Caltrans PeMS Workshop

presented to

Caltrans District 5

presented by

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CAMBRIDGE SYSTEMATICS

October 30, 2018

Think Forward

Workshop Objectives

- Provide guidance such that attendees feel comfortable using the PeMS platform and its data.
- Describe general usage, tips, and identify resources and materials for future consultation.
- Give attendees real examples to use for the development of a corridor analysis study.

Content

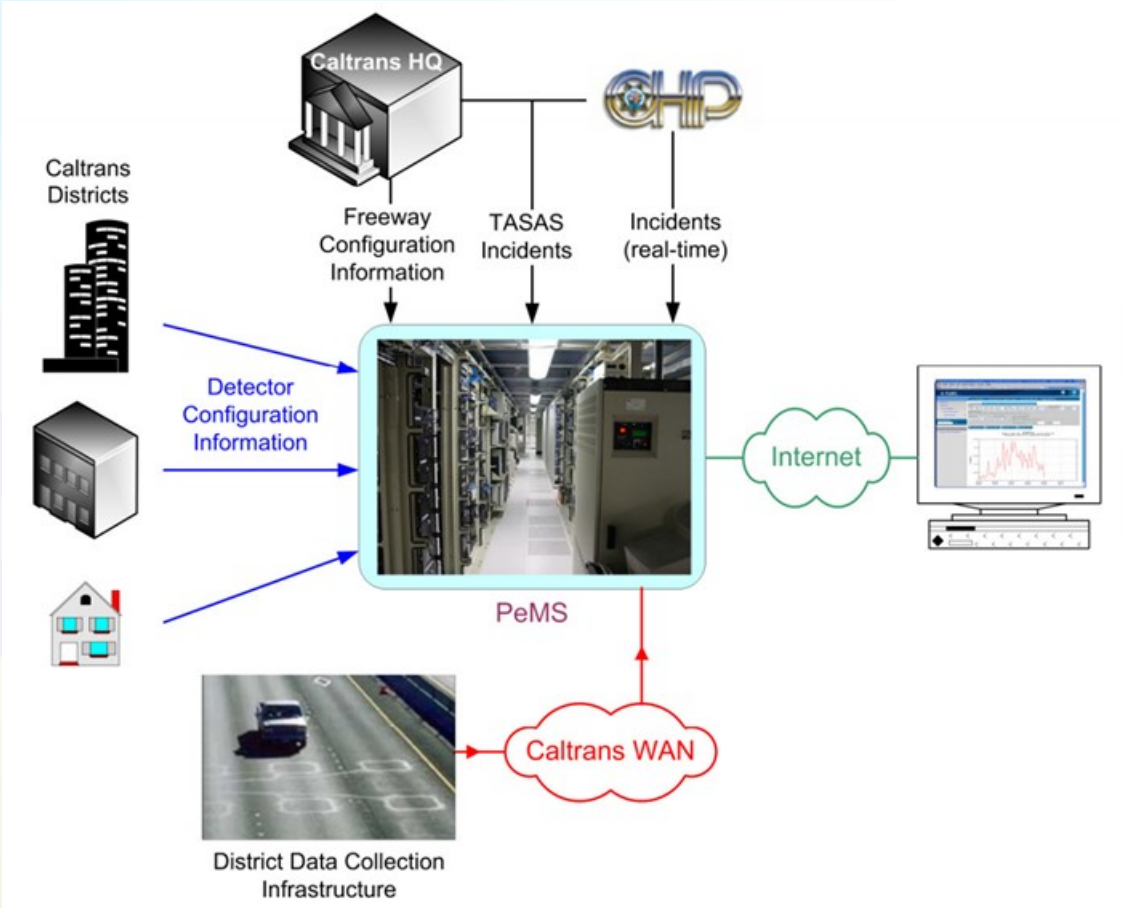
- Introduction to PeMS
  - Introduction
  - How Does PeMS Work?
  - Data Available
  - System Overview
  - Help & References
- Exercise 1 – Familiarizing with Dashboard
- Exercise 2 – Evaluate Data Quality on Corridor
- Exercise 3 - Evaluate Traffic Counts on Corridor
- Exercise 4 – Evaluate Typical Speeds on Corridor
- Exercise 5 – Downloading Raw Data

INTRODUCTION TO PEMS

Introduction

- What is PeMS?
  - PeMS stands for Performance Measurement System, it is Caltrans depository for real-time traffic data.
  - PeMS started in 1999 as a UC PATH research project.
  - Processes data of over 35,000 detectors, every 30 seconds.
  - Data is stored from inception (detector added) and never deleted, it has now over 12 Tb of data.
- How can I access it?
  - Go to http://pems.dot.ca.gov/
  - Create User Profile (User Name and Password).

How Does PeMS Work?



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Data Sources

- Intelligent Transportation System (ITS) Vehicle Detector Stations (VDS)
- Traffic Counters
  - Traffic Census Stations
  - Weight-In-Motion (WIM) Sensors
- Other Data Sets
  - California Highway Patrol (CHP) Incident data
  - The Caltrans Traffic Accident Surveillance and Analysis System (TASAS) accident data (for Caltrans users only)
  - Lane Closure information from the Caltrans Lane Closure System
  - Electronic Toll Collection (ETC) Reader data (Bay Area only)
  - Changeable Message Signs (real-time information only)
  - Arterial Detector data and Timing Plans (limited data in District 11)
  - Transit data such as routes and schedules, Automated Vehicle Location (AVL) and Automated Passenger Count (APC) data (limited data in District 11)

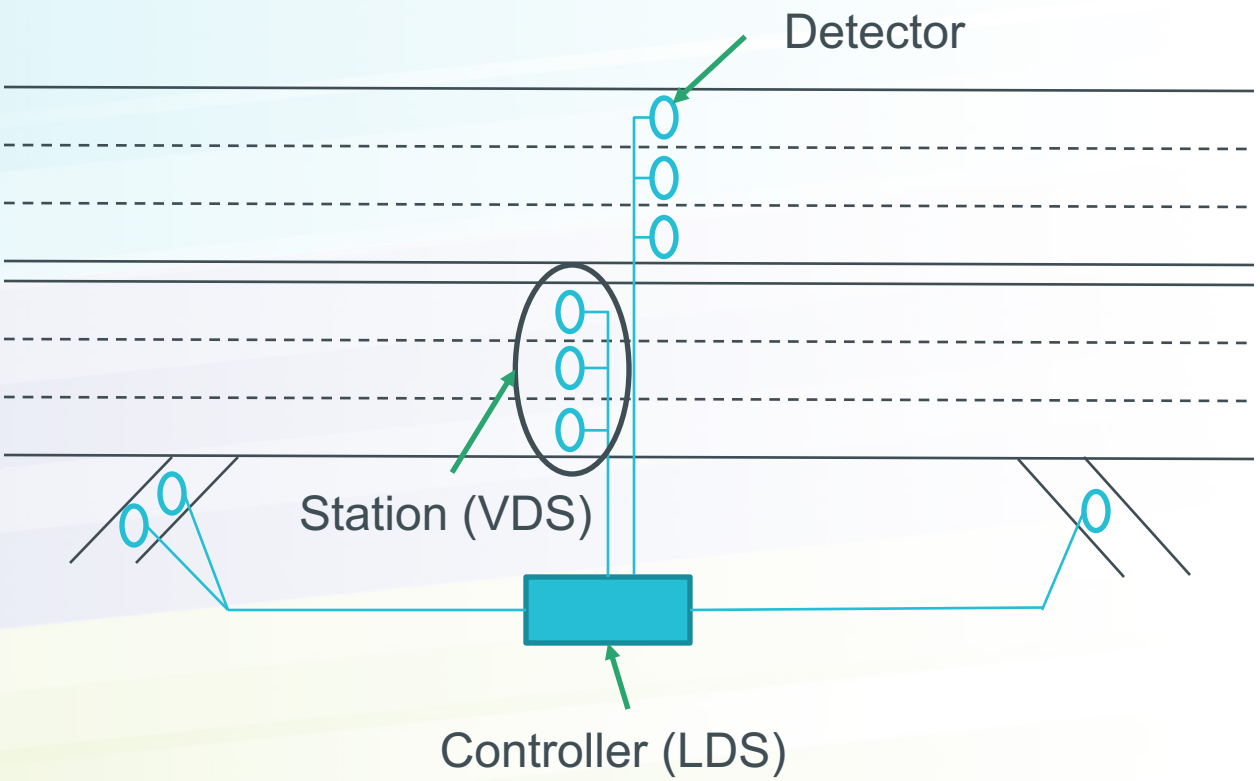
Data Available

- Computes standard transportation performance measures, such as **VMT**, **VHT**, **Delay** (expressed in vehicle-hours), and **Level of Service (LOS)**
- Calculates **travel time** and travel time reliability measures, such as the **Buffer Time Index**, **Travel Time Index**, and other descriptive statistics
- Produces **summary reports**, such as locations with low traffic flow or high VMT over several years
- **Imputes data** for missing or bad detector data in real-time.
- Provides **speed** as reported by detectors, or computed speed based on flow and occupancy if the detector does not report speed.

System Overview (1)

- The primary data source is the **vehicle detector stations** (VDS).
- PeMS compiles 30 second data of vehicle flow and occupancy from VDS.
- VDS data might have gaps (missing data sets, errors, etc). PeMS conducts diagnostic tests to determine quality of data.
- PeMS calculates missing data using data imputation methods.
- Once 30-second dataset is complete, PeMS aggregates these into 5-minute datapoints.
- PeMS uses 5-minute data to calculate performance measures and saves it on servers for user access.

System Overview (2)



Help & Resources

- PeMS User Manual:

http://pems.dot.ca.gov/PeMS_Intro_User_Guide_v5.pdf

- PeMS Help Page →

- PeMS FAQ:

http://pems.dot.ca.gov/?directory=Help&dnode=Help&content=var_faq

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EXERCISE 1: FAMILIARIZING WITH DASHBOARD.

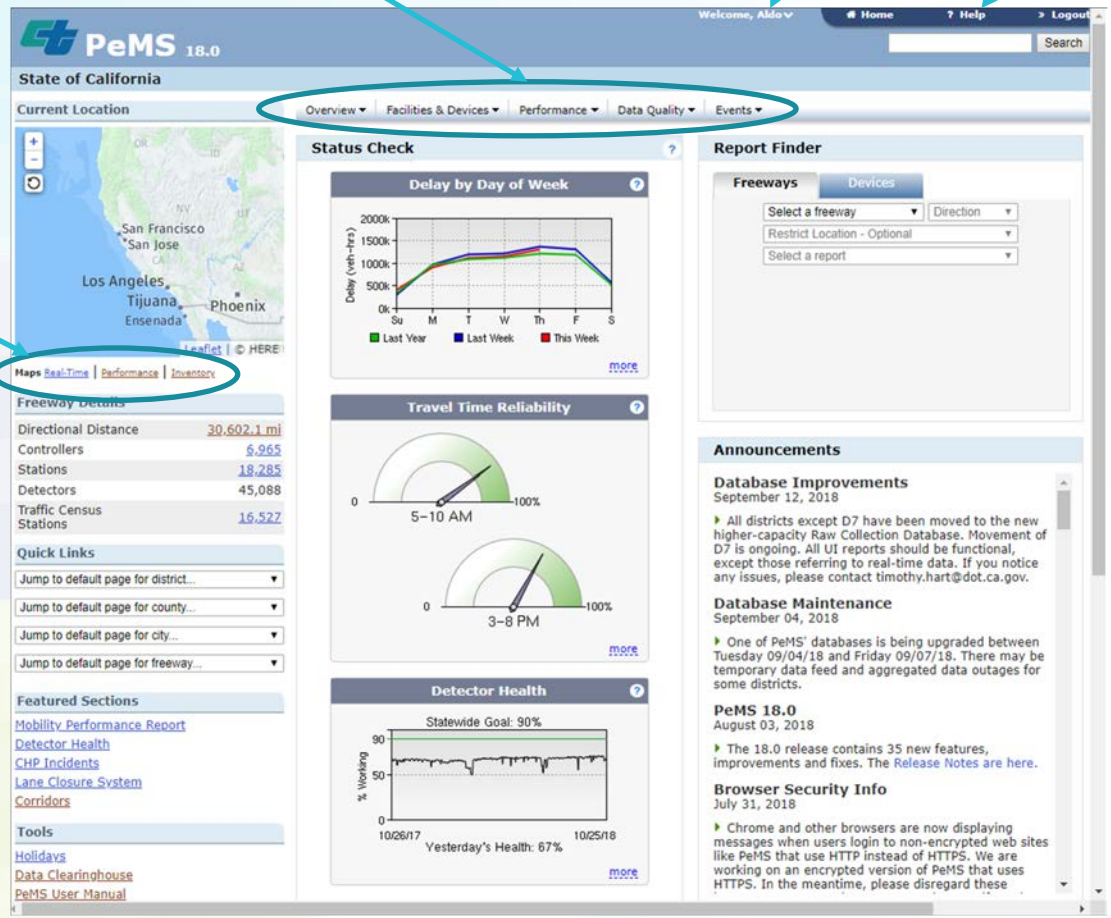
Dashboard

Reports Tab

Account Settings

Help Sources

Map view



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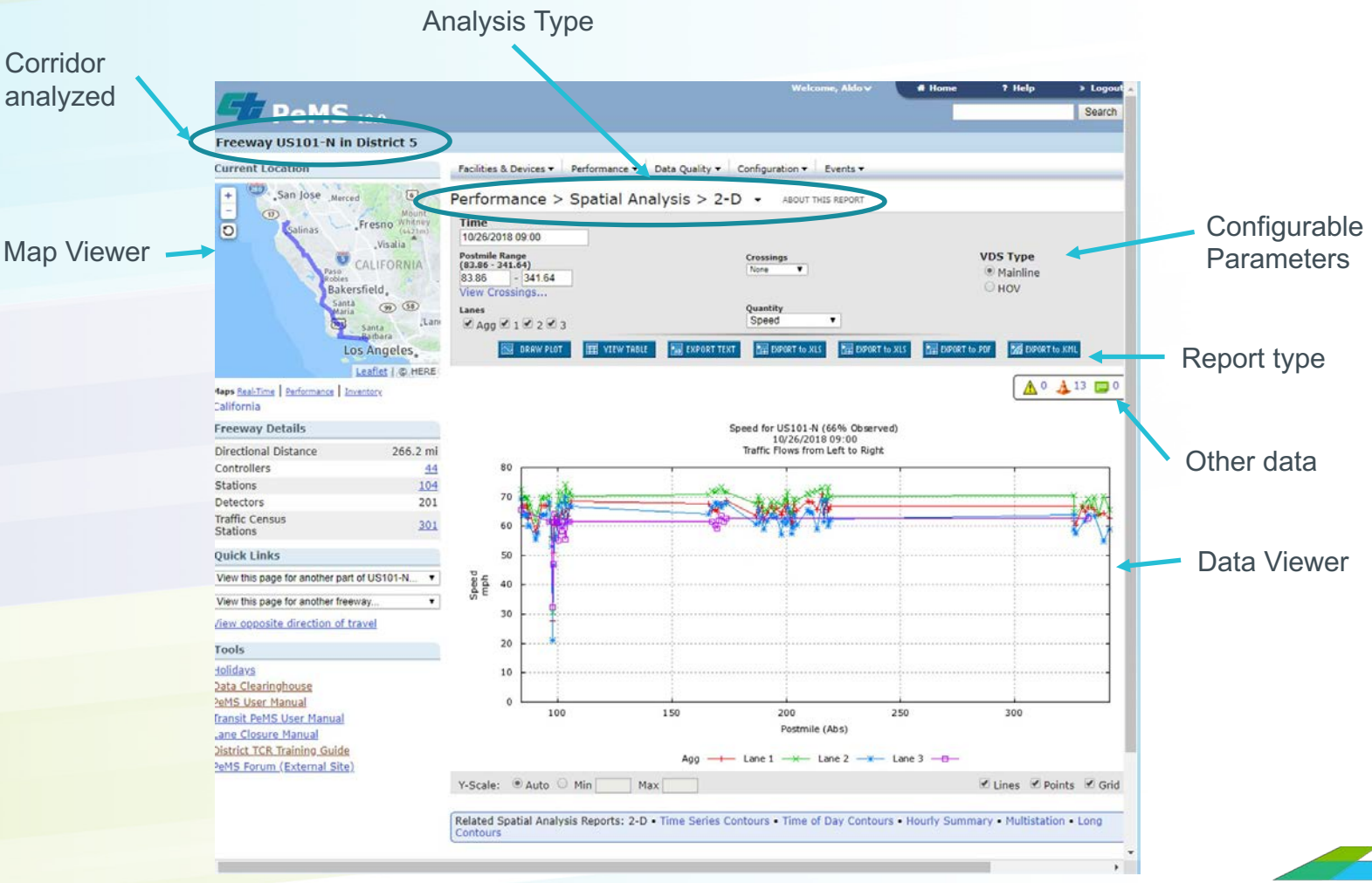
Finding data



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EXERCISE 2: EVALUATE DATA QUALITY ON CORRIDOR

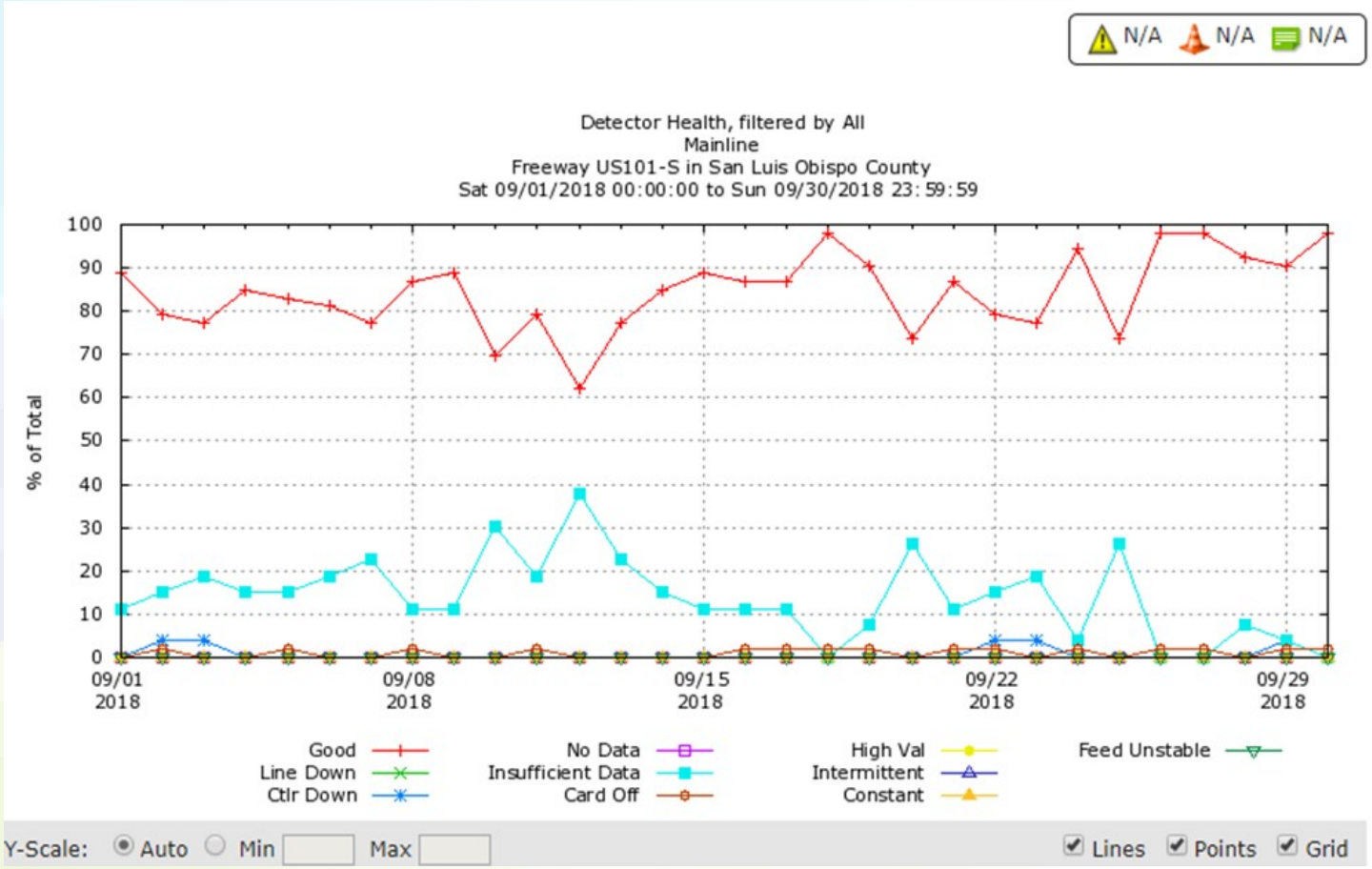
Objectives

- We want to assess the data quality for the US101 corridor in the San Luis Obispo County.
- We are interested in the Southbound direction only.
- We are interested in seeing the data quality of the corridor in the month of September.
- We want to assess the mainline and ramps separately .

Process

1. Select the corridor and geographic boundary of interest
2. Select data only for San Luis Obispo County
3. Navigate to Data Quality → Time Series
4. Modify dates for data

Output



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Let's try new queries!

- Can we develop the same graph for on and off ramps?
- Can we take a look at specific data by day?
- What types of reports can be developed?

10 MINUTE BREAK!

EXERCISE 3 - EVALUATE TRAFFIC COUNTS ON CORRIDOR

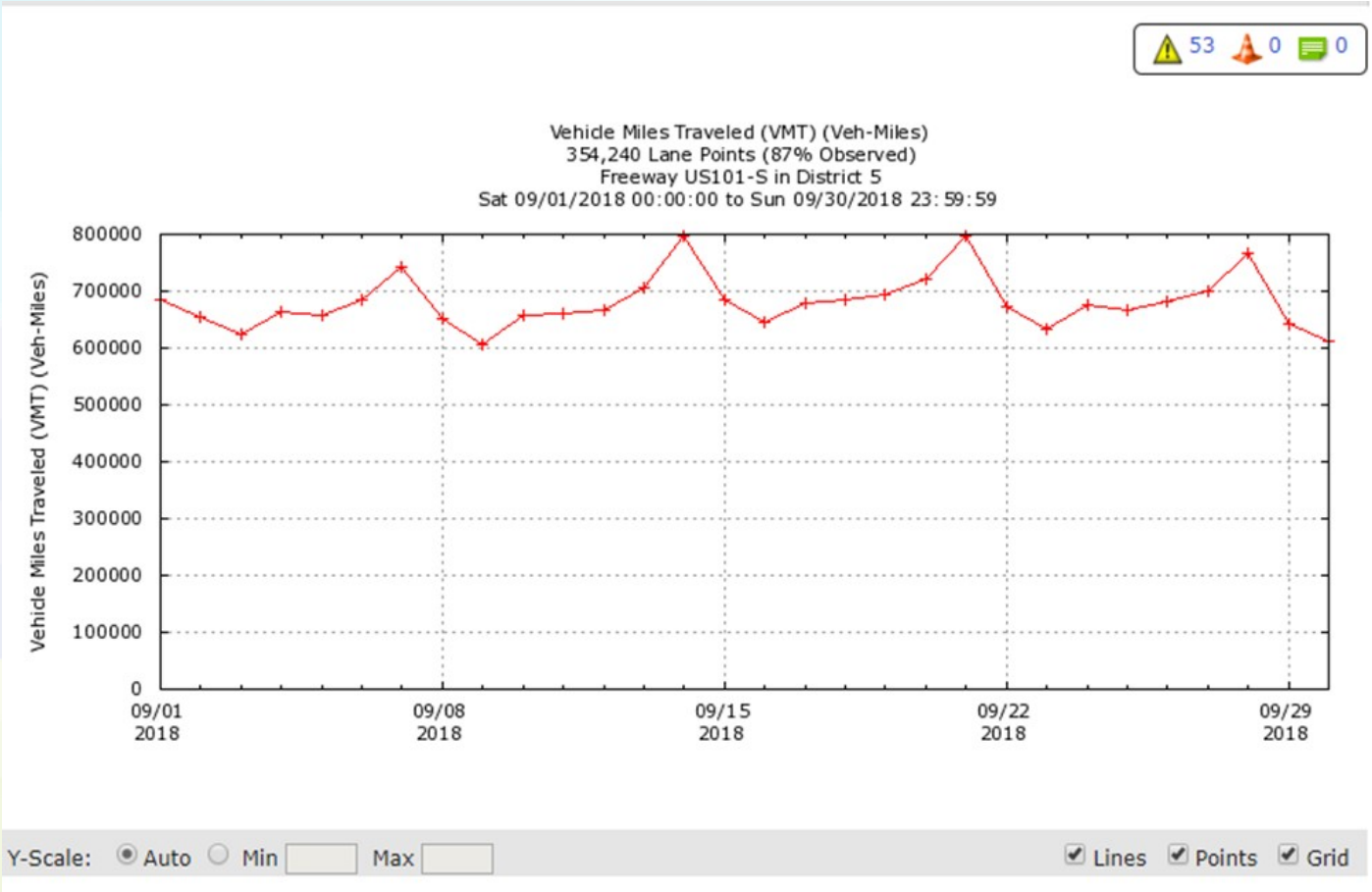
Objectives

- We want to assess traffic volumes for the US101 corridor.
  - We want to see the VMT profile for the month of September
  - We want to select traffic counts for a specific day in September
- We want to reduce the corridor section to only San Luis Obispo to Santa Maria
- We are interested in the SB direction

Process for VMT analysis

1. Select the corridor and geographic boundary of interest and select the ‘Stations’ report
2. Identify the section of interest mileposts
3. Navigate to Performance → Aggregates → Time Series
4. Modify dates for data and other parameters

VMT Output



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Process for Day Counts

1. Select the corridor and geographic boundary of interest and select the ‘Stations’ report
2. Identify the section of interest mileposts
3. Navigate to Performance → Spatial Analysis → Multistation
4. Modify dates for data and other parameters to get the hourly counts for all stations in the area, for September 14.

Day Counts Output

Hour	501014092 Mainline 89.834 (172.471)	501014101 Mainline 90.953 (173.590)	501015143 Mainline 14.705 (188.240)	501016053 Mainline 17.916 (191.451)	501016071 Mainline 19.797 (193.322)	501016082 Mainline 20.938 (194.463)	501016091 Mainline 21.995 (195.520)	501016102 Mainline 24.268 (197.793)	501016113 Mainline 24.806 (198.331)	501016122 Mainline 25.849 (199.366)	Data Quality # Lane Points	Data Quality % Observed
09/14/2018 00:00	294	344	241	287	271	301	260	259	250	221	276	75.0
09/14/2018 01:00	124	138	118	177	158	151	158	156	152	137	276	100.0
09/14/2018 02:00	116	133	111	138	134	138	144	142	140	115	276	100.0
09/14/2018 03:00	170	155	89	121	121	112	114	114	111	96	276	100.0
09/14/2018 04:00	292	261	119	127	137	129	136	138	135	116	276	100.0
09/14/2018 05:00	798	632	276	348	312	335	352	402	395	330	276	100.0
09/14/2018 06:00	1,724	1,539	752	934	881	898	918	980	965	759	276	100.0
09/14/2018 07:00	2,735	2,762	1,248	1,573	1,378	1,365	1,392	1,375	1,380	1,101	276	100.0
09/14/2018 08:00	2,384	2,287	1,282	1,779	1,473	1,487	1,522	1,590	1,574	1,184	276	100.0
09/14/2018 09:00	2,221	2,229	1,420	1,923	1,660	1,661	1,723	1,713	1,685	1,267	276	100.0
09/14/2018 10:00	2,284	2,324	1,555	2,198	1,956	1,921	1,976	1,963	1,962	1,491	276	100.0
09/14/2018 11:00	2,278	2,358	1,495	2,350	2,071	2,099	2,187	2,229	2,207	1,594	276	100.0
09/14/2018 12:00	2,316	2,469	1,465	2,653	2,414	2,424	2,495	2,503	2,478	1,918	276	100.0
09/14/2018 13:00	2,353	2,563	1,562	2,816	2,492	2,514	2,613	2,668	2,650	2,017	276	100.0
09/14/2018 14:00	2,656	2,998	1,862	3,313	3,016	3,035	3,129	3,099	3,051	2,418	276	100.0
09/14/2018 15:00	2,810	3,351	1,876	3,282	2,942	2,982	3,296	3,215	3,206	2,526	276	100.0
09/14/2018 16:00	2,839	3,571	2,340	3,281	2,877	2,775	3,352	3,346	3,349	2,681	276	100.0
09/14/2018 17:00	2,961	3,796	2,390	3,403	2,959	2,773	3,254	3,239	3,195	2,534	276	100.0
09/14/2018 18:00	2,955	3,476	1,559	2,899	2,569	2,436	2,512	2,577	2,546	1,979	276	100.0
09/14/2018 19:00	1,875	2,193	1,357	2,385	2,107	2,040	2,078	2,058	2,041	1,660	276	100.0
09/14/2018 20:00	1,496	1,701	1,147	1,844	1,706	1,641	1,653	1,705	1,683	1,392	276	100.0
09/14/2018 21:00	1,231	1,395	968	1,618	1,505	1,462	1,485	1,547	1,508	1,317	276	100.0
09/14/2018 22:00	998	1,127	915	1,424	1,304	1,298	1,348	1,339	1,316	1,150	276	100.0
09/14/2018 23:00	620	699	568	832	747	735	739	730	732	643	276	100.0
Total											**6,624**	**99.0**

NOTE: Showing first 10 of 19 stations in postmile range.

NOTE: To see data for all stations use 'Export to XLS'.

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Let's try new queries!

- Can we get the average for all weekdays on a week?

EXERCISE 4 – EVALUATE TYPICAL SPEEDS ON CORRIDOR

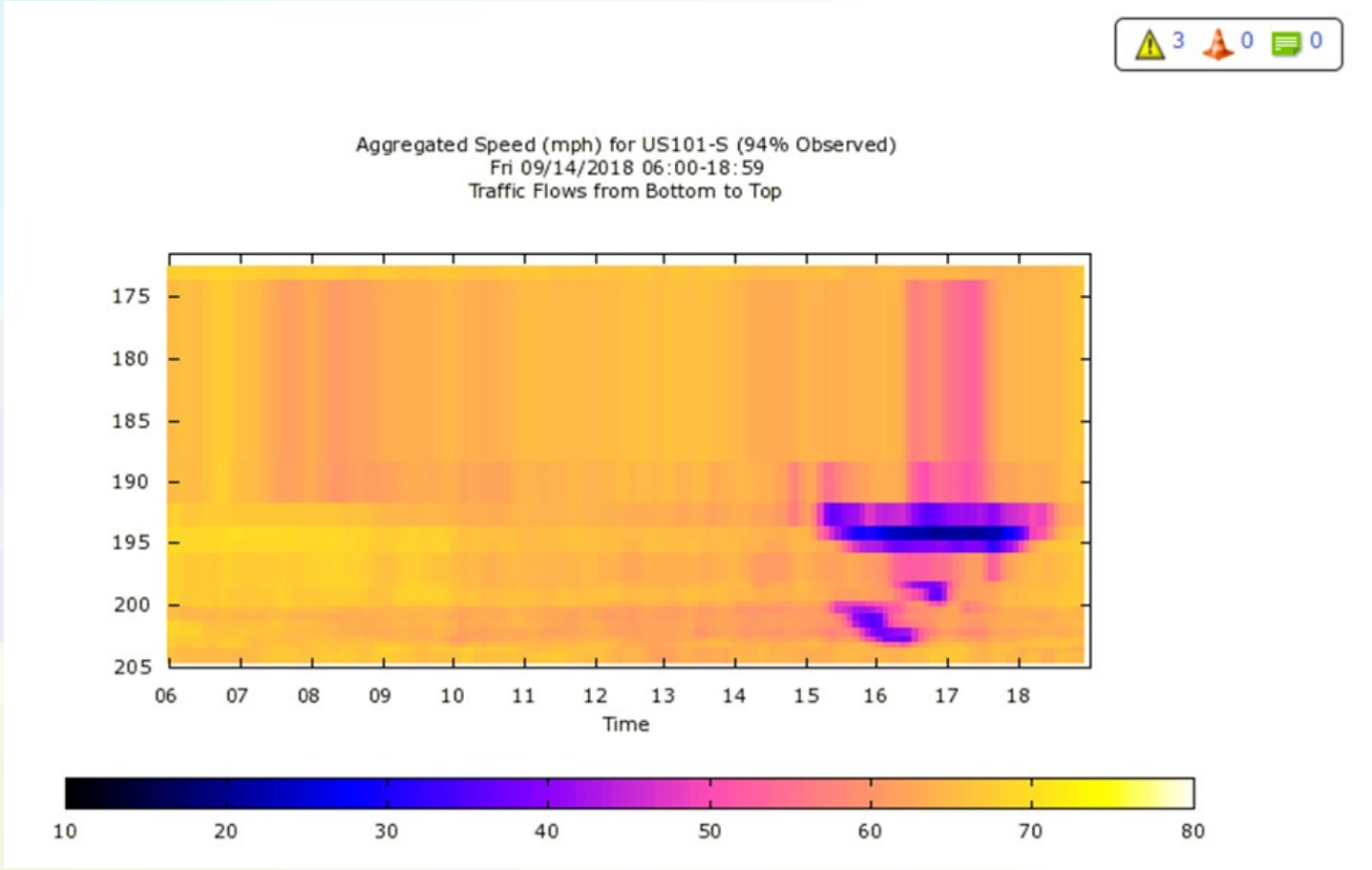
Objectives

- We want to assess speeds for the US101 corridor.
  - We want to see speed contours and assess where are queues being formed on a particular day
  - We want to see average speeds and assess where are queues being formed on an average weekday
- We want to reduce the corridor section to only San Luis Obispo to Santa Maria
- We are interested in the SB direction

Procedure for Speeds Contours on a Particular Day

1. Select the corridor and geographic boundary of interest and select the 'Stations' report
2. Identify the section of interest mileposts
3. Navigate to Performance → Spatial Analysis → Time Series Contours
4. Modify dates for data and other parameters to get the speeds for all stations in the area, for September 14.

Speed Contours for a Particular Day Outputs



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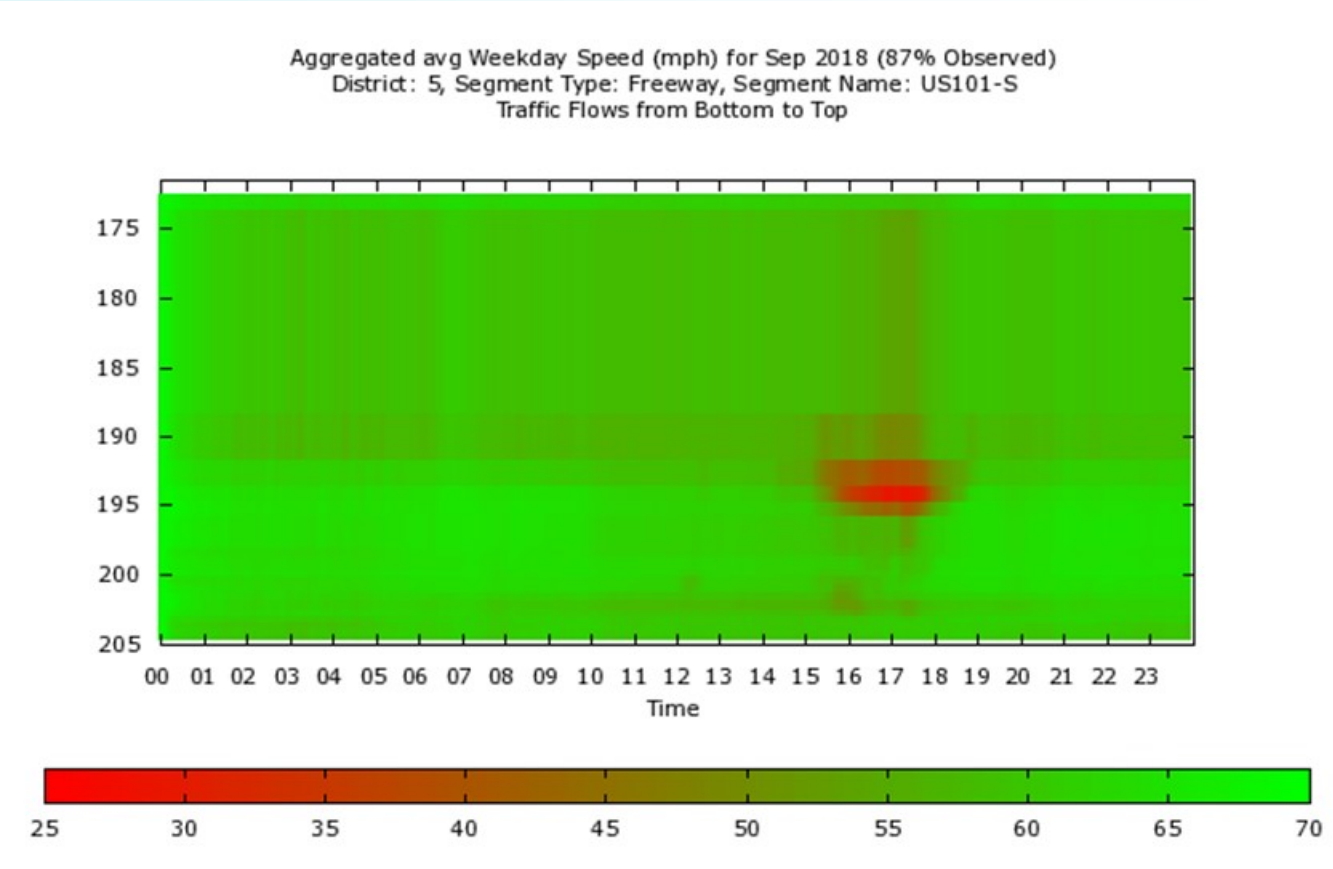
Procedure for Speeds Contours on a an Average Weekday

1. Select the corridor and geographic boundary of interest and select the 'Stations' report
2. Identify the section of interest mileposts
3. Navigate to Performance → Spatial Analysis → Long Contours
4. Modify dates for data and other parameters to get the speeds for all stations in the area, for September 14.

Speeds Contours on a an Average Weekday Outputs



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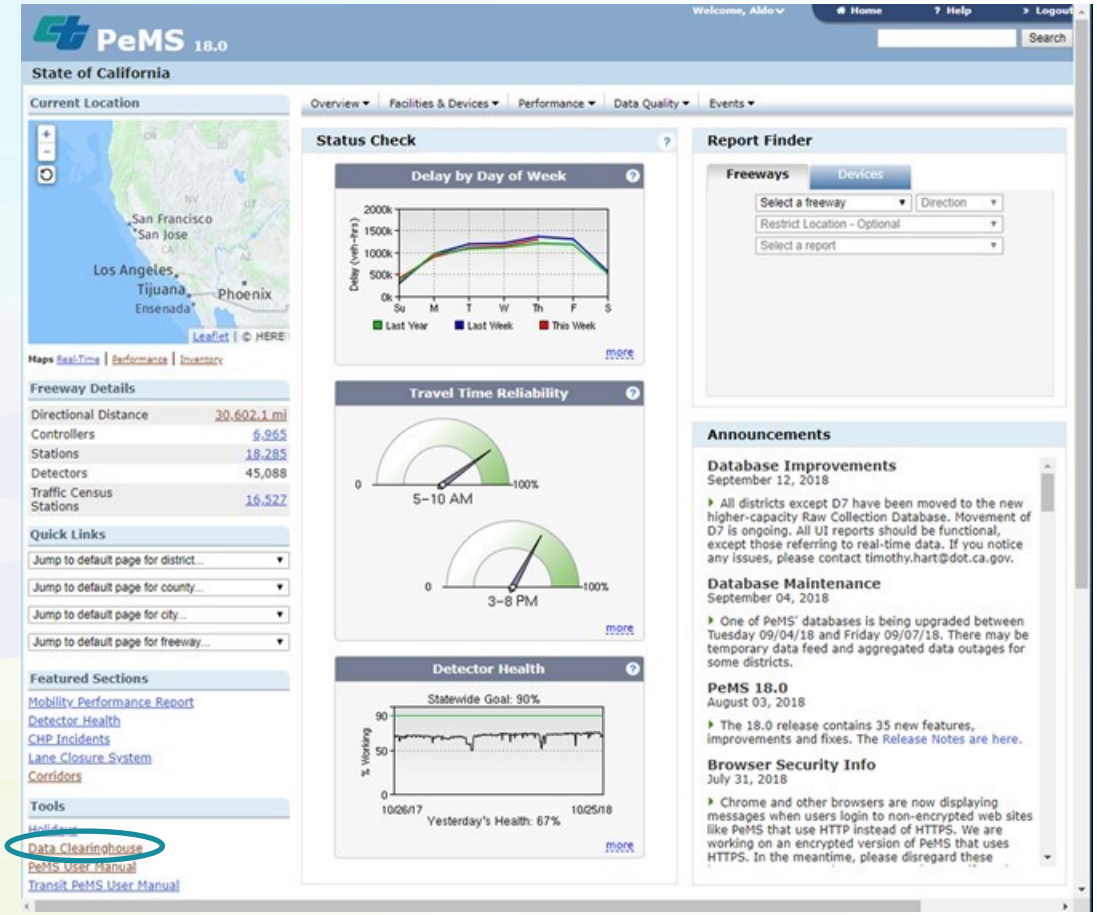
EXERCISE 5 – DOWNLOADING RAW DATA

PeMS Data Clearinghouse



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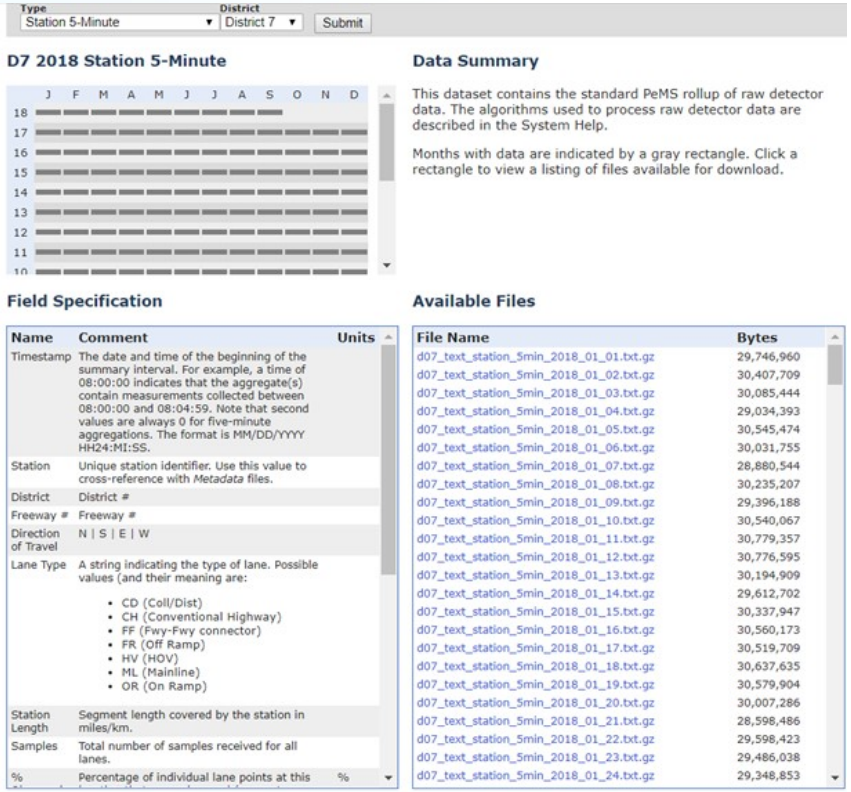
Downloading Data

- eMS Data Clearinghouse provides a single access point for downloading PeMS data sets.
- Data is available at 5-minutes, Hour, Day intervals.
- Station data for 5-minute intervals include:
  - Timestamp
  - Station ID
  - District #
  - Freeway #
  - Direction of Travel
  - Lane Type
  - Station Length
  - % of Observed Data
  - Flow (by lane and total)
  - Speed (by lane and total)
  - Occupancy (by lane and total)
  - Number of Data Samples (by lane)



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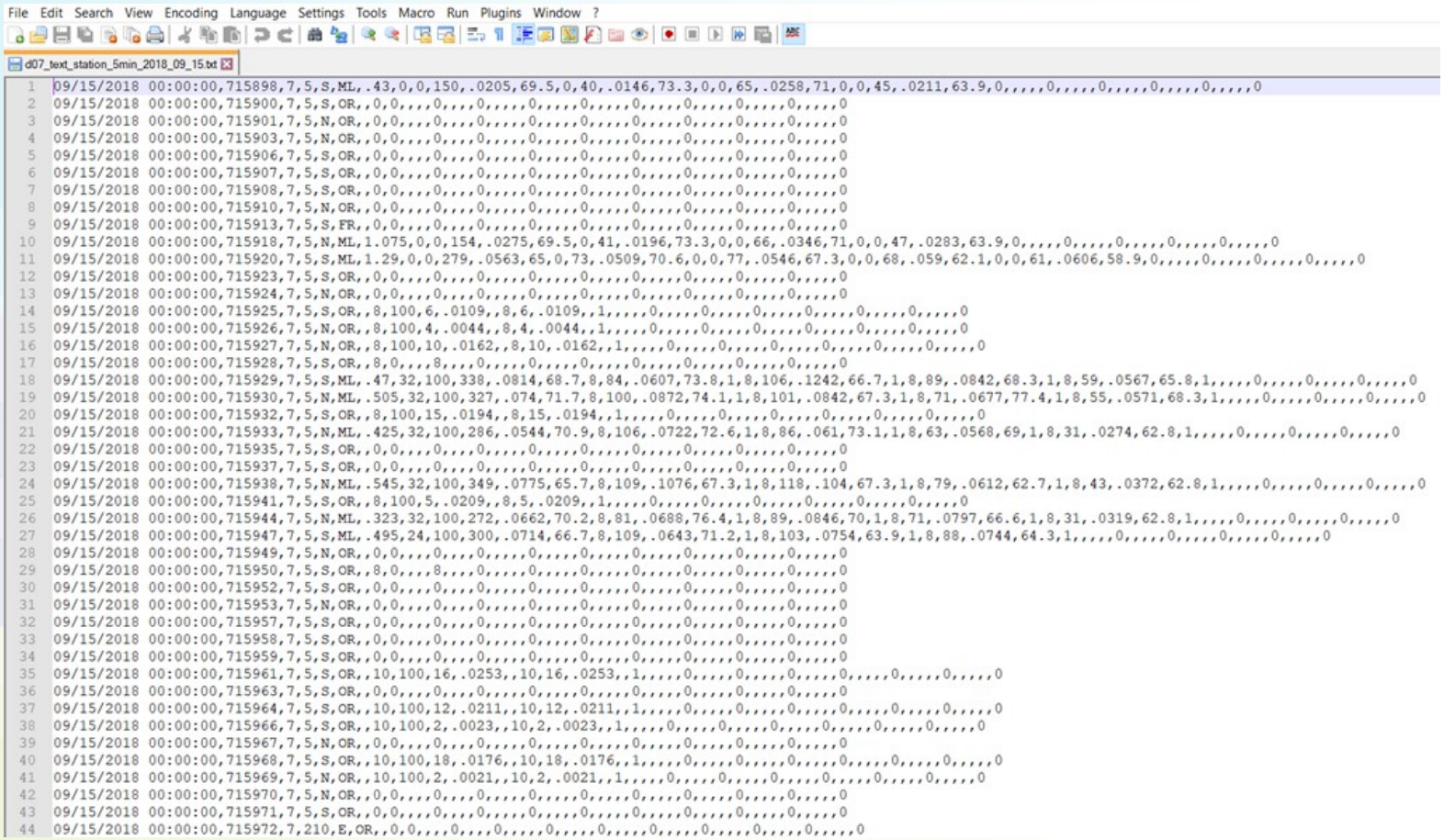
Example Sample



File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

d07_text_station_5min_2018_09_15.txt

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Processing Raw Data

- Desired data is downloaded from the Clearinghouse, selecting District, interval (5-min, hour, or daily data), and the specific days.
- A Python script is used to read the Comma Separated Value data, and extract only the PeMS stations of interest.
- The script outputs an excel file with the desired data for further analysis.

```
In [1]: import pandas as pd
        import os
        import matplotlib.pyplot as plt
        import numpy as np
        %matplotlib inline
        pd.options.display.max_columns = 50

In [2]: #We start by reading the PeMS stations we want to analyze
        stations = pd.read_excel('pems_stations.xlsx', sheet_name='PeMS')

In [3]: #We now create a dataframe with all the speed data
        head = ['Timestamp','Station','District','Route','Direction','Type','Length','Samples','%Observed','TotalFlow','AvgOCc','AvgSpeed
        path = "Speeds/"

        df = pd.DataFrame()

        for file in os.listdir(path):
            filename = path+file
            temp = pd.read_csv(filename, header=None, names=head, parse_dates=['Timestamp'], infer_datetime_format=True)
            df = df.append(temp, ignore_index=True)

In [4]: df.head(10)
```

Out[4]:

	Timestamp	Station	District	Route	Direction	Type	Length	Samples	%Observed	TotalFlow	AvgOCc	AvgSpeed	Delay35	Delay40	Delay45	Delay50
0	2017-01-01	500010011	5	1	N	ML	2.713	117	100	108.0	0.0115	64.2	0.0	0.0	0.0	0.0
1	2017-01-01	500010012	5	1	S	ML	2.714	117	100	41.0	0.0043	64.8	0.0	0.0	0.0	0.0
2	2017-01-01	500010021	5	1	N	ML	0.697	109	0	266.0	0.0226	66.9	0.0	0.0	0.0	0.0
3	2017-01-01	500010022	5	1	S	ML	0.698	109	0	171.0	0.0123	67.7	0.0	0.0	0.0	0.0
4	2017-01-01	500010031	5	1	N	ML	0.831	228	100	233.0	0.0134	68.1	0.0	0.0	0.0	0.0
5	2017-01-01	500010032	5	1	S	ML	0.831	114	100	202.0	0.0212	63.9	0.0	0.0	0.0	0.0
6	2017-01-01	500010041	5	1	N	ML	1.242	240	100	361.0	0.0182	68.0	0.0	0.0	0.0	0.0
7	2017-01-01	500010042	5	1	S	ML	1.241	240	100	220.0	0.0103	67.2	0.0	0.0	0.0	0.0
8	2017-01-01	500010072	5	1	S	ML	1.606	240	100	181.0	0.0065	69.5	0.0	0.0	0.0	0.0

Analyzing Raw Data

- Once data is selected for the region and time of interest, heat maps can be developed to visualize speeds, congestion, flows, and quality of data for a specific time period.

	Hour																							
Name	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
BROADWAY HWY 135 101 SB VDS MLSB	67	67	67	67	67	67	67	66	66	65	65	65	65	65	64	63	63	62	64	67	67	67	67	67
OAK PARK BLVD 101 NB VDS MLSB SB	66	66	66	66	66	66	65	63	62	63	63	63	63	63	63	63	60	57	61	62	64	65	66	66
SHELL BEACH RD 101 NB VDS MLSB S	65	65	65	65	65	65	65	65	64	64	64	63	63	63	62	59	56	56	61	64	64	65	65	65
SPYGLASS DR 101 SB VDS MLSB SB	69	69	69	69	69	69	68	67	67	66	65	65	64	64	61	51	38	35	55	66	67	67	68	68
AVILA BEACH DR 101 NB VDS MLSB S	70	70	70	69	70	70	70	70	70	69	69	67	67	67	65	59	44	38	60	69	69	69	70	70
SAN LUIS BAY DR 101 SB VDS MLSB	69	69	69	69	69	69	68	67	67	66	65	65	64	64	63	61	59	58	64	67	67	68	68	69
SO HIGUERA ST EXIT 101 NB VDS ML	67	67	67	67	67	67	67	67	66	65	64	64	63	63	62	58	54	55	64	66	66	67	67	67
SO HIGUERA ST ON RAMP ST 101 NB	67	67	66	66	67	67	67	67	67	66	65	65	64	64	63	59	53	56	64	67	66	66	67	67
LOS OSOS VALLEY RD 101 SB VDS ML	69	69	69	69	69	68	67	67	67	67	66	66	66	65	64	61	55	60	65	67	67	67	68	68
PRADO RD CMS 101 NB VDS MLSB SB	67	66	66	66	66	67	67	66	65	65	65	64	63	62	61	59	55	58	65	67	67	67	67	67
PRADO RD 101 NB VDS MLSB SB	67	66	66	66	66	67	67	67	66	66	66	65	64	63	63	59	55	57	66	67	67	67	67	67
MADONNA RD 101 SB VDS MLSB SB	69	69	69	69	69	68	67	67	66	66	66	65	64	64	63	61	59	61	66	67	67	67	68	68
MARSH ST 101 SB VDS MLSB SB	69	69	69	69	69	68	67	66	65	65	64	64	63	63	62	61	61	61	65	67	67	68	68	68
BROAD ST 101 SB VDS MLSB SB	69	70	70	70	69	69	68	66	65	64	64	63	63	63	62	60	60	60	64	66	67	68	69	69
TORO ST 101 NB VDS MLSB SB	66	66	66	66	67	67	67	65	65	66	66	65	65	65	65	63	63	63	66	67	67	67	67	67
GRAND AVE IN SLO AT 101 SB VDS M	69	69	68	69	68	69	67	65	65	66	67	67	66	66	65	65	66	66	67	68	68	68	68	69
MONTEREY ST 101 NB VDS MLSB SB	66	65	65	65	66	66	66	65	65	66	66	66	66	66	65	65	66	66	67	67	66	66	66	66
FOX HOLLOW RD 101 NB VDS MLSB SB	67	66	66	66	67	67	66	65	65	65	65	65	65	64	64	64	64	64	66	67	67	67	67	67

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THANK YOU!

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