UTAH'S EXPERIENCE WITH AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES

Mark Taylor, P.E., PTOE
Utah Department of Transportation
Traffic Signal Operations Engineer
marktaylor@utah.gov

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UDOT Asset Management Tiers (2015 & Prior)

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

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Tier 3 Assets
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Rest Areas

ATSPM

Automated Traffic Signal Performance Measures

Started Development November 2012.

- State of Utah Department of Technology Services

Estimate 8,000+ hours of UDOT development

(November 2012 to February 2018)

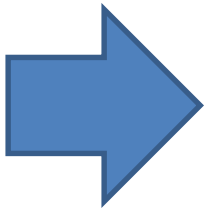
History of ATSPMs

- ✓ 2005: Purdue & InDOT initiated research to develop new performance measures.
- ✓ 2012: Purdue publishes “Indiana Traffic Signal Hi Resolution Data Logger Enumerations”.
- ✓ 2012: UDOT (with Purdue & InDOT assistance) started development on ATSPMs.
- ✓ 2013: “Pooled Fund” on “Traffic Signal Systems Operations & Management” – InDOT & Purdue.
- ✓ 2014: AASHTO Innovation Initiative (AASHTO Aii) accelerated ATSPMs.
- ✓ 2016: UDOT released UDOT ATSPMs as open source and free to everyone (public & private).
- ✓ 2017: FHWA EDC-4 accelerated ATSPMs.
- ✓ April/May 2018: ATSPM Version 4.2.0 will be available.

Automated Traffic Signal Performance Measures (ATSPM) Basic Concept

Automated Data Collection

- Signal controller
- Probe source



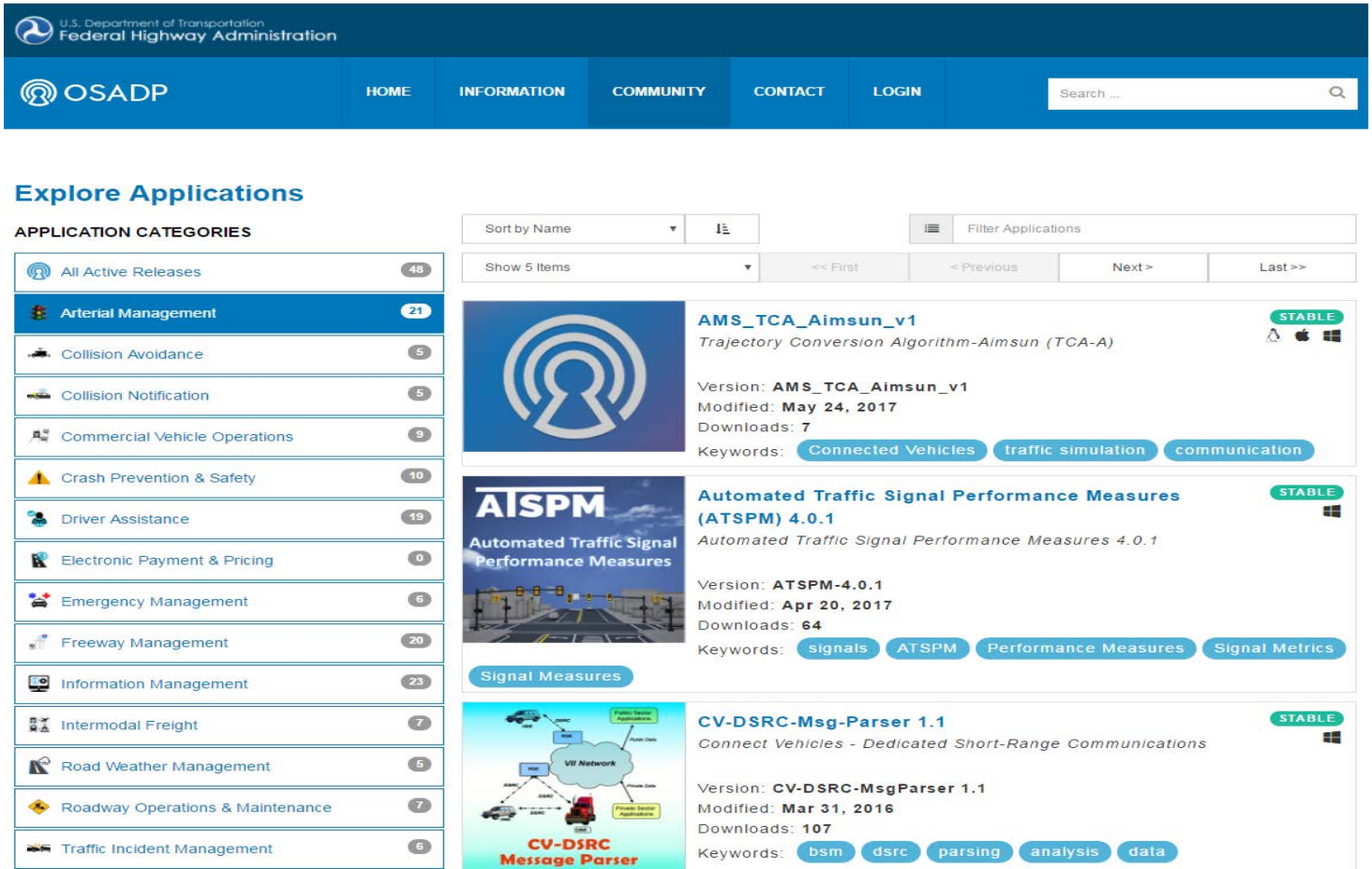
Useful Information about Performance

- Signal
- Corridor
- System

Why Model what you can Measure?

UDOT ATSPM Source Code

https://www.itsforge.net



Open Source ATSPM Implementation Cost Estimate

	Small System (~50 signals)	**Large System** (~1000 signals)
Controllers w/ High-definition Loggers	Unknown	Unknown
Communication or In-cabinet Data Storage	Unknown	Unknown
ATSPM Open Source Software	$0	$0
Server	$3,000	$20,000
SQL Database License	$7,000	$100,000
IT Consultant (software installation)	$5,000	$10,000
Engineering Consultant (detector configuration)	$5,000	$100,000
Total	$20,000	$230,000
Cost per signal	*$400*	*$230*

22+ Installations of ATSPMs

High-resolution Data Example

0.1-second resolution

Timestamp	Event Code	Event Parameter
6/27/2013 1:29:51.1	10	8
6/27/2013 1:29:51.1	82	5
6/27/2013 1:29:52.2	1	2
6/27/2013 1:29:52.2	1	6
6/27/2013 1:29:52.3	82	2
6/27/2013 1:29:52.8	82	4
6/27/2013 1:29:52.9	81	4
6/27/2013 1:29:54.5	81	2
6/27/2013 1:30:02.2	8	2
6/27/2013 1:30:02.2	8	6
6/27/2013 1:30:06.1	10	2
6/27/2013 1:30:06.1	10	6
6/27/2013 1:30:08.1	1	8
6/27/2013 1:30:15.8	81	5
6/27/2013 1:30:18.5	82	6
6/27/2013 1:30:27.5	81	6
6/27/2013 1:30:30.4	8	8

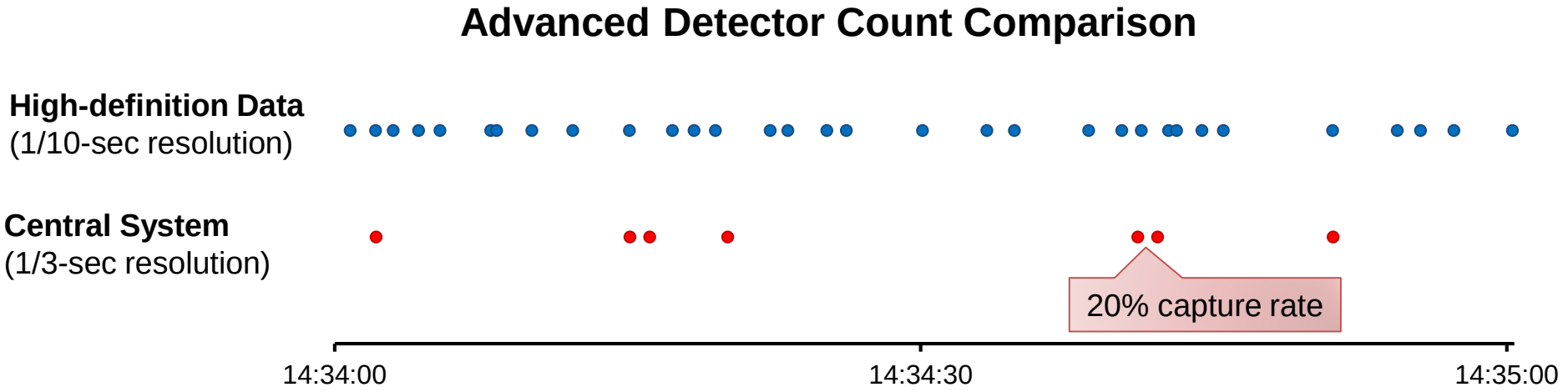
Detector 5 ON

Phase 8 GREEN

Detector 5 OFF

Phase 8 YELLOW

Why is High-resolution Data Important?



ATSPM System Architecture

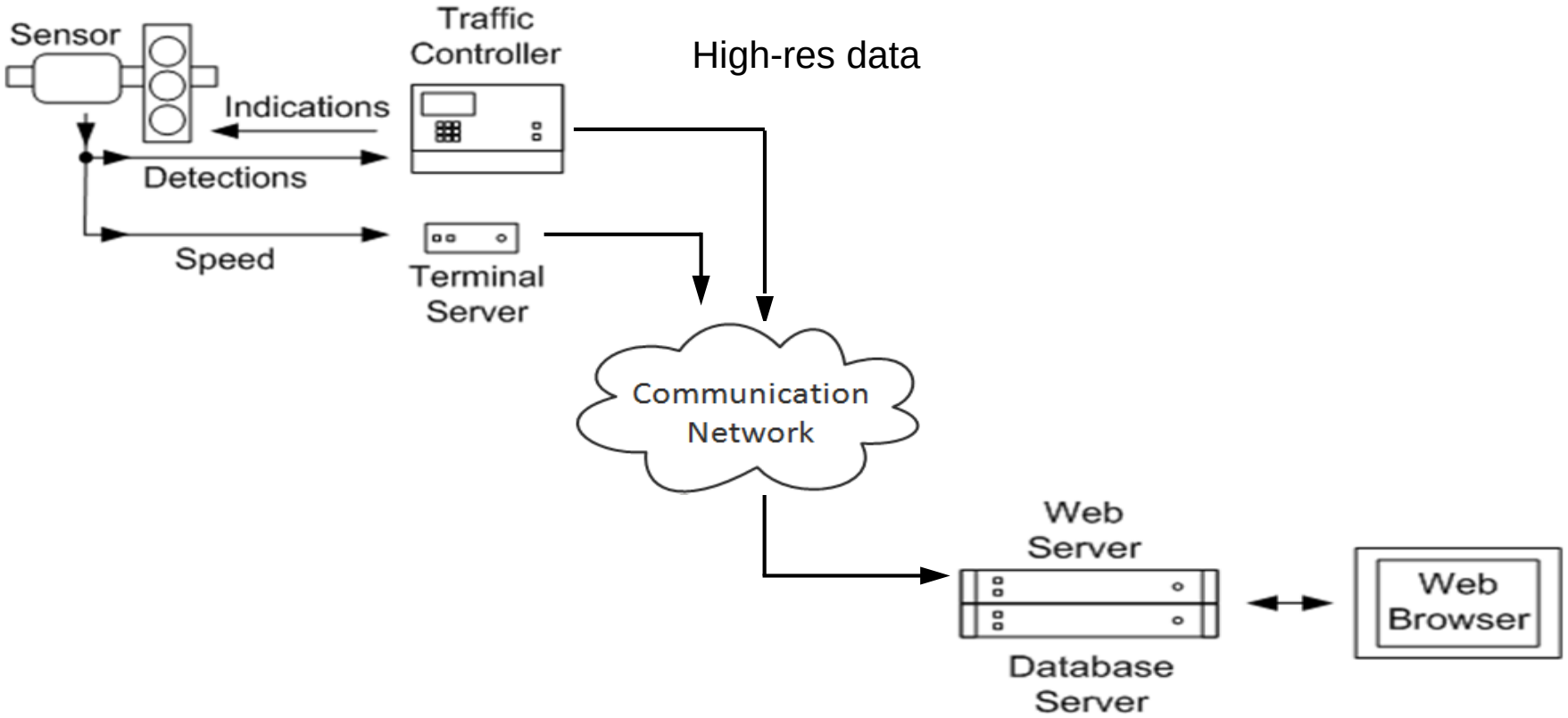
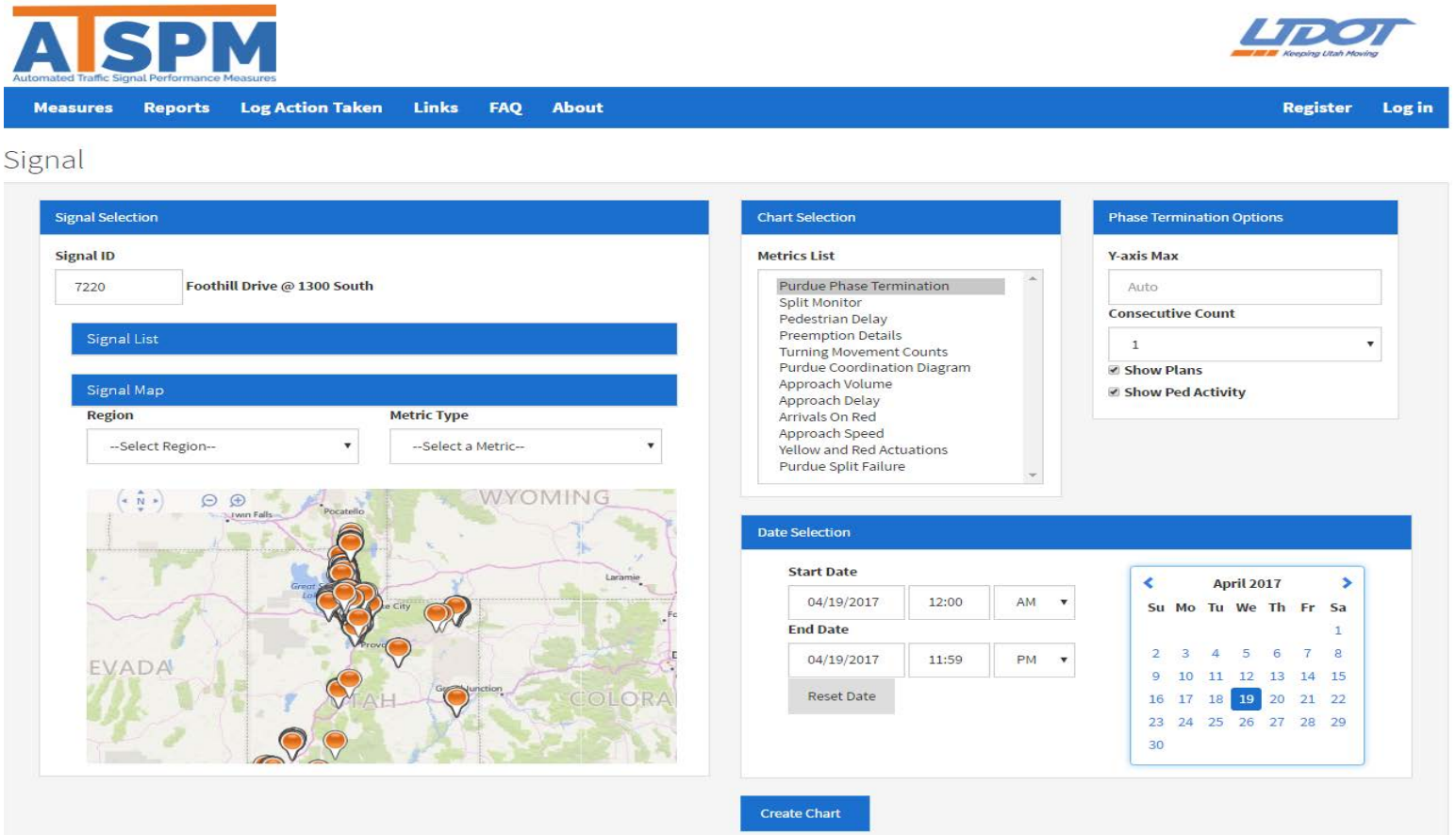
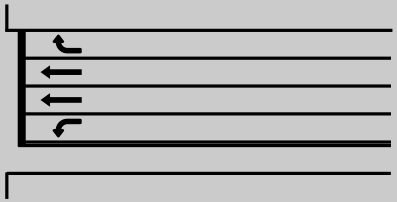
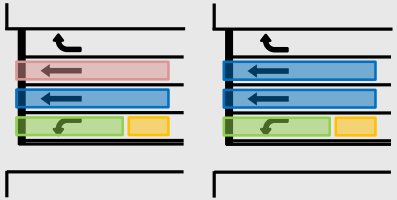


Image courtesy of Wavetronix

UDOT's ATSPM Website

https://udottraffic.utah.gov/ATSPM

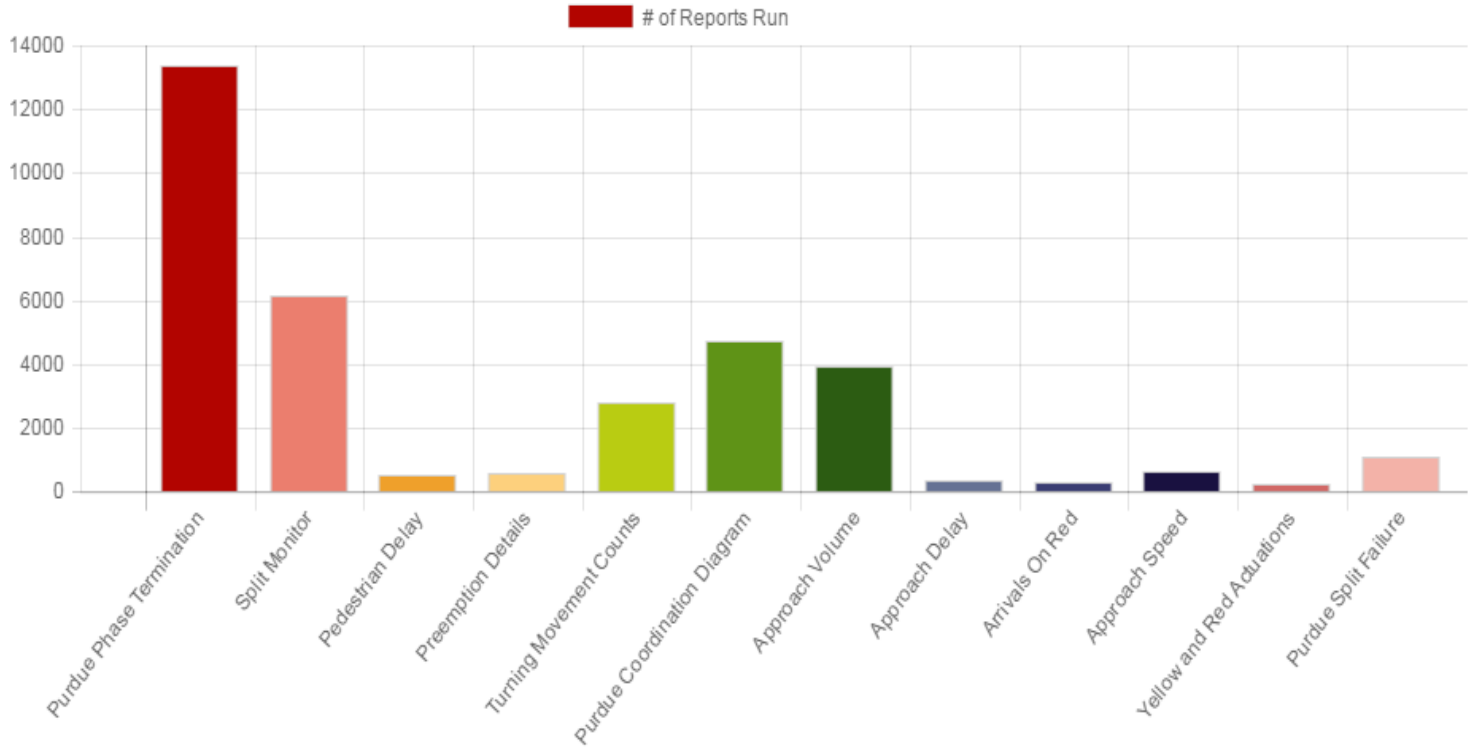


Detection		Metric
None		Phase Termination Chart Split Monitor Preemption Details Pedestrian Delay
Lane-by-lane or Lane Group Presence		Purdue Split Failure
Lane-by-lane Stop Bar Count		Turning Movement Counts
Advanced Count		Purdue Coordination Diagram Purdue Link Pivot Offset Optimization Approach Volume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

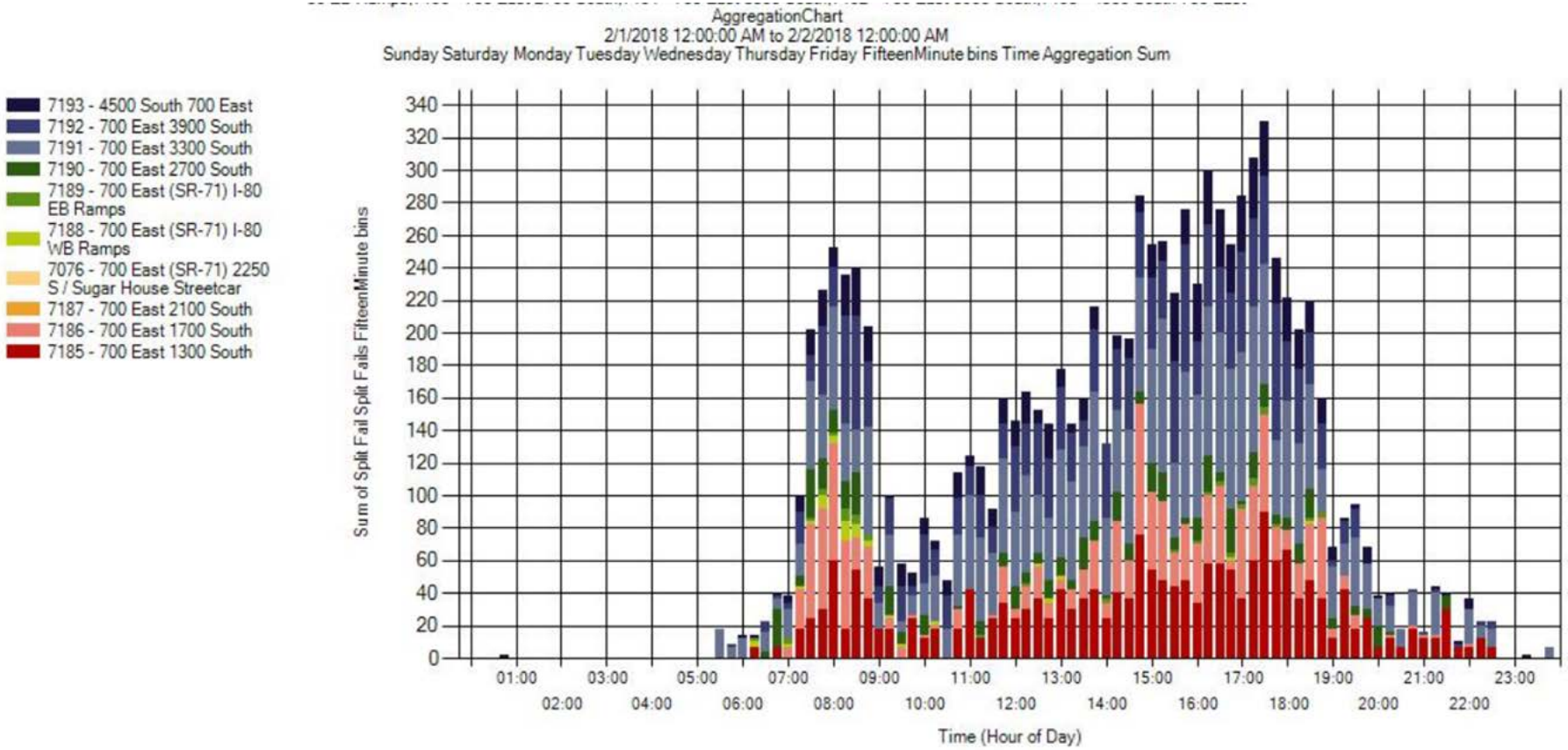
Metric Usage

Metrics Run
1/1/2017 – 5/21/2017

Collected by automatic logger

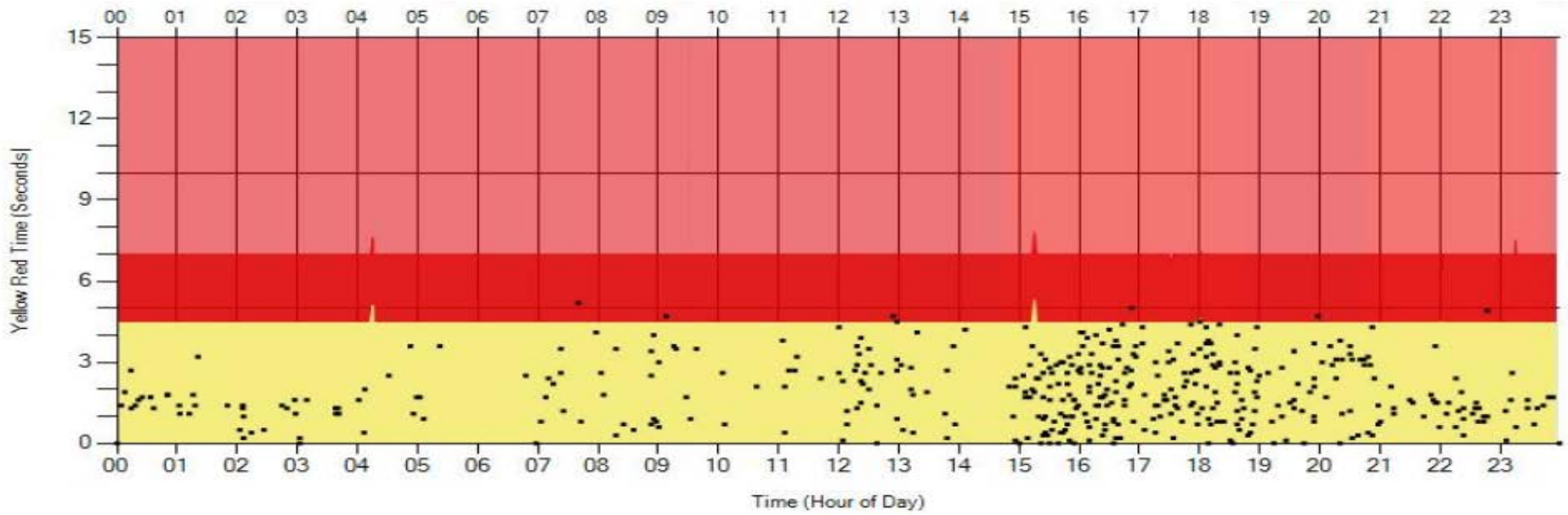


Corridor Metrics: Purdue Split Fail

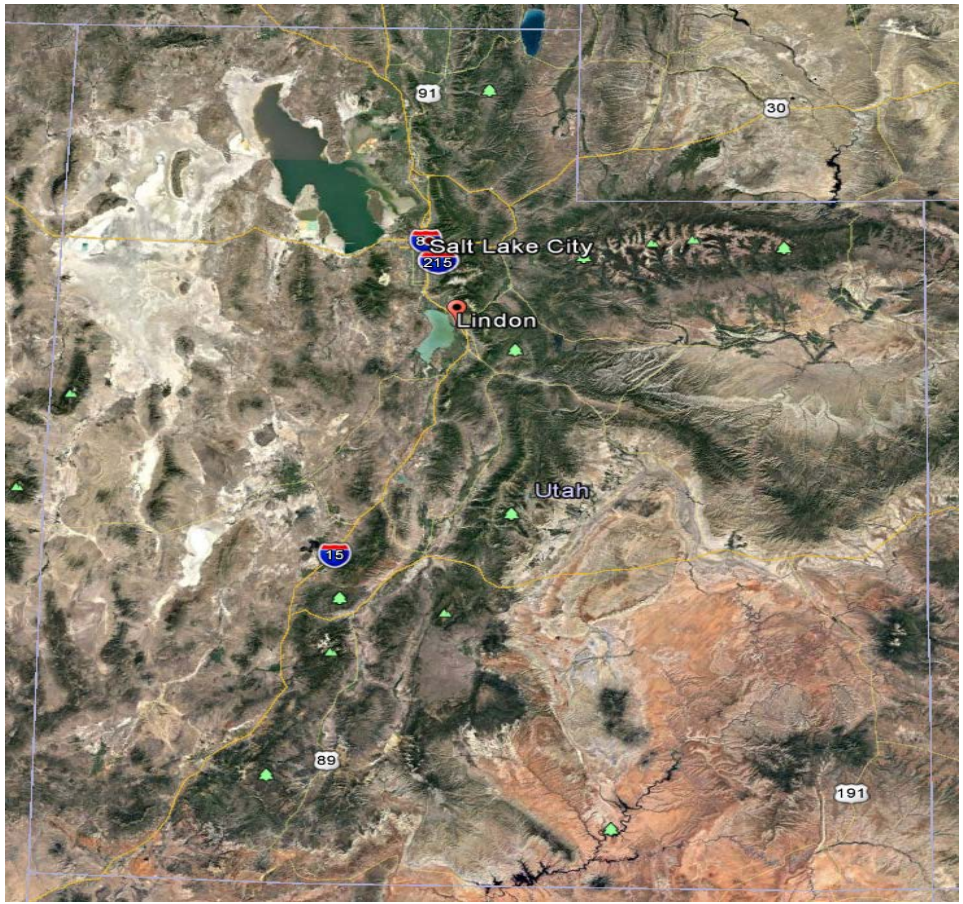


Yellow & Red Actuations (Southbound Through)

5600 West & 2700 South – October 17, 2017



Railroad Preemption Example – Lindon Utah



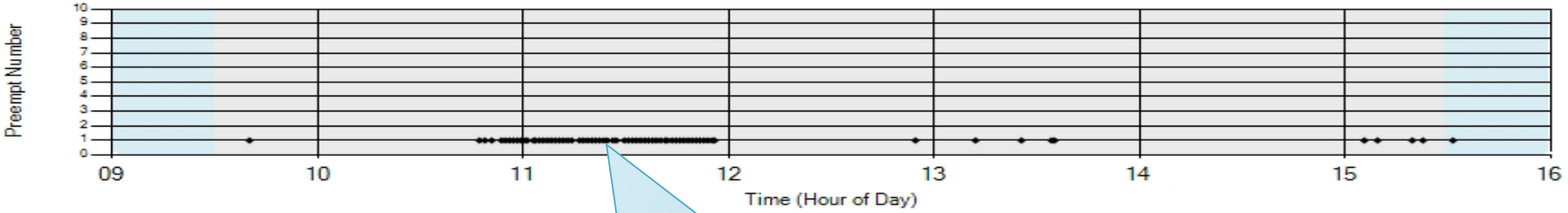

City of Lindon, Utah
200 South
Geneva Rd
W 200 S St
114
S 1060 W St
©2016 Google
Google


City of Lindon, Utah
200 South
Geneva Rd


RAIL ROAD CROSSING
RAIL ROAD CROSSING
DO NOT STOP ON TRACKS
GENEVA RD

Preemption Calls

Wednesday May 25, 2016 between 9:00 AM and 4:00 PM



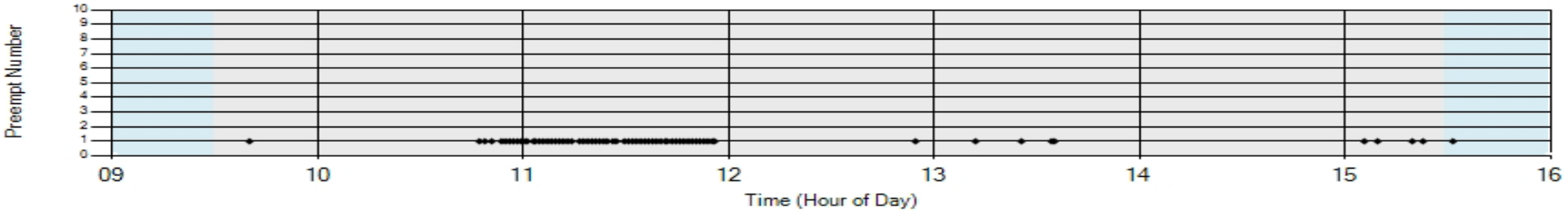
56 Preempt Requests & Services in **70** minutes

Gate down **35%** of the time

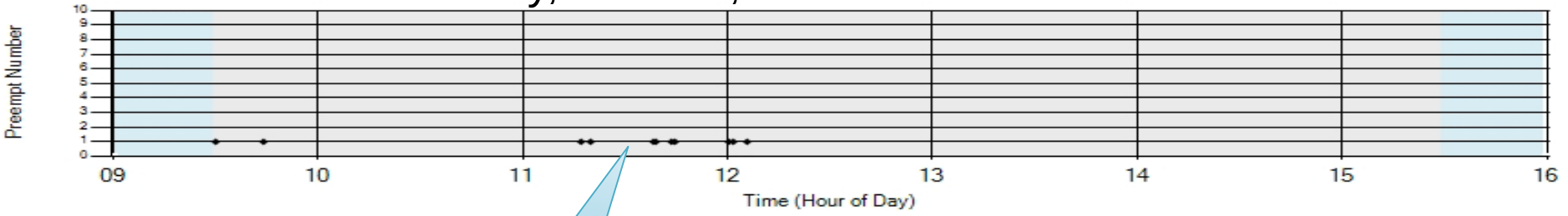
- Train passes through 2x a day Monday, Wednesday, Friday
- Complaints received monthly for a long time. Techs frustrated at this signal.
- Previously, there was no data to provide Union Pacific.

Union Pacific installed some isolation on the spur line where the track switched so the circuit wasn't being falsely triggered

Wednesday, May 25, 2016: 9:00 AM to 4:00 PM



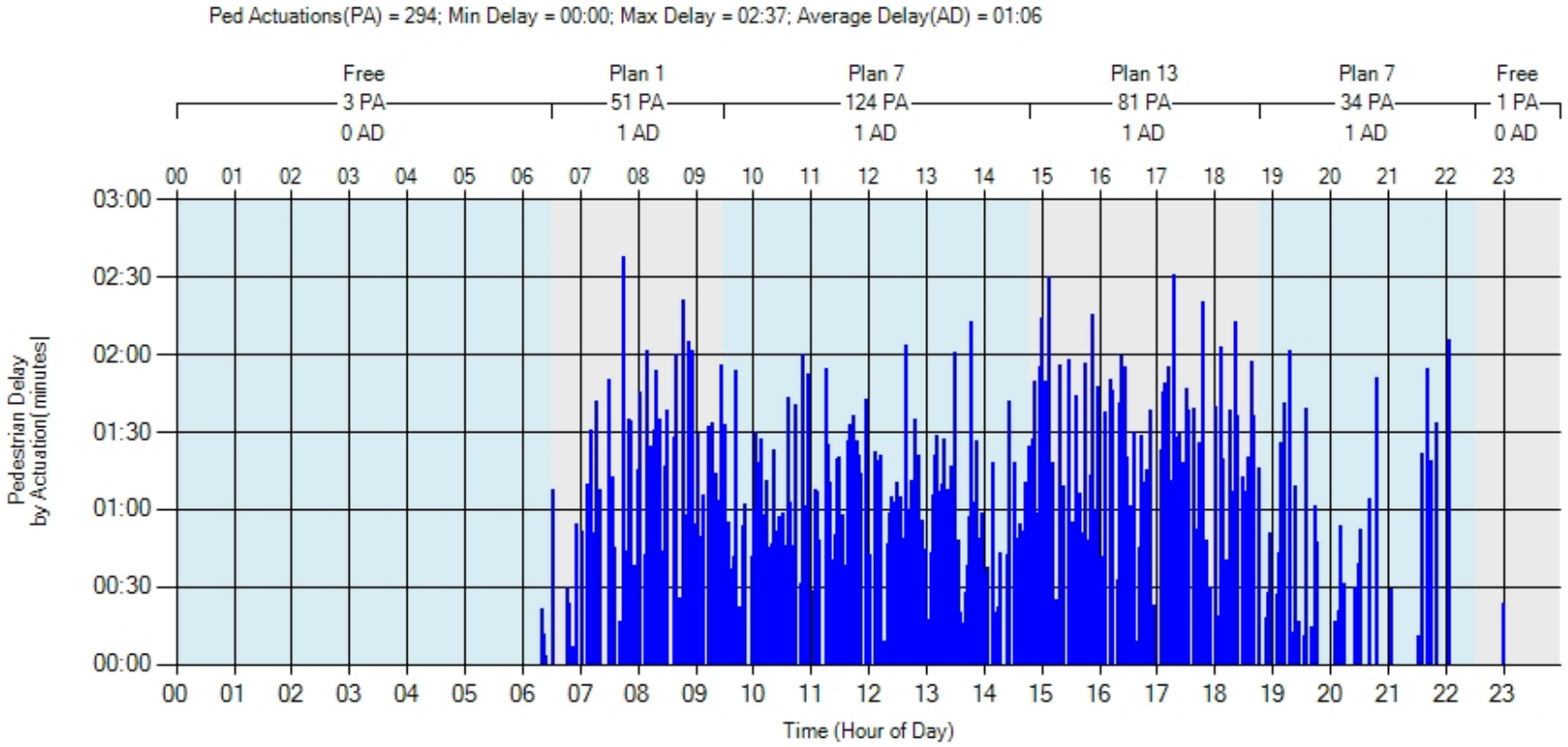
Wednesday, June 22, 2016: 9:00 AM to 4:00 PM



Fixed!

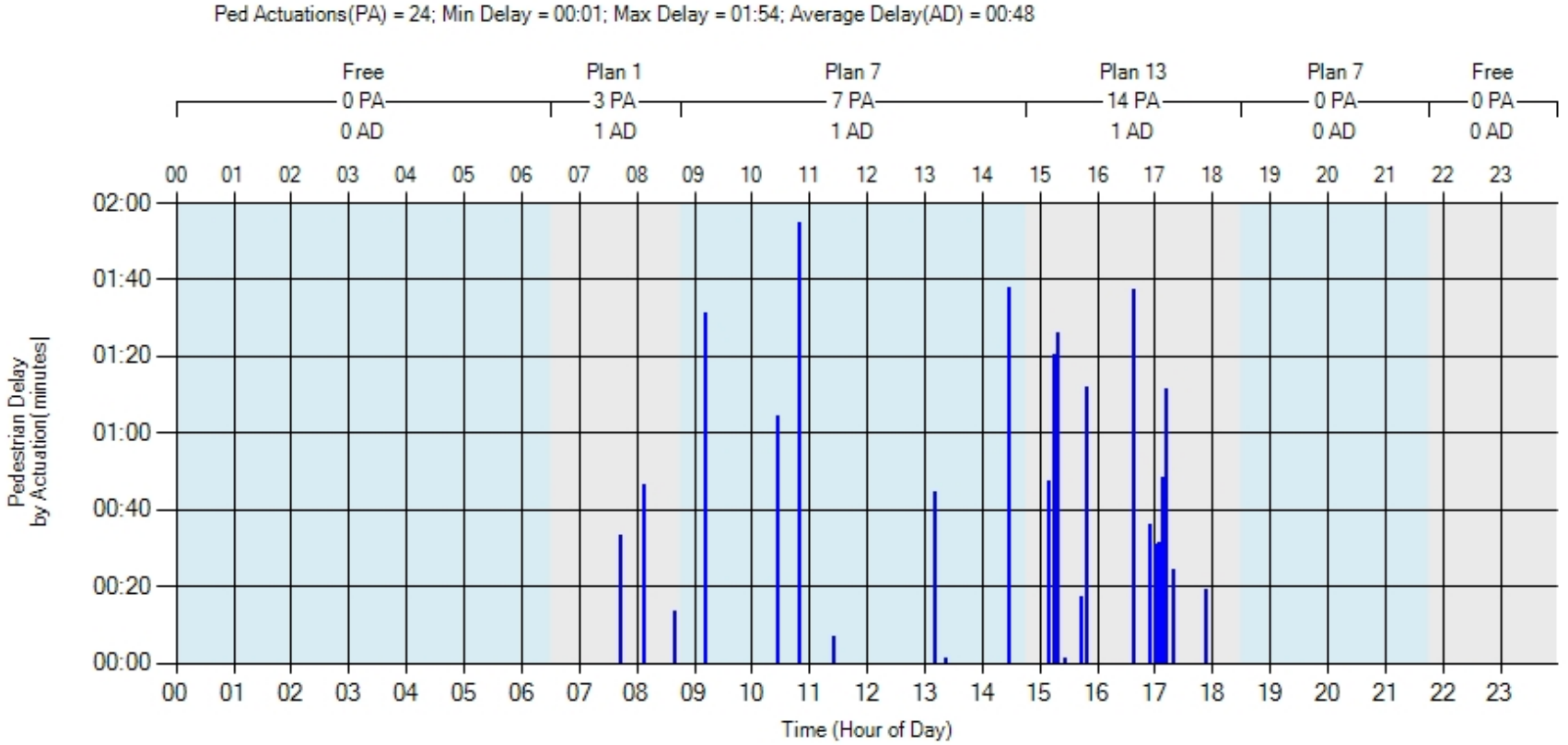
Pedestrians: Delay & Actuations

West Leg of Intersection: 500 South & Guardsman Way – Wed. February 14, 2018

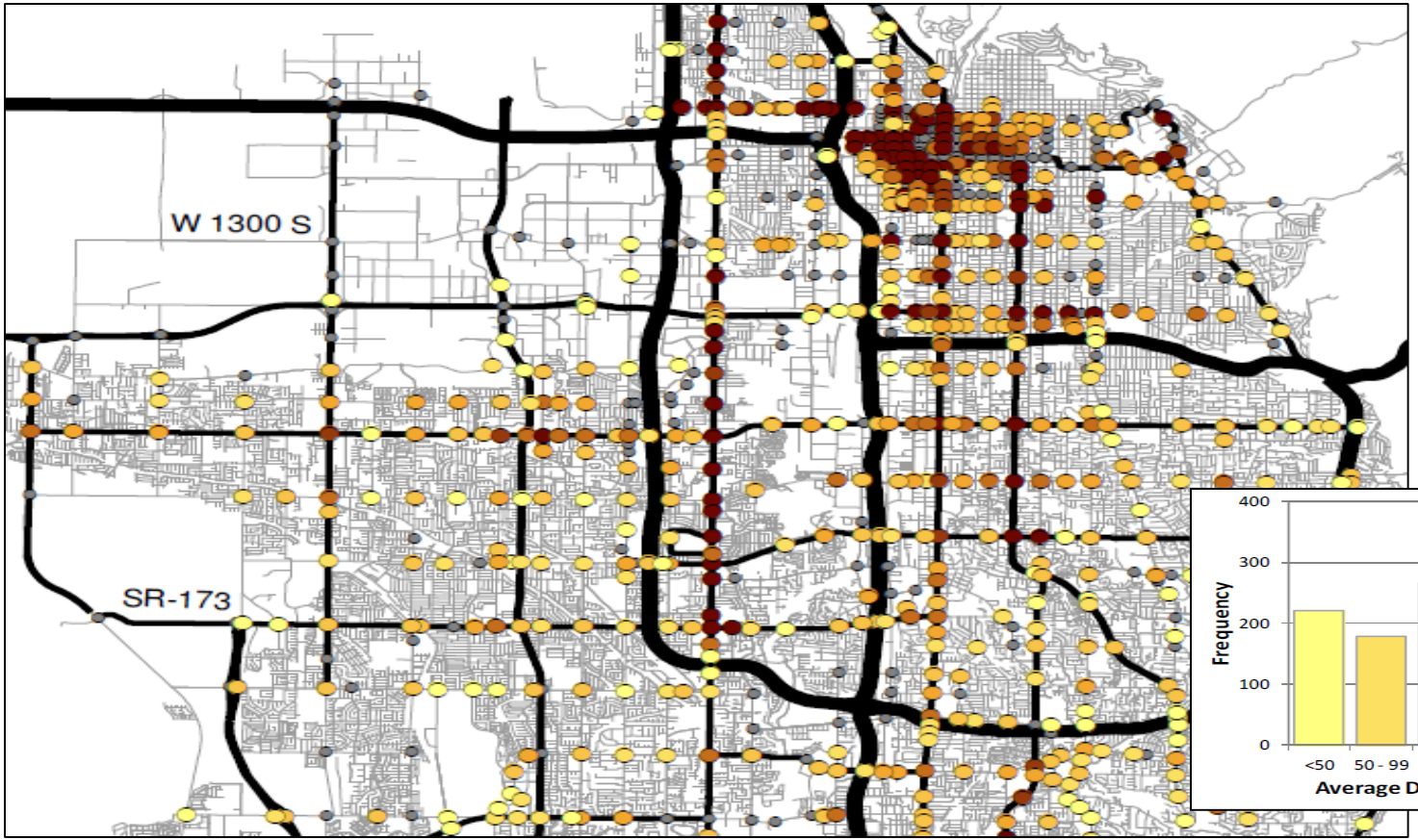


Pedestrians: Delay & Actuations

North Leg of Intersection: 8890 South (Newcastle) & Highland– Monday Feb 12, 2018

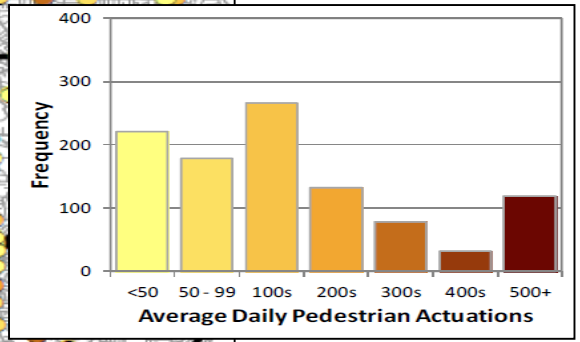


Pedestrian Actuations



Average Daily Pedestrian Actuations

- <50
- 50 - 99
- 100 - 199
- 200 - 299
- 300 - 399
- 400 - 499
- 500+
- Unknown



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

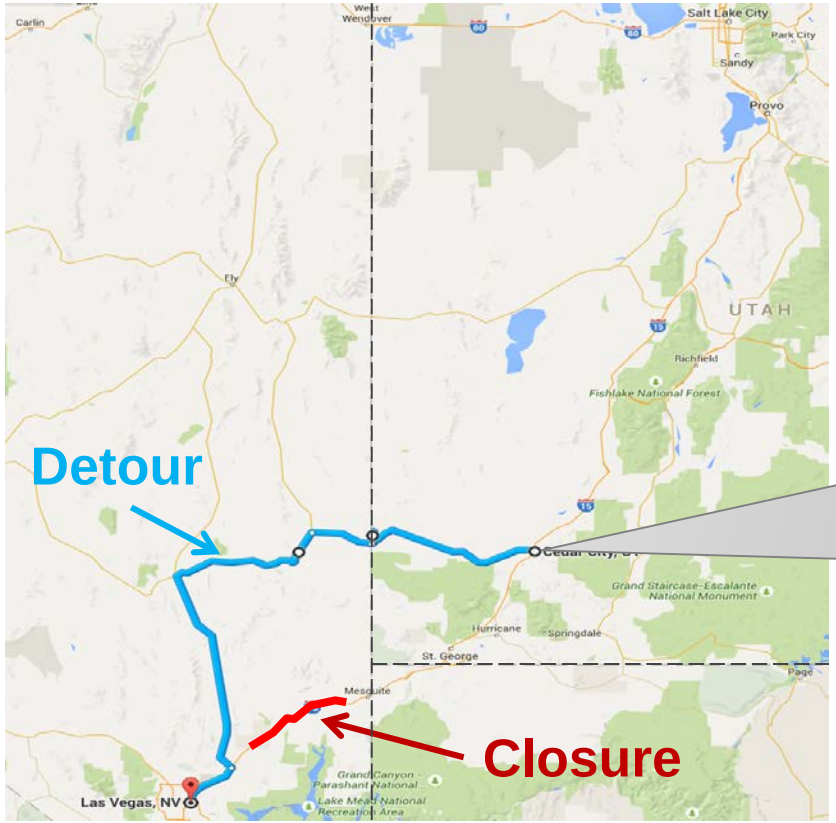
Heavy rain rips apart I-15 in Nevada, forces freeway closure

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

Source: KSL

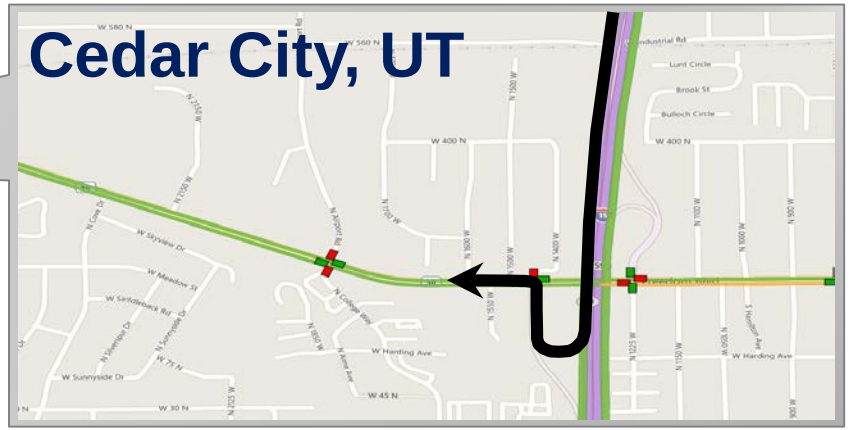

© Reuters

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

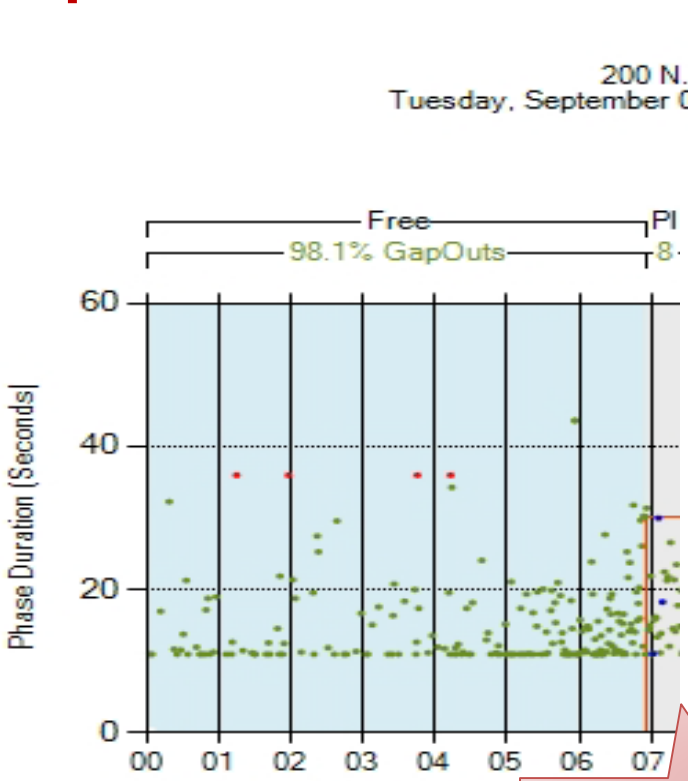


Southbound I-15 Closed in Nevada

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



Split Monitor for Incident Management

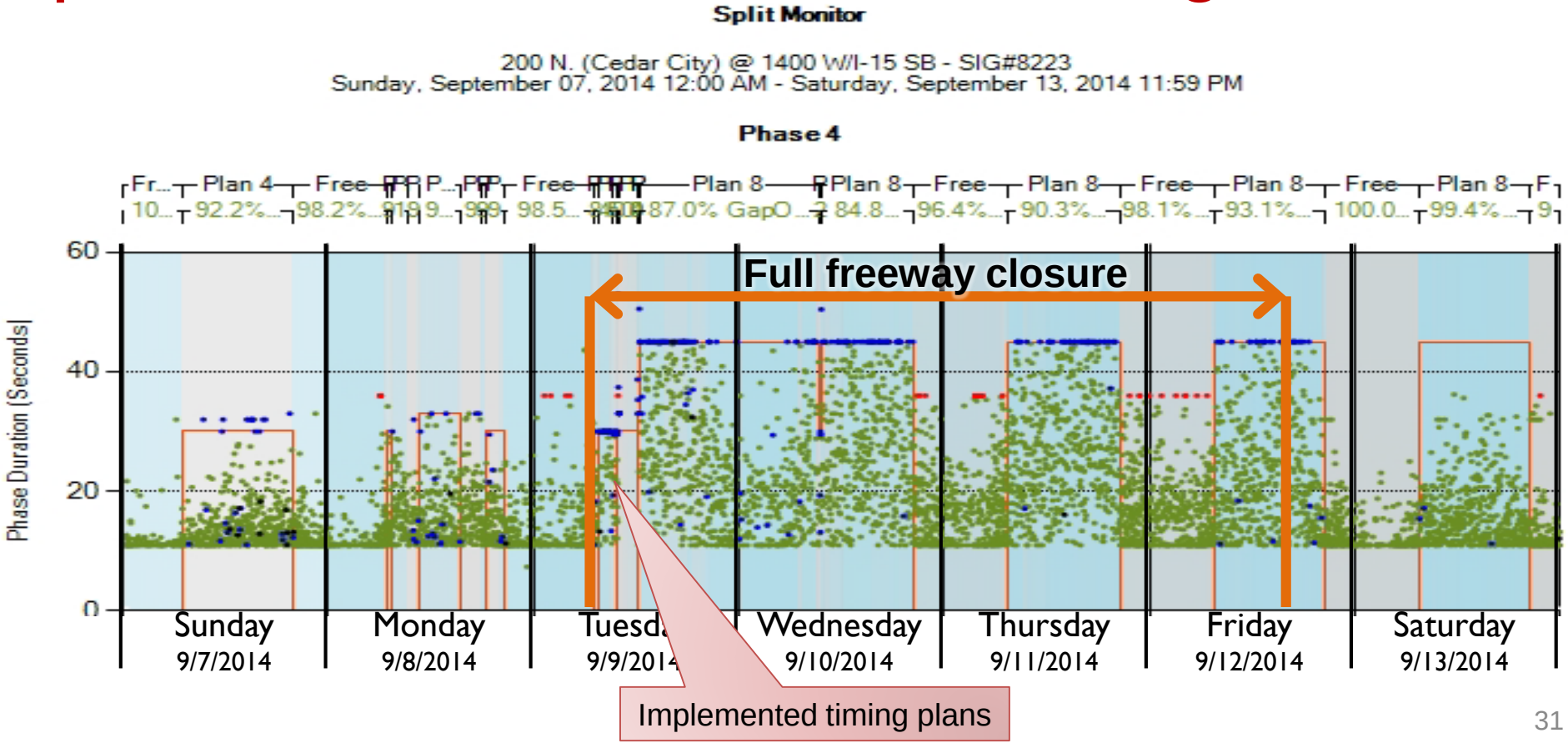


Revise Timing Plan for better % gap outs

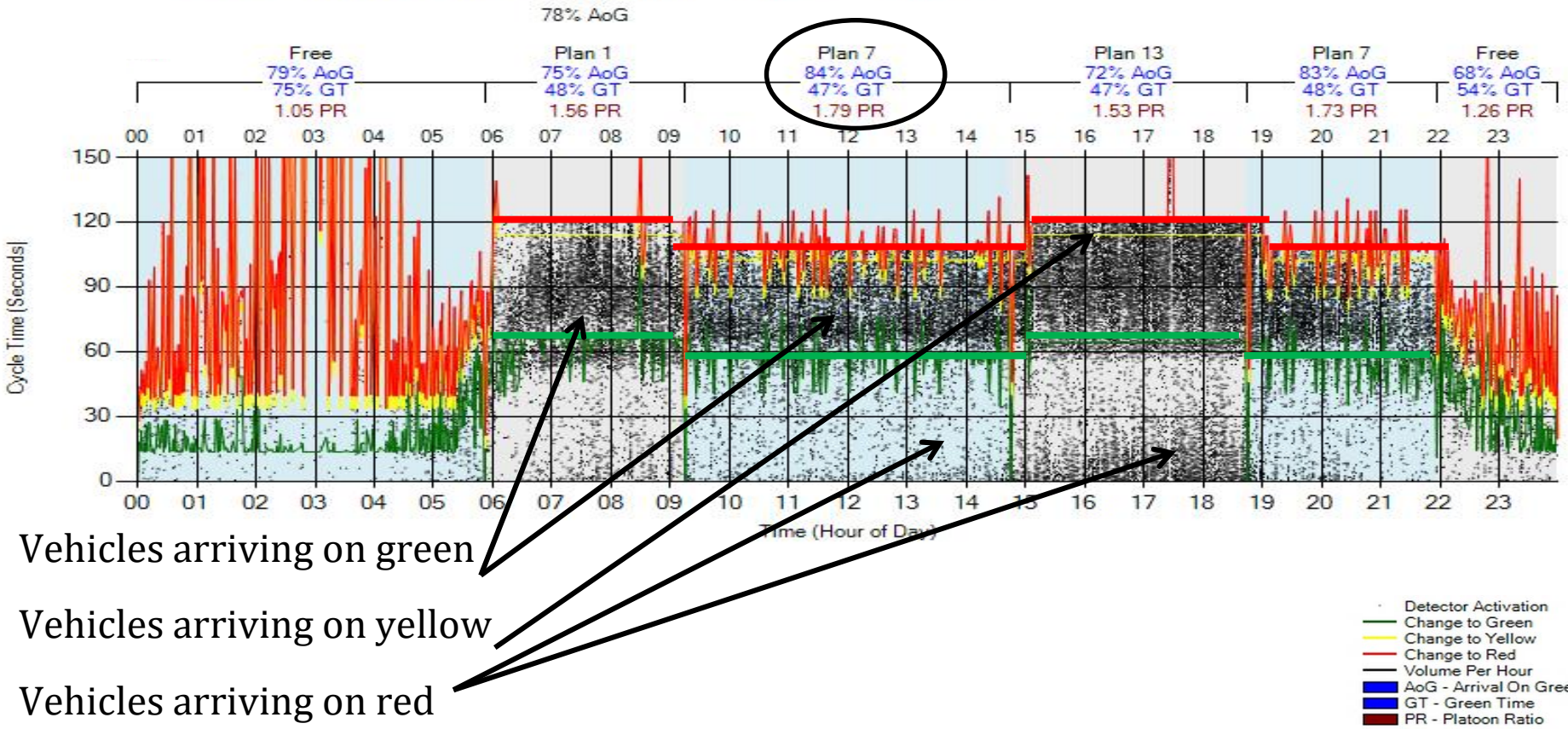
Detour starts

Implement Timing Plans

Split Monitor for Incident Management

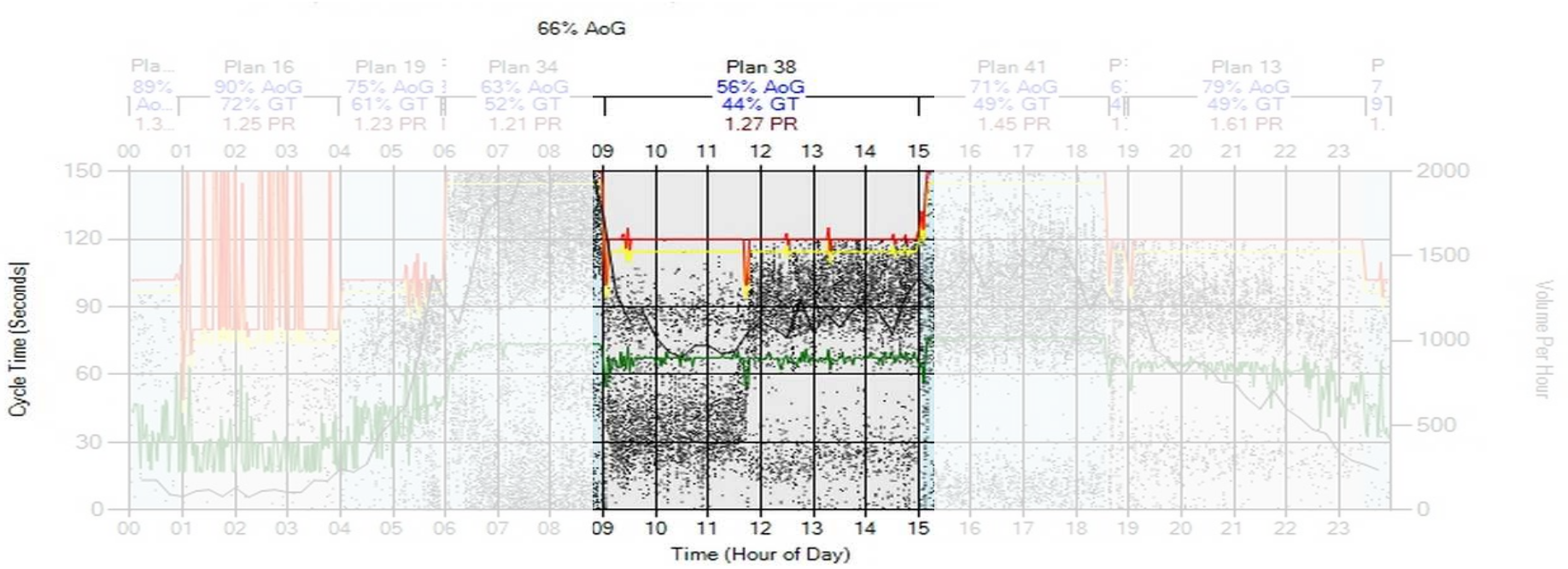


Purdue Coordination Diagram

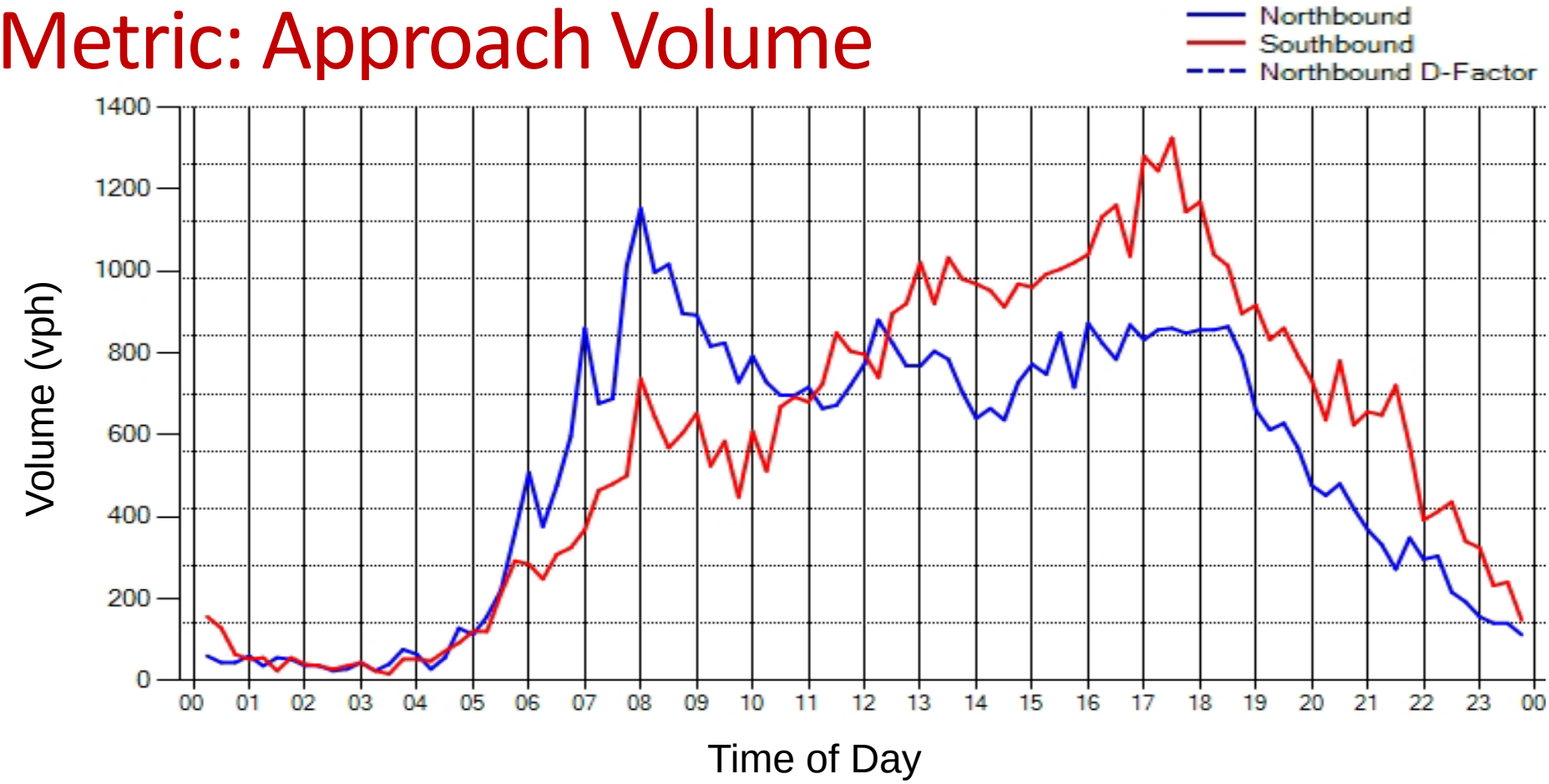


Complaint: Too many vehicles arriving during red

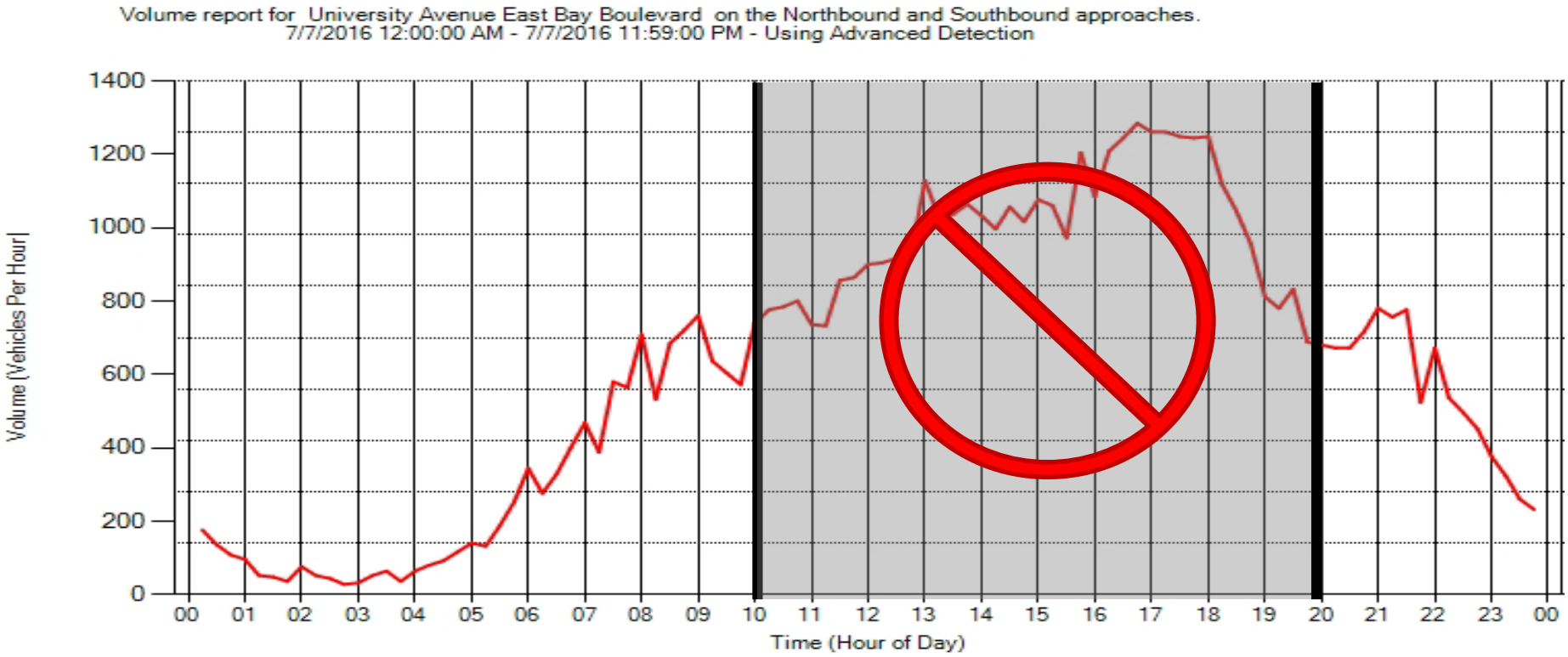
(starting at 9:00 AM)



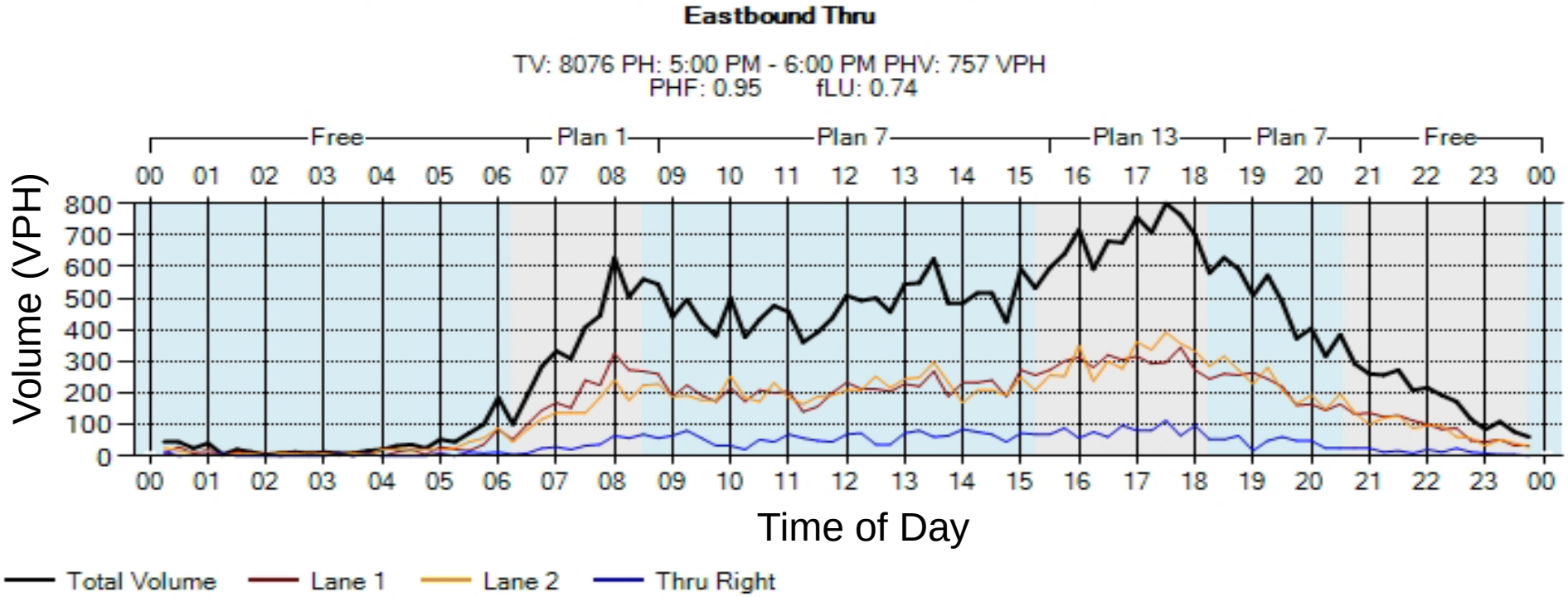
Metric: Approach Volume



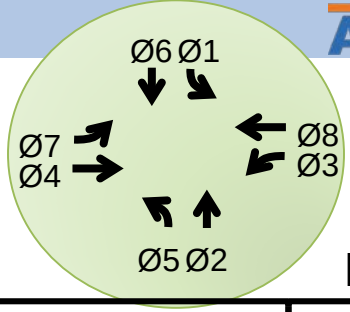
Allow Lane Closures?

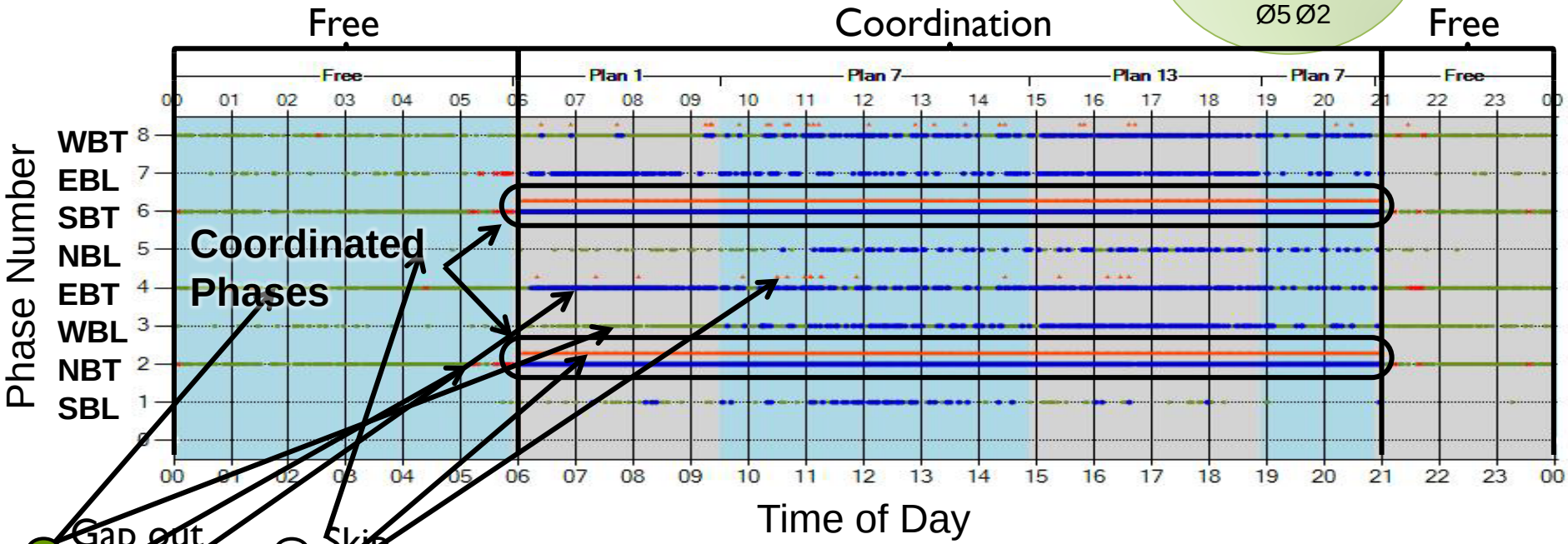


Metric: Turning Movement Counts



Metric: Phase Termination Chart





Gap out

Max out

Force off

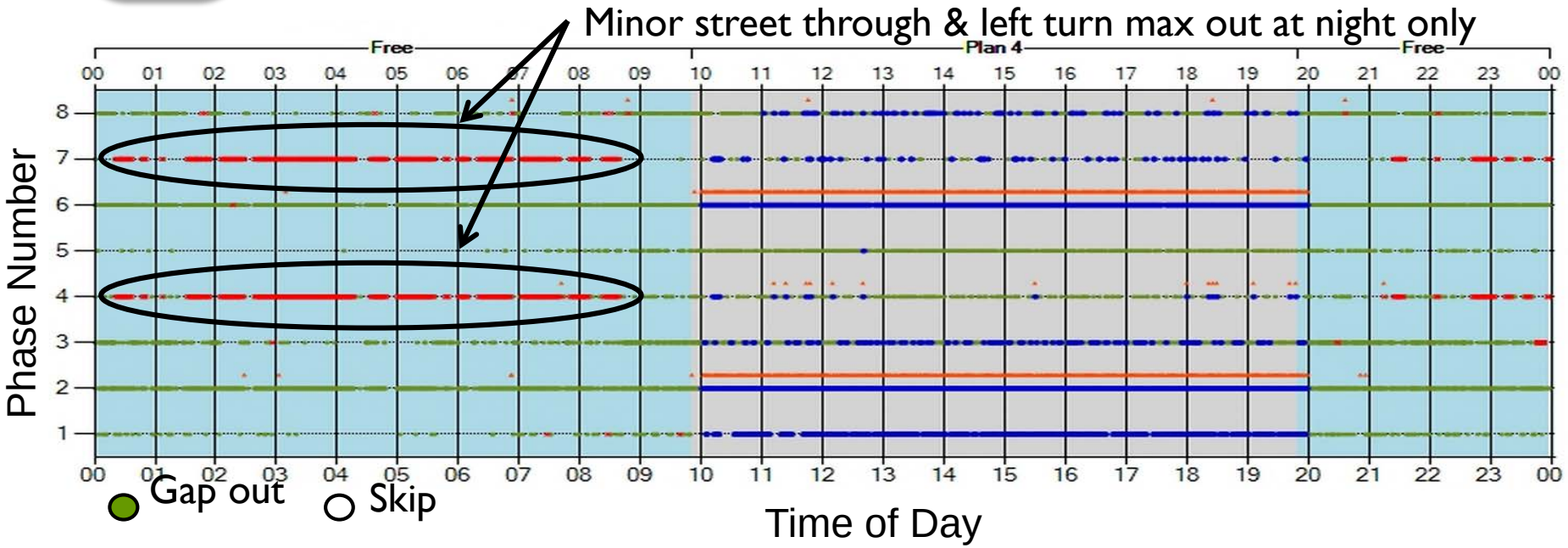
Skip

Pedestrian activation
(shown above phase line)

Complaint: Long main street red at 2 a.m.

Before

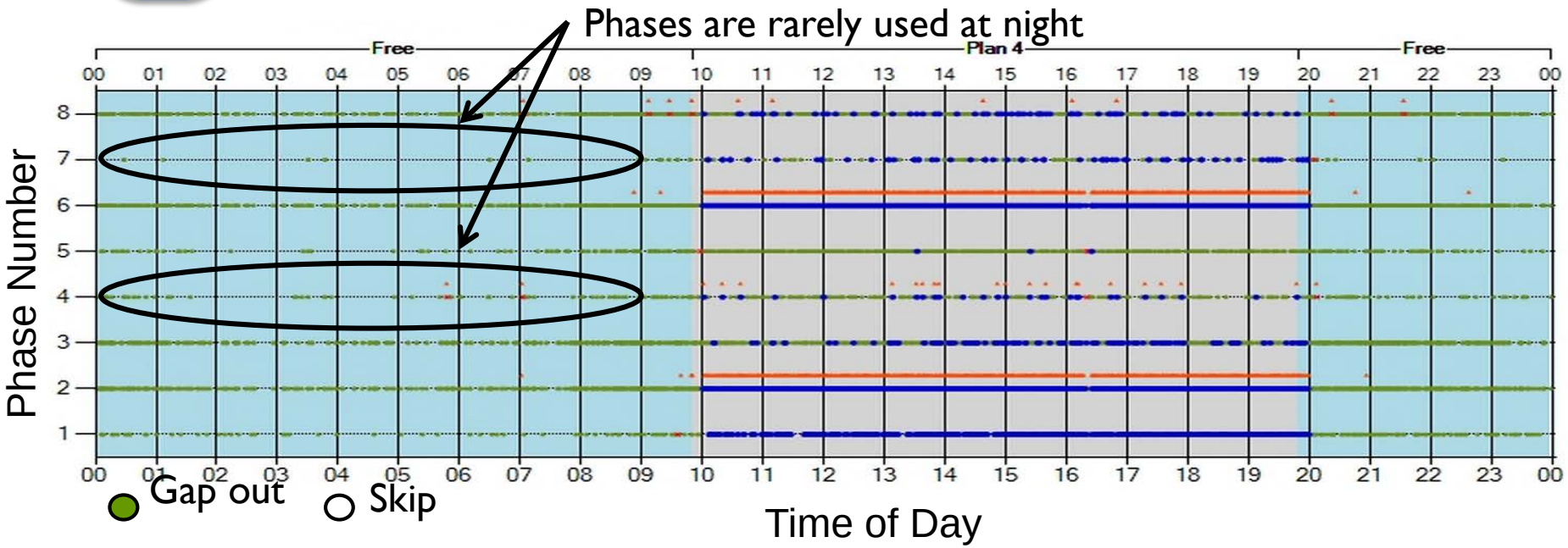
Video detection not working at night



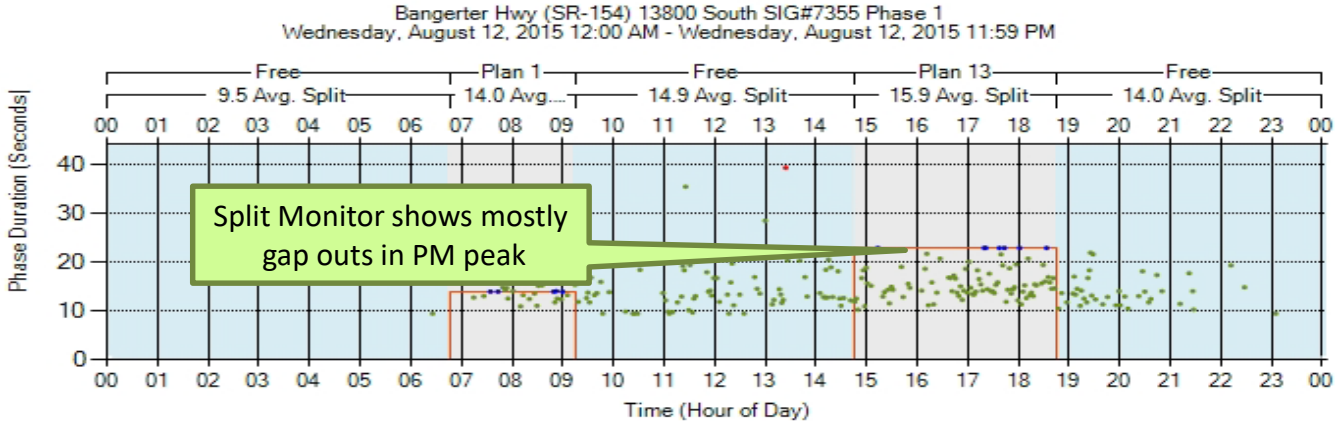
Complaint: Long main street red at 2 a.m.

After

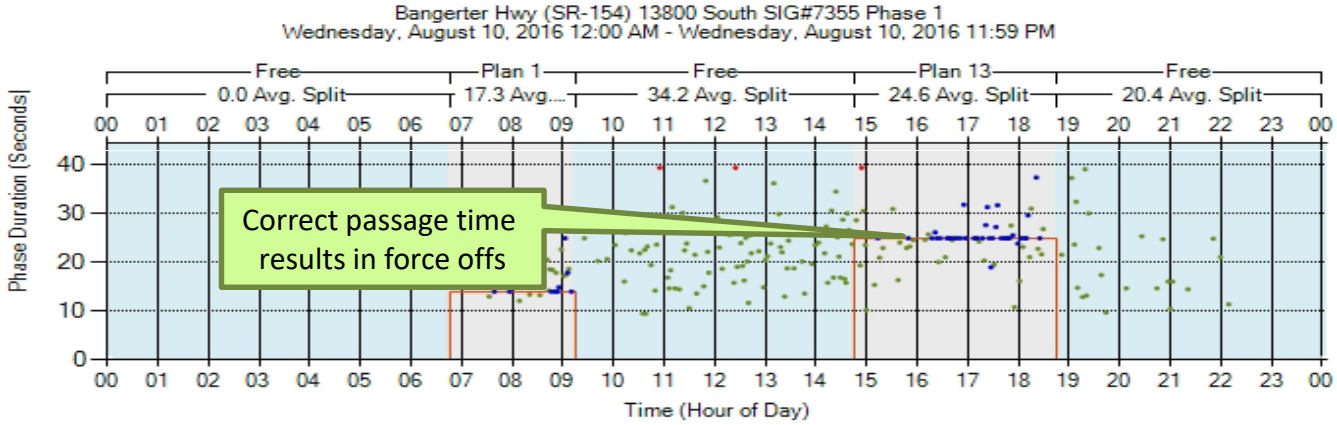
New detection technology installed



Complaint: Long queue, short green, PM peak



Before

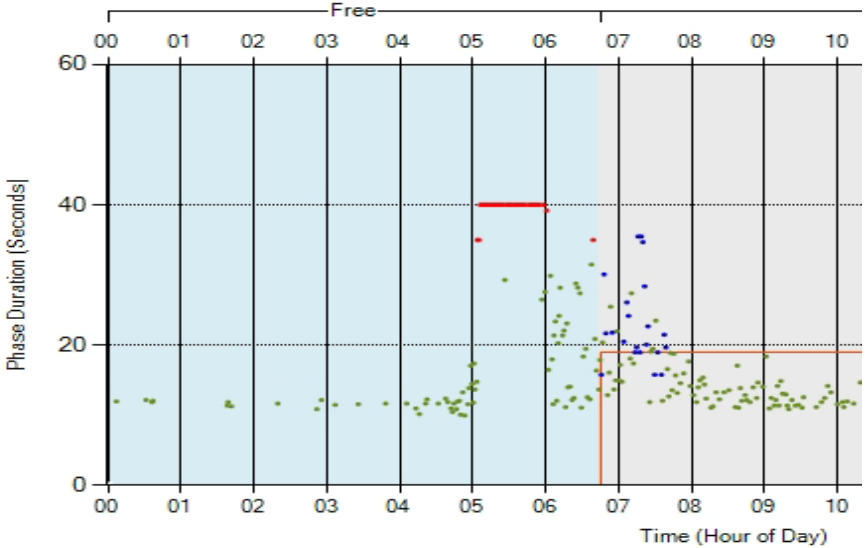


After

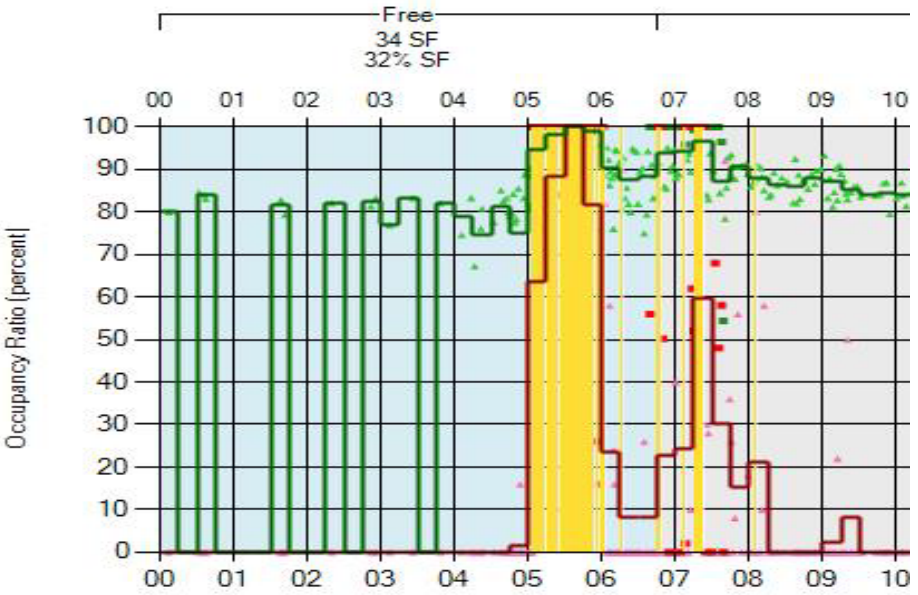
Complaint: Green too short in the morning

Before

Split Monitor



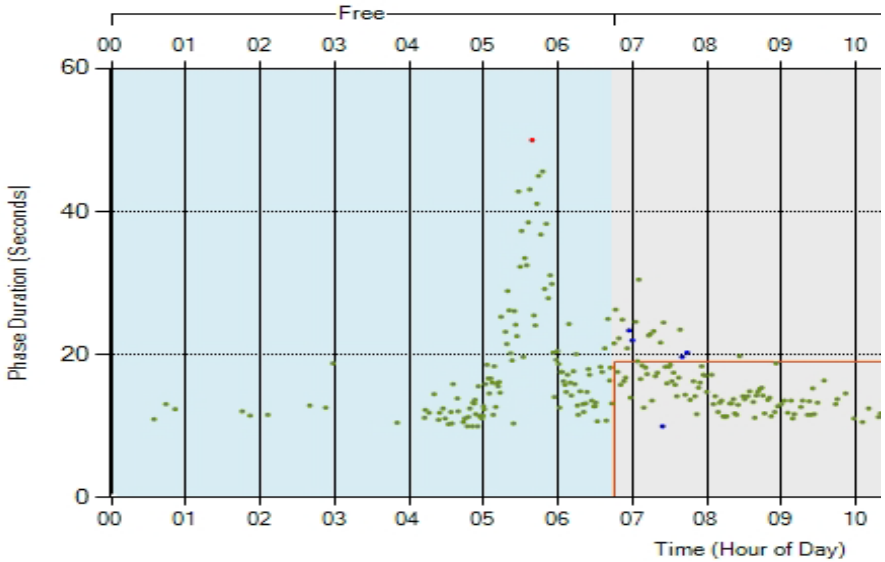
Purdue Split Failure



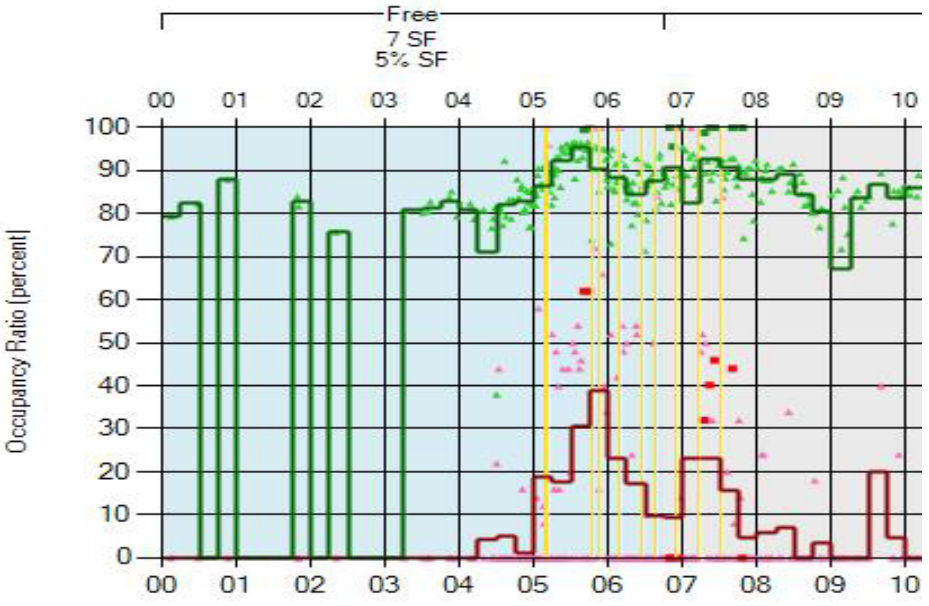
Complaint: Green too short in the morning

After

Split Monitor



Purdue Split Failure



SYSTEM HEALTH ALERTS FOR PROACTIVE MAINTENANCE

UDOT Automated Traffic Signal Performance Measures

System Health Alerts

1. **No ATSPM data:** identifies signals with less than 500 records in the database between midnight and midnight the previous day
2. **Too many max outs:** identifies phases with more than 90% max outs in at least 50 activations between 1 a.m. and 5 a.m.
3. **Too many force offs:** identifies phases with more than 90% force offs in at least 50 activations between 1 a.m. and 5 a.m.
4. **Too many ped calls:** identifies phases with more than 200 pedestrian activations between 1 a.m. and 5 a.m.
5. **Low PCD detector count:** identifies phases with PCD detectors that have less than 100 vehicles counted between 5 p.m. and 6 p.m. the previous day.

SPM Alerts for 5/22/2016

SPMWatchdog@utah.gov
to marktaylor, me, signaldesk, shanejohnson, bryan.meenen, kbarnes, SWinters, tforbush, jay

--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)

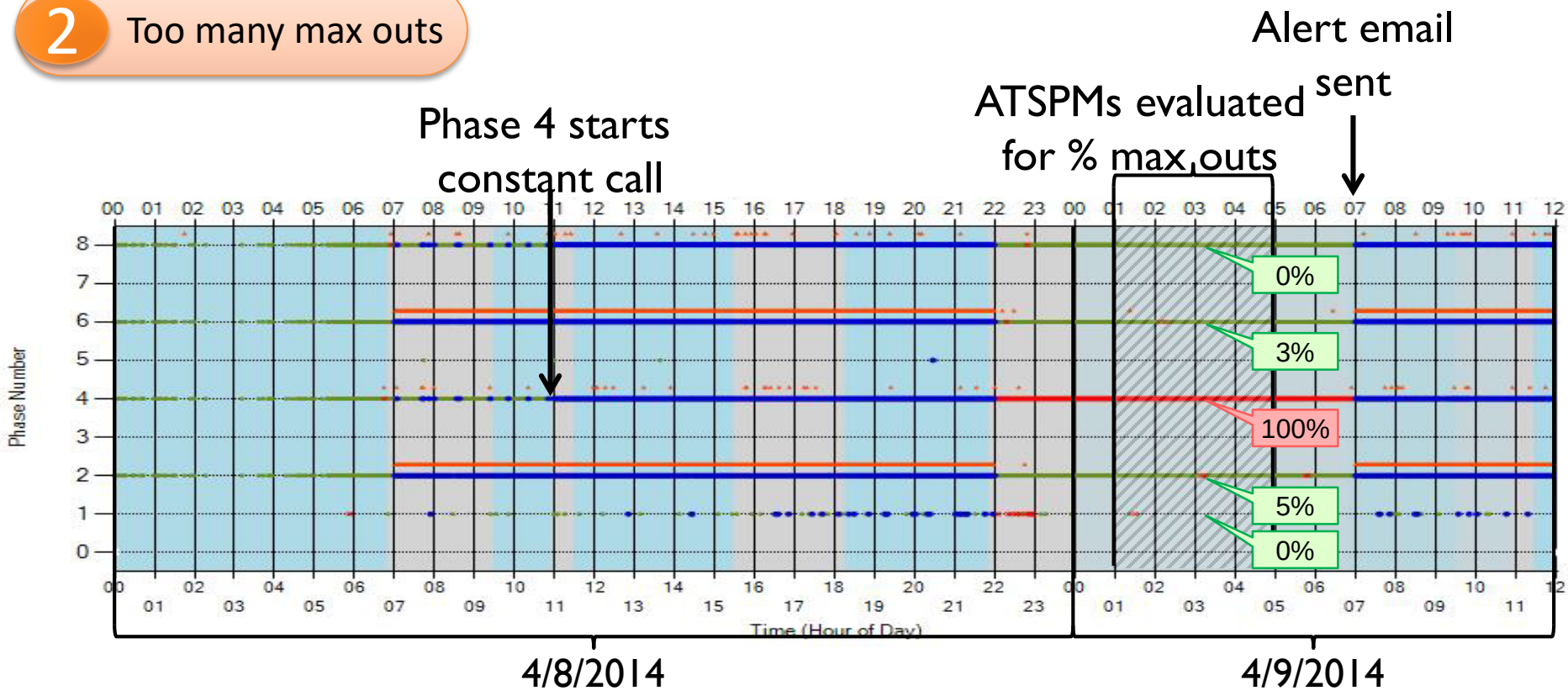
--The following signals had too many force off occurrences:
1224 - North Temple & Main Street - Phase: 3 (Force Offs 97.6%)
7252 - 500 South & Main Street - Phase: 2 (Force Offs 100%)
7252 - 500 South & Main Street - Phase: 6 (Force Offs 100%)

--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.)

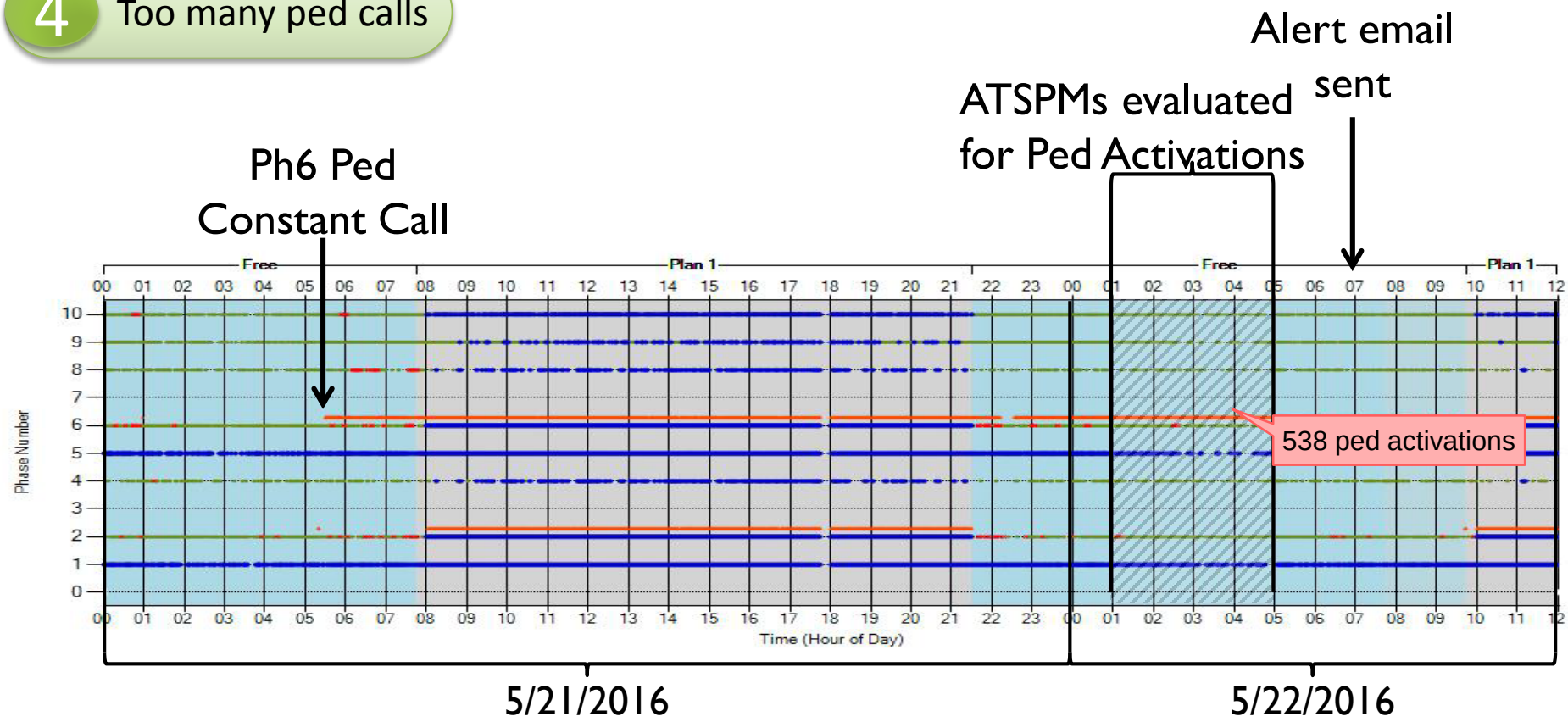
--The following signals have stuck ped detectors:
1023 - South Temple & 200 West - Phase: 2 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 4 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 6 (Stuck Ped)
1023 - South Temple & 200 West - Phase: 8 (Stuck Ped)
4511 - 4100 South & 3200 West - Phase: 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



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

4 Too many ped calls



More Information

Mark Taylor
UDOT Traffic Signal Operations Engineer
marktaylor@utah.gov

UDOT ATSPMs

ATSPM Website
https://udottraffic.utah.gov/ATSPM

Green Lights Commercial
http://udot.utah.gov/greenlights

FHWA's Open Source Application Development Portal (OSADP)
https://www.itsforge.net

ATSPM Forums

National Operations Center of Excellence (NOCoE)
http://forum.transportationops.org/forum/5-traffic-signals/
- General ATSPM topics

FHWA's Open Source Application Development Portal (OSADP)
https://www.itsforge.net/forum/ATSPM
- Questions regarding UDOT's ATSPM source code


udottraffic.utah.gov/ATSPM
Mark Taylor
marktaylor@utah.gov
UDOT
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