant issues are adequately addressed in the traffic impact study, and that no extraneous elements are included in the study.

If a traffic impact analysis is warranted (see Chapter 6), some of the issues that need to be addressed in this meeting are discussed below.

5.1 STUDY AREA

Any Traffic Impact Study should include at least all site access points and major intersections adjacent to the site. For added guidance, Table 2-3 in ITE's Recommended Practice *Transportation Impact Analyses for Site Development* [2010] is reproduced here as Table 5.1. Beyond this area, the reviewers and the preparer should collectively determine any additional area that may directly or indirectly be impacted by the proposed development.

Table 5.1 Suggested Study Area Limits for Transportation Impact Analyses

Development	Study Area
Fast-food restaurant Service station with or without fast-food counter Mini-mart or convenience grocery with or without gas pumps Other development with fewer than 200 trips during any peak hour	Adjacent intersection if corner location Adjacent intersection if corner location 660 ft. from access drive 1,000 ft. from access drive
Shopping center less than 70,000 sq. ft. or Development w/peak-hour trips between 200 and 500 during peak hour	All signalized intersections and access drives within 0.5 miles from a property line of the site and all major unsignalized intersections and access drives within 0.25 miles
Shopping center between 70,000 and 100,000 sq. ft. GLA or Office or industrial park with between 300 and 500 employees or Well-balanced, mixed-use development with more than 500 peak-hour trips	All signalized and major unsignalized intersections and freeway ramps within 1 mile of a property line of the site
Shopping center greater than 100,000 sq. ft. GLA or Office or industrial park with more than 500 employees or All other developments with more than 500 peak-hour trips	All signalized intersections and freeway ramps within 2 miles of a property line and all major unsignalized access (streets and driveways) within 1 mile of a property line of the site
Transit station	0.5-mile radius

ft = feet, sq. ft. = square feet, GLA = gross leasable area

5.2 HORIZON YEAR

The horizon year of a Traffic Impact Study should refer to the anticipated completion date of the proposed development, assuming full build-out and occupancy.

5.3 TIME PERIODS TO BE ANALYZED

The critical time period for any development will be directly associated with the peaking characteristics of both the development and the adjacent roadway system. Special consideration should be given to developments like shopping centers, which might peak after the adjacent street peak or on a Saturday. The following time periods should be considered during the initial meeting:

- AM and PM street peak (weekday)
- AM and PM site peak (weekday)
- Noon peak (weekday)

5.4 FUTURE OFF-SITE DEVELOPMENTS

Most studies will have to take into account future off-site developments to ascertain the "base condition" in the horizon year. Both the reviewer and the study preparer should agree on off-site development assumptions for the horizon year. In case of a failure to reach an agreement, the reviewer will designate the quantity, type and location and types of developments to be assumed in the study.

5.5 DISCUSSION CHECKLIST

A discussion checklist has been provided in Appendix A to aid both the parties in recording information and comments. However, the discussions should not be restricted to the issues addressed in the checklist. The checklist in the 1992 Applicant's Guide has been updated, using the ITE Recommended Practice and comments collected during the research project.

An Initial Meeting Checklist is shown in Appendix B of this Guide. After Preliminary Notification (see Figure 3.1), the District completes its part of the template and sends it to the Applicant, who adds as much information as possible before the scoping meeting, and returns it to the District. In this way, the participants in the Initial meeting can devote their time in the meeting to less routine items. After agreement has been reached between Applicant and Reviewer, the updated pdf template serves as a record of the Initial Meeting.

Larger developments in densely developed areas will need more in-depth discussion, while smaller sites might not need discussion on many of the issues in the checklist. Table 3-2 in ITE's Recommended Practice *Transportation Impact Analyses for Site Development* [2010] is reproduced here as Table 5.2, listing data that should be used in preparing a TIS.

Table 5.2 Suggested Background Data for a TIS

Category	Data
Traffic Volumes	• Current and (if needed for analysis) historical daily and hourly volume counts • Recent intersection turning movement counts • Seasonal variations • Projected volumes from previous studies or regional plans • Relationships of count day to average and design days
Land Use	• Current land use, densities and occupancy in vicinity of site • Approved development projects and planned completion dates, densities and land use types • Anticipated development on other undeveloped parcels • Comprehensive land use plan • Zoning in vicinity • Absorption rates by type of development
Demographics	• Current and future population and employment within the study area by census tract or transportation analysis zone (as needed for use in site trip distribution)
Transportation System	• Current street system characteristics, including direction of flow, number and types of lanes, right-of-way width, type of access control and traffic control, including signal timings • Roadway functional classification • Route governmental jurisdiction • Traffic signal locations, coordination and timing • Adopted local and regional plans • Planned thoroughfares in the study area and local streets in vicinity of site, including improvements • Transit service and usage • Pedestrian and bicycle linkages and usages • Available curb and off-site parking facilities • Obstacles to the implementation of planned projects • Implementation timing, funding source and certainty of funding for study area transportation improvements (whether or not funded in current capital improvement program)
Other Transportation Data	• Origin-destination or trip distribution data • Crash history (3 years, if available) adjacent to site and at nearby major intersections, if hazardous condition has been identified

5.6 RECORD OF INITIAL MEETING

Immediately after the initial meeting, the TIA study preparer should submit a document that confirms the following:

- study scope
- data sources
- any unusual methods or subjective assumptions that may be applied
- report content (see Chapter 16 and Appendix C of this Guide)
- other pertinent issues discussed in the initial meeting

The meeting record should request concurrence by the reviewing agency staff representative.

5.7 STAFF CONCURRENCE

The reviewing agency should review the contents of the meeting record. If the reviewers agree, the reviewing agency should communicate staff concurrence to the applicant/preparer. This can be done in electronic or written form, including use of a template such as that provided in Appendix B.

Chapter 6 WARRANTS FOR A COMPLETE TIA

A formal transportation impact analysis (TIA) will be requested for any development that meets any of the warrants described below:

Warrant 1. Land Use Intensity

This warrant is satisfied when a development generates more than 100 trips during the street peak hour. Table 4.1 gives Land Use Intensity values that are equivalent to 100 street peak hour trips.

Warrant 2. Level-Of-Service Warrant

This warrant is satisfied if the traffic generated by the proposed development causes the level-of-service of the adjacent streets/intersections to drop to "C" or lower or where nearby intersections presently operate at level-of-service D or worse. Level-of-service determination should be in accordance with the procedures described in the Highway Capacity Manual [2010], using data provided by or approved by the reviewer.

Warrant 3. Roadway Modifications

This warrant is met when the proposed development is expected to significantly impact a roadway segment identified in the Transportation Improvement Program for improvement. This criterion is also met when the proposed development includes modifications to the roadway system. Modifications include addition of lanes to accommodate site-generated traffic, addition of exclusive turning lanes, acceleration/deceleration lanes, median openings, installation of traffic signals and other traffic control devices, etc.

Warrant 4. Special Cases

This warrant is satisfied if the preliminary study reveals that the traffic generated from the proposed development will create safety, operational, or some other traffic problems. Whether or not a development meets this warrant should be decided at the initial meeting.

Chapter 7 TRAFFIC OPERATIONS ANALYSIS

Typically a traffic operations analysis is conducted whenever a proposed development compromises the existing design standards and therefore might cause safety and operational problems in the immediate vicinity of the site. The analysis should be done for the entire traffic impact study area (see Table 5.1) and not just the driveway or access point under consideration. A traffic operations analysis might include:

1) Study of proposed driveway locations, resulting sight distances, queueing provisions, etc.
2) Safety analysis
3) Traffic signal warrants and progression analysis
4) Delay analysis
5) Gap studies

7.1 WARRANTS FOR TRAFFIC OPERATIONS ANALYSIS

A traffic operations analysis will be required if one or more of the following conditions may apply:

1) Development generates enough turning movements into or out of the development to require an auxiliary lane, such as an acceleration/deceleration lane, passing blister, or separate turn lane.
2) Request for new or modified driveways near intersections or interchanges.
3) Requests or probable need for a new (or modified) traffic signal to control driveways or streets serving a proposed or existing development (s).
4) Opportunity to evaluate alternative intersection geometries.
5) Sight distance limitations, high crash locations, or possible weaving movements exist near the site.
6) Requests for median openings.

The guidelines suggested in the INDOT *Driveway Permit Manual* [10] should be consulted.

Chapter 8 NON-SITE TRAFFIC ESTIMATE

To estimate the traffic impacts of a proposed development, it is essential to analyze the traffic conditions on the horizon year roadway network for two cases: (a) with the proposed development and (b) without the proposed development. The incremental impacts are attributed to the site-generated traffic. To do this, we must establish the "base condition". The base condition will correspond to the traffic that would exist in the study area in the horizon year without the proposed development. The *horizon year* is normally the build-out year for the development, but the TIS can account for phased development, with the approval of INDOT. This traffic is commonly referred to as non-site traffic. Non-site traffic may be of two kinds:

- Through traffic, which has neither an origin nor a destination in the study area.
- Traffic that has either an origin or a destination or both in the study area. This traffic is generated by <u>other</u> developments in the study area.

Non-site traffic estimation may be done by one of three methods:

1. Build-Up
2. Using the Transportation Plan for the (sub)area
3. Trends or Growth Rate

See Chapter 4 of the ITE *Recommended Practice* [ITE 2010] for details.

Chapter 9 TRIP GENERATION

Trip generation involves estimating the number of trips that will be produced from or attracted to the proposed development. This is one of the most important steps in traffic impact analysis.

9.1 ACCEPTABLE DATA SOURCES

9.1.1 ITE Trip Generation Data

The most popular and widely used sources of trip generation data come from the Institute of Transportation Engineers (ITE). In October 2012, ITE released the *Trip Generation Manual* (9th edition). This document can be used to estimate the number of vehicle trip ends generated over a specified time period by a proposed development. The data supporting the estimates have been collected and shared with ITE by transportation engineers and planners in many parts of the US. In its current format [15], the *Trip Generation Manual* consists of three volumes. Volume 1 is a 154-page "User's Guide and Handbook", which provides guidance on the proper use of the data in Volumes 2 and 3. The User's Guide was Volume 1 of the 3-volume *Trip Generation Informational Report* (8th ed.) [ITE 2008]. The Handbook—formerly a separate publication [ITE 2004] but now part of Volume 1 [ITE 2012] -- provides information on issues of importance that arise when estimating trip generation. These issues include pass-by and diverted-link trips, multi-use developments, and other factors that may influence the actual amount of new traffic [10]. The data in Volumes 2 and 3 are displayed on 2000-plus pages for hundreds of land use types. Despite this extensive resource, trip generation can be a challenging undertaking, even for common land uses such as shopping centers. Examples of challenges are mentioned later in this chapter.

9.1.2 Primary Sources of Trip Generation Data

Data obtained from other sources, such as ITE, are called *secondary* data. *Primary* data are collected by the analyst for a specific purpose. Normally, secondary data have the advantage of being based on a larger sample size than can be acquired with reasonable time and expense for a specific project. The drawback of secondary data is that they may have been collected at locations that do not replicate the particular site that is the subject of a TIA. For example, secondary data in the *Trip Generation Manual* [15] for a proposed Fast-Food Restaurant with Drive-Through Window are based on 132 studies. It is probably not worth the time and expense to collect trip generation data at enough local Fast-Food Restaurants with Drive-Through Window to replace the secondary data, unless the trip rates do not seem to fit the case at hand. If some local data are available, however, they can be combined with secondary data to improve the data. See Section 4.2 of the Technical Report.

9.1.3 Other Sources of Trip Generation Data

Data from prior studies made on a similar kind of land use under similar conditions may be used, if properly documented. If existing data are not available or are not a good representation of specialized characteristics that the site under consideration might have, a data collection effort has to be conducted at sites that exhibit similar characteristics as the study site. Forms that guide the collection of trip generation data can be found in Appendix C of the User's Guide in the ITE *Trip Generation Manual* [15].

9.2 MIXED-USE DEVELOPMENTS

In case of mixed-use developments, certain deductions might have to be made to the trip generation rate derived by adding the trip generation rates of the individual land uses to accommodate the possibility of internal trips. Mixed-use developments are discussed in Chapter 12 of this guide.

9.3 PASS-BY TRIPS

The methodology for handling pass-by trips is discussed in detail in Chapter 11 of this guide.

Chapter 10 TRIP DISTRIBUTION AND TRAFFIC ASSIGNMENT

10.1 TRIP DISTRIBUTION

Trip generation estimates the number of trip ends associated with a proposed development. Because each trip has two ends, it is necessary to determine where the other end of each trip is, at least in terms of the direction from which a trip arrived, or to which a departing trip will go. This step is called *trip distribution.* The outcome is an origin-destination pattern of trips to/from the site, which permits an assessment of which streets are being used by those trips.

The trip distribution step in Traffic Impact Analysis is not precise. There are at least four methods that could be used, each with its advantages and limitations.

1. Using the *subarea analysis* feature of the regional travel demand model, estimate a matrix of trips that have one end at the site and the other end at the boundary of the TIA study area or traffic analysis zones within the study area. This method keeps the pattern of trips to/from the site in the context of non-site traffic, but assumes that the model (if it exists) has been validated and has the level of refinement to provide good representations of origin-destination "choice" at the non-site ends.
2. A gravity model can be applied for the TIA study manually or by computer, taking into account the non-site traffic in the horizon year. This will not depend on a regional travel demand model, but it will depend on good knowledge of the area and good judgment in using the gravity model.
3. The researchers were able to combine driveway turning movement counts with a good knowledge of the area around the site to produce very good estimates of pass-by trip percentages for existing sites. See Chapter 12 and Dey and Fricker [1993a]. It may be possible to take estimates of the pass-by percentage for a proposed site and, using knowledge of the area, produce a good estimate of origins and destinations for trips to/from the site. The pass-by percentage value serves as a constraint, even though it is also an estimate, but this method is a low-cost way to accomplish a task with much potential variability.

4. With the introduction of traffic microsimulation software in recent years, it may be possible to load a proposed origin-destination matrix for a site and compare the resulting flow pattern in the study area against the expected flow pattern. This comparison may provide clues as to how to adjust the origin-destination matrix for the site, although it involves comparing one model result (microsimulated flows) with another (flow patterns from a travel demand model).

No single method is clearly superior to the others, but TIA report preparers often have adopted or developed methods in which they have confidence. A brief description of the method used should be included in the report.

10.2 TRAFFIC ASSIGNMENT

Traffic assignment loads the distributed site trips onto specific paths in the road network. The result of traffic assignment is the total project-generated traffic by direction and by turning movements on the horizon-year roadway network in the study area. Assignment should be made after taking into account logical routing, available roadway capacities, and projected and perceived minimum travel times.

- User-equilibrium static traffic assignment has been done by travel demand software for many years.
- Dynamic traffic assignment software is now available that can account or the variability of traffic between and within hours, if there are data to support such a loading.
- Some traffic microsimulation software allows the user to input an origin-destination matrix, whereupon the software loads the network while taking into account signal timing at intersections.

Chapter 11 PASS-BY TRIPS

11.1 Definitions

In trip generation, each vehicle trip that arrives at a development can be classified as *primary, diverted, or pass-by*. (Figure 11.1 below is Figure 5.1 in ITE 2004 and ITE 2012.) Traffic that does not enter or exit the site is considered *background traffic*.

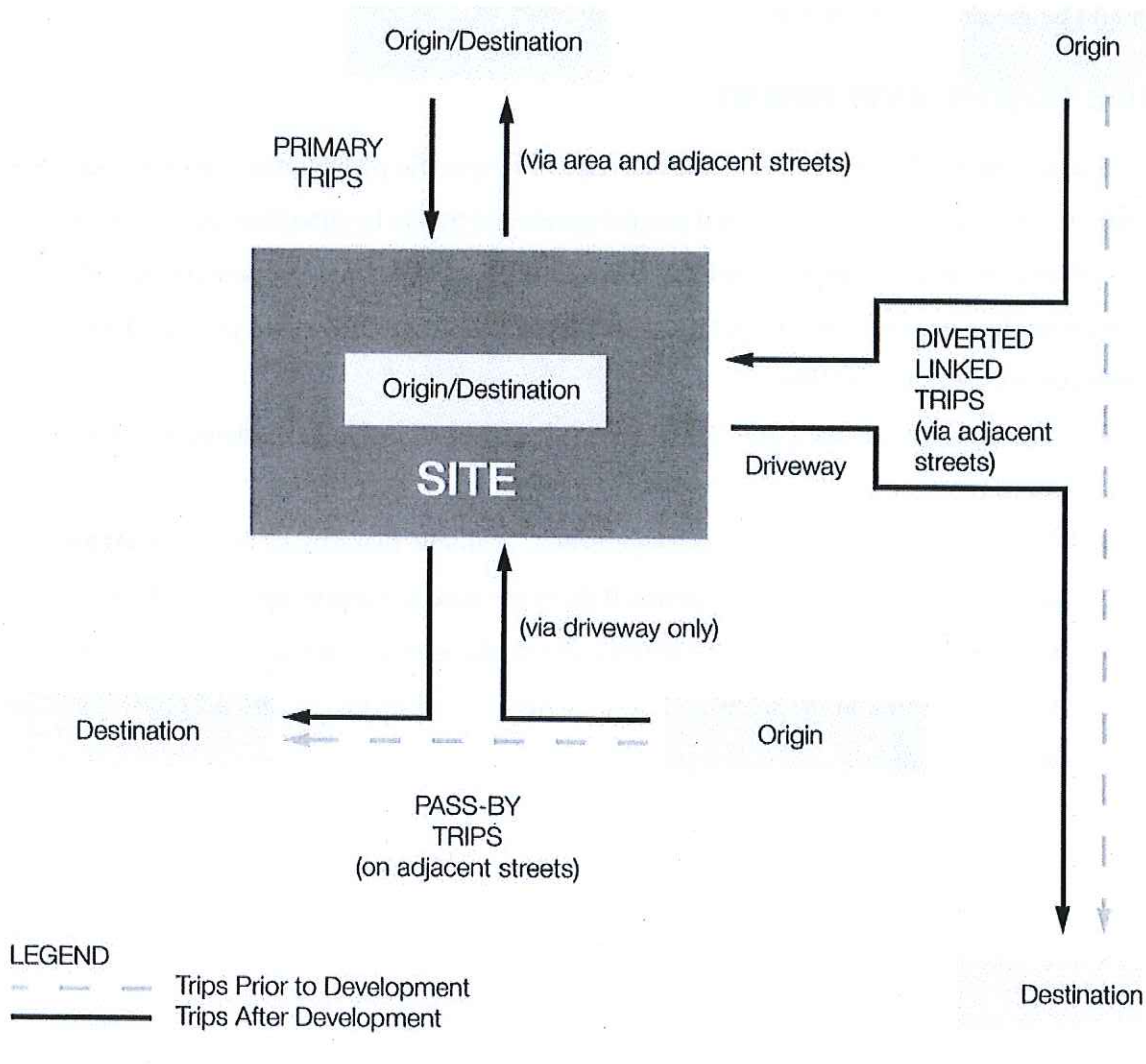


Figure 11.1 Types of Trips

A pass-by trip is a trip that would have been on the roadway passing the new development's site, whether the development was in existence or not. The definition in the ITE Trip Generation Handbook [ITE 2004, ITE 2012] is given below:

> *Pass-by trips* are made as intermediate stops *on the way* from an origin to a primary trip destination without a route diversion. Pass-by trips are attracted from traffic passing the site *on an adjacent street* or roadway that offers direct access to the generator. **Pass-by trips are not diverted from another roadway.**

Primary and diverted trips attracted to the new development's site add to the number of vehicles on the roadway; the pass-by vehicles do not. However, all three trip types – even the pass-by trips -- involve vehicles turning into and out of the development's site, adding traffic conflicts at the access points. If the vehicles shown in Figure 11.2 would have been on the streets shown in any case, but the drivers chooses to patronize the new shopping center or new gas station, no new traffic has been added to the streets. However, the number of traffic conflicts has been increased.

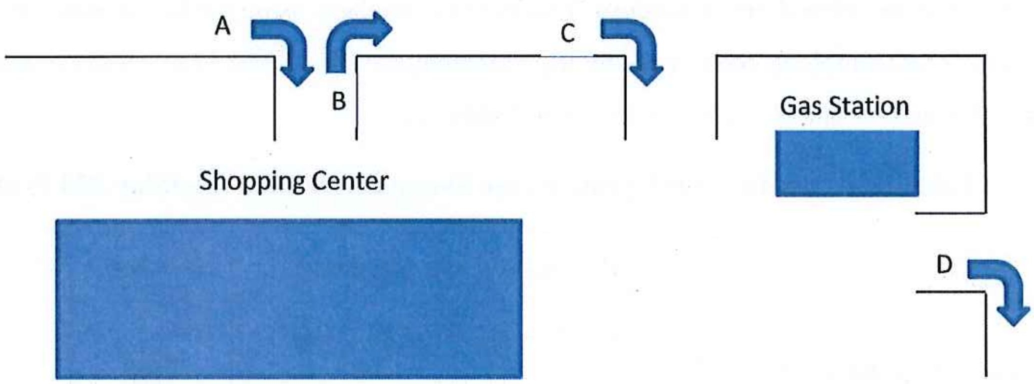


Figure 11.2 Pass-by Trip and Traffic Conflict Points

11.2 Pass-by Trip Data Collection

The three types of trips are easy to define, but they are not easy to document. A vehicle entering an existing site cannot be easily categorized as primary, diverted, or pass-by. The best way to determine the trip type is to ask the driver, but this is tedious and intrusive. During the 1991 study [Dey and Fricker 1993a], such a personal interview survey was carried out at the same time that a license plate survey was being done at the same small shopping center in Lafayette IN. The license plate survey data were used to approximate the results from the personal interviews. The estimates of pass-by trips were so good, that the experiment was repeated at a small shopping center in Indianapolis IN. Again, the license plate survey was able to produce a very good estimate of percent pass-by trips. The license plate method is described in Chapter 3 of the 1992 INDOT Manual [Dey and Fricker 1993a]. Section 5.6 of the ITE Trip Generation Handbook [ITE 2004, ITE 2012] sets out an interview-based survey that is similar to the customer survey used in 1991 for JHRP Project HPR-2039.

11.3 Estimating Pass-by Trip Percentage at a New Development

Section 5.4 of the ITE *Trip Generation Manual* [ITE 2012] contains a database with pass-by percentages for several types of retail developments. The pass-by percentage equation for retail/shopping center during the weekday PM peak period is an exponential function. (See the first equation in Table 11.1.) The variable X is the size of the development, in thousands of square feet of floor space. Lan [17] focuses on ITE's retail/shopping center equation, pointing out that its exponential form may lead to over or underestimating pass-by trip percentages when extrapolating outside the lower limit (X=9) and upper limit (X=1200) of the independent variable. Lan developed new equations from the ITE database using nonlinear least squares (NLS) for retail/shopping center pass-by trip percentages. (See Table 11.1.) The computed values of P at X=9 and X=1200 are shown in Table 11.1.

Table 11.1 Pass-by Trip Equations for Shopping Center, Weekday PM Peak

	P = pass-by trip percentage	P at X=9	P at X=1200
Original ITE equation [ITE 2012]	$\ln(P) = -0.29 \ln(X) + 5.00$ $R^2 = 0.37$	78.5	19.0
Re-estimated ITE equation using nonlinear least squares [Lan 2010]	$P = 129.18\, X^{-0.252}$ $R^2 = 0.344$	74.3	21.6
Lan equation using nonlinear least squares [Lan 2010]	$P = 20.93 + 33.16 * 0.996^X$ $R^2 = 0.336$	52.9	21.2

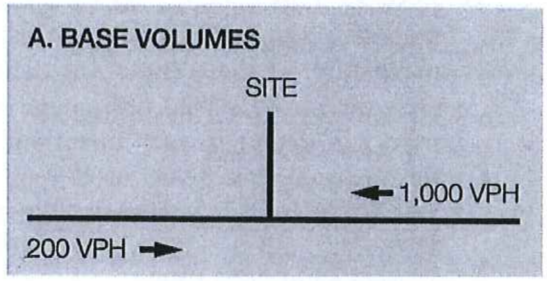
It appears that Lan's concern about overestimating percent pass-by trips is justified only for very low values of X, where the lowest number of trips occur. Any of the three equations in

Table 11.1 are reasonable bases for estimating P for moderate values of X, given the wide scatter in the data collected at various locations for *percent pass-by trips*.

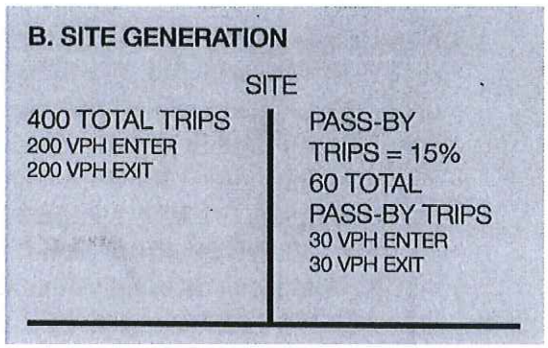
11.4 The Pass-by Trip Assignment Process

Section 5.2 of the ITE Trip Generation Handbook [ITE 2004, ITE 2012] demonstrates the steps involved in estimating the number of trips added to the traffic volume on a street adjacent to proposed shopping center, along with the associated turning movements into and out of the site. An annotated overview of the steps is given below:

Figure 11.3 Application of Pass-By Trips

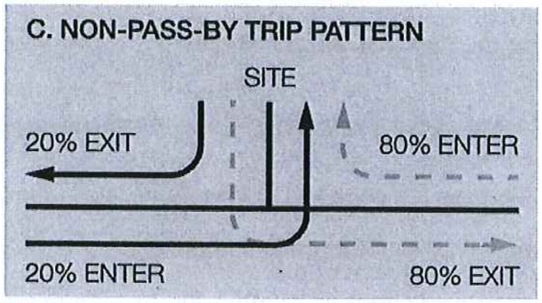


A. Base Volumes. Indicate the Base Volumes (each direction) on the adjacent street at each proposed driveway. (There may be more than one driveway or access point for a development.) At the driveway shown in Figure 11.3A, the traffic is 200 vph eastbound and 1000 vph westbound. The Base Volume is the traffic that would occur <u>without</u> the new development, and is usually for the peak hour and the year in which the development will open, or be built out, whichever is specified.

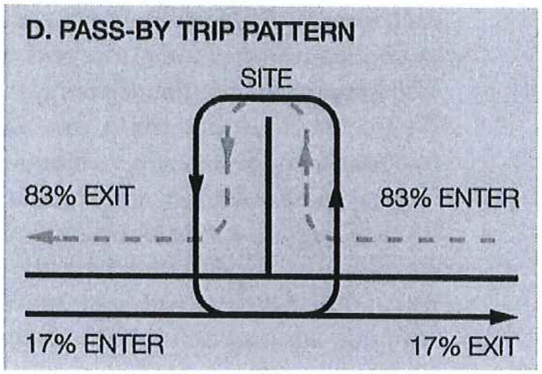


B. Site Generation. Estimate and allocate the Trip Ends predicted for the site to each of its driveways. In this example, 2000 evening peak hour trips are predicted, 20 percent of which (or 400) will use the driveway shown in Figure 11.3B. Using an equation such as those in Table 11.1, estimate the pass-by trip percentage for the site. Apply this percentage to each driveway. Here, 15 percent of 400 = 60 pass-by trips.

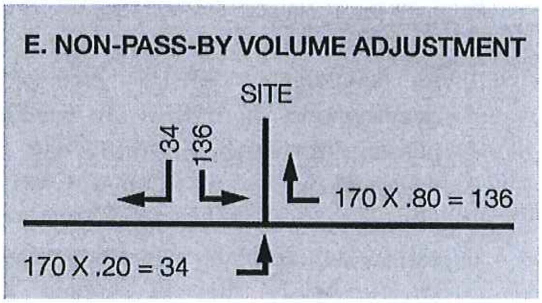
C. Non-Pass-By Trip Pattern. At each driveway, assume a pattern for non-pass-by trips. What percentage of these trips will come from each direction? What percentage of these trips will depart in each direction? Here, 80 percent of the non-pass-by trips are expected to arrive from the east and the other 20 percent from the west. Although it is not always the case, here all the non-pass-by trips are expected to leave in the direction from which they came, or at least the percentages will be the same.



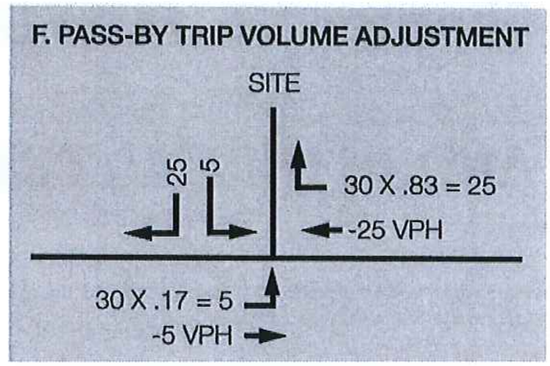
D. Pass-By Trip Pattern. At each driveway, assume a pattern for pass-by trips. What percentage of these trips will come from each direction? What percentage of these trips will depart in each direction? Here, the Base Volumes are used as a guide: The 1000 vph WB volume is 83 percent of 1000+200 and the 200 vph EB volume is 17 percent of 200+1000.



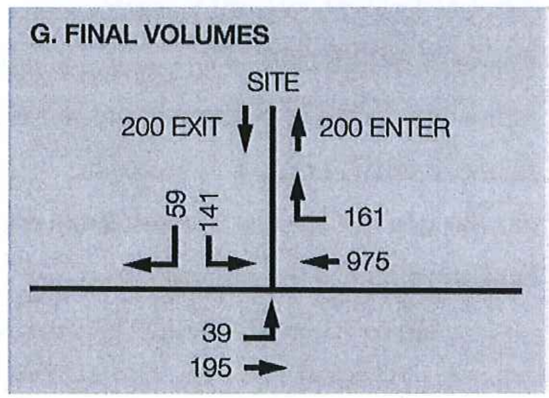
E. Non-Pass-By Volume Adjustment. At each driveway, subtract pass-by trips from total trips, then apply the directional distribution found in Step C. Example for WB turn into site: 200 trips enter – 30 pass-by entries = 170 non-pass-by-trips entering. 80 percent (from Step C) of 170 = 136. The result is usually four values – the number of non-pass-by vehicles entering and exiting the driveway from/to each direction. Based on the directional distribution assumed in Step C, the turning movement volumes are symmetrical.



F. Pass-By Volume Adjustment. At each driveway, take the results from Step B and apply the directional distribution found in Step D. 30 entering pass-by trips * 83 percent from the east = 25 vph from the east. The result is usually four values – the number of pass-by vehicles entering and exiting the driveway from/to each direction.



G. Final Volumes. Add the turn volumes from Steps E and F. Trips entering = 136 + 25 = 161 from the east and 34 + 5 = 39 from the west. Convert the Base Volumes to account for non-site and site traffic movements. For the WB Base Volume, 1000 – 25 = 975 accounts for the pass-by traffic (25 vph) that would have been there, even without the new shopping center, but is now part of the 161 trips entering the site.



Chapter 12 MIXED-USE DEVELOPMENTS AND INTERNAL TRIPS

12.1 Internal Capture Rate

Chapter 7 of the ITE *Trip Generation Handbook* [ITE 2004, ITE 2012] describes the difficulty in estimating the traffic impacts of mixed use developments. They are difficult to define and data for the *internal capture rate* are scarce. The internal capture rate is the percent of trips made to one location at a site that began at another location at that site. A trip was made, but it did not have any effect on the external streets.

Tables 7.1 and 7.2 in the ITE *Trip Generation Handbook* combine locations at a site into office, retail, and residential categories. The internal capture rates vary from 0% to 53% for various categories and times of day. The challenge for any large mixed use site is to develop a relationship between driveway counts and visits made to locations at the site.

12.2 Lessons Learned from a Data Collection Effort

Chapter 9 in the research report for this project covers Internal trips in Mixed Use Developments. A data collection effort was made for a new mixed use shopping center, attempting to estimate the internal capture rate for the site. A summary of the findings is presented here.

As a result of attempting to count internal trips at a shopping center, it became very obvious how difficult it was to visually track internal trips from origin to destination within a shopping center. Even with more observers, the size of the site would make it difficult to conduct counts. Theoretically, it would seem the method to obtain accurate internal trip counts would be placing an observer at the entrance to each store within the shopping center asking entering patrons what their previous stop was, but this is an intrusive method. The ITE *Trip Generation Manual* [17] Volumes 2 and 3 do not contain equations or data to use to predict the trip generation for many of the individual store types within a shopping center. These store types may be absent from the ITE *Trip Generation Manual* because they do not commonly locate in stand-alone buildings.

A few factors could have significant impacts on internal trips at shopping centers. Store type and location within a shopping center may impact the site's total trip generation and number of internal trips. This would directly correlate to whether the site's total trip generation would be over or underestimated. The location of stores may also induce more trips to the site. It would be interesting to conduct trip generation counts at shopping centers once fully developed and compare the counts to what the predicted total trip generation prior to construction was for the shopping center.

Chapter 13 Innovative Intersection Designs

Chapter 6 of the research report for this project [Bollinger and Fricker 2013a] describes some non-traditional designs that might be considered as ways to improve operations at intersections affected by new development nearby. The innovative intersection designs are:

13.1 Median U-Turn (MUT) Intersections (Figure 13.1)

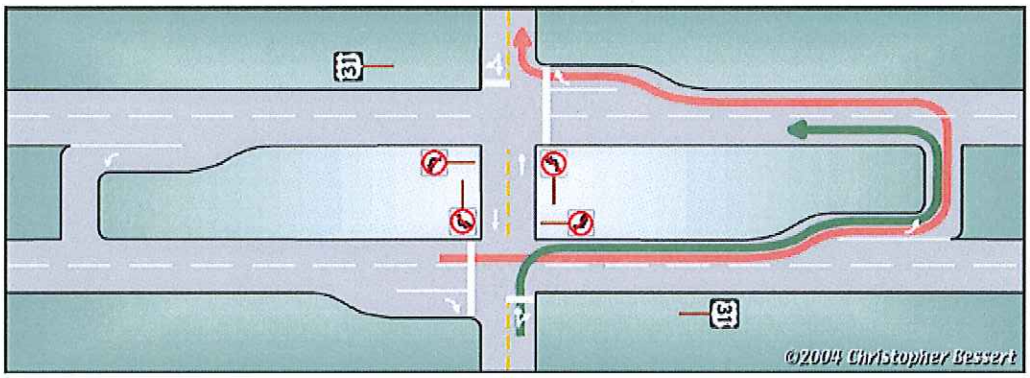


Figure 13.1. Left turn movements at an MUT. [2]

13.2 Restricted-Crossing U-Turn (RCUT) Intersections (Figure 13.2)

Figure 13.2. RCUT intersection near Wilmington, NC. [5]

13.3 Displaced Left Turn (DLT) Intersections (Figure 13.3)

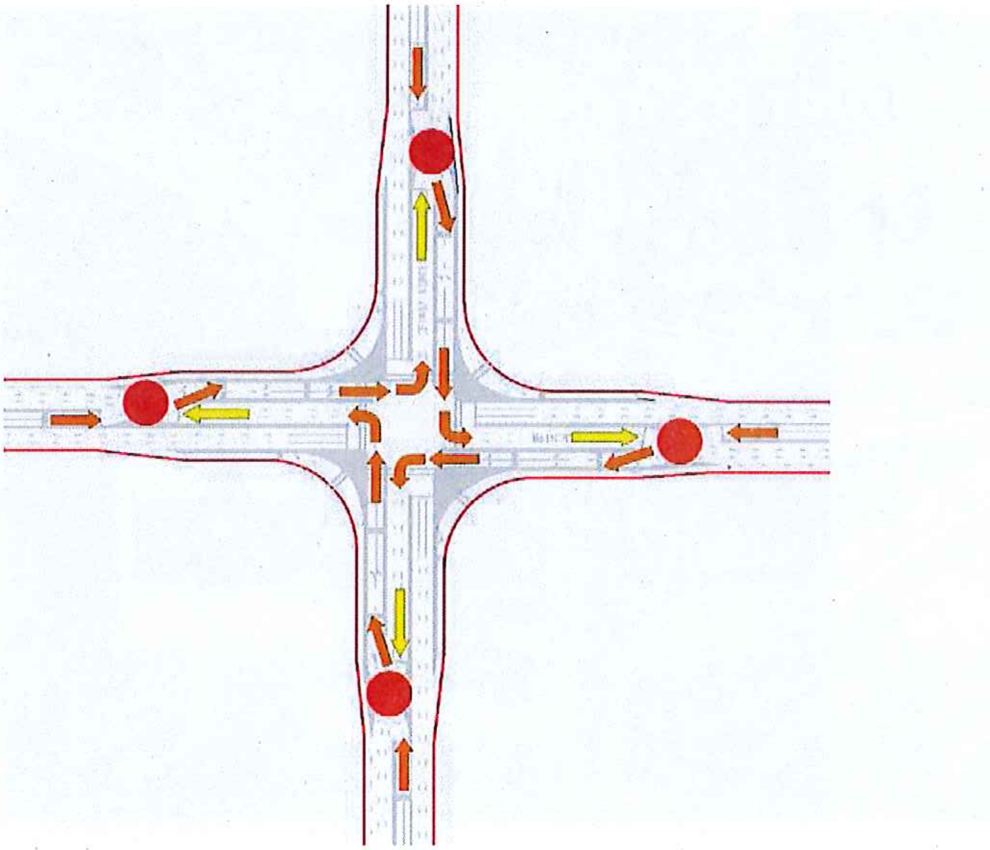


Figure 13.3. Full displaced left-turn intersection. [10]

13.4 Quadrant Roadway (QR) Intersections (Figure 13.4)

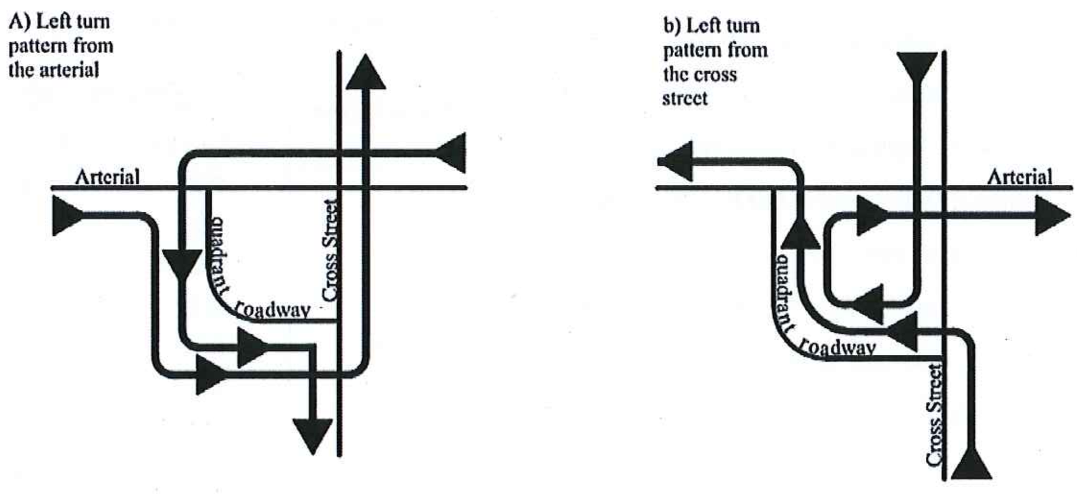


Figure 13.4. QR left turn movements. [10]

13.5 Roundabouts (Figure 13.5)

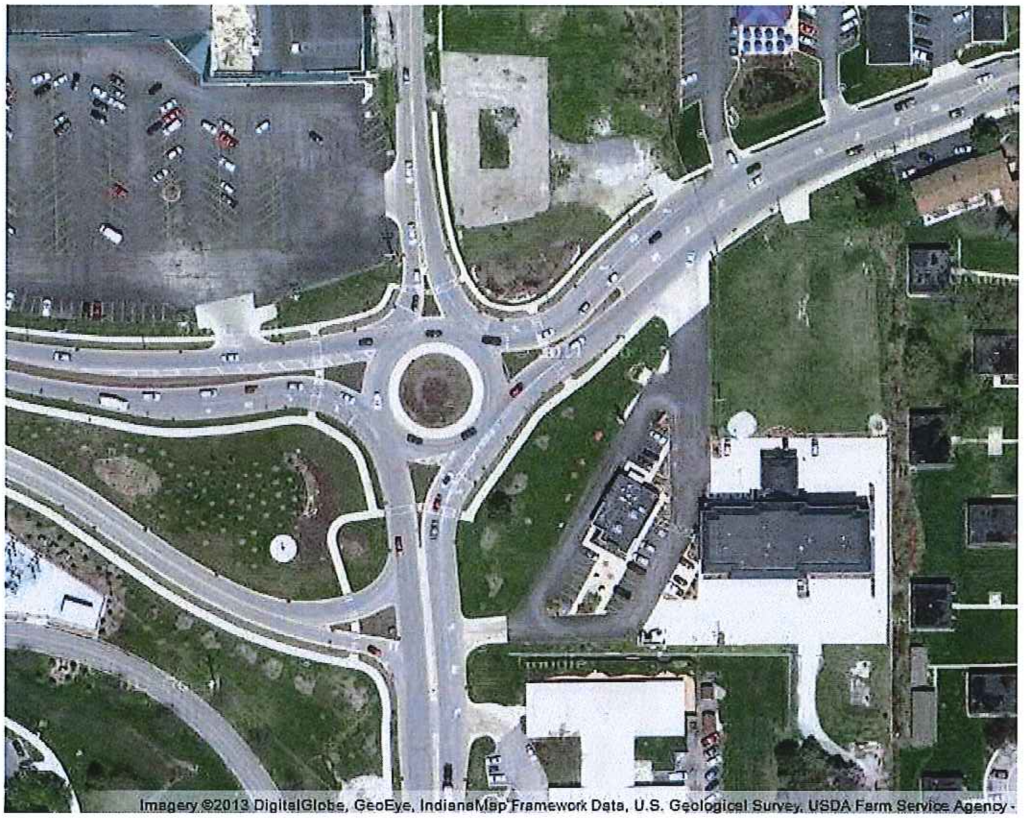


Figure 13.5. Roundabout on SR 130 in Valparaiso. [5]

Chapter 7 of the research report for this project [Bollinger and Fricker 2013a] shows the results of simulations that were run to predict how a new intersection design may operate. The basic intersection design was a four-lane divided state highway intersecting a two-lane rural highway not under INDOT's jurisdiction. The peak hour approach volume for the major highway (controlled by INDOT) was kept constant at 800 vph throughout the simulations. The volume on the minor highway was varied as shown in Table 13.1.

Table 13.1 Approach volumes (each direction) used in the intersection simulations

Simulation	Volume (vph)	
	Major Hwy	Minor Hwy
1	800	800
2	800	700
3	800	600
4	800	500
5	800	400
6	800	300
7	800	200
8	800	100

The simulations were too few in number and too generic to declare that one intersection design is superior to others, but the analysis demonstrates the capability of simulation to assist the evaluation of a set of proposed intersection designs for particular locations.

INDOT has a written procedure to follow in determining whether a non-traditional intersection has merit. It is the INDOT *Intersection Decision Guide*, published in January 2014. The link to that document is http://www.in.gov/indot/files/ROP_IntersectionDecisionGuide.pdf.

Chapter 14 ANALYSIS

14.1 FACTORS TO CONSIDER IN A TRAFFIC IMPACT ANALYSIS

Chapter 7 of the ITE Recommended Practice [ITE 2010] lists the analytical techniques that are an integral part of a Traffic Impact Study:

- Capacity analysis at each major street and site access intersection location (signalized and unsignalized) within the study area.
- Capacity analyses for roadway segments or transportation links that are likely to be sensitive to site traffic, such as weaving sections, ramps, major internal site roadways and on- and off-site storage for vehicle queueing.

Other factors that should be considered for analysis include [ITE 2010]:

- Safety
- Circulation patterns
- Traffic control needs
- Transit needs or impacts
- Transportation demand management
- Neighborhood impacts
- On-site parking adequacy and off-site parking facilities
- Pedestrian and bicycle movements
- Service and delivery vehicle access
- ADA provisions. (See Indiana Building Code, Chapter 11 and INDOT Operations Memorandum 14-10, *Accessible Pedestrian Signal (APS) Studies and Installation Considerations*, dated Jan. 9, 2014.)

The analyses to be conducted as part of the Traffic Impact Study should be decided at the Initial Meeting. They provide the basis for the Traffic Impact Study's findings, recommendations and conclusions. The Traffic Impact Analysis should not be ended until one of three conclusions has been reached:

1. The proposed development can be accommodated in the horizon year transportation infrastructure with no additional improvements.

2. The proposed development can be accommodated in the horizon year transportation infrastructure consistent with agency policy and operating conditions subject to specified recommended improvements/modifications.
3. The area will operate below the accepted level of service even without the development. No further significant deterioration will result if the proposed development is accommodated with the recommended changes.

14.2 ANALYTICAL METHODS

The ITE Recommended Practice [ITE 2010] presents further explanation for some of the analyses listed above and describes the state-of-the-practice methods commonly used. Brief excerpts and updates are provided below.

14.2.1 CAPACITY ANALYSIS

Level of Service -- Intersection Capacity Analysis.

The *Highway Capacity Manual* [2010], which was published after the ITE Recommended Practice, is the source document used almost exclusively. The level of service (LOS) is a qualitative assessment of the quantitative effect of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays and freedom to maneuver. Many jurisdictions currently apply LOS "C" or LOS "D" thresholds for defining automobile site traffic mitigation. Exhibit 18-4 in the 2010 HCM (replicated here as Table 14.1) lists the LOS thresholds for the automobile mode at a signalized intersection.

Table 14.1 LOS Criteria for Automobile Mode

	LOS by Volume-to-Capacity Ratio	
Control Delay (s/veh)	≤ 1.0	>1.0
≤ 10	A	F
>10-20	B	F
>20-35	C	F
>35-55	D	F
>55-80	E	F
>80	F	F

At many signalized intersections, nonautomobile modes should also be considered. Exhibit 18-5 in the 2010 HCM (replicated here as Table 14.2) lists the LOS thresholds for the pedestrian and bicycle modes at a signalized intersection.

Table 14.2 LOS Criteria for Pedestrian and Bicycle Modes

LOS	LOS Score
A	≤ 2.00
B	>2.00-2.75
C	>2.75-3.50
D	>3.50-4.25
E	>4.25-5.00
F	>5.00

Level of Service—Roadway Segment Analysis.

Again, the *Highway Capacity Manual* [2010] is the most commonly used reference, but arterial analysis computer packages are also available to evaluate complex situations. The LOS criteria in the 2010 HCM (shown in Table 14.3) depend on the facility type.

Table 14.3 Level of service criteria

Facility type	HCM chapter(s)	Auto criteria	Non-auto criteria
Multilane highways	14	Free-flow speed and density (pc/mi/la)	LOS score for bicycles
2-lane highways	15	Average travel speed and percent time spent following	LOS score for bicycles
Urban Streets	16-17	Average travel speed as percent of base free-flow speed	LOS scores for pedestrians, bicycles, transit

14.2.2 SAFETY ANALYSIS

Sometimes when conducting a TIA, there are locations within the study area that experience high crash rates or an usual number of specific crash types. For these locations, a safety analysis may be warranted and should be included in the TIA. The ITE Recommended Practice [2010] suggests that an intersection with a collision rate of more than one per million entering vehicles may be worthy of additional analysis, subject to consultation with the appropriate agency. The need for a safety analysis should be discussed with the governing jurisdictions at the scoping meeting.

In Indiana, crash data are collected by law enforcement agencies and compiled into an Automated Report and Information Exchange System (ARIES) database by an independent contractor. INDOT's policy is to require the applicant to acquire the crash data needed for the analysis directly from the appropriate source(s). In this way, the TIS preparer can decide what data (and how much) are needed for the TIS.

Also published after the *ITE Recommended Practice* was the *Highway Safety Manual* [AASHTO 2010]. The HSM can help quantify and predict the safety performance of roadway elements, but its use requires an investment in time to learn its procedures.

The safety analysis should include identification and recommendations about locations with frequent crashes, restricted sight distances, and pedestrian/bicycle safety.

14.2.3 SITE ACCESS POINTS

All site access points should conform to current INDOT standards and specifications. [INDOT 1996]

14.2.4 TRAFFIC CONTROL NEEDS

Warrant analyses for traffic control devices such as traffic signals, stop and yield signs should be carried out in accordance with the *Indiana Manual on Uniform Traffic Control Devices* [INDOT 2011].

14.2.5 MEDIAN OPENINGS

In some cases, a new development causes questions to arise regarding a median. Two common examples are:

A. Should an existing median opening be closed to prevent unsafe left turns into a new development? See Figure 4.5 in Bollinger and Fricker (2013a).

B. Should a new median opening be created to permit left turns into a new development? See Figure 4.5 in Bollinger and Fricker (2013a).

Section 4.6 of the Research report for this project looks at the legal and operational issues that affect the answers to Questions A and B above. INDOT has the legal authority to either introduce or close a median opening [INDOT 2009, p. 26], as long as INDOT is using the authority granted it by IC 9-21-4-2 to "maintain traffic control devices … and specifications upon all state highways" to (under IC 8-23-4-8) "promote public convenience and safety".

If a median opening is requested, a detailed analysis should be carried out to find out whether a median opening would hamper the operating condition of the roadway. Due consideration should be given to the following:

- warrants for a left turn signal at the opening
- approach speed of the opposing vehicles
- gaps in opposing traffic
- storage space at the median opening
- queueing and delay to the vehicles
- distance from nearest intersection
- spacing between median openings
- special geometric situations, including sight distance and perceived approach speeds.

With the growing use of traffic microsimulation software, several proposed geometric and traffic control device solutions can be evaluated against each other and against reasonable standards for delay and level of service.

14.2.6 NEIGHBORHOOD IMPACTS

Neighborhood transportation impacts are primarily caused by site-generated traffic using neighborhood streets as short cuts. This can hamper pedestrian safety, air quality, community cohesion and, consequently, property values. Most neighborhoods are sensitive to this and hence an analysis should be conducted to estimate the neighborhood impacts of the proposed development and mitigating measures suggested.

Chapter 15 CONCLUSIONS AND RECOMMENDATIONS

If the traffic impact analysis reveals that the projected traffic volumes on the horizon year roadway network will operate in a safe and efficient manner at an acceptable level of service, then no improvements are required. However, if deficiencies are detected, mitigating measures have to be recommended. These measures may include:

1) Installation of traffic signals
2) Installation of traffic control signs
3) Addition of through lanes
4) Addition of acceleration, deceleration, and turn lanes (specify length)
5) Restricted turn movements
6) Adjusting cycle lengths
7) Introducing additional signal phases

However, if reasonable mitigating measures cannot be found to make the traffic operate in an efficient way, a more detailed evaluation of project size, land use types, and development phasing may be required. If viable transportation improvements cannot be recommended, then steps have to be taken to reduce the trip generation rate of the proposed development during the problem period. Some of the possible approaches that may be adopted are:

- increased transit usage
- carpool/vanpool programs
- congestion pricing
- reduced parking or increased parking fees
- staggered work schedules

Any transportation demand management recommendations should take into account:

1) Timing of the short and long-range transportation system improvements that are already scheduled or anticipated.

2) Anticipated timing of adjacent developments.

3) Phasing of the subject development.

4) ROW needs and availability.

5) Local priorities of transportation improvement funding.

6) Cost-effectiveness of the proposed improvements.

15.1 RECOMMENDED PLAN OF ACTION

Implementation recommendations should be presented as a "plan of action". This action plan should recommend improvements, state why they are needed, and when they are to be implemented.

Chapter 16 THE REPORT

The traffic impact study report should document the purpose, procedures, data sources, assumptions, findings, conclusions and recommendations of the study. It should be concise and complete. The report should be organized in a logical sequence and methodically take the reader through the entire process of traffic impact analysis. A Sample Report Outline is provided in Appendix C of this Guide. A uniform framework will facilitate both the preparation and the review of the report. Any major departures from this standard format should be agreed upon at the initial meeting and mentioned in the subsequent memorandum of understanding (see Chapter 5).

It should be kept in mind that the report might be of interest to the decision makers and other non-technical people. Hence, clarity should not be sacrificed. Two ways to accomplish this are (a) an effective Executive Summary and (b) effective use of exhibits.

16.1 EXECUTIVE SUMMARY

An executive summary should be placed near the beginning of the traffic impact study report (Section I.B in Appendix C Sample Report Outline). It should be one-page or two-page document to facilitate examination by the reviewing agency. It should contain the salient features of the study and should summarize the study purpose, and its conclusions and recommendations. Letters and memorandum reports under 10 pages do not need an executive summary.

16.2 SUGGESTED EXHIBITS

Visual displays (figures and maps) and tabular displays (tables) can improve the communication of information to reviewers, public officials, and citizens. Table 16.1 is Table 10-2 in the ITE Recommended Practice [2010]. The "Examples" cited in the rightmost column of Table 16.1 refer to exhibits in the ITE Recommended Practice [2010]. The exhibits listed in Table 16.1 that are actually used in a TIS report will depend on the nature of the particular Traffic Impact Analysis.

Table 16.1 Suggested Figures and Tables for a Transportation Impact Study Report

Item	Title	Description	Example in [10]
Figure A	Site location	Area map showing site location	Figure 6-1
Figure B	Study Area	Map showing area of influence	Figure 6-2
Figure C	Existing transportation system	Existing roadway system serving site. Show all major streets, minor streets adjacent to site and site boundaries. Show also transit, bicycle and major pedestrian routes, if applicable, along with right-of-way widths and signal locations. In some cases, may be combined with Figure A.	Figure 3-4
Figure D	Existing and anticipated area development	Map at same scale as Figure H showing existing and anticipated land uses/developments in study area	Figure 4-3
Figure E	Current daily traffic volumes	Recent or existing daily volumes on roads in study area. May be combined with Figure C or F. Include existing moving lanes if not shown in Figure C.	Figure 3-2
Figure F	Existing peak-hour turning volumes	Current peak hour turning volumes at each location critical to site volumes access or serving major traffic volumes through study area. May be combined with Figure E. Also existing moving lanes if not shown in Figure C.	Figure 3-3
Figure G	Anticipated transportation system	Area transportation system map showing programmed and applicable planned roadway, transit, bikeway and pedestrian-way improvements affecting site access or traffic flow through the study area. May be combined with Figure C.	Figure 4-5
Table A or Figure H	Directional distribution of traffic	Map or table showing (by percentages) the portion of site traffic approaching and departing the area on each roadway. May differ by land use within multi-use development.	Figure 6-5
Table 8	Estimated site traffic generation	Estimated peak hour (and daily, if required) trips to be generated by each major component of the proposed development. Must be shown separately for inbound and outbound directions.	Table 5-4
Figure I	Site traffic	Map of anticipated study area roadway network showing peak hour turning volumes generated by site development.	Figure 6-7
Table C	Estimated trip generation for non-site development	Trips generated by off-site development within study area. Similar to Table B. A map similar to Figure I can also present this information.	Table 4-1
Figure J	Estimated non-site traffic	Map similar to Figure H, showing peak hour turning volumes generated by off-site development within study area plus through horizon year traffic.	Figure 4-2
Figure K	Estimated total future traffic	Map similar to Figure H, showing sum of traffic from Figures I and J.	Figure 7-1
Figure L or Table D	Projected levels of service	Levels of service computed for critical intersections in study area. Include existing, horizon year non-site and total horizon year (with site development) conditions.	Figure 7-2 or Table 7-1
Figure M or Table E	Recommended improvements	Map showing recommended off-site transportation improvements, site access points, and on-site circulation and parking features, as appropriate. May require more than one figure. Table will describe improvements by location and type. If phasing of improvements is to be stipulated, this should also be shown on these or on a separate figure or table.	Figures 8-1, 8-2, 8-3, and 8-4
Figure N or Table F	Study checklist	Checklist showing the required/optional elements of a transportation impact analysis report, whether or not they have been incorporated and their locations in the report.	Figure 10-1

16.3 PUBLIC RECORD

Traffic impact study reports become public record upon acceptance by INDOT.

Chapter 17 STAFF REVIEW

The purpose of staff review is to ensure that the traffic impact study (TIS) has been properly prepared, and that the recommendations made by the preparer are realistic and can be implemented. Staff reviews are not intended to deter new developments. They are to ensure that traffic-related problems are anticipated and that effective mitigation measures are identified. If questions arise, contact between the preparer and the reviewer during the preparation of the TIS is encouraged and should be documented in the final report.

17.1 FORMAL REVIEW

Traffic impact studies should be reviewed by departments and agencies that are (a) responsible for operating the roadways and/or (b) planning and implementing roadway improvements that are likely to be impacted by the proposed development. The formal review process is conducted after the report has been submitted by the preparer. This review process should develop a list of the following findings:

- Acceptable analyses and conclusions
- Unacceptable analyses and conclusions
- Acceptability of recommended site access provisions and roadway improvements
- List of required improvements that might be considered to mitigate impacts of the proposed development.

Following the review, the reviewer(s) should send to the preparer a list of requested study revisions.

17.2 REQUEST FOR REVISION

Any requests for study revisions should concisely indicate the findings of the formal review and clearly specify the additional information required. This additional report should normally be in the form of an addendum to the original study. In certain specific cases, a revised report may be requested.

17.3 ACCEPTANCE

Following the review, the reviewer(s) should send to the preparer a letter accepting the study. The acceptance letter can be transmitted electronically, and it should be attached to the final report.

APPENDIX A. INITIAL MEETING CHECKLIST

The applicant and reviewer(s) can use this appendix as a worksheet to ensure that no important elements are overlooked. This appendix could be used as a form to follow, crossing out those item that do not apply, with the record of the Initial Meeting (see Section 5.6) describing items decided at that meeting. An Initial Meeting Checklist in pdf template format to accomplish the same purpose is shown in Appendix B.

Date and Place of the Initial Meeting

Name and Location of Proposed Development

Which jurisdictions are affected?

Representative(s) of Applicant at Initial Meeting:

Name, Job Title, Organization, Address, Telephone Number, Email'
Indicate the name and registration number of the licensed professional engineer who will be responsible for preparation of the Traffic Impact Study, if one is required.

Representatives of Reviewing Agency at Initial Meeting

Name, Job Title, Organization, Address, Telephone Number, Email

Application of Flow Diagram in Figure 3.1 of Applicant's Guide

1. **Does proposed development meet preliminary warrants?** (See Chapter 4)
   The preliminary notification should include:
   - For each land use type (ITE Land Use Code), intensity (Gross Floor Area, etc.)
   - Current zoning at site. Change in zoning needed or pending?
   - The complete site plan, with the site's requested access points in relation to existing access points nearby
   - The nearest signalized intersection in each direction
   - A market study (if applicable)

- Trip generation values and the method (s) used to compute them

The preliminary notification should be submitted along with the petition for an access permit.

2. **Are warrants for Traffic Impact Study met?** (See Table 4.1)
    - Define boundaries of Study Area (See Table 5.1). Other jurisdictions to contact?
    - Agree on Horizon Year, Non-Site Traffic Forecasts
    - Site Trip Generation method and data sources
    - Reductions in trip rates: pass-by trips, internal trips, transit use
    - Trip distribution method (and software) to be used
    - Traffic assignment method (and software) to be used
3. **Are warrants for Traffic Operations Analysis met?** (See Chapter 7)
    - Crash locations
    - Factors affecting Traffic Operations: Access locations, geometrics, intersection design (including innovative designs), traffic control devices, etc.
    - Data Sources

Traffic Impact Study Report Contents

See Appendix C.

Contact information and signatures for

- Study Preparer(s)
- Reviewer(s)

APPENDIX B. EXAMPLE OF TEMPLATE FOR INITIAL MEETING CHECKLIST

A four-page template Initial Meeting Checklist template is shown in this Appendix. The template can be used to facilitate the documentation of items discussed in the Initial Meeting.

INITIAL MEETING CHECKLIST

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

Date: Time:

Location:

People Attending

Name, title, affiliation, address, phone number

Study Preparer:

Preparer's Name and Title

Organization & Telephone Number:

Reviewer(s)

Reviewer's Name & Title:

Organization & Telephone Number:

Reviewer's Name & Title:

Organization & Telephone Number:

Applicant

Applicant's Name, Address, & Telephone Number:

Proposed development

Name:

Location:

Location within area ___ CBD ___ Rural

___ Urban (Non CBD) ___ Freeway interchange

___ Suburban (Non-CBD) ___ Other

___ Suburban CBD

ITE Land Use Code(s)#

Description:

Proposed number of development units:

Zoning

Existing:

Comprehensive plan recommendation:

Requested:

Findings of the Preliminary Study:

Study Type Needed:

___ Complete Study ___ Traffic Operations ___ None

Study Area

Boundaries:

Additional intersections to be analyzed:

Horizon Year(s):

Analysis Time Period(s):

Future Off-Site Developments

Source of Trip Generation Rates

Reduction in Trip Generation Rates

None (check if applicable)

Pass-by trips:

Internal trips (mixed-used developments):

Transit use:

Other:

Horizon Year Roadway Network Improvements

Methodology & Assumptions

Non-site traffic estimates:

Site trip generation:

Trip distribution method:

Traffic assignment method:

Traffic growth rate:

Accident locations:

Sight distance:

Queueing:

Access location & configuration:

Traffic control:

Signal system location & progression needs:

On-site parking needs:

Data Sources:

Base maps:

Prior Study reports:

Access policy and jurisdiction:

Review Process:

Requirements:

Miscellaneous:

APPENDIX C. SAMPLE REPORT OUTLINE

As Traffic Impact Analyses have been conducted over the past two decades, the outline shown below has become fairly standard. [Dey and Fricker 1992b, ITE 2010] Use this outline as a checklist to ensure that no important elements are overlooked. The Executive Summary should be concise and in the first section of the report. The use of illustrations and graphics can help the presentation of report contents.

Title Sheet

A. Development Name and Location

B. Preparer's Name, Title, Organization, Address, Telephone Number and Email.

C. Statement of Certification (See *Preparer Qualifications* in this Guide)

D. Date of Original Report

E. Date of Revised Report

Table of Contents, List of Figures, List of Tables

Introduction and Summary

A. Purpose of Report and Study Objectives

B. Executive Summary

1. Site location and study area
2. Development description
3. Principal findings
4. Conclusions and recommendations

I. Proposed Development

A. Subject Site

1. Location
2. Site plan

3. Land use and intensity
4. Zoning
5. Project phasing and timing

B. Off-site Developments

II. Existing Area Conditions

A. Study Area Limits

B. Study Area Land Use

1. Existing land use
2. Existing zoning
3. Anticipated future developments

C. Site Accessibility

1. Area roadway system
   a. existing
   b. committed and/or proposed
2. Traffic volumes (data in appendix)
3. Transit service
4. Pedestrians and bicyclists
5. Transportation system management programs

III. Projected Traffic

A. Site Traffic (each horizon year)

1. Trip generation
2. Pass-by traffic
3. Internal trips, if applicable
4. Trip distribution
5. Traffic assignment

B. Non-Site Traffic (each horizon year)

1. Method of projection
2. Trip generation
3. Trip distribution
4. Traffic assignment

C. Total Traffic (each horizon year)

IV. Analysis

A. Capacity and Level of Service for Streets and Intersections within the Study Area
B. Traffic, Pedestrian, and Bicycle Safety
C. Traffic Control Devices
D. Data sources

V. Improvement Analysis

A. Improvements to Accommodate Site Traffic
   1. Physical
   2. Operational
   3. Travel demand reduction
B. Additional Improvements to Accommodate Non-Site Traffic
   1. Physical
   2. Operational
C. Alternative Improvements
D. Status of Improvements Already Funded, Programmed or Planned
E. Evaluation

VII. Findings

A. Site Access: Driveways, Median Cuts
B. Transportation Impacts, Neighborhood Impacts
C. Need for Additional Improvements
D. Compliance with Applicable Local Codes

VIII. Recommendations

A. Site Access
B. Roadway Improvements
   1. On-site
   2. Off-site
C. Transportation System Management Actions
D. Other

Conclusion

A. Traffic Impact of Proposed Development

B. Adequacy of Proposed Plan, Including Recommended Improvements

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