

# 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

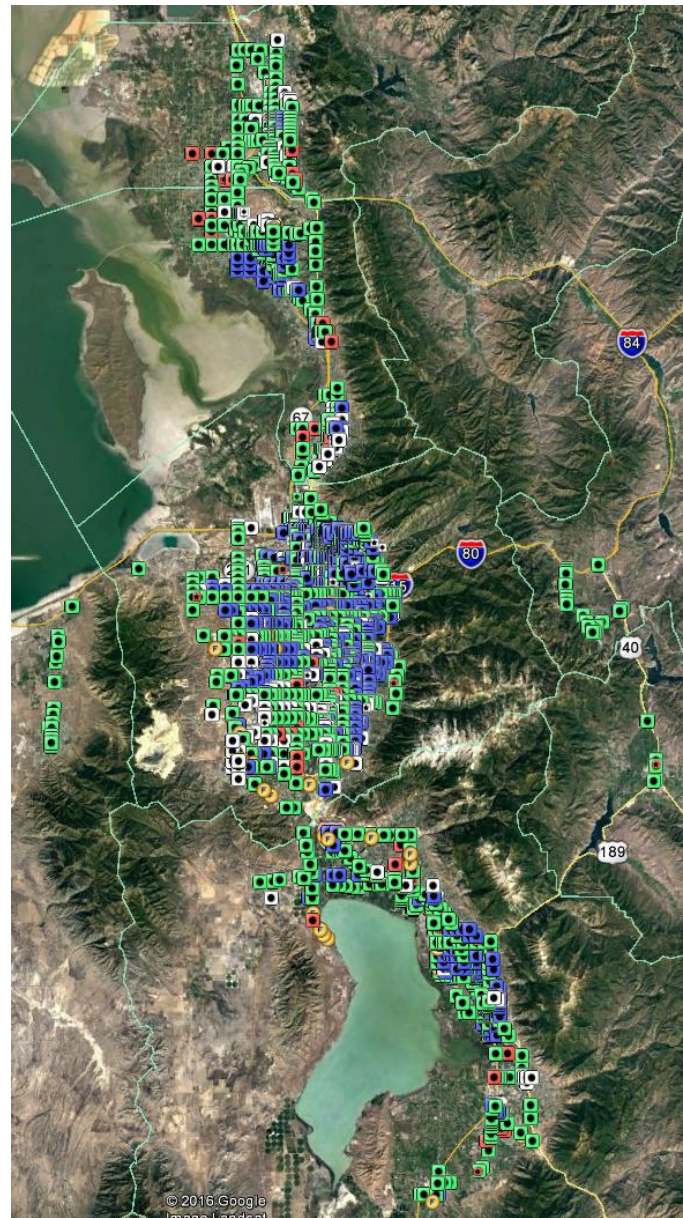
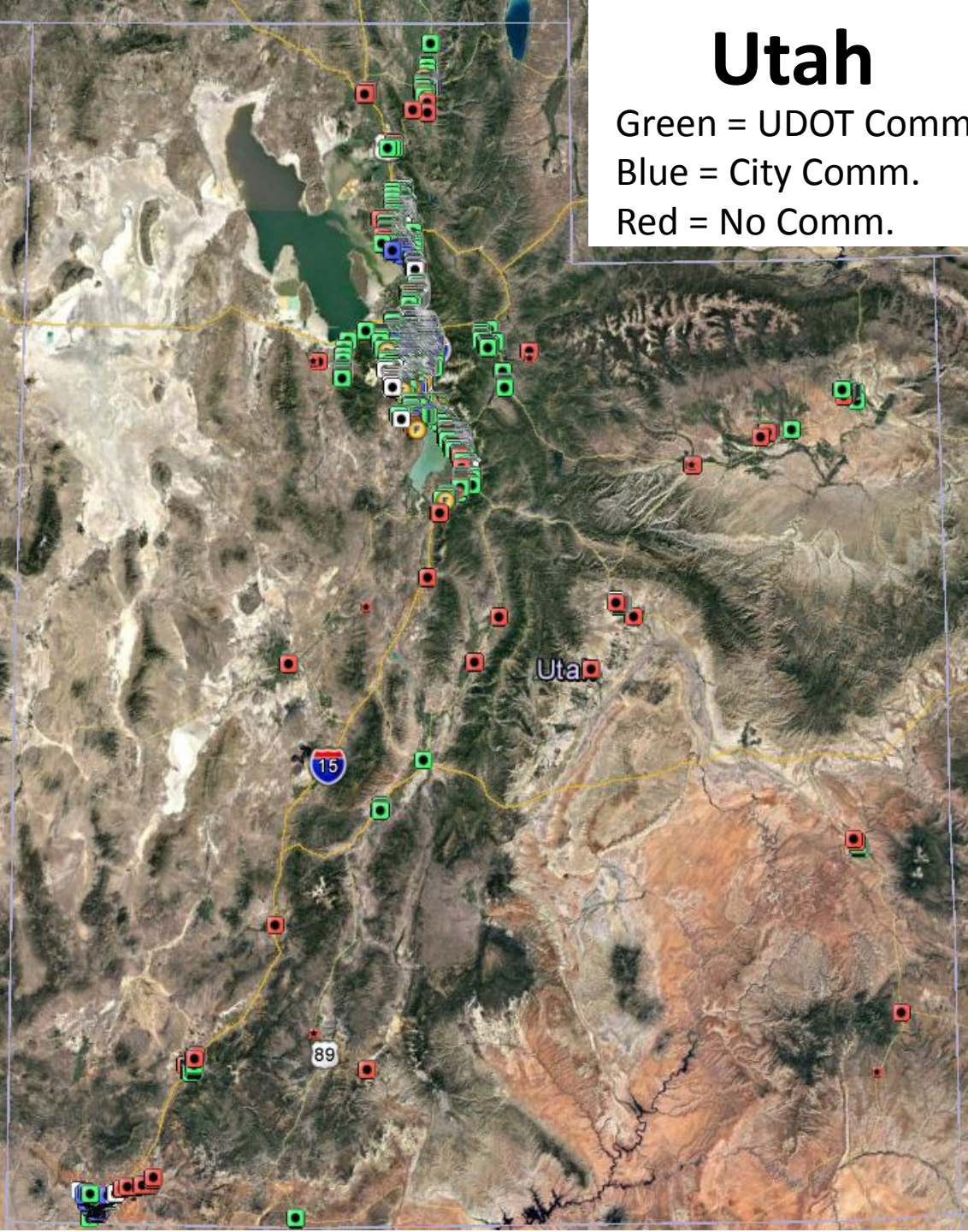


- All cities in Utah & UDOT share same ATMS



# 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**

UTAH DEPARTMENT OF TRANSPORTATION

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WORLD CLASS  
TRAFFIC SIGNAL MAINTENANCE  
& OPERATIONS



QUALITY IMPROVEMENT TEAM  
Final Report

July 2011

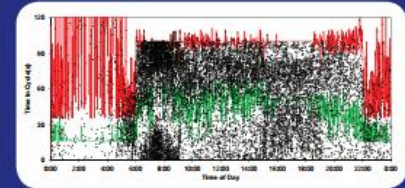


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# PERFORMANCE MEASURES FOR TRAFFIC SIGNAL SYSTEMS

*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*



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# POOLED FUND STUDY

## INDIANAPOLIS

NOVEMBER 12, 2014

PERFORMANCE MEASURES FOR  
TRAFFIC SIGNAL SYSTEMS

*An Outcome-Oriented Approach*



Christopher M. Day, Cheryl M. Dubick, Howard L. Stephen M. Roman, Alexander M. Haimm, Richard G. Fragi, Amanda L. Stevens, Jason P. Stankovic, 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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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*

<http://docs.lib.purdue.edu/atspmw>



Institute of Transportation Engineers

ITE 3-part Webinar  
April, May, June 2014

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Automated Traffic Signal Performance Measur

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.



## Helping Traffic Engineers Manage Data to Make Better Decisions

# Automated Traffic Signal Performance Measures

DARCY BULLOCK, P.E., ROB CLAYTON, P.E., PTOE, JAMIE MACKEY, P.E.,  
E MISGEN, 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.<sup>1</sup> 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

The screenshot displays the OSADP (Open Source Applications Development Platform) website interface. At the top, the U.S. Department of Transportation Federal Highway Administration logo is visible. The navigation bar includes links for HOME, INFORMATION, COMMUNITY, CONTACT, and LOGIN, along with a search bar. The main content area is titled "Explore Applications" and features a sidebar of "APPLICATION CATEGORIES" with counts for each. The main list shows three applications: CV-DSRC-Msg-Parser 1.1, CVD-DME 1.0, and DIRECTView-AMS-v1.0. Each application entry includes a thumbnail image, a title, a subtitle, version information, modification date, download count, and a set of keywords.

**APPLICATION CATEGORIES**

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

**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
Pavement
Bridges

Tier 2 Assets
ATMS / Signal Devices
Pipe Culverts
Signs
Barriers & Walls
Rumble Strips
Pavement Markings

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

# UDOT Asset Management Tiers (2016 & Future)

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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

Selected Signal

No Signal Selected

Signals

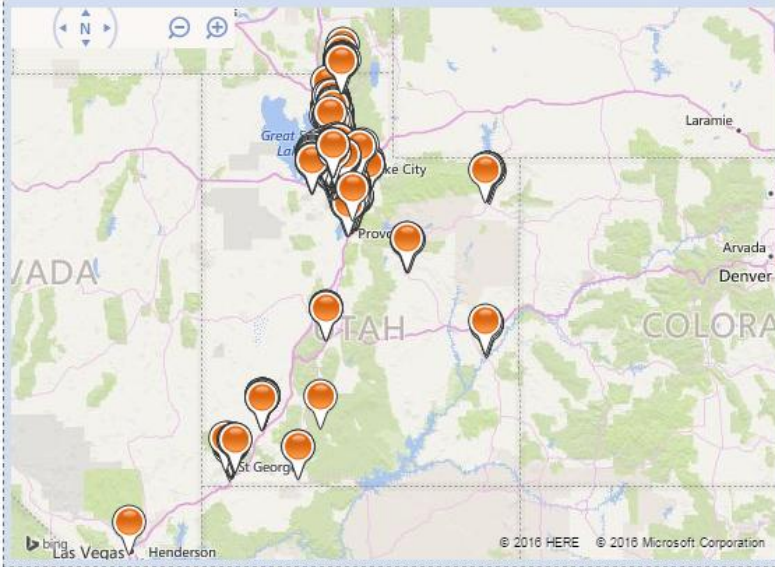
Region All

Metric Type All

Filter Signal Id Filter Clear Filter

#### Signal List

#### Map



Metric Settings

Metric Type

- Purdue Phase Termination
- 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

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



Others

Traffic  
Division x.

~~SILOS~~

Department Z

w at



# Signal Performance Metrics



Charts  
Signal  
Time Space Diagram  
Enter Chart Comments

Reports

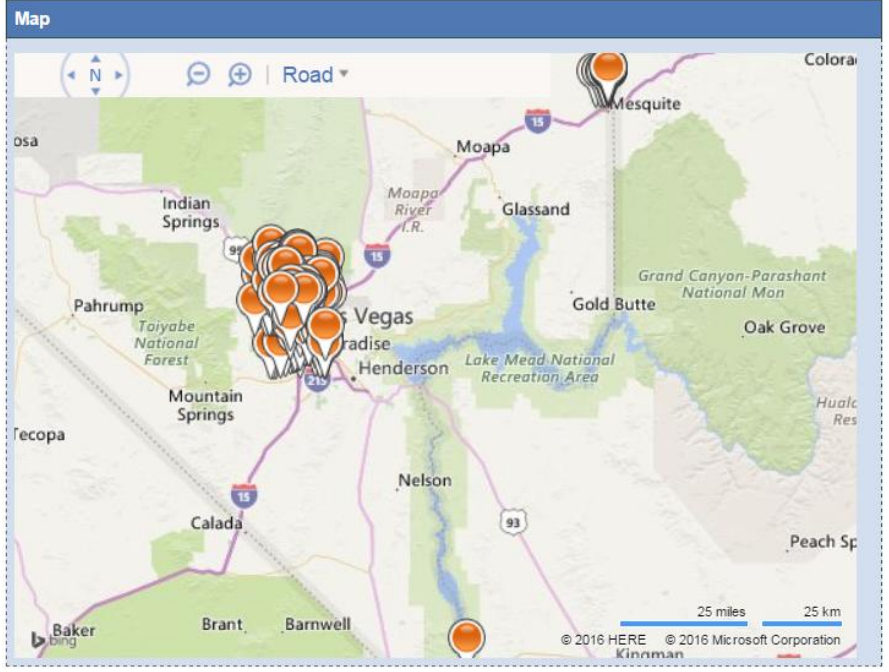
Links

FAQ

Selected Signal

Signals  
Region   
Metric Type   
Filter

### Signal List



Metric Settings

Metric Type

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

Time Y Axis Maximum   
Volume Y Axis Maximum   
Volume Bin Size   
Dot Size   
 Show Plan Statistics  
 Show Volumes  
[Export Data](#)

Dates

Start Date   AM  
End Date   PM  
 

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

286 traffic signals

Create Metrics



## Signal Performance Metrics



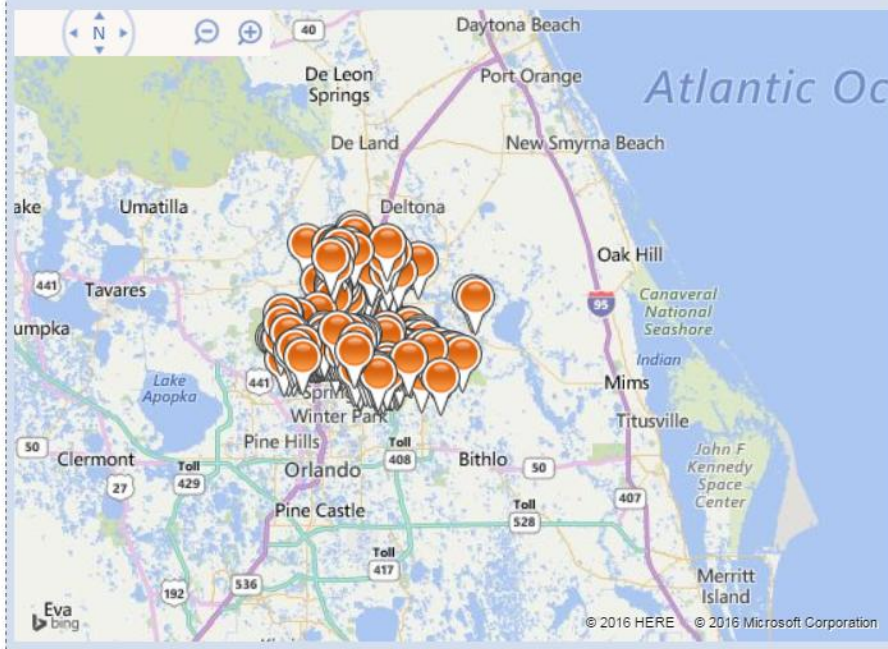
->Signal Metrics

Selected Signal  
 No Signal Selected

Signals  
Region   
Metric Type   
Filter

### Signal List

### Map



Metric Settings  
Metric Type  
 Approach Delay  Purdue Phase Termination  
 Approach Volume  Speed  
 Arrivals On Red  Split Monitor  
 Purdue Coordination Diagram  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   AM  
End Date   PM  
 

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

316 trafficsignals

Create Metrics



## Signal Performance Metrics

->Signal Metrics

Selected Signal  
 No Signal Selected

Signals

Region

Metric Type

Filter

**Signal List**

**Map**

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

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   
Metric Type   
Filter

**Signal List**

**Map**

Metric Settings

Metric Type

- 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

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
28	29	30	31	1	2	3
4	5	6	7	8	9	10

# New Website – November 15th

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



#### Signal Selection

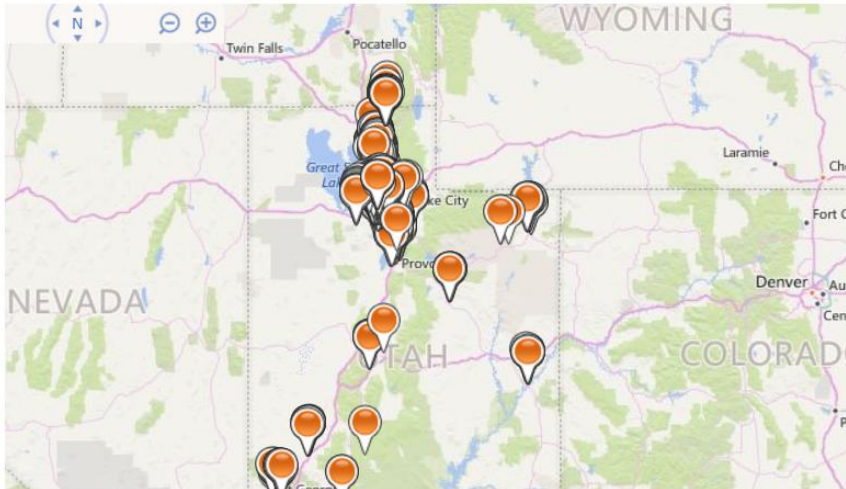
##### Signal ID

#### Signal List

#### Signal Map

##### Region

##### Metric Type



#### 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

##### End Date





# How to use ATSPM Website

Signal Selection

Signal ID

7220

Foothill Drive @ 1300 South

Signal List

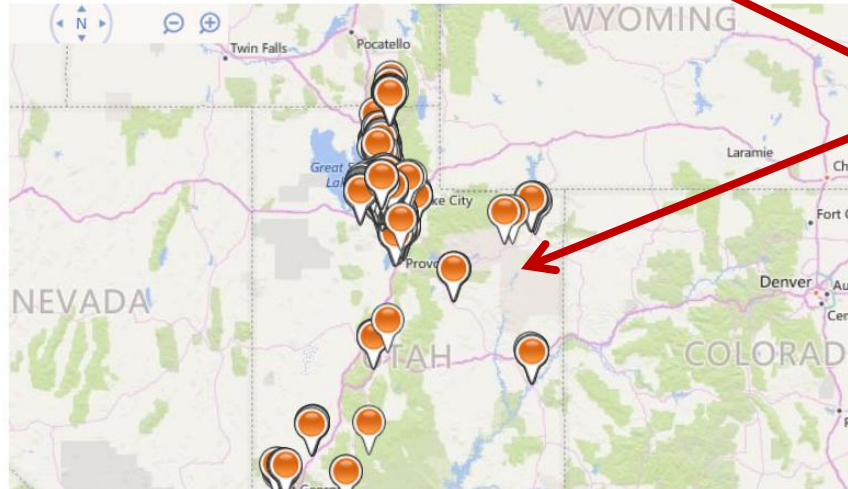
Signal Map

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

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 displays the ATSPM website interface with the following sections:

- Metric Selection:** A dropdown menu titled "Metrics List" with "Turning Movement Counts" selected.
- Turning Movement Counts Options:** Fields for "Y-axis Max" (1000), "Secondary Y-axis Max" (300), and "Volume Bin Size" (15). Checkboxes for "Show Lane Volume" and "Show Total Volume" are present.
- Date Selection:** Fields for "Start Date" (10/28/2016, 12:00 AM) and "End Date" (10/28/2016, 11:59 PM), along with a "Reset Date" button.
- Calendar:** A calendar for October 2016 with the 28th selected.
- Create Metric:** A blue button at the bottom left.

Red arrows and numbered circles (3 and 4) indicate the sequence of actions: 3 points to the date selection area, and 4 points to the "Create Metric" button.

3 Select a date and time range

4 Click "Create Metric", wait a few seconds and scroll down to see data.

# How to use ATSPM Website

## (Filter Map by Metric Type)

The screenshot displays the ATSPM website interface. At the top, there is a blue header bar labeled "Signal Selection". Below this, there is a "Signal ID" section with a text input field and a button that says "Press Enter to get Signal info". Underneath are two more blue header bars: "Signal List" and "Signal Map". The "Signal Map" section features a "Region" dropdown menu set to "--Select Region--" and a "Metric Type" dropdown menu. The "Metric Type" menu is open, showing a list of options: "Turning Movement Counts" (highlighted in blue), "--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", and "Purdue Split Failure". Below the dropdowns is a map of the region with numerous orange circular markers representing signal locations.

A

Select a Metric from the dropdown list.

The map will filter all available signals with that metric.

B

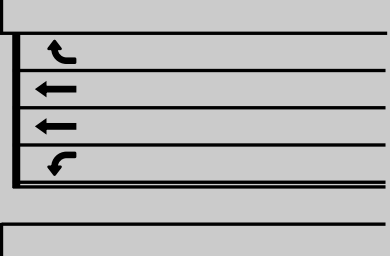
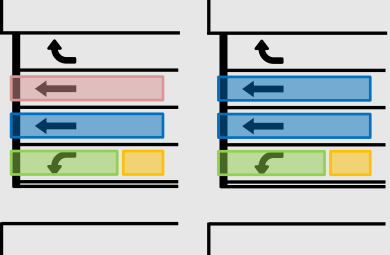
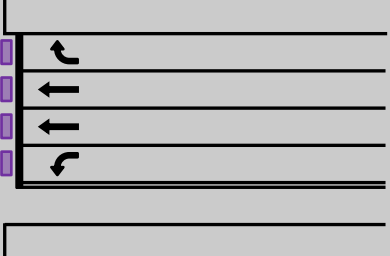

Zoom in on map and select your desired signal.

C

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

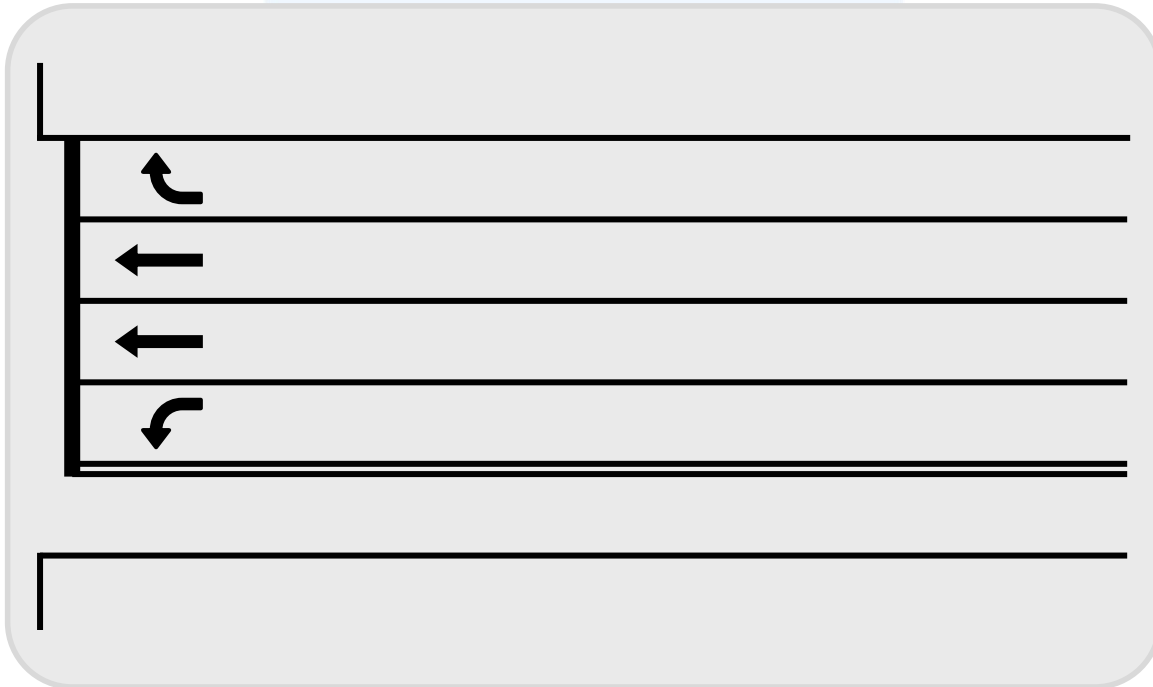
# METRICS & DETECTION REQUIREMENTS

---

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

## Detection

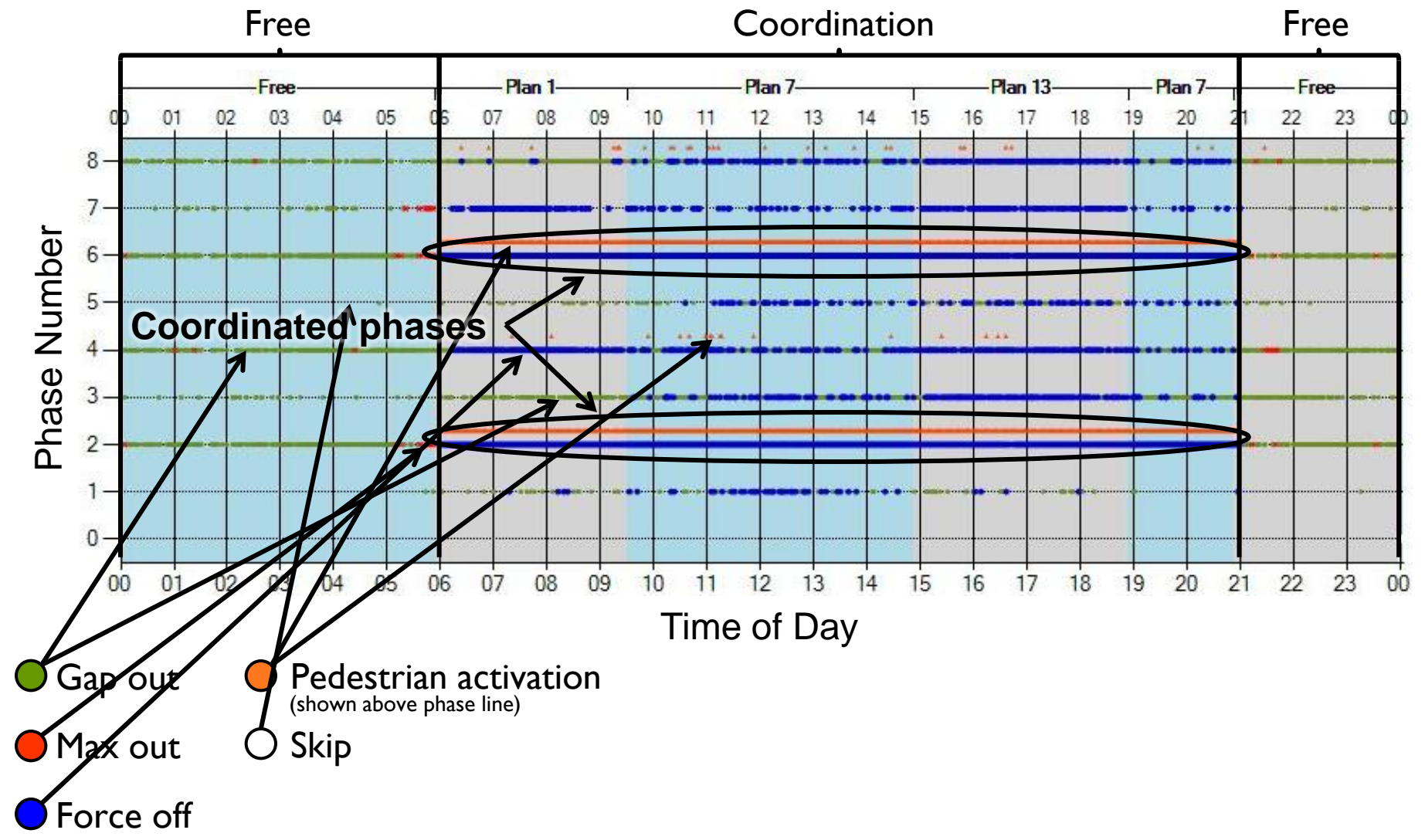
None



## Available Metrics

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

# Metric: Phase Termination Chart



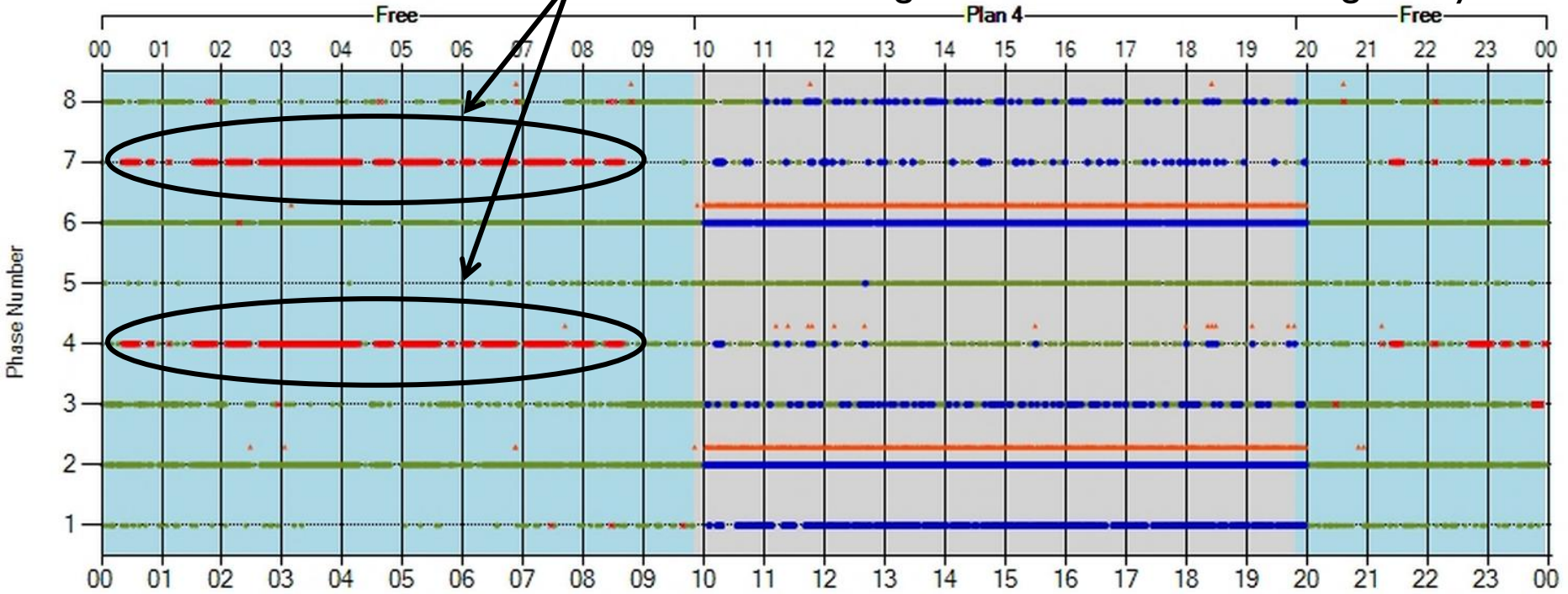


# Complaint: Long red at 2 a.m., no other traffic

**Before**

Video detection not working at night

Minor street through & left turn max out at night only

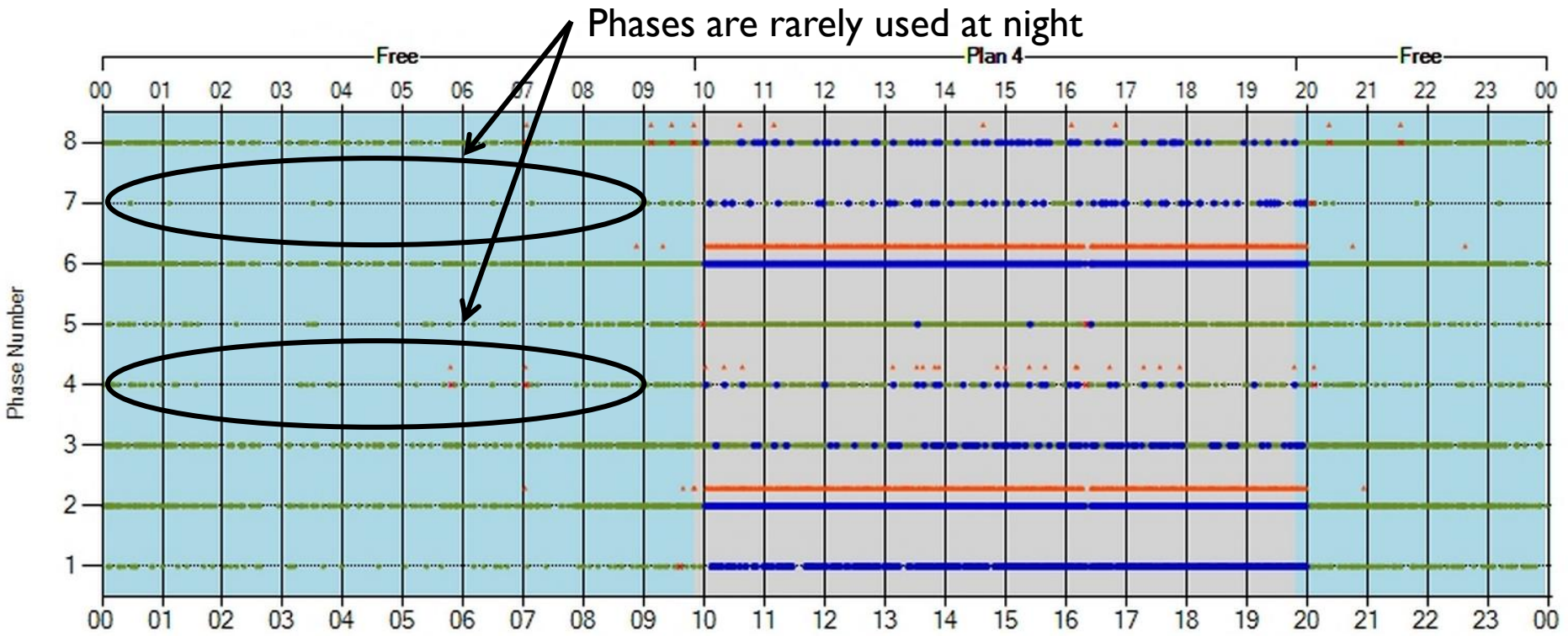


- Gap out
- Pedestrian activation (shown above phase line)
- Max out
- Force off
- Skip

**Metric: Purdue Phase Termination**  
**Detection Requirements: None**

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

**After** New detection technology installed



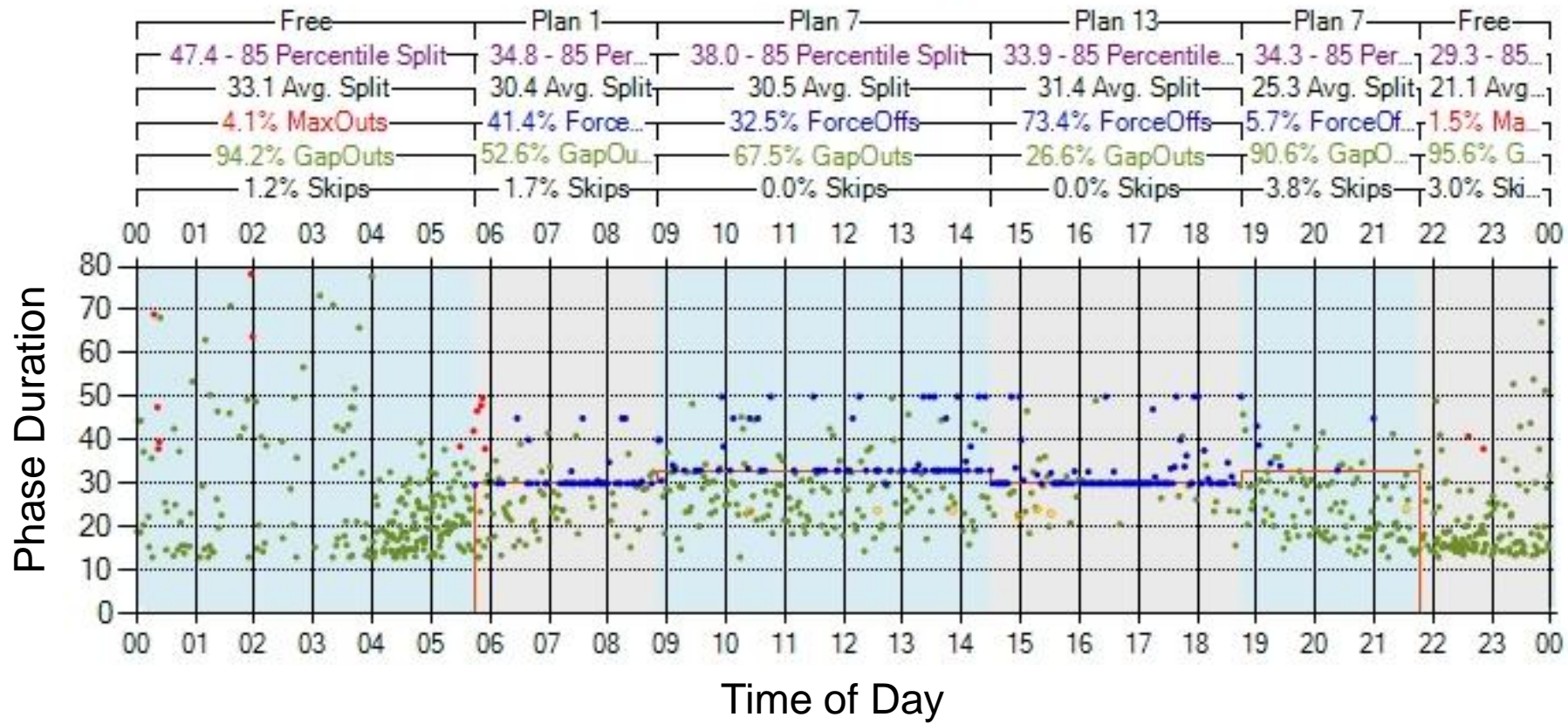
- Gap out
- Max out
- Force off
- Pedestrian activation (shown above phase line)
- Skip

**Metric: Purdue Phase Termination**  
**Detection Requirements: None**

# Metric: Split Monitor

Phase 6

US-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

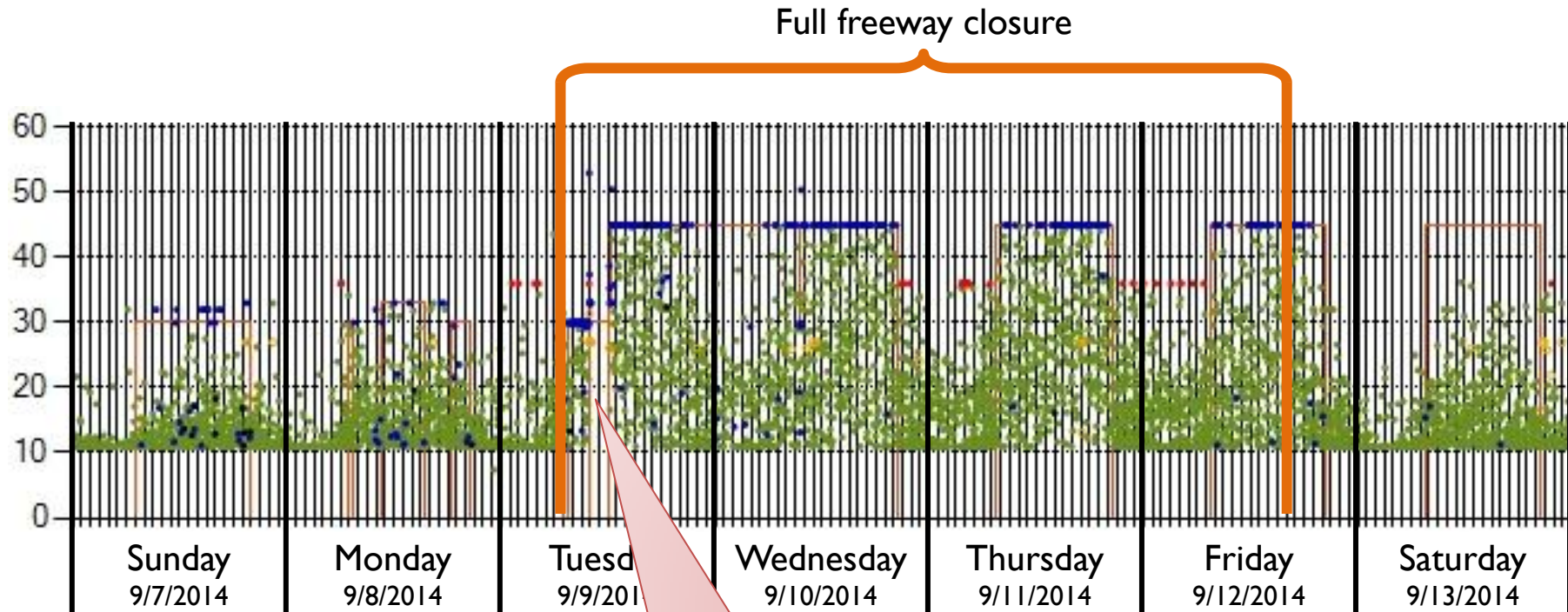


**Heavy rain rips apart I-15 in  
Nevada, forces freeway closure**

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



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



Implemented timing plans

- 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)

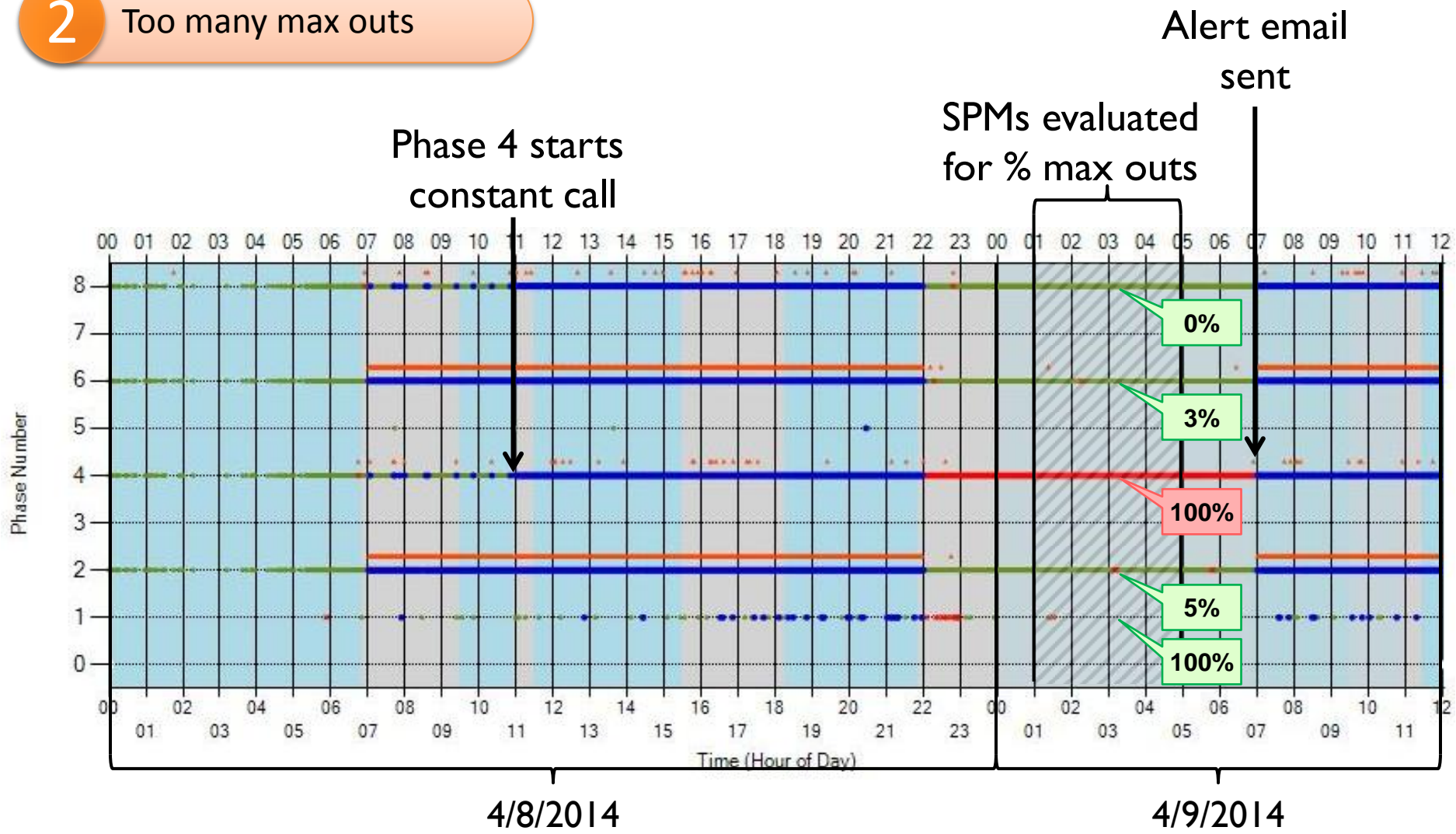
--The following signals had too many force off occurrences:  
1224 - North Temple & Main Street - Phase: 3 (Force Offs 97.6%)  
7252 - 500 South & Main Street - Phase: 2 (Force Offs 100%)  
7252 - 500 South & Main Street - Phase: 6 (Force Offs 100%)

--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 - Bangarter Hwy (SR-154) & 4100 South - Phase: 1 ( Has Unusually Low Counts. )  
7061 - Bangarter Hwy (SR-154) & 4100 South - Phase: 7 ( Has Unusually Low Counts. )  
7361 - Bangarter 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

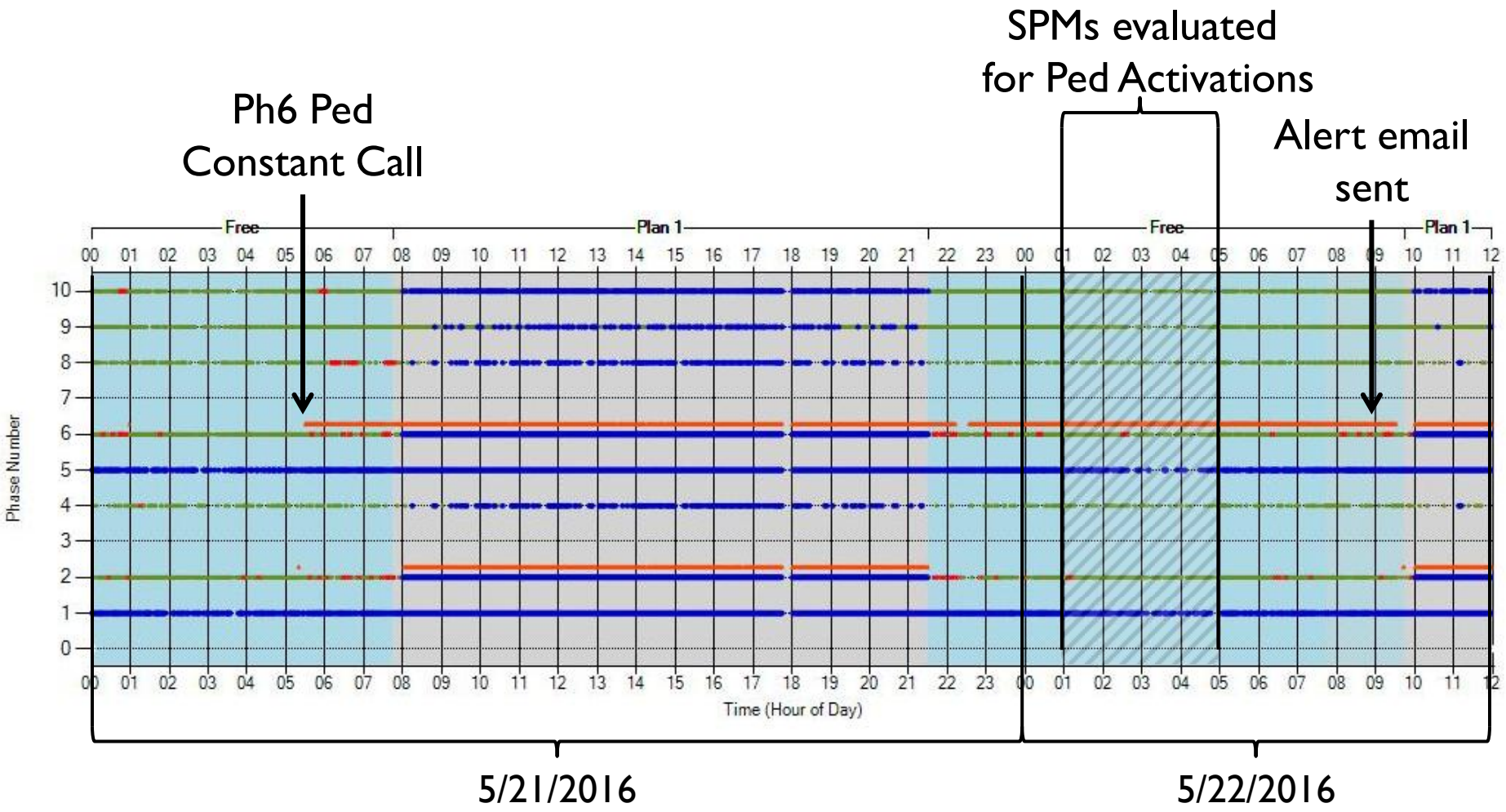


- Gap out
- Pedestrian activation (shown above phase line)
- Max out
- Force off
- Skip

**Metric: Purdue Phase Termination**  
**Detection Requirements: None**

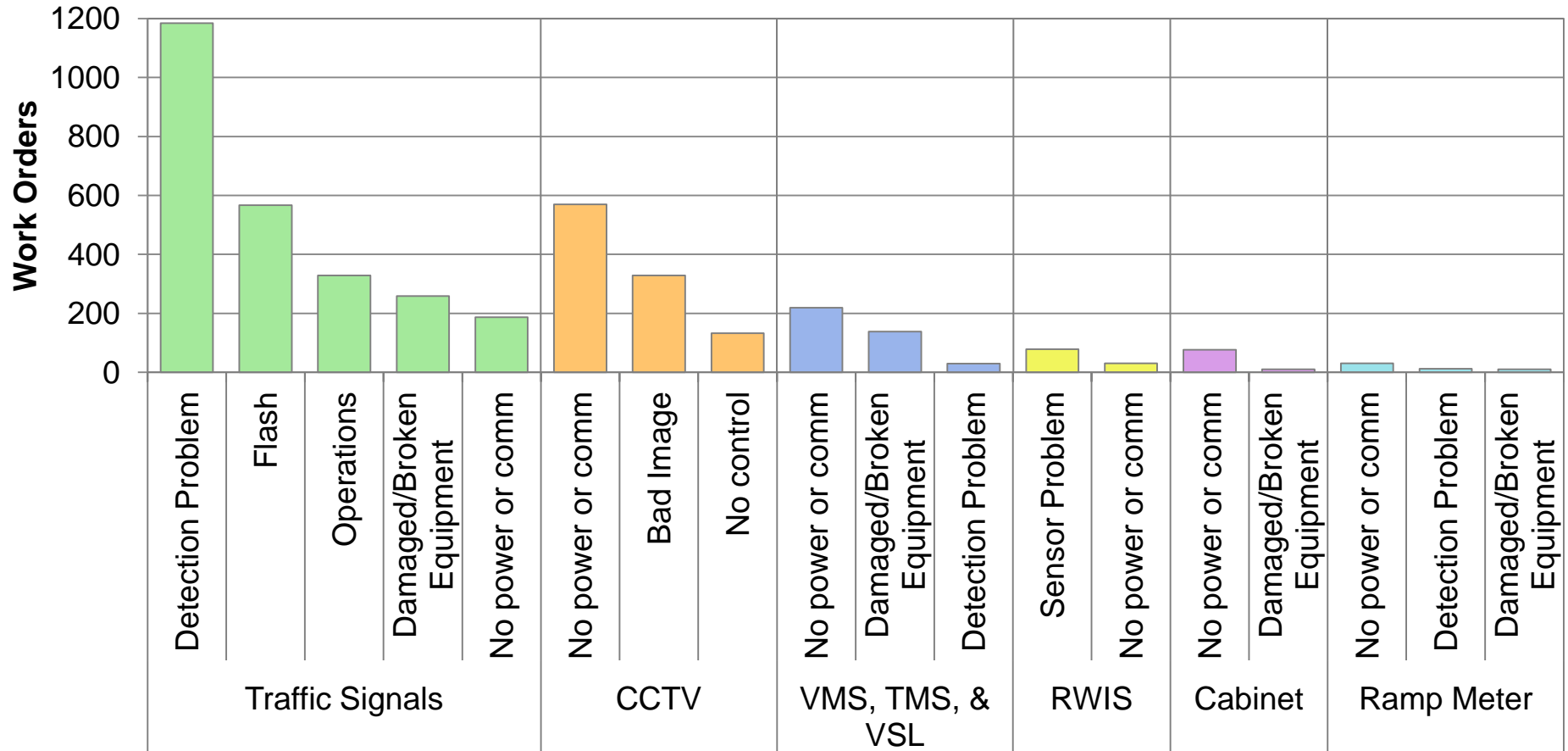


**4** Too many ped calls



# Work Orders for UDOT ATMS

# Work Orders for ATMS Equipment  
July 2015 to July 2016

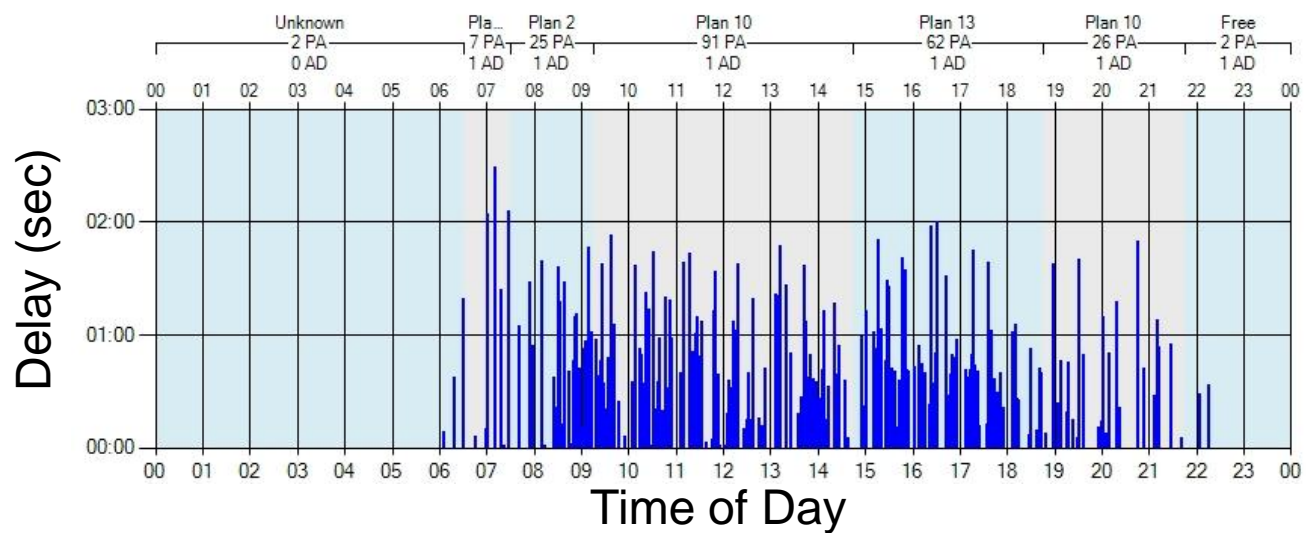
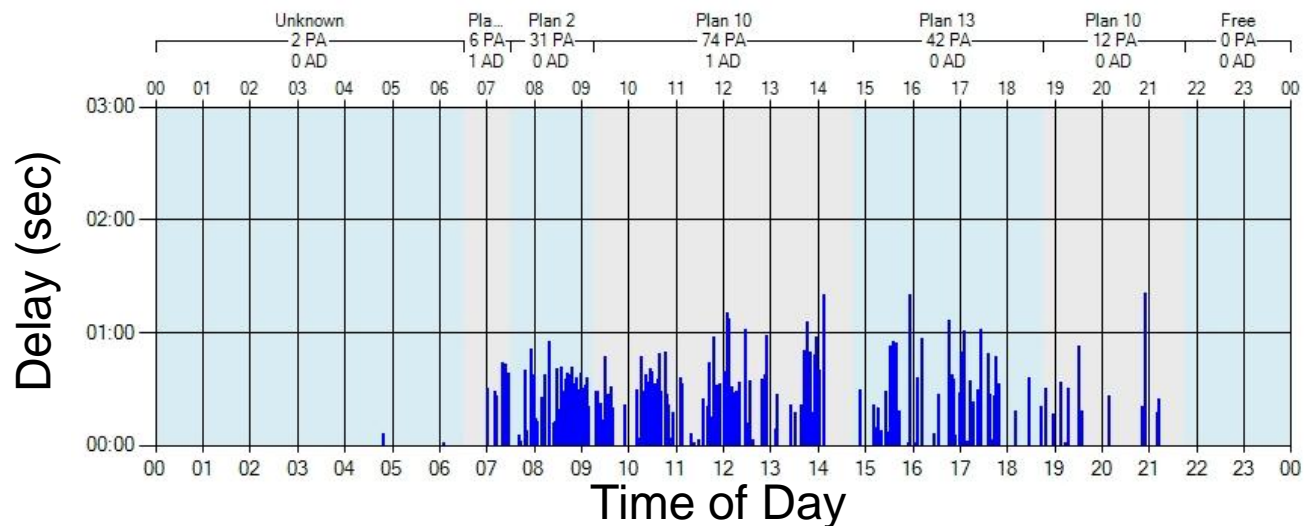


**EVENT CODES**  
 45 – Ped Call on  
 21 – Ped Walk on

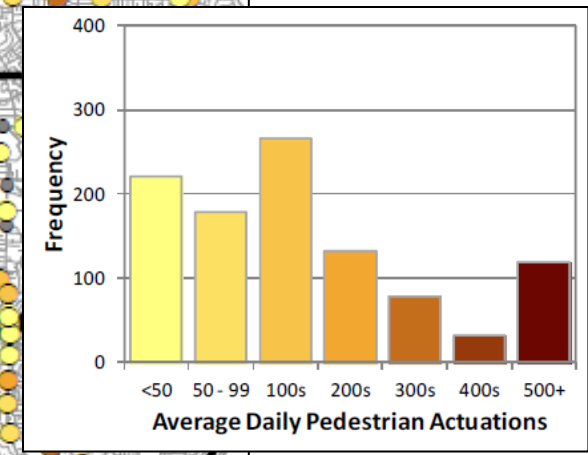
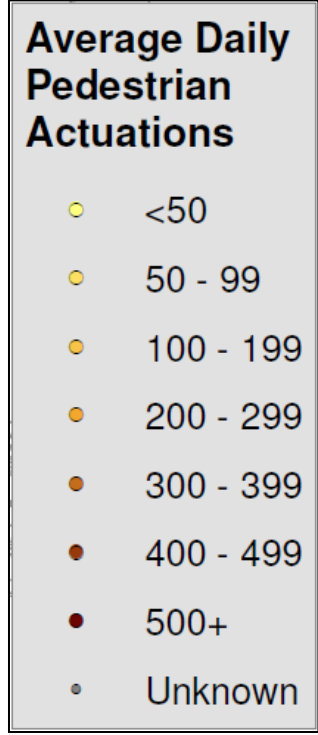
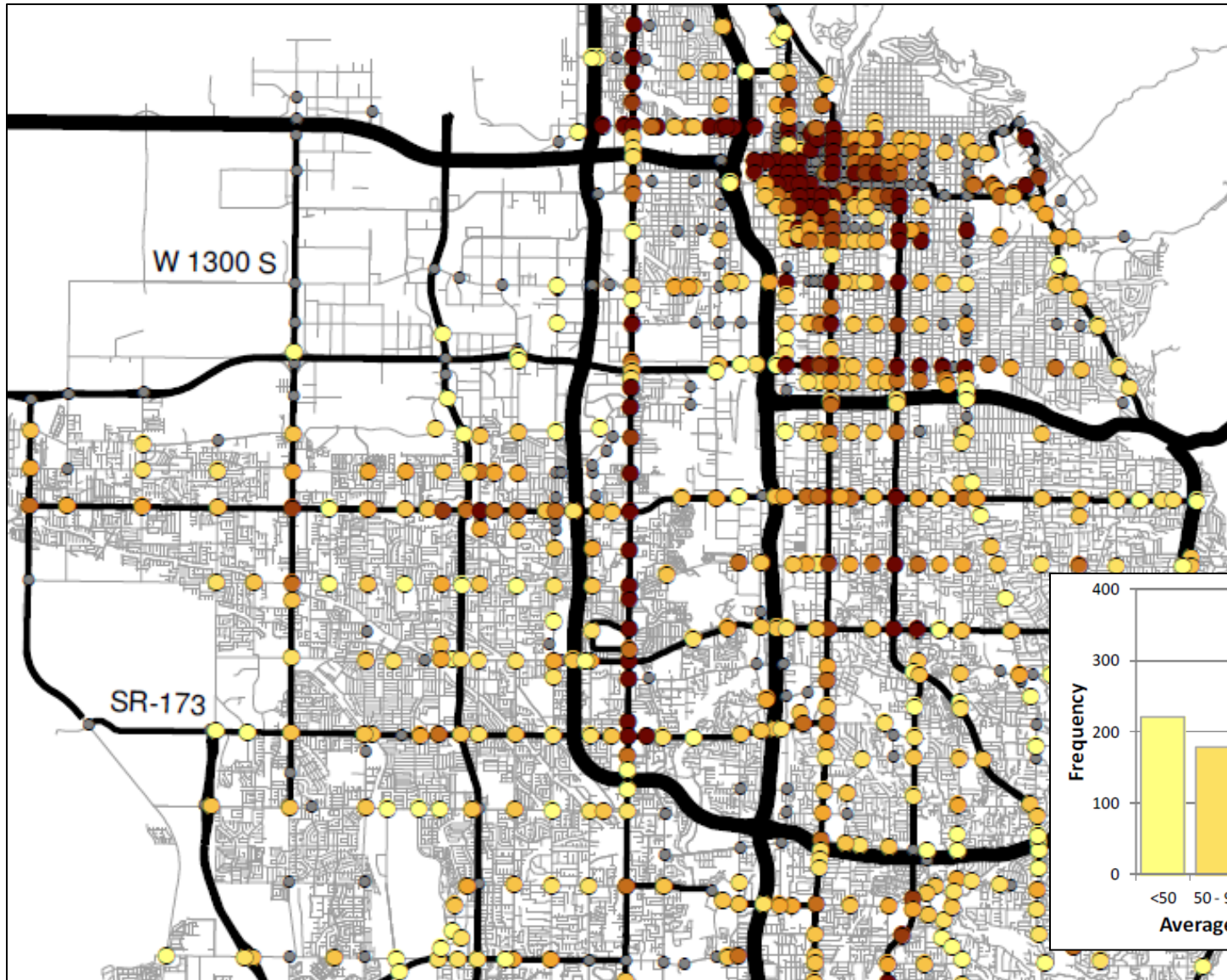
# Metric: Pedestrian Delay

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)



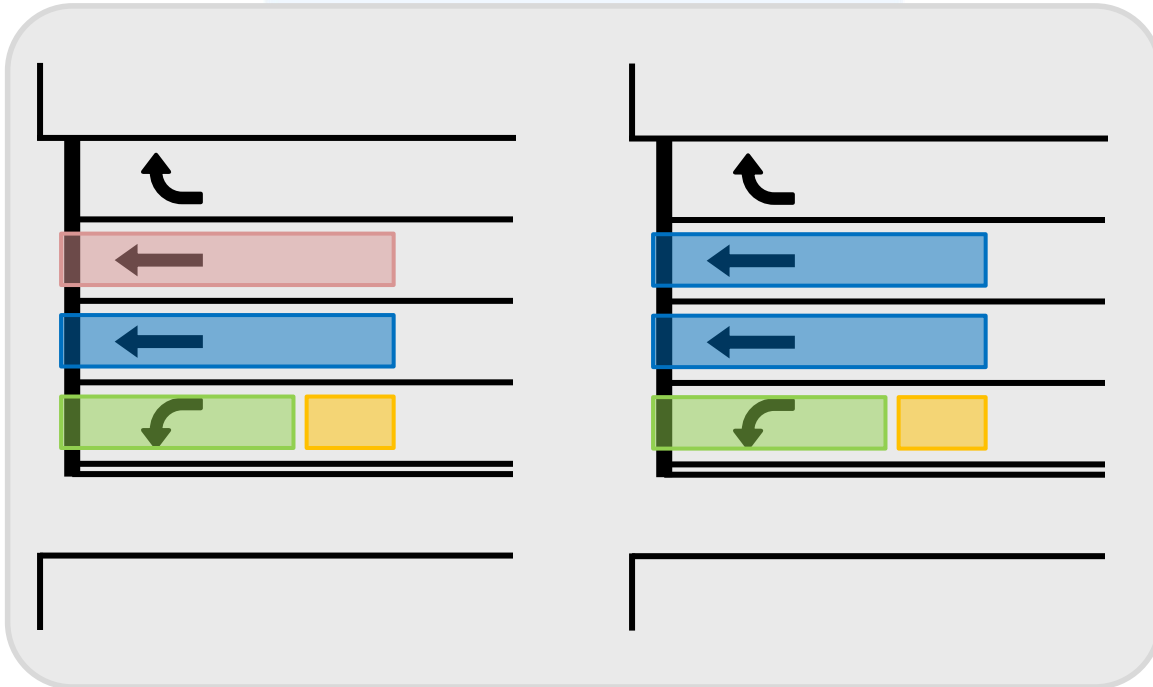
# Active Transportation



## Detection

Lane-by-lane Presence

Lane Group Presence



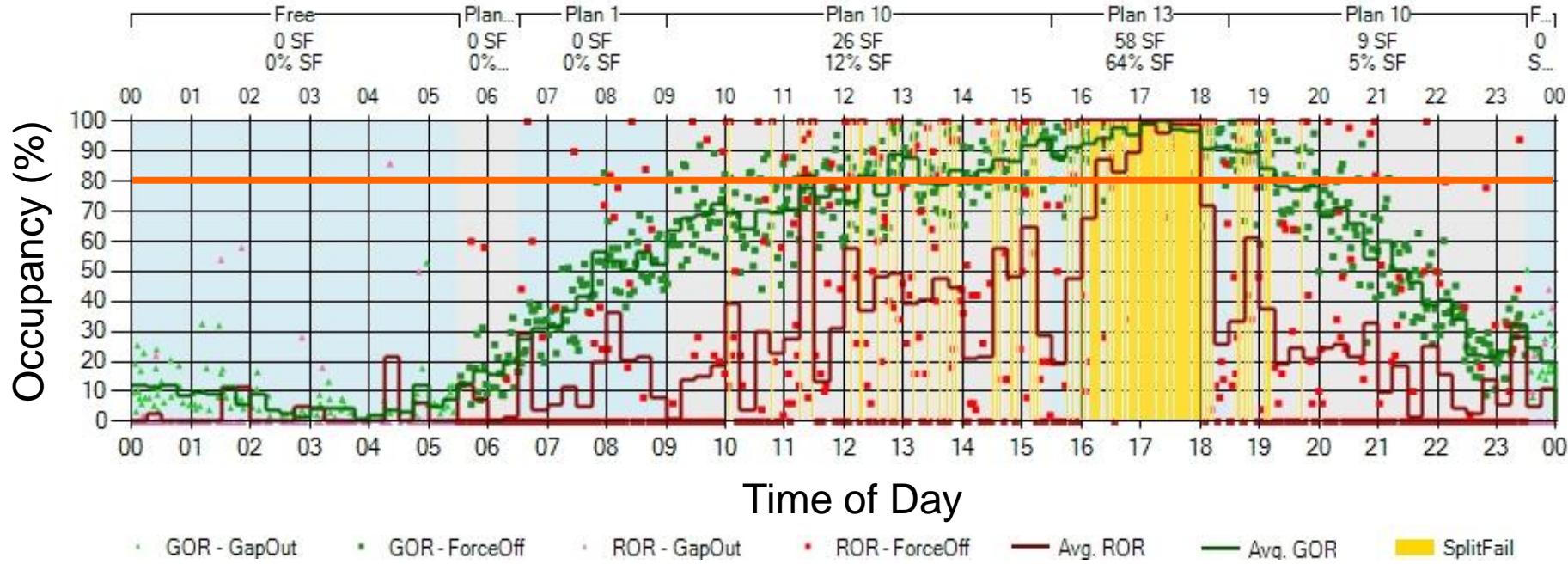
## Available Metrics



Purdue Split Failure

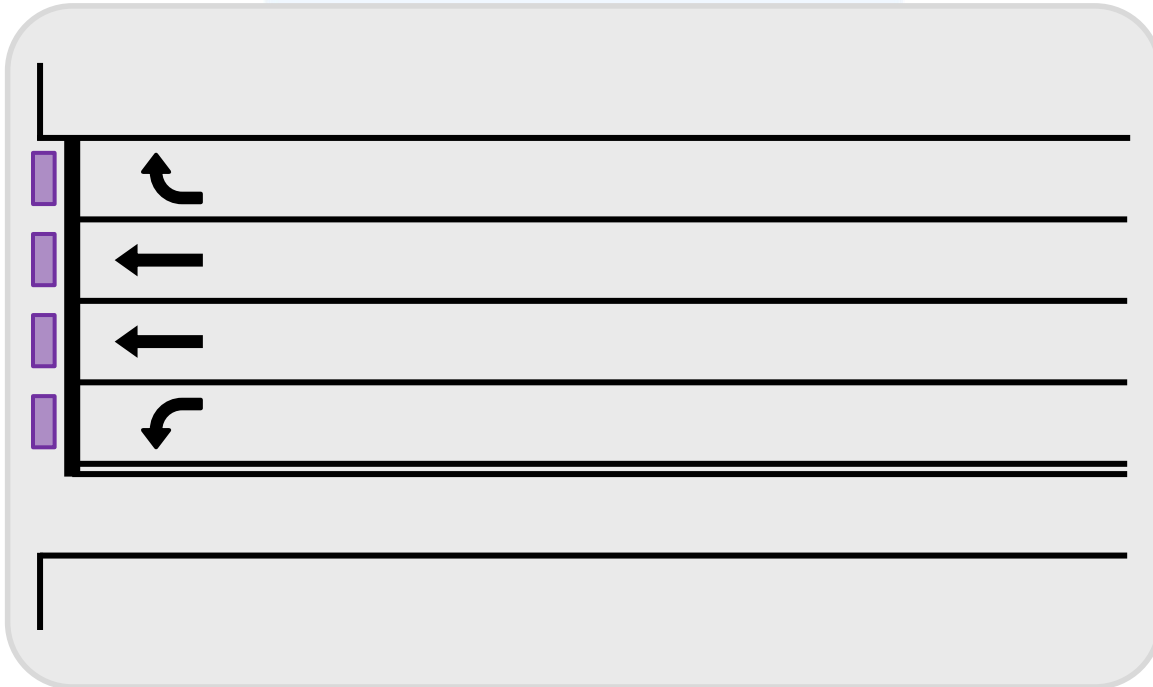
# Metric: Purdue Split Failure

700 East 900 South Signal 7184 Phase: 6 Southbound  
 Wednesday, April 27, 2016 12:00 AM - Wednesday, April 27, 2016 11:59 PM  
 Total split fails for the selected period = 93



## Detection

Lane-by-lane Count

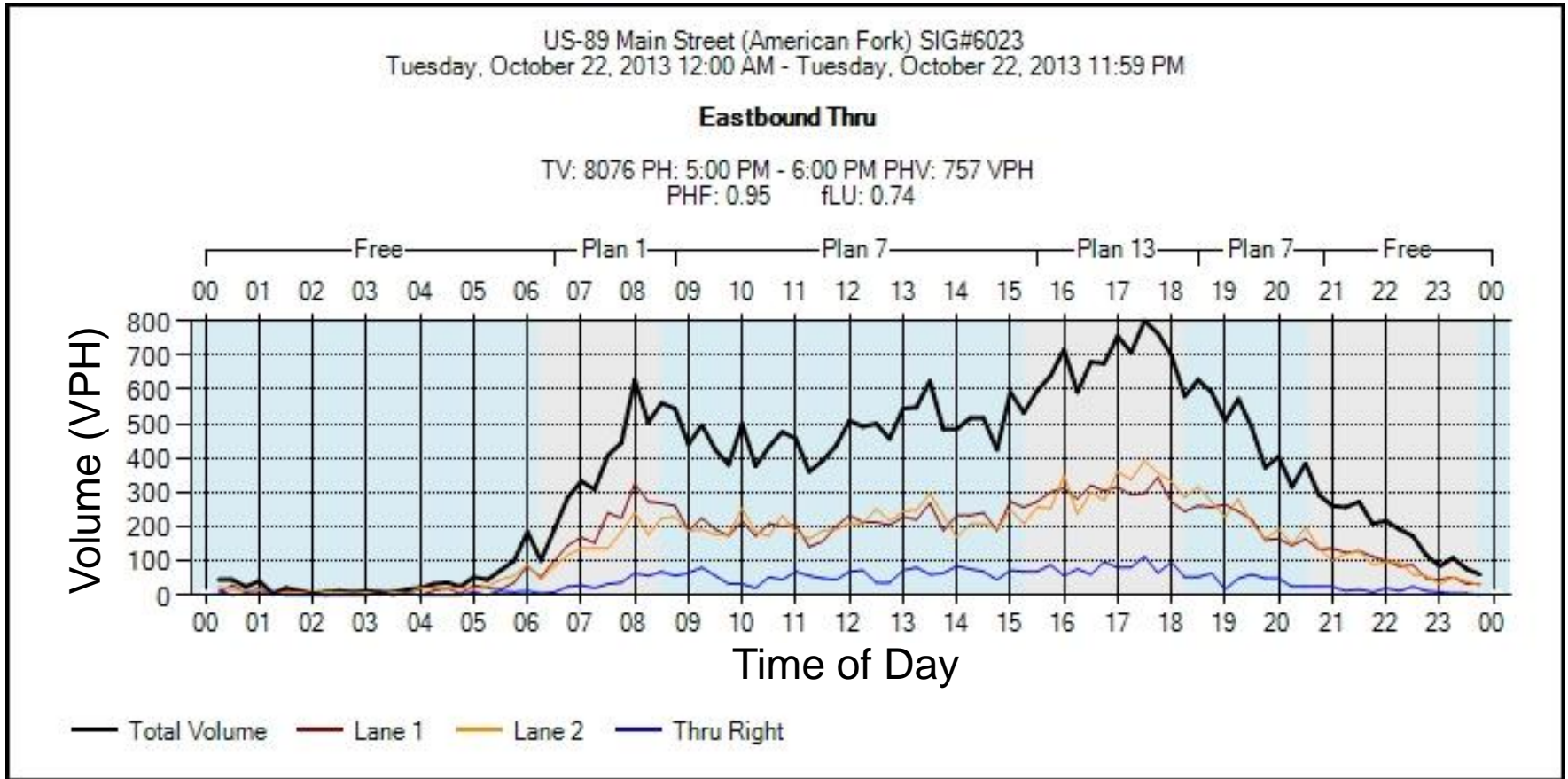


## Available Metrics



Turning Movement Counts

# Metric: Turning Movement Counts



**Metric: Turning Movement Counts**  
**Detection Requirements: Stop Bar Counters**



# Turning Movement Counts Detection



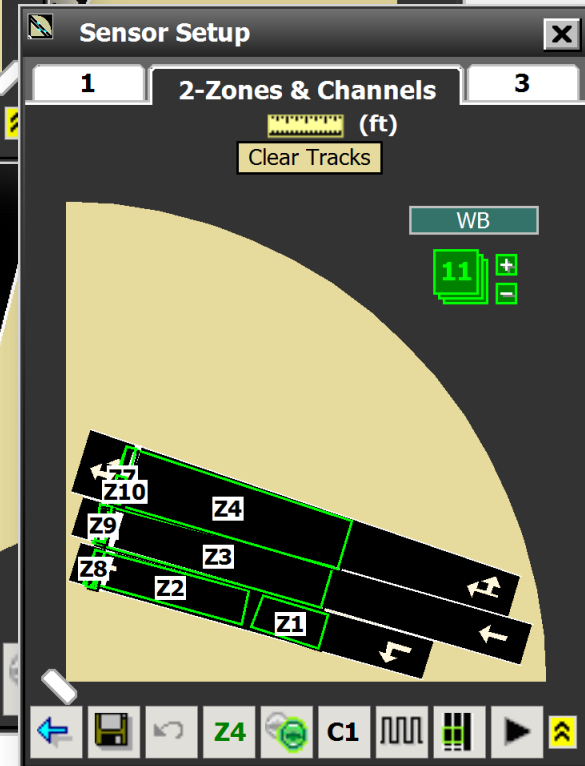
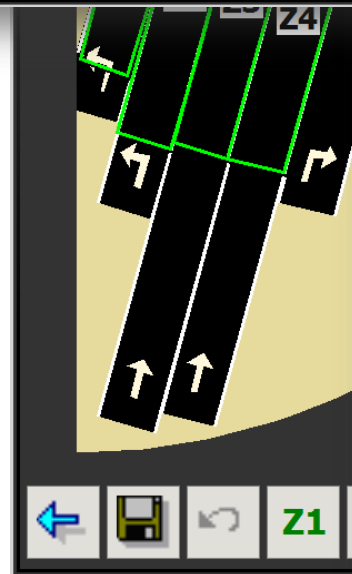
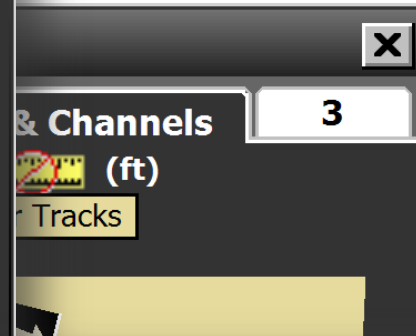
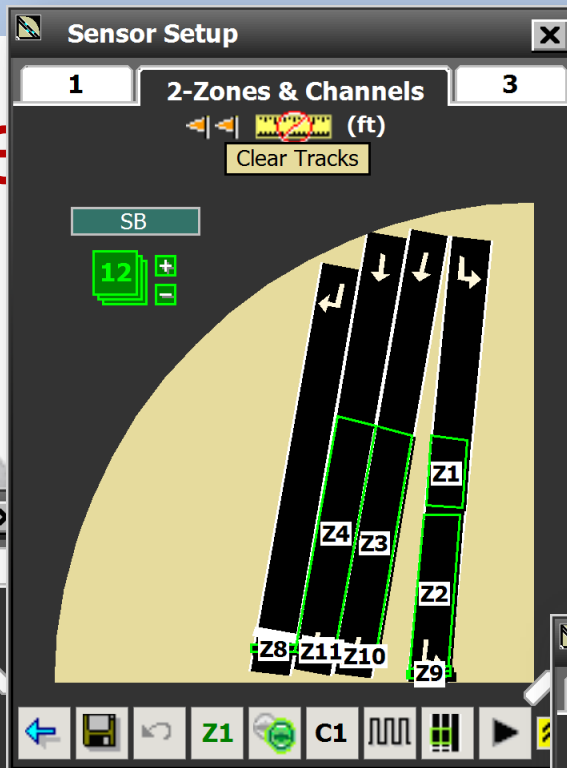
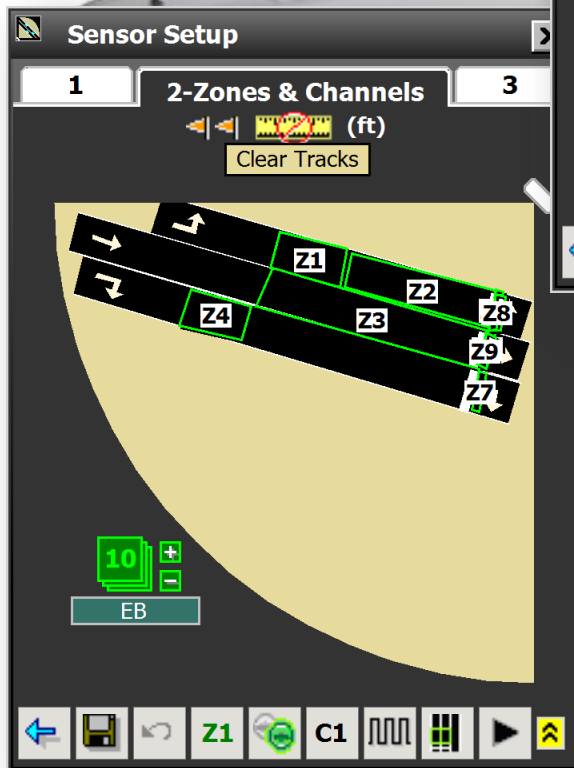
Wavetronix  
SmartSensor  
Matrix



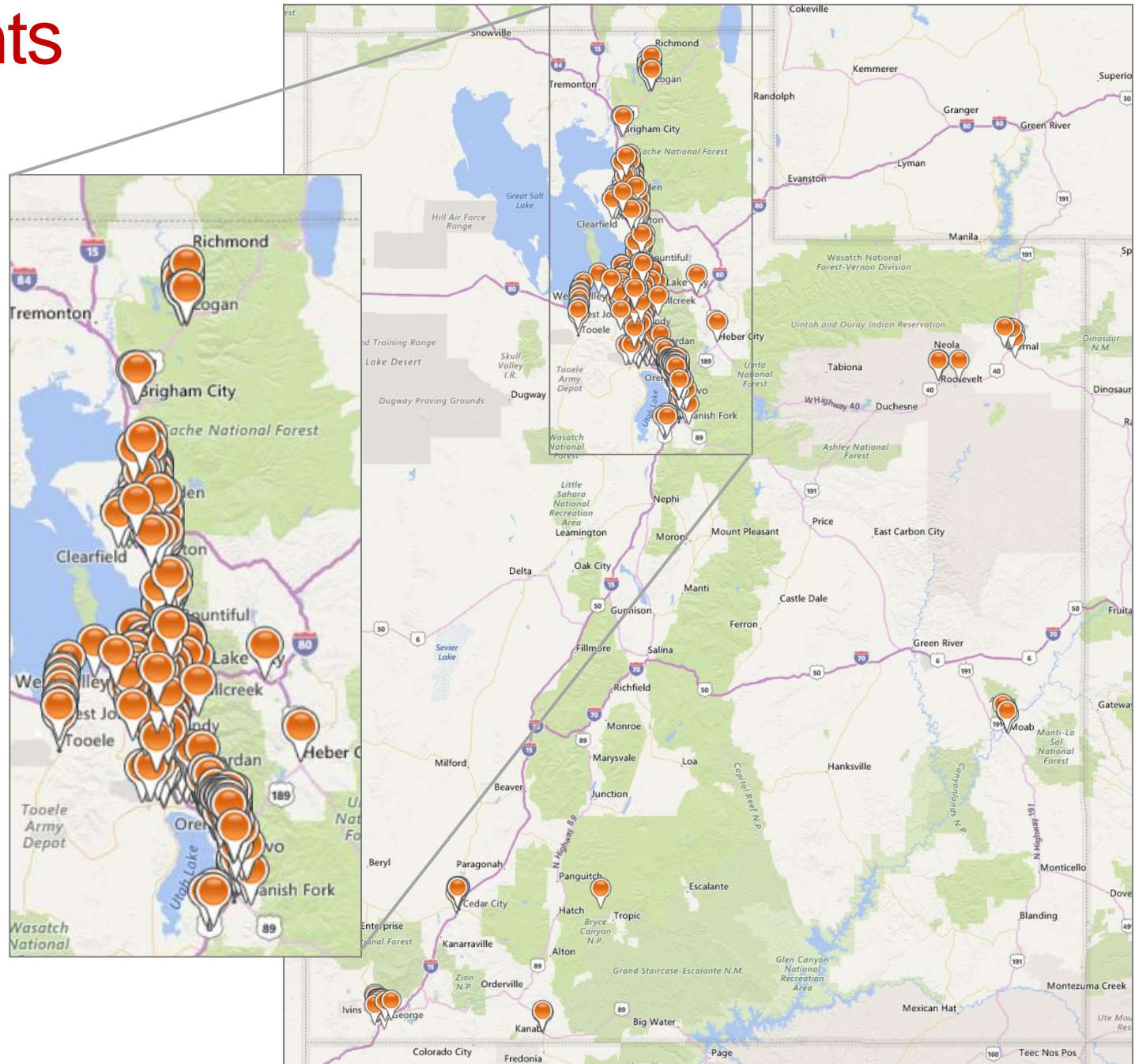
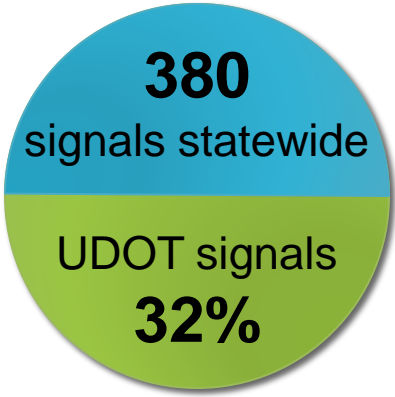
Wavetronix  
Cabinet Interface Device  
Click 650

# Turning Movement

# Detection



# Lane Counts Availability



# TMC Data Accuracy

RESEARCH



Utah Department of Transportation - Research Division  
4501 South 2700 West - P.O. Box 148410 - SLC, UT 84114-8410

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:

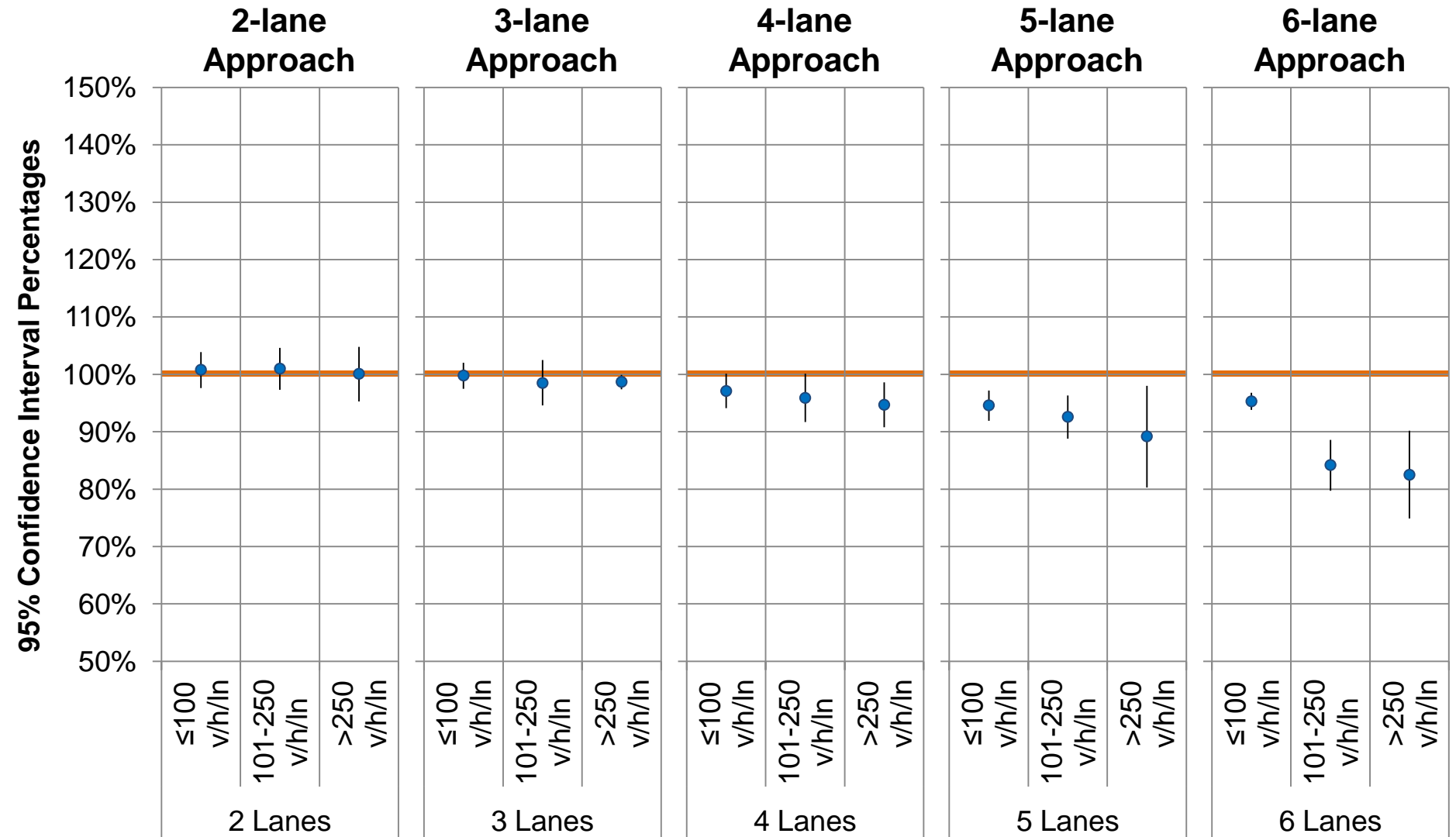
Brigham Young University  
Department of Civil and Environmental  
Engineering

### Authored By:

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

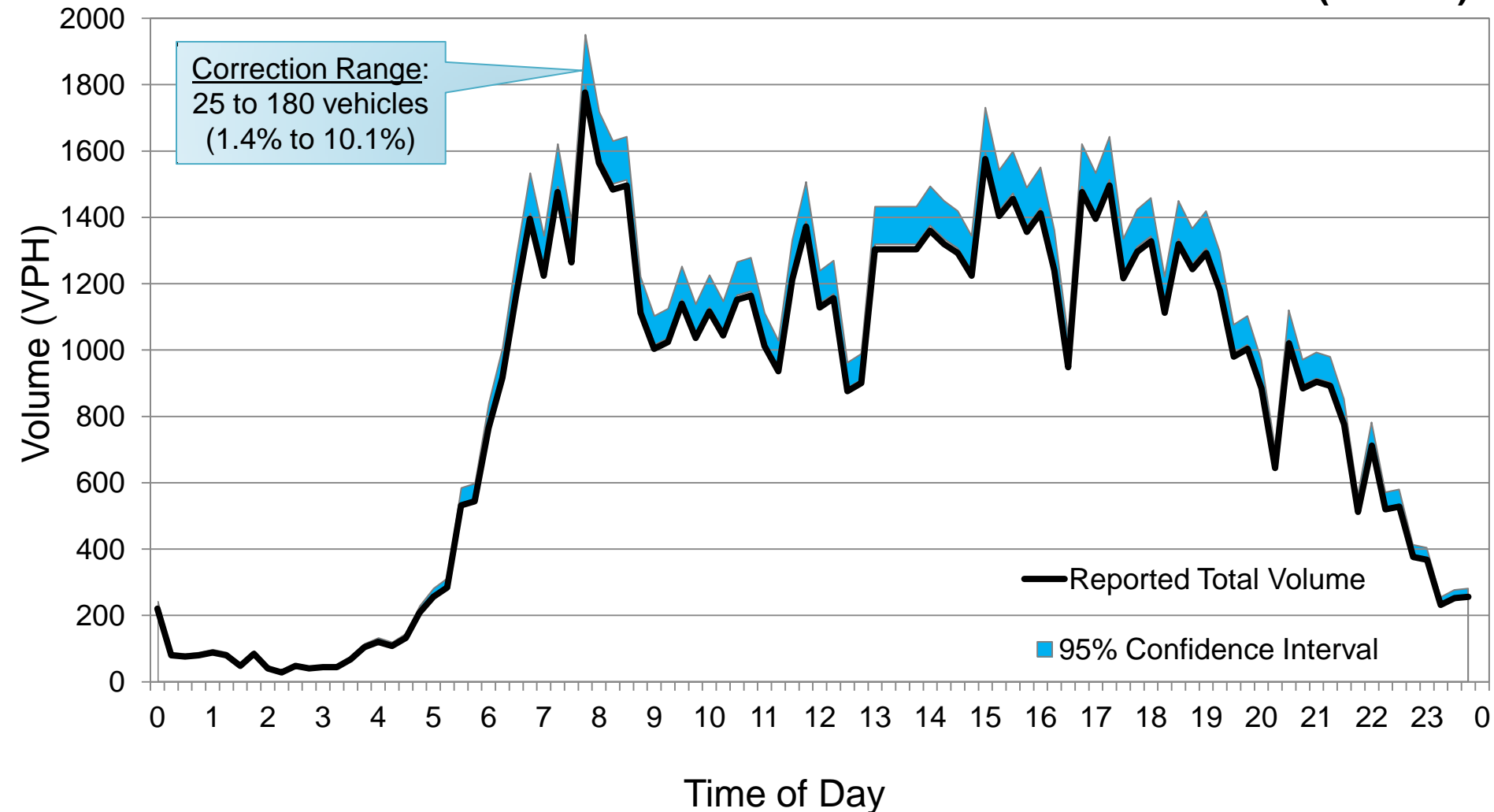
**Final Report**  
**September 2015**

# TMC Volume Accuracy



# TMC Volume Accuracy - Example

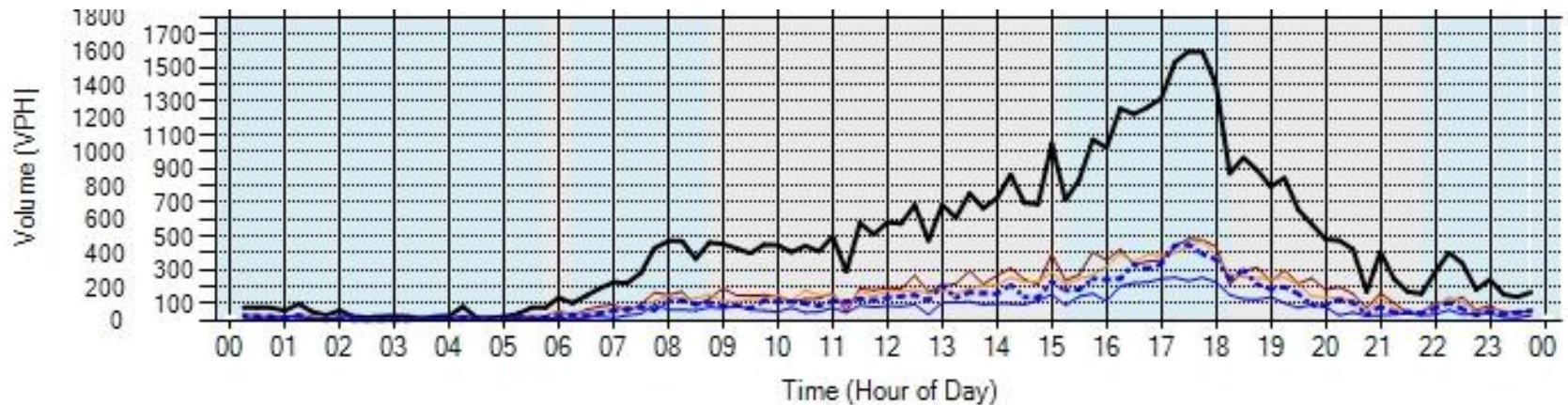
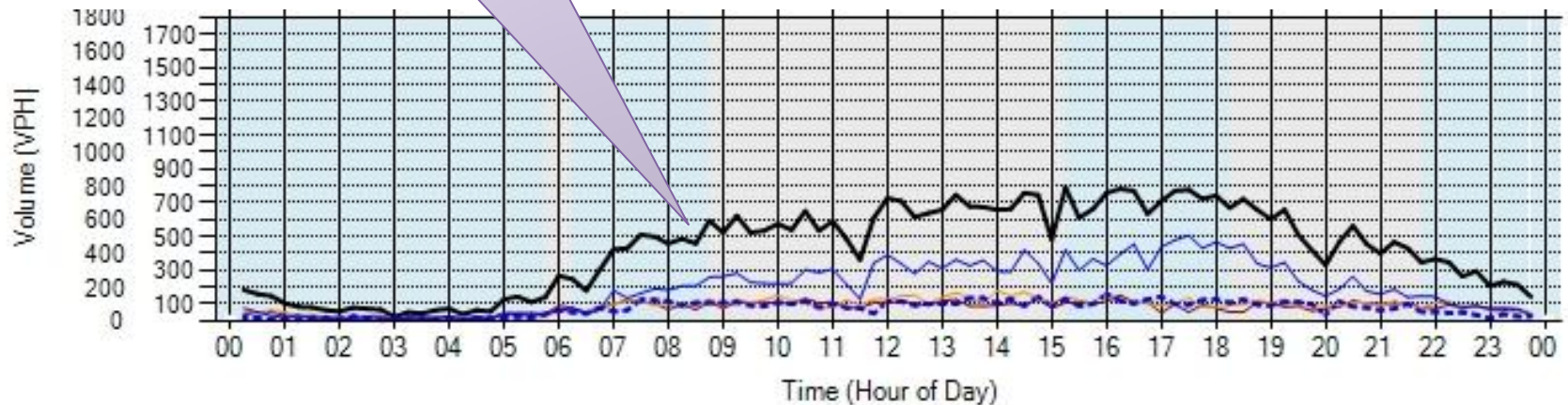
9000 S & Monroe WB Thru Lanes (4 lanes)



# TMC Data Smell Test

Incorrect detectors  
configured

## State St & 3300 S SB Thru Lanes



— Total Volume    — Lane 1    — Lane 2    ..... Lane 3    — Thru Right

# 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

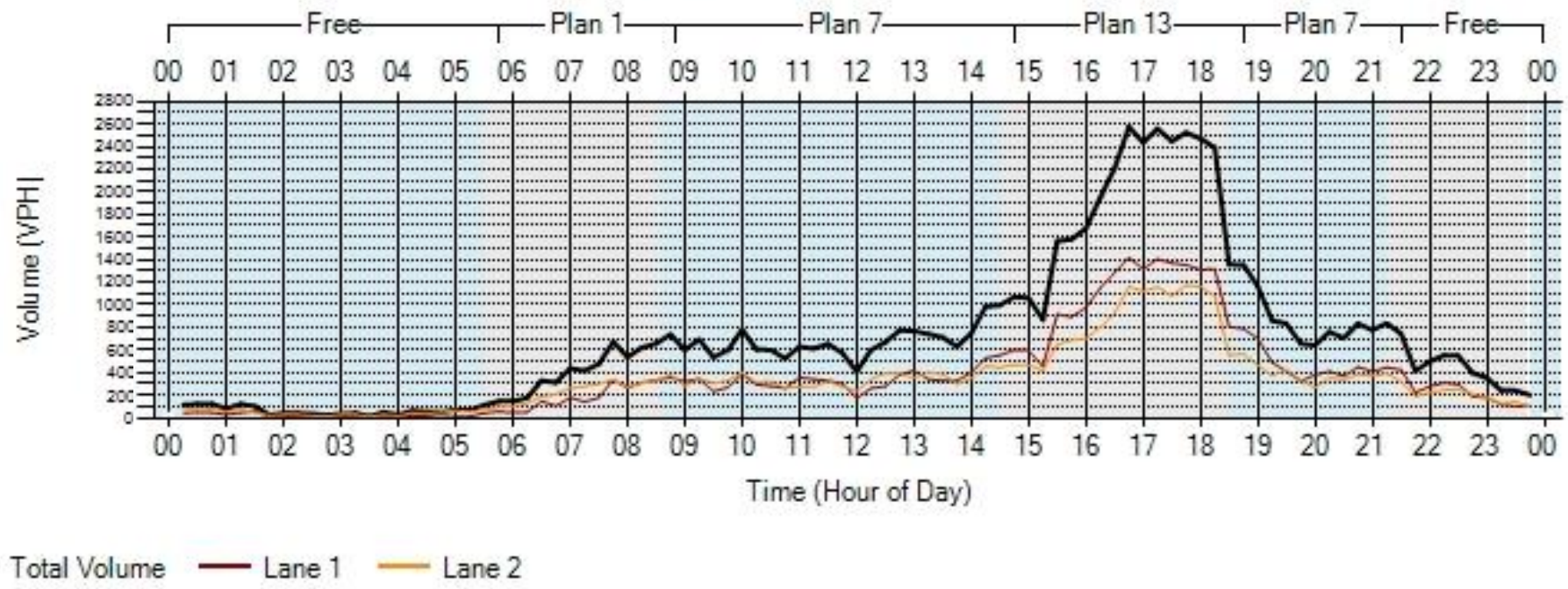


# Determine Approach Capacity

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

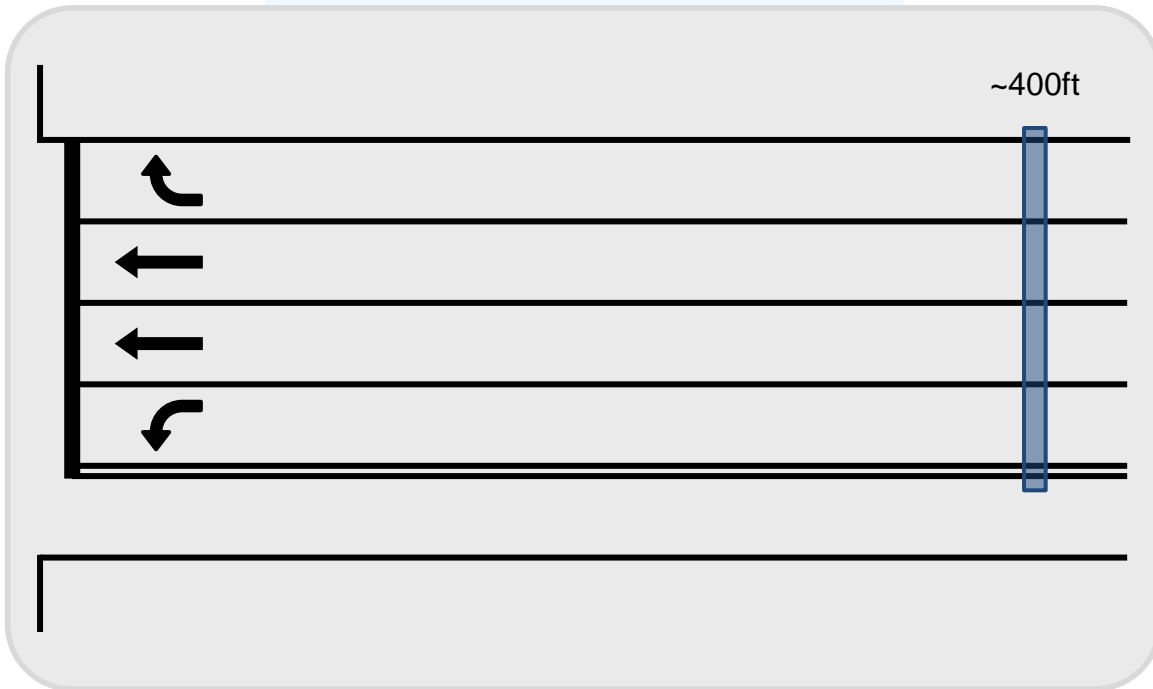


— Lane 1 — Lane 2 — Thru Right



## Detection

Setback Count Zones

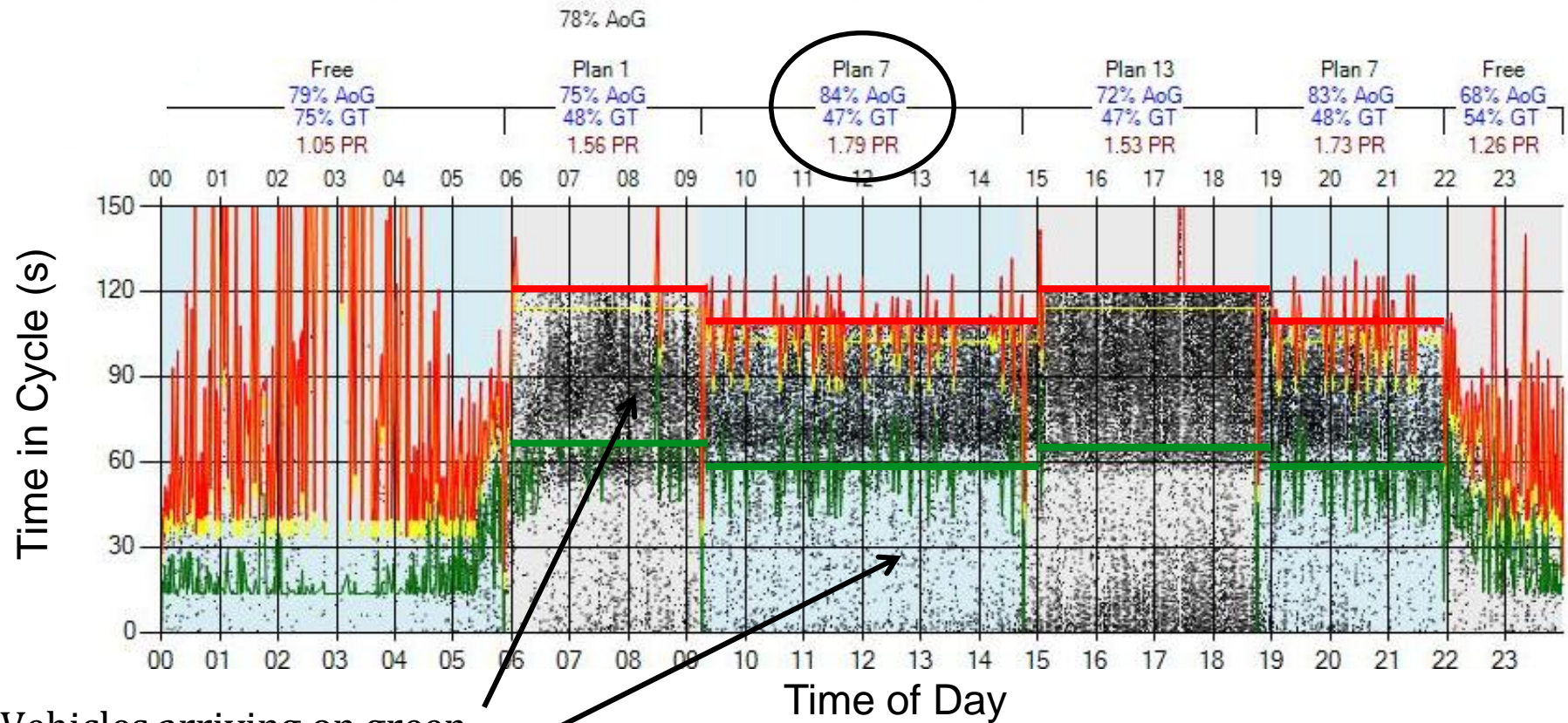


## Available Metrics

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

# Metric: Purdue Coordination Diagram

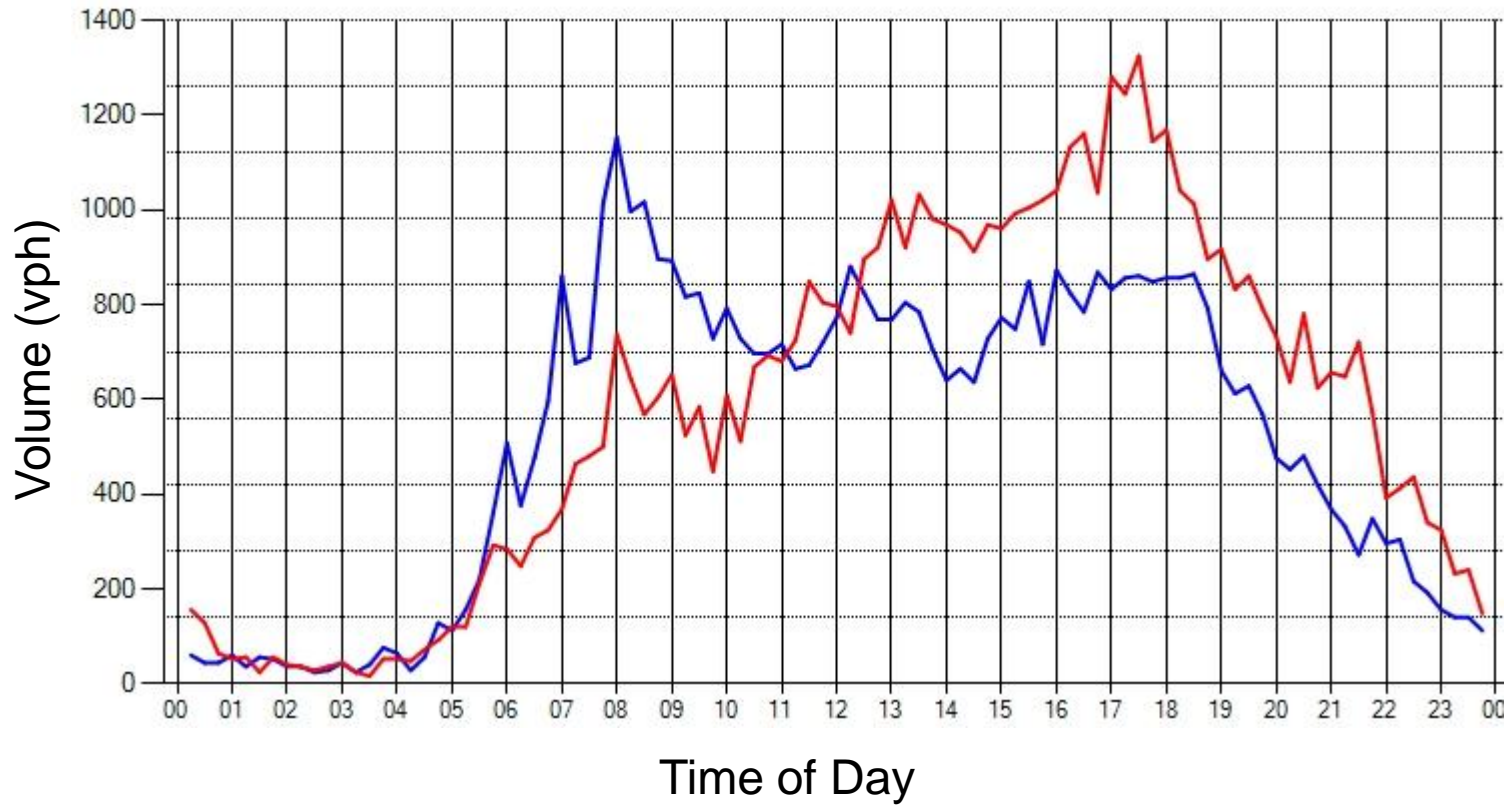
Bangerter Hwy (SR-154) 10400 South Signal 7364 Phase: 6 Southbound  
 Wednesday, September 03, 2014 12:00 AM - Wednesday, September 03, 2014 11:59 PM



Vehicles arriving on green  
 Vehicles arriving on red

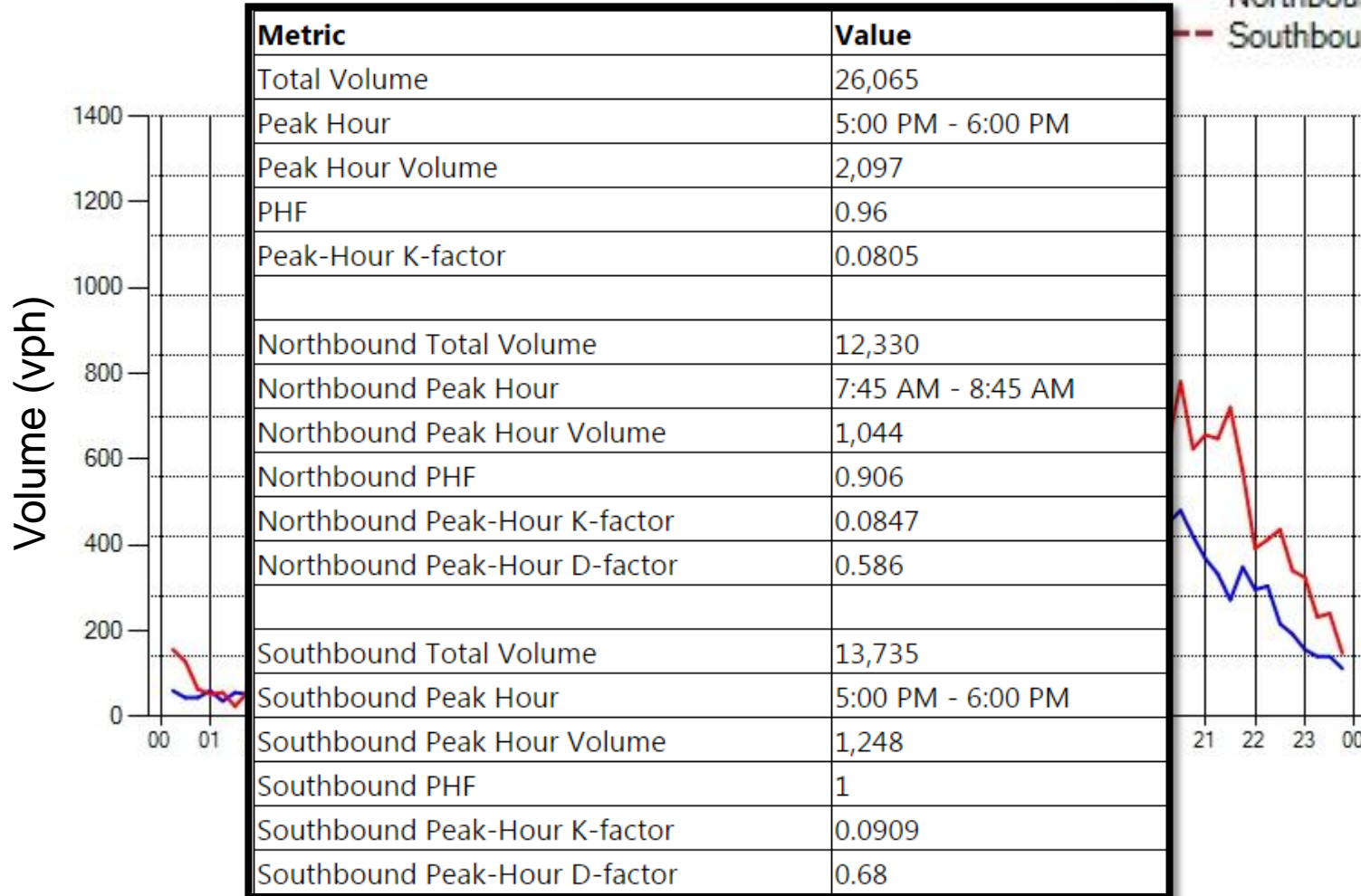
# Metric: Approach Volume

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



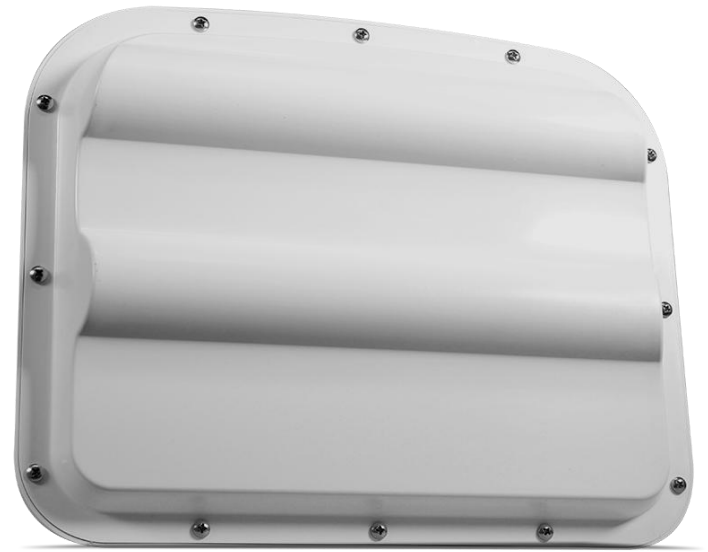
# Metric: Approach Volume

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



# Approach Volume Detection

Wavetronix  
SmartSensor  
Advance



# Approach Volume Detection

**Setup Channels-Alerts-Zones**

1 **2-EB Count** 3 4 5 6 7 8

Name **EB Count**

Type **Pulse**

**Enabled**

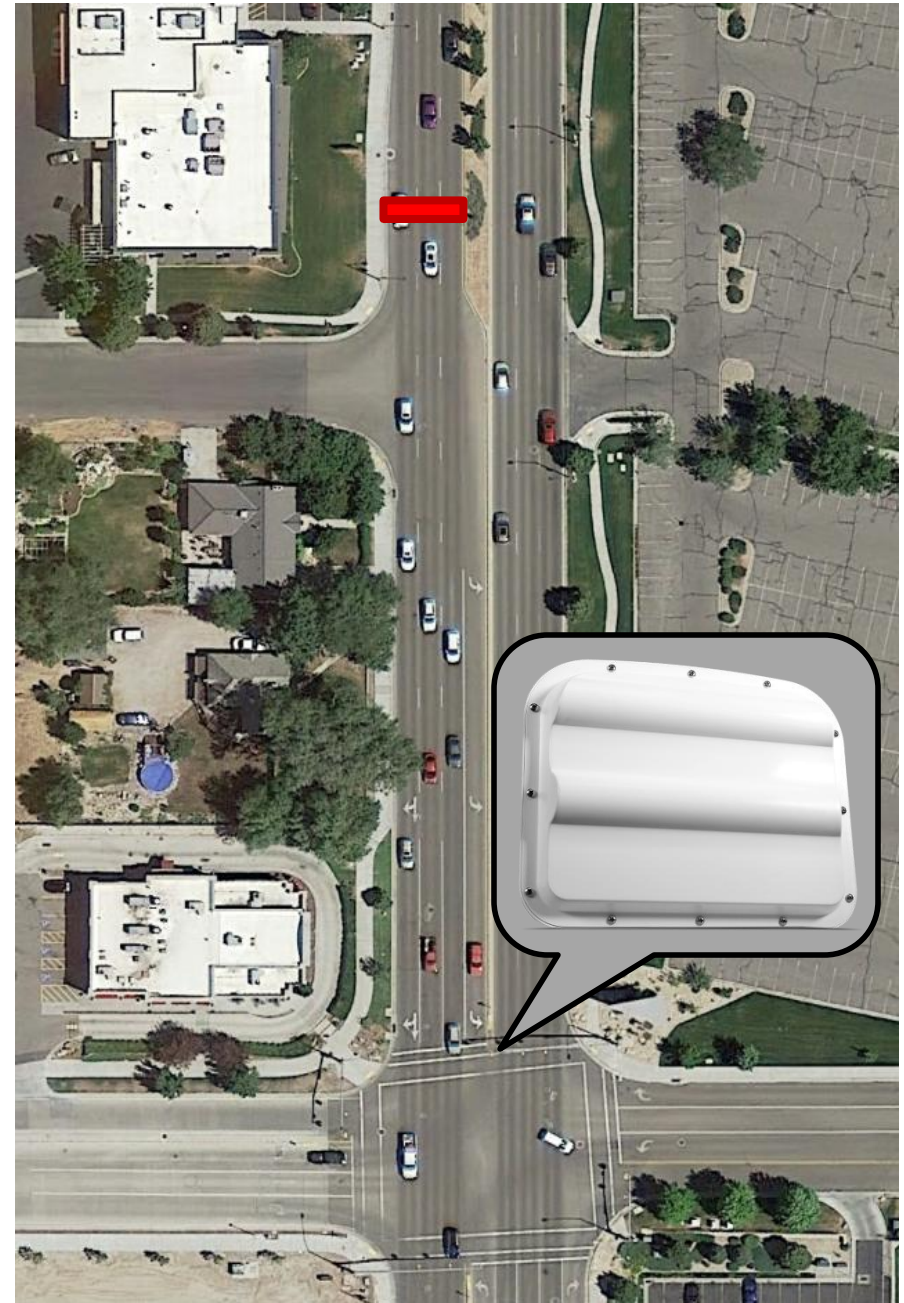
**Zone Settings**

Range (feet): **390 to 400**

**Speed (mph):** **035 - 100**

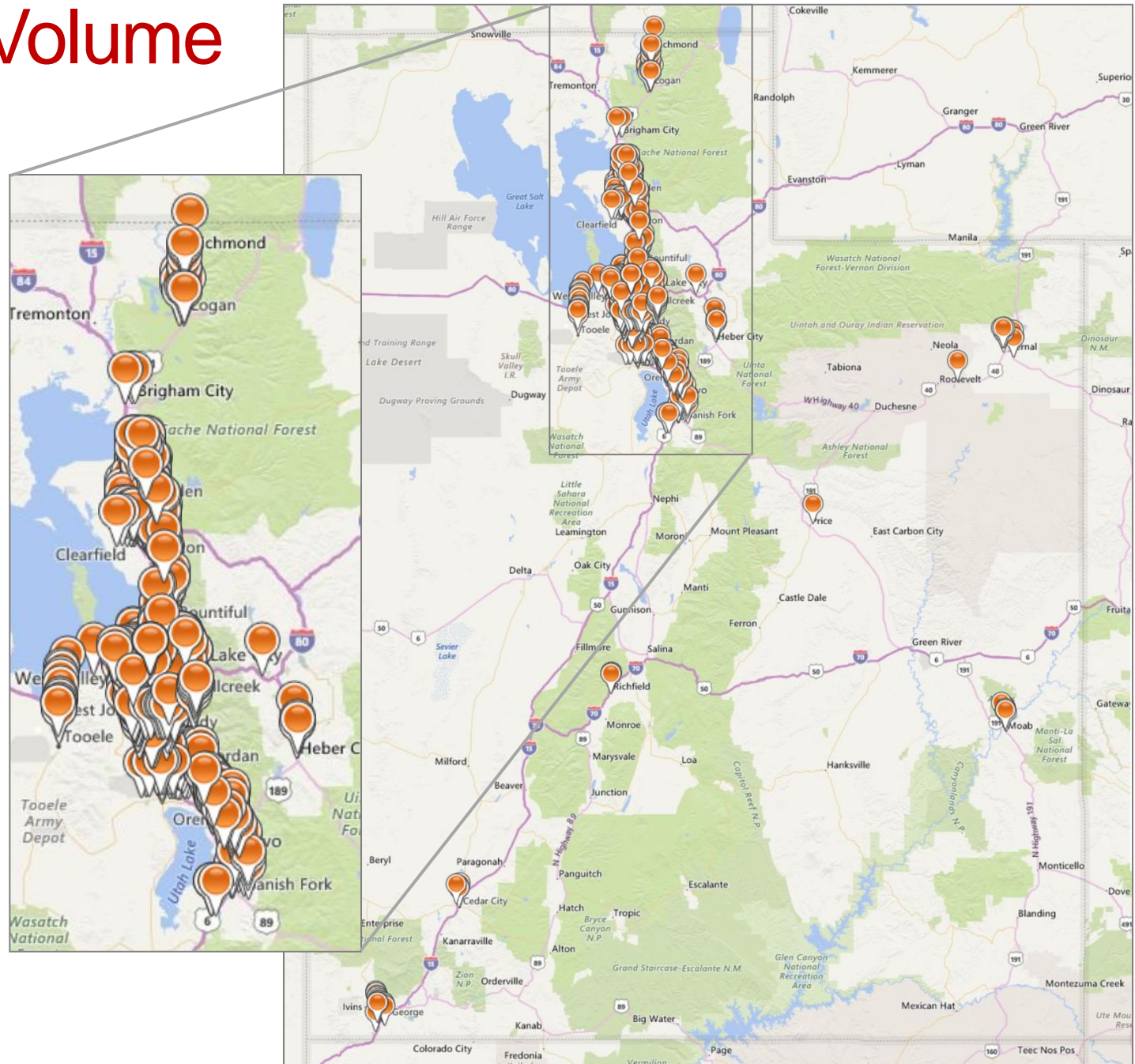
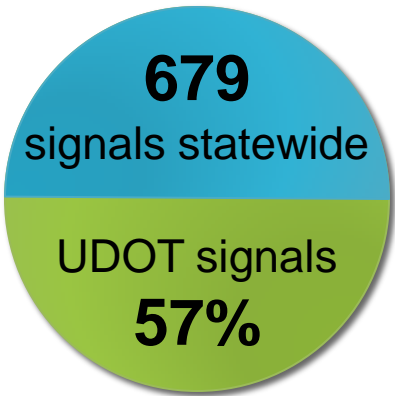
20

OK Undo Cancel





# Approach Volume Availability



# Approach Volume Accuracy

## RESEARCH

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

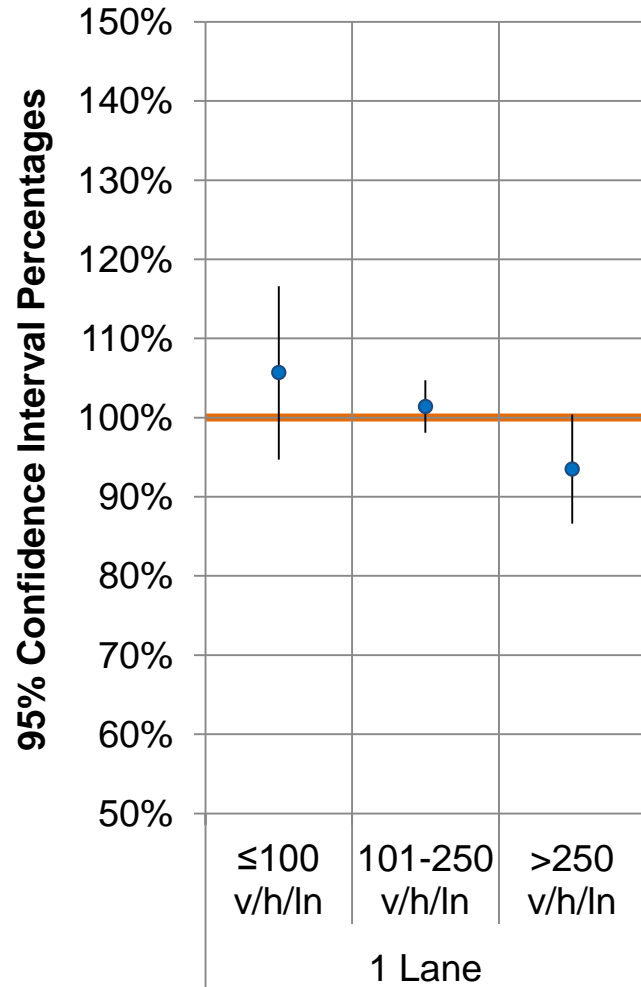
**Authored By:**

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

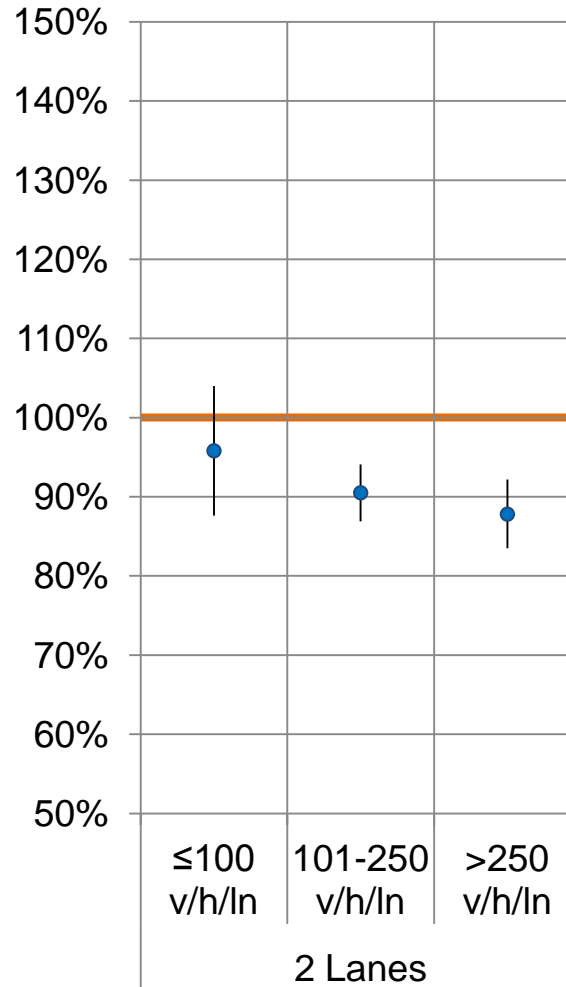
**Final Report  
May 2016**

# Approach Volume Accuracy

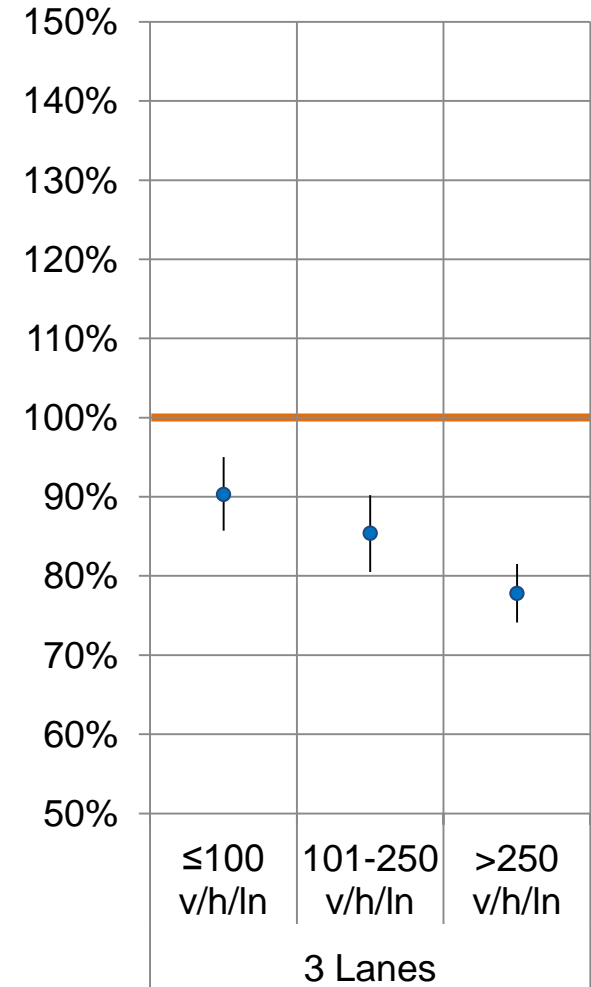
## 1-lane Approach



## 2-lane Approach

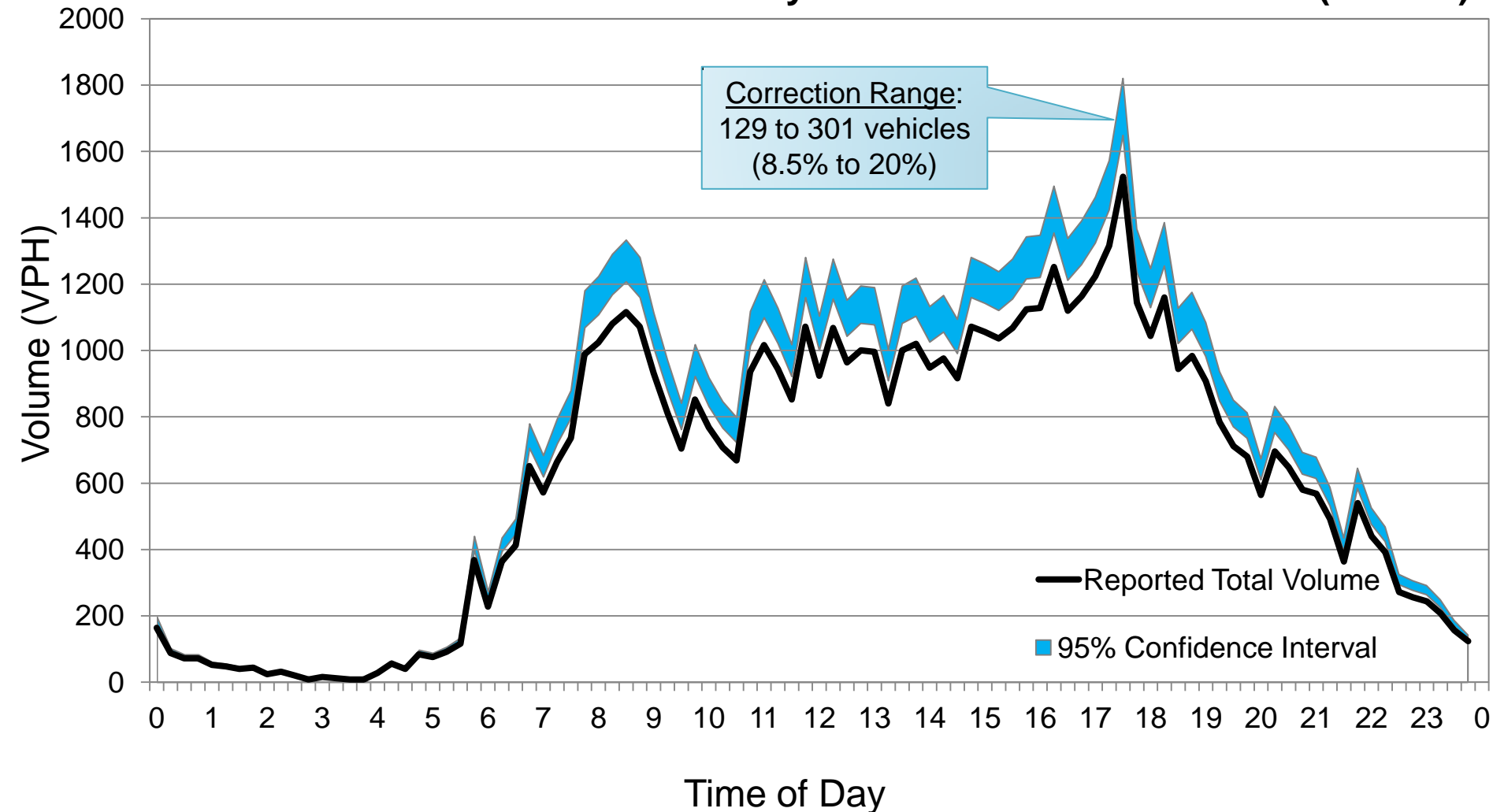


## 3-lane Approach



# Approach Volume Accuracy - Example

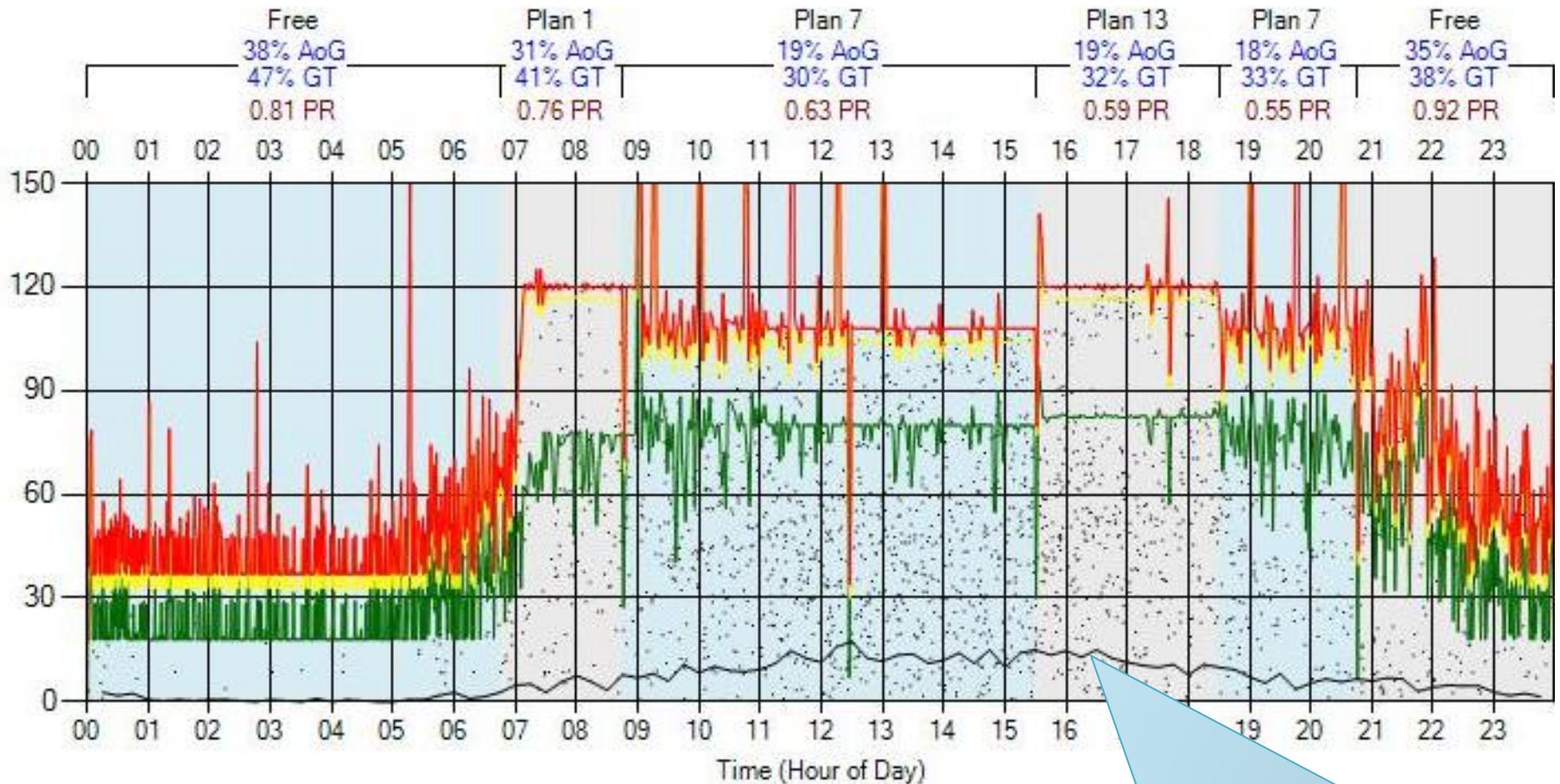
University Avenue & 3300 N NB Lanes (2 lanes)



# 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

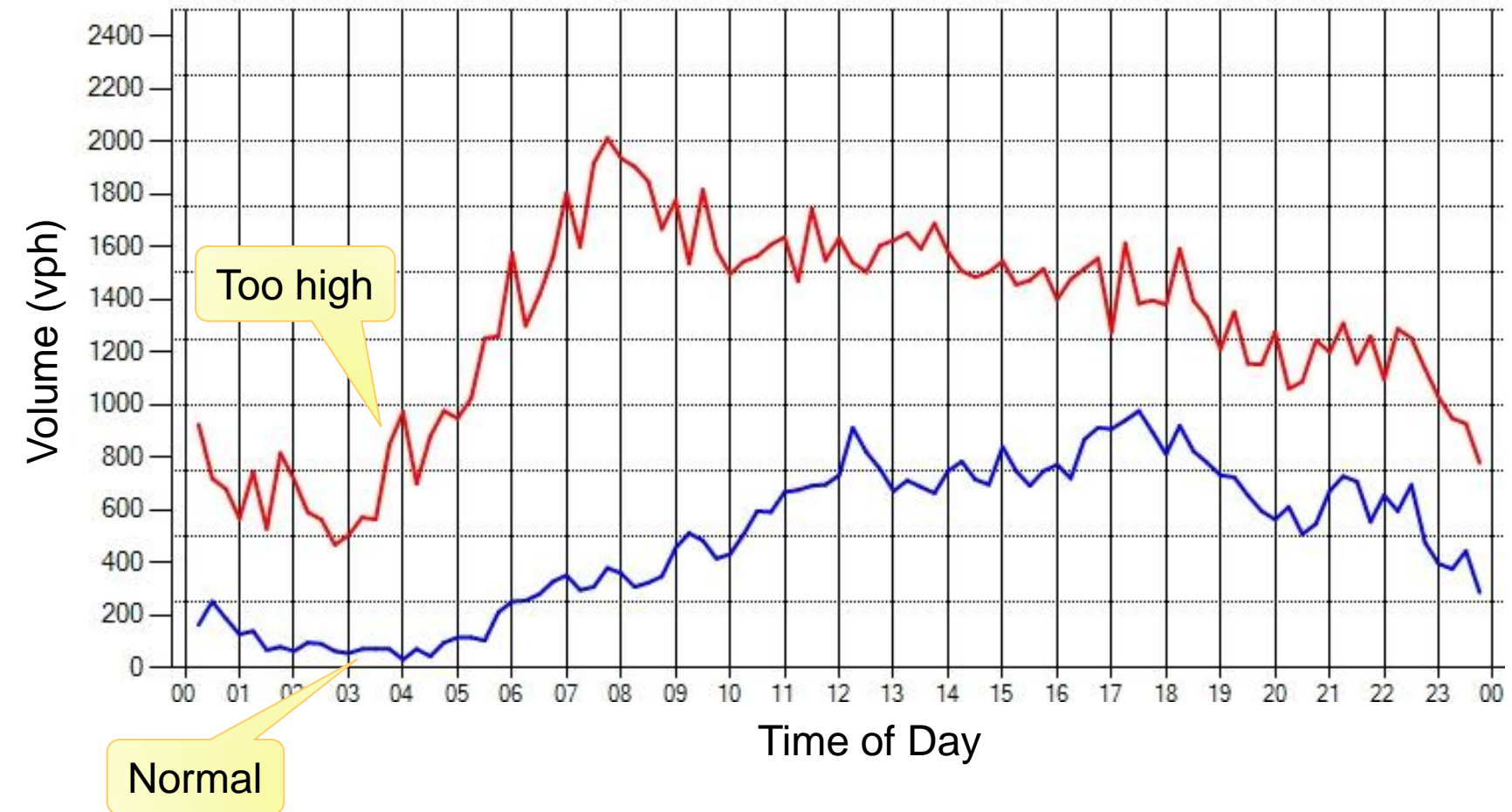
22% AoG



PCD is very sparse. Low volume without peaks.

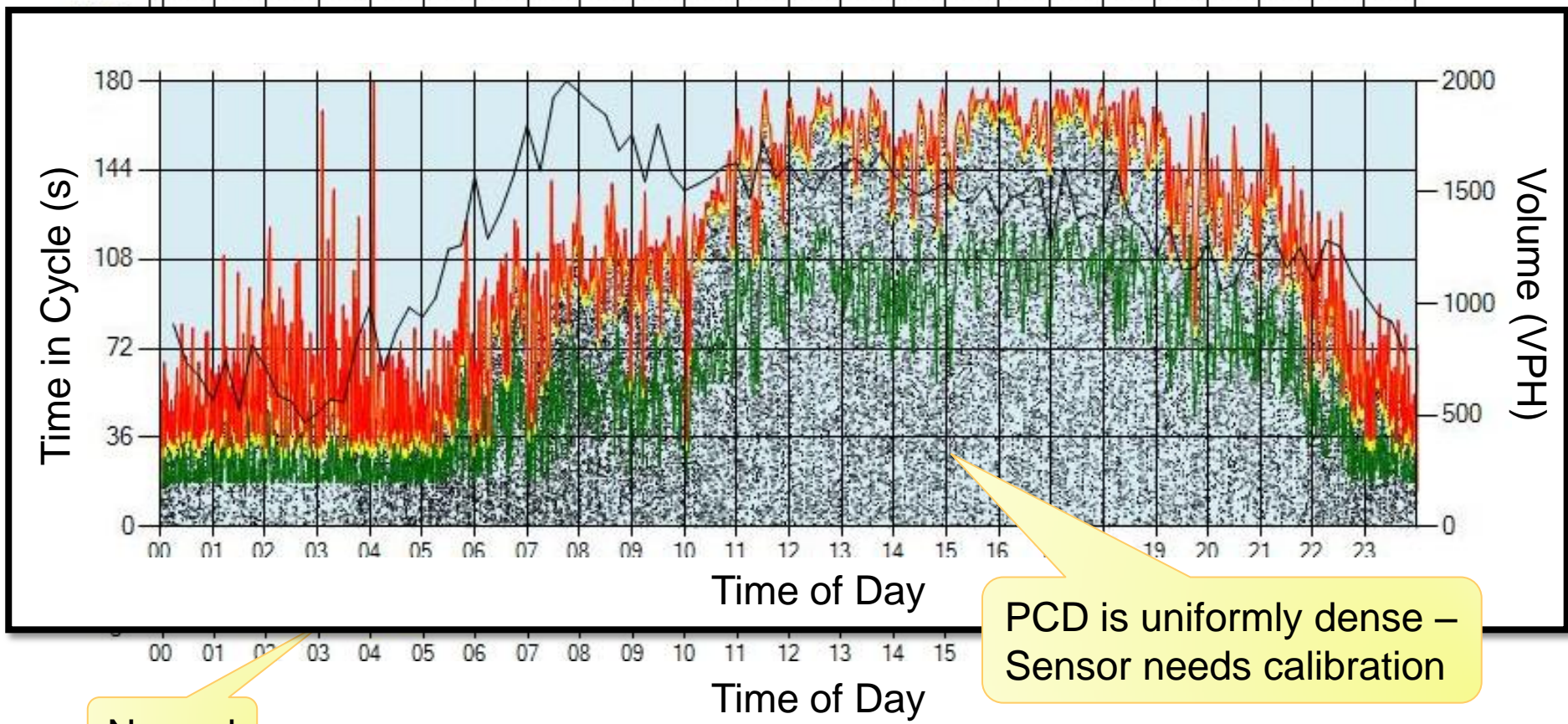
# Approach Volume Smell Test - Overcounting

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



Normal

PCD is uniformly dense -  
Sensor needs calibration

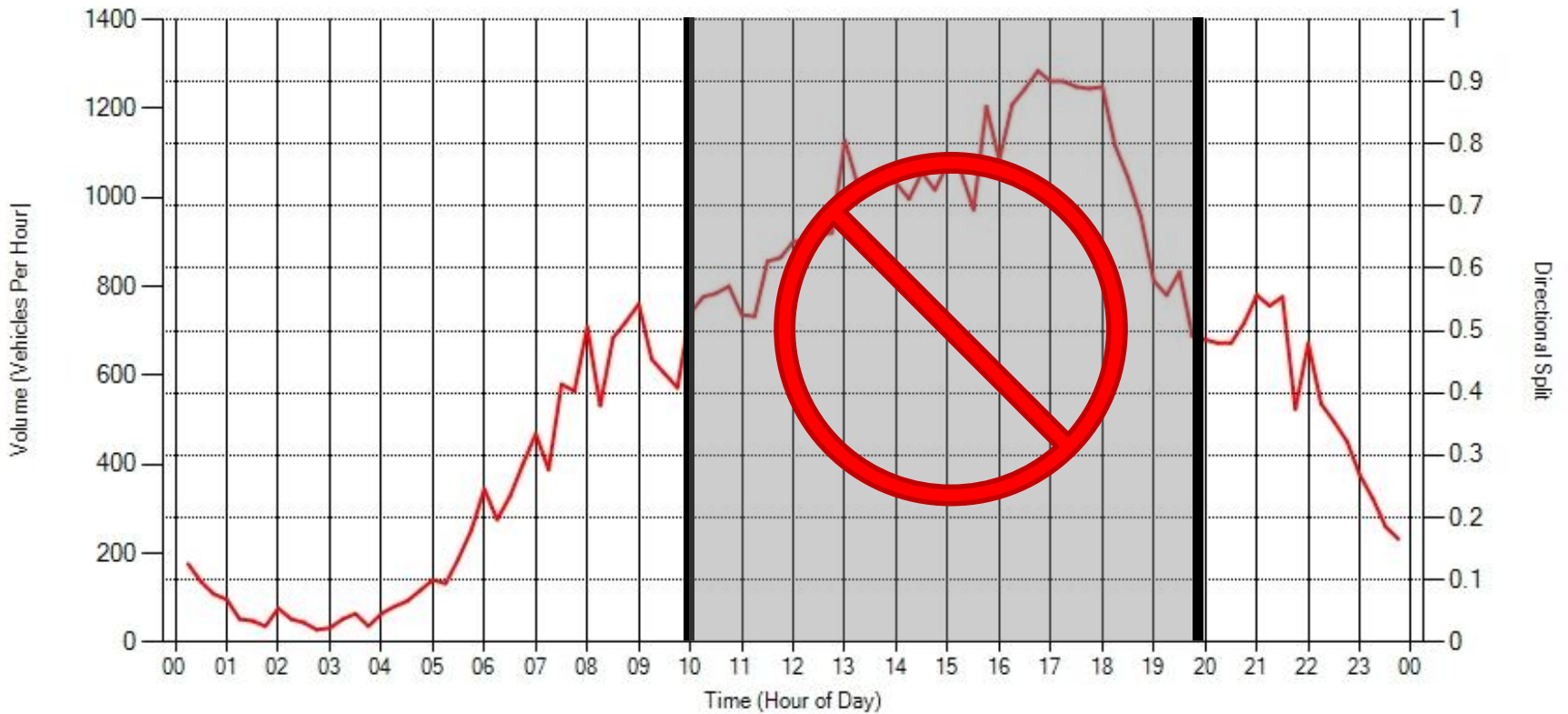
# Approach Volume Uses

- 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



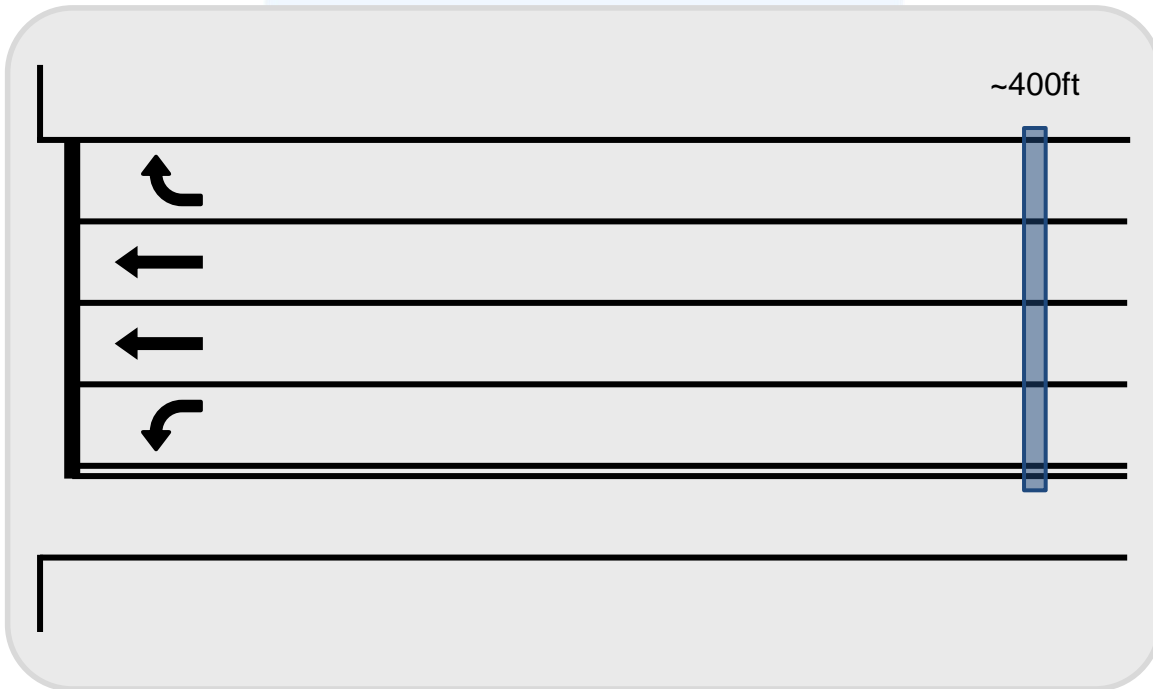
# Allow Lane Closures

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

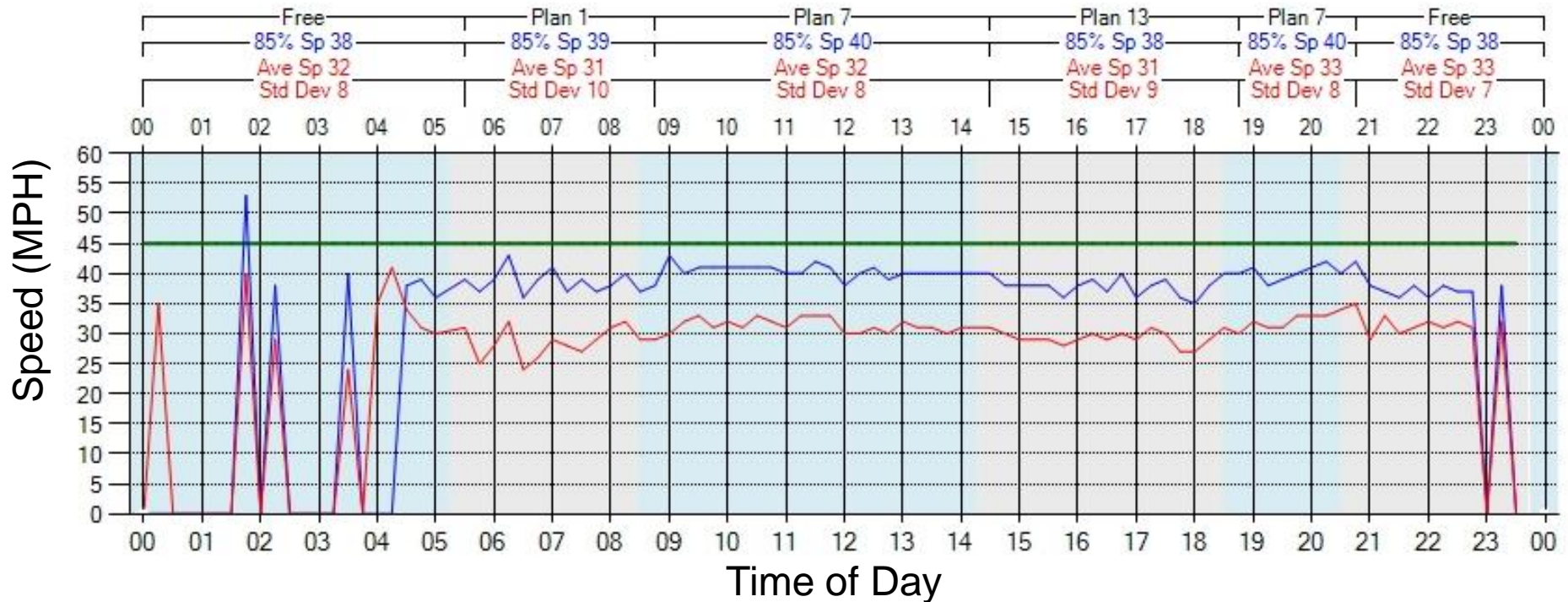


Approach Speed

# 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

**Setup Channels-Alerts-Zones** [X]

1 **2-EB Count** 3 4 5 6 7 8

Name **EB Count**

Type **Pulse**

**Enabled**

**Zone Settings**

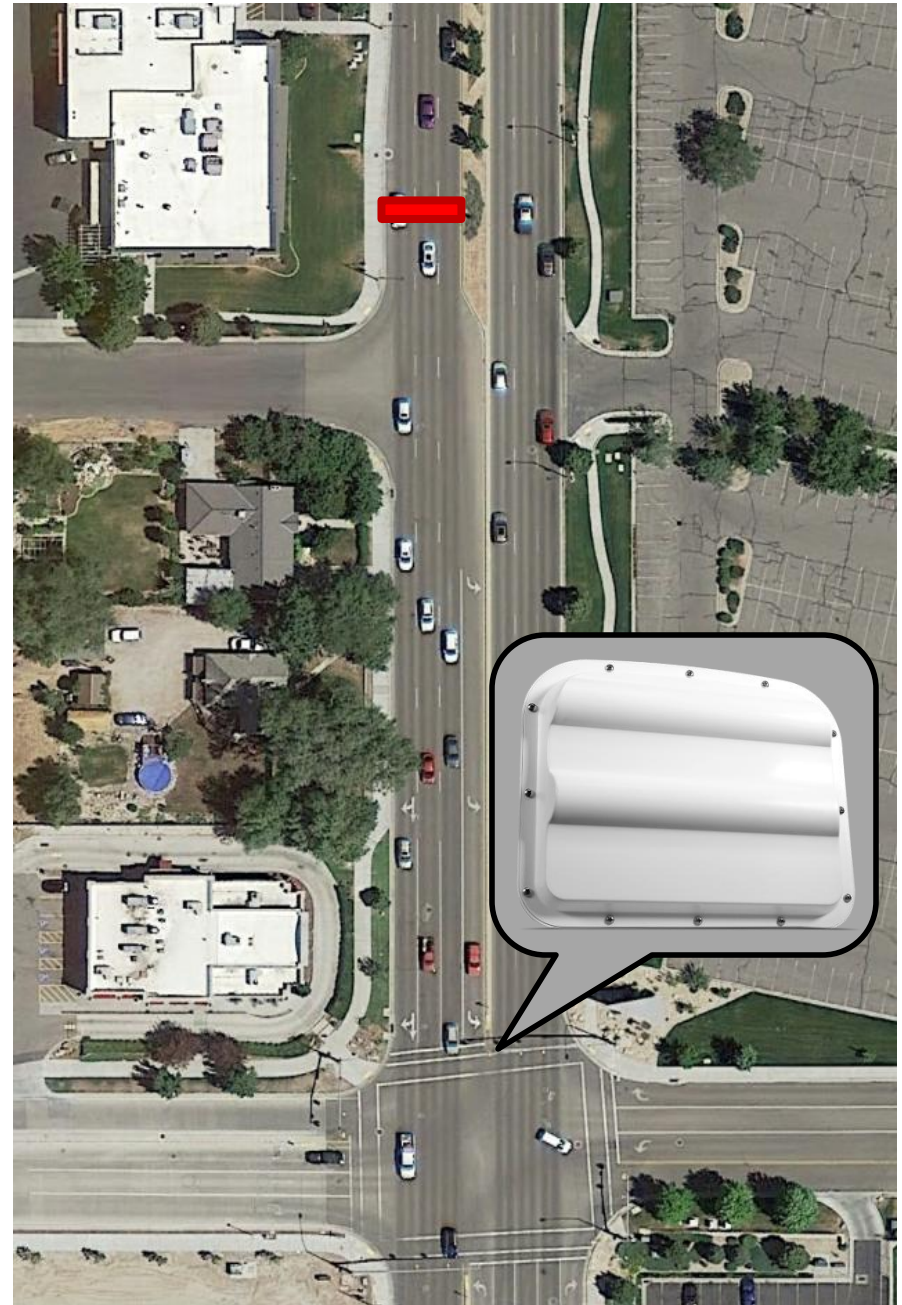
Range (feet): **400** **390**

**390 to 400**

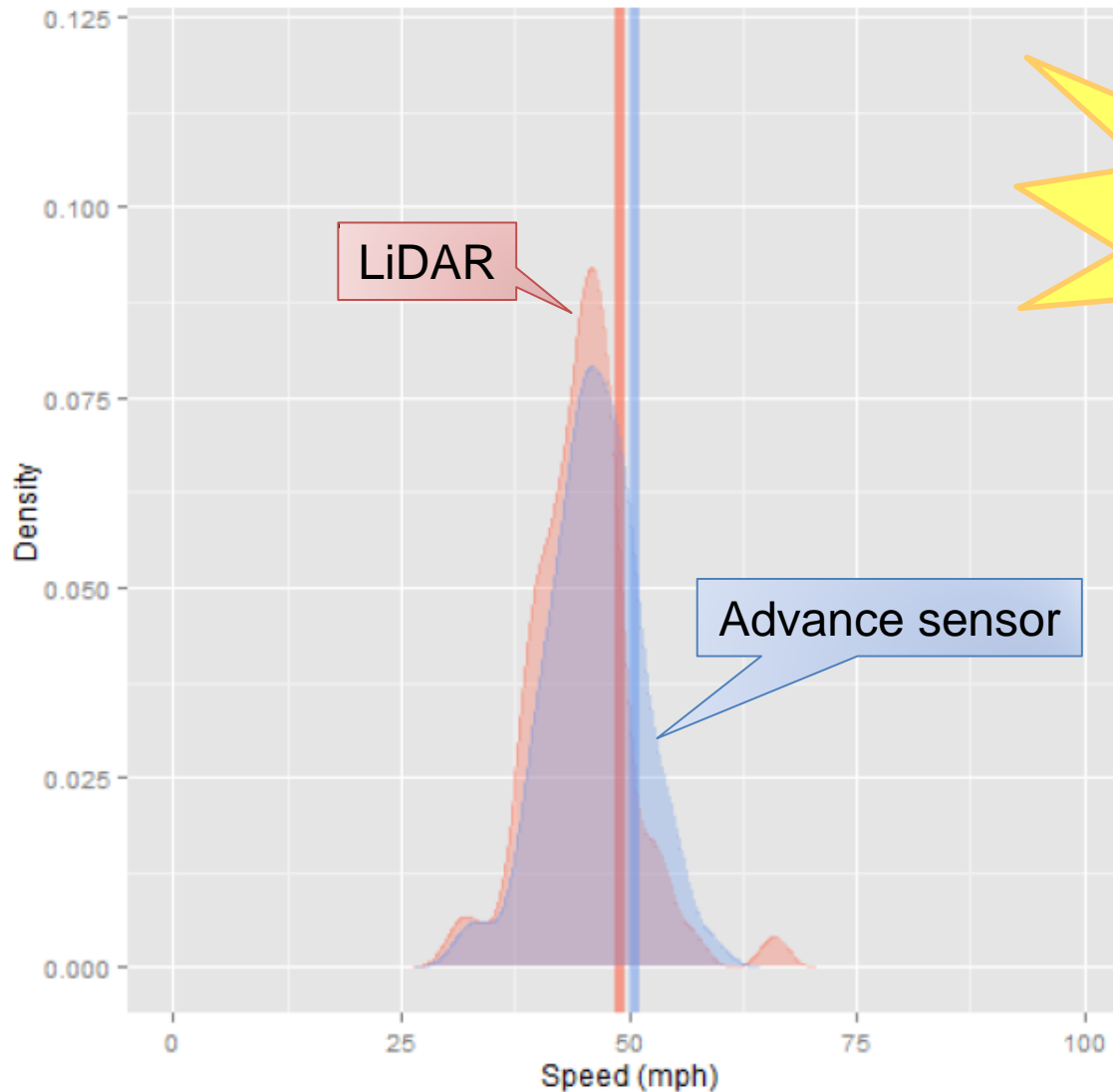
**Speed (mph):** **035 - 100**

**20**

OK Undo Cancel



# Approach Speed Data Accuracy



**+/- 2 mph**

“Good enough for practical engineering applications”

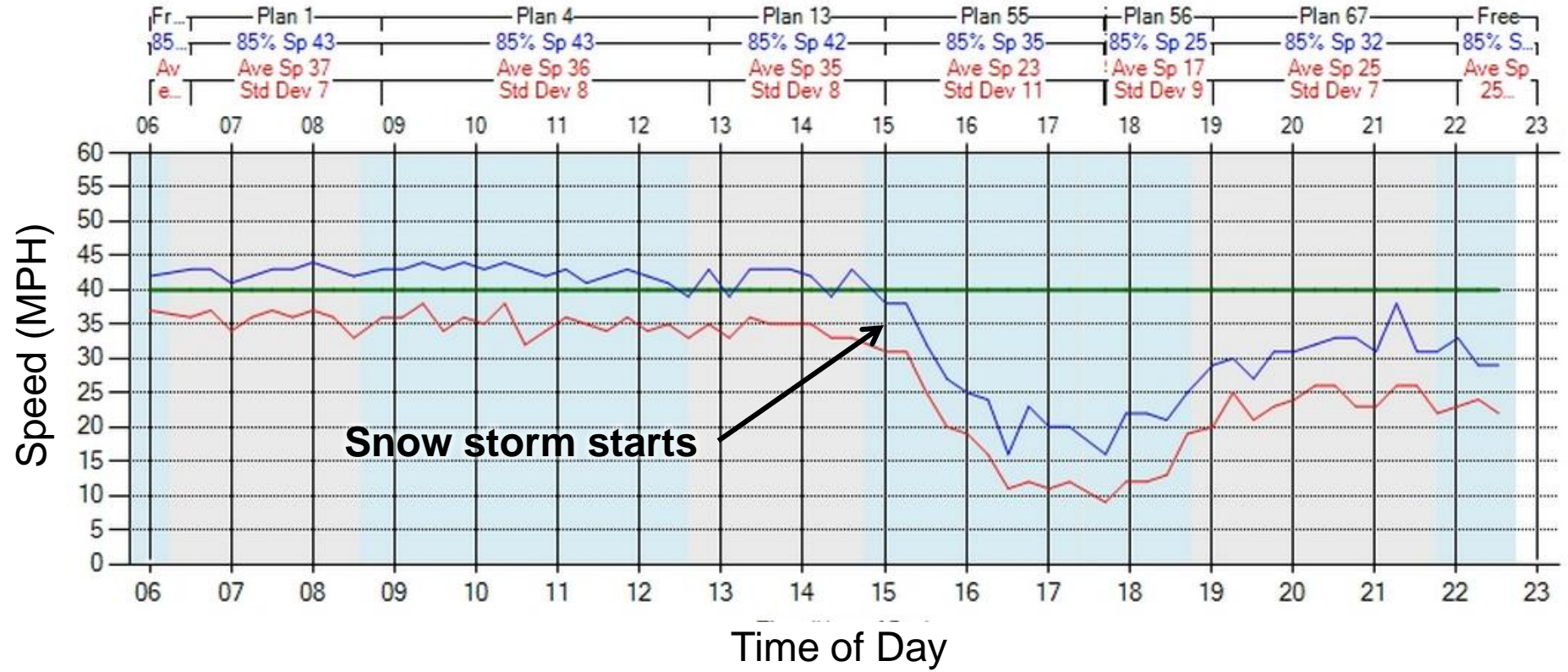
# Approach Speed Uses

- 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

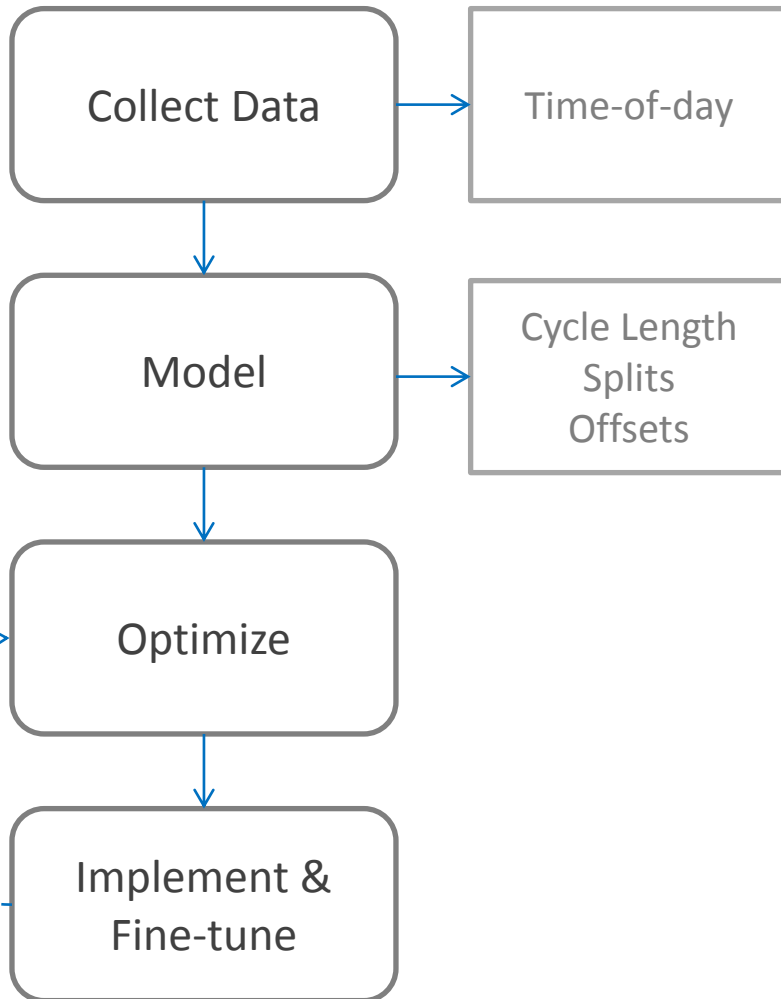
Riverdale Rd Shopko Signal 5008 Phase 2 Northbound  
 Thursday, January 10, 2013 6:00 AM - Thursday, January 10, 2013 11:00 PM  
 Detector Distance from Stop Bar: 350 feet; Min Speed Filter: 5 MPH;  
 Time Filter: 15s after start of green to start of yellow  
 Speed Accuracy: + - 5 MPH

— Posted Speed  
 — 85th Percentile Speed  
 — Average MPH

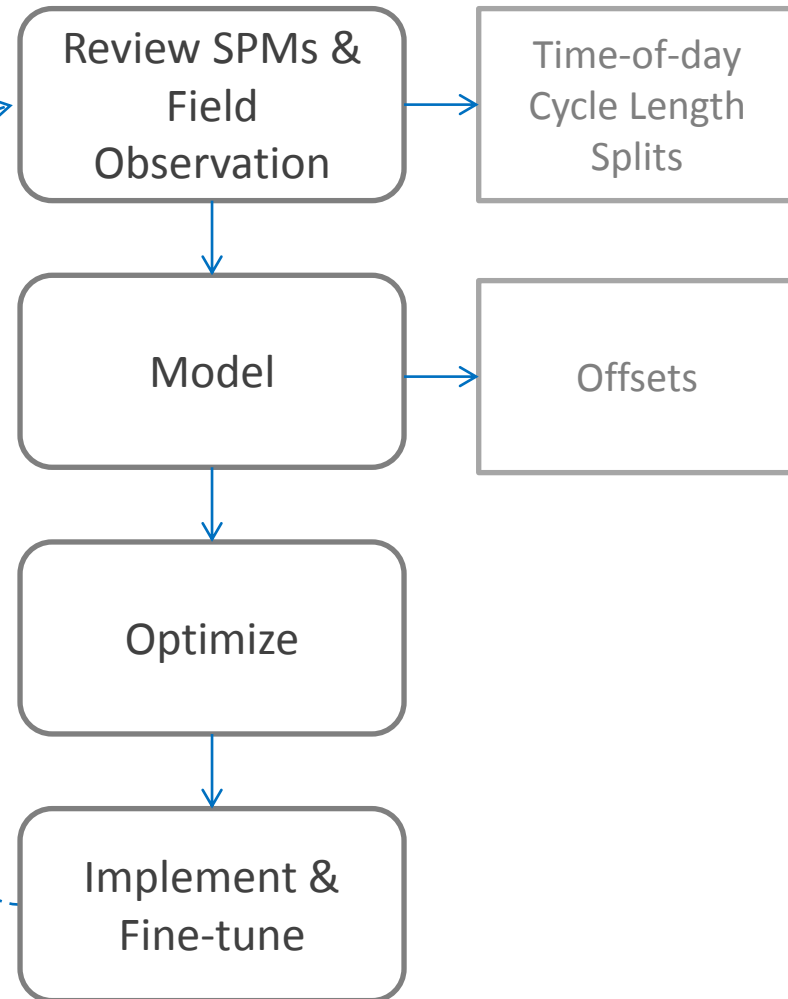


# Optimization with ATSPMs

## Traditional Process



## Modified Process with SPMs



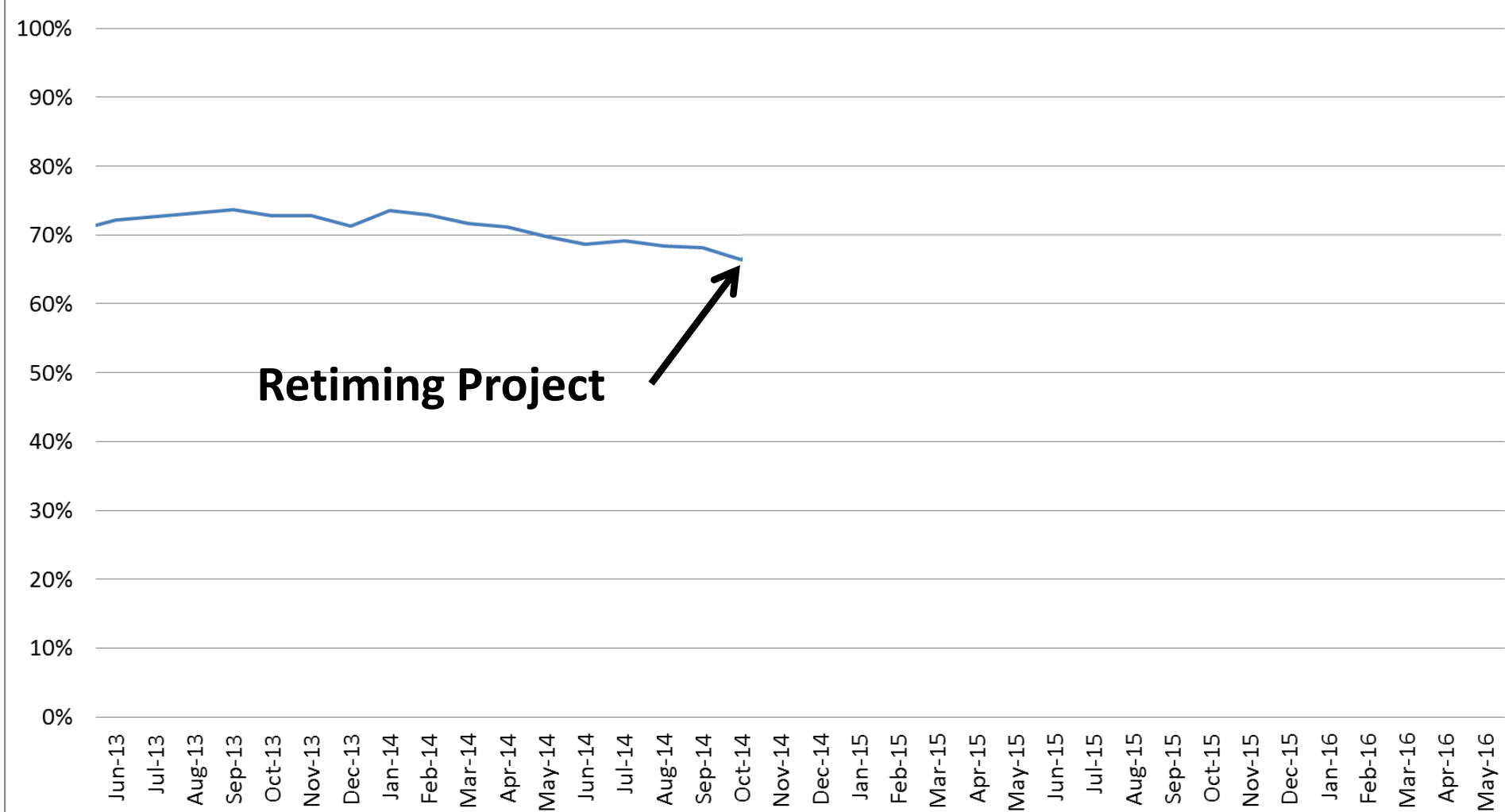


# Monitoring Trends

(Riverdale Rd – 11 intersections)

## Percent of Vehicles Arriving on Green - Riverdale Rd

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

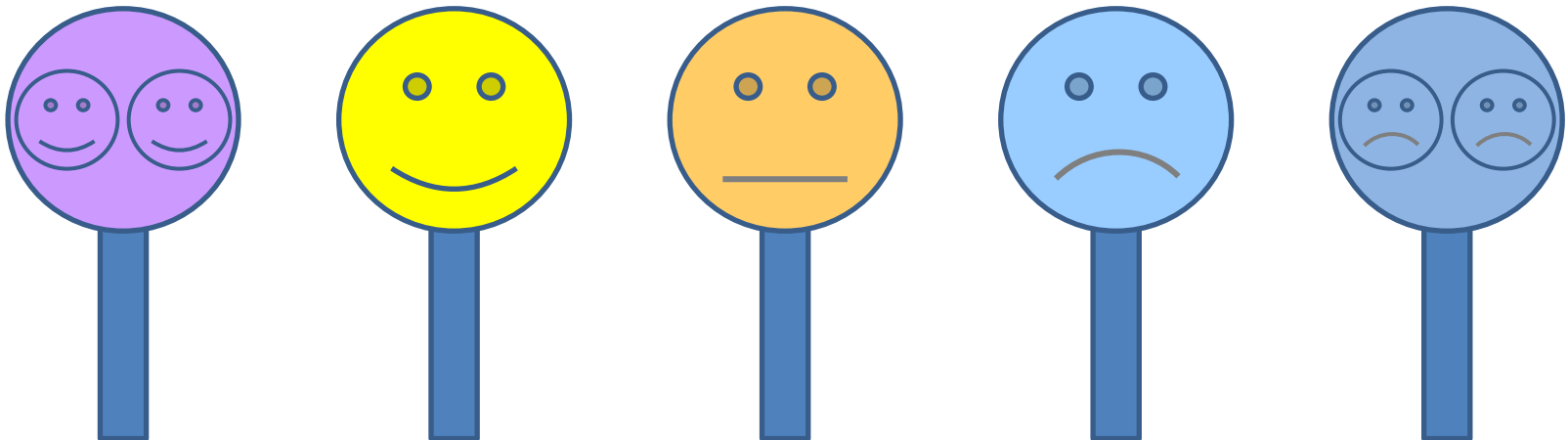


# UDOT Signal Timing Focus Group (July 2014)

- *How do you feel about UDOT?*



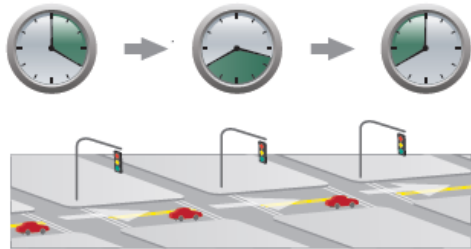
- *How do traffic signals make you feel?*



# 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](http://udottraffic.utah.gov/SPM)

**Mark Taylor**  
marktaylor@utah.gov

**Jamie Mackey**  
jamiemackey@utah.gov

