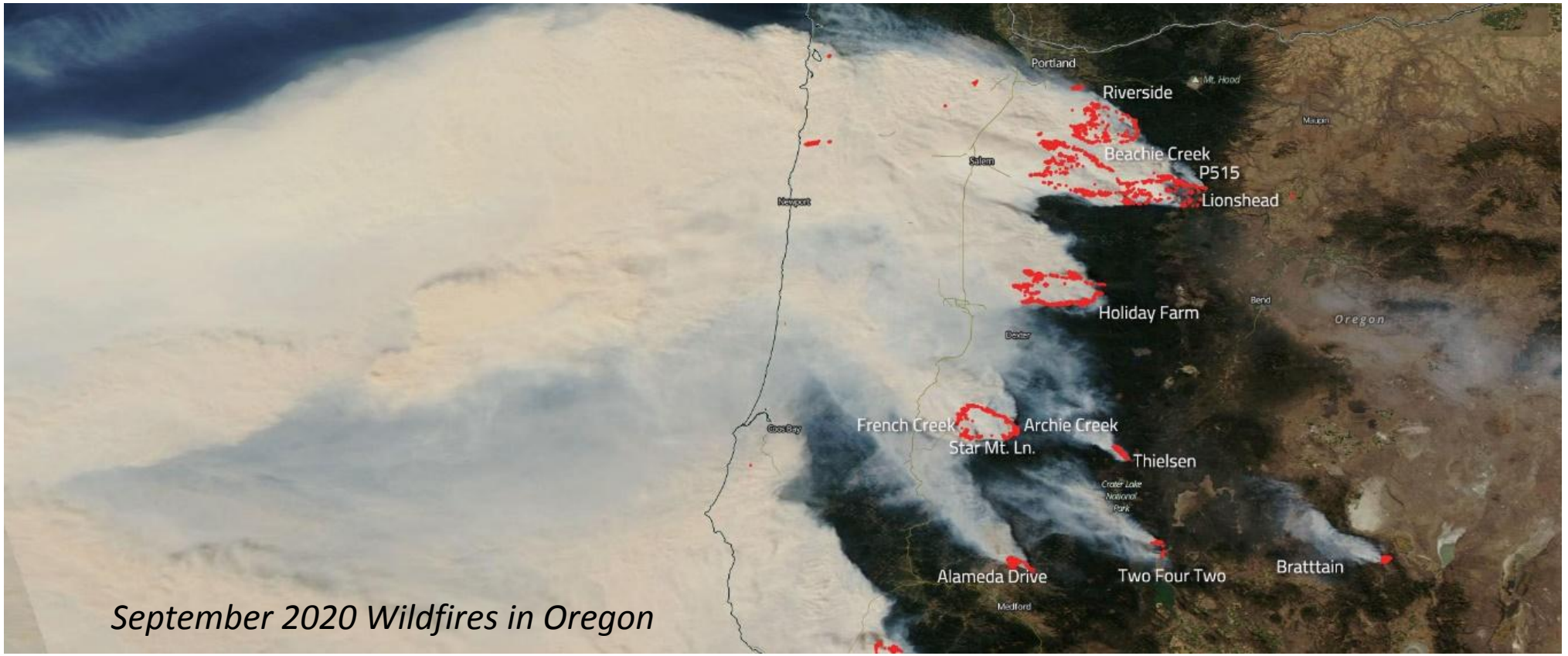
Air Sensors International Conference
May 2022

Dan Johnson, Oregon DEQ

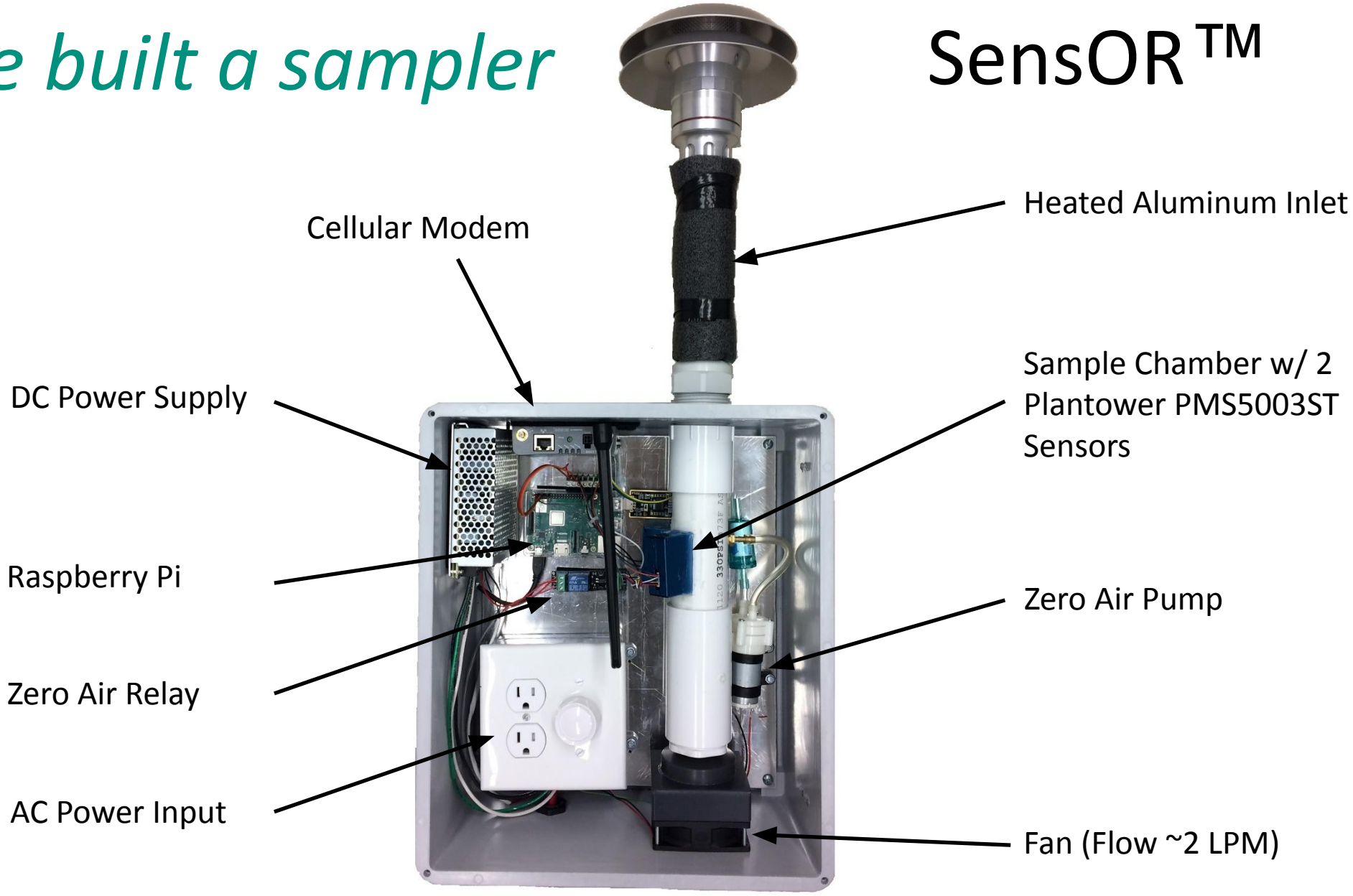


September 2020 Wildfires in Oregon

SensOR Team
Anthony Barnack (Project Mgr: Anthony.Barnack@deq.oregon.gov)
Daniel Johnson (Outreach: Daniel.Johnson@deq.oregon.gov)
Lance Hochmuth
Aaron Fellows
Luke Mattheis
Marissa Meyer
Matthew Shrensel

We built a sampler

SensOR™



Monitoring Cost and Accuracy

Highly Accurate & Expensive → Lower Accuracy & Cheaper

Federal Equivalent Method

MetOne BAM 1022

Radiance Nephelometer

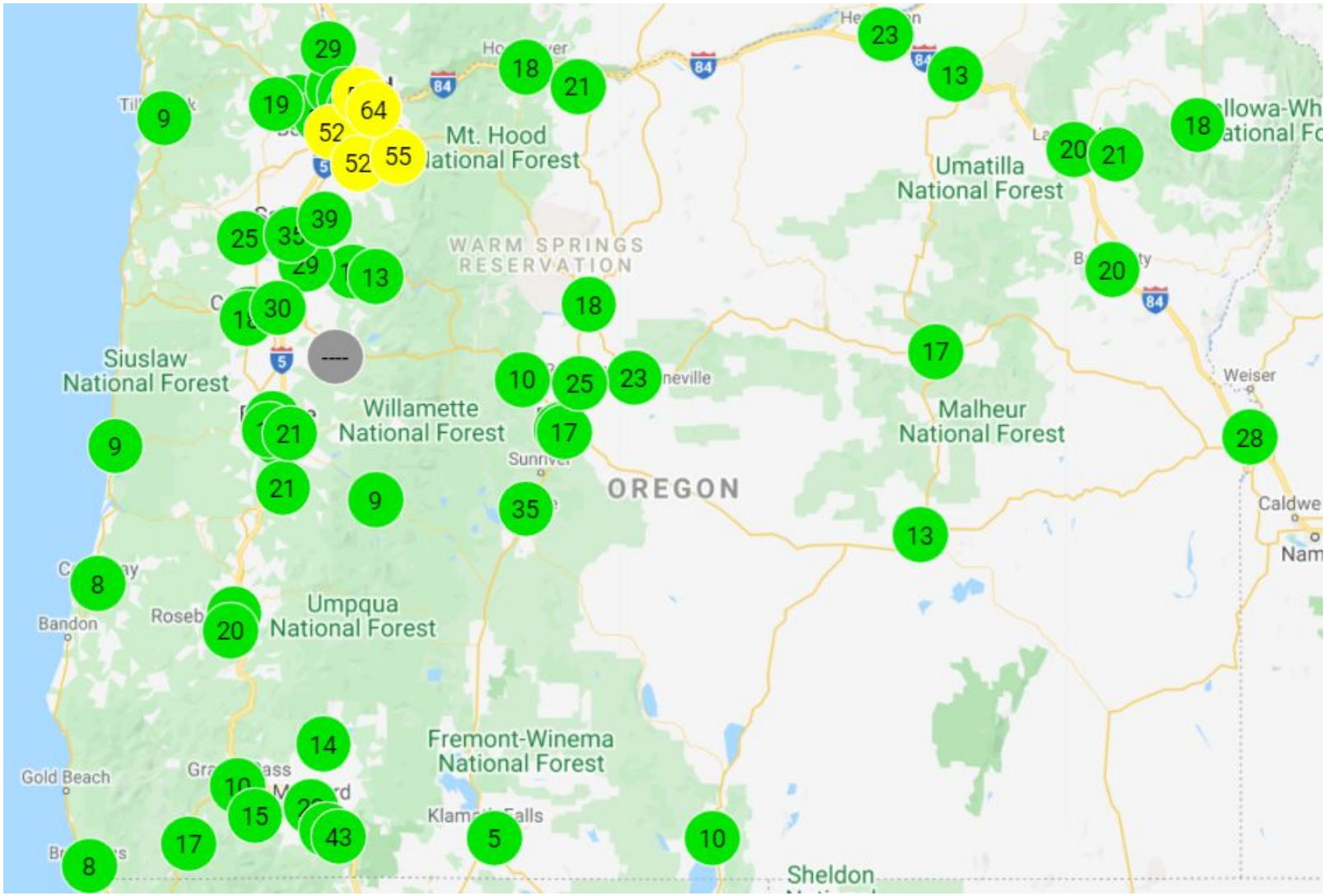
Oregon DEQ SensOR

Purpleair

Plantower

Sensor evaluation by South Coast AQMD at http://www.aqmd.gov/aq-spec

Near real time information for public health guidance (Nowcast AQI)



https://oraqi.deq.state.or.us/home/map and OregonAir mobile apps

Why build a low-cost PM sensor package at DEQ?

- Received funding in 2017 to add 30 new sites
  - Completed Spring 2022
- Expand PM-2.5 monitoring using an approach that is consistent with existing methods in Oregon
  - Measurement & QA/QC approach
  - Use existing IT and AQM network infrastructure
- Provide publicly-owned near real-time data
  - Shared through AirNow Tech
- Provide data of known quality (e.g., traceable)
- Data should meet DEQ data quality objectives

Oregon DEQ data quality objectives

- Data completeness >= 75%

https://www.oregon.gov/deq/FilterDocs/aqmlowcost.pdf

https://www.oregon.gov/deq/FilterDocs/aqmtargets.pdf

- Air Quality Index data should be within +/- 20% FRM Data

State of Oregon Department of Environmental Quality

Air Quality Monitoring Performance Targets[1]

Application	Pollutants	Precision & Accuracy[2]	Examples	Supporting Documentation
Regulatory or compliance monitoring, Air toxics monitoring[3]	Ozone, PM2.5, CO, NO2, SO2, Lead, VOCs, HAPs[3]	+/- 10%	Filter-based FRM[4] sampler, Continuous FEM[5] PM monitor, FEM ozone analyzer, EPA laboratory protocols	40 CFR parts 50, 53, and 58, National Air Toxics Trend Station Technical Assistance document
Supplemental monitoring, Special studies, Real-time Air Quality Index	Ozone, PM2.5, H2S, VOCs, Meteorology	+/- 20%	Nephelometer, E-BAM, H2S monitor for odors, Calibrated met station, Sensor-based with quality control and validation	Organization's approved quality assurance plan or sampling analysis plan
Area and source surveys, Screening; Fenceline monitoring, Personal exposure	Ozone, PM2.5, NO2, VOCs, Meteorology	+/- 30%	Calibrated sensors, Home met station	EPA Air Sensor Toolbox
Information, Education, Community monitoring	Ozone, PM2.5, NO2, CO, VOCs and others	+/- 50%	Low-cost sensors, Personal monitors	South Coast AQMD Air Quality Sensor Performance and Evaluation Center

1 This document is for informational use only. DEQ makes no claim, warranty or guarantee of instrument performance when operated by users for their specific applications.

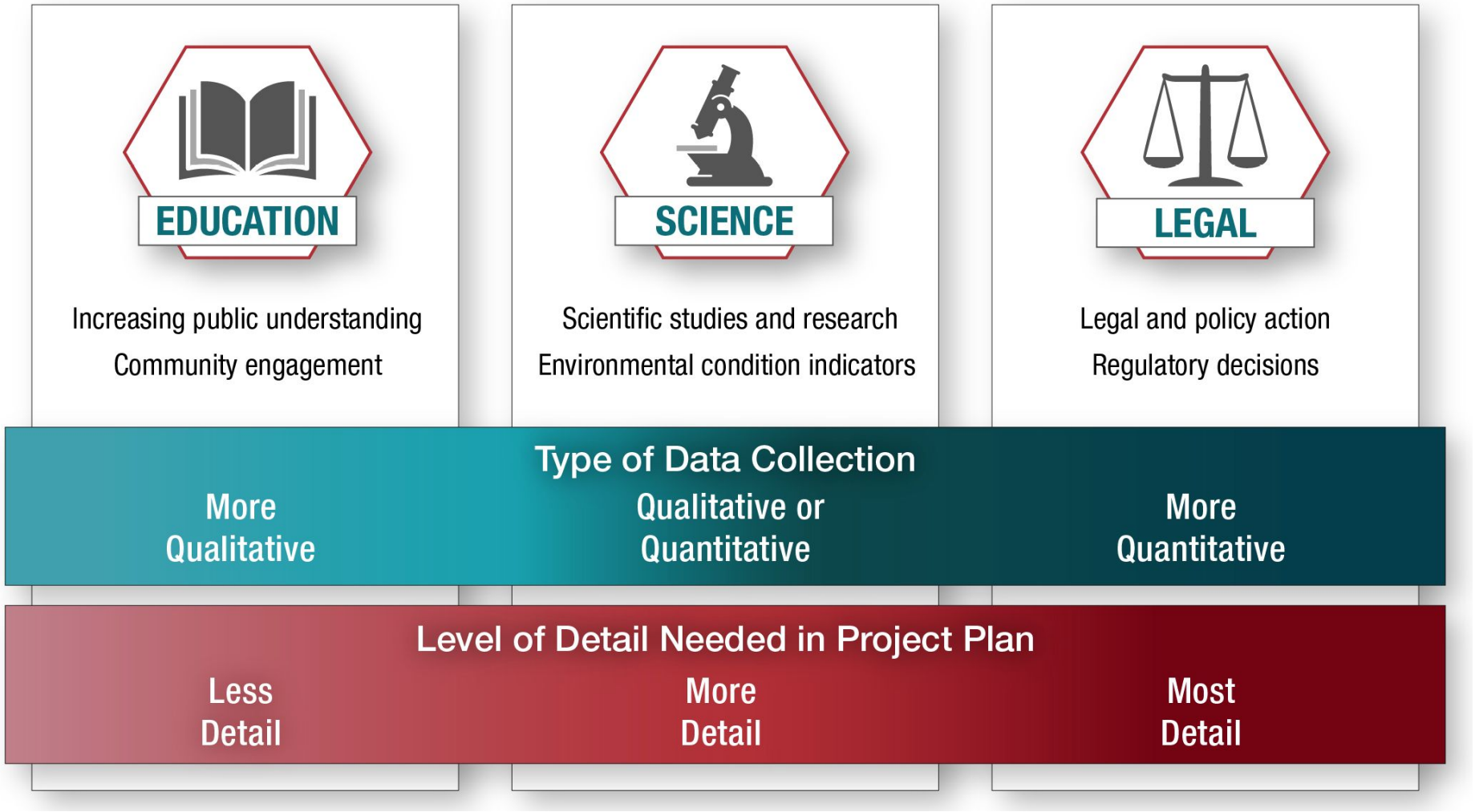
2 These guidelines are likely to evolve as technology and science advance.

3 Hazardous air pollutants or air toxics

4 Federal Reference Method

5 Federal Equivalent Method

Association of Public Health Labs / EPA



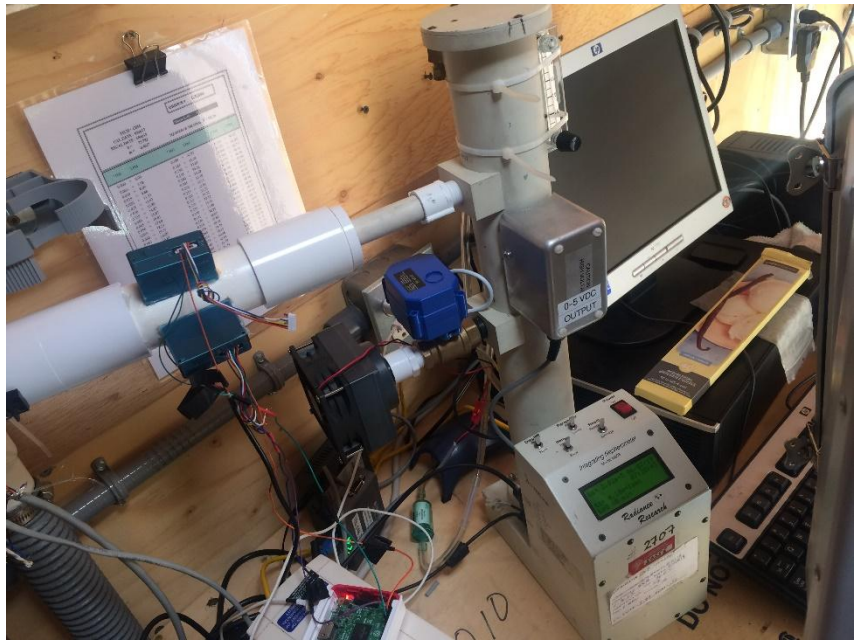
From "Working Together to Improve Citizen Science Data Quality: A Guide for Government Agencies"
https://www.epa.gov/system/files/documents/2021-11/aphl-epa-citizenscience-qualityassurance-orientationguide.pdf

Approach

- Treat SensOR™ similar to the nephelometer
- Inline sensors run at multiple sites for at least 30 days
- Correct Plantower output to nephelometer back scatter (BScat)
  - Range of corrections is +/- 20%
- Use nephelometer to Federal Reference Method (FRM) correlations specific to each site as implemented over many years in OR
  - Range of correlations is +/- 15%
  - Wildfire correlation is different from winter time correlations
- Quarterly maintenance checks
  - Sensors don’t respond to calibration gas
- Verify with collocated sites and performance audits
  - 10% of samplers collocated
  - ARP Grant funding for three BAM 1022s to verify and improve SensOR PM2.5 estimates

Use Nephelometer as a ‘transfer standard’ to correlate PM 2.5 estimates

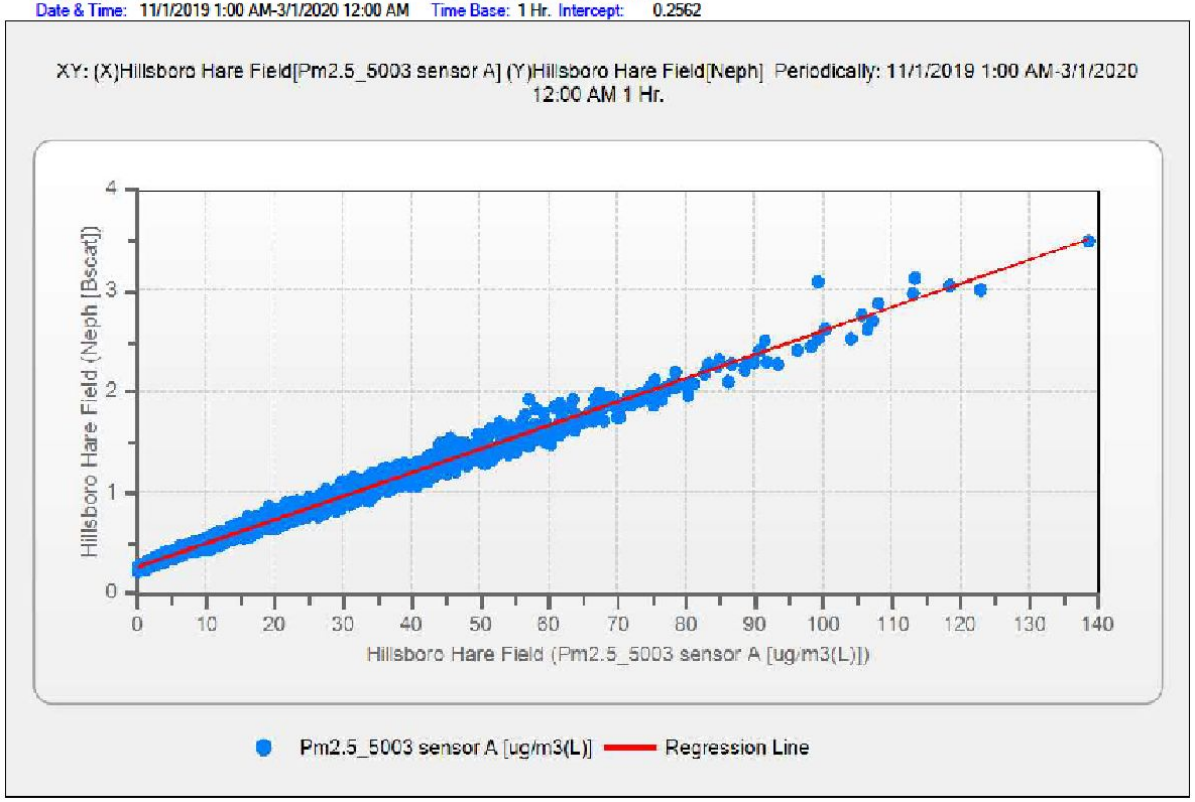
Inline comparison with Radiance M903 Nephelometer



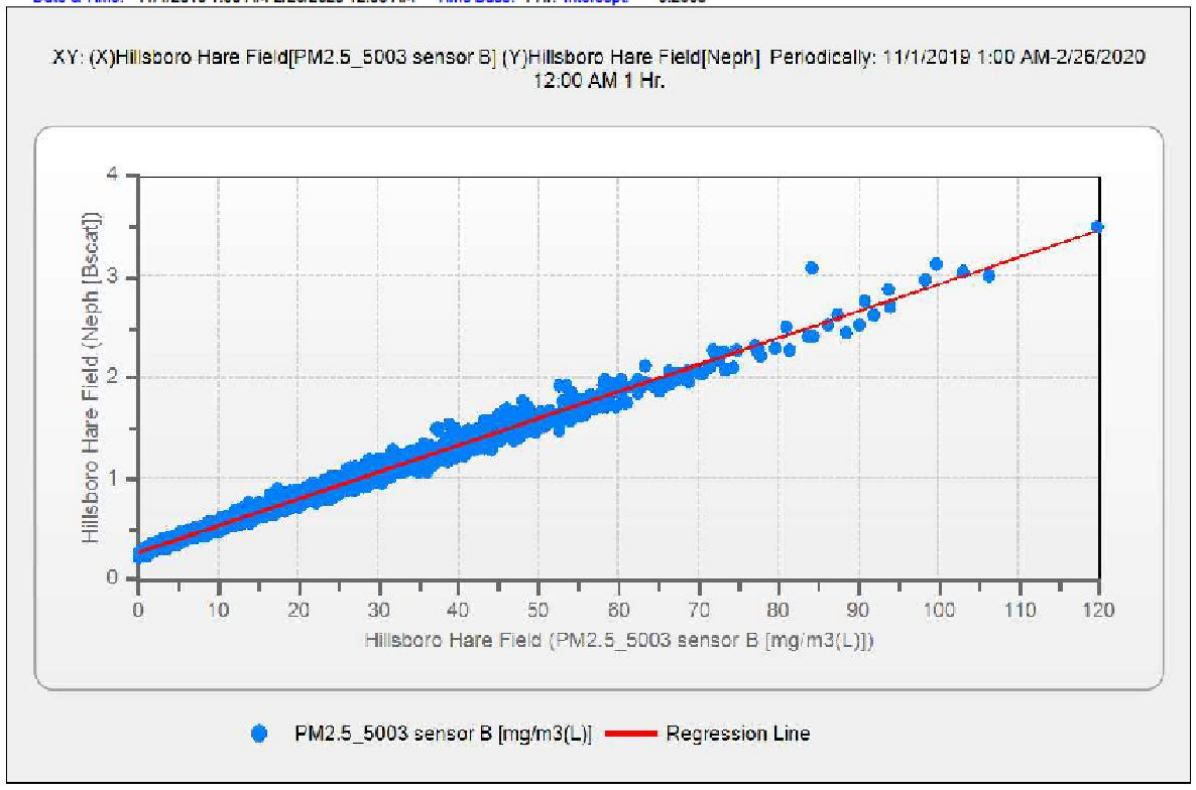
SensOR uses site correlations to FRM

Comparison of inline sensor to Nephelometer Bscat

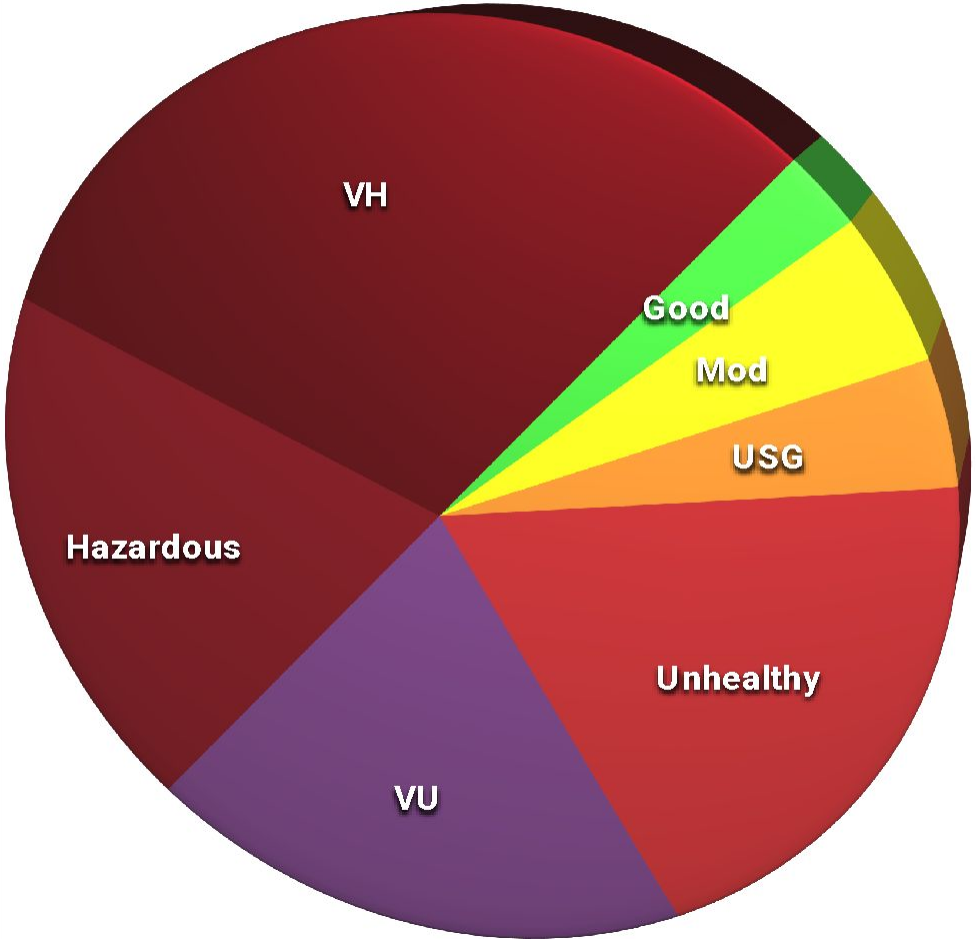
XY: (X)Hillsboro Hare Field[Pm2.5_5003 sensor A] (Y)Hillsboro Hare Field[Neph] Periodically: 11/1/2019 1:00 AM-3/1/2020 12:00 AM 1 Hr.
Report Type: XY Avg Type: AVG Slope: 0.0235
Date & Time: 11/1/2019 1:00 AM-3/1/2020 12:00 AM Time Base: 1 Hr. Intercept: 0.2562



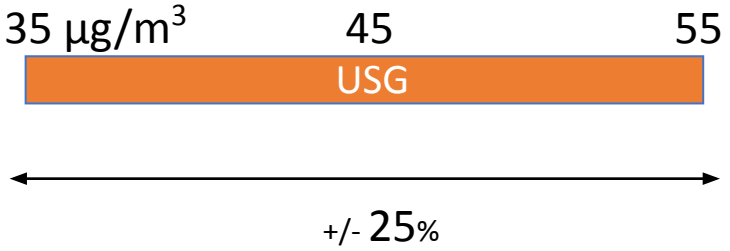
XY: (X)Hillsboro Hare Field[PM2.5_5003 sensor B] (Y)Hillsboro Hare Field[Neph] Periodically: 11/1/2019 1:00 AM-2/26/2020 12:00 AM 1 Hr.
Report Type: XY Avg Type: AVG Slope: 0.0267
Date & Time: 11/1/2019 1:00 AM-2/26/2020 12:00 AM Time Base: 1 Hr. Intercept: 0.2603



AQI categories aren't created equally

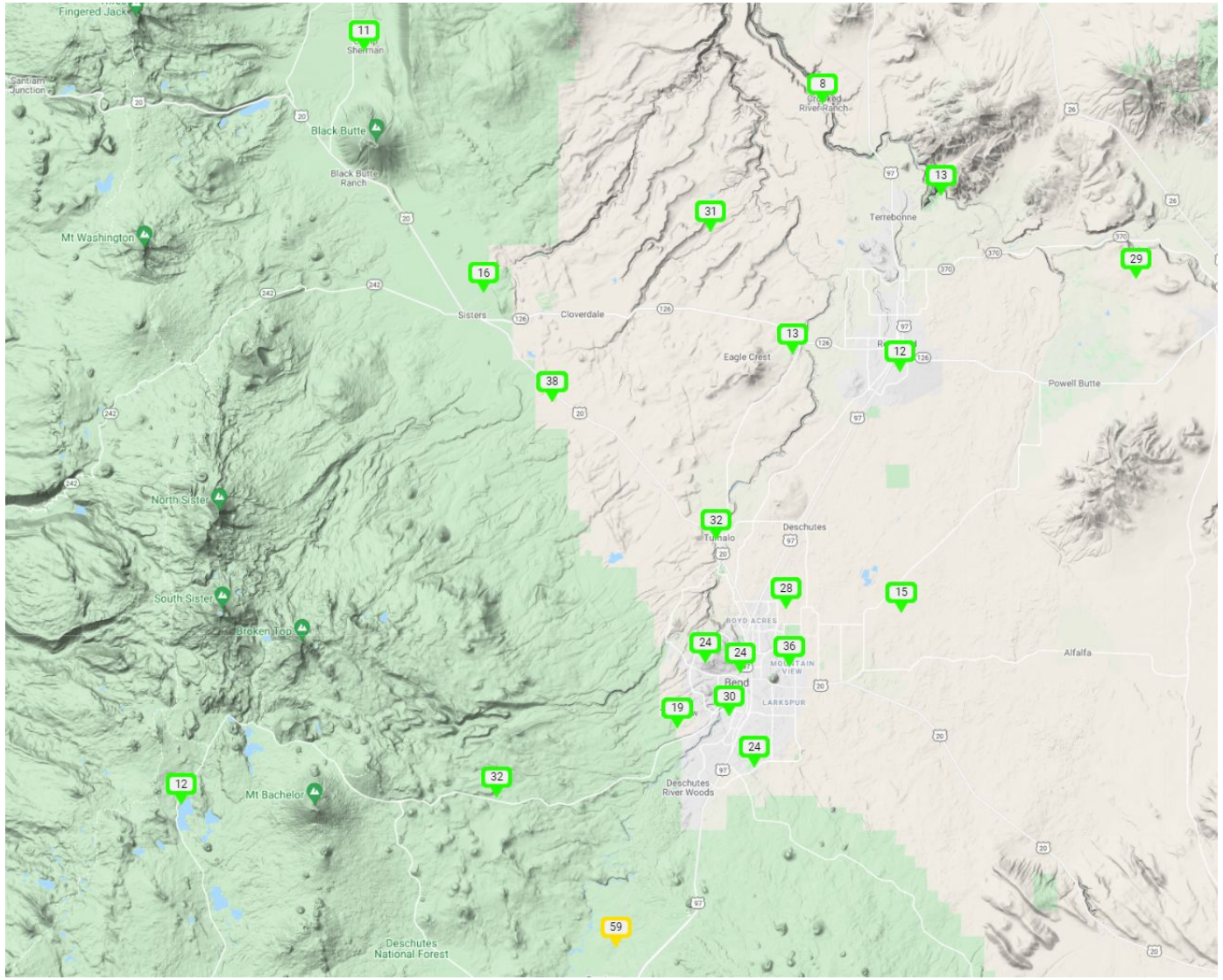


USG is the most difficult target…



…and the most important

Central Oregon Air Quality Network



Designed their sensor in partnership with OSU Cascades.

(aqi.espacelabs.us)

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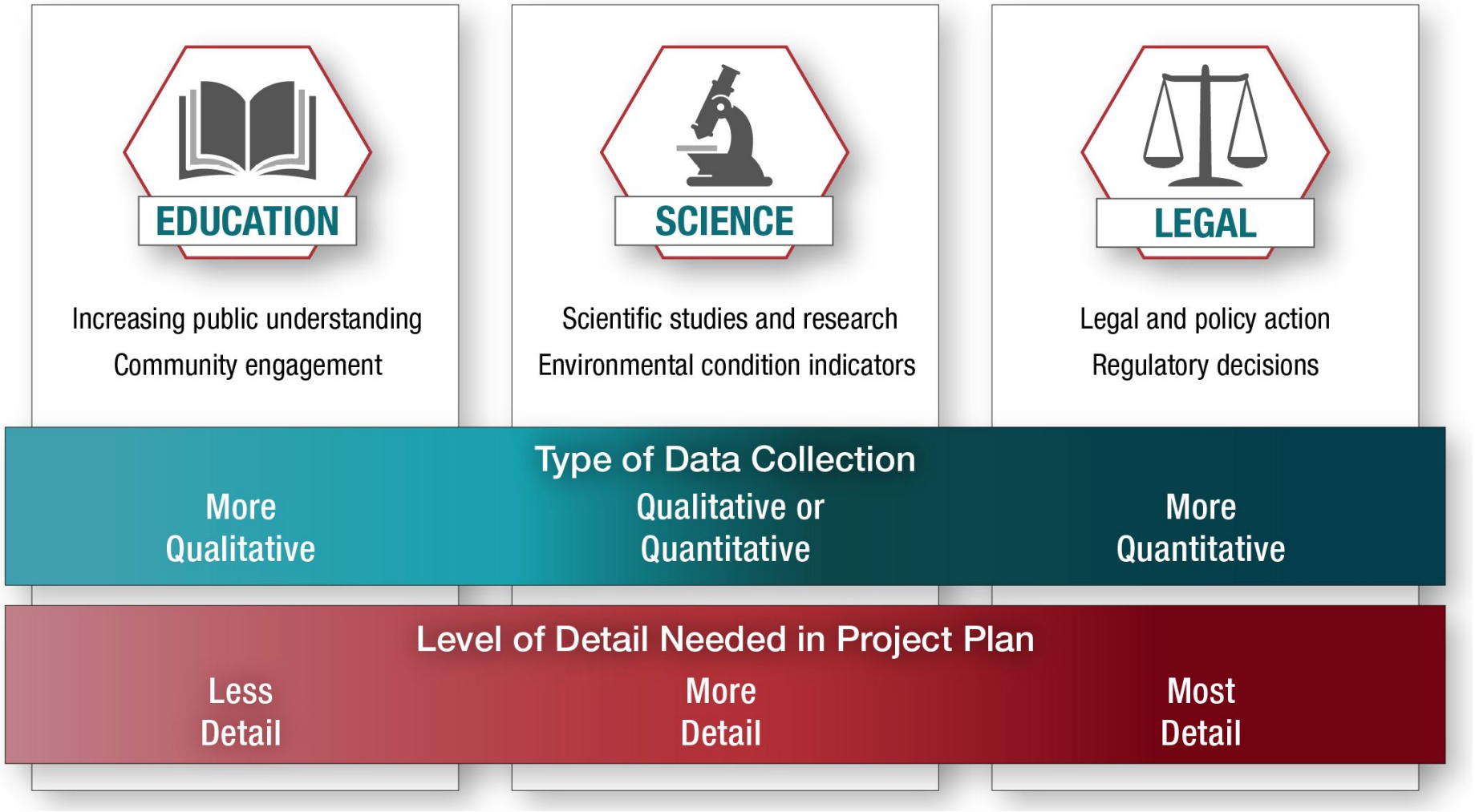

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How do I make my data count?

- Define the monitoring objective
  - What data quality is needed?
- Develop a monitoring plan and a QA plan
  - Describe the process in detail
  - Ask questions to support and defend the data
  - How can you verify the data quality objectives are met?
- Validate the data
  - Are the monitoring objectives achieved?
  - Refine and improve the process as needed

Quality Assurance Handbook and Guidance Documents for Citizen Science Projects

https://www.epa.gov/citizen-science/quality-assurance-handbook-and-guidance-documents-citizen-science-projects