

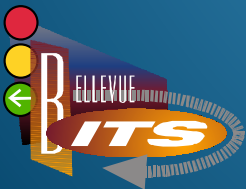
Bellevue's Success Story with SCATS

(Sydney Coordinated Adaptive Traffic System)

Raid Tirhi – Senior Intelligent Transportation Engineer

April 21 , 2018

Bellevue Neighborhood Conference

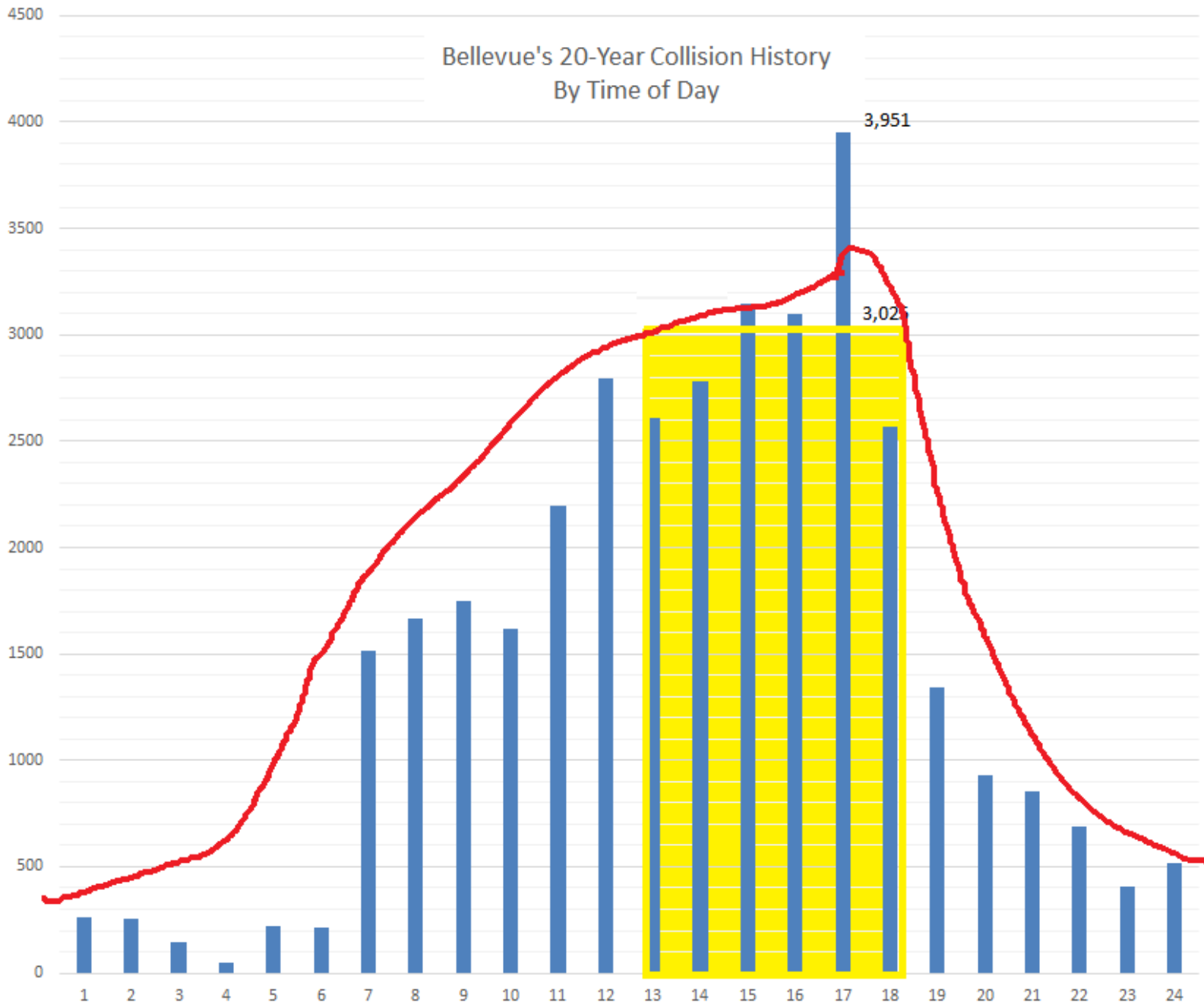


Intelligent Transportation Systems Primary Goal

Moving Traffic Efficiently & Safely

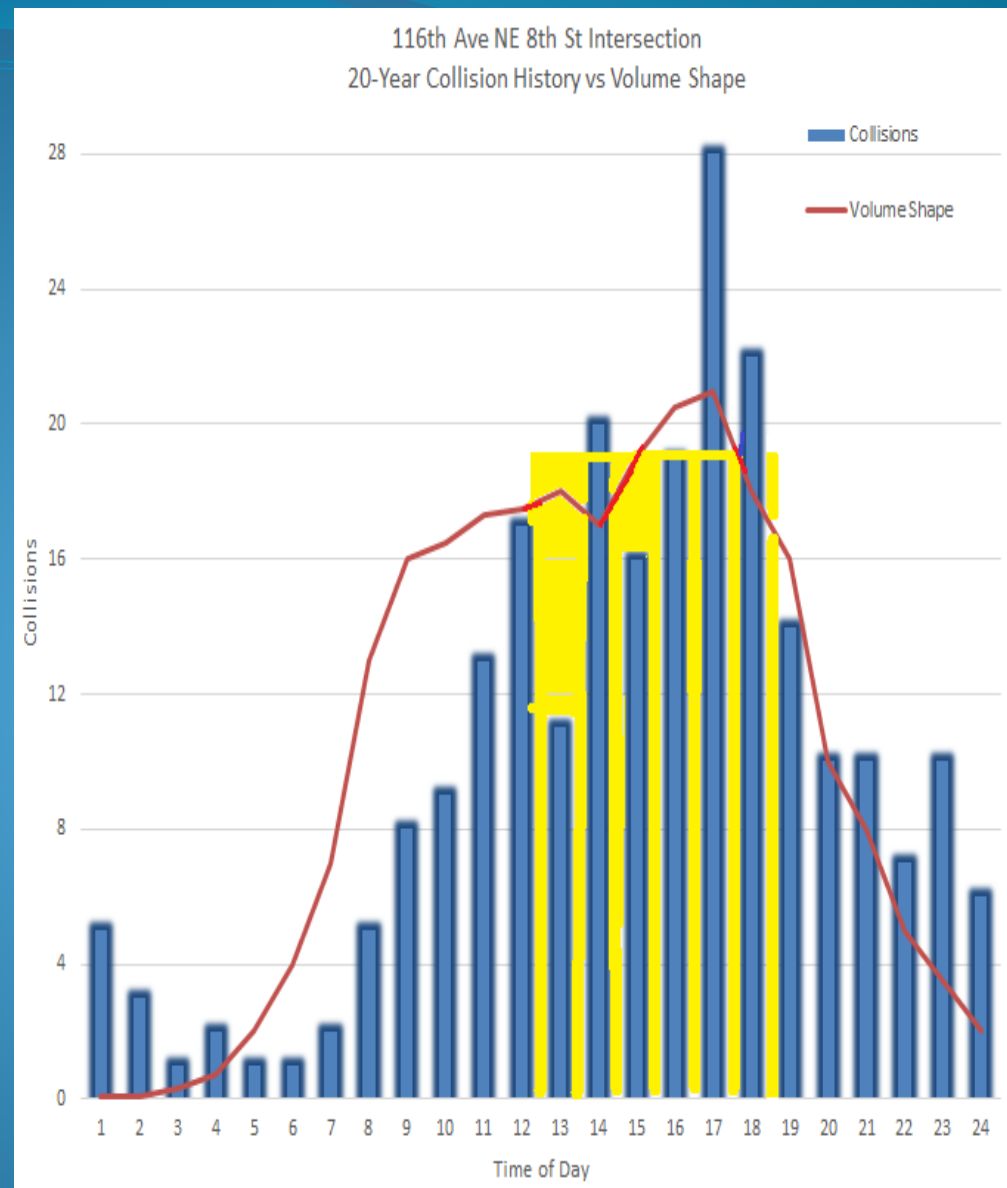


Bellevue's 20-Year Collision History By Time of Day



PM Peak Hour
vs
noon to 7pm

10 % traffic increase
yet
50 % Spike in Collisions



Also see:

“Exploring the level of Service and Traffic Safety Relationship at Signalized Intersections” (By Ana M. Almonte & Mohamad A. Abdel-Aty, ITE Journal/June 2010)



Collision Causes

94% Erroneous Human Behavior



Vehicle Malfunction



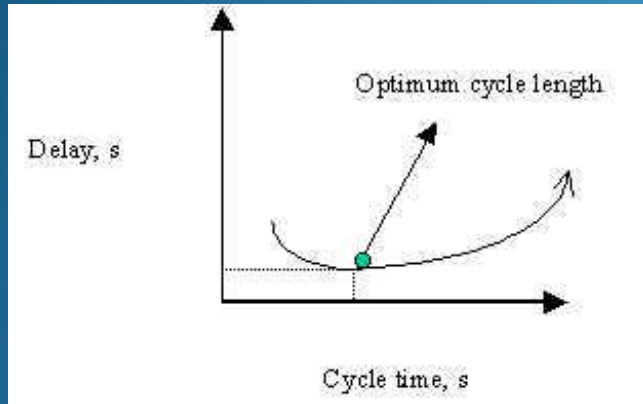
Maintenance or Design Issues



Objectives

- Minimize delay
(for all modes of transportation)
- Minimize the number of stops
(Rear-end and T-bone collisions)
- Manage traffic queues
(Rear-end and Sideswipe collisions)
- Maximize the green band width yet utilize the optimum cycle length

Traffic Signal Optimization



Optimum cycle →
More efficiency →
Less driver frustration →
Less Collisions

**Signal coordination is a
balanced mix of art and science**

SCATS Main Screens

SCATS Access

File View Edit Tools Window Help

Cycle lock	Trim	Detector alarm	RAM update	Short clearance	Fallback	Manager
Dwell	Notices	Lamp fault		Long clearance	High density	Region
Plan lock	Incidents	Major alarm	System alarm	Messages	Increment failure	File update

Central Manager - 10.102.2.33 User 0 - Level 0

(1) 30 - Ne 8th St , 116th Ave Ne : Bellevue - BELVU1

Show Configure Options

Find Monitor Subsystem Strategic Monitor

30	Alarms LC SC IH NF	BELVU1 Subsystem 55	Degree of saturation 145	SCATS 6
Split plan 1	Masterlink	System plan 1	Divorced -	Cycle generator 74
Offset plan 3	Offset 0, 0 E	Link plan 3	Link 15, 15 A 26	Active link 15 A 26
Special facilities Z- Z3,5-6		Cycle plan none	Cycle time 115	Required cycle time 116

XSF 2-3

<A>	36%	42
B	15%	17
C	15%	17
D	15%	17
E	19%	22
F		

Active plan

Site operation

<A>	61	1
B	16	1
C	17	0
D	17	2
E		
F		

10 STAGES

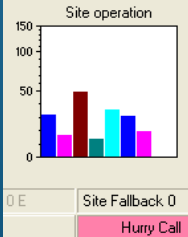
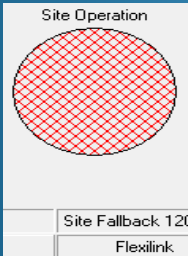
A	C2	F1
B	D	F2
C	E	
C1	F	

YEL D TG2 Z5@6 MX@12 P^E@13

Active offset 0 E Site Fallback 0

MSS Masterlink

Region - BELVU1 User 0 - Level 0 11/26/2012 11:29:31 AM



Detection

is the most critical part for SCATS to properly work



SCATS calculations are based on
“Space Time” relationship between vehicles

Degree of Saturation (DS)

DS is a measure of the effectiveness
of the green time for a particular lane

Degree of Saturation

(1) 30 - Ne 8th St , 116th Ave Ne : Bellevue - BELVU1

Show Configure Options

Find | Monitor | Subsystem | Strategic Monitor

INT	TYPE	PH	PT	DS	VO	VK	DS	VO	VK	DS	VO	VK	DS	VO	VK	ADS
30	SA367	3	11	04	2	27	30	3	8	-	-	-	-	-	-	-100
30	SA368^	8	24	125	10	13	85	7	8	-	-	-	-	-	-	-1 94
30	SA369^	DE	46	65	7	10	57	10	9	-	-	-	-	-	-	-1 58
30	SA370^	1	22	82	5	6	50	3	4	-	-	-	-	-	-	-1 88
30	SA371	'	6	50	75	15	15	82	15	17	72	14	14	-	-	-1 78
30	LK103^	2	53	63	15	15	79	19	20	-	-	-	-	-	-	-1100
35	LK104^	6	105	37	18	17	29	15	13	-	-	-	-	-	-	-1 900
A=<24> B=19 C=9 D=19 E=19 F=1																
15:01 SS 55 - PL1.3 PVa17.3 CT 115+00 RL115' SA360 DS 97																
INT	TYPE	PH	PT	DS	VO	VK	DS	VO	VK	DS	VO	VK	DS	VO	VK	ADS
30	SA363^	7	12	44	3	3	0	0	0	-	-	-	-	-	-	-1 63
30	SA364	'	4	38	47	8	8	53	7	9	-	-	-	-	-	-1 68
30	SA365	5	0	0	0	0	0	0	0	-	-	-	-	-	-	-1 50
30	SA366	'	2	41	56	9	10	66	11	13	96	11	16	-	-	-1 90
30	SA367^	3	23	60	3	4	103	6	9	-	-	-	-	-	-	-110
30	SA368^	8	49	35	6	7	35	7	7	-	-	-	-	-	-	-1 73
30	SA369^	DE	60	45	10	9	31	6	6	-	-	-	-	-	-	-1 54
30	SA370^	1	21	121	7	9	92	5	7	-	-	-	-	-	-	-1103
30	SA371	'	6	61	42	11	11	46	9	11	44	11	11	-	-	-1 63
30	LK103^	2	41	56	9	10	66	11	13	-	-	-	-	-	-	-1 920
35	LK104^	6	89	34	14	13	31	12	12	-	-	-	-	-	-	-1 840
A=<26> B=15 C=21 D=19 E=19 F=1																

Region - BELVU1 User 0 - Level 0

Bellevue programmed SCATS to look at Max detector DS in lane group

Green times are assigned based on Average DS in the last 3 cycles for all voting stages

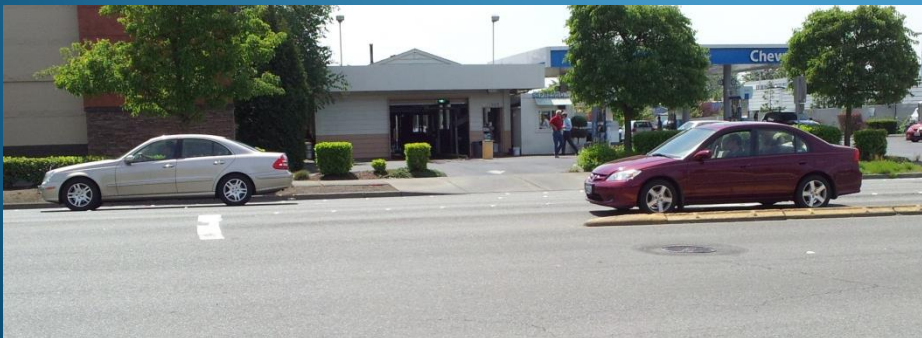
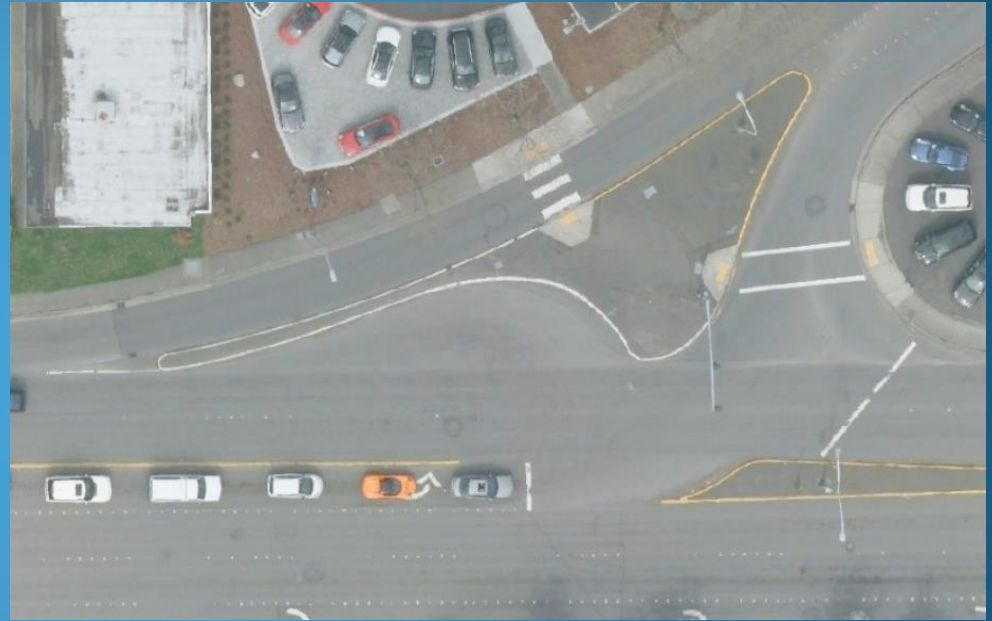


Stopping At Detection Zones

Are drivers stopping at the detection zone?

Which clues are they using?

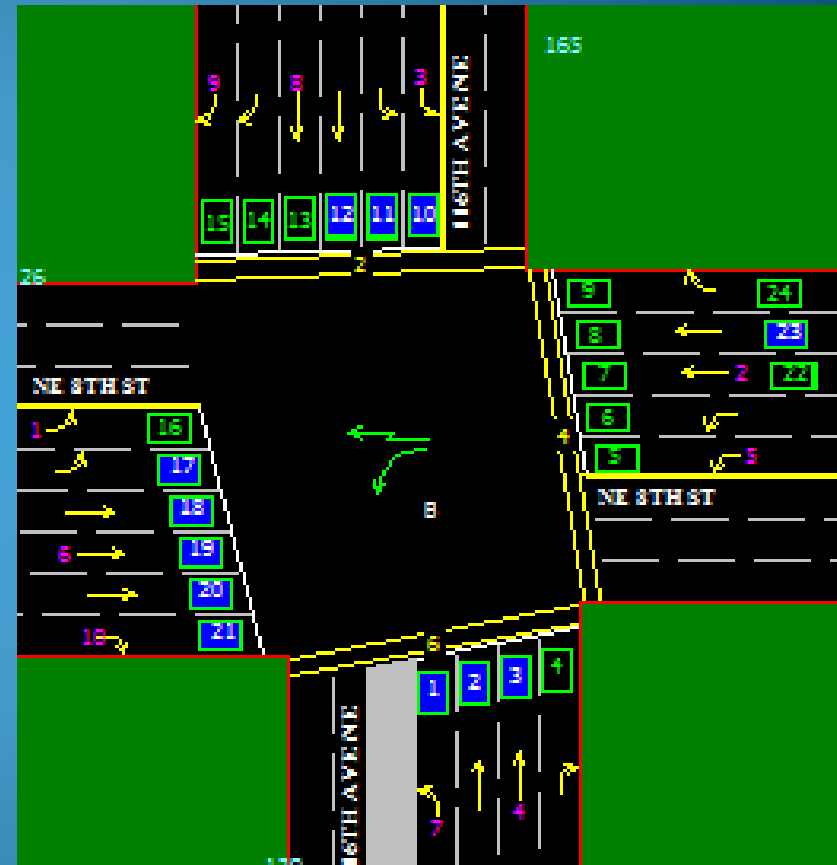
How does that work with SCATS?



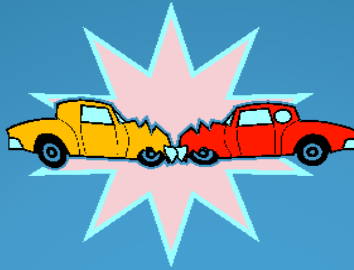
Detection & Construction

So, what would SCATS do if:

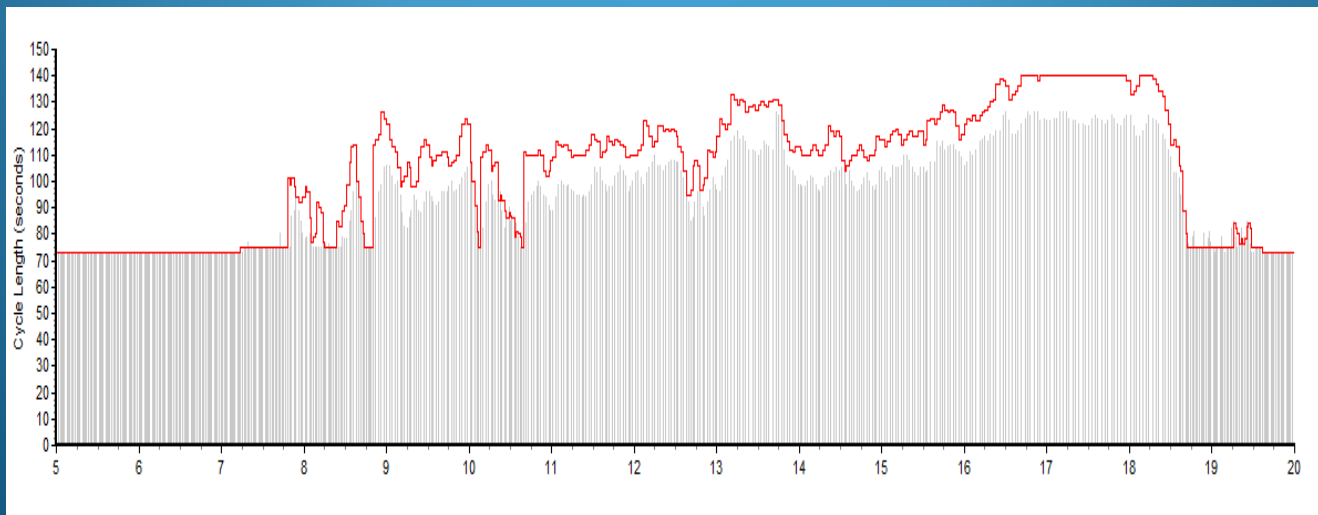
1. The NB LT lane is closed, phase is simply skipped.
2. If one of the 2 NB thru lanes is closed, the other lane will have more volume & votes for more time.



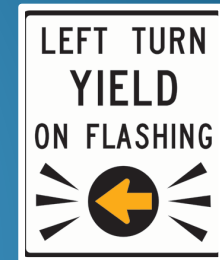
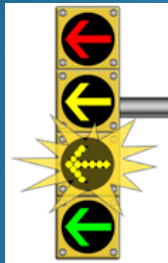
Variable Conditions



Dynamic Traffic Volumes → Dynamic Optimum Cycle
→ Adaptive system



Adaptive Left Turn Flashing Yellow Arrow With Ped Minus Phasing



Special Events

When goals & objectives change → SCATS programming must change

Fourth of July celebration accommodates 65,000 people leaving downtown park within 30 minutes.



I=159!PM=.2#!	I=234!PM=.2#!
I=72!PM=.2#!	;Lock 10th Street into 180 or 90 second Cycle Length
I=224!PM=.2#!	I=154!CL=180#!
I=225!PM=.2#!	I=190!CL=180#!
;Lock 8th Street into 180 or 90 second Cycle Length	I=332!CL=90#!
I=26!CL=180#!	I=235!CL=180#!
I=27!CL=180#!	I=234!CL=180#!
I=21!CL=180#!	;Divorce locks to keep each street to the desired locked cycle length
I=16!CL=180#!	SS=63!DV#!
I=322!CL=90#!	SS=64!DV#!
I=7!CL=180#!	SS=56!DV#!
I=4!CL=180#!	;Change VR35 values to ensure Stage A gets majority of the cycle time
;Lock 4th Street into 180 second Cycle Length	I=3!VP3=5!VP10=10!VP11=10!VP12=10!VP13=40!
I=17!CL=180#!	I=16!VP10=40!VP11=6!VP12=15!VP13=15!
I=22!CL=180#!	I=21!VP10=40!VP11=6!VP12=15!VP13=15!
I=159!CL=180#!	I=27!VP10=40!VP11=6!VP12=15!VP13=15!
I=72!CL=180#!	I=26!VP10=49!VP11=10!VP12=15!VP13=10!
I=224!CL=180#!	I=17!VP10=35!VP11=8!VP12=15!VP13=15!
I=225!CL=180#!	I=23!VP10=25!VP11=9!VP12=15!VP13=15!

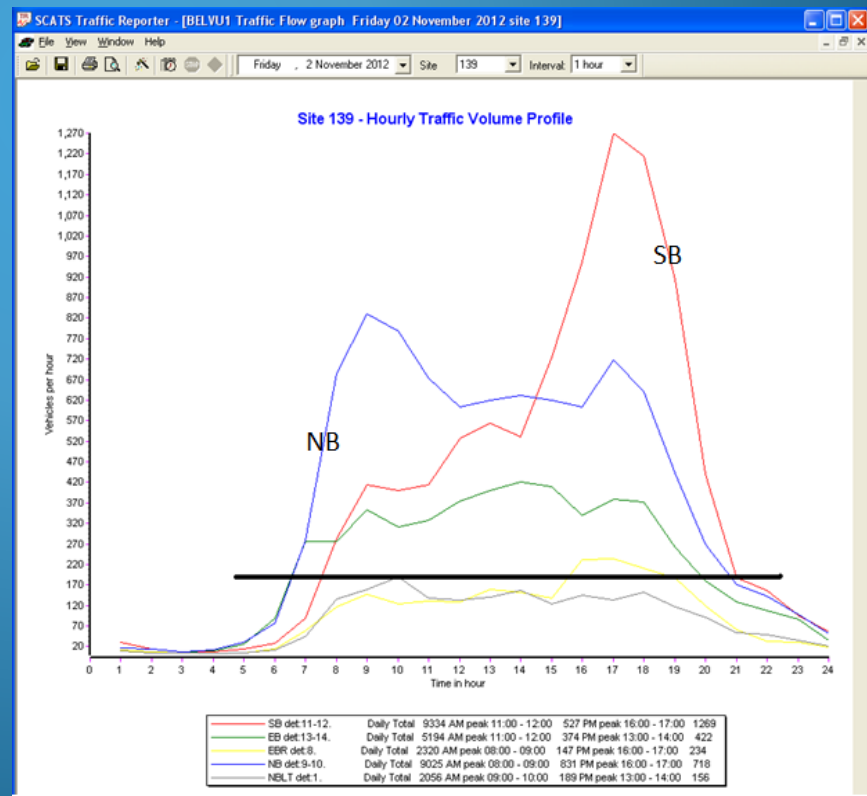
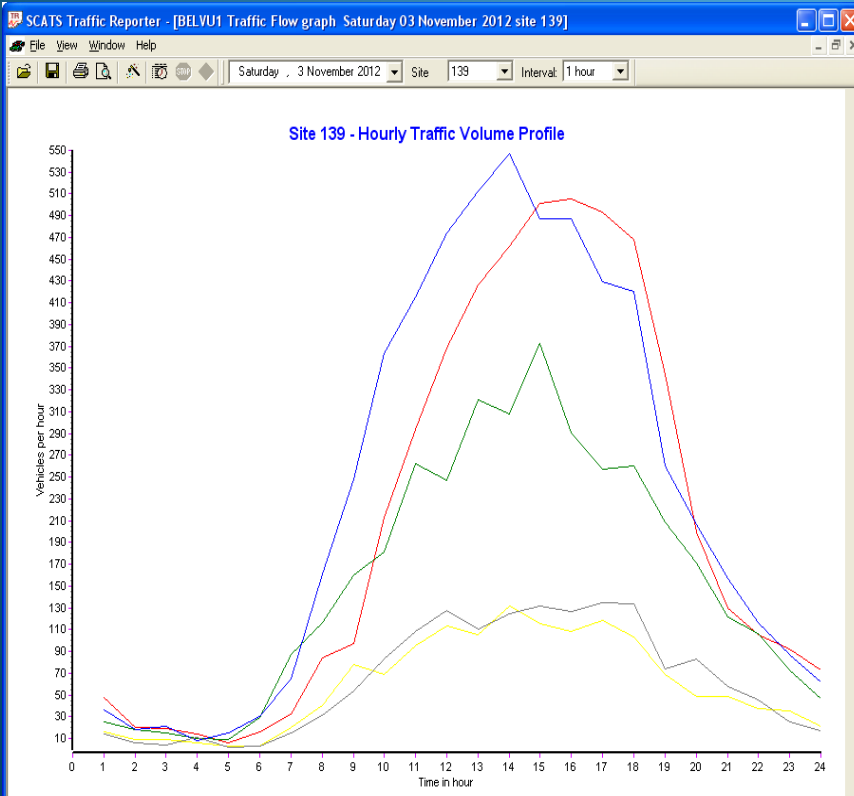
Loop Data & Construction Schedules

Goal is:

Reduce traffic impacts as long as reasonable contractor schedule allows it.

Recommendations on:

- Best time of the day and day of the week to allow lane closures.
- Construction mobilization direction.



Before & After SCATS Studies

148th St Travel Time studies
19 traffic signals, 4.5 miles

	Average Day		Peak Hours	
	Travel Time	Stops	Travel Time	Stops
Avg. Both Directions (Before SCATS)	00:12:17	6.7	00:12:41	7.3
Avg. Both Directions (After SCATS)	00:10:38	4.6	00:11:00	4.5
% Improvement	13%	32%	13%	38%



Corridor	Time	Travel Time Reduction
NE 8 th St – Bel Way to 112 th	2pm to 6pm	43%
NE 4 th St – Bel Way to I-405	2pm to 6pm	16%
Factoria Blvd – SE 32 nd to Newport Way	5pm to 6pm	36%
NE 8 th St – 116 th to 124 th	Noon to 6pm	35%

NB 148th, Travel Time Study (Before SCATS)

Date	Run #	Newport	SE 38		SE 37		
			Veh. in Q	Clear	Stop	Clear	Stop
09/20/12	1	10	08:16:20	08:17:03	08:17:36	08:17:46	08:18:04
09/20/12	2	10	08:59:47		09:00:26	09:00:34	09:01:48
09/20/12	3	3	09:31:32		09:32:07		09:32:18
09/20/12	4	1	11:19:06		11:19:43	11:19:55	11:20:29
09/20/12	5	5	11:49:40		11:50:15	11:50:26	11:50:50

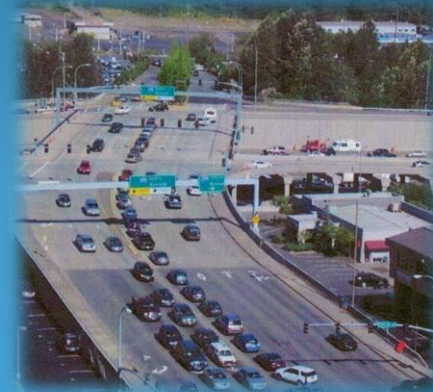
Before & After SCATS Studies

Eastbound NE 4th Queue to NB I-405

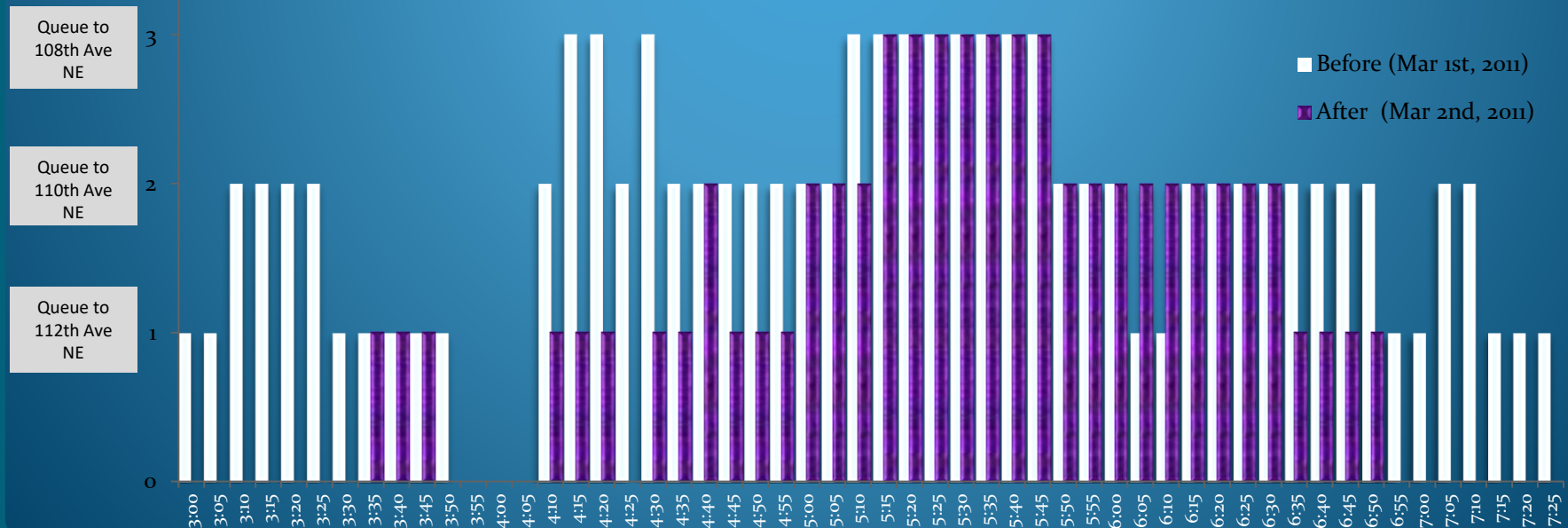
EB 4th Queued Past 110th:

	<u>Start</u>	<u>End</u>
Old System	4:10pm	7:00pm
SCATS	4:40pm	6:30pm

Result = Total 1 hour less congestion



WB 4th Ave NE & I-405 Ramp Meter Queue Analysis (Worst 5-Minute Intervals Between 3:00 PM and 7:30 PM)



Fatal Pedestrian Collision Investigation



SCATS History Reader - [Y:\History\BELVU2_20141201.Hist]

File Window Help

Site: 174

Phases Cycles Timeline Statistics

Date	Start Time	End Time	Duration	Phase
Mon 1-Dec-2014	05:43:15	05:43:28	13	D
Mon 1-Dec-2014	05:43:28	05:43:54	26	A
Mon 1-Dec-2014	05:43:54	05:44:07	13	D
Mon 1-Dec-2014	05:44:07	05:45:02	55	A
Mon 1-Dec-2014	05:45:02	05:45:13	11	C
Mon 1-Dec-2014	05:45:13	05:45:52	39	A
Mon 1-Dec-2014	05:45:52	05:46:02	10	C
Mon 1-Dec-2014	05:46:02	05:46:54	52	A
Mon 1-Dec-2014	05:46:54	05:47:05	11	C
Mon 1-Dec-2014	05:47:05	05:47:31	26	A
Mon 1-Dec-2014	05:47:31	05:47:42	11	C
Mon 1-Dec-2014	05:47:42	05:47:54	12	D
Mon 1-Dec-2014	05:47:54	05:49:27	93	A
Mon 1-Dec-2014	05:49:27	05:49:40	13	D
Mon 1-Dec-2014	05:49:40	05:50:11	31	A
Mon 1-Dec-2014	05:50:11	05:50:23	12	D
Mon 1-Dec-2014	05:50:23	05:51:08	45	A
Mon 1-Dec-2014	05:51:08	05:51:20	12	D
Mon 1-Dec-2014	05:51:20	05:51:38	18	A
Mon 1-Dec-2014	05:51:38	05:52:01	23	D
Mon 1-Dec-2014	05:52:01	05:52:22	21	A
Mon 1-Dec-2014	05:52:22	05:52:44	22	D
Mon 1-Dec-2014	05:52:44	05:55:05	141	A
Mon 1-Dec-2014	05:55:05	05:55:15	10	C
Mon 1-Dec-2014	05:55:15	05:55:51	36	A
Mon 1-Dec-2014	05:55:51	05:56:01	10	C
Mon 1-Dec-2014	05:56:01	05:57:45	104	A
Mon 1-Dec-2014	05:57:45	05:57:57	12	D
Mon 1-Dec-2014	05:57:57	05:58:23	26	A
Mon 1-Dec-2014	05:58:23	05:58:38	16	D
Mon 1-Dec-2014	05:58:38	06:00:14	95	A
Mon 1-Dec-2014	06:00:14	06:00:25	11	D
Mon 1-Dec-2014	06:00:25	06:03:17	172	A
Mon 1-Dec-2014	06:03:17	06:03:29	12	D
Mon 1-Dec-2014	06:03:29	06:04:29	60	A
Mon 1-Dec-2014	06:04:29	06:04:55	26	C
Mon 1-Dec-2014	06:04:55	06:05:07	12	D
Mon 1-Dec-2014	06:05:07	06:05:41	34	A
Mon 1-Dec-2014	06:05:41	06:05:53	12	C
Mon 1-Dec-2014	06:05:53	06:06:05	12	D
Mon 1-Dec-2014	06:06:05	06:07:06	61	A
Mon 1-Dec-2014	06:07:06	06:07:16	10	C
Mon 1-Dec-2014	06:07:16	06:07:52	36	A
Mon 1-Dec-2014	06:07:52	06:08:04	12	D
Mon 1-Dec-2014	06:08:04	06:08:57	53	A
Mon 1-Dec-2014	06:08:57	06:09:09	12	D
Mon 1-Dec-2014	06:09:09	06:10:06	57	A
Mon 1-Dec-2014	06:10:06	06:10:18	12	C
Mon 1-Dec-2014	06:10:18	06:10:33	15	D
Mon 1-Dec-2014	06:10:33	06:12:26	113	A
Mon 1-Dec-2014	06:12:26	06:13:15	49	D
Mon 1-Dec-2014	06:13:15	06:13:51	36	A
Mon 1-Dec-2014	06:13:51	06:14:03	12	B
Mon 1-Dec-2014	06:14:03	06:14:14	11	C

History file loaded



Lessons Learned

- Think outside the box
- For every action there is a reaction and unintended consequences
- Signal coordination is part art part science,
- Avoid violating driver expectancy,
- Moderation is best & overly conservative assumptions may lead to unsafe designs.



Future ITS Projects

- Street light management
- Bluetooth travel time info
- Real time traffic map upgrade
- Roadway weather & pavement temperature
- Variable message signs
- Camera system expansion & monitoring (Park and Rides, Ramp meters, etc)
- ITS system security
- Connected vehicle technology applications
- Camera full motion video on web/mobile
- ITS Master Plan update
- Variable channelization
- Parking management
- Flood monitoring
- Automated traffic counting
- ??? The NEXT BIG THING ???

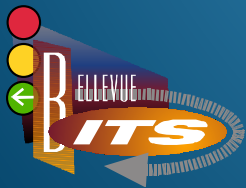


Congrats Bellevue & Thanks to all for making this a Successful Project



ITE's 2016
Transportation Operations
Achievement Award
presented to the city of Bellevue

“Together, we are the best”



Questions?

PRESENTED BY RAID TIRHI, PE

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