APPENDIX 3-3
WORK SHEETS AND TABLES FOR LEVEL OF SERVICE ANALYSIS
- MULTI-LANE HIGHWAY -

OPERATIONAL ANALYSIS WORKSHEET

Facility Section:________________________________

Date:________________ Time:________________(of analysis data)

I. GEOMETRY

____m. Distance to Roadside Obstructions

____m. ← DIR. 1 N = ____

____m.

____m. → DIR. 2 N = ____

____m. Distance to Roadside Obstructions

INDICATE NORTH

	Highway Classification D or U, S or R	Design Speed (kph)	Lane Width (m)	Terrain Type (L, R, or M)	or Grade (%)	Length (km)	Median Type
Dir. 1							
Dir. 2							

II. VOLUMES

	Vol. (vph)	PHF	SF=Vol./PHF	Traffic Composition(%) Car	Jeep-ney	Motor-cycle	Tri-cycle	Truck	Bus	Driver Population
Dir. 1										☐ Commuter ☐ Other
Dir. 2										☐ Commuter ☐ Other

III. ANALYSIS

$v/c = SF/[c_i \times N \times f_w \times f_{HV} \times f_E \times f_p]$

$c = c_i \times N \times f_w \times f_{HV} \times f_p$

$f_{HV} = 1 / (P_{car} + P_{jny} E_{jny} + P_{mcy} E_{mcy} + P_{mtr} E_{mtr} + P_{trk} E_{trk} + P_{bus} E_{bus})$

	v/c =	SF	$/[c_i$ Table 3.3-1	$\times N$	$\times f_w$ Table 3.3-2	$\times f_E$ Table 3.3-4	$\times f_p$ Table 3.3-5	$\times f_{HV}]$
Dir. 1								
Dir. 2								

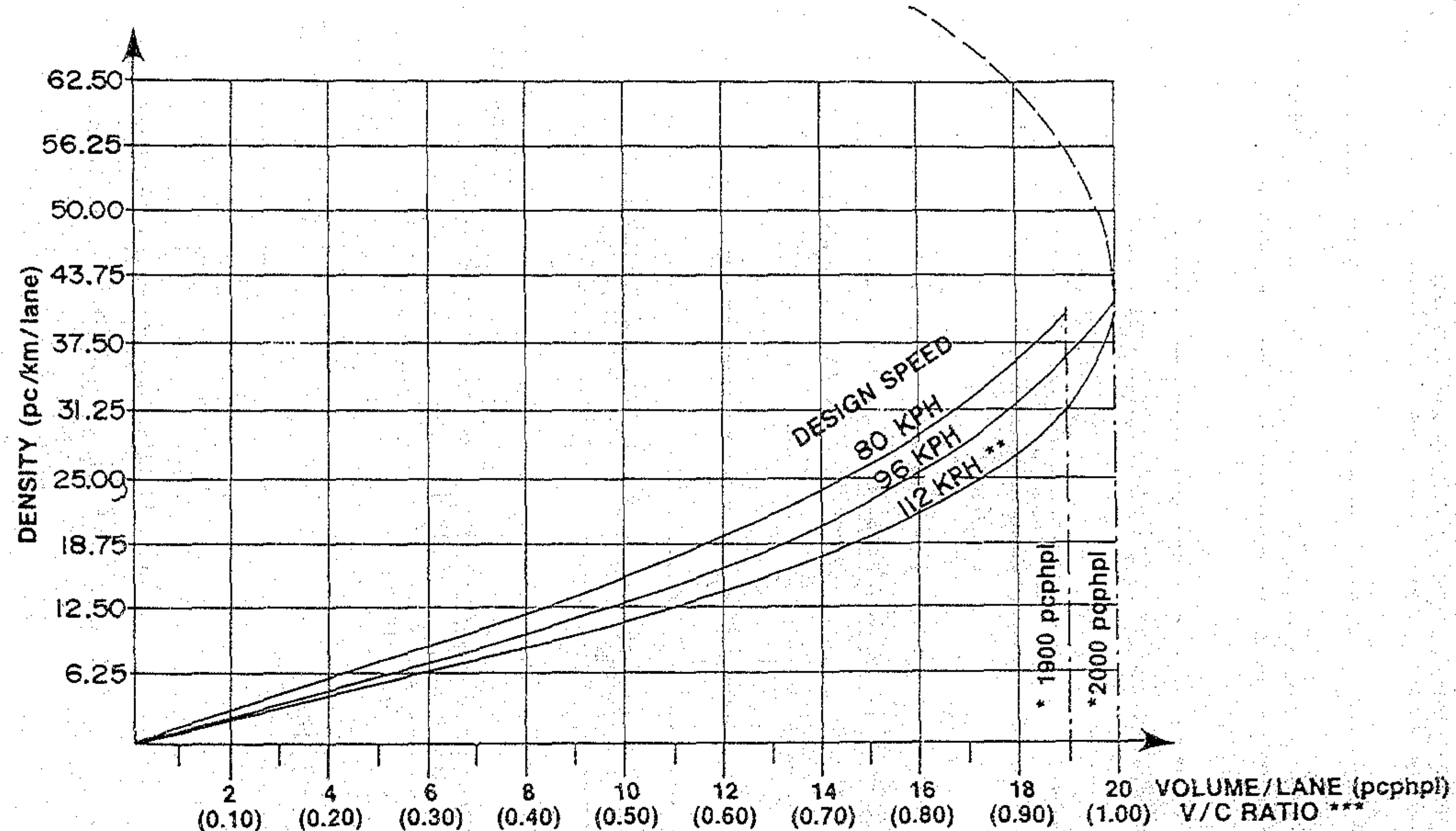
	P_{car}	P_{jny}	E_{jny}	P_{mcy}	E_{mcy}	P_{mtr}	E_{mtr}	P_{trk}	E_{trk}	P_{bus}	E_{bus}
Dir. 1											
Dir. 2											

	c	v/c	LOS (Table 3.3-1)	Speed (Fig.3.3-2)	Density (Fig.3.3-1)
Dir. 1					
Dir. 2					

COMMENTS on back of page.

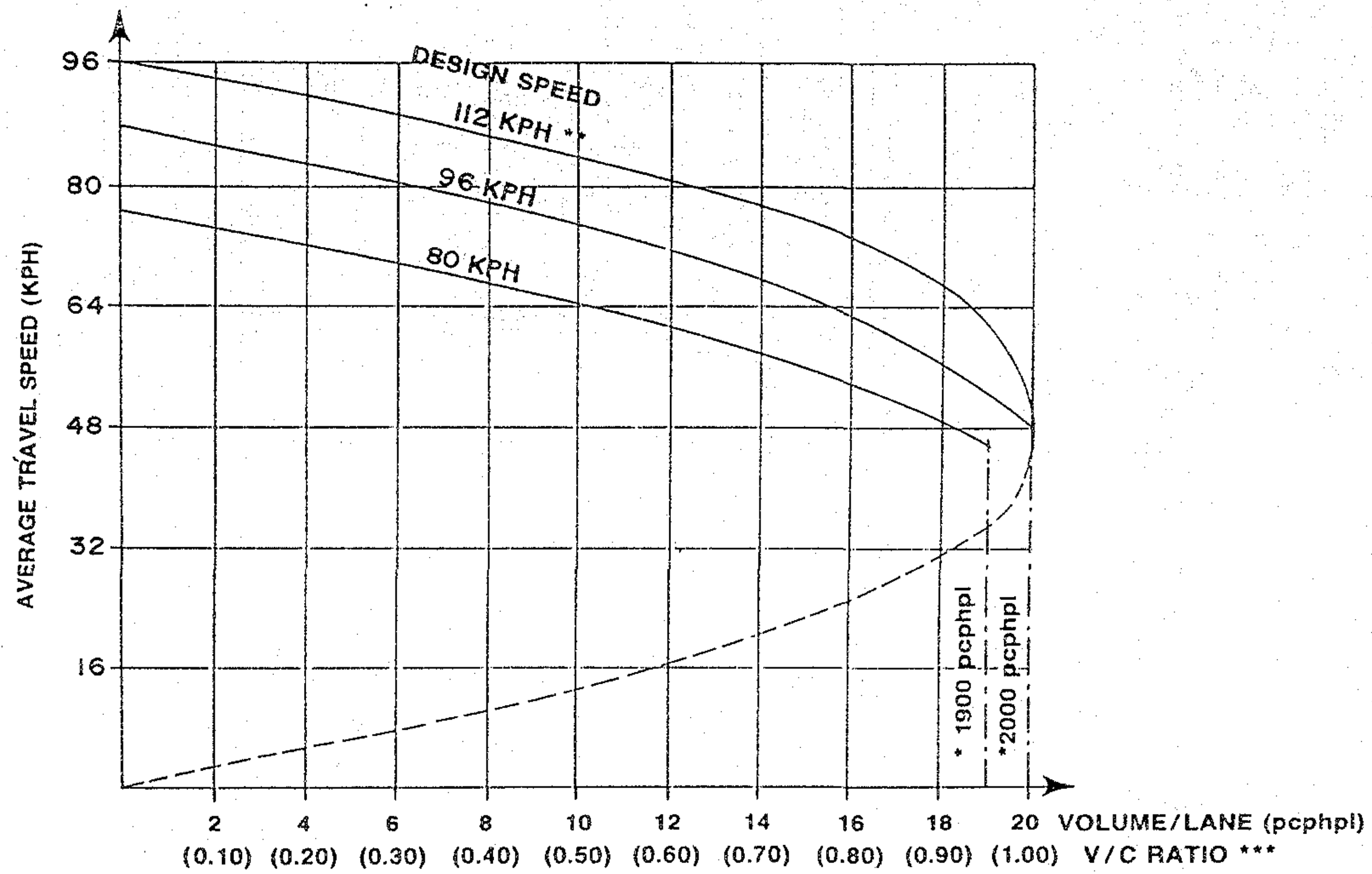
Name:________________ Date:________________

Checked by:________________



* capacity
** reflects 88 KPH speed limit
*** v/c ratio based on capacity of 2000 pcphpl, applies only to 96 and 112 KPH design speeds

Figure 3.3-1 Density flow characteristics for uninterrupted flow segments of multilane highways.



* capacity

** reflects 88 KPH speed limit

*** v/c ratio based on capacity of 2000 pcphpl, applies only to 96 and 112 KPH design speeds

Figure 3.3-2 Speed-flow characteristics for uninterrupted flow segments of multilane highways.

Table 3.3-1 LEVEL-OF-SERVICE CRITERIA FOR MULTILANE HIGHWAYS

LEVEL OF SERVICE	DENSITY (PC/Km/LN)	70 MPH DESIGN SPEED			60 MPH DESIGN SPEED			50 MPH DESIGN SPEED		
		SPEED[a] (KmPH)	v/c	MSF[b] (PCPHPL)	SPEED[a] (KmPH)	v/c	MSF[b] (PCPHPL)	SPEED[a] (KmPH)	v/c	MSF[b] (PCPHPL)
A	≤ 8	≥ 91	0.36	700	≥ 80	0.33	650	—	—	—
B	≤ 13	≥ 85	0.54	1,100	≥ 77	0.50	1,000	≥ 67	0.45	850
C	≤ 19	≥ 80	0.71	1,400	≥ 70	0.65	1,300	≥ 62	0.60	1,150
D	≤ 26	≥ 64	0.87	1,750	≥ 64	0.80	1,600	≥ 56	0.76	1,450
E	≤ 42	≥ 48	1.00	2,000	≥ 48	1.00	2,000	≥ 45	1.00	1,900
F	> 42	< 48	c	c	< 48	c	c	< 45	c	c

[a] Average travel speed.
[b] Maximum rate of flow per lane under ideal conditions, rounded to the nearest 50 pcphpl.
[c] *Highly variable.*

Table 3.3-2 ADJUSTMENT FACTOR FOR RESTRICTED LANE WIDTH AND LATERAL CLEARANCE

DISTANCE FROM EDGE OF TRAVELED WAY TO OBSTRUCTION[a]	ADJUSTMENT FACTOR, f_w							
	OBSTRUCTION ON ONE SIDE OF ROADWAY[b]				OBSTRUCTION ON BOTH SIDES OF ROADWAY[c]			
	LANE WIDTH (FT)							
(m)	3.65	3.35	3.05	2.75	3.65	3.35	3.05	2.75
	4-LANE DIVIDED MULTILANE HIGHWAYS (2 LANES EACH DIRECTION)							
≥ 1.8	1.00	0.97	0.91	0.81	1.00	0.97	0.91	0.81
1.2	0.99	0.96	0.90	0.80	0.98	0.95	0.89	0.79
0.6	0.97	0.94	0.88	0.79	0.94	0.91	0.86	0.76
0	0.90	0.87	0.82	0.73	0.81	0.79	0.74	0.66
	6-LANE DIVIDED MULTILANE HIGHWAYS (3 LANES EACH DIRECTION)							
≥ 1.8	1.00	0.96	0.89	0.78	1.00	0.96	0.89	0.78
1.2	0.99	0.95	0.88	0.77	0.98	0.94	0.87	0.77
0.6	0.97	0.93	0.87	0.76	0.96	0.92	0.85	0.75
0	0.94	0.91	0.85	0.74	0.91	0.87	0.81	0.70
	4-LANE UNDIVIDED MULTILANE HIGHWAYS (2 LANES EACH DIRECTION)							
≥ 1.8	1.00	0.95	0.89	0.77	NA	NA	NA	NA
1.2	0.98	0.94	0.88	0.76	NA	NA	NA	NA
0.6	0.95	0.92	0.86	0.75	0.94	0.91	0.86	NA
0	0.88	0.85	0.80	0.70	0.81	0.79	0.74	0.66
	6-LANE UNDIVIDED MULTILANE HIGHWAYS (3 LANES EACH DIRECTION)							
≥ 1.8	1.00	0.95	0.89	0.77	NA	NA	NA	NA
1.2	0.99	0.94	0.88	0.76	NA	NA	NA	NA
0.6	0.97	0.93	0.86	0.75	0.96	0.92	0.85	NA
0	0.94	0.90	0.83	0.72	0.91	0.87	0.81	0.70

[a] Use the average distance to obstruction on "both sides" where the distance to obstructions on the left and right differs.
[b] Factors for one-sided obstructions allow for the effect of opposing flow.
[c] Two-sided obstructions include one roadside and one median obstruction. Median obstruction may exist in the median of a divided multilane highway or in the center of an undivided highway which periodically divides to go around bridge abutments or other center objects.
NA = Not applicable; use factor for one-sided obstruction.

TABLE 3.3-3 PASSENGER-CAR EQUIVALENTS ON EXTENDED GENERAL MULTILANE HIGHWAY SEGMENTS

Factor	Type of Terrain		
	Level	Rolling	Mountainous
Ejny	1.5	1/	1/
Emcy	0.5	0.5	0.5
Etrk	1.7	4.0	8.0
Ebus	1.5	3.0	5.0

1/ Further study needed to obtain PCEF.

TABLE 3.3-4 ADJUSTMENT FACTOR FOR TYPE OF MULTILANE HIGHWAY AND DEVELOPMENT ENVIRONMENT, f_E

Type	Divided	Undivided
Rural	1.00	0.95
Suburban	0.90	0.80

TABLE 3.3-5 ADJUSTMENT FACTOR FOR DRIVER POPULATION

Driver Population	Factor, fp
Commuter, or Other Regular Users	1.00
Recreational, or Other Nonregular Users	0.75-0.90

APPENDIX 3-4

WORK SHEETS AND TABLES FOR

LEVEL OF SERVICE ANALYSIS

- SIGNALIZED INTERSECTION -

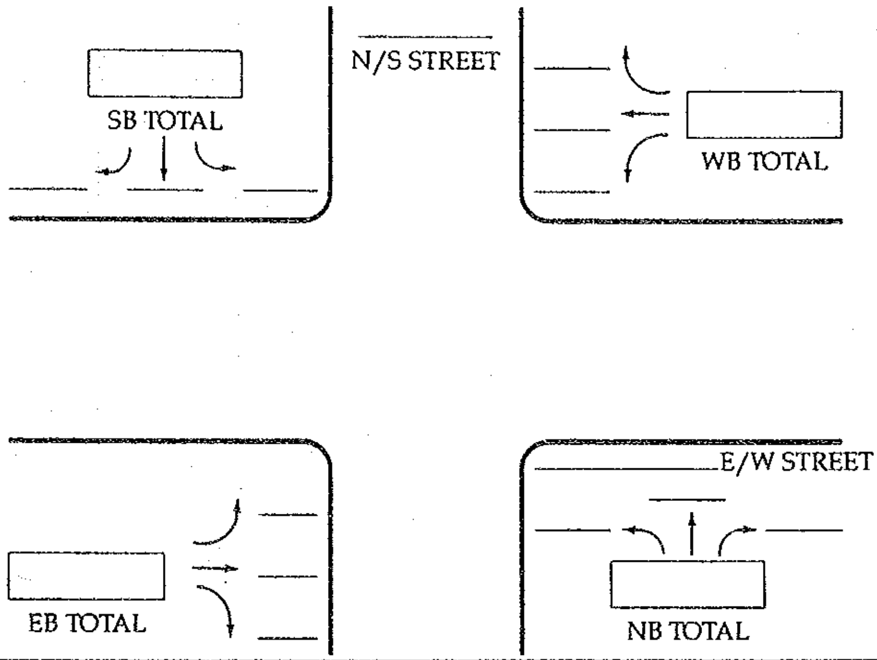
INPUT WORKSHEET

Intersection:________________________________ Date:______________

Analyst:________________ Time Period Analyzed:__________ Area Type: ☐ CBD ☐ Other

Project No.:________________________ City/State:__________________

VOLUME AND GEOMETRICS



IDENTIFY IN DIAGRAM:

1. Volumes
2. Lanes, lane widths
3. Movements by lane
4. Parking (PKG) locations
5. Bay storage lengths
6. Islands (physical or painted)
7. Bus stops

TRAFFIC AND ROADWAY CONDITIONS

Approach	Grade (%)	% HV	Adj. Pkg. Lane		Buses (N_B)	PHF	Conf. Peds. (peds./hr)	Pedestrian Button		Arr. Type
			Y or N	N_m				Y or N	Min. Timing	
EB										3
WB										3
NB										3
SB										3

Grade: + up, − down
HV: veh. with more than 4 wheels
N_m: pkg. maneuvers/hr

N_B: buses stopping/hr (include Jeepneys and tricycles)
PHF: peak-hour factor
Conf. Peds: Conflicting peds./hr

Min. Timing: min. green for pedestrian crossing
Arr. Type: Type 1-5 (usually 3)

PHASING

DIAGRAM								
Timing	G = Y + R =	G = Y + R =	G = Y + R =	G = Y + R =	G = Y + R =	G = Y + R =	G = Y + R =	G = Y + R =
Pretimed or Actuated								

Protected turns | Permitted turns | -------- Pedestrian | Cycle Length______Sec

VOLUME ADJUSTMENT WORKSHEET

① Appr.	② Mvt.	③ Mvt. Volume (vph)	④ Peak Hour Factor PHF	⑤ Flow Rate v_p (vph) ③ ÷ ④	⑥ Lane Group	⑦ Flow rate in Lane Group v_g (vph)	⑧ Number of Lanes N	⑨ Lane Utilization Factor U Table 3.4-11	⑩ Adj. Flow v (vph) ⑦ × ⑨	⑪ Prop. of LT or RT P_{LT} or P_{RT}
EB	LT									
	TH									
	RT									
WB	LT									
	TH									
	RT									
NB	LT									
	TH									
	RT									
SB	LT									
	TH									
	RT									

SATURATION FLOW ADJUSTMENT WORKSHEET

LANE GROUPS				ADJUSTMENT FACTORS								
① Appr.	② Lane Group Movements	③ Ideal Sat. Flow (pcphgpl)	④ No. of Lanes N	⑤ Lane Width f_w Table 3.4-2	⑥ Heavy Veh f_{HV} Table 3.4-3	⑦ Grade f_g Table 3.4-4	⑧ Pkg. f_p Table 3.4-5	⑨ Bus Blockage f_{bb} Table 3.4-6	⑩ Area Type f_a Table 3.4-7	⑪ Right Turn f_{RT} Table 3.4-8	⑫ Left Turn f_{LT} Table 3.4-9	⑬ Adj. Sat. Flow Rate s (vphg)
EB												
WB												
NB												
SB												

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR, f_{LT}

INPUT VARIABLES	EB	WB	NB	SB
Cycle Length, C (sec)				
Effective Green, g (sec)				
Number of Lanes, N				
Total Approach Flow Rate, v_a (vph)				
Mainline Flow Rate, v_M (vph)				
Left-Turn Flow Rate, v_{LT} (vph)				
Proportion of LT, P_{LT}				
Opposing Lanes, N_o				
Opposing Flow Rate, v_o (vph)				
Prop. of LT in Opp. Vol., P_{LTO}				

COMPUTATIONS	EB	WB	NB	SB
$S_{op} = \dfrac{1800\ N_o}{1 + P_{LTO}\left[\dfrac{400 + v_M}{1400 - v_M}\right]}$				
$Y_o = v_o / S_{op}$				
$g_u = (g - CY_o) / (1 - Y_o)$				
$f = (875 - 0.625\ v_o) / 1000$				
$P_L = P_{LT}\left[1 + \dfrac{(N - 1)\,g}{f_s g_u + 4.5}\right]$				
$g_q = g - g_u$				
$P_T = 1 - P_L$				
$g_f = 2\ \dfrac{P_T}{P_L}\left[1 - P_T^{\ 0.5\, g_q}\right]$				
$E_L = 1800 / (1400 - v_o)$				
$f_m = \dfrac{g_f}{g} + \dfrac{g_u}{g}\left[\dfrac{1}{1 + P_L(E_L - 1)}\right] + \dfrac{2}{g}(1 + P_L)$				
$f_{LT} = (f_m + N - 1) / N$				

CAPACITY ANALYSIS WORKSHEET

LANE GROUP		③ Adj. Flow Rate v (vph)	④ Adj. Sat. Flow Rate s (vphg)	⑤ Flow Ratio v/s ③ ÷ ④	⑥ Green Ratio g/C	⑦ Lane Group Capacity c (vph) ④ × ⑥	⑧ v/c Ratio X ③ ÷ ⑦	⑨ Critical ? Lane Group
① Appr.	② Lane Group Movements							
EB								
WB								
NB								
SB								

Cycle Length, C ______ sec

Lost Time Per Cycle, L ______ sec

$\Sigma (v/s)_{ci} =$ ______

$$X = \frac{\Sigma (v/s)_{ci} \times C}{C - L} = \text{\_\_\_\_\_\_}$$

LEVEL-OF-SERVICE WORKSHEET

Lane Group		First Term Delay				Second Term Delay				Total Delay & LOS		
① Appr.	② Lane Group Move-ments	③ v/c Ratio X	④ Green Ratio g/C	⑤ Cycle Length C (sec)	⑥ Delay d_1 (sec/veh)	⑦ Lane Group Capacity c (vph)	⑧ Delay d_2 (sec/veh)	⑨ Progression Factor PF Table 9-13	⑩ Lane Group Delay (sec/veh) (⑥+⑧) × ⑨	⑪ Lane Group LOS Table 3.4-1	⑫ Approach Delay (sec/veh)	⑬ Appr. LOS Table 3.4-1
EB												
WB												
NB												
SB												

Intersection Delay ________ sec/veh

Intersection LOS ________ (Table 3.4-1)

Table 3.4-2. ADJUSTMENT FACTOR FOR LANE WIDTH

Lane Width, ft	8	9	10	11	12	13	14	15	≥ 16
Lane Width Factor, f_w	0.87	0.90	0.93	0.97	1.00	1.03	1.07	1.10	Use 2 Lanes

Table 3.4-3 ADJUSTMENT FACTOR FOR HEAVY VEHICLES

Percent Heavy Vehicles, %HV	0	2	4	6	8	10	15	20	25	30
Heavy Vehicle Factor, f_{HV}	1.00	0.99	0.98	0.97	0.96	0.95	0.93	0.91	0.89	0.87

Table 3.4-4 ADJUSTMENT FACTOR FOR GRADE

	DOWNHILL			LEVEL	UPHILL		
Grade, %	−6	−4	−2	0	+2	+4	+6
Grade Factor, f_g	1.03	1.02	1.01	1.00	0.99	0.98	0.97

Table 3.4-5 ADJUSTMENT FACTOR FOR PARKING, f_p

NO. OF LANES IN LANE GROUP	NO PKG	NUMBER OF PARKING MANEUVERS PER HOUR, N_m				
		0	10	20	30	40
1	1.00	0.90	0.85	0.80	0.75	0.70
2	1.00	0.95	0.92	0.89	0.87	0.85
3	1.00	0.97	0.95	0.93	0.91	0.89

Table 3.4-6 ADJUSTMENT FACTOR FOR BUS BLOCKAGE, f_{bb}

NO. OF LANES IN LANE GROUP	NUMBER OF BUSES STOPPING PER HOUR, N_B				
	0	10	20	30	40
1	1.00	0.96	0.92	0.88	0.83
2	1.00	0.98	0.96	0.94	0.92
3	1.00	0.99	0.97	0.96	0.94

Table 3.4-7 ADJUSTMENT FACTOR FOR AREA TYPE

TYPE OF AREA	FACTOR f_a
CBD	0.90
All other areas	1.00

Table 3.4-8 ADJUSTMENT FACTOR FOR RIGHT TURNS

CASE	TYPE OF LANE GROUP	RIGHT-TURN FACTORS, f_{RT}
1	EXCLUSIVE RT LANE; PROTECTED RT PHASING	0.85
2	EXCLUSIVE RT LANE; PERMITTED RT PHASING	$f_{RT} = 0.85 - (\text{peds}/2{,}100)$ peds $\leq$ 1,700 $f_{RT} = 0.05$ peds > 1,700
3	EXCLUSIVE RT LANE; PROTECTED PLUS PERMITTED PHASING	$f_{RT} = 0.85 - (1 - P_{RTA})(\text{peds}/2{,}100)$ $f_{RT} = 0.05$ (minimum)
4	SHARED RT LANE; PROTECTED PHASING	$f_{RT} = 1.0 - 0.15\,P_{RT}$
5	SHARED RT LANE; PERMITTED PHASING	$f_{RT} = 1.0 - P_{RT}\,[0.15 + (\text{peds}/2{,}100)]$ $f_{RT} = 0.05$ (minimum)

Case 2:

No. of Conf. Pedestrians (peds)	0	50 (Low)	100	200 (Mod)	300	400 (High)	500
Factor	0.85	0.83	0.80	0.75	0.71	0.66	0.61

No. of Conf. Pedestrians (peds)	600	800	1,000	1,200	1,400	1,600	≥ 1,700
Factor	0.56	0.47	0.37	0.28	0.18	0.05	0.05

Case 3:

No. of Conf. Pedestrians (peds)	Prop. of RT Using Prot. Phase, P_{RTA}					
	0.00	0.20	0.40	0.60	0.80	1.00
0	0.85	0.85	0.85	0.85	0.85	0.85
50 (Low)	0.83	0.83	0.84	0.84	0.85	0.85
100	0.80	0.81	0.82	0.83	0.84	0.85
200 (Mod)	0.75	0.77	0.79	0.81	0.83	0.85
300	0.71	0.74	0.76	0.79	0.82	0.85
400 (High)	0.66	0.70	0.74	0.77	0.81	0.85
600	0.56	0.62	0.68	0.74	0.79	0.85
800	0.47	0.55	0.62	0.70	0.77	0.85
1,000	0.37	0.47	0.56	0.66	0.75	0.85
1,400	0.18	0.32	0.45	0.58	0.72	0.85
≥ 1,700	0.05	0.20	0.36	0.53	0.69	0.85

Case 4:

Prop. of RT in Lane, P_{RT}	0.00	0.20	0.40	0.60	0.80	1.00
Factor	1.00	0.97	0.94	0.91	0.88	0.85

Case 5:

No. of Conf. Pedestrians (peds)	Prop. of RT in Lane Group, P_{RT}					
	0.00	0.20	0.40	0.60	0.80	1.00
0	1.00	0.97	0.94	0.91	0.88	0.85
50 (Low)	1.00	0.97	0.93	0.90	0.86	0.83
100	1.00	0.96	0.92	0.88	0.84	0.80
200 (Mod)	1.00	0.95	0.90	0.85	0.80	0.75
400 (High)	1.00	0.93	0.86	0.80	0.73	0.66
600	1.00	0.91	0.83	0.74	0.65	0.56
800	1.00	0.89	0.79	0.68	0.58	0.47
1,000	1.00	0.87	0.75	0.62	0.50	0.37
1,400	1.00	0.84	0.67	0.51	0.35	0.18
≥ 1,700	1.00	0.81	0.62	0.42	0.23	0.05

Table 3.4-8. ADJUSTMENT FACTOR FOR RIGHT TURNS
CONTINUED

CASE	TYPE OF LANE GROUP	RIGHT-TURN FACTORS, f_{RT}
6	SHARED RT LANE; PROTECTED PLUS PERMITTED PHASING	$f_{RT} = 1.0 - P_{RT}$ [0.15 + (peds/2,100) (1 − P_{RTA})] f_{RT} = 0.05 (minimum)

Prop. RT's Using Prot. Phase P_{RTA}	No. of Conf. Peds. (peds)	Prop. of RT's in Lane Group P_{RT}: 0.00	0.20	0.40	0.60	0.80	1.00
0.00	All	Same as Case 5					
0.20	0	1.00	0.97	0.94	0.91	0.88	0.85
	50	1.00	0.97	0.93	0.90	0.86	0.83
	200	1.00	0.95	0.91	0.86	0.82	0.77
	400	1.00	0.94	0.88	0.82	0.76	0.70
	600	1.00	0.92	0.85	0.77	0.70	0.62
	1,000	1.00	0.89	0.79	0.68	0.58	0.47
	1,400	1.00	0.86	0.73	0.59	0.45	0.32
	≥ 1,700	1.00	0.81	0.62	0.42	0.23	0.20
0.40	0	1.00	0.97	0.94	0.91	0.88	0.85
	50	1.00	0.97	0.94	0.91	0.87	0.84
	200	1.00	0.96	0.92	0.88	0.83	0.79
	400	1.00	0.95	0.89	0.84	0.79	0.74
	600	1.00	0.94	0.87	0.81	0.74	0.68
	1,000	1.00	0.91	0.83	0.74	0.65	0.56
	1,400	1.00	0.89	0.78	0.67	0.56	0.45
	≥ 1,700	1.00	0.87	0.75	0.62	0.49	0.36
0.60	0	1.00	0.97	0.94	0.91	0.88	0.85
	50	1.00	0.97	0.94	0.90	0.87	0.84
	200	1.00	0.96	0.92	0.89	0.85	0.81
	400	1.00	0.95	0.91	0.86	0.82	0.77
	600	1.00	0.94	0.89	0.84	0.79	0.74
	1,000	1.00	0.93	0.86	0.80	0.73	0.66
	1,400	1.00	0.92	0.83	0.75	0.67	0.58
	≥ 1,700	1.00	0.91	0.81	0.72	0.62	0.53
0.80	0	1.00	0.97	0.94	0.91	0.88	0.85
	50	1.00	0.97	0.94	0.91	0.88	0.85
	200	1.00	0.97	0.93	0.90	0.86	0.83
	400	1.00	0.96	0.92	0.89	0.85	0.81
	600	1.00	0.96	0.92	0.88	0.83	0.79
	1,000	1.00	0.95	0.90	0.85	0.80	0.75
	1,400	1.00	0.94	0.89	0.83	0.77	0.72
	≥ 1,700	1.00	0.94	0.88	0.81	0.75	0.69
1.00	All	Same as Case 4					

CASE	TYPE OF LANE GROUP	RIGHT-TURN FACTORS, f_{RT}
7	SINGLE LANE APPROACH	$f_{RT} = 0.90 - P_{RT}$ [0.135 + (peds/2,100)] f_{RT} = 0.05 (minimum)

No. of Conf. Peds. (peds)	Prop. of RT's in Single Lane P_{RT}: 0.00	0.20	0.40	0.60	0.80	1.00
0	1.00	0.87	0.85	0.82	0.79	0.77
50 (Low)	1.00	0.87	0.84	0.81	0.77	0.74
100	1.00	0.86	0.83	0.79	0.76	0.72
200 (Mod)	1.00	0.86	0.81	0.77	0.72	0.68
300	1.00	0.85	0.79	0.74	0.69	0.64
400 (High)	1.00	0.84	0.78	0.72	0.65	0.59
600	1.00	0.82	0.74	0.66	0.59	0.51
800	1.00	0.80	0.71	0.61	0.52	0.42
1,000	1.00	0.79	0.67	0.56	0.45	0.34
1,200	1.00	0.77	0.64	0.51	0.38	0.25
1,400	1.00	0.75	0.61	0.46	0.31	0.16
≥ 1,700	1.00	0.73	0.55	0.38	0.21	0.05

CASE	TYPE OF LANE GROUP	RIGHT-TURN FACTORS, f_{RT}
8	DOUBLE EXCLUSIVE RT LANE; PROTECTED PHASING	0.75

Table 3.4-9 ADJUSTMENT FACTOR FOR LEFT TURNS

CASE	TYPE OF LANE GROUP	LEFT-TURN FACTOR, f_{LT}						
1	EXCLUSIVE LT LANE; PROTECTED PHASING	0.95						
2	EXCLUSIVE LT LANE; PERMITTED PHASING	Special Procedure; See Worksheet Fig. 9-9						
3	EXCLUSIVE LT LANE; PROTECTED PLUS PERMITTED PHASING	0.95[a]						
4	SHARED LT LANE; PROTECTED PHASING	$f_{LT} = 1.0/(1.0 + 0.05\ P_{LT})$						
		Prop. of LT's in Lane, P_{LT}	0.00	0.20	0.40	0.60	0.80	1.00
		Factor	1.00	0.99	0.98	0.97	0.96	0.95
5	SHARED LT LANE; PERMITTED PHASING	Special Procedure; See Worksheet Fig. 9-9						
6	SHARED LT LANE; PROTECTED PLUS PERMITTED PHASING	$f_{LT} = (1{,}400 - V_o)/[(1{,}400 - V_o) + (235 + 0.435\ V_o)P_{LT}]$ $V_o \leq 1{,}220$ vph; $f_{LT} = 1/[1 + 4.525\ P_{LT}]$ $V_o > 1{,}220$ vph						
		Opposing Volume V_o	Prop. of Left Turns, P_{LT}					
			0.00	0.20	0.40	0.60	0.80	1.00
		0	1.00	0.97	0.94	0.91	0.88	0.86
		200	1.00	0.95	0.90	0.86	0.82	0.78
		400	1.00	0.92	0.85	0.80	0.75	0.70
		600	1.00	0.88	0.79	0.72	0.66	0.61
		800	1.00	0.83	0.71	0.62	0.55	0.49
		1,000	1.00	0.74	0.58	0.48	0.41	0.36
		1,200	1.00	0.55	0.38	0.29	0.24	0.20
		≥ 1,220	1.00	0.52	0.36	0.27	0.22	0.18
7	SINGLE LANE APPROACH	Special Procedures; See Worksheet Fig. 9-9						
8	DOUBLE EXCLUSIVE LT LANE; PROTECTED PHASING	0.92						

[a] This value is a starting estimate. Solutions are iterated for this case.

Table 3.4-10 PROGRESSION ADJUSTMENT FACTOR, PF

TYPE OF SIGNAL	LANE GROUP TYPES	v/c RATIO, X	ARRIVAL TYPE[a]				
			1	2	3	4	5
Pretimed	TH, RT	≤ 0.6	1.85	1.35	1.00	0.72	0.53
		0.8	1.50	1.22	1.00	0.82	0.67
		1.0	1.40	1.18	1.00	0.90	0.82
Actuated	TH, RT	≤ 0.6	1.54	1.08	0.85	0.62	0.40
		0.8	1.25	0.98	0.85	0.71	0.50
		1.0	1.16	0.94	0.85	0.78	0.61
Semiactuated	Main St. TH, RT[b]	≤ 0.6	1.85	1.35	1.00	0.72	0.42
		0.8	1.50	1.22	1.00	0.82	0.53
		1.0	1.40	1.18	1.00	0.90	0.65
Semiactuated	Side St. TH, RT[b]	≤ 0.6	1.48	1.18	1.00	0.86	0.70
		0.8	1.20	1.07	1.00	0.98	0.89
		1.0	1.12	1.04	1.00	1.00	1.00
	All LT[c]	all	1.00	1.00	1.00	1.00	1.00

[a] See Table 3.4-12

[b] Semiactuated signals are typically timed to give all extra green time to the main street. This effect should be taken into account in the allocation of green times.

[c] This category refers to exclusive LT lane groups with protected phasing only. When LT's are included in a lane group encompassing an entire approach, use factor for the overall lane group type. Where heavy LT's are intentionally coordinated, apply factors for the appropriate through movement.

Table 3.4-11 LANE UTILIZATION FACTORS

NO. OF THROUGH LANES IN GROUP (EXCLUDING LANES USED BY LEFT-TURNING VEHICLES)	LANE UTILIZATION FACTOR, U
1	1.00
2	1.05
≥ 3	1.10

Table 3.4-12 RELATIONSHIP BETWEEN ARRIVAL TYPE AND PLATOON RATIO

ARRIVAL TYPE	RANGE OF PLATOON RATIO, R_p
1	0.00 to 0.50
2	0.51 to 0.85
3	0.86 to 1.15
4	1.16 to 1.50
5	≥ 1.51

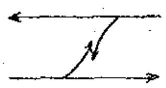
APPENDIX 3-5
STUDY ON LEVEL OF SERVICE ANALYSIS METHOD FOR UNCONTROLLED INTERSECTION

Study On Level of Service Analysis Method For Uncontrolled Intersection:

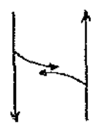
No method for the capacity analysis of uncontrolled intersections is discussed either in Highway Planning Manual of MPWH nor in the Highway Capacity Manual. No better alternative for the estimation is found than the application of the criteria for other facilities. Following three kinds of criteria were subject to comparison.

i) Signalized intersection with the following assumptions:

- Two-phase signal as shown below, where left-turns will be made mainly using gaps in the opposing flow.



first phase



second phase

- Signal split prorated on the basis of the flow ratios in the critical flow of each phase.

- Ideal saturation flow rate which might be lower than that in actually signalized intesection.

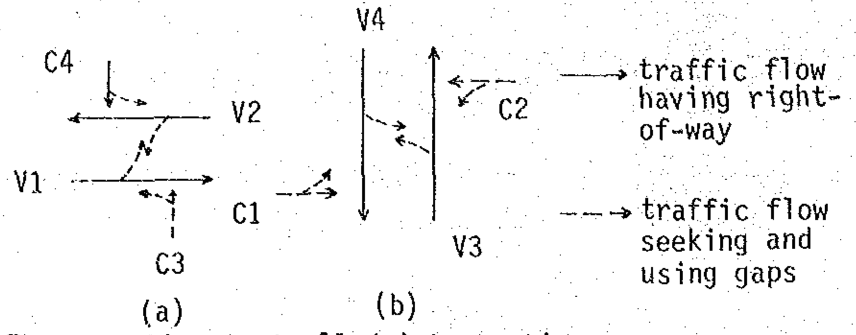
ii) Two-way yield-controlled intersection

The analysis is based on the use of gaps in a major traffic stream by vehicles crossing or turning through that stream and therefore, it requires that the right-of-way be clearly assigned and that the movements seeking gaps remain unchanged. However, the intersections on the Study Road under consideration do not satisfy the condition at all. For better approximation, the capacity is estimated in the following manner:

- Under the condition (a) as shown below, the capacities, C3 and C4 are dependent on the volumes V1 and V2.

Under the condition (b), the capacities, C1 and C2. are dependent on the volumes, V3 and V4.

- The v-values which satisfy the relation of vi-ci (i=1 to 4) under the given demand split are obtained by the iterative calculation and the total of such v-values is regarded as the intersection capacity under the condition that all vehicles seek gaps.



iii) Four-way stop-controlled intersection

The Highway Capacity Manual gives typical capacity values for four-way stop-controlled intersections, under the basic rules of the road wherein the "vehicle on the right" has the right-of-way. Those figures, although not exactly applicable to the intersections on the Study Road because of the vehicle movement not conforming to the above rules, are used as a reference.

Figure 1 shows the intersection capacities estimated by the above three criteria. The values based on the signalized intersection criteria with the assumption of ideal saturation flow rate of 1,600 pcphgpl are very close to those by the criteria for two-way yield-controlled intersections. Both methods are judged to give an enough approximation to evaluate the present conditions. In this study, used are the signalized intersection criteria in which various conditions at an intersection and its vicinity are reflective. In the application, the following modifications/assumptions are made:

- Ideal saturation flow rate is reduced to 1,600 pcphgpl.

- Two-phase signal with signal split prorated on the basis of the flow ratio in the critical flow of each phase is assumed.

- Right-turn traffic is disregarded in the analysis because the field observation shows that right-turn is made mostly using shoulder and this movement is considered to have little effect on intersection capacity。

- The passenger-car equivalent factors are as follows:

Heavy vehicle	:	1.5
Jeepney	:	1.0
Tricycle	:	0.6

The passenger-car equivalent factor for heavy vehicles is based on the Highway Capacity Manual. The movement of jeepney at an intersection is considered to be basically the same as that of ordinary jeep except for stopping, the effect of which is, however, adjusted separately. This is the reason of its equivalent factor of 1.0. As for tyricycle which shows the flexible movement at an intersection, a special discussion was made. Figure 2 shows the change of volume/capacity ratio against the change of passenger-car equivalent factor. Based on the same idea made for two-lane highways, the factor of 0.6 was selected for this Study。

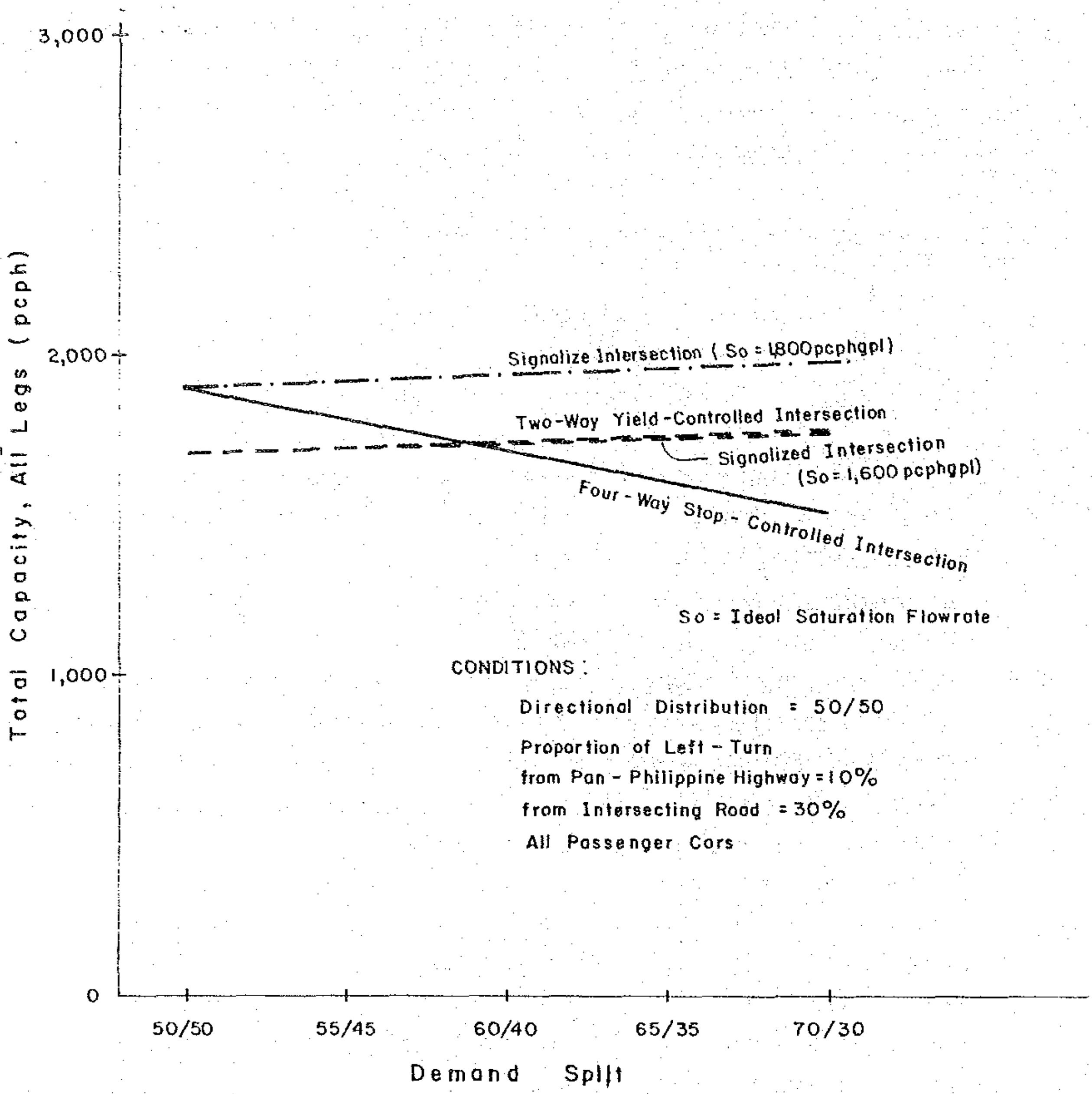


Figure 1 Intersection Capacities by Various Analysis Methods

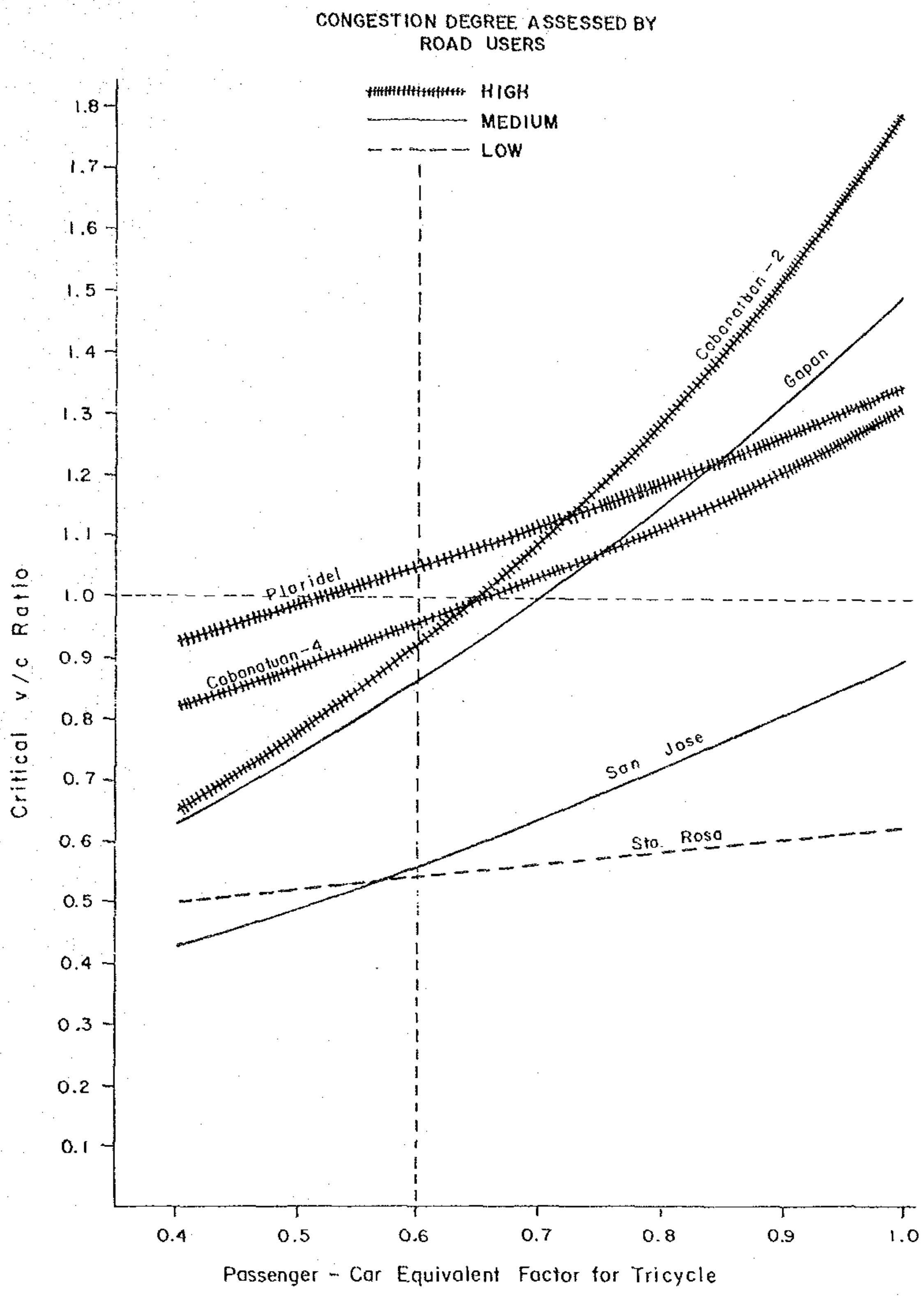


Figure 2 Critical v/c Ratio by the Change of Passenger-Car Equivalent Factor for Tricycle (Intersection)

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