Signal optimization using Highway Capacity Software (HCS) 2010

Overview and demonstration

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Highway Capacity Software

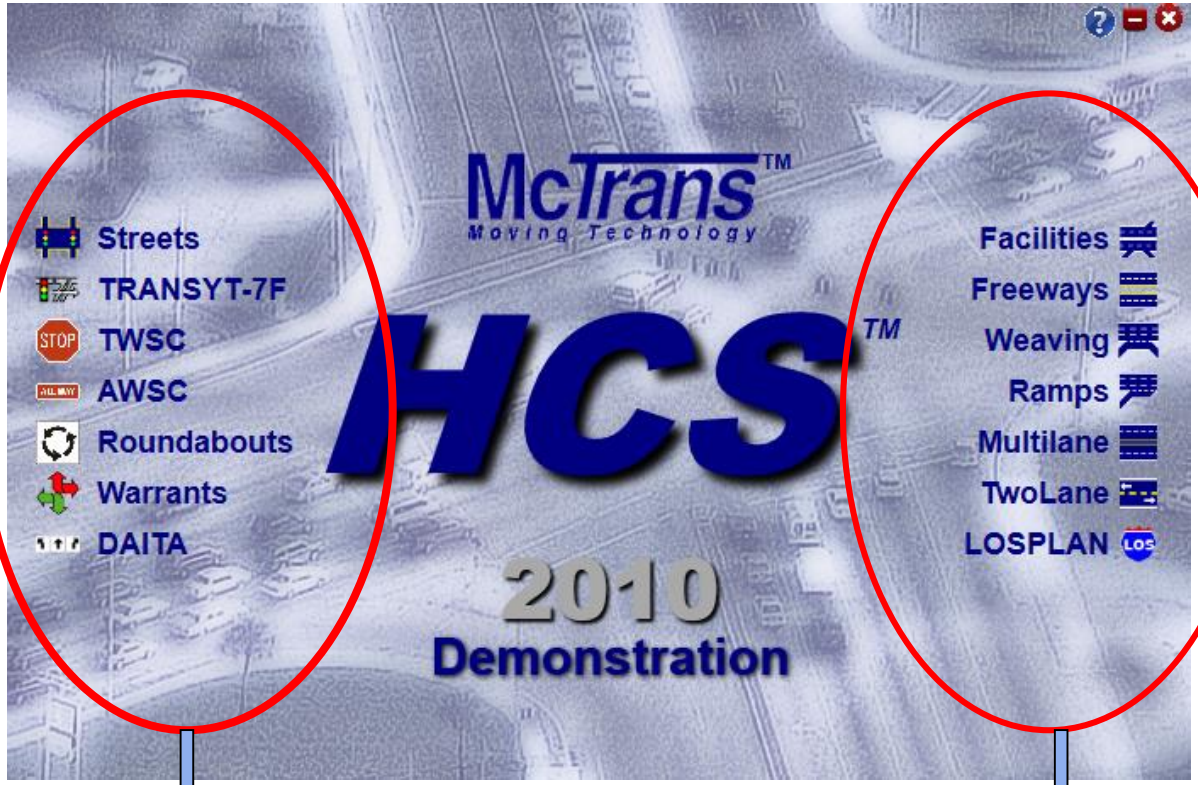
Developed and maintained by McTrans

- Originally founded by the FHWA in 1986 as the Center for Microcomputers in Transportation (McTrans)
- Now a full-service software support center, associated with the University of Florida

HCS 2010

- HCS 2010 implements the procedures defined in the Highway Capacity Manual (HCM) 2010 published by the Transportation Research Board (TRB)
- This release includes the new Streets module that combines the Signalized Intersections with the Urban Streets Segments, Facilities and Multimodal procedures.

Fourteen Modules



Synchro:
Cannot be used for

- Freeways
- Interchange systems or ramps

Intersection Module

Highway Module

Street Module

Signalized Intersections

- Signal analysis
- Interchange analysis
- Multimodal analysis
- LOS

Signalized intersections

- Traffic Conditions
  - Approach volumes (left, through, right)
  - Vehicle type (heavy vehicle, bicycles)
  - Pedestrian movement

Signalized intersections

- Roadway Conditions
  - Number and width of lanes
  - Grades
  - Lane use
- Traffic Signal Characteristics
  - Signal phasing
  - Signal timing
  - Type of control (Actuated/pre-timed)
  - Signal progression (un/co-ordinated)

Signalized intersections

- Total delay:
  - Difference between actual travel time and ideal travel time
    - In the absence of traffic control, delay due to roadway geometries, incidents and when there are no vehicles on the road
  - In HCS control delay is quantified
    - initial deceleration delay
    - Queue move-up time
    - Stopped delay
    - Final acceleration delay

Level of Service (LOS)

- LOS criteria are stated in terms of average control delay per vehicle
  - Delay on signal control depends on
    - Quality of progression
    - Cycle length
    - Green ratio
    - V/c ratio for lane group
    - ICU (Intersection Capacity Utilization)
- Designated by letters A - F

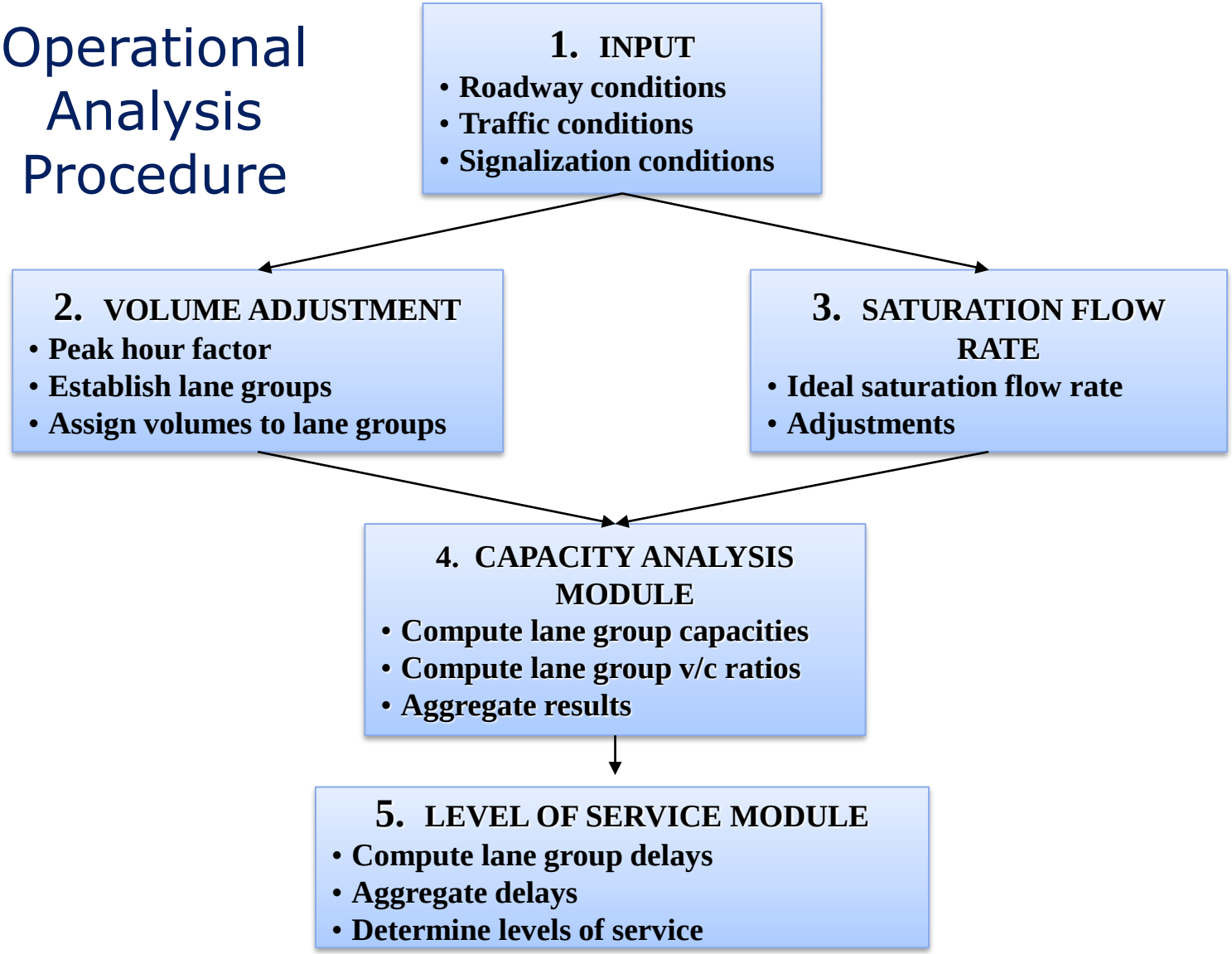
Level of Service (LOS)

LEVEL OF SERVICE	CONTROL DELAY PER VEHICLE (SEC/VEHICLES)
A	≤ 10
B	>10 and ≤ 20
C	>20 and ≤ 35
D	>35 and ≤ 55
E	>55 and ≤ 80
F	> 80

ICU	Level of Service
0 to 55%	A
>55% to 64%	B
>64% to 73%	C
>73% to 82%	D
>82% to 91%	E
>91% to 100%	F
>100% to 109%	G
>109%	H

Source: Highway Capacity Manual 2010

Operational Analysis Procedure

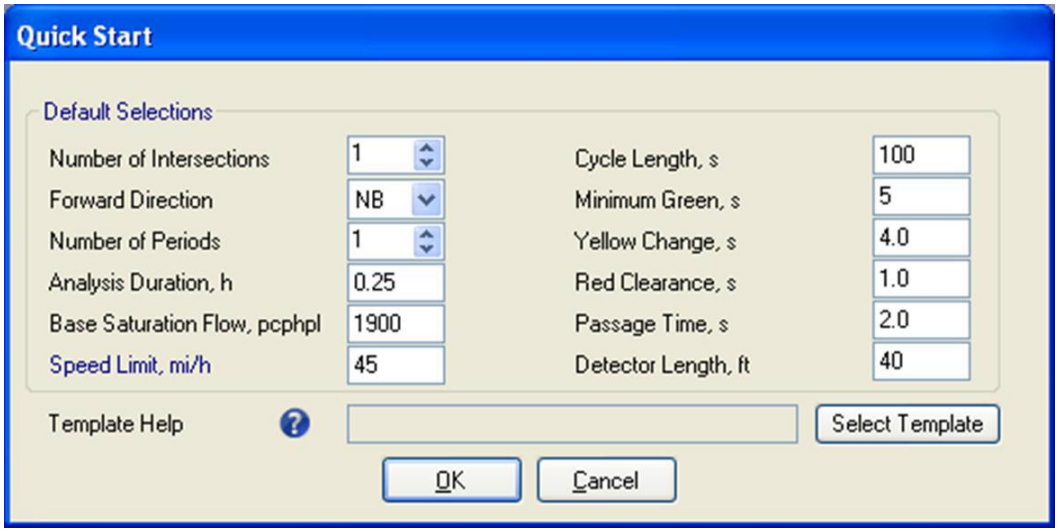


Getting Started:

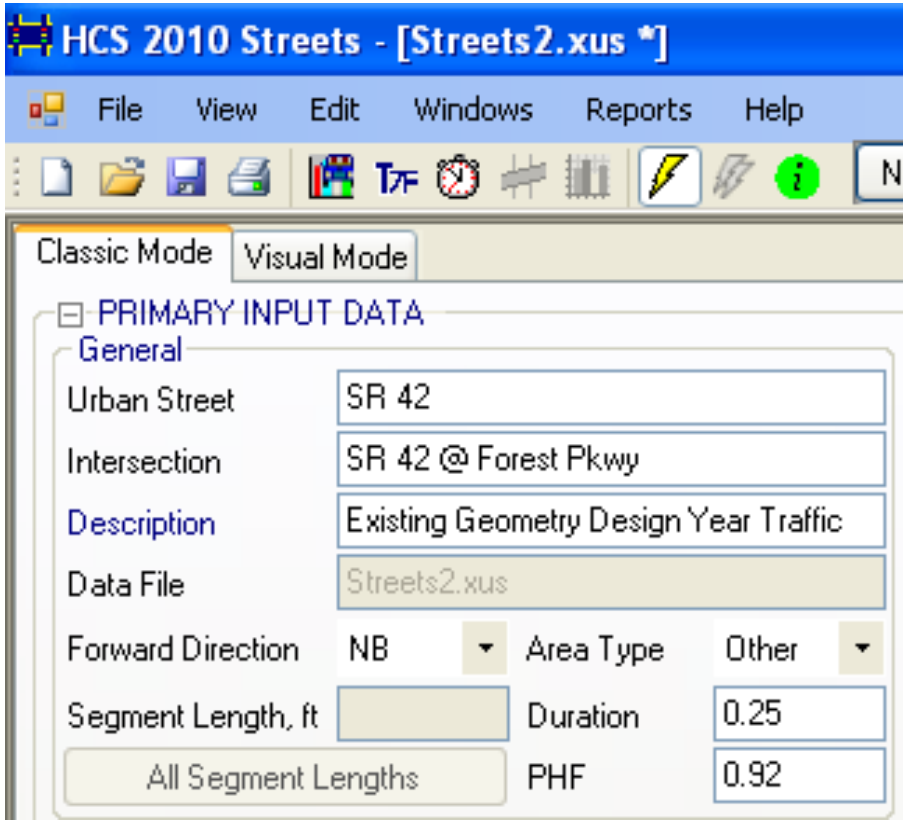
1. Open HCS 2010
2. Select the Streets *(handles signals and signalized corridors)*

Getting Started:

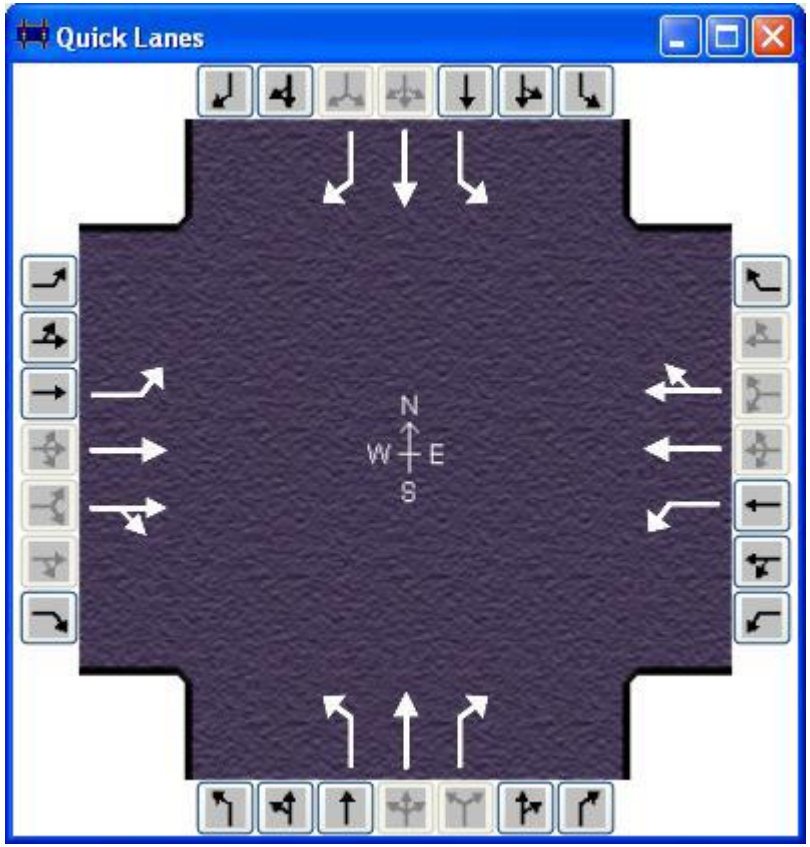
3. Complete The Quick Start Screen



4. Enter Information in the **General** Section



5. Enter **Lane Configuration**

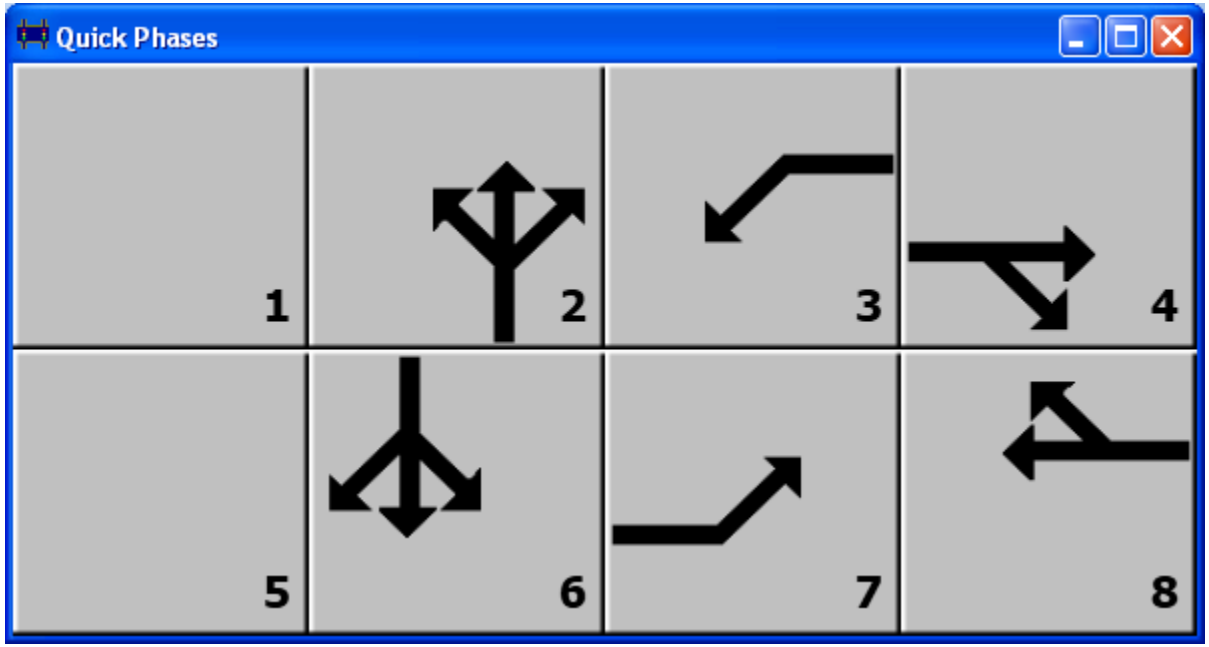


6. Enter **Traffic** Data

Traffic

	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Demand, veh/h	350	1315	285	385	740	125	130	320	240	225	780	310
Lane Width, ft	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0
Storage Length, ft	350	0	0	300	0	0	190	0	300	200	0	370
Saturation, pc/h/ln	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Heavy Vehicles, %	10	10	0	10	10	0	10	10	10	10	10	10
Grade, %		-2			1			6			-2	
Buses, per h			0			0			0			0
Parking, per h	0	N	0	0	N	0	0	N	0	0	N	0
Bicycles, per h		0			0			0			0	
Pedestrians, per h		0			0			0			0	
Arrival Type	3	3	3	3	3	3	3	3	3	3	3	3
Upstream Filtering (I)			1.00			1.00			1.00			1.00
Initial Queue, veh	0	0	0	0	0	0	0	0	0	0	0	0
Speed Limit, mi/h		45			45			45			45	
Detector, ft	40	40	40	40	40	40	40	40	40	40	40	40
RTOR, veh/h			0			0			0			0

7. Enter **Phasing** data



Quick Exercise on Phase Diagram

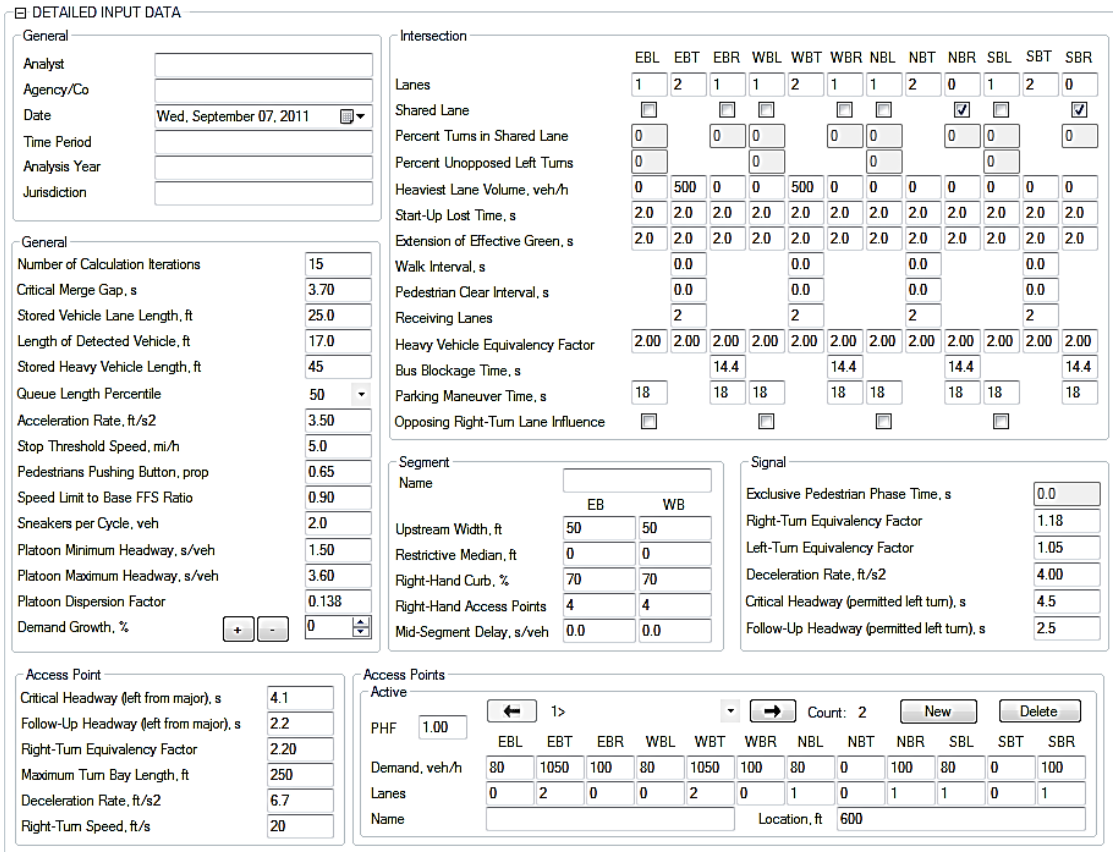
8. Enter **Timing**

Timing

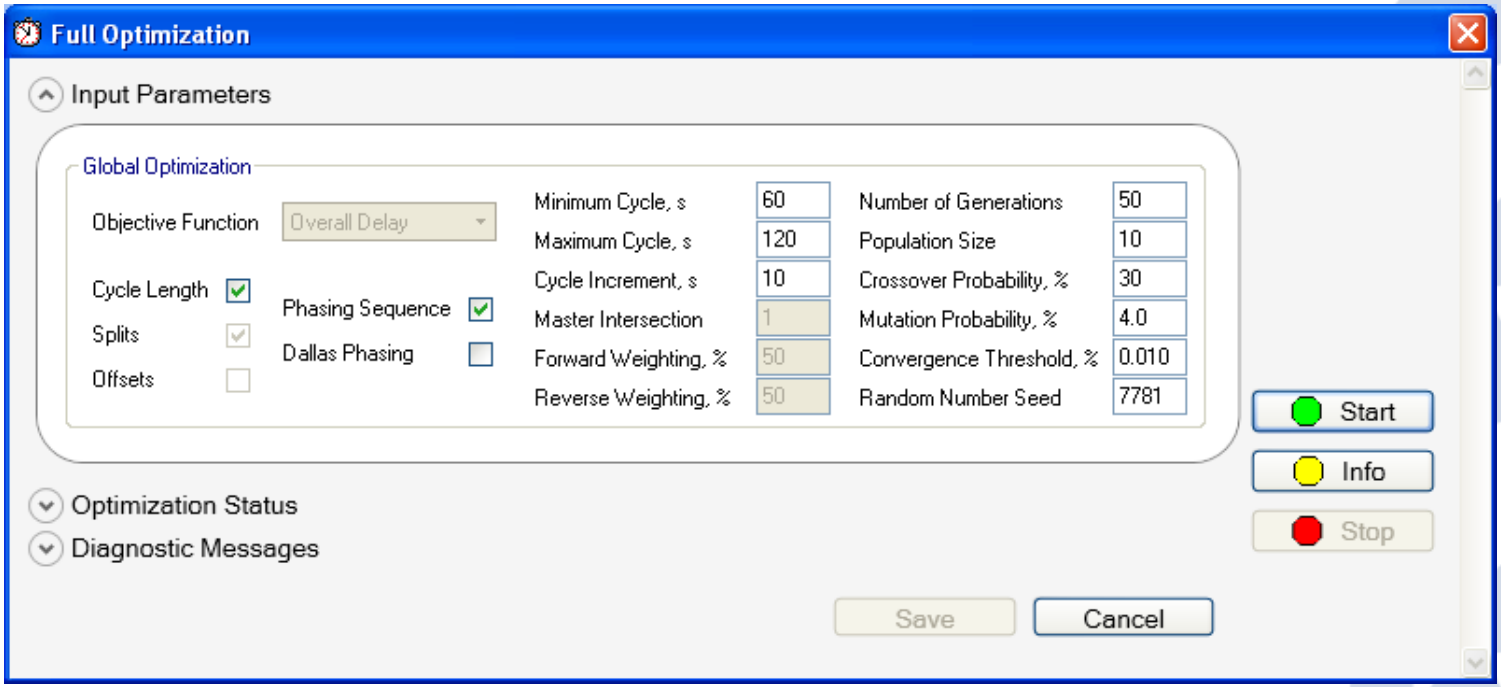
	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Phase Split, s	15.0	40.0	15.0	40.0	0.0	45.0	0.0	45.0
Yellow Change, s	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Red Clearance, s	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Minimum Green, s	5	5	5	5	5	5	5	5
Lag Phase	☐ EL	☐ ET	☐ WL	☐ WT	☐ NL	☐ NT	☐ SL	☐ ST
Passage Time, s	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Recall Mode	Off	Off	Off	Off	Off	Min	Off	Min
Dual Entry	☐ EL	☑ ET	☐ WL	☑ WT	☐ NL	☑ NT	☐ SL	☑ ST
Dallas Phasing	☐ E/W	☐ N/S	Simultaneous Gap	☑ E/W	☑ N/S			

Green	40.0	10.0	35.0	0.0	0.0	0.0
Yellow	4.0	4.0	4.0	0.0	0.0	0.0
Red	1.0	1.0	1.0	0.0	0.0	0.0

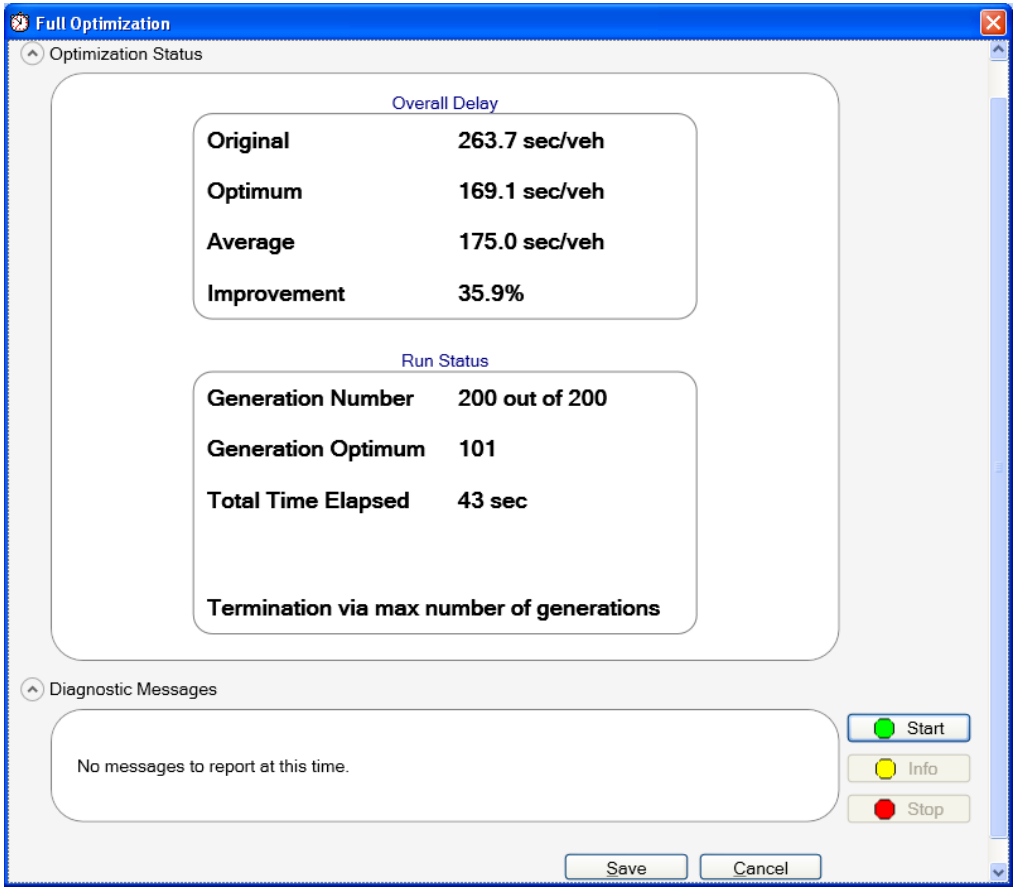
9. Enter the **Detailed** Data



10. Run **Full Optimization**



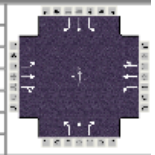
11. **Optimization** Results



12. View/Print **Results** Summary Report

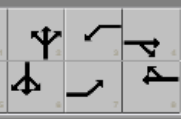
HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	GDOT			Duration, h	0.25
Analyst	Design Engineer	Analysis Date	Apr 12, 2012	Area Type	Other
Jurisdiction	Clayton County	Time Period	2032 PM	PHF	0.92
Intersection	SR 42 @ Forest Pkwy	Analysis Year	2012	Analysis Period	1> 7:00
File Name	pdt example.xus				
Project Description	Existing Geometry Design Year Traffic				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand (*v*), veh/h	350	1315	285	385	740	125	130	320	240	225	780	310

Signal Information					EB			WB			NB			SB		
Cycle, s	110.0	Reference Phase	2		L	T	R	L	T	R	L	T	R	L	T	R
Offset, s	0	Reference Point	End	Green	0.0	0.0		0.0	0.0	0.0	0.0					
Uncoordinated	No	Simult. Gap E/W	On	Yellow	0.0	0.0		0.0	0.0	0.0	0.0					
Force Mode	Fixed	Simult. Gap N/S	On	Red	0.0	0.0		0.0	0.0	0.0	0.0					

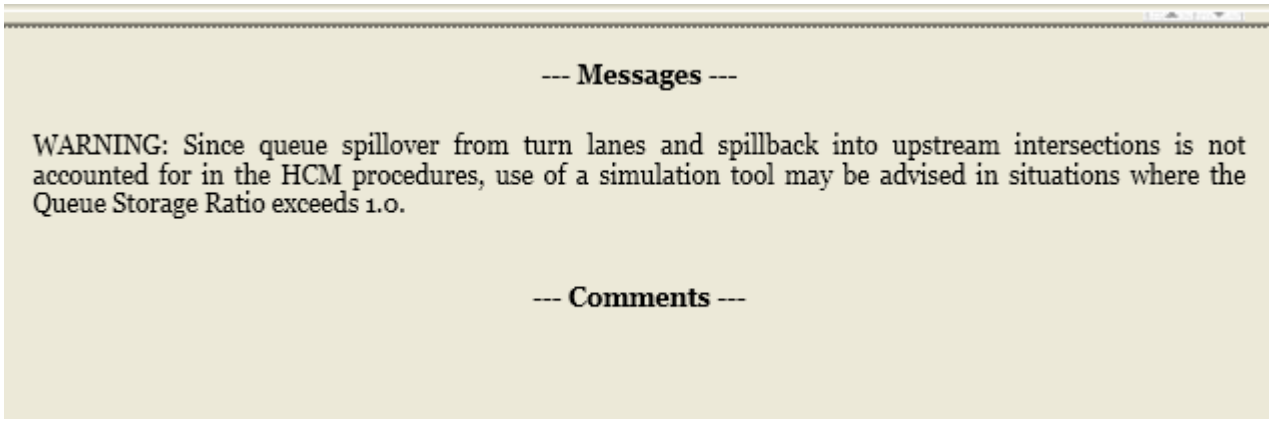


Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	7	4	3	8		2		6
Case Number	2.0	4.0	2.0	4.0		5.0		5.0
Phase Duration, s	32.2	50.0	21.0	38.8		39.0		39.0
Change Period, ($Y+R_c$), s	5.0	5.0	5.0	5.0		5.0		5.0
Max Allow Headway (*MAH*), s	0.0	0.0	0.0	0.0		0.0		0.0
Queue Clearance Time (g_s), s	0.0	0.0	0.0	0.0		0.0		0.0
Green Extension Time (g_e), s	0.0	0.0	0.0	0.0		0.0		0.0
Phase Call Probability	0.00	0.00	0.00	0.00		0.00		0.00
Max Out Probability	0.00	0.00	0.00	0.00		0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	7	4	14	3	8	18	5	2	12	1	6	16
Adjusted Flow Rate (*v*), veh/h	0	0	0	0	0	0	0	0	0	0	0	0
Adjusted Saturation Flow Rate (*s*), veh/h/ln	0	0	0	0	0	0	0	0	0	0	0	0
Queue Service Time (g_s), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cycle Queue Clearance Time (g_c), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Capacity (*c*), veh/h	412	714	670	238	527	501	66	518	439	188	539	457
Volume-to-Capacity Ratio (*X*)	0.924	1.233	1.282	1.758	0.915	0.915	2.1[illegible]9	0.672	0.594	1.303	1.572	0.737
Available Capacity (c_a), veh/h	0	0	0	0	0	0	0	0	0	0	0	0
Back of Queue (*Q*), veh/ln (95th percentile)	15.2	58.8	61.9	47.3	21.1	20.3	21[illegible]	13.5	10.4	22.9	82.4	13.9
Overflow Queue (Q_b), veh/ln	0.0	0.0	0.0	0.0	0.0	0.0	0.[illegible]	0.0	0.0	0.0	0.0	0.0
Queue Storage Ratio (*RQ*) (95th percentile)	1.17	0.00	0.00	4.25	0.00	0.00	3.09	0.00	0.94	3.09	0.00	1.01
Uniform Delay (d_1), s/veh	40.4	32.5	32.5	47.0	36.7	36.7	55[illegible]	33.1	32.2	50.4	38.0	34.0
Incremental Delay (d_2), s/veh	3.9	116.9	138.0	357.7	20.2	21.0	568.5	6.8	5.8	169.7	266.4	10.2
Initial Queue Delay (d_3), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0[illegible]	0.0	0.0	0.0	0.0	0.0
Control Delay (*d*), s/veh	44.2	149.4	170.5	404.7	56.9	57.7	623.5	39.9	38.0	220.1	304.4	44.2
Level of Service (LOS)	D	F	F	F	E	E	F	D	D	F	F	D
Approach Delay, s/veh / LOS	139.1	F		164.3	F		149.2	F		228.6	F	
Intersection Delay, s/veh / LOS	169.1						F					

13. View Messages Report

- Look for any warnings

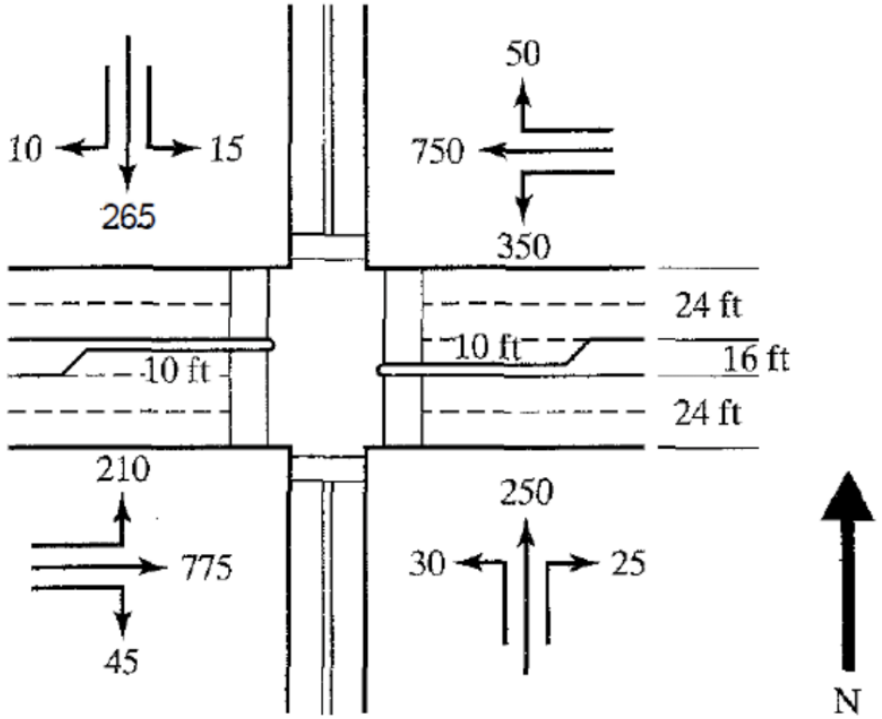


--- **Messages** ---

WARNING: Since queue spillover from turn lanes and spillback into upstream intersections is not accounted for in the HCM procedures, use of a simulation tool may be advised in situations where the Queue Storage Ratio exceeds 1.0.

--- **Comments** ---

2. What should be your recommended phasing and cycle length for the following intersection?



PHF = 0.98
Target *v/c* ratio = 0.95
Moderate pedestrian activity
Speed limits:
30 miih N–S
40 miih E–W
Crosswalk widths = 10ft

Questions?

References

Mctrans Center (2016, May 7), HCS 2010 Streets - Tutorial [Video file]. Retrieved from https://www.youtube.com/watch?v=OjgB-ufDPfk

GDOT (2013), Getting Started: HCS 2010, retrieved from: http://www.dot.ga.gov/PartnerSmart/DesignManuals/ElectronicPlanProcess/Getting%20Started%20HCS2010.pdf