

Automated Traffic Signal Performance Measures

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Brief Utah Update

- 2012 Traffic Signals in the State of Utah
 - 1192 owned and operated by UDOT (59%)
 - 820 owned and operated by cities /counties (41%)



- All cities share same ITS communications
 - 93% of UDOT signals connected
 - 79% of non-UDOT signals connected

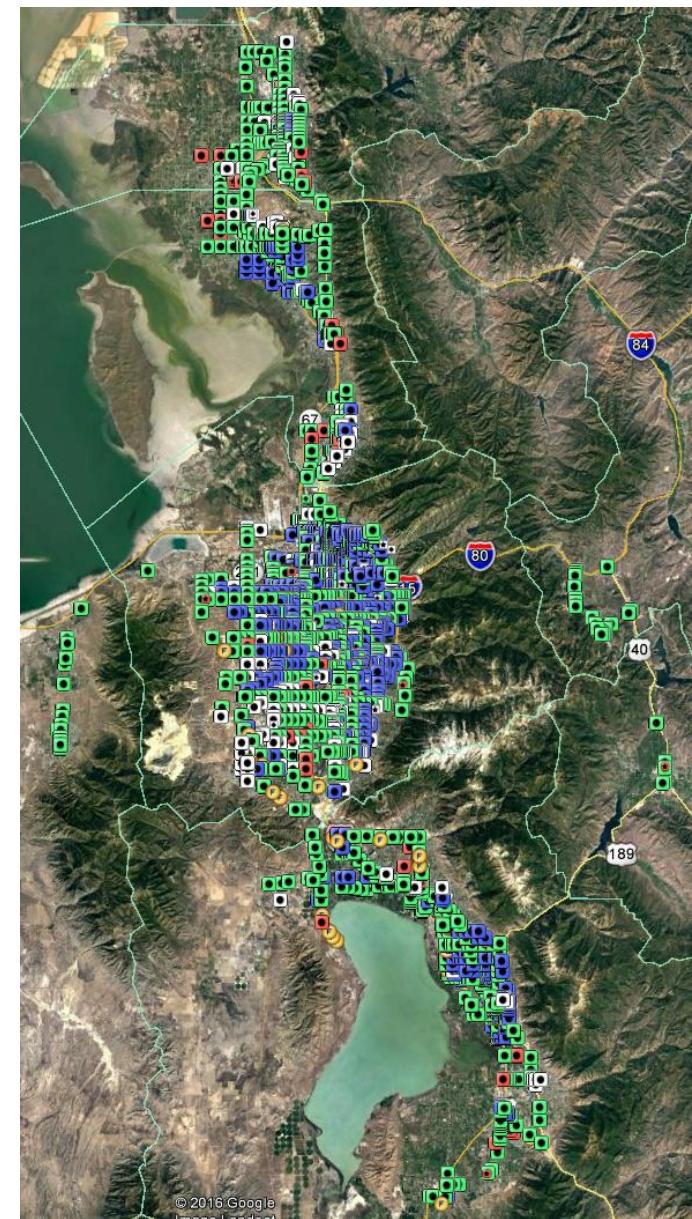
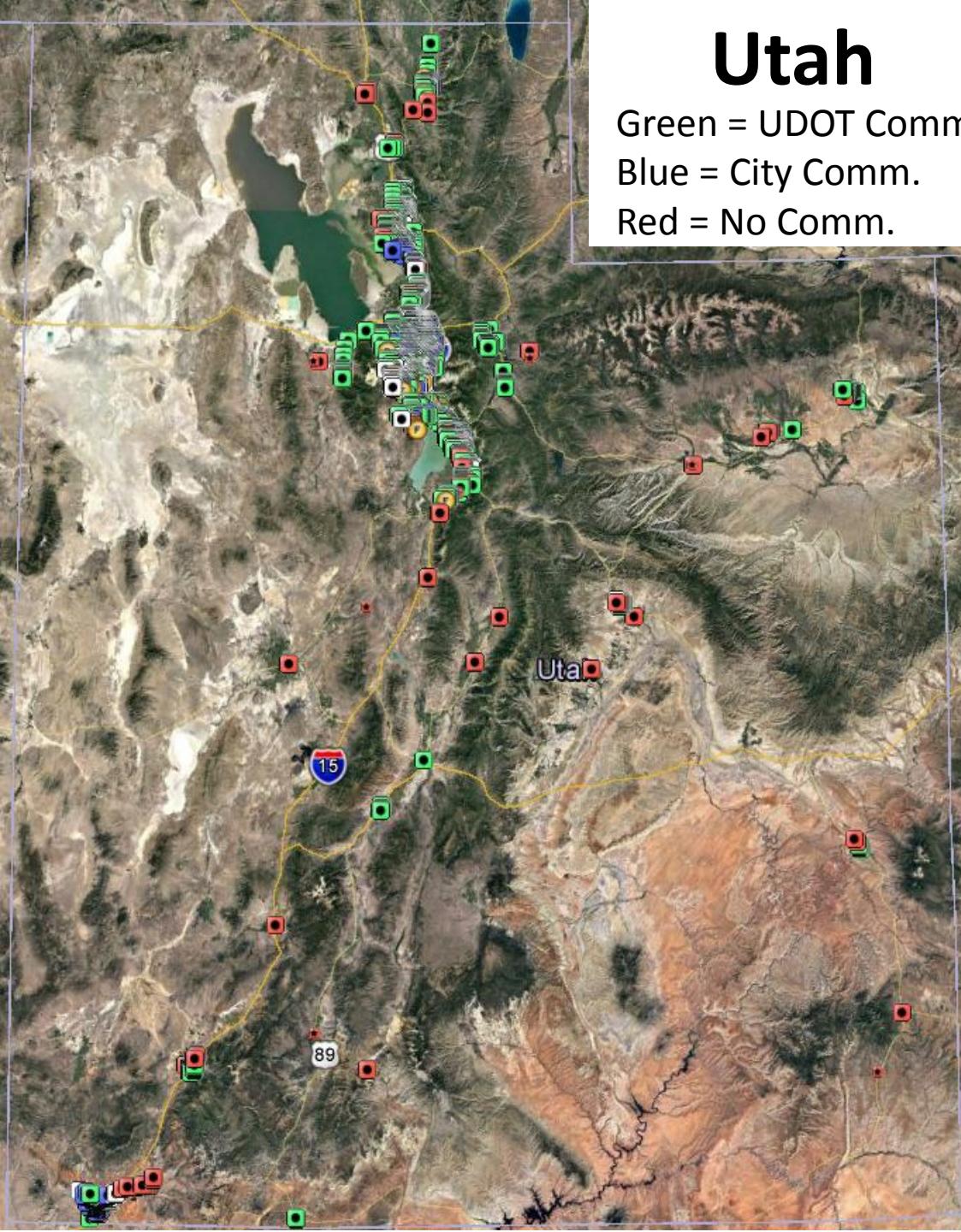


- All cities in Utah & UDOT share same ATMS



Utah

Green = UDOT Comm.
Blue = City Comm.
Red = No Comm.



Wasatch Front

Challenge from UDOT Executive Leaders (2011)

“What would it take for UDOT’s traffic signals to be world class?”

“What’s the trend – are signal operations improving, staying the same or getting worse?”

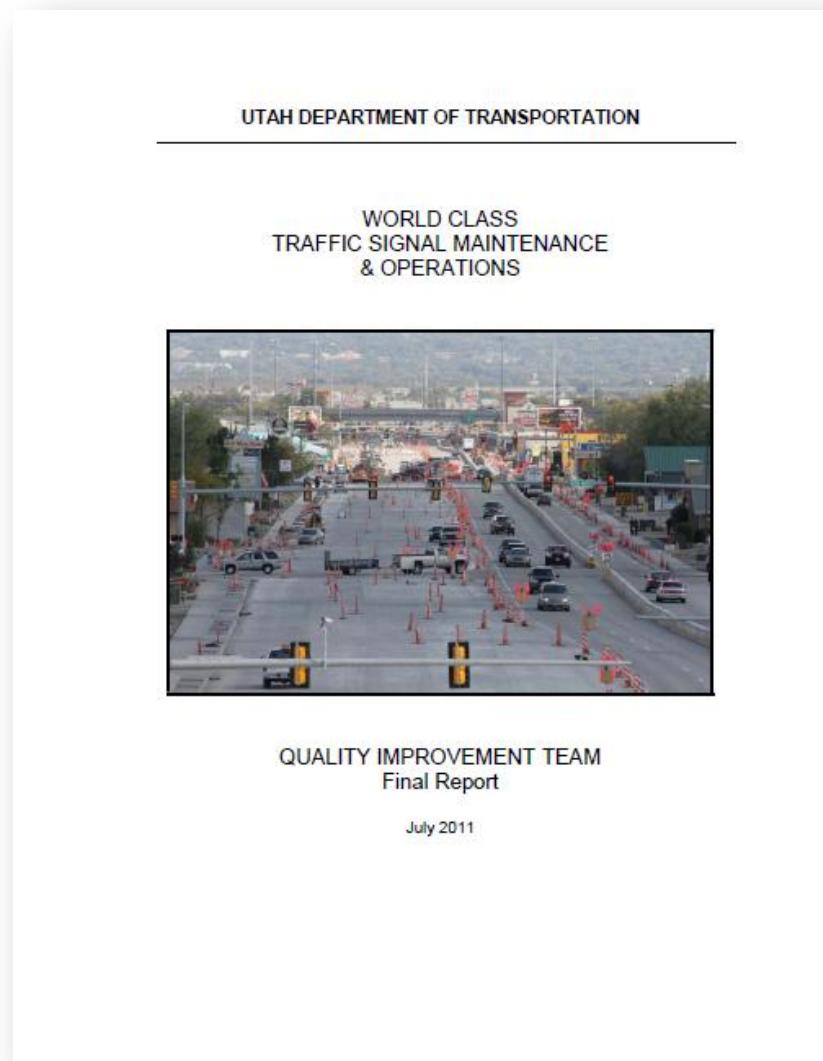
“What are our areas of most need?”

 **Quality
Improvement
Team**



QIT Recommendations (July 2011)

- Communications and detection maintained during projects
- Proactive signal maintenance
- **Real-time monitoring of system health and quality of operations**





PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS

An Outcome-Oriented Approach



Christopher M. Day, Darcy M. Bullock, Howell Li, Stephen M. Remias, Alexander M. Hainen,
Richard S. Freije, Amanda L. Stevens, James R. Sturdevant, and Thomas M. Brennan



POOLED FUND STUDY

INDIANAPOLIS

NOVEMBER 12, 2014

PERFORMANCE MEASURES FOR
TRAFFIC SIGNAL SYSTEMS

An Outcome-Oriented Approach



Christopher M. Day, Darcy M. Bullock, Howell Li, Stephen M. Remous, Alexander M. Hauer, Richard S. Frojje, Amanda L. Stevens, James R. Shandarin, and Thomas M. Brennan



Salt Lake ATSPM Workshop Participants – Jan 2016

- 20 State & Federal Agencies
- 25 Public Agencies
- 5 Universities
- 35 Private Sector Locations



170 Representatives from 85 Different Organizations, 28 States, DC, & Canada

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Enter search terms:

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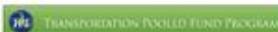
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PURDUE

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PRESENTATIONS FROM JANUARY 26–27, 2016



2016

Tuesday, January 26th

Traffic Signal Performance Measures Workshop

Darcy Bullock, *Purdue University*

TSM&O in Florida

Raj Ponnaluri, *Florida Department of Transportation*

Automated Traffic Signal Performance Measures, AASHTO Innovation Initiative 2013 Focus Technology

Rob Clayton, *Utah Department of Transportation*

Lessons Learned from ASCT and Systems Engineering

Eddie Curtis, *Federal Highway Administration*

Transportation Pooled Fund Program Recap

Jim Sturdevant, *Indiana Department of Transportation*
Richard Denney, *Federal Highway Administration*

Public/Private Partnerships: Expanding the Reach of Traffic Signals

Lynne Yocom, *Utah Department of Transportation*

ite
Institute of Transportation Engineers

BOOKSTORE EMPLOYMENT CENTER TECHNICAL INFORMATION

ABOUT ITE JOIN ITE TODAY! COUNCILS

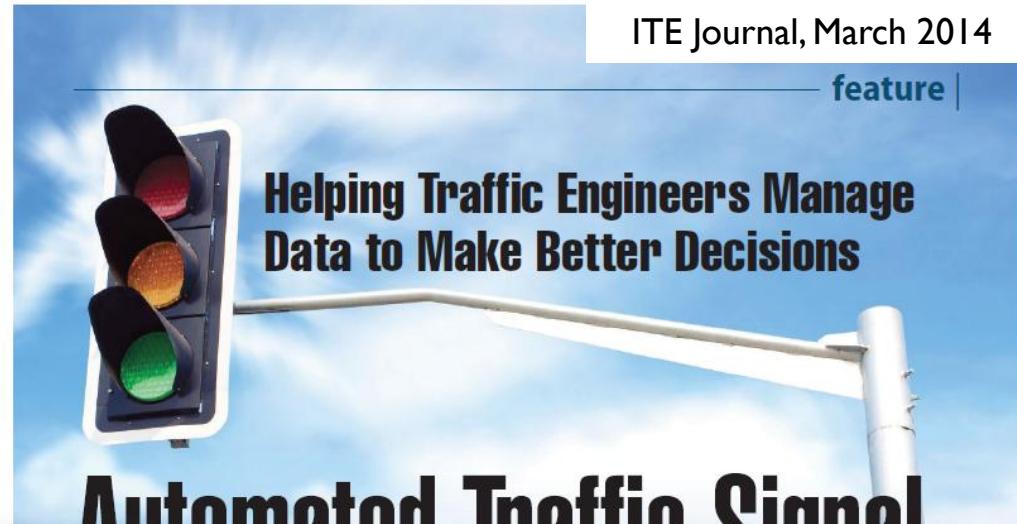
Automated Traffic Signal Performance Measu

ITE 3-part Webinar
April, May, June 2014

ITE Journal, August 2016

Implementation of Automated Traffic Signal Performance Measures

By CHRISTOPHER M. DAY, PH.D., MARK TAYLOR, P.E., PTOE,
JAMIE MACKEY, P.E., PTOE, ROB CLAYTON, P.E., PTOE,
SHITAL K. PATEL, P.E., GANG XIE, P.E., HOWELL LI,
JAMES R. STURDEVANT, P.E., AND DARCY BULLOCK, P.E.



ITE Journal, March 2014

feature |

**Helping Traffic Engineers Manage
Data to Make Better Decisions**

Automated Traffic Signal Performance Measures

www.istockphoto.com/verdoros

DARCY BULLOCK, P.E., ROB CLAYTON, P.E., PTOE, JAMIE MACKEY, P.E.,
SHITAL K. PATEL, P.E., GANG XIE, P.E., HOWELL LI, P.E.,
JAMES R. STURDEVANT, P.E., PTOE, AMANDA STEVENS, P.E., JIM STURDEVANT, P.E.,
MARK TAYLOR, P.E., PTOE

Improved signal operations with smooth and equitable traffic flow are goals for most traffic engineers; however the limited snapshot-view retiming methods that involve manual data collection, traffic signal modeling, and field fine-tuning are resource intensive and unresponsive to changes in traffic patterns. The National Transportation Operations Coalition's 2012 National Traffic Signal Report Card has led agencies to focus on these activities and develop methodologies to examine all the components of traffic operations.¹ These data-driven program management plans provide objective methods for identifying shortcomings and encourages coordination with neighboring jurisdictions. In addition, agencies need tools to prioritize activities when resources are constrained.

SPM Source Code -> Open Source

Mid Nov. 2016

U.S. Department of Transportation
Federal Highway Administration

OSADP HOME INFORMATION COMMUNITY CONTACT LOGIN Search ...

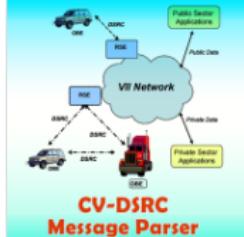
Explore Applications

APPLICATION CATEGORIES

- All Active Releases (38)
- Arterial Management (16)
- Collision Avoidance (5)
- Collision Notification (4)
- Commercial Vehicle Operations (8)
- Crash Prevention & Safety (8)
- Driver Assistance (10)
- Electronic Payment & Pricing (0)
- Emergency Management (6)
- Freeway Management (15)
- Information Management (20)
- Intermodal Freight (7)
- Road Weather Management (4)
- Streets & Roads Management (6)

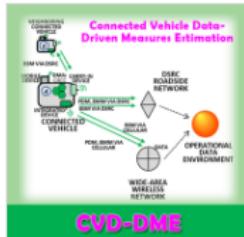
Sort by Name ▾  Filter Applications

Show 5 Items ▾ << First < Previous Next > >> Last



CV-DSRC-Msg-Parser 1.1
Connect Vehicles - Dedicated Short-Range Communications  

Version: CV-DSRC-MsgParser 1.1
Modified: Mar 31, 2016
Downloads: 50
Keywords: bsm, dsrc, parsing, analysis, data



CVD-DME 1.0
Connected Vehicle Data-Driven Measures Estimation  

Version: CVD-DME 1.0
Modified: Aug 22, 2016
Downloads: 59
Keywords: connected vehicles, data, trajectory converter analysis



DIRECTView-AMS-v1.0
Dynamic Intermodal Routing Environment for Control and Telematics - Analysis, Modeling and Simulation  

Version: DIRECTView-AMS-v1.0
Modified: Sep 1, 2016
Downloads: 3

Train the Trainer Workshop

When: Salt Lake City: January 18 & 19, 2017

For Whom: Consultants, Vendors, IT Personnel

Learning Objectives: Installing UDOT ATSPM Source Code, Server/Network Requirements, Configuration, Q&A.

Register: <https://www.eventbrite.com/e/udot-train-the-trainer-workshop-for-atspm-tickets-28563394883?aff=es2>

Attendance is free.

UDOT's Road Map

Vision: Keeping Utah Moving

Mission: Innovating transportation solutions that strengthen Utah's economy and enhance quality of life.

Strategic Goals:

1. Zero Crashes, Injuries and Fatalities
Yellow & Red Actuations, Speed, Preemption Details
2. Optimize Mobility
PCD, Split Monitor, Volumes, Purdue Link Pivot, Purdue Split Failure
3. Preserve Infrastructure
Purdue Phase Termination, Daily Detector Problem Email

UDOT Asset Management Tiers (2015 & Prior)

- Asset Management Tiers range from 1 to 3
- Tier 1 assets:
 - Highest value combined with highest risk of negative financial impact for poor management.
 - Very important to UDOT.
 - Receive separate funding source.
 - Targets and measures are set and tracked.

Tier 1 Assets	Tier 2 Assets	Tier 3 Assets
Pavement	ATMS / Signal Devices	Cattle Guards
Bridges	Pipe Culverts	Interstate Lighting

Signs	Barriers & Walls	Fences
	Rumble Strips	Curb & Gutter
	Pavement Markings	Rest Areas

UDOT Asset Management Tiers (2016 & Future)

- Asset Management Tiers range from 1 to 3
- Tier 1 assets:
 - Highest value combined with highest risk of negative financial impact for poor management.
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Tier 1 Assets
Pavement
Bridges
ATMS / Signal Devices



Tier 2 Assets
Pipe Culverts
Signs
Barriers & Walls
Rumble Strips
Pavement Markings

Tier 3 Assets
Cattle Guards
Interstate Lighting
Fences
Curb & Gutter
Rest Areas

ATSPM Basic Concept

Hi Def Data Logger
included in controller
firmware

Hi Def logs retrieved
every 10-60 minutes
from controller to server

Website to display
SPM's



A Central Signal System is NOT used or Needed!
Why Model what you can Measure?

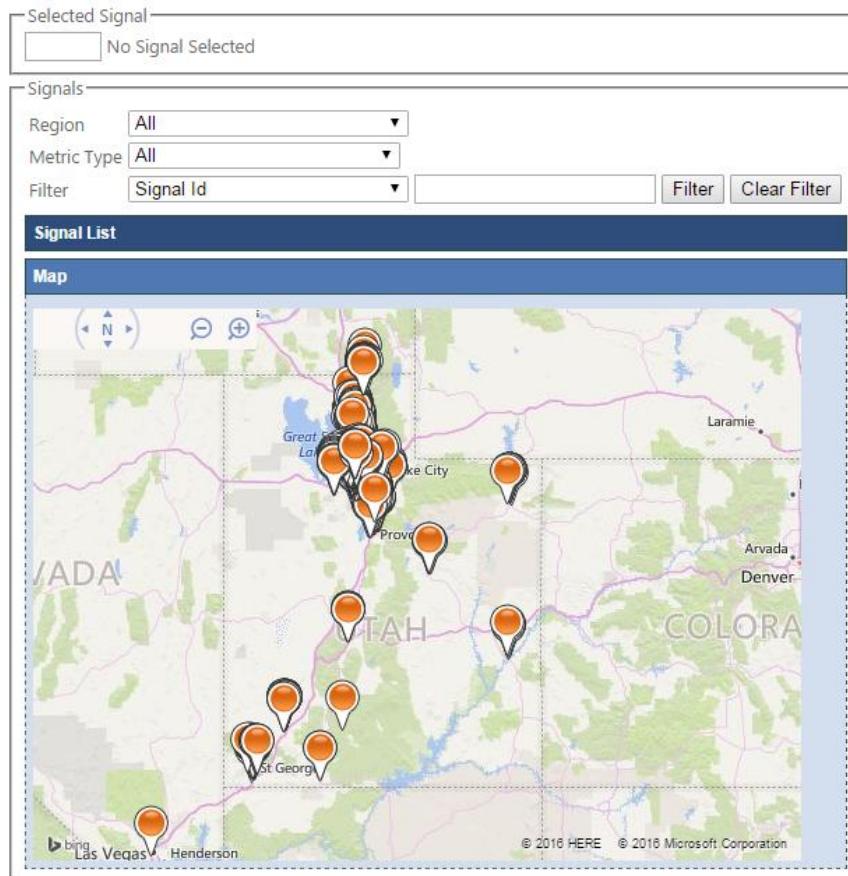


Signal Performance Metrics



Charts Reports Log Action Taken Links FAQ

-> Signal Metrics



Metric Settings

Metric Type

- Purdue Phase Termination
- Approach Volume
- Split Monitor
- Approach Delay
- Pedestrian Delay
- Arrivals On Red
- Preemption Details
- Approach Speed
- Turning Movement Counts
- Yellow and Red Actuations
- Purdue Coordination Diagram
- Purdue Split Failure

Time Y Axis Maximum 150

Volume Y Axis Maximum 2000

Volume Bin Size 15

Dot Size Small

Show Plan Statistics

Show Volumes

[Export Data](#)

Upload Current Data

Dates

Start Date 8/11/2016 ... 12:00 AM

End Date 8/11/2016 ... 11:59 PM

Reset Date

August 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
4	5	6	7	8	9	10

1710 (85%) Utah's traffic signals [Create Metrics](#)

SILOS of Traffic Data

Full Transparency & Data for Everyone





Signal Performance Metrics



Charts

Signal

Time Space Diagram

Enter Chart Comments

Reports

Links

FAQ

Selected Signal

No Signal Selected

Signals

Region

All

Metric Type

All

Filter

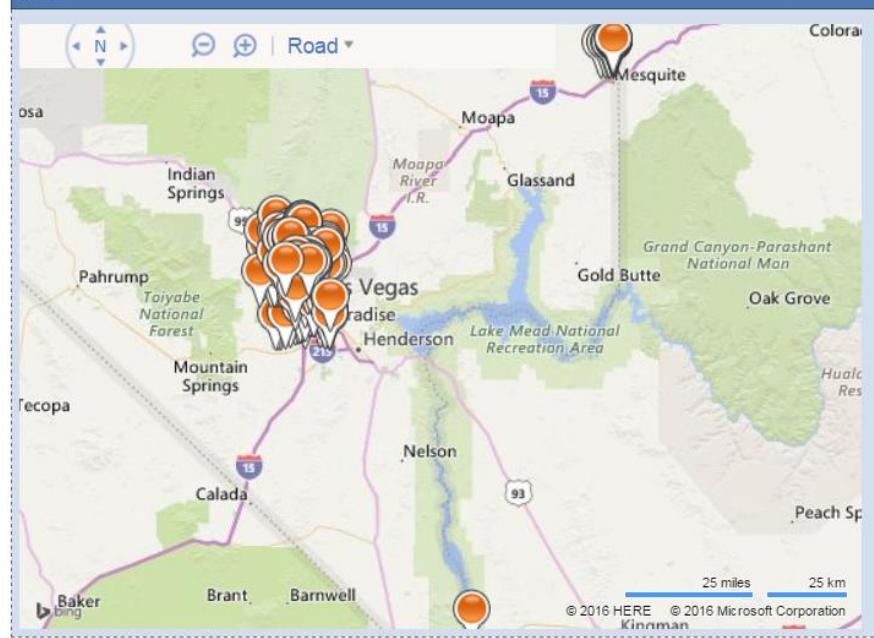
Signal Id

Filter

Clear Filter

Signal List

Map



286 traffic signals

Create Metrics

Metric Settings

Metric Type

- Approach Delay
- Speed
- Approach Volume
- Arrivals On Red
- Split Monitor
- Turning Movement Counts
- Purdue Coordination Diagram
- Ped Button Push Diagram

Purdue Phase Termination

Speed

Approach Volume

Arrivals On Red

Split Monitor

Turning Movement Counts

Ped Button Push Diagram

Time Y Axis Maximum

150

Volume Y Axis Maximum

2000

Volume Bin Size

15

Dot Size

Small

Show Plan Statistics

Show Volumes

[Export Data](#)

Dates

Start Date

...

12:00

AM

End Date

...

11:59

PM

[Reset Date](#)

<

August 2016

>

Sun Mon Tue Wed Thu Fri Sat

31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
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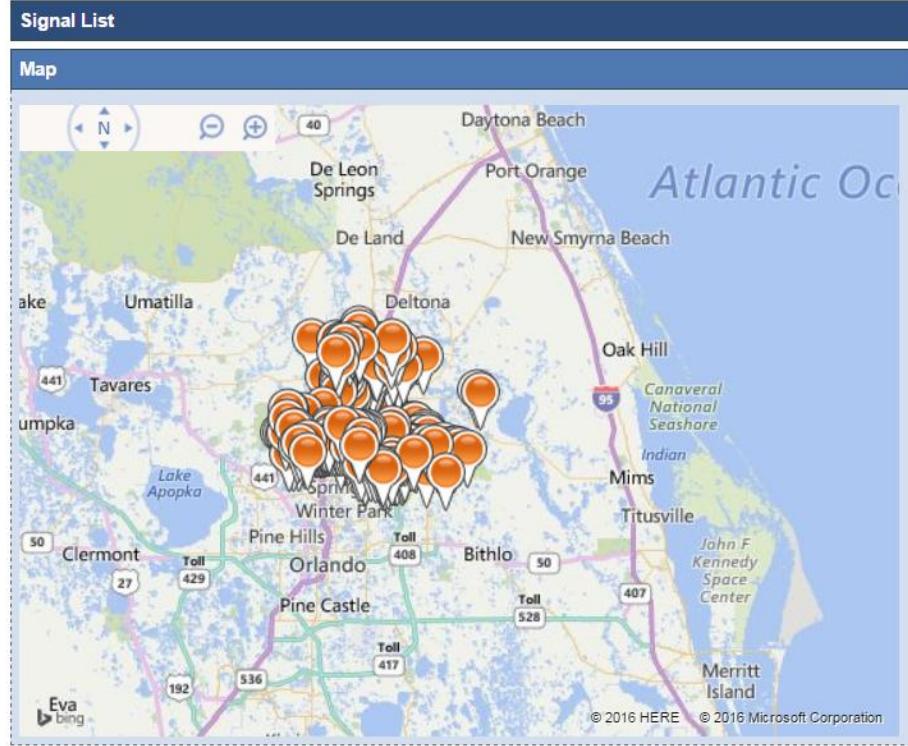
Signal Performance Metrics



->Signal Metrics

Selected Signal

Signals
Region Metric Type Filter



316 traffic signals

[Create Metrics](#)

Metric Settings

Metric Type

- Approach Delay
- Approach Volume
- Arrivals On Red
- Purdue Coordination Diagram
- Purdue Phase Termination
- Speed
- Split Monitor
- Turning Movement Counts

Time Y Axis Maximum

Volume Y Axis Maximum

Volume Bin Size

Dot Size

Show Plan Statistics

Show Volumes

[Export Data](#)

Upload Current Data

Dates

Start Date

End Date

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
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Signal Performance Metrics

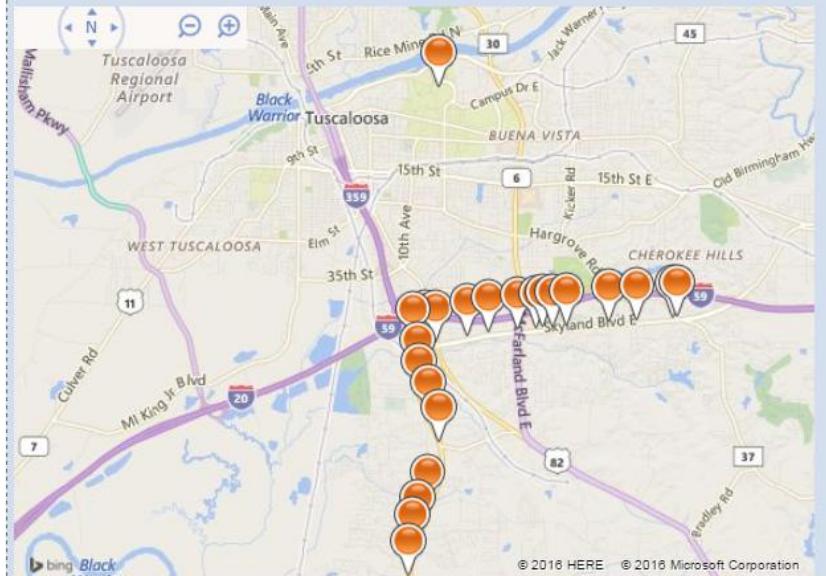
-> Signal Metrics

Selected Signal—
No Signal Selected

Signals
Region: All
Metric Type: All
Filter: Signal Id

Signal List

Map



© 2016 HERE © 2016 Microsoft Corporation

Metric Settings—

Metric Type—

- Approach Delay
- Approach Volume
- Arrivals On Red
- Purdue Coordination Diagram
- Purdue Split Failure
- Pedestrian Delay
- Preemption Details
- Purdue Phase Termination
- Speed
- Split Monitor
- Turning Movement Counts
- Yellow and Red Actuations

Time Y Axis Maximum:

Volume Y Axis Maximum:

Volume Bin Size:

Dot Size:

Show Plan Statistics

Show Volumes

Export Data
 Upload Current Data

Dates—

Start Date:

End Date:

Reset Date August 2016

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
4	5	6	7	8	9	10

45 traffic signals

[Create Metrics](#)

Agencies using ATSPMs – Separate systems deployed (16 and growing)



Old Website



Signal Performance Metrics



Charts Reports Log Action Taken Links FAQ

->Signal Metrics

Selected Signal

No Signal Selected

Signals

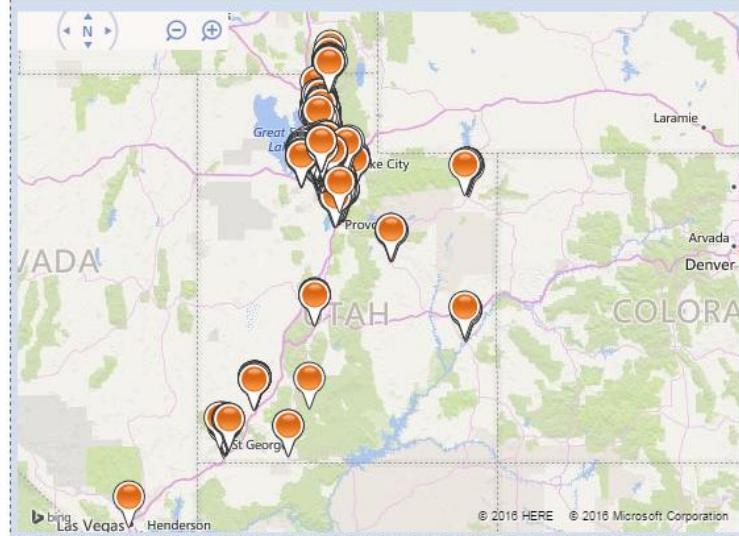
Region All

Metric Type All

Filter Signal Id Filter Clear Filter

Signal List

Map



Metric Settings

Metric Type

- Purdue Phase Termination
- Approach Volume
- Split Monitor
- Approach Delay
- Pedestrian Delay
- Arrivals On Red
- Preemption Details
- Approach Speed
- Turning Movement Counts
- Yellow and Red Actuations
- Purdue Coordination Diagram
- Purdue Split Failure

Time Y Axis Maximum 150

Volume Y Axis Maximum 2000

Volume Bin Size 15

Dot Size Small

Show Plan Statistics

Show Volumes

Export Data

Upload Current Data

Dates

Start Date 8/11/2016

... 12:00

AM

End Date 8/11/2016

... 11:59

PM

Reset Date

August 2016						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
31	1	2	3	4	5	6
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4	5	6	7	8	9	10

Create Metrics

New Website – November 15th

<http://udottraffic.utah.gov/SPM>

UDOT Keeping Utah Moving **Signal Performance Measures** Home Charts Reports Log Action Taken Links FAQ Admin Vs 4.0 Regi

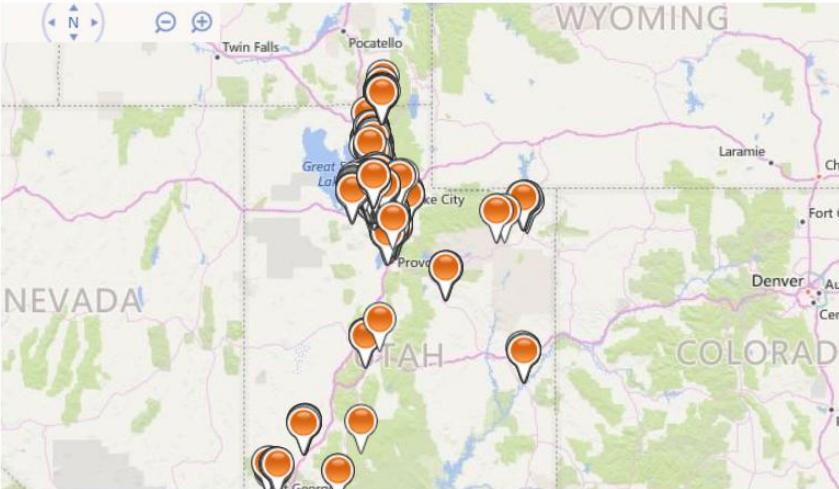
Signal Selection

Signal ID
T220 Foothill Drive @ 1300 South

Signal List

Signal Map

Region --Select Region-- **Metric Type** --Select a Metric--



Metric Selection

Metrics List

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals On Red
- Approach Speed
- Purdue Split Failure
- Turning Movement Counts
- Yellow and Red Actuations

Date Selection

Start Date 11/02/2016 12:00 AM

End Date 11/02/2016 11:59 PM

Reset Date

Create Metric

November 2016

Su	Mo	Tu	We	Th	Fr	Sa
1	2	3	4	5		
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

How to use ATSPM Website

Utah Department of Transportation (UDOT) Keeping Utah Moving

Signal Performance Measures

Home Charts Reports Log Action Taken Links FAQ Admin

Vs 4.0 Region

Signal Selection

Signal ID: T220 (highlighted with a red arrow)

Signal List: Foothill Drive @ 1300 South

Signal Map

Region: --Select Region--

Metric Type: --Select a Metric--

Metric Selection

Metrics List:

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals On Red
- Approach Speed
- Purdue Split Failure
- Turning Movement Counts
- Yellow and Red Actuations

1

Pick a signal from the map OR enter 4 digit signal number (if known).

How to use ATSPM Website

Metric Selection

Metrics List

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals On Red
- Approach Speed
- Purdue Split Failure
- Turning Movement Counts
- Yellow and Red Actuations

2

Select an available Metric from the list.

Note: Not all signals have all metrics.

How to use ATSPM Website

The screenshot shows the ATSPM website interface. The top navigation bar is blue with the text "ATSPM" and "Metrics". Below the navigation, there are three main sections: "Metric Selection", "Date Selection", and "Turning Movement Counts Options".

- Metric Selection:** A sidebar with a "Metrics List" containing options like "Purdue Phase Termination", "Split Monitor", "Pedestrian Delay", "Preemption Details", "Purdue Split Failure", and "Turning Movement Counts".
- Date Selection:** Fields for "Start Date" (10/28/2016, 12:00, AM) and "End Date" (10/28/2016, 11:59, PM). A "Reset Date" button is also present.
- Turning Movement Counts Options:** Settings for "Y-axis Max" (1000), "Secondary Y-axis Max" (300), "Volume Bin Size" (15), and checkboxes for "Show Lane Volume" (checked) and "Show Total Volume".

Red arrows and numbers are overlaid on the interface to guide the user:

- Red arrow pointing to the "Create Metric" button at the bottom left.
- Red arrow pointing to the "Start Date" field in the Date Selection section.
- Red arrow pointing to the "Y-axis Max" field in the Turning Movement Counts Options section.
- Red arrow pointing to the date picker calendar in the Date Selection section.

Select a date and time range

Click “Create Metric”,
wait a few seconds
and scroll down to see
data.

How to use ATSPM Website

(Filter Map by Metric Type)

Signal Selection

Signal ID

Signal ID Press Enter to get Signal info

Signal List

Signal Map

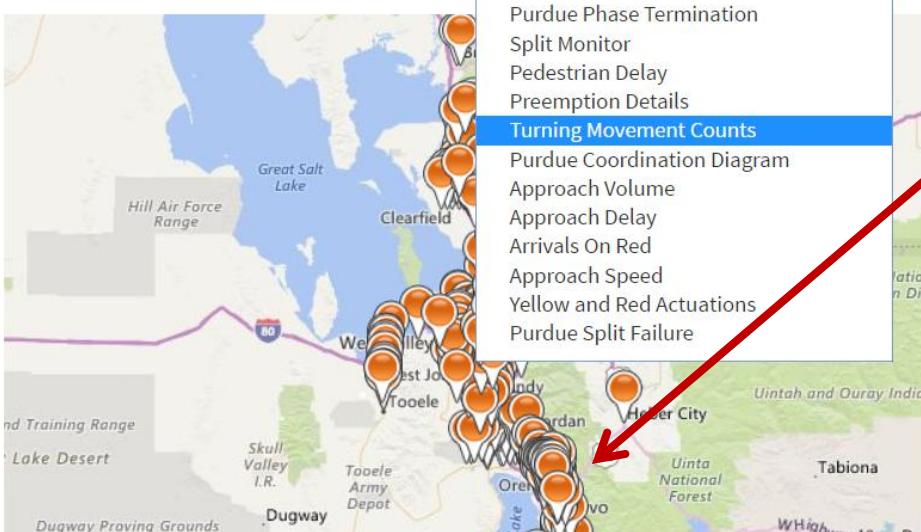
Region

Metric Type

Turning Movement Counts

--Select a Metric--

- Purdue Phase Termination
- Split Monitor
- Pedestrian Delay
- Preemption Details
- Turning Movement Counts
- Purdue Coordination Diagram
- Approach Volume
- Approach Delay
- Arrivals On Red
- Approach Speed
- Yellow and Red Actuations
- Purdue Split Failure



A

Select a Metric from the dropdown list.

The map will filter all available signals with that metric.

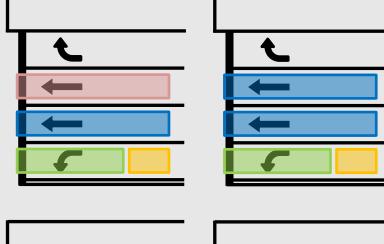
B

Zoom in on map and select your desired signal.

C

Follow steps 3&4 shown previously (e.g. select date & click "create metrics")

METRICS & DETECTION REQUIREMENTS

Detection	Metric
None	 Phase Termination Chart Split Monitor Preemption Details Pedestrian Delay
Lane-by-lane Presence Lane Group Presence	 Purdue Split Failure
Lane-by-lane Stop Bar Count	 Turning Movement Counts
Advanced Count	 Purdue Coordination Diagram Approach Volume Approach Speed (requires detection with speed service)

Detection

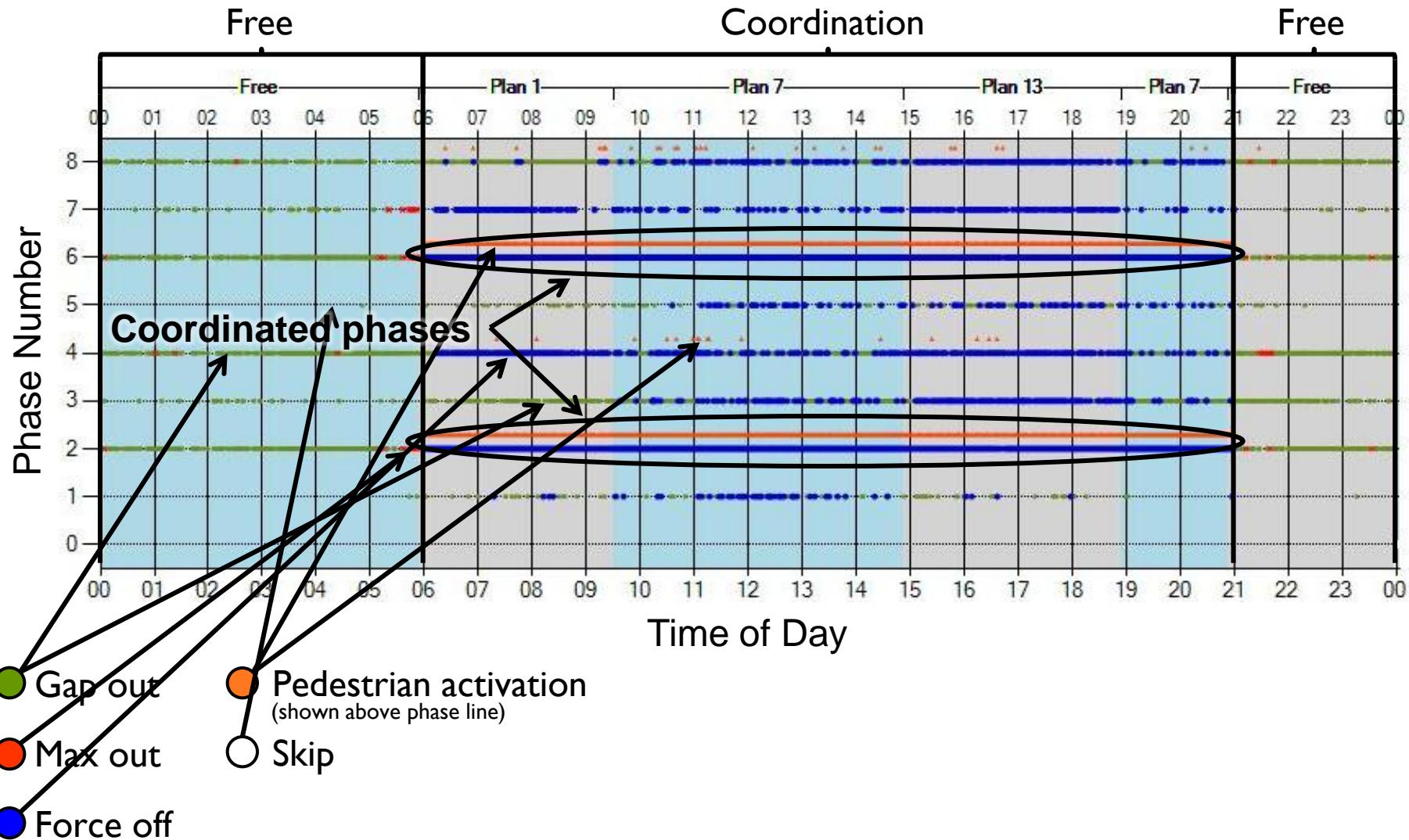
None



Available Metrics

- Phase Termination Chart
- Split Monitor
- Pedestrian Delay
- Preemption Details

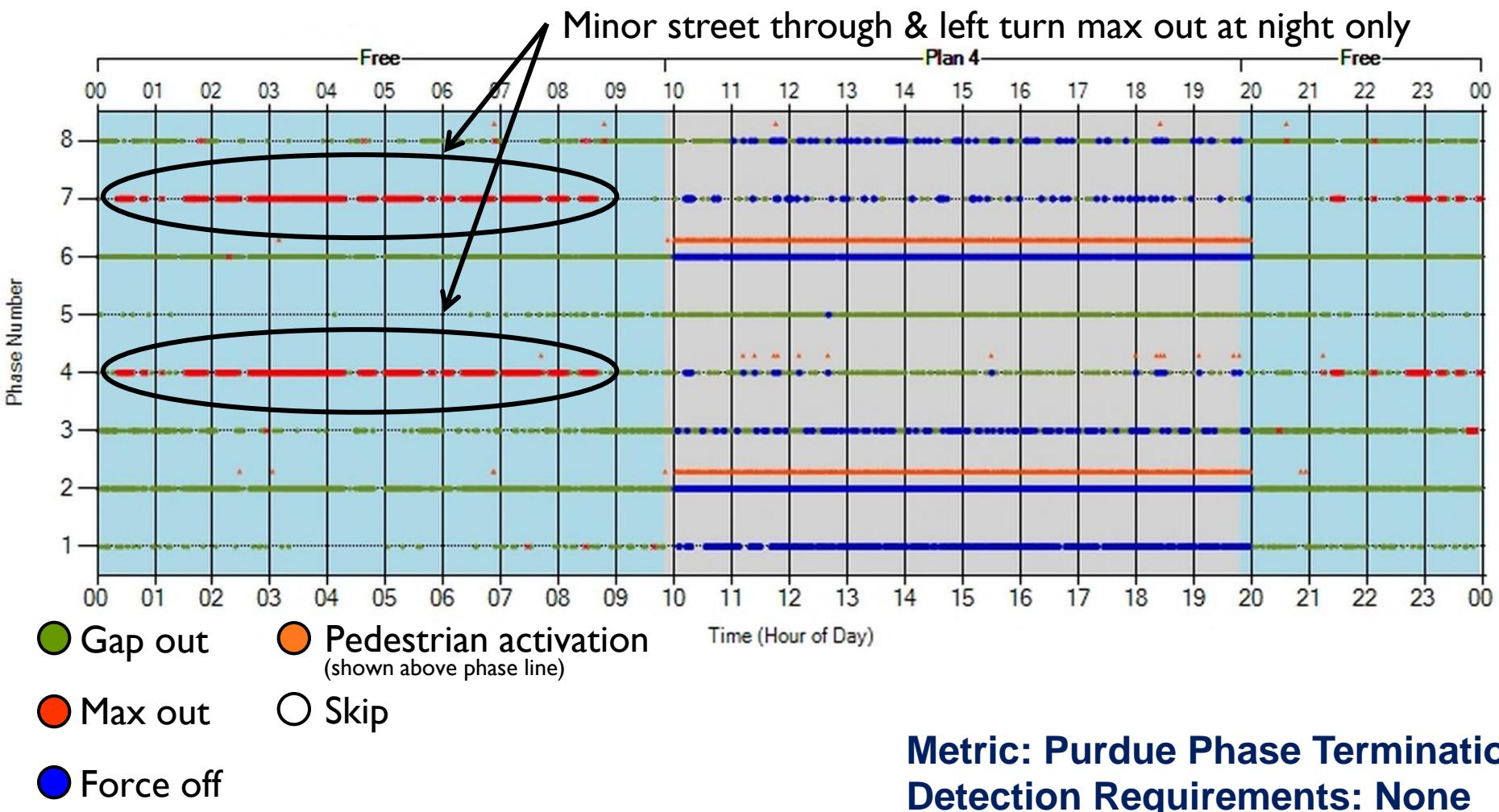
Metric: Phase Termination Chart



Complaint: Long red at 2 a.m., no other traffic

Before

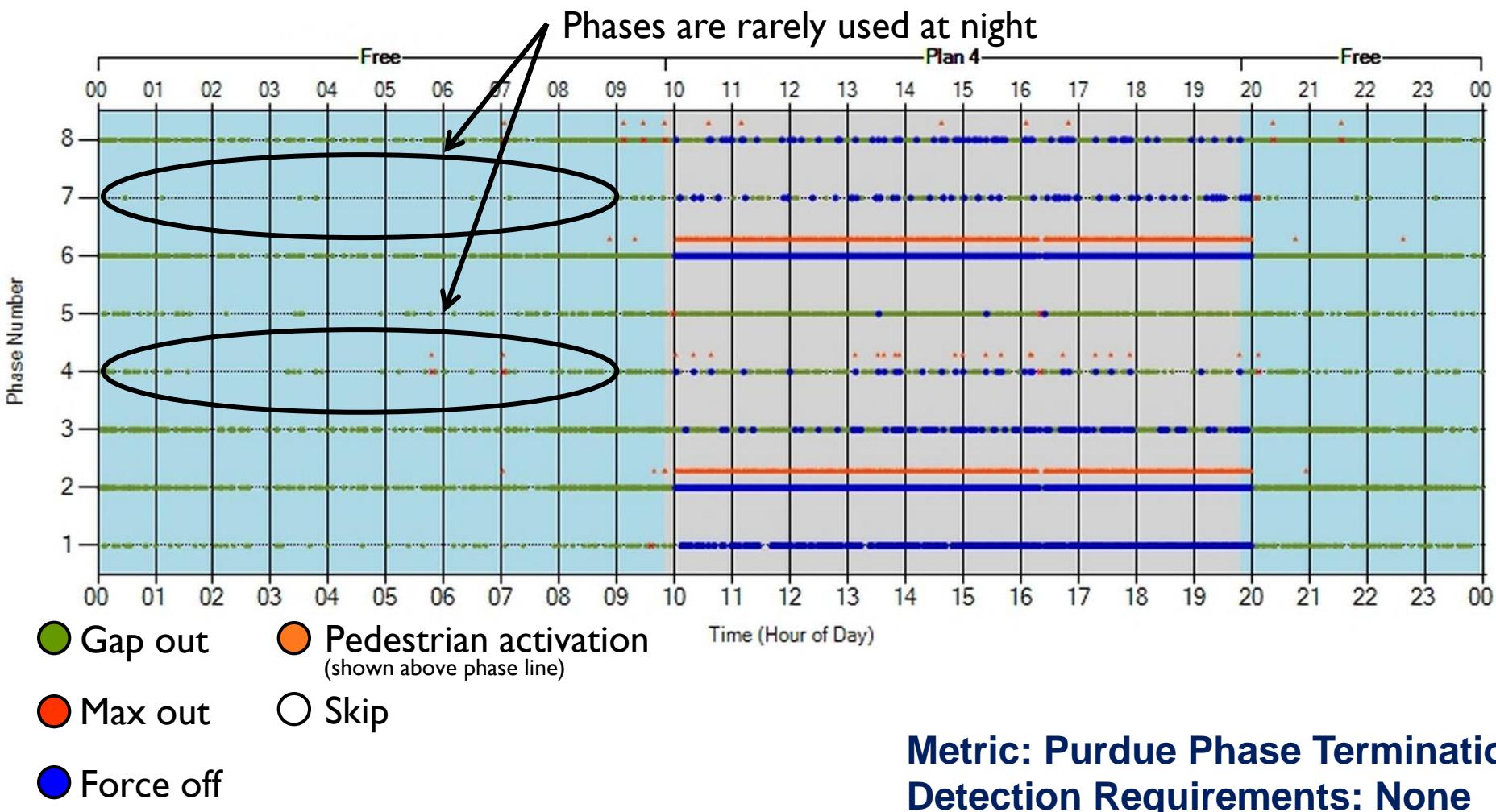
Video detection not working at night



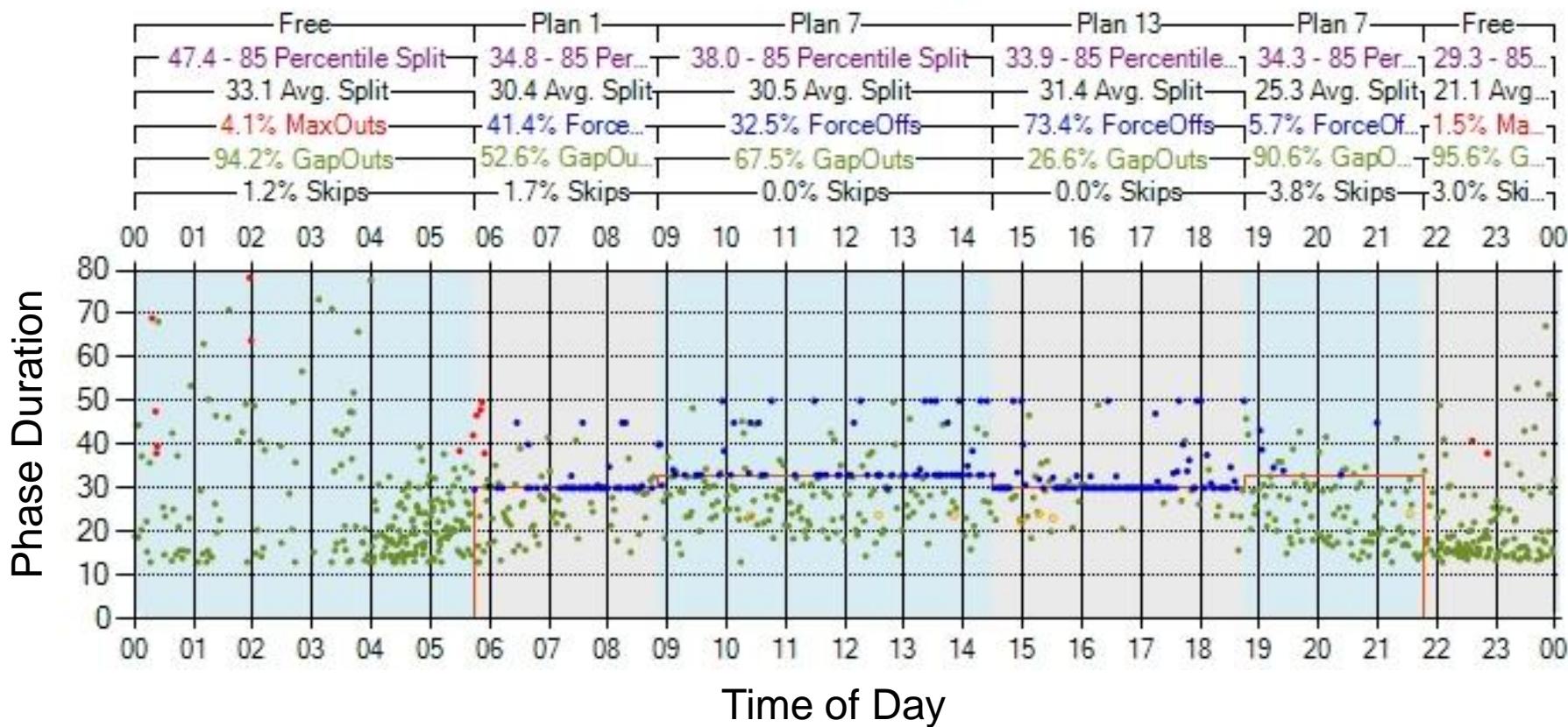
Complaint: Long red at 2 a.m., no other traffic

After

New detection technology installed



Metric: Split Monitor

Phase 6US-89 2700 North SIG#5372 Phase 6
Wednesday, March 09, 2016 12:00 AM - Thursday, March 10, 2016 12:00 AM

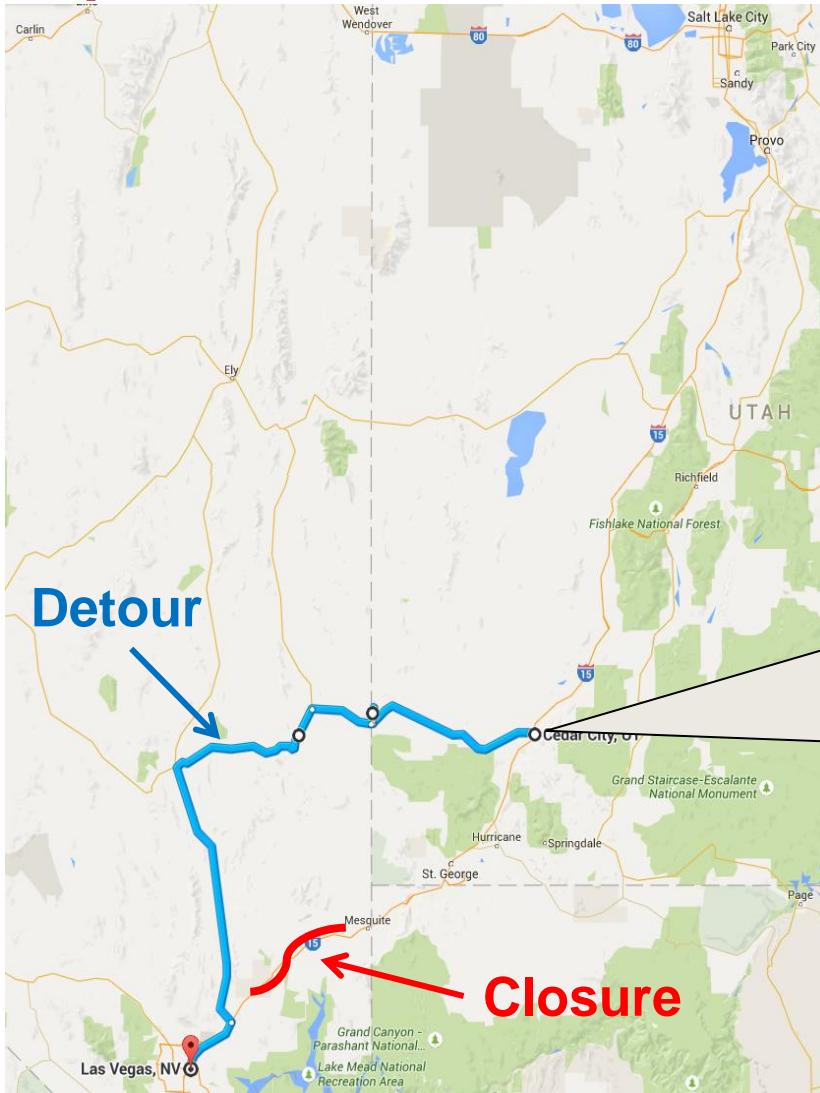
Example: I-15 Freeway Closure, September 9-12, 2014



Heavy rain rips apart I-15 in Nevada, forces freeway closure

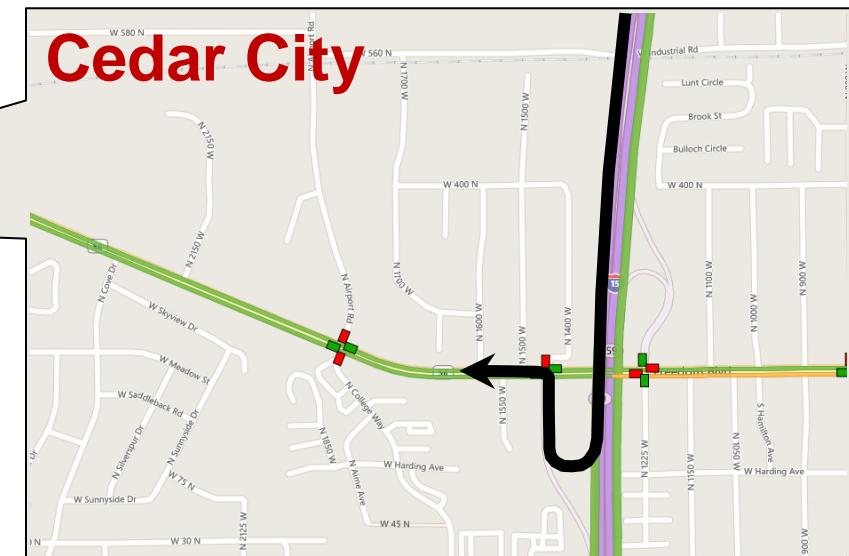
By Ken Ritter, Michelle Rindels, Associated Press | Posted Sep 9th, 2014 @ 7:44pm

Example: I-15 Freeway Closure, September 9-12, 2014

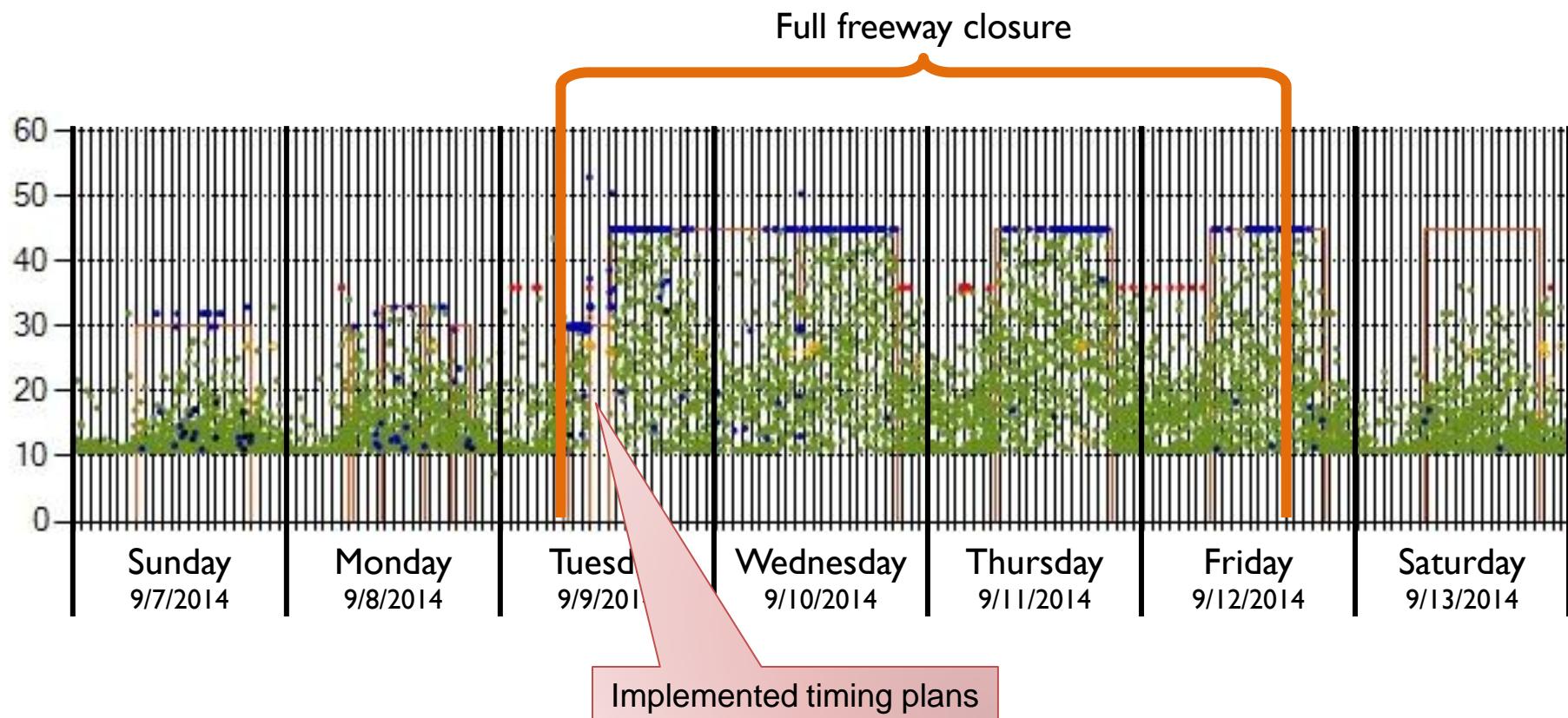


Southbound I-15 Closed in Nevada

- 4-day closure
- Detour to Las Vegas: Exit I-15 in Cedar City



Split Monitor for Northbound (Phase 4) at I-15 and 200 N, Cedar City



- Gap out
- Max out
- Force off

System Health Alerts

1 No SPM Data

2 Too many max outs

3 Too many force offs

4 Too many ped calls

5 Low PCD detector count

SPM Alerts for 5/22/2016



SPMWatchdog@utah.gov

to marktaylor, me, signaldesk, shanejohnson, bryan.meenen, kbarnes, SWinters, tforbush, jay.smith,

–The following signals had too few records in the database:
4671 - 13400 South & 4500 West - Phase: 0 (Missing Records)
5701 - 500 South & 400 East (Btfl) - Phase: 0 (Missing Records)

–The following signals had too many force off occurrences:
1224 - North Temple & Main Street - Phase: 3 (Force Offs 97.6%)
7252 - 500 South & Main Street - Phase: 2 (Force Offs 100%)
7252 - 500 South & Main Street - Phase: 6 (Force Offs 100%)

–The following signals had too many max out occurrences:
1123 - Wolcott St & 100 South - Phase: 2 (Max Outs 100%)
1124 - Sunnyside (850 S) & Gaurdsman Way - Phase: 2 (Max Outs 100%)
1124 - Sunnyside (850 S) & Gaurdsman Way - Phase: 6 (Max Outs 100%)
4024 - 7000 South (Fort Union) & 1300 East - Phase: 7 (Max Outs 92.6%)
4029 - 7200 South & 700 East - Phase: 1 (Max Outs 100%)
4103 - 4680 South (Murray-Holladay) & 2320 East (Holladay) - Phase: 5 (Max Outs 100%)
4118 - 6200 South & 3655 West (Dixie) - Phase: 2 (Max Outs 100%)
4511 - 4100 South & 3200 West - Phase: 4 (Max Outs 100%)
4820 - 4835 South & 2700 West - Phase: 2 (Max Outs 100%)
5063 - Lincoln & 24th - Phase: 4 (Max Outs 100%)
5063 - Lincoln & 24th - Phase: 8 (Max Outs 100%)
5080 - Washington & Adams - Phase: 5 (Max Outs 100%)
5170 - 200 N (Kaysville) & Main St. - Phase: 4 (Max Outs 100%)
5305 - Main St. & 200 North (Logan) - Phase: 7 (Max Outs 96.2%)
5900 - 900 W. (Kays Dr.) & 200 North, (Kaysville) - Phase: 4 (Max Outs 90.4%)
6035 - Pioneer Crossing & Millpond Drive - Phase: 8 (Max Outs 91.9%)
6608 - 100 West & 100 North - Phase: 8 (Max Outs 98.5%)
7107 - Redwood Road & 4700 South - Phase: 5 (Max Outs 93.2%)

–The following signals had unusually low detector hits:
5134 - SR-193 (700 S) & I-15 NB (Clearfield) - Phase: 2 (Has Unusually Low Counts.)
7061 - Bangerter Hwy (SR-154) & 4100 South - Phase: 1 (Has Unusually Low Counts.)
7061 - Bangerter Hwy (SR-154) & 4100 South - Phase: 7 (Has Unusually Low Counts.)
7361 - Bangerter Hwy (SR-154) & 13400 South - Phase: 1 (Has Unusually Low Counts.)

–The following signals have stuck ped detectors:
1023 - South Temple & 200 West - Phase: 2 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 4 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 6 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 8 (Stuck Ped)
4511 - 4100 South & 3200 West - Phase: 4 (Stuck Ped)
6009 - Main (Lehi) & I-15 SPUI - Phase: 6 (Stuck Ped)
7826 - 9800 S (Little Cottonwood Rd) & Wasatch Blvd (3500 E) - Phase: 4 (Stuck Ped)

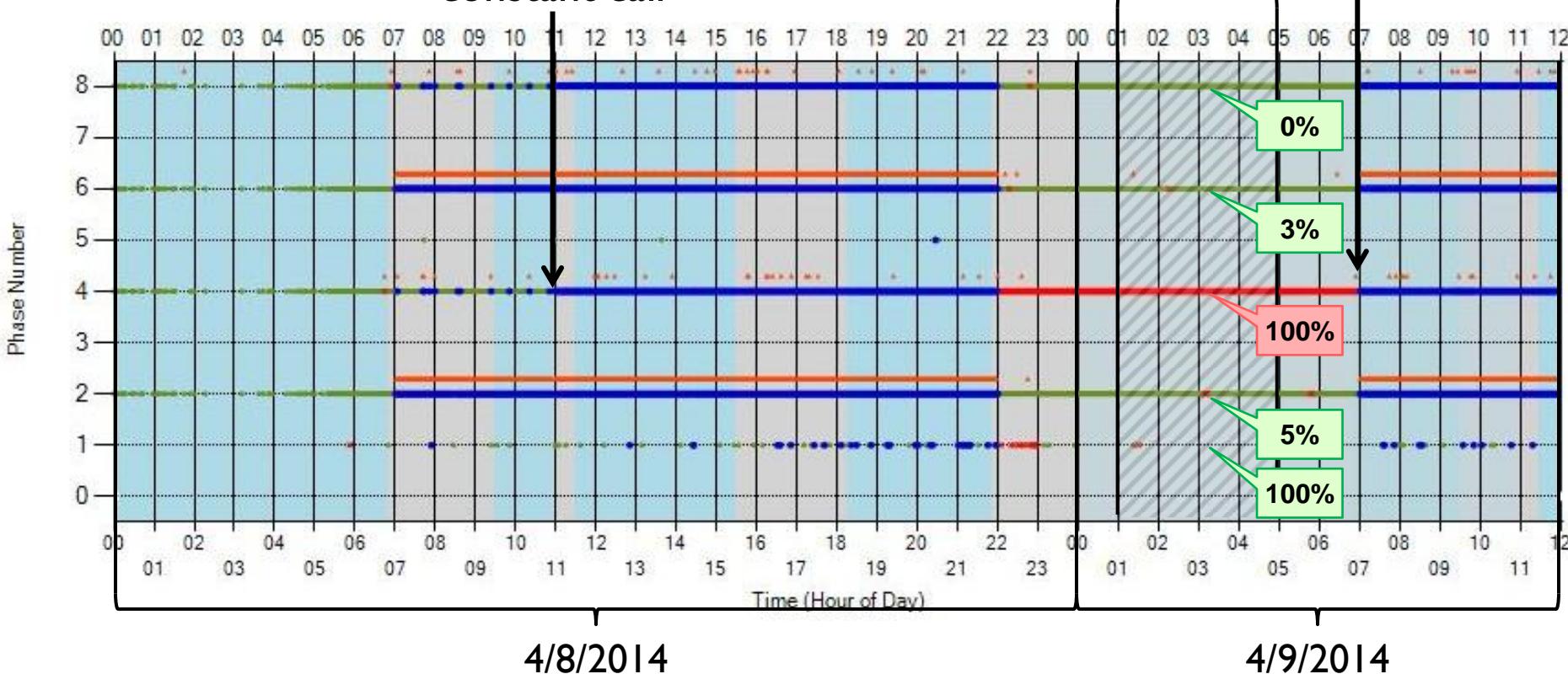
2

Too many max outs

Phase 4 starts
constant call

Alert email
sent

SPMs evaluated
for % max outs



- Gap out
- Max out
- Force off

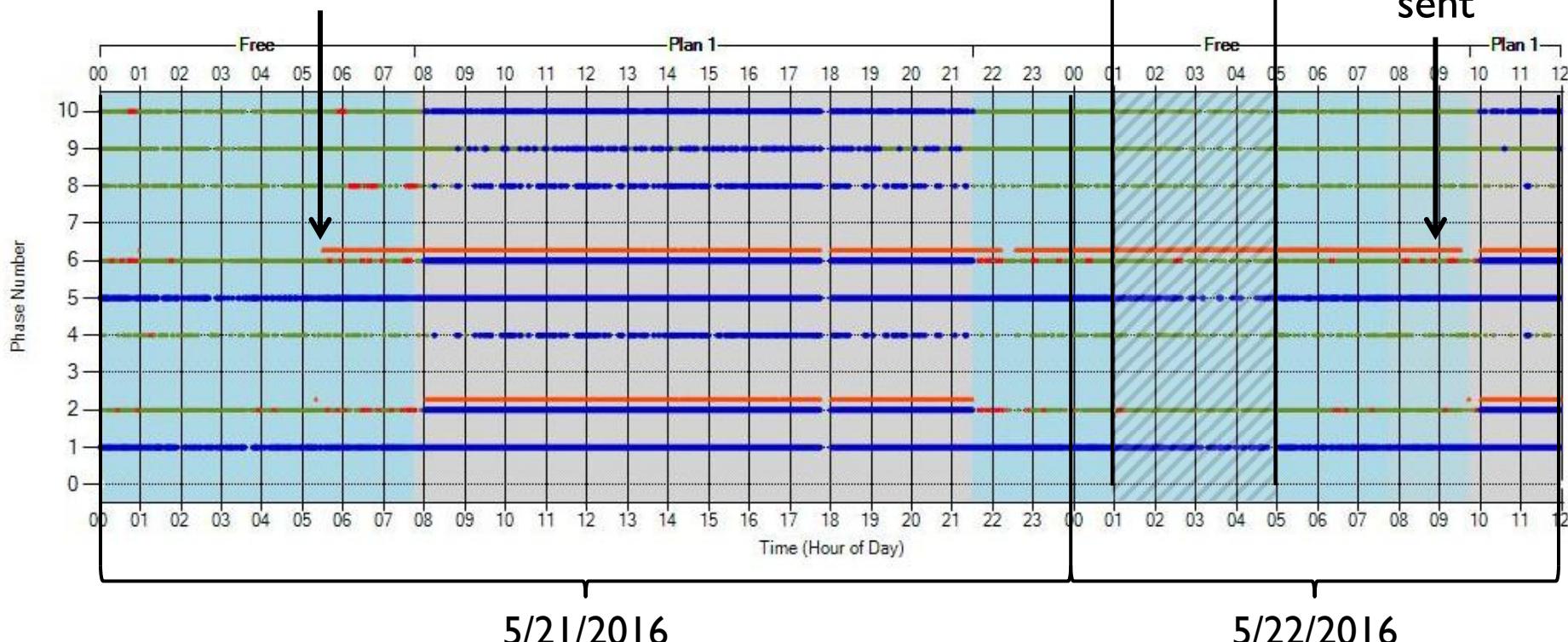
- Pedestrian activation (shown above phase line)
- Skip

Metric: Purdue Phase Termination
Detection Requirements: None

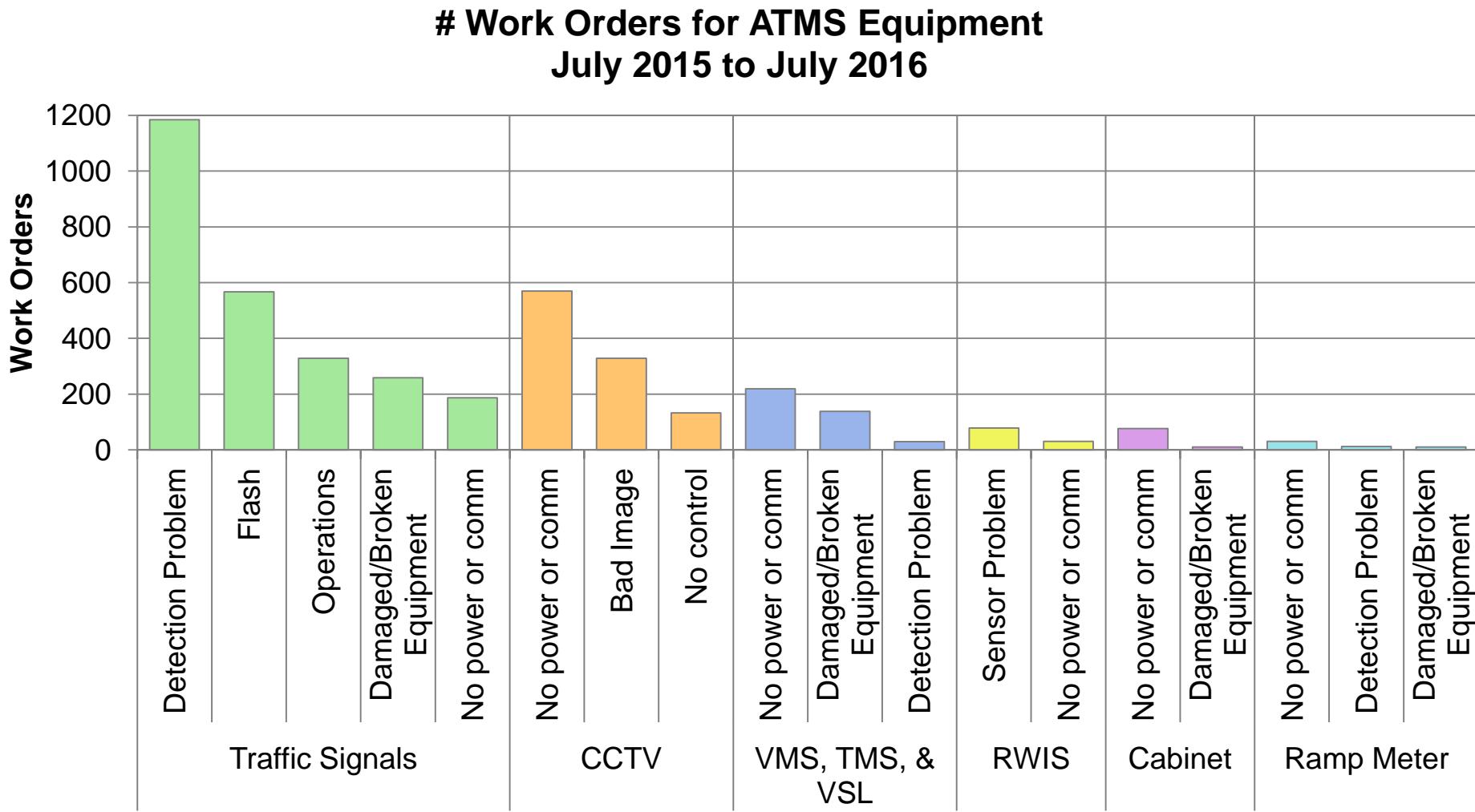
4

Too many ped calls

Ph6 Ped Constant Call



Work Orders for UDOT ATMS

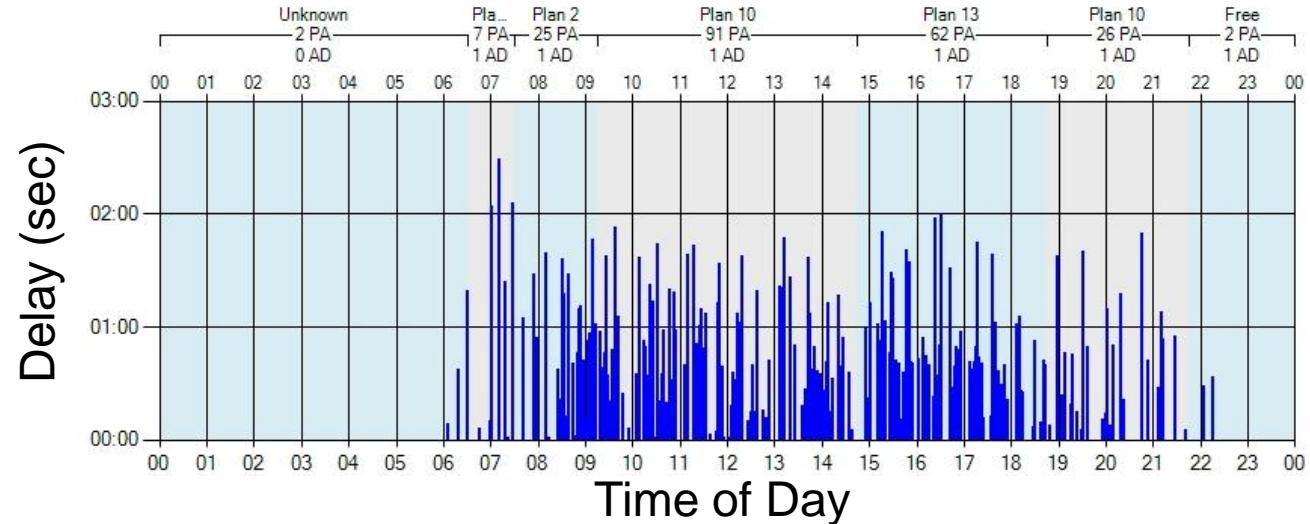
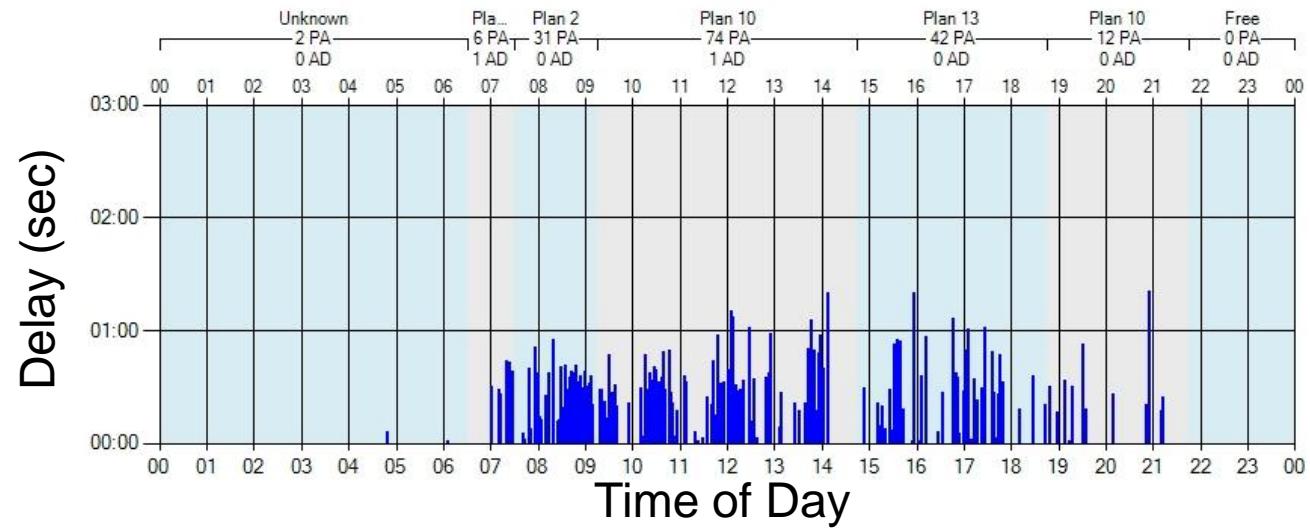


Metric: Pedestrian Delay

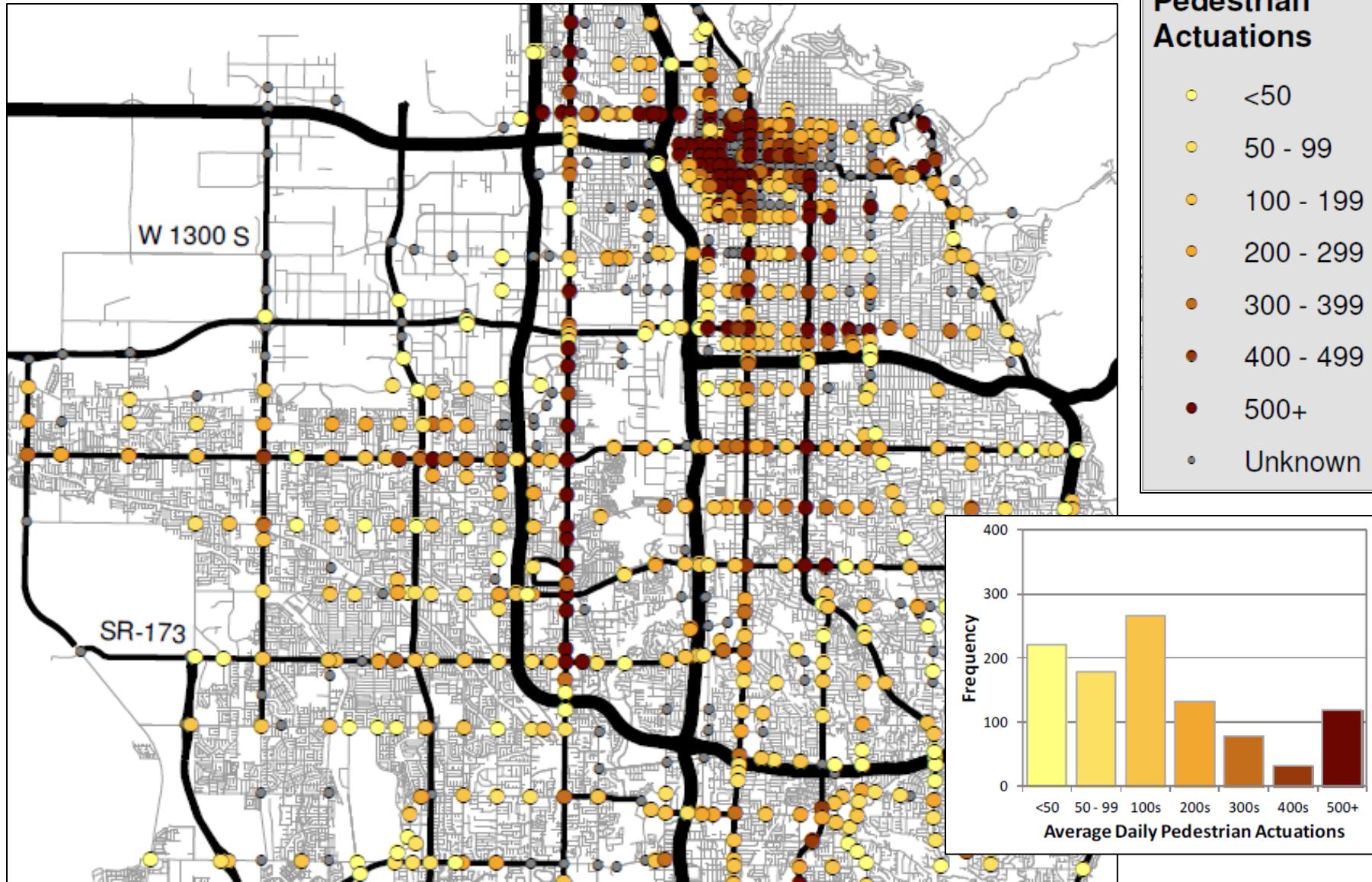
EVENT CODES
45 – Ped Call on
21 – Ped Walk on

Pedestrian Delay
500 South Guardsman Way (1580 E.) Signal 7216
Tuesday, September 01, 2015 12:00 AM - Wednesday, September 02, 2015 12:00 AM
Phase 2

167-Ped Acutations(PA) 00:00-Min Delay 01:20-Max Delay 00:30-Average Delay(AD)



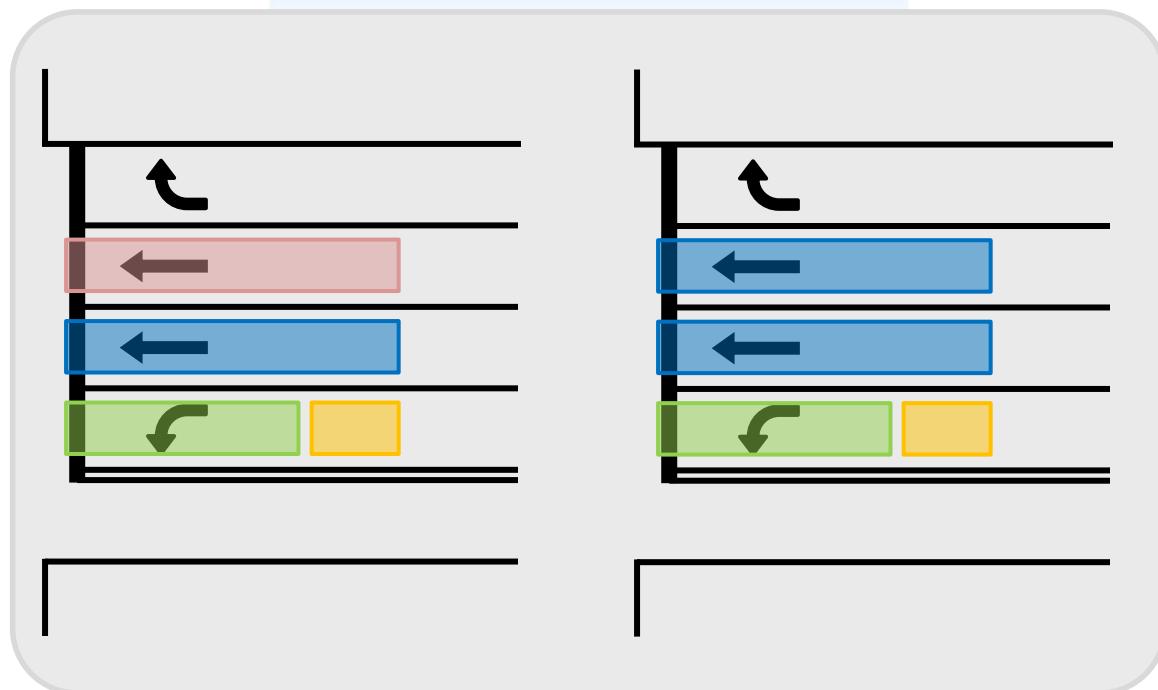
Active Transportation



Detection

Lane-by-lane Presence

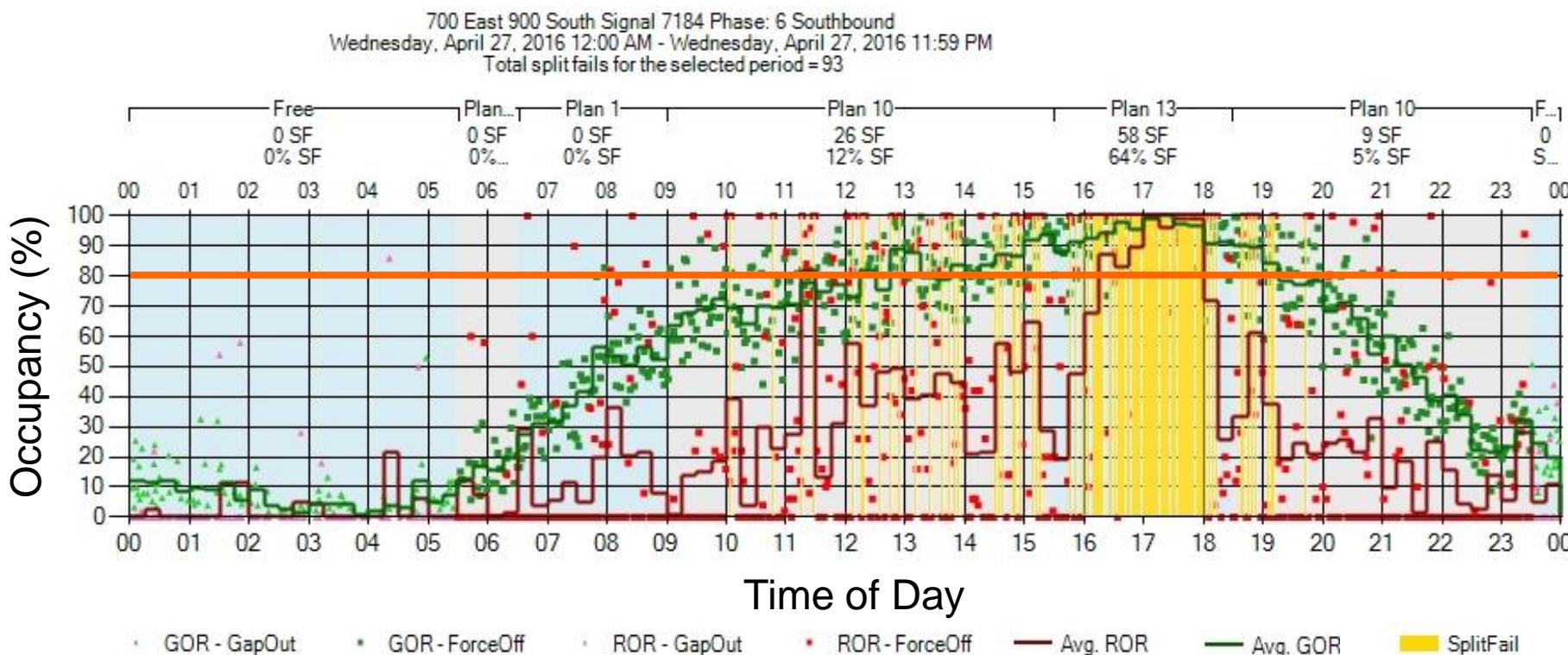
Lane Group Presence



Available Metrics

➤ Purdue Split Failure

Metric: Purdue Split Failure



Detection

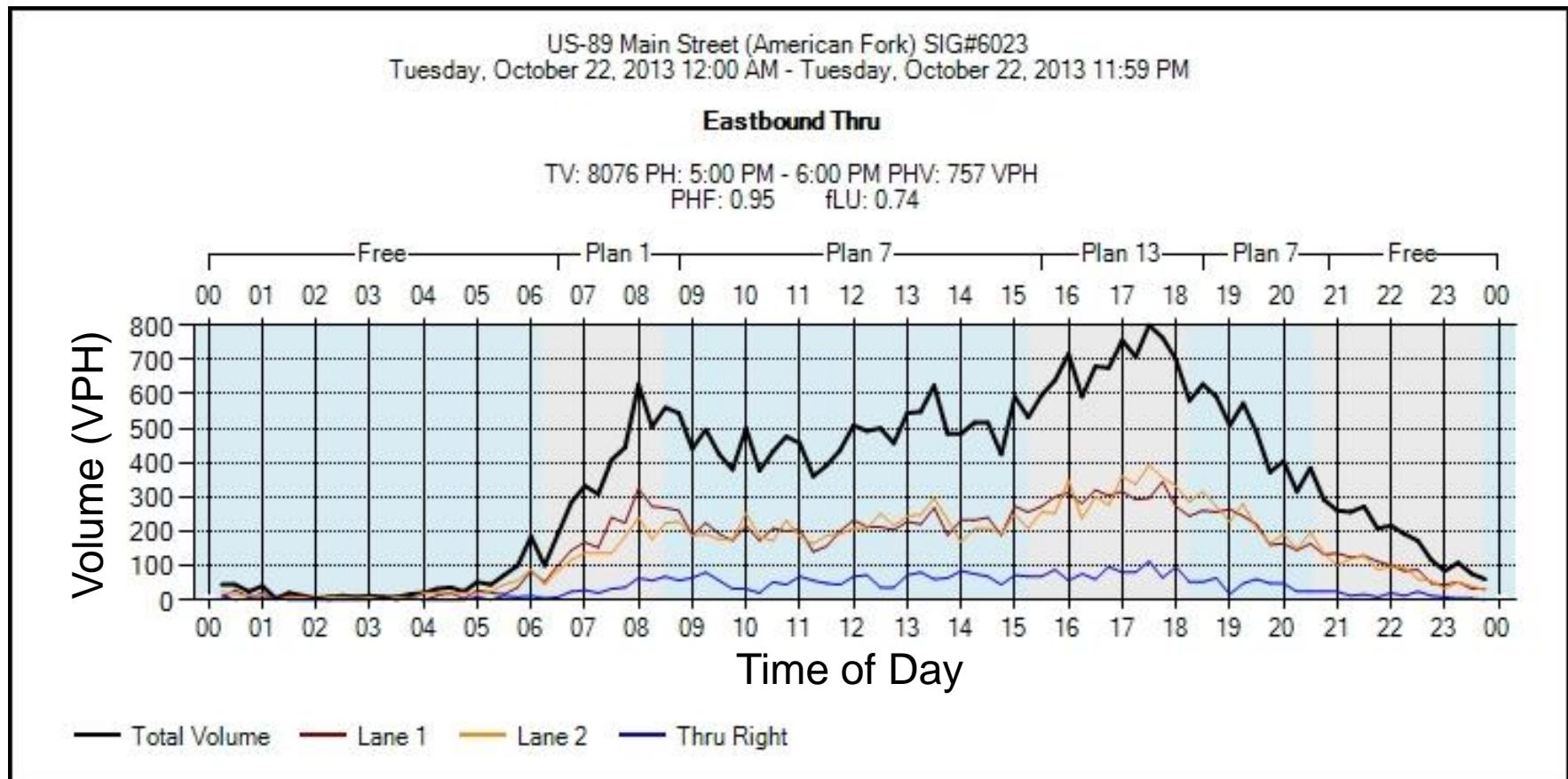
Lane-by-lane Count



Available Metrics

Turning Movement Counts

Metric: Turning Movement Counts



Metric: Turning Movement Counts
Detection Requirements: Stop Bar Counters

Turning Movement Counts Detection

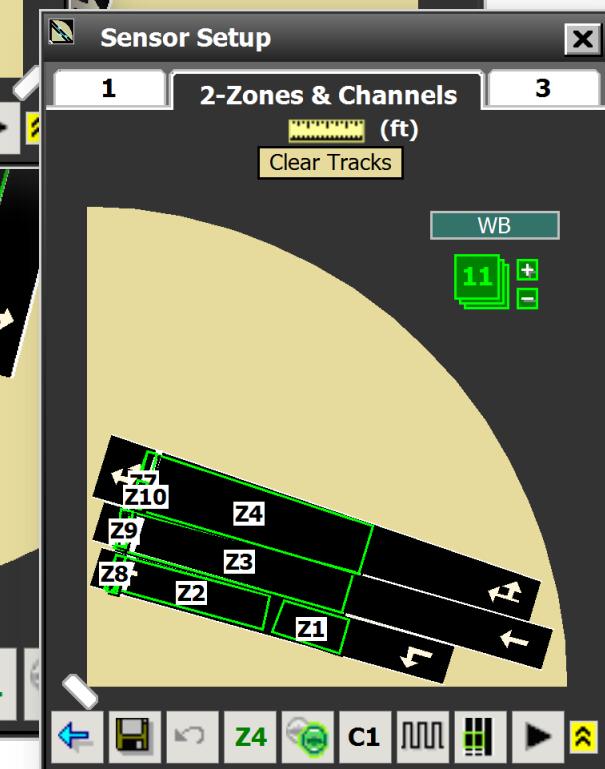
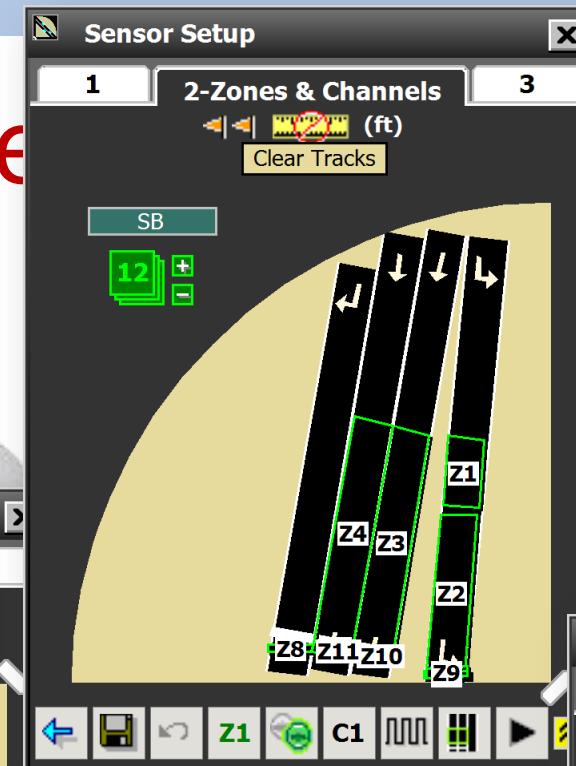
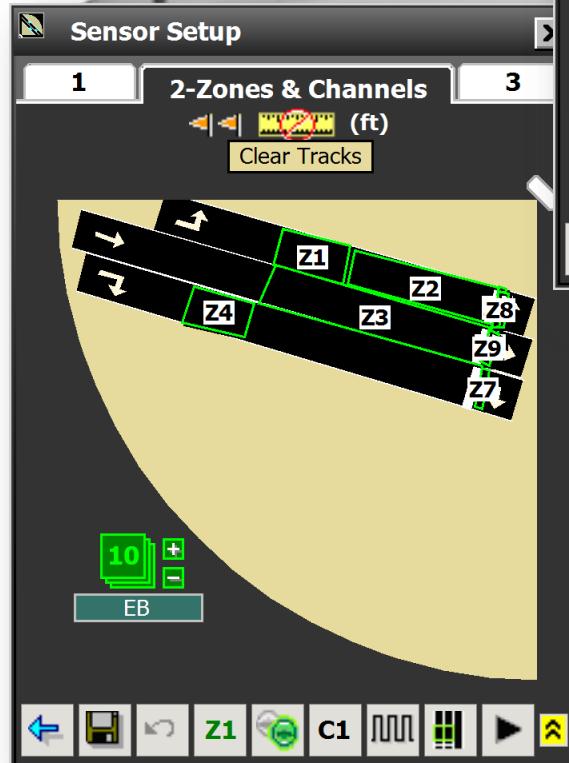


Wavetronix
SmartSensor
Matrix



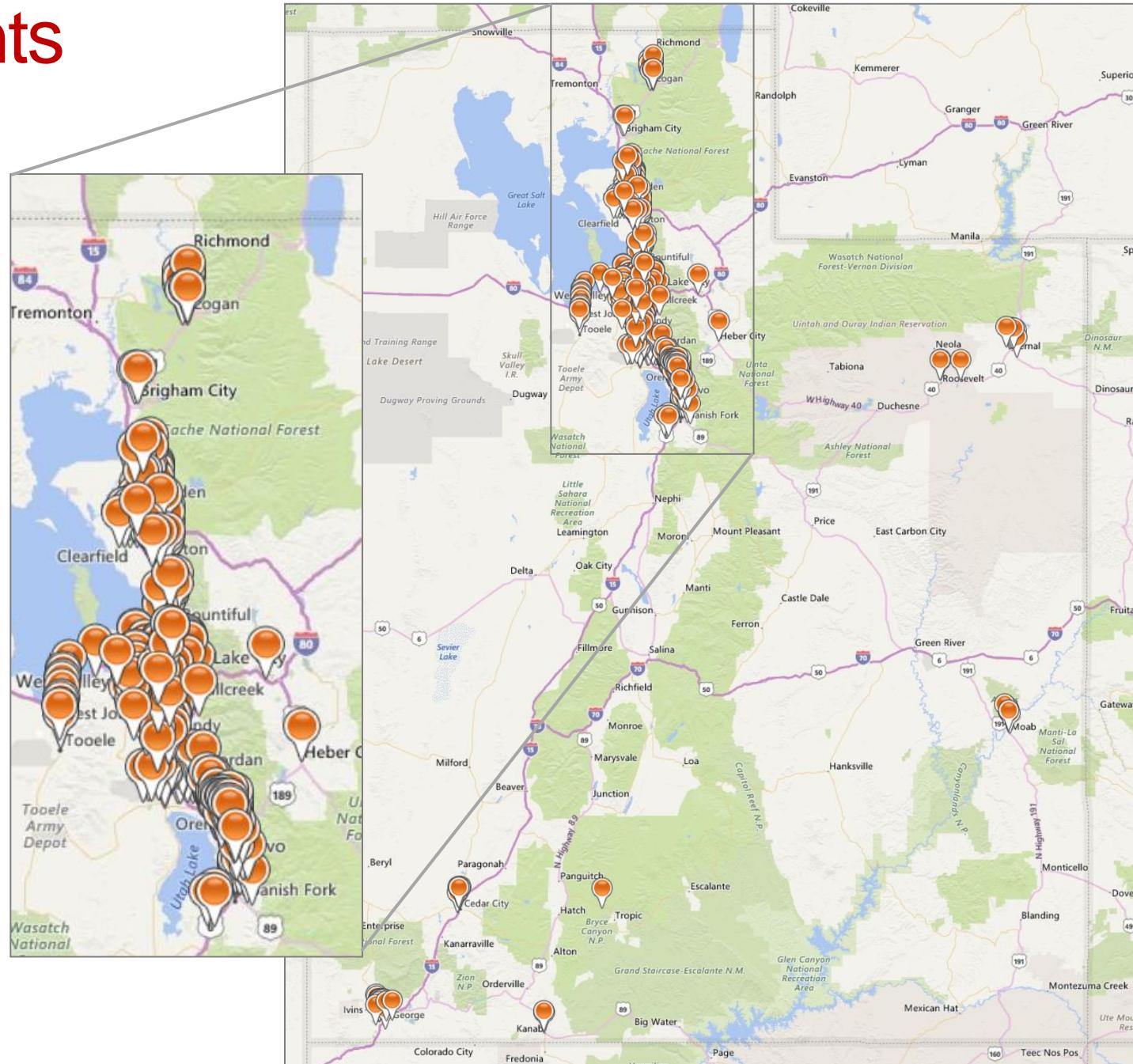
Wavetronix
Cabinet Interface Device
Click 650

Turning Movement Detection



Lane Counts Availability

380
signals statewide
UDOT signals
32%



TMC Data Accuracy



Report No. UT-15.14

CALIBRATION OF AUTOMATIC PERFORMANCE MEASURES – SPEED AND VOLUME DATA: VOLUME 1, EVALUATION OF THE ACCURACY OF TRAFFIC VOLUME COUNTS COLLECTED BY MICROWAVE SENSORS

Prepared For:

Utah Department of Transportation
Research Division

Submitted By:

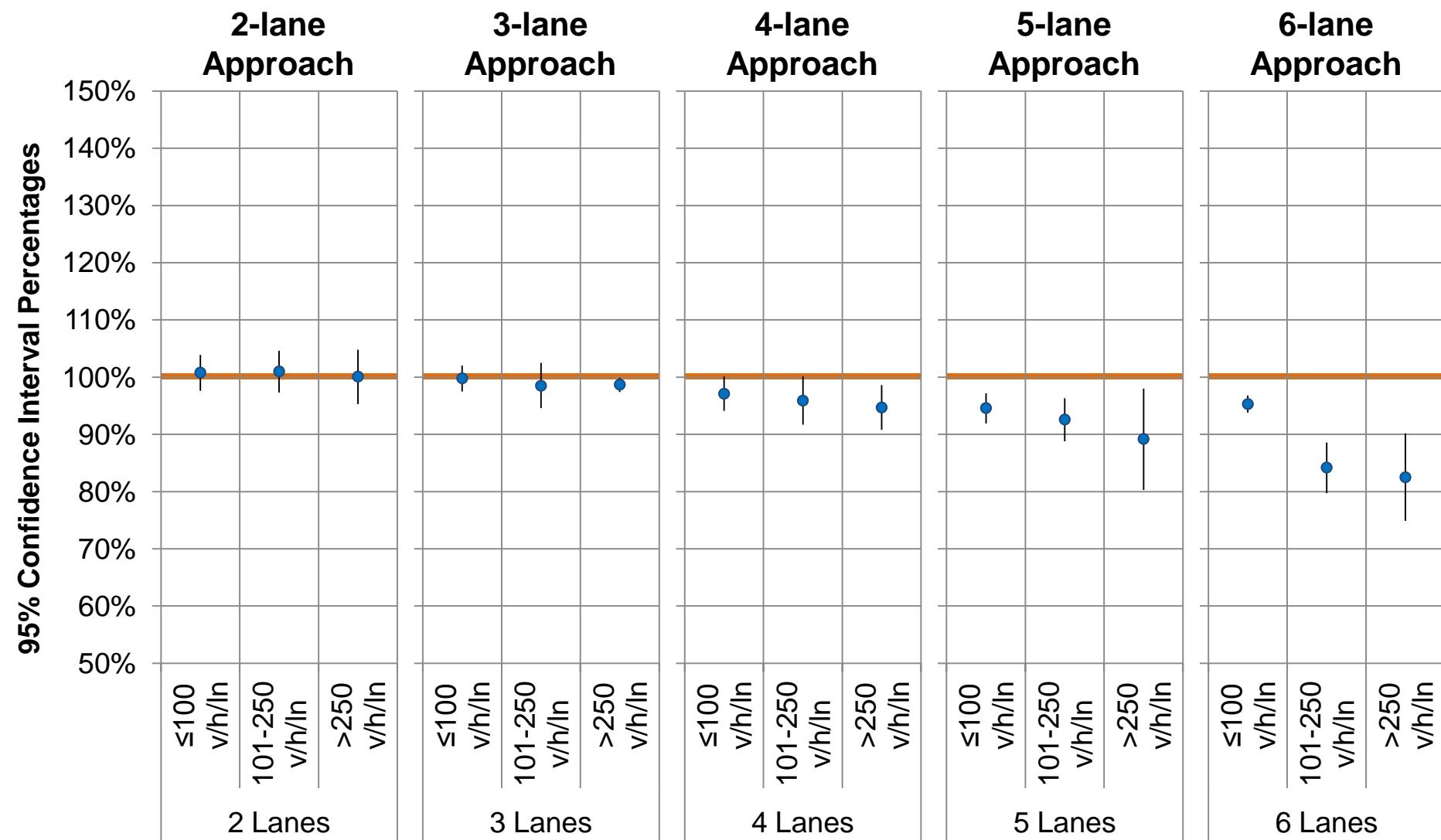
Brigham Young University
Department of Civil and Environmental
Engineering

Authored By:

Mitsuru Saito, Ph.D., P.E.
David Keali'i Chang, EIT
Grant G. Schultz, Ph.D., P.E., PTOE

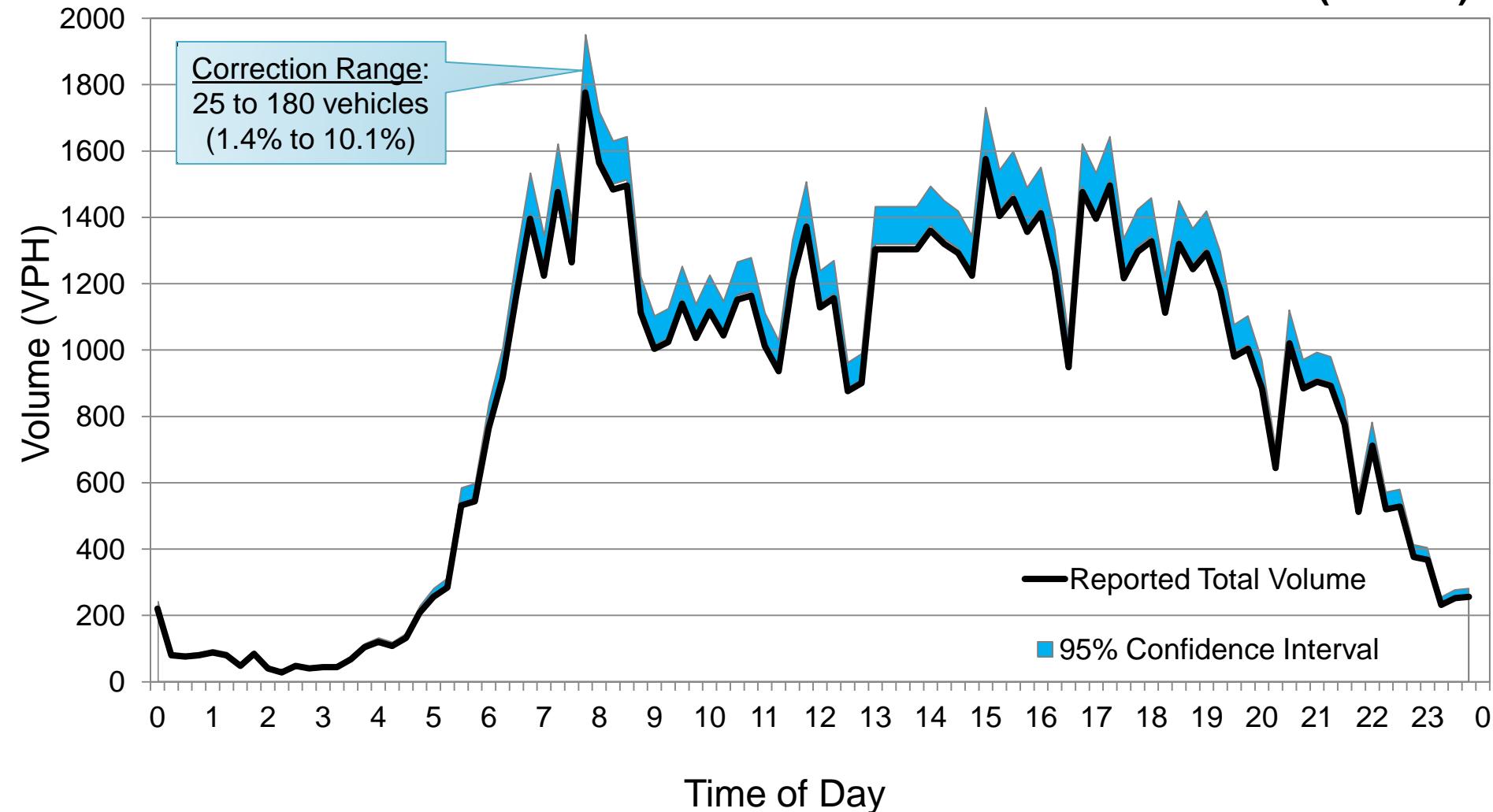
Final Report
September 2015

TMC Volume Accuracy

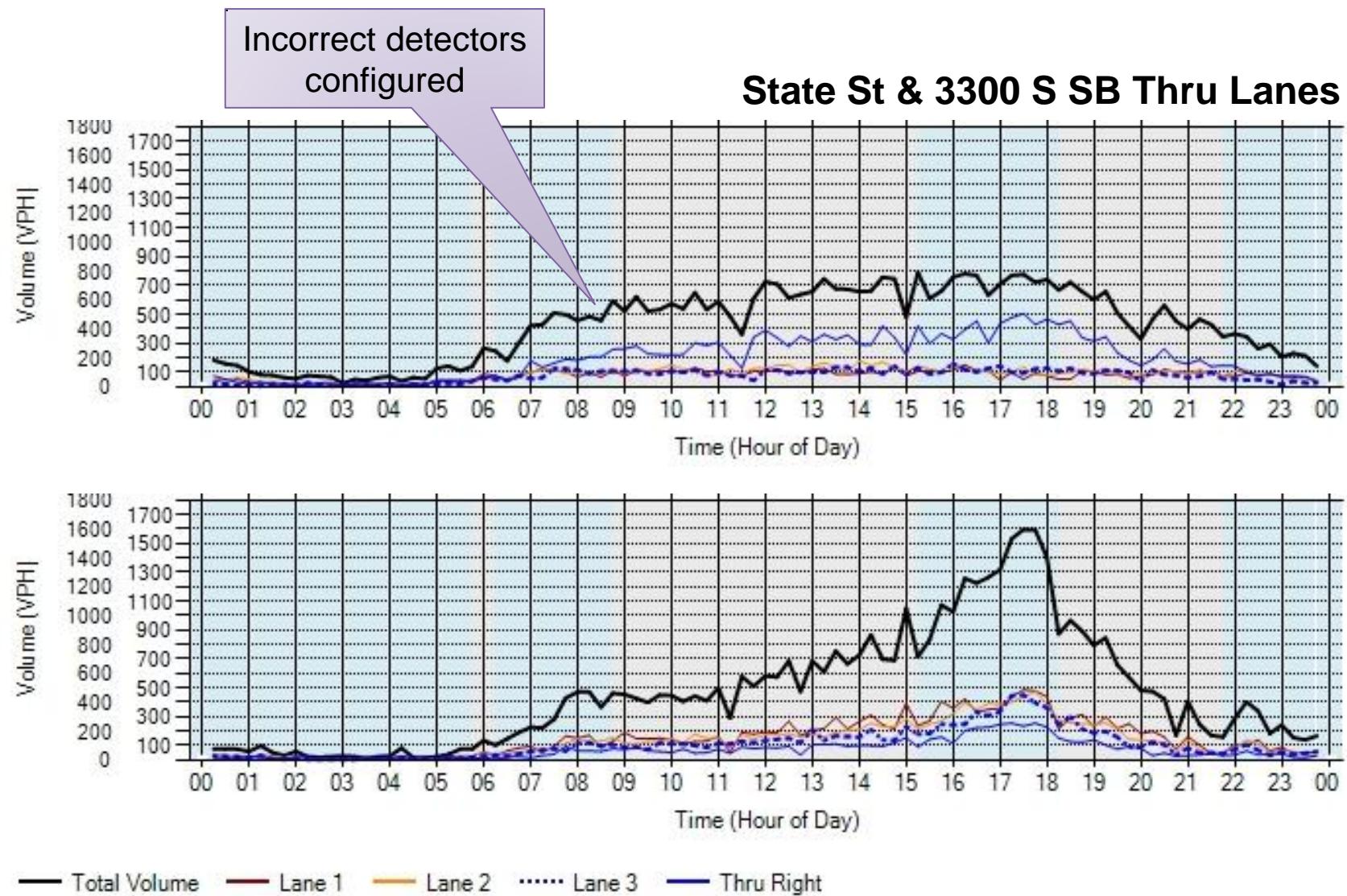


TMC Volume Accuracy - Example

9000 S & Monroe WB Thru Lanes (4 lanes)



TMC Data Smell Test



TMC Uses

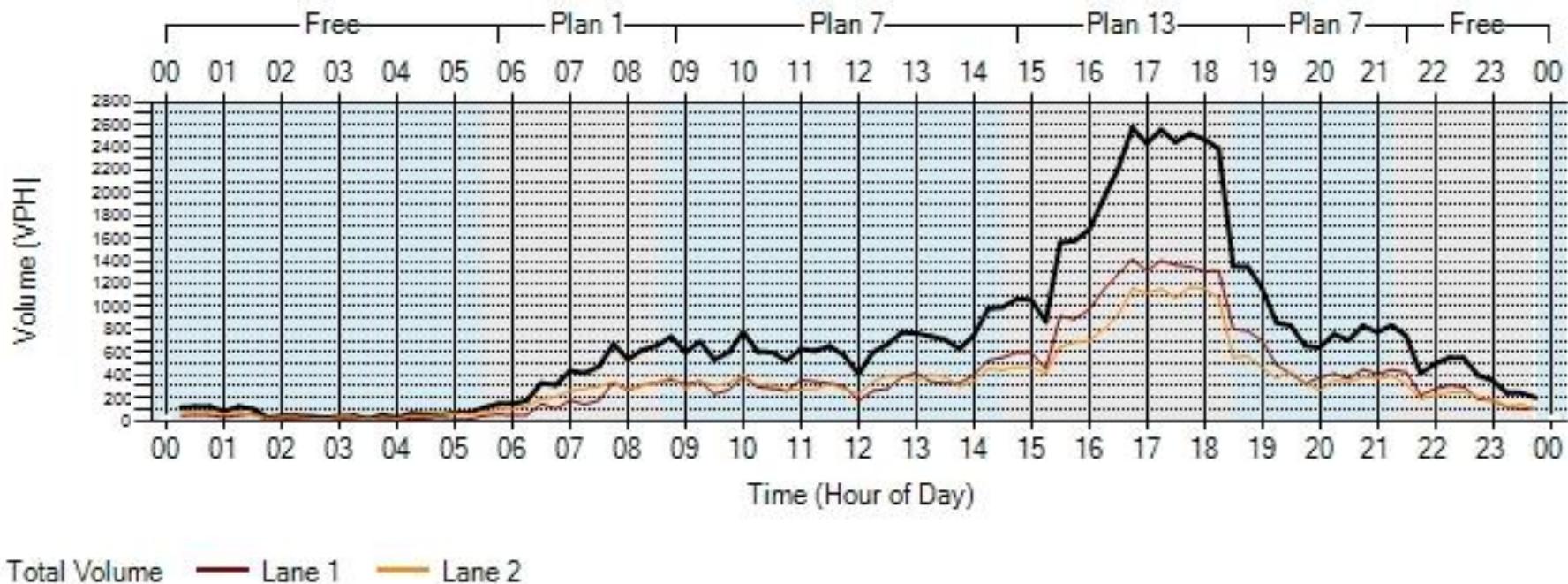
- Traffic Studies
 - Counts
 - Signal Warrants
 - Growth
- Performance evaluation
 - Capacity analysis
 - Lane utilization
- Planning models
- Traffic patterns and impacts
 - Weather
 - Events, School, Holiday
 - Construction, Maintenance
- Construction & Maintenance
 - Lane closures
 - Performance targets
- Signal Timing Optimization
 - Split allocation
 - TOD schedule

Determine Approach Capacity

US-89 Nicholls Rd SIG#5208
Wednesday, May 11, 2016 12:00 AM - Wednesday, May 11, 2016 11:59 PM

Northbound Thru

TV: 16693 PH: 4:45 PM - 5:45 PM PHV: 2505 VPH
PHF: 0.97 FLU: 0.95



Quantify Lane Utilization

9000 South Monroe SIG#7621

Wednesday, October 26, 2016 12:00 AM - Wednesday, October 26, 2016 11:59 PM

Westbound Thru

TV: 19850 PH: 7:30 AM - 8:30 AM PHV: 1575 VPH
PHF: 0.88 FLU: 0.86



— Lane 1 — Lane 2 — Thru Right



Detection

Setback Count Zones

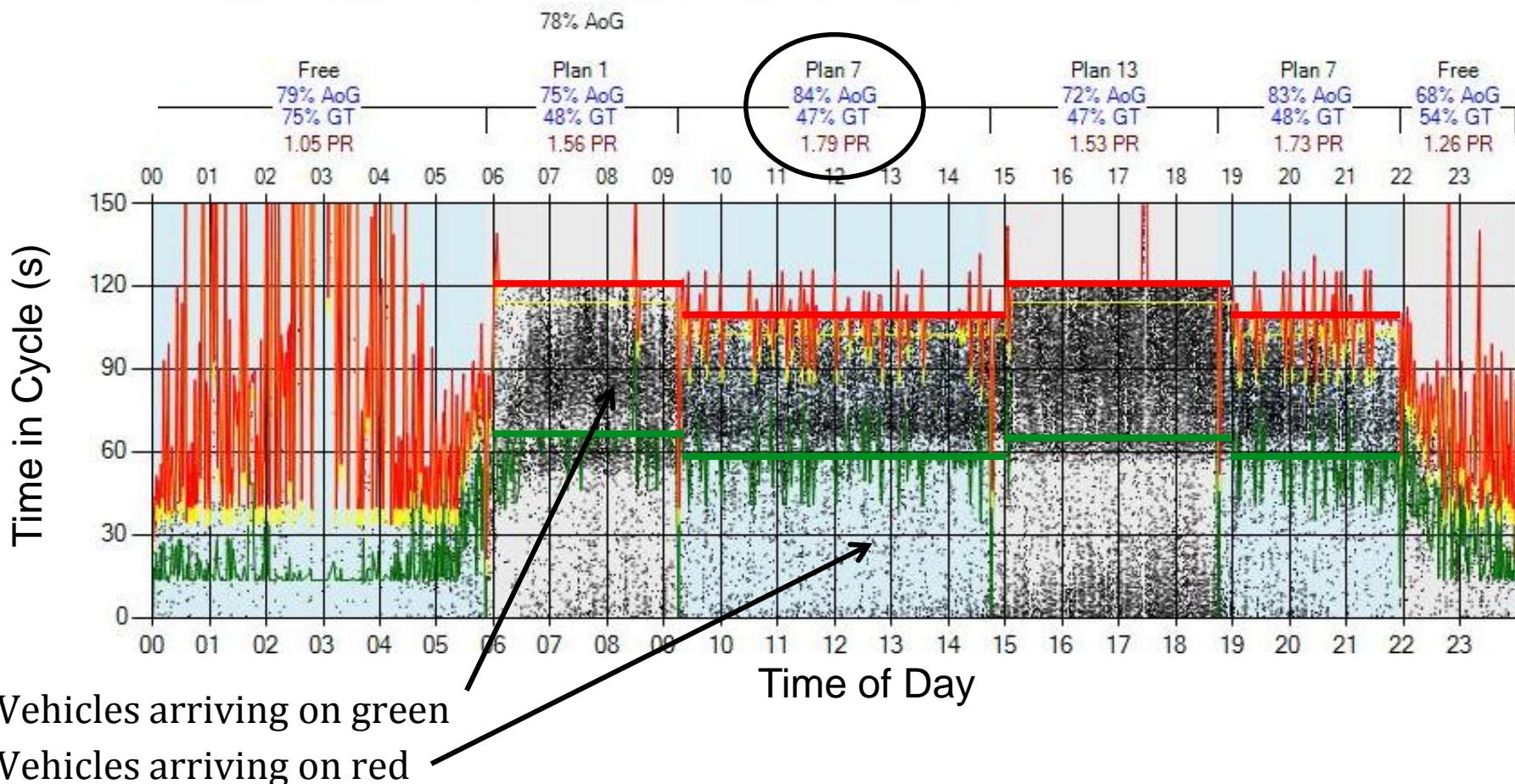


Available Metrics

- ❯ Purdue Coordination Diagram
- ❯ Approach Volume
- ❯ Arrivals on Red
- ❯ Approach Delay

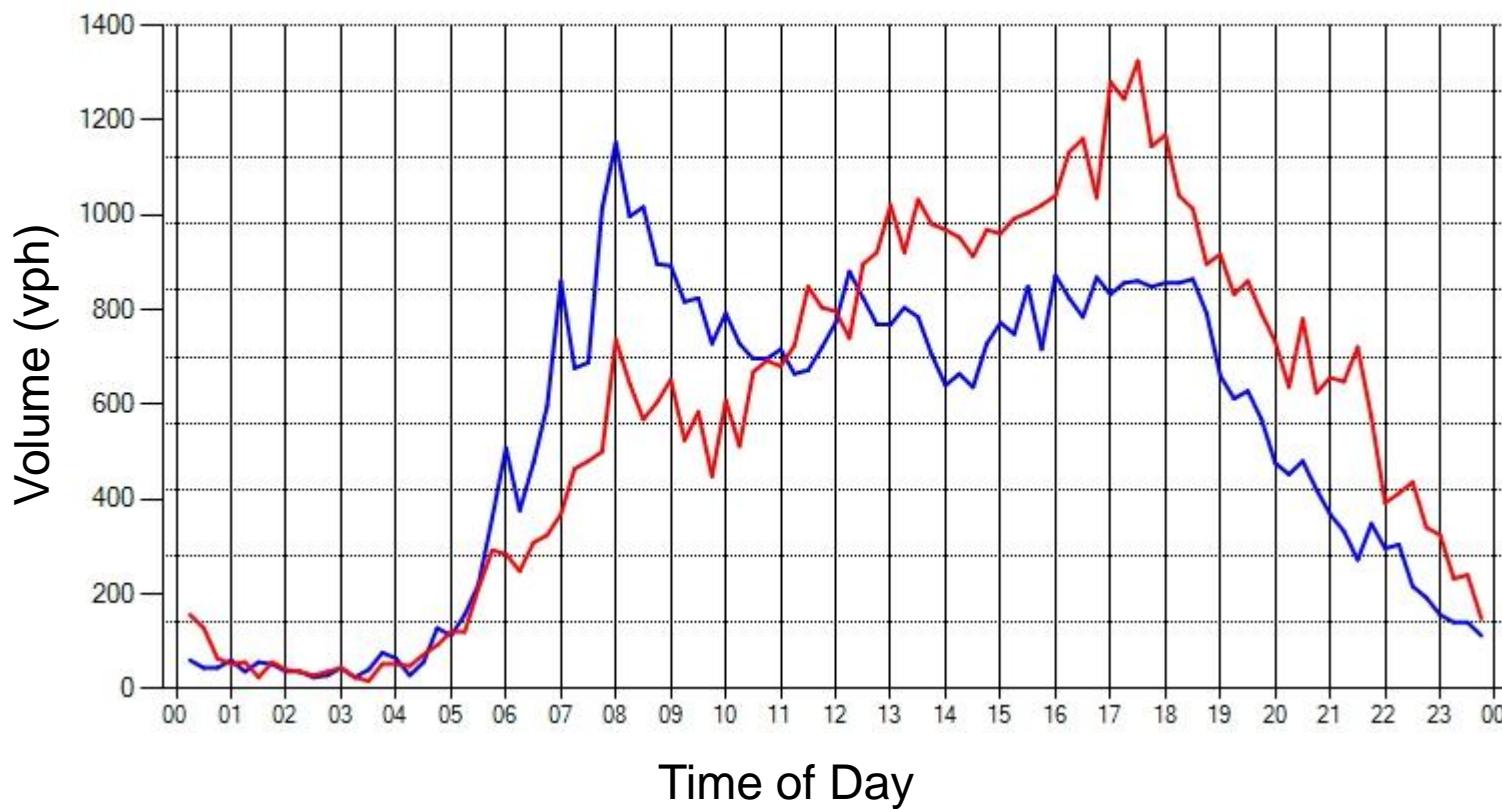
Metric: Purdue Coordination Diagram

Bangerter Hwy (SR-154) 10400 South Signal 7364 Phase: 6 Southbound
 Wednesday, September 03, 2014 12:00 AM - Wednesday, September 03, 2014 11:59 PM

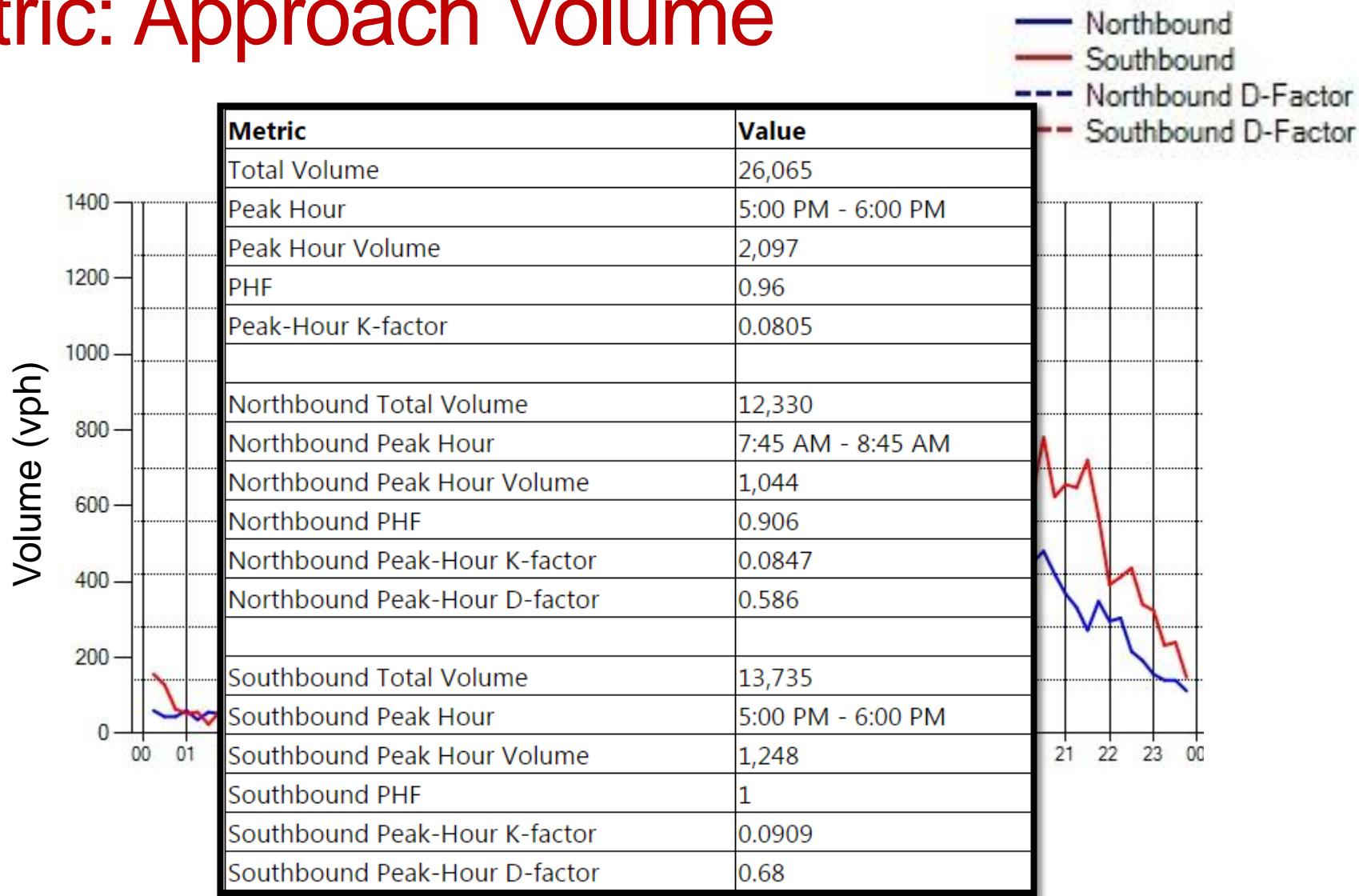


Metric: Approach Volume

— Northbound
— Southbound
- - - Northbound D-Factor
- - - Southbound D-Factor

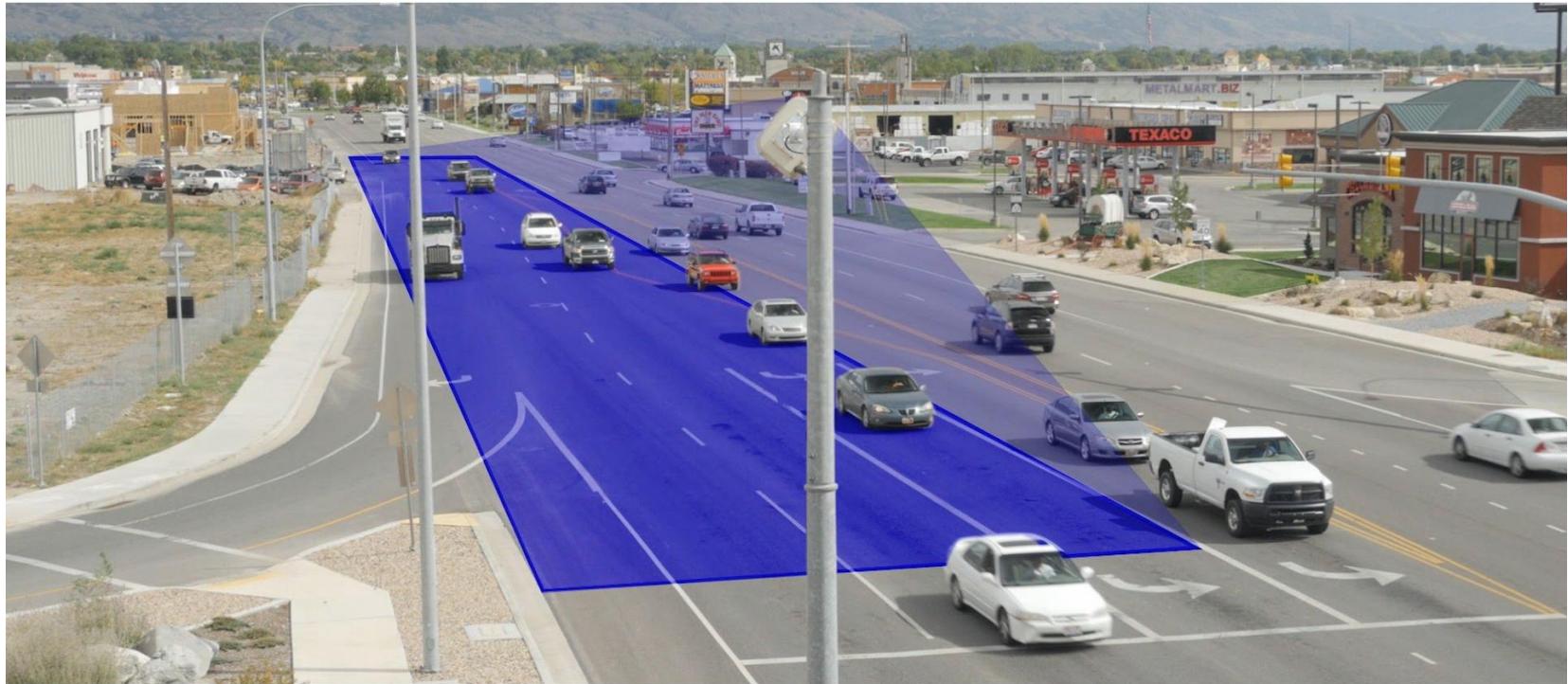


Metric: Approach Volume

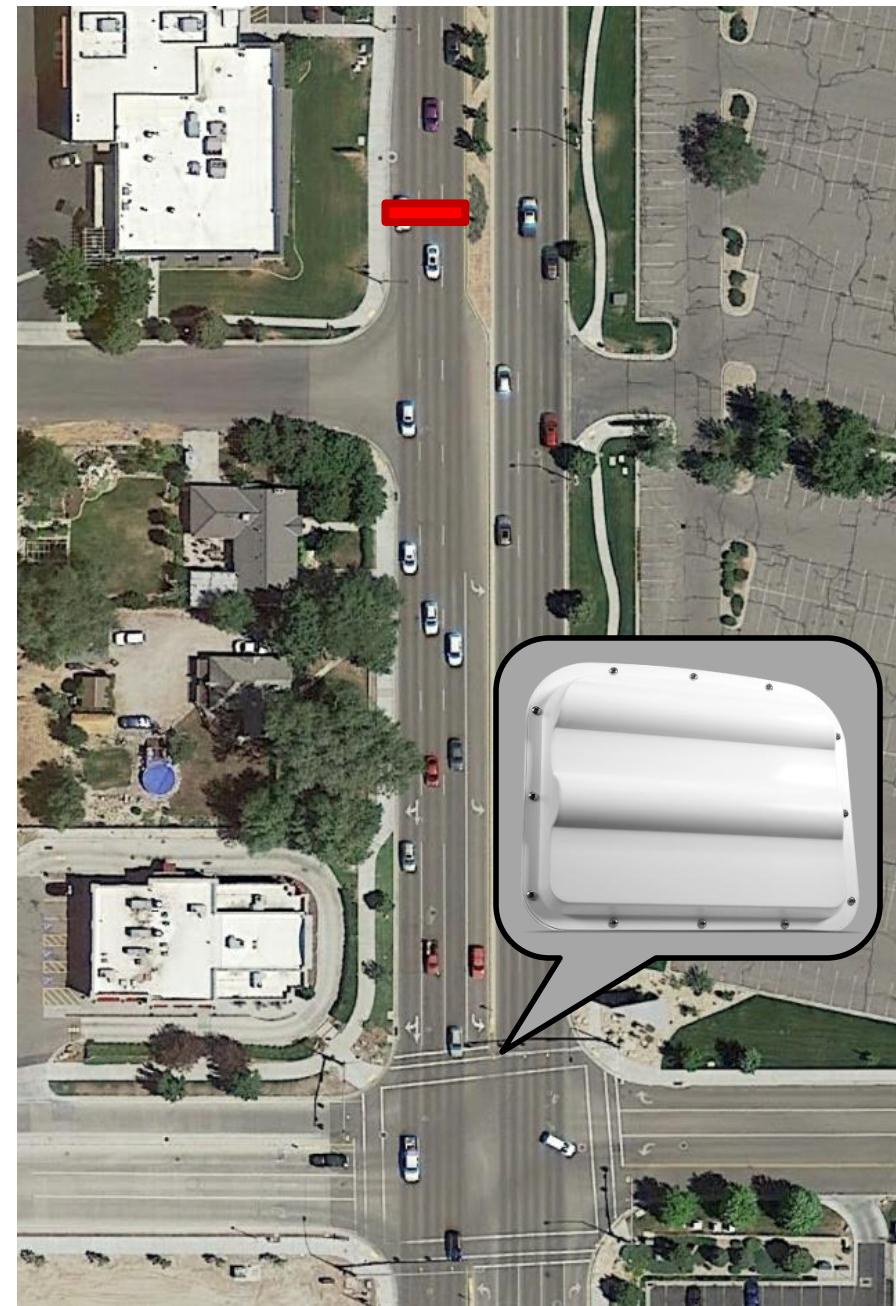
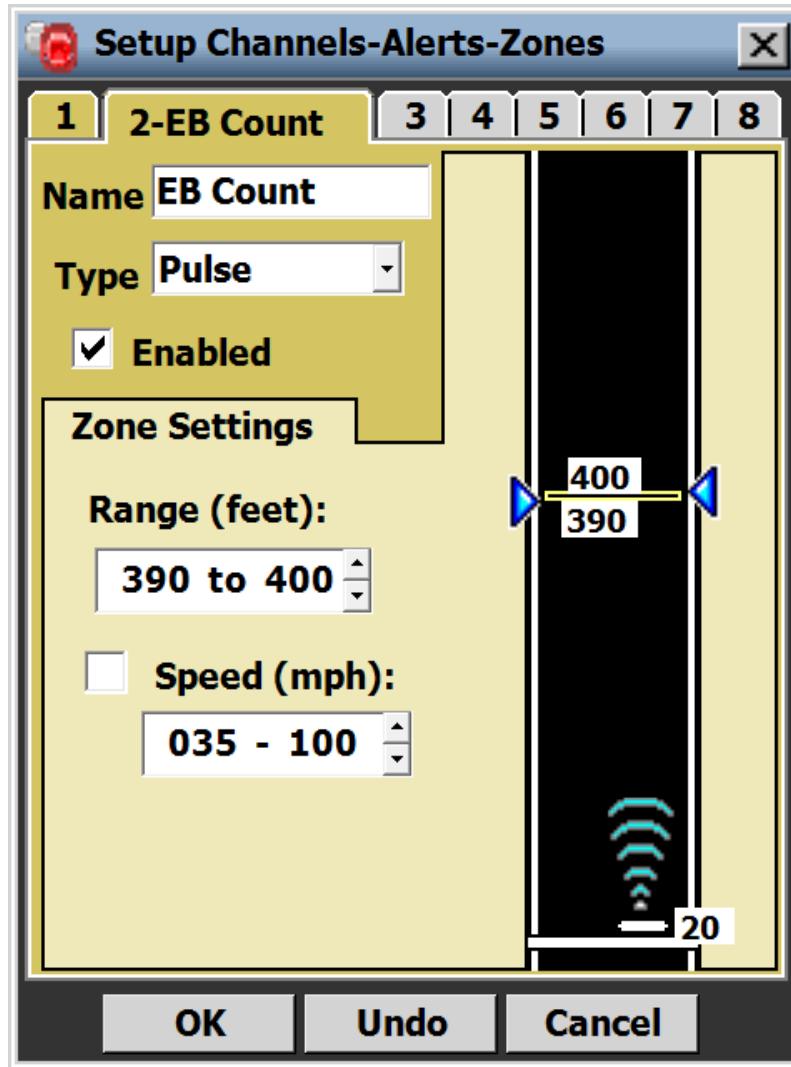


Approach Volume Detection

Wavetronix
SmartSensor
Advance

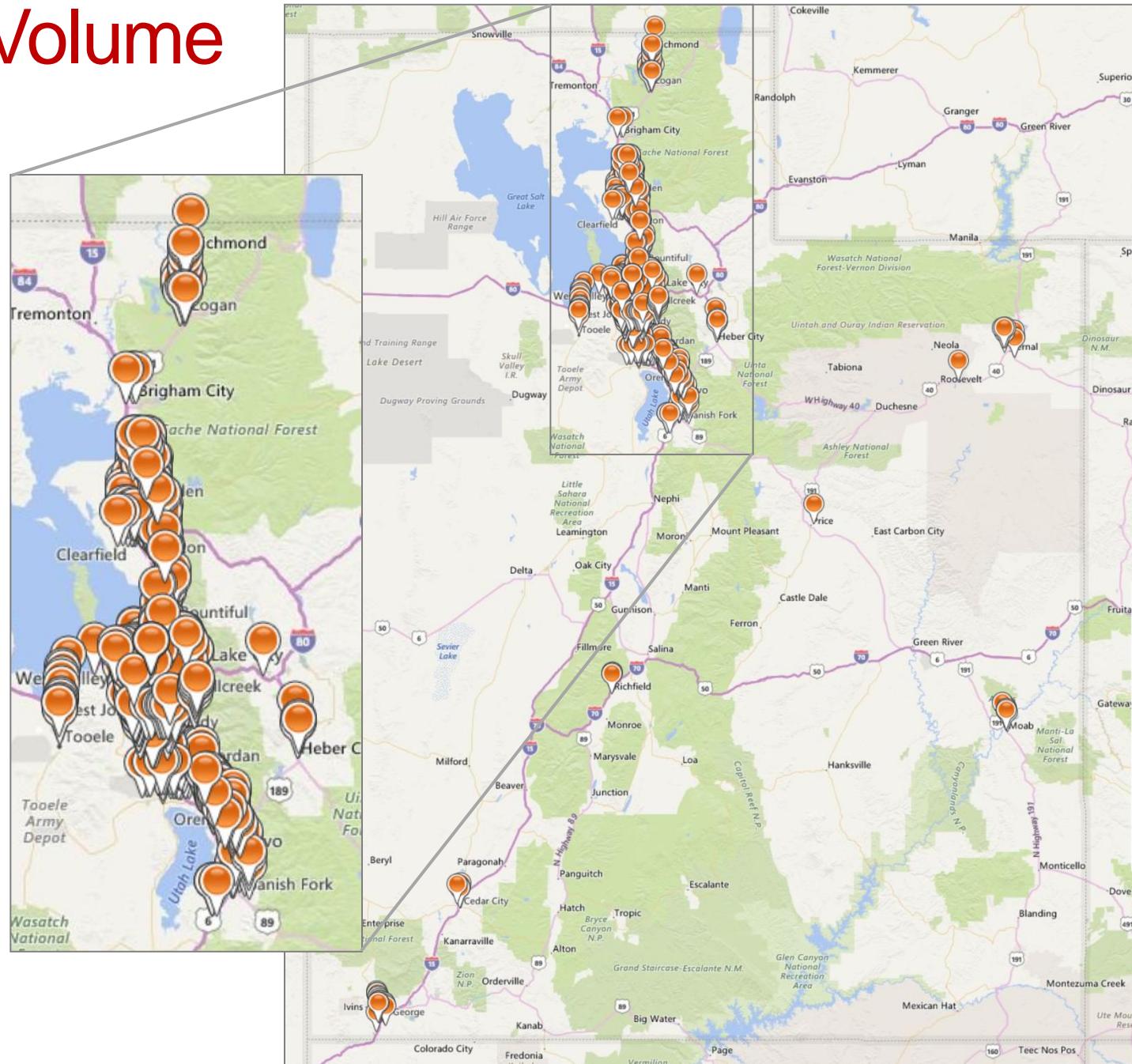


Approach Volume Detection



Approach Volume Availability

679
signals statewide
UDOT signals
57%



Approach Volume Accuracy



Report No. UT-16.05

**CALIBRATION OF AUTOMATIC
PERFORMANCE MEASURES –
SPEED AND VOLUME DATA:
VOLUME 2, EVALUATION OF THE
ACCURACY OF APPROACH VOLUME
COUNTS AND SPEEDS COLLECTED
BY MICROWAVE SENSORS**

Prepared For:

Utah Department of Transportation
Research Division

Submitted By:

Brigham Young University
Department of Civil and Environmental
Engineering

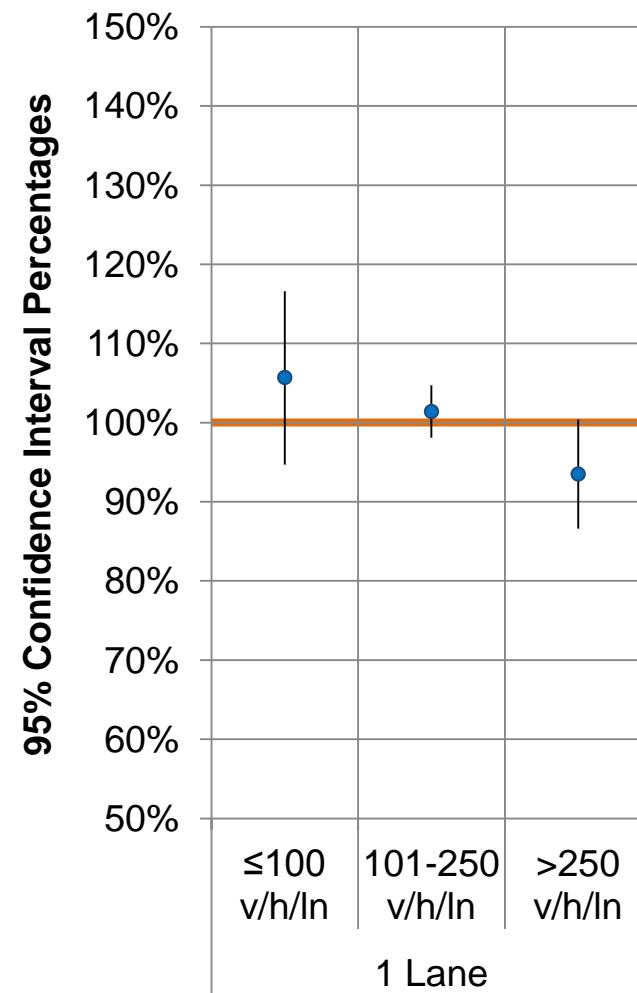
Authored By:

Mitsuru Saito, Ph.D., P.E.
Gregory H. Sanchez, EIT
Grant G. Schultz, Ph.D., P.E., PTOE

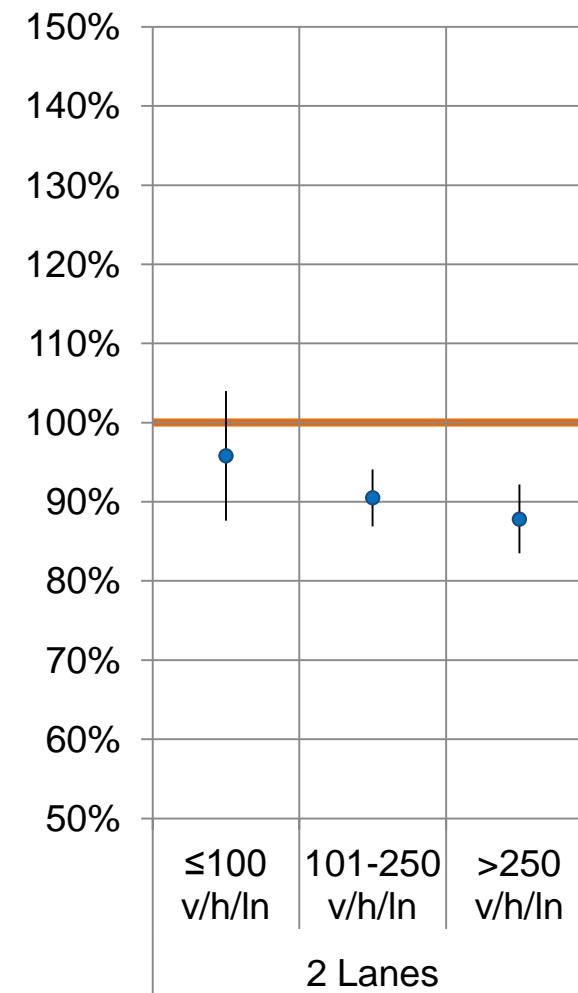
**Final Report
May 2016**

Approach Volume Accuracy

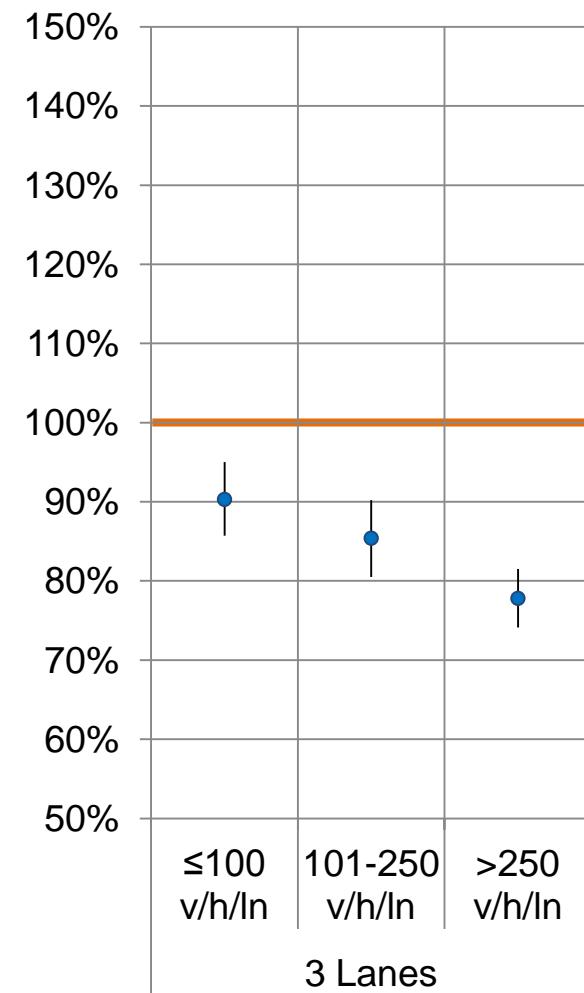
1-lane Approach



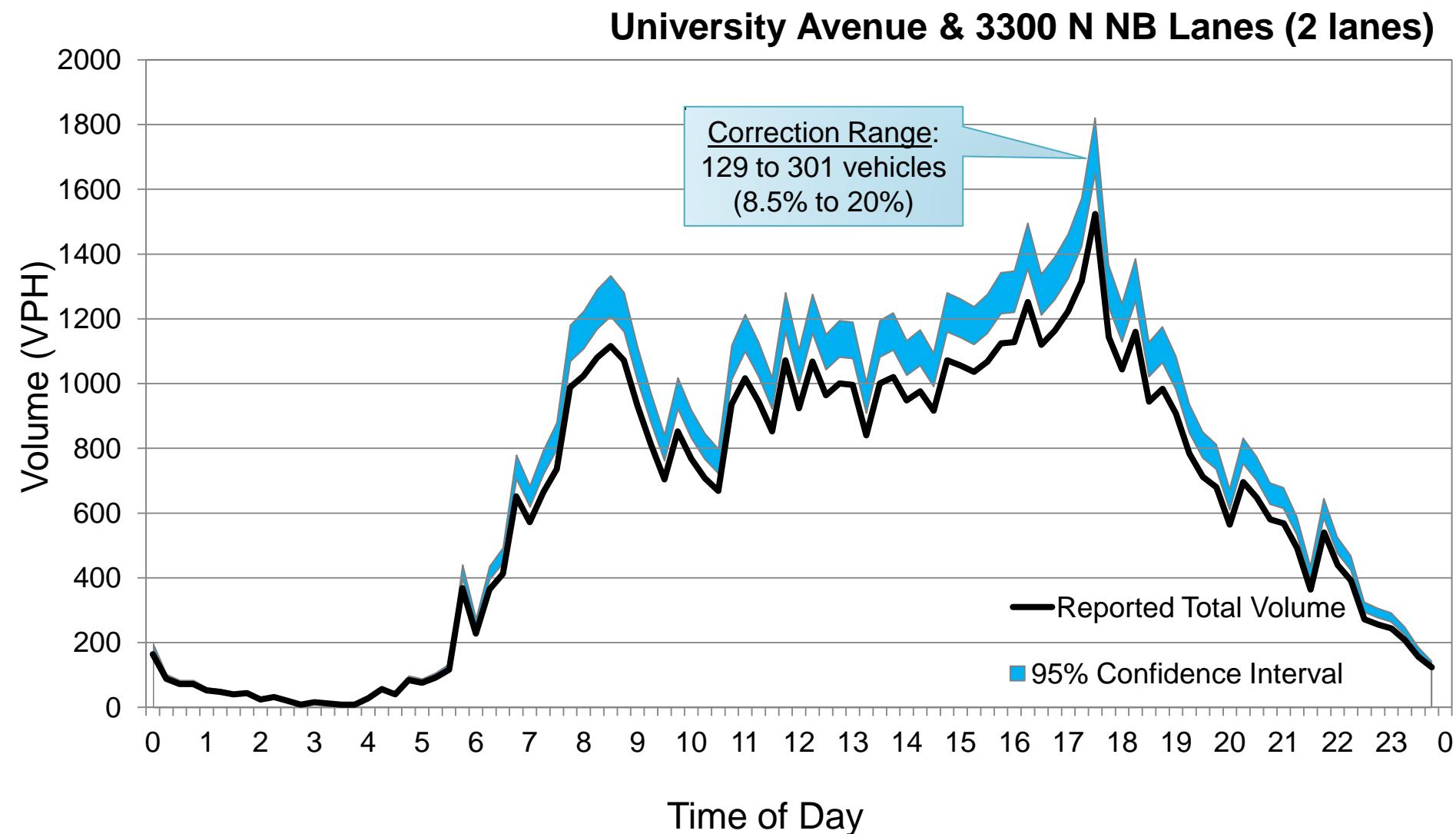
2-lane Approach



3-lane Approach

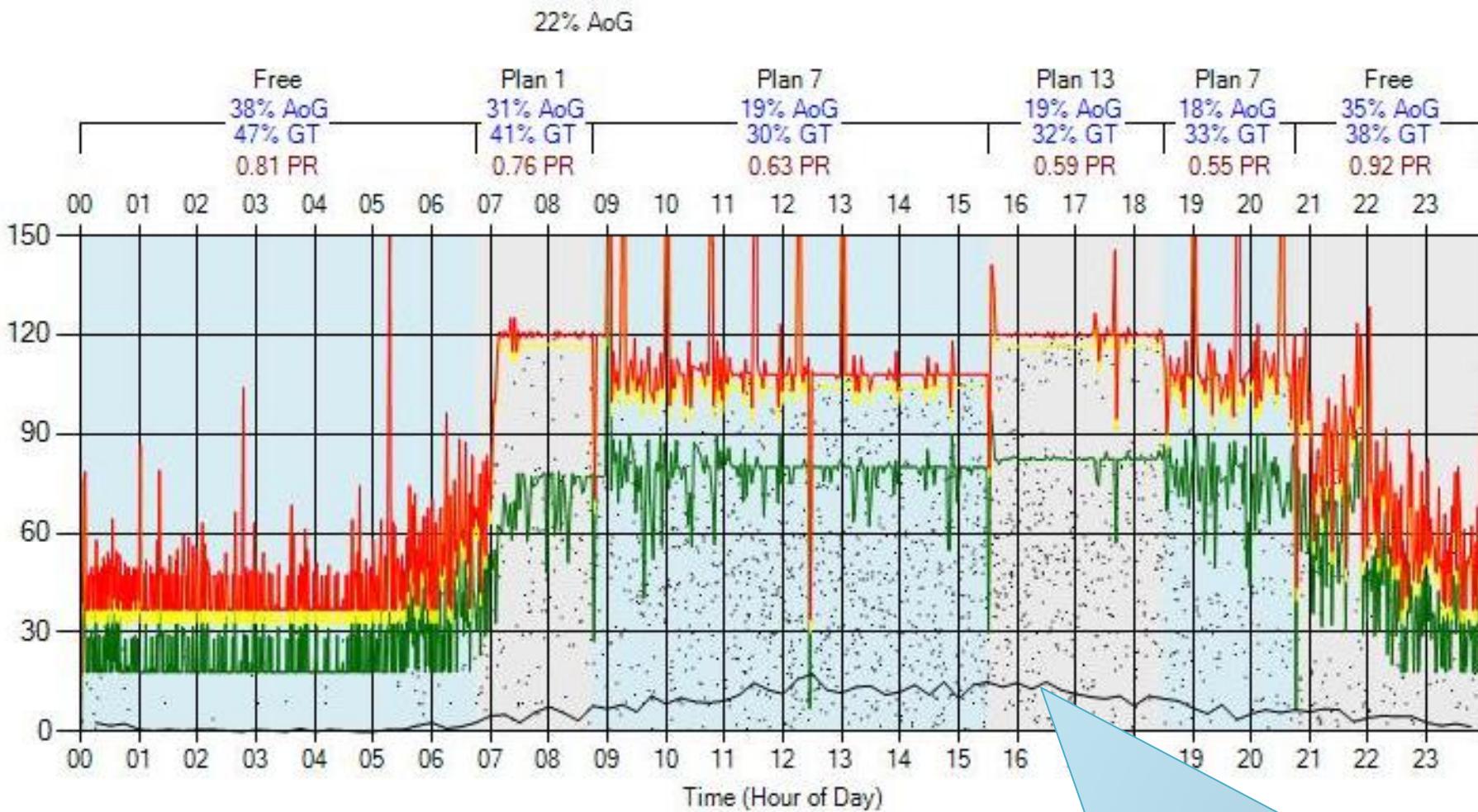


Approach Volume Accuracy - Example



Approach Volume Smell Test - Undercounting

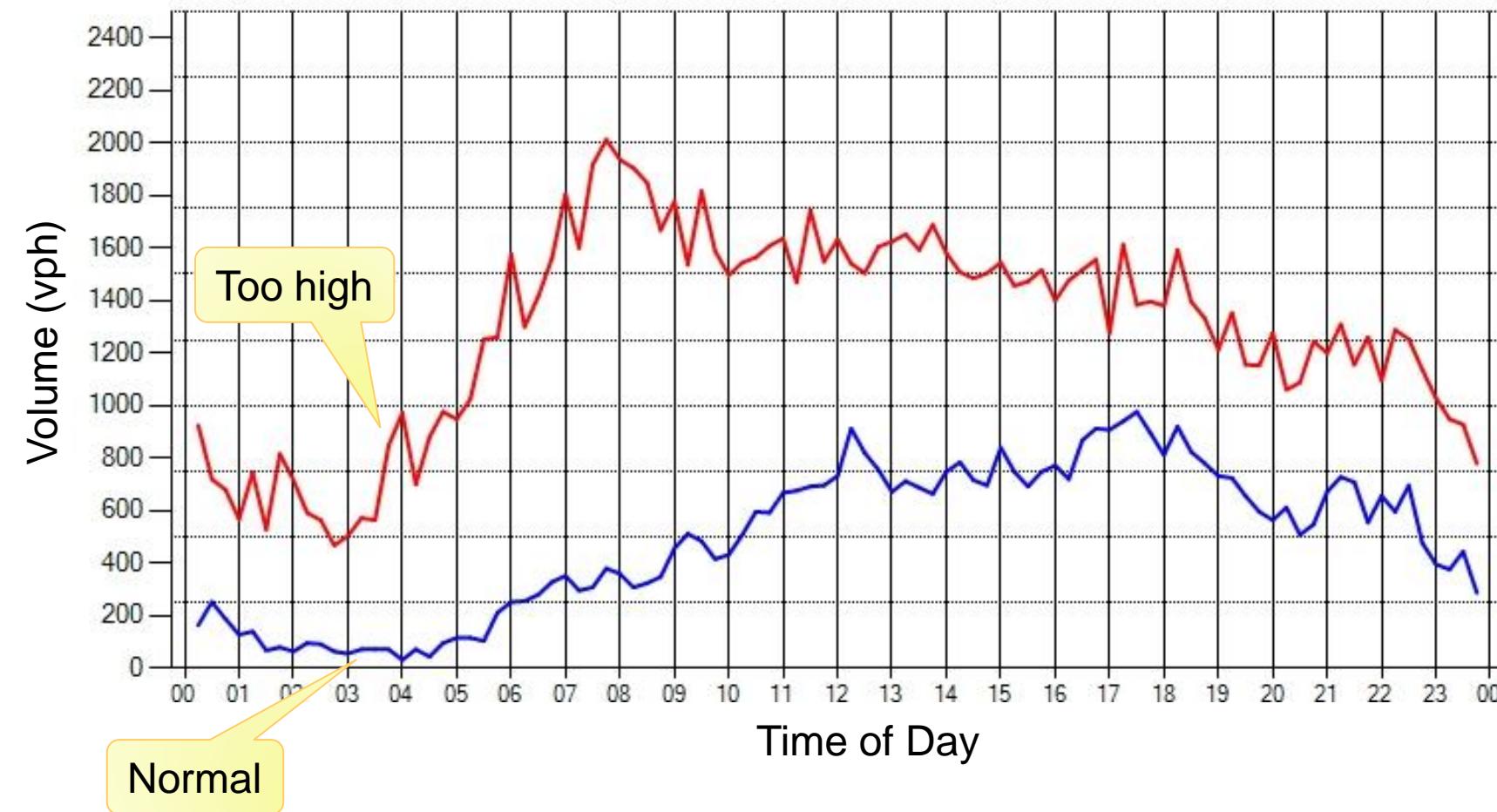
State Street 3300 South Signal 7155 Phase: 6 Southbound
Wednesday, August 03, 2016 12:00 AM - Wednesday, August 03, 2016 11:59 PM



PCD is very sparse. Low volume without peaks.

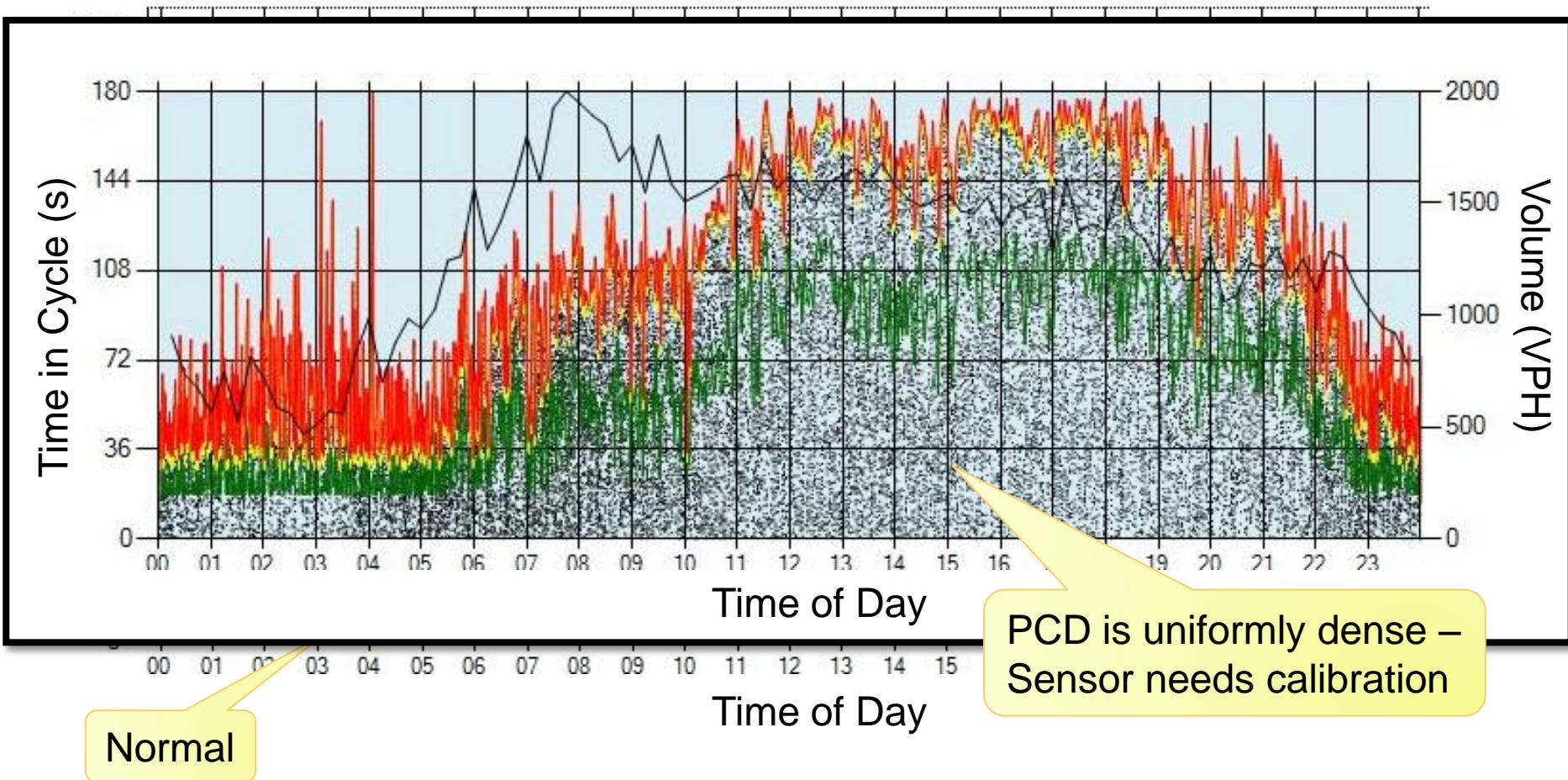
Approach Volume Smell Test - Overcounting

Volume report for Washington 12th on the Northbound and Southbound approaches.
8/4/2016 12:00:00 AM - 8/4/2016 11:59:00 PM - Using Advanced Detection



Approach Volume Smell Test - Overcounting

Volume report for Washington 12th on the Northbound and Southbound approaches.
8/4/2016 12:00:00 AM - 8/4/2016 11:59:00 PM - Using Advanced Detection

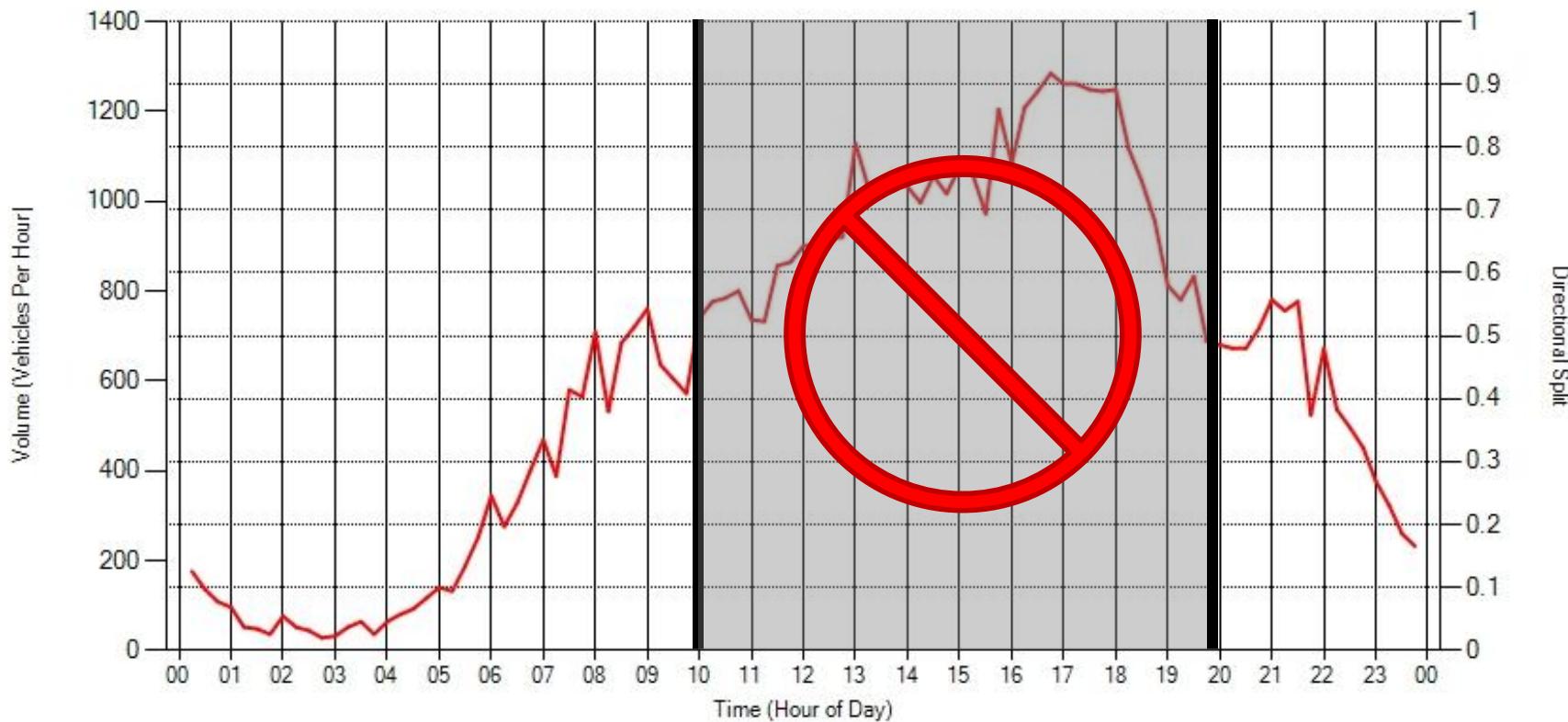


Approach Volume Uses

- Traffic Studies
 - TOD distribution
 - AADT
 - Growth
- Performance evaluation
 - Overcapacity periods
- Planning models
- Traffic Impacts
 - Weather
 - Events, School, Holiday
 - Construction, Maintenance
- Construction & Maintenance
 - Lane closures
 - Performance targets

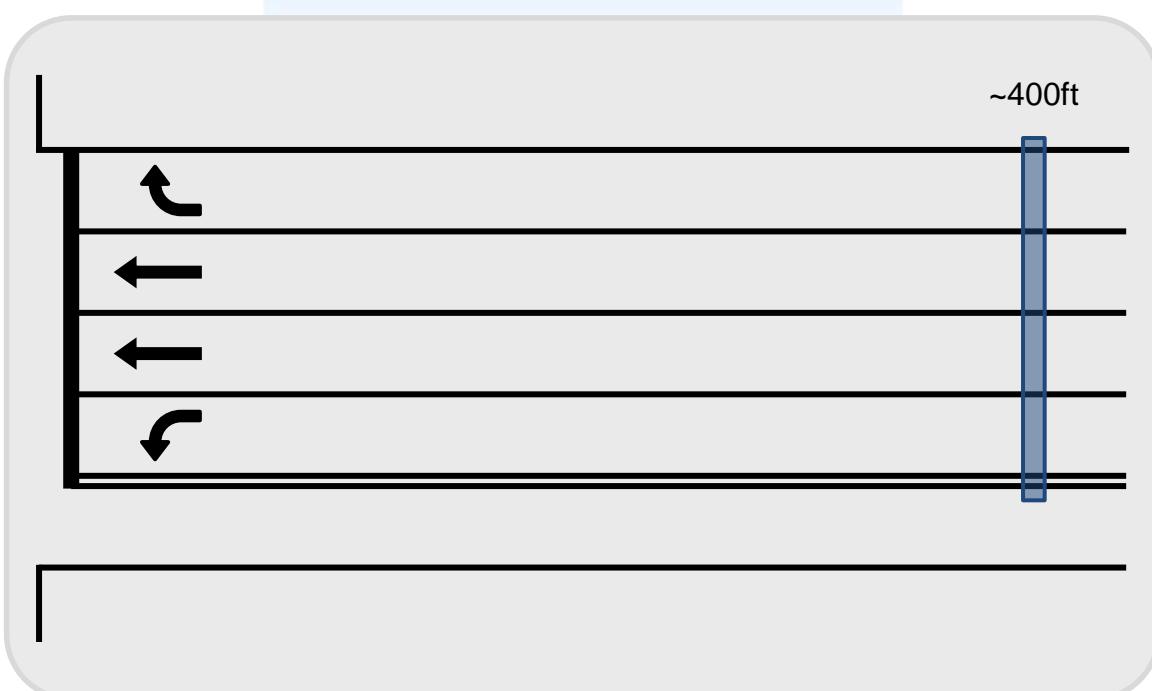
Allow Lane Closures

Volume report for University Avenue East Bay Boulevard on the Northbound and Southbound approaches.
7/7/2016 12:00:00 AM - 7/7/2016 11:59:00 PM - Using Advanced Detection



Detection

Setback Count Zones
with speed



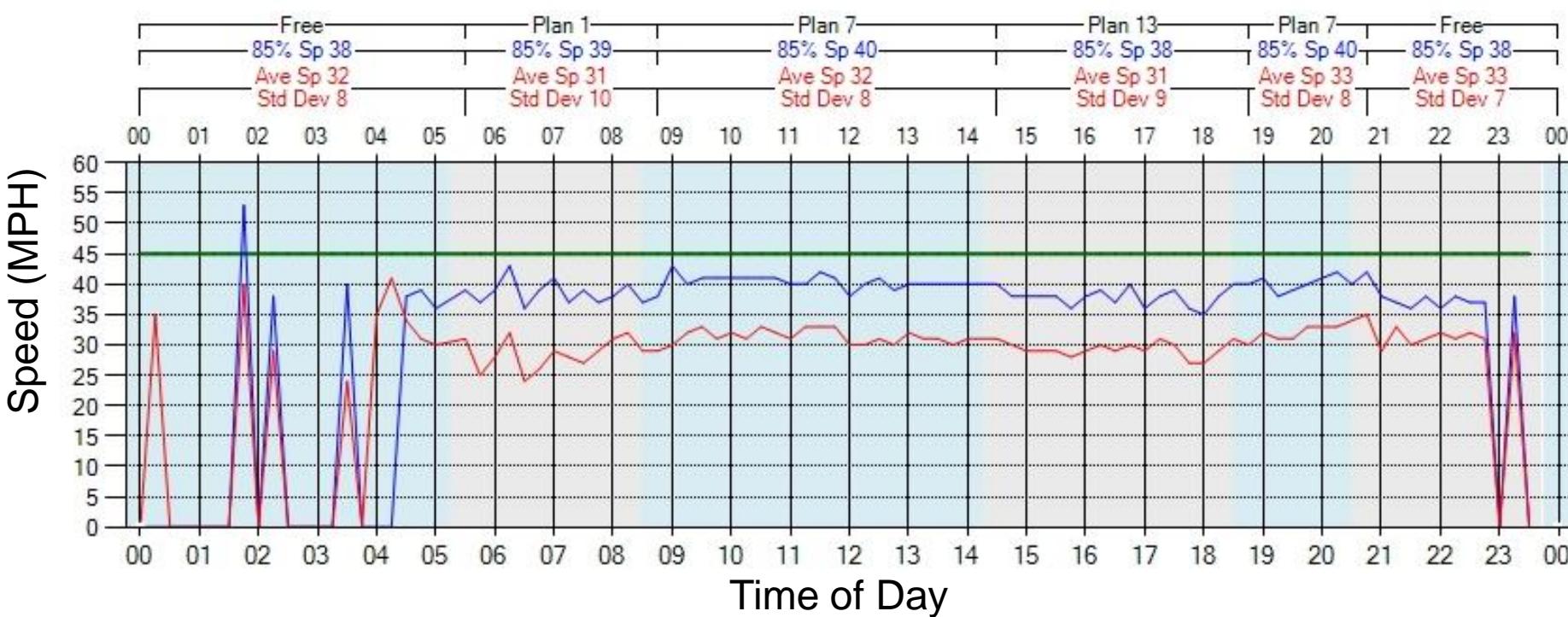
Available Metrics

Approach Speed

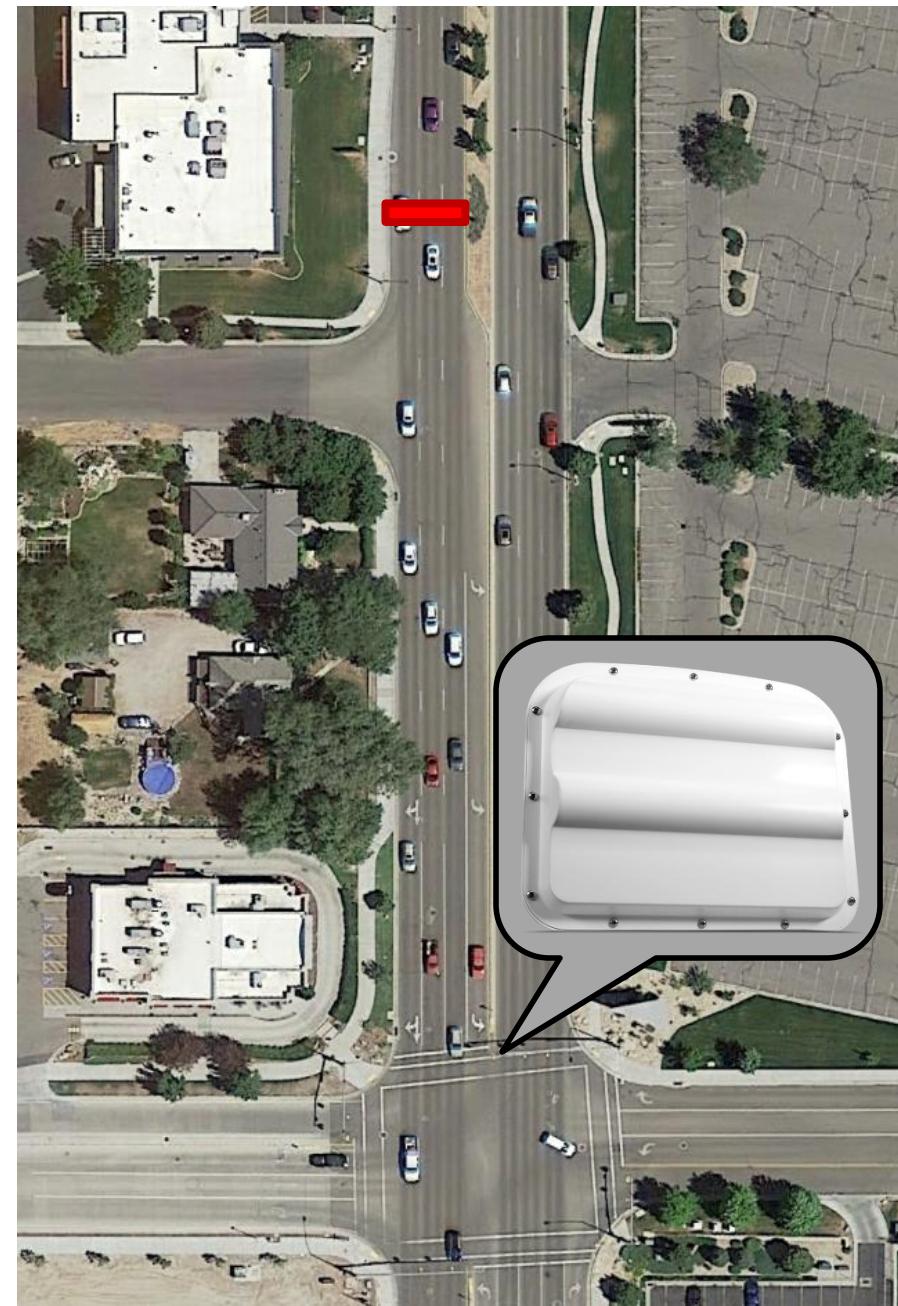
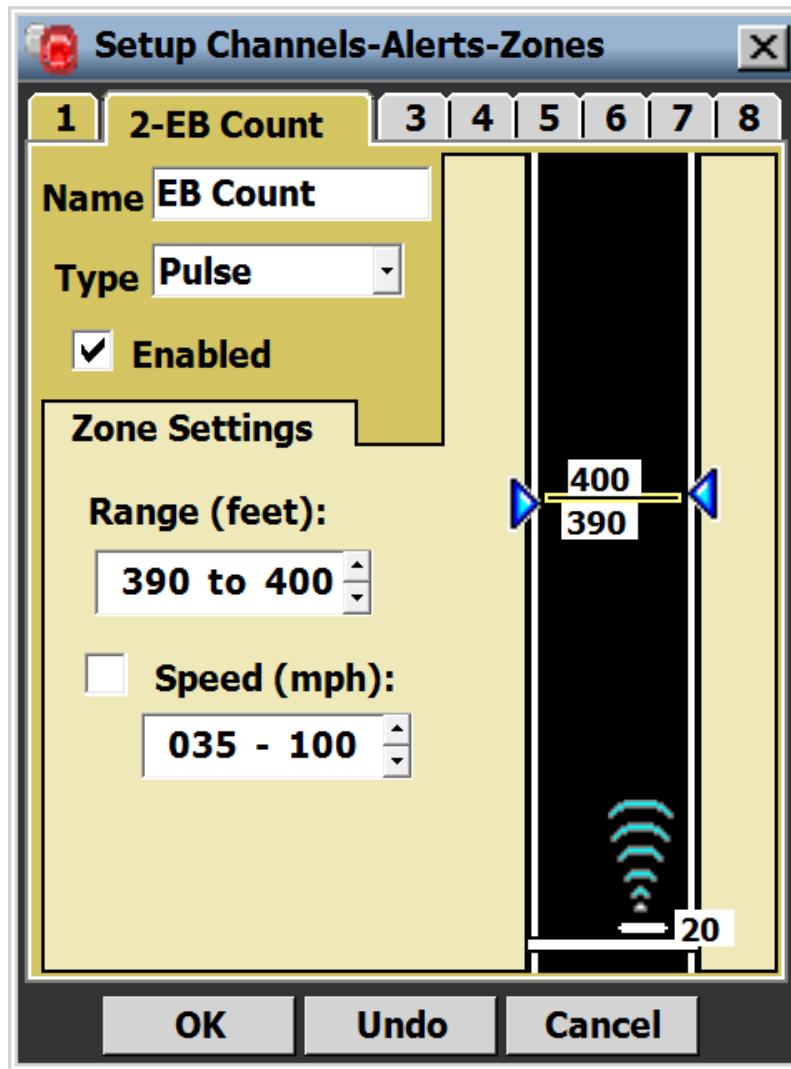
Metric: Approach Speed

SR-126 (1900 W) 5700 South (Roy) Signal 5088 Phase 6 Southbound
Wednesday, September 30, 2015 12:00 AM - Wednesday, September 30, 2015 11:59 PM
Detector Distance from Stop Bar: 350 feet; Min Speed Filter: 5 MPH;
Time Filter: 15s after start of green to start of yellow
Speed Accuracy: + - 5 MPH

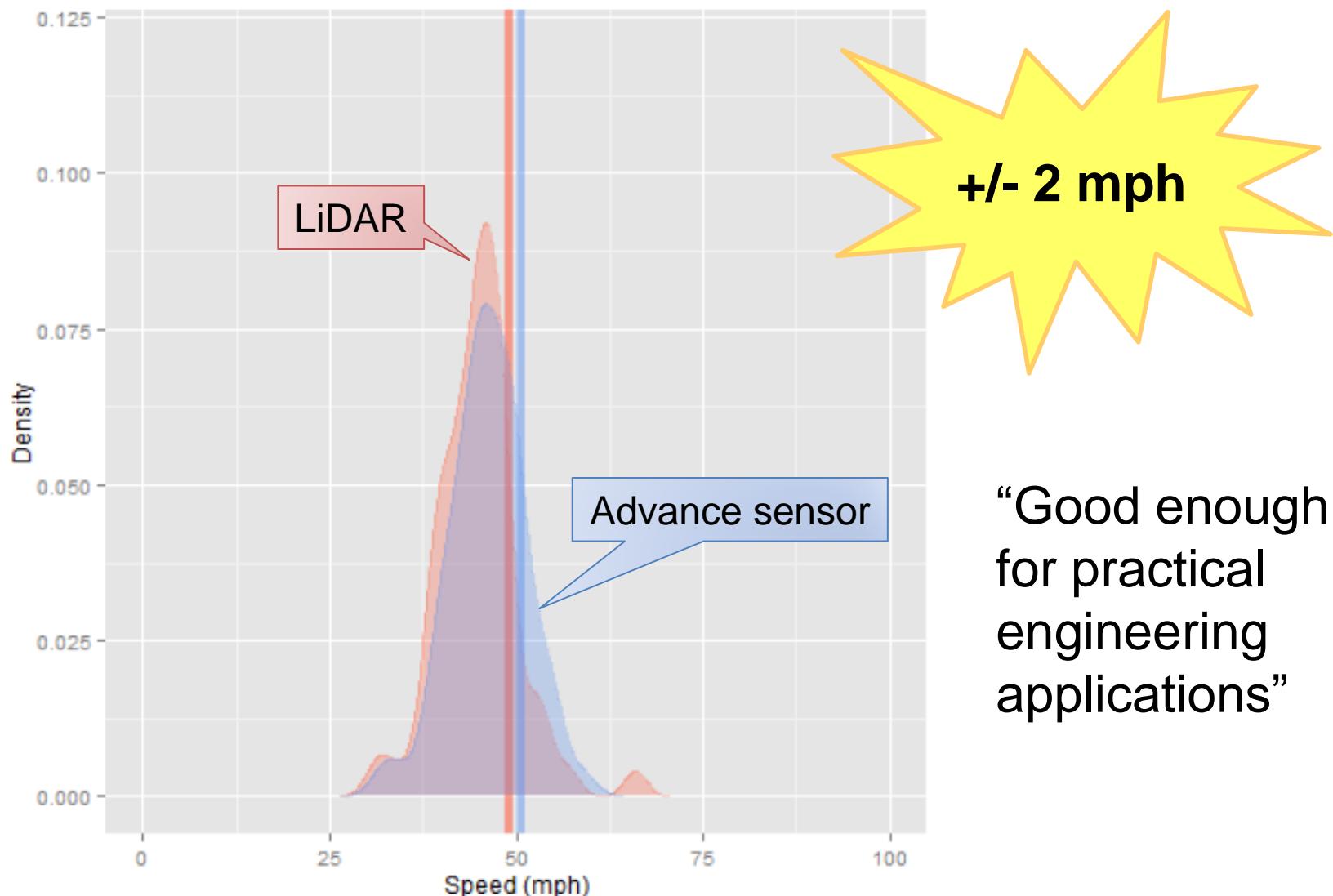
Posted Speed
85th Percentile Speed
Average MPH



Approach Speed Detection



Approach Speed Data Accuracy



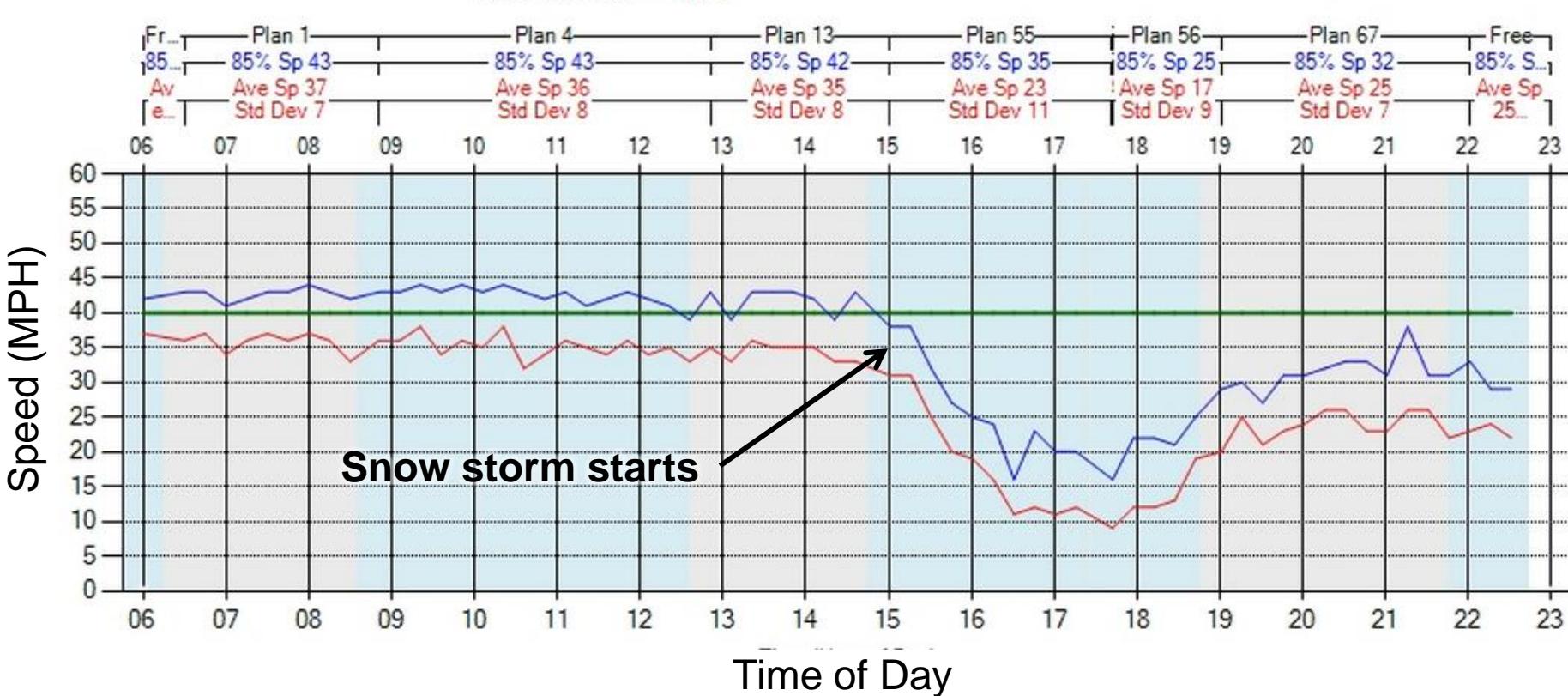
Approach Speed Uses

- Traffic studies
 - Speed Limits
- Performance evaluation
 - Overcapacity periods
 - Corridor evaluation and comparison
 - Purdue Traffic Ticker
- Planning models
- Traffic Impacts
 - Weather
 - Events, School, Holiday
 - Construction, Maintenance
- Signal Timing Optimization
 - Yellow/Red calculations
 - Link travel times

Metric: Approach Speed

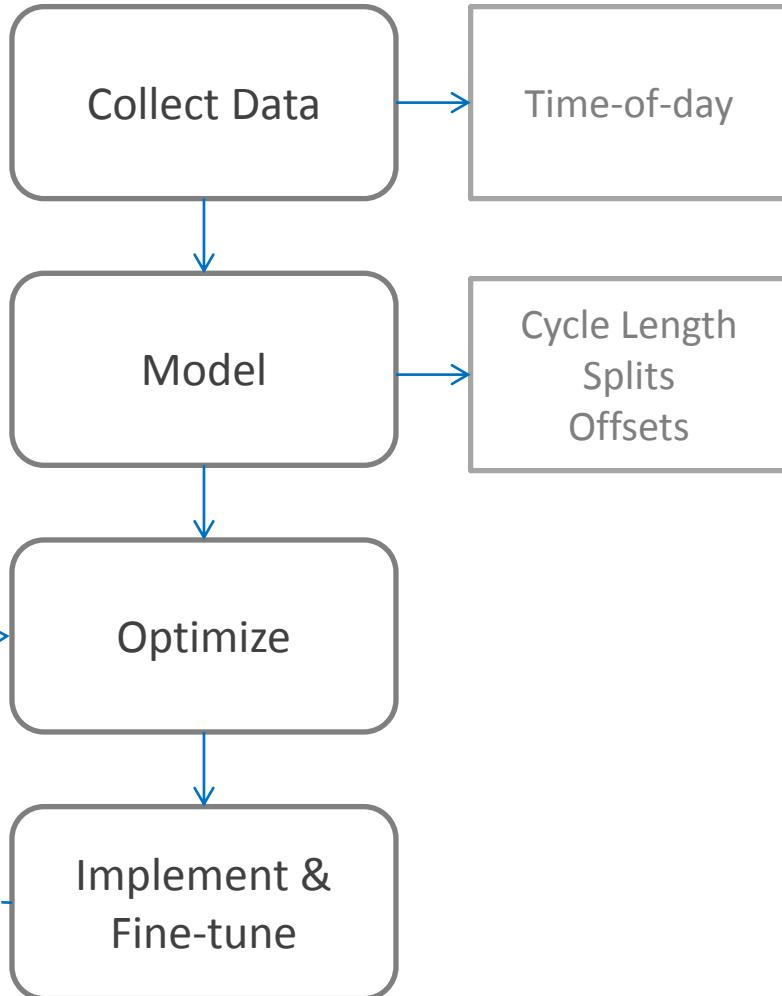
Riverdale Rd Shopko Signal 5008 Phase 2 Northbound
Thursday, January 10, 2013 6:00 AM - Thursday, January 10, 2013 11:00 PM
Detector Distance from Stop Bar: 350 feet; Min Speed Filter: 5 MPH;
Time Filter: 15s after start of green to start of yellow
Speed Accuracy: + - 5 MPH

Posted Speed
85th Percentile Speed
Average MPH

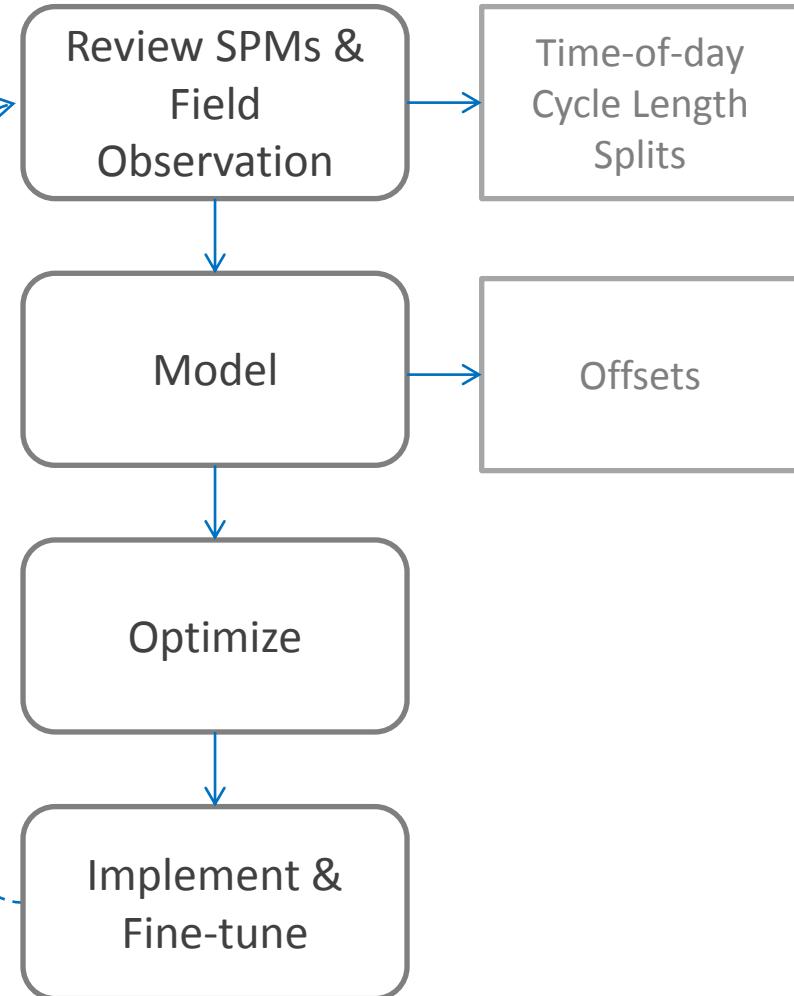


Optimization with ATSPMs

Traditional Process



Modified Process with SPMs

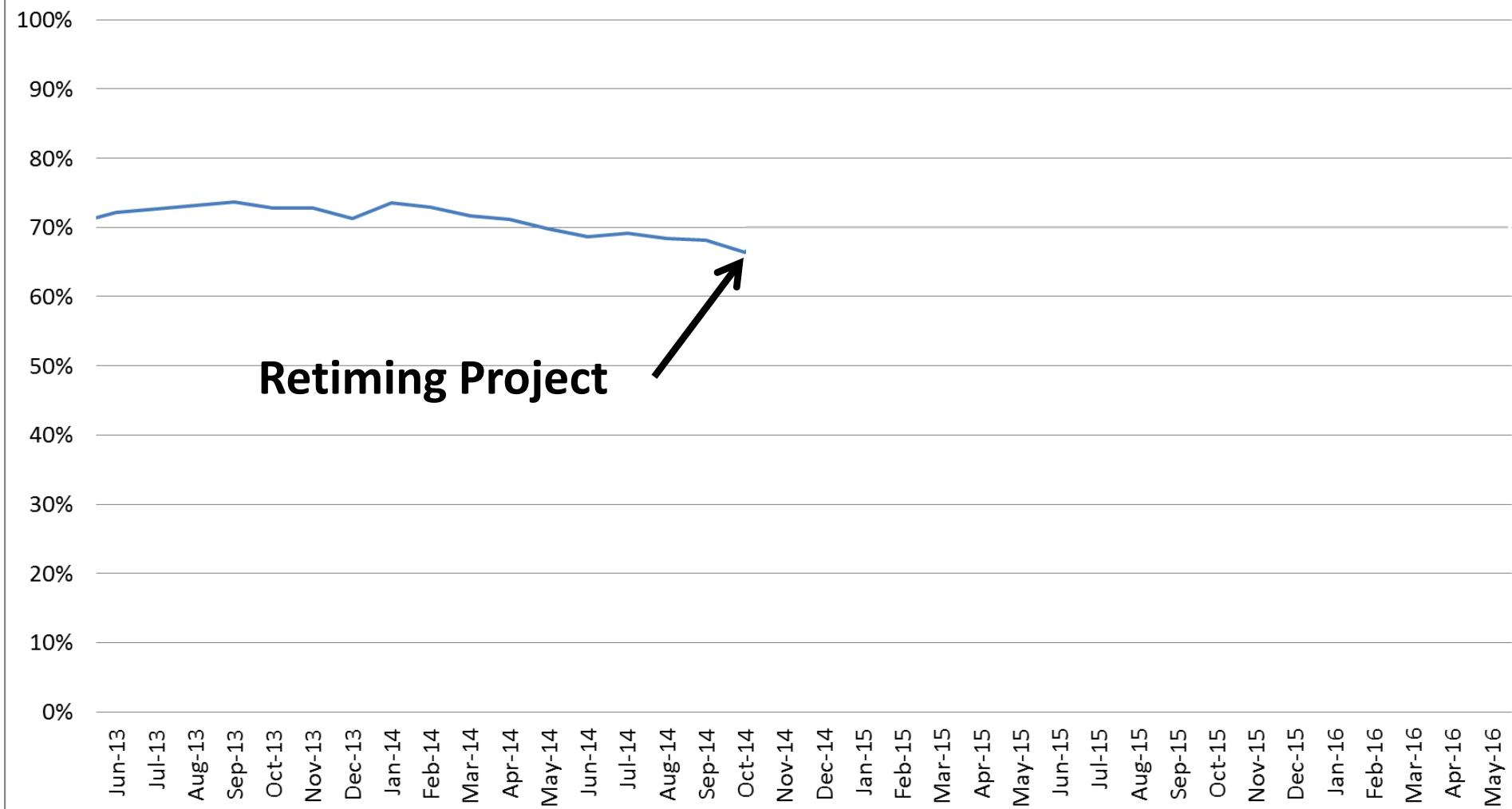


Monitoring Trends

(Riverdale Rd – 11 intersections)

Percent of Vehicles Arriving on Green - Riverdale Rd

10:00 AM to 2:00 PM Monday through Friday

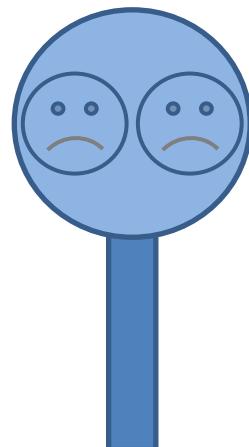
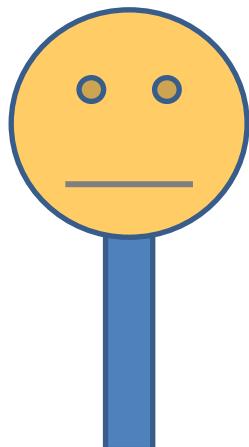
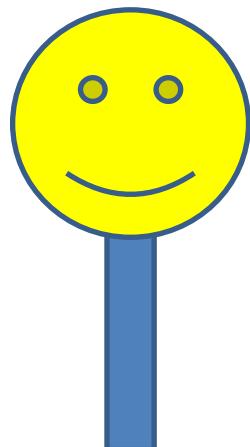
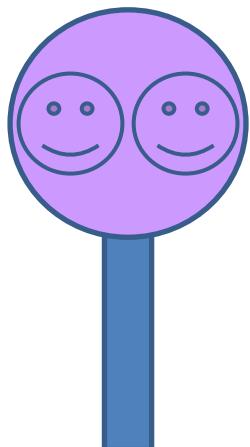


UDOT Signal Timing Focus Group (July 2014)

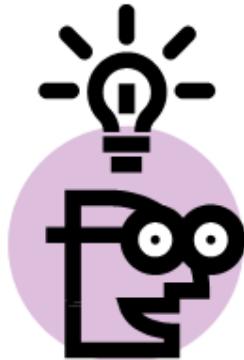
- *How do you feel about UDOT?*



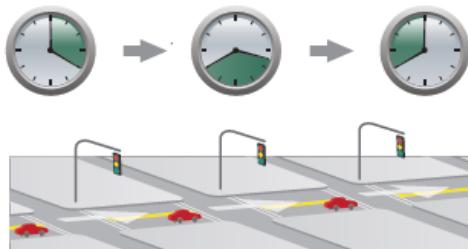
- *How do traffic signals make you feel?*



Focus Group Key Findings (July 2014)



UDOT is perceived positively, with innovation as the primary driver of positive impressions.



Drivers believe traffic signal synchronization is improving.



Drivers feel UDOT should be open about its accomplishments in a way that protects its credibility.

60 S Commercial – Love green lights? So do UDOT traffic engineers



<http://udot.utah.gov/greenlights>



udottraffic.utah.gov/SPM

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