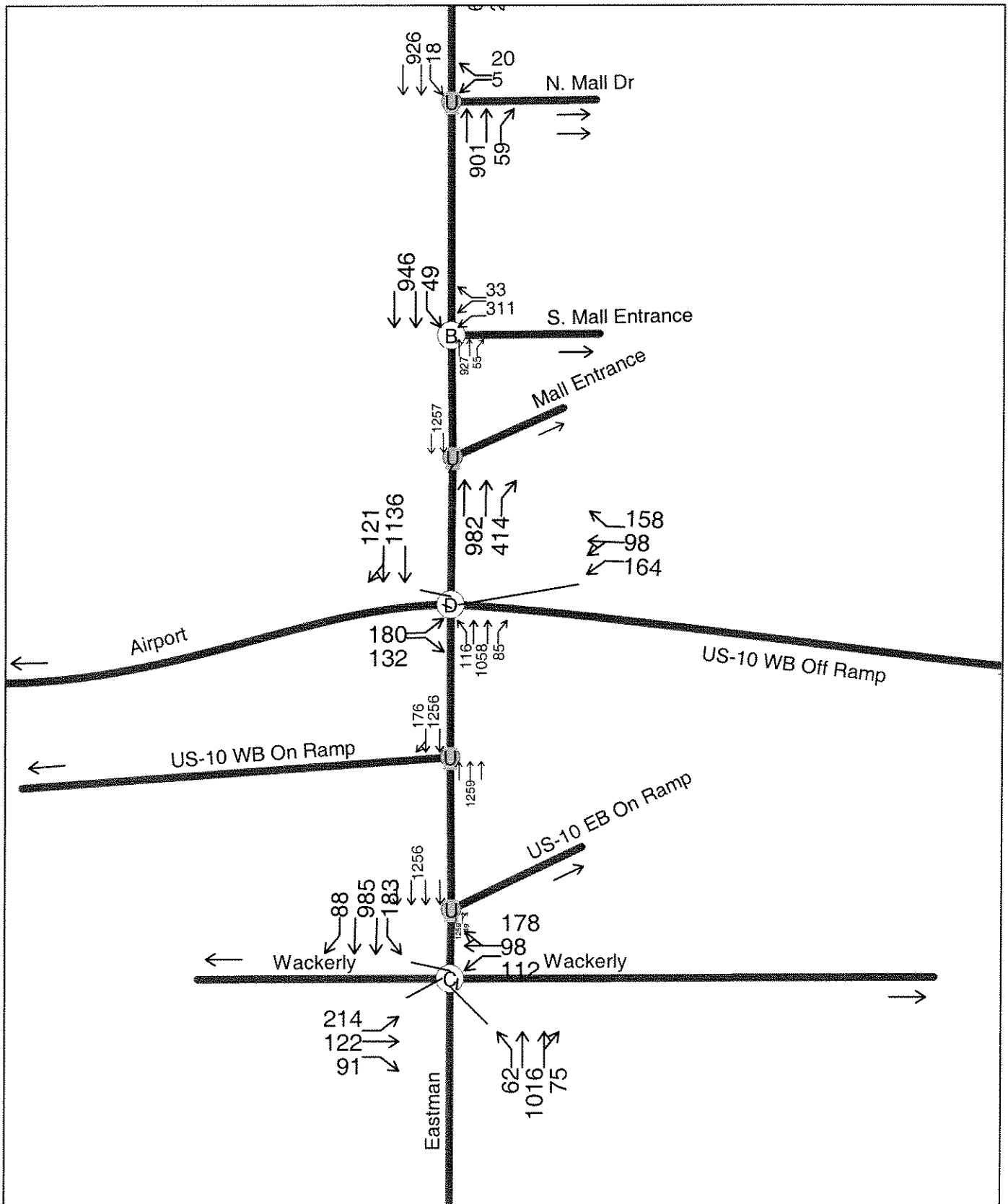




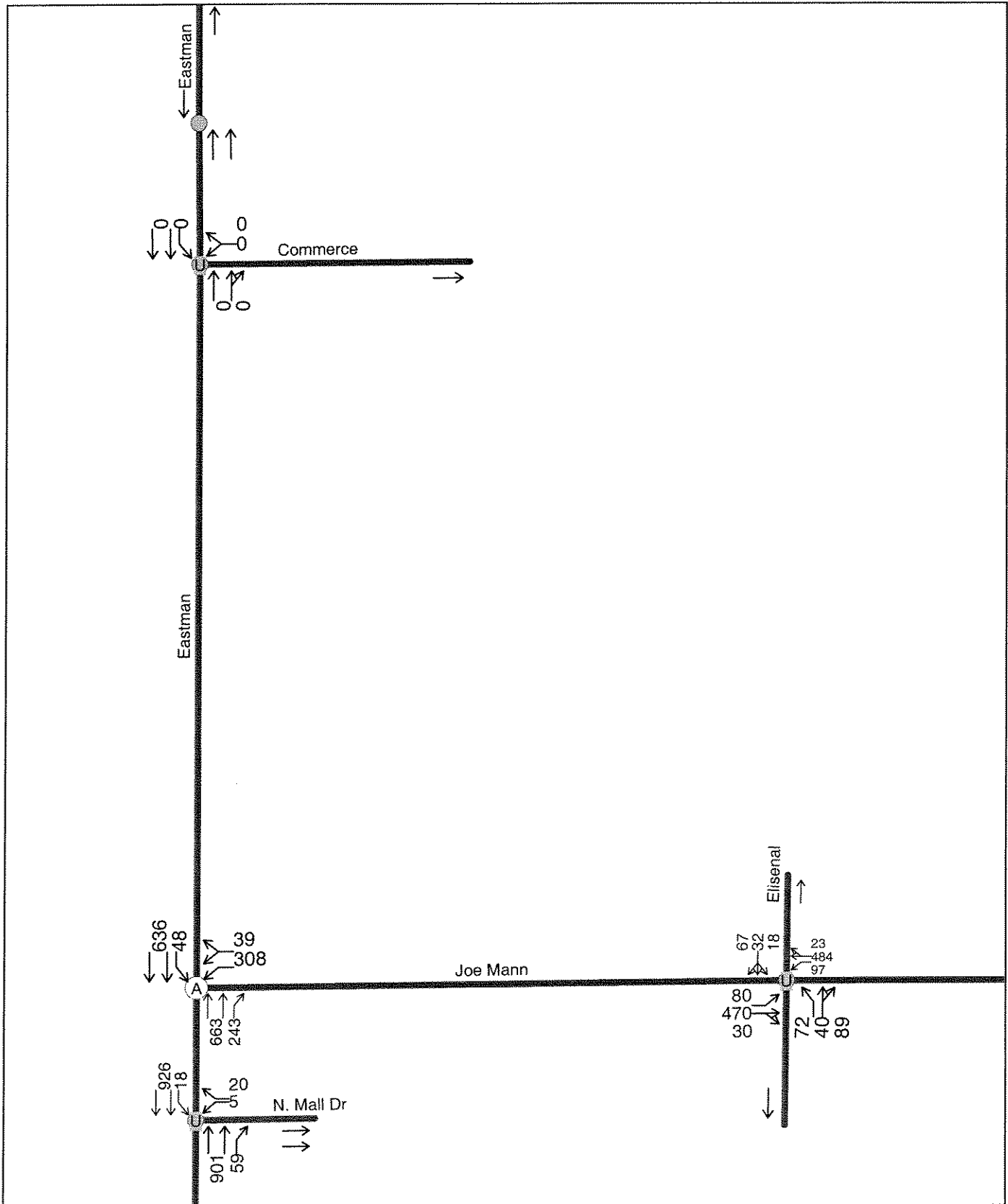
APPENDIX C
SYNCHRO AND HCS OUTPUTS

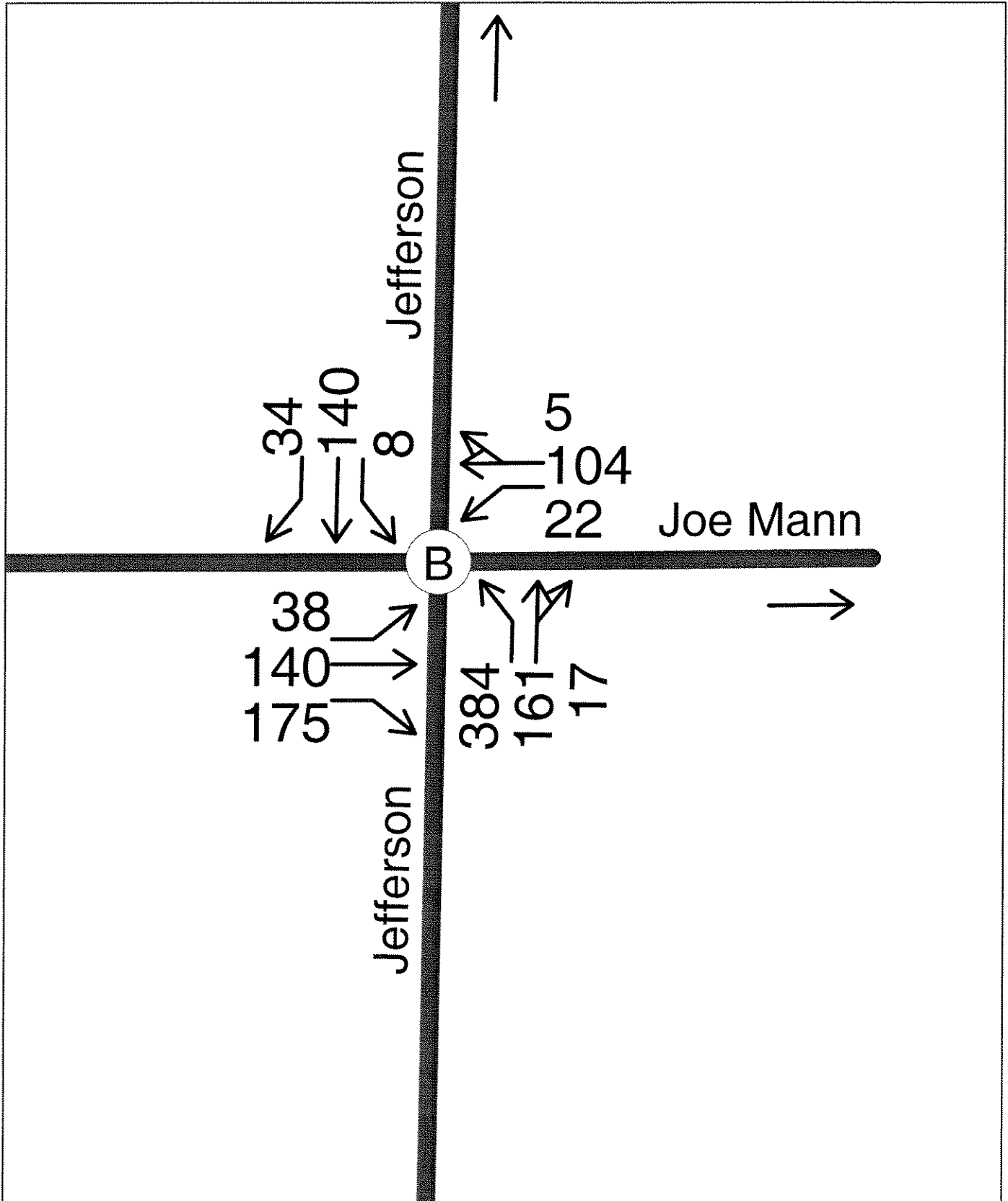


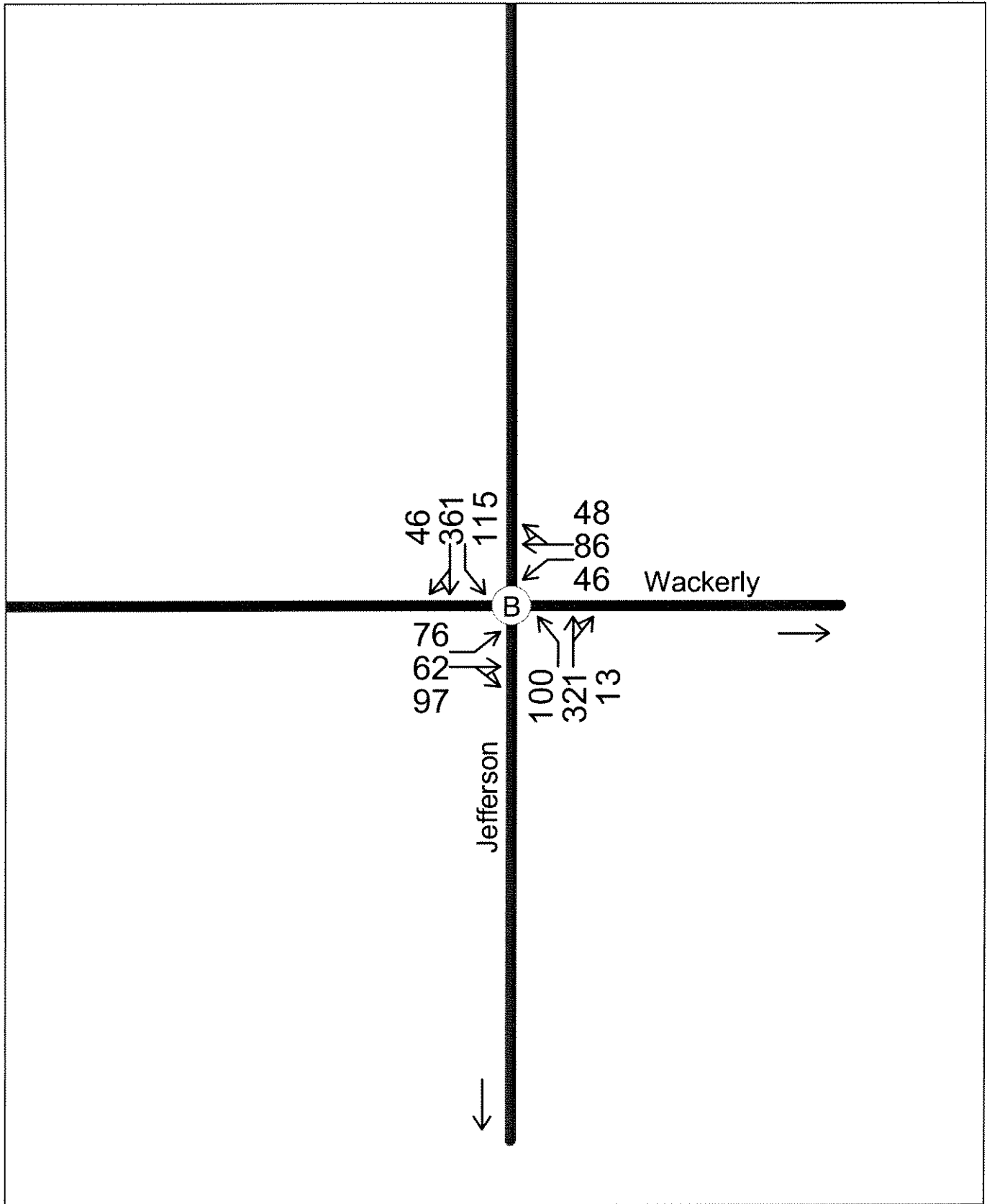
2003 Noon



M:\PROJ\0541\5965\00\Traffic\Synco\EX2003-Noon.sy7









Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations										
Volume (vph)	214	122	91	112	98	62	1016	183	985	88
Turn Type	pm+pt		Perm	pm+pt		pm+pt		pm+pt		pm+ov
Protected Phases	7	4		3	8	5	2	1	6	7
Permitted Phases	4		4	8		2		6		6
Detector Phases	7	4	4	3	8	5	2	1	6	7
Minimum Initial (s)	5.0	10.0	10.0	5.0	10.0	5.0	10.0	5.0	10.0	5.0
Minimum Split (s)	11.1	22.1	22.1	11.1	22.1	11.3	22.3	11.3	22.3	11.1
Total Split (s)	13.0	31.0	31.0	13.0	31.0	13.0	43.0	13.0	43.0	13.0
Total Split (%)	13.0%	31.0%	31.0%	13.0%	31.0%	13.0%	43.0%	13.0%	43.0%	13.0%
Yellow Time (s)	3.6	3.6	3.6	3.6	3.6	4.3	4.3	4.3	4.3	3.6
All-Red Time (s)	2.5	2.5	2.5	2.5	2.5	2.0	2.0	2.0	2.0	2.5
Lead/Lag	Lead	Lag	Lag	Lead	Lag	Lead	Lag	Lead	Lag	Lead
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Recall Mode	None	Max	Max	None	Max	None	C-Max	None	C-Max	None
Act Effct Green (s)	36.0	27.0	27.0	36.0	27.0	47.8	39.0	48.8	41.6	54.6
Actuated g/C Ratio	0.36	0.27	0.27	0.36	0.27	0.48	0.39	0.49	0.42	0.55
v/c Ratio	0.70	0.26	0.20	0.26	0.58	0.29	0.95	0.84	0.73	0.11
Control Delay	34.4	30.4	7.0	21.1	26.9	15.4	47.1	40.8	26.4	1.4
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	34.4	30.4	7.0	21.1	26.9	15.4	47.1	40.8	26.4	1.4
LOS	C	C	A	C	C	B	D	D	C	A
Approach Delay		27.4			25.2		45.4		26.8	
Approach LOS		C			C		D		C	

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 24 (24%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 0.95
 Intersection Signal Delay: 33.3
 Intersection Capacity Utilization 81.9%
 Analysis Period (min) 15
 Intersection LOS: C
 ICU Level of Service D

Splits and Phases: 3: Wackerly & Eastman

ø1	ø2	ø3	ø4
13 s	43 s	13 s	31 s
ø5	ø6	ø7	ø8
13 s	43 s	13 s	31 s



Lane Group	EBL	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBT
Lane Configurations									
Volume (vph)	180	132	164	98	158	116	1058	85	1136
Turn Type	Prot	custom	Split		Prot	pm+pt		Free	
Protected Phases	3	3	4	4	4	1	1 2		2
Permitted Phases		1				1 2		Free	
Detector Phases	3	3	4	4	4	1	1 2		2
Minimum Initial (s)	5.0	5.0	5.0	5.0	5.0	5.0			10.0
Minimum Split (s)	11.0	11.0	17.0	17.0	17.0	11.3			35.3
Total Split (s)	21.0	21.0	18.0	18.0	18.0	13.0	61.0	0.0	48.0
Total Split (%)	21.0%	21.0%	18.0%	18.0%	18.0%	13.0%	61.0%	0.0%	48.0%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	4.3			4.3
All-Red Time (s)	2.5	2.5	2.5	2.5	2.5	2.0			2.0
Lead/Lag	Lead	Lead	Lag	Lag	Lag	Lead			Lag
Lead-Lag Optimize?	Yes	Yes	Yes	Yes	Yes	Yes			Yes
Recall Mode	None	None	None	None	None	None			C-Max
Act Effct Green (s)	15.8	26.9	13.1	13.1	13.1	55.1	59.1	100.0	44.0
Actuated g/C Ratio	0.16	0.27	0.13	0.13	0.13	0.55	0.59	1.00	0.44
v/c Ratio	0.70	0.30	0.63	0.63	0.56	0.46	0.55	0.06	1.14
Control Delay	50.6	11.3	51.9	51.7	21.9	25.3	20.1	0.0	97.3
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	50.6	11.3	51.9	51.7	21.9	25.3	20.1	0.0	97.3
LOS	D	B	D	D	C	C	C	A	F
Approach Delay				40.5			19.2		97.3
Approach LOS				D			B		F

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 18 (18%), Referenced to phase 2:NBSB, Start of Green
 Natural Cycle: 90
 Control Type: Actuated-Coordinated
 Maximum v/c Ratio: 1.14
 Intersection Signal Delay: 53.6
 Intersection Capacity Utilization 68.3%
 Analysis Period (min) 15
 Intersection LOS: D
 ICU Level of Service C

Splits and Phases: 8: Airport & Eastman

ø1	ø2	ø3	ø4		
13 s	48 s	21 s	18 s		



Lane Group	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	311	33	927	55	49	946
Turn Type	custom		Perm Perm			
Protected Phases	4	4	2			6
Permitted Phases		4		2	6	
Detector Phases	4	4	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	23.0	23.0	22.1	22.1	22.1	22.1
Total Split (s)	31.4	31.4	68.6	68.6	68.6	68.6
Total Split (%)	31.4%	31.4%	68.6%	68.6%	68.6%	68.6%
Yellow Time (s)	3.5	3.5	4.3	4.3	4.3	4.3
All-Red Time (s)	2.5	2.5	1.8	1.8	1.8	1.8
Lead/Lag	Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	Max	Max	Max
Act Effect Green (s)	27.4	27.4	64.6	64.6	64.6	64.6
Actuated g/C Ratio	0.27	0.27	0.65	0.65	0.65	0.65
v/c Ratio	0.36	0.08	0.44	0.06	0.19	0.45
Control Delay	30.6	9.6	8.3	1.4	7.3	7.9
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	30.6	9.6	8.3	1.4	7.3	7.9
LOS	C	A	A	A	A	A
Approach Delay	28.5		8.0			7.9
Approach LOS	C		A			A

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 33 (33%), Referenced to phase 2:NBT, Start of Green
 Natural Cycle: 50
 Control Type: Pretimed
 Maximum v/c Ratio: 0.45
 Intersection Signal Delay: 11.0
 Intersection Capacity Utilization 47.8%
 Analysis Period (min) 15
 Intersection LOS: B
 ICU Level of Service A

Splits and Phases: 13: S. Mall Entrance & Eastman

2	4
68.6 s	31.4 s
6	
68.6 s	



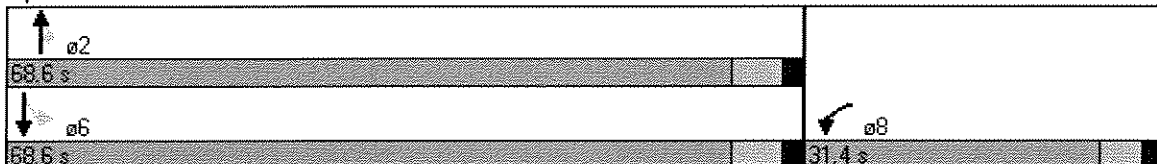
Lane Group	WBL	NBT	NBR	SBL	SBT
Lane Configurations	↔↔↔	↑↑	↗	↘	↑↑
Volume (vph)	308	663	243	48	636
Turn Type			Perm	Perm	
Protected Phases	8	2			6
Permitted Phases			2	6	
Detector Phases	8	2	2	6	6
Minimum Initial (s)	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	22.0	22.2	22.2	22.2	22.2
Total Split (s)	31.4	68.6	68.6	68.6	68.6
Total Split (%)	31.4%	68.6%	68.6%	68.6%	68.6%
Yellow Time (s)	3.5	4.3	4.3	4.3	4.3
All-Red Time (s)	2.5	1.9	1.9	1.9	1.9
Lead/Lag					
Lead-Lag Optimize?					
Recall Mode	Max	Max	Max	Max	Max
Act Effect Green (s)	27.4	64.6	64.6	64.6	64.6
Actuated g/C Ratio	0.27	0.65	0.65	0.65	0.65
v/c Ratio	0.40	0.32	0.24	0.12	0.30
Control Delay	30.0	4.6	0.6	7.8	8.2
Queue Delay	0.0	0.0	0.0	0.0	0.0
Total Delay	30.0	4.6	0.6	7.8	8.2
LOS	C	A	A	A	A
Approach Delay	30.0	3.5			8.2
Approach LOS	C	A			A

Intersection Summary

Cycle Length: 100
 Actuated Cycle Length: 100
 Offset: 37 (37%), Referenced to phase 2:NBT and 6:SBTL, Start of Green
 Natural Cycle: 45
 Control Type: Pretimed
 Maximum v/c Ratio: 0.40
 Intersection Signal Delay: 9.9
 Intersection Capacity Utilization 41.7%
 Analysis Period (min) 15

Intersection LOS: A
 ICU Level of Service A

Splits and Phases: 16: Joe Mann & Eastman





Lane Group	EBL	EBT	EBR	WBL	WBT	NBL	NBT	SBL	SBT	SBR
Lane Configurations	↖	↑	↗	↖	↑	↖	↑	↖	↑	↗
Volume (vph)	38	140	175	22	104	384	161	8	140	34
Turn Type	Perm		Perm	Perm		Perm		Perm		Perm
Protected Phases		4			8		2		6	
Permitted Phases	4		4	8		2		6		6
Detector Phases	4	4	4	8	8	2	2	6	6	6
Minimum Initial (s)	3.0	3.0	3.0	3.0	3.0	4.0	4.0	4.0	4.0	4.0
Minimum Split (s)	20.7	20.7	20.7	20.7	20.7	21.3	21.3	21.3	21.3	21.3
Total Split (s)	20.7	20.7	20.7	20.7	20.7	39.3	39.3	39.3	39.3	39.3
Total Split (%)	34.5%	34.5%	34.5%	34.5%	34.5%	65.5%	65.5%	65.5%	65.5%	65.5%
Yellow Time (s)	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6
All-Red Time (s)	0.7	0.7	0.7	0.7	0.7	1.7	1.7	1.7	1.7	1.7
Lead/Lag										
Lead-Lag Optimize?										
Recall Mode	Max	Max	Max	Max	Max	Max	Max	Max	Max	Max
Act Effct Green (s)	16.7	16.7	16.7	16.7	16.7	35.3	35.3	35.3	35.3	35.3
Actuated g/C Ratio	0.28	0.28	0.28	0.28	0.28	0.59	0.59	0.59	0.59	0.59
v/c Ratio	0.12	0.29	0.33	0.07	0.23	0.58	0.18	0.01	0.14	0.04
Control Delay	17.3	18.9	5.0	16.7	17.6	11.7	5.7	5.2	6.0	2.2
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Delay	17.3	18.9	5.0	16.7	17.6	11.7	5.7	5.2	6.0	2.2
LOS	B	B	A	B	B	B	A	A	A	A
Approach Delay		11.8			17.4		9.8		5.2	
Approach LOS		B			B		A		A	

Intersection Summary

Cycle Length: 60
 Actuated Cycle Length: 60
 Offset: 5 (8%), Referenced to phase 2:NBTL and 6:SBTL, Start of Green
 Natural Cycle: 55
 Control Type: Pretimed
 Maximum v/c Ratio: 0.58
 Intersection Signal Delay: 10.5
 Intersection Capacity Utilization 52.7%
 Analysis Period (min) 15
 Intersection LOS: B
 ICU Level of Service A

Splits and Phases: 18: Joe Mann & Jefferson

↑ φ2 39.3 s	→ φ4 20.7 s
↓ φ6 39.3 s	← φ8 20.7 s

Noon - 2003

HCS2000: Two-Lane Highways Release 4.1c

DLZ

Phone: Fax:
E-Mail:

Directional Two-Lane Highway Segment Analysis

Analyst AIngle
Agency/Co. DLZ
Date Performed 10/06/05
Analysis Time Period Noon Peak
Highway Joe Mann
From/To Eastman / Jefferson
Jurisdiction City of Midland
Analysis Year 2003
Description

Input Data

Highway class	Class 1	Peak-hour factor, PHF	0.92
Shoulder width	2.0 ft	% Trucks and buses	2 %
Lane width	12.0 ft	% Trucks crawling	0.0 %
Segment length	1.0 mi	Truck crawl speed	0.0 mi/hr
Terrain type	Level	% Recreational vehicles	0 %
Grade: Length	mi	% No-passing zones	100 %
Up/down	%	Access points/mi	10 /mi

Analysis direction volume, Vd 604 veh/h
Opposing direction volume, Vo 580 veh/h

Average Travel Speed

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1	1.1
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adj. factor, (note-5) fHV	0.998	0.998
Grade adj. factor, (note-1) fG	1.00	1.00
Directional flow rate, (note-2) vi	658 pc/h	632 pc/h

$V_p = 658 + 632 = 1290 \text{ pc/h}$

Free-Flow Speed from Field Measurement:

Field measured speed, (note-3) S FM - mi/h
Observed volume, (note-3) Vf - veh/h
Estimated Free-Flow Speed:
Base free-flow speed, (note-3) BFFS ~~45.0~~ mi/h
Adj. for lane and shoulder width, (note-3) fLS 2.6 mi/h
Adj. for access points, (note-3) fA 2.5 mi/h

$= \text{speed limit} + 7 \text{ mph} = 30 + 7 = 37 \text{ mph}$

Free-flow speed, FFSd

$30.9 \text{ mi/h} = 37 - 2.6 - 2.5 = 31.9 \text{ mph}$

Adjustment for no-passing zones, fnp
Average travel speed, ATSD

$28.2 \text{ mi/h} = \text{FFS} - 0.00776 (V_p) - f_{np} = 31.9 - 0.00776 (1290) - 1.7$

Percent Time-Spent-Following

Direction	Analysis(d)	Opposing (o)
PCE for trucks, ET	1.1*	1.1*
PCE for RVs, ER	1.0	1.0
Heavy-vehicle adjustment factor, fHV	0.998	0.998
Grade adjustment factor, (note-1) fG	1.00	1.00
Directional flow rate, (note-2) vi	658 pc/h	632 pc/h
Base percent time-spent-following, (note-4) BPTSFd	78.2 %	

$L_p = 20.2 \text{ mph}$

NOON - 2003

Adjustment for no-passing zones, fnp 16.5
 Percent time-spent-following, PTSFd 94.8 %

Level of Service and Other Performance Measures

Level of service, LOS E ✓
 Volume to capacity ratio, v/c 0.39
 Peak 15-min vehicle-miles of travel, VMT15 164 veh-mi
 Peak-hour vehicle-miles of travel, VMT60 604 veh-mi
 Peak 15-min total travel time, TT15 5.8 veh-h

Checked from Exhibit 20-3
 in HCM 2000,

Notes:

1. If the highway is extended segment (level) or rolling terrain, fG = 1.0
2. If v_i (vd or vo) \geq 1,700 pc/h, terminate analysis-the LOS is F.
3. For the analysis direction only.
4. Exhibit 20-21 provides factors a and b.
5. Use alternative Equation 20-14 if some trucks operate at crawl speeds on a specific downgrade.

Passing Lane Analysis

Total length of analysis segment, Lt 1.0 mi
 Length of two-lane highway upstream of the passing lane, Lu mi
 Length of passing lane including tapers, Lpl mi
 Average travel speed, ATSD (from above) 28.2 mi/h
 Percent time-spent-following, PTSFd (from above) 94.8
 Level of service, (note-1) LOSd (from above) E

Average Travel Speed

Downstream length of two-lane highway within effective length of passing lane for average travel speed, Lde 1.70 mi
 Length of two-lane highway downstream of effective length of the passing lane for average travel speed, Ld mi
 Adj. factor for the effect of passing lane on average speed, fpl 1.11
 Average travel speed including passing lane, (note-2) ATSpI

Percent Time-Spent-Following

Downstream length of two-lane highway within effective length of passing lane for percent time-spent-following, Lde 6.04 mi
 Length of two-lane highway downstream of effective length of the passing lane for percent time-spent-following, Ld mi
 Adj. factor for the effect of passing lane on percent time-spent-following, fpl 0.62
 Percent time-spent-following including passing lane, (note-3) PTSFpl %

Level of Service and Other Performance Measures (note-4)

Level of service including passing lane, LOSpl
 Peak 15-min total travel time, TT15 veh-h

Notes:

1. If LOSd = F, passing lane analysis cannot be performed.
2. If $L_d < 0$, use alternative Equation 20-22.
3. If $L_d < 0$, use alternative Equation 20-20.
4. v/c, VMT15, and VMT60 are calculated on Directional Two-Lane Highway Segment Worksheet.