Site Impact Applications Guide

State of Florida
Department Of Transportation

Systems Planning Office
www.dot.state.fl.us/planning

This page intentionally left blank.

State of Florida
Department Of Transportation

Systems Planning Office
www.dot.state.fl.us/planning

This page intentionally left blank.

1. Applications Guide Overview

1.1. Purpose of Document

The Florida Department of Transportation (FDOT) has developed this Applications Guide to serve as a companion document to the "Transportation Site Impact Handbook" (TSIH). The TSIH was developed to serve two primary purposes: 1) to provide guidelines to assist FDOT staff in their review of developments, and 2) to communicate FDOT's guidance for reviewing various documents to local governments and other transportation partners. This Applications Guide builds upon the guidance provided in the TSIH by providing ***real-world*** examples from ***actual developments in Florida*** to demonstrate the concepts discussed in the TSIH.

No two development projects are identical, and every traffic study must take into account the unique context of each proposed project. Local agency requirements, neighboring land uses, existing and forecasted traffic congestion, the extent and quality of the surrounding multimodal network, and community priorities for the site and the transportation network all influence the traffic study and shape the land use decision-making process. Given these interrelated factors, thorough documentation of all assumptions and key decisions is critical to every traffic study.

The traffic studies discussed in the following pages are not intended to serve as step-by-step guides, but rather as examples of how to approach each component of a traffic study and key questions to consider. Each example discusses the thought process behind each decision and highlights some potential pitfalls and common misconceptions. While the original studies were taken from real Florida projects, many of the assumptions and results have been changed and adapted in order to demonstrate each concept clearly and concisely.

1.2. How to Use Document

Rarely does a single traffic study allow for a comprehensive discussion of all key issues; a study in a downtown environment may require more focus on multimodal considerations, for example, while a suburban site may need to focus more on site design and drive-through queuing. For this reason, several studies have been selected that serve as representative examples for each stage in the process.

Each Chapter in this Applications Guide begins with a bulleted list of Key Issues that the Chapter will focus on through the lens of the example study. For context, all key study assumptions are provided in the introductory section, but only the key concepts are covered within each Chapter.

Each Chapter is intended to serve as a standalone reference, and users should feel free to jump between Chapters to focus on relevant issues of interest. It is important to note that these examples are not intended to demonstrate a single “correct” approach, but rather an examination of the types of issues to consider during the process.

1.3. Site Impact Analysis Overview

For added context, the following section provides a high level overview of the Site Impact Analysis process. For additional detail, consult the TSIH.

A major part of FDOT’s role in growth management involves reviewing proposed developments, comprehensive plan amendments, proportionate share agreements, Development of Regional Impact (DRI) agreements, and other local government actions identified for state review. Transportation impact analyses are conducted to evaluate how the transportation network would function once the proposed land use change or development takes place.

In accordance with Sections 163.3184, 334.044, and 386.06(6), Florida Statutes (F.S.), FDOT is responsible for reviewing and providing comments on local government comprehensive plan amendments and Development Orders as they relate to transportation impacts on state and regional multimodal facilities.

As new development is built and existing development continues to change in Florida, FDOT is responsible for protecting the state transportation system and ensuring that sufficient facility capacity is provided for public use. In order to do this, the traffic impacts of new development must be monitored and developers must be held responsible for mitigating any adverse impacts that their projects may have on the roadway network.

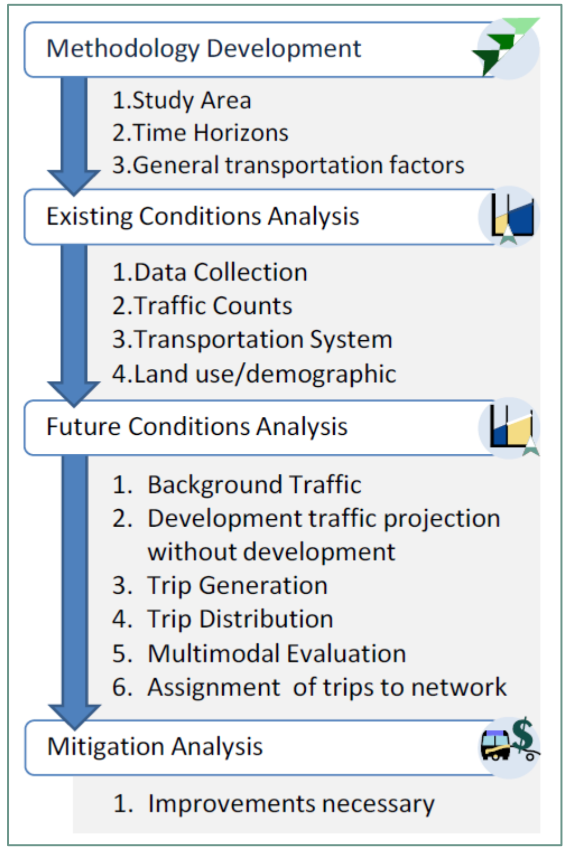
A number of additional reasons for FDOT to perform transportation impact reviews listed in the *Transportation Site Impact Handbook* include:

- To provide public agencies with a mechanism for managing transportation impacts of land development within the context of metropolitan transportation planning, local government comprehensive planning, and concurrency
- Provide applicants with recommendations for effective site transportation planning

- Provide public agencies with a method for analyzing the effects of development on transportation
- Establish a framework for the negotiation of mitigation measures for the impacts created by development
- Coordinate with local governments when a state facility will be impacted by a proposed development
- Promote multimodal transportation systems where appropriate

By understanding the current conditions of the roadway network, as well as the projected traffic impacts of anticipated development, FDOT can more effectively plan for and manage growth throughout the state.

The Applications Guide will focus on the "Methodology" and the "Future Conditions Analysis" components of the process.



2. Case Study A – Traffic Impact Analysis for New Use

2.1. Study Overview and Key Concepts

The following case study outlines a Traffic Impact Analysis completed for two proposed restaurants on the site of an existing underutilized surface parking lot in an urbanized area. Key concepts addressed in this study include:

- Trip Generation Rates
- Pass-By
- Trip Assignment
- Intersection Analysis

Table 2-1: Case Study A Summary

Study Type	Traffic Impact Analysis for New Use
Proposed Land Use(s)	High-Turnover (Sit-Down) Restaurant Coffee/Donut Shop with Drive-Through Window
Study Area Determination	Decision by City Staff
Intersections Analyzed	4
Access Driveways	2
Study Period(s)	AM Peak Hour Midday Peak Hour PM Peak Hour
Pass-By Rate / Determination	50% (Based on Available ITE Rates and Professional Judgement)
Internal Capture	-
Modal Split	-
Net New Trips	119 AM 149 Midday* 57 PM*
Existing Site Trip Reduction	-
Distribution Method	Site Access Professional Judgement
Background Growth	1% (Based on Input from City Staff and Surrounding Development)*
Scenarios	Existing Conditions (2015) Background Conditions (2017) Buildout Conditions (2017)

*Items marked with an asterisk are provided for context only and are not discussed in detail in the Case Study

2.2. Trip Generation

Overview

Trip generation refers to the number of one-way trips expected to travel to or from each land use within the proposed project during the time period(s) of interest. The most widely recognized and comprehensive report of vehicle trip generation data is ITE's *Trip Generation Manual*. It includes a very large collection of vehicle count data collected over several decades for a variety of land uses. All data included in the manual represents *vehicle* trip generation rather than *person* trip generation. Additionally, most data within the manual was collected in suburban settings with free parking and limited transit service, and adjustments are often necessary to estimate vehicle trip generation characteristics in more urban settings which often have greater potential for pedestrian, bicycle, and transit trips.

Chapter 2 of the *Transportation Site Impact Handbook* (TSIH) provides a more detailed breakdown of how to use the data contained within the *Trip Generation Manual*. The TSIH also provides several suggestions to consider when using the manual:

- When selecting the most appropriate land use for the study, read the land use description which describes where and when the sites were studied, and other land uses that might be contained within the trip generation equation (such as restaurants or bars in the "Hotel" use)
- Consider the number of data points available as some land uses have a very limited amount of data
- Consider the area context, particularly when applying suburban trip generation equations to urban settings
- Consider if travel patterns related to the land use have evolved over time (such as drive-through banks due to online banking)
- When practical, consider collecting or obtaining local data

Case Study

For the proposed site, trip generation average rates from *Trip Generation, 9th Edition* were used, as described in the following table.

Table 2-2: Trip Generation Rates

Land Use	Land Use Code	Independent Variable(s)	Average Rate	Range of Site Sizes	Method Used
AM					
High-Turnover (Sit-Down) Restaurant	932	1,000 ft^2 GFA	10.81	2,800 to 11,200 ft^2	Average Rate
Coffee/Donut Shop with Drive-Through Window	937	1,000 ft^2 GFA	100.58	400 to 5,400 ft^2	Average Rate
MIDDAY					
High-Turnover (Sit-Down) Restaurant	932	1,000 ft^2 GFA	25.61	(No Midday Rate)	PM Average Rate * 2.6
Coffee/Donut Shop with Drive-Through Window	937	1,000 ft^2 GFA	111.28	(No Midday Rate)	PM Average Rate * 2.6
PM					
High-Turnover (Sit-Down) Restaurant	932	1,000 ft^2 GFA	9.85	800 to 13,400 ft^2	Average Rate
Coffee/Donut Shop with Drive-Through Window	937	1,000 ft^2 GFA	42.80	400 to 5,400 ft^2	Average Rate

Trip Generation Rates: In many cases, a directly applicable rate is not available. In these cases, you should recommend an approach and clearly document the justification for the approach used.

No midday rates were available for either of the land use codes. However, page 1,911 of *Trip Generation, 9th Edition* states that approximately 14.65% of daily trips occur during the midday peak hour for fast-food restaurants, Land Use Code (LUC) 934, compared to 5.55% each hour between 4 and 6 p.m. This suggests that the trip generation rate for restaurants that serve both lunch and dinner may have a midday trip generation rate that is 2.6 times higher than the PM rate.

When applying offline adjustments, it is expected that a reasonableness check should be performed. In this case, depending on the type of high-turnover sit-down restaurant, it is reasonable to assume that the lunch peak may be the highest trip generator during the day. While a coffee/donut shop often peaks in the morning, the similar midday and AM rates in this case may be a reasonable, if somewhat conservative, assumption.

2.2.1. Pass-By Traffic

Overview

Many retail and convenience-oriented land uses such as gas stations and coffee shops tend to seek out heavily traveled corridors so that customers can simply "stop in" on the way to their primary destination. As discussed in **Section 2.4** of the TSIH, when estimating the potential amount of traffic added to the roadway network surrounding a proposed site that includes retail uses, it is important to take this effect into account. These "pass-by" trips are already on the roadway network under existing conditions and will not impact intersection operations (other than shifting turning movement percentages if medians restrict direct site access). ITE's *Trip Generation Handbook* provides recommended pass-by percentages for a variety of land uses including shopping centers, supermarkets, gas stations, banks, and restaurants.

Diverted trips are similar to pass-by trips, except that they would need to *divert* from their original path in order to access a roadway adjacent to the site. For example, a gas station near a freeway interchange is likely to draw a significant percentage of trips diverted from the freeway. Diverted trips are not new to the overall system, but depending on the size of the study area, they are typically new to the study area. In most cases, attempting to account for diverted trips presents an unnecessary complication in the analysis. For cases in which a heavily traveled corridor is 1) within the study area, 2) not immediately adjacent to the site, and 3) expected to serve as the source for a number of retail trips, accounting for diverted trips may be a useful exercise. In most other cases, separating diverted trips from new trips is not necessary.

Pass-By Rates: As with trip generation rates, pass-by rates are not always available for every land use or time of day. If there is reasonable justification for applying pass-by, the approach should be documented clearly.

Case Study

Pass-by data was not available for all time periods for both uses within ITE's *Trip Generation Handbook,* 3rd Edition, so a rate was developed based on the available data shown below.

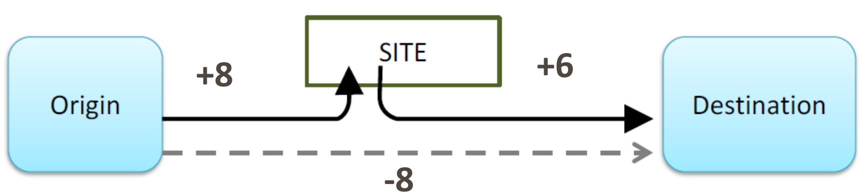
Table 2-3: Pass-By Percentages

ITE Land Use	AM	Midday	PM
High-Turnover (Sit-Down) Restaurant (932)	-	-	43%
Fast-Food Restaurant with Drive-Through Window (934)	49%	-	50%
Coffee/Donut Shop with Drive-Through Window (937)	-	-	-
Coffee/Donut Shop with Drive-Through Window and No Indoor Seating (938)	83%	83%	83%

As shown, no data was available for Land Use Code 937, and only the PM rate was available for Land Use Code 932. **A single rate of 50% was applied** to the full site, which is similar to the typical rate for a fast-food restaurant.

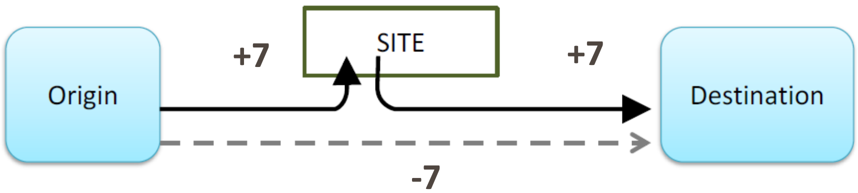
As noted in the introduction, pass-by trips are only applicable to retail-related land uses, which typically have an inbound/outbound split close to 50 percent (in other words, a nearly equal number of inbound and outbound trips each hour). Because of this, it is typically advisable to calculate pass-by trips assuming an equal number of inbound and outbound trips rather than tracking a slightly different number of inbound and outbound pass-by trips through the network. The example below helps to demonstrate the benefits of balancing pass-by trips:

Unequal Number of Inbound and Outbound Pass-By Trips:



In this case, *negative* two trips must be tracked through the rest of the study area network to ensure balance.

Equal Number of Inbound and Outbound Pass-By Trips:



With an equal number of inbound and outbound trips, balance is typically achieved at the site driveways.

The AM peak hour trip generation summary for the proposed site are shown in the following table.

Table 2-4: AM Trip Generation

				Trip Generation				Pass-By				Net New Trips		
Land Use	**ITE Code**	**Units**	**Enter (%)**	**Exit (%)**	**Enter (Trips)**	**Exit (Trips)**	**External Trips**	**Pass-By (%)**	**Enter (Trips)**	**Exit (Trips)**	**Pass-By (Trips)**	**Enter (Trips)**	**Exit (Trips)**	**Total (Trips)**
High-Turnover (Sit-Down)	932	2.5k ft^2	55%	45%	15	12	27	50%	7	7	14	8	5	**13**
Coffee/Donut Shop with Drive-Thru[1]	937	2.1k ft^2	51%	49%	108	104	212	50%	53	53	106	55	51	**106**
[1]Using trip generation average					**123**	**116**	**239**		**60**	**60**	**120**	**63**	**56**	**119**

2.2.1.1. 10% OF ADJACENT STREET TRAFFIC

As a general guideline, the number of pass-by trips assumed for a site should not exceed 10% of the adjacent street traffic. To check this, the calculated number of pass-by trips should be compared to two-way volume on the roadway(s) adjacent to the project site for each analysis hour.

For sites with access to two roadways, in some cases the two-way volumes for the adjacent streets may be combined, but vehicles that use both roadways should be subtracted from the total before making the comparison. In the example below, the total adjacent street traffic used in the comparison should be calculated as follows:

Pass-By Trips: In general, total pass-by trips should not exceed 10 percent of the adjacent street volume. When the development is served by two or more adjacent streets, if the calculated number of pass-by trips exceeds 10 percent of the traffic on the *highest volume* adjacent street, it is good practice to confirm with the reviewing agencies if combining traffic on two streets is an acceptable approach before making the comparison.

■ North-South Roadway:	1,396 + 1,153	2,549
		+
■ East-West Roadway:	1,186 + 1,793	2,979
		-
■ Shared Volume:	122 + 137	259
■ Combined Two-Way Volume for Comparison	=	5,269

Based on this volume, **no more than 530 pass-by trips** should be assumed for the analysis (10% of 5,269). In this case, the assumed number of pass-by trips (120) is less than 10% of the adjacent roadway volumes, so no adjustments are necessary.

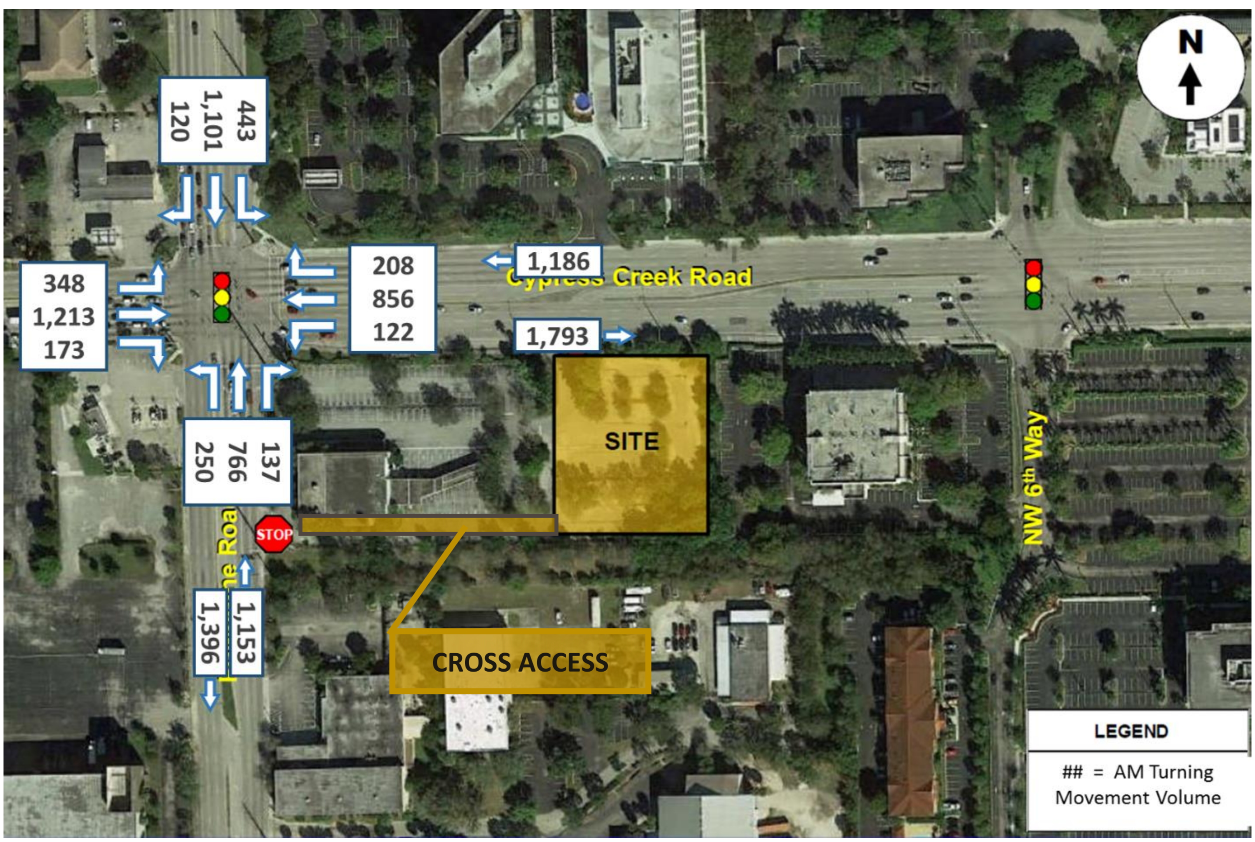


Figure 2-1: Pass-By 10 Percent Check

2.3. Trip Distribution

Overview

Trip distribution refers to the anticipated origins and destination of new trips to and from the proposed site. In some cases, an existing travel demand model can be used as a tool to estimate trip distribution. Using travel demand models for trip distribution purposes is described in Section 2.5 of the *TSIH*, and the Case Study in **Chapter 3** presents the results of a trip distribution exercise using a travel demand model.

Distribution: As a key study assumption, it is good practice to ensure reviewing agencies approve of the methodology and assumptions used.

For small sites or areas where application of a travel demand model is infeasible, a variety of manual distribution methods may be applied (as discussed in Section 2.6 of the *TSIH*). Some commonly applied approaches include:

- Existing local travel patterns
  - Existing traffic count and turning movement data will often provide a good indication of reasonable site distribution when the proposed site fits in with the surrounding land uses
- Nearby existing and proposed land uses (including type and density) that will serve as likely origins and destinations for site trips
  - This method is more applicable for retail uses that are intended to serve neighborhoods within a few miles of the site; new residential and employment centers will tend to be more closely tied to regional commuter patterns than surrounding land uses
- Regional corridor traffic volumes
  - Many residential and employment centers will have distribution patterns that heavily favor trips to and from roadways that provide best access to the major regional corridors
- Driveway counts from a nearby similar site
  - Similar sites located in the same area will often exhibit similar trip distribution characteristics
- Data collection or surveys
  - License plate origin-destination studies, driver response surveys, or home zip code studies

Case Study

For the proposed restaurant and coffee shop, distribution of trips to and from the site was determined *manually,* based on **knowledge of the local network**, **current traffic volumes**, and **discussion with City staff**. The following general assumptions were made:

- 20% to and from the north
- 15% to and from the south
- 30% to and from the east
- 35% to and from the west

The trip distribution percentages for the site are provided in the following figure:

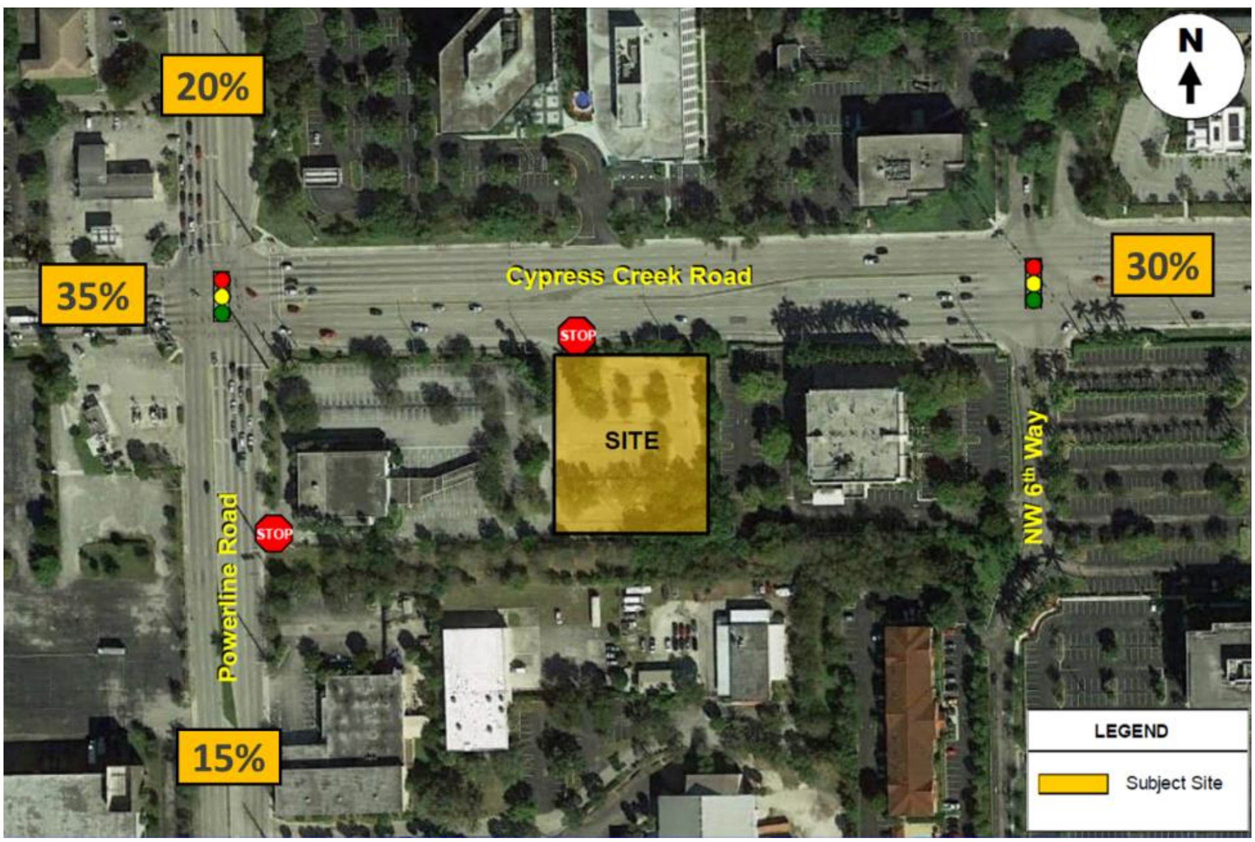


Figure 2-2: Trip Distribution

2.4. Traffic Assignment

Overview

While trip distribution identifies the general origin and destination of site trips, trip *assignment* refers to the process of determining the amount of traffic that will use each potential route. When the site includes a single full access driveway, the task of assigning traffic to the network may be a straightforward exercise. Multiple driveways, access control, one-way streets, and nearby regional facilities all add variability to driver decision-making, often requiring the development of multiple paths for each origin/destination pair.

Section 2.8 of the TSIH identifies several influencing factors to consider when assigning traffic to the local network:

- Driver tendencies and local behavior (such as the percentage of drivers who choose the first available driveway when multiple options exist, and whether the use will draw local, daily users or regional drivers who are not likely to be familiar with the network)
- Internal circulation design (outbound trips tend to be more evenly distributed among multiple exists compared to inbound trips)
- Congestion and travel times by time of day (drivers familiar with the area may consider avoid a congested left turn, for example)
- Planned network improvements that could modify assignment in one or more horizon years
- One-way street or other factors that would lead to different inbound and outbound paths

Case Study

2.4.1. New Site Trip Assignment

Given the driveway configuration for this site, trips were generally assigned to the closest driveway, with some allowance for outbound trips making U-turns at the adjacent signals. For example, trips departing to the west were split between the north driveway (5%) requiring a U-turn at the signal to the east, and the west driveway (30%) with a left at the next signal.

Trip Assignment: When assigning trips to a traffic network, it is advisable to create separate figures for pass-by trip assignment and new site trip assignment.

Additionally, because southbound trips are not able to access the site from the north-south roadway, trips from the north (including pass-by trips) were routed to the east-west roadway to access the site.

Based on these assumptions, a figure showing the percentage distribution of new site trips through the network was developed first, as shown in **Figure 2-3**. These percentages were then converted to hourly trips by multiplying each percentage by the total number of inbound and outbound trips, rounding to the nearest vehicle. Due to rounding, it is good practice to balance site trips through the network as well as confirm the total number of inbound and outbound trips matches expectations. Note that software packages that automatically assign traffic to the network (such as Synchro 9) often do not balance site trips, leading to the occasional "lost" site trip.

The final calculated trip assignment for the AM peak hour is shown in **Figure 2-4.**

Note: Trip assignment for the midday and PM peak hours are note show in this example, but may be calculated by applying the net new trips by the percentages shown in ***Figure 2-3****.*

Figure 2-3: Distribution of New Site Trips by Movement

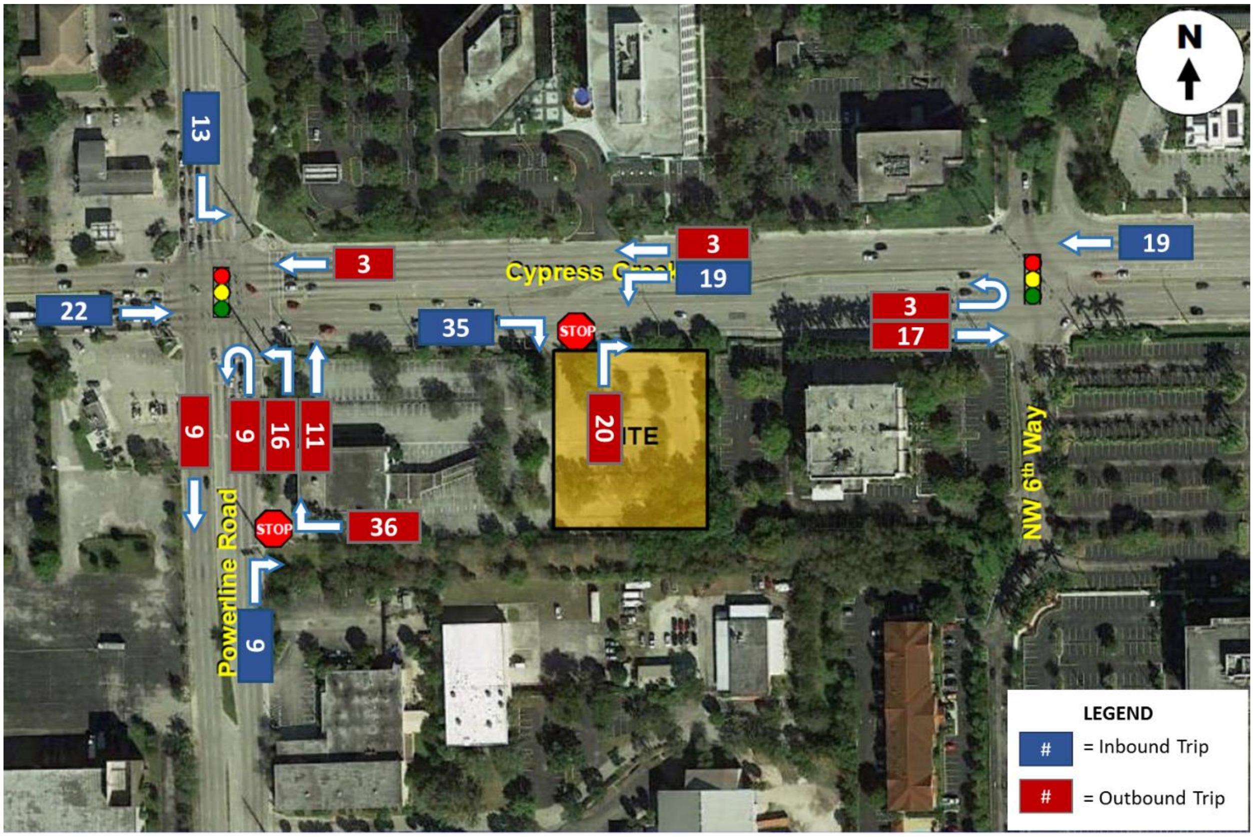


Figure 2-4: Site Trip Assignment (AM Trips)

2.4.2. Pass-By Trip Assignment

Pass-by trips are assigned to the network by removing trips from the mainline through movement, adding them to a turning movement entering the site, then adding them to a turning movement exiting the site in the vehicle's original direction of travel. The assignment of pass-by trips differs from the assignment of new site trips in two significant ways:

- No new trips are added to the network; rather, existing trips are rerouted to and from the site resulting in no net change in trips on the roadway network
- Whereas new site trips are returned in the direction of their *origin* when exiting the site, pass-by trips are routed in the direction of their original *destination* (i.e. returned to their original direction of travel)

An example of pass-by trip assignment for the AM peak hour is provided in **Figure 2-5**. For illustrative purposes, groups of pass-by trips are indicated by different colored boxes.

Pass-By Trip Assignment: Pass-By trips should be analyzed carefully. The assignment should consider the unique turn movement patterns of pass-by trips and should account for the subtraction of existing turn movements related to the pass-by trips that are no longer made. Note that unlike primary trips, the outbound segment of pass-by trips should *continue in the original direction of travel*.

Figure 2-5: Pass-By Trip Assignment

For the simple pass-by assignments shown in the purple and green colored boxes, trips are removed from the through movement, relocated to the turning movement into the site, and then added to the turning movement departing the site in the original direction travel.

The blue and peach colored boxes demonstrate a slightly more complex pass-by assignment. Due to the right-out only restriction at the site driveways, these trips must be routed to the nearest signal to make a U-turn in order to return them back in their original direction of travel.

Note that every inbound movement includes an equivalent outbound movement. As discussed previously, this allows for network balance and avoids the complication of tracking a small number of negative or positive trips through the local network.

2.5. Traffic Operations Analysis

2.5.1. Intersection Analysis

Overview

Intersection analysis can vary in complexity based on the modeling method selected. More simple macroscopic modeling platforms such as HCS and Synchro typically take less time and inputs, but may not analyze certain roadway/intersection configurations nor provide as robust of results as a more complex microscopic simulation platform, such as VISSIM and AIMSUN. Microscopic simulation models are typically able to produce more measures of effectiveness than their simpler macroscopic counterparts.

The level of detail that's required to be analyzed may also vary between projects and reviewing agencies. Delay and Level of Service (LOS) may be reported on an intersection-by-intersection basis, by approach, or by movement. A queueing analysis may be required by movement, especially in areas with tightly-spaced intersections and driveways.

The modeling software that will be used in an analysis and the measures of effectiveness that will be reported should always be agreed upon with the reviewing agency before beginning analysis.

Case Study

Synchro software was used to analyze background and buildout conditions at each of the study area intersections. Each intersection was compared using the following measures:

- Average Intersection Delay & LOS
    - For the side-street stop controlled intersections, only the side street delay is reported
    - LOS E and LOS F are typically considered unacceptable and require mitigation; however, this may vary based on the reviewing agency

Delay and LOS results from the study are shown in **Table 2-5**.

Table 2-5: Delay and LOS Results

Intersection	Control	Analysis Level	Time	2015 Existing		2017 No Build		2017 Build	
				Delay	LOS	Delay	LOS	Delay	LOS
Cypress Creek Road & Powerline Road	Signal	Intersection	AM	**73.4**	**E**	**80.9**	**F**	**85.2**	**F**
			Mid	**74.6**	**E**	**78.2**	**E**	**83.8**	**F**
			PM	**92.3**	**F**	**95.1**	**F**	**97.2**	**F**
Cypress Creek Road & NW 6th Way	Signal	Inter-section	AM	37.4	D	37.3	D	37.4	D
			Mid	36.0	D	38.1	D	39.1	D
			PM	45.7	D	45.8	D	45.9	D
Powerline Road & Bank Driveway	Stop	Westbound Approach	AM	17.9	C	18.3	C	26.3	D
			Mid	19.3	C	19.7	C	**36.3**	**E**
			PM	21.4	C	22.1	C	27.7	D
Cypress Creek Road & Bank Driveway	Stop	Northbound Approach	AM	25.7	D	26.7	D	**38.3**	**E**
			Mid	17.8	C	18.2	C	21.1	C
			PM	25.1	D	26.3	D	29.2	D
		Westbound Left	AM	< 1.0	A	< 1.0	A	3.9	A
			Mi	< 1.0	A	< 1.0	A	1.8	A
			PM	< 1.0	A	< 1.0	A	< 1.0	A

2.5.1. Driveway Analysis

Driveway operations were also evaluated based on a queuing analysis for the drive-thru restaurant:

- On-Site Queuing Analysis
  - The drive-thru lane was determined to provide queue space for approximately 11 vehicles, which is consistent with the recommendations provided in ITE's *Transportation and Land Development, 2nd Edition*
  - Result: *Queuing for 11 vehicles is sufficient to avoid impacting driveway operations*

2.6. Mitigation

Overview

Mitigation is required at locations that are found to operate unacceptably. Agencies set their own criteria for unacceptable operations, and these may vary by agency type and geographic location. Movements or intersections that exceed the threshold set by the reviewing agency require mitigation strategies to improve their operations to within the acceptable range.

Typically, individual turning movements or overall intersections operating at LOS E or LOS F are considered to operate unacceptably, and require mitigation. When analyzing queueing, movements that are expected to produce queues that spill back into the upstream intersection, queues that block turn lanes, or queues that create vehicle spillback out of a turn lane typically require mitigation. Mitigation strategies for locations that are determined to operate unacceptably should be discussed with the reviewing agency.

When a local government implements transportation concurrency, Florida's legislature provides guidance on the cost responsibility of developers for mitigation measures in House Bill (HB) 7202, lines 3566-3584. This section explains that when trips from a proposed development cause a deficiency, the proportionate share contribution shall be calculated using the formula below. However, if any road is determined to have a deficiency without the project traffic, the improvements necessary to correct the deficiency is the funding responsibility of the entity which maintains the roadway, and the costs to correct that deficiency shall be removed from the project's proportionate-share calculation. The development's proportionate share is then based only on the needed transportation improvements that are greater than the identified deficiency with the necessary improvements in place.

Site Access and Internal Circulation: A review of the proposed site plan should be included in all transportation impact analyses. Key operational and multimodal considerations should be addressed, such as potential sources of delay for inbound vehicles, or on-side queues.

$$\text{Proportionate Share Contribution} = \text{Construction cost of the improvement to maintain or achieve the adopted LOS} \times \frac{\text{Number of trips from the proposed development expected to reach roadways during the peak hour from the stage or phase being approved}}{\text{Change in the peak hour maximum service volume of roadways resulting from construction of an improvement necessary to maintain or achieve the adopted LOS}}$$

Case Study

In this case study, although LOS F operations were identified at one intersection, it was determined that the deficiencies of this intersection will be addressed as part of the County’s Transit Oriented Concurrency system.

Additionally, although LOS E can be expected for each driveway during at least one peak period, this was deemed acceptable as queuing would be contained on site.

No mitigation measures were recommended as part of the study.

3. Case Study B – Traffic Impact Analysis for Redevelopment

3.1. Study Overview and Key Concepts

The following example outlines a Traffic Impact Analysis completed for a proposed mixed commercial development on the site of an existing hotel and commercial site. Key concepts addressed in this study include:

- Study Area Determination
- Trip Generation
- Trip Distribution
- Segment Analysis
- Site Access and Internal Circulation

Table 3-1: Case Study B Summary

Study Type	Traffic Impact Analysis for Redevelopment
Proposed Land Use(s)	Convenience Market with Gasoline Pumps Shopping Center High-Turnover (Sit-Down) Restaurant Fast-Food Restaurant with Drive-Through Window
Study Area Determination	2.5% Significance Test
Roadway Segments Analyzed	5
Intersections Analyzed	2
Access Driveways	3
Study Period(s)	AM Peak Hour PM Peak Hour
Pass-By	77% AM / 77% PM - Convenience Market (FDOT Recommendation) 0% AM / 34% PM - Shopping Center(ITE) 0% AM / 43% PM - Restaurant (ITE) 49% AM / 50% PM - Fast Food (ITE)
Internal Capture	-
Modal Split	-
Net New Trips	297 AM 301 PM
Existing Site Trip Reduction	-
Distribution Method	FSUTMS OUATS Site Access Professional Judgement
Background Growth	2% (Based on Historical Traffic Volumes and Professional Judgement)
Scenarios	Existing Conditions (2015) Background Conditions (2017) Buildout Conditions (2017)

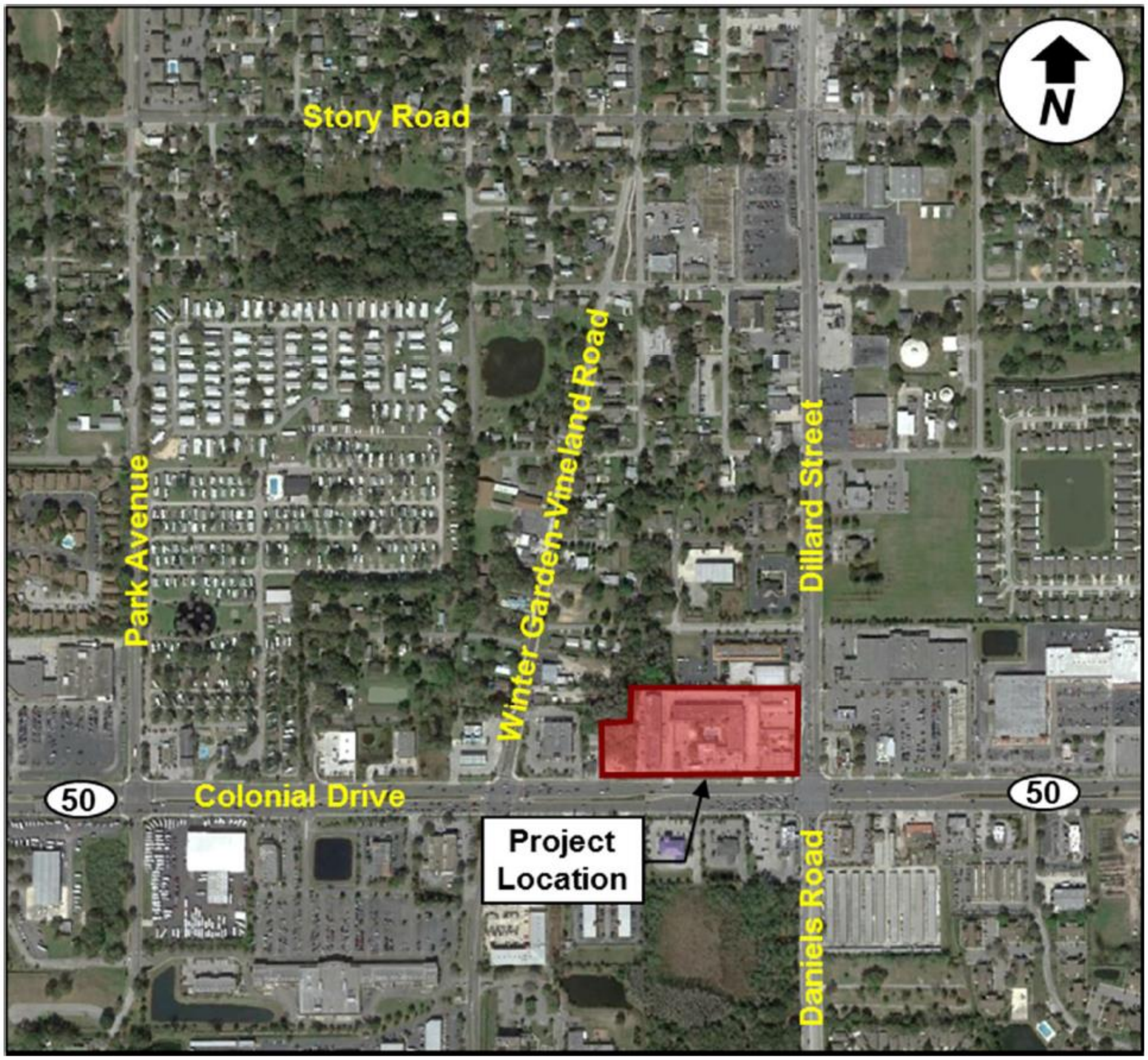


Figure 3-1: Project Location Map

3.2. Study Area

Overview

The process for determining the study area for a traffic analysis often varies depending on the reviewing agency. In some cases, the study area will be pre-determined by the reviewing agency. A set of criteria may be defined by a reviewing agency to guide the determination of the study area. As discussed in Section 2.2.1 of the *TSIH*, examples of criteria used to define a study area include the following:

Study Area: Even when a local agency has a defined procedure in place to determine the size of the study area, it is always good practice to ensure participating agencies agree with the proposed scope and study area before proceeding with the analysis.

- Include all roadways where projected site traffic is equal or greater than X percent of the maximum service volume at the adopted LOS standard for the facility
- Depending on the anticipated number of trips generated by the site, all roadways within a radius of X miles must be included in the analysis

Case Study

The study area for this analysis was determined based on criteria defined by the local reviewing agency. As a starting point, it was determined that roadways where development traffic would make up **2.5 percent or more of the maximum service volume at the adopted level-of-service standard** during either the AM or PM peak hour would be included in the analysis.

Because the determination of the study area is dependent on trip generation, trip distribution, and assignment, those steps were performed first, as discussed in the following sections.

3.3. Trip Generation

Overview

Shopping Centers: Land Use Code 820 generally refers to a large, integrated group of commercial establishments based on studies of sites with an average size of 300,000 square feet. Caution should be used when applying this trip generation rate to small retail buildings. As shown in the table below, when the PM peak trip generation *equation* for Shopping Centers is applied to small retail buildings, the effective trip generate rate tends to be conservative when compared to potential uses for these buildings.

As discussed in Section 2.4.2. of the *TSIH*, many land uses in ITE's *Trip Generation* includes two options for estimating peak hour or daily trips: average trip generation *rates* as well as trip generation *equations*. In general, trip generation *equations*, when available, tend to reflect a decreasing trip rate as building size increases.

ITE's *Trip Generation Handbook* provides detailed guidance on when the average rate or the fitted equation should be used (or neither, as may be the cases when fewer than six data points are available, or when no data is available for the general size of the study site). In general, however, the fitted curve equation should be used when one of the following conditions are satisfied:

- There are at least 20 data points distributed over the range of values typically found for the independent value **AND** the line corresponding to the fitted curve equation is within the cluster of data points near the size of the study site
- The R^2 for the fitted curve equation is ≥ 0.75 **AND** the line corresponding to the fitted curve equation is within the cluster of data points near the size of the study area

Care should also be taken when using the average rate, particularly when the number of data points is small or when the standard deviation listed is more than 55 percent of the average rate. In these cases, it may be necessary to select a different independent variable or collect local data.

Case Study
In this example, the existing site includes a hotel, gas station, restaurant, and office building. The calculated trip generation from these uses was approximately 4,100 daily trips. However, at the time of data collection most of these uses were closed, so no adjustments were made to the existing counts.

> *Had the uses been active at time of data collection, it would be reasonable to obtain counts at the driveways and subtract these trips from the future year build condition.*

The proposed site includes a convenience market (with gas pumps), a small retail building (8,400 ft^2) with no specific use identified, a 5,745 ft^2 high-turnover (sit-down) restaurant, and a 7,526 ft^2 fast food restaurant with drive-thru window.

Table 3-2 summarizes the available trip generation rates and equations for each time period from ITE for the retail and restaurant uses as well as the method selected. For the convenience market with gas pumps, FDOT recommends using FDOT's own locally calibrated equation that includes both fueling positions as well as gross floor area of the convenience market as independent variables.

For the restaurant uses, no fitted curve equations were available and the average rate was selected. For the small retail building, the general "Shopping Center" land use category was selected in the absence of more specific information. However, at 8,400 ft^2, the proposed building is not within the range of site sizes for a typical shopping center. Rather than collect local data, the reviewing agencies agreed to using the *fitted curve equation* for the PM peak hour given the high R^2 value (0.81) and the heavily clustered data near the smallest Shopping Centers measured. For the AM peak hour, the average rate was selected due to the poor R^2 for the equation (0.56).

Table 3-2: Available Trip Generation Average Rates and Equations

Land Use	Land Use Code	Independent Variable(s)	Average Rate	Equation	R^2 for Equation	Range of Site Sizes	Method Used
AM							
Convenience Market with Gas Pumps	(FDOT)	FP and GFA	-	-	-	-	(80% of PM Peak)
Shopping Center	820	1,000 ft^2 GLA	0.96	**Ln(T) = 0.61 Ln(X) + 2.24**	0.56	1,700 to 1,500,000 ft^2	Average Rate
High-Turnover (Sit-Down) Restaurant	932	1,000 ft^2 GFA	**10.81**	-	-	2,800 to 11,200 ft^2	Average Rate
Fast-Food Restaurant with Drive-Through	934	1,000 ft^2 GFA	**45.42**	-	-	1,200 to 9,800 ft^2	Average Rate
PM							
Convenience Market with Gas Pumps	(FDOT)	FP and GFA	85.66 (kft^2) 17.09 (FP)	**12.3 x (FP) + 15.5 x (kft^2)**	0.88	10 to 24 FP, 2,500 to	Equation
Shopping Center	820	1,000 ft^2 GLA	3.71	**Ln(T) = 0.67 Ln(X) + 3.31**	0.81	1,700 to 2,200,000 ft^2	Equation
High-Turnover (Sit-Down) Restaurant	932	1,000 ft^2 GFA	**9.85**	-	-	800 to 13,400 ft^2	Average Rate
Fast-Food Restaurant with Drive-Through	934	1,000 ft^2 GFA	**32.65**	-	-	1,100 to 9,800 ft^2	Average Rate

GFA = Gross Floor Area
GLA = Gross Leasable Area
FP = Fueling Position

The resulting AM and PM peak hour trips are provided in **Table 3-3**.

Table 3-3: Trip Generation

Land Use	LUC	Size	Units	AM			PM		
				In	Out	Total	In	Out	Total
Convenience Market	FDOT	6.119 16	1,000 ft^2 Fueling	119	114	**233**	149	143	**292**
Shopping Center	820	8.400	1,000 ft^2	5	3	**8**	55	59	**114**
High-Turnover (Sit-Down)	932	5.745	1,000 ft^2	34	28	**62**	34	23	**57**
Fast Food w/ Drive-Through	934	7.526	1,000 ft^2	174	168	**342**	128	118	**246**
				332	**313**	**645**	**366**	**343**	**709**

Shopping Centers and Internal Capture: ITE's Land Use Code 820 ("Shopping Center") generally refers to a large, integrated group of commercial establishments based on studies of sites with an average size of 300,000 square feet. Internal capture is typically not applied to shopping centers because shopping center data was collected for the entire site, often including other uses such as restaurants and theaters. For large sites with significant retail component and supporting restaurants, it is often reasonable to combine them together and calculate the trip generation for the entire site using Land Use Code 820.

In this case, however, the restaurants make up a more significant portion of the site than the small retail building, indicating that the site is not representative of a typical "Shopping Center." As such, all trips were calculated independently for each use.

As noted in this example, caution should be used when applying the "Shopping Center" land use rates and equations to small retail buildings. In fact, ITE does not recommend applying rates or equations to sites that fall outside of the range of data. However, as shown in the following figure, when the PM peak trip generation *equation* for Shopping Centers is applied to small retail buildings, the effective trip generation rate tends to be conservative when compared to the average rate for potential uses for buildings of this size. In other words, applying the trip generation equation for a shopping center to a small retail building is likely to *overestimate* trips, which may be an acceptable approach when the specific use is unknown.

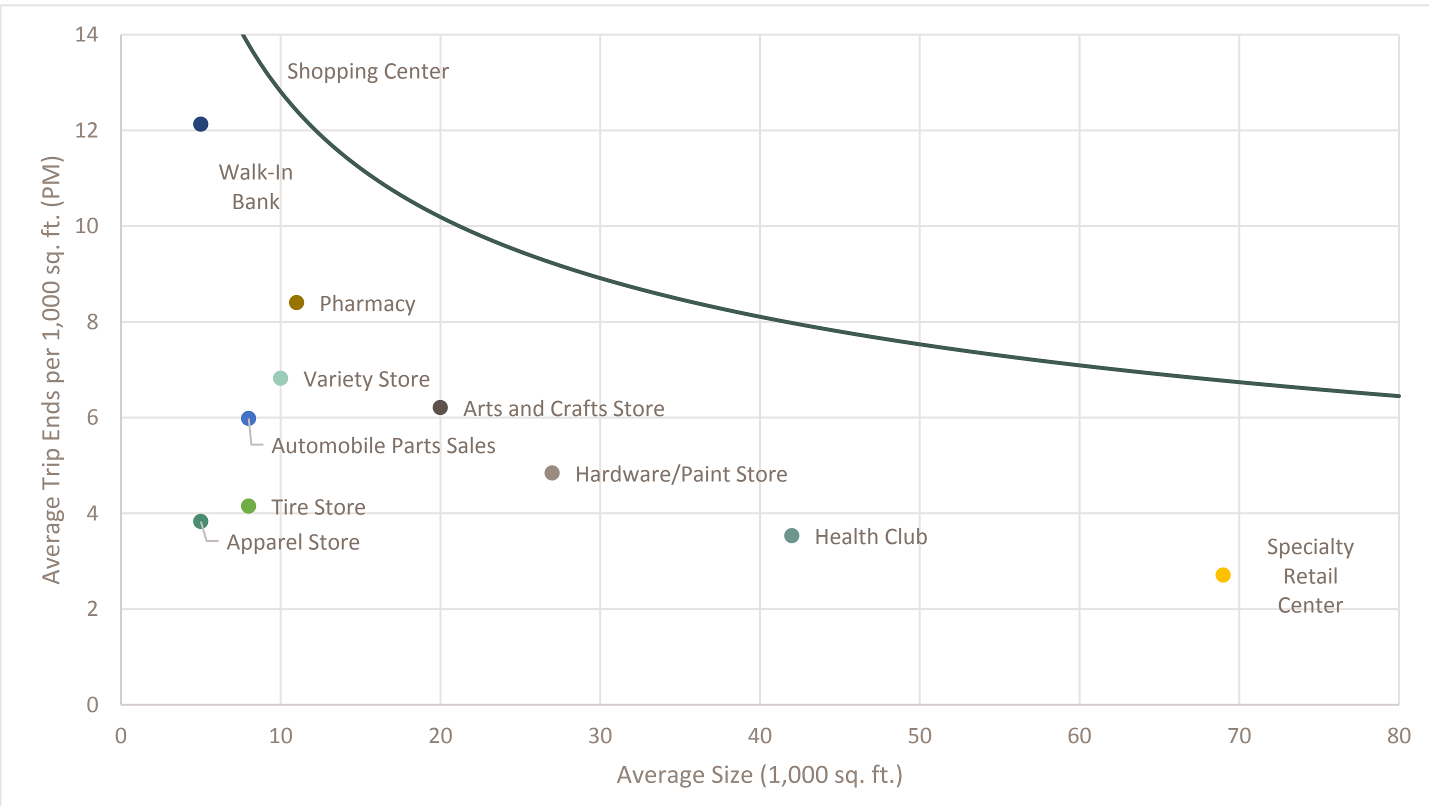


Figure 3-2: Comparison of Shopping Center Trip Generation Equation to Average Rates for Typical Retail Uses

3.3.1. Pass-By Traffic

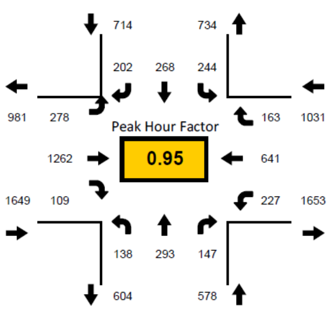
Pass-by rates were determined from the 3rd Edition of ITE's *Trip Generation Handbook*. Note that pass-by trips were split evenly between entering and exiting trips for the reasons discussed in **Case Study A**.

Table 3-4: Pass-By Trips

Land Use	Pass-By Percentage		AM Pass-By Trips			PM Pass-By Trips		
	AM	PM	In	Out	Total	In	Out	Total
Convenience Market	77%	77%	90	90	**180**	112	112	**224**
Shopping Center	-	34%	-	-	-	19	19	**38**
High-Turnover (Sit-Down)	-	43%	-	-	-	12	12	**24**
Fast Food w/ Drive-Through	49%	50%	84	84	**168**	61	61	**122**
		Pass-By Trips:	**174**	**174**	**348**	**204**	**204**	**408**
		Net New:	**158**	**139**	**297**	**162**	**139**	**301**

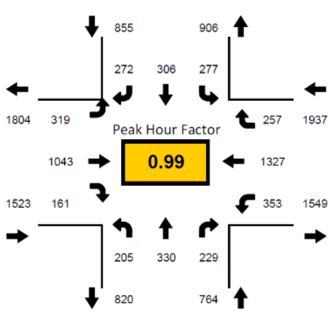
Following the preliminary calculation of pass-by trips, the following AM and PM peak hour checks were performed.

AM



- 348 total pass-by trips
  - North-South Roadway: 714 + 734 — 1,448
  - +
  - East-West Roadway: 981 + 1,649 — 2,630
  - -
  - Shared Volume: 278 + 202 — 480
- Combined Two-Way Volume for Comparison = 3,598
- **Result: 9.7% → OK (Less than 10%)**

PM



- 408 total pass-by trips
  - North-South Roadway: 855 + 906 — 1,761
  - +
  - East-West Roadway: 1,523 + 1,804 — 3,327
  - -
  - Shared Volume: 319 + 272 — 591
- Combined Two-Way Volume for Comparison = 4,497
- **Result: 9.1% → OK (Less than 10%)**

3.4. Trip Distribution and Assignment

Overview

As discussed in **Case Study A** and Section 2.6 of the *TSIH*, trip distribution and assignment may be performed using one of many *manual methods*, or, alternatively, by using a *travel demand model.* Refer to **Case Study A** for a discussion of manual methods. The following case study describes the use of a travel demand model to assist with trip distribution and assignment.

Case Study

The local version of the Florida Standard Urban Transportation Model Structure (FSUTMS) was used to obtain initial estimates for overall site trip distribution and roadway assignment percentages. To accomplish this, a transportation analysis zone (TAZ) including employment numbers to approximately represent the development was added to the network, and a select zone analysis was performed to obtain the percentage of trips assigned to each of the surrounding links. Adjustments were then made to the model to account for programmed and committed future changes to the roadway network on Dillard Street. Additionally, minor adjustments to the model were made to account for changes in driveway access and expected local assignment patterns.

Figure 3-3 shows the resulting trip assignment percentages and **Figure 3-4** shows the driveway assignment percentages, based on the assumption of a 60/40 split between the eastern and western driveways on SR 50, respectively.

Use of a Demand Model for Trip Distribution: Using a travel demand model to serve as a guide for the manual distribution of trips through the network is typically an acceptable approach. It is important to note that this approach should not be confused with a "With or Without" analysis, where total volumes on each link in the network are compared between two model runs. Page 78 of FDOT's Transportation Site Impact Handbook (2014) discusses why a "With or Without" analysis should not be used to estimate trips by link.

Accounting for Network and Land Use Changes: When using a travel demand model to aid with trip distribution, it is important to confirm that any nearby future developments or roadway changes are accounted for in future models in order to account for changes in travel behavior. Some level of professional judgement is typically used with the travel demand model results.

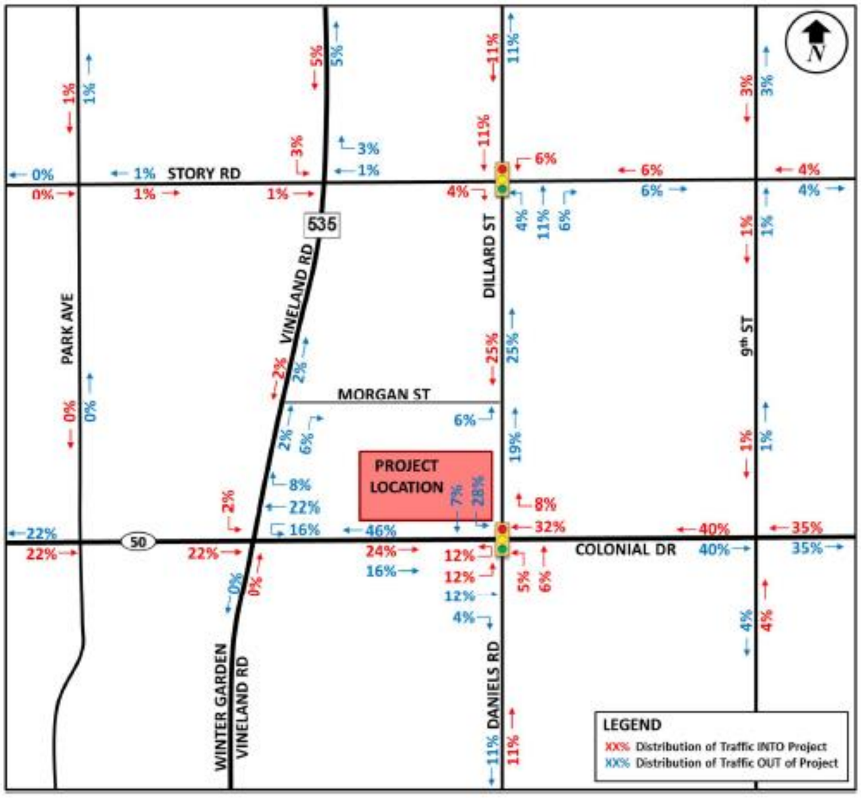


Figure 3-3: Trip Distribution (Percentages)

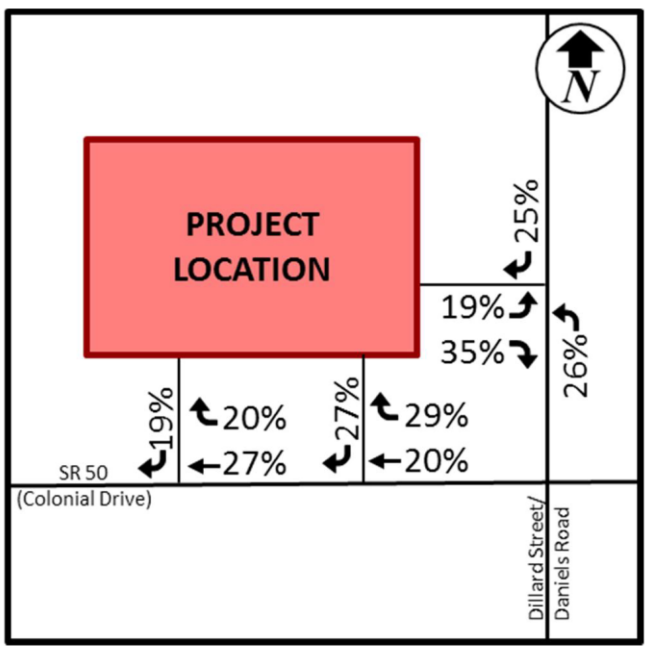


Figure 3-4: Trip Distribution at Project Driveways

3.5. Data Requirements

Overview

Operational analysis at individual intersections typically requires collecting *turning movement counts* at each study area intersection to be used as an input into the model. However, because overall traffic volumes vary week to week and month to month, it is necessary to make adjustments to any short term counts. As discussed in the **Q/LOS Handbook** as well as the **Project Traffic Forecasting Handbook**, two adjustment factors are commonly used for traffic studies:

- **Seasonal Factor (SF)**: The seasonal factor is used to adjust a 24-hour short traffic count to annual average daily traffic (AADT)
- **Peak Season Conversion Factor (PSCF)**: The PSCF is used to adjust a short traffic count to represent peak season traffic volumes, defined as the 13 consecutive weeks with the highest volumes

The process for adjusting traffic counts should be discussed with the reviewing agencies early in the process and clearly documented.

Case Study

3.5.1. Study Area

In order to determine the scope of the analysis and the need for traffic counts, the 2.5% significance test (discussed previously) was applied to both AM and PM peak hours. The results of the PM peak hour analysis are shown in **Table 3-5.**

Table 3-5: Site Trip Significance Test (PM Peak Hour)

Roadway Segment	No. of Lanes	PHPD Serv. Vol	Project Dist.		Project Dir.		Project Trips		% Signif.
			NB/ EB	SB/ WB	NB/ EB	SB/ WB	NB/ EB	SB/ WB	
9th Street									
SR 50/Colonial Drive to Story Road	2	713	1%	1%	out	In	1	2	0.30%
Story Road to SR 438/Plant Street	2	713	3%	3%	out	In	4	5	0.80%
CR 535/Winter Garden-Vineland Road									
Turnpike to SR 50/Colonial Drive	2	720	0%	0%	in	out	0	0	0.00%
Dillard Street/Daniels Road									
Roper Road to Beard Road	4	1,530	11%	11%	in	out	18	15	1.20%
Beard Road to SR 50/Colonial Drive	4	1,530	11%	11%	in	out	18	15	1.20%
SR 50/Colonial Drive to Project Entrance	4	1,530	14%	35%	in	out	23	49	3.30%
Project Entrance to SR 438/Plant Street	4	1,530	25%	25%	out	in	35	41	2.70%
Park Avenue									
SR 50/Colonial Drive to Story Road	2	560	0%	0%	out	in	0	0	0.00%
Story Road to SR 438/Plant Street	2	560	1%	1%	out	in	1	2	0.40%
SR 50/Colonial Drive									
Park Avenue to CR 535/Winter Garden-Vineland Road	6	3,171	22%	22%	in	out	36	31	1.20%
CR 535/Winter Garden-Vineland Road to Project	6	3,171	40%	47%	in/out	out	61	65	2.10%
Project Entrances to Dillard Street/Daniels Road	6	3,171	40%	49%	in/out	in	61	79	2.50%
Dillard Street/Daniels Road to 9th Street	6	3,171	40%	40%	out	in	56	65	2.10%
Story Road									
Western CL to Park Avenue	2	720	0%	0%	in	out	0	0	0.00%
Park Avenue to Dillard Street	2	720	4%	4%	in	out	6	6	0.90%
Dillard Street to 9th Street	2	720	6%	6%	out	in	8	10	1.40%
9th Street to Eastern CL	2	720	4%	4%	out	in	6	6	0.90%
Vineland Road/Main Street									
SR 50/Colonial Drive to SR 438/Plant Street	2	525	8%	5%	out	in	11	8	2.10%

Based on the **2.5% significance test** as well as **discussions with the City**, two adjacent roadways (including a total of 5 segments, shown in the table above) were selected for segment analysis.

Additionally, two signalized intersections along with all three site driveways were selected for intersection capacity analysis.

3.5.2. Data Collection

Counts were collected on a Tuesday in the first week of December. The counts were multiplied by a peak season conversion factor of **1.04** in order to estimate peak season operations, based on a review of county-wide data from the previous year. The weekly seasonal factors and peak season conversion factors for the county are shown in **Figure 3-5**.

Signal timing data was provided by the City.

2014 Peak Season Factor Category Report - Report Type: ALL
Category: 7500 ORANGE COUNTYWIDE

MOCF: 0.98

Week	Dates	SF	PSCF
1	01/01/2014 - 01/04/2014	1.01	1.03
2	01/05/2014 - 01/11/2014	1.03	1.05
3	01/12/2014 - 01/18/2014	1.05	1.07
4	01/19/2014 - 01/25/2014	1.04	1.06
5	01/26/2014 - 02/01/2014	1.03	1.05
6	02/02/2014 - 02/08/2014	1.01	1.03
7	02/09/2014 - 02/15/2014	1.00	1.02
8	02/16/2014 - 02/22/2014	0.99	1.01
9	02/23/2014 - 03/01/2014	0.99	1.01
*10	03/02/2014 - 03/08/2014	0.98	1.00
*11	03/09/2014 - 03/15/2014	0.98	1.00
*12	03/16/2014 - 03/22/2014	0.98	1.00
*13	03/23/2014 - 03/29/2014	0.98	1.00
*14	03/30/2014 - 04/05/2014	0.98	1.00
*15	04/06/2014 - 04/12/2014	0.98	1.00
*16	04/13/2014 - 04/19/2014	0.98	1.00
*17	04/20/2014 - 04/26/2014	0.98	1.00
*18	04/27/2014 - 05/03/2014	0.98	1.00
*19	05/04/2014 - 05/10/2014	0.99	1.01
*20	05/11/2014 - 05/17/2014	0.99	1.01
*21	05/18/2014 - 05/24/2014	0.99	1.01
*22	05/25/2014 - 05/31/2014	0.99	1.01
23	06/01/2014 - 06/07/2014	1.00	1.02
24	06/08/2014 - 06/14/2014	1.00	1.02
25	06/15/2014 - 06/21/2014	1.01	1.03
26	06/22/2014 - 06/28/2014	1.01	1.03
27	06/29/2014 - 07/05/2014	1.01	1.03
28	07/06/2014 - 07/12/2014	1.02	1.04
29	07/13/2014 - 07/19/2014	1.02	1.04
30	07/20/2014 - 07/26/2014	1.02	1.04
31	07/27/2014 - 08/02/2014	1.01	1.03
32	08/03/2014 - 08/09/2014	1.00	1.02
33	08/10/2014 - 08/16/2014	1.00	1.02
34	08/17/2014 - 08/23/2014	0.99	1.01
35	08/24/2014 - 08/30/2014	1.00	1.02
36	08/31/2014 - 09/06/2014	1.00	1.02
37	09/07/2014 - 09/13/2014	1.01	1.03
38	09/14/2014 - 09/20/2014	1.01	1.03
39	09/21/2014 - 09/27/2014	1.01	1.03
40	09/28/2014 - 10/04/2014	1.00	1.02
41	10/05/2014 - 10/11/2014	0.99	1.01
42	10/12/2014 - 10/18/2014	0.99	1.01
43	10/19/2014 - 10/25/2014	0.99	1.01
44	10/26/2014 - 11/01/2014	1.00	1.02
45	11/02/2014 - 11/08/2014	1.01	1.03
46	11/09/2014 - 11/15/2014	1.02	1.04
47	11/16/2014 - 11/22/2014	1.02	1.04
48	11/23/2014 - 11/29/2014	1.02	1.04
49	11/30/2014 - 12/06/2014	1.02	1.04
50	12/07/2014 - 12/13/2014	1.01	1.03
51	12/14/2014 - 12/20/2014	1.01	1.03
52	12/21/2014 - 12/27/2014	1.03	1.05
53	12/28/2014 - 12/31/2014	1.05	1.07

* Peak Season

Figure 3-5: Weekly Conversion Factors

3.1. Traffic Operations Analysis

Measures of Effectiveness: While LOS is the most commonly accepted measure of effectiveness, confirming the specific measures to be analyzed with reviewing agencies is recommended. Delay, queues, v/c, as well as the level of detail for each (by approach or by intersection) are all important considerations.

Overview

Analysis of future conditions determines if the transportation system will operate acceptably with the additional site-generated trips. If not, the analysis will help determine what mitigation may be required.

The *Q/LOS Handbook* discusses several tools for determining LOS for all modes of transportation including automobile, transit, bicycle, and pedestrian. LOS can be determined by using either by the latest *Highway Capacity Manual* (*HCM*) and/or software (*HCS*), *FDOT Quality/Level of Service (Q/LOS) Handbook*, or a methodology determined by FDOT as having comparable reliability.

Case Study

The analysis included both an assessment of intersection operations as well as roadway segment operating conditions, as discussed in the following sections.

3.1.1. Intersection Analysis

Synchro software was used to analyze background and buildout conditions at each of the two study area intersections. Each intersection was compared using the following measures:

- Average Intersection Delay & LOS (Entire Intersections)
- Maximum v/c Ratio (Each Movement)

In this example, overall intersection delay was used as the primary measure, with an additional check of the maximum v/c ratio for all intersection movements.

The results of the analysis (shown in **Table 3-6**) suggested that when compared to background conditions, the site-generated trips do not significantly degrade intersection operations. Note that in this example, signal timing was modified in the Build Condition, leading to a reduction in max v/c for the PM peak hour at one intersection.

Table 3-6: Intersection and Delay LOS

			2015 Existing				2017 No Build				2017 Build			
Intersection	**Control**	**Time**	**Delay**	**LOS**	**Max v/c**	**Movement (for max v/c)**	**Delay**	**LOS**	**Max v/c**	**Movement (for max v/c)**	**Delay**	**LOS**	**Max v/c**	**Movement (for max v/c)**
SR 50 & Daniels Rd/Dillard St	Signal	AM	54.4	D	0.87	NBTR	56.5	E	0.95	NBTR	58.1	E	0.97	NBTR
		PM	65.3	E	0.97	WBL	68.3	E	1.01	WBL	70.0	E	0.96	NBTR
Dillard St & Story Rd	Signal	AM	23.8	C	0.63	NBTR	24.5	C	0.64	NBTR	25.0	C	0.65	NBTR
		AM	24.4	C	0.63	NBTR	25.3	C	0.64	NBTR	25.7	C	0.65	NBTR

3.1.2. Roadway Segment Analysis

A roadway segment analysis was performed to determine if the additional traffic associated with the new project site will create any capacity issues on the surrounding roadway network beyond the two study area intersections. The process for performing a segment analysis is outlined in this section.

The three main components of a segment analysis include the following:

- Maximum service volumes at the adopted LOS standard
- Future year background segment volumes
- Future year buildout segment volumes

Service Volumes

Unless calculated using site-specific maximum service volumes, the peak hour, peak direction (PHPD) maximum service volume at the adopted LOS standard for the study roadway may be obtained from the peak hour directional Generalized Service Volume Tables in the FDOT Quality/Level of Service Handbook. This site is located in an urbanized area so the **Generalized Peak Hour Directional Volumes for Florida's Urbanized Area** table was used to determine the PHPD maximum service volumes at the adopted LOS standard for the analysis segments. The interrupted flow facilities section of this table is shown in **Figure 3-6**.

INTERRUPTED FLOW FACILITIES

STATE SIGNALIZED ARTERIALS

Class I (40 mph or higher posted speed limit)

Lanes	Median	B	C	D	E
1	Undivided	*	830	880	**
2	Divided	*	1,910	2,000	**
3	Divided	*	2,940	3,020	**
4	Divided	*	3,970	4,040	**

Class II (35 mph or slower posted speed limit)

Lanes	Median	B	C	D	E
1	Undivided	*	370	750	800
2	Divided	*	730	1,630	1,700
3	Divided	*	1,170	2,520	2,560
4	Divided	*	1,610	3,390	3,420

Non-State Signalized Roadway Adjustments

(Alter corresponding state volumes by the indicated percent.)

Non-State Signalized Roadways - 10%

Median & Turn Lane Adjustments

Lanes	Median	Exclusive Left Lanes	Exclusive Right Lanes	Adjustment Factors
1	Divided	Yes	No	+5%
1	Undivided	No	No	-20%
Multi	Undivided	Yes	No	-5%
Multi	Undivided	No	No	-25%
–	–	–	Yes	+ 5%

One-Way Facility Adjustment

Multiply the corresponding directional volumes in this table by 1.2

Figure 3-6: Generalized Peak Hour Directional Volumes for Florida's Urbanized Areas

The PHPD maximum service volumes at the adopted LOS standard for the study roadways can be found using the table and adjustment factors. The procedure is outlined for each study roadway below:

Dillard Street

- Speed limit = 35 mpg → **Class II Roadway**
- 2 lanes per direction
- Median Type = TWLTL → **Divided**

These factors result in an unadjusted PHPD maximum service volume of 1,700 for LOS E, which is the adopted LOS standard in the area. Next, adjustment factors should be applied. Since Dillard Street is a non-state signalized roadway, an adjustment factor of -10% should be applied.

- 1,700 * 0.90 = **1,530**

SR 50/Colonial Drive

- Speed limit = 45 mpg → **Class I Roadway**
- 3 lanes per direction
- Median Type → **Divided**

These factors result in an unadjusted PHPD maximum service volume of 3,020, as found in the LOS D column. In this case, volumes greater than LOS D become F because intersection capacities have been reached, so the LOS D column must be used to avoid exceeding the LOS E standard.

Next, adjustment factors should be applied to this volume. Because SR 50/Colonial Drive has right turn lanes, a factor of +5% should be applied. Service volumes are often rounded to the nearest 10 to reflect the level of precision in the estimate

- 3,020 * 1.05 = **3,170**

Future Background Volumes

The future total background volumes were developed by applying the measured or agreed upon growth to the existing volumes, in this case 2% per year.

Future Buildout Volumes

The future total buildout volumes are determined by adding the site trip assignments to the background volumes.

The resulting projected total segment volume is then compared to the maximum service volume at the adopted LOS standard. If the projected total segment volume exceeds the maximum service volume for LOS E, a deficiency is identified on that roadway segment.

The resulting segment analysis for the PM peak hour is provided in **Table 3-7.**

Table 3-7: PM Peak Hour Roadway Segment Analysis

Roadway Segment	No. of Lanes	PHPD Serv. Vol	2017 Background Vol.		Project Trips		Total Trips		Deficiency?
			NB/ EB	SB/ WB	NB/ EB	SB/ WB	NB/ EB	SB/ WB	
Dillard Street/Daniels Road									
SR 50/Colonial Drive to Project Entrance	4	1,530	764	748	23	49	787	797	No
Project Entrance to SR 438/Plant Street	4	1,530	764	748	35	41	799	789	No
SR 50/Colonial Drive									
CR 535/Winter Garden-Vineland Road to Project Entrances	6	3,170	1,716	1,021	61	65	1,777	1,086	No
Project Entrances to Dillard Street/Daniels Road	6	3,170	1,716	1,021	61	79	1,777	1,100	No
Dillard Street/Daniels Road to 9th Street	6	3,170	1,720	1,073	56	65	1,776	1,138	No

As shown in the PM segment analysis table, no deficiencies were identified through 2017.

3.2. Site Access and Internal Circulation

Overview

Typically, impact analysis include a discussion of the proposed site plans and expected improvements. Key considerations are discussed in **Section 2.9** of the TSIH. In general, most site plan assessments should include the following items:

- Median opening locations and spacing
- Access, circulation, and parking
- Landscaping details for analysis of sight distances
- Location of proposed multimodal accommodations

The TSIH includes links to guidance documents related to pedestrian and transit-friendly design, driveway design, and access management.

Case Study

In this example analysis, four key components were analyzed in more detail:

- Site Access and Driveway Spacing
- Right Turn Lane Warrant Analysis
- Internal Circulation
- On-Site Queuing

3.2.1. Site Access and Driveway Spacing

The existing site has four access locations along SR 50/Colonial Drive and three access locations along Dillard Street, totaling seven access locations for the site. One of the existing access locations is located less than 30 feet from the intersection SR 50/Colonial Drive & Dillard Street. Additionally, there is minimal cross-access provided between uses within the site.

The proposed site design includes a reduction from the seven existing access points to three access points. These site driveways include one full access driveway located on Dillard Street approximately 275 feet from the intersection with SR 50/Colonial Drive, and two right-in/right-out driveways on SR 50/Colonial Drive.

The site accesses for the proposed site were designed to improve operations for the site and minimize disruptions to the adjacent street network. Internal connectivity is important within a multi-use development site in order to facilitate internal trips that do not need to use the adjacent roadway network.

While two of the proposed driveways are right-in/right-out, one proposed driveway is full access, and there is some potential that queues from the downstream signal could block the access during peak hours. However, based on an analysis of the volumes and geometry the following conclusion was noted in the report:

- Distance between downstream signal stop bar and driveway opening deemed acceptable.

3.2.2. Right Turn Lane Analysis

A right turn lane warrant analysis was performed at each driveway based on the projected driveway volumes and speed limit. The thresholds from *NCHRP Report 420* as well as *FDOT's Driveway Information Guide* were used to conduct the evaluation. The results of the analysis are shown in **Table 3-7**.

Table 3-8: Right Turn Lane Warrant Analysis

Intersection	SR 50 & Western Project Entrance	SR 50 & Eastern Project Entrance	Dillard St & Northern Project Entrance
AM Peak Hour (veh)	66	96	83
PM Peak Hour (veh)	73	106	92
NCHRP Report 420 Threshold		85 - 110	
FDOT Driveway Information Guide Threshold		80 - 125	
Meets Criteria for Right Turn Lane	No	Consider	Consider

Volumes were sufficient to warrant consideration of a right turn lane at two driveways, but the upper threshold was not exceeded. Based on discussions with the City, the higher threshold was determined to be more appropriate and no right turn lanes were recommended. Result:

- No right turn lanes recommended

3.2.3. Internal Circulation

Driveway geometry and anticipated operations were evaluated at each of the project driveways in order to assess potential issues that may lead to external queuing.

The distance from the edge of the traveled way to the proposed cross access within the site was documented and compared to accepted guidance (*FDOT's Driveway Information Guide*). Based on the analysis, the following conclusion was noted in the report:

- Proposed cross access lengths deemed acceptable.

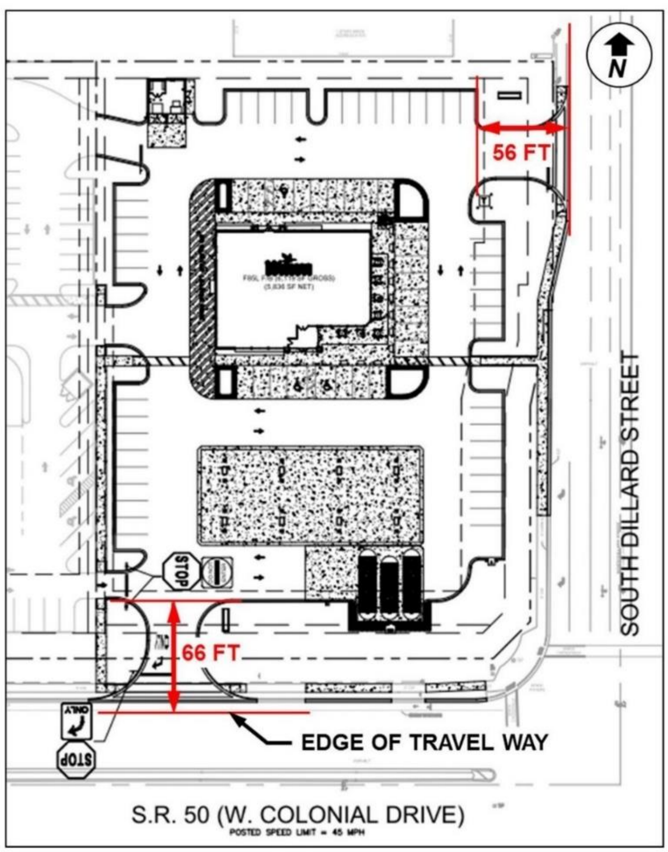


Figure 3-7: Site Plan Showing Internal Circulation

3.2.4. On-Site Queuing Analysis

Because of the presence of the drive-thru restaurant, an on-site queuing analysis was performed. The total queuing distance from the drive-thru pickup window to the driveway cross access was measured to estimate the total queue capacity that would not impact driveway operations. Based on the analysis, the following conclusion was noted in the report:

- *300 feet of storage would allow queuing for 12 vehicles without impact to driveway operations, which was deemed acceptable.*

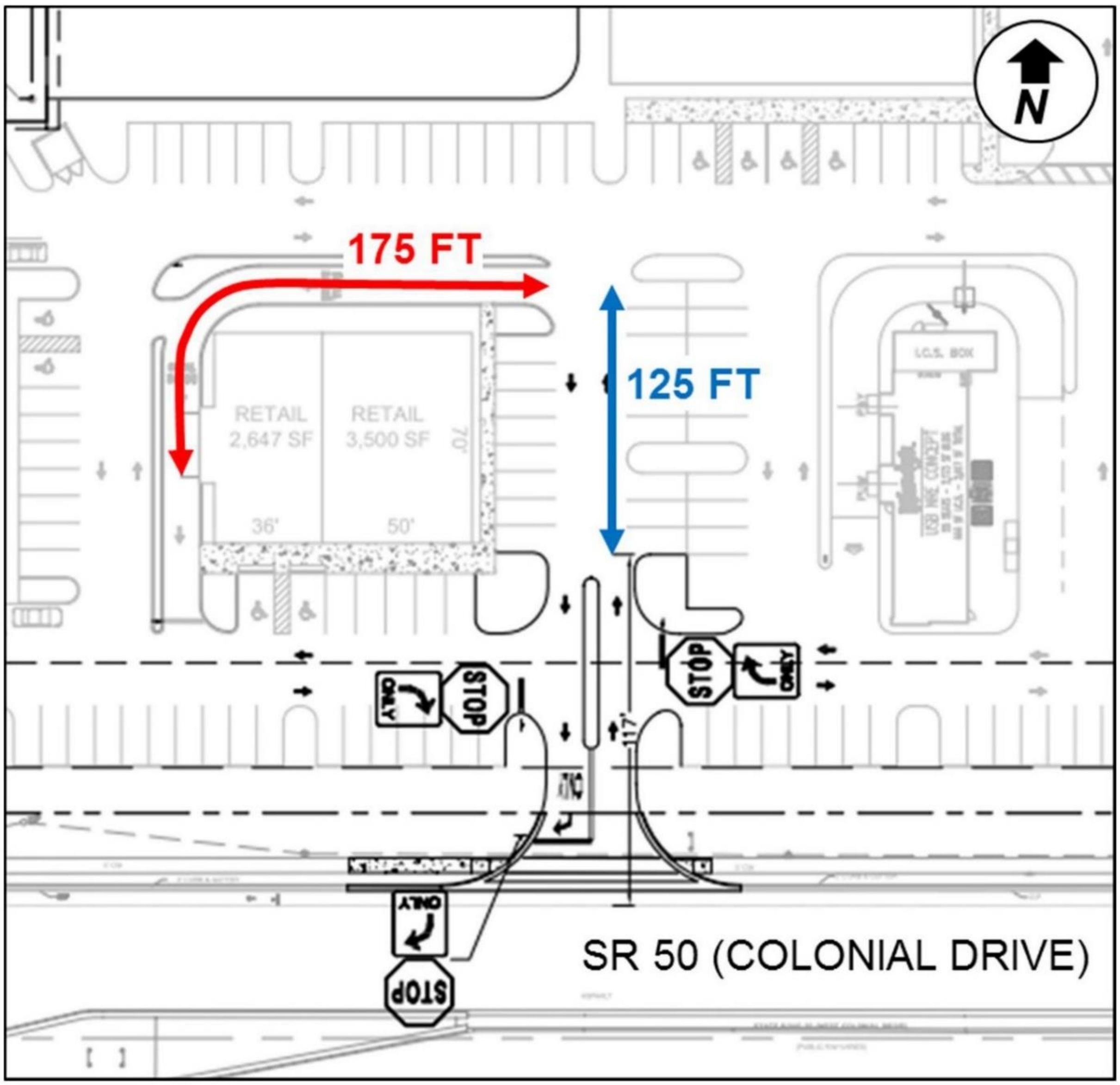


Figure 3-8: On-Site Queuing Analysis

4. Case Study C - Traffic Impact Analysis for Urban Mixed-Use Development

4.1. Study Overview and Key Concepts

The following case study documents an urban mixed-used residential and retail development with underground parking. The site is currently vacant.

Key concepts addressed in this case study include:

- Internal Capture
- Multimodal Factors
- Background Growth

Table 4-1: Case Study C Summary

Study Type	Traffic Impact Analysis for Urban Mixed-Use Development
Proposed Land Use(s)	High-Rise Apartment Units Retail
Study Area Determination	Decision by City Staff
Roadway Segments Analyzed	-
Intersections Analyzed	6
Access Driveways	1
Study Period(s)	AM Peak Hour PM Peak Hour
Pass-By	-
Internal Capture	2.3% AM (ITE Method) 14.5% PM (ITE Method)
Modal Split	0.67 (Assuming 33% Trips by Other Modes)
Net New External Trips	112 AM 150 PM
Existing Site Trip Reduction	-
Distribution Method	FSUTMS OUATS Site Access Professional Judgement
Background Growth	1.5% (Based on Historical Trends and Professional Judgement)
Scenarios	Existing Conditions (2015) Background Conditions (2017) Buildout Conditions (2017)

4.2. Trip Generation

The proposed development includes 464 residential units (high-rise apartments) and 7,000 sq. ft. of ground-level retail. Trip generation rates from the ITE's *Trip Generation*, 9th Edition were used to estimate gross vehicle trip generation for the site. These initial unadjusted trip estimates are provided in the following tables.

Table 4-2: AM Trip Generation

Land Use	ITE Code	Units	Entering Trips	Exiting Trips	Total Trips
High-Rise Apartment[1]	222	464 Units	35	105	140
Retail (Shopping Center)[1]	820	7,000 ft^2	19	12	31
[1]Using trip generation equation			54	117	171

Table 4-3: PM Trip Generation

Land Use	ITE Code	Units	Entering Trips	Exiting Trips	Total Trips
High-Rise Apartment[1]	222	464 Units	98	63	161
Retail (Shopping Center) [1]	820	7,000 ft^2	48	53	101
[1]Using trip generation equation			146	116	262

4.2.1. Internal Capture

Overview

Mixed-use sites have the potential to "capture" some trips on site, reducing the total number of new vehicle trips added to the surrounding network. When a site includes either office, hotel, or residential, internal trips could include:

- Office workers walking to an on-site restaurant
- Residents shopping at an on-site store
- Hotel guests dining in an on-site restaurant

Sites that have residential and nonresidential uses have the highest potential for internal capture, but mixed-use sites with an on-site office building or hotel should consider the effects of internal capture.

Internal Capture: Shopping centers are typically not considered mixed-use developments because shopping center data was collected for the entire site, often including other uses such as restaurants and theaters. For large sites with a number of retail and restaurant uses, it is often reasonable to combine them together and calculate the trip generation for the entire site using Land Use Code 820 rather than apply internal capture rates between retail and restaurant uses.

Case Study

In this case, while the specific retail use is not known, it can be assumed that at least some residents will visit the on-site retail, reducing the number of expected external trips. The method for estimating these trips is discussed below. It should be noted that this example draws from internal capture rates provided in ITE's *Trip Generation Handbook*, 3rd Edition and does not necessarily reflect the most up-to-date research into internal capture. An alternate approach using FDOT recommended rates is presented in the subsequent section.

AM

Based on ITE guidance, for mixed-use site that contain both residential and retail uses, up to 1% of residential trips may *depart to* on-site retail, and up to 17% of retail trips may *arrive from* on-site residential. Based on the proposed trip generation for the site, this leads to 2 captured trips (1 residential exiting trip and 1 retail entering trip) as shown in the graphic below.

Residential	→ 1 Trip	$	
Exiting Trips:	105	Entering Trips:	19
To Retail:	1%	From Residential:	17%
Max. Internal Trips:	**1**	Max. Internal Trips	3
Internal Trips:	1	Internal Trips:	1
Captured Trips: 2			

(house icon) = Residential; $ =Retail; **Bold** refers to the limiting trip count used

In the opposite direction, up to 14% of retail trips may *depart to* on-site residential and up to 2% of residential trips may *arrive from* on-site retail. This also leads to 2 captured trips (1 retail exiting trip and 1 residential entering trip).

$	→ 1 Trip	Residential	
Exiting Trips:	12	Entering Trips:	35
To Residential:	14%	From Retail:	2%
Max. Internal Trips:	2	**Max. Internal Trips:**	**1**
Internal Trips:	1	Internal Trips:	1
Captured Trips: 2			

Combined, 4 trips (2.3%) were taken as internal trips and removed from the total number of external trips.

Table 4-4: AM Internal Capture

Land Use	Trip Generation		Internal Trips		External Trips		
	Entering	Exiting	Entering	Exiting	Entering	Exiting	Total
Residential	35	105	1	1	34	104	**138**
Retail (Shopping	19	12	1	1	18	11	**29**
	54	**117**	**2**	**2**	**52**	**115**	**167**

PM

During the PM peak hour, internal capture represents a more significant proportion of overall site trips. Based on ITE guidance during the PM peak hour, up to 42% of residential trips may *depart to* on-site retail, and up to 10% of retail trips may *arrive from* on-site residential. Based on the proposed trip generation for the site, this leads to 10 captured trips (5 residential exiting trips and 5 retail entering trips) as shown in the graphic below.

→ 5 Trips $

Exiting Trips:	63	Entering Trips:	48
To Retail:	42%	From Residential:	10%
Max. Internal Trips:	26	**Max. Internal Trips**	**5**
Internal Trips:	5	Internal Trips:	5

Captured Trips: 10

In the opposite direction, up to 26% of retail trips may *depart to* on-site residential and up to 46% of residential trips may *arrive from* on-site retail. This leads to 28 captured trips (14 retail exiting trips and 14 residential entering trips).

Captured "Pairs": Internally captured trips always come in pairs; a trip that is captured on-site represents a reduction to both an "exiting" and an "entering" trip. Therefore, the total number of internally captured trips on site should always be an even number. A spreadsheet tool should be used to track how the trip reductions are applied to the entering and exiting trips for each use rather than applying a generalized percentage reduction to the total number of site trips.

$ → 14 Trips

Exiting Trips:	53	Entering Trips:	98
To Residential:	26%	From Retail:	46%
Max. Internal Trips:	**14**	Max. Internal Trips:	45
Internal Trips:	14	Internal Trips:	14

Captured Trips: 28

Combined, 38 trips (14.5%) were taken as internal trips and removed from the total number of external trips.

Table 4-5: PM Internal Capture

Land Use	Trip Generation		Internal Trips		External Trips		
	Entering	Exiting	Entering	Exiting	Entering	Exiting	Total
Residential	98	63	14	5	84	58	**142**
Retail (Shopping	48	53	5	14	43	39	**82**
	146	**116**	**19**	**19**	**127**	**97**	**224**

The FDOT Transportation Site Impact Handbook (2014) provides some additional general guidance for internal capture. Key items noted include:

- "Shopping Centers" are generally not considered "mixed-use"
- Sites having a mix of residential and nonresidential components have the highest potential for internal capture trips
- Internal capture rates should only be used for communities that have income compatible residences and employment centers
- Internal capture rates may need to be adjusted if there are ample nearby substitutes for captured trips
- Internal capture rates should be calculated for each phase of a mixed-use development because total internal capture is dependent on the mix of uses

4.2.2. Multimodal Reduction

Most ITE trip generation data were collected in suburban locations with free parking and little or no transit service. In dense, urban settings it is often necessary to make adjustments to account for the increased likelihood of trips made by other modes of transportation.

While there is no single recommended statewide approach for reducing vehicle trips rates to account for trips by other modes, many cities have mode split data documenting existing conditions, and in some cases, recommended multimodal reduction factors.

In Miami, the "Miami Downtown Development of Regional Impact Increment II" report provides multimodal and pedestrian reduction factors to be applied to certain parts of the city. Within the Central Business District (CBD) where the project is proposed, the recommended transit reduction is approximately **23 percent**, and the recommended pedestrian reduction is **10 percent**. Taken together, a 33 percent multimodal reduction was applied to the estimated number of external trips during both the morning and evening peak hours.

Multimodal Reduction Factors: Any reduction to account for multimodal trips should be discussed with participating agencies before proceeding with the analysis. Even when mode split data is available, these assumptions are likely to vary by land use.

Table 4-6: AM Multimodal Reduction

Land Use	External Trips		Multimodal Trips		Net New External Trips		
	Entering	Exiting	Entering	Exiting	Entering	Exiting	Total
Residential	34	104	11	34	23	70	**93**
Retail (Shopping Center)	18	11	6	4	12	7	**19**
	52	**115**	**17**	**38**	**35**	**77**	**112**

Table 4-7: PM Multimodal Reduction

Land Use	External Trips		Multimodal Trips		Net New External Trips		
	Entering	Exiting	Entering	Exiting	Entering	Exiting	Total
Residential	84	58	28	19	56	39	**95**
Retail (Shopping Center)	43	39	14	13	29	26	**55**
	127	**97**	**42**	**32**	**85**	**65**	**150**

4.3. Background Growth

Overview

The *Transportation Site Impact Handbook* (2014) provides a detailed description of three "trend analysis" methods and the general application for each:

- Linear Growth
    - Assumes a constant ***amount*** of growth in each year and does not consider a capacity restraint
- Exponential Growth
    - Assumes a constant ***percentage*** of growth from the previous year and is most applicable when there is rapid growth and capacity available
- Decaying Exponential Growth
    - Assumes a declining rate of growth over the analysis period and is most applicable in more built out areas

When developing a growth trend based on *historical data*, FDOT recommends using the *Traffic Trends Analysis Tool* (linked from the *TSIH*) and applying a growth trend most applicable for the area.

However, in many cases, agencies prefer to rely on travel demand forecasts for the area to forecast traffic volumes into the future. While travel demand forecasts are based on planning-level assumptions and include a significant amount of uncertainty, they incorporate future year land use assumptions and take into account roadway capacity constraints. They also provide one alternative to estimating growth when recent trends would suggest zero or negative growth. Professional judgement should be used with the results of the travel demand model, including how does the base-year model performs on the particular corridor being analyzed.

Case Study

For this study, sixteen (16) nearby roadway segments were selected from the Miami-Dade MPO FSUTMS Model. The summation of the volumes on all selected roadways for both 2010 and 2040 is provided in the table below, along with the calculated linear growth from 2010 to 2040. **Based on discussions with City staff**, 1.5 percent linear growth was selected to grow the 2015 turning movement counts to 2018 volumes.

Table 4-8: Growth Rate Determination

Year	Volume	Linear Growth		
		Total Increase	Annual Increase	Percentage
2010	91,768	40,806	1,360	**1.48%**
2040	132,574			

In this case, over such a short time period (three years), the difference between applying linear or exponential growth is effectively insignificant after rounding. Additionally, the calculated rate was rounded up to err on the conservative side. However, over longer periods of time, two key items should be considered when forecasting growth from a travel demand model:

- Linear Growth
    - Linear growth assumes a constant ***amount*** of growth each year, and when turning movements counts were collected in a different year from the "base year" for the travel demand model, the calculated annual growth, when expressed as a percentage, will overestimate the total ***amount*** of growth unless adjusted. Put another way, linear growth assumes that the growth ***percentage*** decreases each year because the annual growth amount represents a smaller share of the overall traffic each year. As shown in the table below, linear growth of 1.38% of the 2015 volume would be more applicable when applied to 2015 data. However, as noted in the analysis, 1.5% linear growth was used as a conservative rate.

Table 4-9: Linear Growth Comparison

Year	Volume	Linear Growth (2010 – 2040)			Linear Growth (2015 – 2040)		
		Total Increase	Annual Increase	Percentage	Total Increase	Annual Increase	Percentage
2010	91,768						
2015	98,568	40,806	1,360	1.48%	34,006	1,360	**1.38%**
2040	132,574						

- Exponential Growth
    - Exponential growth eliminates the need to adjust for revised based year volumes because a constant growth ***rate*** is applied each year. When developing growth rates based on travel demand model forecasts, a calculated exponential growth rate assumes less annual growth for the first few years of the analysis when compared to linear growth derived from the same data. This is because the total amount of growth increases over time. In the example, calculating and applying an exponential growth rate to obtain 2018 volumes would therefore lead to *lower volumes* compared to the linear approach used.

5. Case Study D – Comprehensive Plan Amendment/Future Land Use Map Change Case Study

5.1. Study Overview and Key Concepts

The following case study outlines a traffic study completed for a Comprehensive Plan Amendment for two parcels. The study was performed to analyze the roadway impacts from changing the currently allowed future land uses to a new future land use with greater trip generation potential.

The following key concepts are addressed in this study:

- Trip Generation
- Study Area
- Background Growth
- Segment Level of Service Analysis

Table 5-1: Case Study D Summary

Study Type	Comprehensive Plan Amendment Traffic Study
Parcels	2
Existing Future Land Use (FLU)	Parcel 1 – County General Commercial Parcel 2 – Oxford Neighborhood Mixed Use (ONMU)
Proposed Future Land Use (FLU)	Parcel 1 – C-3 Commercial Parcel 2 – C-3 Commercial
Study Area Determination	5% Significance Area and Decision by MPO Staff
Roadway Segments Analyzed	20
Intersections Analyzed	- (Not typically analyzed for CPAs)
Access Driveways	- (Not typically analyzed for CPAs)
Analysis Years	5-Year Planning Horizon (2020) 15-Year Planning Horizon (2030)
Pass-By	Existing Future Land Use – 34% (ITE) Proposed Future Land Use – 15% (Limited by 10% of Adjacent Side-Street Traffic)
Internal Capture	Existing Future Land Use – 7.7% Proposed Future Land Use – 0%
Modal Split	-
Net New Daily External Trips	6,96 Daily Trips
Distribution Method	CFRPM Select Zone
Background Growth	2015-2020 – 5% per year (Based on Historical Growth) 2020-2030 – 1% per year (Assumed Long Term Growth)

5.2. Trip Generation

Overview

Trip generation for comprehensive plans is used to estimate the maximum potential number of vehicle trips generated by an area based on the allowed and proposed land uses.

The first step in any comprehensive plan amendment traffic study is to determine if the proposed amended future land use would generate a *greater* number of vehicle trips compared to the allowed future land use. In some cases, the proposed amended future land would generate fewer trips than the allowed future land use.

As an example, consider an area that is currently allowed for general single family residential. Changing the allowed land use from single family residential to age-restricted residential would actually *decrease* the potential number of vehicle trips from the area (assuming no change in density). In these types of cases, no additional traffic analysis would be required; the approved plan already assumes a greater number of trips than would be generated by the proposed land use.

When the proposed land use has the potential to generate a greater number of vehicle trips than the allowed use, a traffic study is needed in order to determine potential network deficiencies.

Traffic Operations Analysis Requirement: A traffic operations (link) analysis is typically only required for a Comprehensive Plan Amendment when the proposed future land use has the potential to generate more trips than the maximum development scenario allowed by the current Plan.

Case Study

5.2.1. Trip Generation Potential for Allowed Future Land Use

Parcel 1 has an existing future land use of County General Commercial, which allows a maximum Floor Area Ratio (FAR) of 0.5.

Parcel 2 has an allowed Future Land Use (FLU) designation of Oxford Neighborhood Mixed Use (ONMU). The ONMU land use allows for a mixture of residential and non-residential land uses, and allows a maximum FAR of 0.3 for non-residential uses and a maximum of 7 dwelling units per acre for residential land uses. The land use designation outlines the following minimum and maximum land use percentages:

- Minimum of 35% residential uses
- Minimum of 5% recreational uses
- Maximum of 40% commercial uses
- Maximum of 40% office uses

Table 5-2 shows the maximum development potential by use based on these maximum and minimum land use percentages, assuming the maximum amount of retail. For this analysis, the maximum amount of retail was assumed because this land use will lead to more trips per day when compared to an office land use and therefore estimates the *maximum* trip generation potential for the site.

Table 5-2: Development Potential for Allowed Future Land Used

Parcel	Area	Existing Future Land Use	Land Use	Assumed Balance of Uses	Max. Intensity	Max. Development Potential
1	25,874 ft^2	Commercial	Retail	100%	0.5 FAR	**12,937 ft^2**
2	562,795 ft^2	ONMU	Retail	40%	0.3 FAR	**67,535 ft^2**
			Office	20%	0.3 FAR	**33,768 ft^2**
			Residential	35%	7 DU/Acre	**32 DU**
			Recreation	5%	-	-
	588,669 ft^2					

These development assumptions were then used to determine the maximum trip generation potential for the allowed uses, as shown in **Table 5-3**.

Table 5-3: Trip Generation Potential for Allowed Future Land Use

Land Use	LUC	Intensity	Average Rate or Equation	Daily External Trips	
				Entering	Exiting
Single-Family Residential	210	16 DU	Equation	97	98
Apartment	220	16 DU	Equation	111	110
General Office	710	16,884 ft^2	Equation	170	170
Medical-Dental Office	720	16,884 ft^2	Equation	238	237
Shopping Center	820	80,472 ft^2	Equation	2,948	2,949
				3,564	**3,564**
				7,128	

Internal capture between the different land uses was then applied based on methodology from ITE's *Trip Generation Handbook,* 3rd Edition, as shown in **Table 5-4**.

Table 5-4: Internal Capture for Allowed Future Land Use

Land Use	Daily Trip Generation		Daily Internal Trips		Daily External Trips	
	Entering	Exiting	Entering	Exiting	Entering	Exiting
Residential	208	208	54	51	154	157
Office	408	407	77	102	331	305
Retail (Shopping	2,948	2,949	143	121	2,805	2,828
	3,564	**3,564**	**274**	**274**	**3,290**	**3,290**
	7,128		**548**		**6,580**	
			7.7%			

Pass-by reductions were applied based on the methodology from ITE's *Trip Generation Handbook,* 3rd Edition, as shown in **Table 5-5**. A check was performed to determine if the proposed pass-by trip rate exceeded 10% of adjacent street traffic volumes. The pass-by capture using ITE's methodology did not exceed 10% of the adjacent street traffic.

Table 5-5: Pass-By Reduction for Allowed Future Land Use

Land Use	Daily External Trips		Daily Pass-By Trips			Net New Daily External Trips	
	Entering	Exiting	Percentage	Potential	10% Check	Entering	Exiting
Residential	154	157	-	-	2,072	154	157
Office	331	305	-	-		331	305
Retail (Shopping	2,805	2,828	34%	**1,916**		1,847	1,870
	3,290	**3,290**	**1,916**[1]			**2,332**	**2,332**
	6,580					**4,664**	

[1]Checked to confirm less than 10% of adjacent street traffic, or 20,720*10% = 2,072 → OK

Overall, the potential net new external trips generated by the allowed future land use is up to **4,664 vehicle trips per day**.

5.2.2. Trip Generation Potential for Proposed Future Land Use

The proposed land use amendment would change the allowed future land uses on both parcels to C-3 Commercial, which allows a maximum FAR of 0.5. This would allow up to **294,335 ft^2 of retail development** on the two parcels.

ITE land use code 820 – Shopping Center was used to calculate the daily trip generation potential for the proposed land use amendment. The proposed amendment would generate up to **13,700 vehicle trips per day**.

Pass-by trips were calculated based on methodology from ITE's *Trip Generation Handbook,* 3rd Edition. A check was then performed to determine if the proposed pass-by trip rate exceeded 10 percent of adjacent side-street traffic volumes. In this case, the calculated number of potential pass-by trips was greater than 10 percent of adjacent street traffic, so the lower of the two values was used, as shown in **Table 5-6**.

Table 5-6: Pass-By Reduction for Proposed Future Land Use

Land Use	Daily External Trips		Daily Pass-By Trips			Net New Daily External Trips	
	Entering	Exiting	Percentage	Potential	10% Check	Entering	Exiting
Retail (Shopping	6,850	6,850	34%	4,658	**2,072**	5,814	5,814
	13,700		**2,072**			**11,628**	

Overall, the potential net new external trips generated by the proposed future land use would be up to **11,628 vehicle trips per day**. This represents an increase of **6,964 vehicle trips per day** over the allowed future land use.

Because the proposed future land use has greater trip generation potential than the existing allowed future land use, improvements to the roadway network may be necessary to provide sufficient roadway capacity to serve the proposed future land use. A segment analysis was therefore performed to identify potential network deficiencies and potential mitigation measures.

5.3. Study Area

Overview

There are a number of methods for determining the extent of the study area for a comprehensive plan amendment traffic study. At a minimum, all major roadways adjacent to the site should be included. Some examples of methods used for study area determination for a comprehensive plan amendment traffic study include:

- **Study Area Radius –** this may include all monitored segments within a specified radius of the project's access point(s) based on trip per hour or trip per day threshold guidelines. **Table 5-7** shows an example of this approach, as adapted from *Hillsborough County's Land Development Code:*

Table 5-7: Example Study Area Determination by Radius and Trip Generation

Daily Trips	Study Area Radius
≤ 200	Adjacent Roads Only
>200	0.5 miles
>500	1.0 miles
>1,000	2.0 miles
>5,000	3.0 miles
>10,000	4.0 miles
>20,000	5.0 miles

- **Percent Impact –** In this method, the study area includes segments on which project traffic is greater than or equal to a specified percentage of the maximum service volume of monitored roadways surrounding the project. Maximum service volume is defined in FDOT's 2013 Quality/Level of Service Handbook as the highest number of vehicles for a given level of service. The maximum service volume is typically based on the level of service standard for a roadway. In most cases, the level of service standard for a county roadway is LOS D, however along state roadways it can often be LOS C.
    - As an example, if 5% is used as the threshold, a segment with a maximum service volume of 10,000 vehicles per day at the adopted LOS standard would need to be included within the analysis if it is expected to serve *500 or more* project trips per day.

Links to Include When Using a Percent Impact Approach: It is common to include one link beyond each roadway segment that meets the percent impact threshold. This approach helps to clearly define the edges of the study area.

Beyond the areas specified by the study area determination guidelines, the review agency (with input from the applicant) should determine any additional area to be included, based on local or site-specific issues, development size, or local policy.

Case Study

The study area for this project was determined primarily based on county guidelines, and modified based on comments from reviewing agency staff. The final study area determination included:

- Classified roadway segments within a 1.94-mile radius of the site
- All roadway segments expected to have 5% or greater impact

The first step in determining the roadway segments to include in the analysis requires the distribution of new trips through the network. In this example, a transportation model run was completed using the Central Florida Regional Planning Model (CFRPMv.5.01). The assumed distribution of trips used as an input into the study area determination process is shown in **Figure 5-1**.

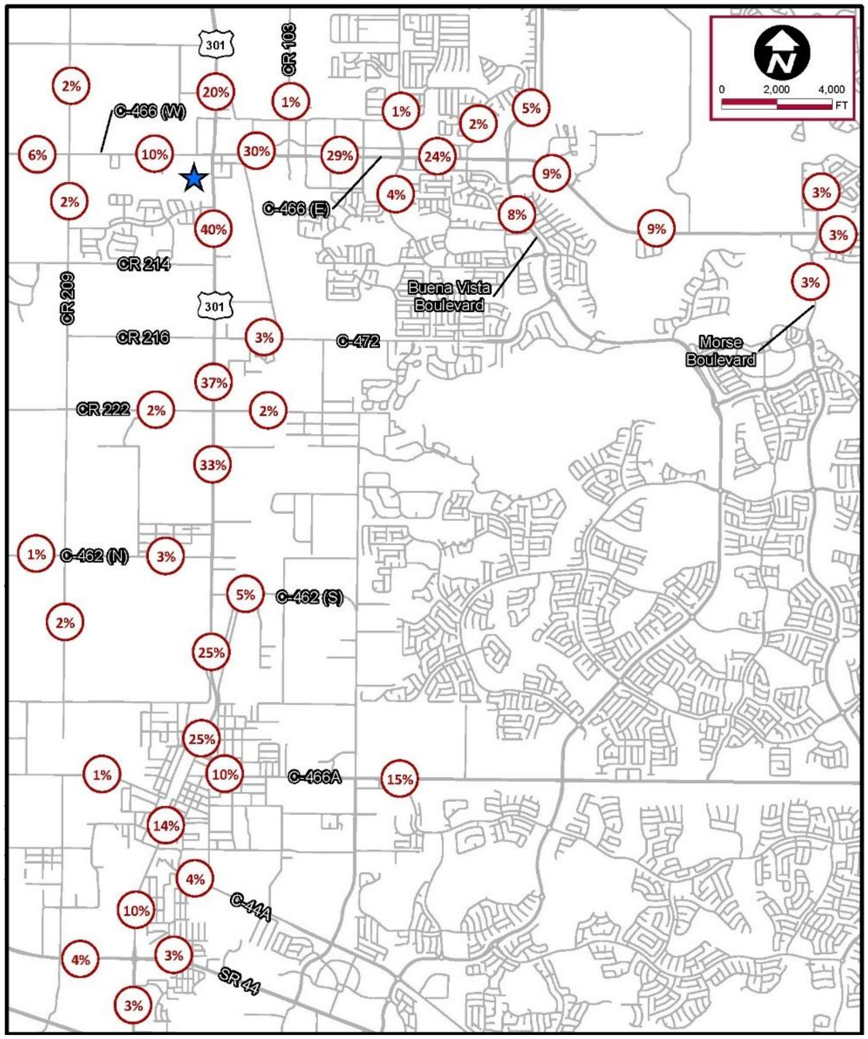


Figure 5-1: Site Trip Distribution

With the determination of both trip generation and distribution, the final step in determining the study area requires comparing the net increase in project trips associated with the comprehensive plan amendment to the maximum daily service volume at the adopted LOS standard of area roadways. **Table 5-8** shows all roadways considered for inclusion within the study area. Each roadway is marked for inclusion in the analysis if either 1) the amendment is expected to have a 5% impact or greater (relative to the maximum daily service volume at the adopted LOS standard), or 2) is located within 1.94 miles of the site, as specified in the methodology.

Table 5-8: Study Area Roadway Determination

Roadway From	To	Maximum Daily Service Volume[1]	Daily Project Traffic from CPA			Include in Study Area?
			% Distribution	Daily Traffic	% Impact[2]	
US-301						
C-466A (Cleveland Ave)	C-462 (S)	39,800	25.0%	1,741	4.37%	--
C-462 (S)	C-462(N)	34,000	30.0%	2,089	6.14%	Yes
C-462(N)	CR 222	39,800	33.0%	2,298	5.77%	Yes
CR 222	C-472	39,800	37.0%	2,576	6.47%	Yes
C-472	C-466	39,800	40.0%	2,785	7.00%	Yes
C-466	CR 204	39,800	20.0%	1,393	3.50%	Yes
CR 204	County Bdry	39,800	20.0%	1,393	3.50%	Yes
C-466						
C-475	CR 229	12,900	6.0%	418	3.24%	Yes
CR 229	CR 209	12,900	6.0%	418	3.24%	Yes
CR 209	US 301/SR 35	14,800	10.0%	696	4.70%	Yes
US 301/SR 35	CR 105	39,800	30.0%	2,089	5.25%	Yes
CR 105	CR 103	39,800	30.0%	2,089	5.25%	Yes
CR 103	CR 101	39,800	29.0%	2,019	5.07%	Yes
CR 101	Buena Vista Blvd	39,800	24.0%	1,671	4.20%	Yes
CR 101						
C-466	Woodridge Dr	29,160	1.0%	70	0.24%	Yes
Woodridge Dr	CR 102	13,320	1.0%	70	0.53%	Yes
CR 103						
C-466E	Woodridge Dr	29,160	1.0%	70	0.24%	Yes
Woodridge Dr	CR 102	13,320	1.0%	70	0.53%	Yes
CR 209						
CR 216	C-466	15,930	2.0%	139	0.87%	Yes
C-466	CR 202	13,320	2.0%	139	1.04%	Yes
CR 462						
CR 209	US 301	15,930	3.0%	209	1.31%	--
US 301	C-466A	15,930	5.0%	348	2.18%	--
CR 472						
US 301	CR 117	15,930	3.0%	209	1.31%	Yes
C-466A						
US 301	C-462/Powell Rd	15,930	10.0%	696	4.37%	--

[1]Maximum daily service volumes are based on the Sumter County TMS Segment Report for the adopted LOS standard for each roadway

[2]Percent impact was calculated as the maximum new daily project traffic (proposed traffic minus allowed traffic) across the segment divided by the maximum daily service volume at the adopted LOS standard.

The resulting study area is shown in **Figure 5-2**, with all study area roadways highlighted in red.

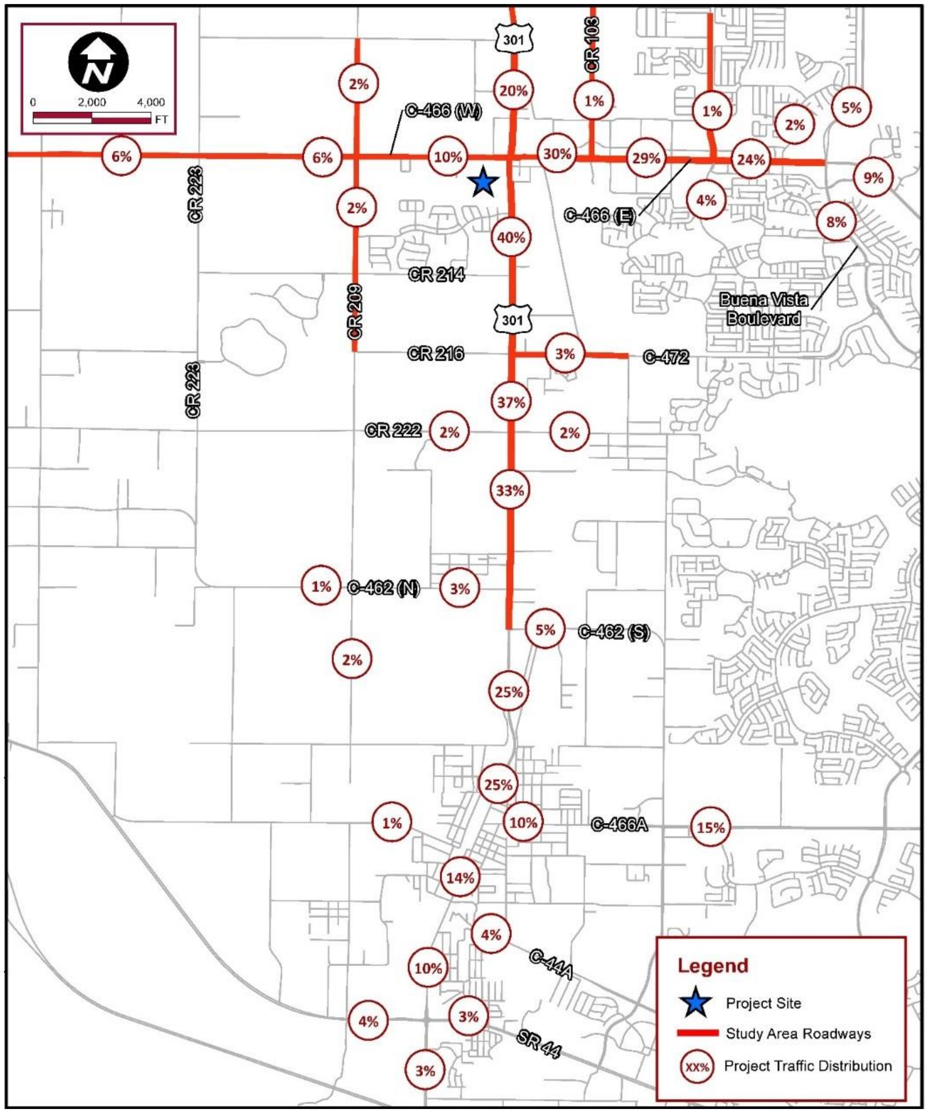


Figure 5-2: Study Area and Distribution

5.4. Background Growth

Overview

As with traditional traffic impact studies, comprehensive plan amendment studies require a comparison of future background conditions with and without the proposed changes.

Planning Horizons: Typical planning horizon timeframes for comprehensive plans are 5 years and 10 years.

Case Study

For this study, 5-year and 15-year planning horizons were evaluated. Background growth was determined for each planning horizon year. The background annual growth for the 5-year planning horizon was taken as 5% per year, calculated as the weighted average of the historic growth calculated from three years of traffic counts on the studied roadway segments.

This amount of significant growth is not typically applicable for long-term analysis, and the short-term growth experienced in this area is not anticipated to continue long-term. 1% growth per year was selected to be applied between the years 2020 and 2030.

5.5. Segment Level of Service Analysis

Overview

A roadway segment level of service (LOS) analysis is typically performed for each of the identified roadway segments in order to determine if the proposed change in the allowed future land uses would lead to network deficiencies without improvements. The following inputs are required for this analysis:

- Roadway attributes (existing and committed)
- Existing and future year background daily traffic volumes
- Daily project traffic volumes

Case Study

Each component of the segment analysis is described in detail in this chapter, and examples for some of the roadway segments from the 2020 analysis are included.

5.5.1. Roadway Attributes (Existing and Committed)

The characteristics of the study area roadways are used to determine the maximum daily service volume at the adopted LOS standard for each segment being analyzed. Key roadway attributes include functional classification, area type, and number of lanes.

Existing geometry should be used for all segments unless there are known committed roadway improvements planned within the planning horizon. Since the roadway maximum daily service volume at the adopted LOS standard is determined based on the geometry of a roadway, it is important to accurately represent the roadway network in the future years analyzed.

The adopted LOS is the maximum level of service considered acceptable for a roadway set by the planning organization for the area the study roadway is located within. It is determined based on the functional class and area type of each roadway segment. The adopted LOS and the roadway geometry are used as inputs to the FDOT Q/LOS Generalized Service Volume Tables to determine the maximum daily service volume of each roadway segment.

Table 5-9 shows the function classification, area type, adopted LOS, number of lanes, and corresponding maximum daily service volume for each study area roadway.

Table 5-9: Roadway Attributes

Roadway From	To	Roadway Attributes			Maximum Daily Service Volume
		Area Type	Adopted LOS	Number of Lanes	
US-301					
C-462 (S)	C-462(N)	U	D	4	39,800
C-462(N)	CR 222	T	C	4	34,000
CR 222	C-472	U	D	4	39,800
C-472	C-466	U	D	4	39,800
C-466	CR 204	U	D	4	39,800
CR 204	County Bdry	U	D	4	39,800
C-466					
C-475	CR 229	R	C	2	12,900
CR 229	CR 209	R	C	2	12,900
CR 209	US 301/SR 35	U	D	2	14,800
US 301/SR 35	CR 105	U	D	4	39,800
CR 105	CR 103	U	D	4	39,800
CR 103	CR 101	U	D	4	39,800
CR 101	Buena Vista Blvd	U	D	4	39,800
CR 101					
C-466	Woodridge Dr	U	D	4	29,160
Woodridge Dr	CR 102	U	D	2	13,320
CR 103					
C-466E	Woodridge Dr	U	D	4	29,160
Woodridge Dr	CR 102	U	D	2	13,320
CR 209					
CR 216	C-466	U	D	2	15,930
C-466	CR 202	U	D	2	13,320
CR 472					
US 301	CR 117	U	D	2	15,930

5.5.2. Existing and Future Year Background Traffic Volumes

Forecasted future year traffic volumes by roadway segment are required inputs for a segment LOS analysis. The existing daily traffic volumes are used as the baseline to determine the expected level of service for the year of analysis.

Annual average daily traffic (AADT) is sometimes used for the base year of the analysis. In many cases, this information is available through Florida Traffic Online. In some cases, it may be necessary to obtain a daily traffic count and apply a seasonal factor and an axle correction factor in order to obtain annual average daily traffic (AADT) volumes for each roadway segment.

Table 5-10 shows the study area roadway volumes for the base year, along with the forecasted year 2020 and 2030 volumes without the proposed comprehensive plan amendment, based on the linear background growth discussed in the previous section.

Table 5-10: Traffic Volumes without Comprehensive Plan Amendment

Roadway From	To	2015 AADT	Linear Growth (2015- 2020)	2020 Daily Traffic Volumes w/o Amendment	Linear Growth (2020- 2030)	2020 Daily Traffic Volumes w/o Amendment
US-301						
C-462 (S)	C-462(N)	18,150*	5%	23,595	1%	25,955
C-462(N)	CR 222	18,150*	5%	23,595	1%	25,955
CR 222	C-472	20,500*	5%	26,650	1%	29,315
C-472	C-466	20,300*	5%	26,390	1%	29,029
C-466	CR 204	16,000*	5%	20,800	1%	22,880
CR 204	County Bdry	16,000*	5%	20,800	1%	22,880
C-466						
C-475	CR 229	4,500	5%	5,625	1%	6,188
CR 229	CR 209	5,530	5%	6,913	1%	7,604
CR 209	US 301/SR 35	6,560	5%	8,200	1%	9,020
US 301/SR 35	CR 105	24,380	5%	30,475	1%	33,523
CR 105	CR 103	20,690	5%	25,863	1%	28,449
CR 103	CR 101	26,110	5%	32,638	1%	35,902
CR 101	Buena Vista Blvd	20,740	5%	25,925	1%	28,518
CR 101						
C-466	Woodridge Dr	6,960	5%	8,700	1%	9,570
Woodridge Dr	CR 102	3,770	5%	4,713	1%	5,184
CR 103						
C-466E	Woodridge Dr	2,390	5%	2,988	1%	3,287
Woodridge Dr	CR 102	2,600	5%	3,250	1%	3,575
CR 209						
CR 216	C-466	800	5%	1,000	1%	1,100
C-466	CR 202	490	5%	613	1%	674
CR 472						
US 301	CR 117	4,210	5%	5,263	1%	5,789

*Represents 2014 volume, grown for 6 years to 2020

5.5.3. Daily Project Traffic Volumes

Future year background daily traffic volumes should include growth associated with approved development in the area. Assessing the impacts of comprehensive plan amendments therefore compares future background conditions to the net increase with the comprehensive plan amendment in place rather than the total traffic increase associated with the development of the site.

Daily traffic volumes including the change in future land use are therefore calculated by adding the *net additional* daily project traffic from the site to the daily background traffic for each segment.

Table 5-11 shows the future year daily traffic volumes with and without the comprehensive plan amendment, based on the assumption that the amendment would add approximately **6,964 daily trips** to the network compared to the allowed uses for the site by 2020 (full buildout). Refer to **Table 5-8** for the calculation of the additional trips by segment associated with the amendment.

Table 5-11: Daily Traffic Volume Comparison with Comprehensive Plan Amendment

Roadway From	To	Net New Daily Project Trips from CPA	2020		2030	
			Daily Traffic without Amendment	Daily Traffic with Amendment	Daily Traffic without Amendment	Daily Traffic with Amendment
US-301						
C-462 (S)	C-462(N)	2,089	23,595	25,684	25,955	28,044
C-462(N)	CR 222	2,298	23,595	25,893	25,955	28,253
CR 222	C-472	2,576	26,650	29,226	29,315	31,891
C-472	C-466	2,785	26,390	29,175	29,029	31,814
C-466	CR 204	1,393	20,800	22,193	22,880	24,273
CR 204	County Bdry	1,393	20,800	22,193	22,880	24,273
C-466						
C-475	CR 229	418	5,625	6,043	6,188	6,606
CR 229	CR 209	418	6,913	7,331	7,604	8,022
CR 209	US 301/SR 35	696	8,200	8,896	9,020	9,716
US 301/SR 35	CR 105	2,089	30,475	32,564	33,523	35,612
CR 105	CR 103	2,089	25,863	27,952	28,449	30,538
CR 103	CR 101	2,019	32,638	34,657	35,902	37,921
CR 101	Buena Vista Blvd	1,671	25,925	27,596	28,518	30,189
CR 101						
C-466	Woodridge Dr	70	8,700	8,770	9,570	9,640
Woodridge Dr	CR 102	70	4,713	4,783	5,184	5,254
CR 103						
C-466E	Woodridge Dr	70	2,988	3,058	3,287	3,357
Woodridge Dr	CR 102	70	3,250	3,320	3,575	3,645
CR 209						
CR 216	C-466	139	1,000	1,139	1,100	1,239
C-466	CR 202	139	613	752	674	813
CR 472						
US 301	CR 117	209	5,263	5,472	5,789	5,998

5.5.4. Level of Service

After the daily traffic volumes are determined for the proposed change in future land use, segment LOS is then determined using the FDOT Q/LOS Generalized Service Volume Tables.

If the expected daily LOS with the proposed change in future land use results in a roadway segment with a daily LOS worse than the adopted LOS, then that segment is identified as having an expected capacity deficiency. If this is the case, roadway improvements that mitigate the roadway to an acceptable LOS must be analyzed. Some examples of improvements to consider include adding dedicated turn lanes, adding traffic signals, and widening roadways.

The results of the LOS analysis are shown in **Table 5-12**. In this example, all roadway segments in both the 2020 and 2030 segment analyses had daily levels of service that were projected to meet the adopted LOS, and no mitigation was recommended.

Table 5-12: LOS Comparison with Comprehensive Plan Amendment

Roadway From	To	Maximum Daily Service Volume	Adopted LOS	2020 LOS without Amendment	2020 LOS with Amendment	2030 LOS without Amendment	2030 LOS with Amendment
US-301							
C-462 (S)	C-462(N)	34,000	D	C	C	C	C
C-462(N)	CR 222	39,800	C	C	C	C	C
CR 222	C-472	39,800	D	C	C	C	C
C-472	C-466	39,800	D	C	C	C	C
C-466	CR 204	39,800	D	C	C	C	C
CR 204	County Bdry	39,800	D	C	C	C	C
C-466							
C-475	CR 229	12,900	C	C	C	C	C
CR 229	CR 209	12,900	C	C	C	C	C
CR 209	US 301/SR 35	16,320	D	D	D	D	D
US 301/SR 35	CR 105	39,800	D	C	C	C	C
CR 105	CR 103	39,800	D	C	C	C	C
CR 103	CR 101	39,800	D	C	C	C	D
CR 101	Buena Vista Blvd	39,800	D	C	C	C	C
CR 101							
C-466	Woodridge Dr	29,160	D	C	C	C	C
Woodridge Dr	CR 102	13,320	D	C	C	C	C
CR 103							
C-466E	Woodridge Dr	29,160	D	C	C	C	C
Woodridge Dr	CR 102	13,320	D	C	C	C	C
CR 209							
CR 216	C-466	15,930	D	C	C	C	C
C-466	CR 202	13,320	D	C	C	C	C
CR 472							
US 301	CR 117	15,930	D	C	C	C	C

As mentioned in Case Study A, when a local government implements transportation concurrency, Florida's legislature provides guidance on the cost responsibility of developers for mitigation measures in House Bill (HB) 7202, lines 3566-3584. This section explains that when trips from a proposed development cause a deficiency, the proportionate share contribution shall be calculated using the proportionate-share formula. However, if any road is determined to have a deficiency without the project traffic, the improvements necessary to correct the deficiency is the funding responsibility of the entity which maintains the roadway, and the costs to correct that deficiency shall be removed from the project's proportionate-share calculation. The development's proportionate share is then based only on the needed transportation improvements that are greater than the identified deficiency with the necessary improvements in place.

6. Guidebook Summary

The purpose of this Application Guide is to demonstrate how the Transportation Site Impact Handbook can be used with real-world examples from actual developments in Florida. It is intended to help demonstrate the concepts and guidelines outlined in the Transportation Site Impact Handbook. This guide is not intended to be an exhaustive set of steps to show how to perform site impact analyses, nor is it intended to be prescriptive on how things must be done.

No two development projects are identical, and every project requires consideration of the unique context of the project. Professional judgement is often required in traffic studies. Much of the direction regarding analysis methodology depends on input from local jurisdictions and review of their specific requirements.

It is expected that additional case studies will be added in the future to supplement this Application Guide to address questions as they arise from the use of this Application Guide.