ITERIS®

Innovation for Better Mobility

FDOT Data Symposium

Analyzing Bottlenecks with Various Data Sources

NYSE MKT: ITI

Who We Are…

- **Iteris** is a leader in traffic and weather systems
- Three focus areas:

Sensors

Systems

iPerform
(Weather & Traffic Analytics)

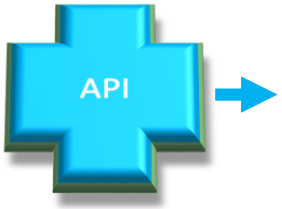
iPerform Traffic & Weather Data & Analytics

Data Aggregation

- Public Traffic Sensor Data
- GPS Probe Data
- Weather Reports & Sensors
- Traffic Incident Reports
- Traffic and Weather Video

Big Data Fusion by Iteris PeMS (iPeMS) & ClearPath Weather

iPeMS Data Feed & APIs



Performance Measurement Tools

Applications

Precision Ag

Financial/Insurance

Automotive

TRAFFIC MONITORING & PERFORMANCE MANAGEMENT

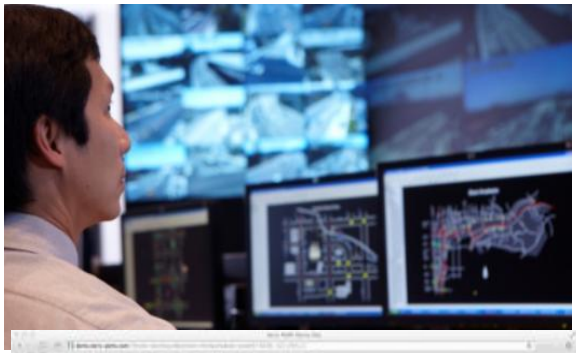
Road Maintenance

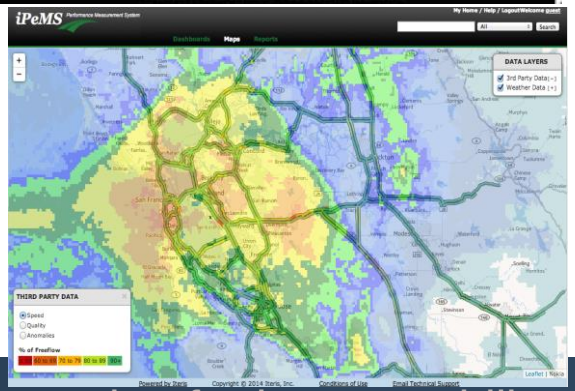
iPeMS

Tools to Support Planning and Operations

iPeMS Performance Measurement

- Reliable measurement of transportation networks, freeways, integrated corridors, routes and artierals
- Real-time and actionable decision support data and historical planning reports
- Incorporates traffic data from loops, radar, bluetooth, probe, incidents, lane closures, managed lanes, signals, and transit
- Delivered and visualized in key analytics, reports, dashboards and mapping

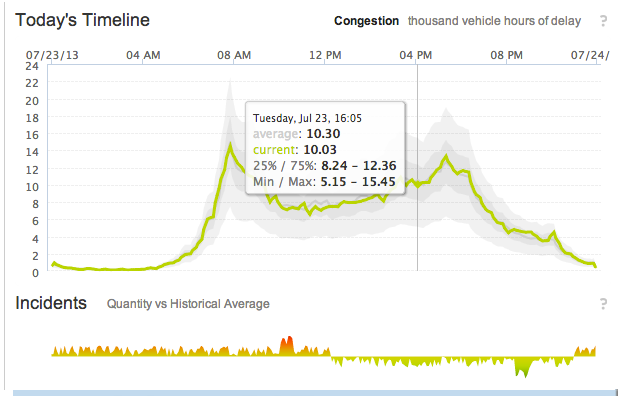


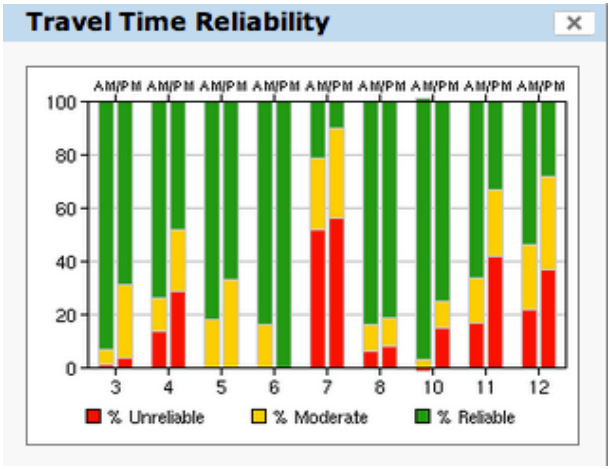


Performance Measurement Constituencies

iPeMS Bottleneck Visualizations

- Operations and Planning
  - Real-time dashboards
  - Summary maps, plots and contours
- Understand performance
  - Through visualizations and analytics
- Sample report types
  - Dashboards
  - Regional indexes
  - Incident analysis and visualization
  - Travel time reliability





Performance Measurement: Regional Planning

Bottlenecks >

Bottlenecks are are identified with large speed drops including bottleneck durations, upstream queues and total delay as well as filterable top bottlenecks on maps and lists.

VMT >

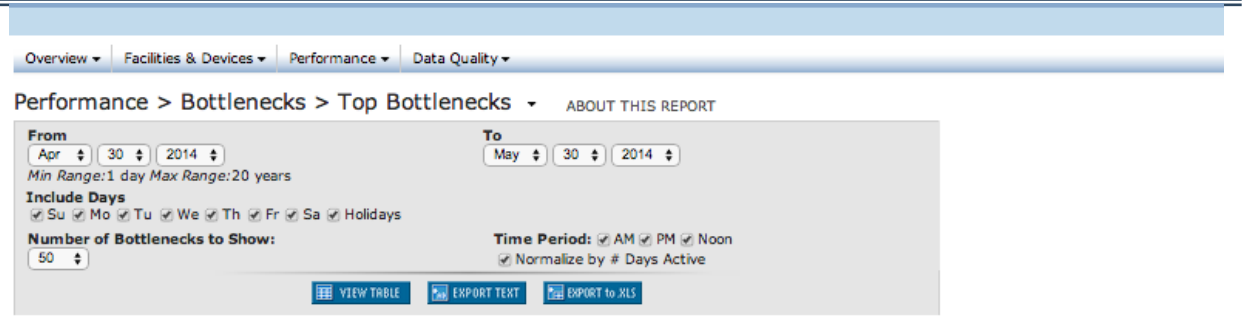
Detector stations are aggregated spatially to show Vehicle Miles Traveled (VMT) in lists or displayed in charts.

Long Term Trends >

Report provides user with a view of commonly used freeway performance measures over long periods of time. It segments the values to commonly used time ranges for peak and off-peak hours over large geographic segments including State, Districts and Counties.

Bottlenecks in PeMS

- Statistics about bottlenecks for any geographical segment
- Statewide or along a freeway-direction
- This table shows the bottlenecks that were discovered during the last month



						Bottleneck Characteristics			
Station	Name	Shift	Fwy	Abs PM	State PM	# Days Active	Avg Extent (Miles)	Avg Delay (veh-hrs)	Avg Duration (mins)
314	EB SR-201 @ I-215-W (WEST SIDE)	NOON	SR201-E	14.42	14.42	1	0.8	410.3	300.0
330	WB SR-201 @ 800 W	NOON	SR201-W	16.64	16.64	4	0.5	20.9	292.5
330	WB SR-201 @ 800 W	PM	SR201-W	16.64	16.64	4	0.5	22.1	278.8
358	WB SR-201 @ 6800 W	AM	SR201-W	9.15	9.15	25	3.7	1,740.8	261.0
314	EB SR-201 @ I-215-W (WEST SIDE)	PM	SR201-E	14.42	14.42	1	0.8	216.4	220.0
354	WB SR-201 @ 5800 W	AM	SR201-W	10.61	10.61	2	0.5	13.1	182.5
358	WB SR-201 @ 6800 W	NOON	SR201-W	9.15	9.15	21	3.7	1,052.7	179.8
1378	NB I-15 @ 11400 S NB (ON RAMP)	PM	I15-N	292.62	292.62	21	0.2	53.0	174.8
674	WB I-80 @ PARLEY'S SUMMIT	NOON	I80-W	139.44	139.44	1	2.0	165.0	155.0
1378	NB I-15 @ 11400 S NB (ON RAMP)	AM	I15-N	292.62	292.62	21	0.3	171.8	150.5
796	I-15 SB S of Main St - AFK MP 27	NOON	I15-S	278.38	278.38	4	0.5	7.8	150.0
674	WB I-80 @ PARLEY'S SUMMIT	AM	I80-W	139.44	139.44	1	2.0	109.1	130.0
796	I-15 SB S of Main St - AFK MP 27	AM	I15-S	278.38	278.38	3	0.5	6.4	128.3
330	WB SR-201 @ 800 W	AM	SR201-W	16.64	16.64	4	0.5	7.6	125.0
99730	SB I-15 HOV @ SR-92	PM	I15-S	284.01	284.01	1	0.8	121.7	125.0
358	WB SR-201 @ 6800 W	PM	SR201-W	9.15	9.15	6	3.3	628.6	124.2
723	SB I-15 @ MP 286.05	PM	I15-S	286.05	286.05	18	1.6	356.0	121.7
559	SB I-15 @ 8600 S	AM	I15-S	296.35	296.35	1	2.6	905.0	120.0
4563	SB I-15 HOV @ 13600 S	PM	I15-S	289.61	289.61	2	0.5	28.5	117.5
710	NB I-15 @ MAIN - LEHI	PM	I15-N						
354	WB SR-201 @ 5800 W	NOON	SR201-						
940	NB I-15 @ 2700 N -Ogden	PM	I15-N						
314	EB SR-201 @ I-215-W (WEST SIDE)	AM	SR201-						
393	NB I-15 @ 8000 S	PM	I15-N						
720	NB I-15 @ 15200 S	PM	I15-N						
2385	SB I-15 @ 10600 S SB (OFF RAMP)	NOON	I15-S						
357	WB SR-201 @ 6500 W	PM	SR201-						
723	SB I-15 @ MP 286.05	NOON	I15-S						
455	NB I-15 @ 3000 S (BOUNTIFUL Coor	PM	I15-N						
717	NB I-15 @ NORTH ALPINE (N OF SR-	NOON	I15-N						
99565	SB I-15 HOV @ 9600 S	PM	I15-S						
99723	SB I-15 HOV @ MP 286.05	NOON	I15-S						
300	EB SR-201 @ 5800 W	PM	SR201-						
99579	SB I-15 HOV @ 12700 S	PM	I15-S						
796	I-15 SB S of Main St - AFK MP 27	PM	I15-S						
3397	NB I-15 to I-215 CON (Leading)	NOON	I15-N						
710	NB I-15 @ MAIN - LEHI	AM	I15-N	283.21	283.21	1	2.1	330.7	80.0
99732	SB I-15 HOV @ 600 W Lehi	PM	I15-S	281.84	281.84	1	0.8	33.4	80.0
99723	SB I-15 HOV @ MP 286.05	PM	I15-S	286.05	286.05	4	3.9	107.1	76.3
351	WB SR-201 @ 5100 W	PM	SR201-W	11.42	11.42	11	0.7	20.5	75.5
985	NB I-15 @ Antelope NB Off Layton	PM	I15-N	332.55	332.55	1	3.4	314.6	75.0
983	NB I-15 @ Antelope NB On Layton	PM	I15-N	333.15	333.15	1	3.4	309.0	70.0
767	NB I-15 @ Frontage Rd Farmington	PM	I15-N	323.07	323.07	1	1.4	145.0	70.0

Bottlenecks in PeMS: Additional facts

- # days active: during the time period, how many times was this particular bottleneck activated?
- Avg extent: what is the average spatial extent of congestion for this bottleneck when it's activated?
- Avg delay: what's the average delay caused by this bottleneck?
- Ave duration: how long does the bottleneck last on average?

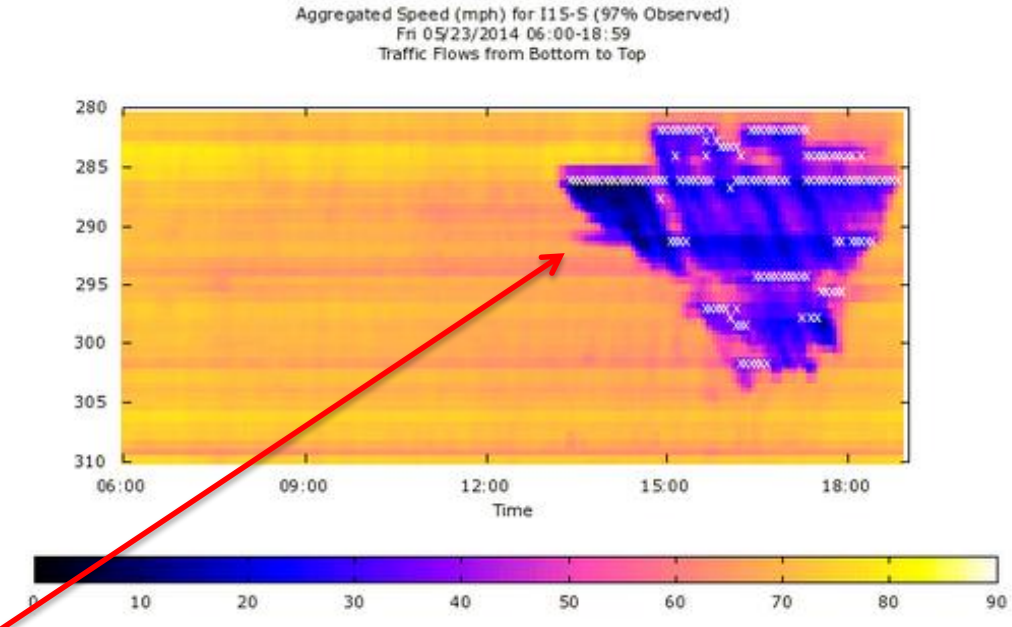
Jumps to delay vs time of day for this station

Jumps to speed contour diagram for first day of period

						Bottleneck Characteristics			
Station	Name	Shift	Fwy	Abs PM	State PM	# Days Active	Avg Extent (Miles)	Avg Delay (veh-hrs)	Avg Duration (mins)
741	SB I-15 @ 1200 N - OREM	AM	I15-S	272.24	272.24	31	1.2	426.2	284.8
99409	NB I-15 @ 4550 S HOV Lane	AM	I15-N	301.52	301.52	31	0.4	127.2	224.8
700	NB I-15 @ 1200 N - OREM	AM	I15-N	272.24	272.24	25	1.2	105.3	206.6
369	NB I-15 @ 13400 S	AM	I15-N	289.96	289.96	1	0.3	22.5	195.0
612	EB I-80 @ SR 65 (WEST SIDE)	AM	I80-E	133.58	133.58	1	0.5	43.5	180.0

Bottleneck Exploring: Lists and Plots

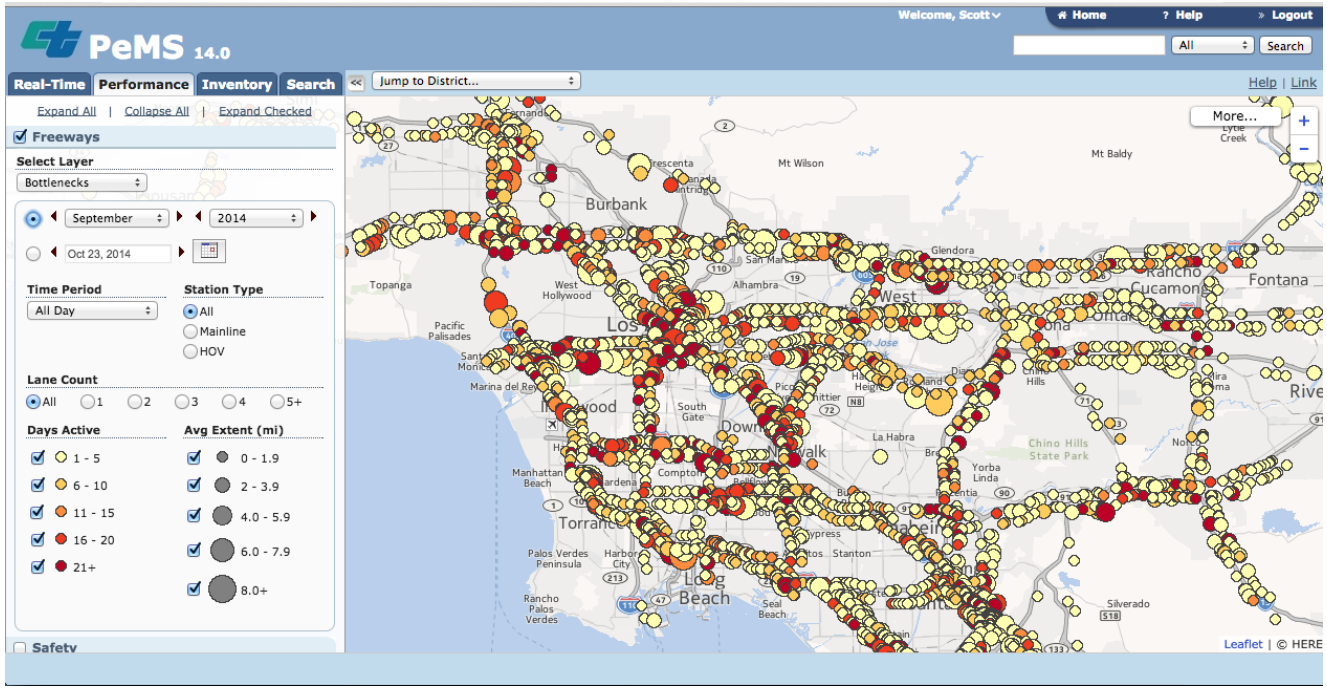
- I15-S
- PM 280-310
- Weekdays
- PM period



						Bottleneck Characteristics			
Station	Name	Shift	Fwy	Abs PM	State PM	# Days Active	Avg Extent (Miles)	Total Delay (veh-hrs)	Total Duration (mins)
723	SB I-15 @ MP 286.05	PM	I15-S	286.05	286.05	4	1.9	1,980	475
559	SB I-15 @ 8600 S	PM	I15-S	296.35	296.35	2	4.7	793	85
8578	SB I-15 Ramp Meter @12300 South	PM	I15-S	291.15	291.15	4	1.2	522	215
732	SB I-15 @ 600 W Lehi	PM	I15-S	281.84	281.84	2	2.2	433	135
557	SB I-15 @ 8000 S	PM	I15-S	296.86	296.86	4	3.3	349	75
580	SB I-15 @ 13275 S	PM	I15-S	290.26	290.26	1	3.5	331	55

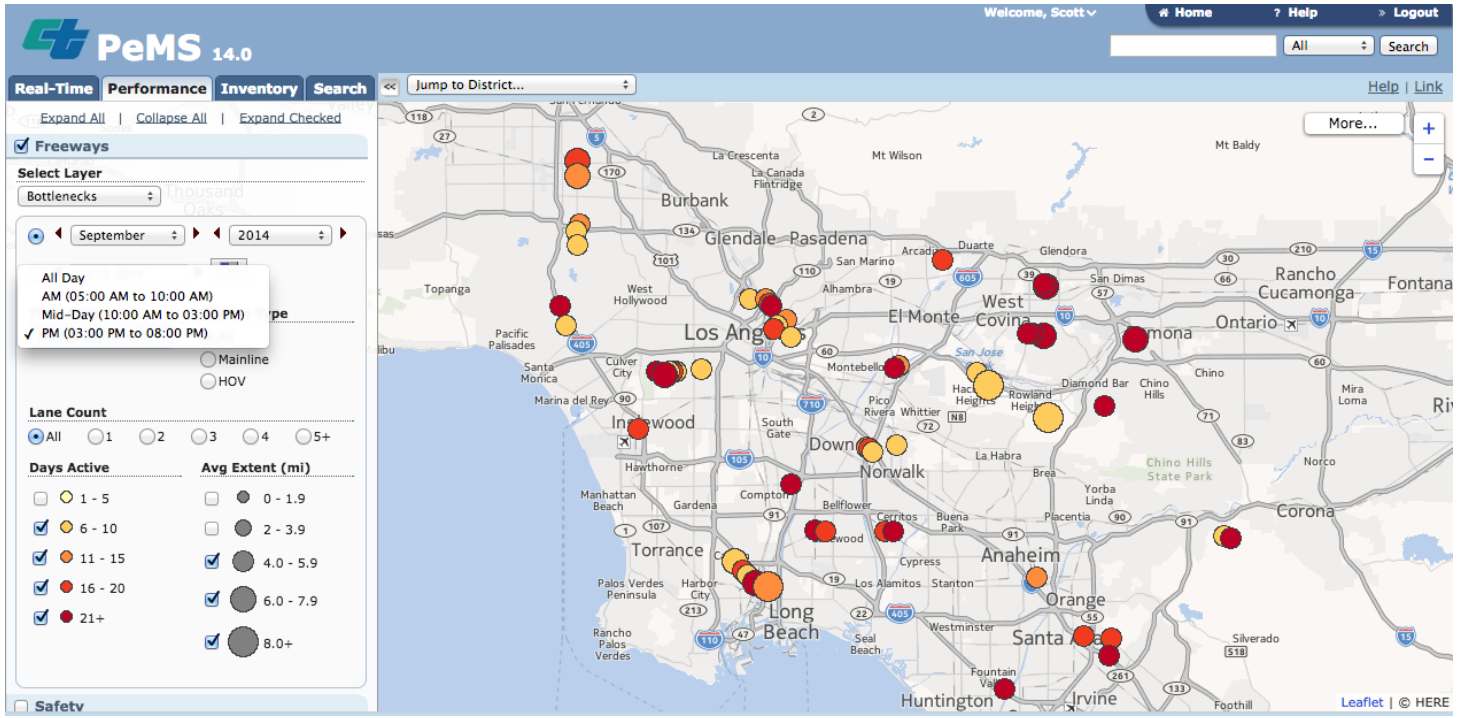
Different Types of Analysis: Detector Bottleneck Map

- The PeMS Bottleneck Identification Algorithm
  - Finds places where there is a persistent slowdown in speed
  - When viewed over many days, the trends become clear
- Size = number of days the bottleneck was activated
- Color = spatial extent of the backup



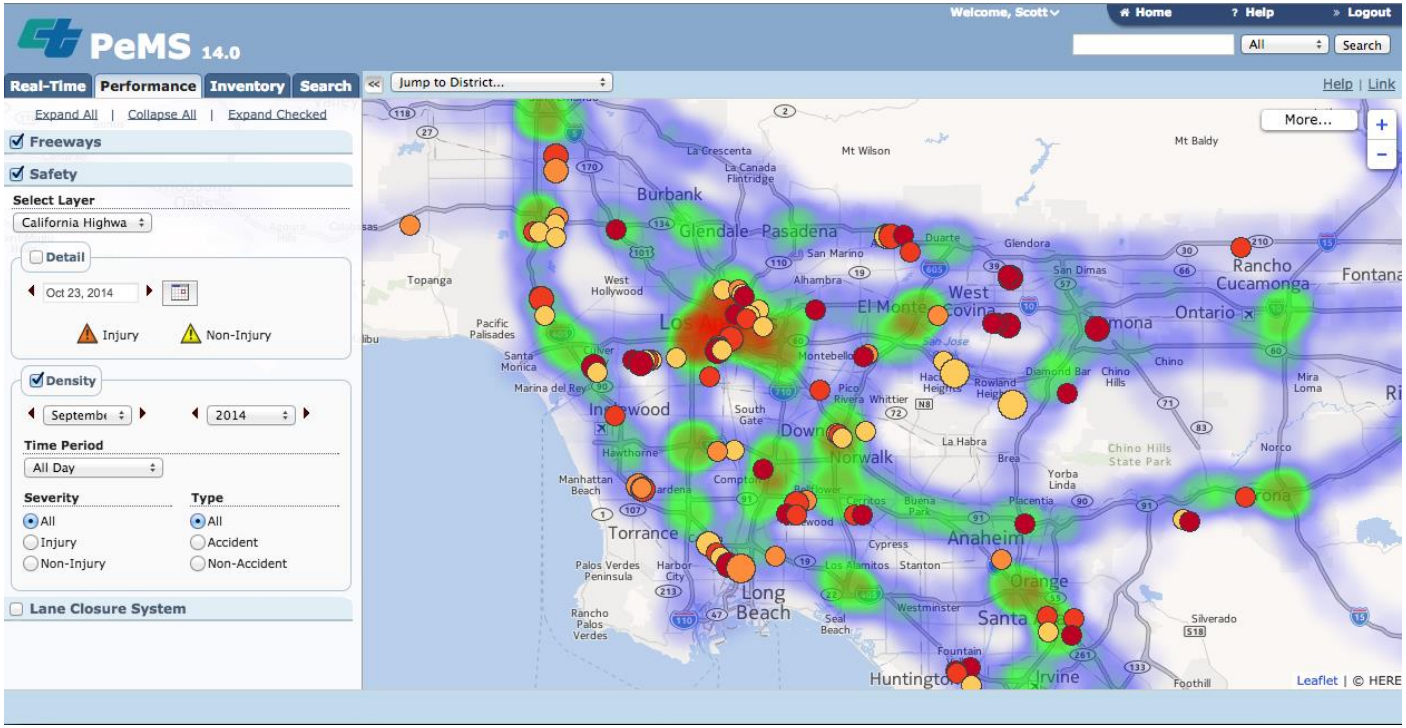
Different Types of Analysis: Detector Bottleneck Map

- Can adjust filters
  - Time of Day (AM & PM Peak, mid-day, All Day)
  - Number of days
  - Length of queue

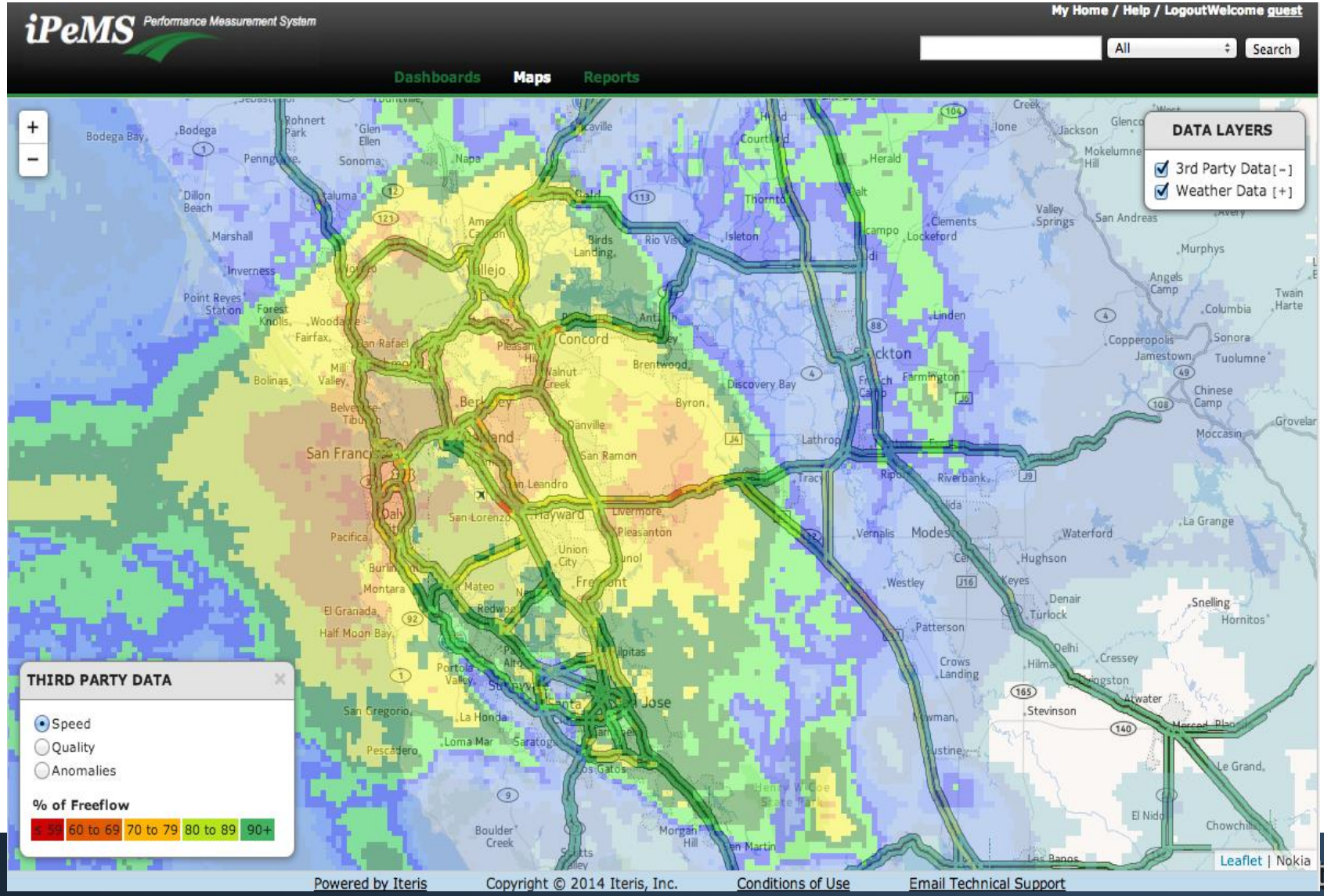


Different Types of Analysis: Adding Causes - Incidents

- Adding incident data lets you see other patterns
- Are bottlenecks correlated to incidents?
- Example shows persistent and long bottlenecks in the LA region Sep 2014 vs. heat map of CHP incident data for the same region

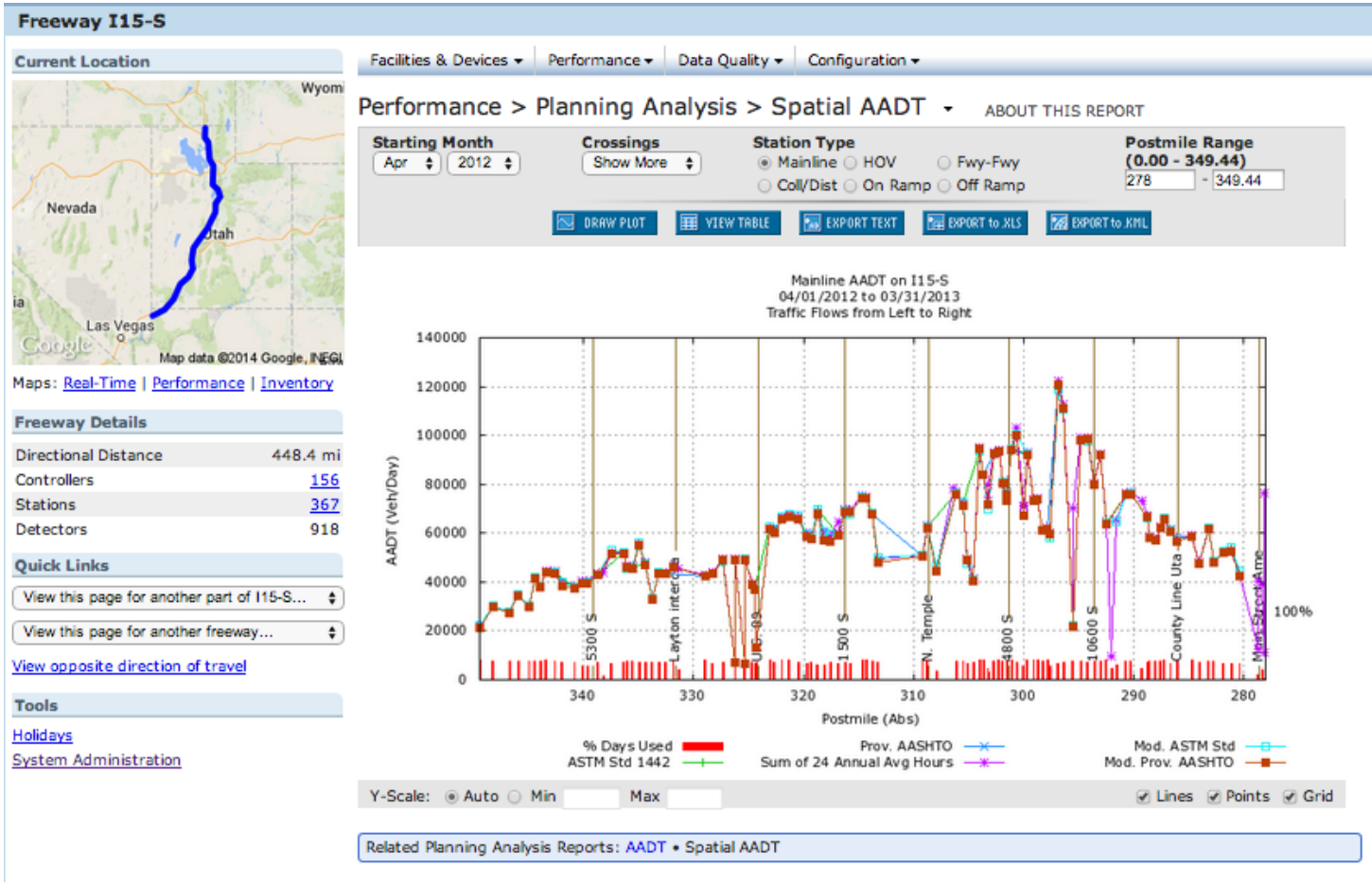


Different Types of Analysis: Adding Causes - Weather



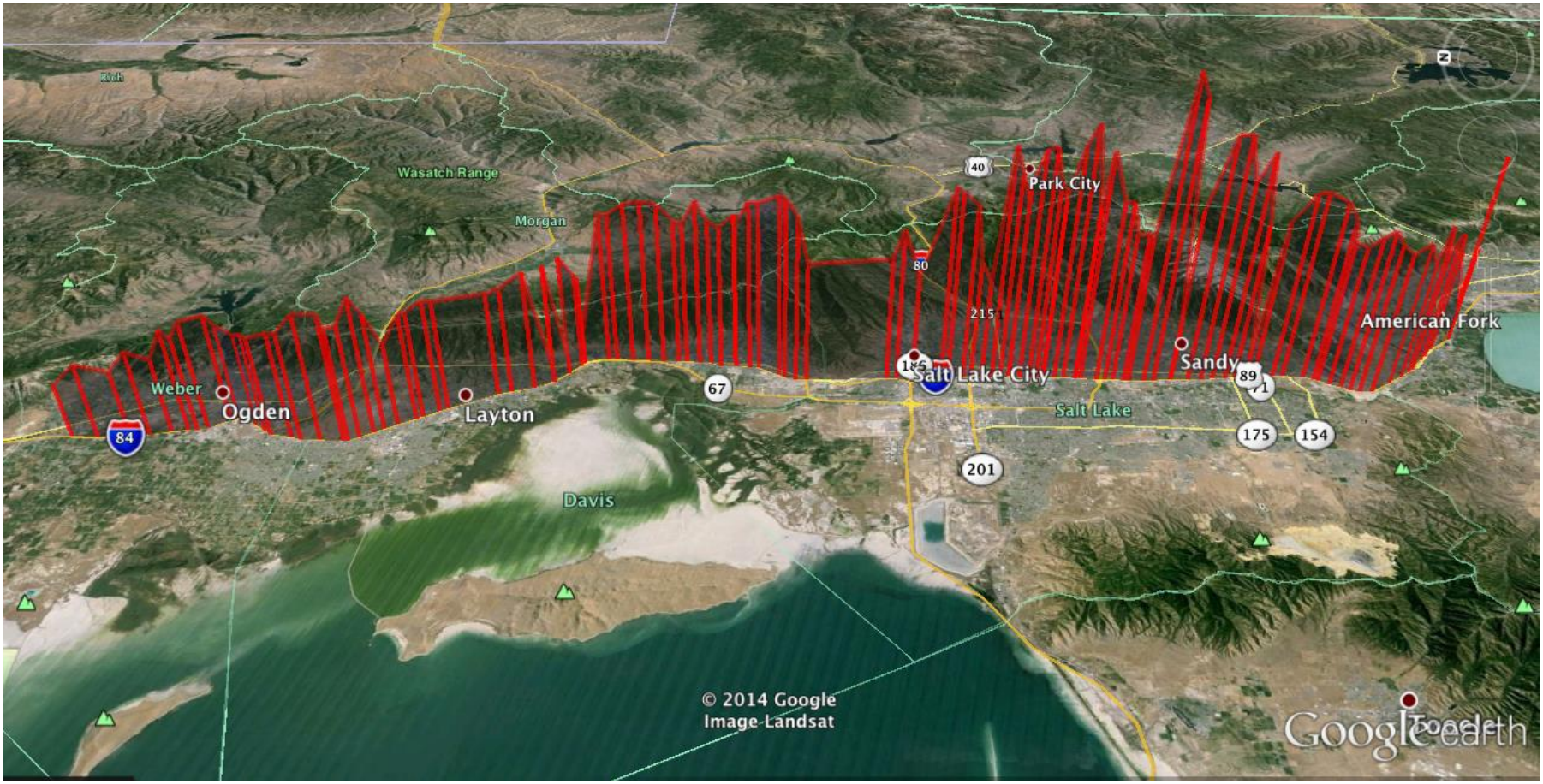
Volume Impacts: Spatial AADT

- Is the issue volume?
- Spatial AADT along a freeway in a direction (I-15 SB)



Long-term Trends: AADT

- And you can export to KML to see the AADT data on a map



Performance Measurement: Operations Tools

Ramp Metering >

Ramp metering analysis lets users compare ramp data with data and performance measures from nearby stations.

Managed Lanes Dashboard >

The Managed Lanes Dashboard monitors the performance of HOV lanes and other managed facilities. Includes overall and peak congestion, weekly performance timeseries, weekly demand time series and weekly ratio of demand.

Freeway Service Patrol >

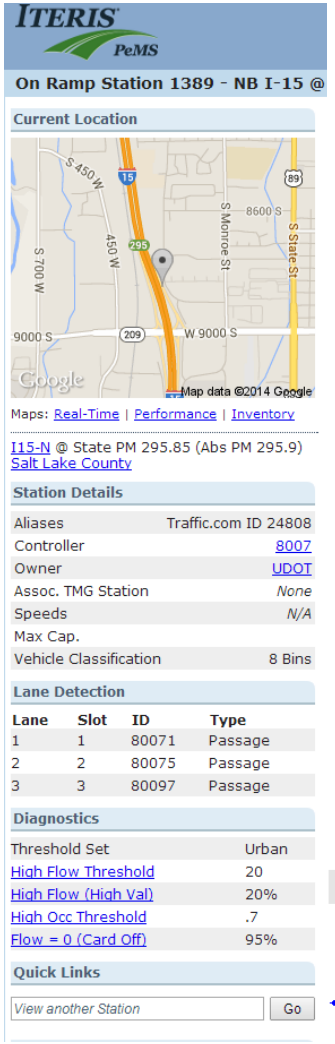
The Freeway Service Patrol (FSP) beats dashboard summarizes performance of freeways that are patrolled by roving tow trucks that help stranded motorists, clear debris, and assist Highway Patrol with incident response during peak hours.

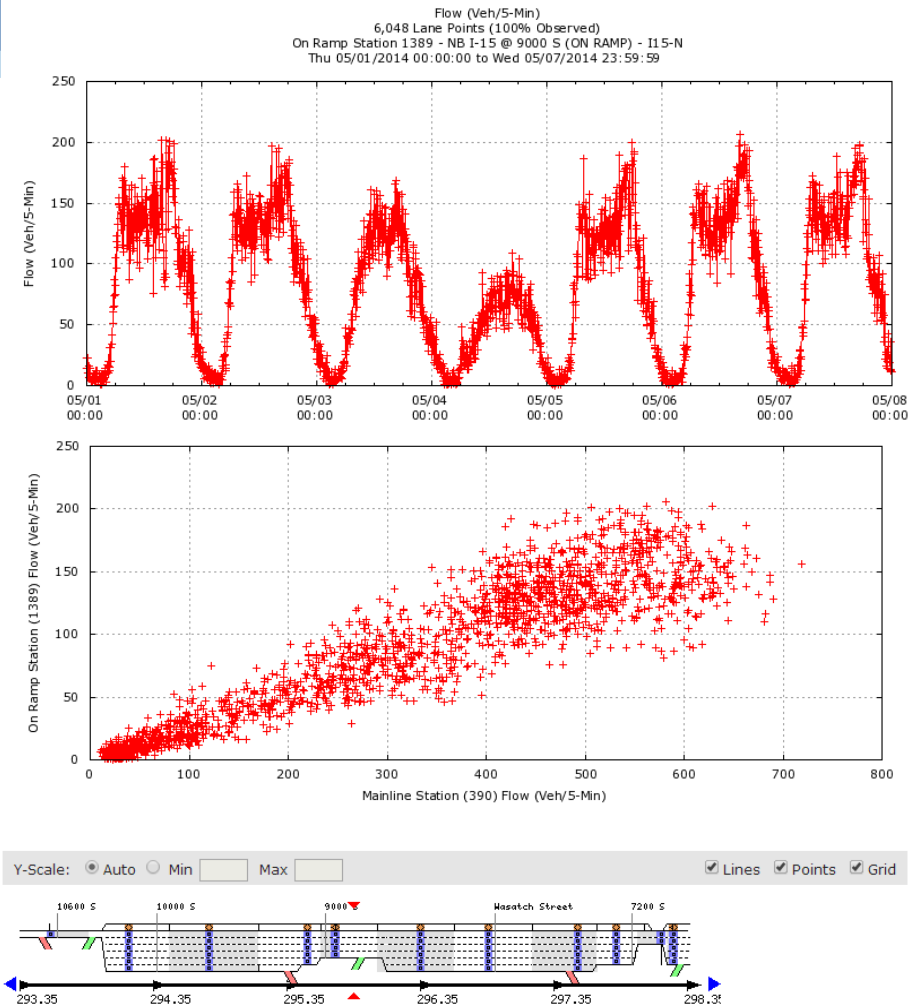
Lane Closures >

Lane closure reports provide visibility into the quantities and types of lane closures that can be grouped, measured and compared.

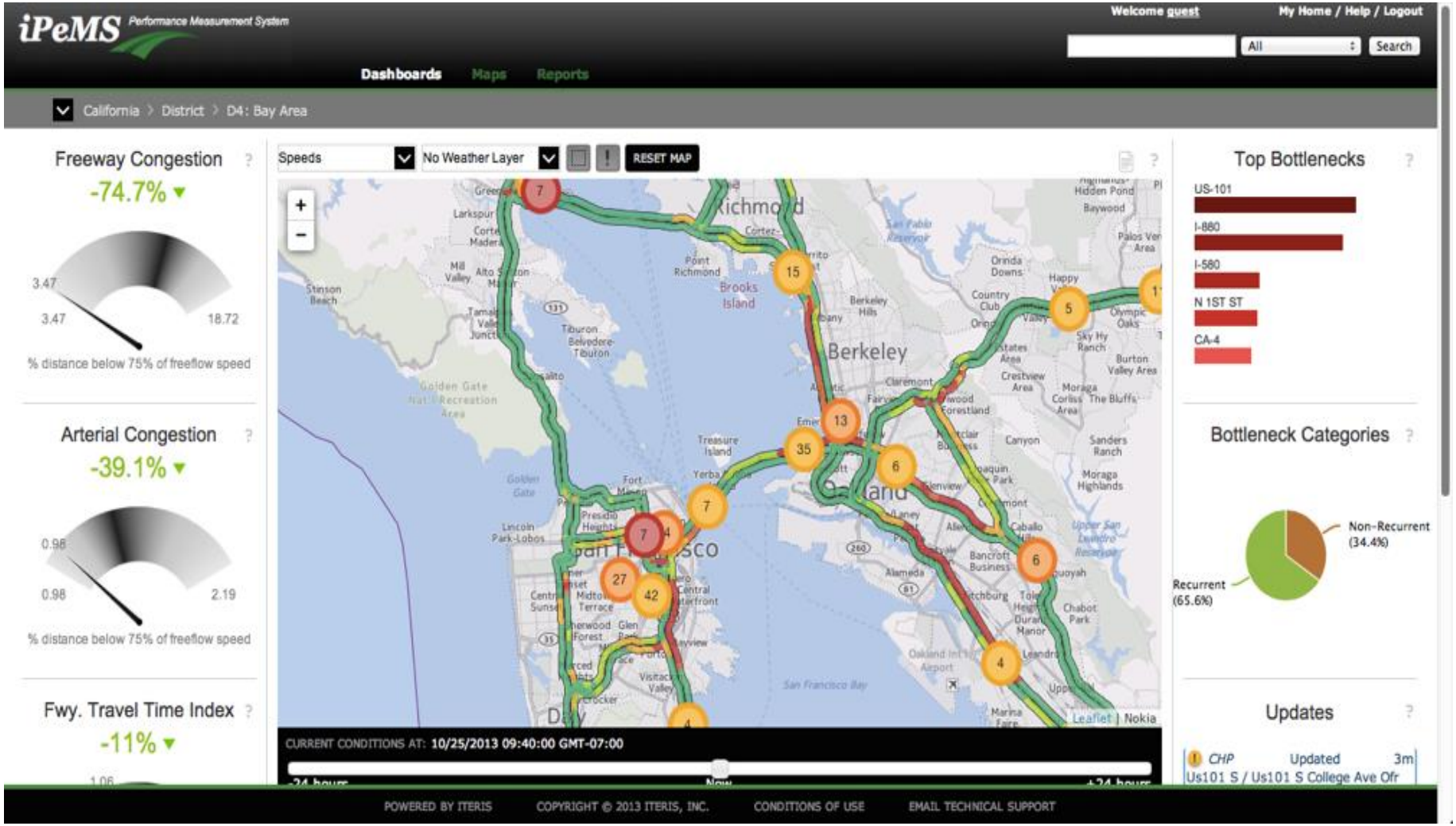
Operations Bottleneck Tools: Ramp Data and Metering

- Ramp metering
  - In the morning from 6:30am-9:15am
  - Is it working?
  - If yes, during AM peak on-ramp flow should be restricted
- Plots to show on-ramp flow vs. mainline flow
  - As mainline flow is increases, on-ramp flow will stay at constant metering rate



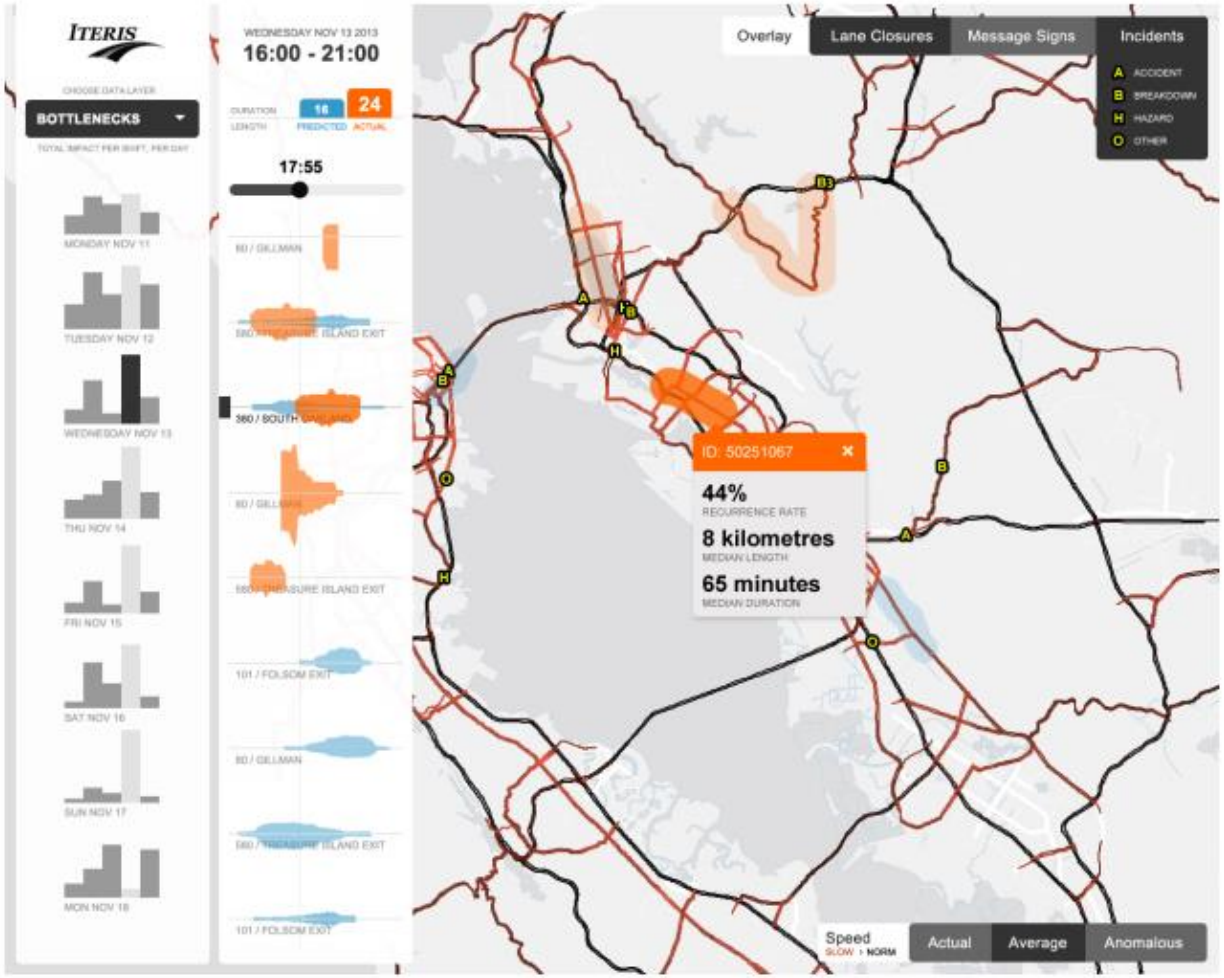


Operations Bottleneck Tools: Dashboard Visualizations



Visualizations: Map Based Bottleneck Identification

- Third-party speeds (e.g. Nokia HERE)
- Full road network graph
- Forecast recurrent bottlenecks

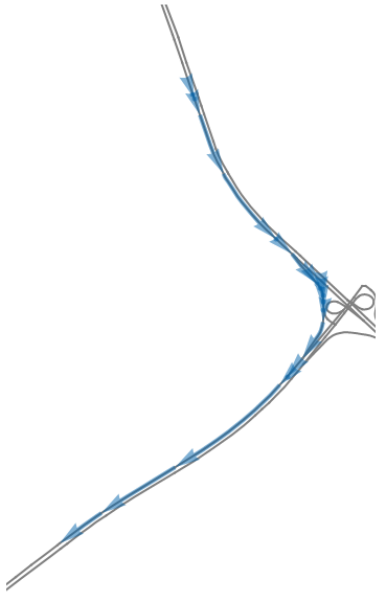


Bottleneck detection: Generalize to road network

- Previously: limited to single linear road (e.g. sequence of detectors)

Linear bottleneck **on freeway mainline**
(Toll booth of Richmond bridge)

- Generalization: Look for queue on all parts of network upstream of bottleneck

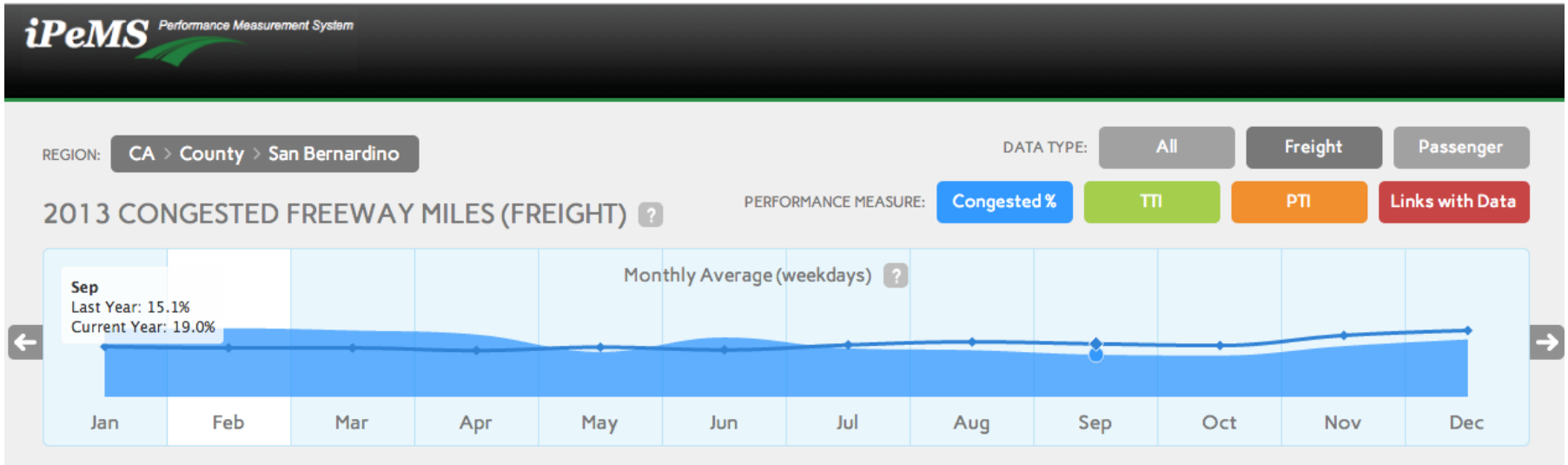


Linear bottleneck **not on freeway mainline** (Dumbarton bridge)

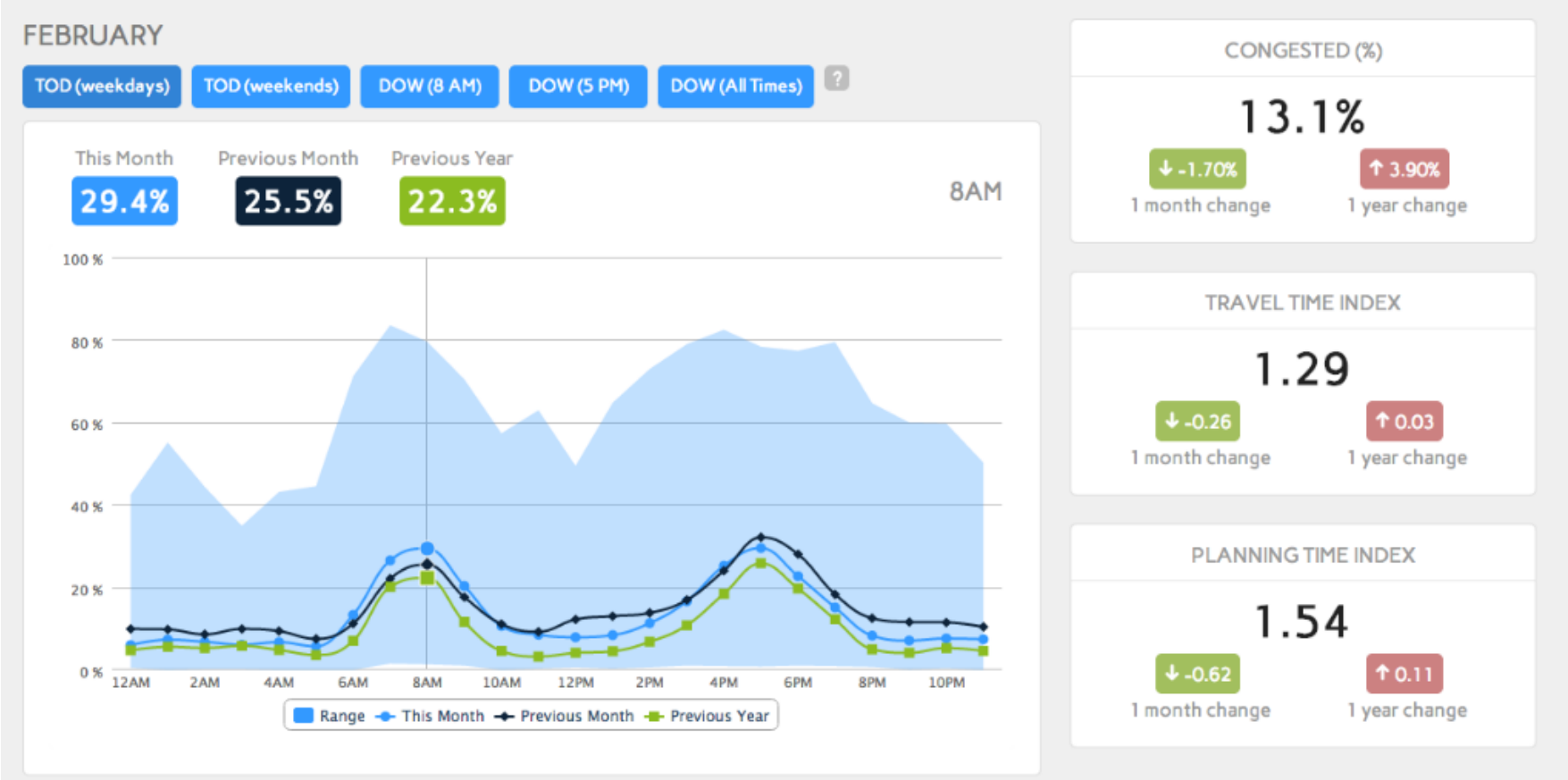
“Nonlinear” bottlenecks

- We also see bottleneck-like conditions with multiple, branching queues (i.e. on and off mainline)

Operations Bottleneck Tools: Regional Passenger & Freight Planning



Operations Bottleneck Tools: Regional Passenger & Freight Planning



Bottlenecks, Congestion, Travel Time and Measures for Routes and Corridors

Time Series >

The time series plots allow the user to show volume, delay and other variables over time by individual lane or aggregated by direction and lane type.

Contour Plots >

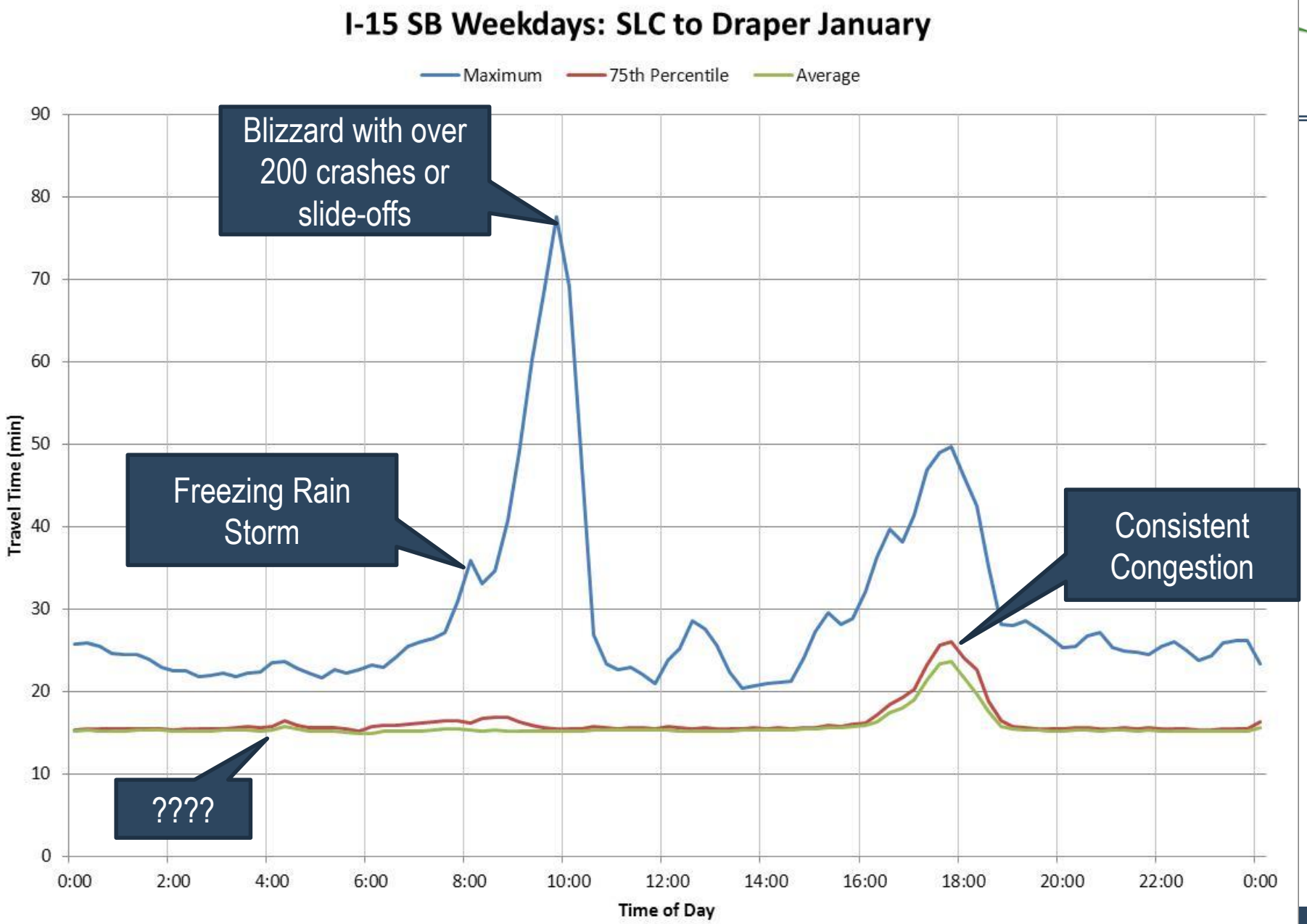
Visualize traffic speeds from traffic sensor data through contour plots that show congestion, bottleneck and incident patterns.

Departure Time Series >

Departure Time Series lets users see the variability in travel time for a specfied time of day.

Lane Requirements Chart (Planning for Closures) >

Determine the number of lanes to keep open during construction based on capacity and demand on the freeway.

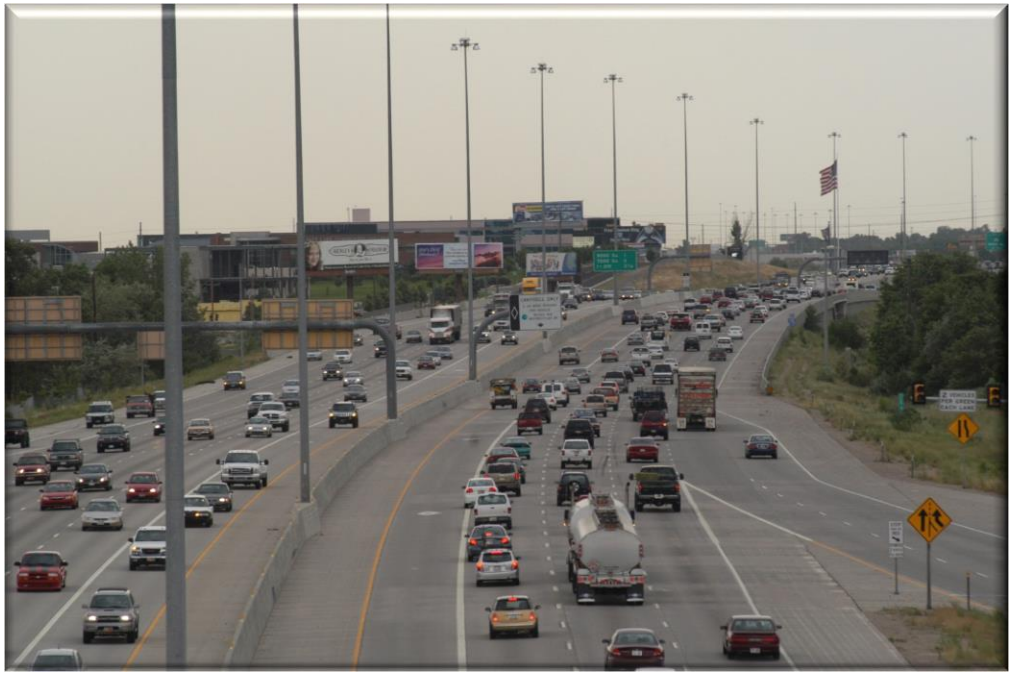

I-15 SB Weekdays: SLC to Draper January
Maximum
75th Percentile
Average
Travel Time (min)
Time of Day
0
10
20
30
40
50
60
70
80
90
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:00
0:00
Blizzard with over 200 crashes or slide-offs
Freezing Rain Storm
Consistent Congestion
????

Using Delay to Show Bottlenecks

- Vehicle Speeds Under 55 mph

  Vehicle-Hours = Vehicle Volumes X Additional Travel Time

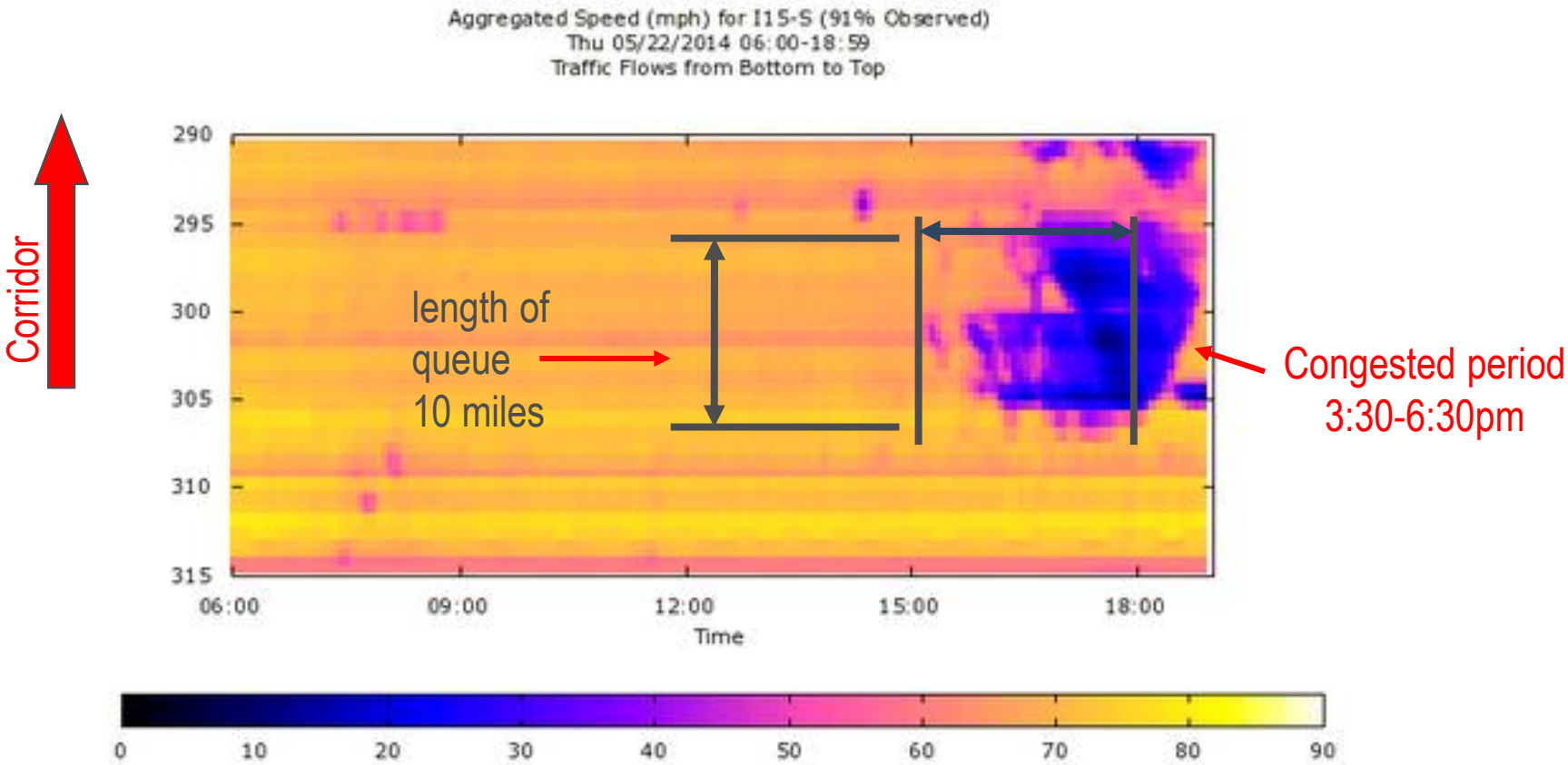
  All Days: I-15 SB SLC to Draper



Cumulative Delay

Cumulative Delay

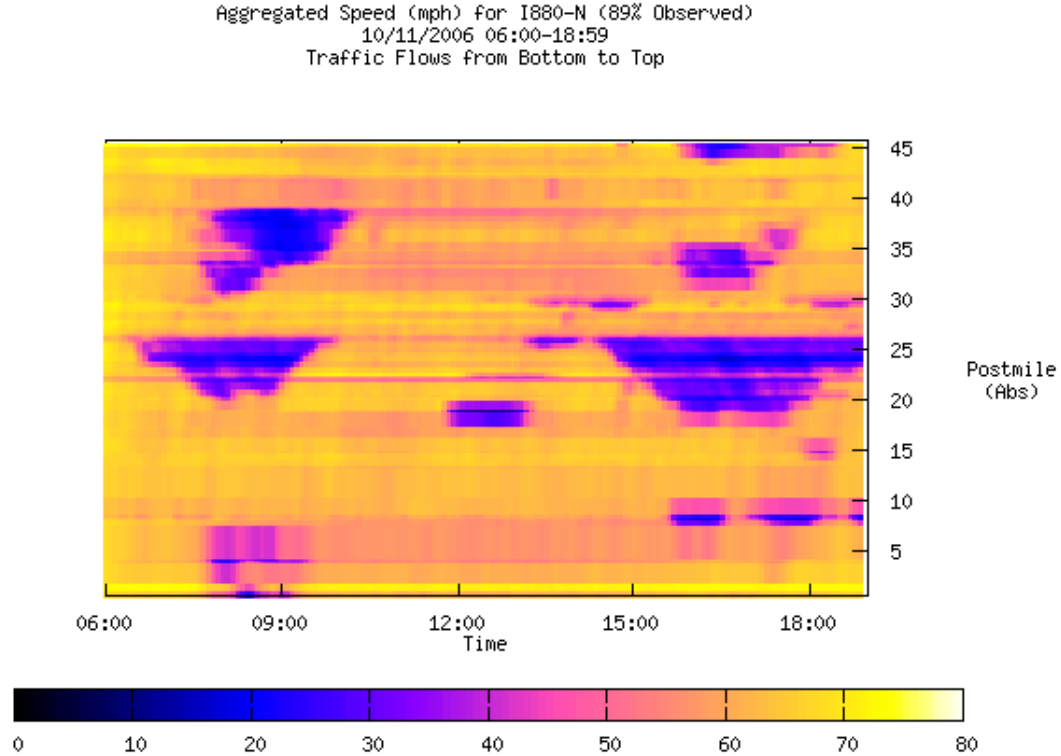
Bottlenecks: Timeseries Contour Plots



Contour Patterns

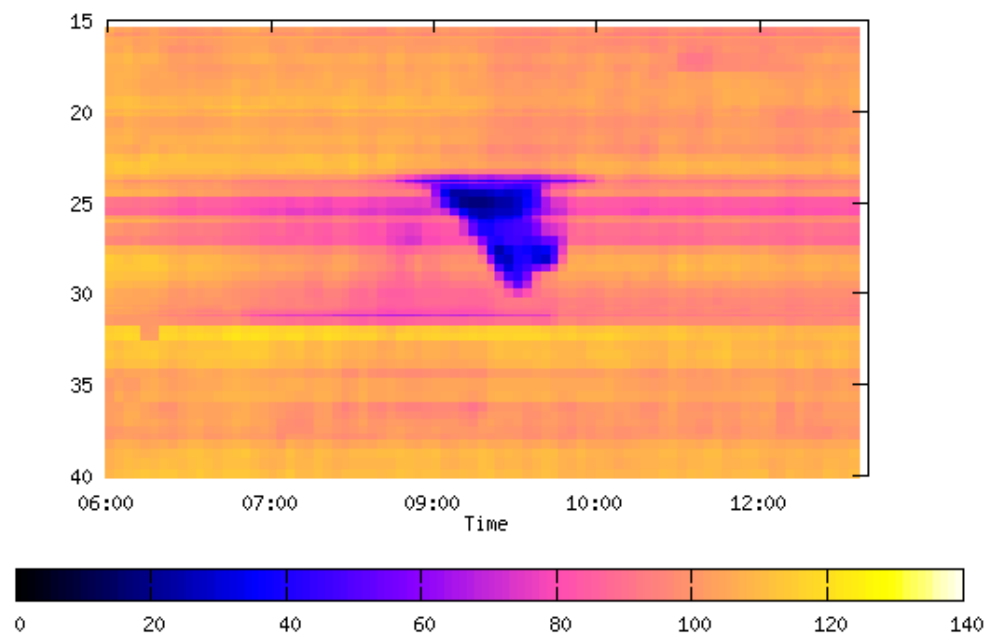
Demand based congestion

- Queue builds and shrinks with demand: queue shrinks from the end.



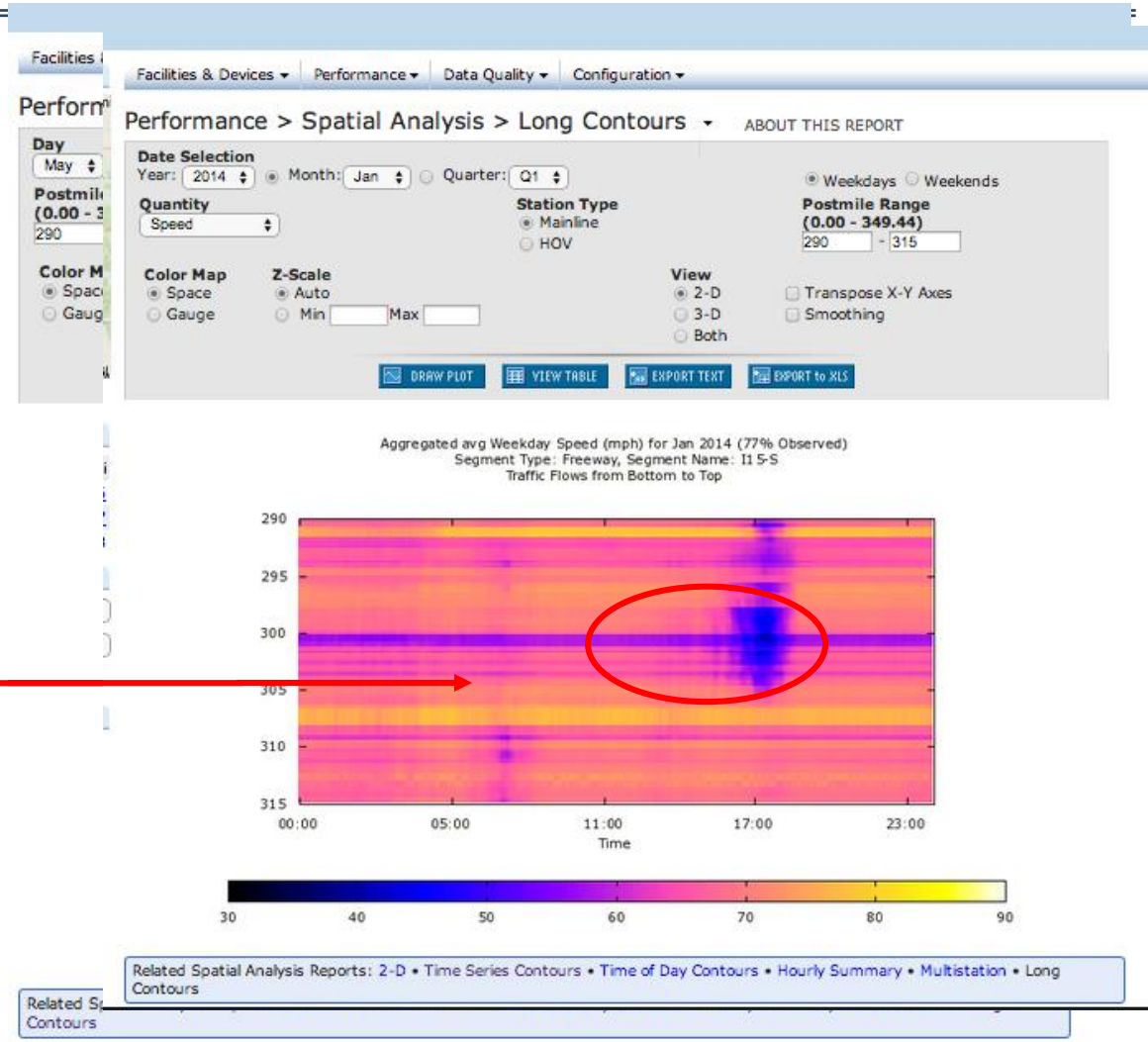
Incident-based congestion

- Capacity is suddenly restored: queue doesn't dissipate from the end



Long Term Timeseries Contour Plots

- Looking at recurrent bottlenecks

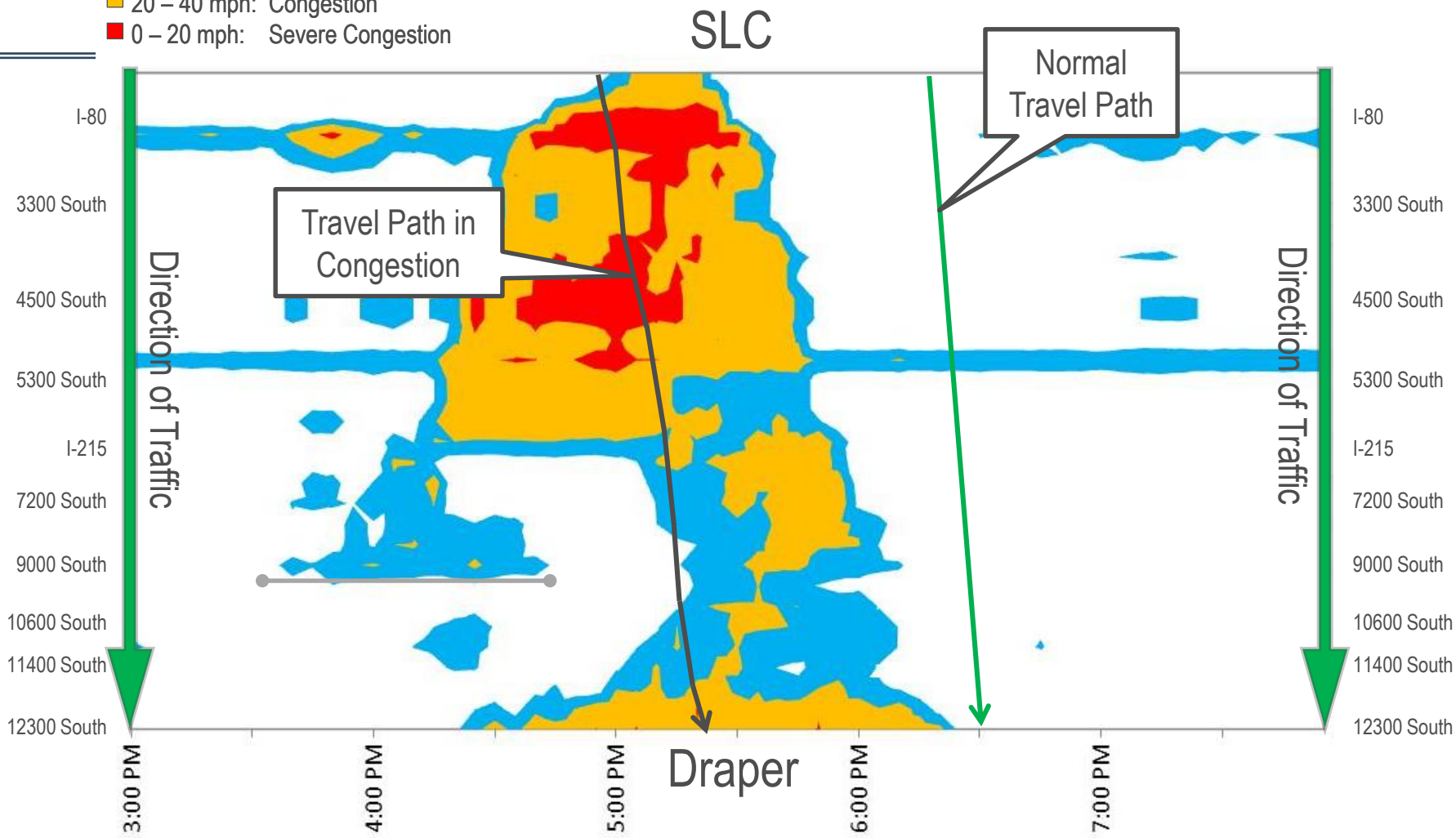


The same queue, but on the Friday before Memorial Day it stared earlier and lasts longer

Speed Contours

I-15 SB SLC to Draper

- 55+ mph: Free-flow conditions
- 40 – 55 mph: Delay
- 20 – 40 mph: Congestion
- 0 – 20 mph: Severe Congestion



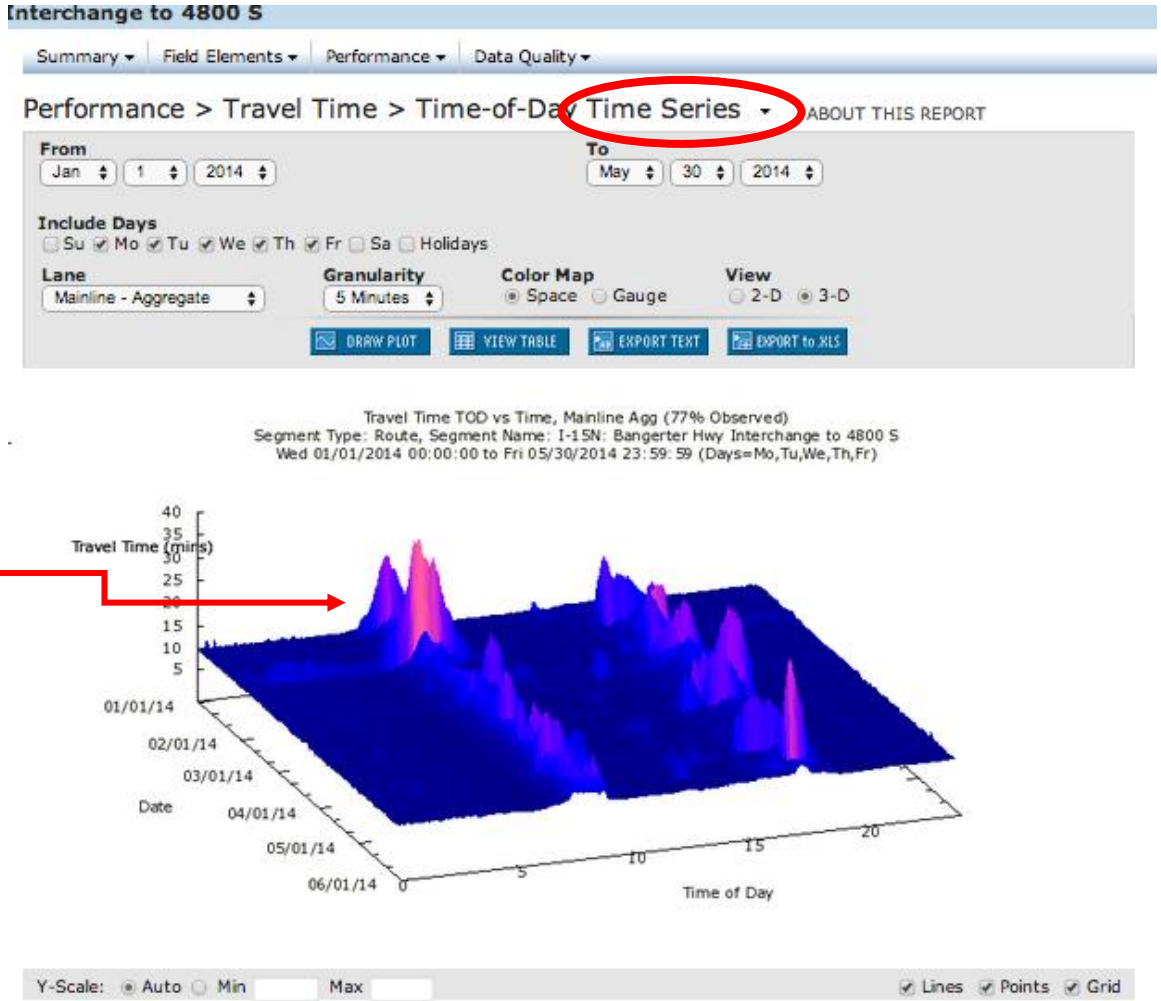
Incident Impact Level

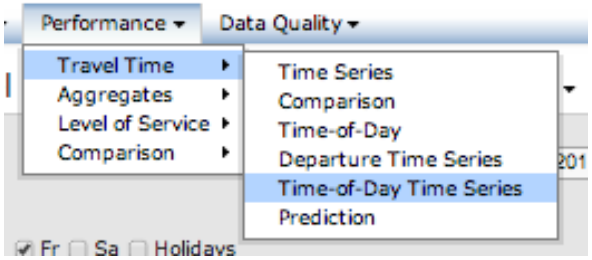
- 1: Not blocking any lane
- 2: Blocking less than ½ thru lanes
- 3: Blocking at least ½ thru lanes

12/14 Friday

Bottlenecks by Travel Time: Time of Day Timeseries

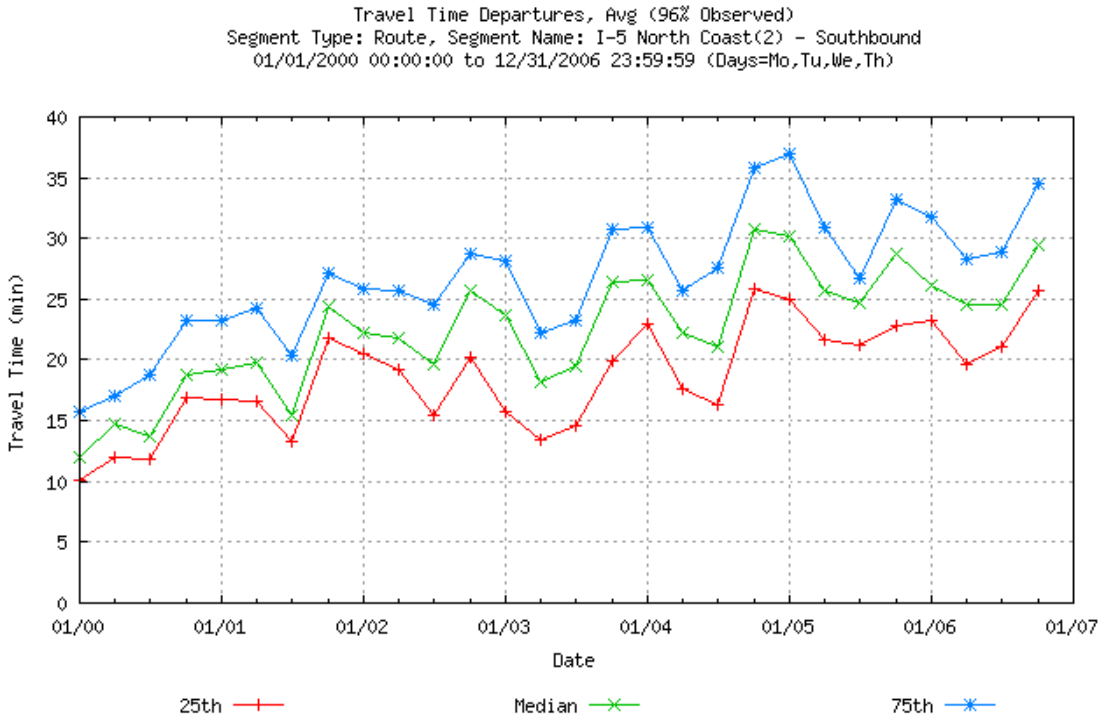
- Showing travel time over the course of the day, over many days
- Can see the ridge that is the morning commute

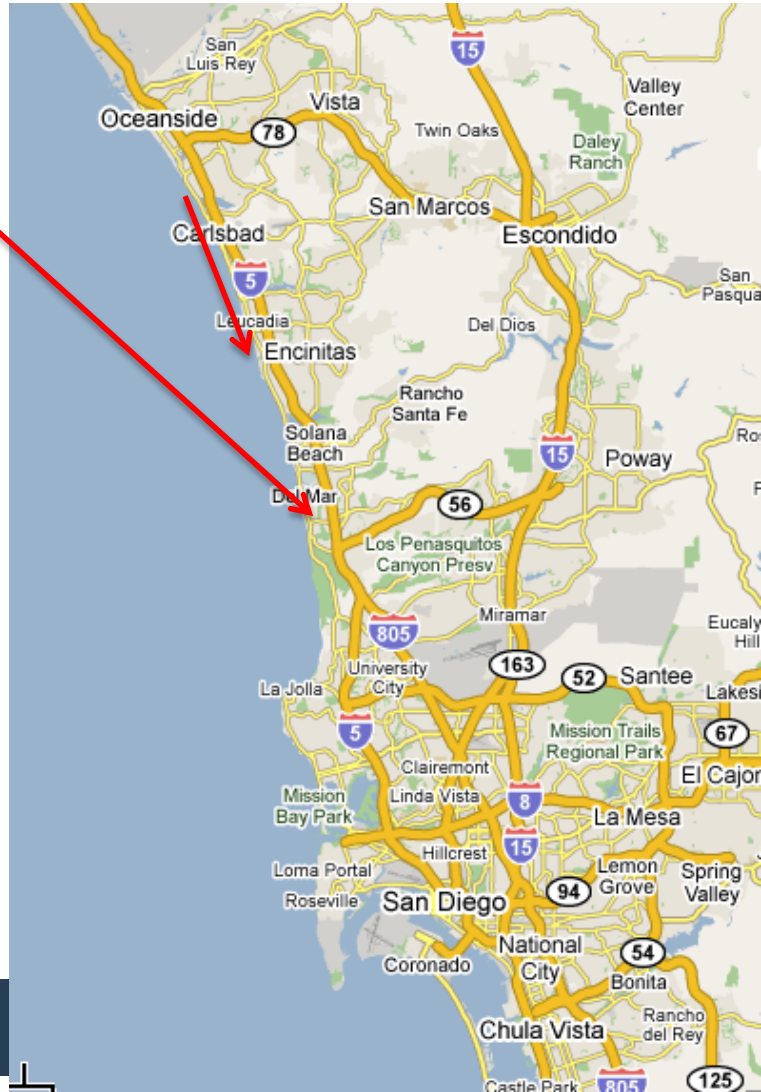




Case Study:
I5 SB Santa Fe Additional Lanes

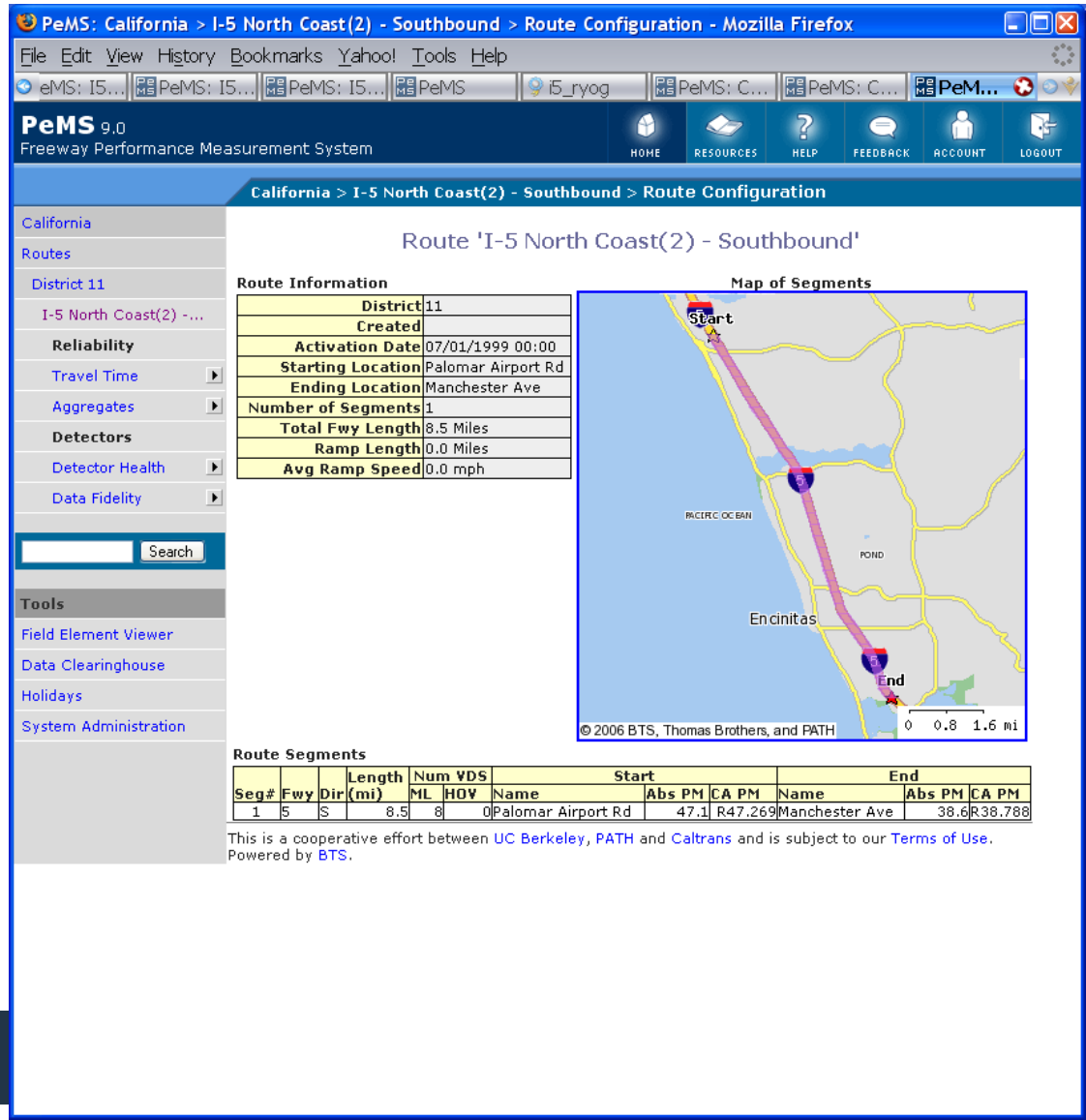
- SB I-5 approaching San Diego is a heavy AM commute route
- Where SR56 merges with I5 is especially bad
- Over time, demand has risen along with congestion
- Plotting the weekday AM travel time per quarter over 7 years

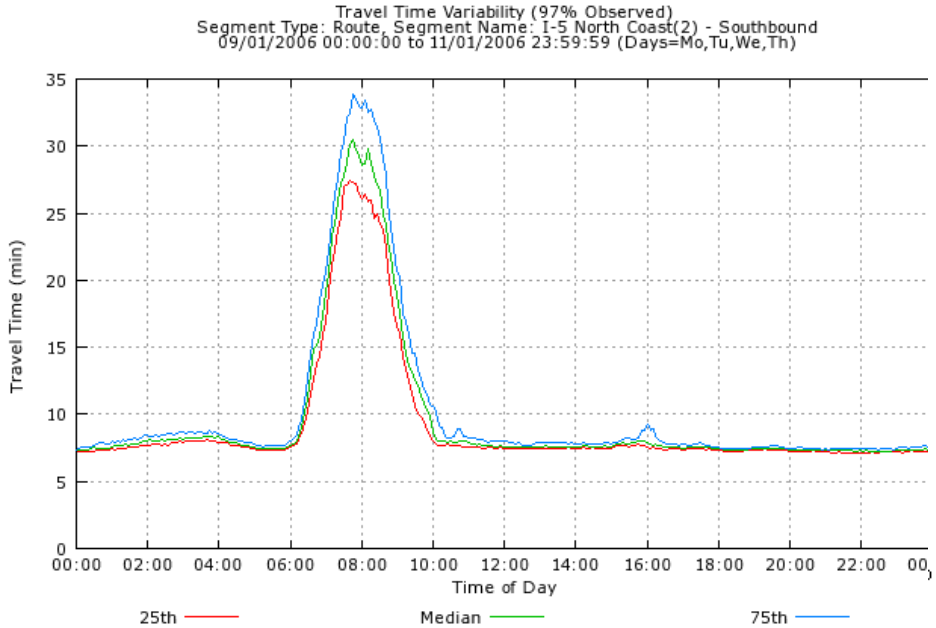


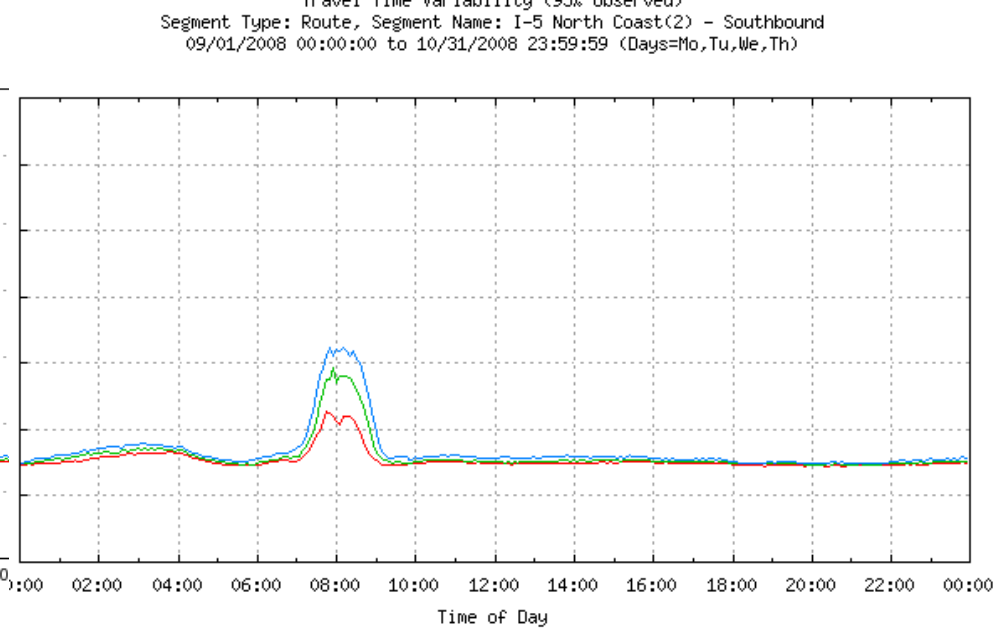


Case Study:
I5 SB Santa Fe Additional Lanes

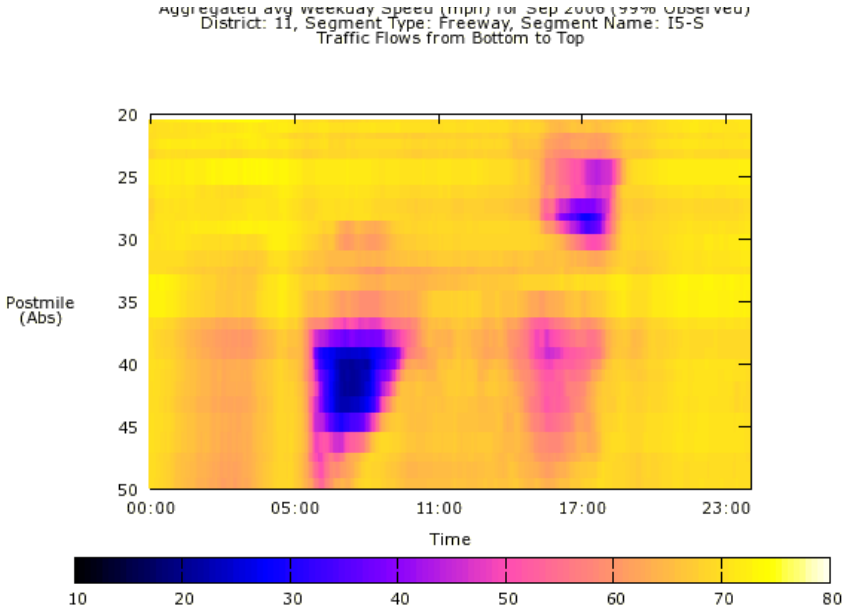
- Decided to do a construction project to add a lane in the southbound direction at SR56 merge
- Construction done during the summer of 2007
- We can compare the "Before" scenario (timeframe was September/October 2006)
- And "After" scenario (timeframe was September/October 2008)
- Here we're showing a "route" that has been defined in PeMS for that section of freeway
- Routes allow us to compute certain performance measures over that section of freeway

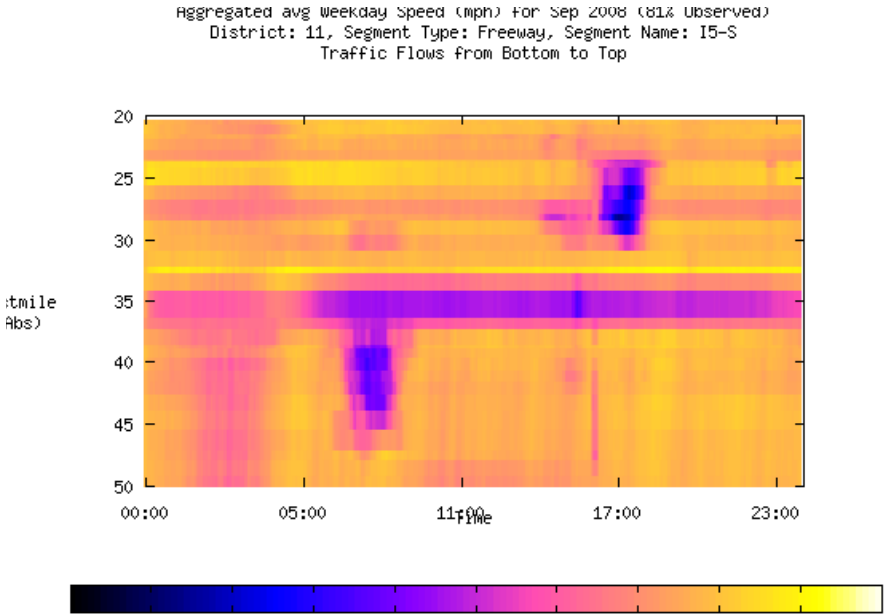






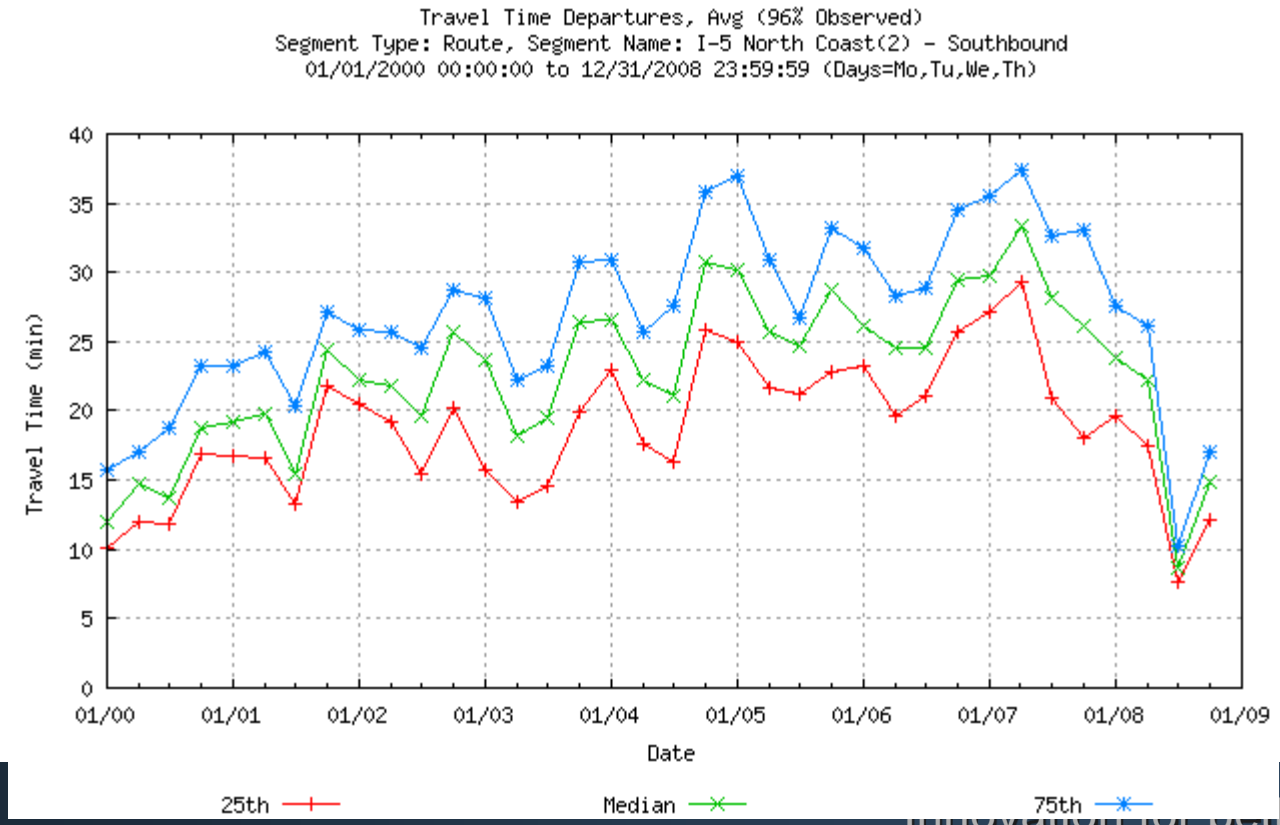
- Top shows travel time versus time of day (M-Th). Left is Sep/Oct '06, Right is Sep/Oct '08.
- Bottom shows speed contour for weekdays. Left is Sep 2006, Right is Sep 2008.
- In both cases we can see significant AM savings





Case Study:
I-5 SB Santa Fe Aux Lanes Open

- Extended the travel time plot through 2008
- Can see a significant decrease in travel times
- Graphs and charts are used to present to decision makers and public officials that efforts by the DOT and MPO are effective



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