

# AirSMART.

**A community air-quality network in Santa Cruz County, Arizona —  
Year 1 of pre-operational baseline for the South32 Hermosa Project.**

*9 calibrated PM sensors · 6.25M observations · Apr 2025 – May 2026*

**Calabasas Alliance × University of Arizona**

Calibrated against PDEQ/EPA Orange Grove BAM-1020 · May 2026



**ASU** Arizona State University

# What the network captured.

9

PM sensors deployed

14 mo

Apr 2025 – May 2026

6.25M

1-min observations

33,036

sensor-MINUTES over EPA PM10 (150  $\mu\text{g}/\text{m}^3$ )

3,850

sensor-minutes over 500  $\mu\text{g}/\text{m}^3$  (extreme)

669

highest 1-min PM10 (network-confirmed,  $\mu\text{g}/\text{m}^3$ )

## CALIBRATION

Reference: PDEQ Orange Grove BAM-1020  
(AQ5 04-019-0011)

PM10  $R^2$  per sensor:  
0.79 – 0.93 (robust)

PM2.5  $R^2$  per sensor:  
0.45 – 0.63 (modest)\*

\* PM2.5  $R^2$  limited by BAM near-MDL during co-location (median 5  $\mu\text{g}/\text{m}^3$ ). Bias correction still applies.

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*Air quality is clean by chronic standards but punctuated by frequent acute dust events.*

FINDING 2 — ACUTE PM10 EXPOSURE INEQUITY

Acute peaks are sharply unequal across sites.

| Site (sensor)                        | km to Hermosa | 1-min max | Min > 500 | Min > 150 (EPA) | 1-hr max | Hours > 150 (EPA) |
|--------------------------------------|---------------|-----------|-----------|-----------------|----------|-------------------|
| La Linea Art Studio (Nogales border) | 26.4          | 6,119     | 381       | 8,130           | 1,689    | 114               |
| Treehouse, Patagonia                 | 2.2           | 6,452     | 1,100     | 6,280           | 1,301    | 89                |
| Borderlands Nursery                  | 10.7          | 3,457     | 740       | 5,725           | 469      | 40                |
| Borderlands Food Bank                | 24.2          | 26,960*   | 424       | 5,416           | 652      | 26                |
| Veggies Inc.                         | 24.8          | 15,978*   | 390       | 2,313           | 691      | 28                |
| Rio Rico Firestation                 | 26.5          | 5,246     | 275       | 1,606           | 583      | 22                |
| City of Patagonia Park Gazebo        | 10.5          | 3,305     | 144       | 1,444           | 582      | 17                |
| Rio Rico High School                 | 30.4          | 2,539     | 321       | 1,328           | 728      | 18                |
| Little Red Schoolhouse               | 17.7          | 7,081     | 75        | 794             | 533      | 11                |

All values µg/m³ (calibrated 1-min). EPA 24-h PM10 standard = 150 µg/m³. Sorted by minutes-over-EPA.

\* 1-min maxes >5,000 at Borderlands Food Bank / Veggies / Little Red Schoolhouse / Treehouse reflect brief spikes (likely dust devils or vehicle pass-by adjacent to sensor) — minute-counts and hour-counts are the more robust acute-exposure metrics.

ACUTE EXPOSURE INEQUITY

Minute-level: La Linea = 8,130 min over EPA PM10 (= 135 hours of exposure). Little Red Schoolhouse = 794 min (10×–14× less). Hours-by-1h-mean understates because brief spikes are smoothed.

TREEHOUSE

Closest to Hermosa (2.2 km). 6,280 minutes over EPA PM10 + 1,100 minutes over 500 µg/m³. 1-h peak 1,301 µg/m³.

# Peaks scale modestly with averaging window.

NETWORK-MEDIAN PEAK BY RESOLUTION

| Resolution          | PM2.5 max | PM10 max | PM10 99th-pctile |
|---------------------|-----------|----------|------------------|
| 1-minute            | 52.7      | 669      | 46               |
| 5-minute            | 50.7      | 647      | 45               |
| 15-minute           | 49.5      | 632      | 46               |
| 1-hour (regulatory) | 47.7      | 582      | 45               |

Hourly averaging hides only ~13% of the 1-min peak amplitude.

Events are multi-hour, not flash spikes.

AUG 22–23, 2025 EVENT — PER-SENSOR 1-MIN PEAK

| Sensor                 | Peak PM10 | Time (MST)   |
|------------------------|-----------|--------------|
| Veggies Inc.           | 929       | Aug 22 22:37 |
| Rio Rico HS            | 908       | Aug 22 23:18 |
| La Linea (border)      | 865       | Aug 22 22:38 |
| Borderlands Food Bank  | 829       | Aug 22 21:23 |
| Rio Rico Firestation   | 801       | Aug 22 22:36 |
| City of Patagonia Park | 765       | Aug 22 22:39 |
| Little Red Schoolhouse | 733       | Aug 22 21:34 |
| Treehouse              | 497       | Aug 22 22:00 |
| Borderlands Nursery    | 344       | Aug 22 22:53 |

FINDING 3 — PEAKS ARE SUSTAINED, NOT FLASH SPIKES

## One event swept the whole network – August 23, 2025



# Routine patterns set the pre-operational baseline.

MONTHLY NETWORK MEAN (µg/m³)

| Month    | PM2.5 | PM10 | PM10 99th-pctile (1-h) |
|----------|-------|------|------------------------|
| Apr 2025 | 6.1   | 25.3 | 117                    |
| May 2025 | 6.5   | 25.7 | 88                     |
| Jul 2025 | 7.1   | 19.3 | 122                    |
| Aug 2025 | 7.6   | 19.1 | 151                    |
| Nov 2025 | 8.4   | 23.0 | 134                    |
| Dec 2025 | 9.0   | 22.4 | 142                    |

DIURNAL CYCLE (NETWORK MEAN, KEY HOURS)

| Hour MST | PM2.5 | PM10 | Pattern                |
|----------|-------|------|------------------------|
| 00:00    | 8.5   | 20.6 | nighttime accumulation |
| 06:00    | 9.0   | 23.7 | morning peak           |
| 12:00    | 5.1   | 15.6 | midday minimum         |
| 18:00    | 6.6   | 22.5 | evening rise           |
| 21:00    | 8.2   | 25.2 | evening peak           |

DAY-OF-WEEK NETWORK MEAN (µg/m³)

| Day | PM2.5 | PM10 | PM10 95th-pctile (1-h) |
|-----|-------|------|------------------------|
| Mon | 7.3   | 21.2 | 53                     |
| Tue | 7.2   | 22.1 | 56                     |
| Wed | 7.2   | 19.6 | 48                     |
| Thu | 7.4   | 20.4 | 51                     |
| Fri | 7.4   | 21.0 | 50                     |
| Sat | 7.2   | 19.8 | 50                     |
| Sun | 7.1   | 17.2 | 43                     |

HERMOSA-READINESS BASELINE

- PM10 averages 12% LOWER during M-F 7am–6pm than off-hours.
- Top 5 events: 3 of 5 occurred outside work hours.
- Only 11 of 66 events with S/SE wind (downwind of Hermosa).
- Two closest sensors to Hermosa lead 27 of 70 events (39%).

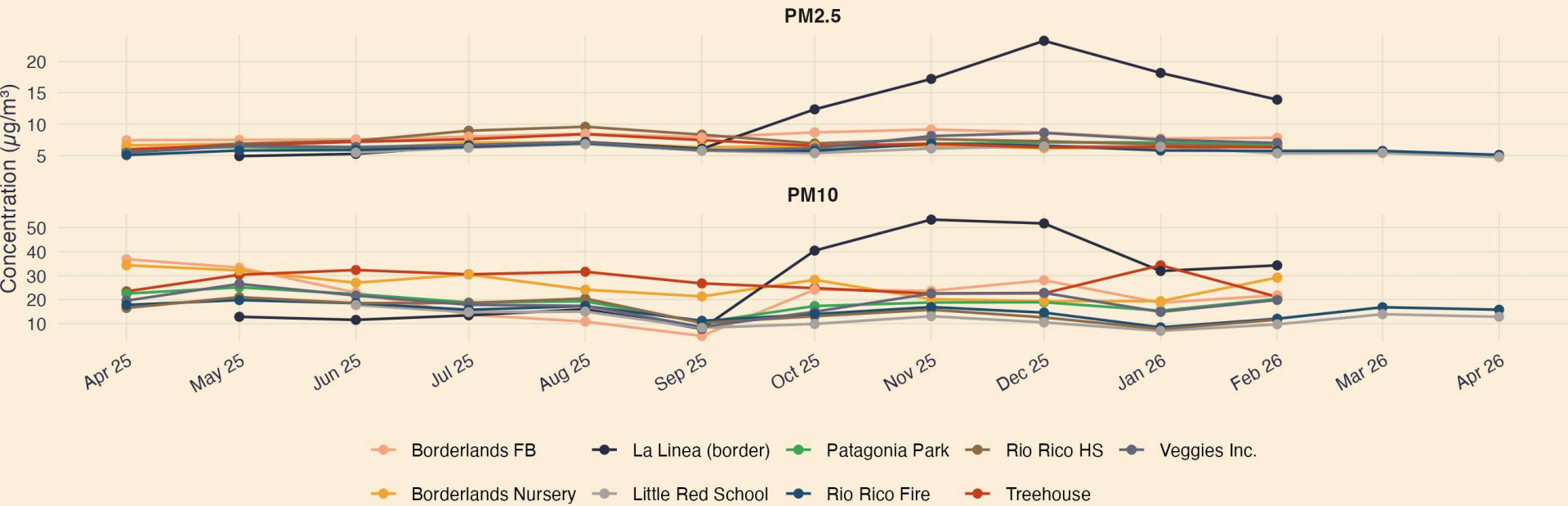
Current dominant pattern is mostly meteorological.

Caveat: 14 months covers a single annual cycle. Year-over-year variability not yet established.

# Monthly mean by sensor.

## Monthly mean by sensor — calibrated

Higher PM10 in spring (dust season) and Nov–Dec (winter inversions). La Linea + Borderlands sites consistently above network.



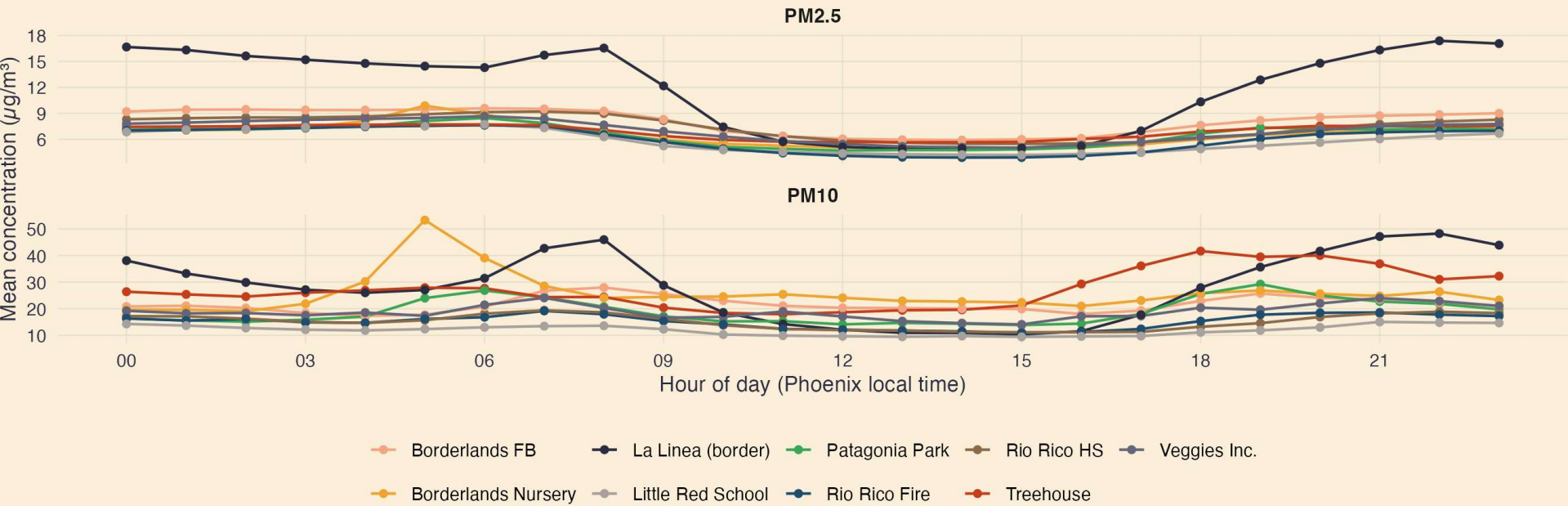
Calibrated against PDEQ Orange Grove BAM (Model B, per-sensor).

PM10 highest in spring (dust season) and Nov–Dec (winter inversions). La Linea + Borderlands Nursery + Borderlands Food Bank consistently above network mean every month.

# Diurnal cycle by sensor.

## Diurnal cycle by sensor — calibrated

PM10 peaks early-morning (5–9 a.m.) and evening (6–9 p.m.); midday minimum from boundary-layer mixing.



Calibrated against PDEQ Orange Grove BAM (Model B, per-sensor).

All sensors share the early-morning + evening twin-peak pattern. La Linea morning peak (8 a.m.) is 2–3× the network. Treehouse evening peak (8–9 p.m.) is anomalously high.

# Next Steps?



## Next Steps – U of A proposes the following

- **Data Analysis Enhancements:**

- Incorporate **satellite-based air quality measurements** for broader regional coverage.
- Correlate sensor data with traffic cameras / video for source attribution (especially trucks, construction and dust).

- **Monitoring Upgrades:**

- Researching adding **gas monitors** (for traffic-related pollutants) and filters for metals analysis in dust.
- Investigating low-cost sensor improvements or prototypes.

- **Community & Response Tools:**

- Develop or integrate a **public alert system** for high-dust events (link to state emergency alerts if possible).
- Build real-time public dashboards.



# What does all of this mean

## 1. Overall Air Quality is Clean on Average, but Acute Dust Events Are Frequent and Significant

- Long-term / chronic levels meet regulatory standards today.
- However, there are **33,000+ sensor-minutes** above the EPA 24-hour PM10 limit ( $150 \mu\text{g}/\text{m}^3$ ), with **3,850 minutes** over  $500 \mu\text{g}/\text{m}^3$  (extreme).
- This represents a notable portion of total observations (~6.25 million data points).

## 2. Strong Spatial Inequity in Exposure

- Acute peaks (high PM10) vary sharply by location and distance from the Hermosa mine area.
- Closest sites (e.g., **Treehouse at 2.2 km**) show the highest intensity and frequency of exceedances.
- Sites like La Linea (Nogales border) have the most total minutes over the EPA limit as expected – additional traffic will add to exposure.
- This creates clear **exposure inequity** across the county.

## 3. Peaks Are Sustained, Not Just Flash Spikes

- High dust events last multiple hours.
- Hourly regulatory averages only hide ~13% of the true peak intensity (peaks reduced modestly with longer averaging times).
- Example: The August 22–23, 2025 event affected the entire network for 4+ hours.

## 4. Current Patterns Are Mostly Meteorological and Truck Traffic (Pre-Operational Baseline)

- Strong seasonal patterns: highest PM10 in spring (dust season) and Nov–Dec (inversions).
- Clear time of day cycle: morning and evening peaks from vehicles / buses.
- Weekday vs. weekend differences are visible from work schedules.
- Only a minority of events so far are clearly downwind from the mine direction
- This sets the critical **pre-mine baseline** for detecting future increases from mine operations.



# Realtime Actionable Air Quality Info on the Web

- **Air Smart:** <https://aq-sensors.shinyapps.io/AirSMART/> -  
Both Quant & PurpleAir with real-time metrics and visualizations
- **PurpleAir:** <https://map.purpleair.com/air-quality-standards-us-epa-aqi> -  
Air Quality calculated levels
- **IQAir:** <https://www.iqair.com/air-quality-map> -  
Select Purple Airs with wind visualizations
- **AirNow:** <https://fire.airnow.gov/#10/31.5045/-110.9726>  
US Govt Smoke / Fire site with our Purple Airs

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# Thank You

