5-1752-01-P13

Hardware-in-the-Loop Demonstration/ Workshop

Presented to the TxDOT Corpus Christi District

Presented in partial completion of requirements of 5-1752-01
By the Texas Transportation Institute

August 12, 2005

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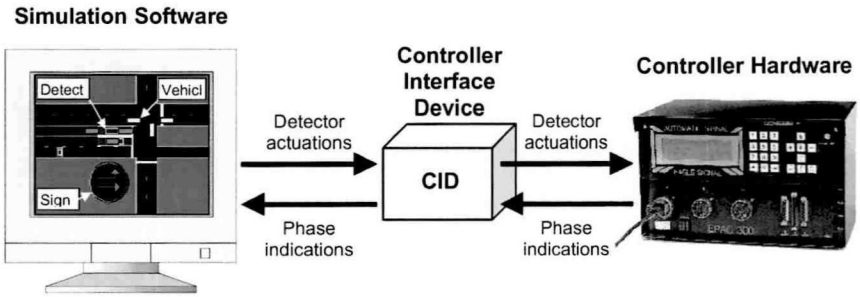
Purpose of Workshop

- Demonstrate HITL capabilities
- Show default files
  - T-Intersection
  - 4-leg
  - Diamond
- Step through modifying default files
  - Modifying volume
  - Modifying phasing
  - Modifying detectors
  - Modifying geometry
- Special Cases

Elements of HITL



CID Interface Device

- Allows controller to communicate with simulation software
- Three interface devices
  - Eagle TS-2
  - Naztec TS-2
  - NIATT TS-1
- Two files
  - " .exe" file
  - " .ini" file

Simulation Files

- TSIS CORSIM files
  - " .trf" files → actual simulation files
  - " .sdi" files → maps approaches with phases

IMPORTANT

.trf and .sdi files NEED to have same file name!!!

Example: "*Example_diamond.trf*" must have corresponding "*Example_diamond.sdi*" file

Look at files

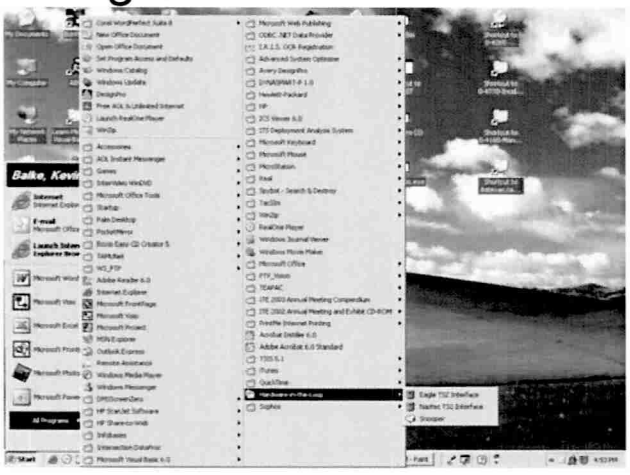
- HITL CID .ini file
- TSIS CORSIM .sdi file
- TSIS CORSIM .trf file

Running HITL Scenario

Sequence of Programs

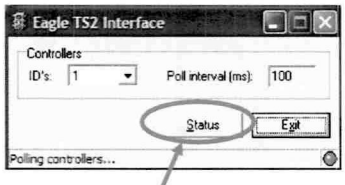
- Step 1. Start CID Interface Program
  - EagleTs2Interface.exe
  - NaztecTs2Interface.exe
- Step 2. Open Snooper
- Step 3. Start TSIS
  - Real-Time CORSIM
  - TRAFVU (after equilibrium reached)

Step 1. Running CID Interface Program

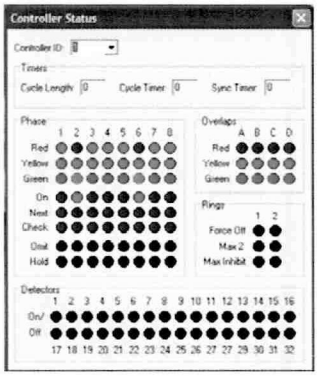


- "Start"
- "All Programs"
- "Hardware-in-the-Loop" Folder
- Appropriate CID Interface Icon

Step 1. Running CID Interface Program (cont.)

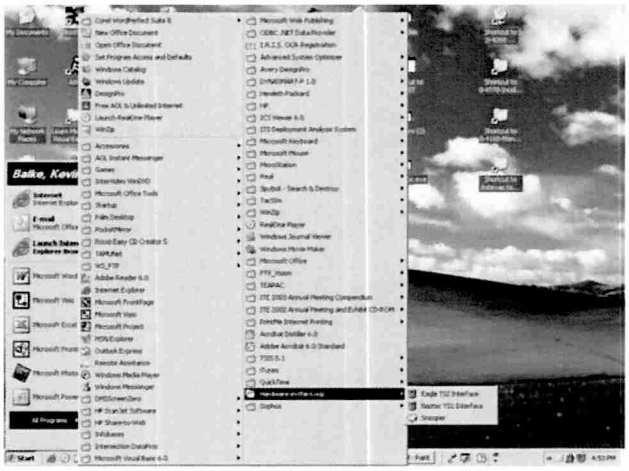


Green Light means CID communicating with Controller



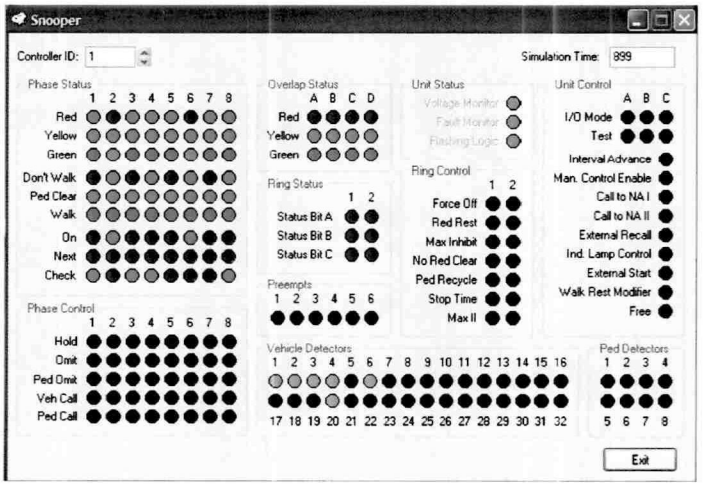
If you click on "Status"

Step 2. Running Snooper

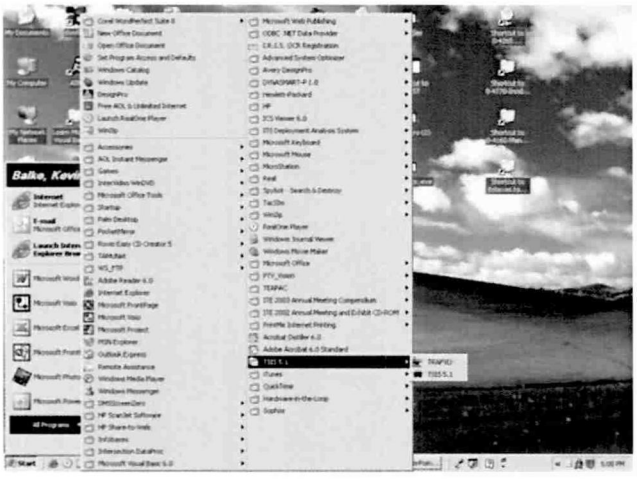


- **"Start"**
- **"All Programs"**
- **"Hardware-in-the-Loop" Folder**
- **"Snooper" Icon**

Step 2. Running Snooper (cont.)



Step 3. Running Simulation

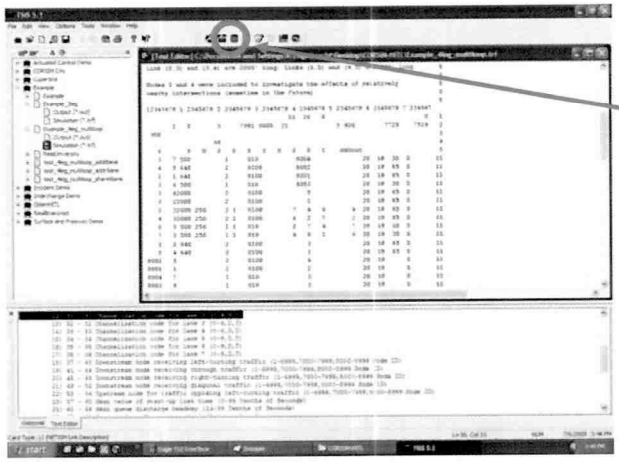


- "Start"
- "All Programs"
- "TSIS 5.1" Folder
- "TSIS 5.1" Icon

Step 3. Running Simulation

- "File"
- "Open"
- Navigate to folder and click on ".trf" file

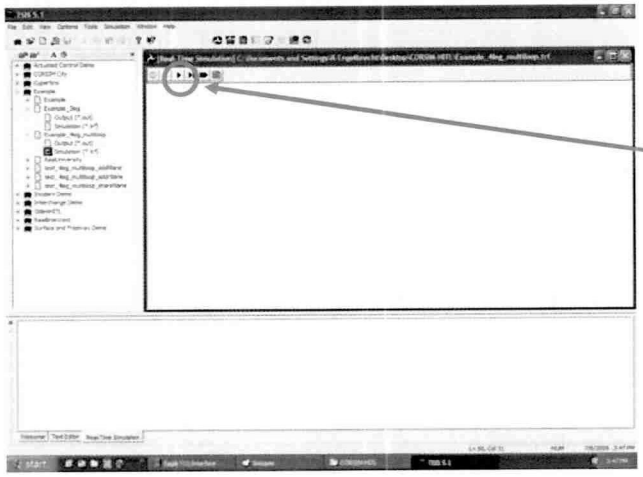
Step 3. Running Simulation (Cont.)



Click on

icon to run Real-Time TSIS

Step 3. Running Simulation (Cont.)



Click on

icon to start real-time simulation

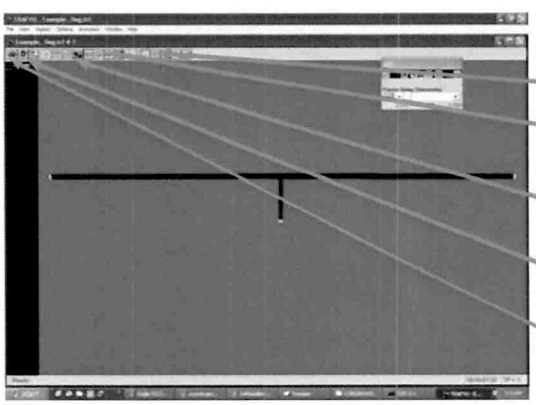
Step 3. Running Simulation (Cont.)

Once simulation finishes initialization period:

Click on

icon to run animation

Step 3. Running Simulation (Cont.)



Click on :

To zoom in

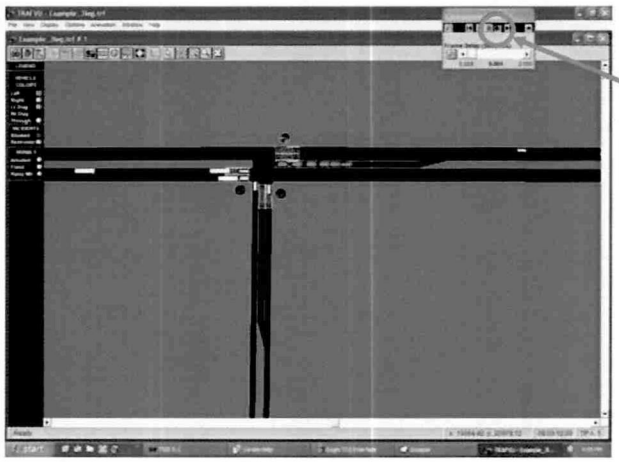
To see detectors

To see markings

To see signals

To see vehicles

Step 3. Running Simulation (Cont.)



Click on  icon to start real-time animation

Hands-On Practice

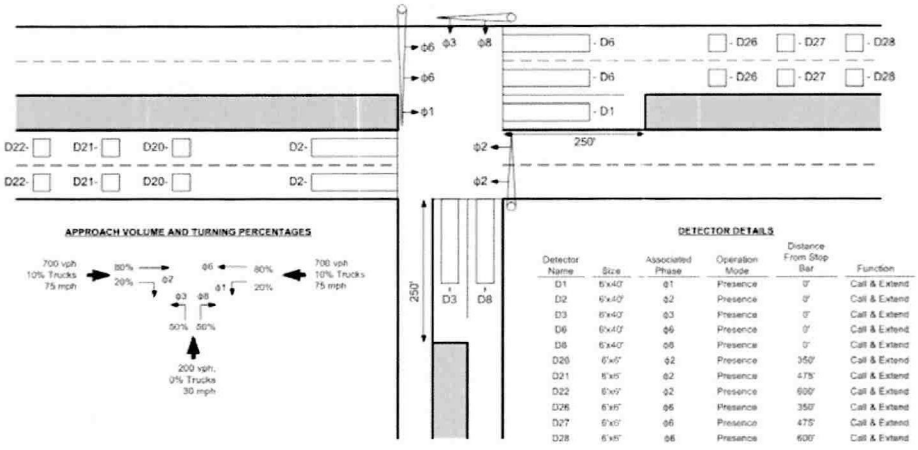
- Run Example_4leg_Multiloop.trf

Default intersections

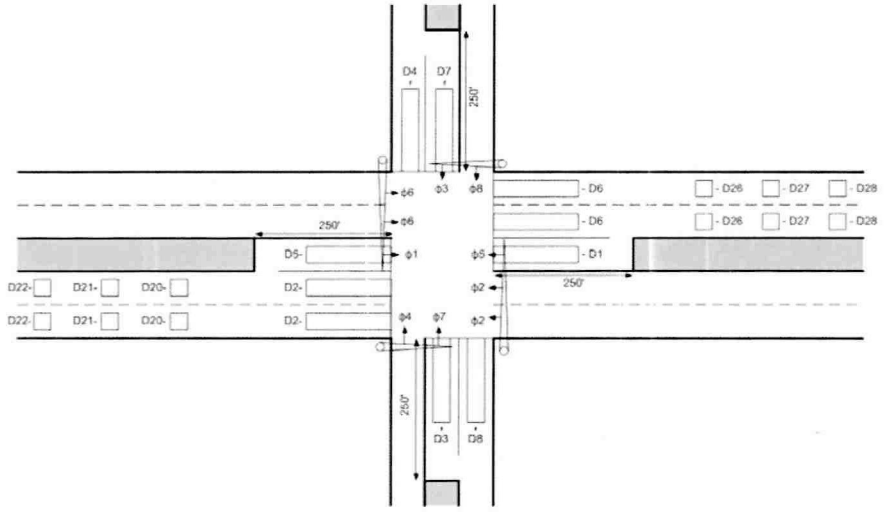
Default TSIS files

- T-intersection
- 4-leg intersection
- Diamond
  - Wide Diamond
  - Tight Diamond

Default T-Intersection

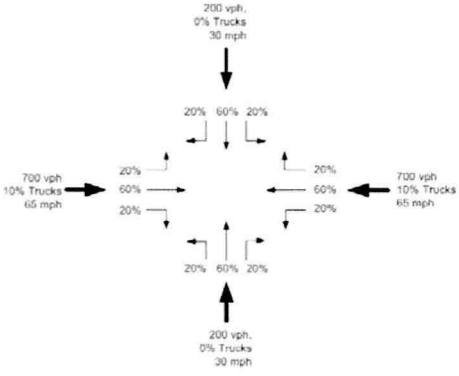


Default 4-leg Intersection



Default 4-Leg Intersection (Cont.)

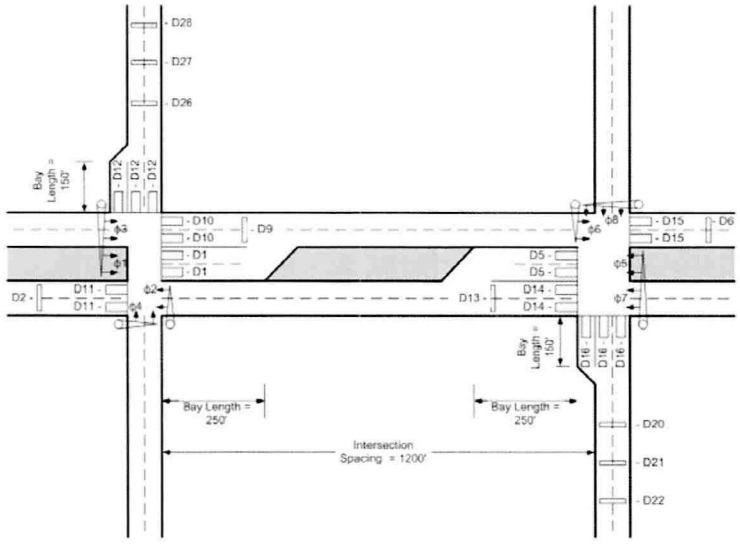
APPROACH VOLUME AND TURNING PERCENTAGES



DETECTOR DETAILS

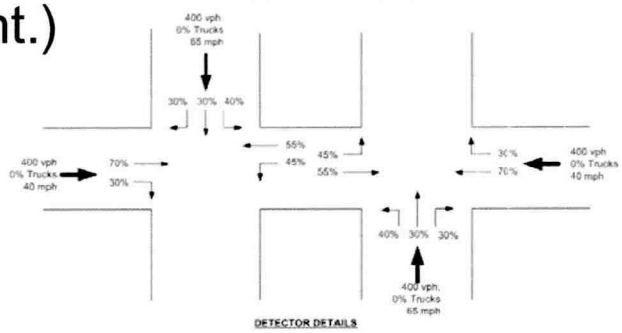
Detector Name	Size	Associated Phase	Operation Mode	Distance From Stop Bar	Function
D1	6'x40'	ϕ1	Presence	0'	Call & Extend
D2	6'x40'	ϕ2	Presence	0'	Call & Extend
D3	6'x40'	ϕ3	Presence	0'	Call & Extend
D4	6'x40'	ϕ4	Presence	0'	Call & Extend
D5	6'x40'	ϕ5	Presence	0'	Call & Extend
D6	6'x40'	ϕ6	Presence	0'	Call & Extend
D7	6'x40'	ϕ7	Presence	0'	Call & Extend
D8	6'x40'	ϕ8	Presence	0'	Call & Extend
D20	6'x6'	ϕ2	Presence	320'	Call & Extend
D21	6'x6'	ϕ2	Presence	430'	Call & Extend
D22	6'x6'	ϕ2	Presence	540'	Call & Extend
D26	6'x6'	ϕ6	Presence	320'	Call & Extend
D27	6'x6'	ϕ6	Presence	430'	Call & Extend
D28	6'x6'	ϕ6	Presence	540'	Call & Extend

Default Wide Diamond Interchange



Default Wide Diamond Interchange (Cont.)

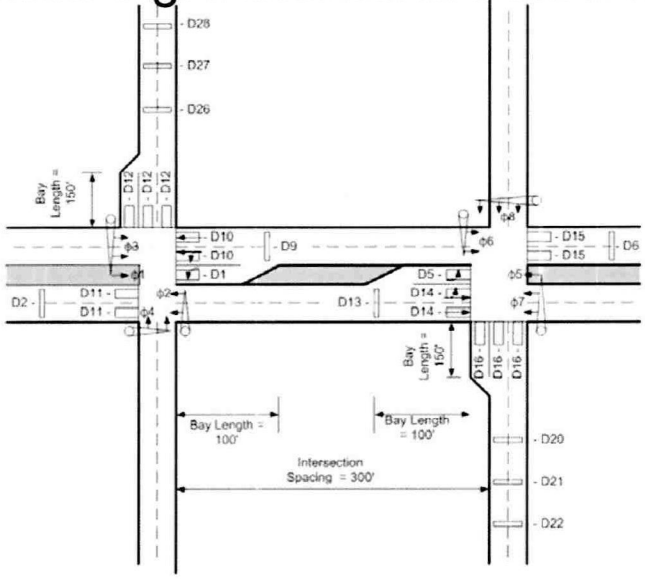
APPROACH VOLUME AND TURNING PERCENTAGES



DETECTOR DETAILS

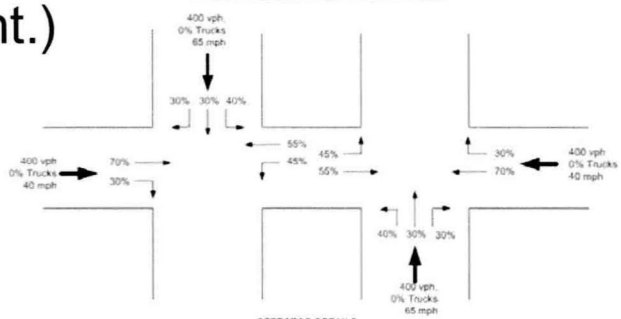
Detector Name	Size	Operation Mode	Distance From Stop Bar	Function
D1	6'x40'	Presence	0'	Call & Extend
D2	6'x6'	Presence	150'	Call & Extend
D5	6'x40'	Presence	0'	Call & Extend
D6	6'x6'	Presence	150'	Call & Extend
D9	6'x6'	Presence	150'	Call & Extend
D10	6'x40'	Presence	0'	Call & Extend
D11	6'x40'	Presence	0'	Call & Extend
D12	6'x40'	Presence	0'	Call & Extend
D13	6'x6'	Presence	150'	Call & Extend
D14	6'x40'	Presence	0'	Call & Extend
D15	6'x40'	Presence	0'	Call & Extend
D16	6'x40'	Presence	0'	Call & Extend
D20	6'x6'	Presence	320'	Call & Extend
D21	6'x6'	Presence	430'	Call & Extend
D22	6'x6'	Presence	540'	Call & Extend
D26	6'x6'	Presence	320'	Call & Extend
D27	6'x6'	Presence	430'	Call & Extend
D28	6'x6'	Presence	540'	Call & Extend

Default Tight Diamond Interchange



Default Tight Diamond Interchange (Cont.)

APPROACH VOLUME AND TURNING PERCENTAGES



DETECTOR DETAILS

Detector Name	Size	Operation Mode	Distance From Stop Bar	Function
D1	6'x40'	Presence	0'	Call & Extend
D2	6'x6'	Presence	150'	Call & Extend
D5	6'x40'	Presence	0'	Call & Extend
D6	6'x6'	Presence	150'	Call & Extend
D9	6'x6'	Presence	150'	Call & Extend
D10	6'x40'	Presence	0'	Call & Extend
D11	6'x40'	Presence	0'	Call & Extend
D12	6'x40'	Presence	0'	Call & Extend
D13	6'x6'	Presence	150'	Call & Extend
D14	6'x40'	Presence	0'	Call & Extend
D15	6'x40'	Presence	0'	Call & Extend
D16	6'x40'	Presence	0'	Call & Extend
D20	6'x6'	Presence	320'	Call & Extend
D21	6'x6'	Presence	430'	Call & Extend
D22	6'x6'	Presence	540'	Call & Extend
D26	6'x6'	Presence	320'	Call & Extend
D27	6'x6'	Presence	430'	Call & Extend
D28	6'x6'	Presence	540'	Call & Extend

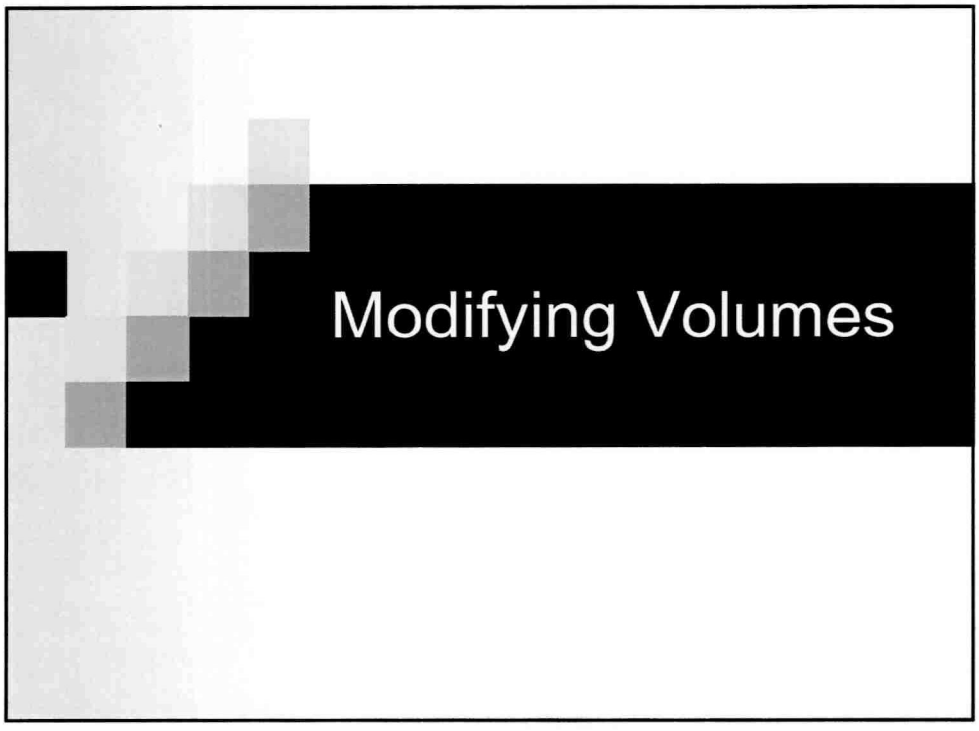
Modifying Default Simulations

Modifying Defaults

- Change Volume Conditions
- Change Phasing Conditions
- Modify Detectors
- Change Intersection Geometry

IMPORTANT

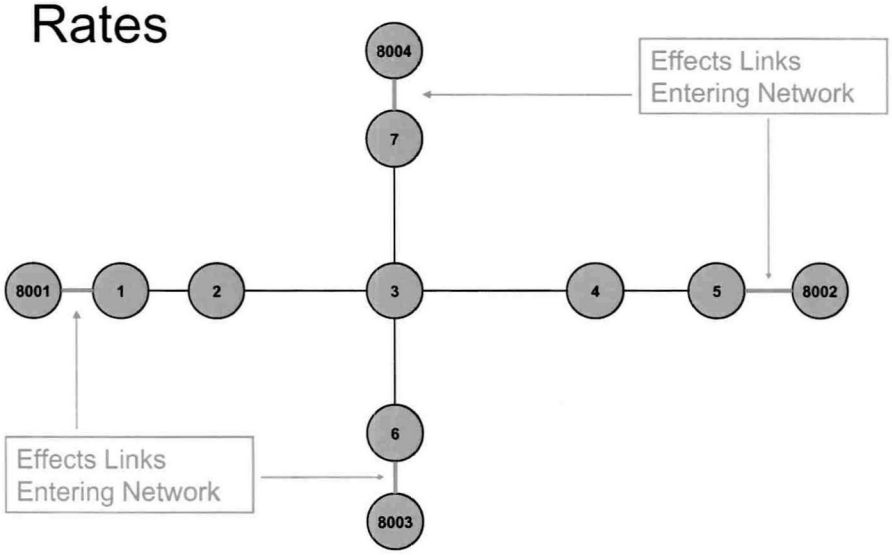
Always rename "Example" files
(i.e., do not save over "Example" files)



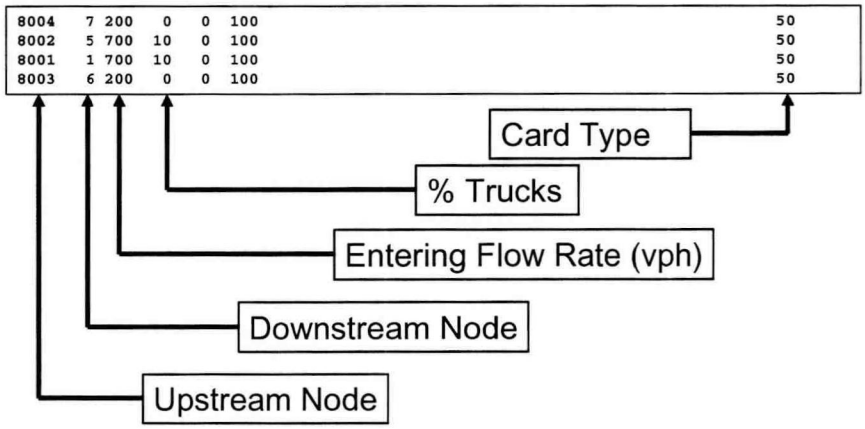
Volume-Related Cards

- Total Approach Flow Rate – Card Type 50
- % Trucks – Card Type 50
- Turning Movement Percentages – Card Type 21

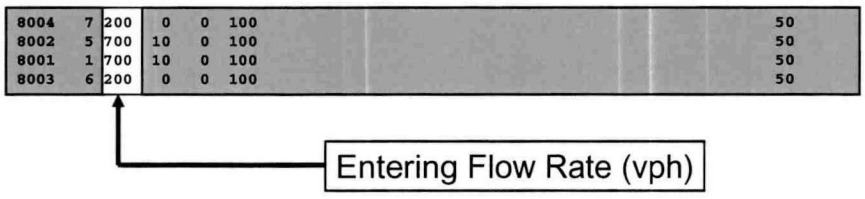
Changing Total Approach Flow Rates



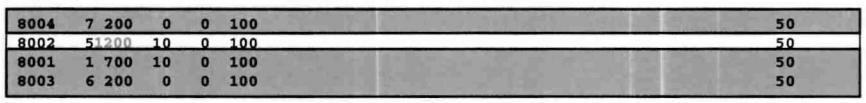
Flow Rates -- Card Type 50



Changing Total Approach Flow Rates



Example:



Changes Total Approach Flow Rate on WB Entering Link to 1200 vph

Changing % Trucks

8004	7 200	0	0	100	50
8002	5 700	10	0	100	50
8001	1 700	10	0	100	50
8003	6 200	0	0	100	50

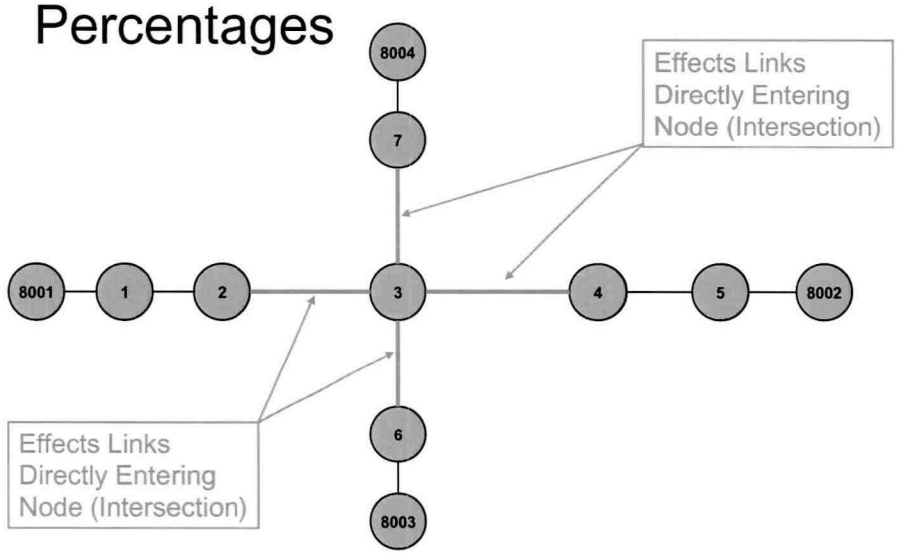
% Trucks

Example:

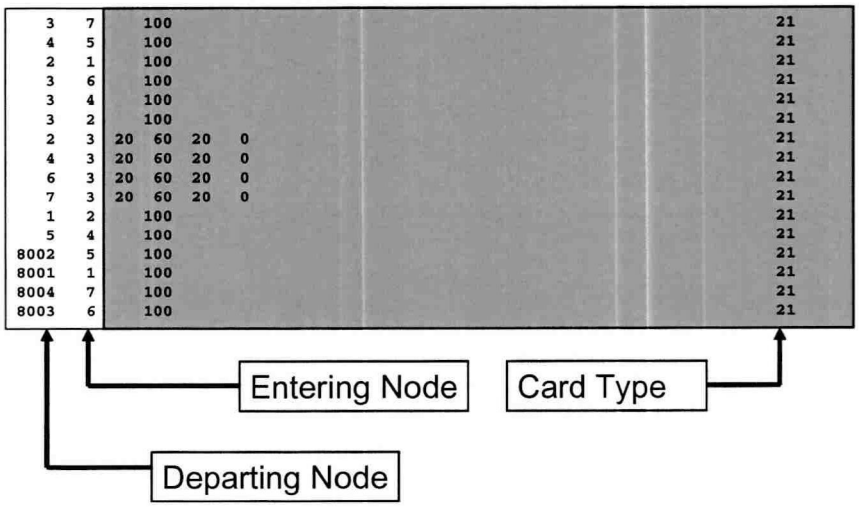
8004	7 200	0	0	100	50
8002	5 700	25	0	100	50
8001	1 700	10	0	100	50
8003	6 200	0	0	100	50

Changes % Trucks on WB Entering Link to 25%

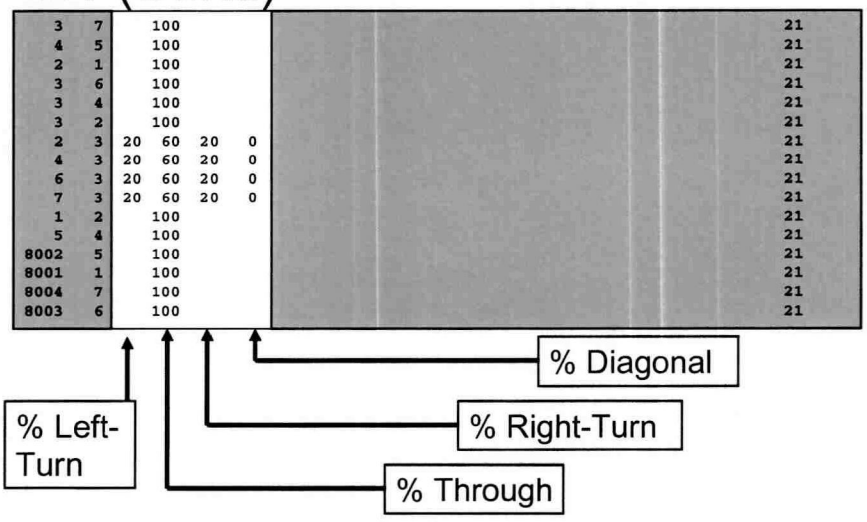
Changing Turning Movement Percentages



Turning Movements -- Card Type 21



Turning Movements -- Card Type 21 (Cont.)



Changing Turning Movement Percentages

```
   3   7     100                                                  21
   4   5     100                                                  21
   2   1     100                                                  21
   3   6     100                                                  21
   3   4     100                                                  21
   3   2     100                                                  21
   2   3  20  60  20   0                                         21
   4   3  20  60  20   0                                         21
   6   3  20  60  20   0                                         21
   7   3  20  60  20   0                                         21
   1   2     100                                                  21
   5   4     100                                                  21
8002   5     100                                                  21
8001   1     100                                                  21
8004   7     100                                                  21
8003   6     100                                                  21
```

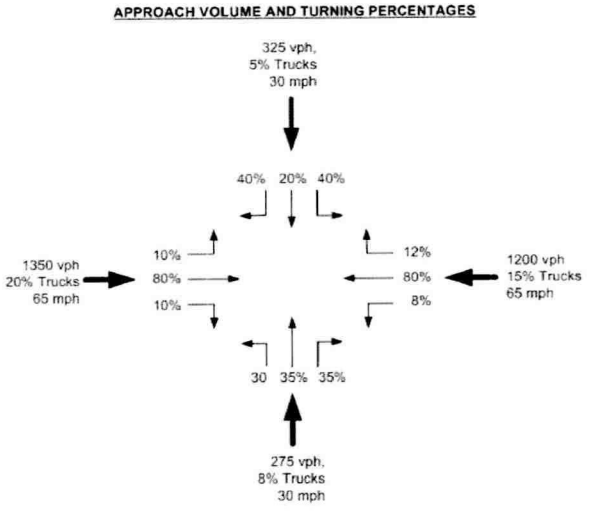
These cards describe turning movement percentages at the test intersection.

Changing Turning Movement Percentages -- Example

```
   3   7     100                                                  21
   4   5     100                                                  21
   2   1     100                                                  21
   3   6     100                                                  21
   3   4     100                                                  21
   3   2     100                                                  21
   2   3  20  60  20   0                                         21
   4   3   8  77  15   0                                         21
   6   3  20  60  20   0                                         21
   7   3  20  60  20   0                                         21
   1   2     100                                                  21
   5   4     100                                                  21
8002   5     100                                                  21
8001   1     100                                                  21
8004   7     100                                                  21
8003   6     100                                                  21
```

Changes turning movement distribution on WB approach to 8% Left-turns, 77% Through, and 15% Right-turns

Hands-On Practice



Modifying Phasing

Default ".sdi" File

*	from	to	turn	type	contlr	phases	
	7	3	T	Prot	1	P4	
	7	3	R	Perm	1	P4	
	7	3	L	P+P	1	P7	P4
	2	3	T	Prot	1	P2	
	2	3	R	Perm	1	P2	
	2	3	L	P+P	1	P5	P2
	4	3	T	Prot	1	P6	
	4	3	R	Perm	1	P6	
	4	3	L	P+P	1	P1	P6
	6	3	T	Prot	1	P8	
	6	3	R	Perm	1	P8	
	6	3	L	P+P	1	P3	P8

Protected Only Phasing

*	from	to	turn	type	contlr	phases	
	7	3	T	Prot	1	P4	
	7	3	R	Perm	1	P4	
	7	3	L	P+P	1	P7	P4
	2	3	T	Prot	1	P2	
	2	3	R	Perm	1	P2	
	2	3	L	Prot	1	P5	
	4	3	T	Prot	1	P6	
	4	3	R	Perm	1	P6	
	4	3	L	Prot	1	P1	
	6	3	T	Prot	1	P8	
	6	3	R	Perm	1	P8	
	6	3	L	P+P	1	P3	P8

Permissive Only Phasing

*	from	to	turn	type	contlr	phases	
	7	3	T	Prot	1	P4	
	7	3	R	Perm	1	P4	
	7	3	L	Perm	1	P4	
	2	3	T	Prot	1	P2	
	2	3	R	Perm	1	P2	
	2	3	L	P+P	1	P1	P2
	4	3	T	Prot	1	P6	
	4	3	R	Perm	1	P6	
	4	3	L	P+P	1	P5	P6
	6	3	T	Prot	1	P8	
	6	3	R	Perm	1	P8	
	6	3	L	Perm	1	P8	

Overlaps

*	from	to	turn	type	contlr	phases	
	7	3	T	Prot	1	P4	
	7	3	R	Perm	1	P4	
	7	3	L	P+P	1	P7	P4
	2	3	T	Prot	1	P2	
	2	3	R	Prot	1	O1	
	2	3	L	P+P	1	P5	P2
	4	3	T	Prot	1	P6	
	4	3	R	Perm	1	P6	
	4	3	L	P+P	1	P1	P6
	6	3	T	Prot	1	P8	
	6	3	R	Perm	1	P8	
	6	3	L	P+P	1	P3	P8

Hands-On Practice

- E-W Protected Only Left-turn
- N-S Permissive Only Left-turn

Default:

* from	to	turn	type	contlr	phases	
7	3	T	Prot	1	P4	
7	3	R	Perm	1	P4	
7	3	L	P+P	1	P7	P4
2	3	T	Prot	1	P2	
2	3	R	Perm	1	P2	
2	3	L	P+P	1	P5	P2
4	3	T	Prot	1	P6	
4	3	R	Perm	1	P6	
4	3	L	P+P	1	P1	P6
6	3	T	Prot	1	P8	
6	3	R	Perm	1	P8	
6	3	L	P+P	1	P3	P8

Change to:

* from	to	turn	type	contlr	phases
7	3	T	Prot	1	P4
7	3	R	Perm	1	P4
7	3	L	Perm	1	P4
2	3	T	Prot	1	P2
2	3	R	Perm	1	P2
2	3	L	Prot	1	P5
4	3	T	Prot	1	P6
4	3	R	Perm	1	P6
4	3	L	Prot	1	P1
6	3	T	Prot	1	P8
6	3	R	Perm	1	P8
6	3	L	Perm	1	P8

- Save as Pract2_Phasing

Modifying Detectors

Basic Detector Configuration

```
  2   3   8       0     2   400  0                                          42
  4   3   1       0  9999    10  0                                          42*
*This card is included as a work around for a programming error in TSIS.
 Do not remove.
  4   3   8    3200    26    60  0                                          42
  4   3   8    4300    27    60  0                                          42
  4   3   8    5400    28    60  0                                          42
  4   3   8       0     6   400  0                                          42
  4   3   7       0     1   400  0                                          42
  2   3   8    3200    20    60  0                                          42
  2   3   8    4300    21    60  0                                          42
  2   3   8    5400    22    60  0                                          42
  2   3   7       0     5   400  0                                          42
  6   3   1       0     8   400  0                                          42
  6   3   7       0     3   400  0                                          42
  7   3   1       0     4   400  0                                          42
  7   3   7       0     7   400  0                                          42
```

- CORSIM Card Type 42

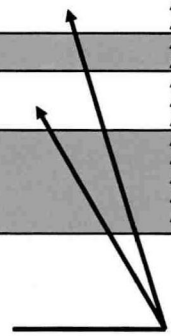
Basic Detectors Configuration

```
  2   3   8       0     2   400  0                                          42
  4   3   1       0  9999    10  0                                          42*
*This card is included as a work around for a programming error in TSIS.
 Do not remove.
  4   3   8    3200    26    60  0                                          42
  4   3   8    4300    27    60  0                                          42
  4   3   8    5400    28    60  0                                          42
  4   3   8       0     6   400  0                                          42
  4   3   7       0     1   400  0                                          42
  2   3   8    3200    20    60  0                                          42
  2   3   8    4300    21    60  0                                          42
  2   3   8    5400    22    60  0                                          42
  2   3   7       0     5   400  0                                          42
  6   3   1       0     8   400  0                                          42
  6   3   7       0     3   400  0                                          42
  7   3   1       0     4   400  0                                          42
  7   3   7       0     7   400  0                                          42
```

DO NOT REMOVE THESE LINES !!!

Basic Detector Configuration

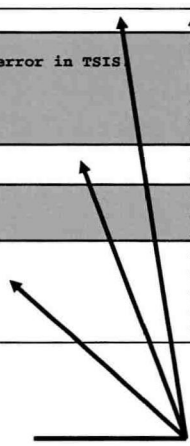
2	3	8	0	2	400	0	42
4	3	1	0	9999	10	0	42*
*This card is included as a work around for a programming error in TSIS. Do not remove.							
4	3	8	3200	26	60	0	42
4	3	8	4300	27	60	0	42
4	3	8	5400	28	60	0	42
4	3	8	0	6	400	0	42
4	3	7	0	1	400	0	42
2	3	8	3200	20	60	0	42
2	3	8	4300	21	60	0	42
2	3	8	5400	22	60	0	42
2	3	7	0	5	400	0	42
6	3	1	0	8	400	0	42
6	3	7	0	3	400	0	42
7	3	1	0	4	400	0	42
7	3	7	0	7	400	0	42



Multi-Loop Detectors for High Speed Approach

Basic Detector Configuration

2	3	8	0	2	400	0	42
4	3	1	0	9999	10	0	42*
*This card is included as a work around for a programming error in TSIS. Do not remove.							
4	3	8	3200	26	60	0	42
4	3	8	4300	27	60	0	42
4	3	8	5400	28	60	0	42
4	3	8	0	6	400	0	42
4	3	7	0	1	400	0	42
2	3	8	3200	20	60	0	42
2	3	8	4300	21	60	0	42
2	3	8	5400	22	60	0	42
2	3	7	0	5	400	0	42
6	3	1	0	8	400	0	42
6	3	7	0	3	400	0	42
7	3	1	0	4	400	0	42
7	3	7	0	7	400	0	42



Long-Loop (40') Stop Bar Detectors

Modifying Detector Configuration

```
  2   3   8      0     2   400  0                                        42
  4   3   1      0  9999    10  0                                        42*
*This card is included as a work around for a programming error in TSIS.
 Do not remove.
  4   3   8   3200    26    60  0                                        42
  4   3   8   4300    27    60  0                                        42
  4   3   8   5400    28    60  0                                        42
  4   3   8      0     6   400  0                                        42
  4   3   7      0     1   400  0                                        42
  2   3   8   3200    20    60  0                                        42
  2   3   8   4300    21    60  0                                        42
  2   3   8   5400    22    60  0                                        42
  2   3   7      0     5   400  0                                        42
  6   3   1      0     8   400  0                                        42
  6   3   7      0     3   400  0                                        42
  7   3   1      0     4   400  0                                        42
  7   3   7      0     7   400  0                                        42
```

Lane Covered: 1=Through
7= Left-turn
8=All-lanes

Downstream Node

Upstream Node

Modifying Detector Configuration

```
  2   3   8      0     2   400  0                                        42
  4   3   1      0  9999    10  0                                        42*
*This card is included as a work around for a programming error in TSIS.
 Do not remove.
  4   3   8   3200    26    60  0                                        42
  4   3   8   4300    27    60  0                                        42
  4   3   8   5400    28    60  0                                        42
  4   3   8      0     6   400  0                                        42
  4   3   7      0     1   400  0                                        42
  2   3   8   3200    20    60  0                                        42
  2   3   8   4300    21    60  0                                        42
  2   3   8   5400    22    60  0                                        42
  2   3   7      0     5   400  0                                        42
  6   3   1      0     8   400  0                                        42
  6   3   7      0     3   400  0                                        42
  7   3   1      0     4   400  0                                        42
  7   3   7      0     7   400  0                                        42
```

Operating Mode: 0=Presence

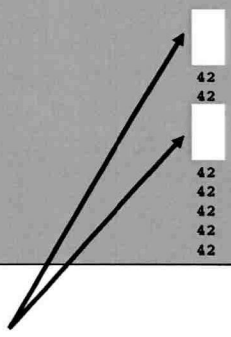
Detector Length (tenths of feet)

Detector Number

Distance from Stop Bar (tenths of feet)

Deleting Detectors

```
  2   3   8       0     2   400  0                                          42
  4   3   1       0  9999    10  0                                          42*
*This card is included as a work around for a programming error in TSIS.
 Do not remove.
  4   3   8    3200    26    60  0
  4   3   8    4300    27    60  0
  4   3   8    5400    28    60  0
  4   3   8       0     6   400  0                                          42
  4   3   7       0     1   400  0                                          42
  2   3   8    3200    20    60  0
  2   3   8    4300    21    60  0
  2   3   8    5400    22    60  0
  2   3   7       0     5   400  0                                          42
  6   3   1       0     8   400  0                                          42
  6   3   7       0     3   400  0                                          42
  7   3   1       0     4   400  0                                          42
  7   3   7       0     7   400  0                                          42
```



Simply remove “42” from last column

Adding Detectors

```
  2   3   8       0     2   400  0                                          42
  4   3   1       0  9999    10  0                                          42*
*This card is included as a work around for a programming error in TSIS.
 Do not remove.
  4   3   8    3200    26    60  0                                          42
  4   3   8    4300    27    60  0                                          42
  4   3   8    5400    28    60  0                                          42
  4   3   8       0     6   400  0                                          42
  4   3   7       0     1   400  0                                          42
  2   3   8    3200    20    60  0                                          42
  2   3   8    4300    21    60  0                                          42
  2   3   8    5400    22    60  0                                          42
  2   3   7       0     5   400  0                                          42
  6   3   1       0     8   400  0                                          42
  6   3   7       0     3   400  0                                          42
  6   3   8    1000    10    60  0                                          42
  7   3   1       0     4   400  0                                          42
  7   3   7       0     7   400  0                                          42
```

Example: Adds a 6’ detector across all lanes 100 ft upstream of stop bar on NB approach. Label as Detector 10.

DON”T FORGET TO CHANGE .INI File !!!

Adding Detector – Changing .INI File

```
NumberOfMappedDetectors = 18
MappedDetector[1] = SimulationDetector[1]->RealDetector[1]
MappedDetector[2] = SimulationDetector[2]->RealDetector[2]
MappedDetector[3] = SimulationDetector[3]->RealDetector[3]
MappedDetector[4] = SimulationDetector[4]->RealDetector[4]
MappedDetector[5] = SimulationDetector[5]->RealDetector[5]
MappedDetector[6] = SimulationDetector[6]->RealDetector[6]
MappedDetector[7] = SimulationDetector[7]->RealDetector[7]
MappedDetector[8] = SimulationDetector[8]->RealDetector[8]
MappedDetector[9] = SimulationDetector[9]->RealDetector[6]
MappedDetector[10] = SimulationDetector[10]->RealDetector[8]
MappedDetector[11] = SimulationDetector[11]->RealDetector[11]
MappedDetector[12] = SimulationDetector[12]->RealDetector[12]
MappedDetector[13] = SimulationDetector[20]->RealDetector[2]
MappedDetector[14] = SimulationDetector[21]->RealDetector[2]
MappedDetector[15] = SimulationDetector[22]->RealDetector[2]
MappedDetector[16] = SimulationDetector[26]->RealDetector[6]
MappedDetector[17] = SimulationDetector[27]->RealDetector[6]
MappedDetector[18] = SimulationDetector[28]->RealDetector[6]
```

Changing Multi-Loop Spacing

```
  2   3   8       0     2   400  0                                          42
  4   3   1       0  9999    10  0                                          42*
*This card is included as a work around for a programming error in TSIS.
 Do not remove.
  4   3   8    2750    26    60  0                                          42
  4   3   8    3750    27    60  0                                          42
  4   3   8    4750    28    60  0                                          42
  4   3   8       0     6   400  0                                          42
  4   3   7       0     1   400  0                                          42
  2   3   8    2750    20    60  0                                          42
  2   3   8    3750    21    60  0                                          42
  2   3   8    4750    22    60  0                                          42
  2   3   7       0     5   400  0                                          42
  6   3   1       0     8   400  0                                          42
  6   3   7       0     3   400  0                                          42
  7   3   1       0     4   400  0                                          42
  7   3   7       0     7   400  0                                          42
```

- Default spacing for 65 mph
- Example: change for 60 mph

Hands-On Practice

- Add 6x6 loop on NB and SB approaches 150 ft from stop line
- Change spacing on dilemma zone loops to 60 mph
- Delete stop bar detectors on EB and WB through lanes
- Save as "Pract3_detectors"

Modifying Geometry

Geometry -- Card Type 11

3	7	500			1		010		8004			20	18	30	0	11
4	5	640			2		0100		8002			20	18	65	0	11
2	1	640			2		0100		8001			20	18	65	0	11
3	6	500			1		010		8003			20	18	30	0	11
3	4	2000			2		0100		5			20	18	65	0	11
3	2	2000			2		0100		1			20	18	65	0	11
2	3	2000	250		2	1	0100	7	4	6	4	20	18	65	0	11
4	3	2000	250		2	1	0100	6	2	7	2	20	18	65	0	11
6	3	500	250		1	1	010	2	7	4	7	20	18	30	0	11
7	3	500	250		1	1	010	4	6	2	6	20	18	30	0	11
1	2	640			2		0100		3			20	18	65	0	11
5	4	640			2		0100		3			20	18	65	0	11
8002	5				2		0100		4			20	18		0	11
8001	1				2		0100		2			20	18		0	11
8004	7				1		010		3			20	18		0	11
8003	6				1		010		3			20	18		0	11

Entering Node

Card Type

Departing Node

Lengths -- Card Type 11 (Cont.)

3	7	500			1		010		8004			20	18	30	0	11
4	5	640			2		0100		8002			20	18	65	0	11
2	1	640			2		0100		8001			20	18	65	0	11
3	6	500			1		010		8003			20	18	30	0	11
3	4	2000			2		0100		5			20	18	65	0	11
3	2	2000			2		0100		1			20	18	65	0	11
2	3	2000	250		2	1	0100	7	4	6	4	20	18	65	0	11
4	3	2000	250		2	1	0100	6	2	7	2	20	18	65	0	11
6	3	500	250		1	1	010	2	7	4	7	20	18	30	0	11
7	3	500	250		1	1	010	4	6	2	6	20	18	30	0	11
1	2	640			2		0100		3			20	18	65	0	11
5	4	640			2		0100		3			20	18	65	0	11
8002	5				2		0100		4			20	18		0	11
8001	1				2		0100		2			20	18		0	11
8004	7				1		010		3			20	18		0	11
8003	6				1		010		3			20	18		0	11

Right-Turn Bay Length

Left-Turn Bay Length

Total Link Length

Number of Lanes -- Card Type 11 (Cont.)

```
   3   7 500       1    010        8004             20  18  30  0       11
   4   5 640       2    0100       8002             20  18  65  0       11
   2   1 640       2    0100       8001             20  18  65  0       11
   3   6 500       1    010        8003             20  18  30  0       11
   3   42000       2    0100          5             20  18  65  0       11
   3   22000       2    0100          1             20  18  65  0       11
   2   32000 250   2 1  0100       7  4   6       4 20  18  65  0       11
   4   32000 250   2 1  0100       6  2   7       2 20  18  65  0       11
   6   3 500 250   1 1  010        2  7   4       7 20  18  30  0       11
   7   3 500 250   1 1  010        4  6   2       6 20  18  30  0       11
   1   2 640       2    0100          3             20  18  65  0       11
   5   4 640       2    0100          3             20  18  65  0       11
8002   5           2    0100          4             20  18      0       11
8001   1           2    0100          2             20  18      0       11
8004   7           1    010           3             20  18      0       11
8003   6           1    010           3             20  18      0       11
```

Right-Turn Bay

Left-Turn Bay

Through Lanes

Approach Grade -- Card Type 11 (Cont.)

```
   3   7 500       1    010        8004             20  18  30  0       11
   4   5 640       2    0100       8002             20  18  65  0       11
   2   1 640       2    0100       8001             20  18  65  0       11
   3   6 500       1    010        8003             20  18  30  0       11
   3   42000       2    0100          5             20  18  65  0       11
   3   22000       2    0100          1             20  18  65  0       11
   2   32000 250   2 1  0100       7  4   6       4 20  18  65  0       11
   4   32000 250   2 1  0100       6  2   7       2 20  18  65  0       11
   6   3 500 250   1 1  010        2  7   4       7 20  18  30  0       11
   7   3 500 250   1 1  010        4  6   2       6 20  18  30  0       11
   1   2 640       2    0100          3             20  18  65  0       11
   5   4 640       2    0100          3             20  18  65  0       11
8002   5           2    0100          4             20  18      0       11
8001   1           2    0100          2             20  18      0       11
8004   7           1    010           3             20  18      0       11
8003   6           1    010           3             20  18      0       11
```

% Grade

Queue Discharge and Start-up Lost Time -- Card Type 11 (Cont.)

3	7 500		1	010	8004			20	18	30	0		11
4	5 640		2	0100	8002			20	18	65	0		11
2	1 640		2	0100	8001			20	18	65	0		11
3	6 500		1	010	8003			20	18	30	0		11
3	42000		2	0100	5			20	18	65	0		11
3	22000		2	0100	1			20	18	65	0		11
2	32000	250	2 1	0100	7	4	6	4	20	18	65	0	11
4	32000	250	2 1	0100	6	2	7	2	20	18	65	0	11
6	3 500	250	1 1	010	2	7	4	7	20	18	30	0	11
7	3 500	250	1 1	010	4	6	2	6	20	18	30	0	11
1	2 640		2	0100	3				20	18	65	0	11
5	4 640		2	0100	3				20	18	65	0	11
8002	5		2	0100	4				20	18		0	11
8001	1		2	0100	2				20	18		0	11
8004	7		1	010	3				20	18		0	11
8003	6		1	010	3				20	18		0	11

Queue Discharges and Start-up Lost Time Distribution Characteristic Code

Permitted Movements by Lane -- Card Type 11 (Cont.)

3	7 500		1	010	8004			20	18	30	0		11
4	5 640		2	0100	8002			20	18	65	0		11
2	1 640		2	0100	8001			20	18	65	0		11
3	6 500		1	010	8003			20	18	30	0		11
3	42000		2	0100	5			20	18	65	0		11
3	22000		2	0100	1			20	18	65	0		11
2	32000	250	2 1	0100	7	4	6	4	20	18	65	0	11
4	32000	250	2 1	0100	6	2	7	2	20	18	65	0	11
6	3 500	250	1 1	010	2	7	4	7	20	18	30	0	11
7	3 500	250	1 1	010	4	6	2	6	20	18	30	0	11
1	2 640		2	0100	3				20	18	65	0	11
5	4 640		2	0100	3				20	18	65	0	11
8002	5		2	0100	4				20	18		0	11
8001	1		2	0100	2				20	18		0	11
8004	7		1	010	3				20	18		0	11
8003	6		1	010	3				20	18		0	11

Channelization Codes

SHARED LANES ONLY – NOT NEEDED if turn pockets used!!

Channelization Codes

CODE	MEANING
0 (or blank)	Unchannelized
1	Left turn only
2	Buses only
3	Closed
4	Right turn only
5	Carpool only
6	Carpools and buses only
7	Right turns + right diagonal; right turns + through; also right turns + right diagonal + through if no other lane allows the through movement
8	Left turns + left diagonal; left turns + through; also left turns + left diagonal + through if no other lane allows the through movement
9	All movements permitted by the geometry and adjacent lane
D	Diagonal traffic only
T	Through traffic only

Receiving Nodes -- Card Type 11 (Cont.)

```
   3   7 500            1      010       8004                 20  18  30  0       11
   4   5 640            2      0100      8002                 20  18  65  0       11
   2   1 640            2      0100      8001                 20  18  65  0       11
   3   6 500            1      010       8003                 20  18  30  0       11
   3   42000            2      0100         5                 20  18  65  0       11
   3   22000            2      0100         1                 20  18  65  0       11
   2   32000 250        2 1    0100      7  4  6            4 20  18  65  0       11
   4   32000 250        2 1    0100      6  2  7            2 20  18  65  0       11
   6   3 500 250        1 1    010       2  7  4            7 20  18  30  0       11
   7   3 500 250        1 1    010       4  6  2            6 20  18  30  0       11
   1   2 640            2      0100         3                 20  18  65  0       11
   5   4 640            2      0100         3                 20  18  65  0       11
8002   5                2      0100         4                 20  18      0       11
8001   1                2      0100         2                 20  18      0       11
8004   7                1      010          3                 20  18      0       11
8003   6                1      010          3                 20  18      0       11
```

Left-Turns

Throughs

Right-Turns

Opposing Left-Turns -- Card Type 11 (Cont.)

3	7	500		1	010		8004					20	18	30	0		11
4	5	640		2	0100		8002					20	18	65	0		11
2	1	640		2	0100		8001					20	18	65	0		11
3	6	500		1	010		8003					20	18	30	0		11
3	42000			2	0100		5					20	18	65	0		11
3	22000			2	0100		1					20	18	65	0		11
2	32000	250	2 1	0100		7	4	6		4		20	18	65	0		11
4	32000	250	2 1	0100		6	2	7		2		20	18	65	0		11
6	3	500	250	1 1	010		2	7	4		7	20	18	30	0		11
7	3	500	250	1 1	010		4	6	2		6	20	18	30	0		11
1	2	640		2	0100		3					20	18	65	0		11
5	4	640		2	0100		3					20	18	65	0		11
8002	5			2	0100		4					20	18		0		11
8001	1			2	0100		2					20	18		0		11
8004	7			1	010		3					20	18		0		11
8003	6			1	010		3					20	18		0		11

Upstream node for traffic opposing left-turn

Mean Values -- Card Type 11 (Cont.)

3	7	500		1	010		8004					20	18	30	0		11
4	5	640		2	0100		8002					20	18	65	0		11
2	1	640		2	0100		8001					20	18	65	0		11
3	6	500		1	010		8003					20	18	30	0		11
3	42000			2	0100		5					20	18	65	0		11
3	22000			2	0100		1					20	18	65	0		11
2	32000	250	2 1	0100		7	4	6		4		20	18	65	0		11
4	32000	250	2 1	0100		6	2	7		2		20	18	65	0		11
6	3	500	250	1 1	010		2	7	4		7	20	18	30	0		11
7	3	500	250	1 1	010		4	6	2		6	20	18	30	0		11
1	2	640		2	0100		3					20	18	65	0		11
5	4	640		2	0100		3					20	18	65	0		11
8002	5			2	0100		4					20	18		0		11
8001	1			2	0100		2					20	18		0		11
8004	7			1	010		3					20	18		0		11
8003	6			1	010		3					20	18		0		11

Start-Up Lost Time

Queue Discharge Headway

Link Speeds -- Card Type 11 (Cont.)

3	7	500		1		010		8004			20	18	30	0	11
4	5	640		2		0100		8002			20	18	65	0	11
2	1	640		2		0100		8001			20	18	65	0	11
3	6	500		1		010		8003			20	18	30	0	11
3	4	2000		2		0100		5			20	18	65	0	11
3	2	2000		2		0100		1			20	18	65	0	11
2	3	2000	250	2	1	0100	7	4	6	4	20	18	65	0	11
4	3	2000	250	2	1	0100	6	2	7	2	20	18	65	0	11
6	3	500	250	1	1	010	2	7	4	7	20	18	30	0	11
7	3	500	250	1	1	010	4	6	2	6	20	18	30	0	11
1	2	640		2		0100		3			20	18	65	0	11
5	4	640		2		0100		3			20	18	65	0	11
8002	5			2		0100		4			20	18		0	11
8001	1			2		0100		2			20	18		0	11
8004	7			1		010		3			20	18		0	11
8003	6			1		010		3			20	18		0	11

Desired Free-Flow Speed (mph)

Fields Most Likely to be Changed

3	7	500		1		010		8004			20	18	30	0	11
4	5	640		2		0100		8002			20	18	65	0	11
2	1	640		2		0100		8001			20	18	65	0	11
3	6	500		1		010		8003			20	18	30	0	11
3	4	2000		2		0100		5			20	18	65	0	11
3	2	2000		2		0100		1			20	18	65	0	11
2	3	2000	250	2	1	0100	7	4	6	4	20	18	65	0	11
4	3	2000	250	2	1	0100	6	2	7	2	20	18	65	0	11
6	3	500	250	1	1	010	2	7	4	7	20	18	30	0	11
7	3	500	250	1	1	010	4	6	2	6	20	18	30	0	11
1	2	640		2		0100		3			20	18	65	0	11
5	4	640		2		0100		3			20	18	65	0	11
8002	5			2		0100		4			20	18		0	11
8001	1			2		0100		2			20	18		0	11
8004	7			1		010		3			20	18		0	11
8003	6			1		010		3			20	18		0	11

- Link and Turn Bay Lengths
- Number of Lanes and Bays
- Approach Speeds
- Channelization Codes (possibly)

Lines where most changes will be made.

Adding Right-Turn Lane

Example: Add Right-turn lane to NB Approach

```
3   7 500         1     010         8004                  20  18  30  0      11
4   5 640         2     0100        8002                  20  18  65  0      11
2   1 640         2     0100        8001                  20  18  65  0      11
3   6 500         1     010         8003                  20  18  30  0      11
3   42000         2     0100           5                  20  18  65  0      11
3   22000         2     0100           1                  20  18  65  0      11
2   32000 250     2 1   0100        7  4   6          4   20  18  65  0      11
4   32000 250     2 1   0100        6  2   7          2   20  18  65  0      11
6   3 500 250 250 1 1 1 010         2  7   4          7   20  18  30  0      11
7   3 500 250     1 1   010         4  6   2          6   20  18  30  0      11
```

Adds Right Turn Lane

Right-Turn Bay Length

Adding Dual Left-Turns

Example: Add Left-turn lane to WB Approach

```
3   7 500         1     010         8004                  20  18  30  0      11
4   5 640         2     0100        8002                  20  18  65  0      11
2   1 640         2     0100        8001                  20  18  65  0      11
3   6 500         2     010         8003                  20  18  30  0      11
3   42000         2     0100           5                  20  18  65  0      11
3   22000         2     0100           1                  20  18  65  0      11
2   32000 250     2 1   0100        7  4   6          4   20  18  65  0      11
4   32000 250     2 2   0100        6  2   7          2   20  18  65  0      11
6   3 500 250     1 1   010         2  7   4          7   20  18  30  0      11
7   3 500 250     1 1   010         4  6   2          6   20  18  30  0      11
```

Change number of lanes in left-turn bay

NOTE: Destination link also need to be changed to accept dual lefts

ALSO NEED TO CHANGE .sdi FILE TO "PROTECTED ONLY"

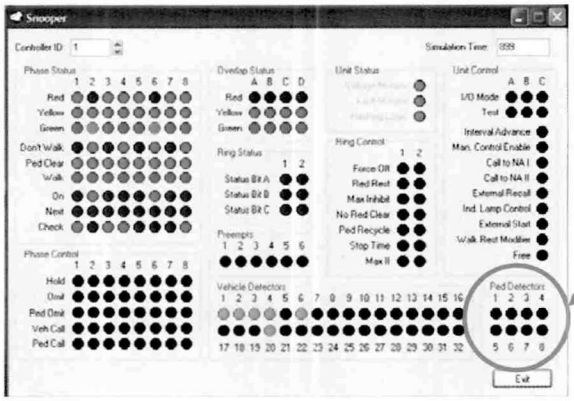
Hands-On Practice

- Add right-turn lane to NB approach
- Make dual left-turns for WB/EB approach
- Save as Pract3_Geometry

Special Operations

Pedestrians

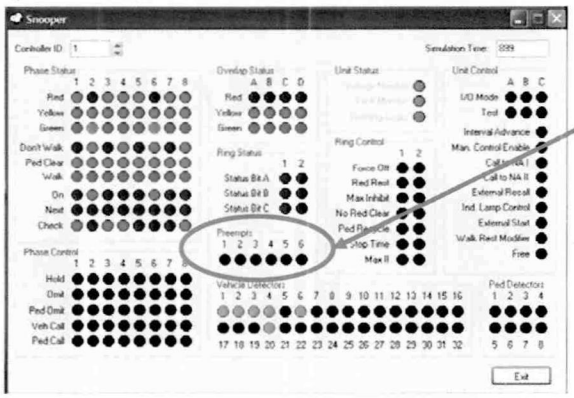
- Use Snooper to manually toggle when pedestrian calls to controller



Click on appropriate *Ped Detector* to place ped call on associated with phase

Preemption

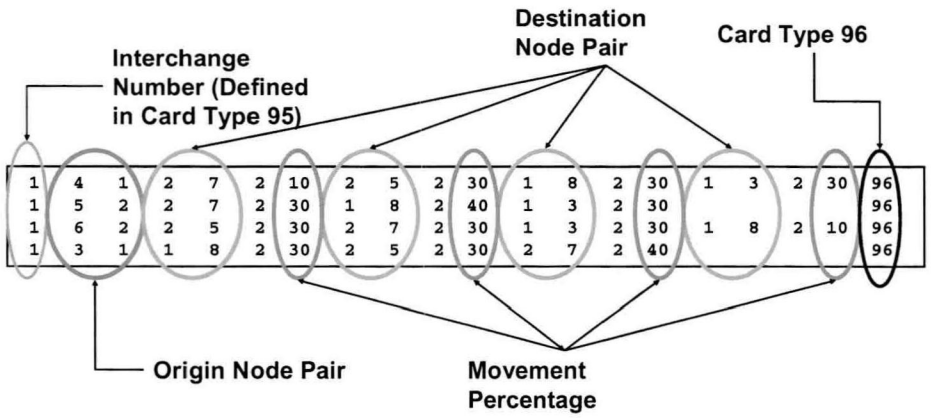
- Use Snooper to manually toggle when preemption to occur



Click on appropriate *Preempts* to place preempt call

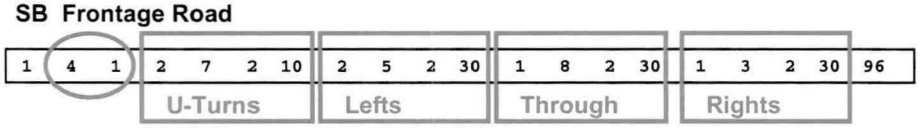
Note: High Priority Preempts only

Diamonds –Volumes Based On Origin/Destinations

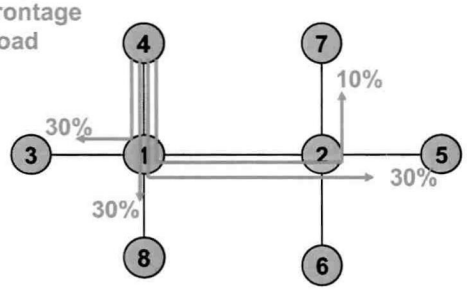


Diamonds – Modifying Volumes

SB Frontage Road



Origin-- SB Frontage Road



U-Turn (4→1→2→7) = 10%

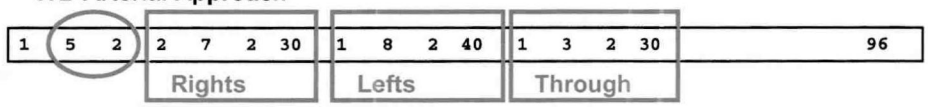
Lefts (4→1→2→5) = 30%

Through (4→1→1→8)= 30%

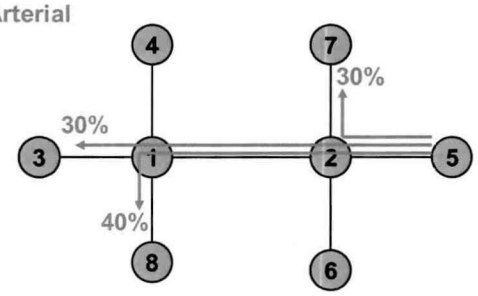
Rights (4→1→2→7) = 10%

Diamonds – Modifying Volumes

WB Arterial Approach



Origin– WB Arterial



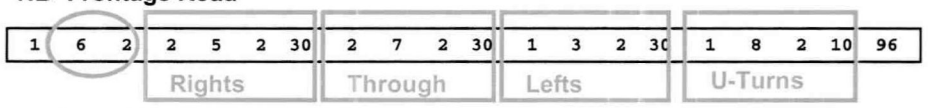
Rights (5→2→2→7) = 30%

Lefts (5→2→2→7) = 40%

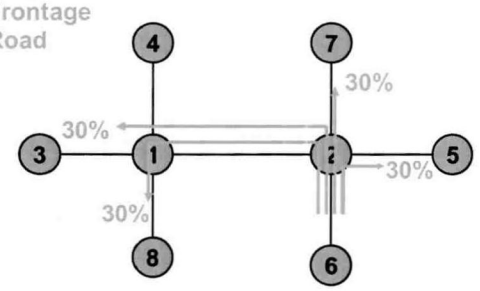
Through (5→2→1→3) = 30%

Diamonds – Modifying Volumes

NB Frontage Road



Origin-- NB Frontage Road



Rights (6→2→2→5) = 30%

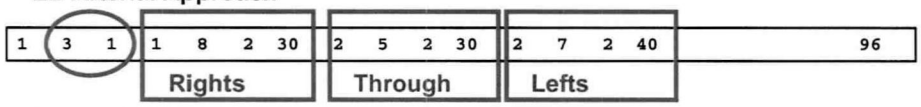
Through (6→2→2→7) = 30%

Lefts (6→2→1→3)= 30%

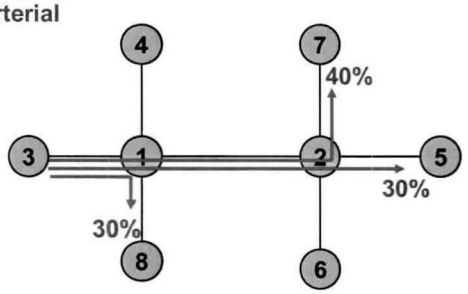
U-Turns (6→2→1→8) = 10%

Diamonds – Modifying Volumes

EB Arterial Approach



Origin– EB Arterial



Rights (3→1→1→8) = 30%

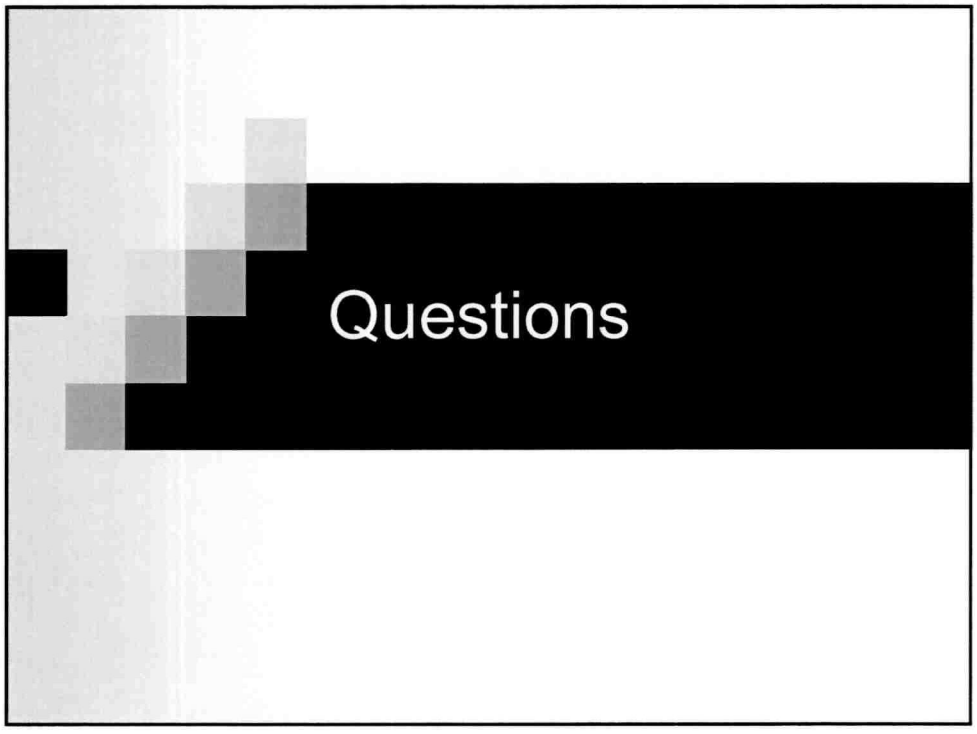
Through (3→1→2→5) = 30%

Left (3→1→2→7) = 40%

Diamonds

- Set Controller in Diamond mode
- Modify .ini file to correct diamond configuration

```
MappedDetector[13] = SimulationDetector[20]->RealDetector[8]
MappedDetector[14] = SimulationDetector[21]->RealDetector[8]
MappedDetector[15] = SimulationDetector[22]->RealDetector[8]
MappedDetector[16] = SimulationDetector[26]->RealDetector[4]
MappedDetector[17] = SimulationDetector[27]->RealDetector[4]
MappedDetector[18] = SimulationDetector[28]->RealDetector[4]
```

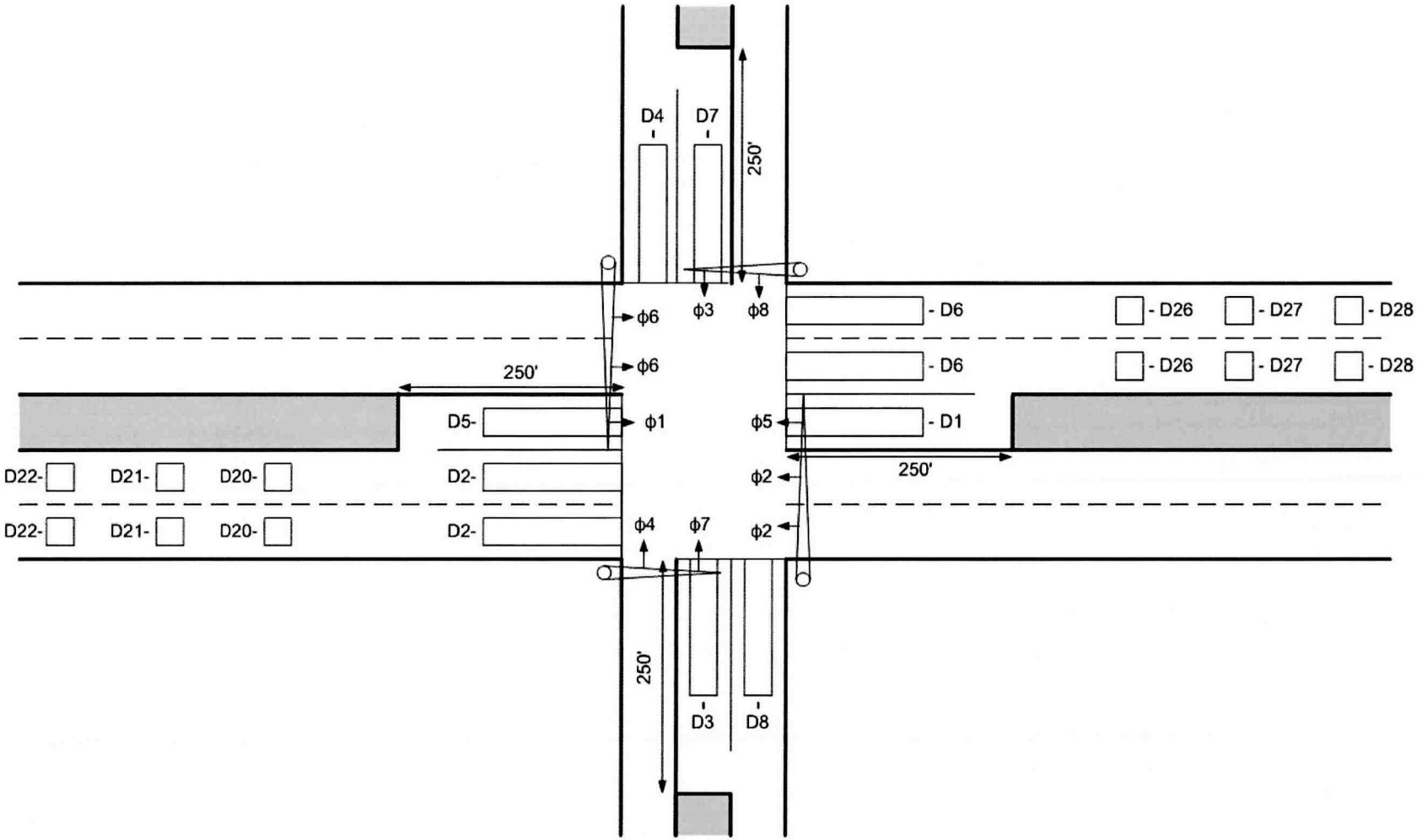

Questions

SCHEMATIC AND PRINTOUT OF SIMULATION FILE

FOR

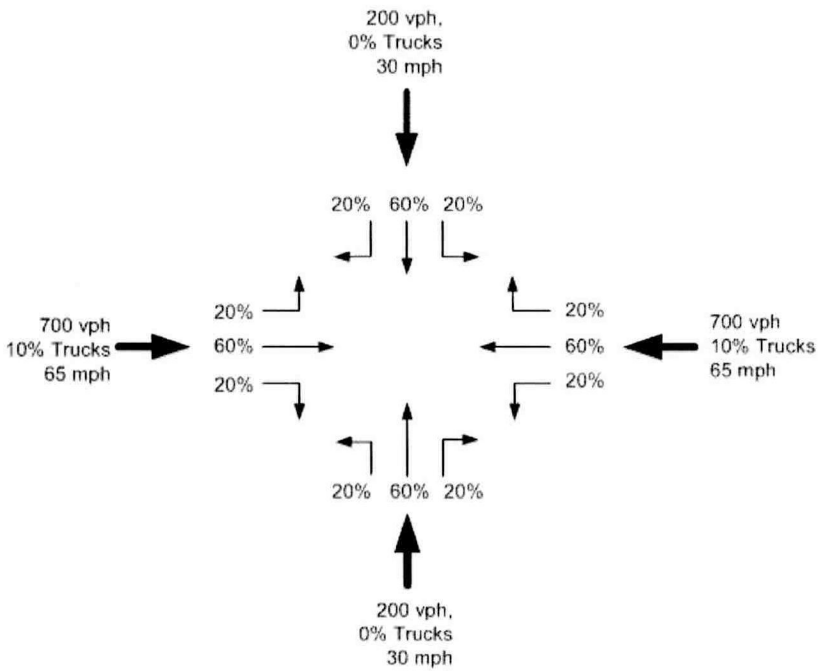
STANDARD 4-LEG INTERSECTION

SCHEMATIC OF EXAMPLE OF STANDARD 4-LEG INTERSECTION WITH MULTI-LOOP DETECTORS



SCHEMATIC OF EXAMPLE OF STANDARD 4-LEG INTERSECTION WITH MULTI-LOOP DETECTORS (CONT.)

APPROACH VOLUME AND TURNING PERCENTAGES



DETECTOR DETAILS

Detector Name	Size	Associated Phase	Operation Mode	Distance From Stop Bar	Function
D1	6'x40'	ϕ1	Presence	0'	Call & Extend
D2	6'x40'	ϕ2	Presence	0'	Call & Extend
D3	6'x40'	ϕ3	Presence	0'	Call & Extend
D4	6'x40'	ϕ4	Presence	0'	Call & Extend
D5	6'x40'	ϕ5	Presence	0'	Call & Extend
D6	6'x40'	ϕ6	Presence	0'	Call & Extend
D7	6'x40'	ϕ7	Presence	0'	Call & Extend
D8	6'x40'	ϕ8	Presence	0'	Call & Extend
D20	6'x6'	ϕ2	Presence	320'	Call & Extend
D21	6'x6'	ϕ2	Presence	430'	Call & Extend
D22	6'x6'	ϕ2	Presence	540'	Call & Extend
D26	6'x6'	ϕ6	Presence	320'	Call & Extend
D27	6'x6'	ϕ6	Presence	430'	Call & Extend
D28	6'x6'	ϕ6	Presence	540'	Call & Extend

CORSIM SIMULATION FILE FOR STANDARD, 4-LEG INTERSECTION

```
Created by TSIS Wed Jan 29 09:27:16 2003 from TNO Version 52                  0
ITRAF 2.6                                                                     0
This is a test configuration for algorithm testing,                           0
                                                                              0
                                                                              0
The link-node diagram is shown below:                                         0
                                                                              0
                                 8004                                         0
                                   |                                          0
                                   |                                          0
                                   7                                          0
                                   |                                          0
                                   |                                          0
      8001----1---2----------------3----------------4---5----8002             0
                                   |                                          0
                                   |                                          0
                                   6                                          0
                                   |                                          0
                                   |                                          0
                                 8003                                         0
                                                                              0
                                                                              0
                                                                              0
Link (2,3) and (3,4) are 2000' long; links (1,2) and (4,5) are 640' long      0
                                                                              0
Nodes 2 and 4 were included to investigate the effects of relatively          0
nearby intersections (sometime in the future).                                0
                                                                              0
12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 234567
                                      11  26   0                           0  1
       1   0       3     7981 0000  21             3 800       7729     7529  2
 900                                                                          3
                  60                                                          4
   0       0   0   0   0   0   0   0   0   0   1    d60out                    5
   3   7 500       1     010          8004                  20  18  30  0    11
   4   5 640       2     0100         8002                  20  18  65  0    11
   2   1 640       2     0100         8001                  20  18  65  0    11
   3   6 500       1     010          8003                  20  18  30  0    11
   3   42000       2     0100            5                  20  18  65  0    11
   3   22000       2     0100            1                  20  18  65  0    11
   2   32000 250   2 1   0100        7   4   6       4      20  18  65  0    11
   4   32000 250   2 1   0100        6   2   7       2      20  18  65  0    11
   6   3 500 250   1 1   010         2   7   4       7      20  18  30  0    11
   7   3 500 250   1 1   010         4   6   2       6      20  18  30  0    11
   1   2 640       2     0100            3                  20  18  65  0    11
   5   4 640       2     0100            3                  20  18  65  0    11
8002   5           2     0100            4                  20  18      0    11
8001   1           2     0100            2                  20  18      0    11
8004   7           1     010             3                  20  18      0    11
8003   6           1     010             3                  20  18      0    11
   3   7     100                                                             21
   4   5     100                                                             21
   2   1     100                                                             21
   3   6     100                                                             21
   3   4     100                                                             21
   3   2     100                                                             21
   2   3  20  60  20   0                                                     21
   4   3  20  60  20   0                                                     21
   6   3  20  60  20   0                                                     21
   7   3  20  60  20   0                                                     21
   1   2     100                                                             21
   5   4     100                                                             21
8002   5     100                                                             21
8001   1     100                                                             21
8004   7     100                                                             21
8003   6     100                                                             21
   1       28001                                                             35
   2       3   1                                                             35
```

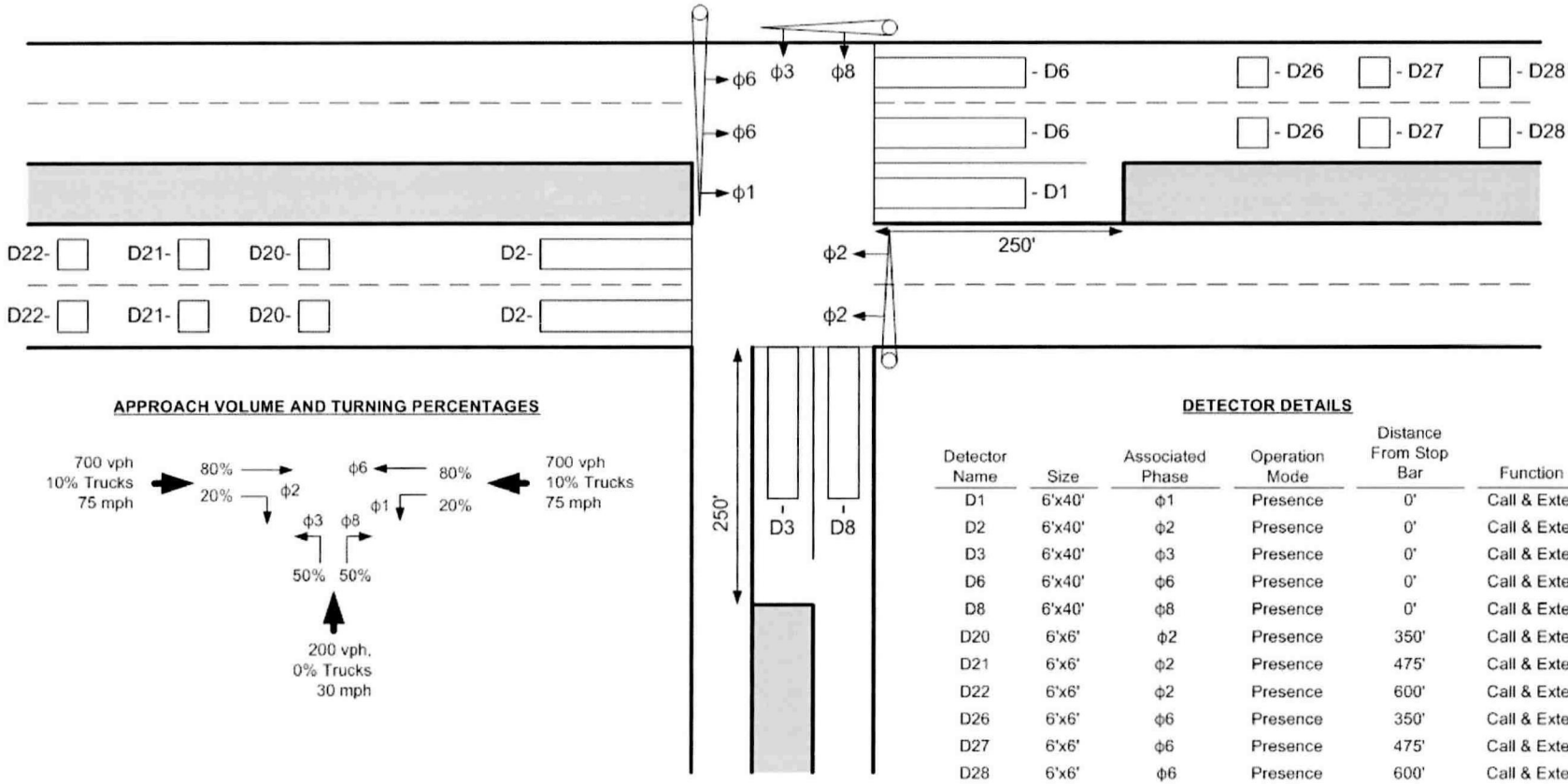
```
   4       3   5                                                          35
   5       48002                                                          35
   6       38003                                                          35
   7       38004                                                          35
   1 11                                                                   36
   2 11                                                                   36
   4 11                                                                   36
   5 11                                                                   36
   6 11                                                                   36
   7 11                                                                   36
   2   3   8       0     2   400  0                                       42
   4   3   1       0  9999    10  0                                       42   This card is
included as a work around for a programming error in TSIS.  Do not remove.
   4   3   8    3200    26    60  0                                       42
   4   3   8    4300    27    60  0                                       42
   4   3   8    5400    28    60  0                                       42
   4   3   8       0     6   400  0                                       42
   4   3   7       0     1   400  0                                       42
   2   3   1       0  9998    10  0                                       42   This card is
included as a work around for a programming error in TSIS.  Do not remove.
   2   3   8    3200    20    60  0                                       42
   2   3   8    4300    21    60  0                                       42
   2   3   8    5400    22    60  0                                       42
   2   3   7       0     5   400  0                                       42
   6   3   1       0     8   400  0                                       42
   6   3   7       0     3   400  0                                       42
   7   3   1       0     4   400  0                                       42
   7   3   7       0     7   400  0                                       42
   2   3   8       0     2   400  0


   3   2   3   6   3   4   3   7   3          0                        2 43
8004   7 200   0   0 100                                                 50
8002   5 700  10   0 100                                                 50
8001   1 700  10   0 100                                                 50
8003   6 200   0   0 100                                                 50
   9  14         100                        0   0   0  25            350  58
   3  16         100                        0   0   0  75            350  58
  79  87  92  95  98 102 105 108 113 121                                147
   0                                                                    170
8004   13440   21800                                                    195
8002   16180   20800                                                    195
8001   10700   20800                                                    195
8003   13440   19800                                                    195
   1   10800   20800                                                    195
   2   11440   20800                                                    195
   3   13440   20800                                                    195
   4   15440   20800                                                    195
   5   16080   20800                                                    195
   6   13440   20300                                                    195
   7   13440   21300                                                    195
   1   0   0                                                            210
```

SCHEMATIC AND PRINTOUT OF SIMULATION FILE

FOR

STANDARD T-INTERSECTION

SCHEMATIC OF EXAMPLE OF T-INTERSECTION WITH MULTI-LOOP DETECTORS



APPROACH VOLUME AND TURNING PERCENTAGES

DETECTOR DETAILS

Detector Name	Size	Associated Phase	Operation Mode	Distance From Stop Bar	Function
D1	6'x40'	φ1	Presence	0'	Call & Extend
D2	6'x40'	φ2	Presence	0'	Call & Extend
D3	6'x40'	φ3	Presence	0'	Call & Extend
D6	6'x40'	φ6	Presence	0'	Call & Extend
D8	6'x40'	φ8	Presence	0'	Call & Extend
D20	6'x6'	φ2	Presence	350'	Call & Extend
D21	6'x6'	φ2	Presence	475'	Call & Extend
D22	6'x6'	φ2	Presence	600'	Call & Extend
D26	6'x6'	φ6	Presence	350'	Call & Extend
D27	6'x6'	φ6	Presence	475'	Call & Extend
D28	6'x6'	φ6	Presence	600'	Call & Extend

CORSIM SIMULATION FILE FOR T-INTERSECTION

```
Created by TSIS Wed Jan 29 09:27:16 2003 from TNO Version 52                    0
ITRAF 2.6                                                                       0
This is a test configuration for algorithm testing,                             0
                                                                                0
                                                                                0
The link-node diagram is shown below:                                           0
                                                                                0
      8001----1---2----------------3----------------4---5----8002               0
                                   |                                            0
                                   |                                            0
                                   6                                            0
                                   |                                            0
                                   |                                            0
                                 8003                                           0
                                                                                0
                                                                                0
                                                                                0
Link (2,3) and (3,4) are 2000' long; links (1,2) and (4,5) are 640' long        0
                                                                                0
Nodes 2 and 4 were included to investigate the effects of relatively            0
nearby intersections (sometime in the future).                                  0
                                                                                0
12345678 1 2345678 2 2345678 3 2345678 4 2345678 5 2345678 6 2345678 7 234567
                                    11  26   0                          0   1
      1   0       3     7981 0000  21             3 800        7729    7529   2
 900                                                                            3
                  60                                                            4
   0       0   0   0   0   0   0   0   0   0   1    d60out                     5
   4   5 640         2     0100          8002              20  18  70  0       11
   2   1 640         2     0100          8001              20  18  70  0       11
   3   6 500         1     010           8003              20  18  30  0       11
   3   42000         2     0100             5              20  18  70  0       11
   3   22000         2     0100             1              20  18  70  0       11
   2   32000   0     2     0170             4   6       4  20  18  70  0       11
   4   32000 250     2 1   0100          6   2          2  20  18  70  0       11
   6   3 500 250     1 1   014           2       4         20  18  30  0       11
   1   2 640         2     0100             3              20  18  70  0       11
   5   4 640         2     0100             3              20  18  70  0       11
8002   5             2     0100             4              20  18      0       11
8001   1             2     0100             2              20  18      0       11
8003   6             1     010              3              20  18      0       11
   4   5     100                                                              21
   2   1     100                                                              21
   3   6     100                                                              21
   3   4     100                                                              21
   3   2     100                                                              21
   2   3   0  80  20   0                                                      21
   4   3  20  80   0   0                                                      21
   6   3  50   0  50   0                                                      21
   1   2     100                                                              21
   5   4     100                                                              21
8002   5     100                                                              21
8001   1     100                                                              21
8003   6     100                                                              21
   1       28001                                                            35
   2       3   1                                                            35
   4       3   5                                                            35
   5       48002                                                            35
   6       38003                                                            35
   1 11                                                                     36
   2 11                                                                     36
   4 11                                                                     36
   5 11                                                                     36
   6 11                                                                     36
   2   3   8       0     2   400  0                                         42
   4   3   8       0  9999    10  0                                         42  This card is
included as a work around for a programming error in TSIS.  Do not remove.
```

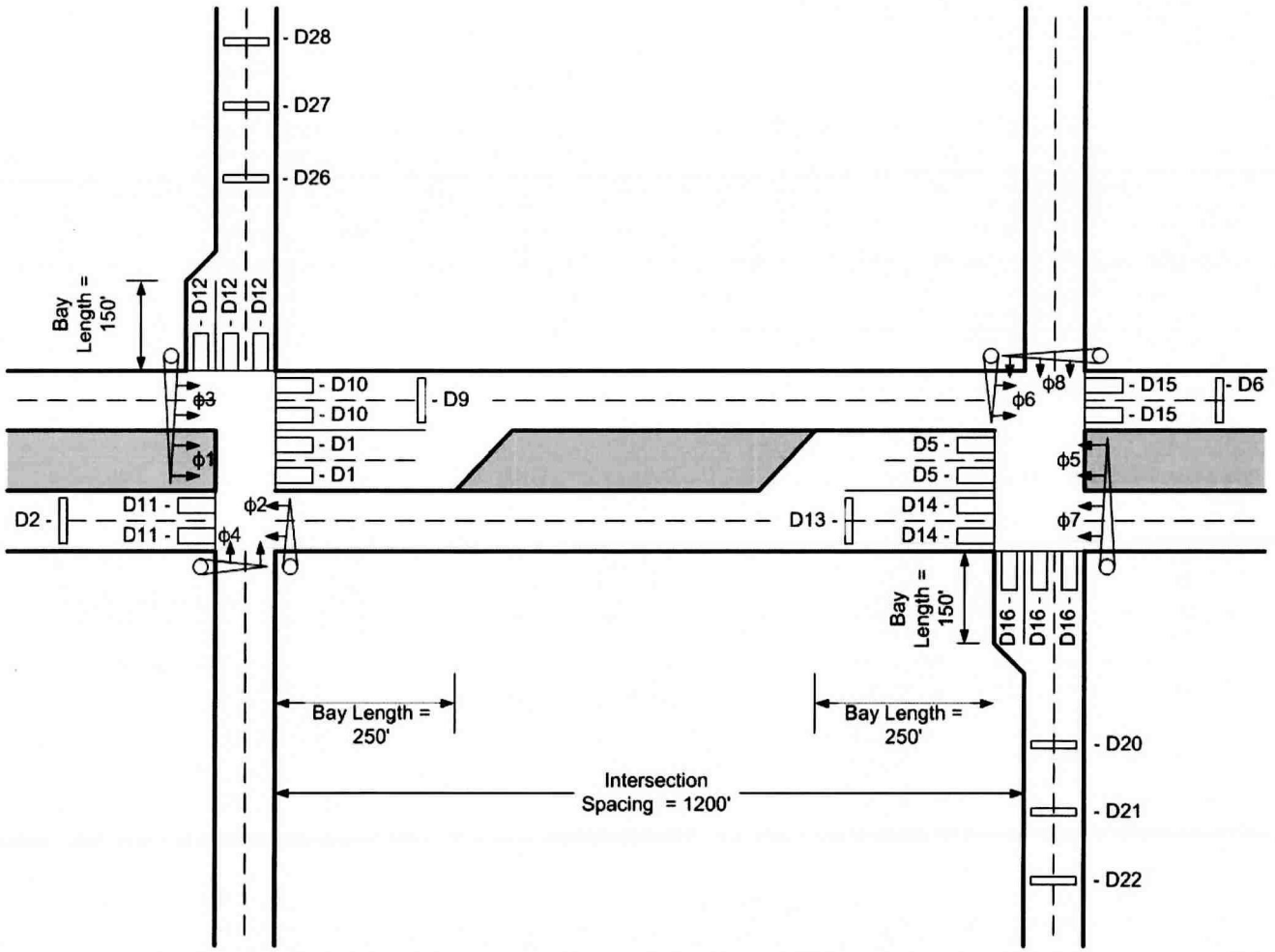
```
   2   3   8    3500    20    60  0                                  42
   2   3   8    4750    21    60  0                                  42
   2   3   8    6000    22    60  0                                  42
   4   3   8    3500    26    60  0                                  42
   4   3   8    4750    27    60  0                                  42
   4   3   8    6000    28    60  0                                  42
   4   3   7       0     1   400  0                                  42
   4   3   8       0     6   400  0                                  42
   6   3   1       0     8   400  0                                  42
   6   3   7       0     3   400  0                                  42
   3   2   3   6   3   4   3                   0                  2 43
8002   5 700  10   0 100                                            50
8001   1 700  10   0 100                                            50
8003   6 200   0   0 100                                            50
   9  14         100                       0   0   0  25        350  58
   3  16         100                       0   0   0  75        350  58
  79  87  92  95  98 102 105 108 113 121                            147
   0                                                                170
8002   16180   20800                                                195
8001   10700   20800                                                195
8003   13440   19800                                                195
   1   10800   20800                                                195
   2   11440   20800                                                195
   3   13440   20800                                                195
   4   15440   20800                                                195
   5   16080   20800                                                195
   6   13440   20300                                                195
   1   0   0                                                        210
```

SCHEMATIC AND PRINTOUT OF SIMULATION FILE

FOR

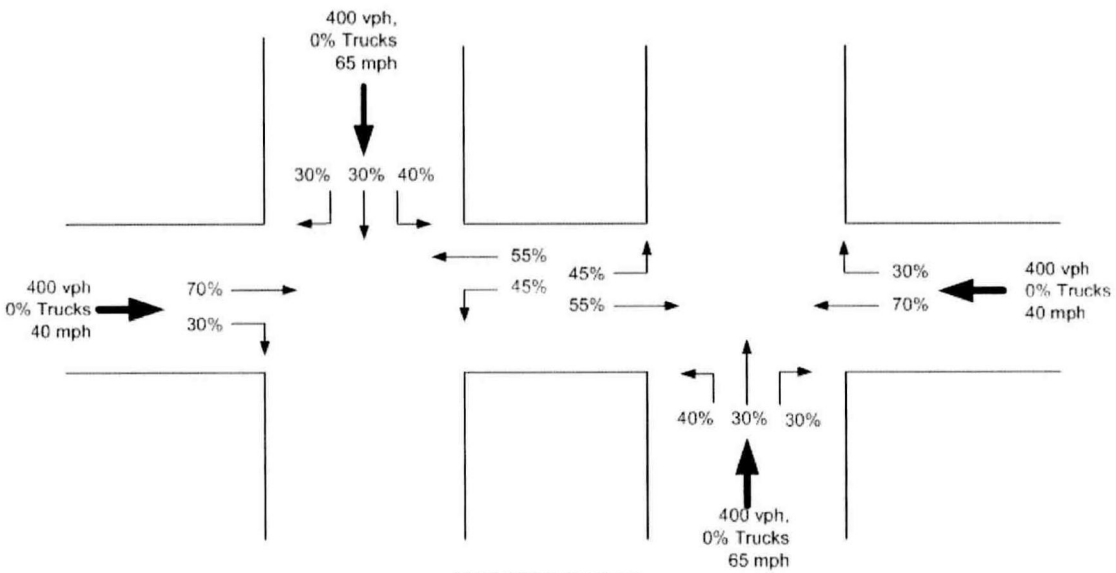
WIDE DIAMOND INTERCHANGE

SCHEMATIC OF EXAMPLE OF WIDE DIAMOND INTERCHANGE WITH MULTI-LOOP DETECTORS



SCHEMATIC OF EXAMPLE OF WIDE DIAMOND INTERCHANGE WITH MULTI-LOOP DETECTORS (CONT.)

APPROACH VOLUME AND TURNING PERCENTAGES



DETECTOR DETAILS

Detector Name	Size	Operation Mode	Distance From Stop Bar	Function
D1	6'x40'	Presence	0'	Call & Extend
D2	6'x6'	Presence	150'	Call & Extend
D5	6'x40'	Presence	0'	Call & Extend
D6	6'x6'	Presence	150'	Call & Extend
D9	6'x6'	Presence	150'	Call & Extend
D10	6'x40'	Presence	0'	Call & Extend
D11	6'x40'	Presence	0'	Call & Extend
D12	6'x40'	Presence	0'	Call & Extend
D13	6'x6'	Presence	150'	Call & Extend
D14	6'x40'	Presence	0'	Call & Extend
D15	6'x40'	Presence	0'	Call & Extend
D16	6'x40'	Presence	0'	Call & Extend
D20	6'x6'	Presence	320'	Call & Extend
D21	6'x6'	Presence	430'	Call & Extend
D22	6'x6'	Presence	540'	Call & Extend
D26	6'x6'	Presence	320'	Call & Extend
D27	6'x6'	Presence	430'	Call & Extend
D28	6'x6'	Presence	540'	Call & Extend

CORSIM SIMULATION FILE FOR WIDE DIAMOND INTERCHANGE WITH MULT-LOOP DETECTORS

```
                                                                              00
                                  [8003]      [8005]                          00
                                    |            |                            00
                                   (4)          (7)                           00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
            [8001]--(3)------------(1)----------(2)----------(5)--[8002]      00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
                                    |            |                            00
                                   (8)          (6)                           00
                                    |            |                            00
                                  [8006]      [8004]                          00
                                                                              00
Srinivasa Sunkari                     06  28  05TTI                            1
       1   0       3    7981          10000       31200        7111    7581    2
3600                                                                           3
                  60                                                           4
                                               1                               5
   1   21200 250     2 2     TT        7   5           5 15  15  40 1 11      11
   1   3 600         2       9          8001             15  15  40 1 11      11
   1   8 600         2       TT         8006             15  15  40   11      11
   2   11200 250     2 2     TT        8   3           3 15  15  40 1 11      11
   2   5 600         2       9          8002             15  15  40   11      11
   2   7 600         2       TT         8005             15  15  40   11      11
   3   1 600         2       7T            2   8         15  15  40   11      11
   4   1 600     150 2   1   T8        2   8   3         15  15  65 0 11      11
   5   2 600         2       7T            1   7         15  15  40   11      11
   6   2 600 150     2 1     78        1   7   5         15  15  65   11      11
8001   3             2                     1             15  15   0   11      11
8002   5             2                     2             15  15   0   11      11
8003   4             2                     1             15  15   0   11      11
8004   6             2                     2             15  15   0   11      11

8001   3     100                                                              21
8002   5     100                                                              21
8003   4     100                                                              21
8004   6     100                                                              21

   3       18001                                                              35
   4    8003                                                                  35
   5       28002                                                              35
   6    8004                                                                  35
   7       2                                                                  35
   8       1                                                                  35

   3 11                                                                       36
   4 1                                                                        36
   5 11                                                                       36
   6 1                                                                        36
   7 1                                                                        36
   8 1                                                                        36

   1   2   67      0     5   400   0                                          42
   1   2   12      0    14   400   0                                          42
   1   2   12   1500    13    60   0                                          42
   2   1   67      0     1   400   0                                          42
   2   1   12      0    10   400   0                                          42
```

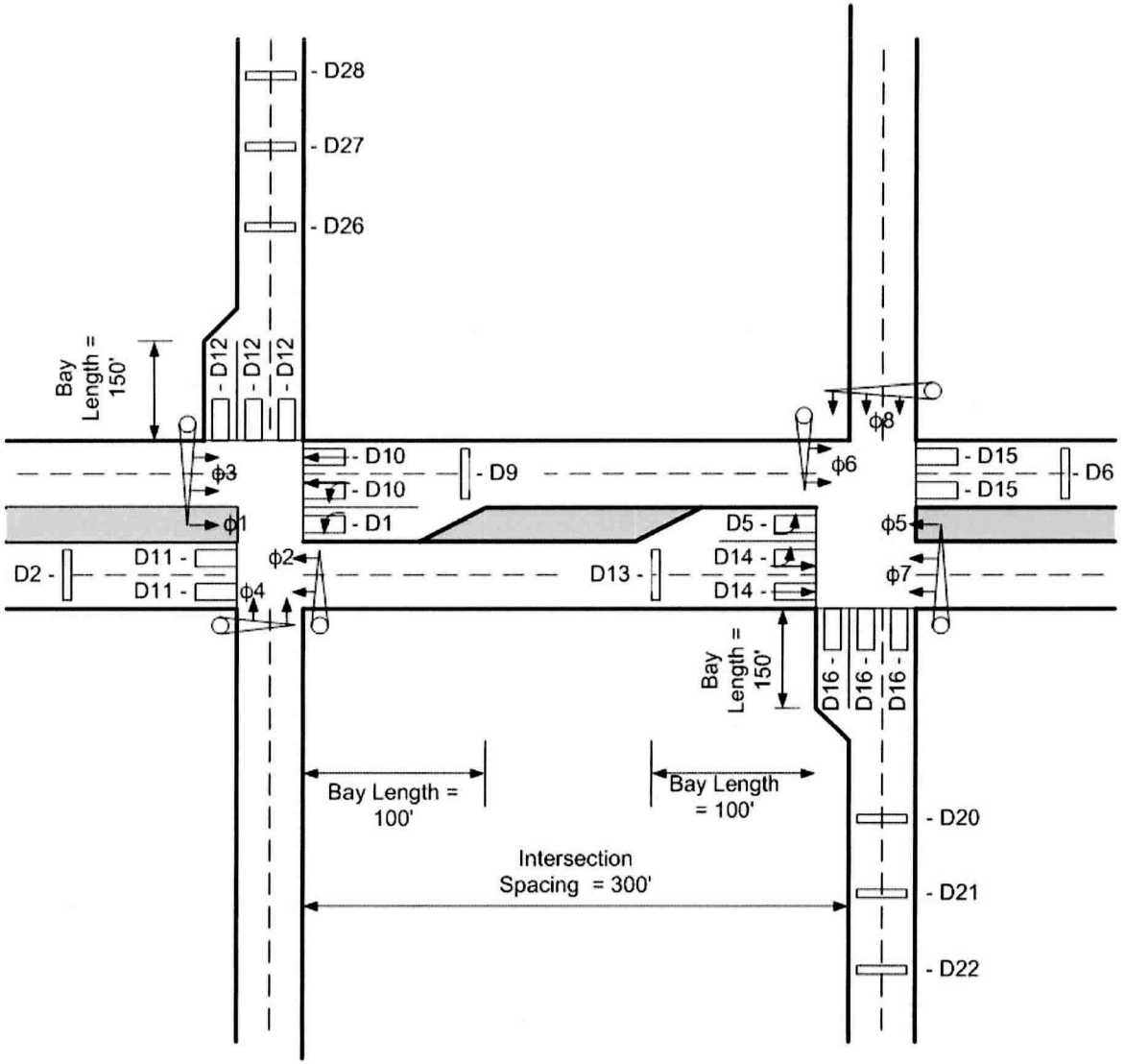
```
   2   1   12   1500     9    60  0                                          42
   4   1   1       0  9999    10  0                                          42  This card is
included as a work around for a programming error in TSIS.  Do not remove.
   4   1   8    3200    26    60  0                                          42
   4   1   8    4300    27    60  0                                          42
   4   1   8    5400    28    60  0                                          42
   4   1   8       0    12   400  0                                          42
   3   1   12      0    11   400  0                                          42
   3   1   12   1500     2    60  0                                          42
   5   2   12      0    15   400  0                                          42
   5   2   12   1500     6    60  0                                          42
   6   2   1       0  9999    10  0                                          42  This card is
included as a work around for a programming error in TSIS.  Do not remove.
   6   2   8    3200    20    60  0                                          42
   6   2   8    4300    21    60  0                                          42
   6   2   8    5400    22    60  0                                          42
   6   2   9       0    16   400  0                                          42

   1   3   1   4   1   2   1                  0                          2 43
   2   6   2   5   2   1   2                  0                          2 43  Col77 - 2 to
flag


8001   3 400                                                                 50
8002   5 400                                                                 50
8003   4 400                                                                 50
8004   6 400                                                                 50

8001   3 100  15 200  30 300  45 400  60                                  0   53
8002   5 100  15 200  30 300  45 400  60                                  0   53
8003   4 100  15 200  30 300  45 400  60                                  0   53
8004   6 100  15 200  30 300  45 400  60                                  0   53

   1   2   1   1   2   4   1   5   2   2   5   6   2   1   3   3   1   2   7  95
   1   1   8                                                                 95

   1   4   1   2   7   2  10   2   5   2  30   1   8   2  30   1   3   2  30  96
   1   5   2   2   7   2  30   1   8   2  40   1   3   2  30                  96
   1   6   2   2   5   2  30   2   7   2  30   1   3   2  30   1   8   2  10  96
   1   3   1   1   8   2  30   2   5   2  30   2   7   2  40                  96

   0                                                                        170

   1    1800    1000                                                        195
   2    3000    1000                                                        195
   3    1200    1000                                                        195
   4    1800    1600                                                        195
   5    3600    1000                                                        195
   6    3000     400                                                        195
   7    3000    1600                                                        195
   8    1800     400                                                        195

8001     900    1000                                                        195
8002    3900    1000                                                        195
8003    1800    1900                                                        195
8004    3000     100                                                        195
8005    3000    1900                                                        195
8006    1800     100                                                        195

   1                                                                        210
```

SCHEMATIC AND PRINTOUT OF SIMULATION FILE

FOR

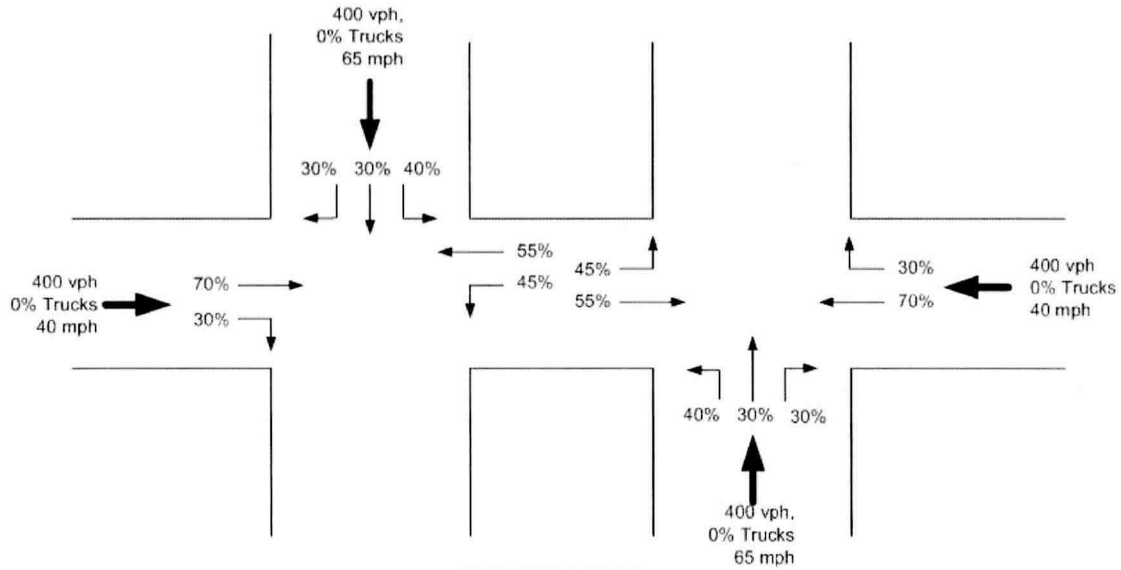
TIGHT DIAMOND INTERCHANGE

SCHEMATIC OF EXAMPLE OF TIGHT DIAMOND INTERCHANGE WITH MULTI-LOOP DETECTORS



SCHEMATIC OF EXAMPLE OF TIGHT DIAMOND INTERCHANGE WITH MULTI-LOOP DETECTORS (CONT.)

APPROACH VOLUME AND TURNING PERCENTAGES



DETECTOR DETAILS

Detector Name	Size	Operation Mode	Distance From Stop Bar	Function
D1	6'x40'	Presence	0'	Call & Extend
D2	6'x6'	Presence	150'	Call & Extend
D5	6'x40'	Presence	0'	Call & Extend
D6	6'x6'	Presence	150'	Call & Extend
D9	6'x6'	Presence	150'	Call & Extend
D10	6'x40'	Presence	0'	Call & Extend
D11	6'x40'	Presence	0'	Call & Extend
D12	6'x40'	Presence	0'	Call & Extend
D13	6'x6'	Presence	150'	Call & Extend
D14	6'x40'	Presence	0'	Call & Extend
D15	6'x40'	Presence	0'	Call & Extend
D16	6'x40'	Presence	0'	Call & Extend
D20	6'x6'	Presence	320'	Call & Extend
D21	6'x6'	Presence	430'	Call & Extend
D22	6'x6'	Presence	540'	Call & Extend
D26	6'x6'	Presence	320'	Call & Extend
D27	6'x6'	Presence	430'	Call & Extend
D28	6'x6'	Presence	540'	Call & Extend

CORSIM SIMULATION FILE FOR TIGHT DIAMOND INTERCHANGE WITH MULT-LOOP DETECTORS

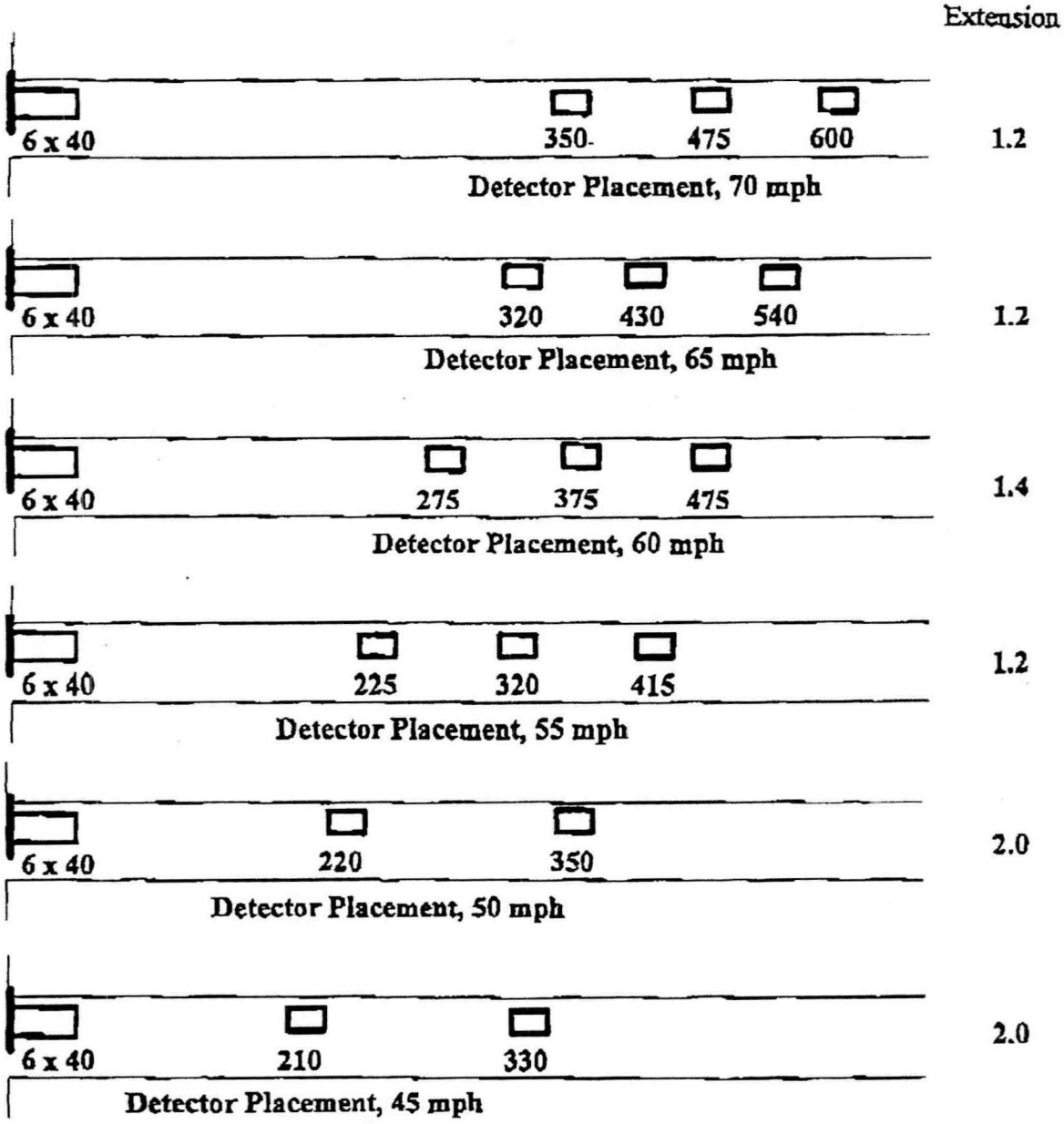
```
                                                                               00
                                  [8003]      [8005]                           00
                                    |            |                             00
                                   (4)          (7)                            00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
            [8001]--(3)------------(1)----------(2)----------(5)--[8002]       00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
                                    |            |                             00
                                   (8)          (6)                            00
                                    |            |                             00
                                  [8006]      [8004]                           00
                                                                               00
Srinivasa Sunkari                     06  28  05TTI                             1
       1   0       3     7981         10000       31200        7111    7581     2
3600                                                                            3
                  60                                                            4
                                               1                                5

   1   2 300 100     2 1     T8        7   5           5  15  15  40   11     11  For 4 phase
   2   1 300 100     2 1     T8        8   3           3  15  15  40   11     11  For 4 phase

   1   3 600         2       9          8001              15  15  40   11     11
   1   8 600         2       TT         8006              15  15  40   11     11
   2   5 600         2       9          8002              15  15  40   11     11
   2   7 600         2       TT         8005              15  15  40   11     11
   3   1 600         2       7T            2   8          15  15  40   11     11
   4   1 600     150 2   1   T8        2   8   3          15  15  65   11     11
   5   2 600         2       7T            1   7          15  15  40   11     11
   6   2 600 150     2 1     78        1   7   5          15  15  65   11     11
8001   3             2                     1              15  15   0   11     11
8002   5             2                     2              15  15   0   11     11
8003   4             2                     1              15  15   0   11     11
8004   6             2                     2              15  15   0   11     11

8001   3     100                                                              21
8002   5     100                                                              21
8003   4     100                                                              21
8004   6     100                                                              21

   3       18001                                                              35
   4    8003                                                                  35
   5       28002                                                              35
   6    8004                                                                  35
   7       2                                                                  35
   8       1                                                                  35

   3 11                                                                       36
   4 1                                                                        36
   5 11                                                                       36
   6 1                                                                        36
   7 1                                                                        36
   8 1                                                                        36

   1   2   7       0     5   400  0                                           42  For 4 phase
   2   1   7       0     1   400  0                                           42  For 4 phase

   1   2   12      0    14   400  0                                           42
```

```
   1   2   12   1500    13    60  0                                          42
   2   1   12      0    10   400  0                                          42
   2   1   12   1500     9    60  0                                          42
   4   1   1       0  9999    10  0                                          42  This card is
included as a work around for a programming error in TSIS.  Do not remove.
   4   1   8    3200    26    60  0                                          42
   4   1   8    4300    27    60  0                                          42
   4   1   8    5400    28    60  0                                          42
   4   1   8       0    12   400  0                                          42
   3   1   12      0    11   400  0                                          42
   3   1   12   1500     2    60  0                                          42
   5   2   12      0    15   400  0                                          42
   5   2   12   1500     6    60  0                                          42
   6   2   1       0  9999    10  0                                          42  This card is
included as a work around for a programming error in TSIS.  Do not remove.
   6   2   8    3200    20    60  0                                          42
   6   2   8    4300    21    60  0                                          42
   6   2   8    5400    22    60  0                                          42
   6   2   9       0    16   400  0                                          42

   1   3   1   4   1   2   1                   0                          2 43
   2   6   2   5   2   1   2                   0                          2 43  Col77 - 2 to
flag


8001   3 400                                                                 50
8002   5 400                                                                 50
8003   4 400                                                                 50
8004   6 400                                                                 50

8001   3 100  15 200  30 300  45 400  60                                    0   53
8002   5 100  15 200  30 300  45 400  60                                    0   53
8003   4 100  15 200  30 300  45 400  60                                    0   53
8004   6 100  15 200  30 300  45 400  60                                    0   53

   1   2   1   1   2   4   1   5   2   2   5   6   2   1   3   3   1   2   7  95
   1   1   8                                                                 95

   1   4   1   2   7   2  10   2   5   2  30   1   8   2  30   1   3   2  30  96
   1   5   2   2   7   2  30   1   8   2  40   1   3   2  30                   96
   1   6   2   2   5   2  30   2   7   2  30   1   3   2  30   1   8   2  10  96
   1   3   1   1   8   2  30   2   5   2  30   2   7   2  40                   96

   0                                                                        170

   1    1800    1000                                                        195
   3    1200    1000                                                        195
   4    1800    1600                                                        195
   8    1800     400                                                        195

   2    2100    1000                                                        195  For 4 phase
   5    2700    1000                                                        195  For 4 phase
   6    2100     400                                                        195  For 4 phase
   7    2100    1600                                                        195  For 4 phase



8001     900    1000                                                        195
8002    3000    1000                                                        195
8003    1800    1900                                                        195
8004    2100     100                                                        195
8005    2100    1900                                                        195
8006    1800     100                                                        195

   1                                                                        210
```

TxDOT DETECTOR LAYOUT

FOR

HIGH SPEED APPROACHES


Extension
6 x 40
350
475
600
1.2
Detector Placement, 70 mph
6 x 40
320
430
540
1.2
Detector Placement, 65 mph
6 x 40
275
375
475
1.4
Detector Placement, 60 mph
6 x 40
225
320
415
1.2
Detector Placement, 55 mph
6 x 40
220
350
2.0
Detector Placement, 50 mph
6 x 40
210
330
2.0
Detector Placement, 45 mph

Link-Node Structure