

Air Monitoring and Regulation Panel 2:

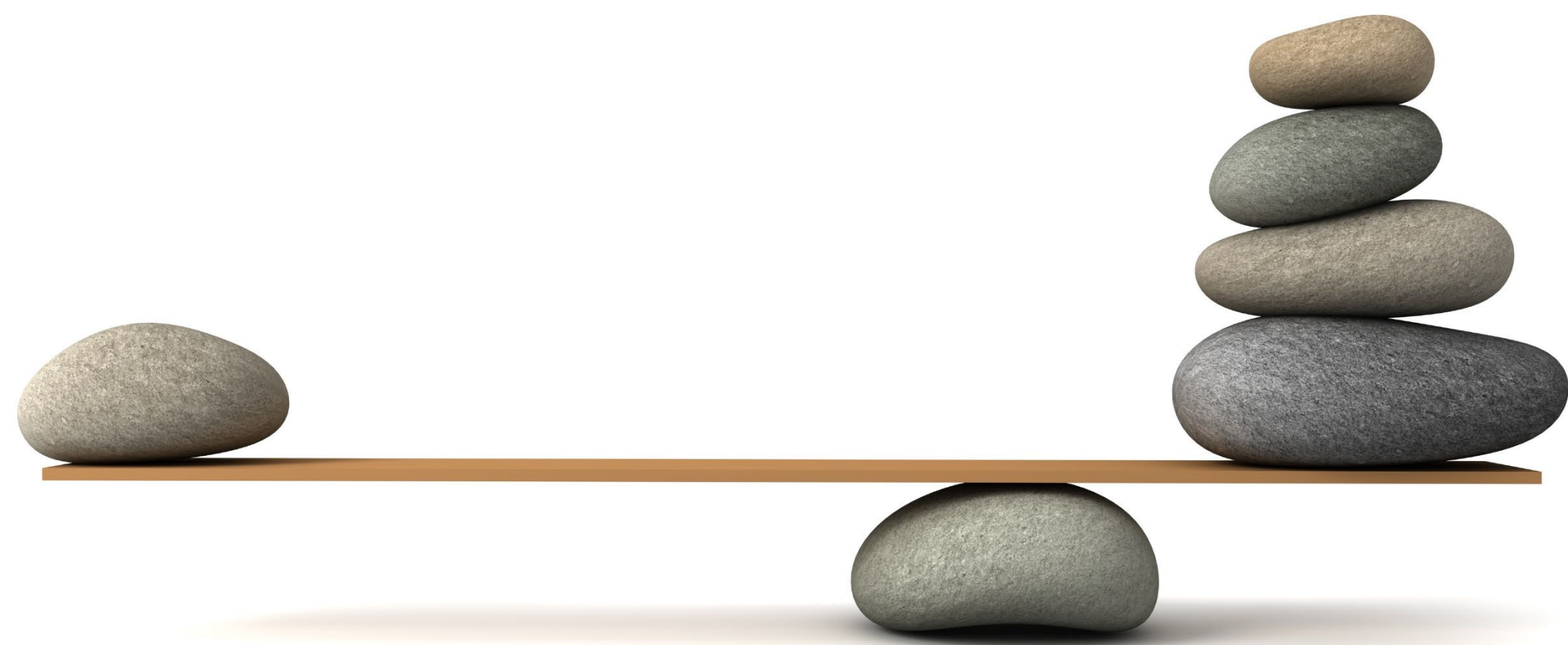
Moderator Ana Gutierrez, Attorney, Hogan and Lovells

Brent Buck, CEO, Ajax Analytics

Kathy Steerman, Manager of Air Compliance & Engineering, Civitas

Jerry Dismukes, Air Compliance Lead, Caerus Oil and Gas

Energy & Environment Symposium
April 13-14, 2022



When performance is measured, performance improves.
When performance is measured and reported back, the rate of improvement accelerates.

- Thomas S. Monson



You get what you measure*

** likely at the expense of something not measured, but also quite important*



Ajax Analytics

Brent Buck, CEO, Ajax Analytics

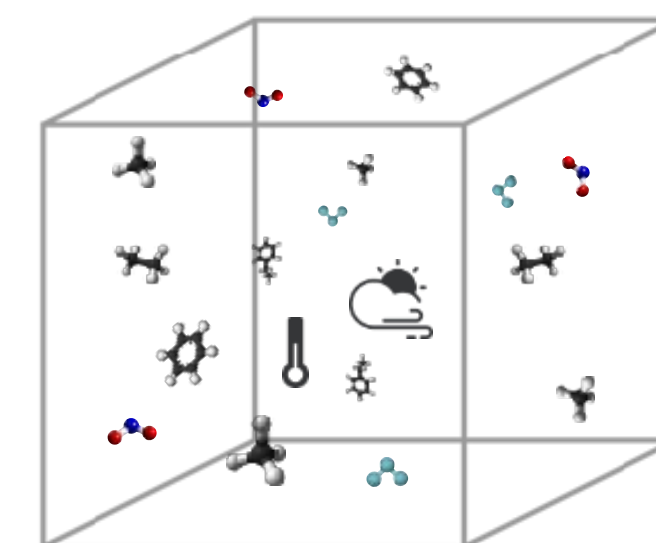
GOAL

KNOW WHAT IS IN THE AIR

minimize assumptions

no knowledge

perfect knowledge
every: compound, m^3 , second



Globally = 53,579,664,000,000,000,000 metrics per year (53 quintillion)
Assuming 100 metrics and 100m high boundary

GOAL

know what is in the air

maximize measurement

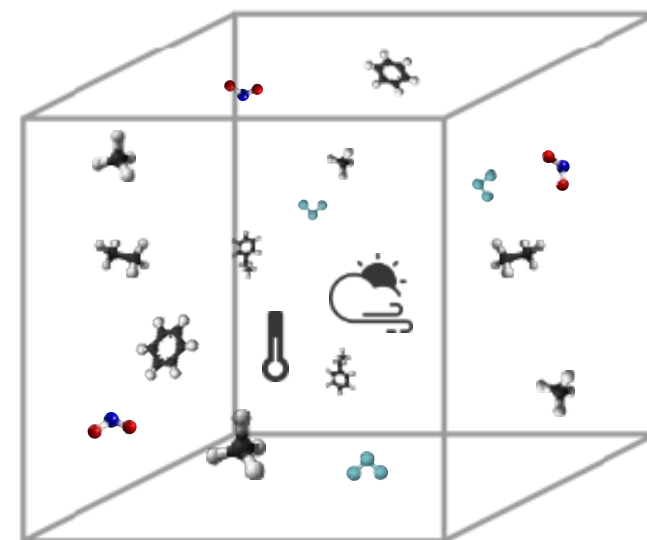
no knowledge

MEASUREMENT

{time, space, quality}

perfect knowledge

every: compound, m^3 , second



Globally = 53,579,664,000,000,000,000 metrics per year (53 quintillion)

Assuming 100 metrics and 100m high boundary

GOAL

know what is in the air

minimize assumptions

no knowledge

MEASUREMENT

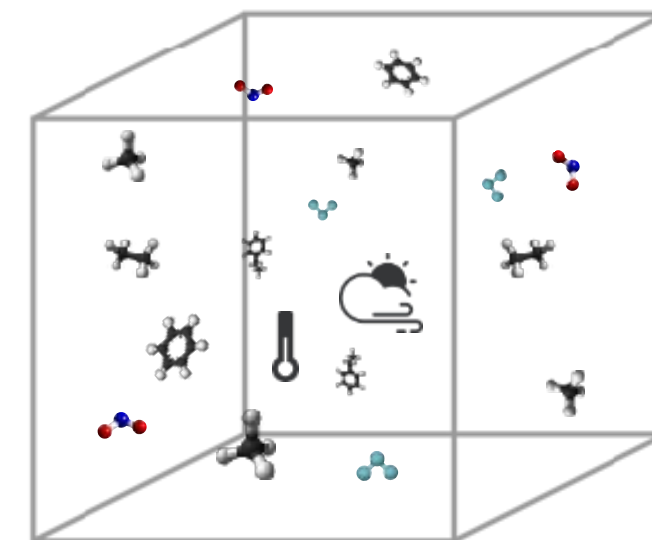
{time, space, quality}

MODELING

{assumptions, probability}

perfect knowledge

every: compound, m^3 , second



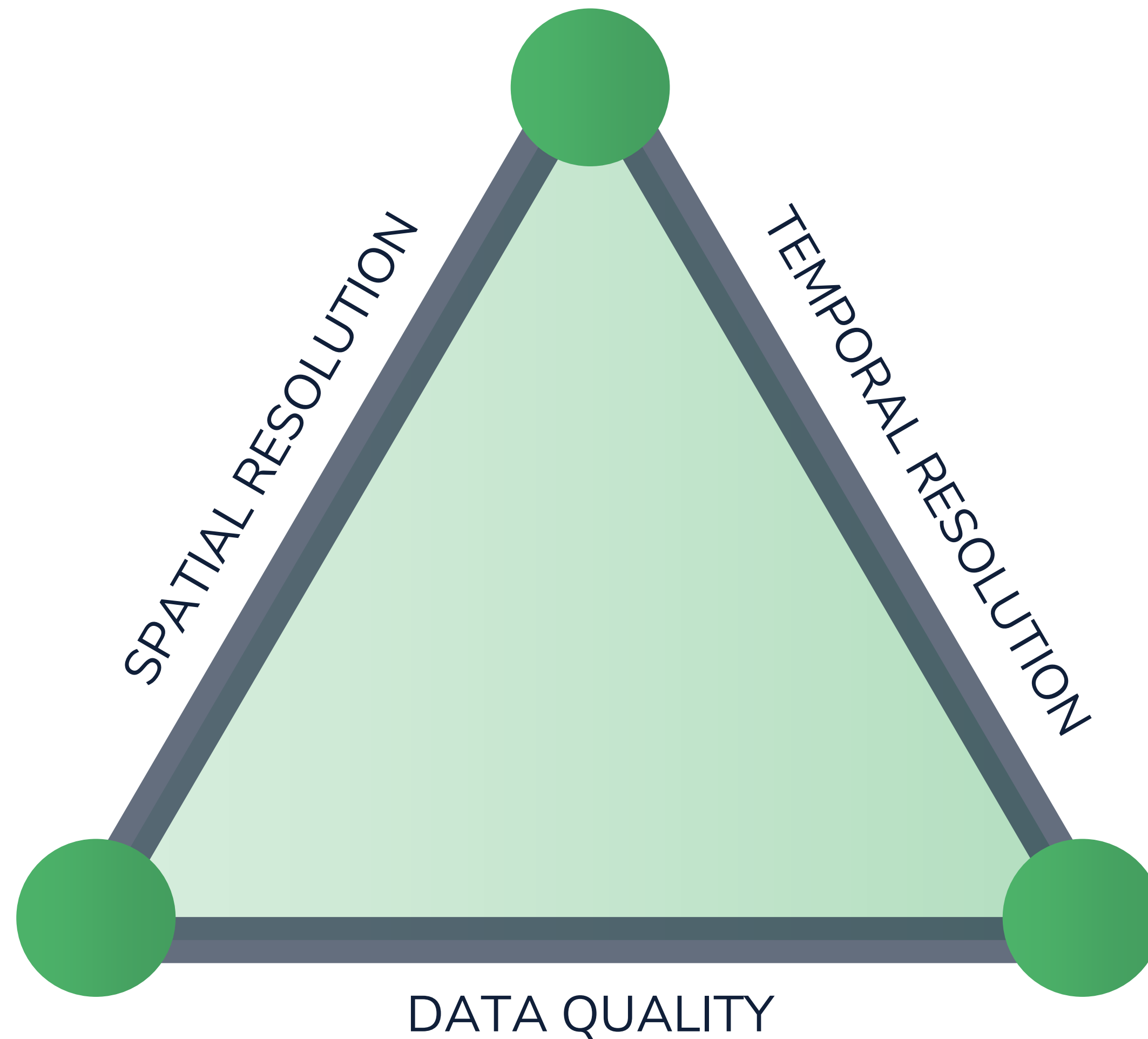
Globally = 53,579,664,000,000,000,000 metrics per year (53 quintillion)

Assuming 100 metrics and 100m high boundary

CONCEPT

principles of useful measurement

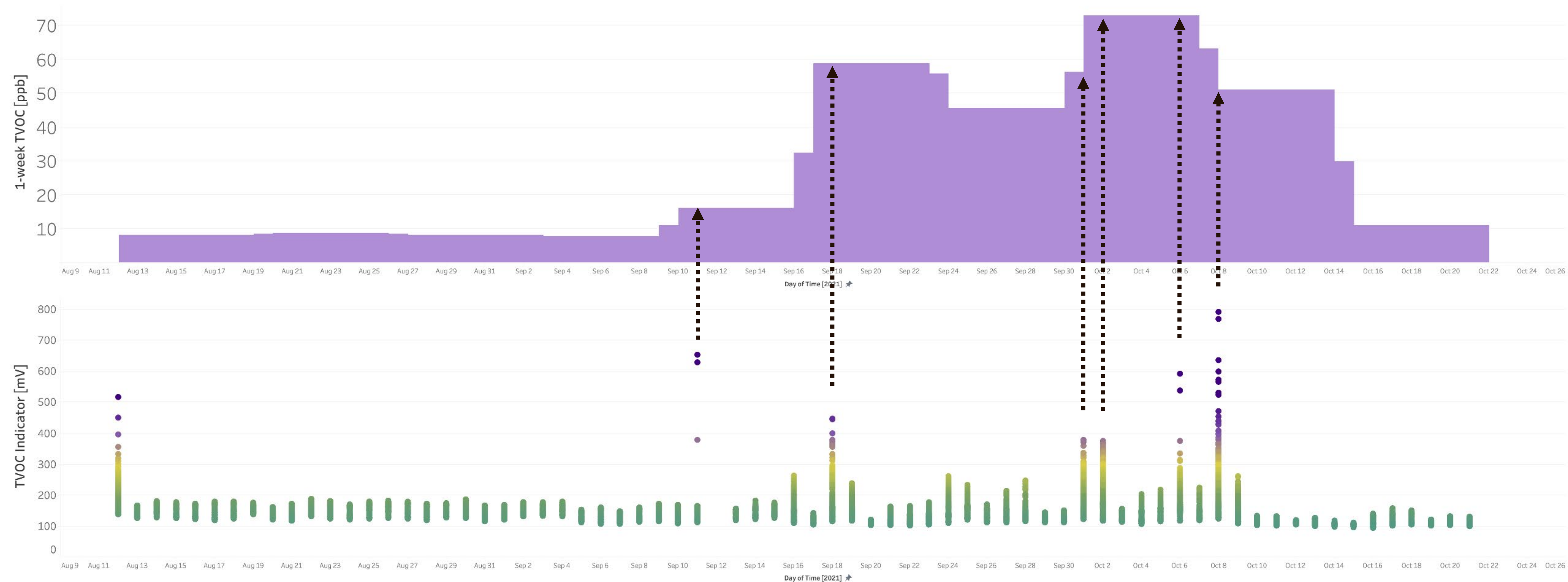
maximize the area of the triangle



CONCEPT VISUALIZATION

value of time resolution

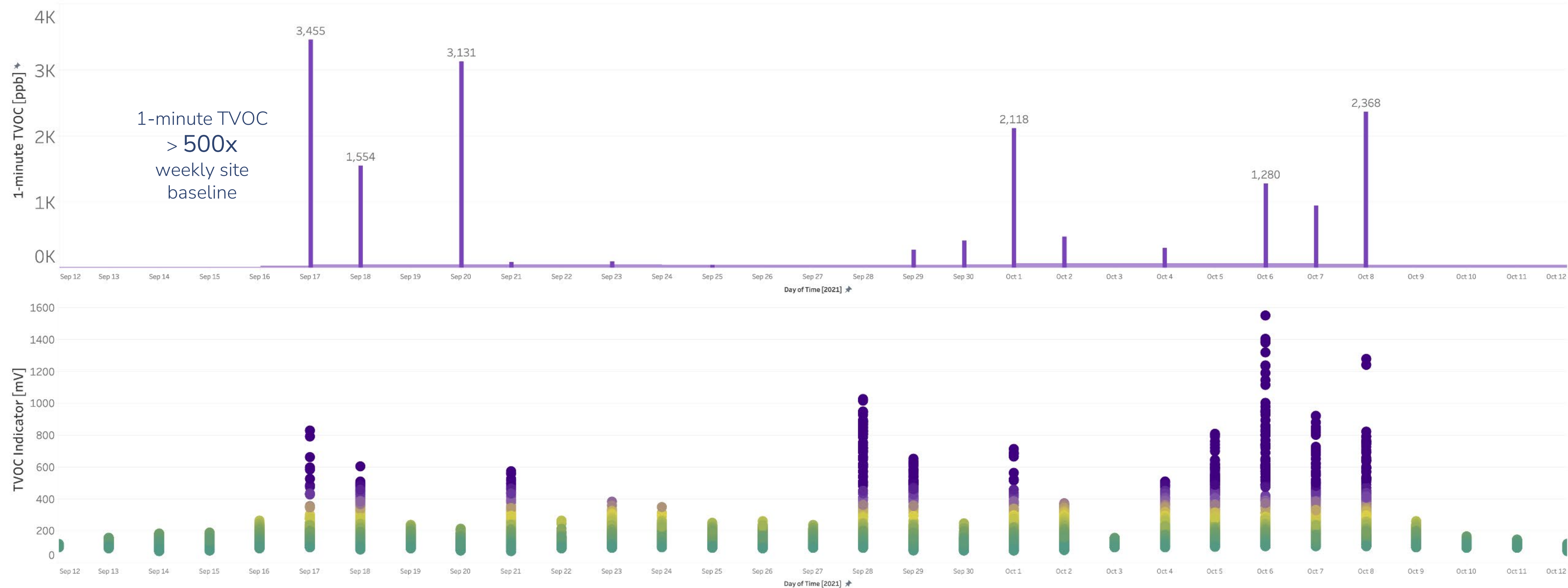
same location, same time period



CONCEPT VISUALIZATION

value of quality data

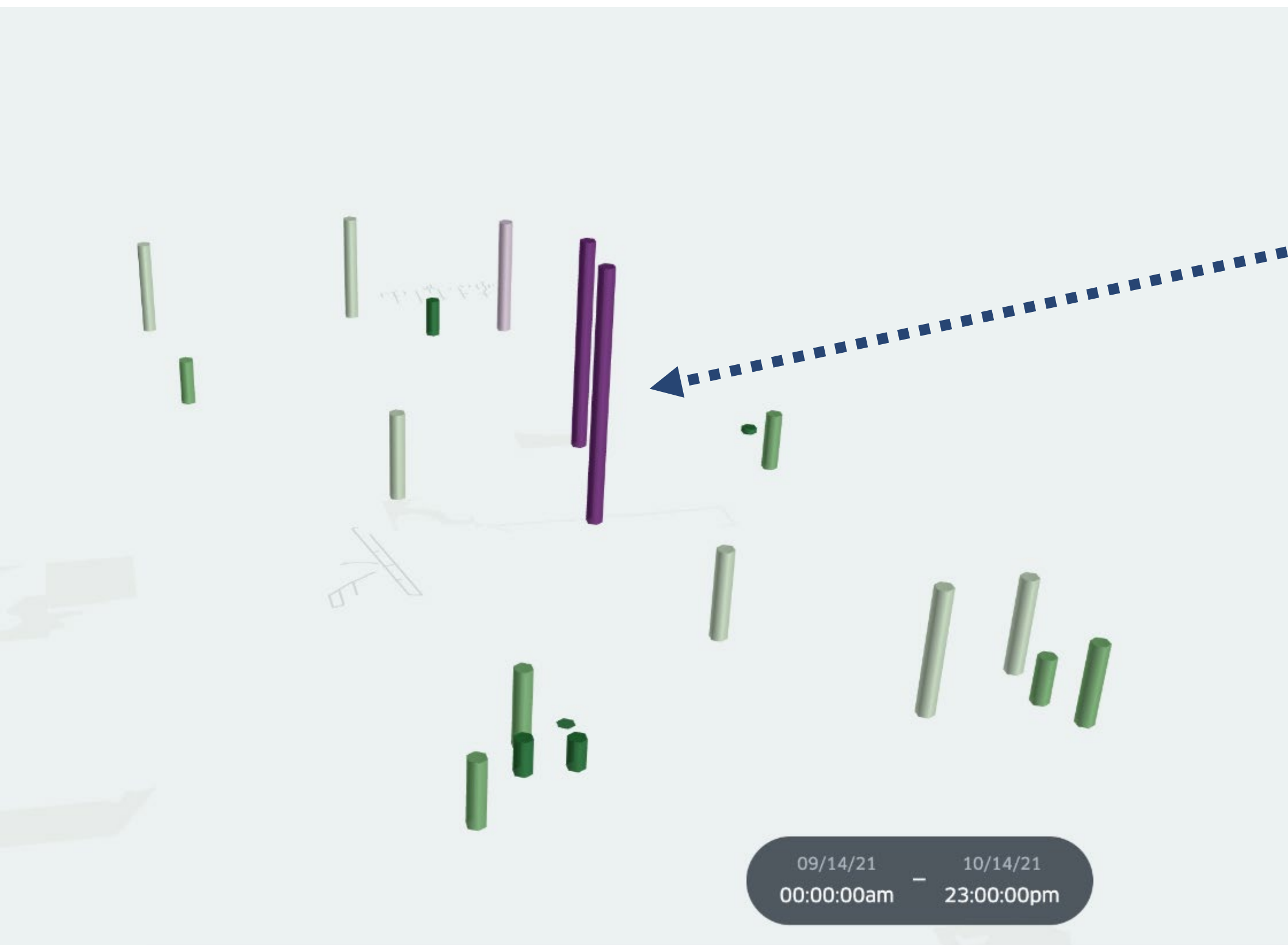
force-multiplier: technology synergies



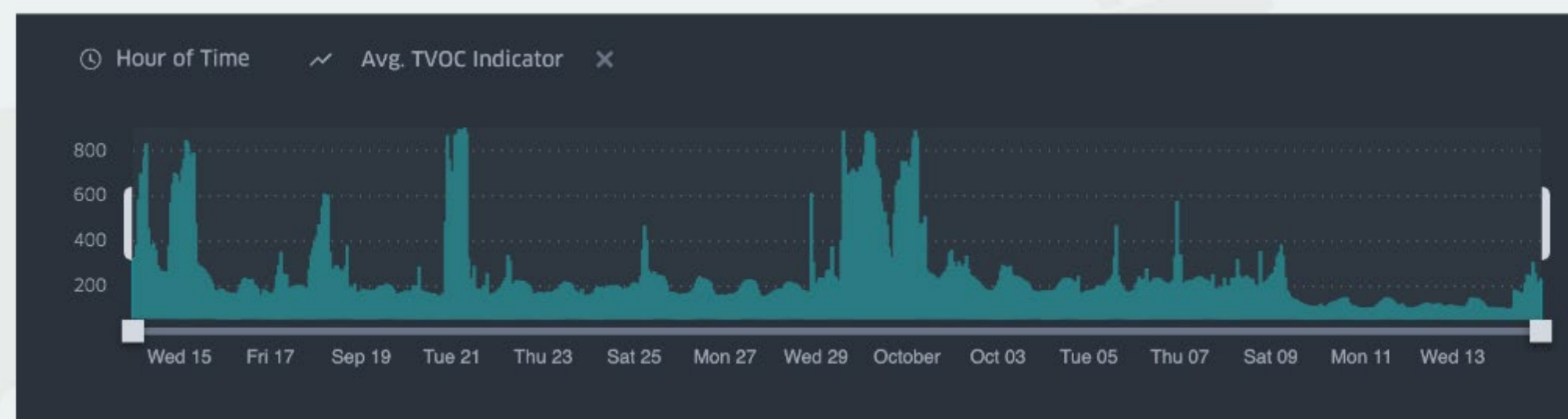
CONCEPT VISUALIZATION

value of spatial resolution

managing uncertainty



TVOC Indicator data suggests something in this area provides more opportunity for air quality improvement overall



END GOAL

maximize environmental ROI

The end goal is to enable
data-driven conversations to
generate the best
environmental return on
investment

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maximize Environmental ROI



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Air Monitoring in Action

Kathy Steerman, Manager of Air Compliance & Engineering, Civitas

Topics to Cover

- 01 Civitas – Blending Companies and Programs
- 02 Pre-Production Regulation Challenges
- 03 Voluntary Programs
- 04 Future of Monitoring

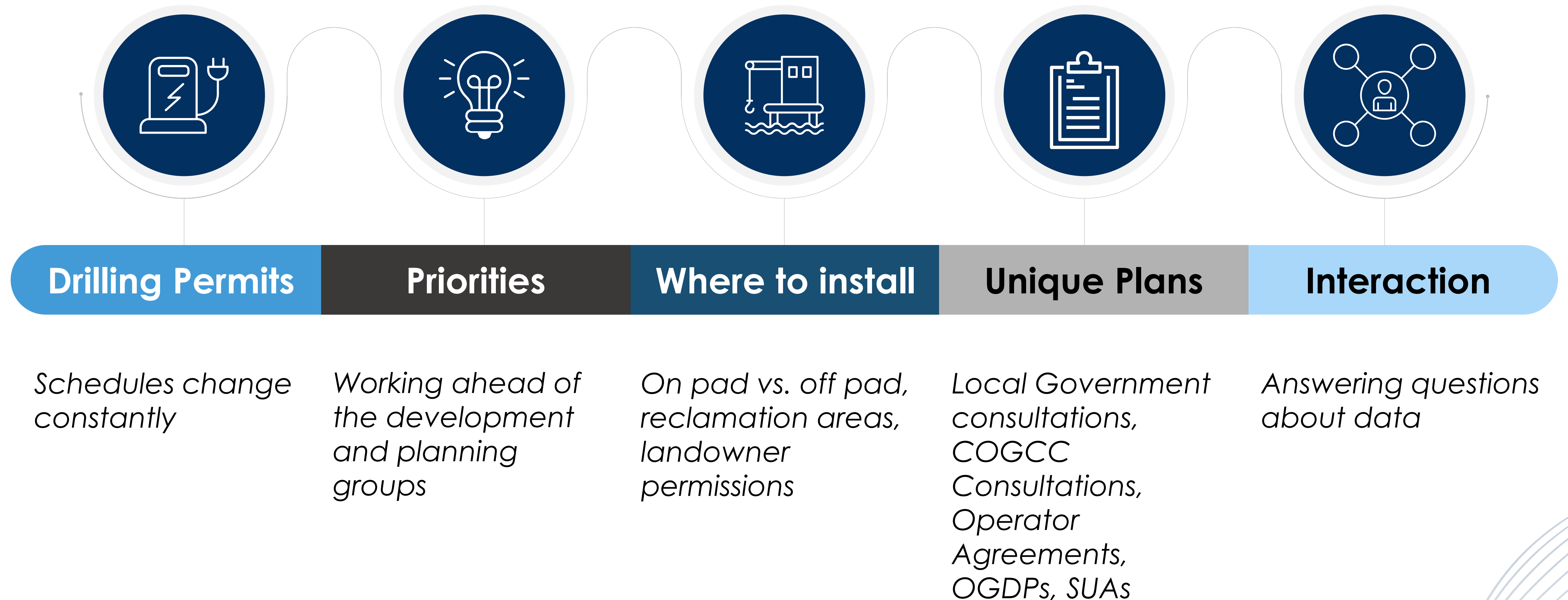
Testing Technologies

Side-by side testing of similar technology

Comparing sensor reliability, sensor sensitivity, unit portability and data portals



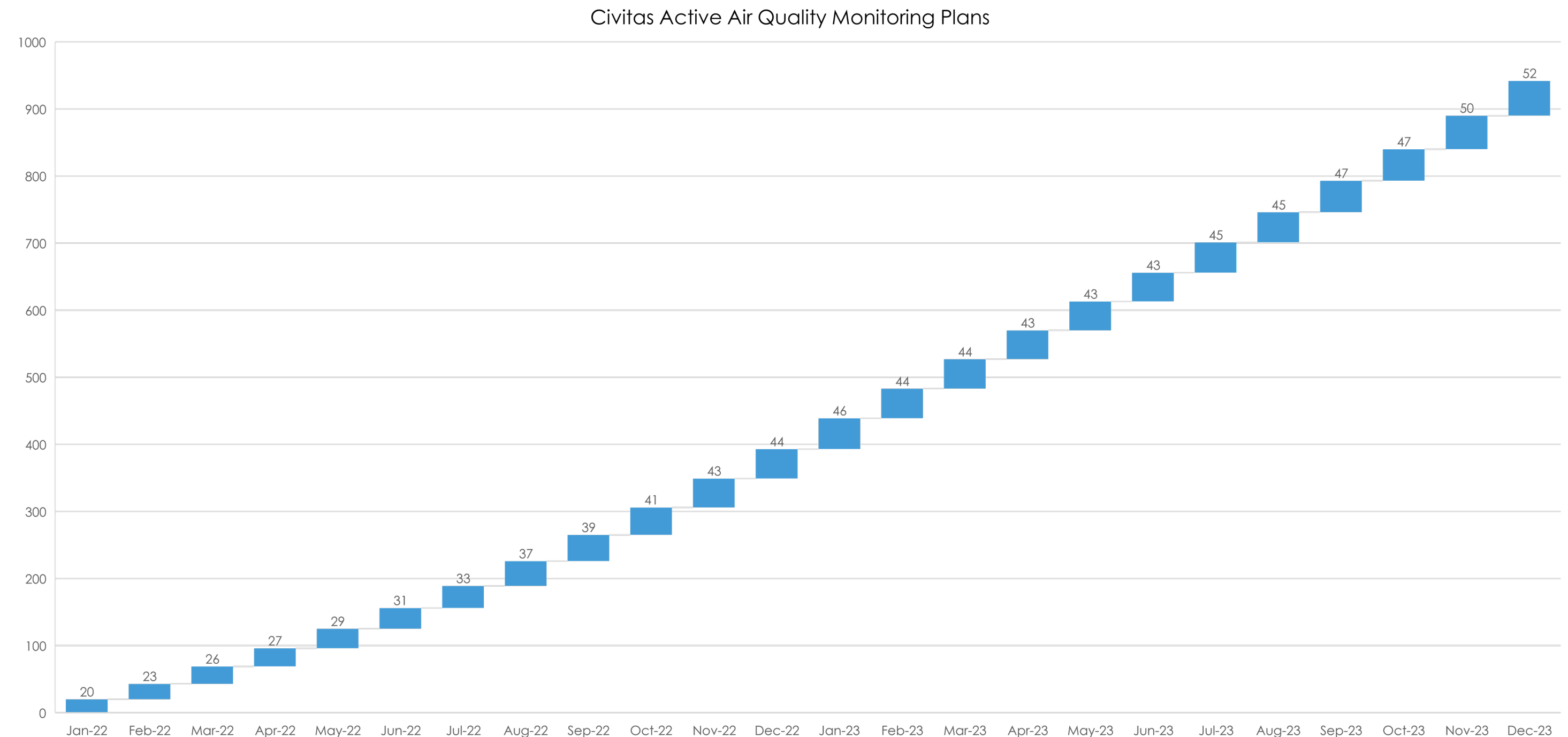
Challenges



Civitas Monitoring Plans

April 2022: Civitas has 27 monitoring plans Approved

By December 2023: Civitas may have 52 monitoring plans filed and active

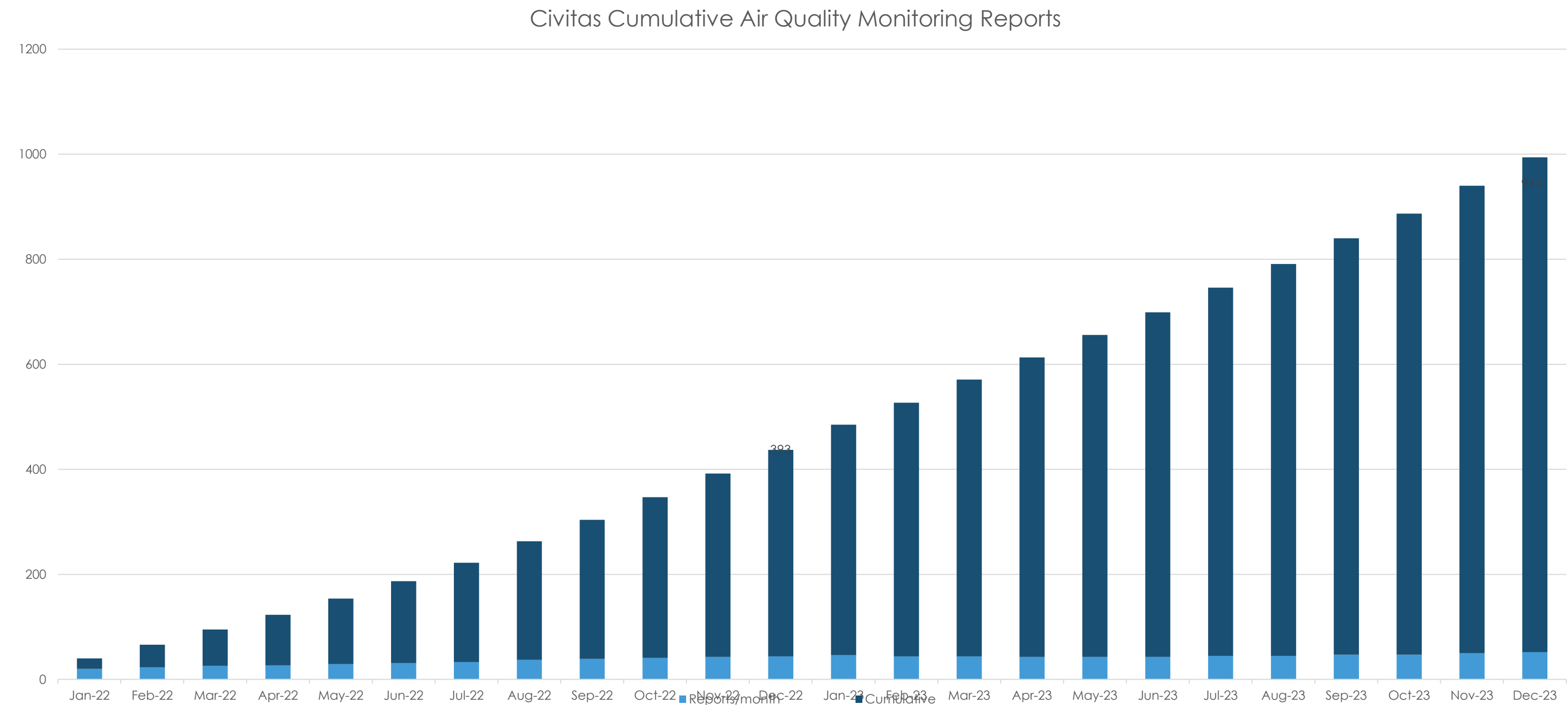


Civitas Monthly Reporting

April 2022: Civitas is filing approximately 27 monthly reports.

By December 2022 Civitas will have filed about 393 monthly reports.

By December 2023 Civitas may be filing approximately 52 reports every month and will have submitted over 900 air monitoring reports to the Division



Air Quality Monitoring

Drilling Phase

Broomfield program alongside Extraction Program



Air Quality Monitoring

Hydraulic Fracturing Phase

Broomfield program alongside Extraction Program



Field Testing

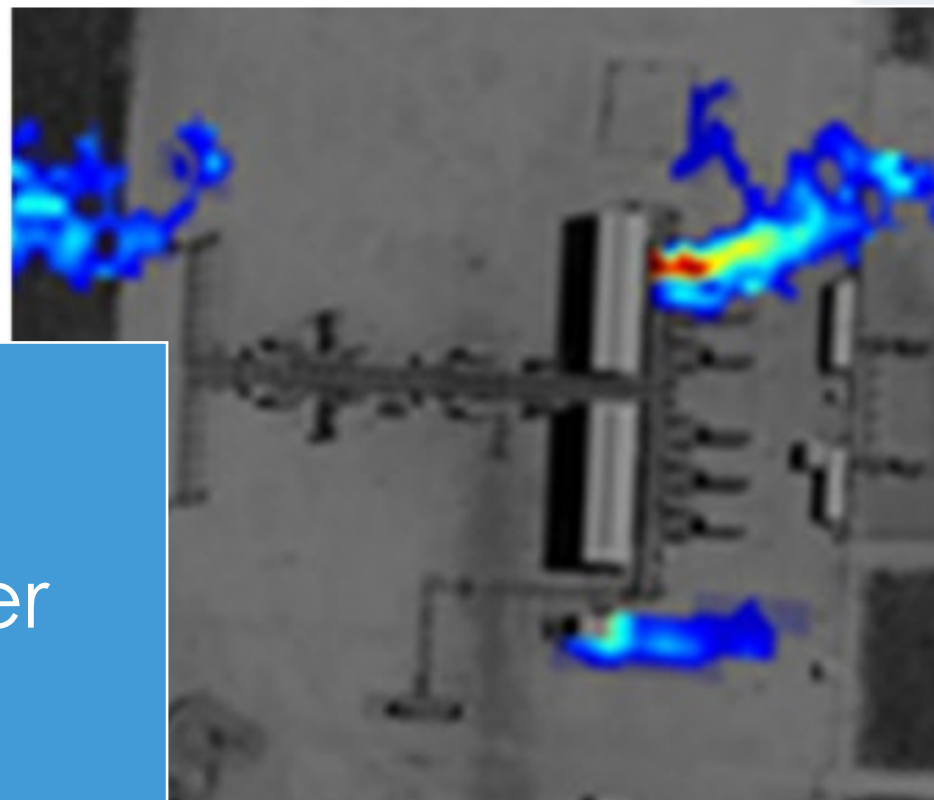
Community
Roving



Passive
Benzene
Tubes



Flyover



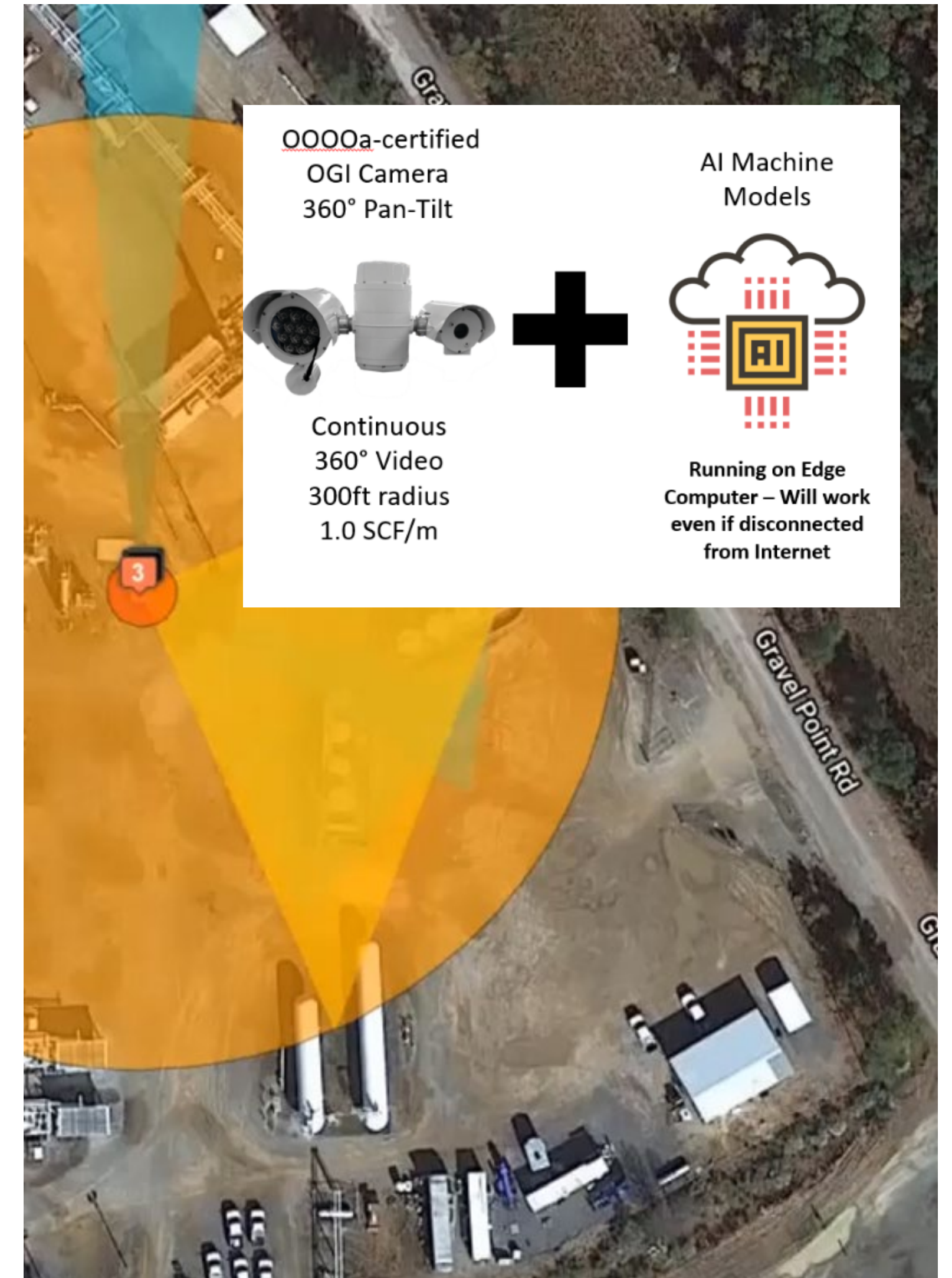
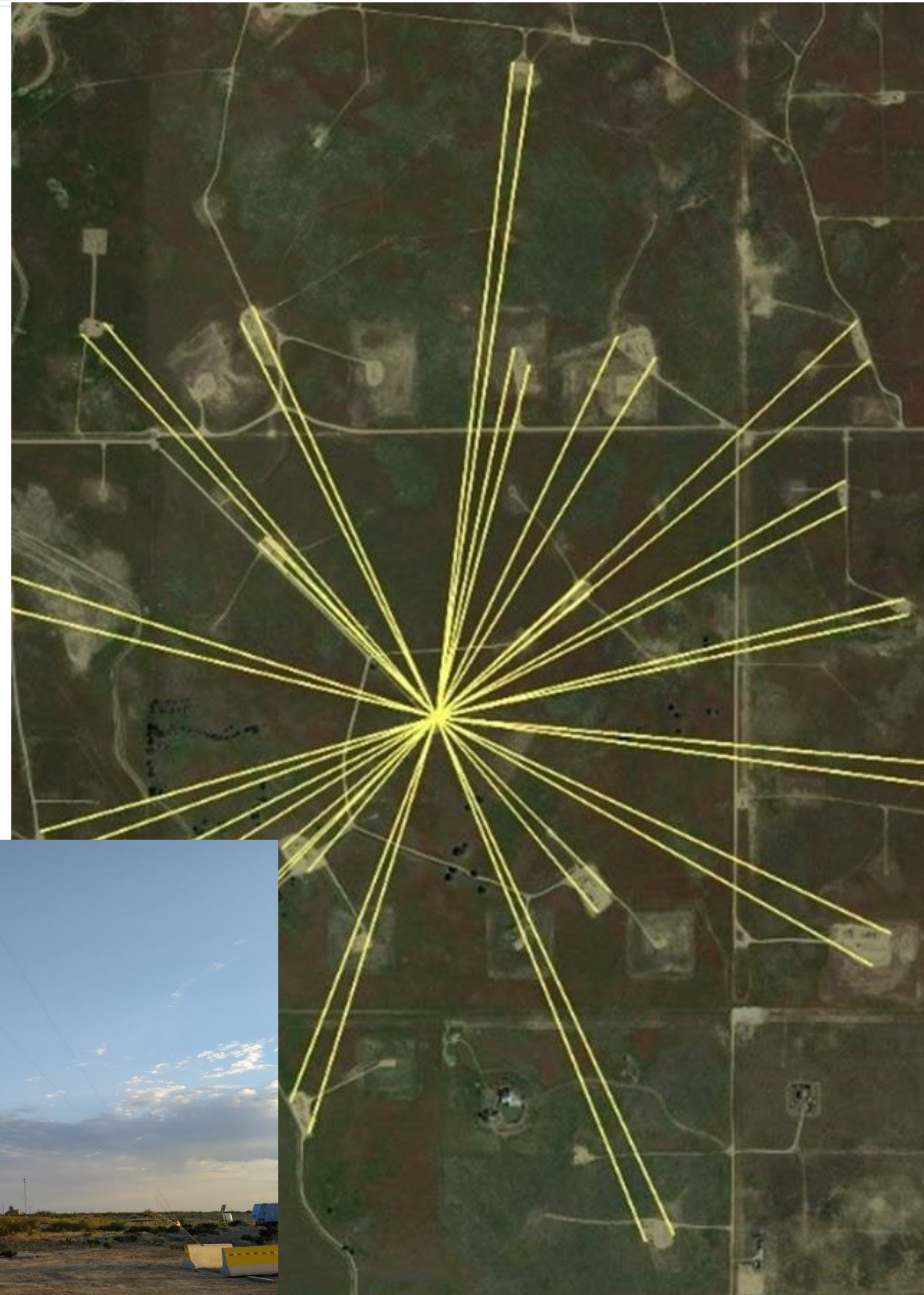
Comparing
apples to
oranges



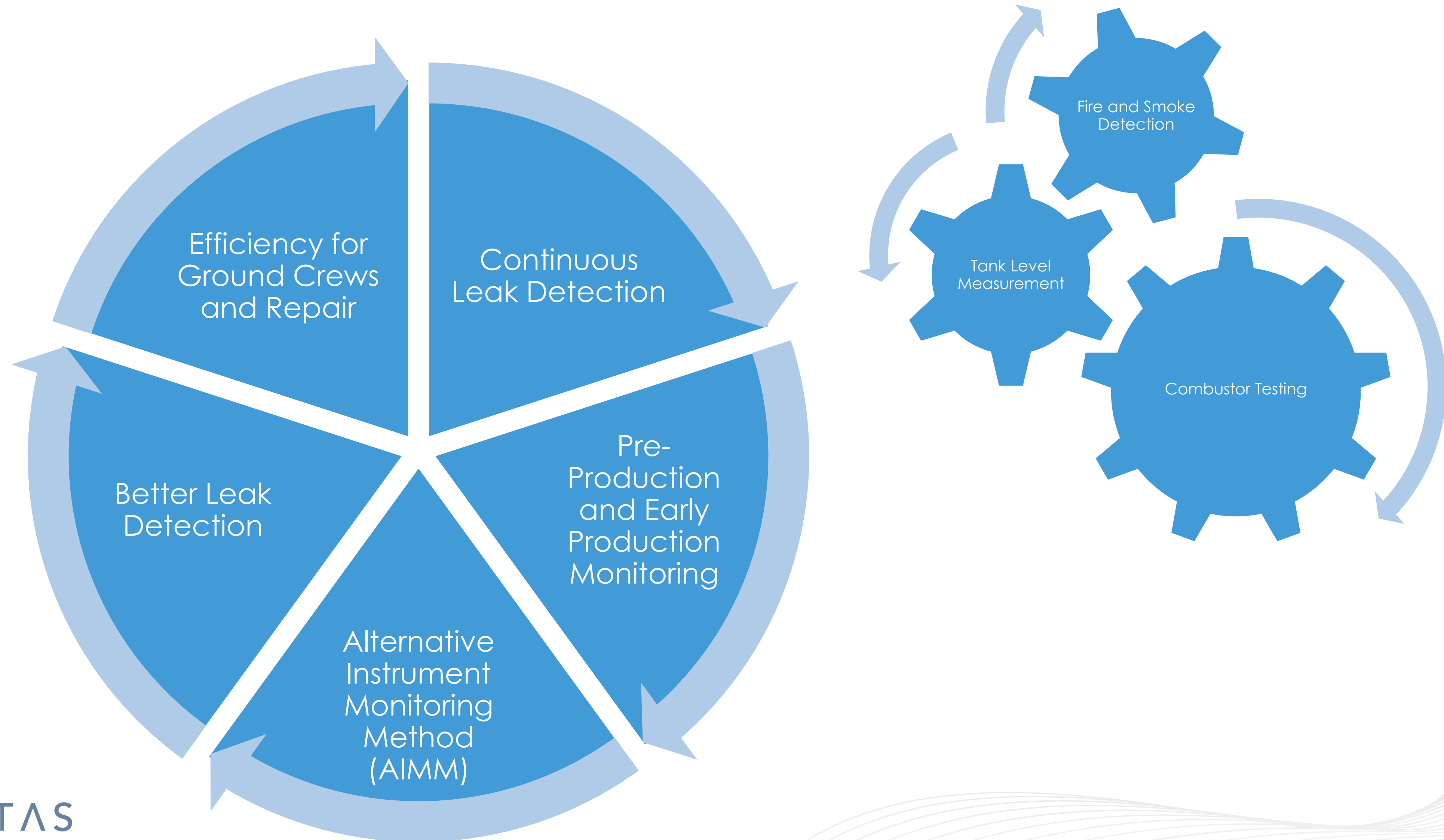
Voluntary Programs

Dual Frequency Laser

Continuous OGI



Future of Monitoring: ONE System



Thank You





VOC Monitoring Overview

Lessons Learned from Existing Monitoring and Optical Gas Imaging (OGI) Surveys



Jerry Dismukes, Air Compliance Lead, Caerus Oil and Gas

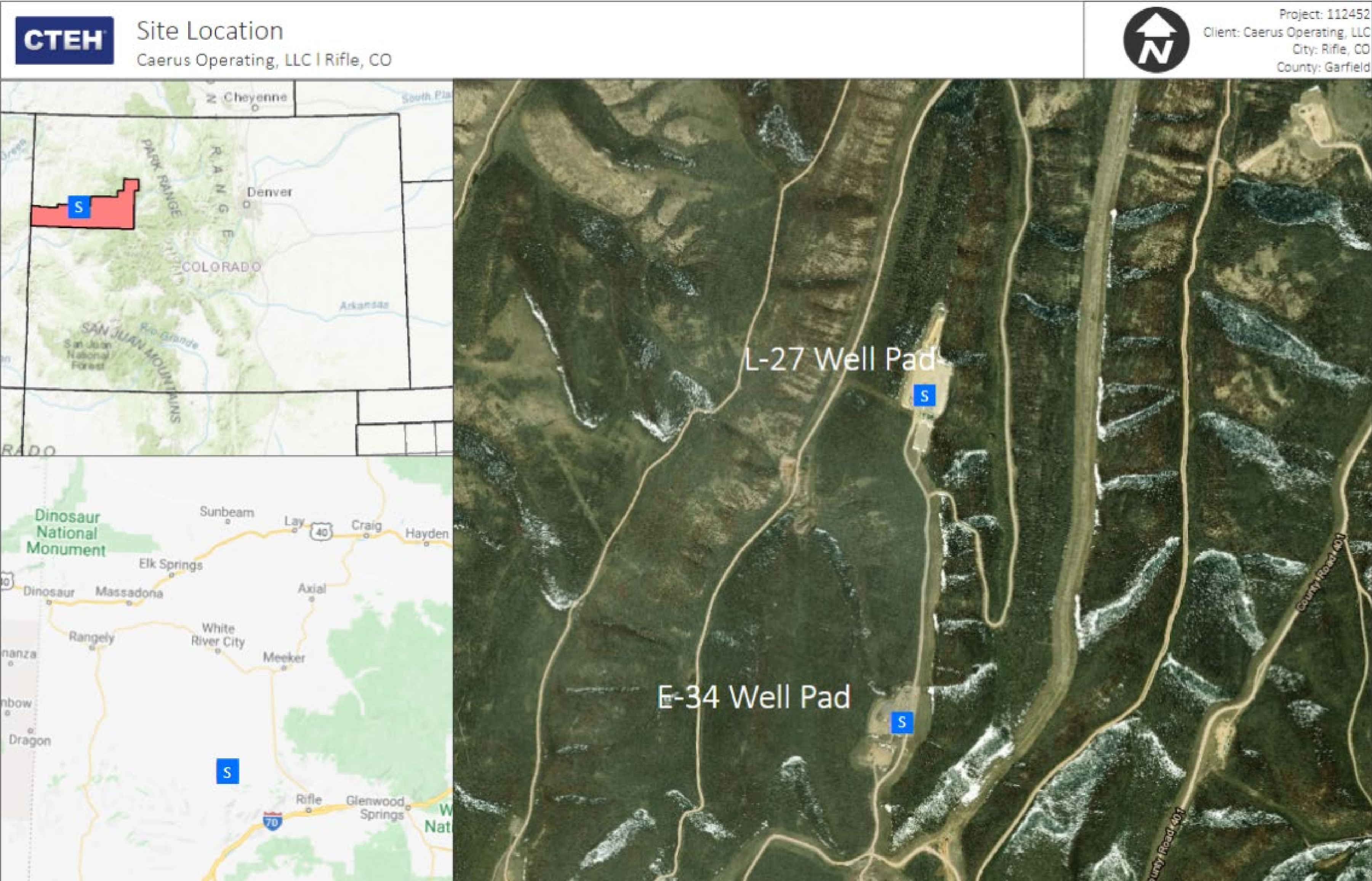
Caerus Monitoring History

- In-house Optical Gas Imaging (OGI) using FLIR cameras since 2014
- Partnered with CTEH to do an air monitoring study in early 2020 to monitor for VOCs and HAPs during drilling, hydraulic fracturing and flowback operations
- Currently monitoring for total VOCs at 2 well pads and 1 flowback facility in the Piceance
- Pilot studies in early 2021 looking at multiple aerial methane survey technologies in Piceance
- Completed full aerial methane survey of Uintah Basin asset in September 2021
- Will complete aerial methane survey of entire Piceance asset in summer 2022

CTEH Air Quality Monitoring Study

- CTEH monitoring study during drilling, hydraulic fracturing, and flowback operations (1/28/2020 – 2/2/2020) on SIMOPs pad
- Intent was to assess if emissions from pre-production well pad operations yield exposures that could lead to harmful health impacts
- Looked at VOCs, H₂S, hexanes, benzene, and toluene
- Combination of:
 - 8-hour worker personal badge sampling
 - 15-minute personal badge sampling
 - Handheld real-time air monitoring
 - Fence line SUMMA canister 24-hour VOC grab samples
- Over 1000 readings were taken in total
- Highest handheld real-time benzene reading was 2.9 ppm on top of flowback tanks
- Vast majority of worker badge readings were non-detects with a few low readings that were ***below all health standards and internal response levels***

CTEH Air Quality Monitoring Study



CTEH Air Quality Monitoring Study – Lessons Learned

- All monitoring was on or inside of fence lines in close proximity to equipment
- Majority of detected readings were on the active flowback pad
- Measured concentrations were **all below health threshold concern levels!**
- This was the last pad where we used traditional flowback tanks in the Piceance
- What happened next?!
 - Dedicated closed-loop Flowback Facility to handle liquids, control gas and route to centralized downstream produced water facilities
 - 3-phase gathering on all well pad locations in development area
 - Immediate drop in need for production tanks and control devices at new pads
 - Required VOC monitoring in Piceance started 16 months later!

Regulation 7 – VOC monitoring

- May 1, 2021, Reg. 7 requirement to do real time air monitoring
- Where do we monitor?
 - All new well pad facilities
 - All satellite facilities used to handle/process flowback liquids
- Caerus first deployed VOC monitors in June 2021 at two facilities
- Caerus chose to monitor for total VOCs (TVOC) and not methane or benzene
- Utilize 3 TVOC monitors at each location triangulated around the location
- Set 2 alarm levels triggered on 5-minute averages:
 - 10ppm – initial response event (**IRE**)
 - must involve an action to determine the issue and mitigate, where possible
 - 20ppm – secondary response event (**SRE**)
 - Must notify CDPHE, COGCC and local government within 48 hours. Caerus to investigate with FLIR and attempt to mitigate and fix the source of hydrocarbons

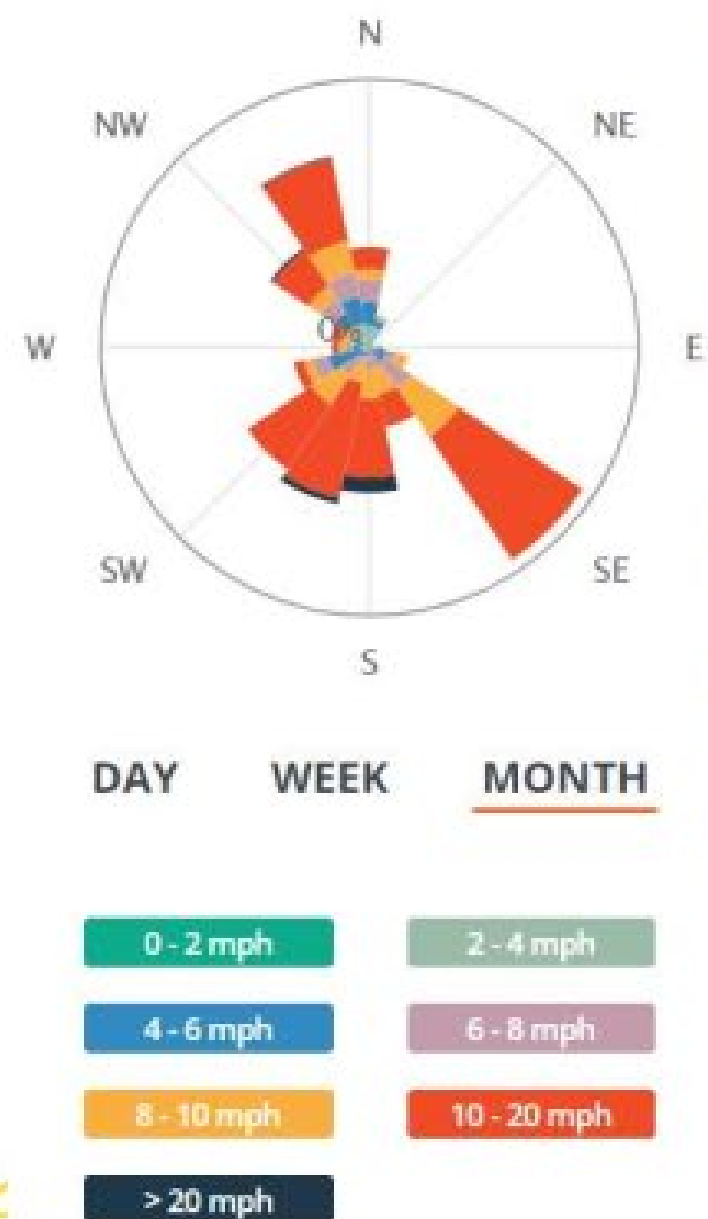
Regulation 7 – VOC monitoring, cont.

Wolf Ranch

- Approx. Unit Placement: (39.689261/-108.119767), (39.690436/-108.119789), (39.690067/-108.121403)
- 3 Canary S units on mobile stands
- Predominant wind direction at all speeds is from SE

Wind Rose

Story Gulch weather data

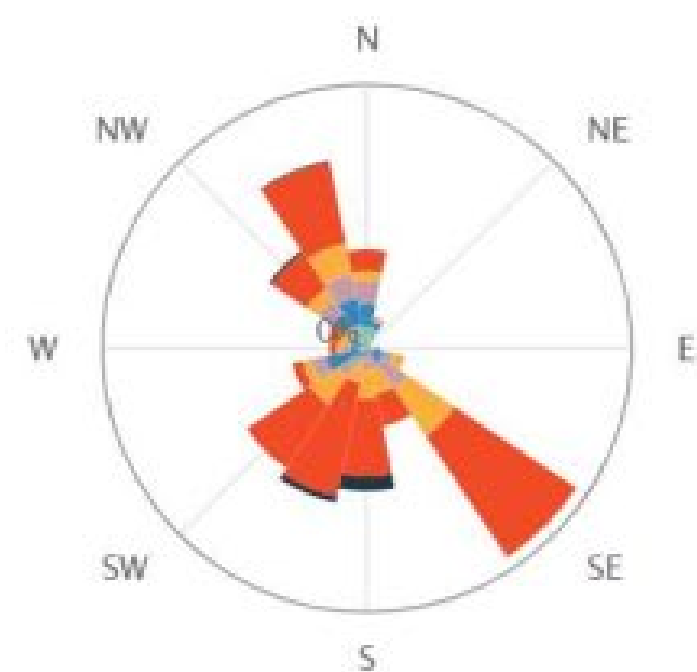


Regulation 7 – VOC monitoring, cont.

J14

- No aerial image available, location approximate (pad edge, at least 75' from any ignition sources)
- 3 Canary S units on mobile stands
- Predominant wind direction at all speeds is from SE

Wind Rose
Story Gulch weather data

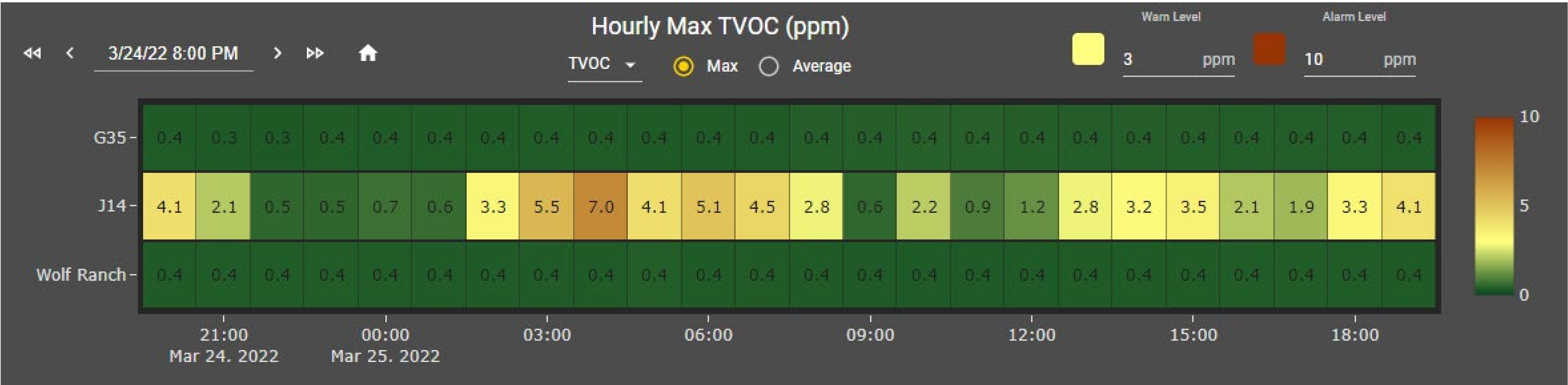


DAY WEEK MONTH

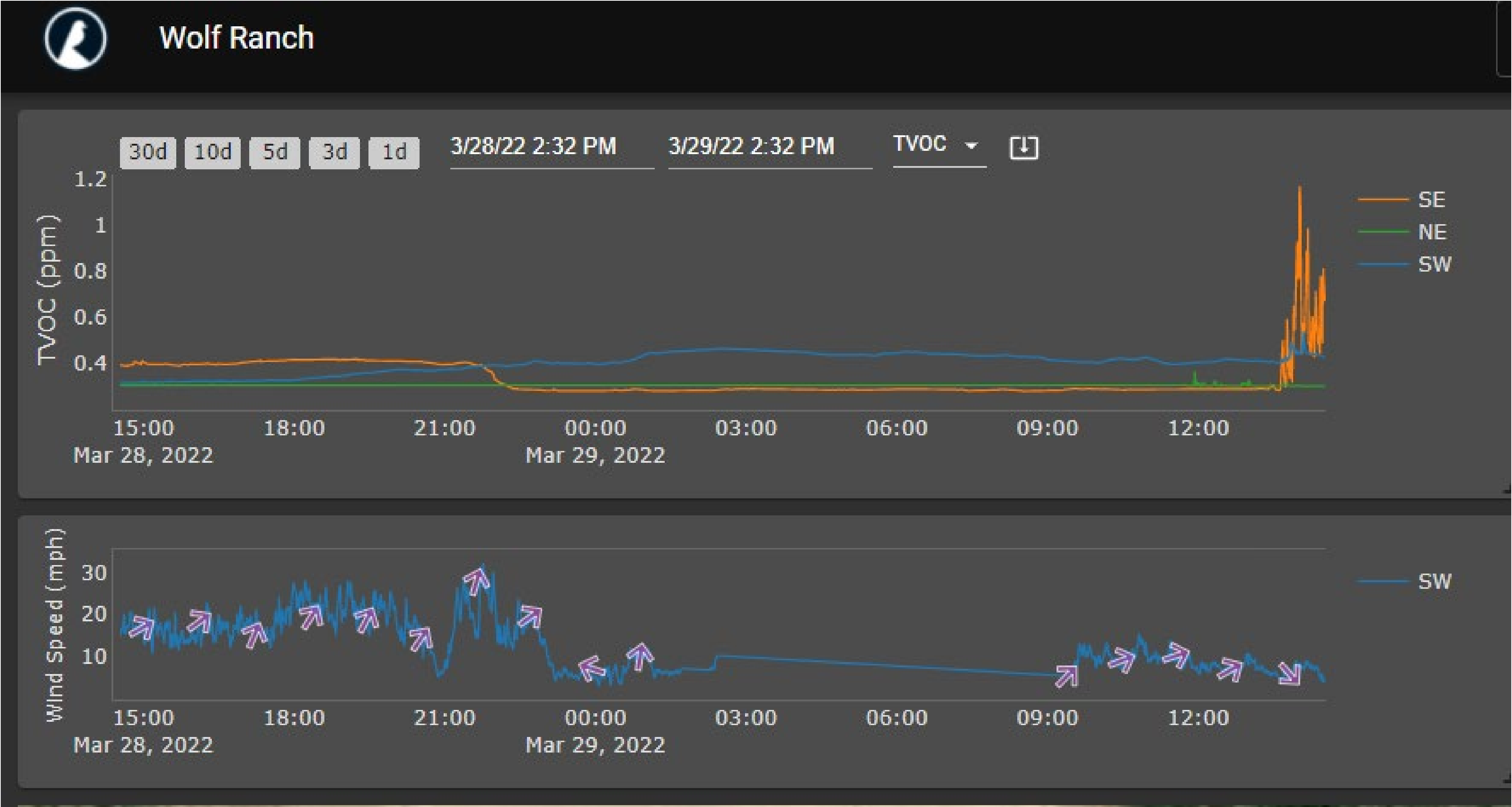


Regulation 7 – VOC monitoring, cont.

- Caerus has access to real-time monitored values on our locations via the dashboard below
- Can see meteorology collected at each facility to trend potential sources of emissions
- Issues Observed:
 - Connectivity!! Numerous periods of downtime due to cell service in remote terrain
 - Sensors blown over on J14 due to exposure in steep terrain
 - Time to get technicians out to the field to address down sensors



Regulation 7 – VOC monitoring, cont.



Start	Duration	Condition
10/14/2021 13:55	6 min	10.2 (5m Avg) >= 10 ppm TVOC
10/04/2021 11:05	10 min	14.6 (5m Avg) >= 10 ppm TVOC
10/03/2021 16:44	6 min	11.5 (5m Avg) >= 10 ppm TVOC
09/23/2021 15:48	60 min	17.7 (5m Avg) >= 10 ppm TVOC
09/23/2021 12:39	20 min	13.5 (5m Avg) >= 10 ppm TVOC
08/01/2021 06:46	10 min	14.9 (5m Avg) >= 10 ppm TVOC
07/11/2021 12:05	9 min	11.8 (5m Avg) >= 10 ppm TVOC
07/10/2021 05:15	12 min	12.1 (5m Avg) >= 10 ppm TVOC
07/05/2021 01:04	6 min	10.3 (5m Avg) >= 10 ppm TVOC

Wolf Ranch IRE Action Levels

- Note that IRE action levels require internal response and notification
- **Zero** SRE alarm levels of ≥ 20 ppm TVOC have ever been triggered

J14 Well Pad IRE Action Levels

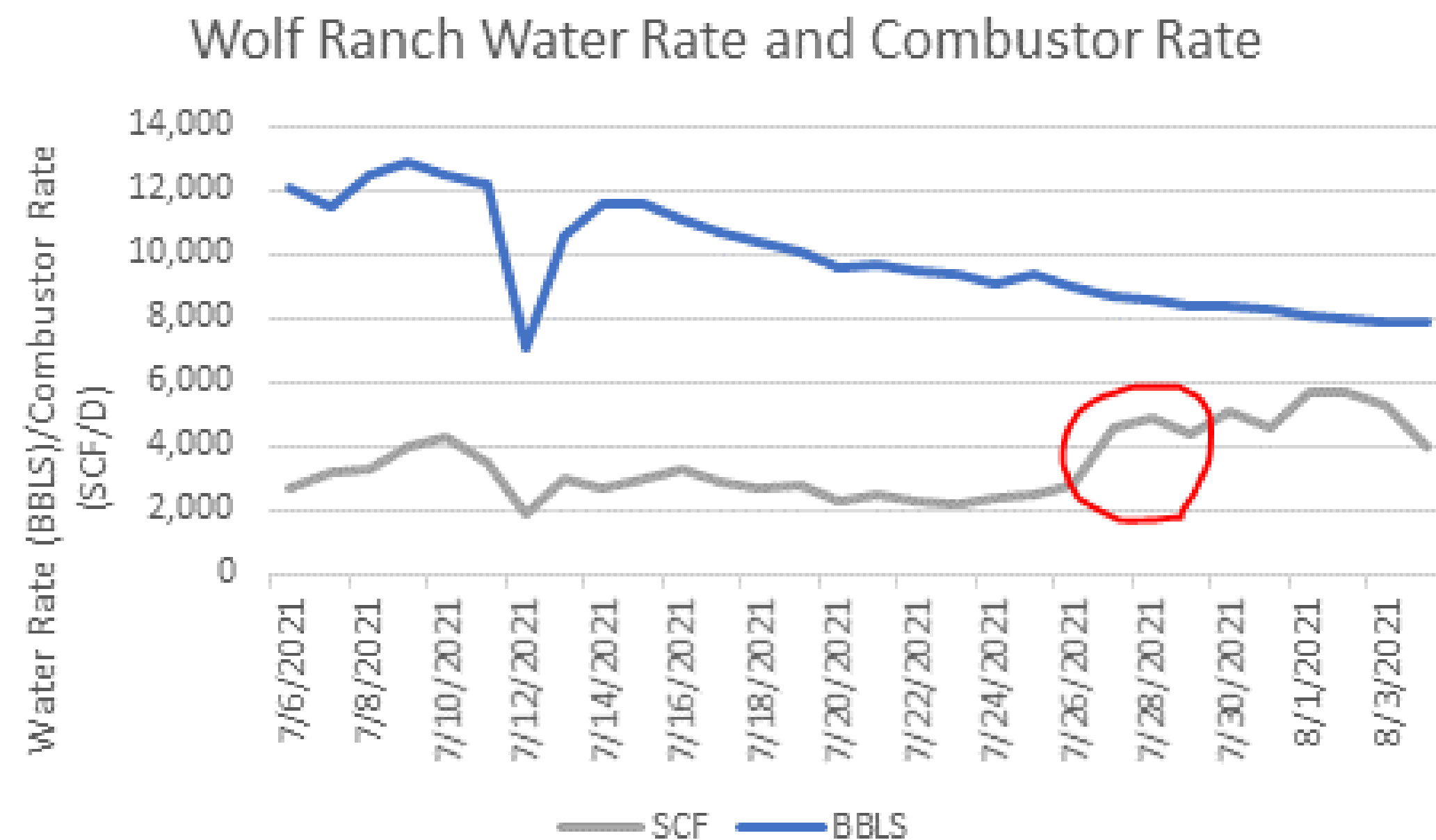
Start	Duration	Condition
03/27/2022 09:08	23 min	10.7 (5m Avg) >= 10 ppm TVOC
03/19/2022 06:17	27 min	14.8 (5m Avg) >= 10 ppm TVOC
03/18/2022 09:25	26 min	14.2 (5m Avg) >= 10 ppm TVOC
03/18/2022 04:35	7 min	10.2 (5m Avg) >= 10 ppm TVOC
03/15/2022 07:03	16 min	11.3 (5m Avg) >= 10 ppm TVOC
03/13/2022 03:48	14 min	11.2 (5m Avg) >= 10 ppm TVOC
03/12/2022 18:04	50 min	13.5 (5m Avg) >= 10 ppm TVOC
03/12/2022 00:39	36 min	14.2 (5m Avg) >= 10 ppm TVOC
03/11/2022 06:31	67 min	16.7 (5m Avg) >= 10 ppm TVOC
03/10/2022 05:47	6 min	10.0 (5m Avg) >= 10 ppm TVOC
03/06/2022 01:19	14 min	12.4 (5m Avg) >= 10 ppm TVOC
03/05/2022 00:23	20 min	12.3 (5m Avg) >= 10 ppm TVOC
03/04/2022 02:58	85 min	13.1 (5m Avg) >= 10 ppm TVOC

Regulation 7 – VOC monitoring (Wolf Ranch)

- Caerus used this data, along with monthly IR camera inspections to make changes
- Wolf Ranch is our first flowback facility!
- Using TVOC data, we saw higher readings on the two monitors on the east side in vicinity of tanks first few months.
- We replaced traditional thief hatches with lockdown style w/immediate results in July
- We replaced existing combustor with 2 higher volume combustors, better automation, and flow metering in February
- Caerus used the monitoring data to drive us to redesign this facility to ensure we are most effectively capturing all vapors, **NOT** venting from tanks and capturing/selling more gas down the pipeline

Technology Improvements

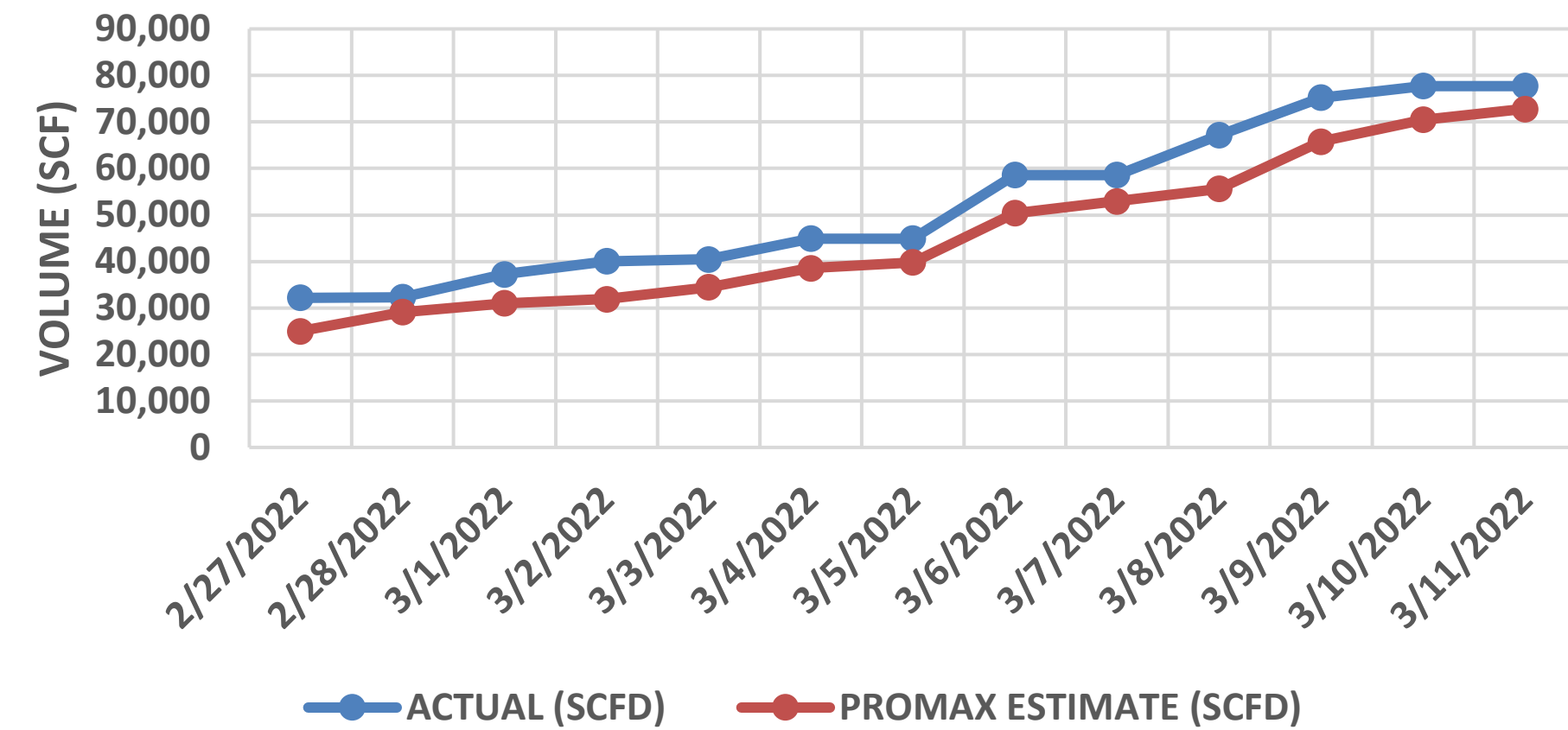
- Utilizing locking style thief hatches
- Had issues over-pressuring standard hatches initially
- Installed these on all 5 tanks on 7/27; immediately saw > 2x flow rate to combustor
- LDAR verified no venting



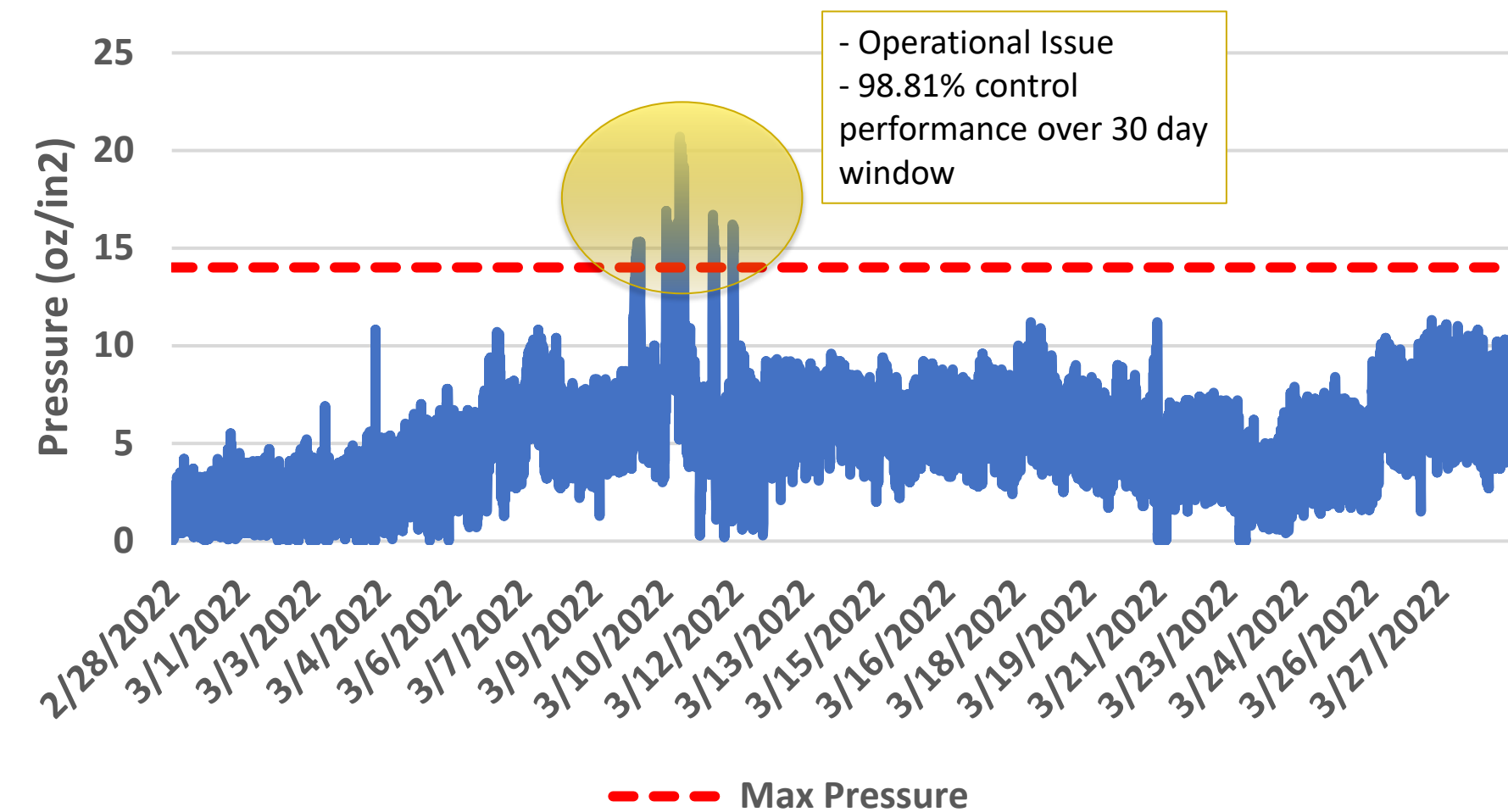
Air Engineering

- ▶ In order to successfully meet regulatory criteria...
 - ▶ Detailed Engineering includes:
 - ▶ Pipe sizing, hydraulics are driven by tiny pressure differentials (oz/in² or inH₂O)
 - ▶ ECD sizing, heating value and operating pressures drive performance
 - ▶ Strategically placed telemetry for pressure, flow rate, temperature on Vapor Collection System (VCS)
 - ▶ Process model
 - ▶ PW is salty, CH₄ solubility decreases with increasing salt content
 - ▶ Utilize telemetry to assess performance
 - ▶ **Big Picture? It takes a village with coordination from Air, Engineering and Facilities groups**

Wolf Ranch FB Facility
Flash Vapors Estimated Flow vs Actual Flow



Wolf Ranch VCS Operating Pressure



Regulation 7 – VOC monitoring (J14 Pad)

- Very few TVOC spikes from July 2021 – February 2022.
- Due to proximity of sensor on exposed berm on west side of facility, it was blown over a few times prompting relocation
- The unit was relocated on to the drill pad close to a trailer mounted blowdown tank in early Feb. 2022
- Blowdown tanks are used when/if wells get loaded up with fluids
- Several IRE level alarms have been triggered since relocation
- **Lesson:** Even with a monitor on pad, no SRE level alarms triggered

Regulation 7 – VOC monitoring (J14 Pad)



Trailer mounted blowdown tank

- Sensor location is **NOT** representative of fence line measurements
- We have moved this Canary monitor a bit further west but it's still on the pad

Regulation 7 – Leak Detection and Repair

- In 2021, Caerus documented 1053 OGI inspections using FLIR cameras at 658 facilities
- 554 of these were voluntary inspections
- ~900 total leaks found/fixed in 2021
- Caerus has 1 full-time LDAR technician in Piceance and several other OGI certified people that help the team as needed
- **Critical** to have certified people that can **find and fix** leaks!
- Currently >80% find/fix in 2021; versus < 40% in 2018
- 2021 saw first LDAR driven retrofit program around certain pneumatics



- Caerus will be deploying TVOC monitors at 2 additional facilities in 2022
- Aerial methane surveys across all assets in 2022
- In-house drone surveys with OGI on pipeline segments...hopefully
- Staffing up for **huge increase** in required LDAR in January 2023
- Applying what we've learned through LDAR to drive equipment upgrades
- Looking at ways to leverage all that we do in the monitoring and OGI world to market our gas as some of the cleanest in the United States
- Questions??