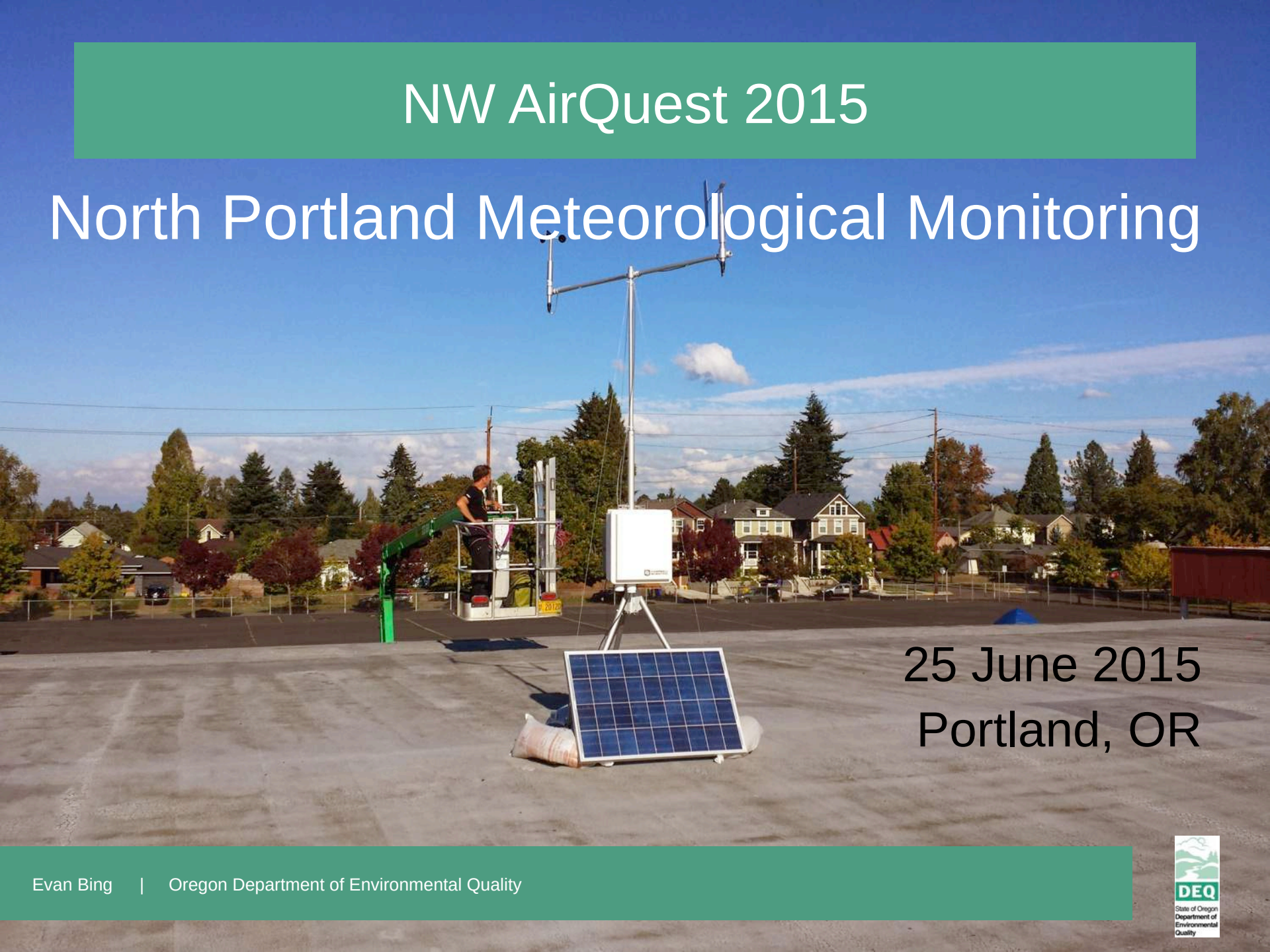
NW AirQuest 2015

North Portland Meteorological Monitoring



25 June 2015

Portland, OR

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Odor Complaints

North Portland residents frequently experience the following odors:

- Paint fumes
- Sewage
- Natural gas or unburnt fuel
- General chemicals

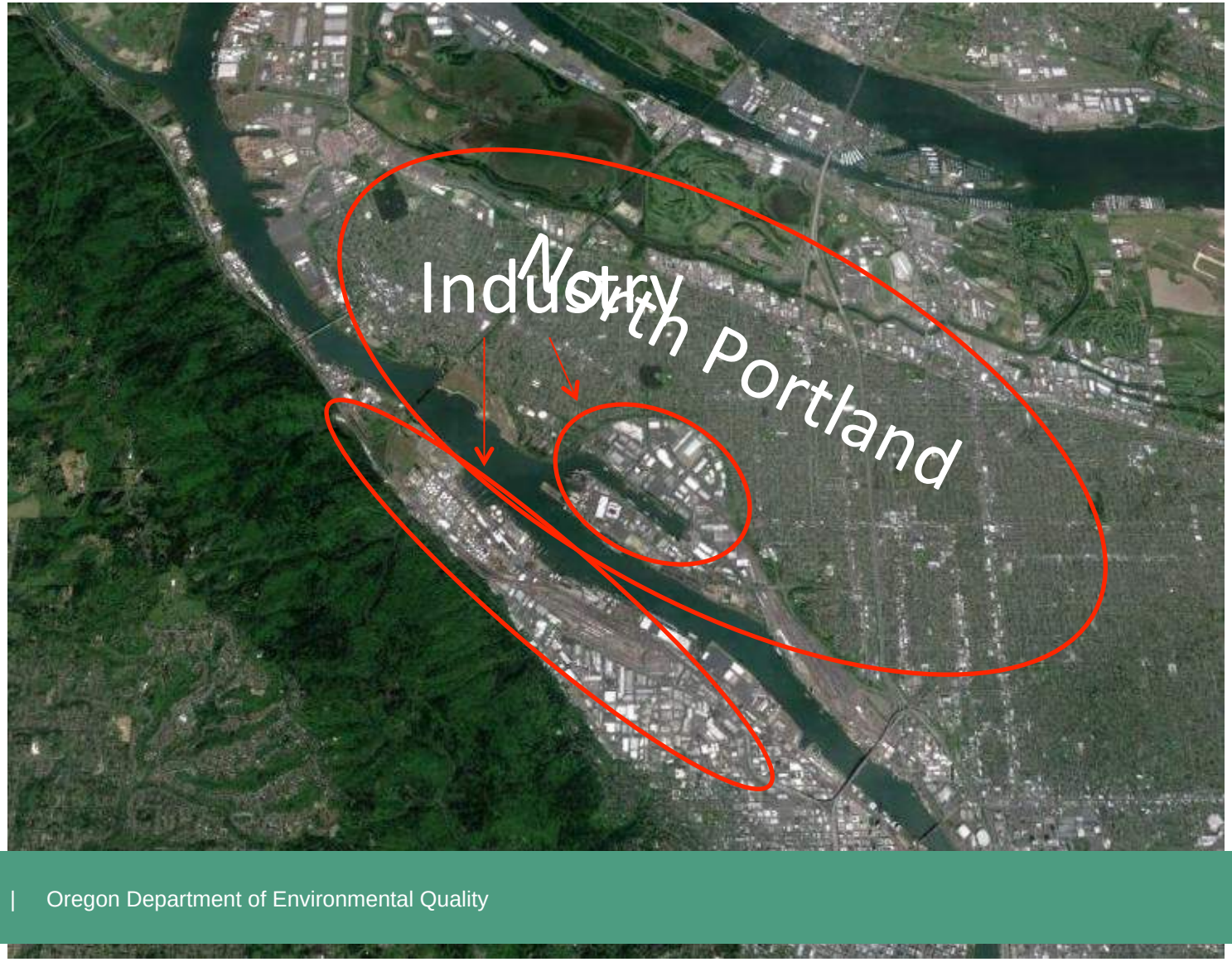
Odor Complaints

Residents concerned that the odors are more than a nuisance and may represent a health hazard to surrounding neighborhoods.

Study Area

- North Portland and Swan Island
- Seven sites contained within a radius of 3.7 kilometers (2.3 miles)

Study Area



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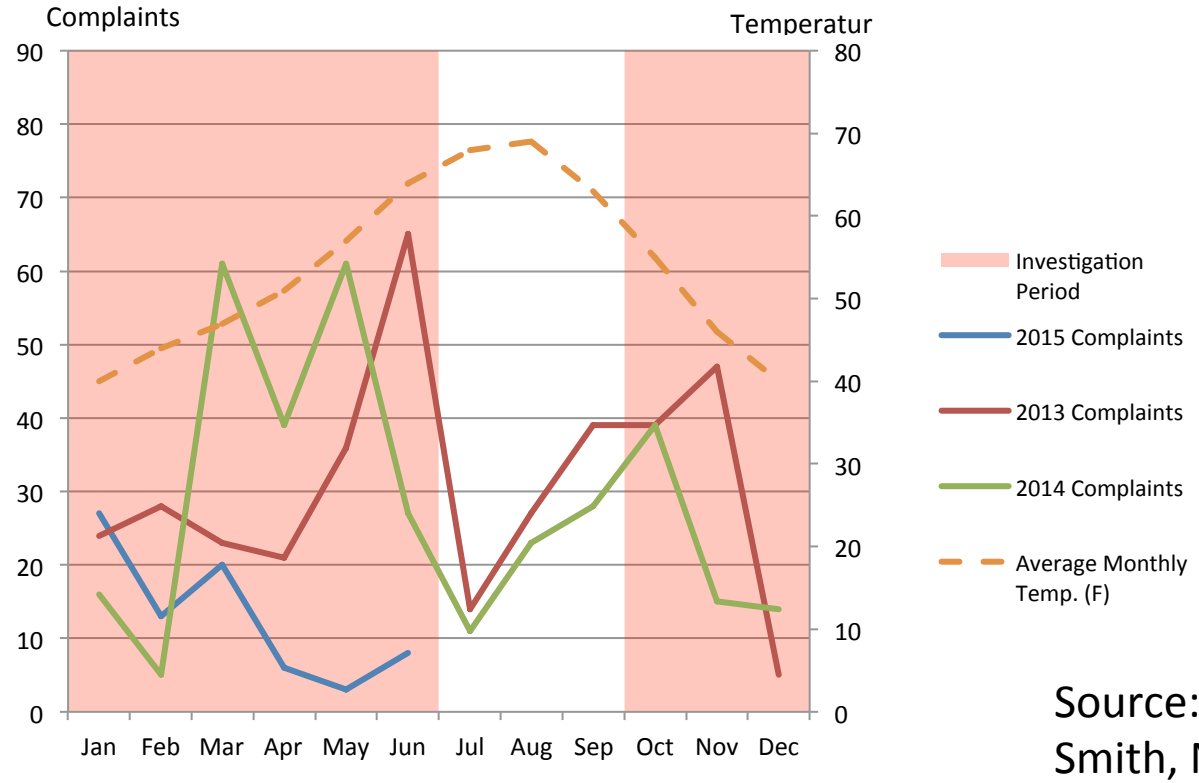
Odor Complaints

- To date, 2015 has logged significantly fewer complaints than 2013 and 2014



Source: Bryan Smith, NWR

Odor Complaints

- Complaints 2015:
  - 79 complaints from 48 different complainants
  - 11 complainants mentioned Daimler as the source (14%)
- Inspections 10/8/2014- 6/8/2015: 509
  - 55 inspection days
  - Average 6 visits/month
  - On site 18 times when a complaint identified on the day (33%).
  - From 10/8/2014- 6/8/2015, odor identified 26 times, or 5% of the time.

Source: Bryan Smith, NWR

Odor Complaints

- Two inspectors perform field surveys in the area six to seven times per month at nine predetermined sites, varying from those sites when appropriate.
- Qualified DEQ odor identifiers must pass a “sniff test”… No, really.

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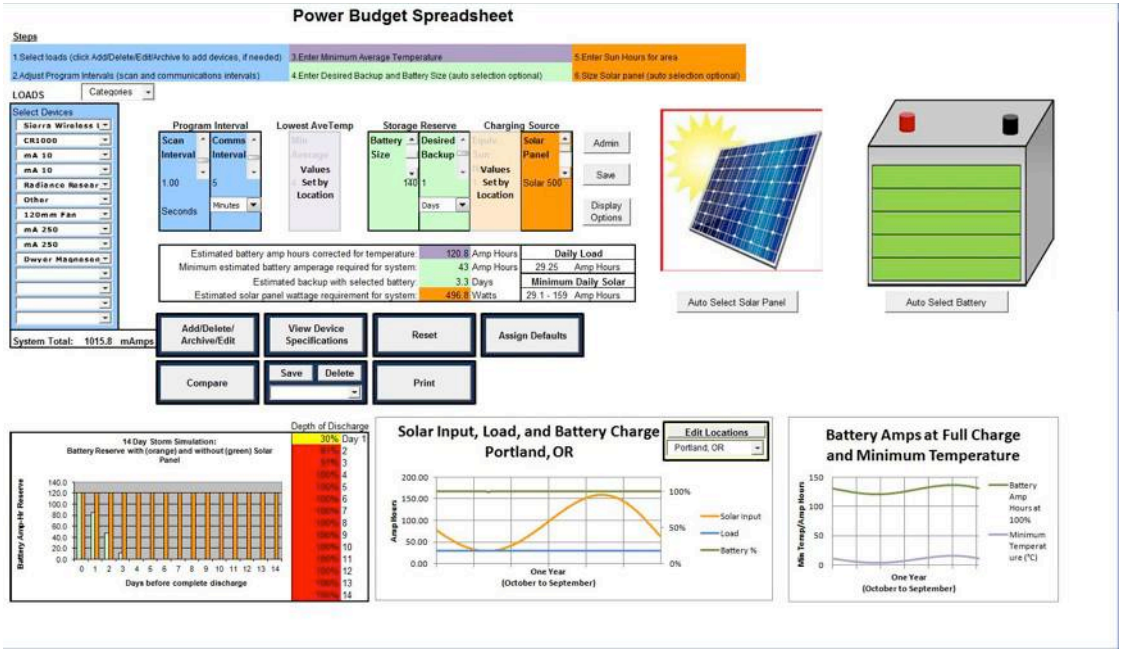
Design Considerations (Hardware)

- Off-grid, renewable energy-powered
- Low Power Consumption
- High reliability
- Non-intrusive installation



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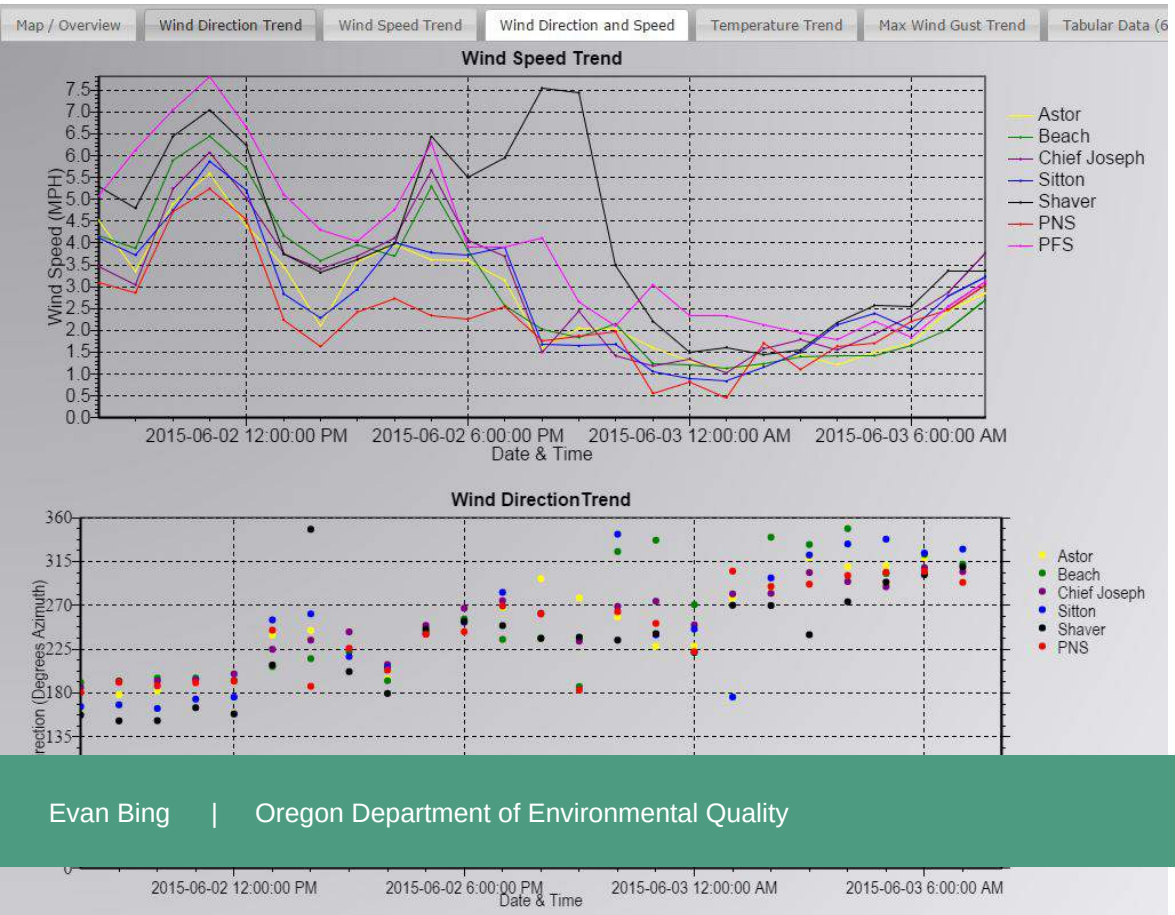
Design Considerations (Software & Web)

- Near-real-time data stream
- Quick, “at a glance” information for general public use
- Easily modifiable layout
- Uniform design




```
'ODEQ_LAB_AQM_PSI_TRIPOD_V1_0_0_001
'Program Author: Evan Bing (Oregon DEQ)
'
'Program History:
'
'V1_0_0_001 October 30, 2014     Original release.
'V1_0_1_001 October 30, 2014     Removed extraneous variables from datatables that were
'                                unintentionally part of the original release.


'Declare Variables and Units
Public BattV
Public PTemp_C
Public ETemp_C
Public WindDir
Public WS_ms
Public WS_mph
Public W_StanDev
Public wGst

Units BattV=Volts
Units PTemp_C=Deg C
Units WindDir=degrees
Units WS_ms=meters/second
Units WS_mph=miles/hour

'Define Data Tables
DataTable(Met_5_Min,True,-1)
  DataInterval(0,5,Min,10)
  WindVector (1,WS_mph,WindDir,FP2,False,0,0,0)
  FieldNames("wSpd,wDir,wSig")
  Average(1,ETemp_C,FP2,False)
  Maximum(1,wGst,FP2,False,1)
  Average(1,BattV,FP2,False)
EndTable

DataTable(Met_60_Min,True,-1)
  DataInterval(0,60,Min,10)
  WindVector (1,WS_mph,WindDir,FP2,False,0,0,0)
  FieldNames("wSpd,wDir,wSig")
  Average(1,ETemp_C,FP2,False)
  Maximum(1,wGst,FP2,False,1)
  Average(1,BattV,FP2,False)
EndTable

'Main Program
BeginProg
  'Main Scan
  Scan(1,Sec,1,0)
    'Default Datalogger Battery Voltage measurement 'BattV'
    Battery(BattV)
    'Default Wiring Panel Temperature measurement 'PTemp_C'
    PanelTemp(PTemp_C,_60Hz)
    'Measure enclosure temperature using Type "T" Thermocouple
    TCDiff(ETemp_C,1,mV2_5_2_0,ETemp_C_Type,0,_60Hz,1.0,0)
    'Calculate 3-second wind gust in mph
    AvgRun(wGst,1,WS_mph,3)
    'Call Data Tables and Store Data
```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Meteorological Site Locations

- Four sites located on Portland Public Schools' rooftops

Meteorological Site Locations

- One trailer site and accompanying suite of air toxics monitors in residential neighborhood

Meteorological Site Locations

- One site (only site to use ultrasonic anemometer) located on private company rooftop on opposite side of the Willamette River

Meteorological Site Locations

- One site (added March 2015) on Front Street Fire Station rooftop

Meteorological Site Locations

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Data QA/QC

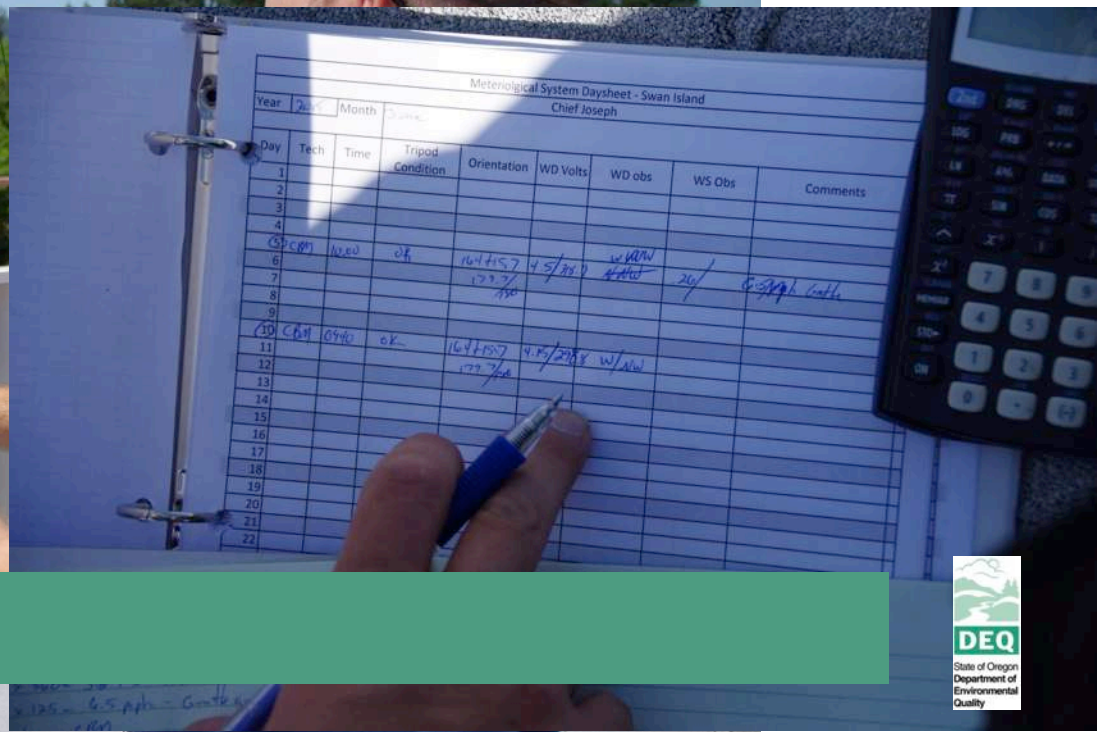
- Data must be continuously QA/QC'D to ensure validity and usability
- Data must be defensible if challenged by industry or others

Data QA/QC

Site visits performed weekly

- Technician documents observed wind speed and direction
- Compares observations against data output

Data QA/QC



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Data QA/QC

- Autonomous nature of stand alone datalogger powered by reliable energy source (solar panels + battery) = very little invalidated data due to equipment failure (< 0.01%)

Meteorological Data

Alright, so what do the data look like after the first six months?

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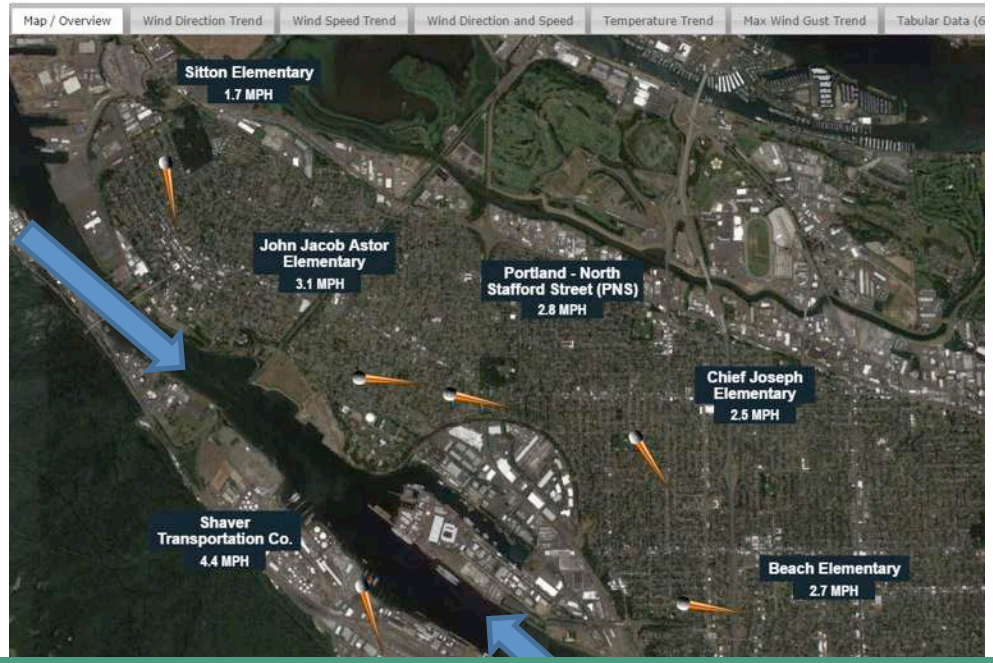
Meteorological Data

First, a frequently heard North Portland “rule of thumb”: winds generally follow the Willamette River, i.e., winds are typically NW or SE



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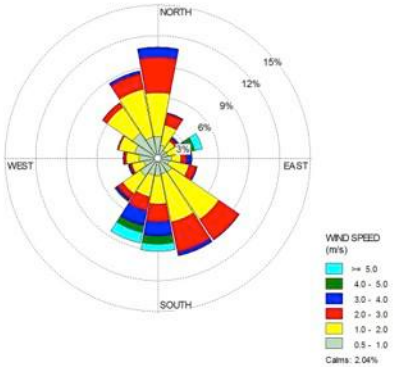
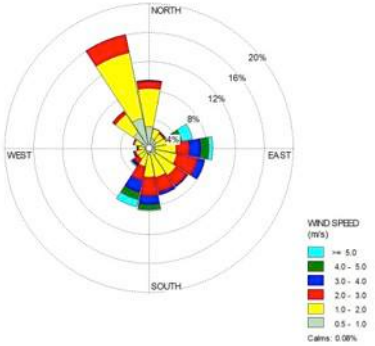
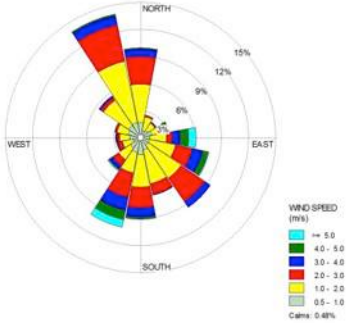
Meteorological Data

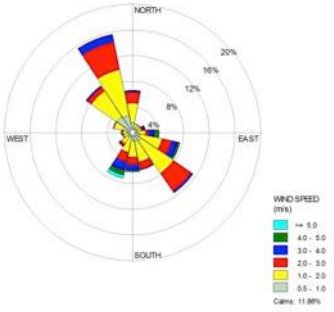
How do the first six months of data stack compare?

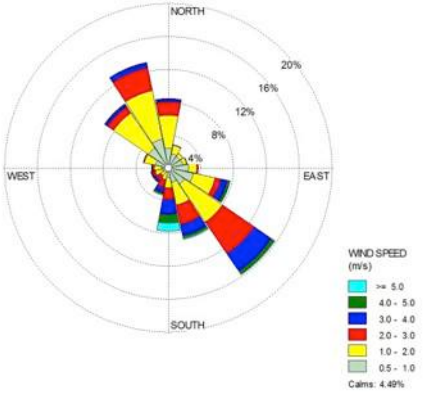
So far, the data have proven the “rule of thumb” to be fairly useful

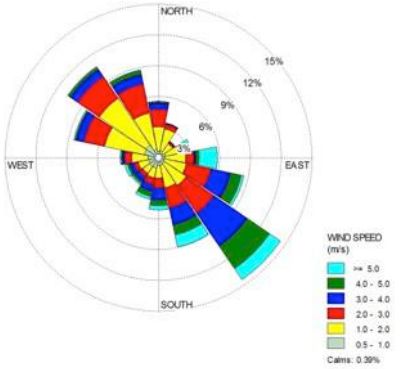












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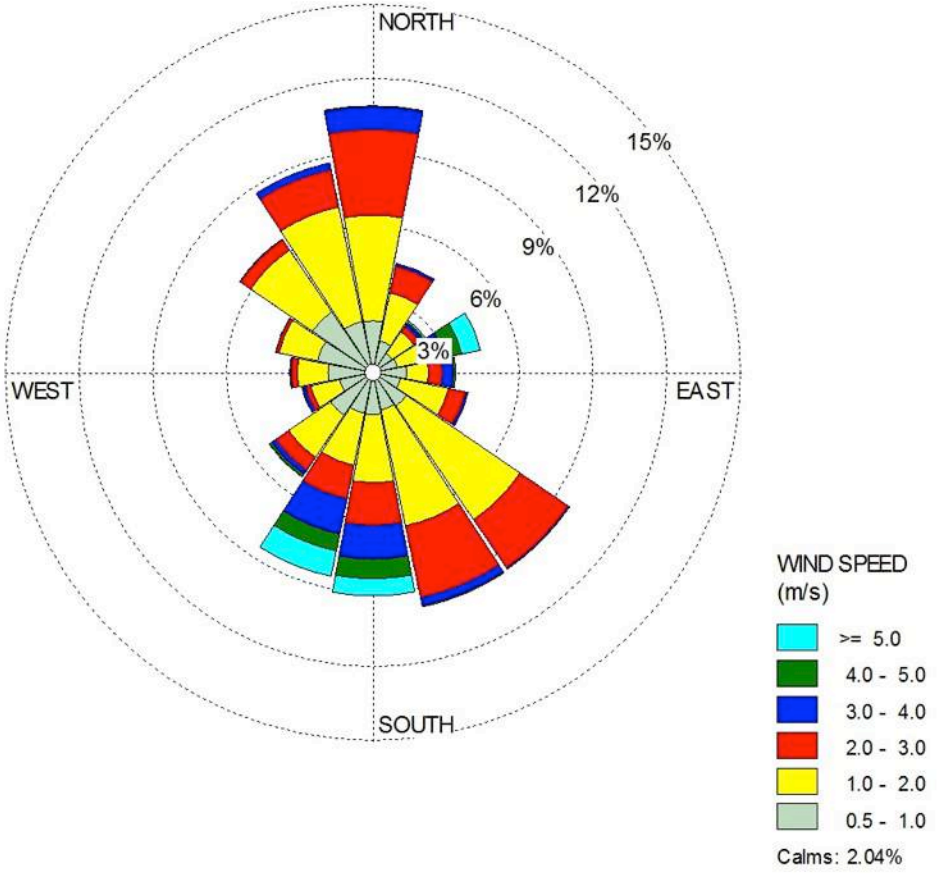
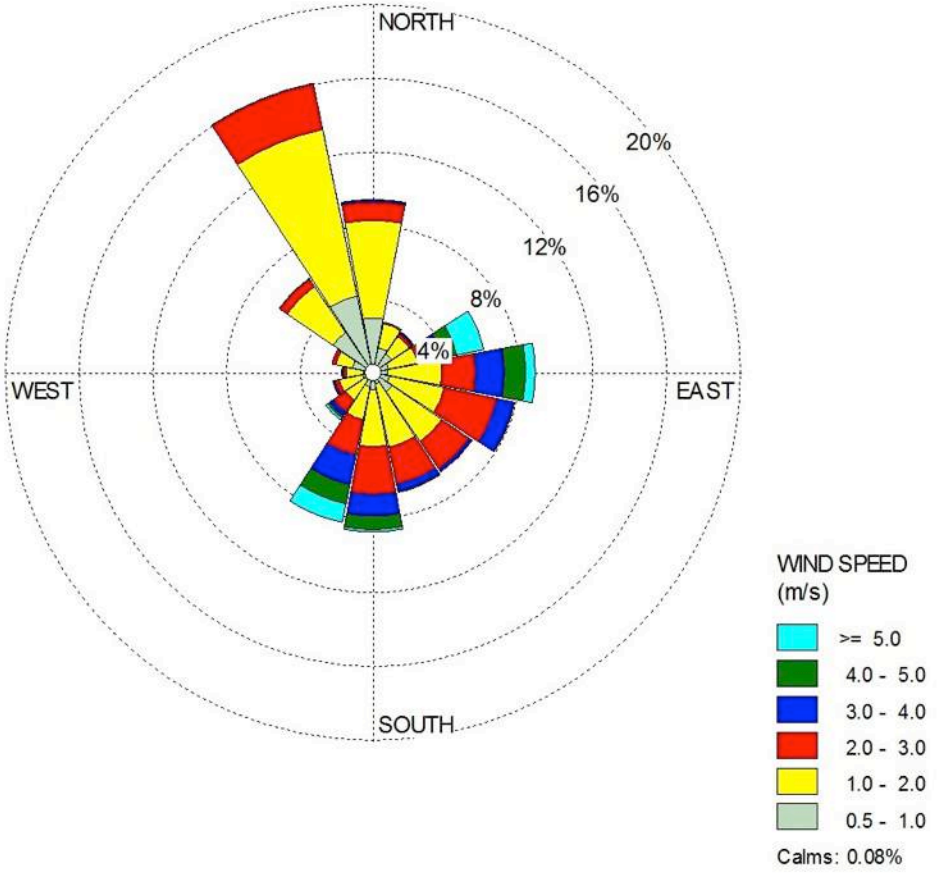
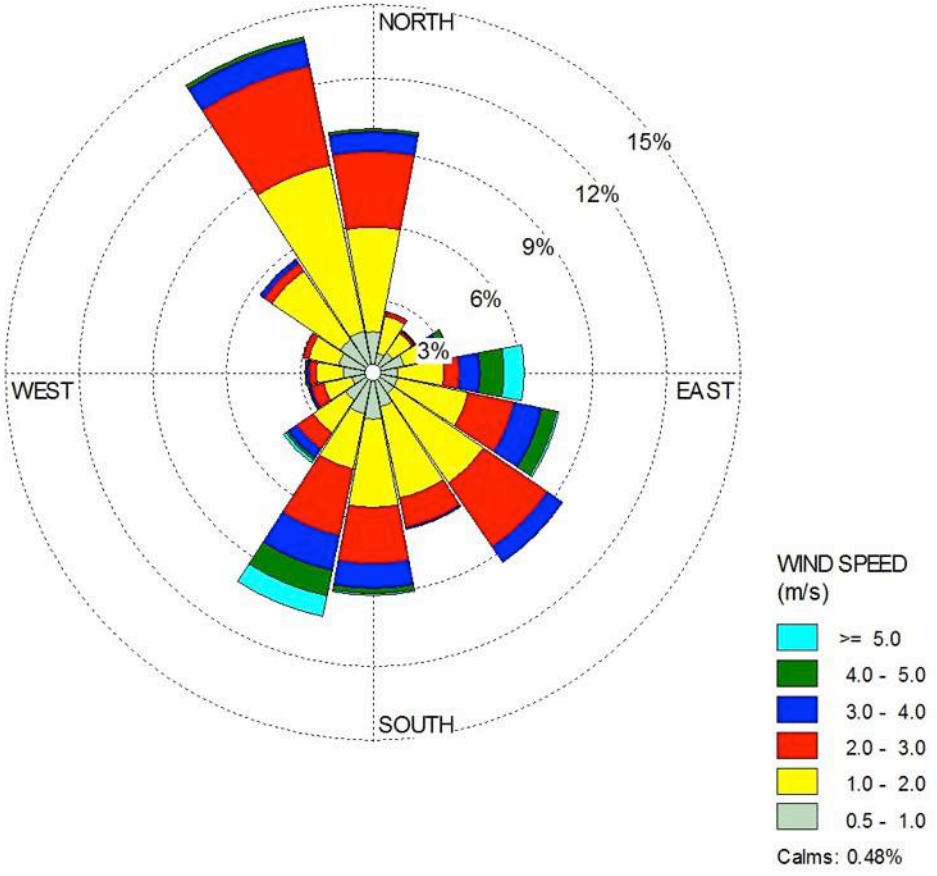
John Jacob Astor Elementary



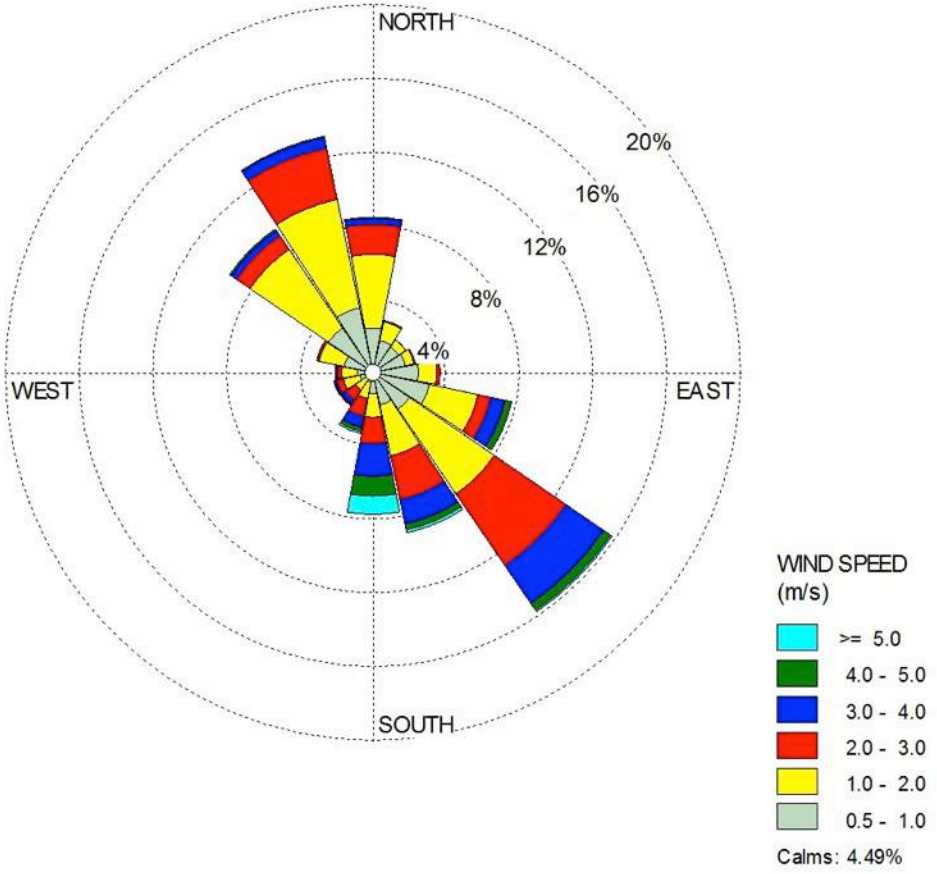
Beach Elementary



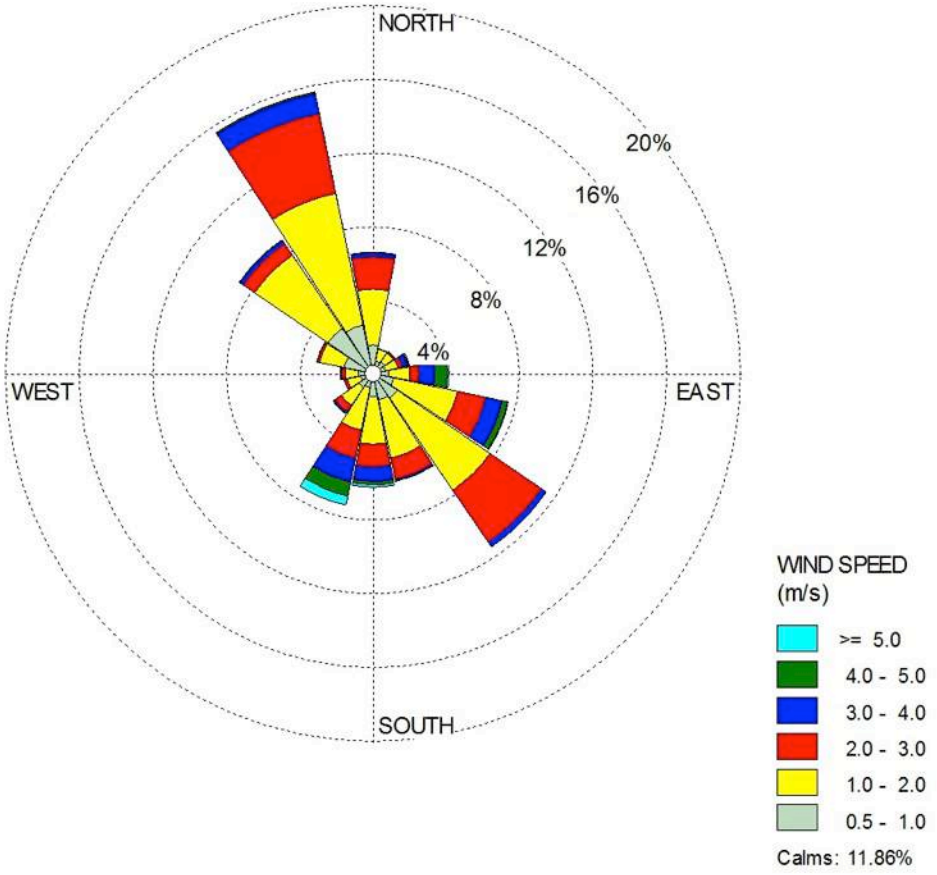
Chief Joseph Elementary



Sitton Elementary

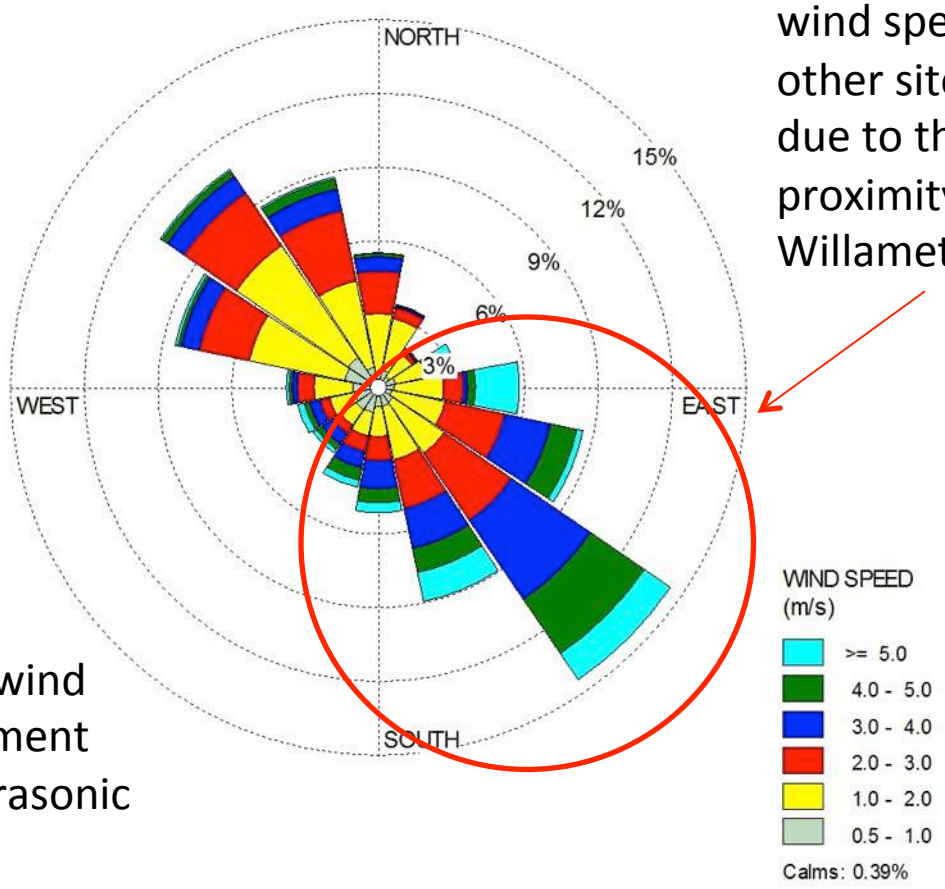


North Stafford Street (PNS)



Shaver Transportation Co.

Note significantly higher wind speeds relative to other sites, which may be due to the site's greater proximity to the Willamette River

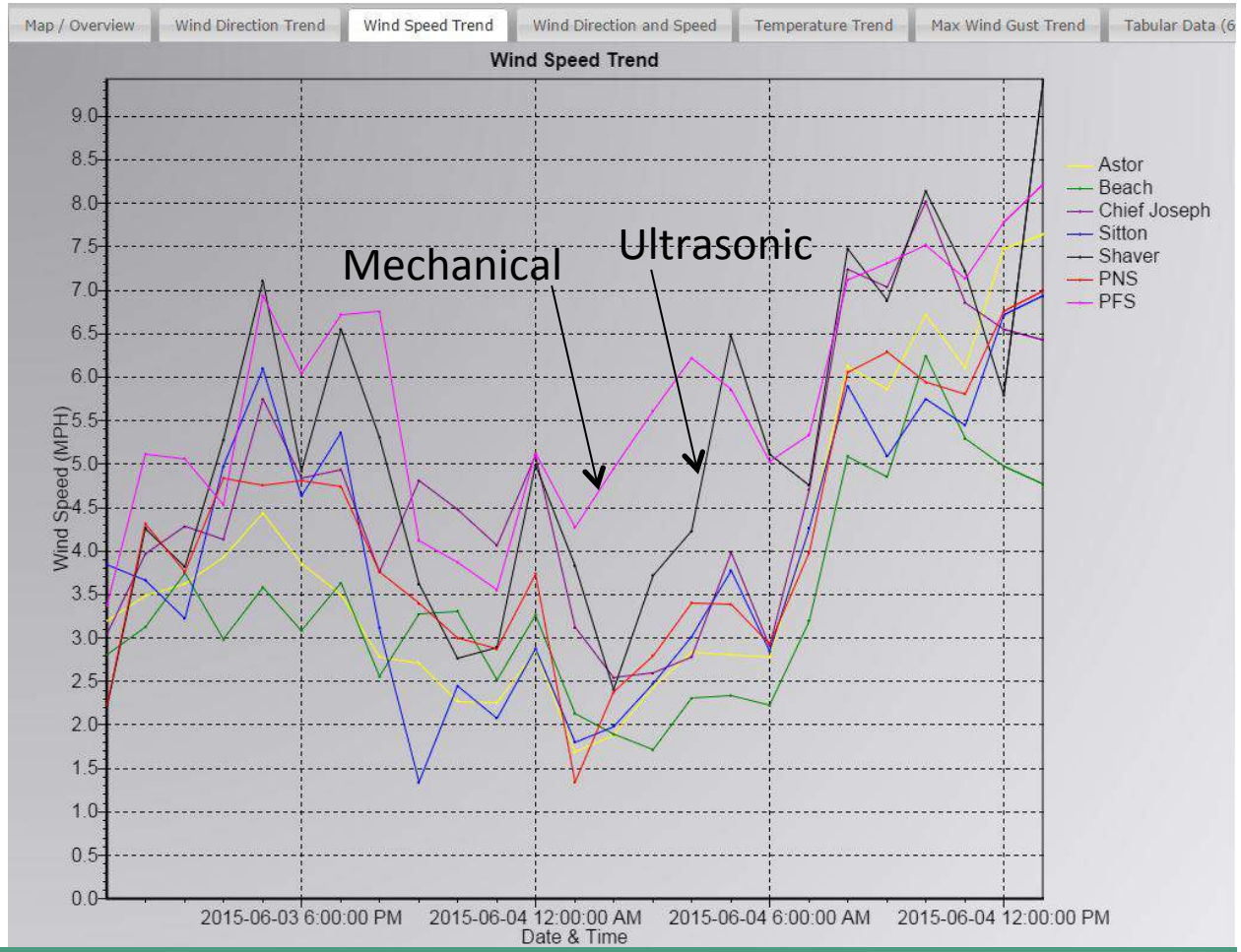


Could the reported higher wind speeds be due to measurement calculation error by the ultrasonic anemometer?

Let's compare with a site installed March 2015 on the same side of the river and only a few km SE which uses mechanical wind sensors (cups and vane):

"Good" correlation between the two is common

…except during heavy rain events



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Meteorological Data

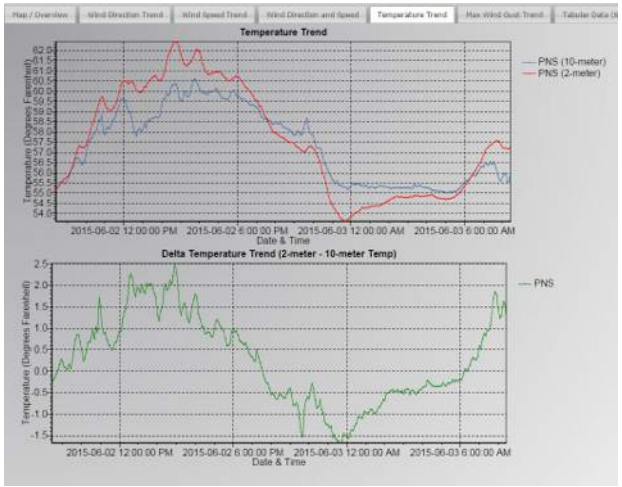
Can we stop collecting data now that we have seen the average wind directions are NW and SE?

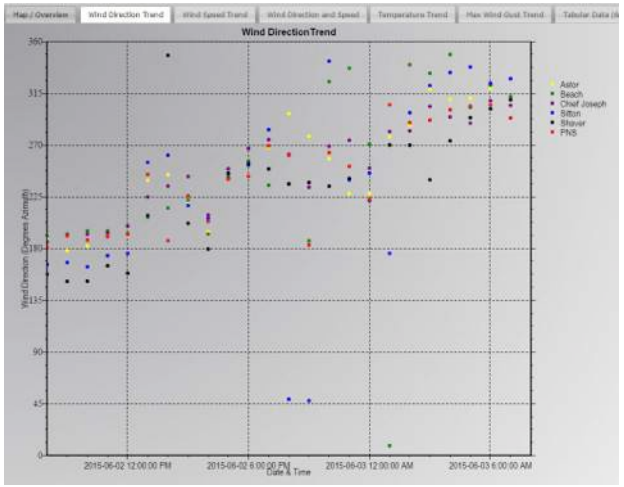
No. The project was designed to collect a full year of meteorological data to account for seasonal fluctuations in all meteorological parameters.

Meteorological Data

Despite predominantly NW and SE winds throughout study area, a more detailed investigation is required

- In recent weeks, interesting trends have emerged





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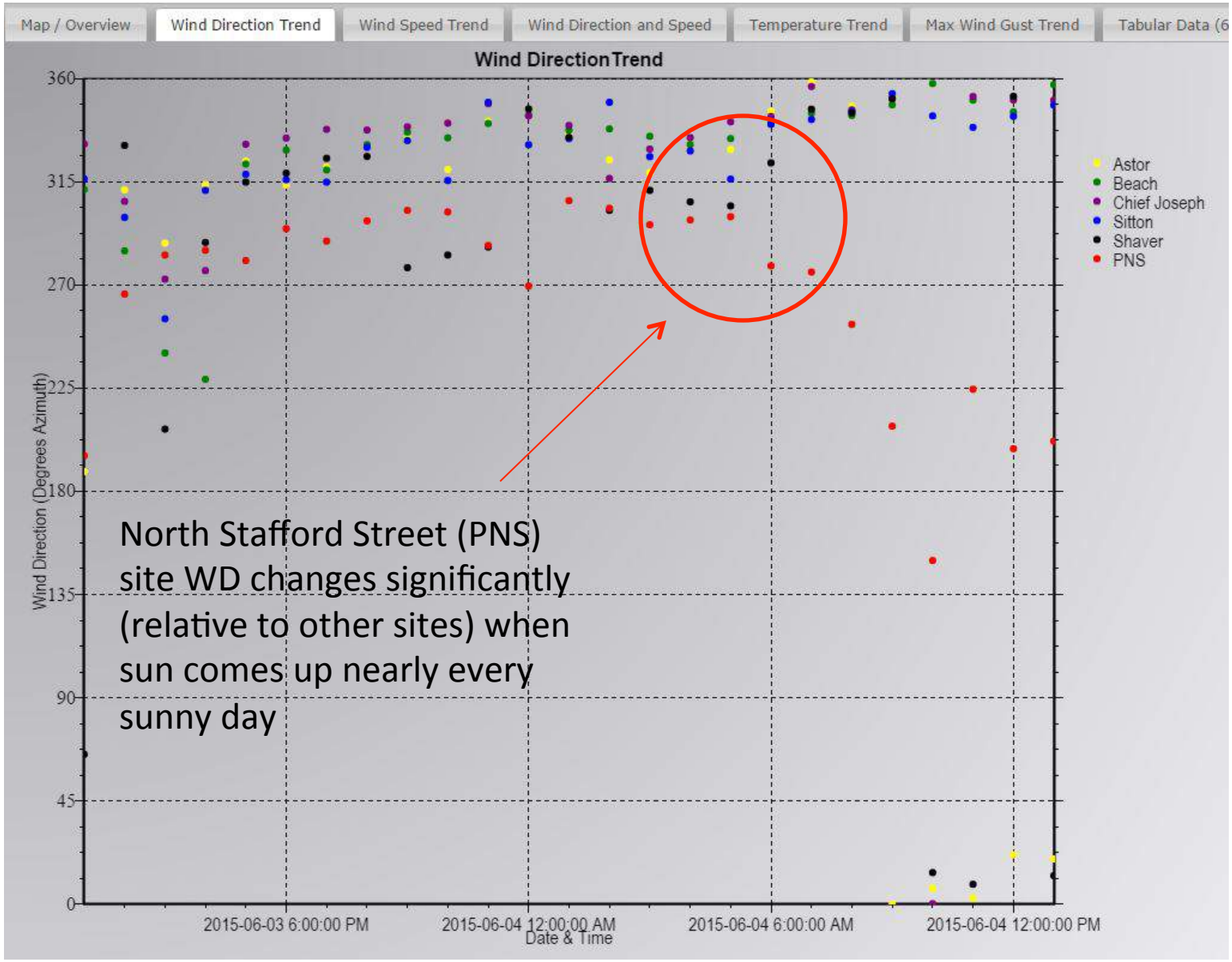
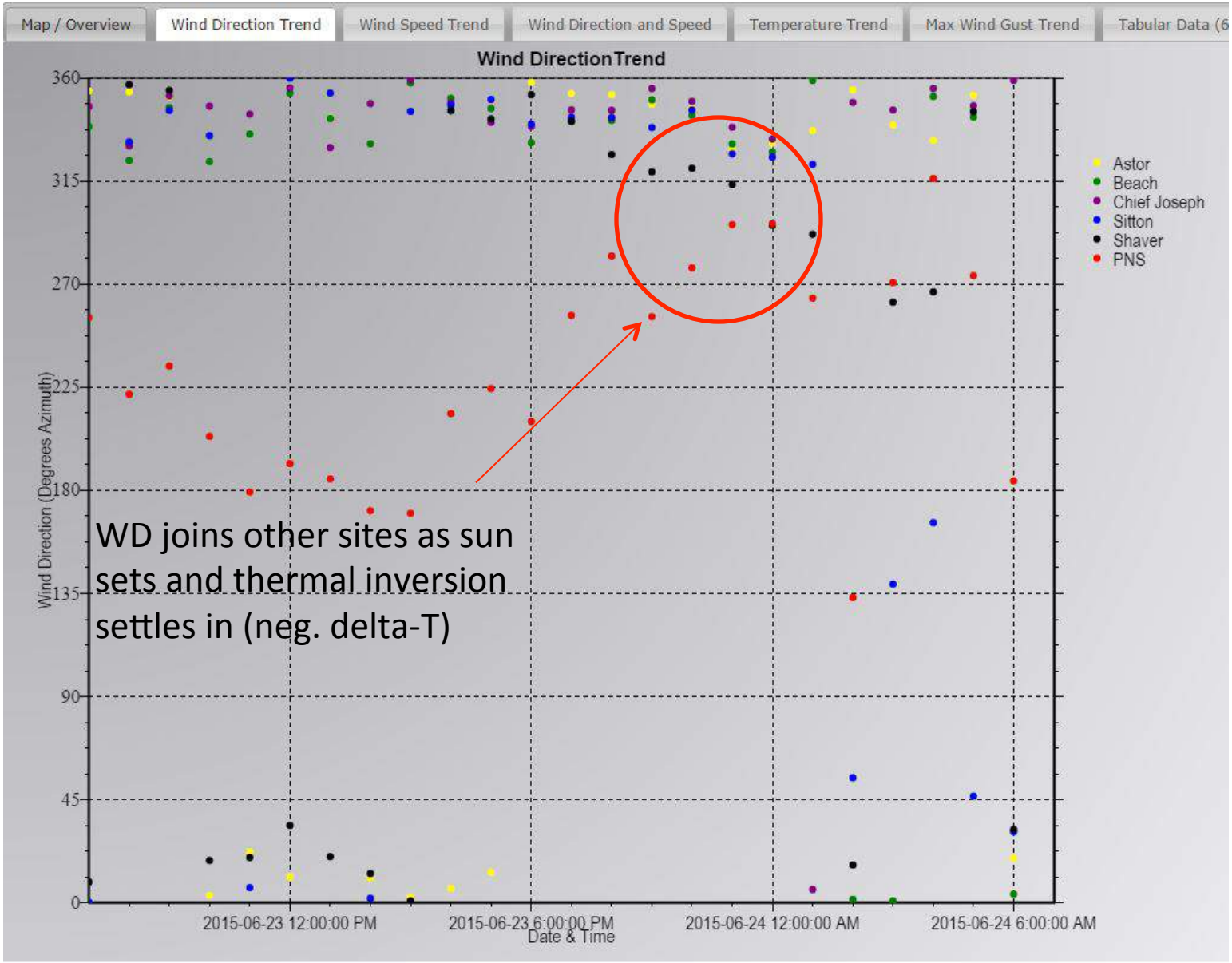
Meteorological Data Analysis

One site (North Stafford Street, PNS) has been particularly interesting to watch

- Trends at this site potentially indicate an extremely localized phenomenon which may be related to a bluff upon which North Portland resides and atmospheric stability…


Map / Overview
Wind Direction Trend
Wind Speed Trend
Wind Direction and Speed
Temperature Trend
Max Wind Gust Trend
Tabular Data (6
Wind Direction Trend
360
315
270
225
180
135
90
45
0
Wind Direction (Degrees Azimuth)
2015-06-03 6:00:00 PM
2015-06-04 12:00:00 AM
2015-06-04 6:00:00 AM
2015-06-04 12:00:00 PM
Date & Time
Astor
Beach
Chief Joseph
Sitton
Shaver
PNS
North Stafford Street (PNS) site WD changes significantly (relative to other sites) when sun comes up nearly every sunny day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Wind Direction Trend
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Wind Direction and Speed
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Wind Direction Trend
360
315
270
225
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90
45
0
Wind Direction (Degrees Azimuth)
2015-06-23 12:00:00 PM
2015-06-23 6:00:00 PM
2015-06-24 12:00:00 AM
2015-06-24 6:00:00 AM
Date & Time
Astor
Beach
Chief Joseph
Sitton
Shaver
PNS
WD joins other sites as sun sets and thermal inversion settles in (neg. delta-T)

Meteorological Data

North Stafford Street (PNS) site has exhibited a significantly impacted average wind direction relative to the other sites in the network under the following meteorological conditions:

- Positive delta-T
- Little to no cloud cover, or sunny
- Moderate winds (~2-6 m/s, or 5-12 MPH)

Meteorological Data Analysis

Swan Island may be acting as an urban heat island due to lack of vegetation

- Air parcels directly above Swan Island may be fairly buoyant relative to the colder, denser air above the river and surrounding vegetated neighborhoods. In these conditions, air parcels above Swan Island will tend to rise and produce turbulent (varying) winds in the vicinity

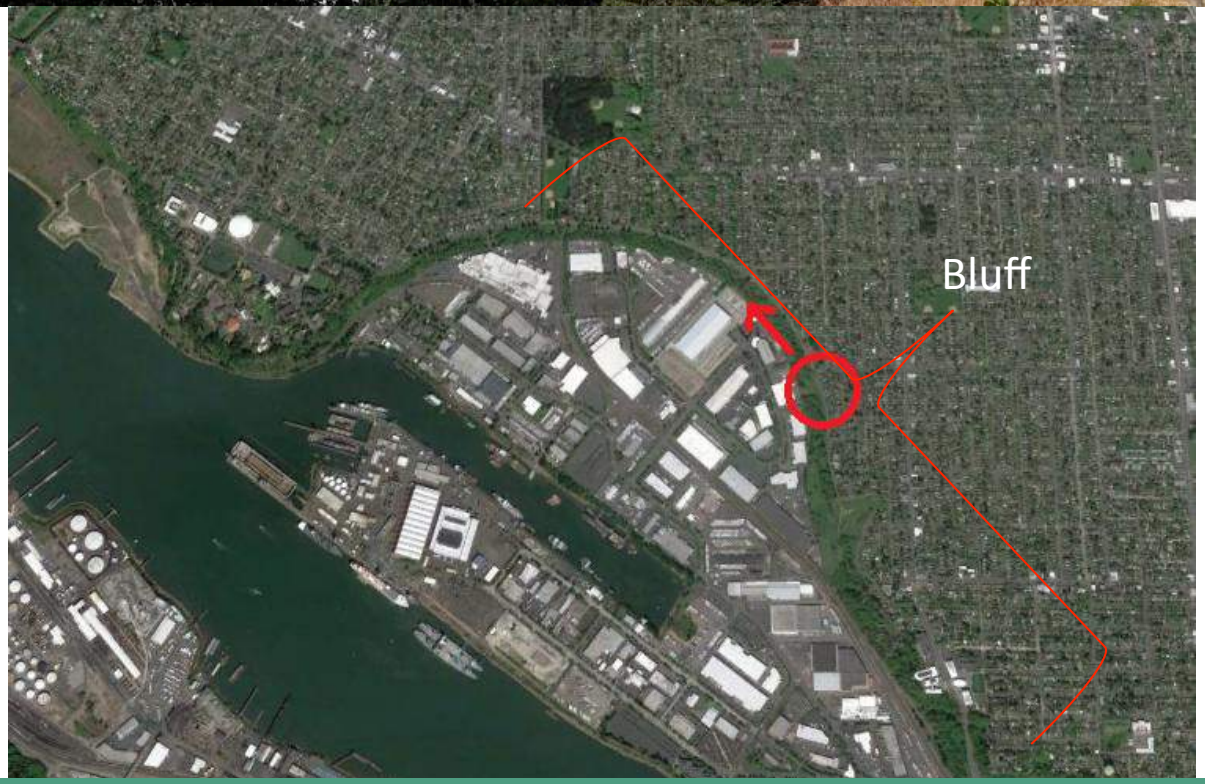
Meteorological Data Analysis

In the surrounding neighborhoods, some heat may be "lost" to evapotranspiration in plants: plants can moderate warm air temperatures due to the cooling effect on surrounding air when water molecules contained in and around plants evaporate. Therefore, hot surfaces on neighboring Swan Island and hot factory emissions will tend to heat the air more quickly and consequently become buoyant.

Meteorological Data Analysis

Additionally, air temperatures just above the River will tend to be much cooler than the air above Swan Island, due to water's greater heat capacity. With high winds coming from the River and the cooler, denser air associated with it, the warm, odorous air on Swan Island can easily be forced over the bluff and into surrounding neighborhoods.

“The Bluff”



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Meteorological Data

What other factors might be influencing this "microclimate"?

- Swirling of winds below bluff due to complex topography of Swan Island area
- Thermal inversions and trapping ability of bluff

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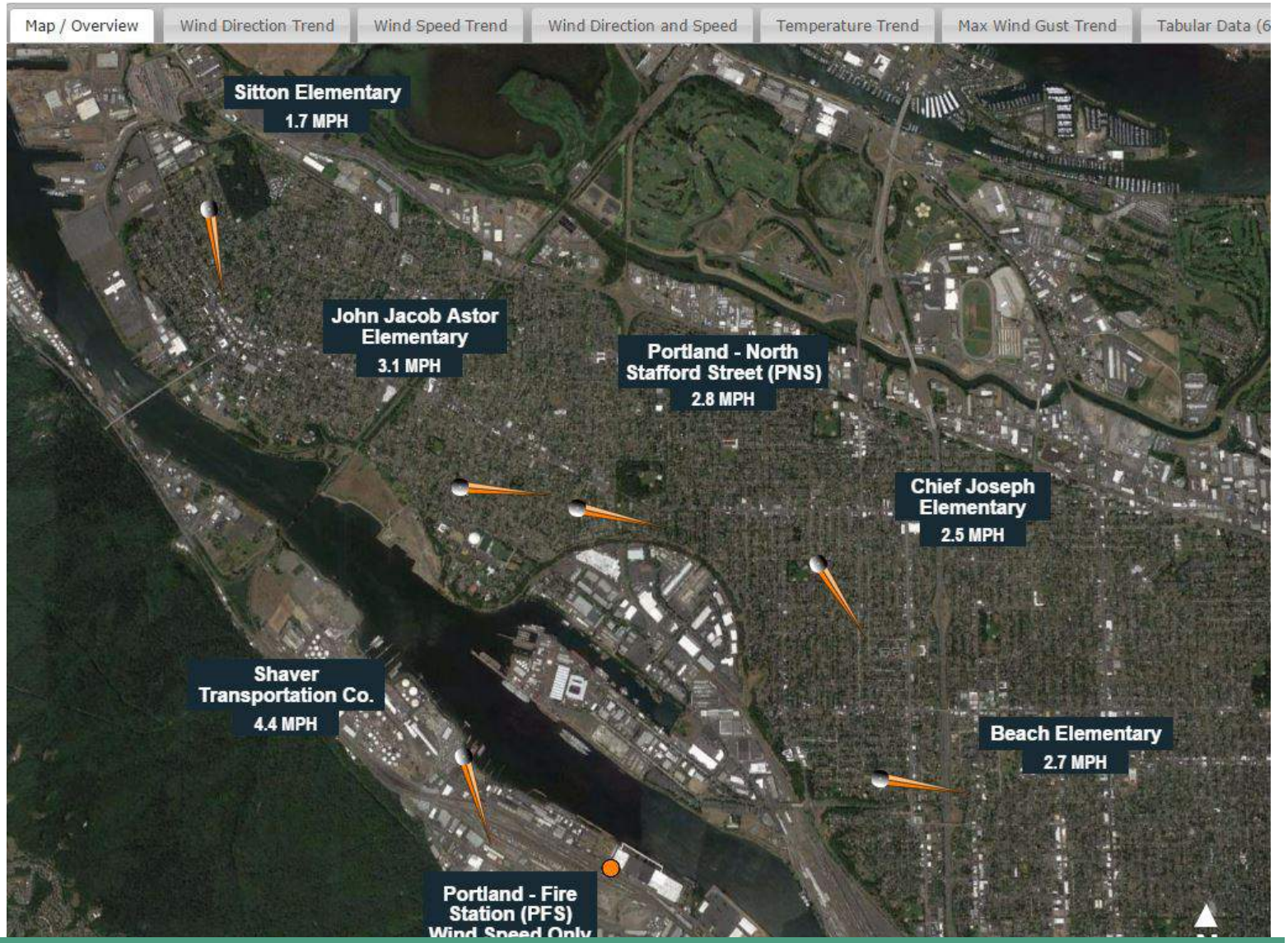
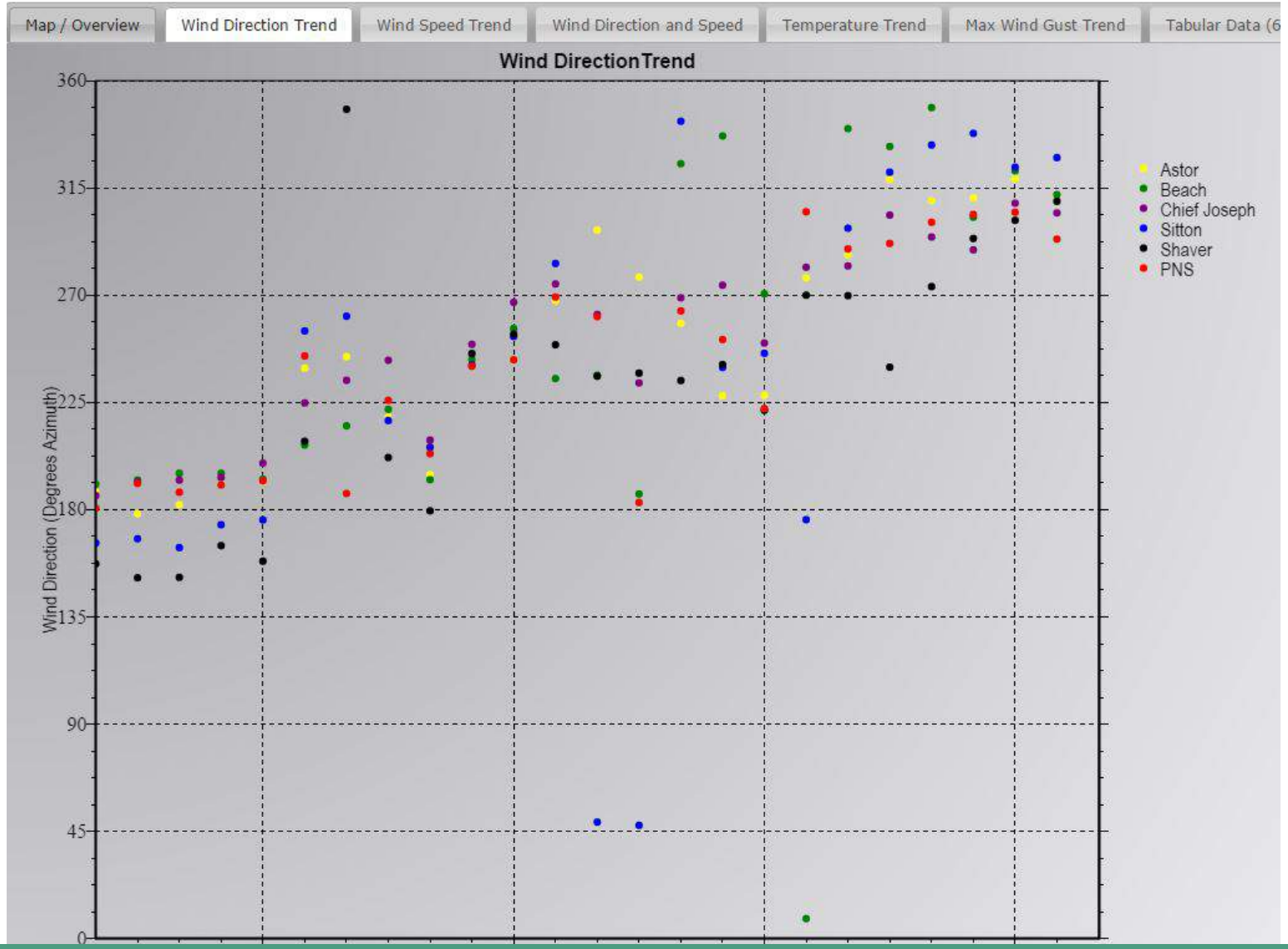
Public Website

http://159.121.9.140/swanislandairtoxics/index.html

Public Website



Public Website



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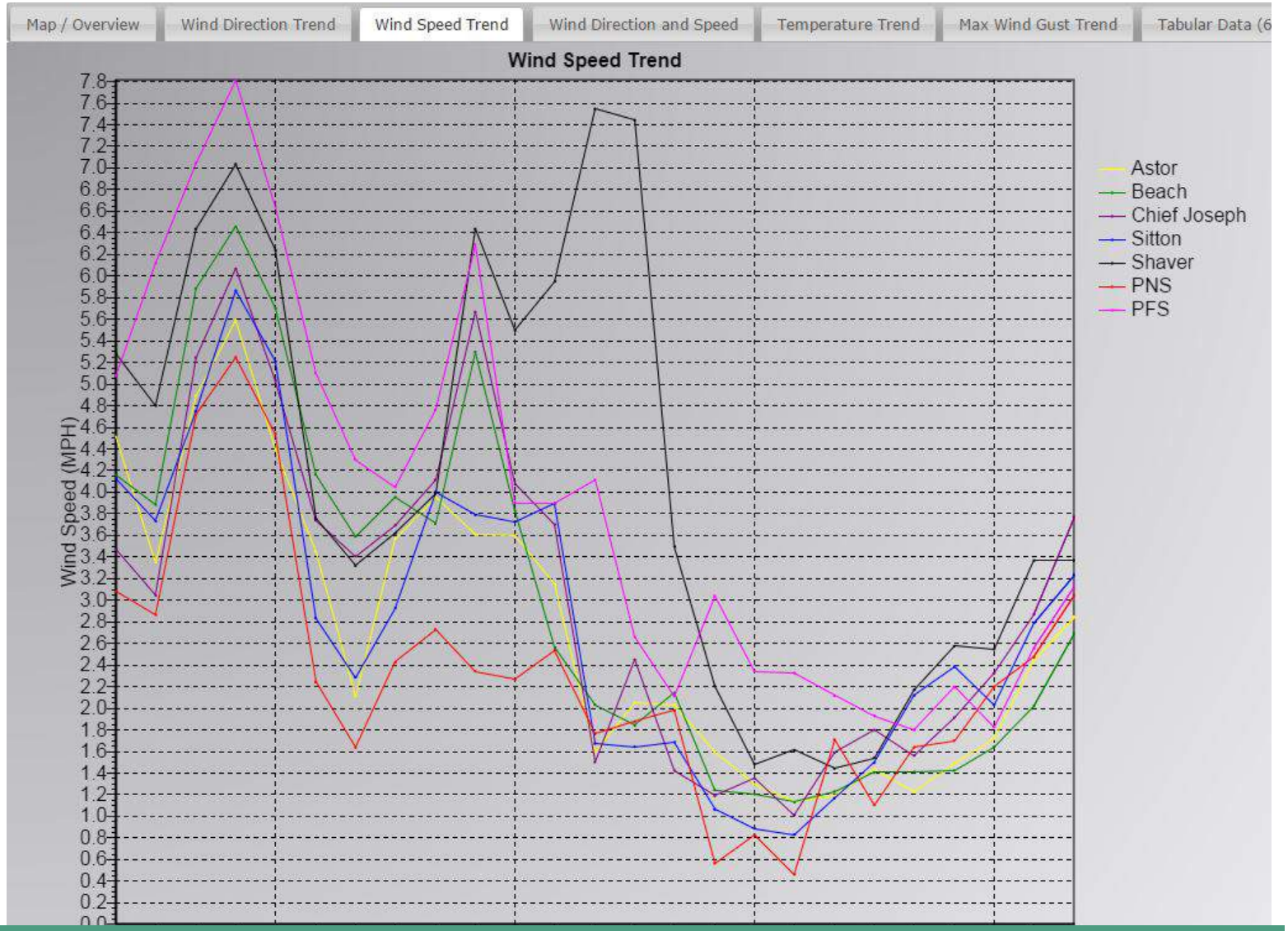
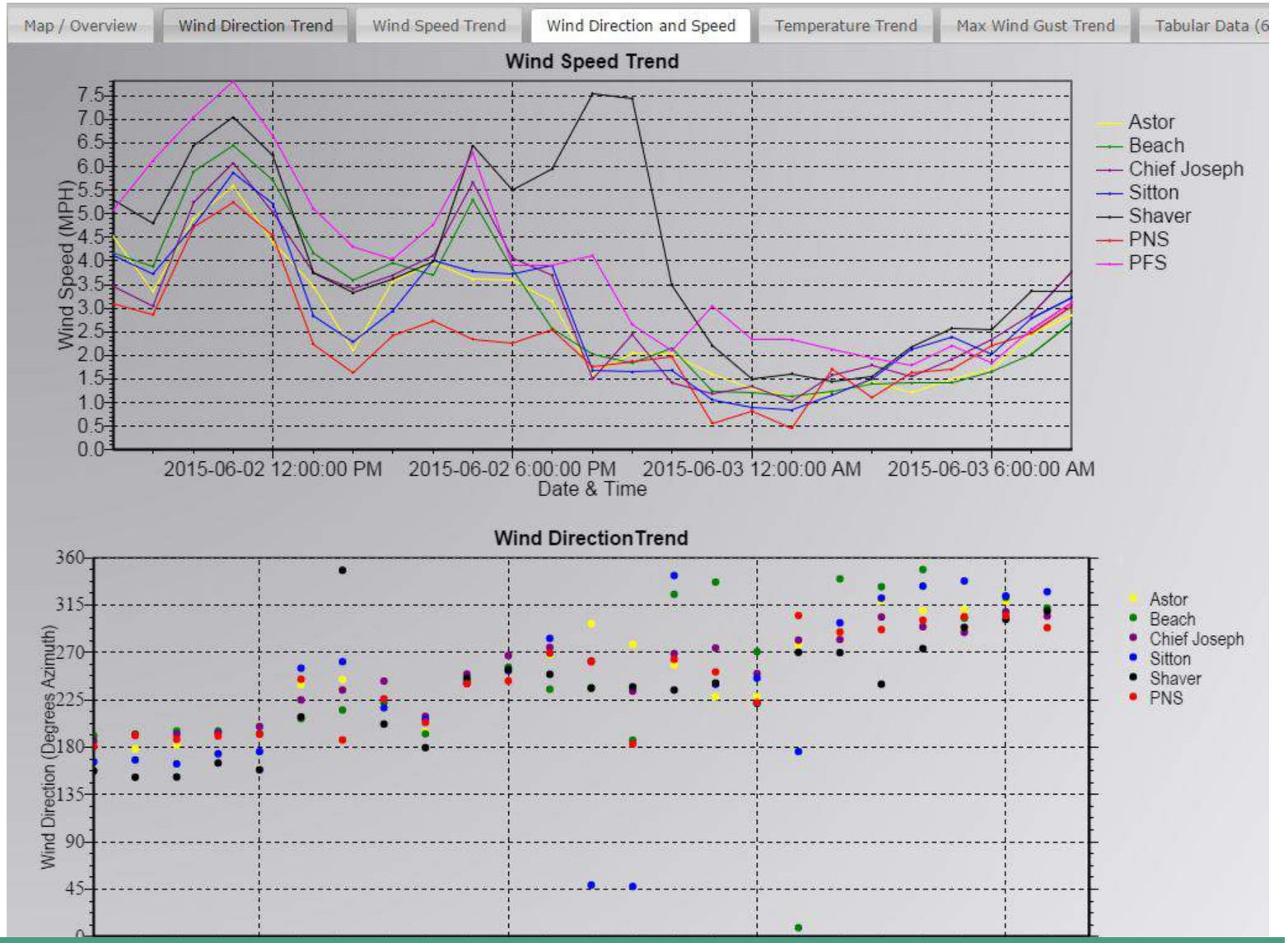


Public Website



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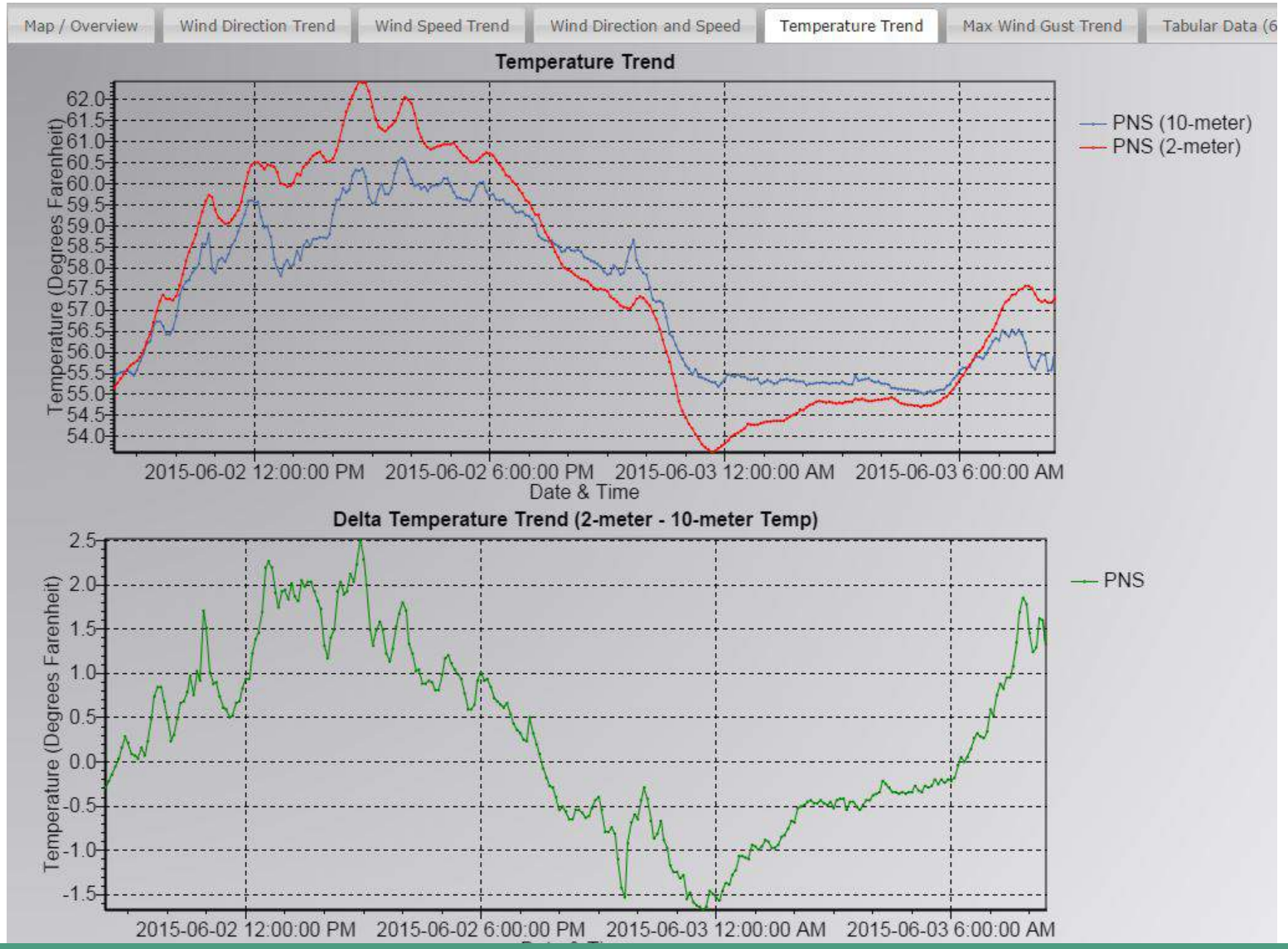

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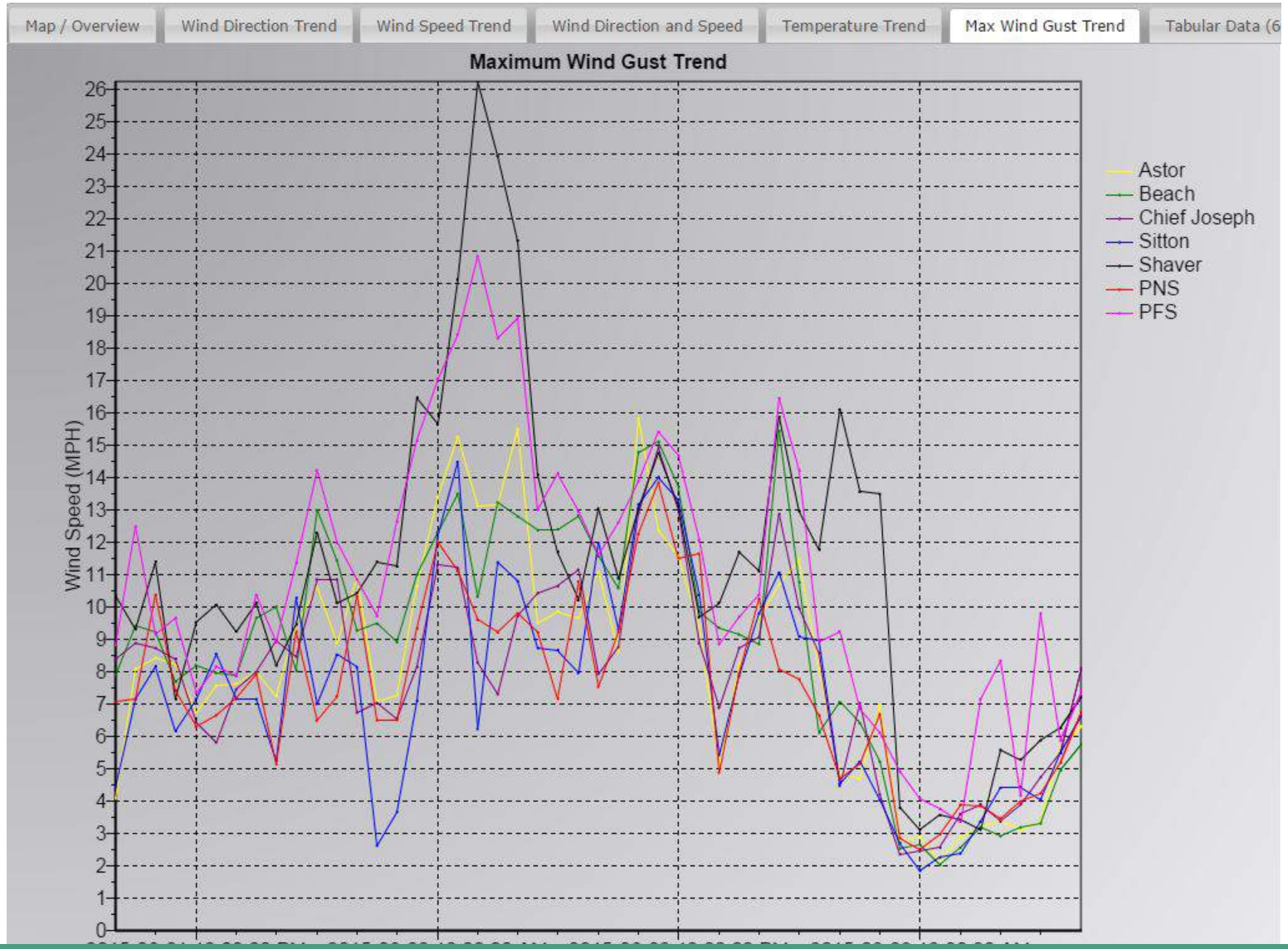
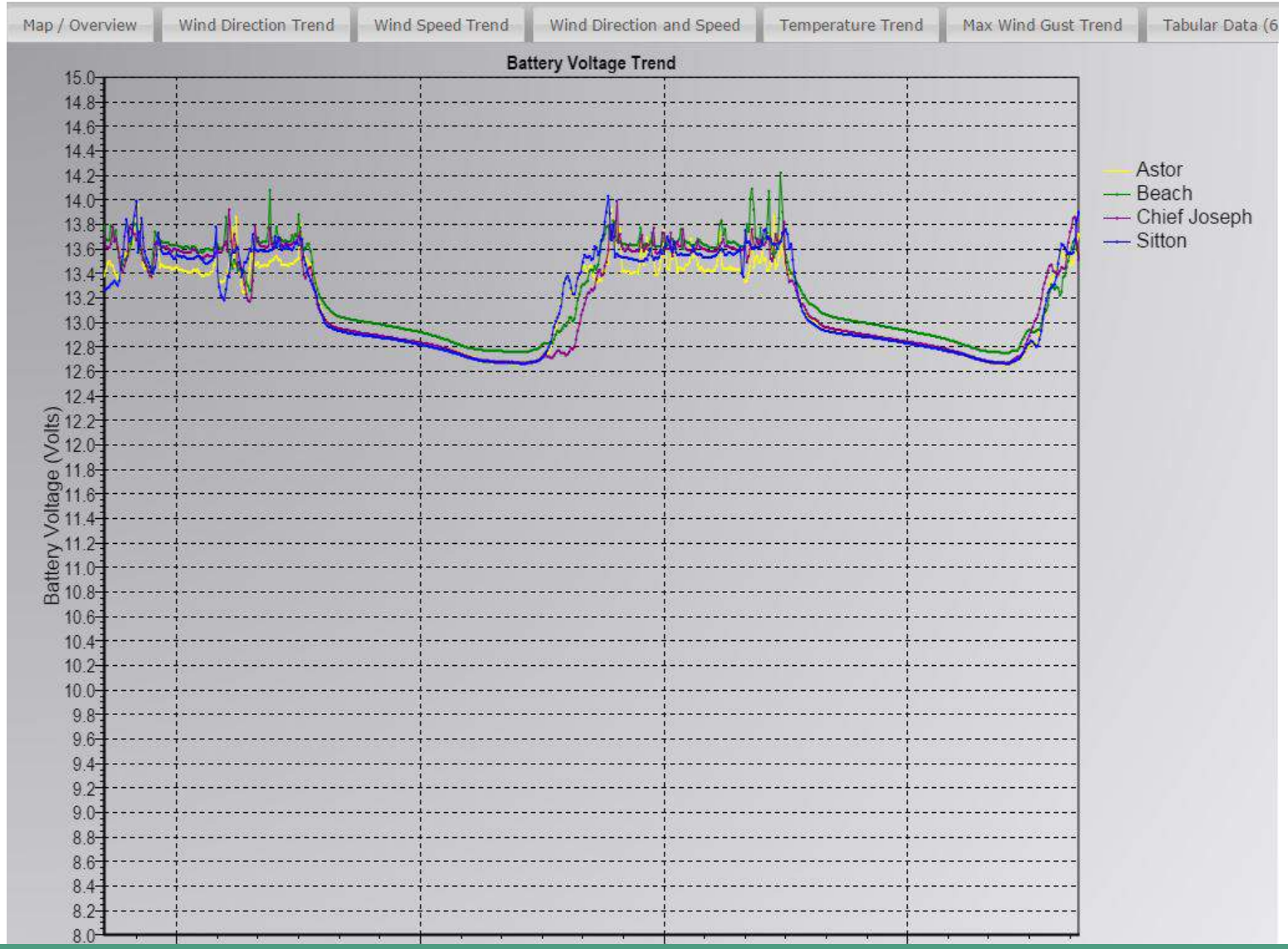
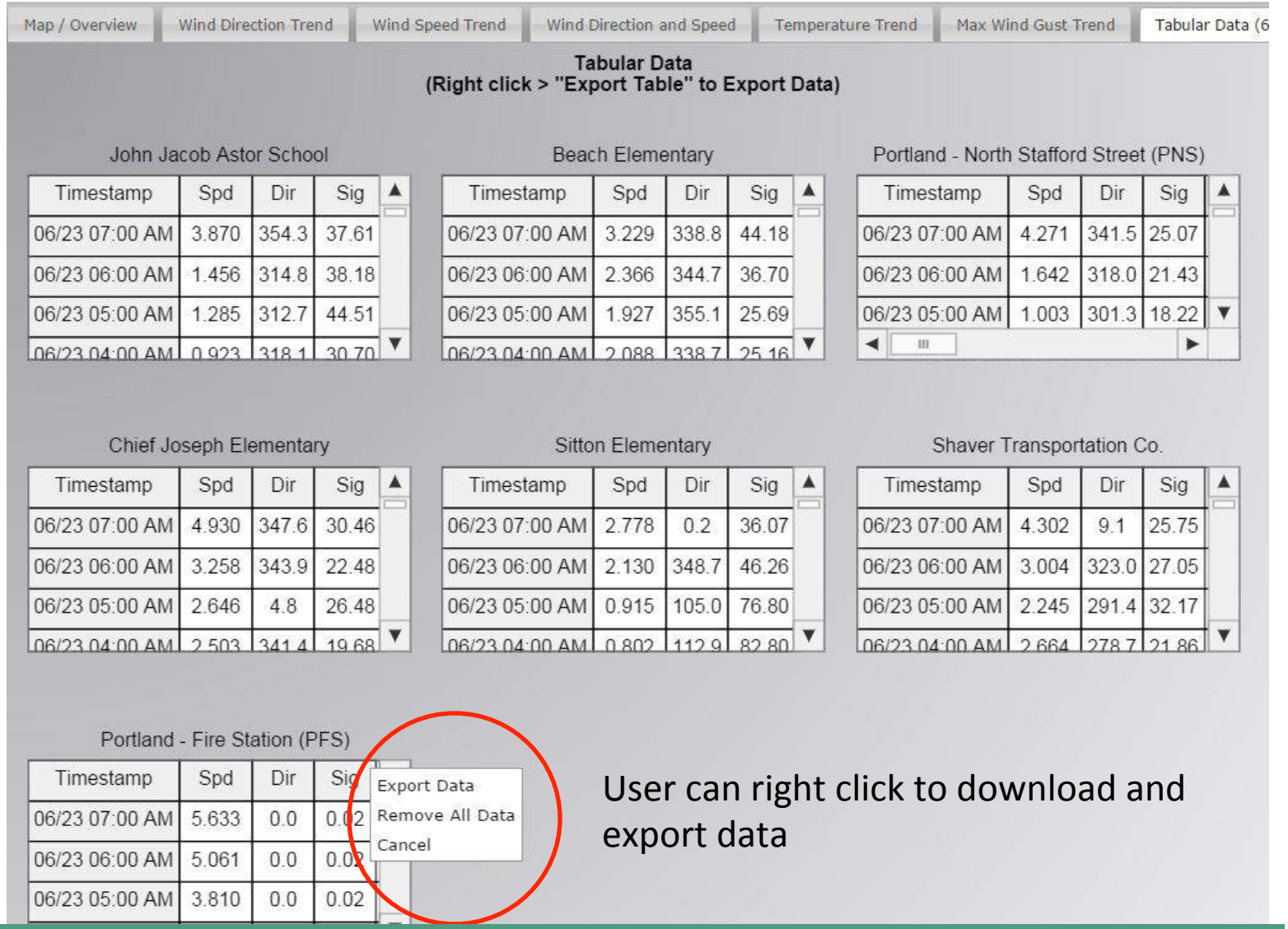


Public Website



Public Website

Public Website



User can right click to download and export data

Conclusions

- Dense network of reliable meteorological sites very useful in identification of local wind fields
- Swan Island/Bluff/River interaction is dynamic, complex system that may have large impact on odor events and should be investigated further
- More qualified odor identifiers should be enlisted to provide greater odor data; meteorological data is plentiful while qualified odor complaints relatively lacking

Project Future

- Complete at least one year of data collection
- Run models with collected data
- Analyze dataset and odor complaints to determine correlations, if any
- Potentially re-site or add additional meteorological stations once “hot spots” have been identified
- Enlist additional qualified odor identifiers

Acknowledgements

- Jessica Reichers
- Topher McGarry
- Anthony Barnack
- Chris Modderman
- Louis Bivins
- Phil Allen
- Bryan Smith

Thank You!

Comments/ Questions?

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Phone: (503) 693-5713