THE UNIVERSITY OF TENNESSEE KNOXVILLE

CENTER FOR TRANSPORTATION RESEARCH

Traffic Impact Analysis

TTAP

Tennessee Transportation Assistance Program

Housekeeping

Attendance – Please sign in typing your full name on the chatbox.

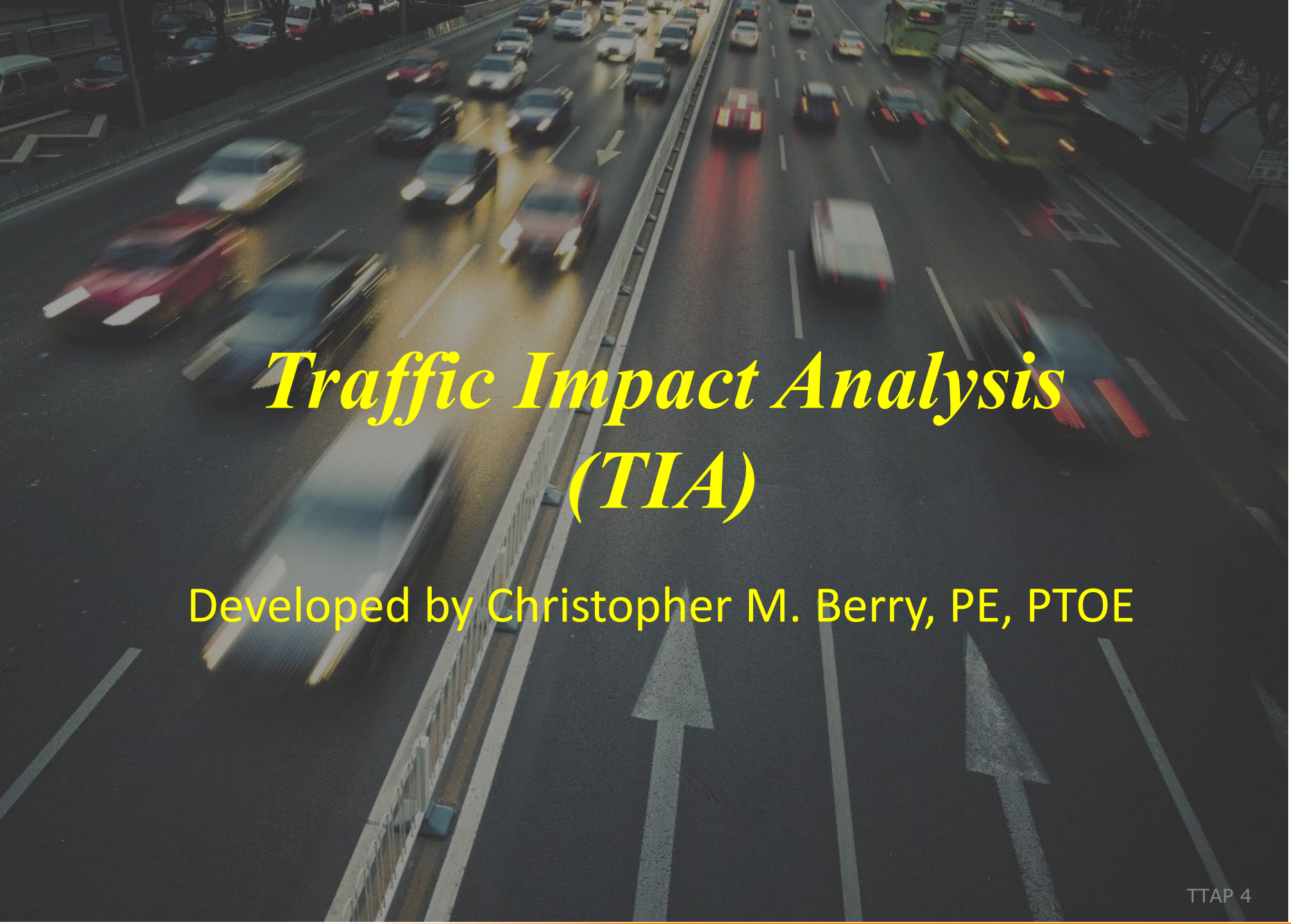
Camera , Audio and Chatbox – Please avoid using your camera during the presentation. Unmute your audio or use the chatbox to answer questions.

PDH certificate – will be sent to your email within the next 2 weeks. Based on your chat box sign in and registration info.

Webinar materials - will be available for download. An email will be sent to you with additional information.

Agenda
Session 1 – TIA Basics

Housekeeping, Introduction, & Session Outline	**2:00-2:15**
What is a TIA?	**2:15-2:25**
Who uses a TIA?	**2:25-2:35**
Qualifications to Prepare a TIA	**2:35-2:45**
Questions & Break	**2:45-3:00**
Typical TIA Policies	**3:00-3:15**
Development Types	**3:15-3:35**
Resources Review	**3:35-3:45**
Questions & Wrap Up	**3:45-4:00**



Traffic Impact Analysis (TIA)

Developed by Christopher M. Berry, PE, PTOE

Instructor

Christopher Berry, PE, PTOE

Berry Engineers, LLC

Cleveland, TN

cberry@berryengineers.com

Session 1: TIA Basics

+ *What is a TIA?*
+ *Who uses a TIA?*
+ *Qualifications to Prepare a TIA*
+ *Typical TIA Policies*
+ *Development Types*

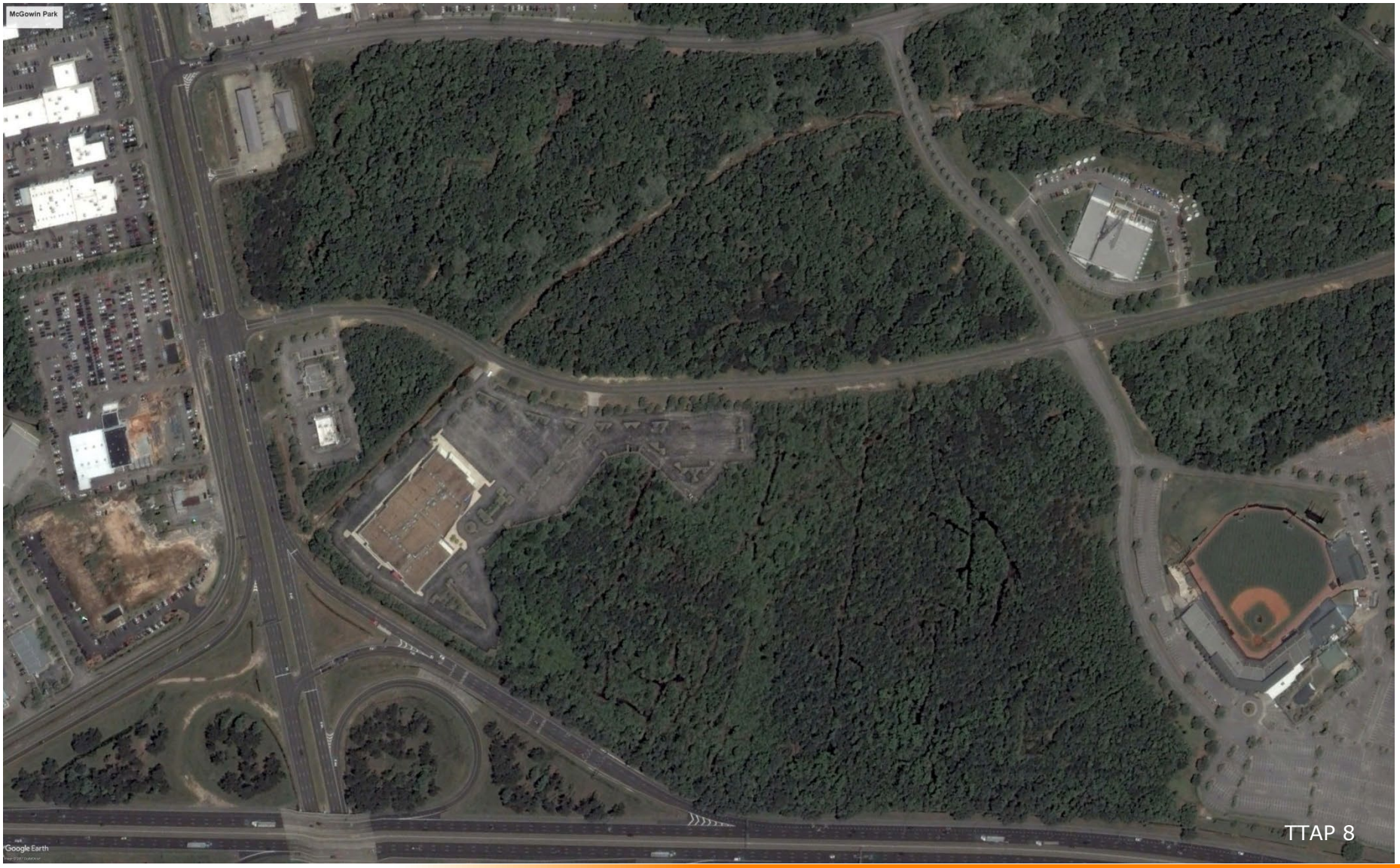
Session 2: TIA Steps

Session 3: TIA Results & Details

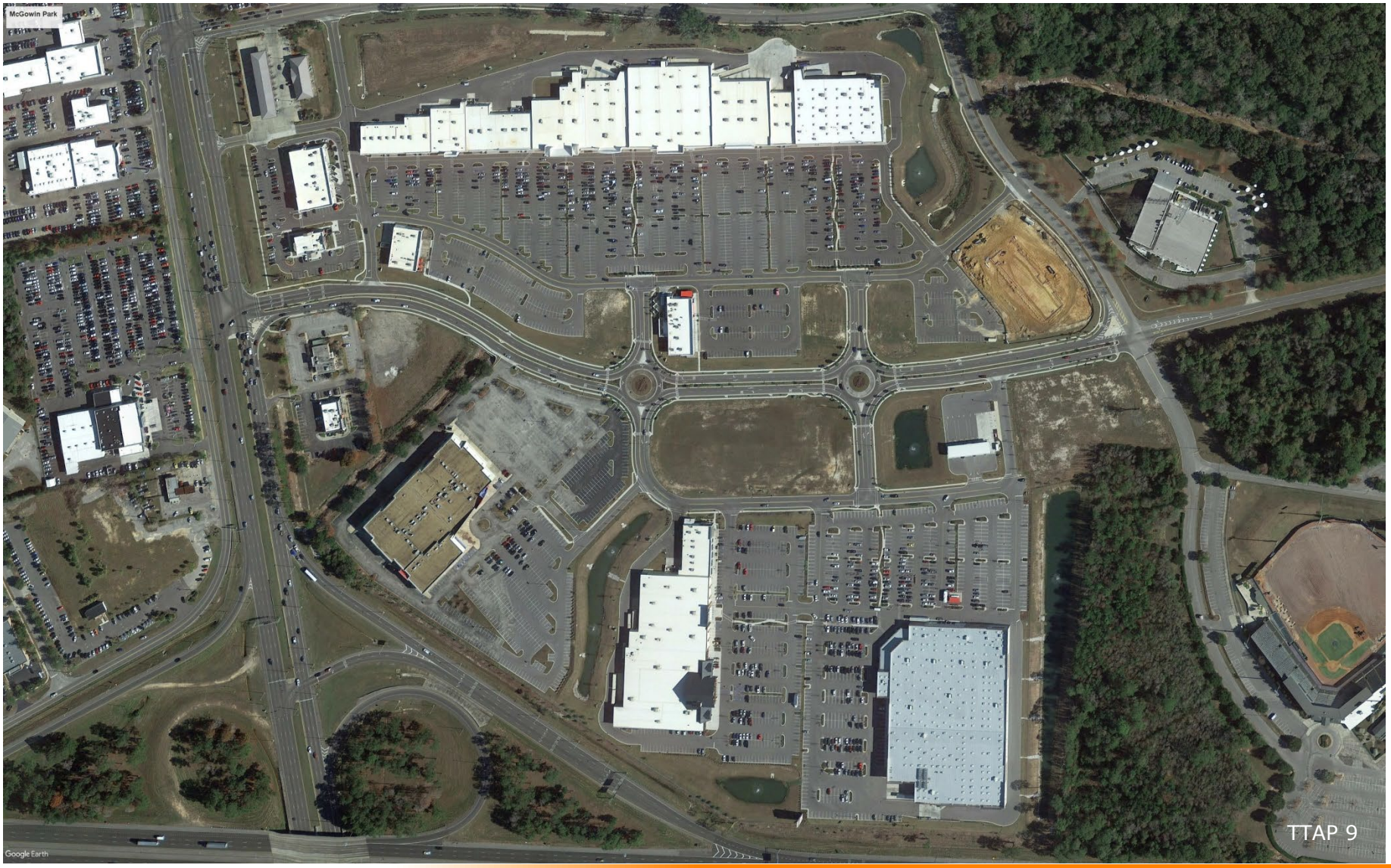
What is a TIA?

Traffic impact analysis (TIA's) are intended to consider the transportation impacts of a proposed development on the existing transportation facilities. Typically the report focuses on operational characteristics (level-of-service, capacity, delay, etc.), but can also include safety items such as intersection geometrics, sight distance, crash history, etc. The objective of the study is to clearly identify the impacts of the proposed project and any corresponding facility improvements that are necessary.

Example of Why – Mobile, AL



Example of Why – Mobile, AL



Who does a TIA involve?

-Department of Transportation
-Local Government (City/County)
-Developer

Others:
-Regional Planning Agency
-Railroad Company
-School Board

What is the purpose of a TIA?

The objective of the study is to clearly identify the impacts of the proposed project and any corresponding facility improvements that are necessary.

Perspectives:

-Department of Transportation
-Local Government (City/County)
-Developer

Who Should Prepare TIA Studies?

Who should prepare TIA?

TDOT Traffic Design Manual, Chapter 2

"All traffic impact studies shall be prepared by a registered P.E., or an individual under the supervision of a registered P.E. The P.E. shall have specific training in traffic engineering and be in good standing with the State of Tennessee. All traffic impact studies submitted to TDOT for final review shall be signed and sealed by the P.E."

Do we need to verify their qualifications beyond a PE?
Considerations to keep in mind:
-Size of the Development/Impacts
-Complexity of the Transportation System

Self-Certification Example

Certification of Qualification

To Perform Transportation Impact Studies

This is to request that my name be added to the Greensboro Department of Transportation's list of professional engineers approved to perform transportation impact studies within the City of Greensboro. I hereby certify that I am a licensed professional engineer in the state of North Carolina and am proficient with the skill necessary to perform transportation impact studies. This includes, but is not limited to, knowledge of The Institute of Transportation Engineers Trip Generation Manual, The Transportation Research Board's (Special Report 209) Highway Capacity Manual, and various signal system analysis techniques. I have performed transportation impact studies in other jurisdictions and I am familiar with the Greensboro Department of Transportation's transportation impact study guidelines.

When should a TIA be prepared and reviewed?

Development Processes

-Rezoning

Many places require TIA's as part of the rezoning process. Before converting a low-traffic property to a higher intensity permissible use, they ensure the transportation facilities are adequate.

-Platting

Some places that don't use zoning may required TIA's as part of the subdivision process.

-Permit Review

Most of the time, we see TIA's required as part of the access permitting review.

Policy Considerations

Often the requirements for TIA's are classified into categories based on their impact size. Typical policy thresholds:

50-100 peak hour trips generated
- Development driveway only

100-500 peak hour trips generated
-Development driveways
-Significant intersections within ¼ mile

>500 peak hour trips generated
-Development driveways
-Significant intersections within ½ mile
-Interstate interchanges impacted?

Example Policy

Traffic Impact Analysis Categories			
TIA Category	**Trip Generation Threshold[1]**	**Horizon Year(s)[2]**	**Study Area**
Traffic Impact Statement	Developments that are estimated to generate less than 100 trips during the highest peak hour.	Opening Year	To be determined by City Traffic Engineer
1	Developments that are estimated to generate greater than 100 but less than 500 vehicle trips during the highest peak hour.	Opening Year and 5 years in the future	1. Site access drives 2. All major signalized and unsignalized intersections within ¼ mile and all major driveways within 500 feet 3. All roadway segments within ¼ mile of the project site boundary
2	Developments that are estimated to generate more than 500 but less than 1,000 vehicle trips during the highest peak hour.	Opening Year plus 5 and 10 years in the future (phasing of the development must also be considered)	1. Site access drives 2. All major signalized and unsignalized intersections and all major driveways within a ½ mile radius of the project site boundary 3. All roadway segments within ½ mile of the project site boundary
3	Those developments that are estimated to generate more than 1,000 but less than 1,500 vehicle trips during the highest peak hour.	Opening Year plus 5, 10, 15 years in the future (phasing of the development must also be considered)	1. Site access drives 2. All major signalized and unsignalized intersections and all major driveways within a 1-mile radius of the project site boundary 3. All roadway segments within 1 mile of the project site boundary
4	Regional Development generating 1,500 or greater trips during the highest peak hour.	Opening Year plus 5, 10, 15, and 20 years in future or as specified in the Phasing Schedule	1. Site access drives 2. All major signalized and unsignalized intersections and all major driveways within an impact area defined during the scoping meeting 3. All roadway segments within an impact area defined during the scoping meeting

Development Types

-Single Family Residential
-Multi-Family Residential
-Commercial (Retail & Services)
-Professional/Office
-Mixed Use
-Industrial

Single Family Residential

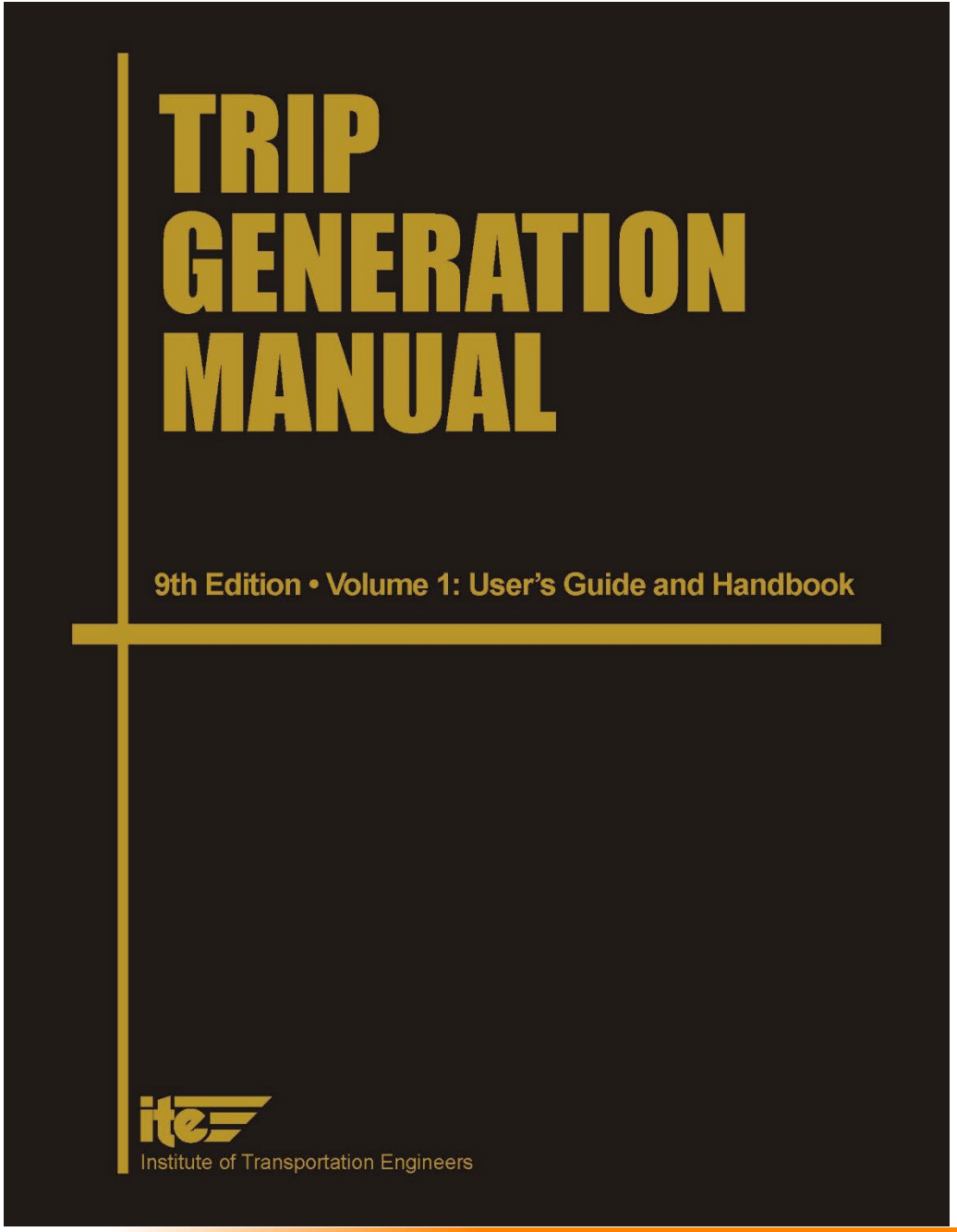
Multi-Family Residential

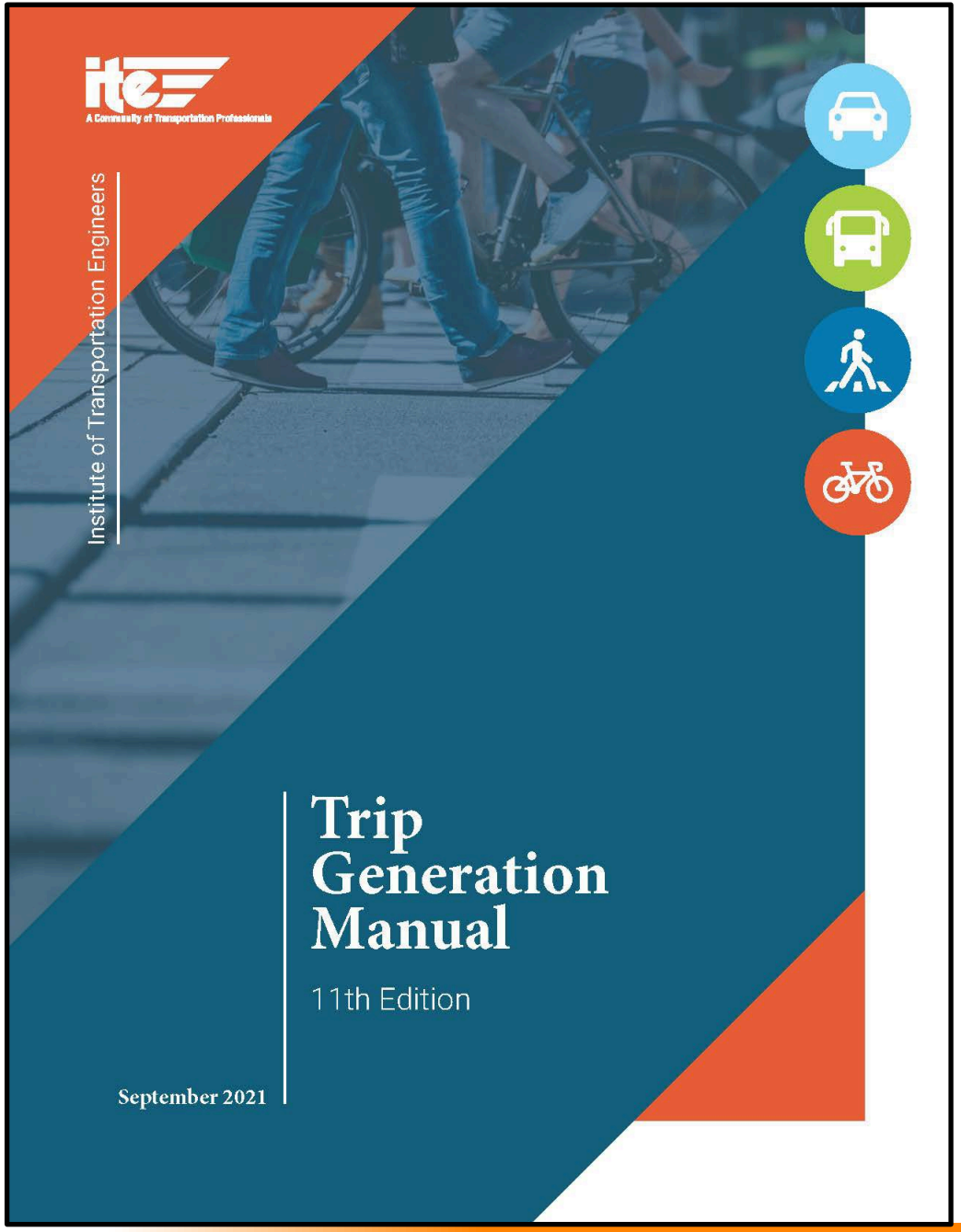
Commercial

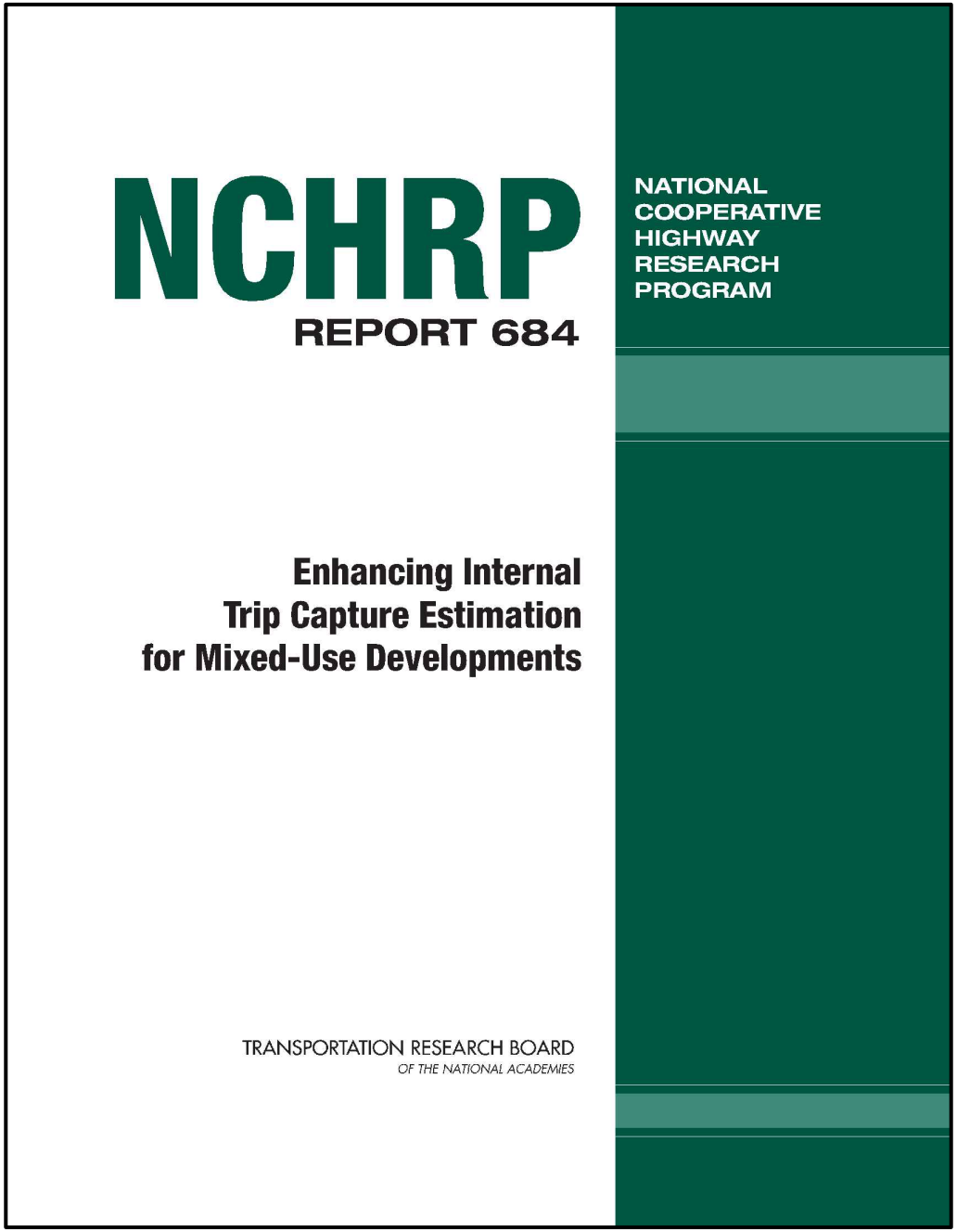
Office

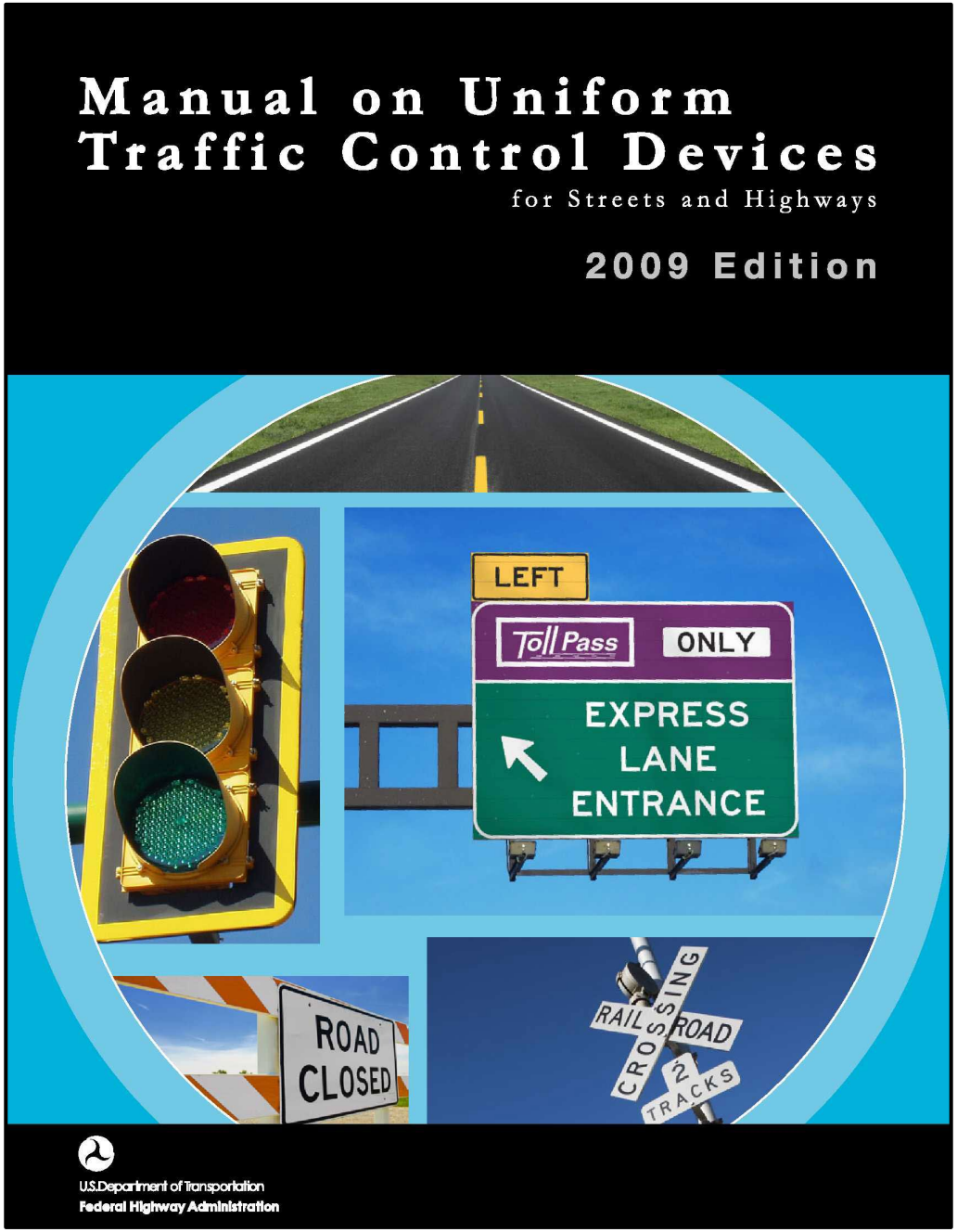
Mixed Use

Questions?









So How Exactly Do We Start?

THE UNIVERSITY OF TENNESSEE KNOXVILLE

CENTER FOR TRANSPORTATION RESEARCH

Traffic Impact Analysis

TTAP

Tennessee Transportation Assistance Program

Housekeeping

Attendance – Please sign in typing your full name on the chatbox.

Camera , Audio and Chatbox – Please avoid using your camera during the presentation. Unmute your audio or use the chatbox to answer questions.

PDH certificate – will be sent to your email within the next 2 weeks. Based on your chat box sign in and registration info.

Webinar materials - will be available for download. An email will be sent to you with additional information.

Agenda
Session 2 – TIA Steps

Housekeeping & Session Outline	**2:00-2:10**
Existing Conditions	**2:10-2:25**
Trip Generation	**2:25-2:45**
Trip Distribution	**2:45-3:00**
Questions & Break	**3:00-3:15**
Project Example	**3:15-3:40**
Questions & Wrap Up	**3:40-4:00**

So How Exactly Do We Start?

TIA Steps

-Existing Conditions / Counts
-Generation of Project Trips
-Distribution of Project Trips
-Operational Analysis Results
-Proposed Improvements
-Other Considerations

Existing Conditions

-Facility Characteristics

+Number of Lanes
+Speed Limit
+Signalized / Unsignalized
+Pedestrian Facilities

-Traffic Characteristics

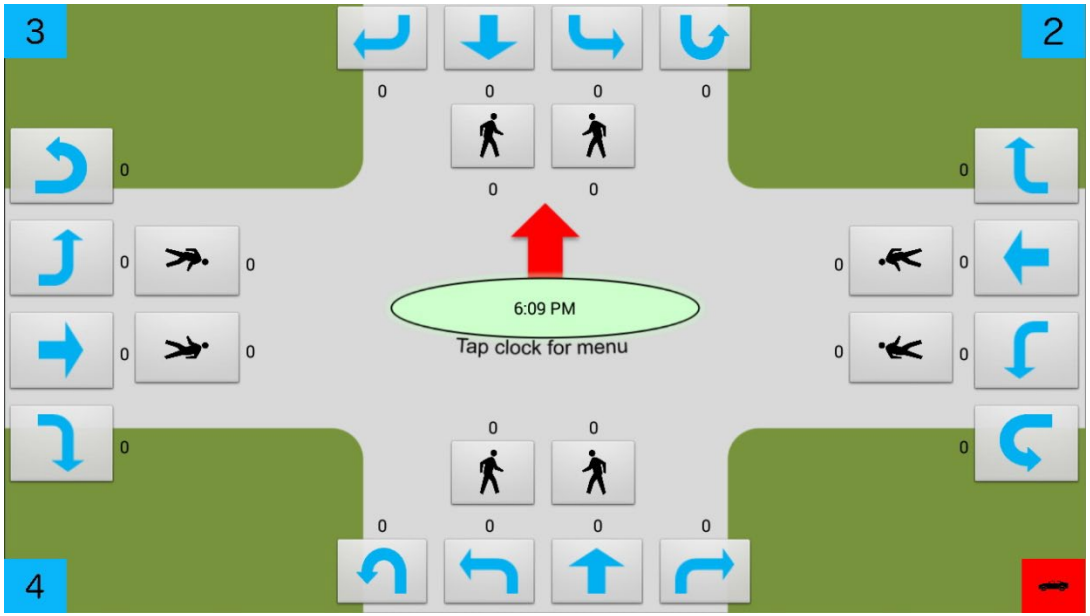
+Existing Traffic Volumes
+Directional Patterns of Traffic
+Percentage of Heavy Vehicles / Trucks
+Pedestrian Volumes

ADT Counts

-Typically 24-48 hour counts used to establish the total daily volume, directional distribution, vehicle classification and the percentage of trips during the AM/PM peak hour.

TMC Counts

-Turning movement counts are conducted at intersections to determine the percentage of traffic making each movement during the AM/PM peak.



What is a Trip?

A trip is defined as a single or one-directional travel movement with either the origin or the destination of the trip inside the study limits.

Trip Generation:

How many trips are there?

Primary Source

Institute of Transportation Engineers (ITE) Trip Generation Manual

Other Sources

Department of Transportation Data
Field Studies
Tenant/Consumer Data

Setting/Location

Center City Core—the downtown area for a major metropolitan region at the focal point of a regional light- or heavy-rail transit system. This area type is typified by multi-storied buildings, a wide range of land uses, an extensive pedestrian sidewalk network, and shared and priced parking both on-street and in structured garages or surface lots. The area typically has more jobs than residents and therefore is typically an employment destination. The area also includes the immediate vicinity of the commercial core.

Dense Multi-Use Urban—a fully-developed area (or nearly so), with diverse and interacting complementary land uses, good pedestrian connectivity, and convenient and frequent transit. This area type can be a well-developed urban area outside a major metropolitan downtown or a moderate size urban area downtown. The land use mix typically includes office, retail, residential, and often entertainment, hotel, and other commercial uses. The residential uses are typically multifamily or single-family on lots no larger than one-fourth acre. The commercial uses often have little or no setback from the sidewalk. Because the motor vehicle still represents the primary mode of travel to and from the area, there typically is on-street parking and often off-street public parking. The complementary land uses provide the opportunity for short trips within the Dense Multi-Use Urban area, made convenient by walking, biking, or transit. The area is served by significant transit (either rail or bus) that enables a high level of transit usage to and from area development.

General Urban/Suburban—an area associated with almost homogeneous vehicle-centered access. Nearly all person trips that enter or exit a development site are by personal passenger or commercial vehicle. The area can be fully developed (or nearly so) at low-medium density with a mix of residential and commercial uses. The commercial land uses are typically concentrated at intersections or spread along commercial corridors, often surrounded by low-density, almost entirely residential development. Most commercial buildings are located behind the parking area or surrounded by parking. The mixing of land uses is only in terms of their proximity, not in terms of function. A retail land use may focus on serving a regional clientele whereas a service land use may target motorists or pass-by vehicle trips for its customers. Even if the land uses are complementary, a lack of pedestrian, bicycling, and transit facilities or services limit non-vehicle travel.

Rural—agricultural or undeveloped except for scattered parcels and at very low densities.

Single-Family Detached Housing (210)

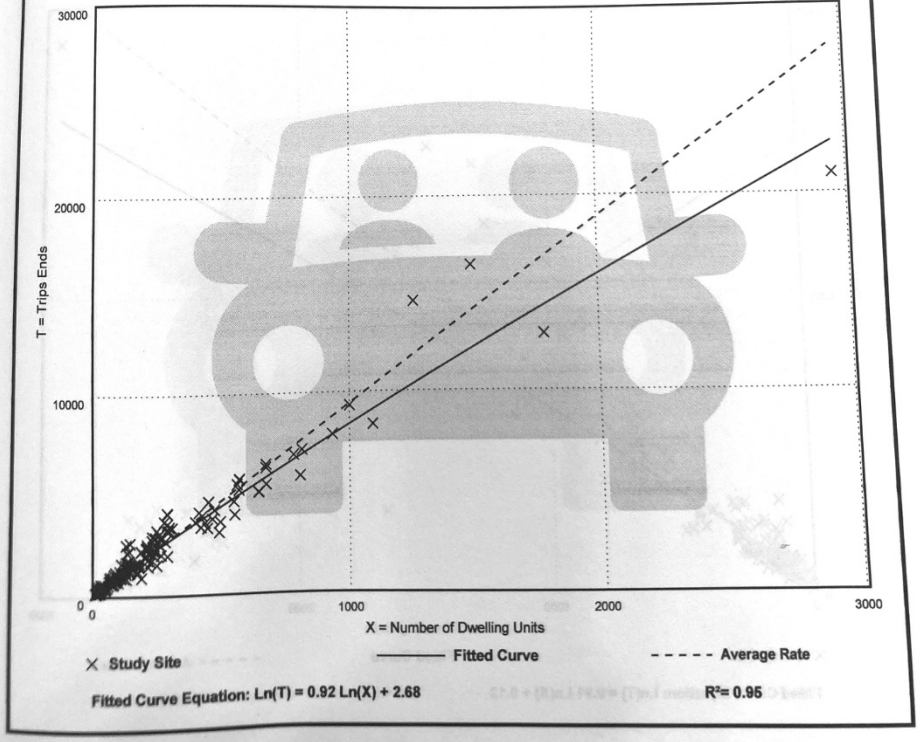
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 174
Avg. Num. of Dwelling Units: 246
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
9.43	4.45 - 22.61	2.13

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.92 Ln(X) + 2.68 R^2= 0.95

Single-Family Detached Housing (210)

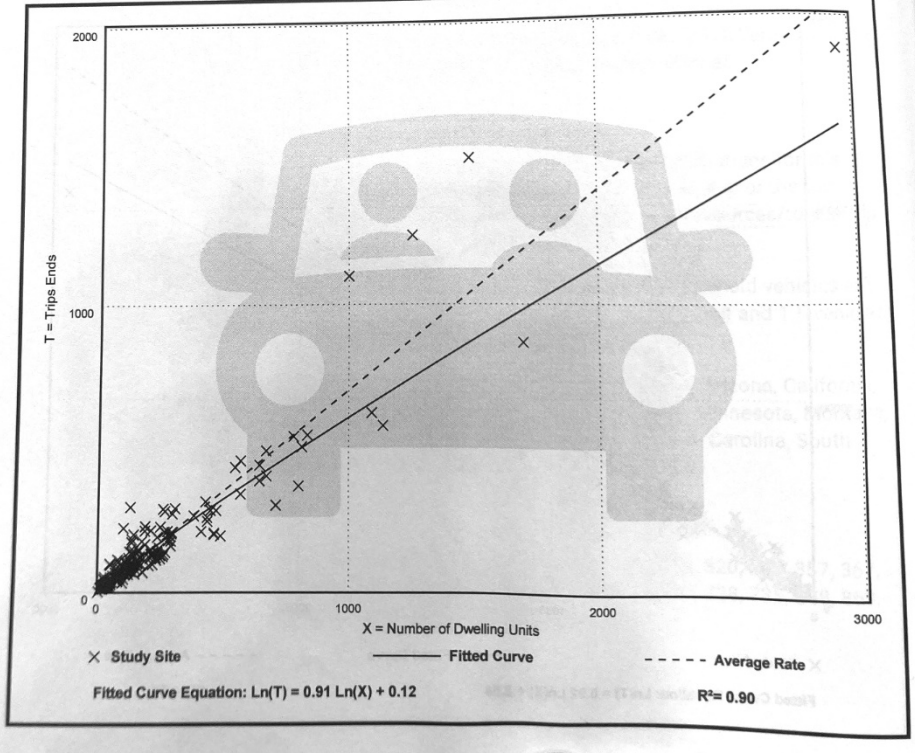
Vehicle Trip Ends vs: Dwelling Units
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 7 and 9 a.m.

Setting/Location: General Urban/Suburban
Number of Studies: 192
Avg. Num. of Dwelling Units: 226
Directional Distribution: 26% entering, 74% exiting

Vehicle Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.70	0.27 - 2.27	0.24

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.91 Ln(X) + 0.12 R^2= 0.90

Shopping Center (>150k)
(820)

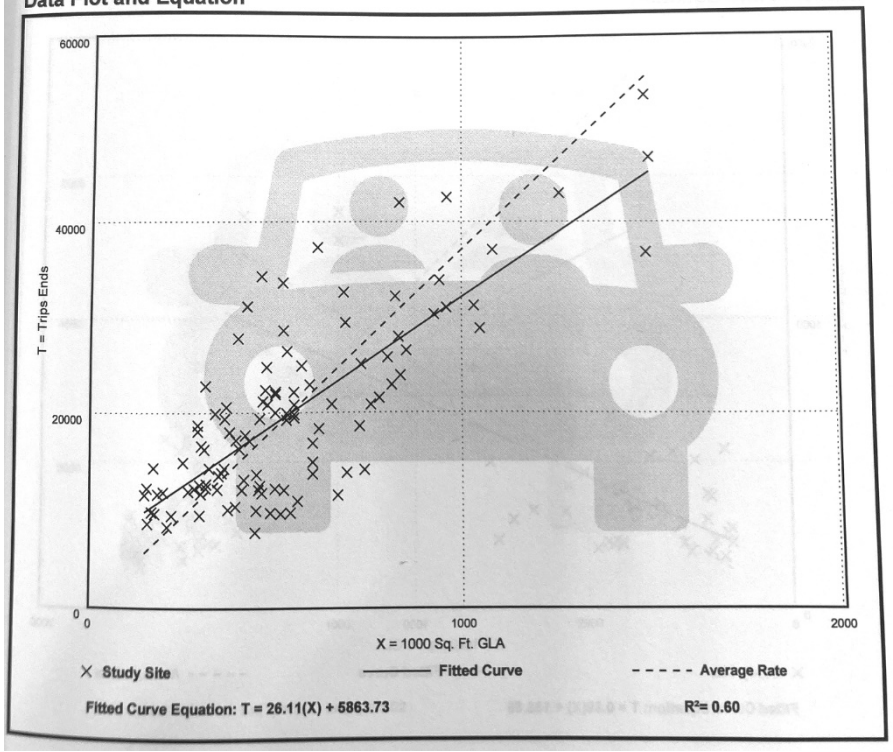
Vehicle Trip Ends vs: 1000 Sq. Ft. GLA
On a: Weekday

Setting/Location: General Urban/Suburban
Number of Studies: 108
Avg. 1000 Sq. Ft. GLA: 538
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per 1000 Sq. Ft. GLA

Average Rate	Range of Rates	Standard Deviation
37.01	17.27 - 81.53	12.79

Data Plot and Equation



Fitted Curve Equation: T = 26.11(X) + 5863.73 R^2= 0.60

Shopping Center (>150k)
(820)

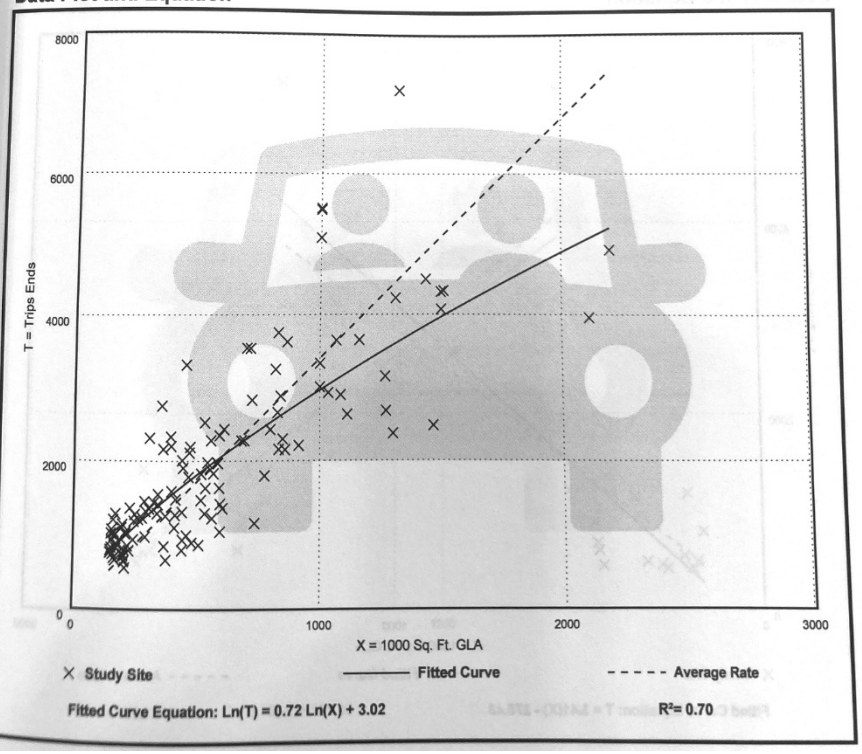
Vehicle Trip Ends vs: 1000 Sq. Ft. GLA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Setting/Location: General Urban/Suburban
Number of Studies: 126
Avg. 1000 Sq. Ft. GLA: 581
Directional Distribution: 48% entering, 52% exiting

Vehicle Trip Generation per 1000 Sq. Ft. GLA

Average Rate	Range of Rates	Standard Deviation
3.40	1.57 - 7.58	1.26

Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.72 Ln(X) + 3.02 R^2= 0.70

Land Use: 820
Shopping Center (>150k)

Description

A shopping center is an integrated group of commercial establishments that is planned, developed, owned, and managed as a unit. Each study site in this land use has at least 150,000 square feet of gross leasable area (GLA). It often has more than one anchor store. Various names can be assigned to a shopping center within this size range, depending on its specific size and tenants, such as community center, regional center, superregional center, fashion center, and power center.

A shopping center of this size typically contains more than retail merchandising facilities. Office space, a movie theater, restaurants, a post office, banks, a health club, and recreational facilities are common tenants.

A shopping center of this size can be enclosed or open-air. The vehicle trips generated at a shopping center are based upon the total GLA of the center. In the case of a smaller center without an enclosed mall or peripheral buildings, the GLA is the same as the gross floor area of the building.

The 150,000 square feet GLA threshold value between community/regional shopping center and shopping plaza (Land Use 821) is based on an examination of trip generation data. For a shopping plaza that is smaller than the threshold value, the presence or absence of a supermarket within the plaza has a measurable effect on site trip generation. For a shopping center that is larger than the threshold value, the trips generated by its other major tenants mask any effects of the presence or absence of an on-site supermarket.

Shopping plaza (40-150k) (Land Use 821), strip retail plaza (<40k) (Land Use 822), and factory outlet center (Land Use 823) are related uses.

Additional Data

Many shopping centers—in addition to the integrated unit of shops in one building or enclosed around a mall—include outparcels (peripheral buildings or pads located on the perimeter of the center adjacent to the streets and major access points). These buildings are typically drive-in banks, retail stores, restaurants, or small offices. Although the data herein do not indicate which of the centers studied include peripheral buildings, it can be assumed that some of the data show their effect.

How many trips does the project generate?

Size of Project x Trip Generation Rate = Total Trips (Daily, Peak Hour, Etc. based on Rate Chosen)

Are all trips the same??

Entering vs. Exiting

Remember: The trips you calculated is the total number. You must multiply by the directional percentage to get entering trips separate from exiting trips.

Types of Trips

New Trips

+These are new vehicles on the road. They represent a user that starts from an origin, travels to the project, and then return to their origin. (technically 2 trips…)

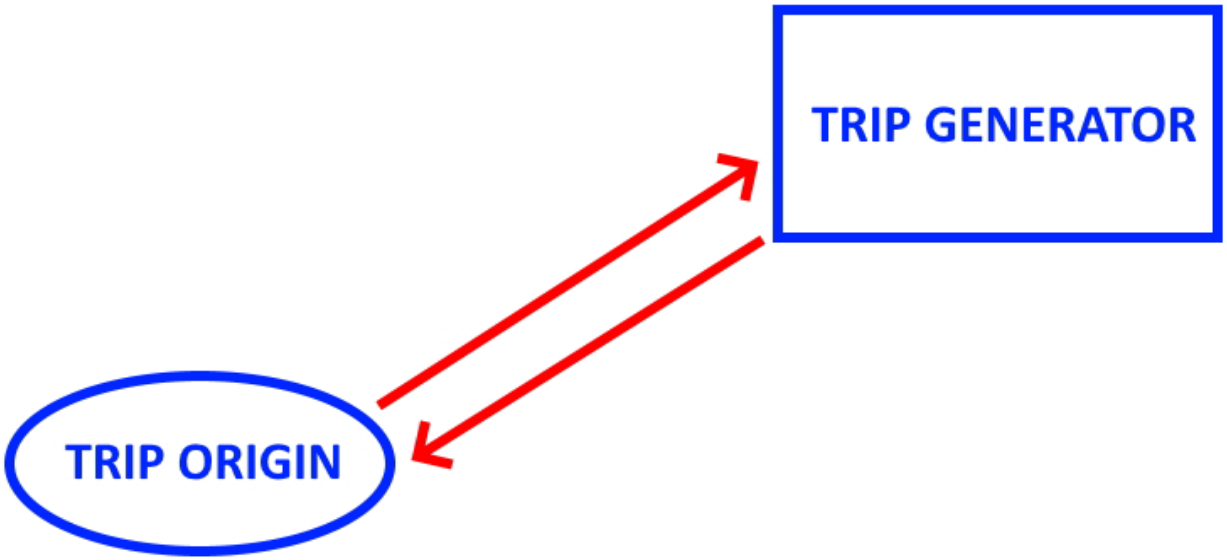
Pass-by Trips (Diverted)

+These are vehicles currently on the roadway network, but they divert their path to the project. These users start from their origin (A), travel to the project, and then exit on to their destination (B).

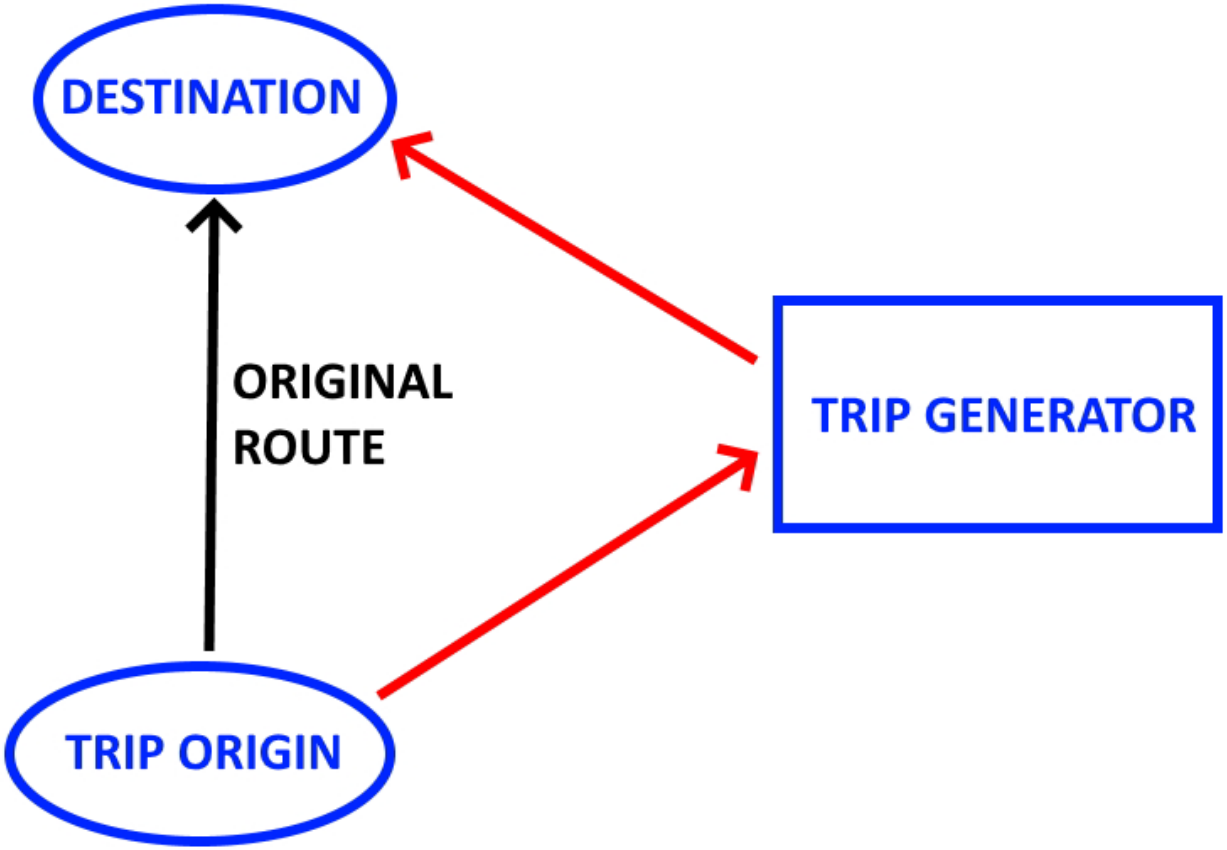
Internal Capture

+This only applies to large projects that have mixed uses. It must have a mix of residential, retail, entertainment, and/or office uses for this to apply.

New Trips



Pass-By Trips



https://www.ite.org/ITEORG/assets/File/Trip%20Generation%20Appendices%20PUBLISHED/Appendices/Pass-By%20Tables%20-%20Trip%20Generation%20Manual%2011th%20Ed.xlsx
(Google it…)

Pass-By Trips – How Many?

Table 5.29
Pass-By Trips and Diverted Linked Trips
Weekday, a.m. Peak Period

Land Use 945—Gasoline/Service Station with Convenience Market

SIZE (1,000 SQ. FT. GFA)	VEHICLE FUELING POSITIONS	LOCATION	WEEKDAY SURVEY DATE	NO. OF INTERVIEWS	TIME PERIOD	PRIMARY TRIP (%)	NON-PASS-BY TRIP (%)	DIVERTED LINKED TRIP (%)	PASS-BY TRIP (%)	ADJ. STREET PEAK HOUR VOLUME	SOURCE
0.8	8	Louisville area, KY	1993	61	7:00–9:00 a.m.	15	—	25	60	4,000	Barton-Aschman Assoc.
0.6	8	Louisville, KY	1993	48	7:00–9:00 a.m.	13	—	19	68	1,307	Barton-Aschman Assoc.
0.7	10	Louisville, KY	1993	47	7:00–9:00 a.m.	11	—	22	67	1,105	Barton-Aschman Assoc.
0.7	8	Louisville area, KY	1993	n/a	7:00–9:00 a.m.	22	—	22	56	1,211	Barton-Aschman Assoc.
0.7	10	Louisville area, KY	1993	n/a	7:00–9:00 a.m.	31	—	12	46	1,211	Barton-Aschman Assoc.
0.3	n/a	Louisville area, KY	1993	75	7:00–9:00 a.m.	15	—	13	72	n/a	Barton-Aschman Assoc.
0.8	8	Silver Spring, MD	1992	36	7:00–9:00 a.m.	14	—	39	47	3,095	RBA
0.4	8	Derwood, MD	1992	46	7:00–9:00 a.m.	0	—	25	75	3,770	RBA
2.2	8	Kensington, MD	1992	31	7:00–9:00 a.m.	34	—	19	47	1,785	RBA
1	8	Silver Spring, MD	1992	35	7:00–9:00 a.m.	9	—	13	78	7,080	RBA

Average Pass-By Trip Percentage: 62

Pass-By Trips – How Many?

Table 5.24
Pass-By Trips and Diverted Linked Trips
Weekday, p.m. Peak Period

Land Use 934—Fast-Food Restaurant with Drive-Through Window

SEATS	SIZE (1,000 SQ. FT. GFA)	LOCATION	WEEKDAY SURVEY DATE	NO. OF INTERVIEWS	TIME PERIOD	PRIMARY TRIP (%)	NON-PASS-BY TRIP (%)	DIVERTED LINKED TRIP (%)	PASS-BY TRIP (%)	ADJ. STREET PEAK HOUR VOLUME	SOURCE
n/a	~2.6	Minn-St. Paul, MN	1987	50	3:00–7:00 p.m.	27	—	48	25	n/a	n/a
n/a	<5.0	Chicago suburbs, IL	1987	80	3:00–6:00 p.m.	—	62	—	38	n/a	Kenig, O'Hara, Humes, Flock
n/a	<5.0	Chicago suburbs, IL	1987	100	3:00–6:00 p.m.	—	45	—	55	n/a	Kenig, O'Hara, Humes, Flock
n/a	<5.0	Chicago suburbs, IL	1987	159	3:00–6:00 p.m.	—	44	—	56	n/a	Kenig, O'Hara, Humes, Flock
n/a	<5.0	Chicago suburbs, IL	1987	225	3:00–6:00 p.m.	—	52	—	48	n/a	Kenig, O'Hara, Humes, Flock
n/a	<5.0	Chicago suburbs, IL	1987	88	3:00–6:00 p.m.	—	65	—	35	n/a	Kenig, O'Hara, Humes, Flock
n/a	<5.0	Chicago suburbs, IL	1987	84	3:00–6:00 p.m.	—	56	—	44	n/a	Kenig, O'Hara, Humes, Flock
88	1.3	Louisville area, KY	1993	n/a	4:00–6:00 p.m.	22	—	10	68	2,055	Barton-Aschman Assoc.
120	1.9	Louisville area, KY	1993	33	4:00–6:00 p.m.	24	—	9	67	2,447	Barton-Aschman Assoc.
87	4.2	New Albany, IN	1993	n/a	4:00–6:00 p.m.	25	—	19	56	1,632	Barton-Aschman Assoc.
150	3.0	Louisville area, KY	1993	n/a	4:00–6:00 p.m.	31	—	38	31	4,250	Barton-Aschman Assoc.
n/a	3.1	Kissimmee, FL	1995	28	2:00–6:00 p.m.	—	29	n/a	71	n/a	TPD Inc.
n/a	3.1	Apopka, FL	1996	29	2:00–6:00 p.m.	—	62	n/a	38	n/a	TPD Inc.
n/a	2.8	Winter Springs, FL	1995	47	2:00–6:00 p.m.	—	34	—	66	n/a	TPD Inc.
n/a	4.3	Longwood, FL	1994	304	2:00–6:00 p.m.	—	38	—	62	n/a	TPD Inc.
n/a	3.2	Altamonte Springs, FL	1996	202	2:00–6:00 p.m.	39	—	21	40	n/a	TPD Inc.
n/a	2.9	Winter Park, FL	1996	271	2:00–6:00 p.m.	41	—	18	41	n/a	TPD Inc.
n/a	3.3*	several	1996	varies	4:00–6:00 p.m.	—	38	—	62	n/a	Oracle Engineering

* Average of several combined studies.
Average Pass-By Trip Percentage: 50

Pass-By Trips – How Many?

Table 5.26
Pass-By Trips and Diverted Linked Trips
Weekday

Land Use 935—Fast-Food Restaurant with Drive-Through Window and No Indoor Seating
(Specialized Land Use: Coffee/Espresso Stand)

EMPLOYEES	LOCATION	WEEKDAY SURVEY DATE	NO. OF INTERVIEWS	TIME PERIOD	PRIMARY TRIP (%)	NON-PASS-BY TRIP (%)	DIVERTED LINKED TRIP (%)	PASS-BY TRIP (%)	SOURCE
1	Vancouver, WA	Nov. 1997	70	6:00 a.m.–6:00 p.m.	—	17	—	83	Kittelson & Associates Inc.
1	Woodburn, OR	Feb. 1998	109	6:00 a.m.–6:00 p.m.	—	5	—	95	Kittelson & Associates Inc.
1	Vancouver, WA	Feb. 1998	83	6:00 a.m.–1:00 p.m.	—	11	—	89	Kittelson & Associates Inc.

Average Pass-By Trip Percentage: 89

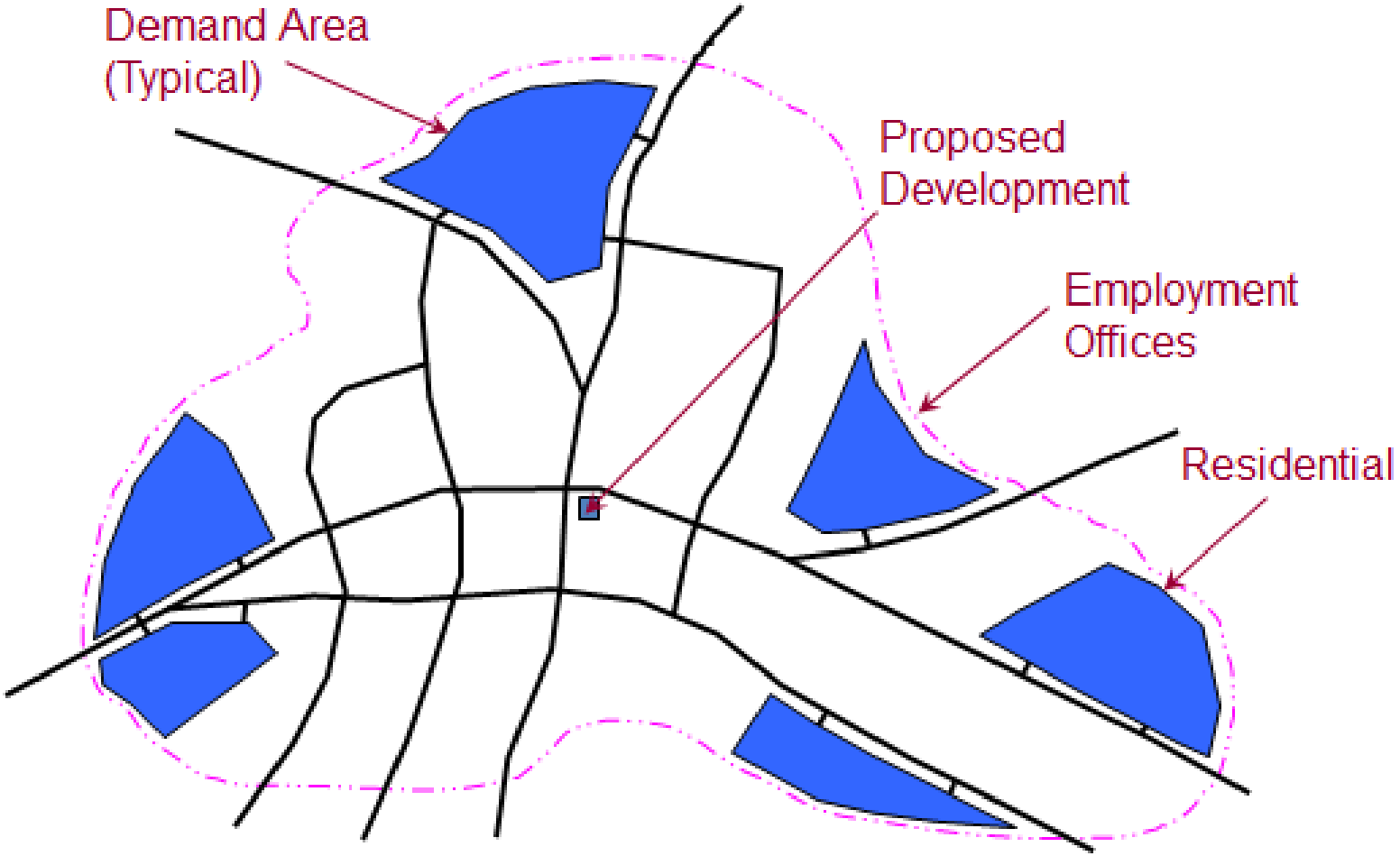
Modal Split:
How are they coming?

Modal split would only apply if users have arrive at the project site by multiple means of transportation.

This means if you have significant public transportation or transit options, then we need to consider how to account that not all users will arrive by personal vehicle.

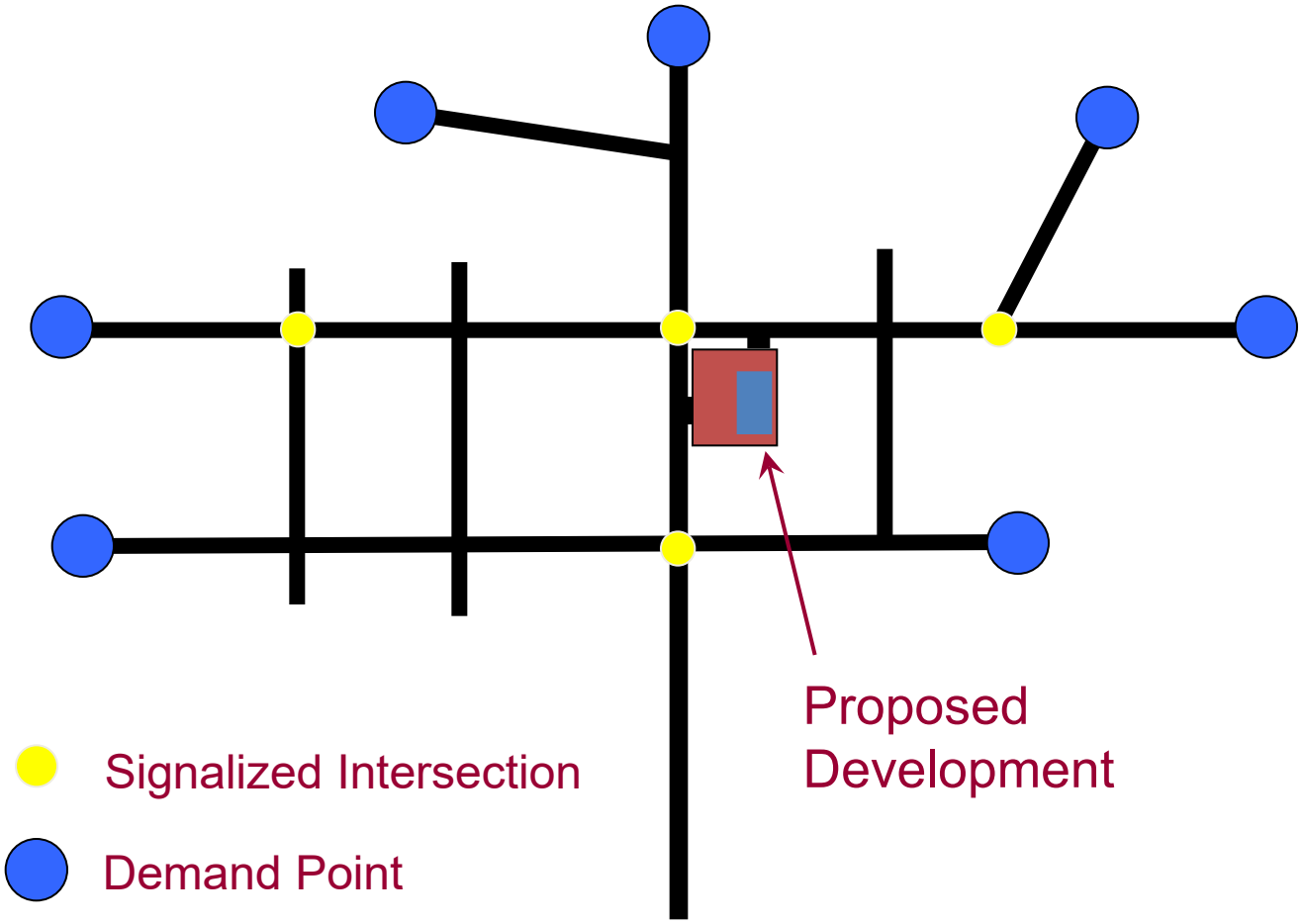
Trip Distribution:

Where did they come from?
Where did they go?

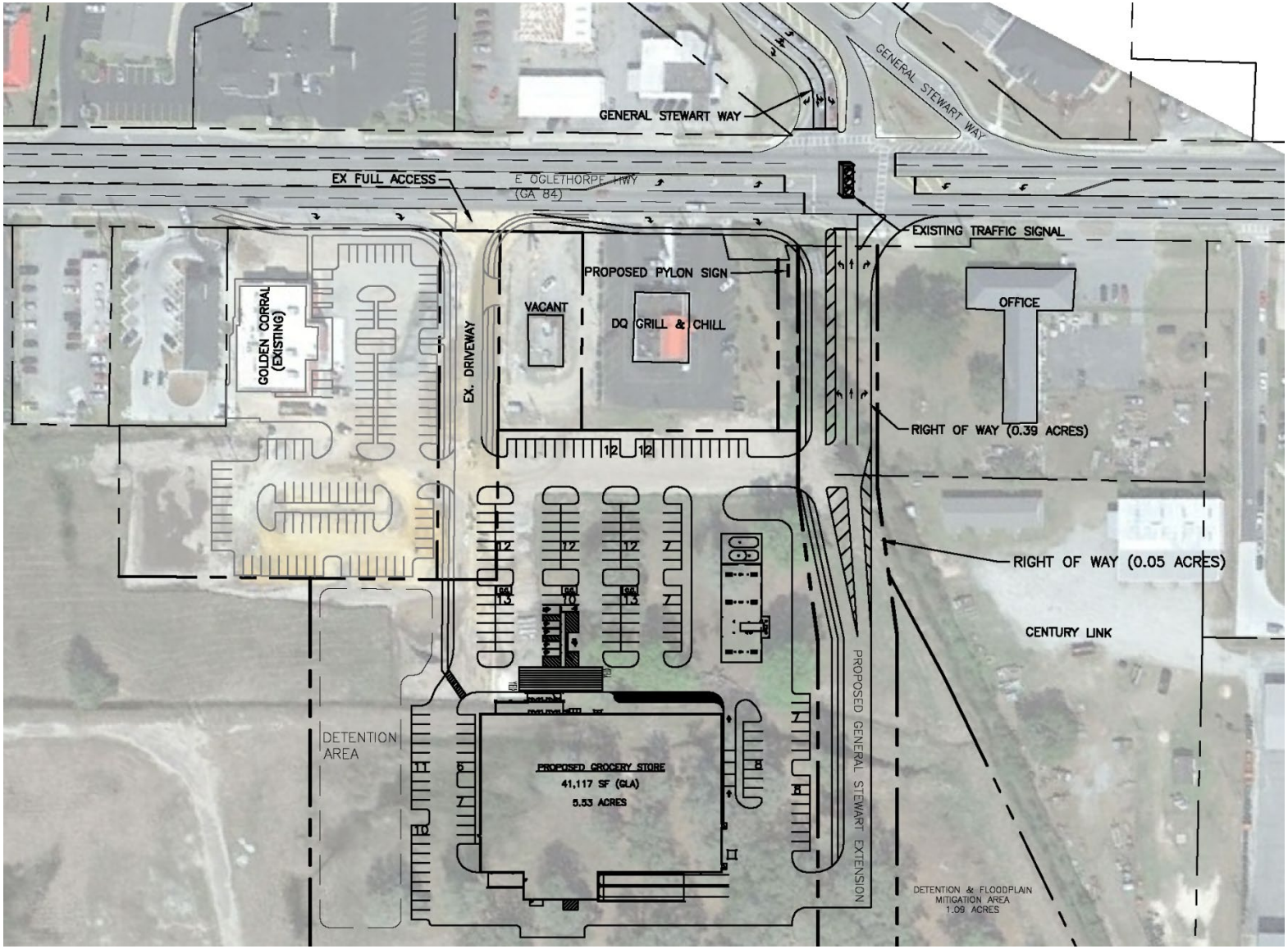


Trip Distribution:

Network Schematic



Project Example–Concept Plan

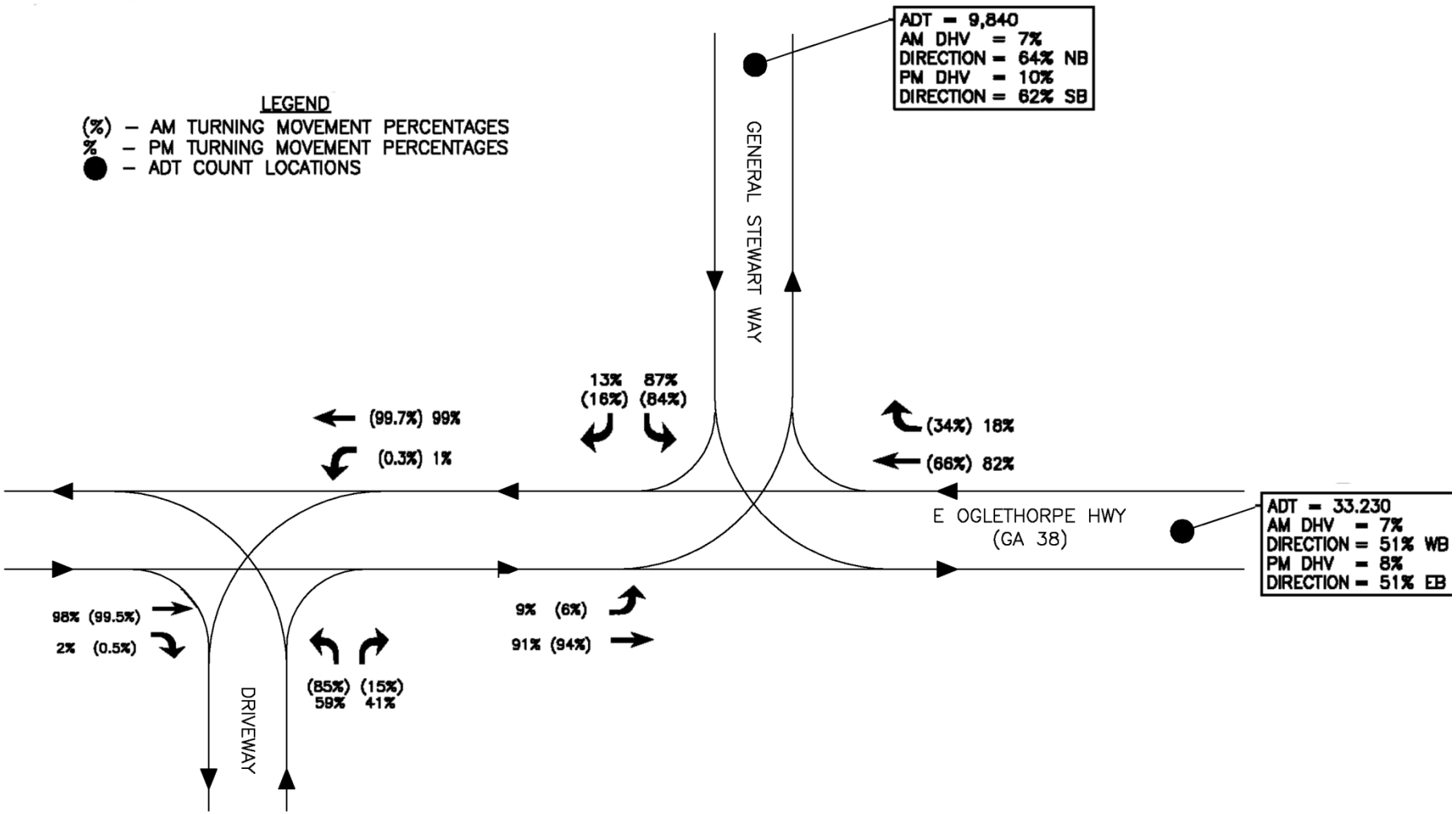


Project Example–Generated Trips

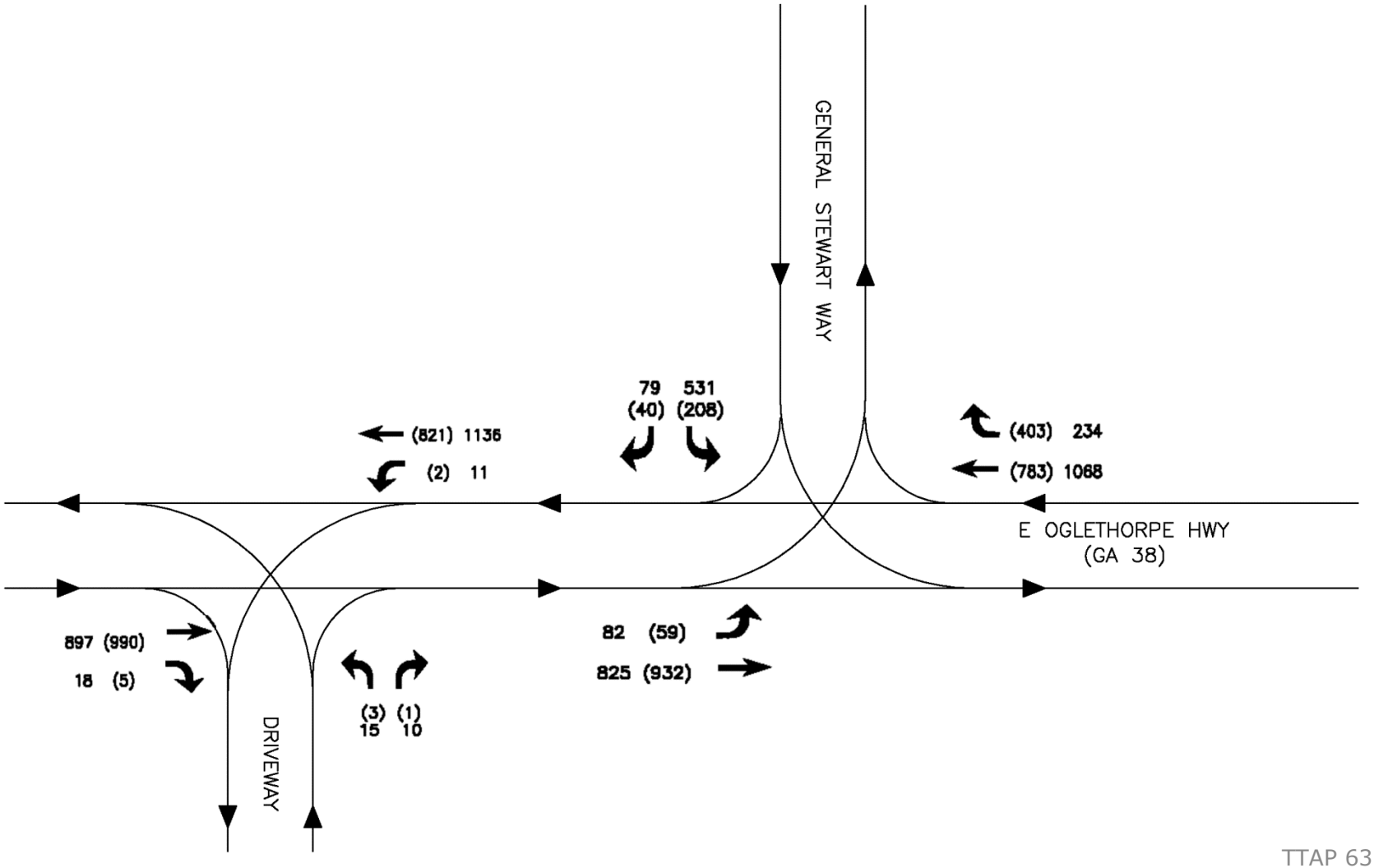
Table 4 – Development Generated Traffic Volumes

TRIP GENERATION DETAILS FOR PROPOSED GROCERY STORE - HINESVILLE, GA									
ITE LAND USE	DESCRIPTION	QUANTITY	UNITS	AM RATE	AM DISTRIBUTION		PM RATE	PM DISTRIBUTION	
					TRIPS IN	TRIPS OUT		TRIPS IN	TRIPS OUT
850	Supermarket	41.1	1000 S.F.	3.4	62%	38%	9.5	51%	49%
					AM TRIPS			PM TRIPS	
					TRIPS IN	TRIPS OUT		TRIPS IN	TRIPS OUT
				TOTAL TRIPS	87	53		199	191
				(36%) PASS-BY TRIPS =	31	19		72	69
				NEW VOLUME TRIPS=	56	34		127	122
944	Gasonline/Service Station	12	Pumps	12.2	51%	49%	13.9	50%	50%
					AM TRIPS			PM TRIPS	
					TRIPS IN	TRIPS OUT		TRIPS IN	TRIPS OUT
				TOTAL TRIPS	75	72		83	83
				(42%) PASS-BY TRIPS =	32	30		35	35
				NEW VOLUME TRIPS=	43	42		48	48

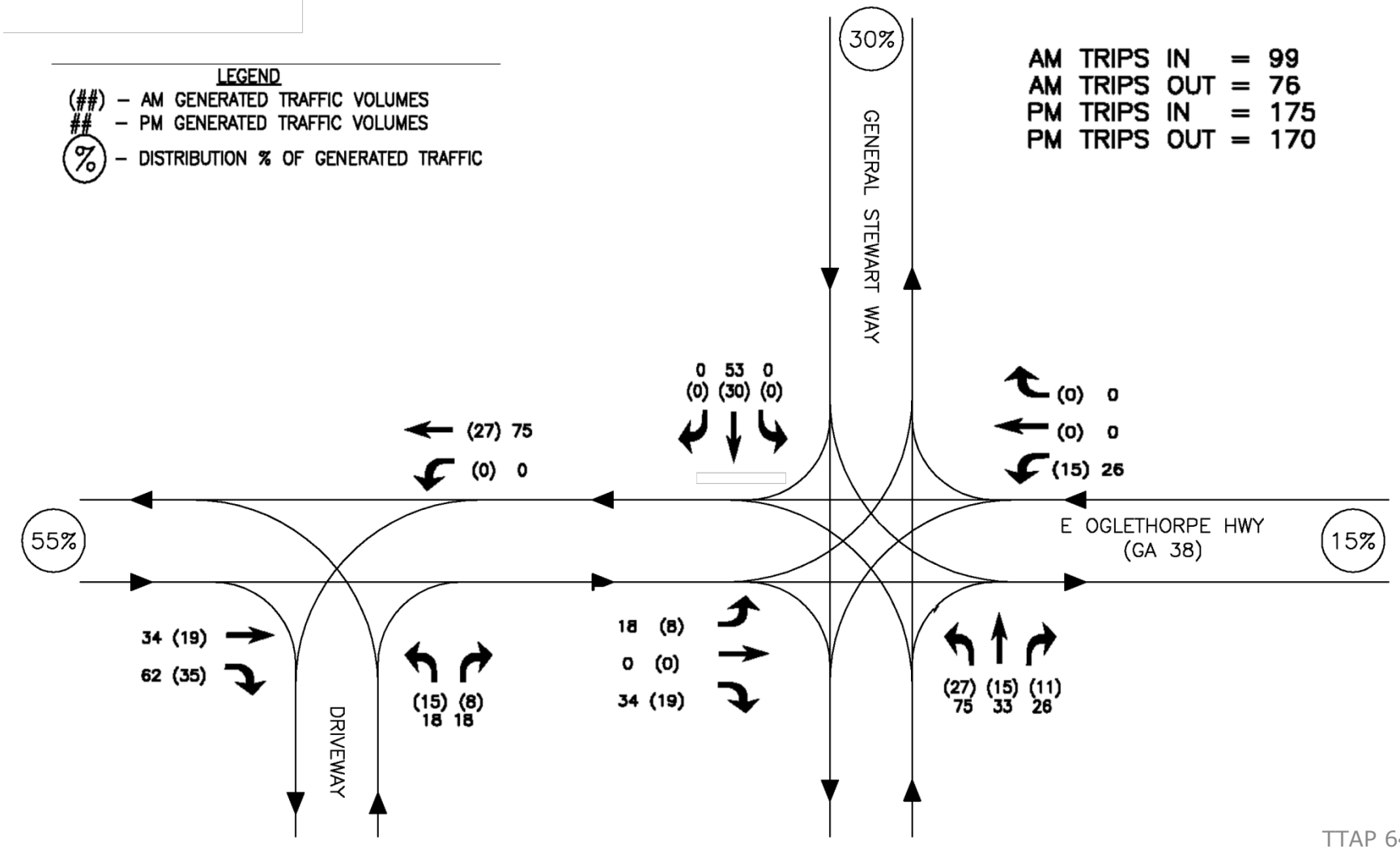
Project Example – Counts



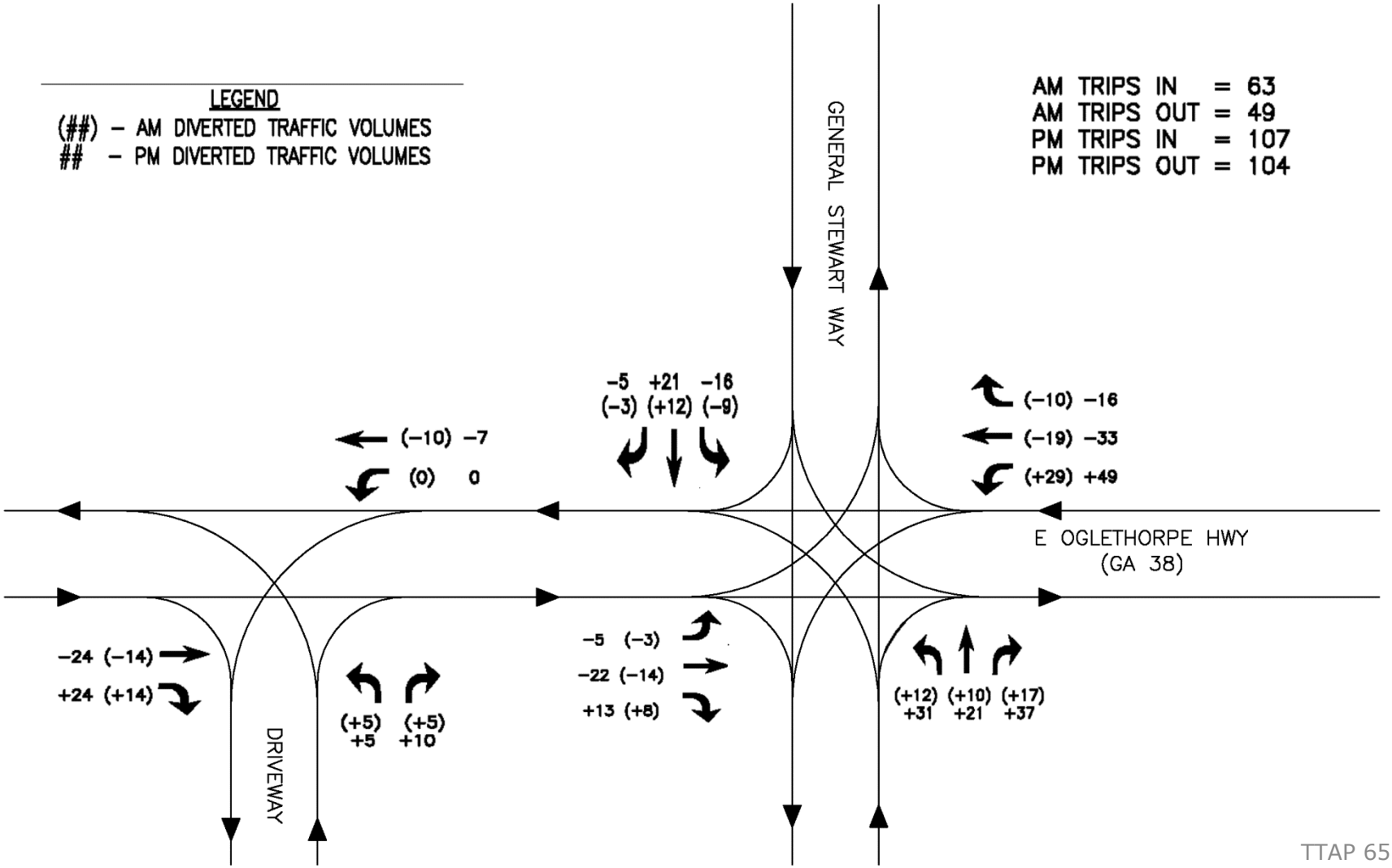
Project Example – Ex. Traffic



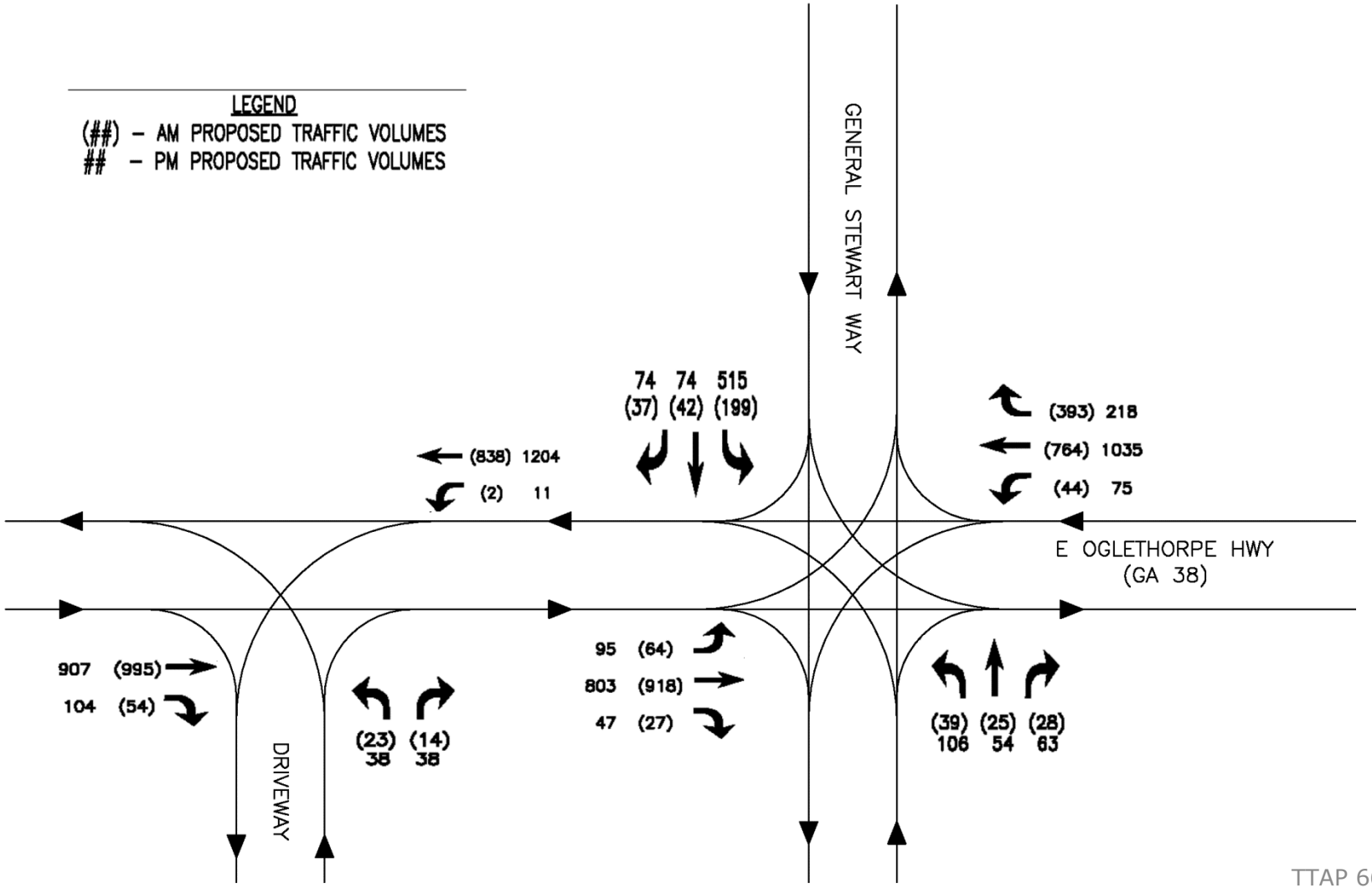
Project Example – New Trips



Project Example–Pass-By Trips



Project Example – Proposed



Questions?

THE UNIVERSITY OF TENNESSEE KNOXVILLE

CENTER FOR TRANSPORTATION RESEARCH

Traffic Impact Analysis

TTAP

Tennessee Transportation Assistance Program

Housekeeping

Attendance – Please sign in typing your full name on the chatbox.

Camera , Audio and Chatbox – Please avoid using your camera during the presentation. Unmute your audio or use the chatbox to answer questions.

PDH certificate – will be sent to your email within the next 2 weeks. Based on your chat box sign in and registration info.

Webinar materials - will be available for download. An email will be sent to you with additional information.

Agenda
Session 3 – TIA Results & Details

Housekeeping & Session Outline	**2:00-2:10**
Operational Analysis	**2:10-2:30**
Watch Out!	**2:30-2:40**
Proposed Improvements	**2:40-2:45**
TIA Report Summary	**2:45-2:50**
Questions & Break	**2:50-3:00**
Horizon Year	**3:00-3:05**
Turn Lane Warrants	**3:05-3:10**
Traffic Signal Warrants	**3:10-3:30**
Consideration of Alternatives	**3:30-3:35**
Intersection Sight Distance	**3:35-3:40**
Crash History	**3:40-3:45**
Questions & Wrap Up	**3:45-4:00**

Operational Analysis:

TIA's are typically considering the operation of signalized, unsignalized (stop-controlled), and roundabout intersections.

Highway Capacity Manual (HCM) methods are typically used to analyze the intersection capacities & delay. This method provides a "Level of Service" (LOS) that is essentially a grading scale of the intersection operations.

LOS Ranges from A to F
Level of Service A = Minimal Delays
Level of Service F = Major Delays / Over Capacity

Operational Analysis:

Level of Service (LOS)	Signalized Intersection	Unsignalized Intersection
A	≤10 sec	≤10 sec
B	10-20 sec	10-15 sec
C	20-35 sec	15-25 sec
D	35-55 sec	25-35 sec
E	55-80 sec	35-50 sec
F	≥80 sec	≥50 sec

LOS For Two-Way Stop Control Intersection

Control Delay (s/vehicle)	LOS by Volume-to-Capacity Ratio	
	$v/c \leq 1.0$	$v/c > 1.0$
0–10	A	F
>10–15	B	F
>15–25	C	F
>25–35	D	F
>35–50	E	F
>50	F	F

Note: The LOS criteria apply to each lane on a given approach and to each approach on the minor street. LOS is not calculated for major-street approaches or for the intersection as a whole.

Operational Analysis:

Occasionally, you may run into a situation that doesn't fit with HCM methodology for level-of-service. This could include:

+Unconventional Signal Phasing

+Two Intersections operating under 1 controller

+Closely Spaced Intersections

+Other Unusual Configurations

WATCH OUT!

If you aren't careful, you might get traffic study results that don't match reality.

When the traffic situation is near capacity or at capacity, then several of these issues can occur.

WATCH OUT – QUEUE LENGTHS

WATCH OUT – WEAVE

Proposed Improvements:

When are roadway facility improvements required by a development:

+Level-of-Service decline

+Capacity of facility is exceeded

+Defined percentage of delay increase

+Queue length storage exceeded

+Adjustment of control devices / signal timings

TIA REQUIRED/PROPOSED IMPROVEMENTS SHOULD BE CLEARLY DEFINED & DEPICTED WITHIN THE STUDY.

Summary of Basic TIA Report:

-Scope of Study
-Existing Facilities
-Existing Volumes/Counts
-Proposed Development Description
-Generation of Project Trips
-Distribution of Project Trips
-Operational Analysis Results
-Proposed Improvements
-Other Considerations (Upcoming Section)

Other Considerations:

-Horizon Year (Future Design Year)
-Turn Lane Warrants
-Traffic Signal Warrants
-Consideration of Alternatives
-Intersection Sight Distance
-Crash History

Horizon Year:

If the proposed project is expected to either:
+Be built in phases over multiple years or
+Be multiple years in the future before opening

THEN YOUR STUDY SHOULD USE A FUTURE DESIGN YEAR!
+Establish a growth trend (DOT historic counts)
+Grow up the background (existing) traffic volumes based on the growth rate and the number of years
+Your analysis should be based on this future design year
+MPO future traffic models

Turn Lane Warrants:

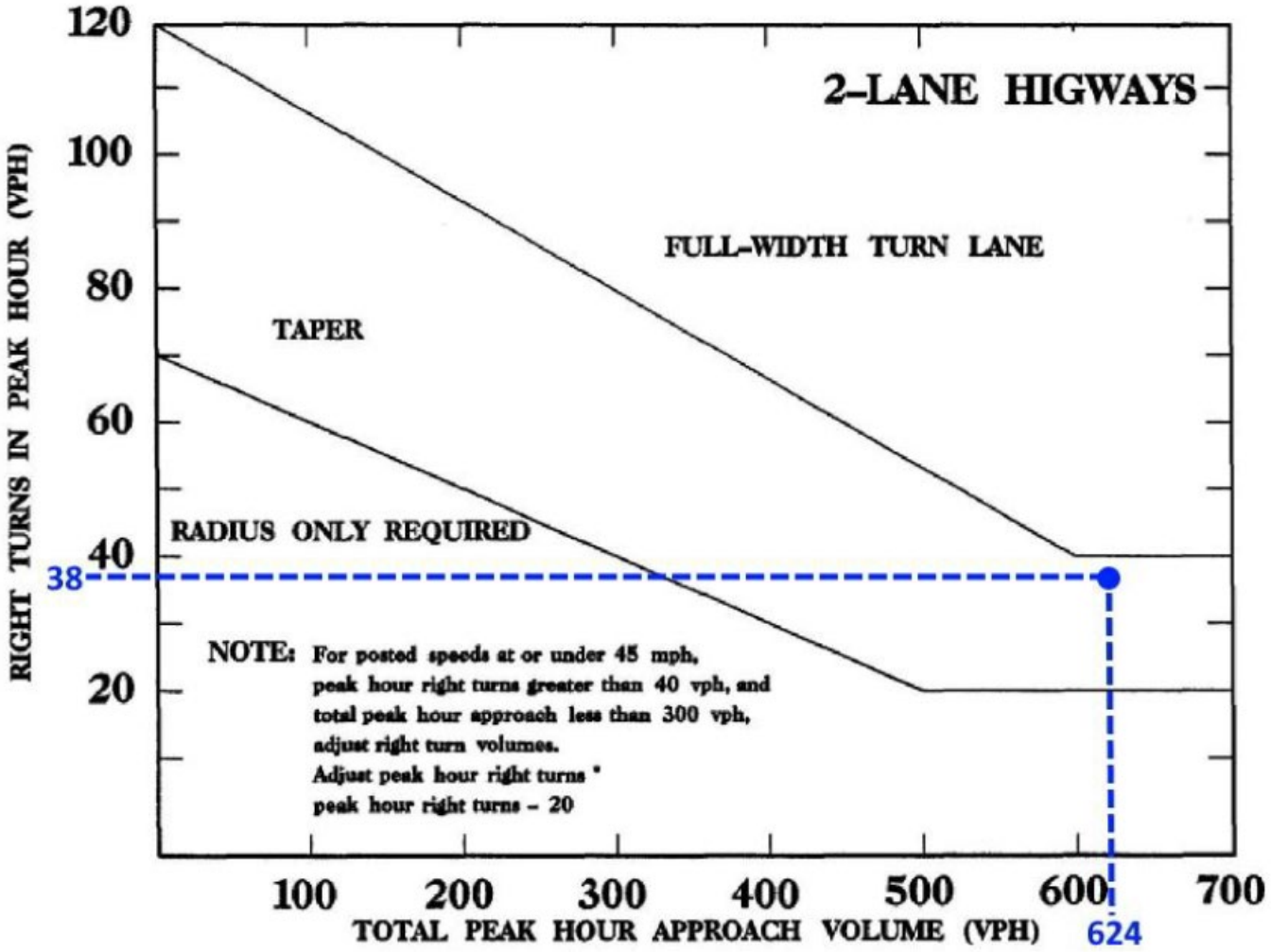
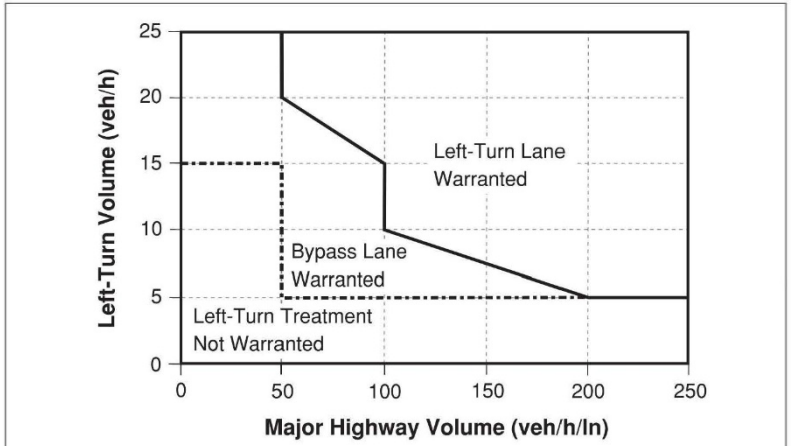
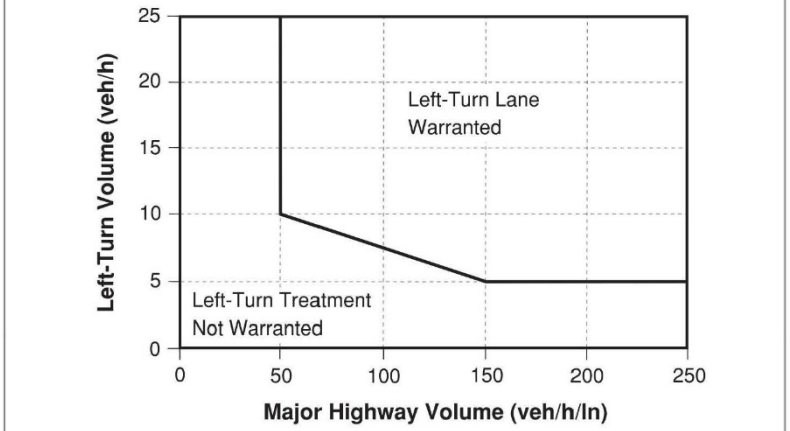


Figure 9 – NCDOT Right Turn Lane Warrant

Turn Lane Warrants:



(a) Three-Leg Intersections



(b) Four-Leg Intersections

STATE OF TENNESSEE	FIGURE B.2
LEFT-TURN LANE WARRANT FOR TWO-LANE RURAL HIGHWAYS (UNSIGNALIZED)	

Traffic Signal Warrants:

IF YOUR PROJECT IS PROPOSING A NEW TRAFFIC SIGNAL, THEN YOUR STUDY SHOULD PROVIDE TRAFFIC SIGNAL WARRANTS!

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

01 Except for a temporary traffic control signal (see Section 4D.11) installed in a temporary traffic control zone, before a traffic control signal is installed at a particular location, an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at that location.

02 The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:

- Warrant 1, Eight-Hour Vehicular Volume
- Warrant 2, Four-Hour Vehicular Volume
- Warrant 3, Peak Hour
- Warrant 4, Pedestrian Volume
- Warrant 5, School Crossing
- Warrant 6, Coordinated Signal System
- Warrant 7, Crash Experience
- Warrant 8, Roadway Network
- Warrant 9, Intersection Near a Grade Crossing

03 The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Traffic Signal Warrants:

Warrant 1: Eight-Hour Vehicular Volume
Warrant 2: Four-Hour Vehicular Volume
Warrant 3: Peak Hour
Warrant 4: Pedestrian Volume
Warrant 5; School Crossing
Warrant 6: Coordinated Signal System
Warrant 7: Crash Experience
Warrant 8: Roadway Network
Warrant 9: Intersection Near a Grade Crossing.

The Difficulty….

Warrant 1: Volumes for 8-hours of an average day

Trip Generation: Daily Volumes or Peak Hour Volumes Only

Ideas??

GDOT Design Policy Manual

The need for traffic signal control is obvious at many intersections that are currently signalized. However, at other intersections traffic signal warrant analysis may be needed to establish the need for traffic signal control. At some intersections, where traffic signals are not currently needed, future traffic increases may warrant signal control. For such intersections, a warrant analysis should be conducted for both the construction year volumes as well as for the design year volumes. Warrant analyses should be conducted using the guidelines of the most current edition of the *MUTCD*.

Signal warrants are typically conducted using hourly volumes throughout the normal day (not just peak hour volumes). Since the design volumes are limited to peak hour and daily volumes, it will be necessary to derive estimates of the volumes that occur during the remaining hours of the day.

An important signal warrant is Warrant 1, Eight-Hour Vehicular Volume. Therefore, the traffic analysis should estimate the eighth-highest volume of the day. The eighth-highest volume can be compared to the requirement of Warrant 1 to estimate if this important warrant will be satisfied with the projected volumes.

The eighth-highest volume can be estimated as representing 5.6 % of the daily volume. If the eighth-highest volume exceeds the minimum volumes for Warrant 1 using the construction year volumes, then signal control should be considered for installation during the construction project.

If Warrant 1 is only met using the design year conditions, then signalization may not be included with construction, but the design may reflect the need for future signal control. For example, turn lanes may be constructed and striped out until signals are installed.

Table 4.1 – Tennessee Statewide Average Traffic Volumes Hourly Percentages

TRAFFIC OPERATIONS DIVISION - TRAFFIC ENGINEERING OFFICE

2017 TRAFFIC VOLUMES HOURLY PERCENTAGES

TENNESSEE STATEWIDE AVERAGE FOR ARTERIAL FACILITIES

TN TDOT Department of Transportation

Hour		TENNESSEE STATEWIDE AVERAGE FOR ARTERIAL FACILITIES		
From	To	Two Lane Facilities	Multi-Lane Facilities	Overall for Both Facility Types
12:00 M	1:00 AM	0.57	0.59	0.58
1:00 AM	2:00 AM	0.37	0.40	0.39
2:00 AM	3:00 AM	0.32	0.33	0.33
3:00 AM	4:00 AM	0.42	0.41	0.42
4:00 AM	5:00 AM	0.77	0.78	0.78
5:00 AM	6:00 AM	1.89	1.94	1.92
6:00 AM	7:00 AM	4.09	4.05	4.07
7:00 AM	8:00 AM	7.29	6.79	7.04
8:00 AM	9:00 AM	5.96	5.93	5.95
9:00 AM	10:00 AM	5.06	5.29	5.18
10:00 AM	11:00 AM	5.06	5.40	5.23
11:00 AM	12:00 N	5.62	6.05	5.84
12:00 N	1:00 PM	6.08	6.56	6.32
1:00 PM	2:00 PM	6.10	6.46	6.28
2:00 PM	3:00 PM	6.86	6.77	6.82
3:00 PM	4:00 PM	7.92	7.61	7.77
4:00 PM	5:00 PM	8.33	8.04	8.19
5:00 PM	6:00 PM	8.39	8.06	8.23
6:00 PM	7:00 PM	6.15	5.91	6.03
7:00 PM	8:00 PM	4.35	4.24	4.30
8:00 PM	9:00 PM	3.44	3.34	3.39
9:00 PM	10:00 PM	2.38	2.42	2.40
10:00 PM	11:00 PM	1.58	1.62	1.60
11:00 PM	12:00 M	1.00	1.02	1.01

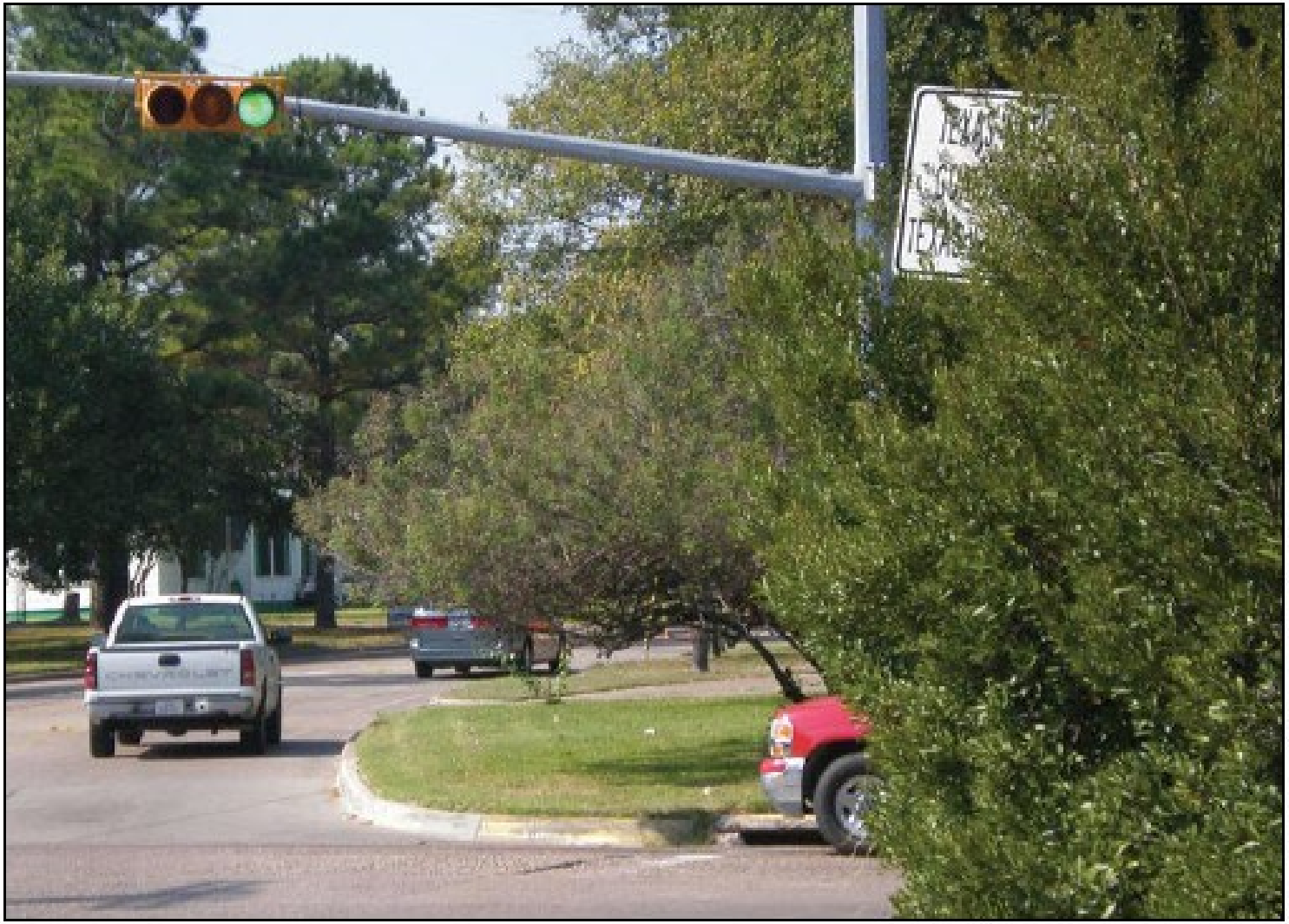
Notes:

1. The seven (7) highest hours are shown in green highlight and the eighth (8th) highest hour is shown in orange highlight.
2. The average traffic volumes hourly percentages shown were based traffic volume data collected at 504 representative traffic count locations (e.g. 126 locations per Region).
3. Values shown are calculated and rounded up which may result in small rounding errors.

Consideration of Alternatives:

VDOT JUNCTION SCREENING TOOL (VJUST)

Intersection Sight Distance:



Crash History:

ITE Trip Generation 11TH EDITION UPDATES

The 11th Edition Supplement of the Trip Generation Manual was released in 2021. Updates include:

+Walk, Transit, & Bike Generation Data

+Location Based Info (City Center, Urban, Suburban, Rural)

+Truck Trip Generation Rates

+Affordable Housing Land Use (ITE Code 223)

+Expanded Data for Fulfillment Center Warehouse

+Expanded Data for Parcel Hub Warehouse

THANK YOU FOR YOUR TIME & ATTENTION!

+QUESTIONS
+COURSE SURVEY
+PDH CERTIFICATES

CONTACT INFO:
TTAP – DR. AIRTON KOHLS
AKOHLS@UTK.EDU
865-974-0298

CHRIS BERRY, PE, PTOE
BERRY ENGINEERS, LLC
CBERRY@BERRYENGINEERS.COM