



Volume Studies

CIVL 4162/6162



Lesson Objectives

- Define critical parameters of interest in traffic volume studies
- Compute and interpret hourly, daily, weekly, and monthly adjustment factors
- Collect intersection traffic volume counts
- Describe origin-destination traffic volume studies



Why are Volume Studies Needed?

- Transportation planning/forecasts
- Assessing operations
- Impact analysis
- Determining need for traffic control, etc.

Traffic counts provide the primary measure of demand.



Parameters of Interest (1)

- Volume
- Rate of flow
- Demand
- Capacity



Parameters of Interest (2)



- **Volume**
 - The number of vehicles (or persons) passing a point during a specified time period which is usually one hour but need not be.
- **Rate of Flow**
 - The rate at which vehicles (or persons) pass a point during a specified time period less than an hour, expressed as an equivalent hourly rate.

Parameters of Interest (3)



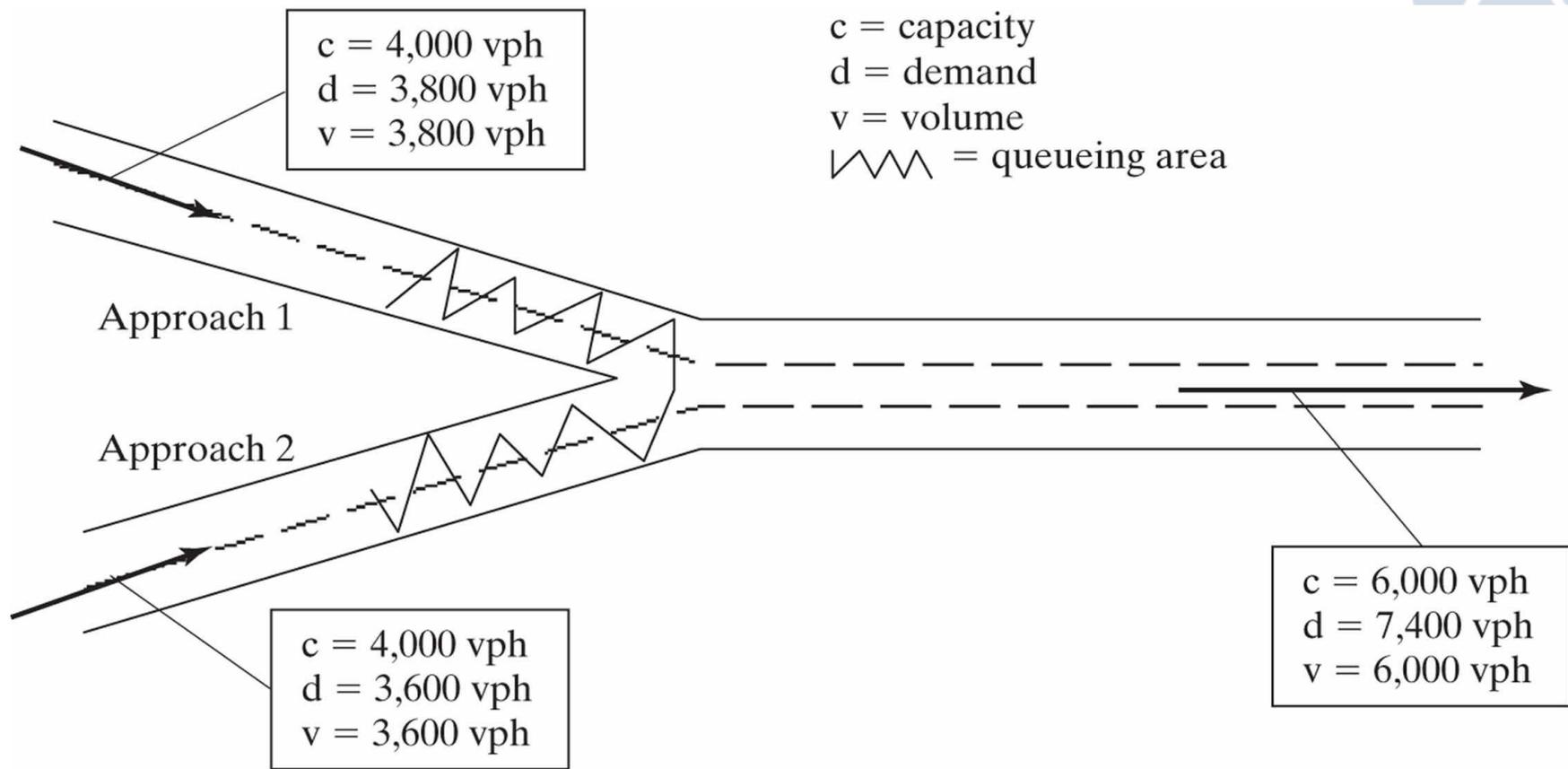
- **Demand**

- The number of vehicles (or persons) that desire to travel past a point during a specified time period (usually one hour).

- **Capacity**

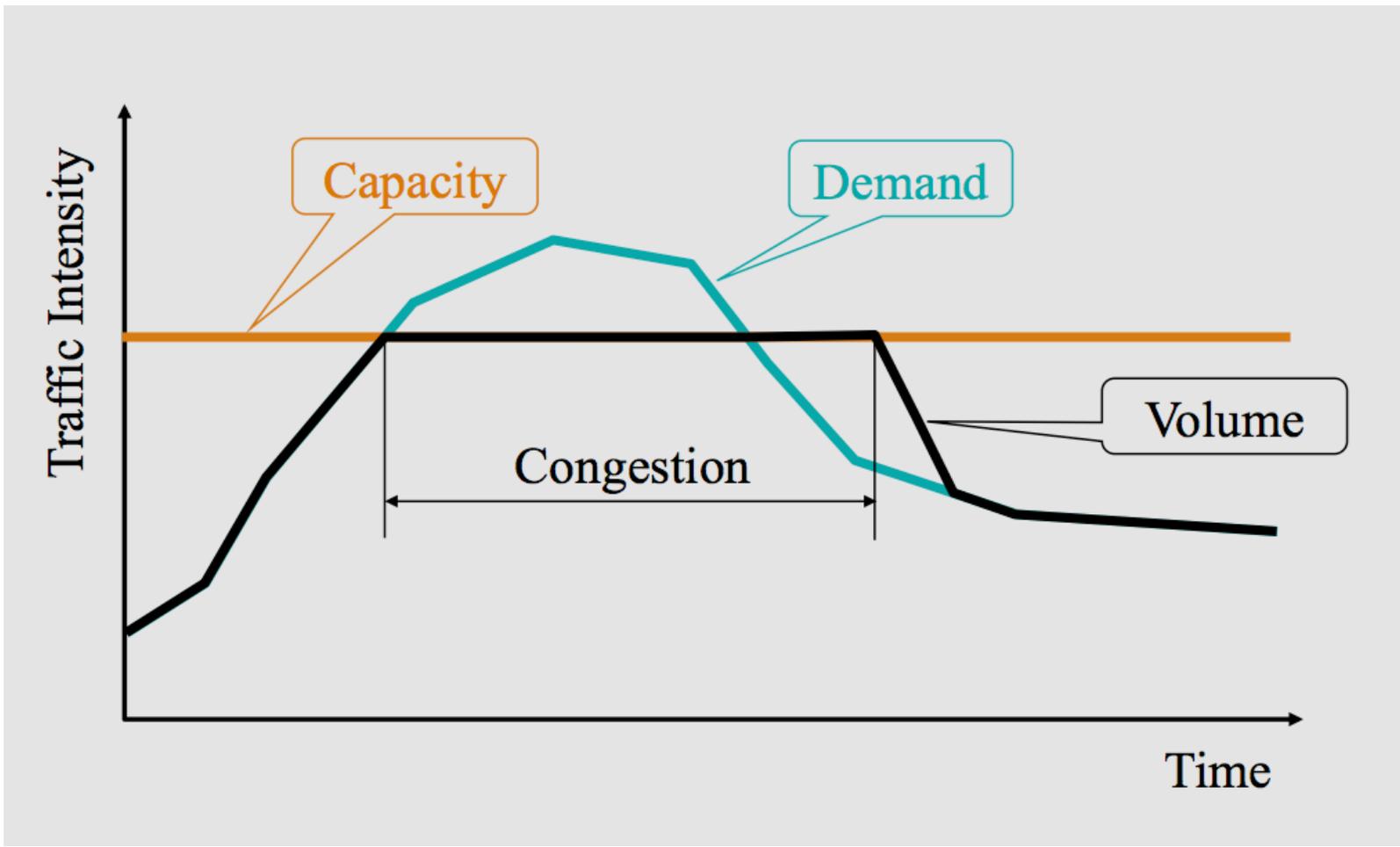
- The maximum rate at which vehicles can traverse a point or short segment during a specified time period.

Volume, Demand and Capacity Illustration

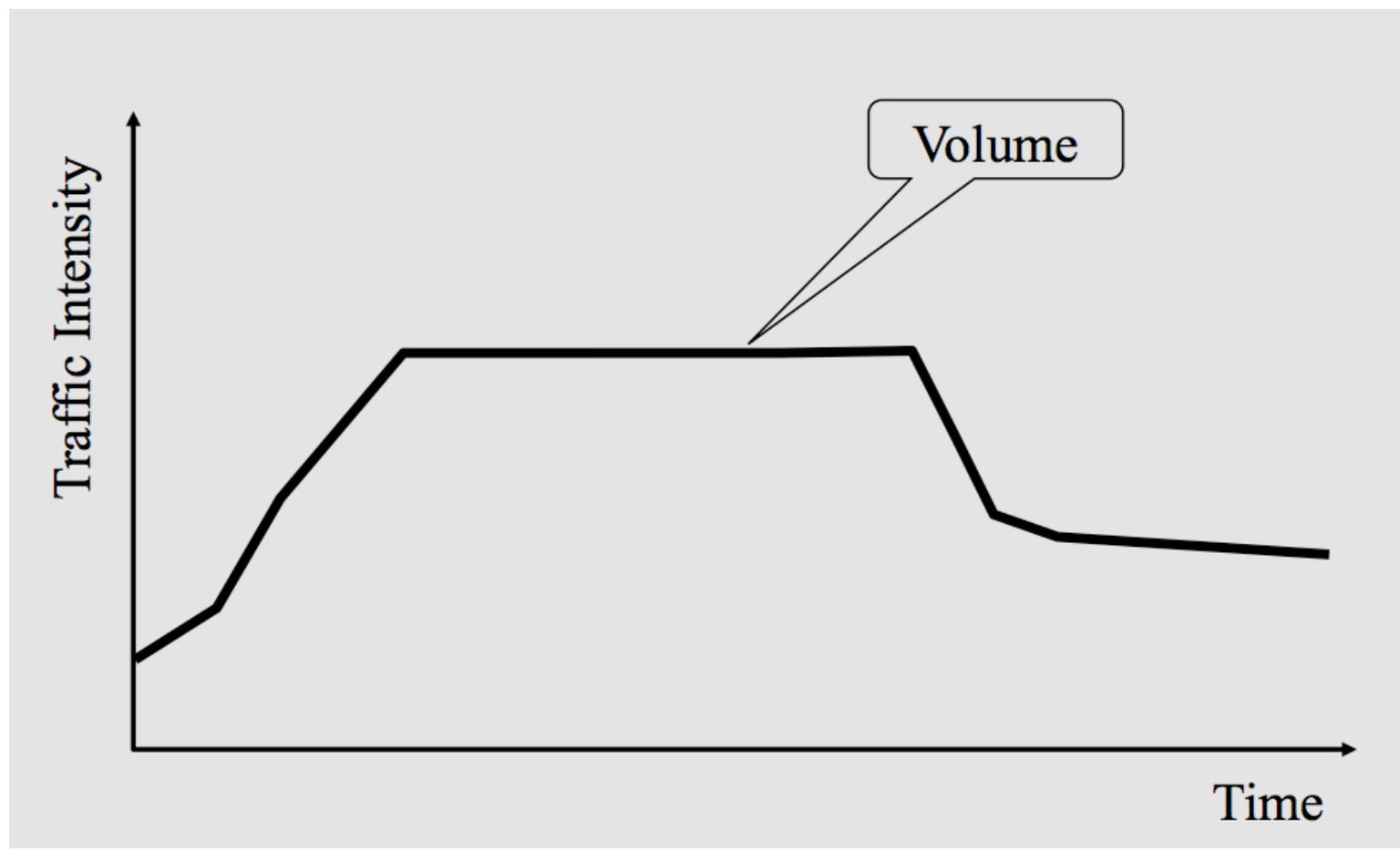


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Demand Exceeding Capacity



Volume Pattern

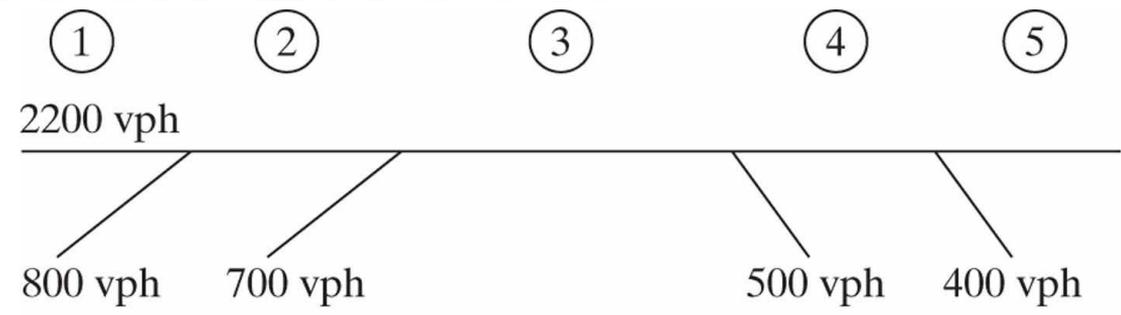


Volume Patterns and Characteristics

- Traffic demand varies!
- Choosing design hour may be complex
- Very important to understand volume variation patterns



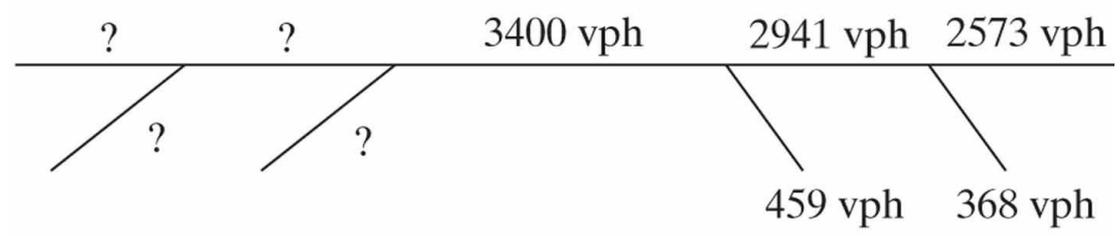
Bottleneck Effects



(a) True Demand

①	②	③	④	⑤
3200 vph	3200 vph	3400 vph	3000 vph	3000 vph

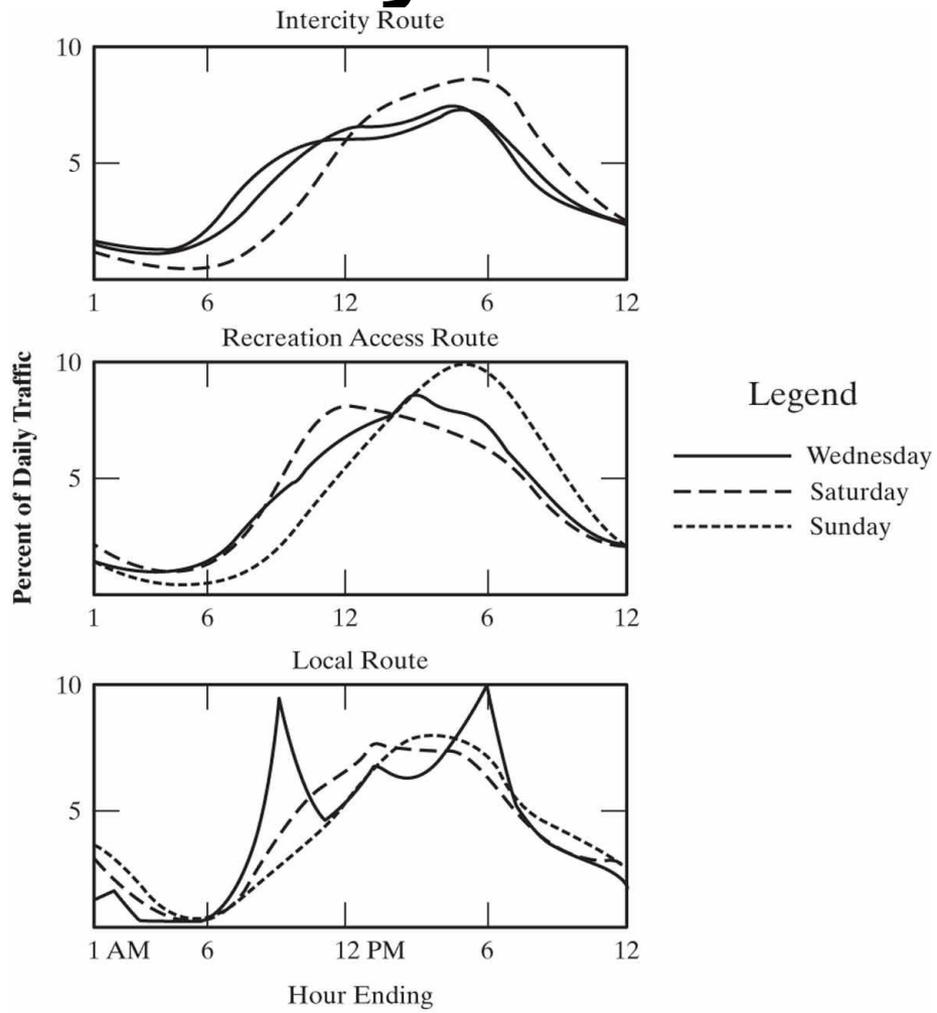
(b) Segment Capacities



(c) Observed Volumes



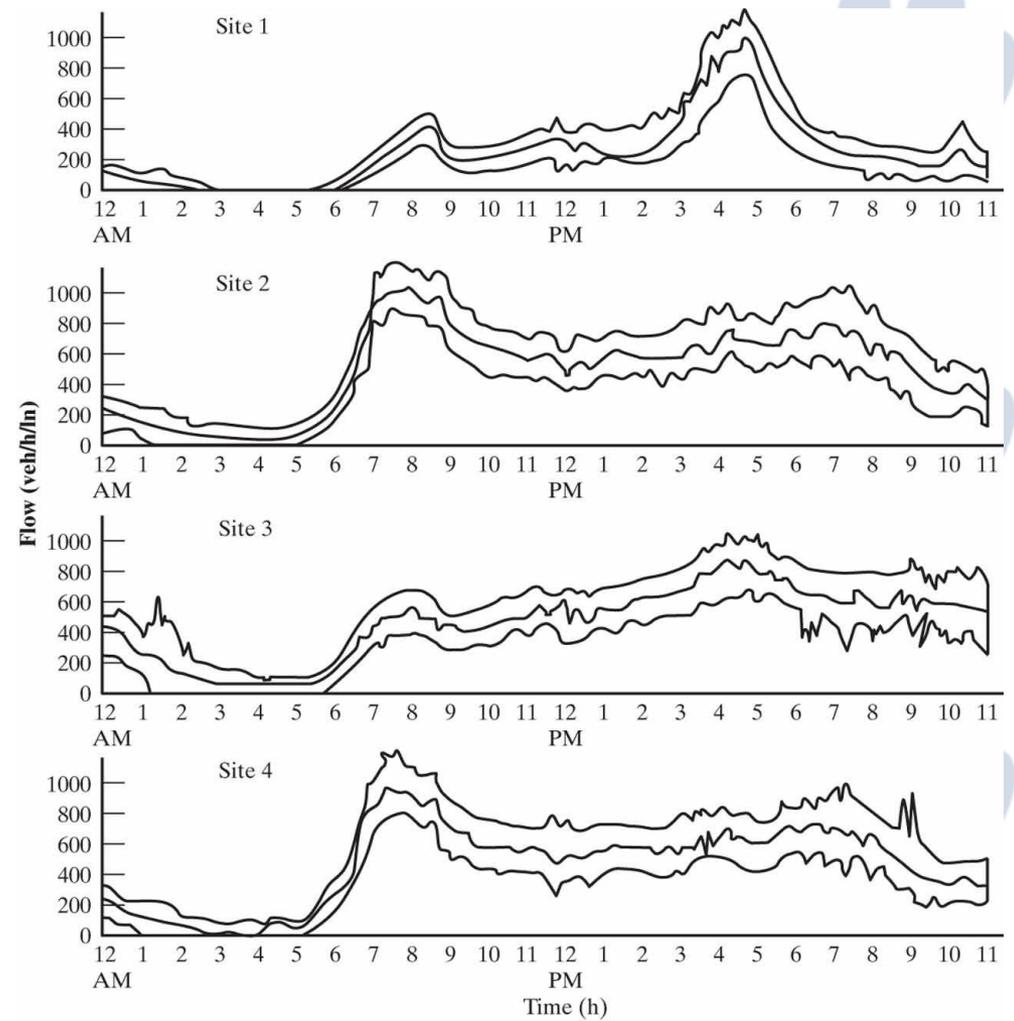
Observed Hourly Traffic Patterns



(a) Typical Variations for Rural Routes



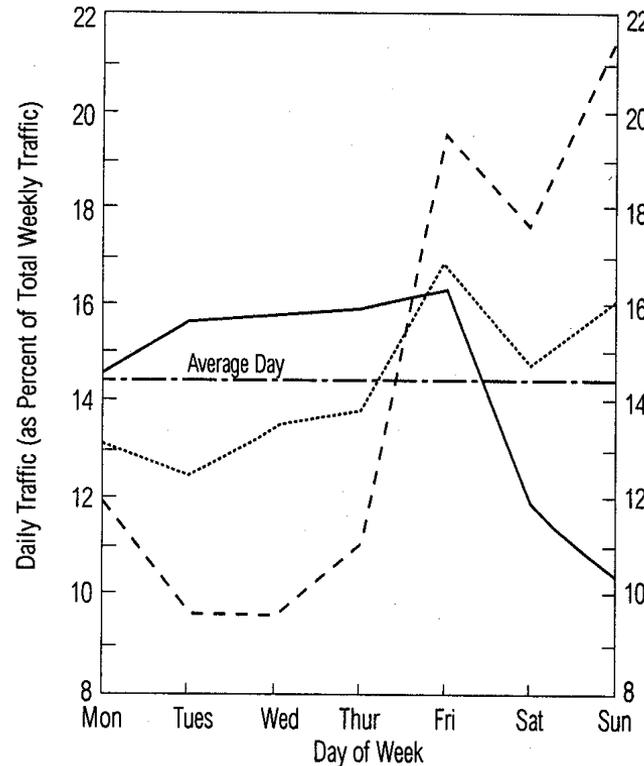
Observed Daily Variations



(b) Daily Variation in Volumes at Four Urban Locations

Volume Patterns and Characteristics

EXHIBIT 8-4. EXAMPLES OF DAILY TRAFFIC VARIATION BY TYPE OF ROUTE



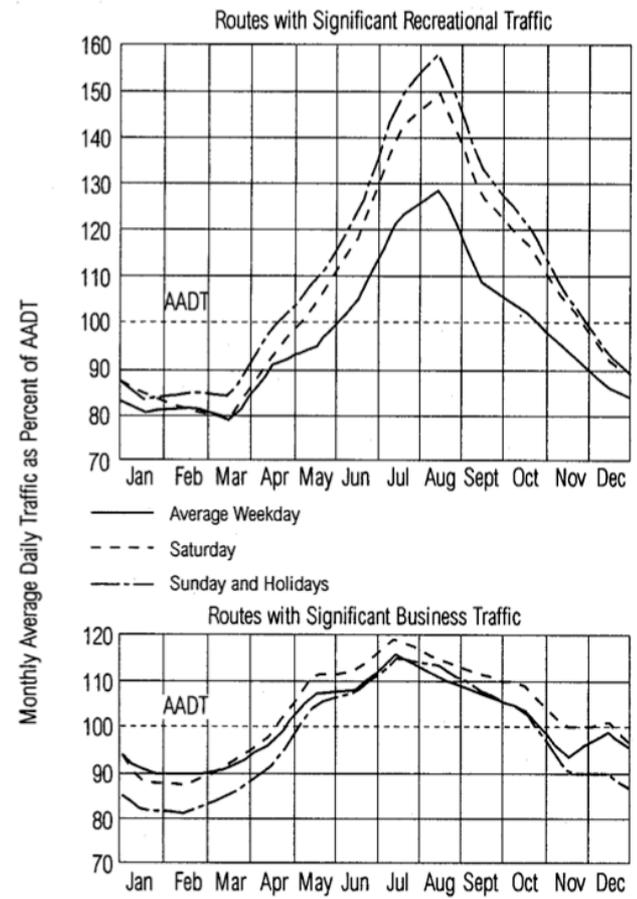
- Main rural route I-35, Southern Minnesota, AADT 10,823, 4 lanes, 1980.
- - - Recreational access route MN 169, North-Central Lake Region, AADT 3,863, 2 lanes, 1981.
- Suburban freeway, four freeways in Minneapolis-St. Paul, AADTs 75,000-130,000, 6-8 lanes, 1982.
- - - Average day.

Source: Minnesota Department of Transportation.



Monthly Variations

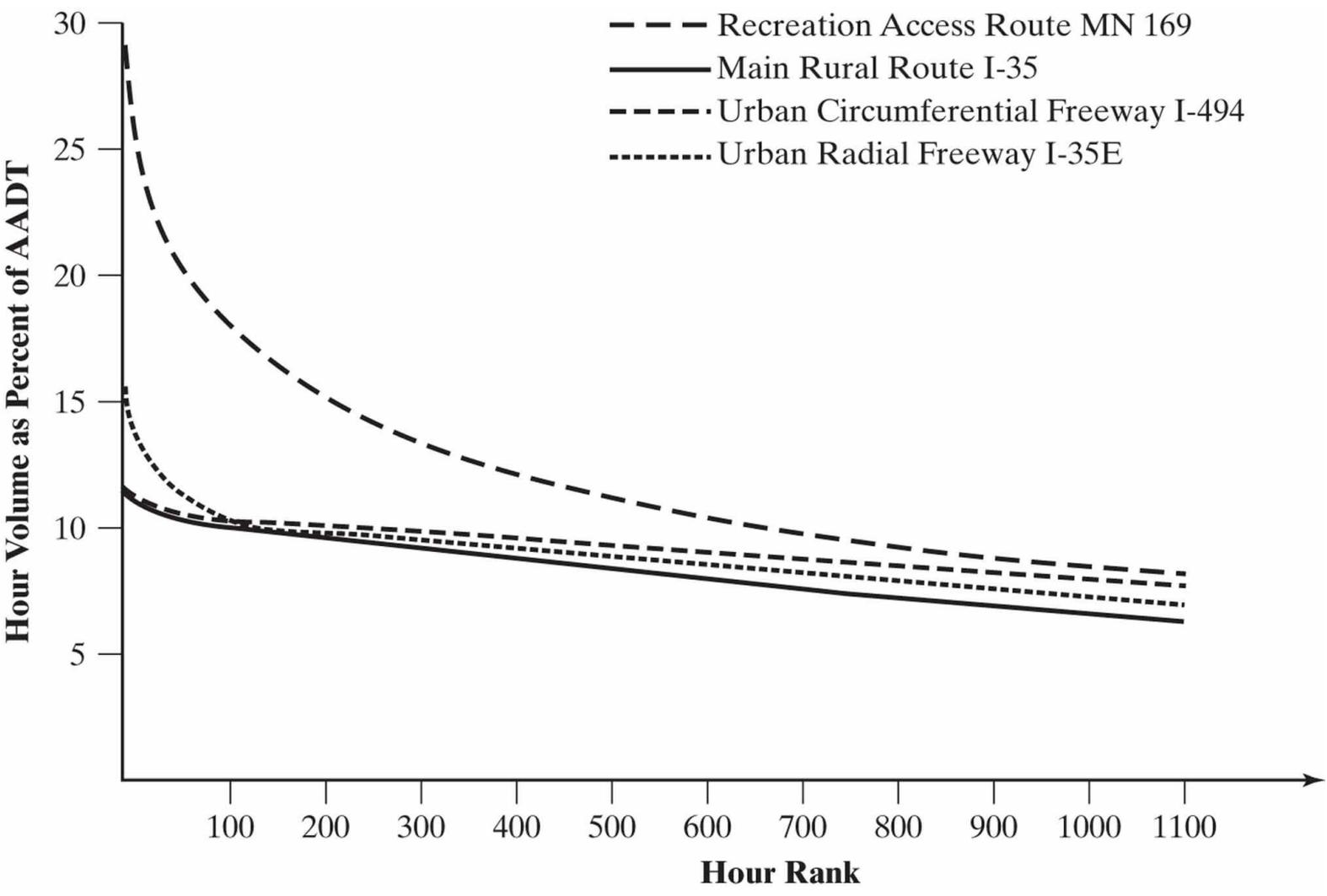
EXHIBIT 8-2. EXAMPLES OF MONTHLY TRAFFIC VOLUME VARIATIONS FOR A FREEWAY

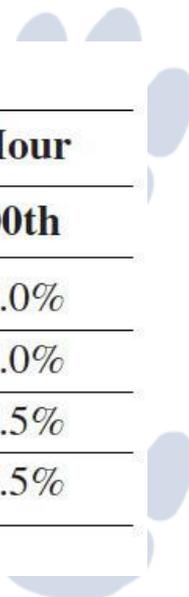


Source: Minnesota Department of Transportation.



Peak Hour Volume





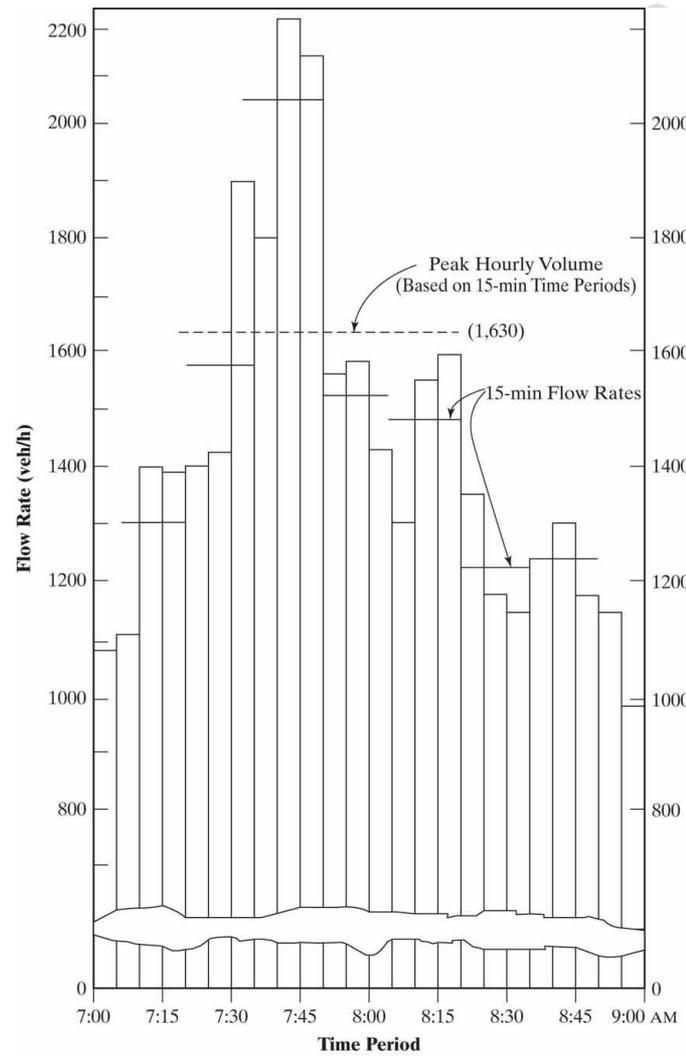
Peak Hour Volume

Table 9.1: Key Values from Figure 9.5

Type of Facility	Percent of AADT Occurring in the ____ Peak Hour			
	1st	30th	100th	200th
Recreational Access	30.0%	22.0%	18.0%	15.0%
Main Rural	15.0%	13.0%	10.0%	9.0%
Urban Circumferential Freeway	11.5%	10.5%	10.0%	9.5%
Urban Radial Freeway	11.5%	10.5%	10.0%	9.5%

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Within Peak Hour



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Volume Studies

Manual counts

- Useful when data is needed quickly, duration of study is short, or scope is limited
- Useful when more detail is needed such as:
 - Vehicle occupancy
 - Pedestrians
 - Turning movements
 - Vehicle classifications

Automatic counts

- Useful when complex classifications not necessary*
- Useful when data is needed over an extended period of time

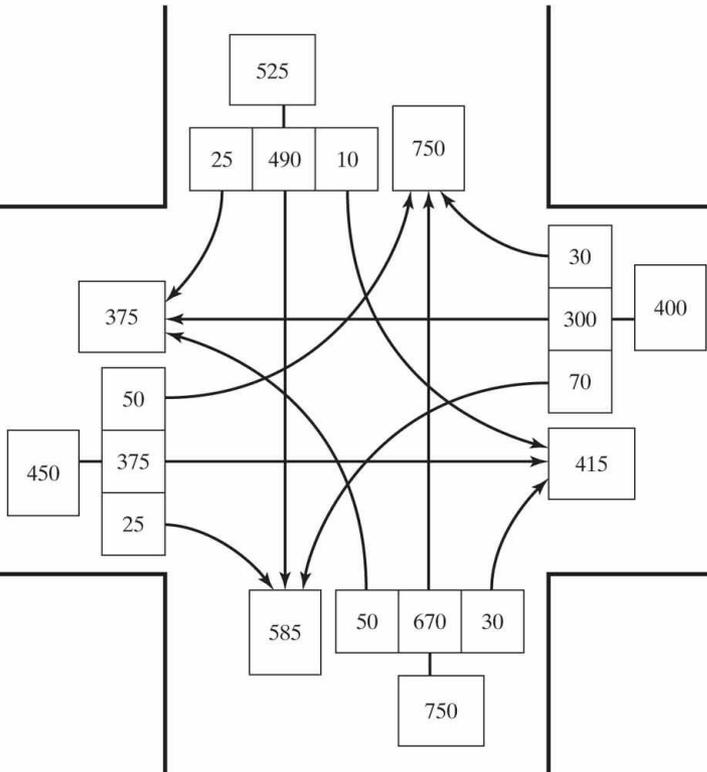


Intersection Traffic Volume Count

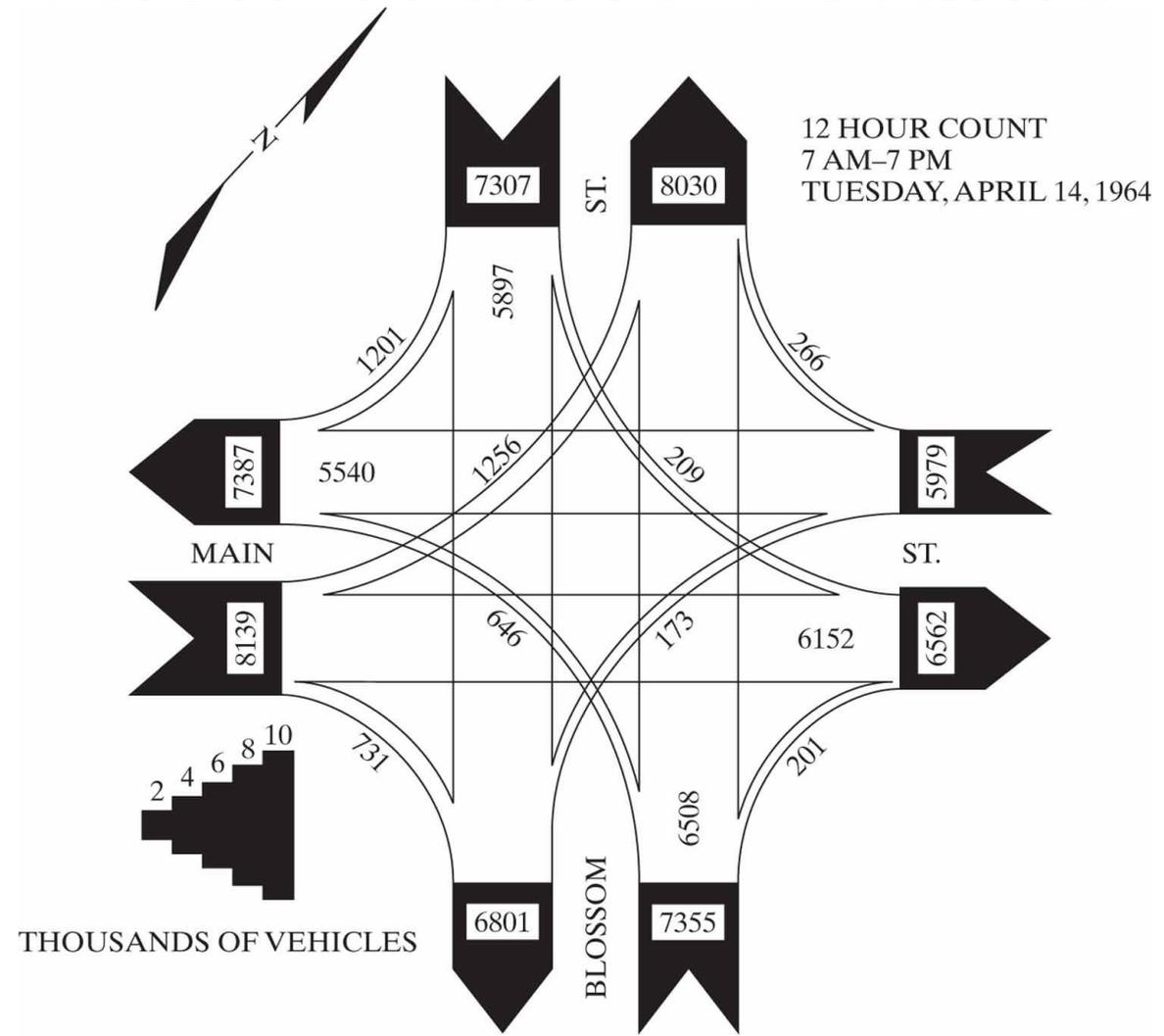


GRAPHIC SUMMARY OF VEHICLE MOVEMENTS

Intersection: *McShane Blvd and Prassas Ave*
 Date: *20 May 97* Time/Day: *Monday, 4-5 PM*
 Observer: *R. Roess*
 City: *Metrotech City*



Intersection Traffic Volume Count



Limited Network Volume Studies

- Sampling techniques are used along with statistical manipulation to develop an hourly volume map for the network
- Requires identification of locations with similar demand patterns over time
- Uses control and coverage counts



Limited Network Volume Studies

- Control count - maintained throughout study period; selected locations are measured to identify demand variation patterns
- Coverage count - taken at all locations in study area for a portion of study period (samples)
- Midblock counts

Limited Network Volume Studies

Control Count

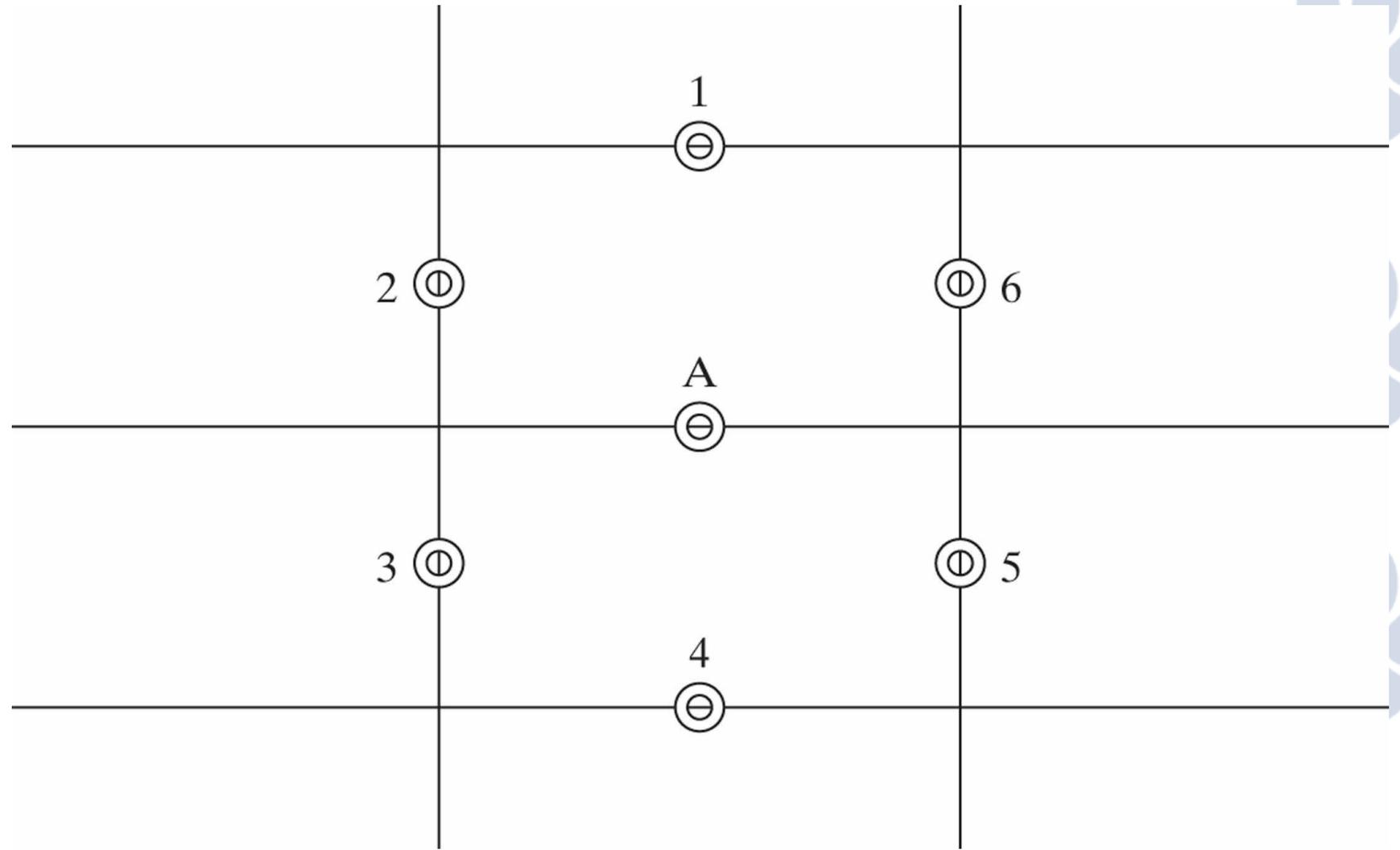
- One control for every 10-20 coverage locations
- Different control for each class of facility
- Different control for significantly different land-use type
- Used to establish volume patterns

Coverage Count

- These are sample locations which will be expanded with control information
- All network links should be counted at least once during study period



Control Count





Networkwide Studies

Table 9.3: Data and Computations for a One-Day Network Volume Study

Control-Count Data Location A		Coverage-Count Data		
Time (PM)	Count (vehs)	Location	Time (PM)	Count (vehs)
12-1	825	1	12-1	840
1-2	811	2	1-2	625
2-3	912	3	2-3	600
3-4	975	4	4-5	390
4-5	1,056	5	5-6	1,215
5-6	1,153	6	6-7	1,440
6-7	938			
7-8	397			

(a) Data from a One-Day Study

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Time (PM)	Count (vehs)	Proportion of 8-Hour Total
12-1	825	$825/7,067 = 0.117$
1-2	811	$811/7,067 = 0.115$
2-3	912	$912/7,067 = 0.129$
3-4	975	$975/7,067 = 0.138$
4-5	1,056	$1,056/7,067 = 0.149$
5-6	1,153	$1,153/7,067 = 0.163$
6-7	938	$938/7,067 = 0.133$
7-8	397	$397/7,067 = 0.056$
Total	7,067	1.000

(b) Computation of Hourly Volume Proportions From Control-Count Data

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Location	Time (PM)	Count (vehs)	Estimated 8-Hr Volume (vehs)	Estimated Peak Hour Volume (vehs)
1	12-1	840	$840/0.117 = 7,179$	$\times 0.163 = 1,170$
2	1-2	625	$625/0.115 = 5,435$	$\times 0.163 = 886$
3	2-3	600	$600/0.129 = 4,651$	$\times 0.163 = 758$
4	4-5	390	$390/0.149 = 2,617$	$\times 0.163 = 427$
5	5-6	1,215	$1,215/0.163 = 7,454$	$\times 0.163 = 1,215$
6	6-7	1,440	$1,440/0.133 = 10,827$	$\times 0.163 = 1,765$

(c) Expansion of Hourly Counts

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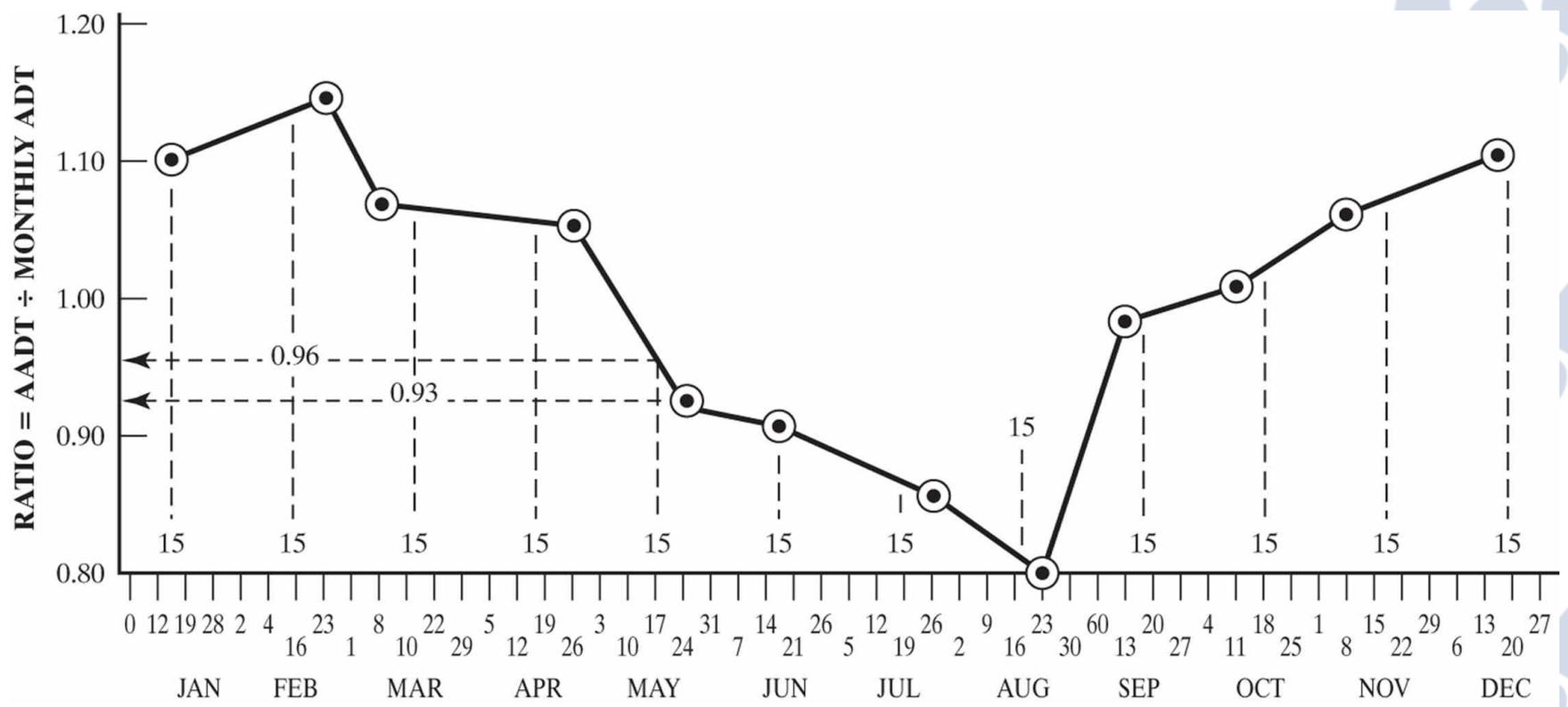
Daily Variation Factor

Table 9.7: Calibration of Daily Variation Factors

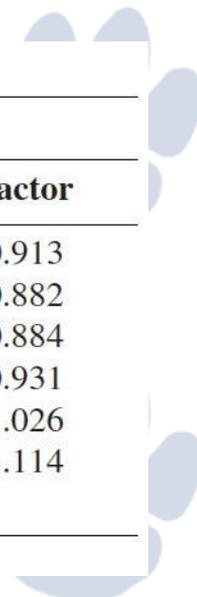
Day	Yearly Average Volume for Day (vehs/day)	Daily Adjustment Factor (DF)
Monday	1820	$1430/1820 = 0.79$
Tuesday	1588	$1430/1588 = 0.90$
Wednesday	1406	$1430/1406 = 1.02$
Thursday	1300	$1430/1300 = 1.10$
Friday	1289	$1430/1289 = 1.11$
Saturday	1275	$1430/1275 = 1.12$
Sunday	1332	$1430/1332 = 1.07$
Total	10,010	
Estimated AADT	1,430	

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Weekly Variation Factor (2)



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Daily and Monthly Adjustment Factors

Table 9.11: Typical Daily and Monthly Variation Factors for a Contiguous Area on a State Highway System

Daily Factors (DF)		Monthly Factors (MF)			
Day	Factor	Month	Factor	Month	Factor
Monday	1.072	January	1.215	July	0.913
Tuesday	1.121	February	1.191	August	0.882
Wednesday	1.108	March	1.100	September	0.884
Thursday	1.098	April	0.992	October	0.931
Friday	1.015	May	0.949	November	1.026
Saturday	0.899	June	0.918	December	1.114
Sunday	0.789				

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Network wide AADT

- $AADT = V_{24ij} * Df_i * MF_j$
 - AADT: Average annual daily traffic
 - V_{24ij} : 24-hour volume for day i, in month j
 - Df_i : Daily adjustment factor for day i
 - MF_j : Monthly adjustment factor for month j



Vehicle Miles Travelled

- $VMT_{365} = AADT * L * 365$
 - Annual vehicle miles travelled over the segment
 - AADT for the segment (veh/day)
 - Length of the segment



Manual Counts



<http://jamartech.com>

Manual Counts

Figure 1 – Manual Count Checklist

Project: _____
Count Location: _____
Date: _____
Time of Count: _____

- _____ 1. Check data collection equipment for proper operation and calibration
- _____ 2. Label the field equipment as needed
- _____ 3. Bring necessary accessory equipment (Batteries, flashlight, etc)
- _____ 4. Stopwatch
- _____ 5. Bring data collection forms and fill in as much data as possible before leaving the office.
- _____ 6. Extra pens and paper for taking notes
- _____ 7. Clipboard or writing surface
- _____ 8. Business cards of the engineer to contact and be prepared to answer the question "What are you doing here?"
- _____ 9. A map to the site
- _____ 10. Weather condition equipment (Sunscreen, umbrella, jacket or warm coat)
- _____ 11. Safety equipment (Flags, Signs, safety vests, or other reflective materials)

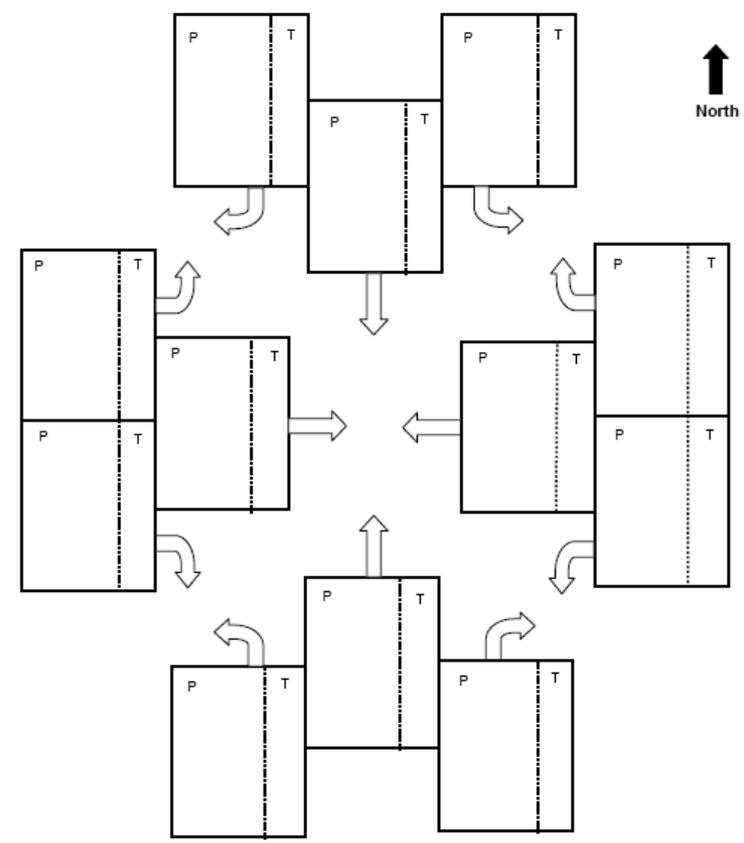


Manual Counts

Vehicle Turn Movement Count Four-Approach Field Sheet

North/South Street _____ Time _____ To _____
 East/West Street _____ Date _____ Day _____
 Weather _____
 Observer _____

P=Passenger cars, mini-vans, two axle trucks, motor cycles and station wagons
 T = Trucks, multi-axle vehicle, city bus or school bus



Field Considerations

- Everyone should be familiar with count procedure/labels/equipment
- Must have enough members in field to adequately record, provide relief, and to address safety concerns
- Be prepared!!!



Field Considerations

- Observer locations (manual studies)
- Count location (automatic studies)
- Be sure to secure equipment for automatic counts
- Install equipment during very low volume time periods
- Safety vests!



Count Periods

- 2 hours, peak period
- 4 hours, am/pm peak period
- 6 hours, am/midday/pm peak periods
- 12 hours daytime (7am-7pm)
- 24 hours, week, month, etc. (automatic)



Count Periods

Table 1 – Typical Peak Flow Traffic Hours

Land Use	Typical Peak Hours
Residential	7:00-9:00 am weekday 4:00-6:00 pm weekday
Regional Shopping center	5:00-6:00 pm weekday 2:30-3:30 pm Saturday 12:30-1:30 pm Saturday
Office	7:00-9:00 am weekday 4:00-6:00 pm weekday
Industrial	Varies
Recreational	Varies
Hospital	Varies based on shift changes
School	Varies based on school release times



Intersection Studies

- Typical 4-leg intersection has 12 separate movements
- Vehicles usually counted as they depart the intersection, but can not do this when $D > Q_{\text{cap}}$
- Must record queue size

$$V_{ai} = V_{di} + N_{qi} - N_{q_{i-1}}$$

V_{ai} = arrival volume in period i , vehs

V_{di} = departure volume in period i , vehs

N_{qi} = number of queued vehs at end of period i , vehs

$N_{q_{i-1}}$ = number of queued vehs at end of period $i - 1$, vehs



Intersection Studies

Time Period	Total Departure Count (veh)	Queue Length (veh)	Arrival Volume (veh)
4:00-4:15 pm	50	0	50
4:15-4:30	55	0	55
4:30-4:45	62	5	$62 + 5 = 67$
4:45-5:00	65	10	$65 + 10 - 5 = 70$
5:00-5:15	60	12	$60 + 12 - 10 = 62$
5:15-5:30	60	5	$60 + 5 - 12 = 53$
5:30-5:45	62	0	$62 - 5 = 57$
5:45-6:00	55	0	55
	Total = 469		Total = 469



Statewide Programs

- Involves entire state highway system in continuous study period
- AADT/ADT (<http://ww3.tdot.state.tn.us/trafficHistory/>)
- Vehicle-miles traveled
- Usually every 2 mile state hwy segment is included in coverage count each year
- Develop AADT estimate for each coverage location annually
- Control locations may be permanent; data collected over entire year



Specialized Counting Studies



- Origin and destination counts
 - Weaving areas
 - Freeway studies
 - Major activity centers
- Cordon counts
 - Estimate vehicle and person accumulation within the cordon
 - Used to supplement O-D studies or for trend analysis
- Screen-line
 - Record travel from one area to another
 - Used to adjust results of O-D studies

For specialized counts, must have more than just count data.

Types of Volume Studies

- Intersection counts (duration depends on the purpose, 15-minute intervals or shorter, turning volumes)
- Pedestrian counts (duration depends on the purpose, 5-minute intervals or longer)
- Cordon counts (one weekday + travelers' survey)
- Screen line counts (hourly counts for a weekday)
- Area wide counts
 - Control counts (hourly counts with permanent stations)
 - Coverage counts (hourly counts for one or two days)



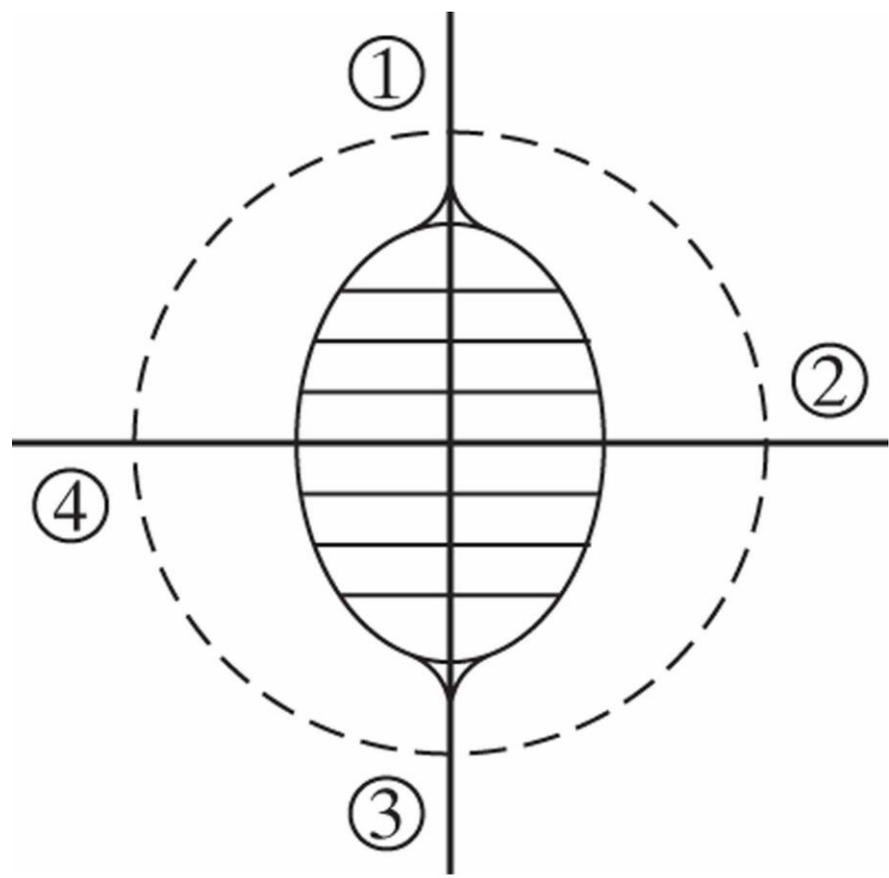
Origin-Destination Counts



- License plate studies
 - Recording license plates at entry and exit
- Postcard studies
 - Handing out color coded post cards at entry points and collecting them at exit
- Interview studies
 - Stopping vehicles and interviewing them about trip details



O-D Counts Example



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O-D Counts Example (2)

Table 9.12: Sample Expansion of Origin and Destination Data

Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	50	8	20	17	95	250	2.63
2	10	65	21	10	106	310	2.92
3	15	12	38	15	80	200	2.50
4	13	14	18	42	87	375	4.31
T_i	88	99	97	84	368		
V_i	210	200	325	400		1135	
F_i	2.39	2.02	3.35	4.76			

(a) Field Data and Factors for Iteration 0

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O-D Counts Example (3)

$$T_{ijN} = T_{ijN-1} \left(\frac{F_i + F_j}{2} \right)$$

- F_i : Adjustment factor for origin i
- F_j : Adjustment factor for origin j
- T_{ijN} : Number of trips from station i to station j after N th iteration
- T_i : Sum of matched trips from station i
- T_j : Sum of matched trips from station j
- V_i : Observed total volume at Station i
- V_j : Observed total volume at Station j



O-D Counts Example (4)



Table 9.12: Sample Expansion of Origin and Destination Data

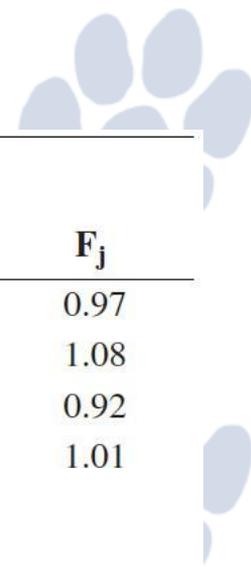
Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	125	19	60	63	267	250	0.94
2	27	161	66	38	292	310	1.06
3	37	27	111	54	229	200	0.87
4	44	44	69	191	347	375	1.08
T_i	232	251	306	346	1135		
V_i	210	200	325	400		1135	
F_i	0.90	0.80	1.06	1.16			

(b) Initial Expansion of O-D Matrix (Iteration 0)

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O-D Counts Example (5)



Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	116	16	60	66	257	250	0.97
2	26	150	70	43	288	310	1.08
3	33	23	108	55	218	200	0.92
4	43	42	74	213	372	375	1.01
T_i	217	230	311	376	1135		
V_i	210	200	325	400		1135	
F_i	0.97	0.87	1.04	1.06			

(c) First Iteration of O-D Matrix

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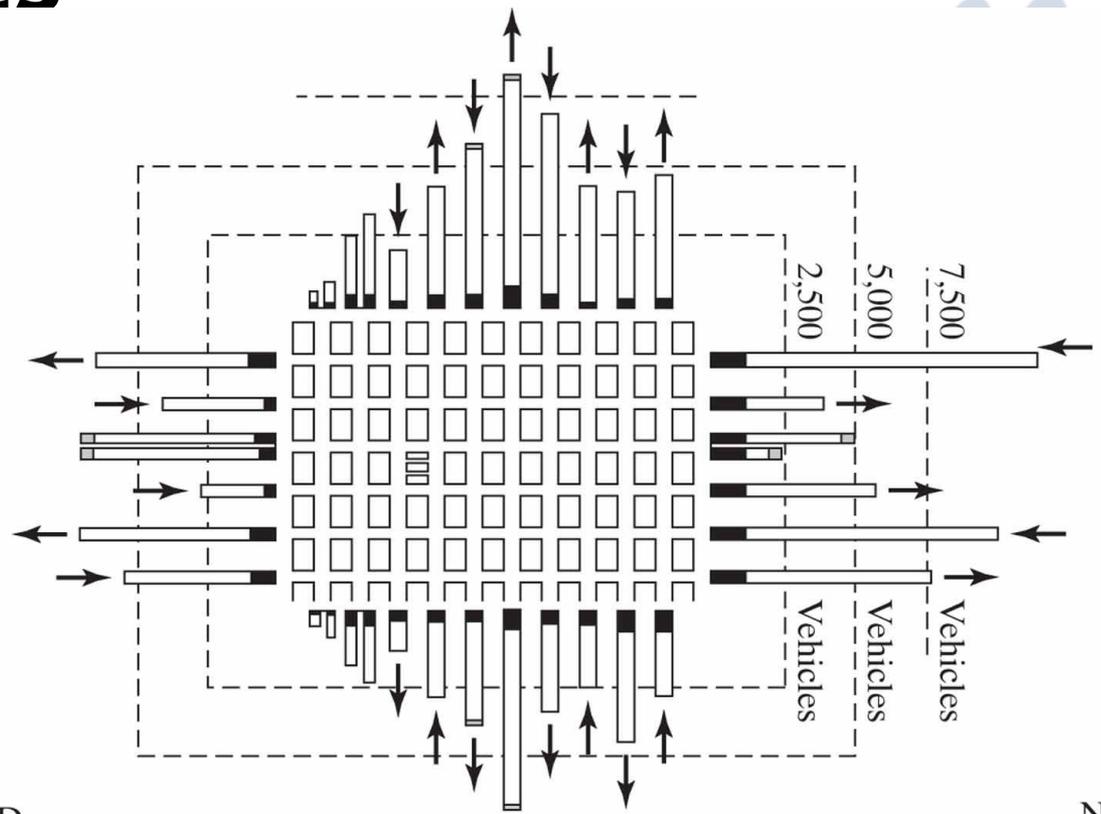
O-D Counts Example (6)

Destination Station	Origin Station				T_j	V_j	F_j
	1	2	3	4			
1	112	15	60	67	254	250	0.98
2	27	145	74	46	292	310	1.06
3	31	20	105	55	211	200	0.95
4	43	39	76	221	378	375	0.99
T_i	212	220	316	388	1135		
V_i	210	200	325	400		1135	
F_i	0.99	0.91	1.03	1.03			

(d) Second Iteration of O-D Matrix

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Cordon Counts



LEGEND

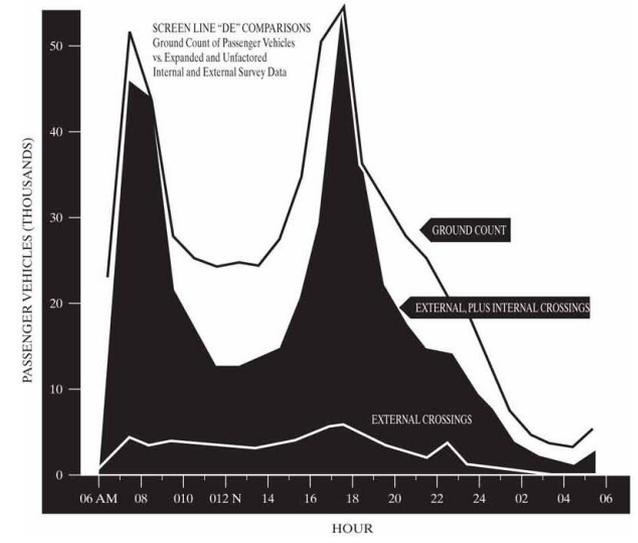
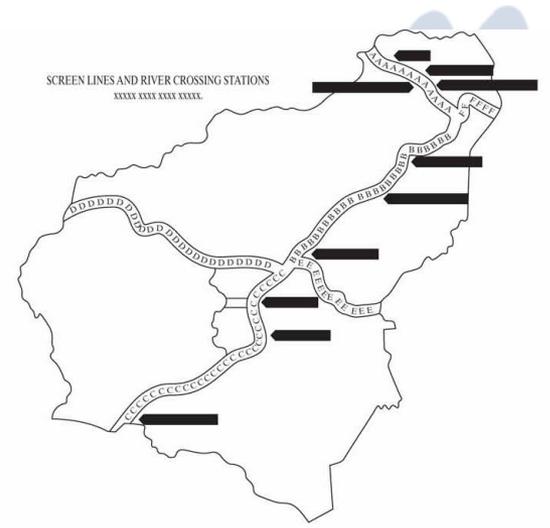
	Buses
	Autos
	Trucks
	Entering
	Leaving

Vehicles entering and leaving cordon area
between 6:00 a.m. – 8:00 p.m. (14 hrs.)

Total vehicles entering – 86,170
Total vehicles leaving – 86,098



Screen-Line Counts



For more information...

- *Chapter 2: Manual of Transportation Engineering Studies, 2nd Edition, ITE 2010.*

