Formerly Appendix P- Critical Movement Summation (CMS) How-To Guide

P.1 BACKGROUND

The critical movement summation (CMS) method focuses on "raw" intersection capacity, that is, the ability for an intersection to process a given traffic demand with a given lane use configuration and given phase sequence.

Traffic signal phasing is one component of the analysis, but it is important to note that most of the subtleties of traffic signal phasing and operation are not included in the analysis.

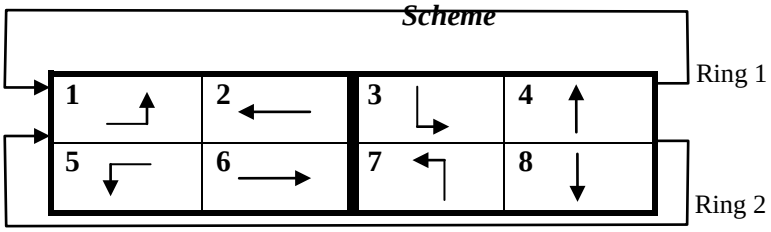
The analyst can use this simple hands-on approach to get right to the point of an intersection's ability to handle traffic demands. CMS looks at each of the "critical" movements at an intersection. It is a volume-based measure.

P.2 PROCESS

Step 1. Gather CMS Inputs

- Hourly Volumes – Use vehicles per hour. If analyzing the peak hour, use the largest sum of 4 consecutive 15-minute periods for that intersection, e.g. 7:45 – 8:45 AM.
- Lane Use Configurations – Determined through observation of existing geometry and operations.
- Signal Phasing – Use National Electrical Manufacturers Association (NEMA) standard 8-phase operation with adjustments as needed. The top line of phasing on the CMS worksheet is intended to show existing phasing. The adjacent line below is workspace intended for conceptual improvements to phasing. See Figure P.1 for a typical NEMA phase numbering schemes.

Figure P-1 Typical Phase numbering Scheme



Step 2. Fill in CMS Worksheet

For each row, fill in the columns:

- Movement (describe in words, e.g. NB through, SB through, EB left, etc.)
- Phase (indicate movement number)
- Volume (in the case of a shared lane, write each volume long-hand, and then sum, e.g. 100 + 150 + 25)
- LU (Lane Use factor, see table at bottom of worksheet.)
- Lane Volume (multiply the Volume by the Lane Use Factor.)
- OL (Opposing Lefts, to be added. See description of Permissive Only Lefts below.)

- LTC (Left Turn Credit, to be subtracted. See description of Concurrent Lefts or Lead/Lead-Lag Left below.)
- Critical Lane Volume (apply OL or LTC to the Lane Volume to get this Critical Lane Volume.)

Step 3. Determine Critical Movements

In the CM column, note the highest of each movement pair (e.g. highest of NB/SB through, highest of NB left/SB left, etc.) with an asterisk*. There should be an asterisk (*) corresponding to each block in the top line of phasing on the CMS worksheet.

Step 4. Sum the Critical Movements

Fill in the "Total" by adding the movements that have asterisks*. Assign a Level of Service (LOS) by using the Level of Service table at the bottom of the CMS worksheet.

P.3 RULES FOR TURNING MOVEMENTS

P.3.1 RIGHT TURNS

If right-turn is "hot" or "free" (i.e. has a dedicated, channelized deceleration and acceleration lanes) and is not signal controlled, leave out of computation.

If right-turn has a dedicated lane and is signal controlled with right-turn-on-red permitted, assume 50% of right-turn volume.

If right-turn has a dedicated lane and is signal controlled with "No right turn on red," assume 100% of right-turn volume.

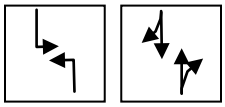
If right-turn has a dedicated lane and is signal controlled for rights to move concurrently with lefts (e.g. NB rights move with WB lefts), reduce the right-turn volume in the amount of the left-turn volume.

If there is a shared through/right lane, add through and right volumes.

P.3.2 LEFT TURNS

Left turns are to be treated as either protected (signalized left-turn arrow) or permissive (no left-turn arrow). If existing condition allows a left-turn movement to be both protected and permissive, analyze as protected (only) in CMS.

P.3.2.1 Concurrent Lefts

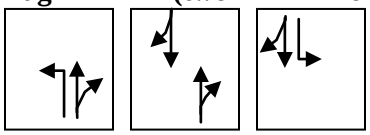


Account for Left Turn Credit (LTC) as follows:

- Calculate lane volumes for left-turn moves
- Apply lane-use factor
- Calculate difference of lefts (e.g. NB/SB lefts or EB/WB lefts)
- Subtract this difference from the through movement that's in the same direction as the greater left-turn volume.

CMS may over or underestimate the impact of left turn traffic on shared left-through-right lane in situations where through opposing volume is high. Additional Analysis (such as the methods of the *Highway Capacity Manual)* may be warranted.

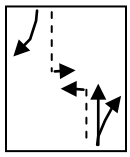
P.3.2.2 Lead Left (one direction), or Lead-Lag (two directions)



Account for Left Turn Credit (LTC) as follows:

- Identify left-turn volume associated with the lead (or lag) phase.
- Apply lane-use factor.
- Subtract that left-turn volume from the through movement on the same approach.

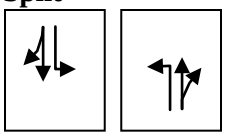
P.3.2.3 Permissive Only Lefts (no left-turn arrow)



Account for Opposing Lefts (OL) as follows:

- Identify left-turn volume that will be awaiting gaps in the through volume. (These lefts are considered "opposing lefts" – opposing the through volume being analyzed.)
- Add that left-turn volume to the opposing through movement.
- The left turns cannot move until the opposing through movement is complete. So you must consider the total of these two movements, since they cannot move simultaneously.

P.3.2.4 Split Phasing



- Left-turn credit (LTC) does not apply.
- Opposing lefts (OL) do not apply.

P.4 SIGNAL TIMING

CMS can be used as a prerequisite to signal timings. The following steps follow CMS to determine cycle length and required green and clearance (yellow and all red) time:

Step 1. Transfer phasing and Critical Lane Volume (CLV) Inputs from CMS worksheet onto the Traffic Signal Timing Worksheet (see Figure P-2)

Step 2. Determine number of vehicles per cycle per phase. The table included in the Traffic Signal Timing Worksheet can be used to determine the number of cycles in an hour (or simply divide 3600 seconds by the cycle length).

Step 3. Determine green time required from Greenshield's model (see Figure P-3)

Step 4. Determine clearance and pedestrian timings.

Step 5. Determine total time required and compare to cycle length.

P.5 CMS SAMPLE EXERCISE PROBLEMS

See Figures P-5 through P-14 for CMS sample exercise problems.

P.6 SIGNAL TIMING SAMPLE EXERCISE PROBLEM

See Figure P-16 for a sample signal timing exercise problem.

Figure P-2 Traffic Signal Timing Worksheet

Location: _____ Date: _____

Cycle Length: _____ Cycles per Hour: _____ Prepared by: _____

Time of Day: _____

Phases	Movement	Critical lane Volume (CLV)	Vehicles per Cycle	Green Time Required (see Greenshield Figure P-3)	Clearance (Red + Yellow)	Walk + Don't Walk

Total Green			
Total Clearance			
Total Time Required			

Cycle Length	Cycles per Hour
45	80
60	60
75	48
90	40
100	36
120	30
150	24
180	20
210	17
240	15

Figure P-3 Traffic Signal Green Time Requirements (Greenshield's Model)

Vehicles per Cycle per lane	Seconds per Vehicle	Cumulative seconds	Vehicles per Cycle per lane	Seconds per Vehicle	Cumulative seconds
1	3.8	3.8	24	2.1	54.1
2	3.1	6.9	25	2.1	56.2
3	2.7	9.6	26	2.1	58.3
4	2.4	12.0	27	2.1	60.4
5	2.2	14.2	28	2.1	62.5
6	2.1	16.3	29	2.1	64.6
7	2.1	18.4	30	2.1	66.7
8	2.1	20.5	31	2.1	68.8
9	2.1	22.6	32	2.1	70.9
10	2.1	24.7	33	2.1	73.0
11	2.1	26.8	34	2.1	75.1
12	2.1	28.9	35	2.1	77.2
13	2.1	31.0	36	2.1	79.3
14	2.1	33.1	37	2.1	81.4
15	2.1	35.2	38	2.1	83.5
16	2.1	37.3	39	2.1	85.6
17	2.1	39.4	40	2.1	87.7
18	2.1	41.5	41	2.1	89.8
19	2.1	43.6	42	2.1	91.9
20	2.1	45.7	43	2.1	94.0
21	2.1	47.8	44	2.1	96.1
22	2.1	49.9	45	2.1	98.2
23	2.1	52.0	46	2.1	100.3

Figure P-4 CMS Blank Sheet

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CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

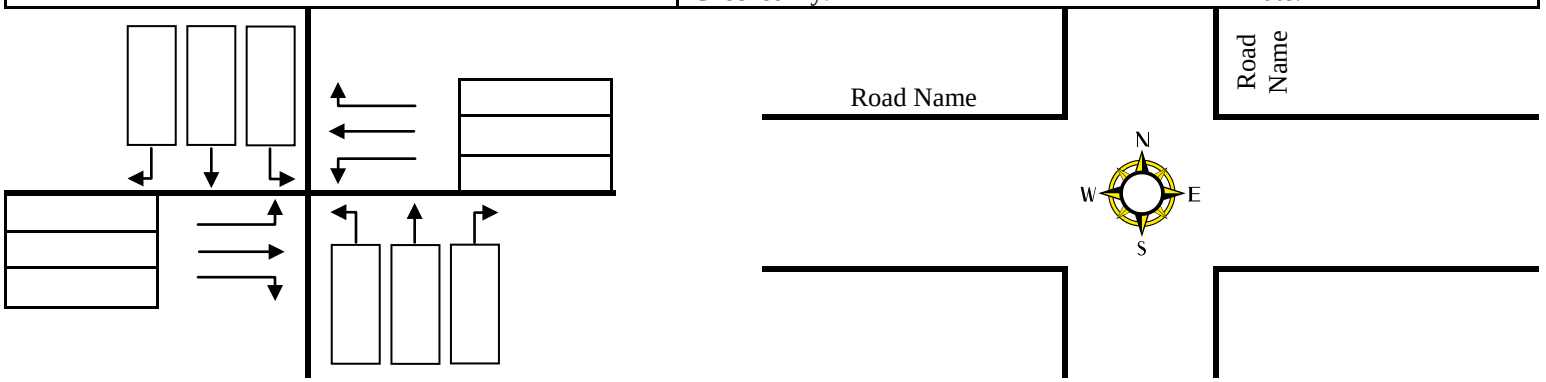
Location: _____

Count Date: _____

Scenario: _____

Computed By: _____ Date: _____

Checked By: _____ Date: _____



Signal Phasing (Φ)

Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)

Remarks:

TOTAL:

LEVEL OF SERVICE:

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-5 CMS Example 1 – Permissive Lefts – Shared Lefts

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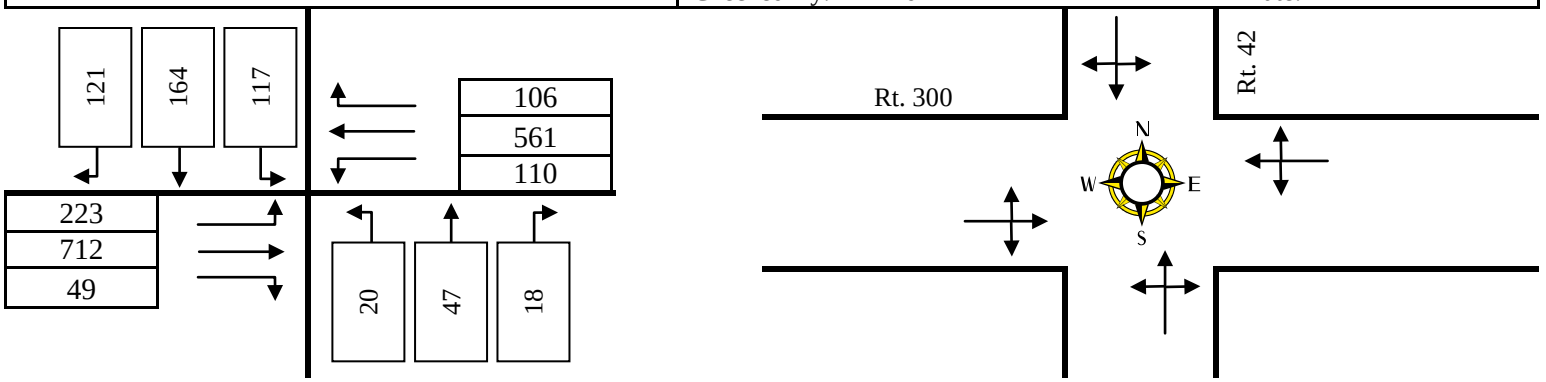
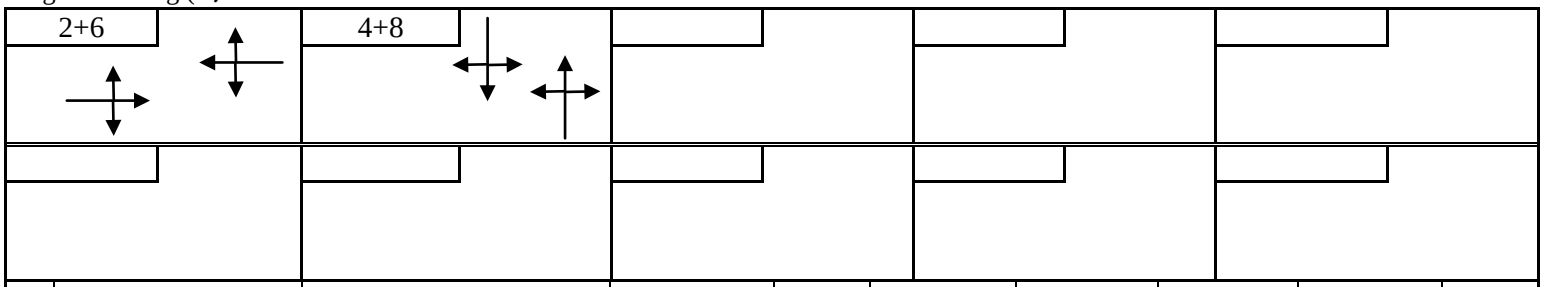
CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42		
Count Date:	12/25/2005		
Scenario:	Existing – Permissive Lefts – Shared lefts		
Computed By:	ABC	Date:	01/01/06
Checked By:	JHI	Date:	01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
2	Rt. 300 EB.	223+712+49	984	1.00	984	110		1094	*
6	Rt. 300 WB.	110+561+106	777	1.00	777	223		1000	
4	Rt. 42 SB.	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB.	20+47+18	85	1.00	85	117		202	

Remarks:

TOTAL:	1516
LEVEL OF SERVICE:	E

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-6 CMS Example 2 – Split E-W Phasing – Shared Lefts

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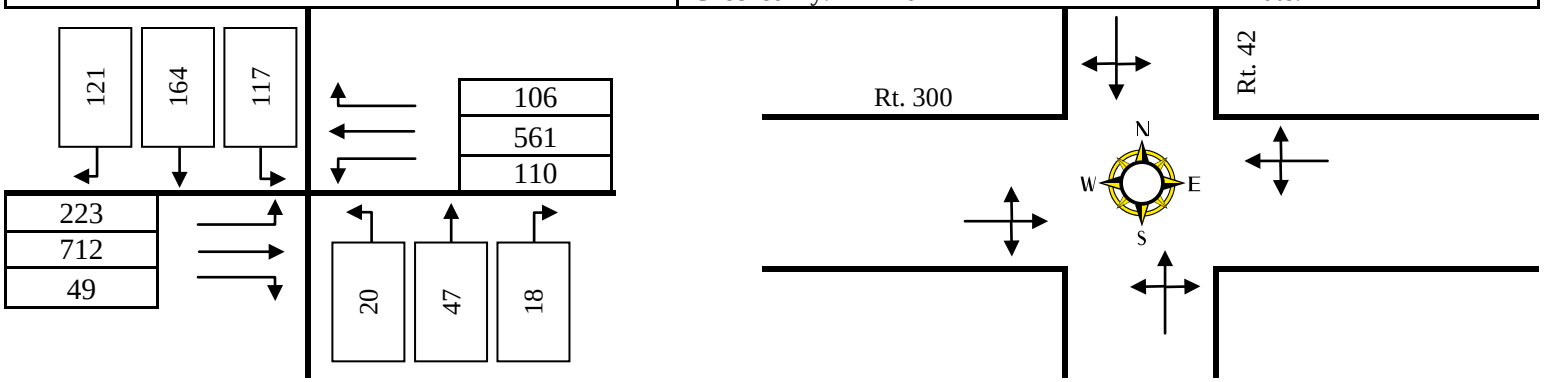
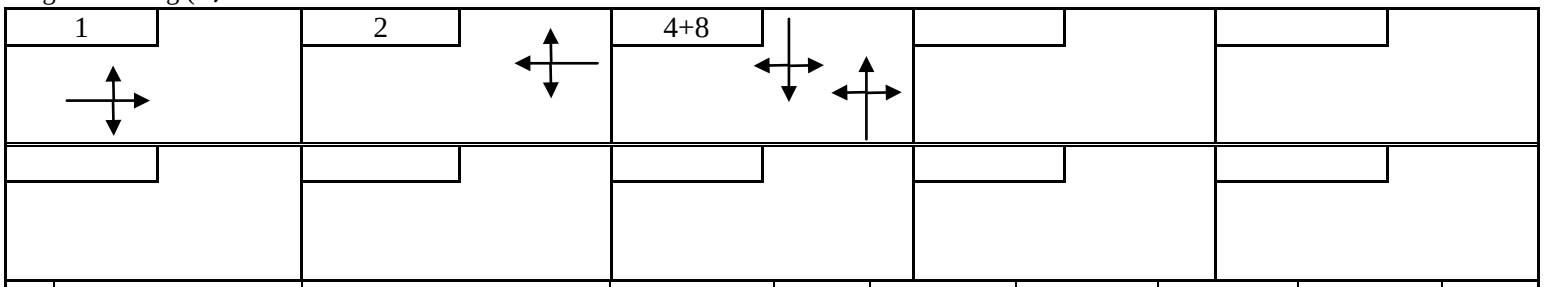
CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42		
Count Date:	12/25/2005		
Scenario:	Existing – Split E-W Phasing – Shared lefts		
Computed By:	ABC	Date:	01/01/06
Checked By:	JHI	Date:	01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	Rt. 300 EB.	223+712+49	984	1.00	984			984	*
2	Rt. 300 WB.	110+561+106	777	1.00	777			777	*
4	Rt. 42 SB.	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB.	20+47+18	85	1.00	85	117		202	

Remarks:

TOTAL:	2183
LEVEL OF SERVICE:	F

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

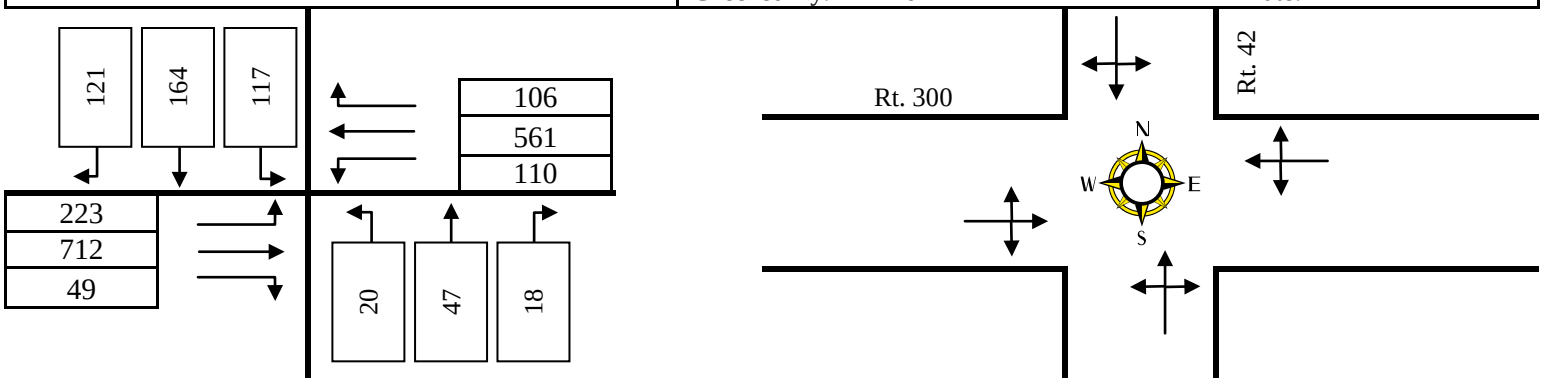
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-7 CMS Example 3 – Split All Phasing – Shared Lefts

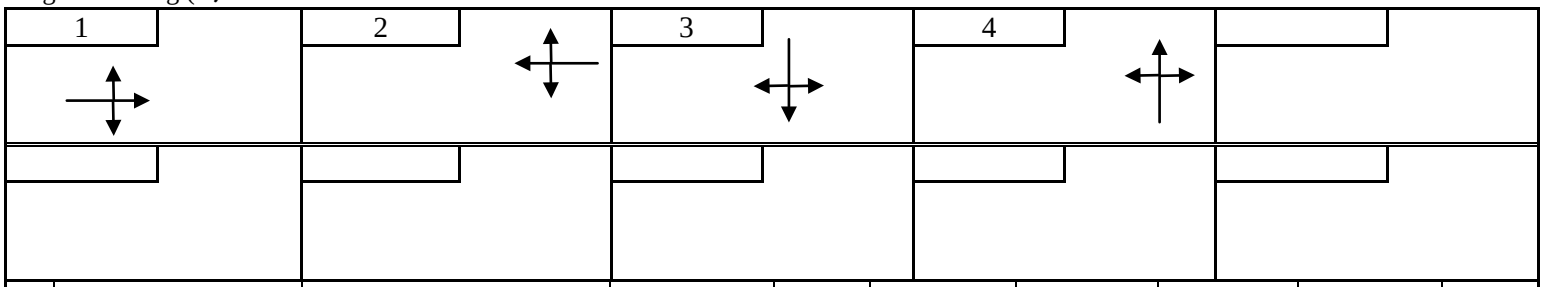
DelDOT

CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42		
Count Date:	12/25/2005		
Scenario:	Existing – Split All Phasing - Shared Lefts		
Computed By:	ABC	Date:	01/01/06
Checked By:	JHI	Date:	01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	Rt. 300 EB.	223+712+49	984	1.00	984			984	*
2	Rt. 300 WB.	110+561+106	777	1.00	777			777	*
3	Rt. 42 SB	117+164+121	402	1.00	402			402	*
4	Rt. 42 NB	20+47+18	85	1.00	85			85	*

Remarks:

TOTAL:	2248
LEVEL OF SERVICE:	F

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

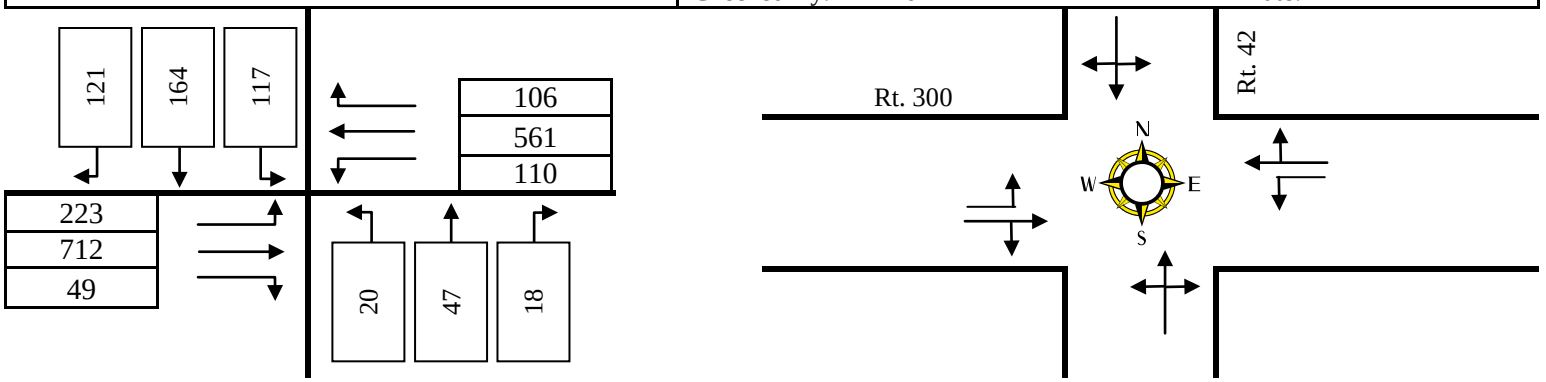
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-8 CMS Example 4 – Permissive Lefts – Separate Lefts

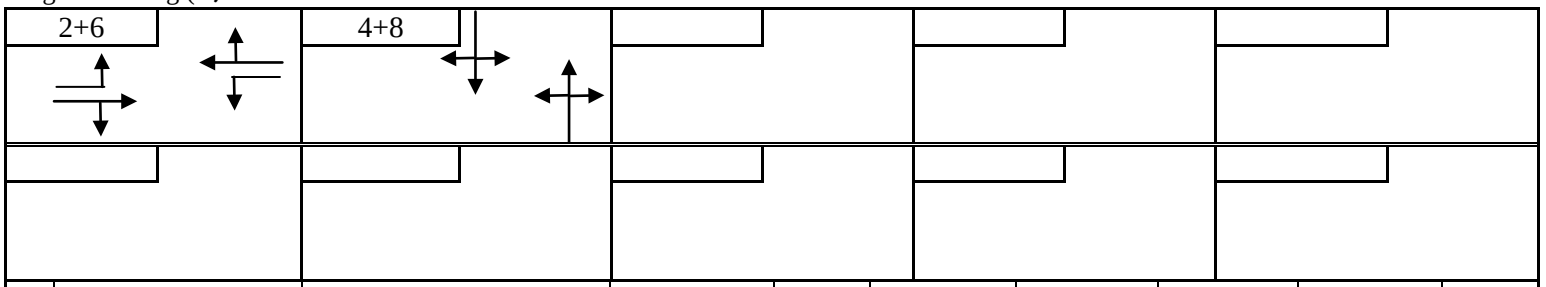
DelDOT

CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42		
Count Date:	12/25/2005		
Scenario:	Existing – Permissive Lefts - Separate Lefts		
Computed By:	ABC	Date:	01/01/06
Checked By:	JHI	Date:	01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
2	Rt.300 EB.	712+49	761	1.00	761	110		871	
6	Rt. 300 WB.	561+106	667	1.00	667	223		890	*
4	Rt. 42 SB	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB	20+47+18	85	1.00	85	117		202	

Remarks:

TOTAL:	1312
LEVEL OF SERVICE:	D

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

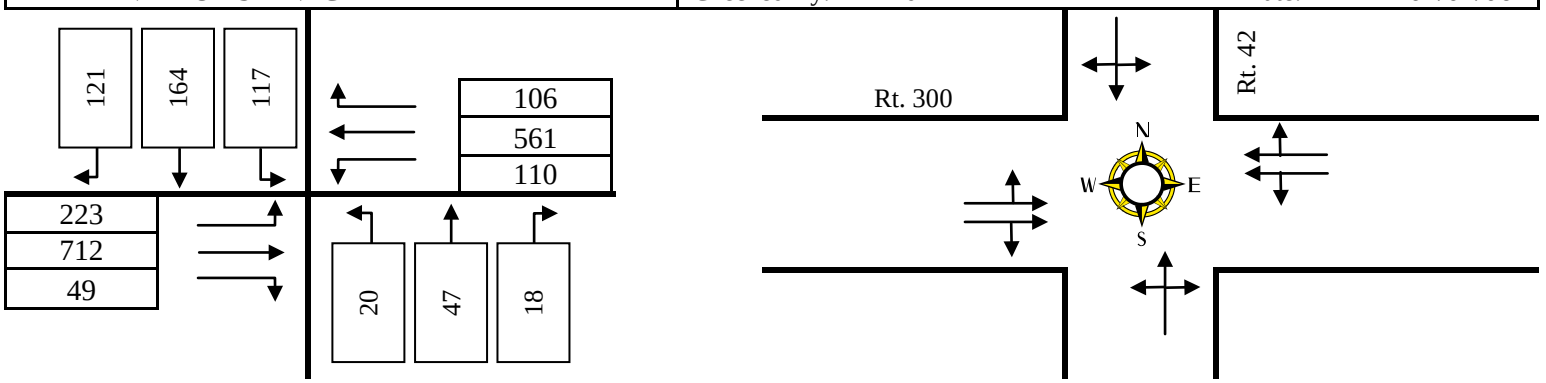
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-9 CMS Example 5 – Permissive Lefts – Two Throughs and a Shared Left

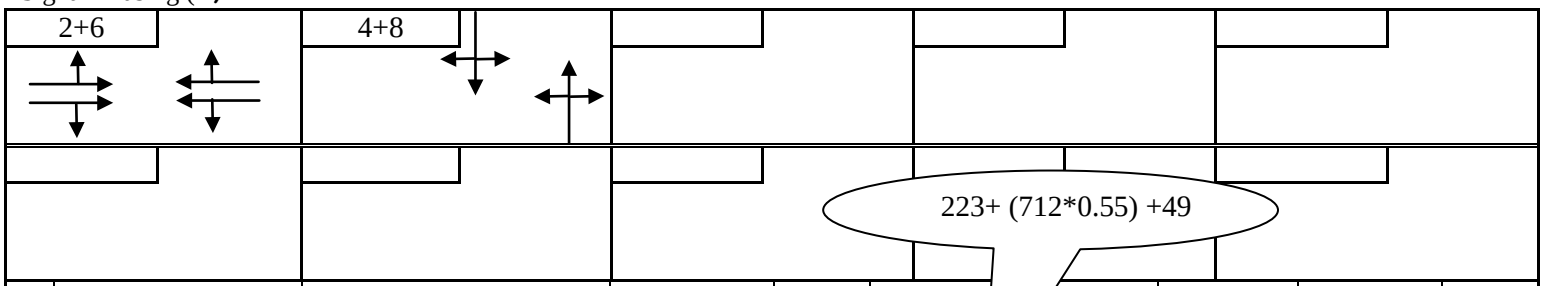
DelDOT

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42		
Count Date:	12/25/2005		
Scenario:	Existing – Permissive Lefts – Two Throughs and a Shared Left		
Computed By:	ABC	Date:	01/01/06
Checked By:	JHI	Date:	01/02/06



Signal Phasing (Φ)



223+ (712*0.55) +49

110+ (561*0.55) +106

Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
2	Rt.300 EB.				664	110		774	*
6	Rt. 300 WB.				525	223		748	
4	Rt. 42 SB	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB	20+47+18	85	1.00	85	117		202	
Remarks:						TOTAL:		1196	
						LEVEL OF SERVICE:		C	

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

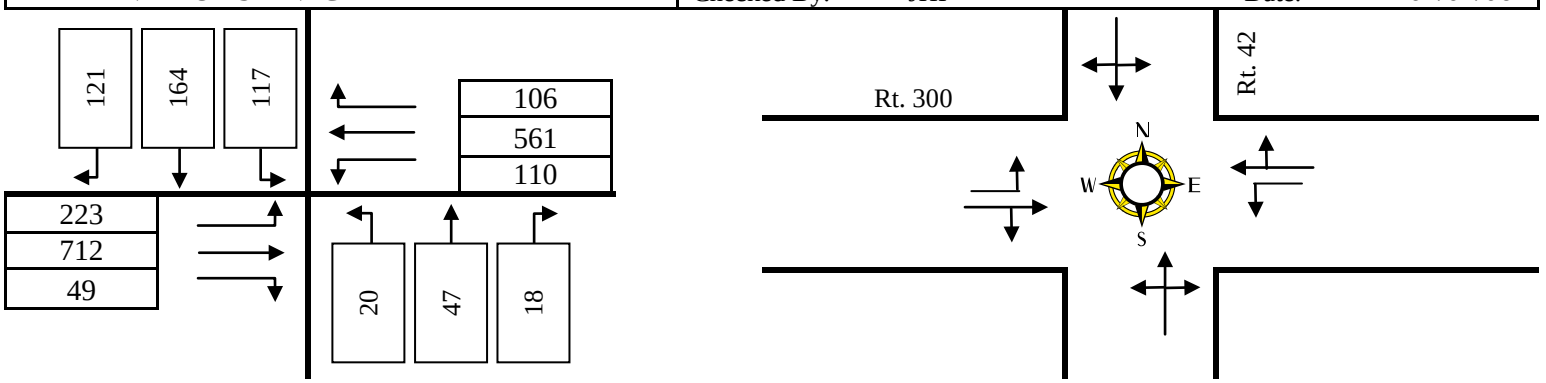
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-10 CMS Example 6 – Protected Lefts – Separate Lefts

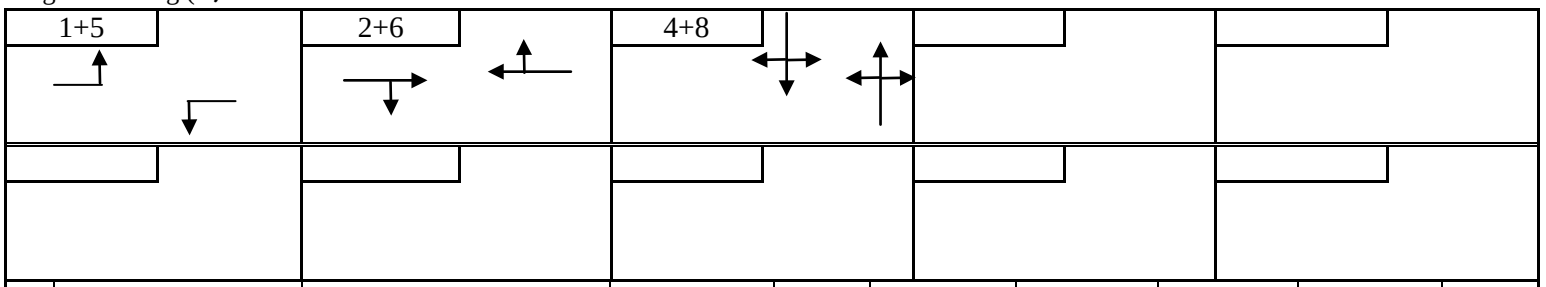
DelDOT

CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42
Count Date:	12/25/2005
Scenario:	Existing – Protected Lefts – Separate Lefts
Computed By:	ABC Date: 01/01/06
Checked By:	JHI Date: 01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	Rt. 300 WB.	110	110	1.00	110			110	
5	Rt.300 EB.	223	223	1.00	223			223	*
2	Rt.300 EB.	712+49	761	1.00	761		113	648	
6	Rt. 300 WB.	561+106	667	1.00	667			667	*
4	Rt. 42 SB	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB	20+47+18	85	1.00	85	117		202	

Remarks:

TOTAL:	1312
LEVEL OF SERVICE:	D

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

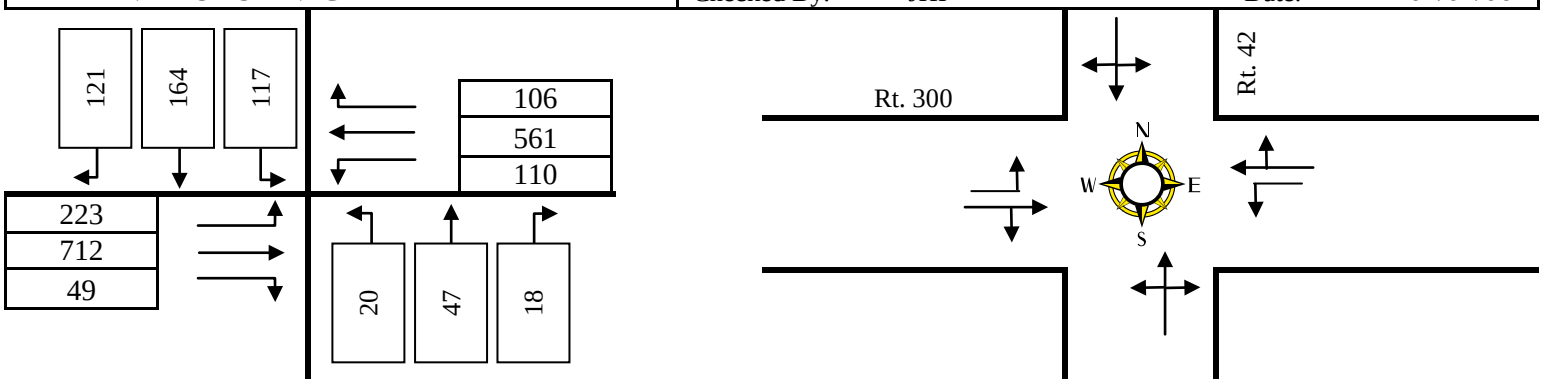
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-11 CMS Example 7 – Split EW – Separate Lefts

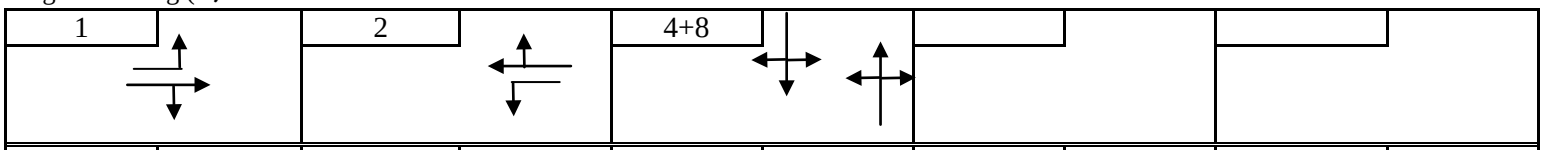
DelDOT

CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42
Count Date:	12/25/2005
Scenario:	Existing – Split EW – Separate Lefts
Computed By:	ABC Date: 01/01/06
Checked By:	JHI Date: 01/02/06



Signal Phasing (Φ)



Max (712+49 or 223)

Max (561+106 or 110)

Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	Rt.300 EB.	712+49	761	1.00	761			761	*
2	Rt. 300 WB.	561+106	667	1.00	667			667	*
4	Rt. 42 SB	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB	20+47+18	85	1.00	85	117		202	
Remarks:						TOTAL:		1850	
						LEVEL OF SERVICE:		F	

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

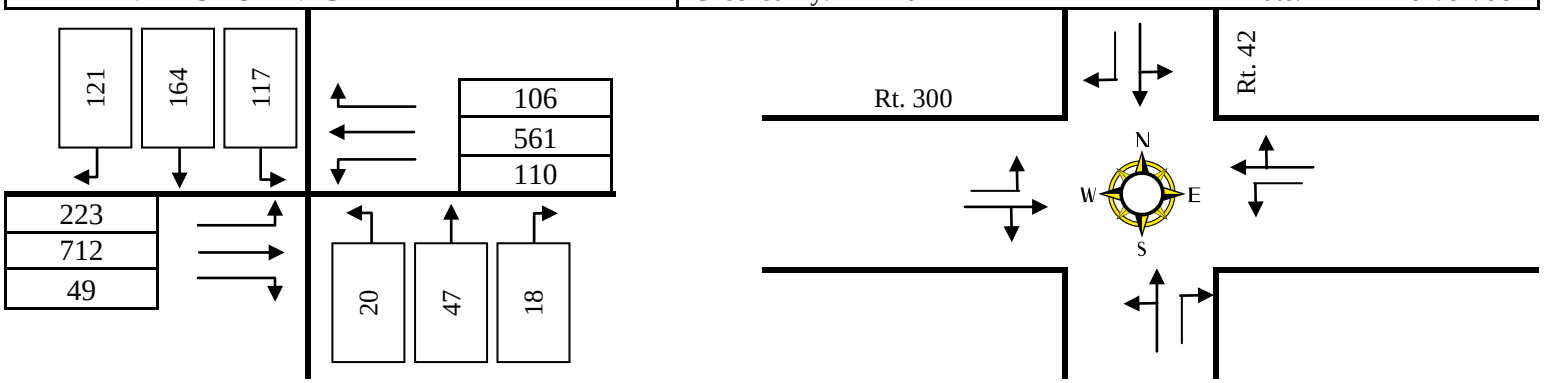
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-12 CMS Example 8 – Protected Permissive Lefts – Separate Lefts – Separate Rights

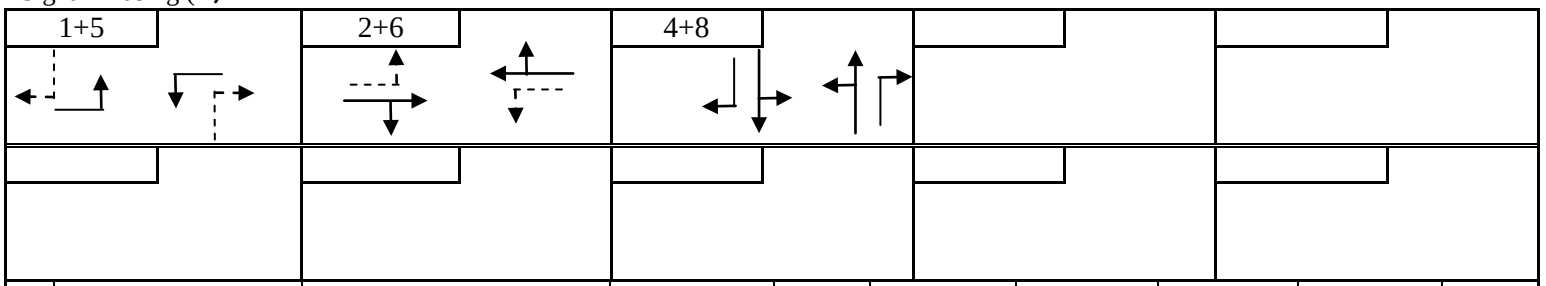
DelDOT

CRITICAL LANE MOVEMENT SUMMATION AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42		
Count Date:	12/25/2005		
Scenario:	Existing – Protected Permissive Lefts – Separate Lefts – Separate Rights		
Computed By:	ABC	Date:	01/01/06
Checked By:	JHI	Date:	01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	Rt. 300 WB.	110	110	1.00	110			110	
5	Rt.300 EB.	223	223	1.00	223			223	*
2	Rt.300 EB.	712+49	761	1.00	761		113	648	
6	Rt. 300 WB.	561+106	667	1.00	667			667	*
4	Rt. 42 SB	117+164	281	1.00	281	20		301	*
8	Rt. 42 NB	20+47	67	1.00	67	117		184	

Remarks:

TOTAL:	1191
LEVEL OF SERVICE:	C

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

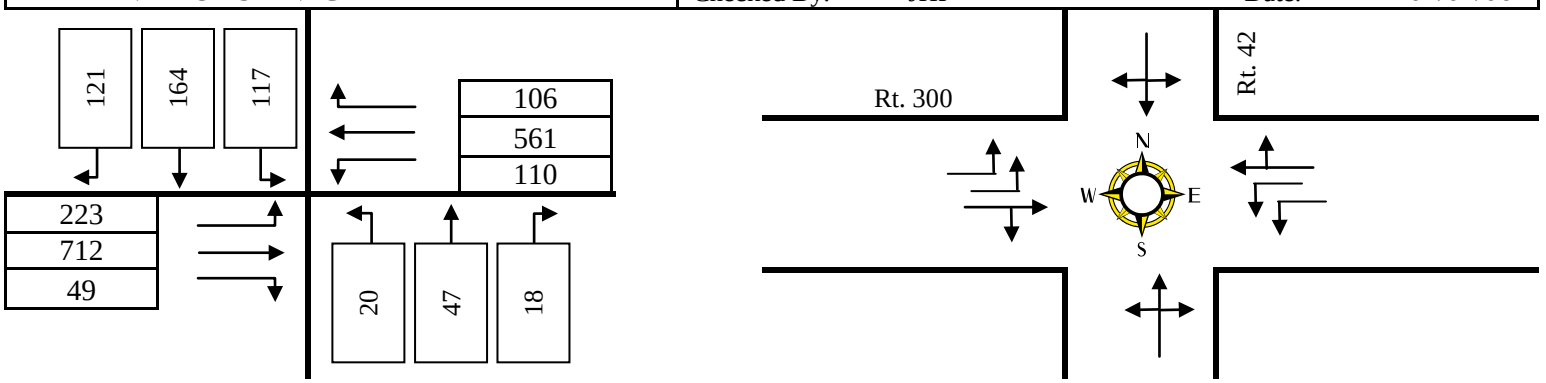
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-13 CMS Example 9 – Protected Lefts – Double Lefts

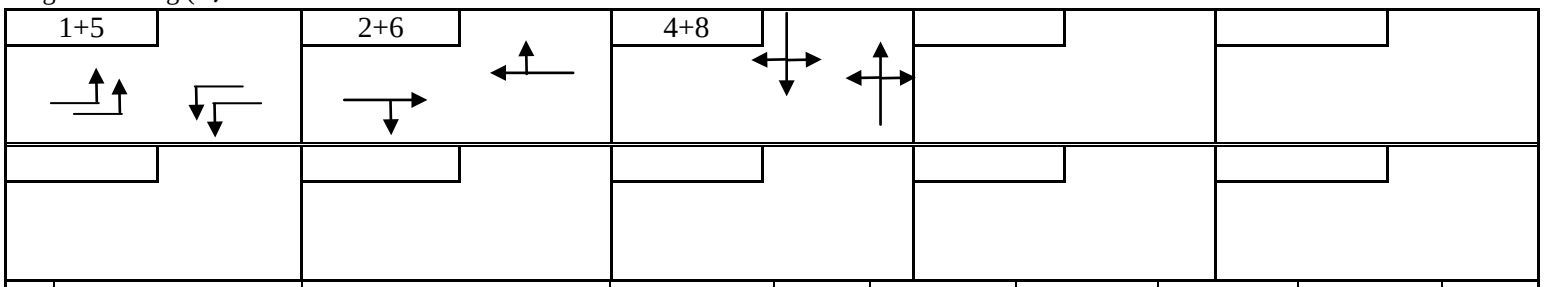
DelDOT

CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42
Count Date:	12/25/2005
Scenario:	Existing – Protected Lefts –Double Lefts
Computed By:	ABC Date: 01/01/06
Checked By:	JHI Date: 01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
1	Rt. 300 WB.	110	110	0.55	66			66	
5	Rt.300 EB.	223	223	0.55	123			123	*
2	Rt.300 EB.	712+49	761	1.00	761		62	699	*
6	Rt. 300 WB.	561+106	667	1.00	667			667	
					= (223*0.55)-(110*0.55)				
4	Rt. 42 SB	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB	20+47+18	85	1.00	85	117		202	
Remarks:						TOTAL:		1244	
						LEVEL OF SERVICE:		C	

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

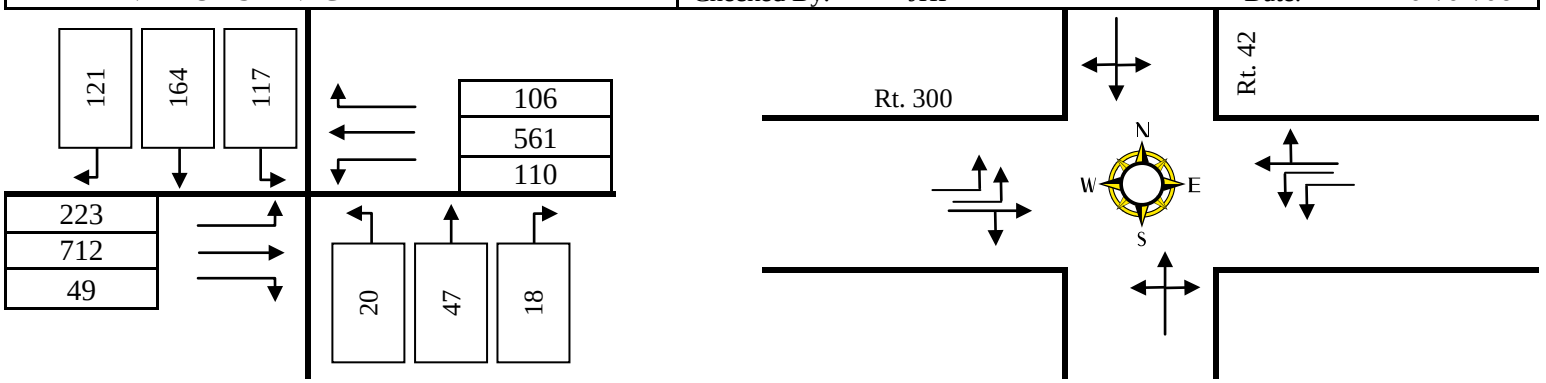
LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-14 CMS Example 10 – Lead-Lag Phasing

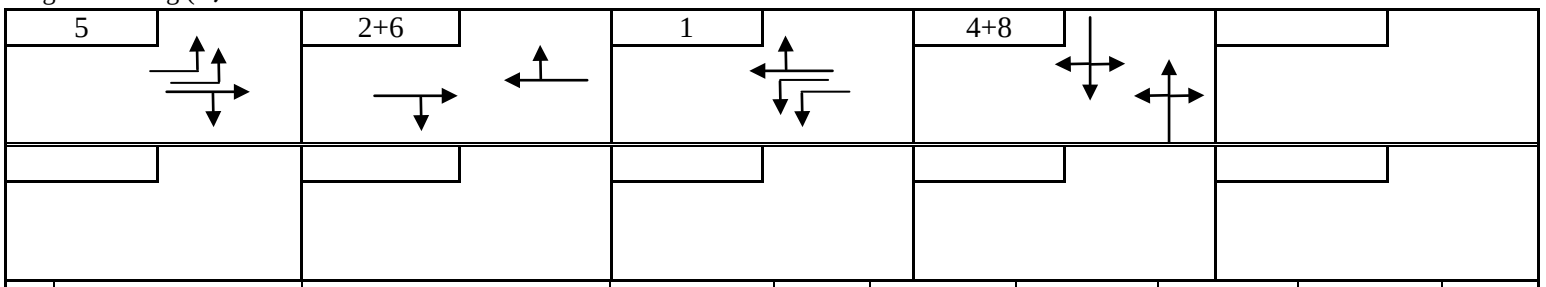
DelDOT

CRITICAL LANE MOVEMENT SUMMATION
AND LEVEL OF SERVICE

Location:	Rt. 300 and Rt. 42		
Count Date:	12/25/2005		
Scenario:	Existing – Lead-Lag Phasing		
Computed By:	ABC	Date:	01/01/06
Checked By:	JHI	Date:	01/02/06



Signal Phasing (Φ)



Φ	Movement	Volume		LU	Lane Volume	OL (Add)	LTC (Subtract)	Critical Lane Volume	CM (*)
5	Rt.300 EB.	223	223	0.55	123			123	*
2	Rt.300 EB.	712+49	761	1.00	761		123	638	*
6	Rt. 300 WB.	106+561	667	1.00	667		61	606	
1	Rt. 300 WB.	110	110	0.55	61			61	*
4	Rt. 42 SB	117+164+121	402	1.00	402	20		422	*
8	Rt. 42 NB	20+47+18	85	1.00	85	117		202	

Remarks:

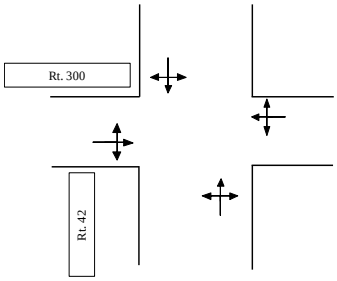
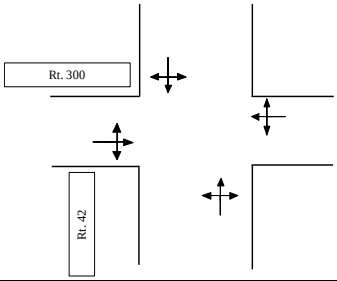
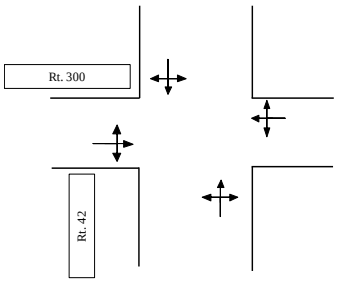
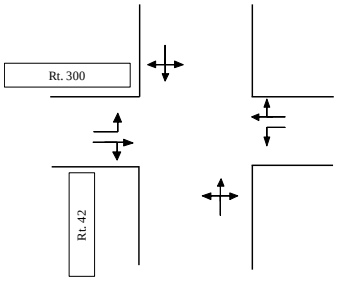
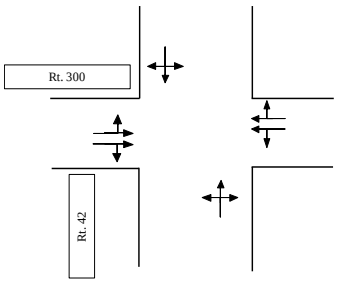
TOTAL:	1244
LEVEL OF SERVICE:	C

Level	Critical Movement Volume
A	Less than 1,000 veh/hr
B	1,000 to 1,150 veh/hr
C	1,151 to 1,300 veh/hr
D	1,301 to 1,450 veh/hr
E	1,451 to 1,600 veh/hr
F	More than 1,600 veh/hr

No. of Lanes	Lane Use factor (LU)
1	1.00
2	0.55
3	0.40
4	0.30

LEGEND	
OL =	Opposing Lefts
LTC =	Left Turn Credit

Figure P-15 Summary of Exercises

Exercise	Picture	Phasing	Number of critical movements	Results	
				Critical Movement Summation	LOS
1		Simple 2-phase (permissive lefts)	2	1516	E
2		Split E-W	3	2183	F
3		Split all	4	2248	F
4		Simple 2-phase (permissive lefts)	2	1312	D
5		Simple 2-phase (permissive lefts)	2	1196	C

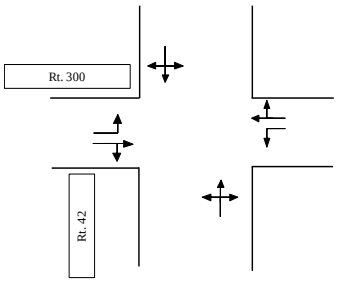
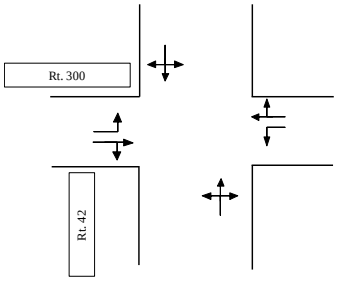
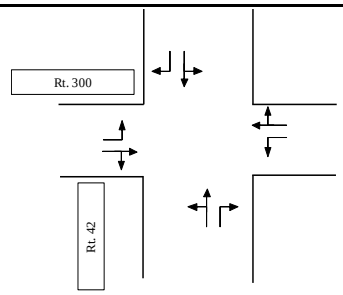
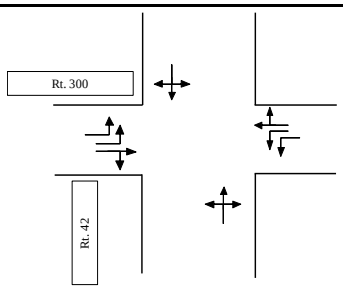
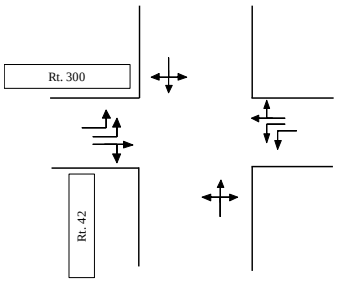
Exercise	Picture	Phasing	Number of critical movements	Results	
				Critical Movement Summation	LOS
6		Exclusive concurrent E-W lefts	3	1312	D
7		Split E-W	3	1850	F
8		Exclusive concurrent E-W lefts with N-S rights	3	1191	C
9		Exclusive concurrent E-W lefts	3	1255	C
10		Lead-Lag E-W	3	1611	F

Figure P-16 Traffic Signal Timing Exercise

Location: Rt. 300 and Rt. 42 Date: 01/01/06

Cycle Length: 100 Cycles per Hour: 36 Prepared by: ABC 01/01/06

Time of Day: AM Peak Hour Checked by: JHI 01/02/06

Phases	Movement	Critical lane Volume (CLV)	Vehicles per Cycle	Green Time Required (see Greenshield Figure P-3)	Clearance (Red + Yellow)	Walk + Don't Walk
2+6	Rt. 300	1094	30	67	3+2	-
4+8	Rt. 42	422	12	29	3+2	-

Total Green	96		
Total Clearance	10		
Total Time Required	106		

Cycle Length	Cycles per Hour
45	80
60	60
75	48
90	40
100	36
120	30
150	24
180	20
210	17
240	15