Site Traffic Studies:

Top Pitfalls *and their solutions*

Florida Department of Transportation
Office of Intermodal Systems Development
Systems Planning Office
Access Management
Tallahassee, Florida

Opening Thought

- Make no small plans,
  …. they have no magic.
  - Daniel Burnham

Source: Adapted from“Free Advice”,
Florida Planning Magazine March 2001
Bill Reads and David Gollick

Opening Thought

- Make no big plans either, they won't get approved.

  Something in the middle is nice.

  Bill Reads and David Golick

Source: Adapted from"Free Advice",
Florida Planning Magazine March 2001
Bill Reads and David Gollick

Major Areas of Concern

- Trip generation
- Trip reduction factors
- Peaking characteristics
- Modeling
- Extreme variables
- Pedestrian access
- Trends

Trip Generation

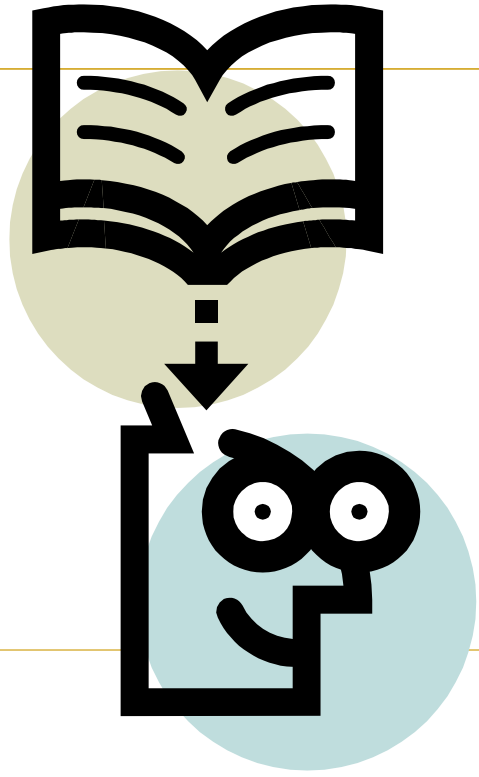
Simple trip generation calculation needed even when the large scale models are used.

Large scale regional models are not
intended for small areas.

Simple Trip Generation Example

- Daily Trip Generation Rate for a Single Family Home = 10
- 10 Homes being built (called "***Dwelling Units")***
- Homes are the "***Independent Variable***"
- How many daily trips do we project?

Trip Generation Report



and use of the 7th Edition

ITE Trip Generation Report and Handbook

ITE Trip Generation Report

Not a Manual

- **National data** – Florida, Arizona and California, played big role
- **Suburban** locations with little or no transit
- Some **small sample** sizes for new **(though important**) uses
  - Discount clubs (861)
  - Stand-alone drug stores (881)
- May not work downtown

ITE Trip Generation Report

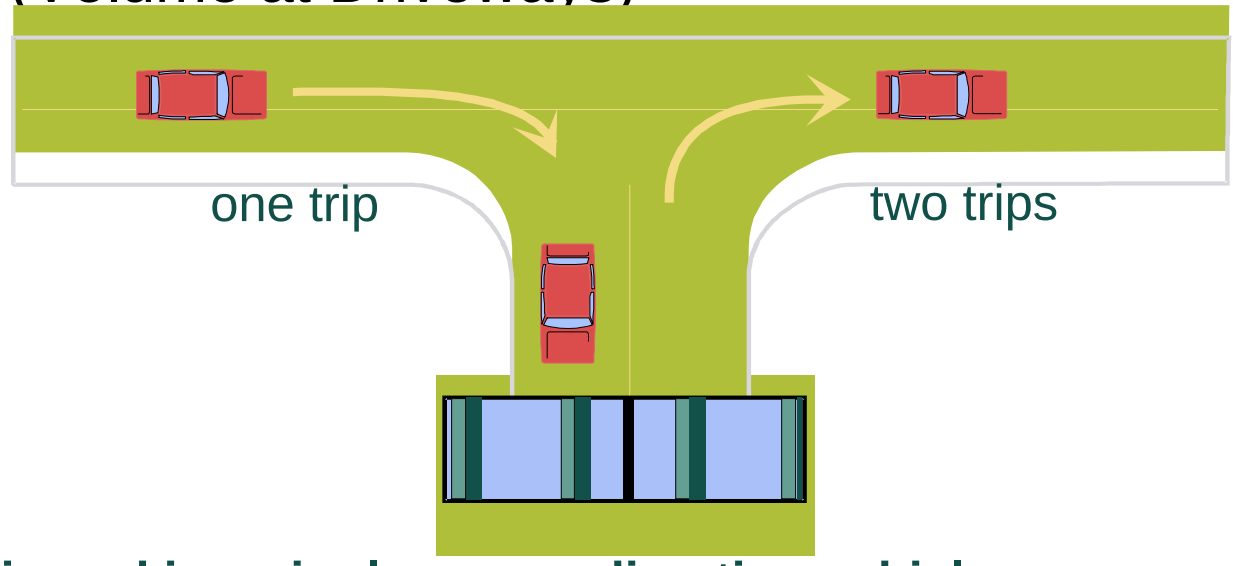
- **Fifth Edition**
  - 7.4 lbs.
  - $21.50/lb.
- **Sixth Edition**
  - $23.00/lb.
    - **But:** you also need the "Handbook" at $90 extra
- **Seventh Edition**
  - 9.75 lbs.
  - $275
  - **$28.21/lbs**

.

Thanks to: David Muntean

What is a Trip End?

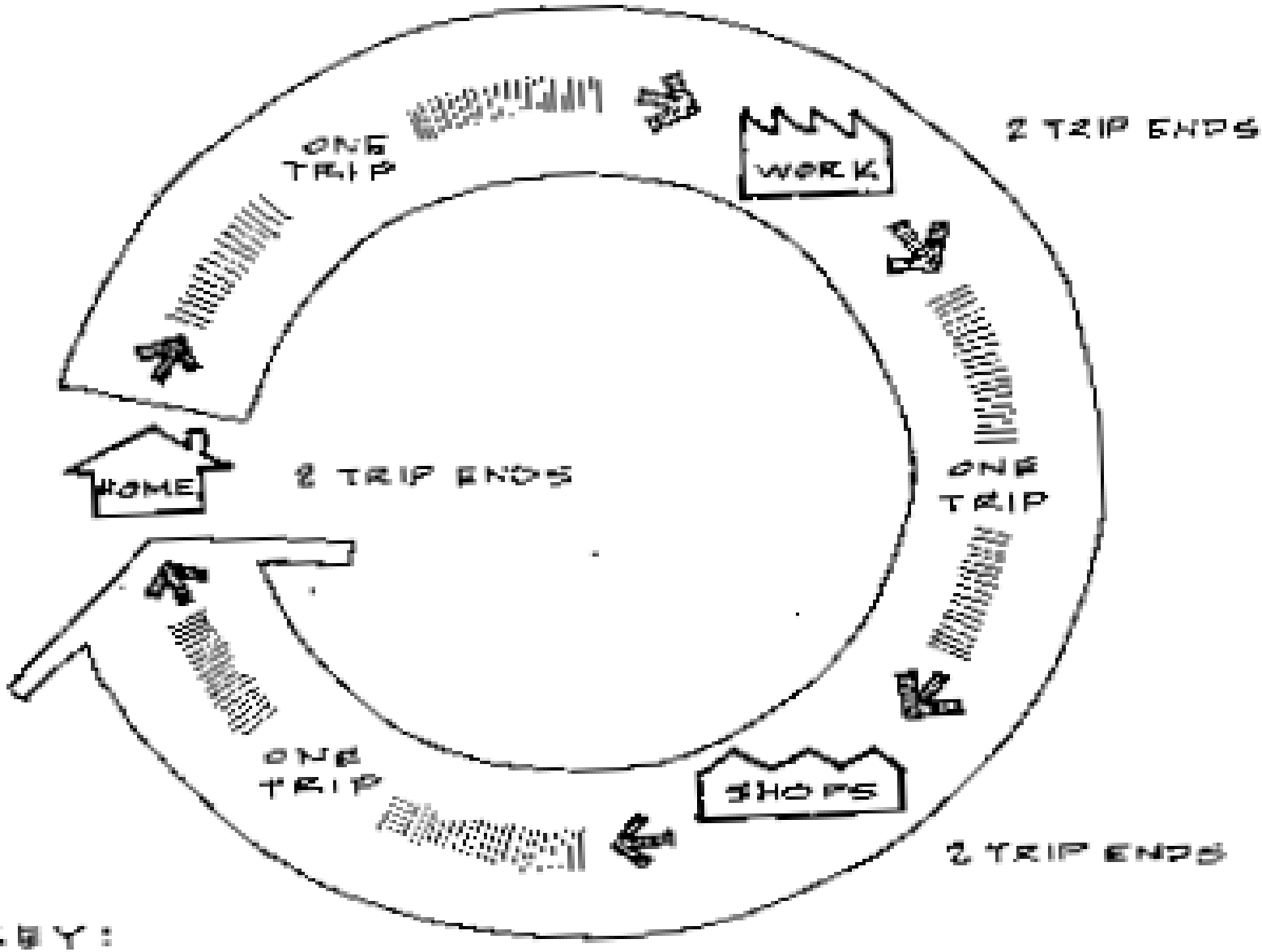
- Number of trips that come in or go out of a development
  - (Volume at Driveways)



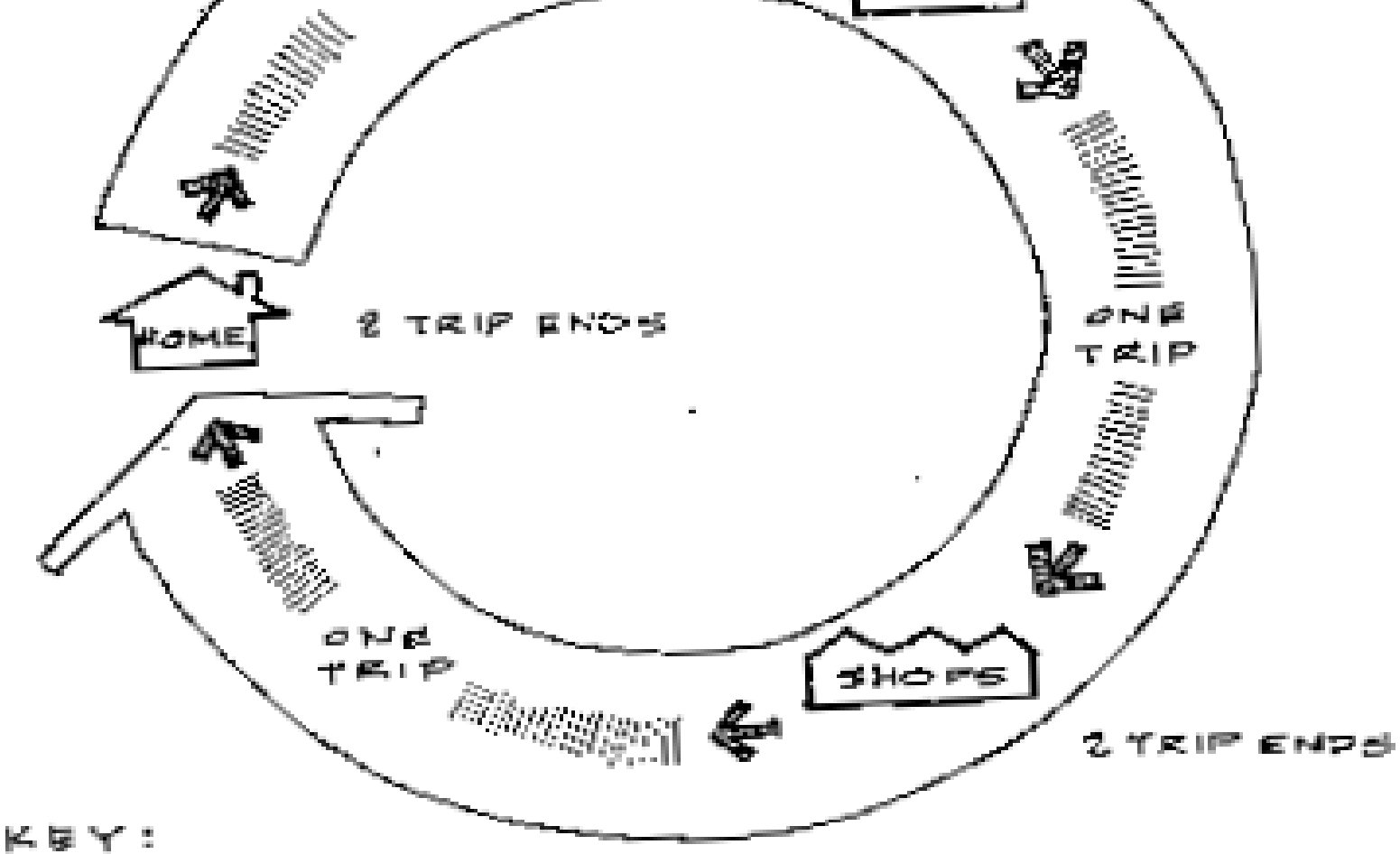
- **A trip end is a single or one-direction vehicle movement with either the origin or destination (exiting or entering) inside the study site.**

ILLUSTRATIVE DEFINITION

JOURNEY / TRIP / TRIP ENDS



KEY:



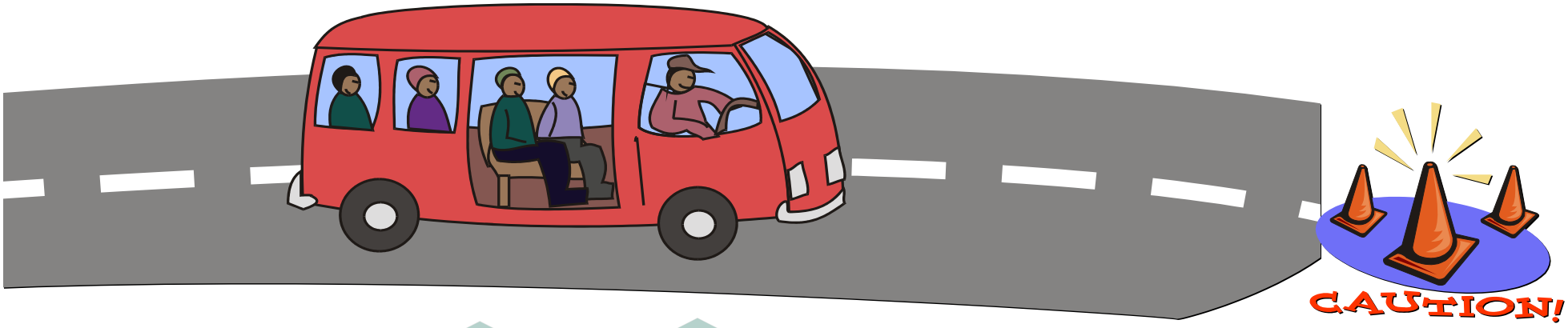
KEY:

JOURNEY (ONE) (HOME-WORK-SHOPS-HOME)

TRIP (THREE) { HOME TO WORK; WORK TO SHOPS; SHOPS TO HOME }

TRIP END (SIX) (2 PER TRIP)

Vehicle Trips *(ITE)* vs. Person Trips



5 Person Trips

1 Vehicle Trip

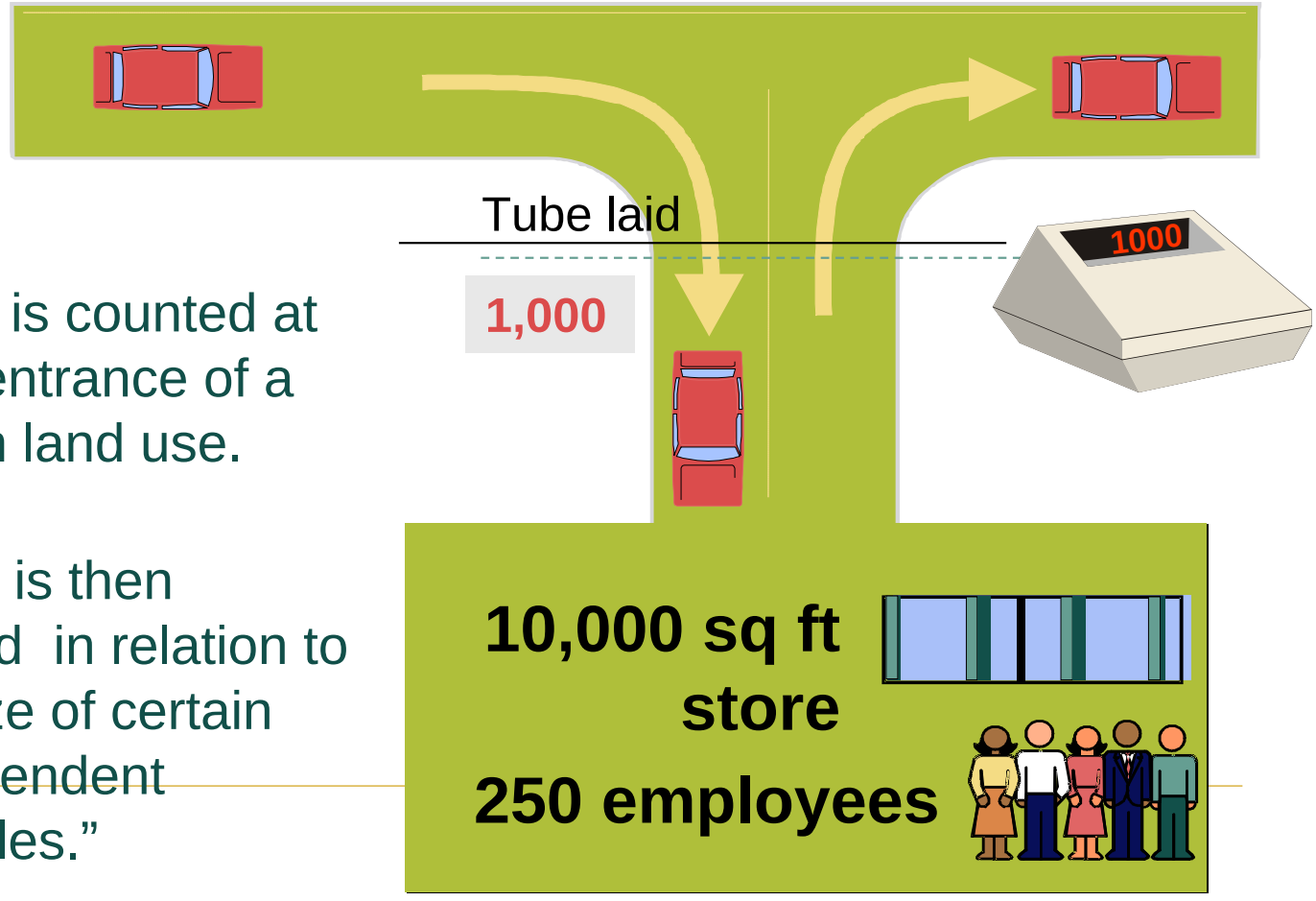
Person Trips

ITE Trips

How Are Trip Generation Rates Determined?

- Traffic is counted at each entrance of a certain land use.

Traffic is then studied in relation to the size of certain "independent variables."




The Tubes

Not This

But this

Sample Page From ITE

Apartment
(220)

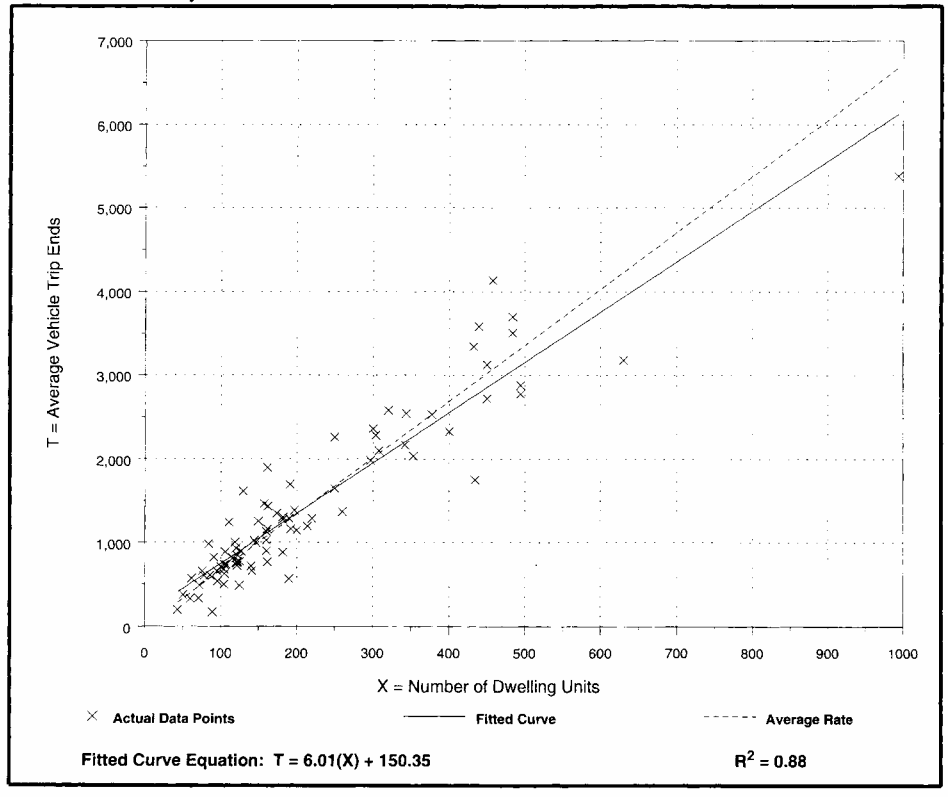
Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Number of Studies: 86
Avg. Number of Dwelling Units: 212
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.72	2.00 - 12.50	3.02

Data Plot and Equation



Fitted Curve Equation: T = 6.01(X) + 150.35

R^2 = 0.88

What is Meant by “Daily Trips”?

- For our use, we usually mean the number of WEEKDAY TRIPS.

SUN	MON	TUE	WED	THU	FRI	SAT
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

The ITE Manual Also Has Some Data On:

- **Saturday**
- **Sunday**
- **Christmas Holiday Season**

Land Use
(ITE Code)

Apartment
(220)

Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday**

Independent Variable

Time Period

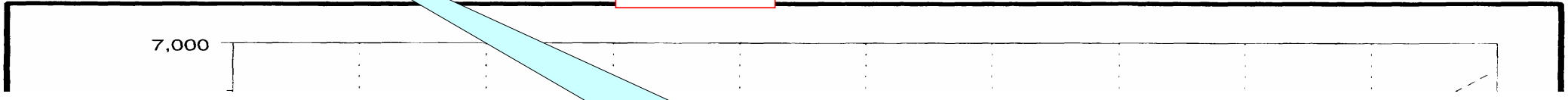
Number of Studies: 86
Avg. Number of Dwelling Units: 212
Directional Distribution: 50% entering, 50% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
6.72	2.00 - 12.50	3.02

6.72

Data Plot and Equation



Trip Generation Rate

Independent Variable

Average Vehicle Trip Ends vs: Dwelling Units
On a: Weekday

Time Period

Number of Studies: 86
Avg. Number of Dwelling Units: 212
Directional Distribution: 50% entering, 5

Trip Generation per Dwelling Unit

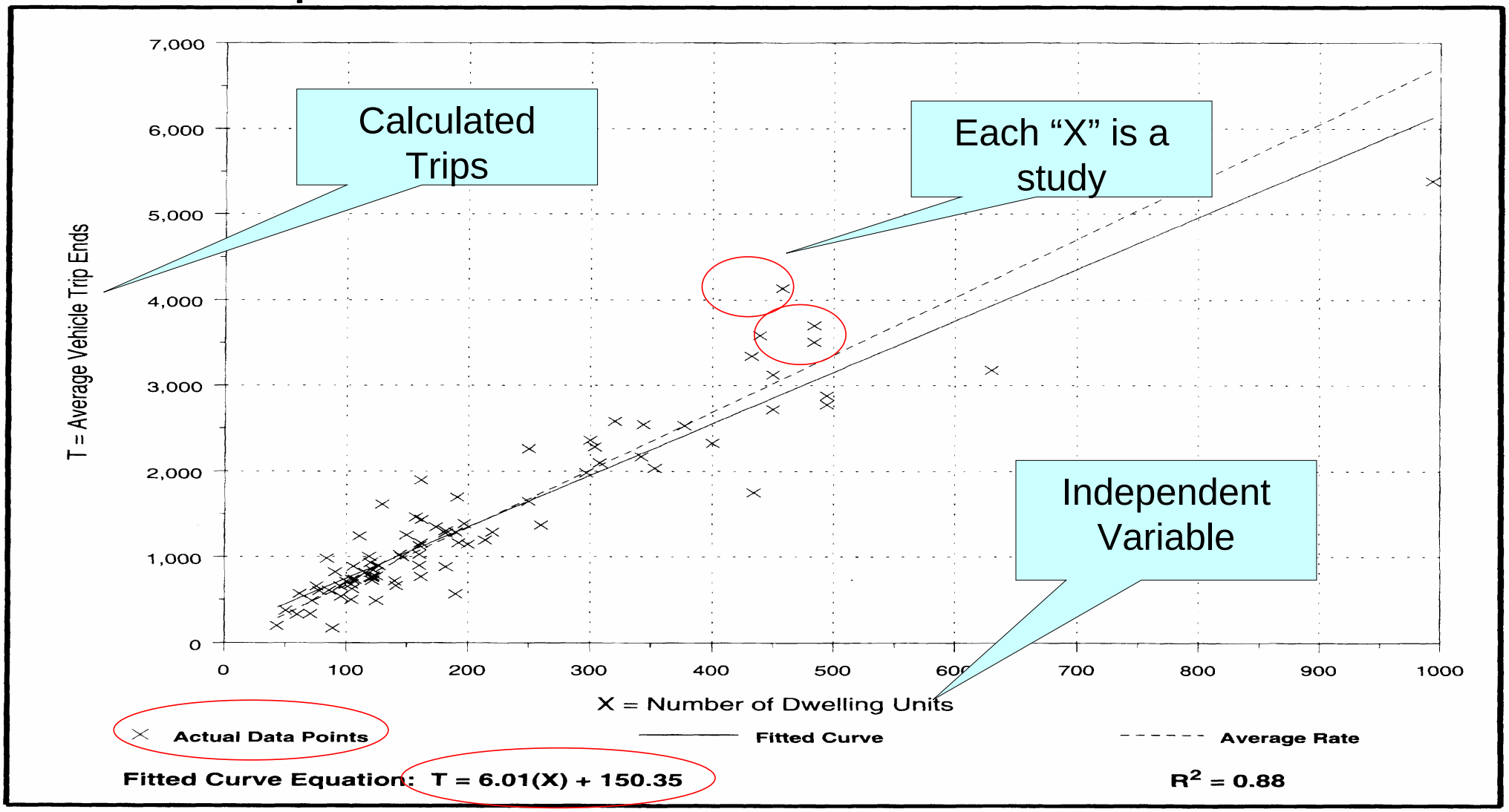
Average Rate	Range of Rates
6.72	2.00 - 12.50

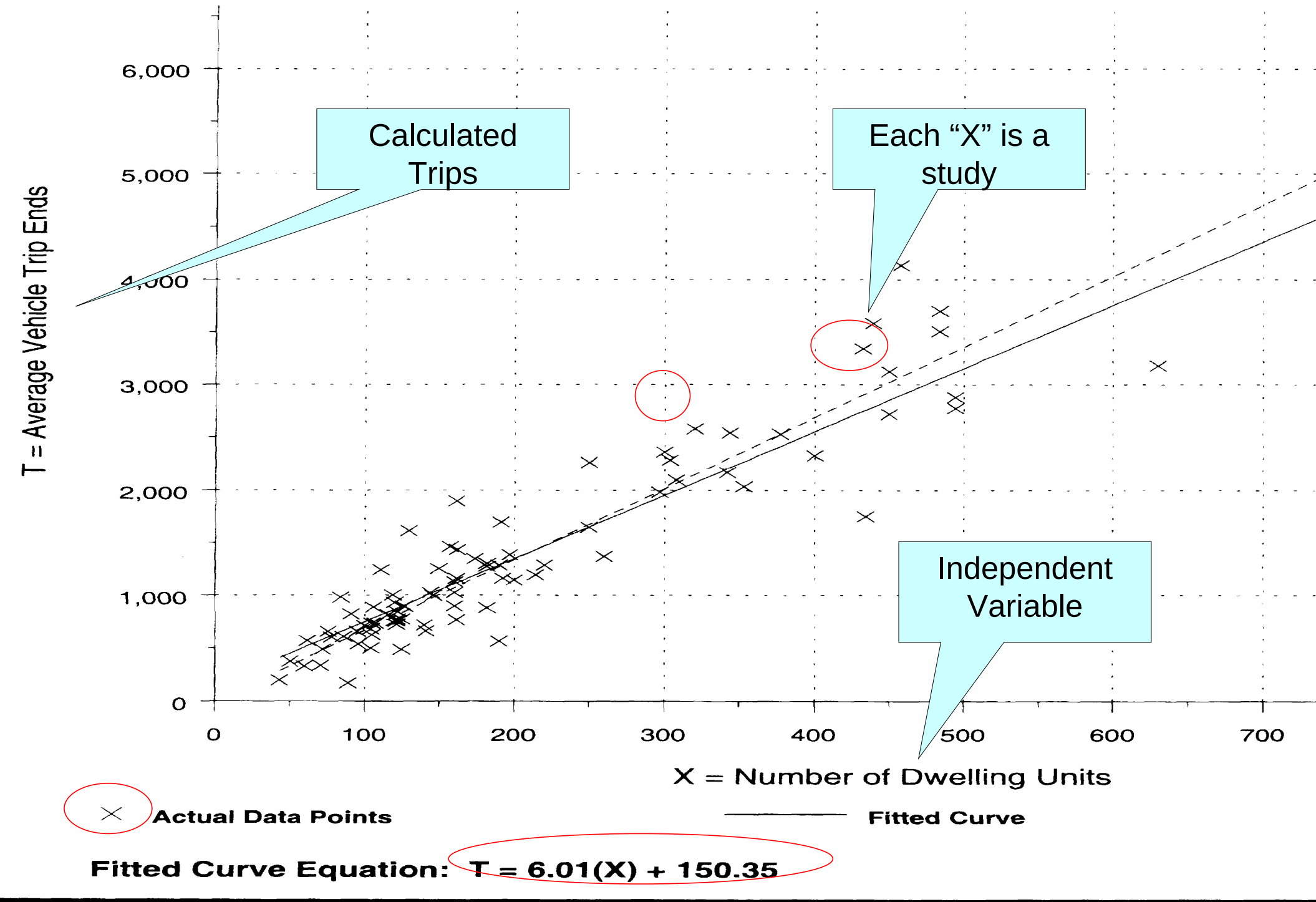
Trip Generation Rate

Trip Generation per Dwelling Unit

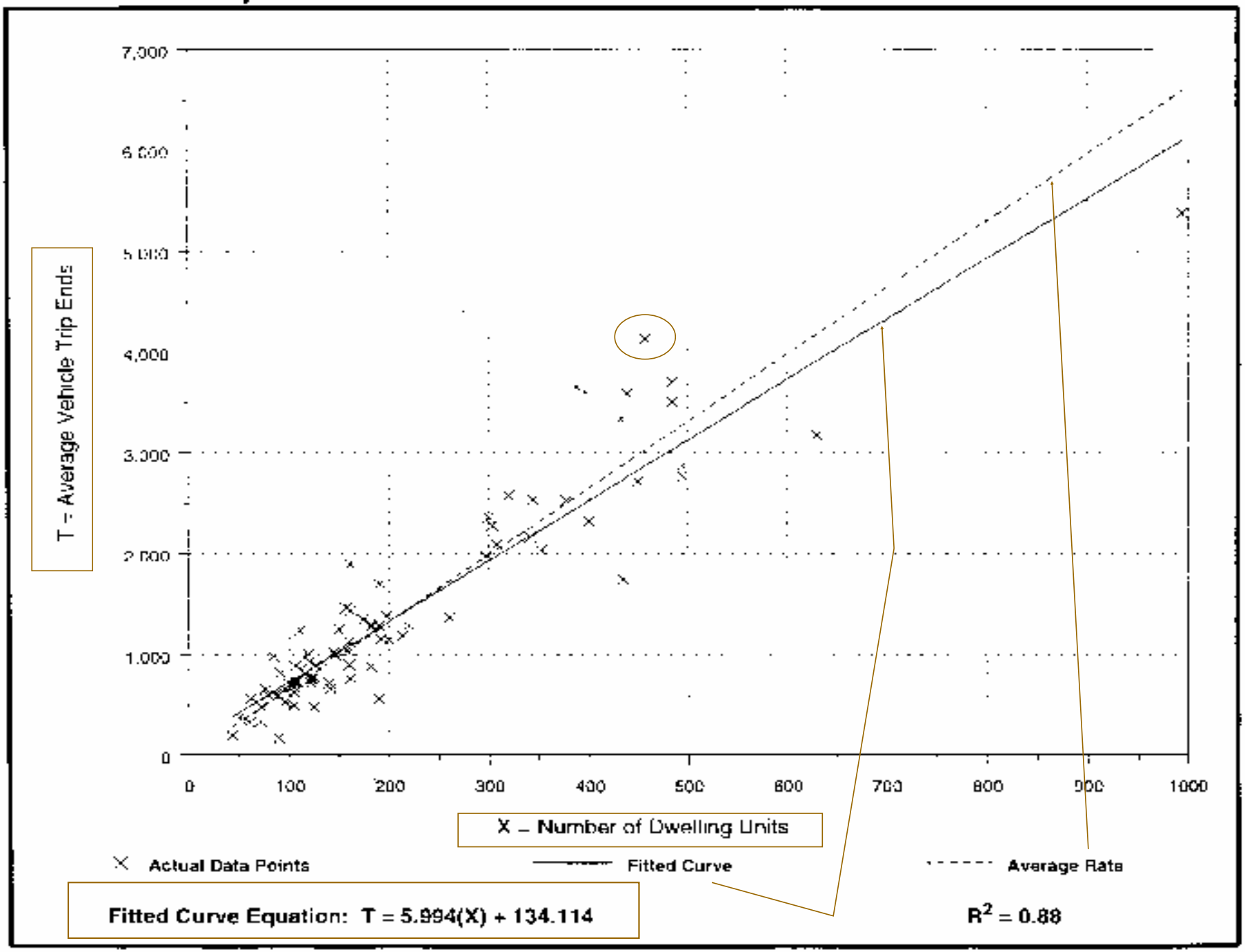
Average Rate	Range of Rates	Standard Deviation
6.72	2.00 - 12.50	3.02

Data Plot and Equation




Calculated Trips
Each "X" is a study
Independent Variable
T = Average Vehicle Trip Ends
X = Number of Dwelling Units
6,000
5,000
4,000
3,000
2,000
1,000
0
0
100
200
300
400
500
600
700
Actual Data Points
Fitted Curve
Fitted Curve Equation: T = 6.01(X) + 150.35

Data Plot and Equation



Trip Generation Problem #1

- Someone is proposing an apartment complex with 100 dwelling units.
- Using the average trip rate, what are the estimated **daily trips**?

Units **Rate** **Trips**

_____ **x** ____ **=** _____

What if there were 250 units?

_____ **x** ____ **=** _____

Trip Generation Problem #1

- Someone is proposing an apartment complex with 100 dwelling units.
- Using the average trip rate, what are the estimated **daily trips**?

Units		Rate		Trips
100	x	**6.72**	=	**672**

What if there were 250 units?

250	x	**6.72**	=	**1,680**

Apartment PM PEAK Adjacent Street Traffic

Apartment
(220)

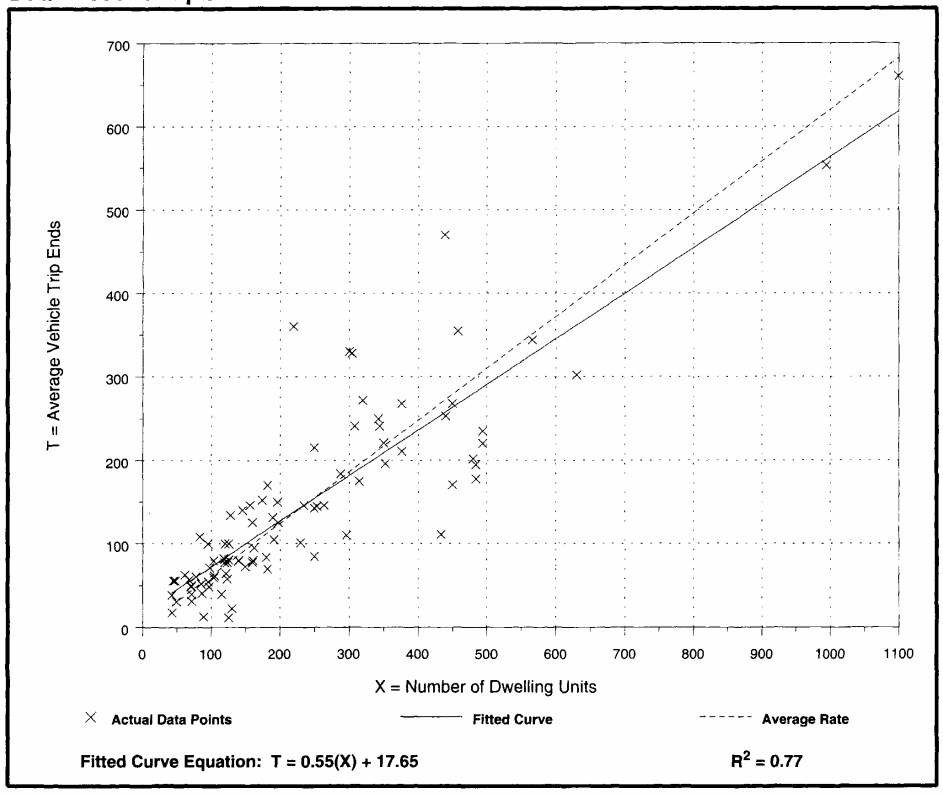
Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 90
Avg. Number of Dwelling Units: 233
Directional Distribution: 65% entering, 35% exiting

Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.62	0.10 - 1.64	0.82

Data Plot and Equation



Fitted Curve Equation: T = 0.55(X) + 17.65

R^2 = 0.77

Apartment
(220)

Average Vehicle Trip Ends vs: **Dwelling Units**
On a: **Weekday,**
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 90
Avg. Number of Dwelling Units: 233
Directional Distribution: 65% entering, 35% exiting

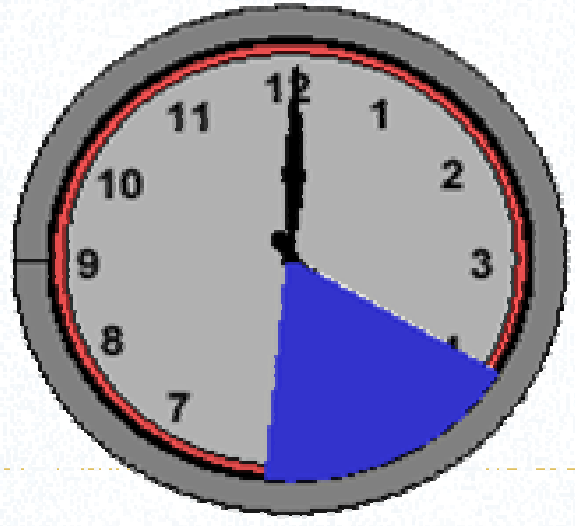
Trip Generation per Dwelling Unit

Average Rate	Range of Rates	Standard Deviation
0.62	0.10 - 1.64	0.82

What's Peak Hour?

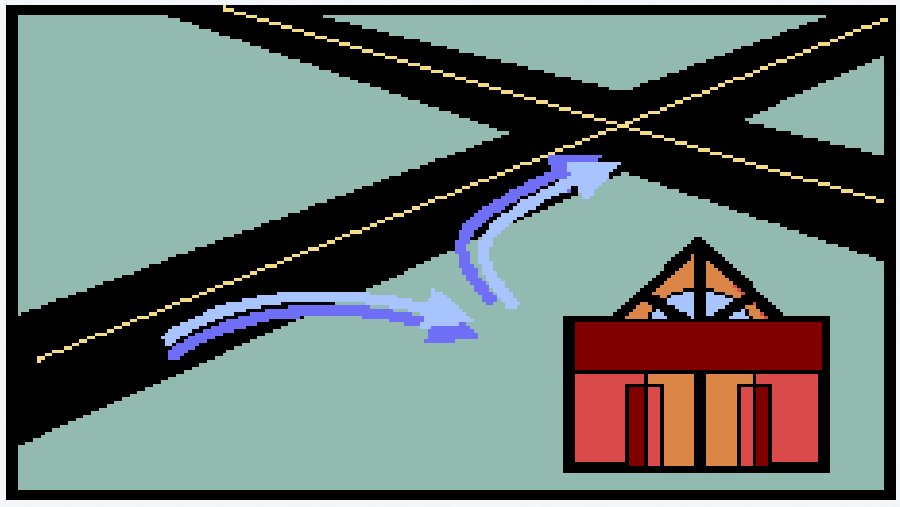
Peak Hour

- Any 4 consecutive 15-minute periods that equals the highest 1-hour volume.

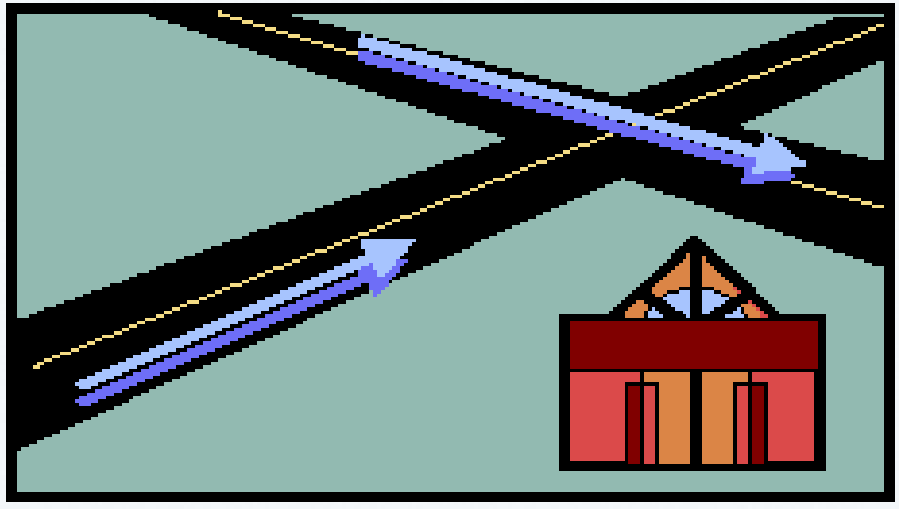


- Peak hour to be analyzed should be period with highest combined street and site generation traffic volumes.
- Peak hour of adjacent street traffic is one hour between 4 and 6 PM.

Generator Traffic vs. Adjacent Street Traffic



GENERATOR TRAFFIC



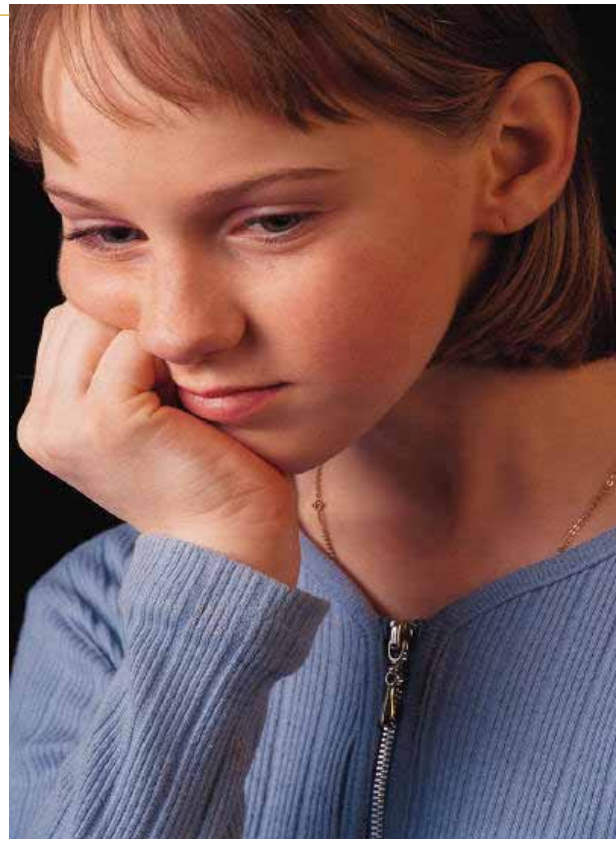
ADJACENT STREET TRAFFIC

- Usually the same PM peak for shopping, office and residential
- Hospitals, industrial and schools may be different due to different work shifts.
- Fast food restaurants have short trip durations and peak during mid-day peak periods.

Think About It

If a major church was proposed, what would be your critical analysis hour?

- AM weekday adjacent street?
- PM Weekday
- Sunday
- Other?



Critical Hour Analysis Period for Various Types of Developments

Development	Weekday Street Peak Hour AM	Weekday Street Peak Hour PM	Saturday[1]	Other[1]
Residential	x	x		
Office	x	x		
Retail Shopping[2]		x		
Intersection capacity		x		
Access design		x	11:00 – 15:00	
Banks				
Intersection capacity		x		
Access design		x	11:00 – 12:00	
Restaurants				
Fast food		x		11:00 – 13:00
Dinner Trade		x		
Industrial[3]	x	x		
Motel		x		
Schools				
Grade	x			14:30 – 15:30
High	x			14:30 – 15:30
College	x	x		
Medical				
Hospitals	x	x		6:30 – 8:00

Medical				
Hospitals	x	x		6:30 – 8:00 14:30 – 15:30
Doctors offices		x		9:00 – 10:00 16:00 – 18:00
Service Stations		x		
Sports/Recreational (theme parks, stadiums, etc.)				Peak entry/exit

[1]As noted, one hour within range shown. (Time is given in 24-hour clock system).
[2]In nearly all cases, counts of existing traffic are not needed on Saturday, but projections of site traffic may be prepared for design lengths of turn lane storage.
[3]Industrial plant shifts may precede typical commuter rush hour.

Adapted From: ANALYSIS OF TRAFFIC IMPACT
FOR NEW DEVELOPMENTS
PAUL C. BOX
Paul C. Box and Associates, Inc.
Traffic Engineering Consultants
Skokie, Illinois

Public Works Magazine: February 1981

Trip Generation Problem # 2

- Someone is proposing an apartment complex with 100 dwelling units. What would be the **peak hour directional** trips for the PM Peak Hour of adjacent street traffic?

Units		Rate		Trips
_____	x	_____	=	_____
Trips		**Distribution**		**Trips**
_____	x	_____	=	_____ **enter**
_____	x	_____	=	_____ **exit**

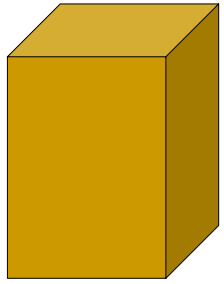
Trip Generation Problem # 2

- Someone is proposing an apartment complex with 100 dwelling units. What would be the **peak hour directional** trips for the PM Peak Hour of adjacent street traffic?

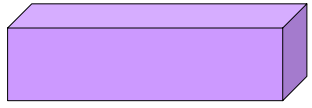
Units		Rate		Trips
100	x	.62	=	62

Trips		Distribution		Trips	
62	x	.65	=	(40.3) 40	enter
62	x	.35	=	(21.7) 22	exit

PM Peak Hour Trips Aren't Always Equal

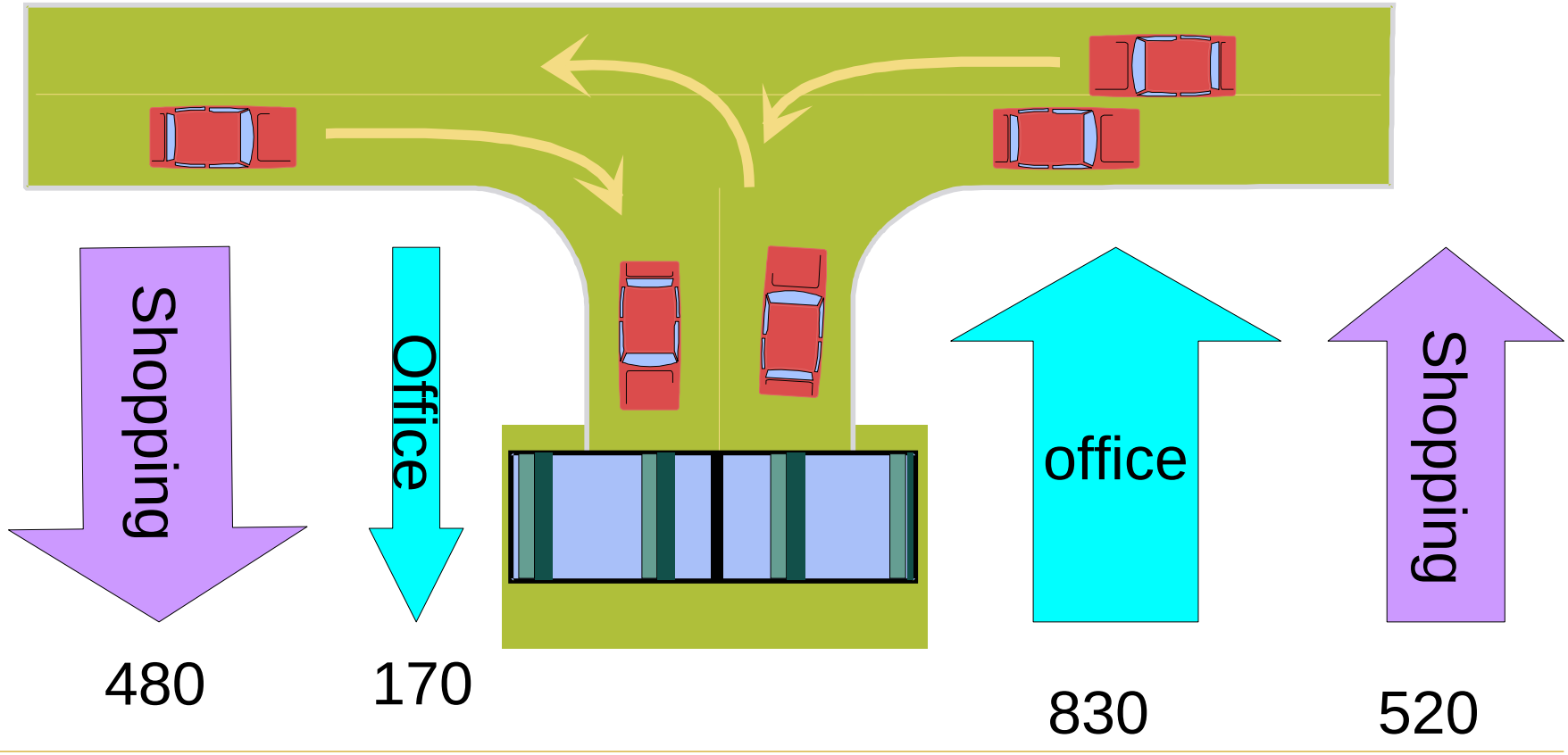


- See peaking characteristics
- **Shopping Center** (820)
  - 202,400 sq.ft = **1,000** Peak Hour trips
    - 480 in
    - 520 out

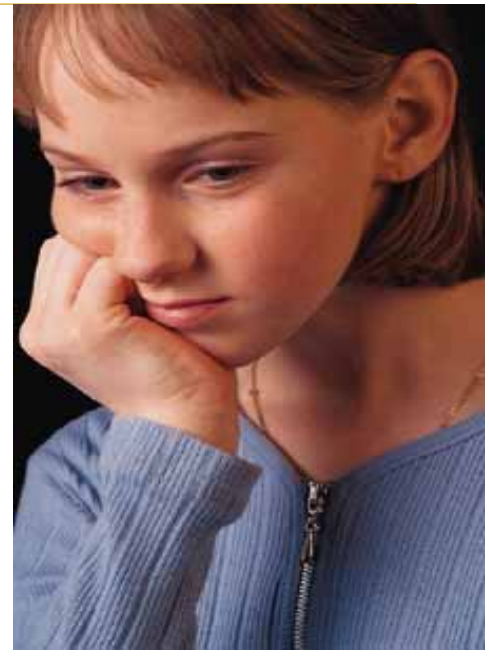


- **General Office** (710)
  - 821,300 sq.ft = **1,000** Peak Hour trips
    - 170 in
    - 830 out

PM Peak Hour Trips Aren't Always Equal



Think About It



- When would a major office development have the most impact on the surrounding road system?

Best Independent Variables

Shopping Centers and Malls

Gross Leaseable Area

Offices and Other "Single" Uses

Gross Floor Area

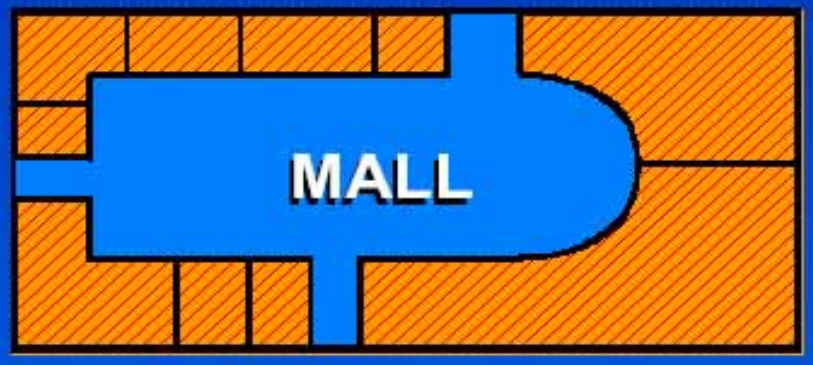
Homes and Apartments

Dwelling Units

Gas Stations

Fueling Positions

Gross Leasable Area (GLA)

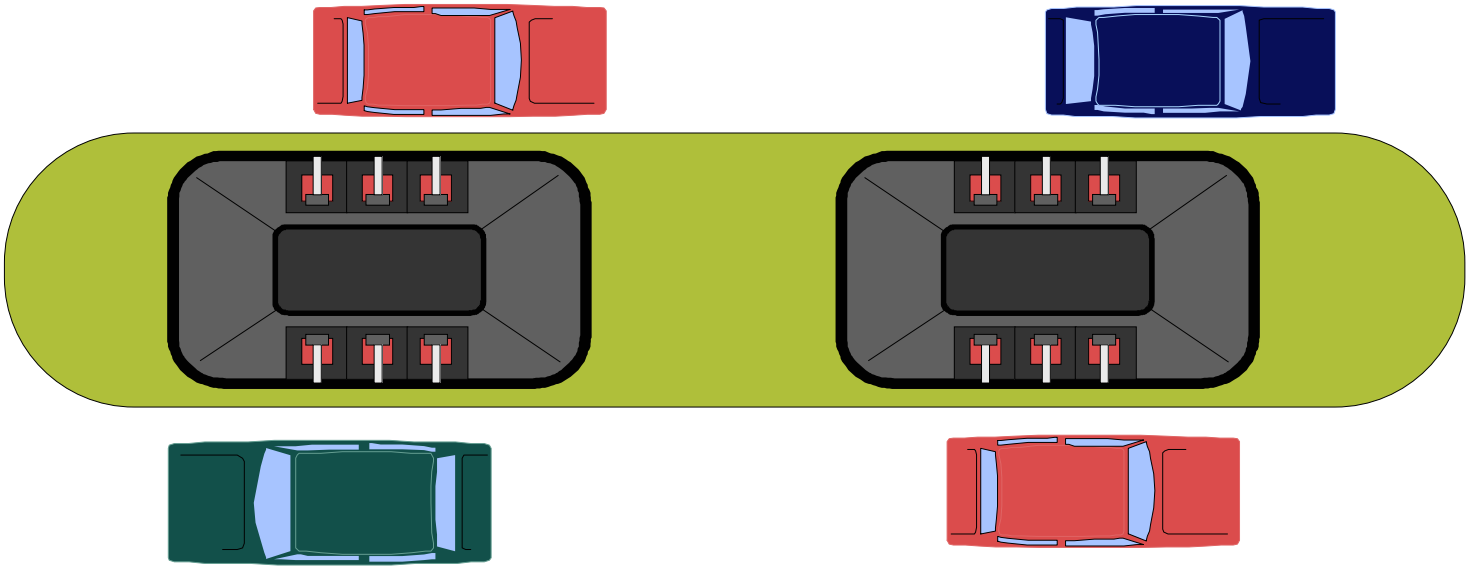


- GLA is only the area that can be used by shops
- Does not include parking area or common pedestrian areas

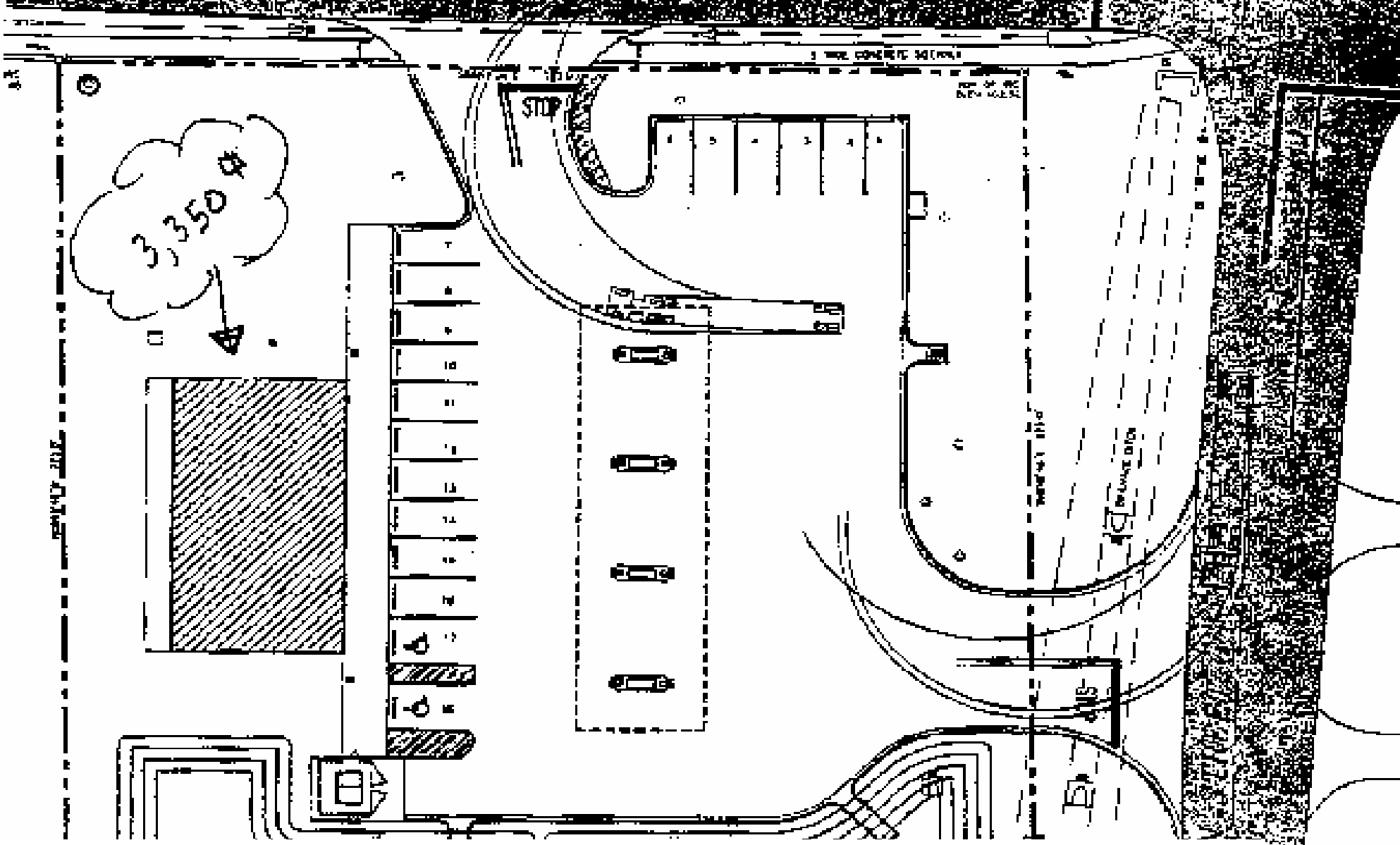
Gross Floor Area (GFA)

- GFA includes all enclosed area for each floor

What's a Fueling Position?

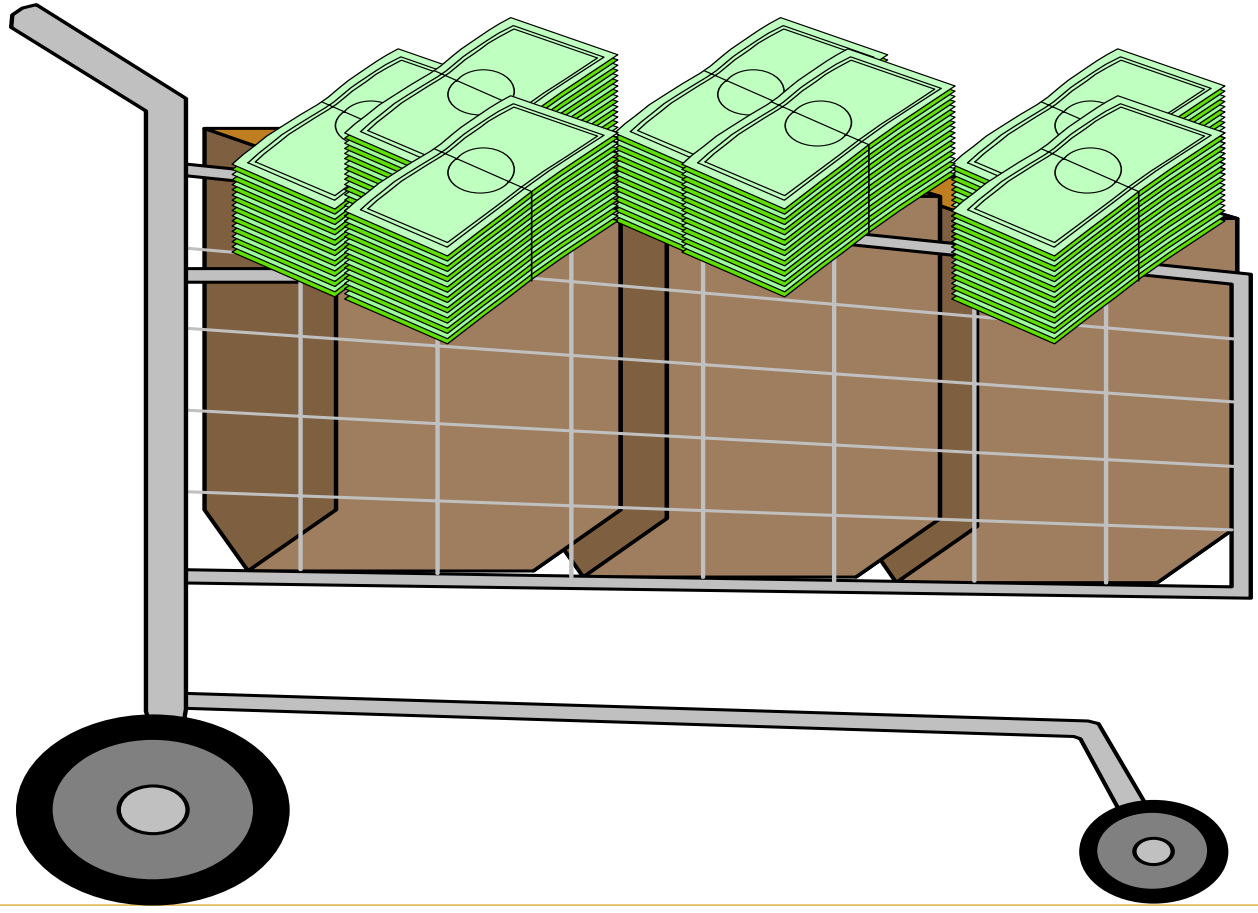


Maximum Number of Vehicles that can be Fueled Simultaneously.



Convenience Market – Applicant Claimed 4 Fueling Positions and 138 Daily Trips

Has the Analyst “Shopped” for the Trip Generation Rate?



Specialty Retail Compared

Specialty Retail Center
(814)

Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Leasable Area
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 5
Average 1000 Sq. Feet GLA: 69
Directional Distribution: 44% entering, 56% exiting

Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
2.71	2.03 - 5.16	1.83

Shopping Center
(820)

Average Vehicle Trip Ends vs: 1000 Sq. Feet Gross Leasable Area
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.

Number of Studies: 407
Average 1000 Sq. Feet GLA: 379
Directional Distribution: 48% entering, 52% exiting

Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
3.75	0.68 - 29.27	2.75

Specialty Retail vs. Shopping Center

Shopping Center (820)

407 studies

379,000 sq.ft. Gross Leasable average

Rate in PM Peak = **3.75**

Specialty Retail Center (814)

5 studies

69,000 sq.ft. Gross Leasable average

Rate in PM Peak = **2.71**

Read the Descriptions in the ITE Report

Read Descriptions – Full of Information

Land Use: 814
Specialty Retail Center

Description

Specialty retail centers are generally small strip shopping centers that contain a variety of retail shops and specialize in quality apparel; hard goods; and services, such as real estate offices, dance studios, florists and small restaurants. Shopping center (Land Use 820) is a related use.

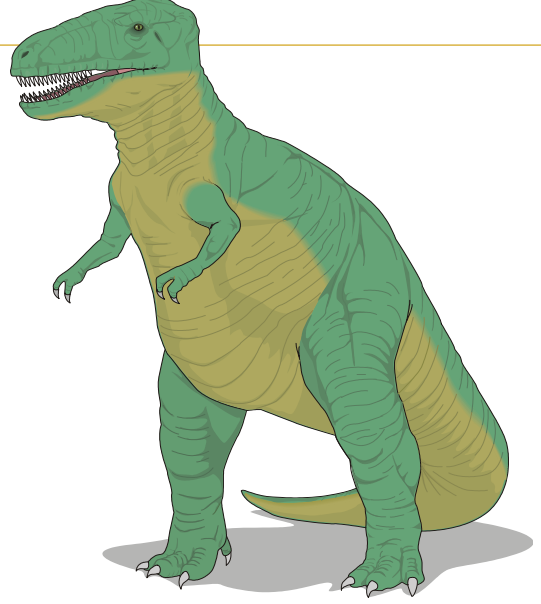
Additional Data

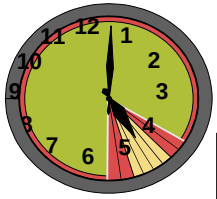
The sites were surveyed from the late 1970s to the 2000s in California, Florida, Georgia, New York and Pennsylvania.

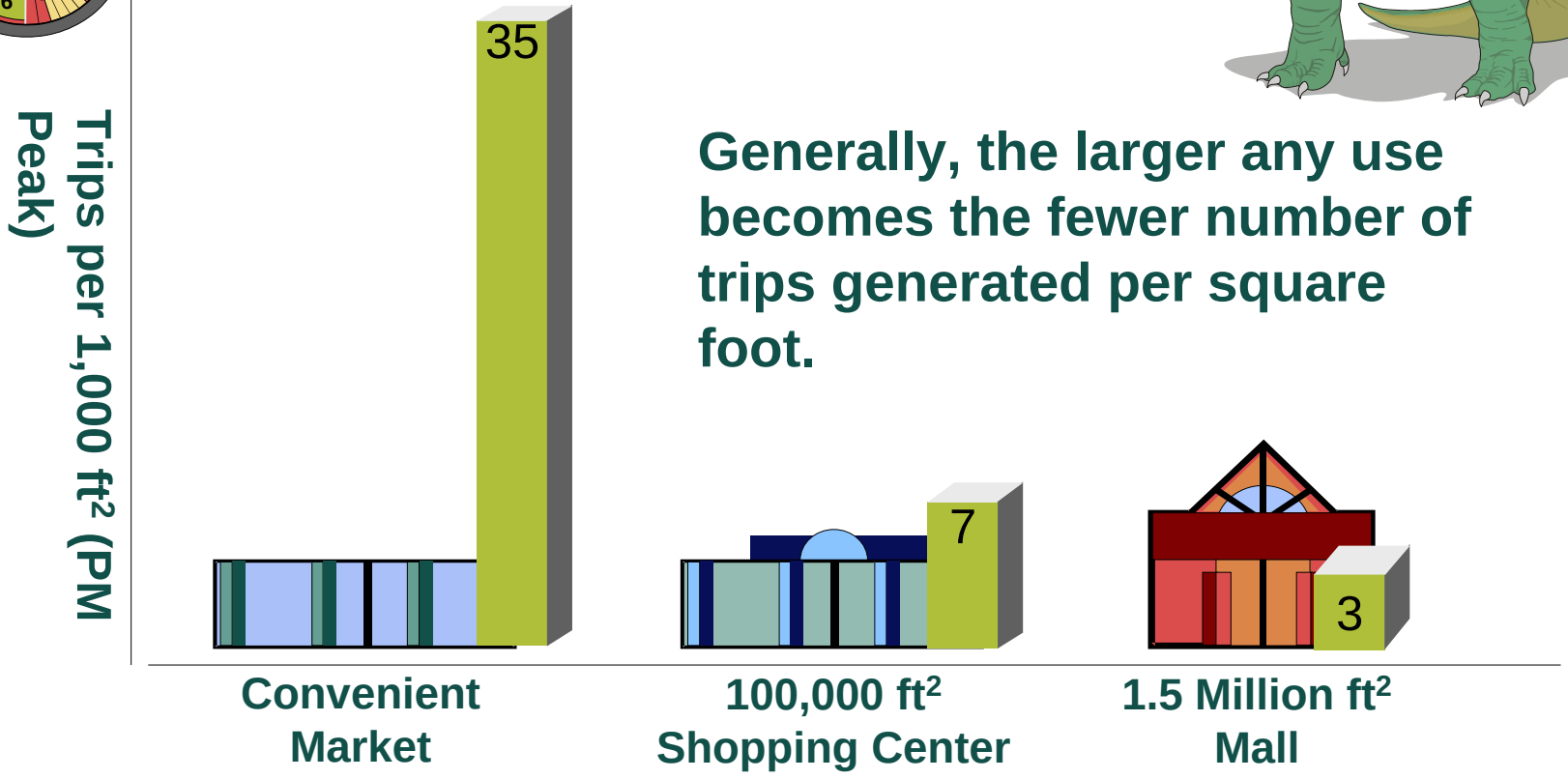
Offices Using Different Independent Variable

- **Business Park (770)**
- 28 acres average
- 379,000 sq.ft. Gross Floor Area average
  - average density = 379/28= 14K sq.ft. per acre
- **An analyst could hide trips by using "acres" if the development was higher than the average**

Size Does Matter





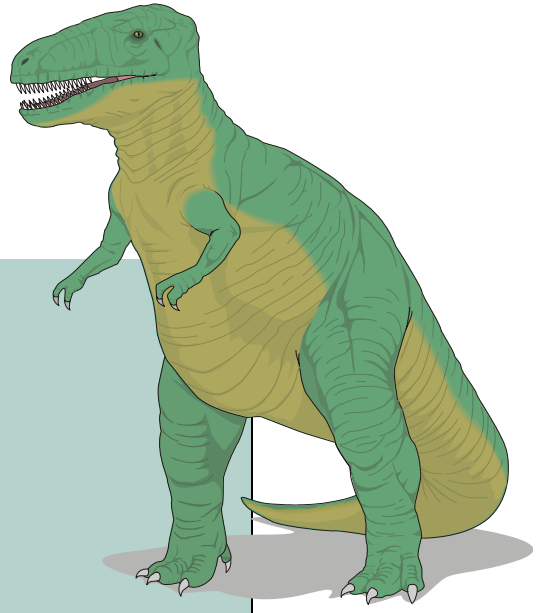


Generally, the larger any use becomes the fewer number of trips generated per square foot.

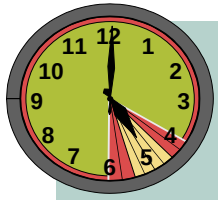
Which to Use: Rates or Equations?

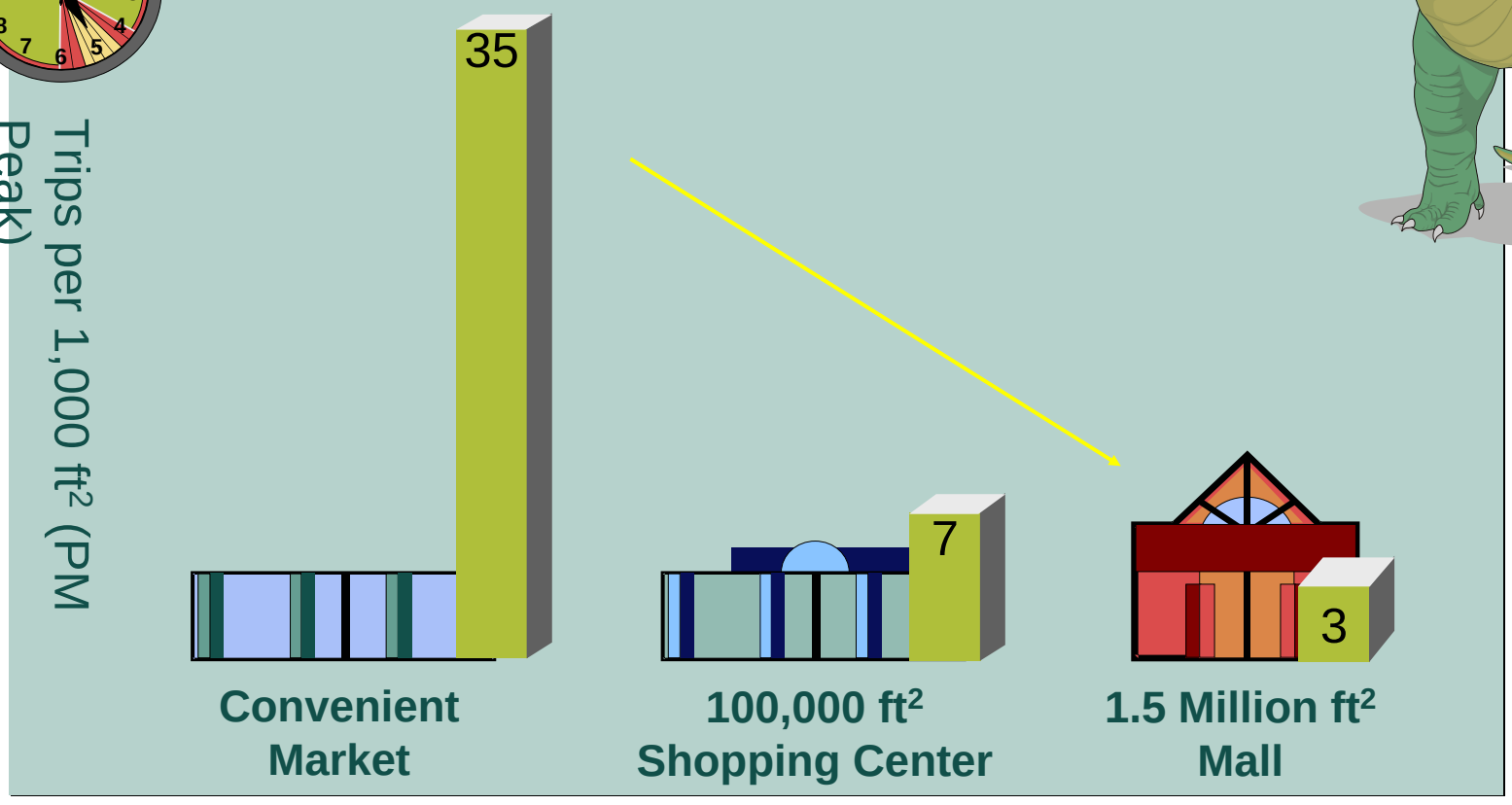
- Compare trips equation and rate
- ITE only provides equations for studies with enough data
- Consider the “unknowns”
  - out parcels
  - new land uses
- ITE Handbook has more guidance

Does Size Really Matter?



Generally, the Larger Any Use Becomes the Fewer Number of Trips Generated Per Square Foot.





Shopping Center

Shopping Center
(820)

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Trip Generation per 1000 Sq. Feet Gross Leasable Area

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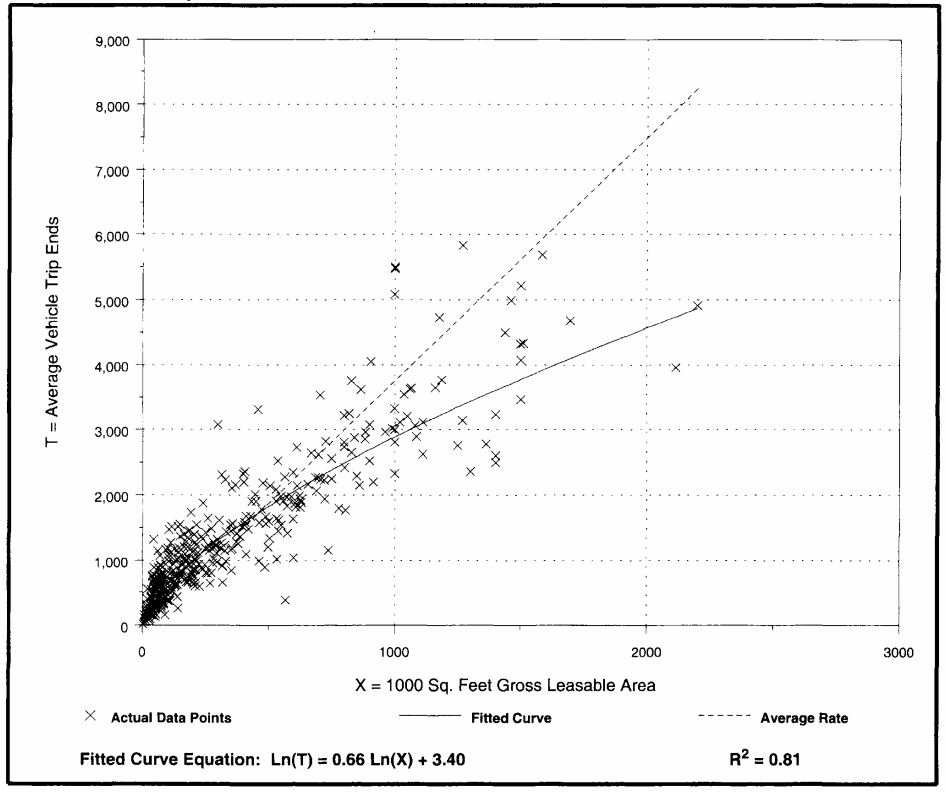
Data Plot and Equation



Fitted Curve Equation: Ln(T) = 0.66 Ln(X) + 3.40 **R^2 = 0.81**

Shopping Center

Shopping Center
(820)

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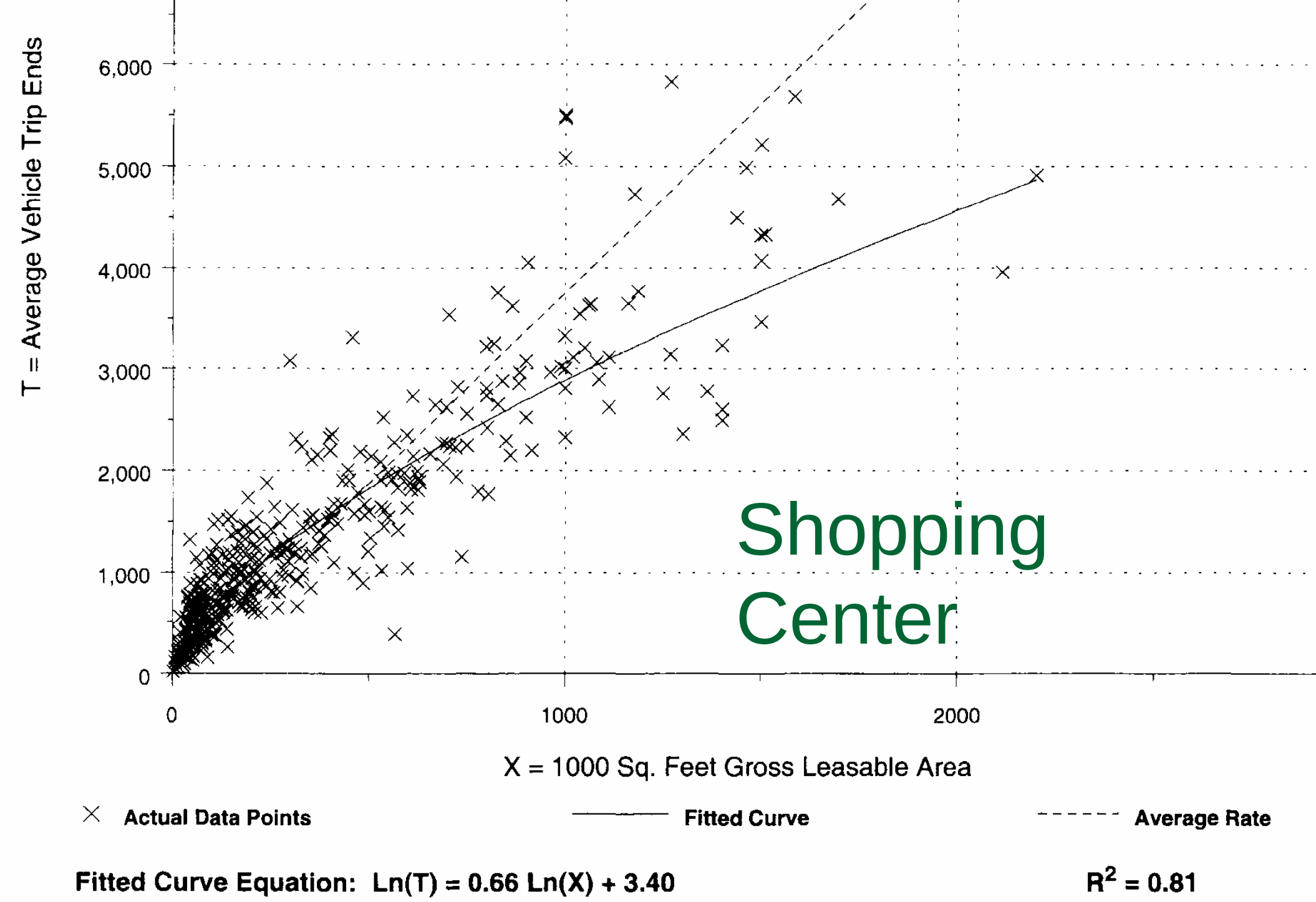
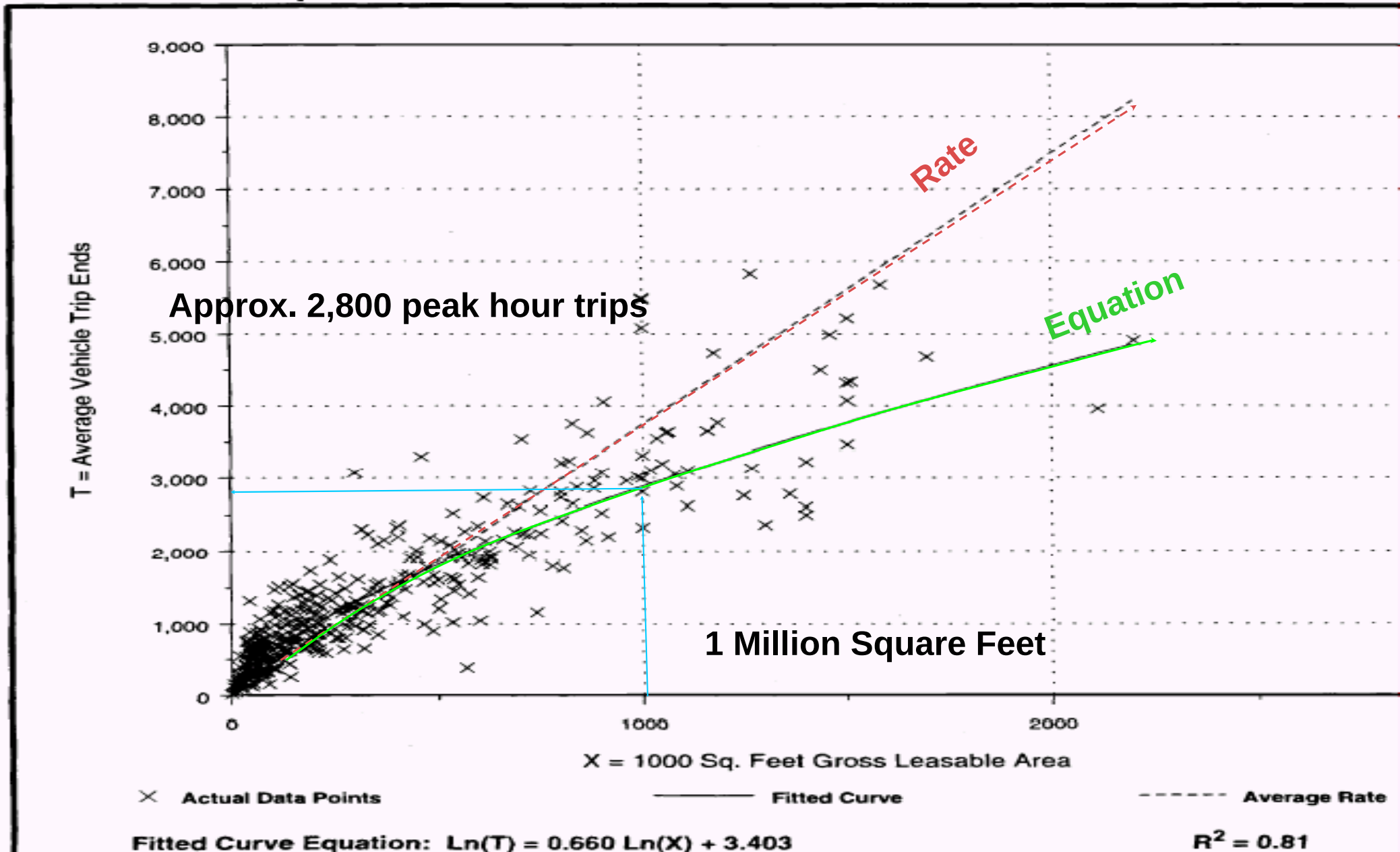
Trip Generation per 1000 Sq. Feet Gross Leasable Area

Average Rate	Range of Rates	Standard Deviation
3.75	0.68 - 29.27	2.75


T = Average Vehicle Trip Ends
6,000
5,000
4,000
3,000
2,000
1,000
0
0
1000
2000
X = 1000 Sq. Feet Gross Leasable Area
Shopping Center
Actual Data Points
Fitted Curve
Average Rate
Fitted Curve Equation: Ln(T) = 0.66 Ln(X) + 3.40
R2 = 0.81

Data Plot and Equation



What the Formulas Look Like in Excel

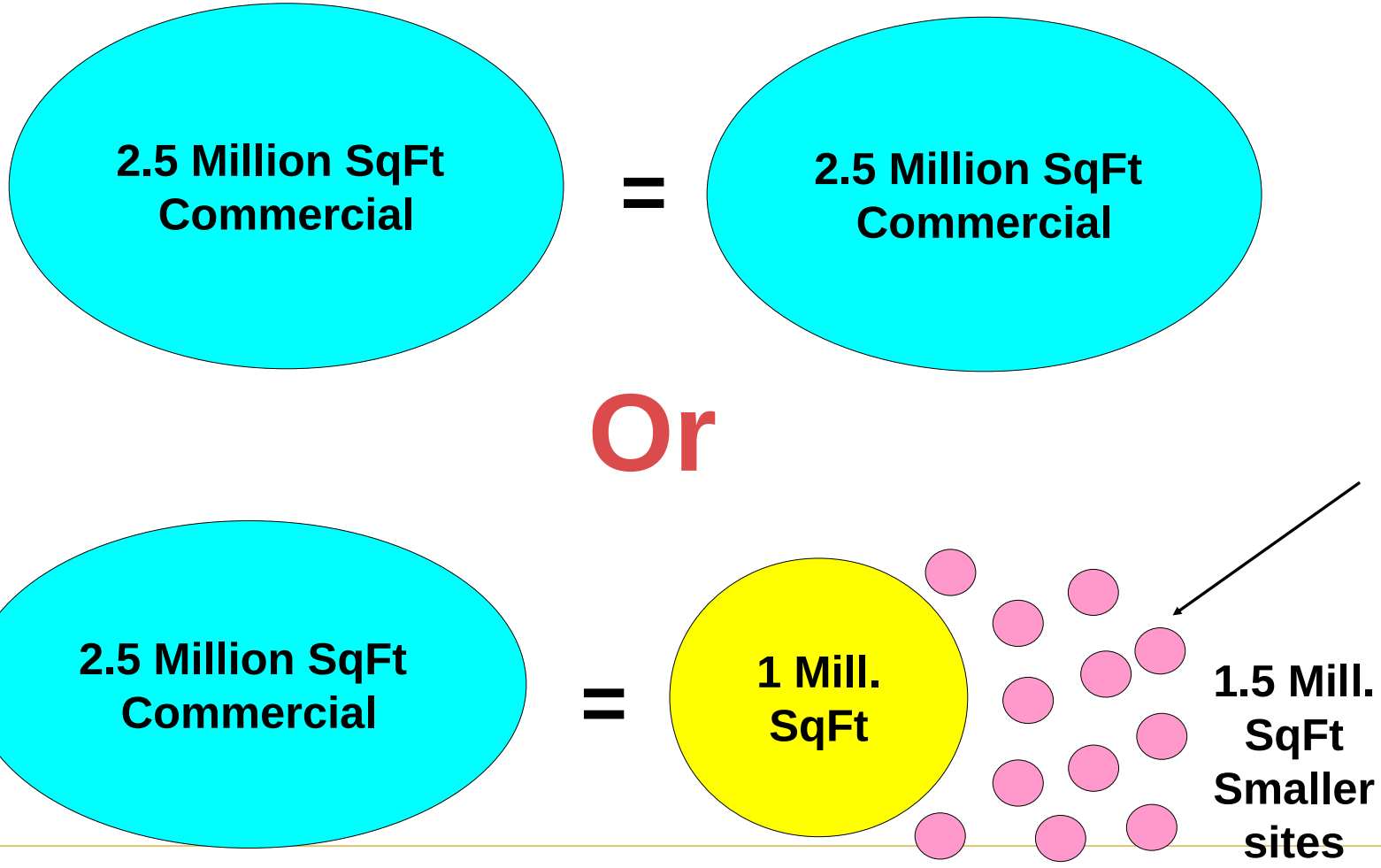
PM Peak Shopping Center

PM Peak =EXP(0.66*LN(TSF)+3.40)

PM Peak Office

PM Peak = (1.12*(TSF)+78.81)

What about “Bubble” maps of development?



Trip Generation Problem #3

- Someone is proposing a shopping center = 150,000 square feet
- What would be the projected PM Peak Hour of adjacent street traffic?

Use Average Rate:

Units **Rate** **Trips**

_____ x ____ = _____

What if the mall were to be 1.5 million square feet?

Units **Rate** **Trips** **Avg. Rate**

_____ x _____ = _____

Using Equation Line

Trip Generation Problem #3

- Someone is proposing a shopping center = 150,000 square feet
- What would be the projected PM Peak Hour of adjacent street traffic?

Use Average Rate:

Units		Rate		Trips
150	x	**3.75**	=	**563**

What if the mall were to be 1.5 million square feet?

Units		Rate		Trips	
1,500	x	**3.75**	=	**5,625**	**Avg. Rate**
				3,700	**Using Equation Line**

Trip Reduction?
Parking Reduction?

Traditional Shopping Centers

BY RUTH L. STEINER

"The alternative to sprawl is simple and timely: neighborhoods of housing, parks and schools placed within walking distance of shops, civic services, jobs and transit—a modern version of the traditional town. The convenience of the car and the opportunity to walk or use transit can be blended in an environment with local access for all the daily needs of a diverse community. It is a strategy which could preserve open space, support transit, reduce auto traffic and create affordable housing."
—Peter Calthorpe

University of California Transportation Center:
Access Number 12 Spring 1998

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CONCLUSION

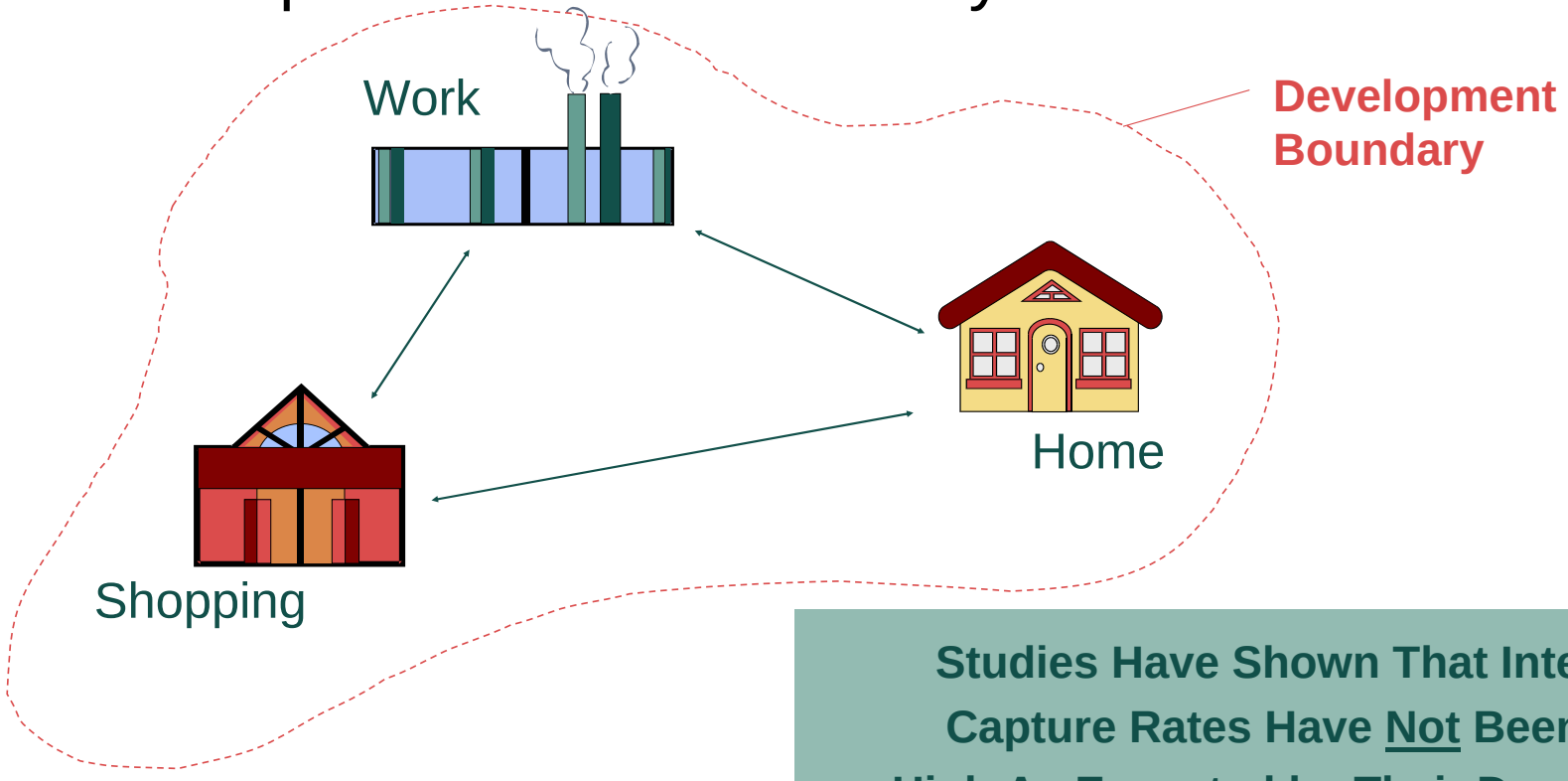
As New Urbanists suggest, traditional shopping areas generate more walking than is usually associated with shopping trips. However, they also attract a significant number of customers who don't live in the adjacent residential area and who drive there. Even those living in adjacent residential areas may drive, especially if they're grocery shopping. **Despite this high frequency of walking, the promise of less automobile traffic is not realized.** Counts and surveys taken during average (not major) shopping days reveal levels of traffic and parking demand in excess of comparable standards for peak demand.

http://www.uctc.net/access/access12.pdf

Is Internal Capture Over Optimistic?

Is Internal Capture Optimistic?

Some Developments Are So Large and Diverse That Trips Are Served Internally



Studies Have Shown That Internal Capture Rates Have Not Been As High As Expected by Their Developers

Land Use: 820
Shopping Center

Description

A shopping center is an integrated group of commercial establishments that is planned, developed, owned and managed as a unit. A shopping center's composition is related to its market area in terms of size, location and type of store. A shopping center also provides on-site parking facilities sufficient to serve its own parking demands. Specialty retail center (Land Use 814) and factory outlet center (Land Use 823) are related uses.

Additional Data

Shopping centers, including neighborhood centers, community centers, regional centers and super regional centers, were surveyed for this land use. Some of these centers contained non-merchandising facilities, such as office buildings, movie theaters, restaurants, post offices, banks, health clubs and recreational facilities (for example, ice skating rinks or indoor miniature golf courses). The centers ranged in size from 1,700 to 2.2 million square feet of gross leasable area (GLA). The centers studied were located in suburban areas throughout the United States and therefore represent typical U.S. suburban conditions.

Many shopping centers, in addition to the integrated unit of shops in one building or enclosed around a mall, [redacted] 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 included peripheral buildings, it can be assumed that some of the data show their effect.

Read Descriptions

Many shopping centers, in addition to the integrated unit of shops in one building or enclosed around a mall, [redacted] 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 included peripheral buildings, it can be assumed that some of the data show their effect.

Internal Capture
New Procedure- ITE Handbook

Match of **both ends** of internal trips

Don't use a "stock" percentage

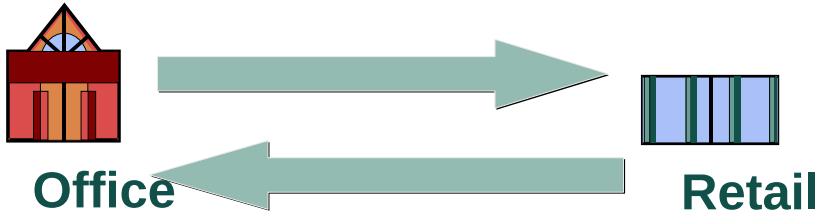


Figure 7.5 Step 7-9 for Multi-Purpose Trip
General Calculation Sample Program

LAND USE A Retail

ITE LU Code	820 (pg 1,339)		
Size	1,000,000 sf GLA		
Direct Dist.		**In: 48%**	**Out: 52%**
	Total	*Internal*	*External*
Enter	1795	90	1705
Exit	1945	103	1842
Total	3740	193	3547
%	100%	5%	95%

Exit to External 1842

1705 *Enter from External*

3% 58 Demand — 39 Balance — 31% 39 Demand

2% 36 Demand — 36 Balance — 23% 142 Demand

12% 233 Demand — 64 Balance — 31% 64 Demand

20% 359 Demand — 54 Balance — 53% Demand

ffice

g 1,054)
0 sf GSF
n: 17% **Out: 83%**

Internal	*External*
39	88
40	578
79	666
11%	89%

Demand 0% 127 — Balanced 0 — Demand 0% 0

2% 12 Demand — 4 Balanced — 2% 4 Demand

ITE LU C
S
Direct D

Enter	
Exit	
Total	
%	

Net External Trips for Multi-Use Development

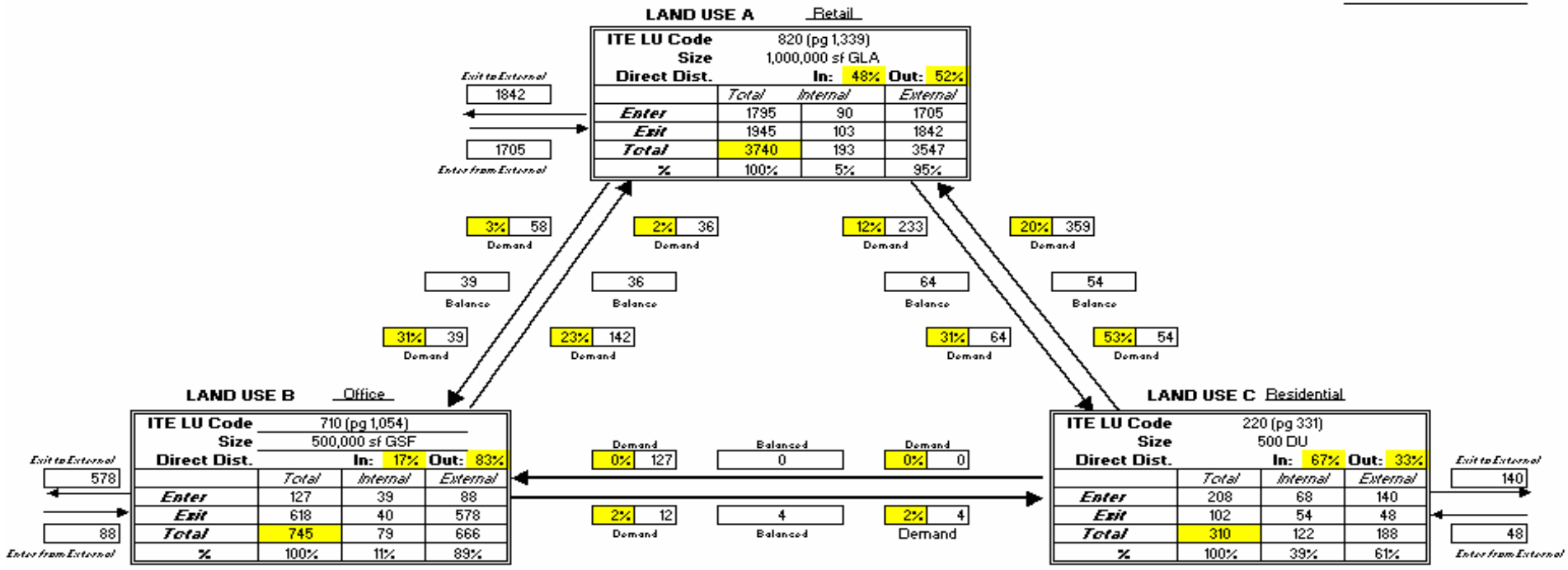
	LAND USE A	LAND USE B	LAND USE C
Enter	1705	88	140
Exit	1842	578	48
Total	3547	666	188
Trip Generation	3740	745	310
ernal Capture	**5%**	**11%**	**39%**

ITE Handbook pencil method...

Analyst _____
Date _____

Figure 7.5 Step 7-9 for Multi-Purpose Trip
General Calculation Sample Program

Name of Dvlpt _____
Time Period _____



Net External Trips for Multi-Use Development

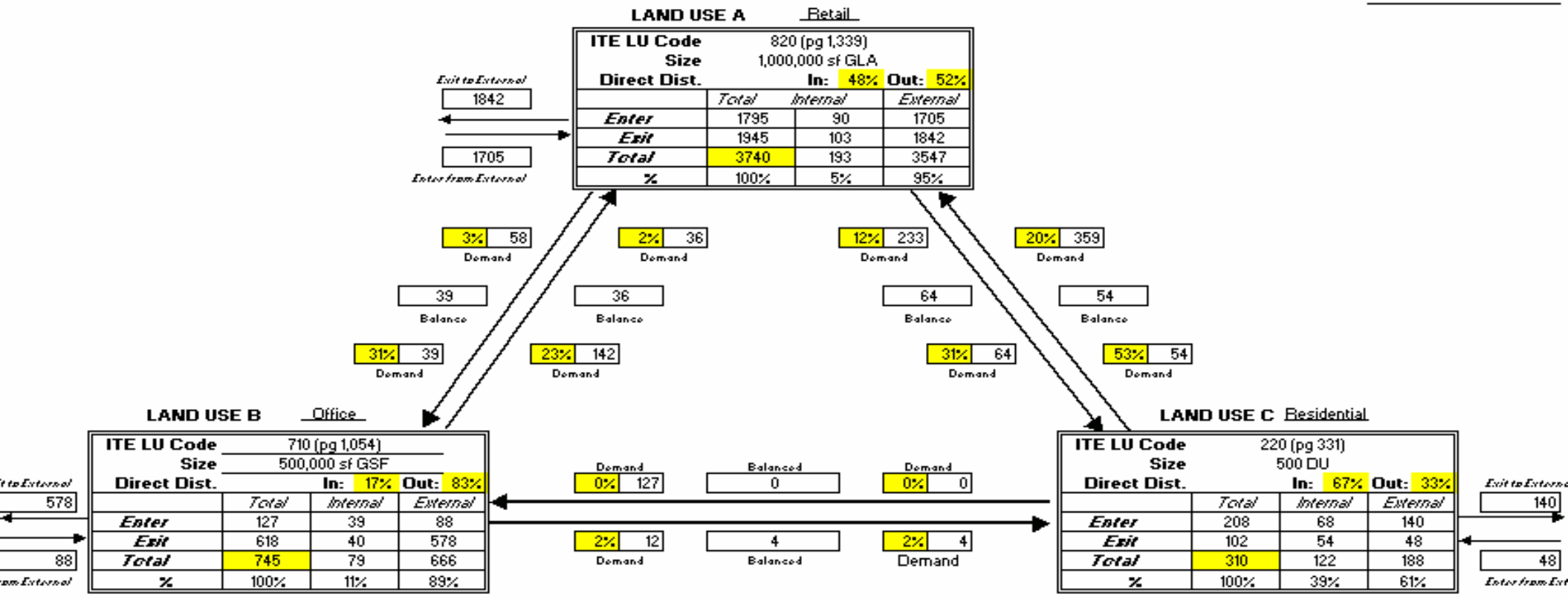
	LAND USE A	LAND USE B	LAND USE C	TOTAL	
Enter	1705	88	140	1933	
Exit	1842	578	48	2468	
Total	3547	666	188	4401	
Single-Use Trip Generation	3740	745	310	4795	8.2%
Balanced Internal Capture	**5%**	**11%**	**39%**		

- **Lookup of data**
- **A minimum of 21 user data entry items for 3 land uses**

Example - ITE Handbook

Analyst _____ Name of Dvlpt _____
Date _____ Time Period _____

Figure 7.5 Step 7-9 for Multi-Purpose Trip
General Calculation Sample Program



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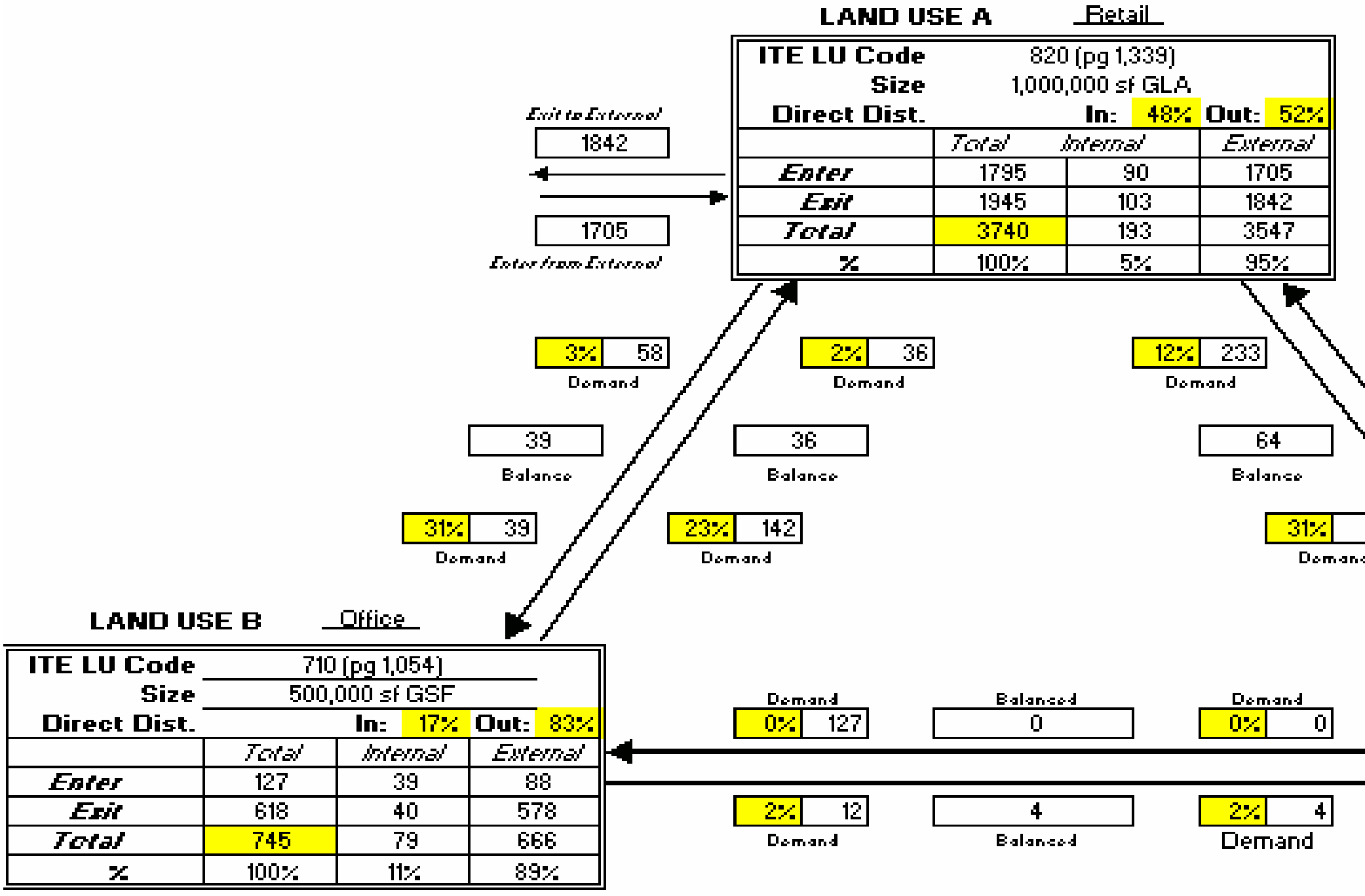
Balanced Internal Capture	**5%**	**11%**	**39%**		


LAND USE A
Retail
ITE LU Code
820 (pg 1,339)
Size
1,000,000 sf GLA
Direct Dist.
In: 48% Out: 52%
Total
Internal
External
Enter
1795
90
1705
Exit
1945
103
1842
Total
3740
193
3547
%
100%
5%
95%
Exit to External
1842
1705
Enter from External
3% 58
Demand
2% 36
Demand
12% 233
Demand
39
Balance
36
Balance
64
Balance
31% 39
Demand
23% 142
Demand
31%
Demand
LAND USE B
Office
ITE LU Code
710 (pg 1,054)
Size
500,000 sf GSF
Direct Dist.
In: 17% Out: 83%
Total
Internal
External
Enter
127
39
88
Exit
618
40
578
Total
745
79
666
%
100%
11%
89%
Demand
0% 127
Balanced
0
Demand
0% 0
2% 12
Demand
4
Balanced
2% 4
Demand

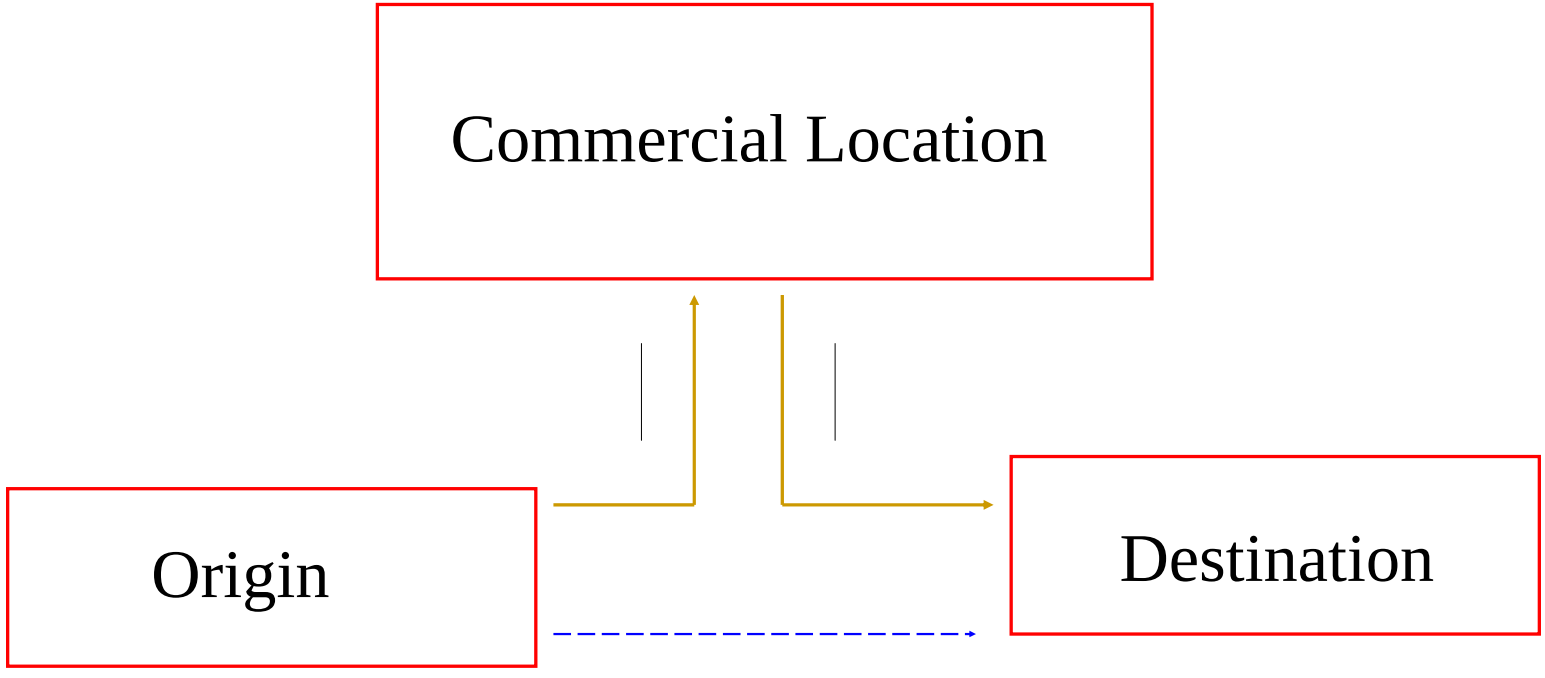
TIPS

Trip Generation, Internal Capture and Pass By System

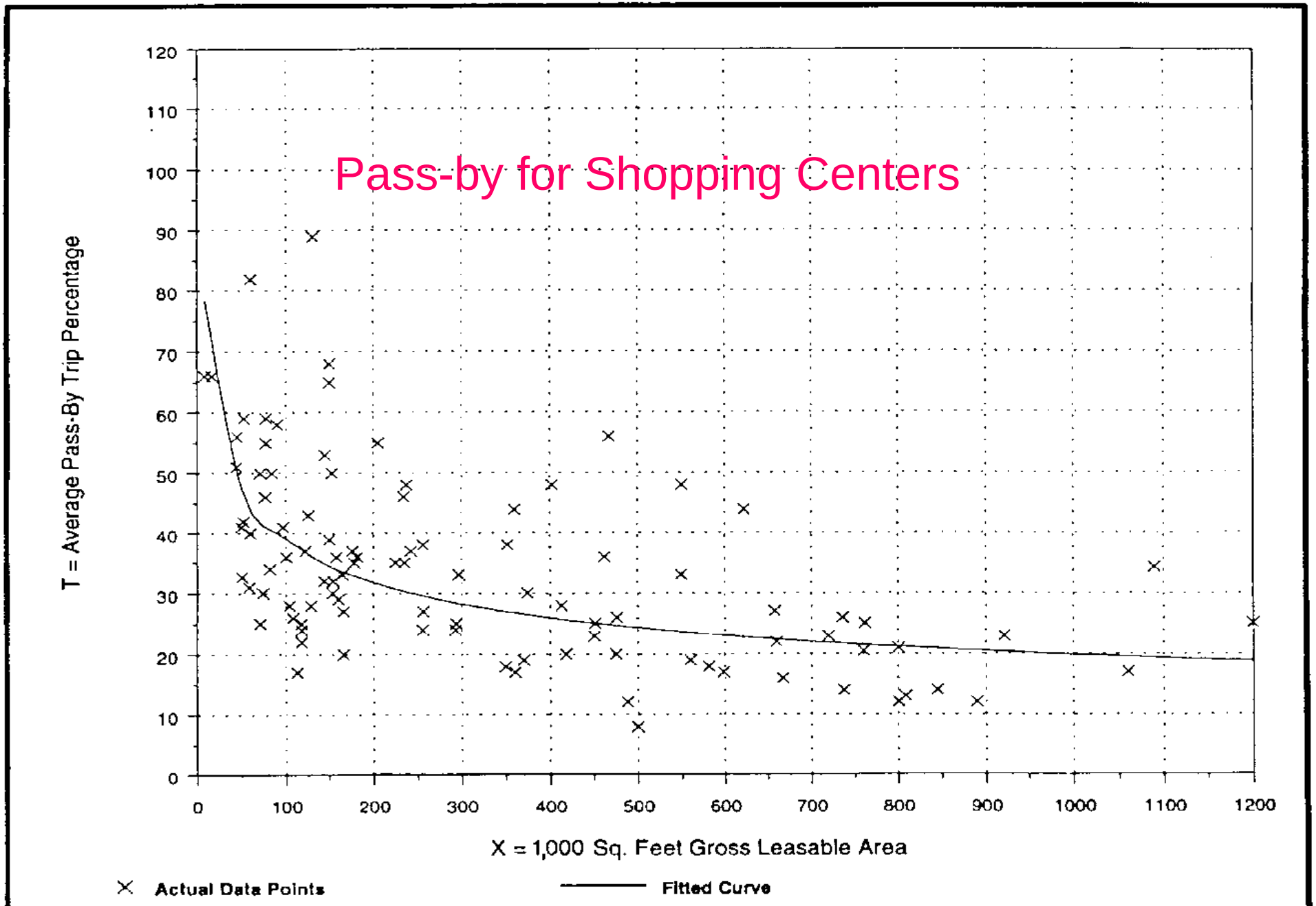
Window 9x/NT/2000/XP

Are Pass-by Trips Over Estimated?

What's a Pass-By Trip?

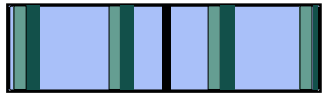


Data Plot


Pass-by for Shopping Centers
T = Average Pass-By Trip Percentage
X = 1,000 Sq. Feet Gross Leasable Area
0
10
20
30
40
50
60
70
80
90
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
Actual Data Points
Fitted Curve
Fitted Curve Equation: Ln(T) = -0.291 Ln(X) + 5.001
R^2 = 0.37

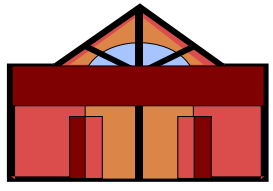
Are Pass-by Trips Over Predicted?

The smaller and more “convenience-oriented” a business is, the higher the proportion of trips generated that are already on the road.



Gasoline /Convenience Mkts **ITE #845**

45 - 80% (measured - but use caution)



Shopping Center **ITE #820**

20% and more **(measured - but use caution)**

Source: ITE Trip Generation, Handbook Oct 1998

Florida's Site Impact Handbook Gives Guidance for Large Developments

- **Pass-by** based on **type** and **size** of retail space
- Generally, the number of pass-by trips should not exceed:
  - **10 percent of the adjacent street traffic** during peak hour or
  - 25 percent of project's external trip generation ***if it is a large scale development***

Don’t Count Twice,

It’s not alright

If internal capture is considered:

Use internal capture first;

then apply pass-by percentages to

shopping external trips *only*

Trip Generation
- Internal Capture
= External Trip Generation

- Pass-By Trips (% of External)
= New External Trip Generation

North DRI
PM Peak Hour Trip Generation Analysis
Internalization

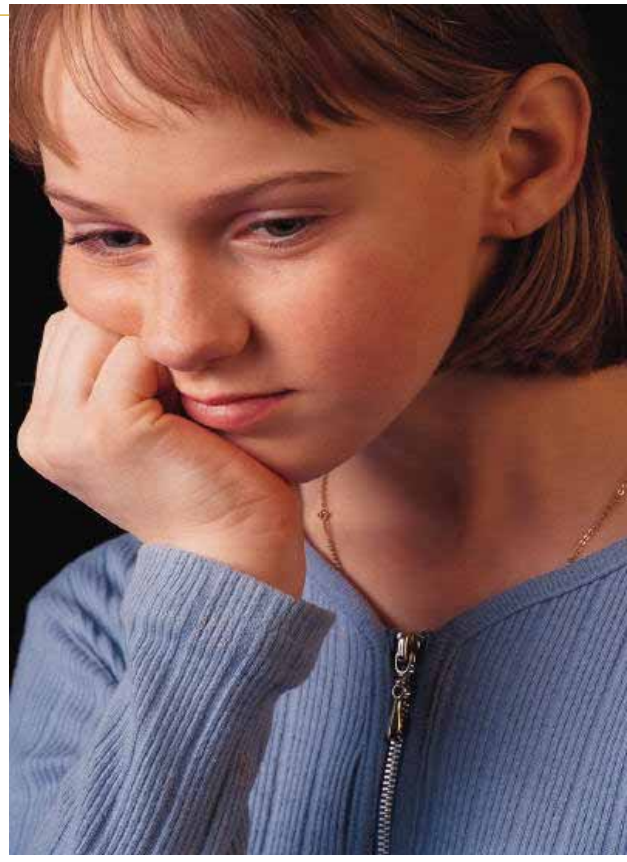
		Residential		Schools		Commercial		Office		Total		
Trip Reduction	Rate	In	Out	In	Out	In	Out	In	Out	In	Out	Total
Percent		66%	34%	50%	50%	48%	39%	17%	83%	53%	47%	100%
Gross Trips		675	351	123	125		499	36	177	1,294	1,152	2,446
Internalization												
Commercial/Residential	20%	-100	-92			-92	-100			-192	-192	-384
Commercial/Schools	0%			0	0	0	0			0	0	0
Commercial/Office	10%					-18	-4	-4	-18	-21	-21	-43
Residential/Office	10%	-18	-4					-4	-18	-21	-21	-43
Residential/Schools	10%	-13	-12	-12	-13					-25	-25	-50
Schools/Office	0%			0	0			0	0	0	0	0
Subtotal Internalization		-130	-108	-12	-13	-110	-103	-7	-35	-259	-259	-518
Trips Less Internalization		545	243	111	113	350	396	29	142	1,035	893	1928
Percent Internal	21.0%	23.2%		10.0%		22.2%		20.0%		21.2%		
Passer-By Reduction	10.0%						-50			-46	-50	-96
Net Internal Trips	75.0%	545	243	111	113	304	346	29	142	989	843	1,832

Percent		66%	34%	50%	50%	48%	39%
Gross Trips		675	351	123	125		499
Internalization							
Commercial/Residential	20%	-100	-92			-92	-100
Commercial/Schools	0%			0	0	0	0
Commercial/Office	10%					-18	-4
Residential/Office	10%	-18	-4				
Residential/Schools	10%	-13	-12	-12	-13		
Schools/Office	0%			0	0		
Subtotal Internalization		-130	-108	-12	-13	-110	-103
Trips Less Internalization		545	243	111	113	350	396
Percent Internal	21.0%	23.2%		10.0%		22.2%	
Passer-By Reduction	10.0%						-50

Think About It

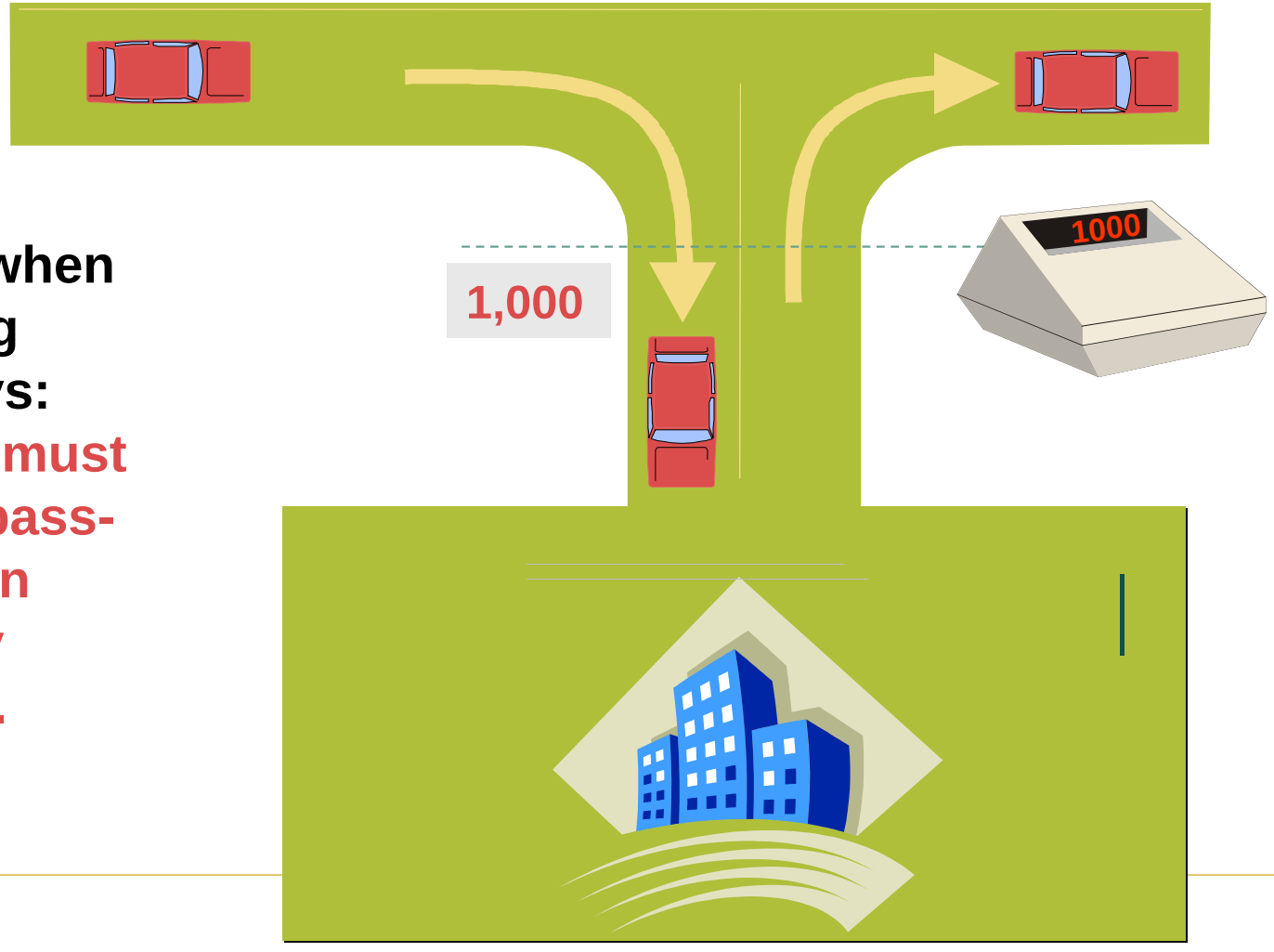
If everything else is correct,
what should be the
answer for the 10%
pass by reduction

Hint: It’s not 46



Driveway Traffic Will Include All Of The Pass By Traffic

Beware when analyzing driveways: **analysis must include pass-by trips in driveway volumes.**



Roughly Right — or — Precisely Wrong

BY DONALD SHOUP

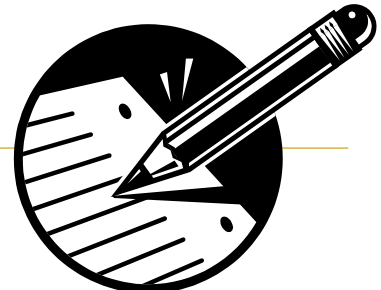
Access Magazine – Spring 2002

Distance from San Francisco to San Diego?

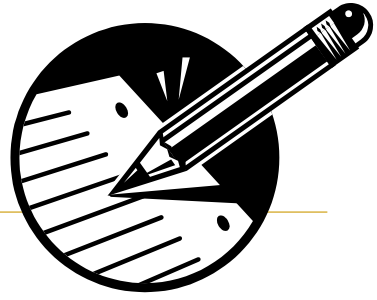
1. Roughly 400 to 500 miles?
2. Or, 632.12 miles?

What you need to Know About Trip Generation

- Simple trip generation is always needed
- Trip Generation studies are estimates
  - Don’t be fooled by the precision
- ITE’s Trip Generation methods may not work downtown
- Read the descriptions of the ITE Report
- Be skeptical of major trip reductions until more studies are done
- Don’t use a “stock” percentage for internalization



What you need to Know About Trip Generation



Most Frequently Used Trip Generation Rates From the 7th Edition ITE Trip Generation Report

gary.sokolow@dot.state.fl.us

Most Used Trip Generation Rates from the 7th Edition ITE Trip Generation Report

Description/ITE Code	Units	Rate/Daily Weekday	PM Peak Rate Adjacent Street	PM In	PM Out	Notes
Truck Terminal 030	Acres	81.90	6.55	43%	57%	Caution- Only 2 Studies daily 3 s
General Light Industrial 110	TSF Gross	6.97	0.98	12%	88%	
Mini Warehouse 151	TSF Gross	2.50	0.26	51%	49%	
Single Family Homes 210	DU	9.57	1.01	64%	36%	
Apartments 220	DU	6.72	0.62	65%	35%	
Mobile Home Park 240	DU	4.99	0.59	62%	38%	
Assisted Living 254	Beds	2.66	0.22	44%	56%	New Category 7th Edition
All Suites Hotel 311	Rooms	4.90	0.40	45%	55%	Caution- few studies
Motel 320	Rooms	5.63	0.47	54%	46%	
Marina 420	Berths	2.96	0.19	60%	40%	Caution- Only 2 Studies for Peak
Health/Fitness Club 492	TSF Gross	32.93	4.05	51%	49%	Caution- Only 1 Study for Daily tri
Church 560	TSF Gross	9.11	0.66	54%	46%	For Weekday
Daycare Center 565	TSF Gross	79.26	13.18	47%	53%	
General Office 710 (Equation)	TSF Gross	**Daily =EXP(0.77*LN(TSF)+3.65)**			PM Peak = (1.12*(TSF)+78.81)	
General Office 710 (Rate)	TSF Gross	11.01	1.49	17%	83%	
Medical Dental Office 720	TSF Gross	36.13	3.72	27%	73%	
Building Materials/Lumber 812	TSF Gross	45.16	4.49	47%	53%	
Hardware/Paint Store 816	TSF Gross	51.29	4.84	47%	53%	Caution- Only 3 Studies
Nursery (Garden Center) 817	TSF Gross	36.08	3.80	NA	NA	
Shopping Center 820 (Equation)	TSF Gross	**Daily =EXP(0.65*LN(TSF)+5.83)**			PM Peak =EXP(0.66*LN(TSF)+3.40)	
Shopping Center 820 (Rate)	TSF Gross	42.94	3.75	48%	52%	
Quality Restaurant 931 (not national chain)	TSF Gross	89.95	7.49	67%	33%	Low Turnover (over 1 hr.) Reserv
High Turnover/Sit Down Rest. 932	TSF Gross	127.15	10.92	61%	39%	Big variation on Daily
Fast Food w/o Drive Thru 933	TSF Gross	716.00	26.15	51%	49%	Caution: Only one observation or
Fast Food with Drive Thru 934	TSF Gross	496.12	34.64	52%	48%	
Drive Thru Only 935	TSF Gross	NA	153.85	54%	46%	Only 2 studies

17	Marina 420
18	Health/Fitness Club 492
19	Church 560
20	Daycare Center 565
21	**General Office 710 (Equation)**
22	**General Office 710 (Rate)**
23	Medical Dental Office 720
24	Building Materials/Lumber 812
25	Hardware/Paint Store 816

Calculations Using the Most Used Trip Generation Rates from the 7th Edition ITE

Description/ITE Code	Units	Expected Units	Expected Daily Trips	PM Peak Trips - Total	PM In	PM Out
Truck Terminal 030	Acres					
General Light Industrial 110	TSF Gross					
Mini Warehouse 151	TSF Gross					
Single Family Homes 210	DU					
Apartments 220	DU					
Mobile Home Park 240	DU					
Assisted Living 254	DU					
All Suites Hotel 311	Rooms					
Motel 320	Rooms					
Marina 420	Berths					
Health/Fitness Club 493	TSF Gross					
Church 560	TSF Gross					
Daycare Center 565	TSF Gross					
General Office 710 (Equation)	TSF Gross					
General Office 710 (Rate)	TSF Gross					
Medical Dental Office 720	TSF Gross					
Building Materials/Lumber 812	TSF Gross					
Hardware/Paint Store 816	TSF Gross					
Nursery (Garden Center) 817	TSF Gross				Not Available	Not Available
Shopping Center 820 (Equation)	TSF Gross					
Shopping Center 820 (Rate)	TSF Gross					
Quality Restaurant 931	TSF Gross					
High Turnover/Sit Down Rest. 932	TSF Gross					
Fast Food w/o Drive Thru 933	TSF Gross					
Fast Food with Drive Thru 934	TSF Gross					
Drive Thru Only 935	TSF Gross		Not Available			
Service Station 944	Fuel Position					
Serv.Station w/ Conven.Mkt 945	Fuel Position					

4	Description/ITE Code	Units	Expected Units	Expected Daily Trips	PM Peak Trips - Total	PM In	PM Out
6	Truck Terminal 030	Acres					
7	General Light Industrial 110	TSF Gross					
8	Mini Warehouse 151	TSF Gross					
9	Single Family Homes 210	DU					
10	Apartments 220	DU					
11	Mobile Home Park 240	DU					
12	Assisted Living 254	DU					
13	All Suites Hotel 311	Rooms					
14	Motel 320	Rooms					
15	Marina 420	Berths					
16	Health/Fitness Club 493	TSF Gross					
17	Church 560	TSF Gross					
18	Daycare Center 565	TSF Gross					
19	**General Office 710 (Equation)**	TSF Gross					
20	General Office 710 (Rate)	TSF Gross					
21	Medical Dental Office 720	TSF Gross					
22	Building Materials/Lumber 812	TSF Gross					

4	Description/ITE Code	Units	Expected Units	Expected Daily Trips
5				
6	Truck Terminal 030	Acres		
7	General Light Industrial 110	TSF Gross		
8	Mini Warehouse 151	TSF Gross		
9	Single Family Homes 210	DU		
10	Apartments 220	DU		
11	Mobile Home Park 240	DU		
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13	All Suites Hotel 311	Rooms		
14	Motel 320	Rooms		
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16	Health/Fitness Club 493	TSF Gross		
17	Church 560	TSF Gross		
18	Daycare Center 565	TSF Gross		
19	**General Office 710 (Equation)**	TSF Gross		
20	General Office 710 (Rate)	TSF Gross		
21	Medical Dental Office 720	TSF Gross		
22	Building Materials/Lumber 812	TSF Gross		

Units	Expected Units	Expected Daily Trips	PM Peak Trips - Total	PM In	PM Out
Acres					
TSF Gross					
TSF Gross					
DU					
DU					
DU					
DU					
Rooms					
Rooms					
Berths					
TSF Gross					
TSF Gross					
TSF Gross					
TSF Gross					
TSF Gross					
TSF Gross					
TSF Gross					

Any Questions?

Avoid Blind Reliance On Extreme Variables And Trends

- Left Turn Bays on 2 Lane Roadways

Harmelink Method for Left Turn Lanes (Earlv 1960s)

- B
- L
- A

$$t_{median} = t_3 \quad A \cong \frac{2}{3} \cdot \frac{3600}{V_A} = \frac{2400}{VA}$$

volume (through, left-turning, and right-
in VA.

s, then, the mean arrival rate is the nur
s behind left-turning vehicles:

$$\lambda \cong [L(1 - L)\ V_A] \frac{t_w + t_e}{\frac{2}{3} t_A}$$

defined earlier

From AASHTO Adapted from Harmelink

Opposing volume (veh/h)	Advancing volume (veh/h) 5% left turns	10% left turns	20% left turns	30% left turns
40-mph operating speed				
800	330	240	180	160
600	410	305	225	200
400	510	380	275	245
200	640	470	350	305
100	720	515	390	340
50-mph operating speed				
800	280	210	165	135
600	350	260	195	170
400	430	320	240	210
200	550	400	300	270
100	615	445	335	295
60-mph operating speed				
800	230	170	125	115
600	290	210	160	140
400	365	270	200	175
200	450	330	250	215
100	505	370	275	240

AASHTO Green Book 2001, Exhibit 9-75 – page 689

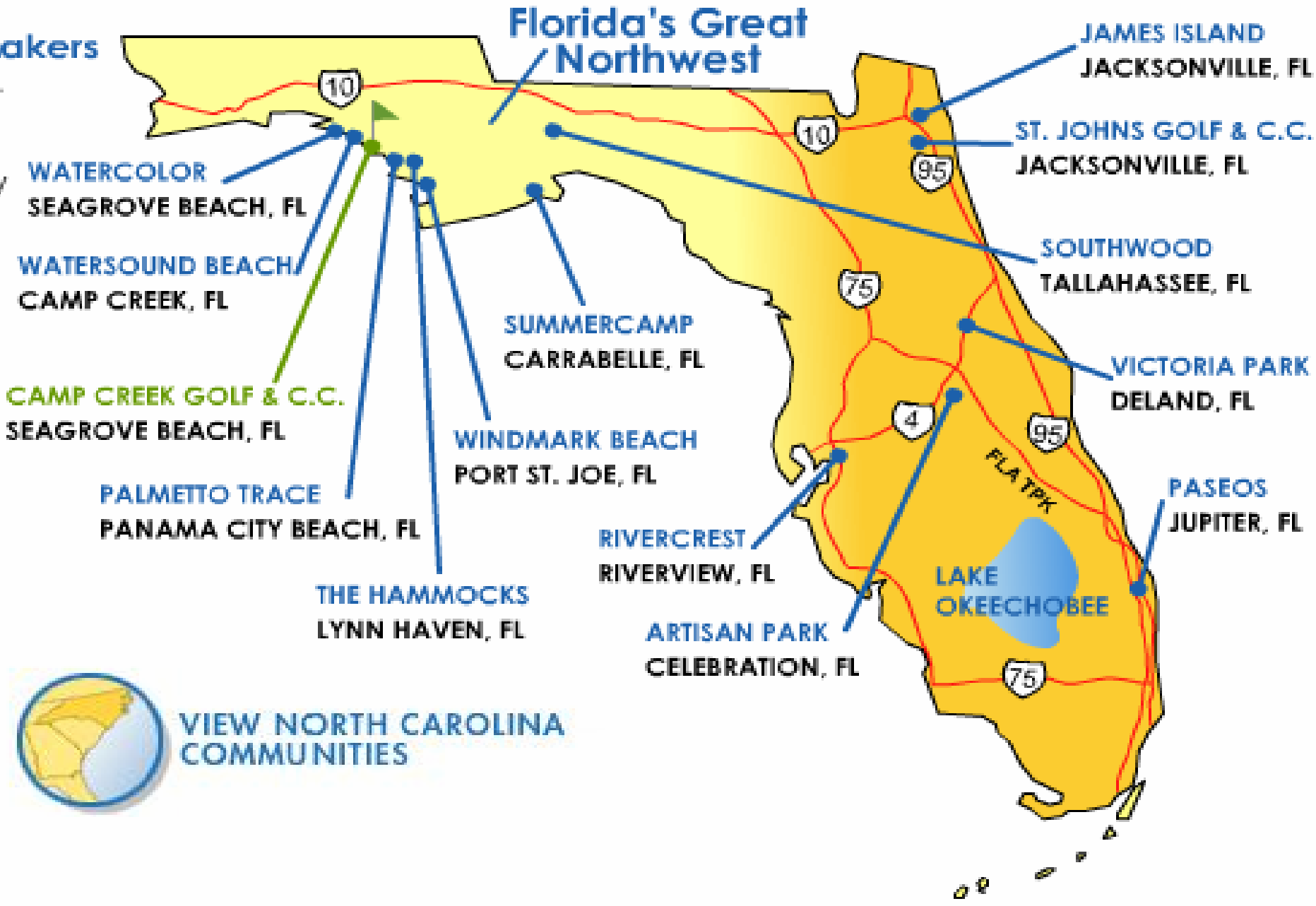
Common Florida Example

driveway or side street. This is based on a 40-mph roadway with 20 left turns expected (5% of 410) and 600 opposing vehicles. If the operating speed was 60 mph, then the number of left turns would be 15 left turns.

e-Makers

or you.
o find
wise
on any
site.

Florida's Great Northwest



JAMES ISLAND
JACKSONVILLE, FL

ST. JOHNS GOLF & C.C.
JACKSONVILLE, FL

SOUTHWOOD
TALLAHASSEE, FL

VICTORIA PARK
DELAND, FL

PASEOS
JUPITER, FL

WATERCOLOR
SEAGROVE BEACH, FL

WATERSOUND BEACH
CAMP CREEK, FL

SUMMERCAMP
CARRABELLE, FL

CAMP CREEK GOLF & C.C.
SEAGROVE BEACH, FL

WINDMARK BEACH
PORT ST. JOE, FL

PALMETTO TRACE
PANAMA CITY BEACH, FL

THE HAMMOCKS
LYNN HAVEN, FL

RIVERCREST
RIVERVIEW, FL

ARTISAN PARK
CELEBRATION, FL

VIEW NORTH CAROLINA COMMUNITIES

SummerCamp

Arvida is in the preliminary planning stages of creating a special new community on 766 acres in Franklin County called SummerCamp. Located at the intersection of Routes 98 and 319, SummerCamp will be a place primarily devoted to weekend and summertime retreats. It will be a place where residents and visitors alike can enjoy an easygoing lifestyle, experience the outdoors, explore nature, and have fun.

Rub elbows with the pines from the comfort of your front porch, while away the hours in a hammock rocked by a gentle breeze, or pack up the kids and walk to the beach. With family, friends and neighbors, the possibilities are endless at SummerCamp.

About SummerCamp

▶ **Get The Latest Information**
Register to get information as it becomes available.

▶ **Florida's Great NorthWest**
Discover other hidden treasures in this region.

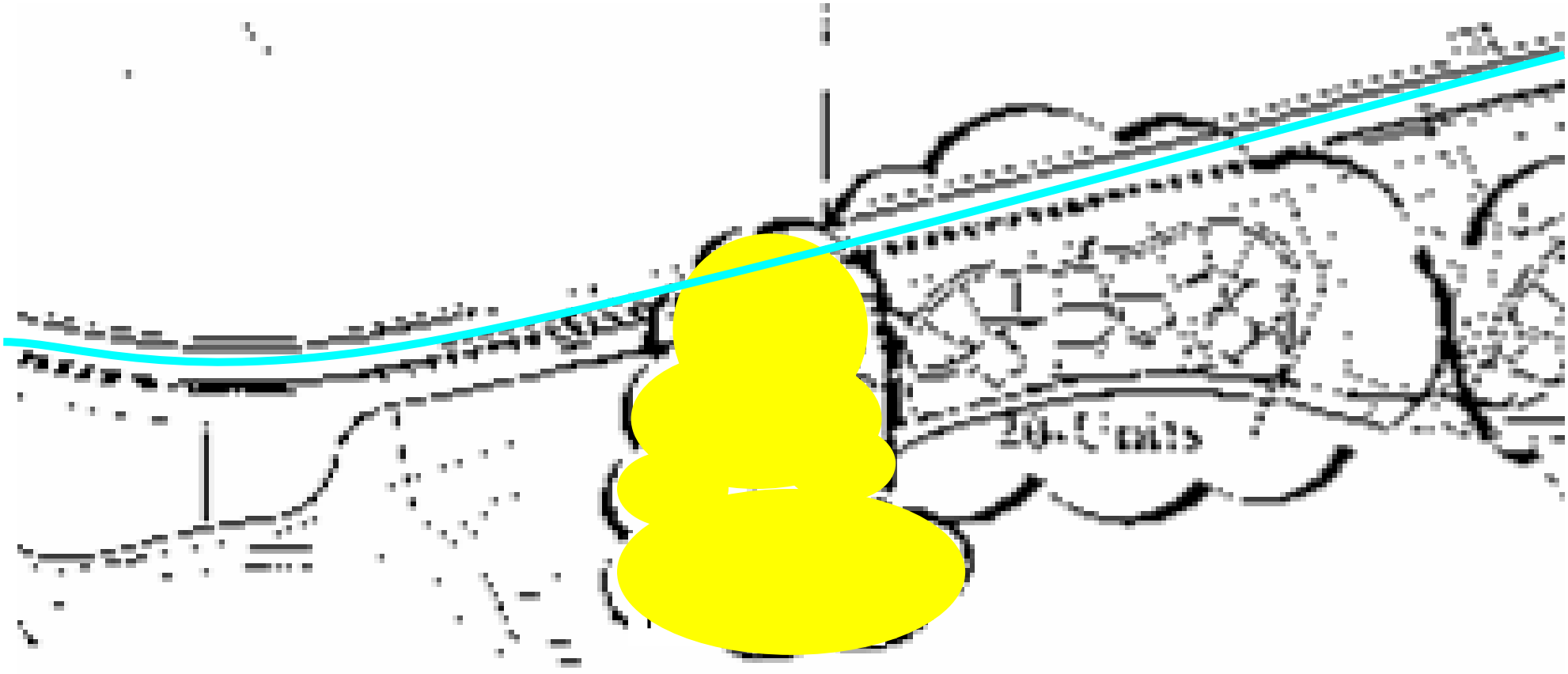
History & the Arts

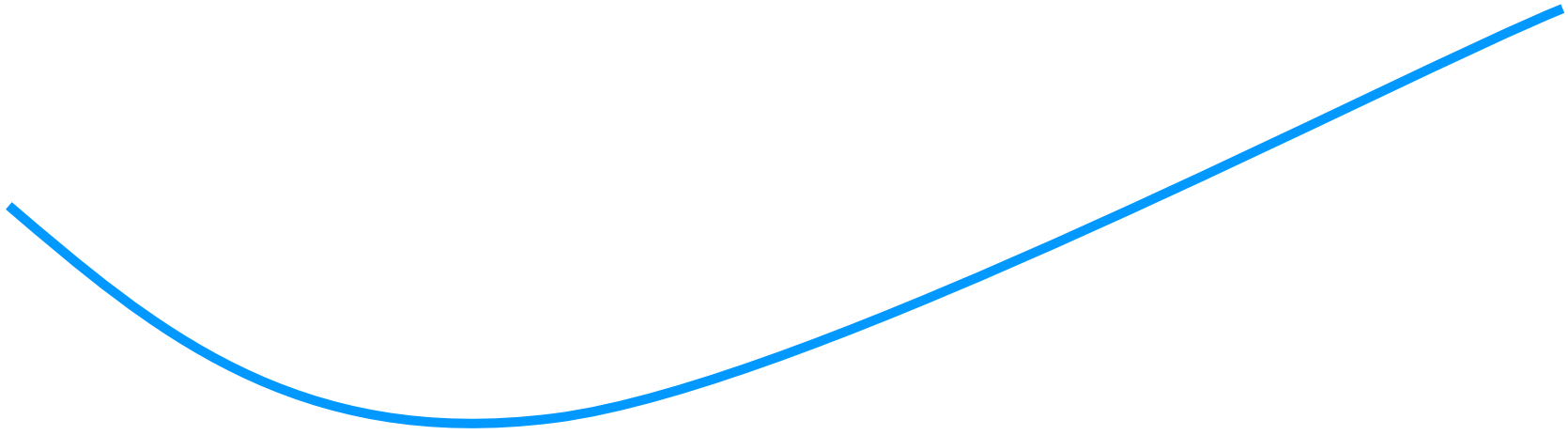
▶ **Florida's Heritage**
Learn about Florida's culture.

Commercial Pod

Commercial
Sales Center (2500 sf)
Beach Club (6200 sf)
Motel (50 rooms)
Restaurant (4000 sf)
Marine Research & Education (10,000 sf)
Recreational Area (1.5 Acres)
RV (168) Storage Spaces
General Store (4000 sf)/Dry Boat Storage

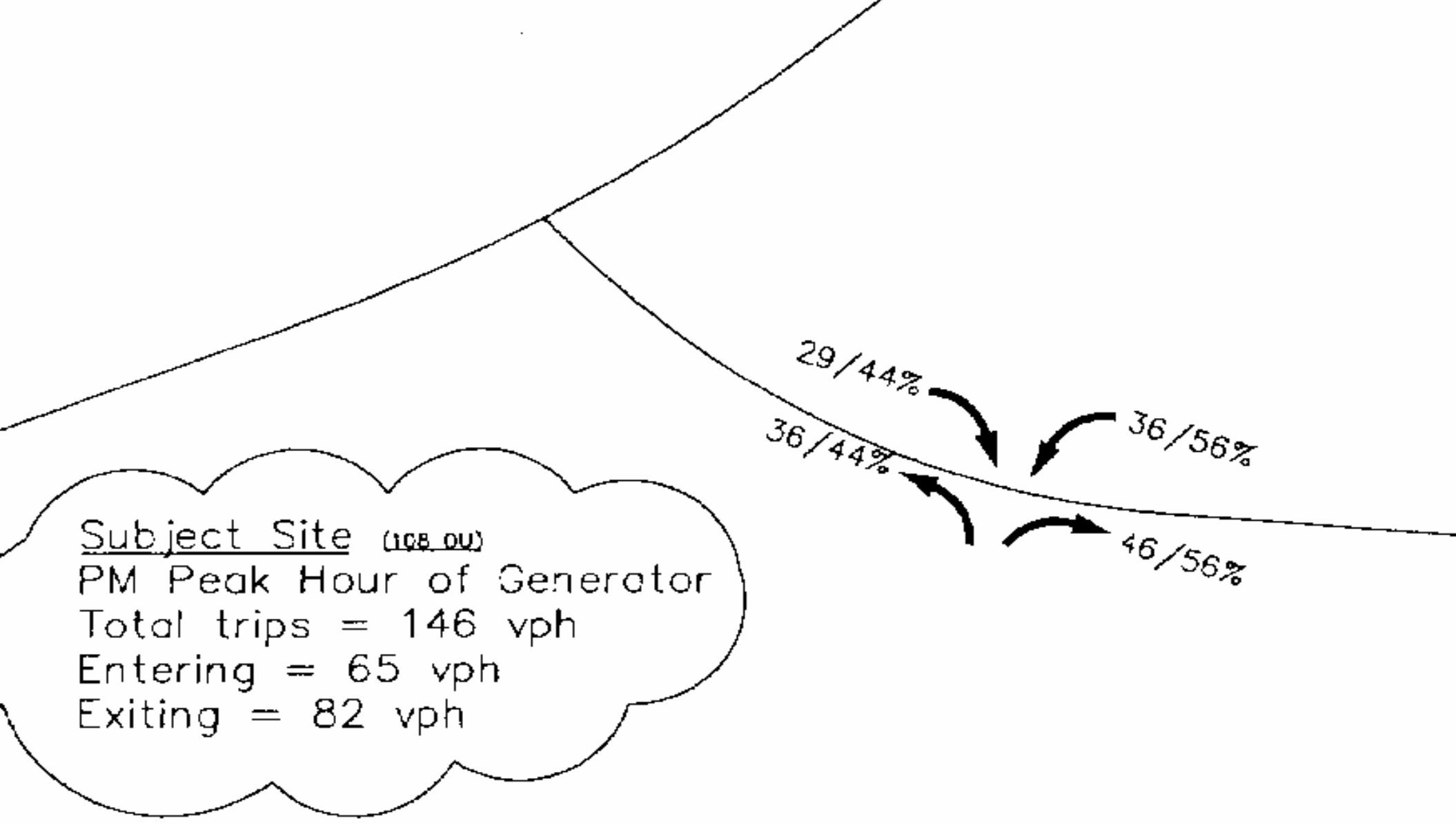
Commercial Node on US 98

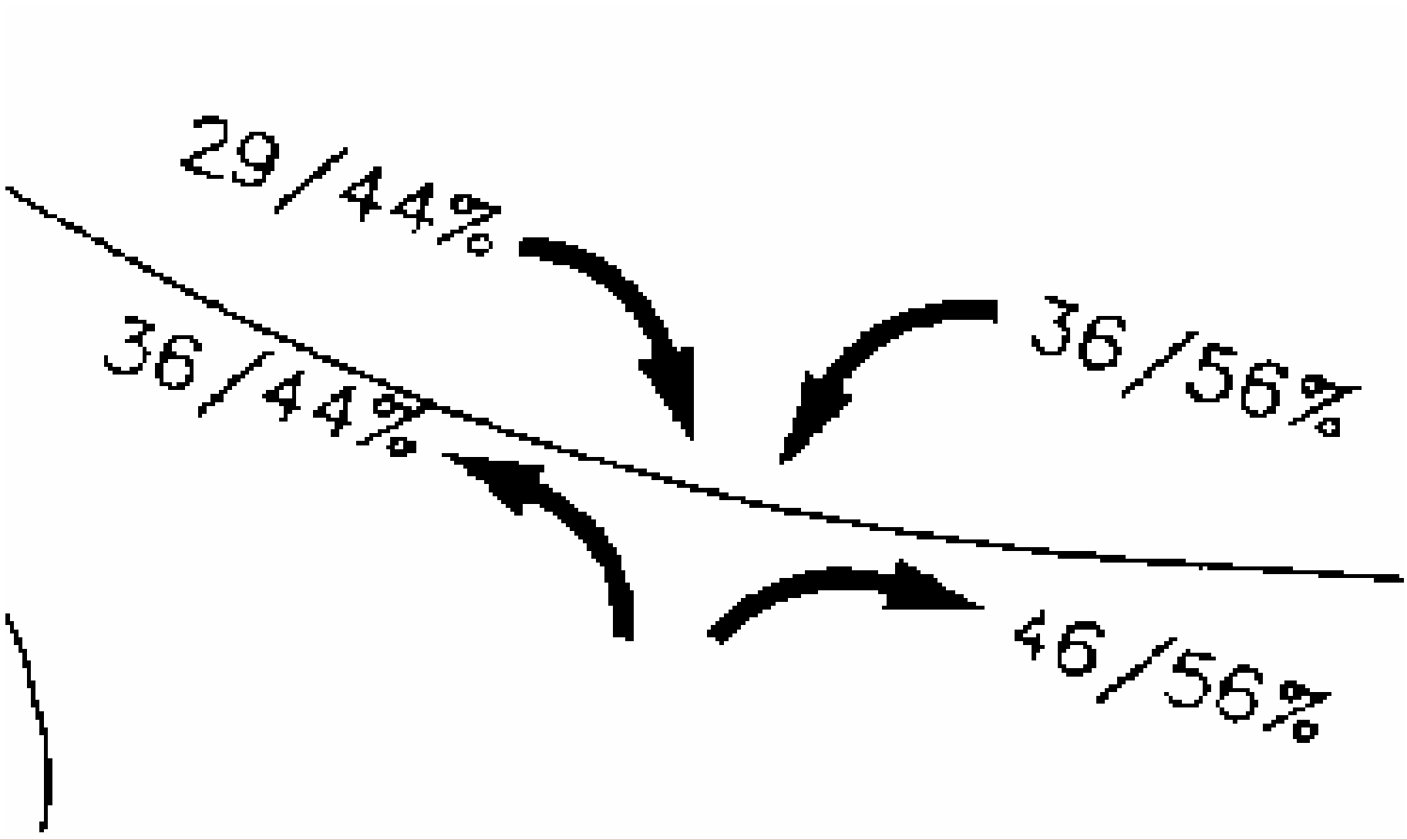




PM Peak Traffic for the Commercial Pod

PM Pk Trips	PM Enter	PM Exit
12	7	5
14	7	7
40	15	25
36	22	14
20	3	17
1	0	1
11	6	6
24	12	12


29/44%
36/56%
36/44%
46/56%
Subject Site (ICE OU)
PM Peak Hour of Generator
Total trips = 146 vph
Entering = 65 vph
Exiting = 82 vph


29/44%
36/56%
36/44%
46/56%

OPERATING SPEED:	55	
TOTAL OPPOSING VOLUME:	143	DHV
TOTAL ADVANCING VOLUME:	127	DHV
LEFT TURN VOLUME:	36	
CRITICAL ADVANCING VOLUME =		256.25

CRITICAL ADVANCING VOLUME IS GREATER THAN TOTAL ADVANCING VOLUME. THEREFORE

Trip Generation 133 Units

Development	Description/ITE Code	Units	No. Units
Residential Homes			
Permanent Homes	Single Family Detached Housing (210)	DU	19
Vacation Homes	Recreational Homes (260)	DU	114
Total			**133**

Units	No. Units	PM Peak Hour of Generator Trip Rate/Equation	PM Enter Split*	PM Exit Split*	PM Pk Trips	PM Enter	PM Exit
DU	19	Ln(T) = 0.887Ln(X) + 0.605	44%	56%	25	11	14
DU	114	T = 0.261(X) + 14.874	44%	56%	45	20	25
	133				**70**	**31**	**39**

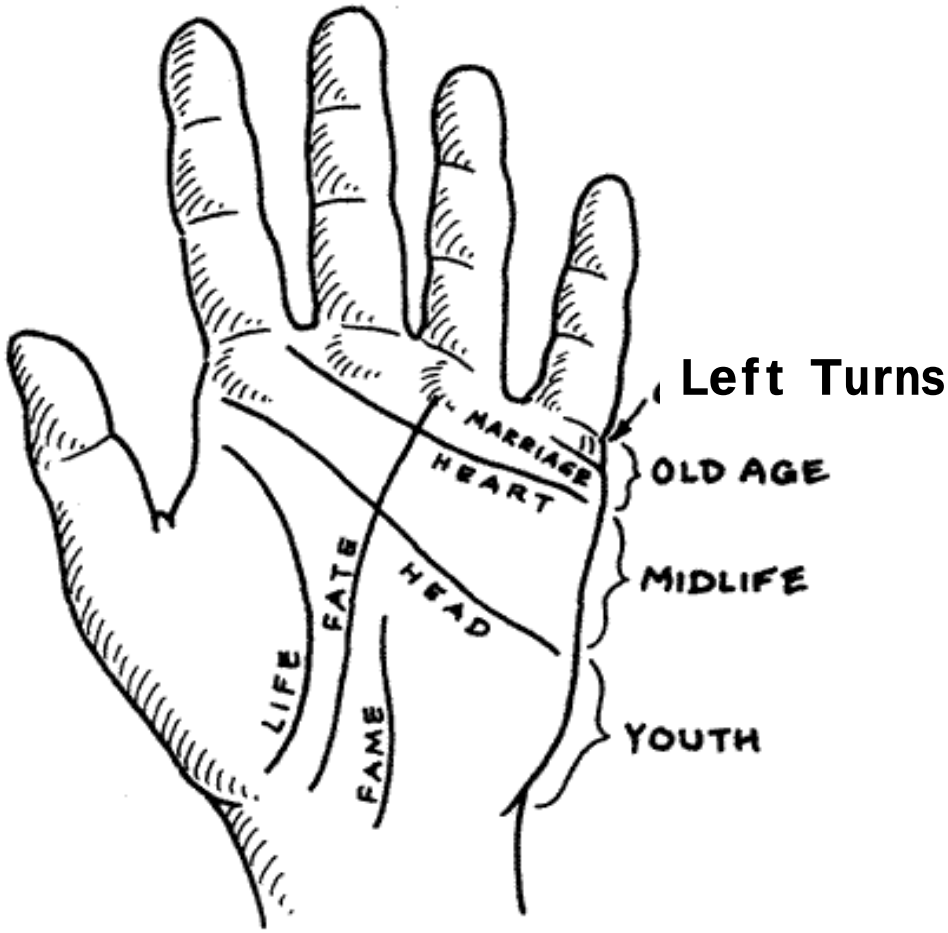
OPERATING SPEED:	55	
TOTAL OPPOSING VOLUME:	417	DHV
TOTAL ADVANCING VOLUME:	284	DHV
LEFT TURN VOLUME:	17	
CRITICAL ADVANCING VOLUME =		351.75

CRITICAL ADVANCING VOLUME IS GREATER THAN TOTAL ADVANCING VOLUME, THEREFORE

LEFT TURN LANE IS NOT WARRANTED

Percent Left Turn Volume = 5.99%

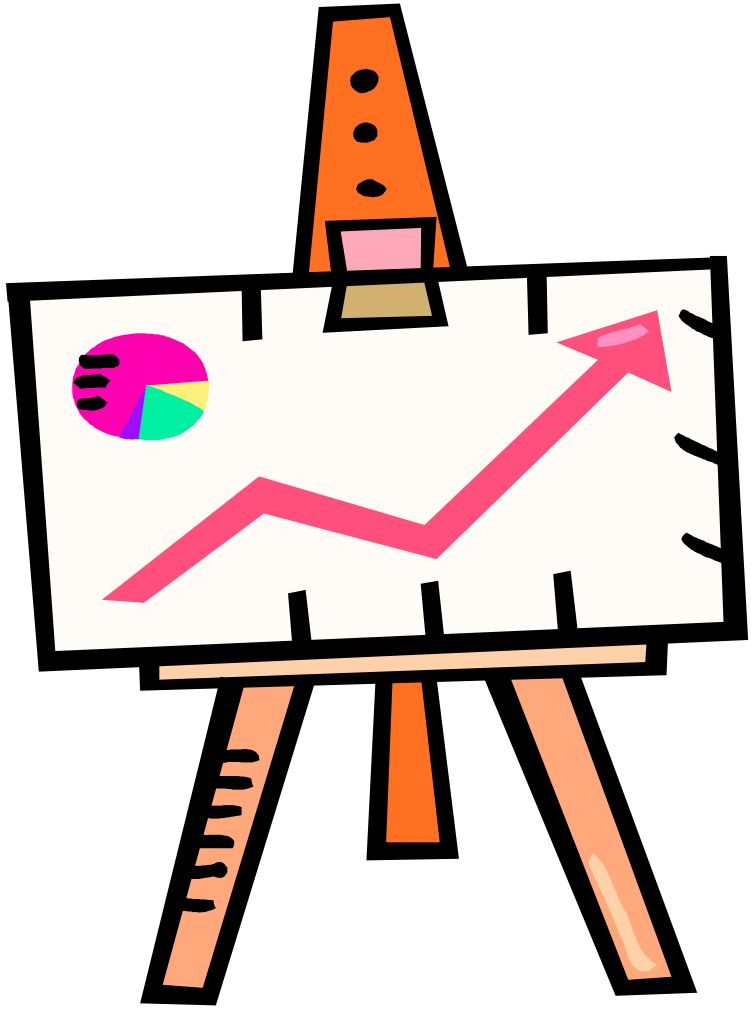
Methods to Determine Left Turns in the Future



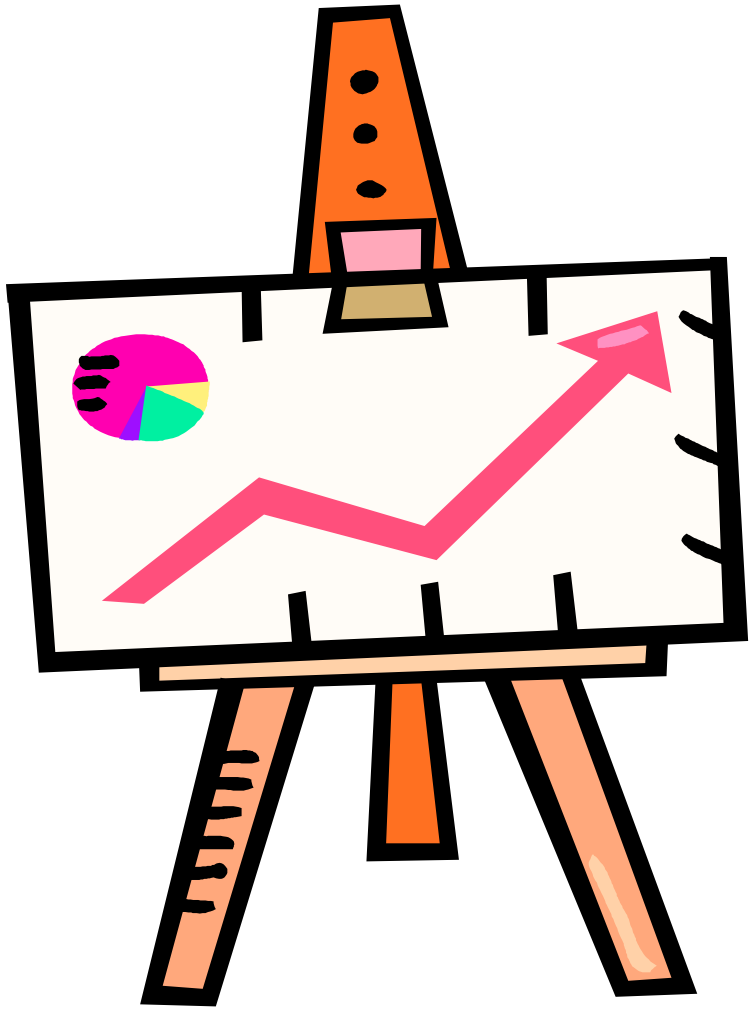
Projections

1997	2,929
1998	2,914
1999	3,060
2000	3,130
2001	3,260
2002	3,303
2003	3,292
2004	3,347
2005	3,402
2006	3,457
2007	3,512
2008	3,567
2009	3,622
2010	3,677
2011	3,732
2012	3,787
2013	3,842
2014	3,897
2015	3,952
2016	4,007
2017	4,062
2018	4,117
2019	4,172
2020	4,227
2021	4,282
2022	4,337
2023	4,393

What Can Go Wrong With Projections?



What Can Go Wrong With Projections?



US 98 Destin Florida Early 1990s

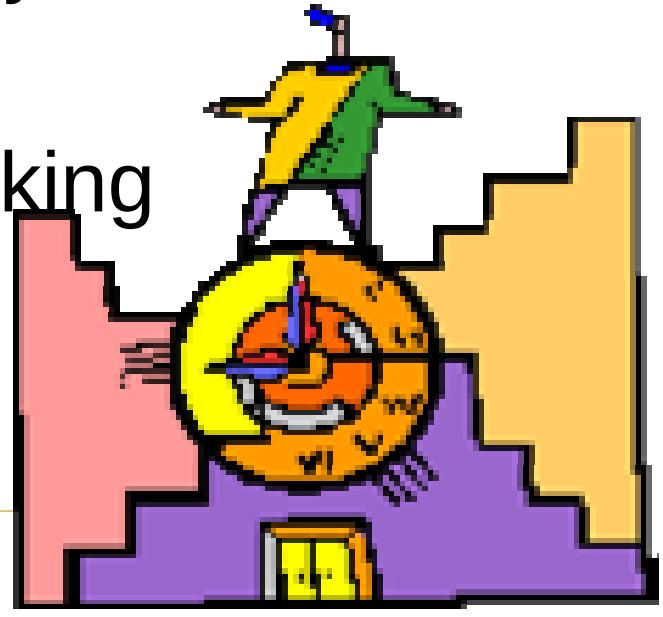
Same Location 5 Years Later

Pedestrian Access and Interaction with the Site

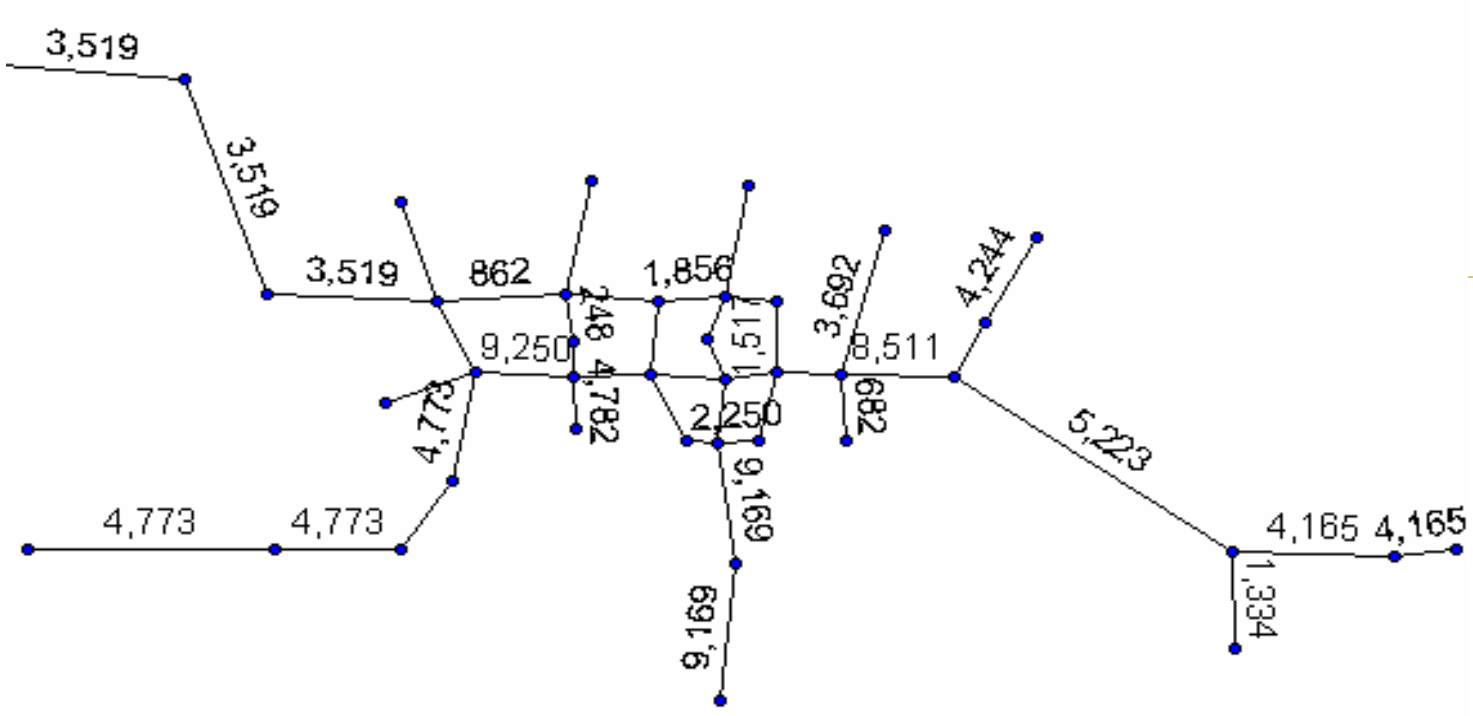
Vergil Stover's Principle of Site Design

Don’t Forget Pedestrians, Cyclists and Bus Patrons

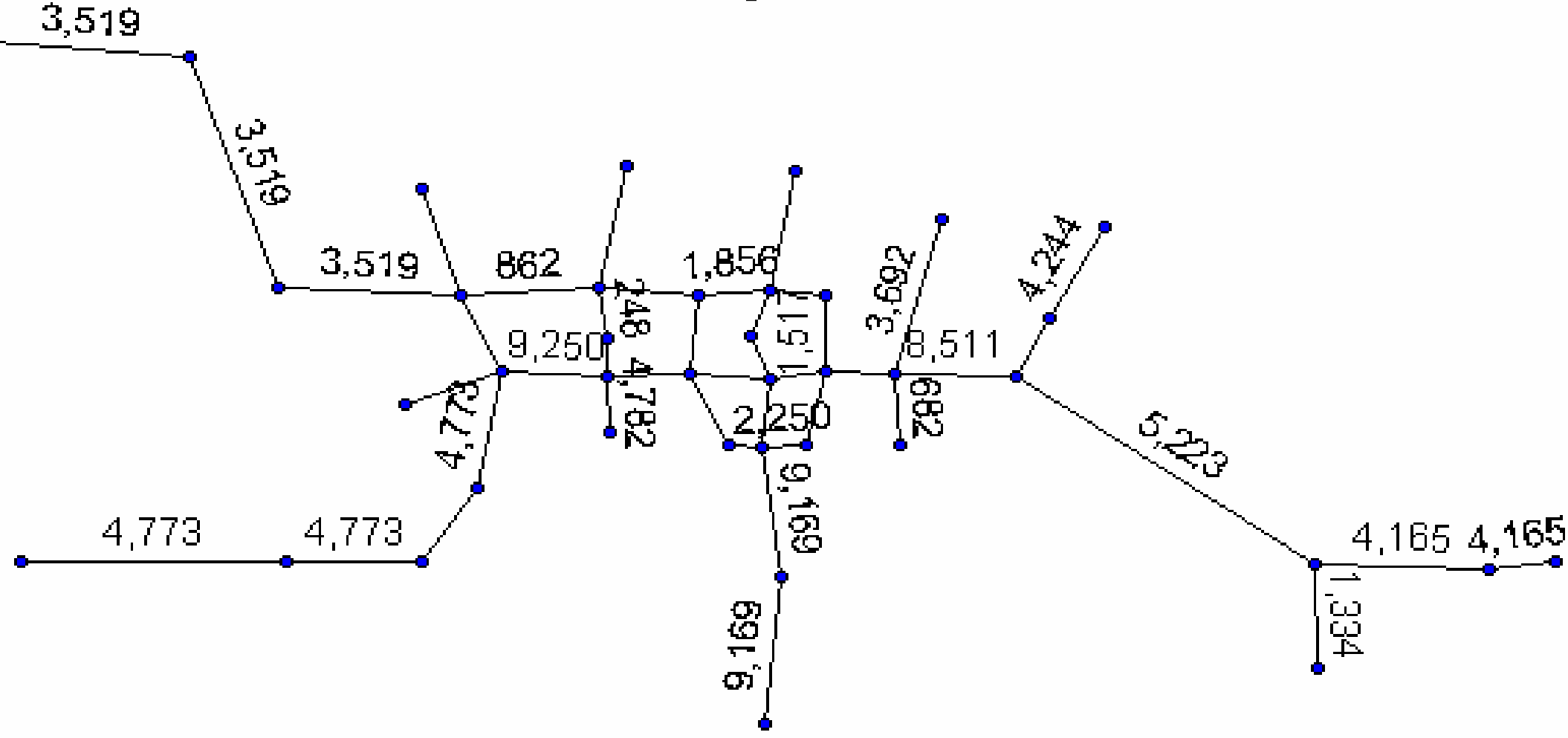
- Sidewalks into the site
  - On both sides of the driveway
- Pedestrian paths to the buildings and shops
- Sight distance issues at driveways and bus stops
- Secure and reasonable bike parking



Modeling Concerns

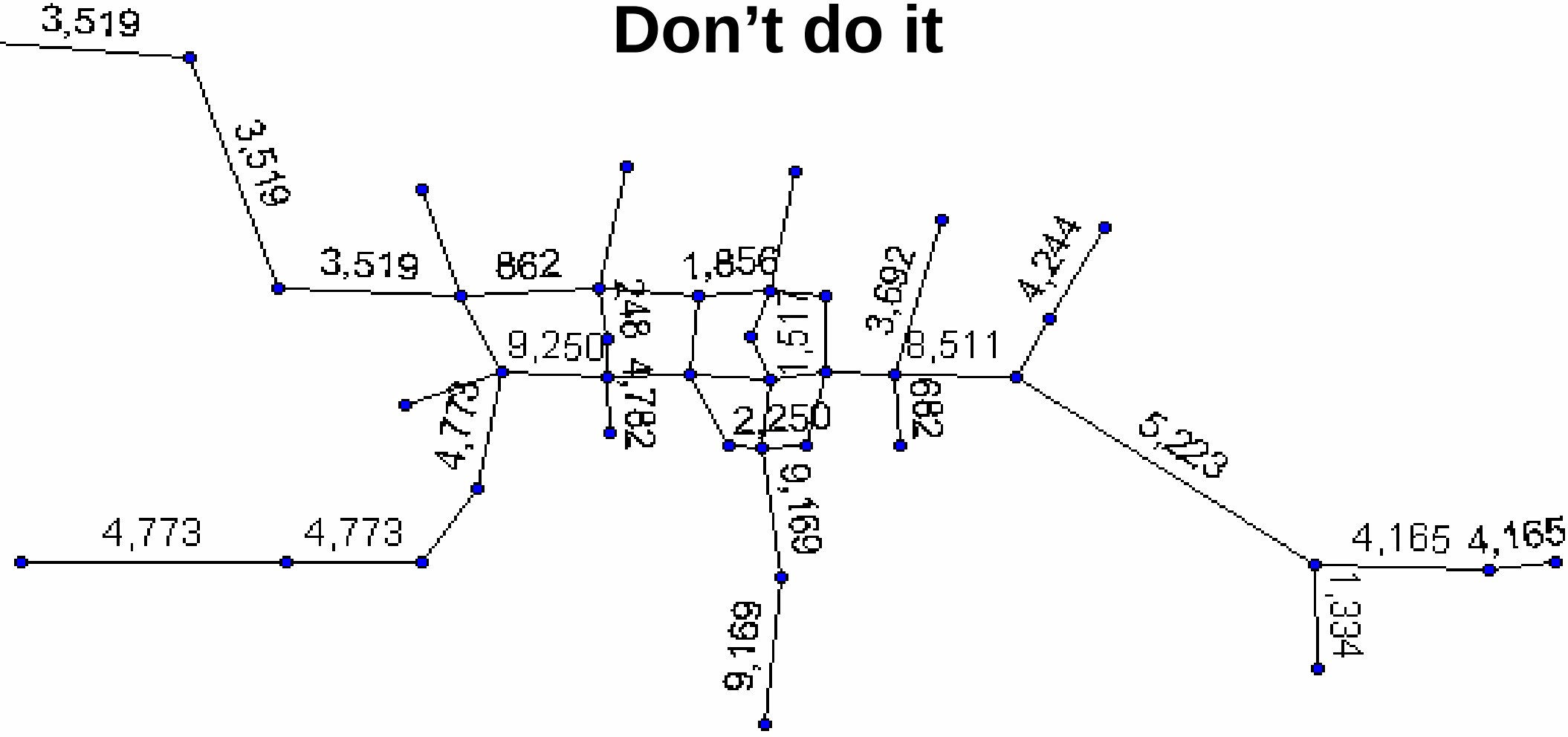


Raw Model Output



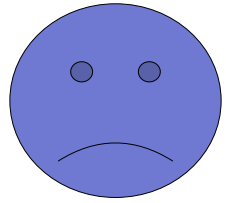
Have Trips Been Directly Projected From the Model?

Don't do it

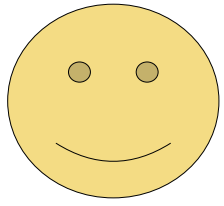


Large Scale Models *vs.* ITE Trip Generation

Which is better for Site Impact Analysis?



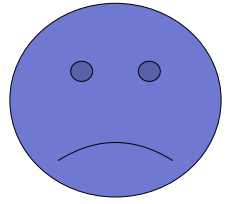
- Large Scale Models - Designed to estimate
  - ***Daily metro area-wide travel***
- ITE Trip Generation Report
  - Designed to estimate trips from **specific uses**
    - Data for peak hours



Large Scale Models *vs.* ITE Trip Gen

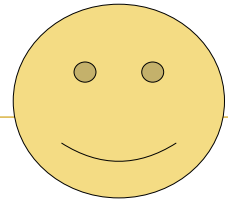
Which is better for Site Impact Analysis?

- **Large Scale Models**
  - Not **"Trips"** for employment sites. but "**Attractions**,"
    - Measure of **relative attractiveness**
    - Only 3 employment types used
      - (Industrial,Service,and Commercial)



  - " **Productions"** are home side of this equation

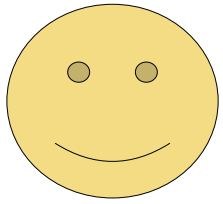
- **ITE Trip Generation Report**
  - Calculates average number of **trips** generated by different land uses.
  - Hundreds of uses - updated frequently



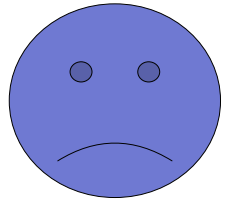
Productions and Attractions Are Balanced

- " **Productions"** are used on the home and population side and they are "balanced" for these
- **Total trips** will be controlled by the number of people so that development will share
  - This has a tendency to "water down" individual site impacts

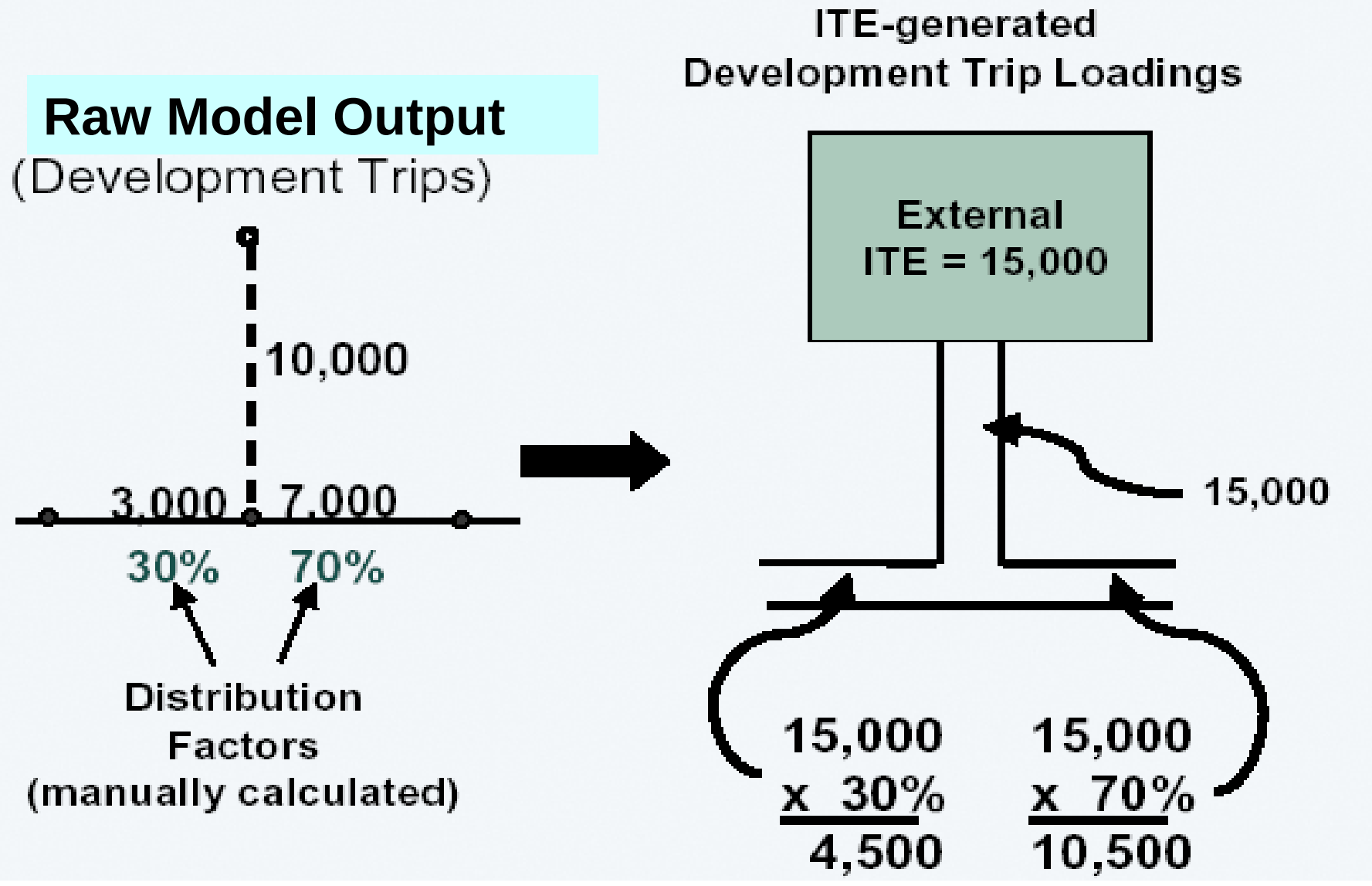
It’s Better to Use the Strength of Both Methods



- Large Scale Models
  - Strength - distribution and assignment of traffic
- ITE Trip Generation Report
  - No distribution help



Link Distribution Percentage Method



Were Models Used to Determine Internal Capture?

Q. Are large scale models the best method for **internal trip estimates**?

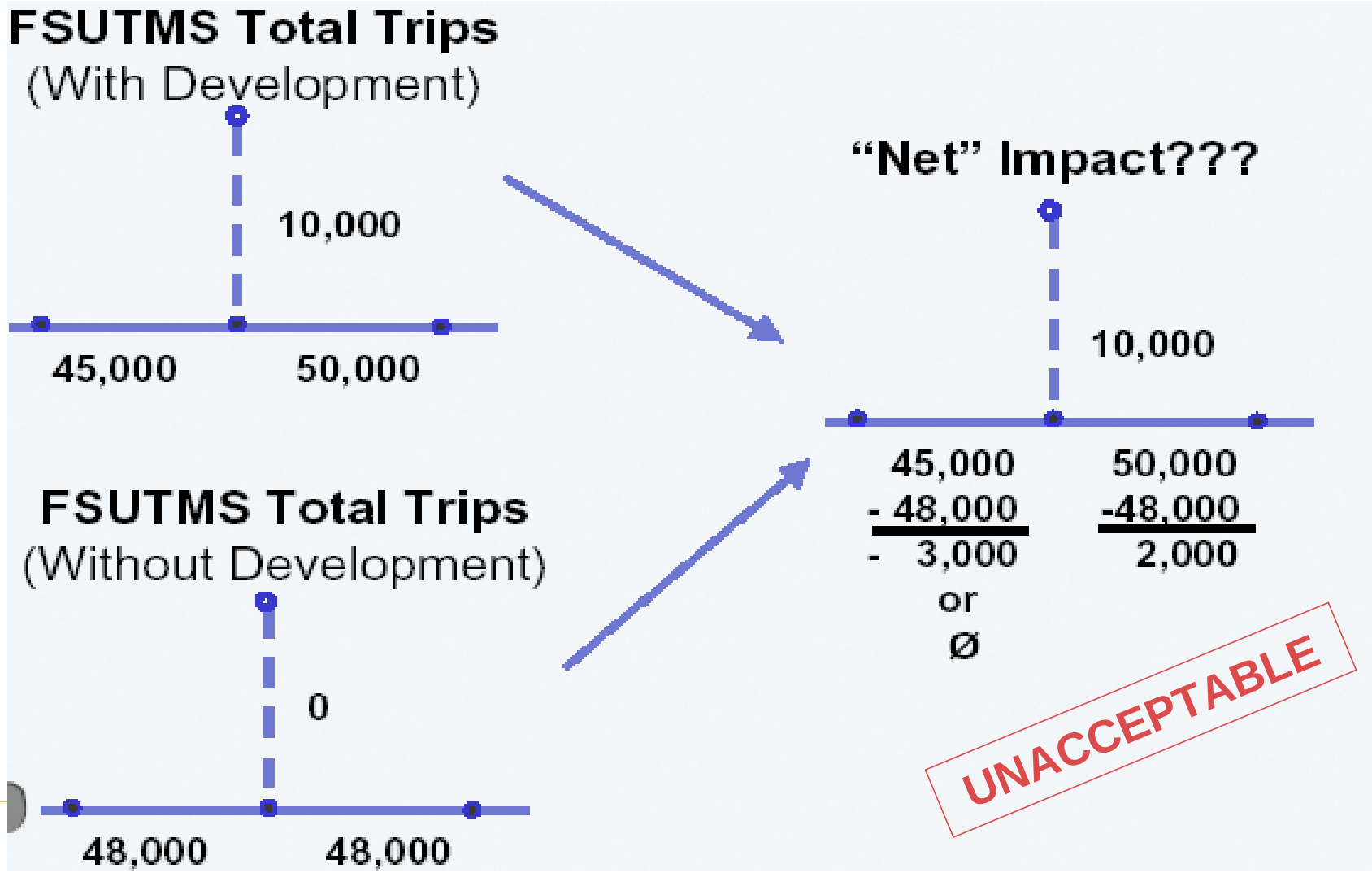
A. Models are only a tool that may help in a manual determination of internal trips.

Caution: **Size (land area) of TAZs and length of centroid connectors are the prime determinants of intrazonal trips in FSUTMS. (Longer centroid link = more intrazonal trips)**

Has the study used the "With vs. Without" method?

- **Selected Zone Analysis**
  - Single model run with two-purpose trip table
  - Purpose 1 = Total Trips, Purpose 2 = DRI Trips
- **"With & Without" Methodology**
  - Two model runs, one with development in place, the other with DRI zonal data "zeroed" out
  - Link volumes for "without" run subtracted from "with" run, yielding net impact of development

With and Without Method



“With & Without” Problem

- Equilibrium highway assessment capacity restraint equation diverts trips, often resulting in virtually no change in traffic volumes
  - Developer: **So, what!** *Diversion occurs in the real world. We should only be required to mitigate for net impact of the development.*

Peaking Characteristics

Is Your Existing Traffic Right?

- **Typical Daily Traffic** is **not** Average Annual Daily Traffic (AADT)
- Peak-to-Daily Ratios **are not** the same as K factors

Average Annual Daily Traffic (AADT)

Not the same as "typical day"

One year's traffic
divided by 365 days

That's 8,760 hours

Usually estimated through nearby permanent count station

with weekly
seasonal and
axle correction factors.

K_{100} Peaking Factor

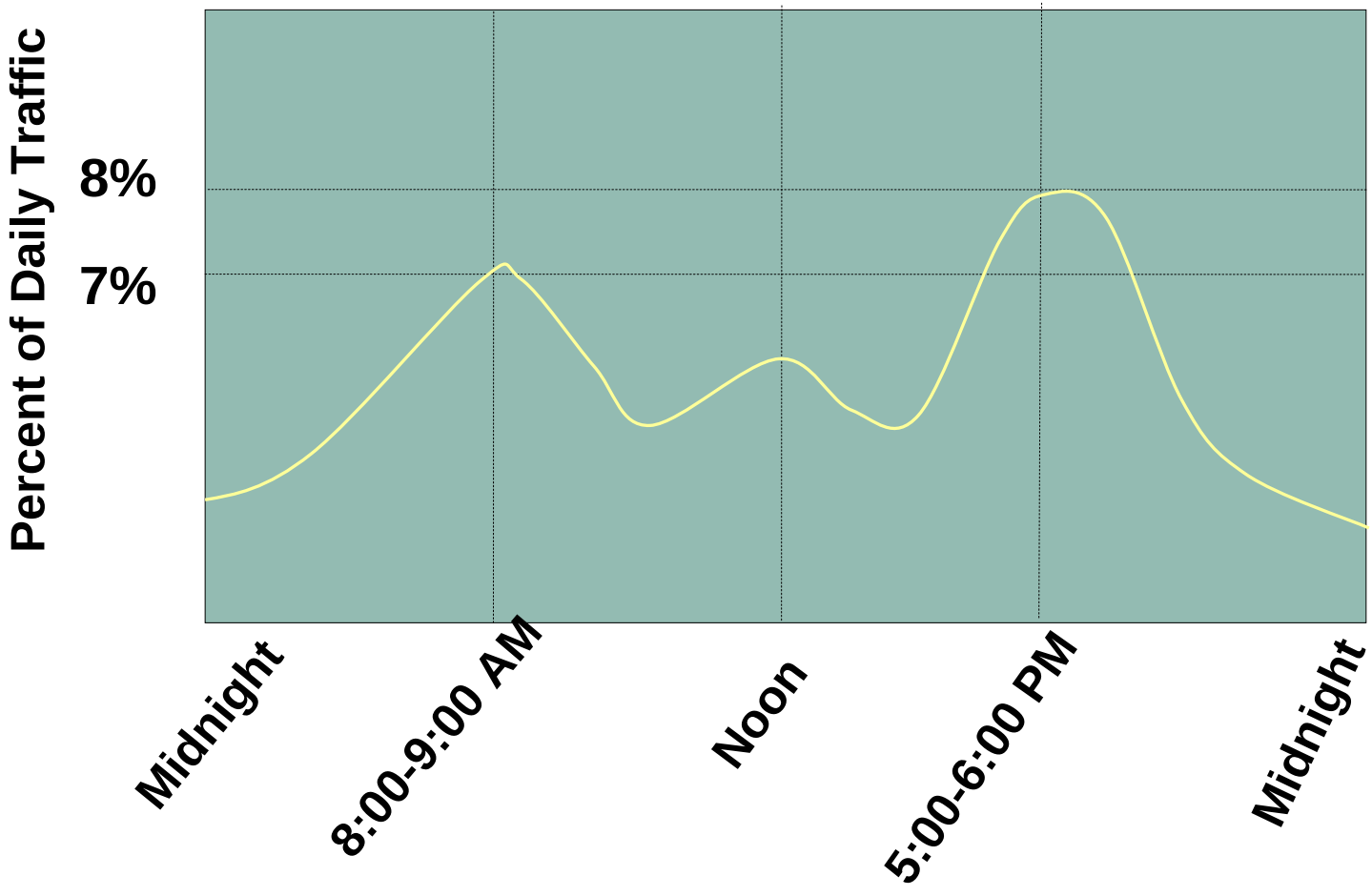
K_{100}

Planning Analysis Hour Factor

- The 100th-highest hourly volume of the year divided by the AADT
- NOT a typical peak-to-daily ratio

See: LOS Handbook Chapter 4.5

Peak To Daily Ratio is not K



K Factors for One Road

One Year's Counts Sorted

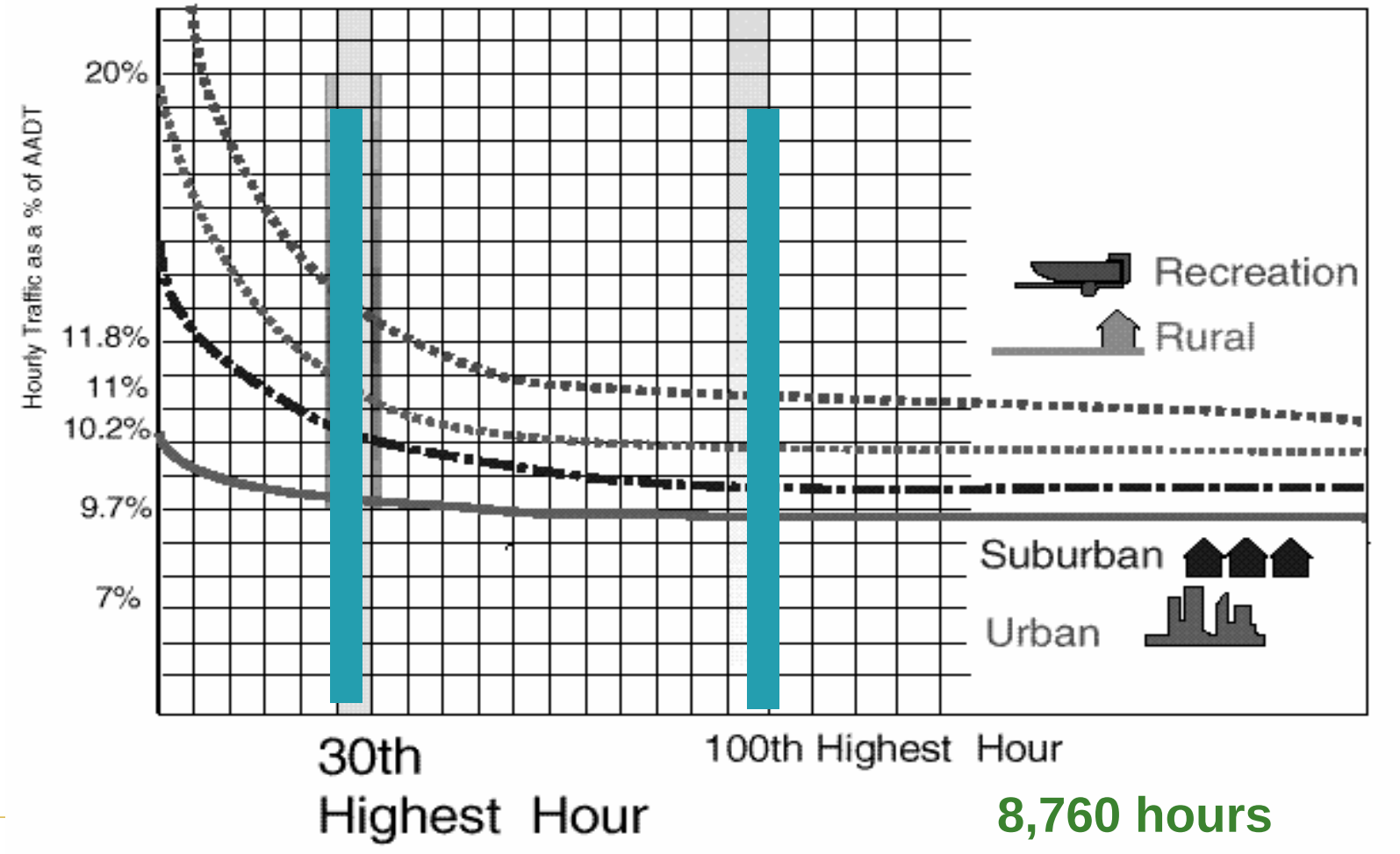


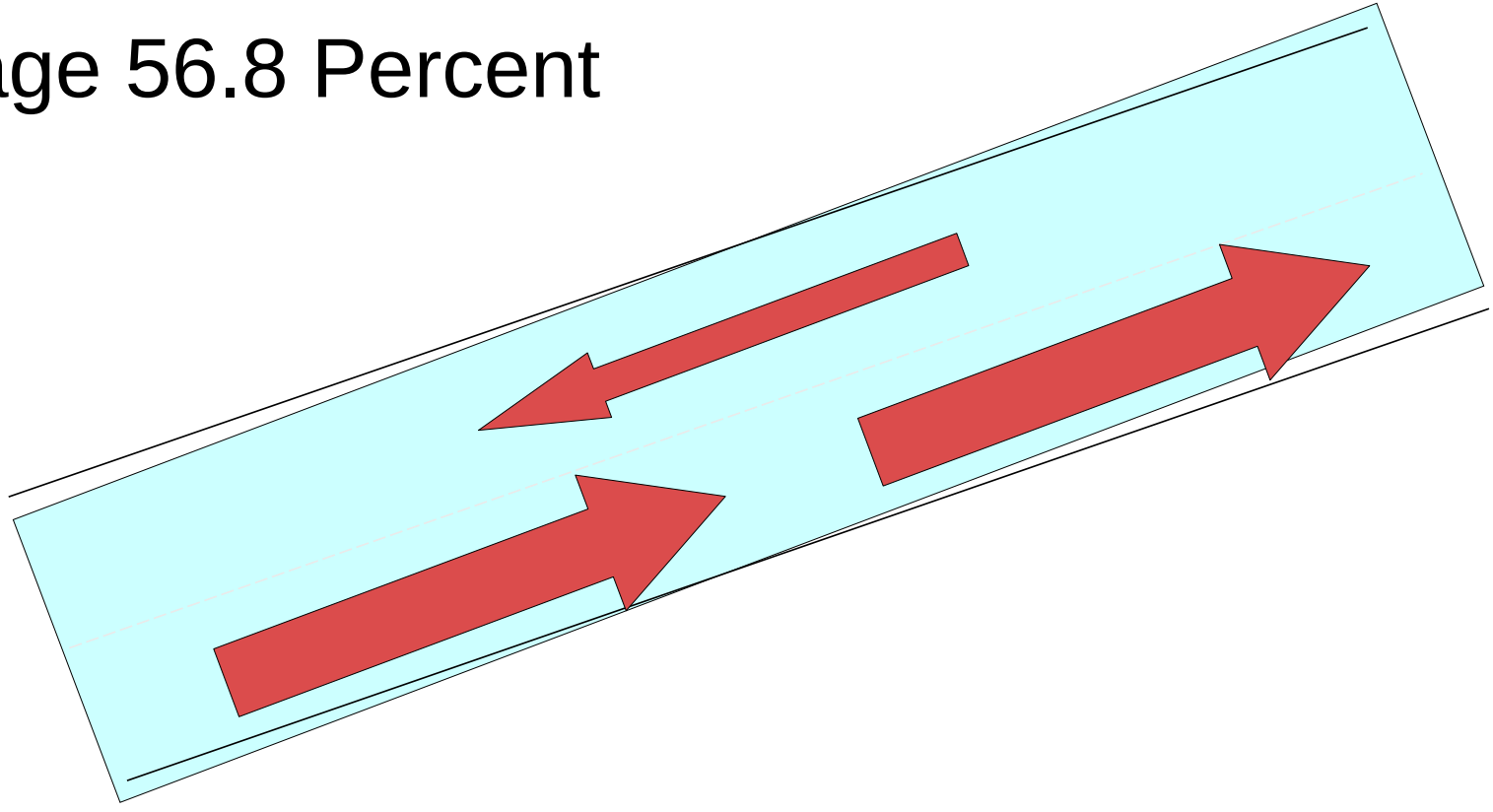
Table 3 – 4
MINIMUM ACCEPTABLE K_{100}S

	Urbanized	Transitioning/ Urban	Rural Developed	Rural Undeveloped
Freeways	8.5%	9.0%	9.0%	9.0%
Multilane Highways	9.0%	9.0%	9.0%	9.0%
Two-Lane Highways	9.0%	9.0%	9.0%	9.0%
Arterials	9.0%	9.0%	9.0%	N.A.

K_{30} is used by FDOT for design purposes. It is the proportion of the AADT occurring during the 30th highest hour of the design year and is commonly known as the Design Hour Factor.

Directional Distribution Factor - D

- Minimum 52.0 Percent
- Average 56.8 Percent



Directional Hourly Volumes

For Planning:

$\times K_{100} \times D_{100} =$ ***Planning*** Directional Hourly Volume

For Design:

$\times K_{30} \times D_{30} =$ ***Design*** Directional Hourly Volume

Level of Service Analysis

2002 Quality/Level of Service

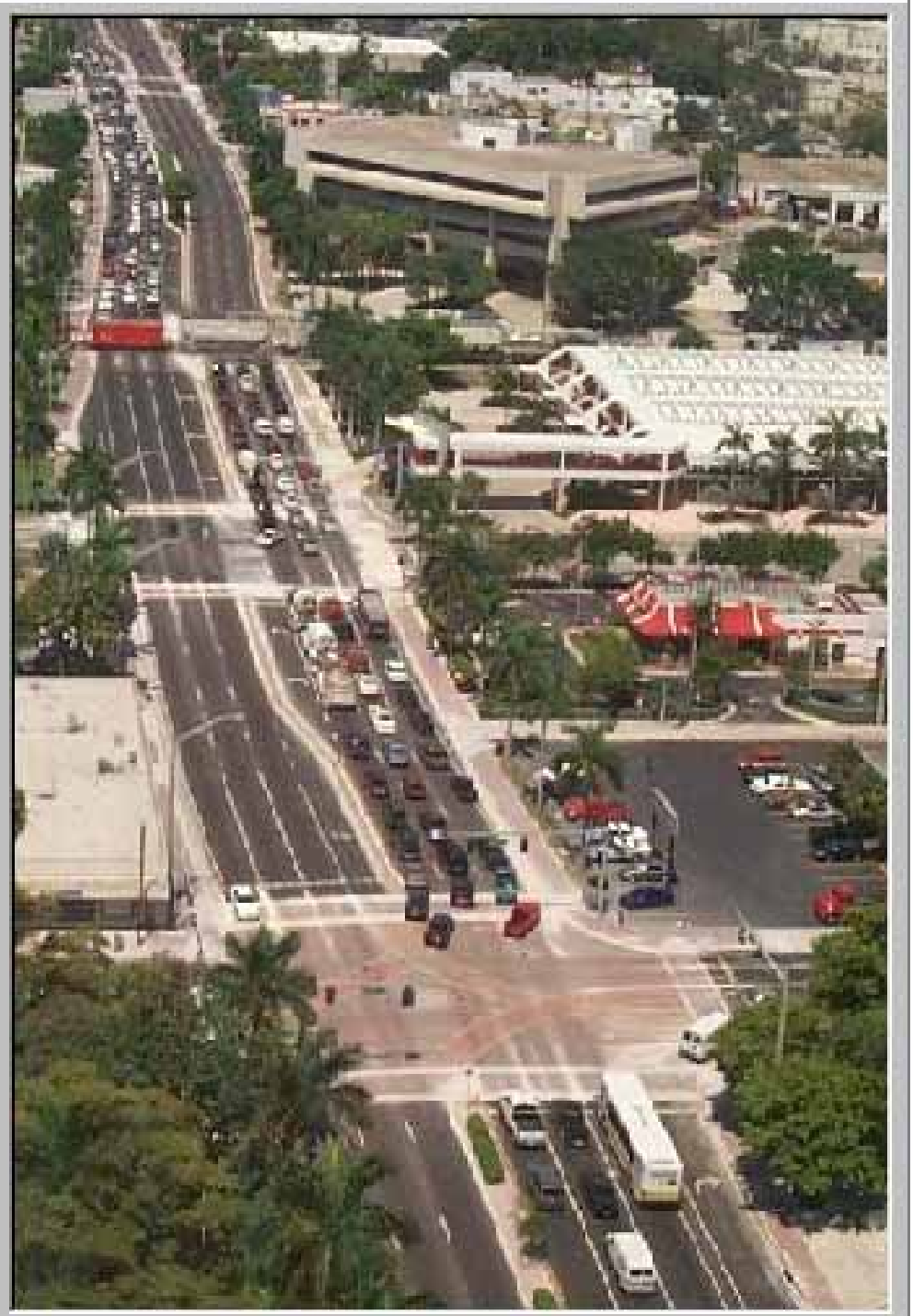
HANDBOOK

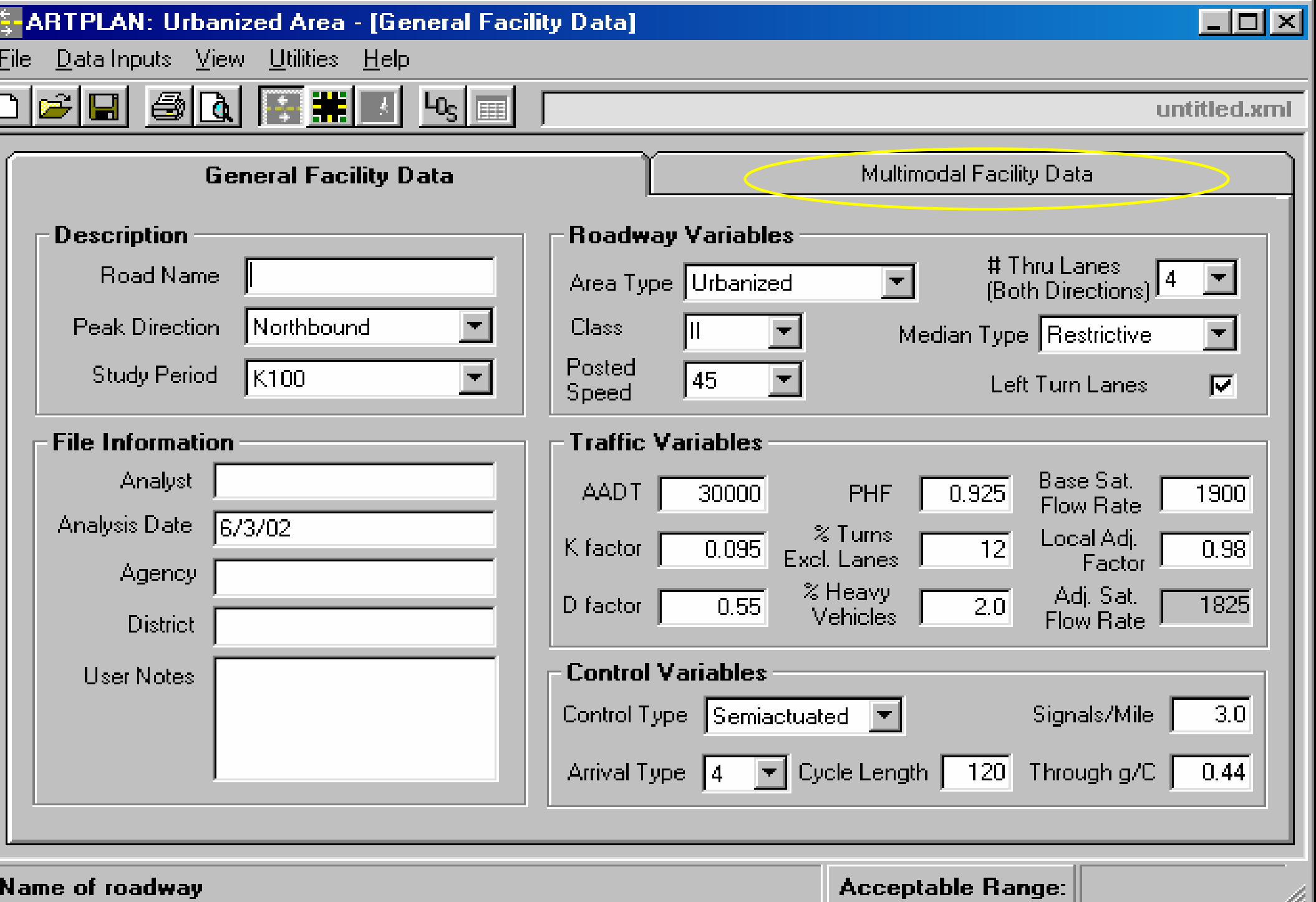
ARTPLAN 2002

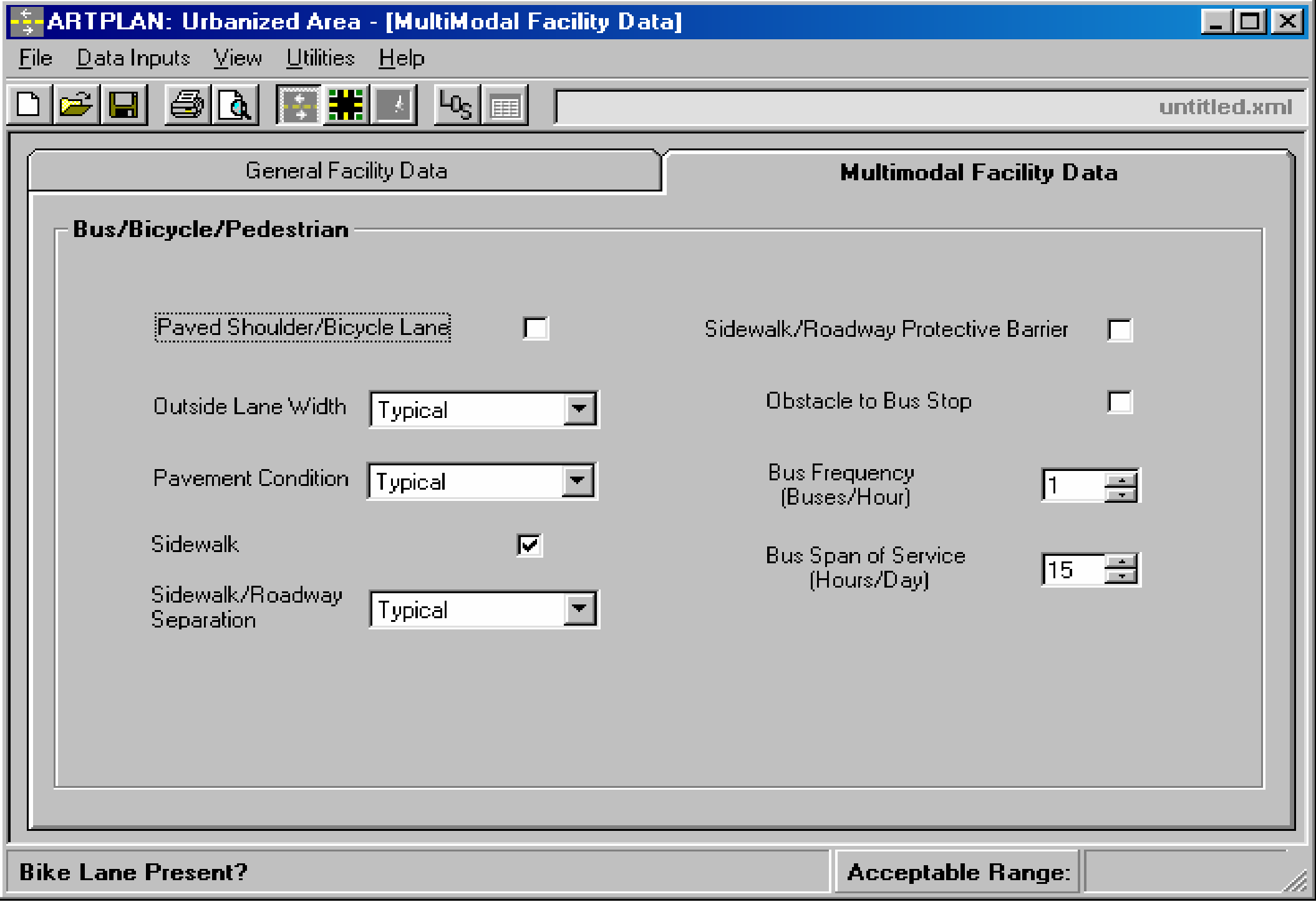
Multimodal Arterial Level of Service

LOS Analysis New Model and Handbook

Release Version
April 2002




ARTPLAN: Urbanized Area - [General Facility Data]
File
Data Inputs
View
Utilities
Help
untitled.xml
General Facility Data
Multimodal Facility Data
Description
Road Name
Peak Direction
Northbound
Study Period
K100
File Information
Analyst
Analysis Date
6/3/02
Agency
District
User Notes
Roadway Variables
Area Type
Urbanized
Thru Lanes (Both Directions)
4
Class
II
Median Type
Restrictive
Posted Speed
45
Left Turn Lanes
Traffic Variables
AADT
30000
PHF
0.925
Base Sat. Flow Rate
1900
K factor
0.095
% Turns Excl. Lanes
12
Local Adj. Factor
0.98
D factor
0.55
% Heavy Vehicles
2.0
Adj. Sat. Flow Rate
1825
Control Variables
Control Type
Semiactuated
Signals/Mile
3.0
Arrival Type
4
Cycle Length
120
Through g/C
0.44
Name of roadway
Acceptable Range:


ARTPLAN: Urbanized Area - [MultiModal Facility Data]
File
Data Inputs
View
Utilities
Help
untitled.xml
General Facility Data
Multimodal Facility Data
Bus/Bicycle/Pedestrian
Paved Shoulder/Bicycle Lane
Outside Lane Width
Typical
Pavement Condition
Typical
Sidewalk
Sidewalk/Roadway Separation
Typical
Sidewalk/Roadway Protective Barrier
Obstacle to Bus Stop
Bus Frequency (Buses/Hour)
1
Bus Span of Service (Hours/Day)
15
Bike Lane Present?
Acceptable Range:

Do certain developments really support multi-modal mobility?

- Do you see a commitment for:
  - Transit
  - Ridesharing
  - Parking policies
  - Pedestrian improvements

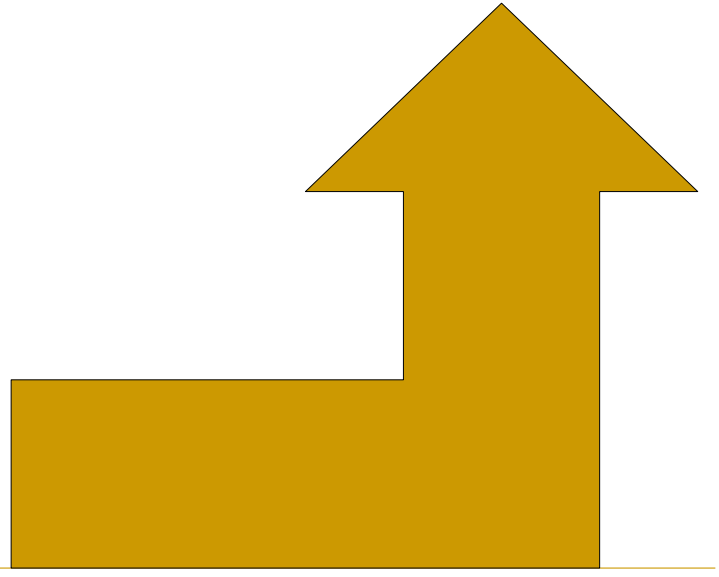
Are the LOS Studies Using Over Optimistic Factors?

- Check FDOT **LOS Handbook** for maximums
- Use the published LOS Tables to give a review of realistic factors
  - *they are on the back of tables*

Hint: Published Assumptions on Back of Table

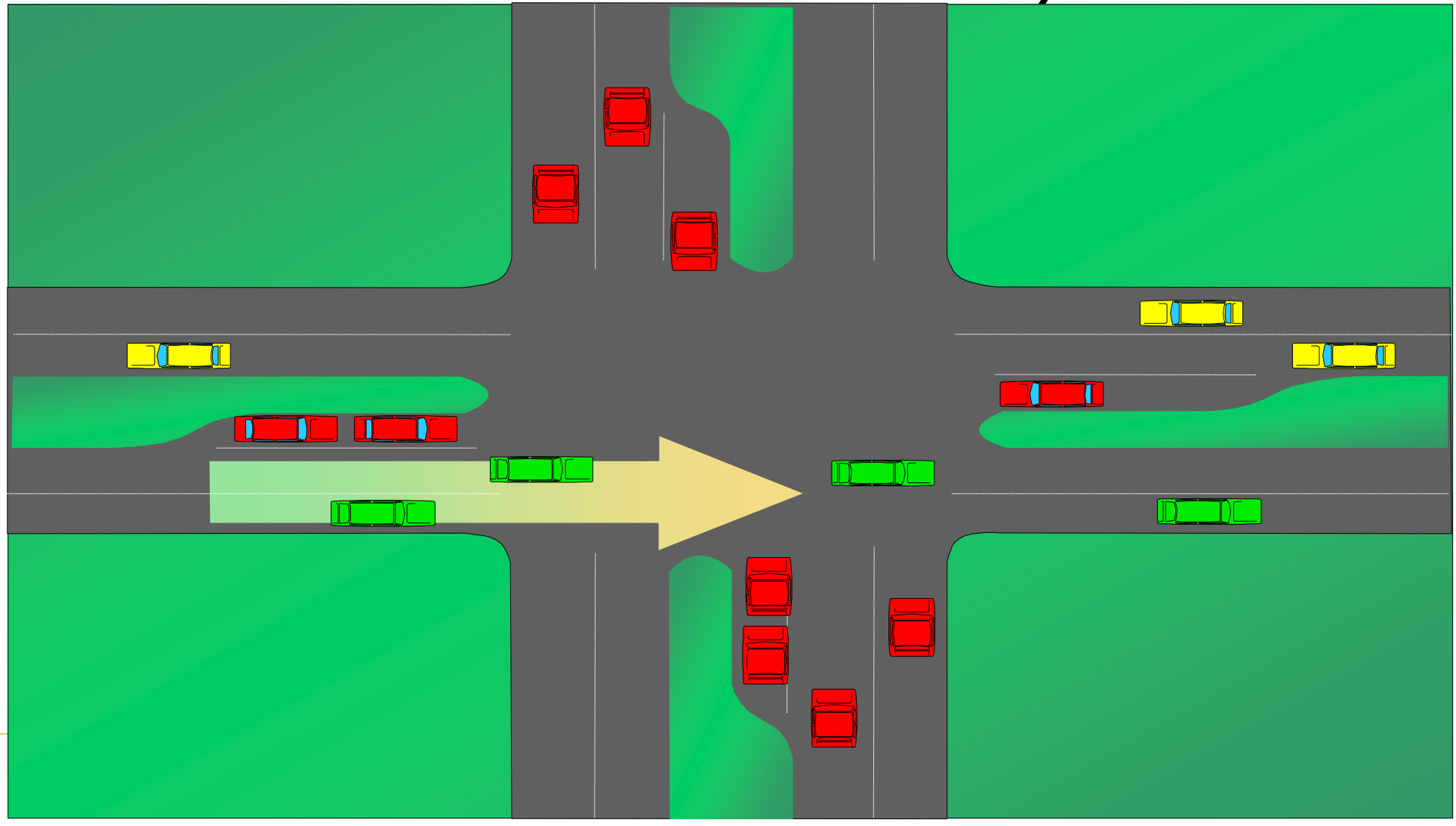
Sidewalk/roadway separation (a,t,w)				
Sidewalk/roadway protective barrier (n,y)				
Obstacle to bus stop (n,y)				
TRAFFIC CHARACTERISTICS				
Planning analysis hour factor (K)	0.095	0.095	0.095	0.095
Directional distribution factor (D)	0.55	0.55	0.55	0.55
Peak hour factor (PHF)	0.925	0.925	0.925	0.925
Base saturation flow rate (pcphpl)	1900	1900	1900	1900
Heavy vehicle percent	2.0	2.0	2.0	2.0
Local adjustment factor	1.0	1.0	0.95	0.98
% turns from exclusive turn lanes	12	12	12	12
Bus span of service				
CONTROL CHARACTERISTICS				
Signalized intersections per mile	1.5	1.0	1.0	3.0
Arrival type (1-6)	3	3	3	4
Signal type (a,s,f)	a	a	a	s
Cycle length (C)	120	120	120	120
Effective green ratio (g/C)	0.44	0.44	0.44	0.44

Are There Too Many Left Turns to Use Our LOS Tables and Programs?



The Planning Assumption

Left Turns Are Out of the Way

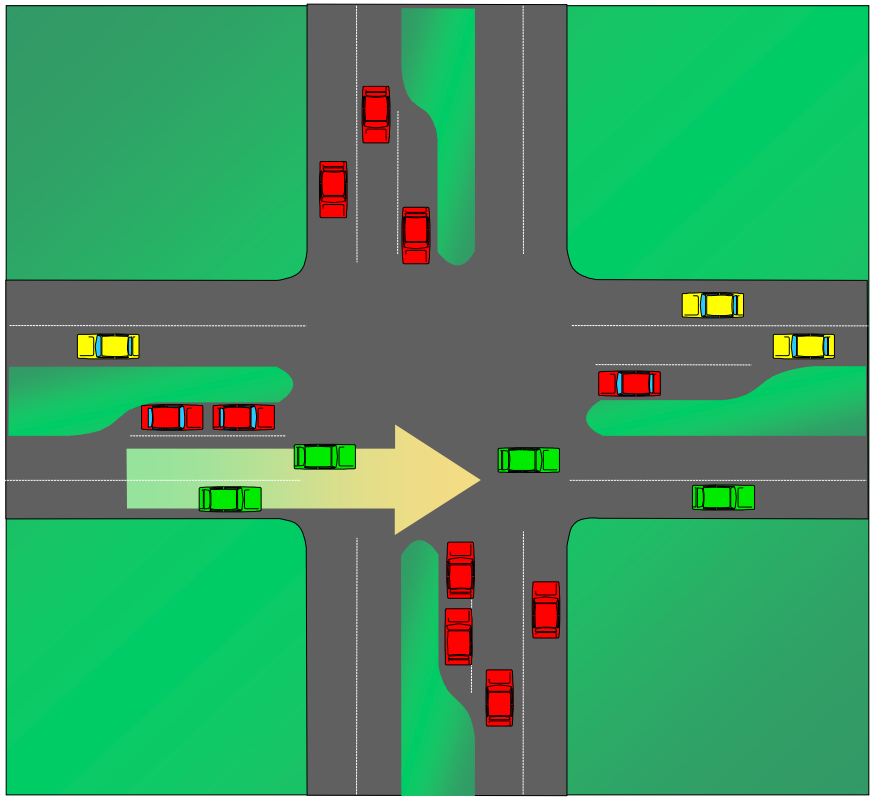


Left Turns Are Out of the Way
The Planning Assumption

Don’t be afraid to use the full Highway Capacity Software

Take into account queues

Can be strung together for arterial analysis



Unsignalized Intersection LOS

- Use a big “grain of salt”
- Almost any side-street or driveway on a major highway will be unacceptable LOS
  - This is especially true where left turns out are allowed

Your Stories?
Questions?
Comments?

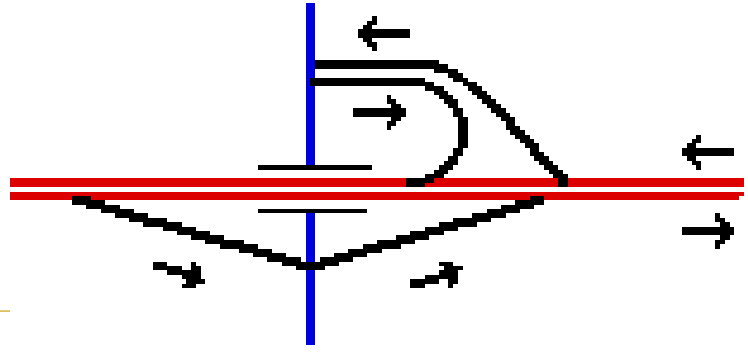
Permits and Related Approvals

Approved Study or Development Order (D.O.) Is Not a Permit

- Driveways and streets still need Permit
- Traffic signals still need warrant study
- Involve Permit staff early

Does the Development Order contain a new Interchange?

- New interchange in Development Order (D.O.) Is **not** a factor in approval
  - Let applicants know this *"up front"*
- D.O. should state what development is allowed, if the interchange is not approved
- Funding commitment may be more than called for in the D.O.



Some Critical Points

- Read descriptions in ITE Trip Generation Report
- Don’t assume a “stock” internal capture
  - Look at both ends of the internal trip
- Don’t take traffic numbers directly out of a model
- Typical ***peak to daily ratio*** is not ***K***
- Use FDOT guides for reasonable traffic factors