

2023 Q2 SENSOR REPORT COMMERCE CITY NORTH DENVER COMMUNITY AIR MONITORING NETWORK COMMERCE CITY, COLORADO

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Executive Summary

In response to feedback received by Suncor Energy (U.S.A.) Inc. (Suncor) through community engagement conducted in the fall of 2020, Suncor voluntarily committed to developing a continuous, near real-time air monitoring program to gain insight into air quality for neighborhoods in the vicinity of the Suncor refinery in Commerce City, Colorado. Montrose Environmental Group - Air Quality Services, LLC (Montrose) was contracted by Suncor to deploy, operate, and maintain the network in the Commerce City and North Denver (CCND) neighborhoods. Air monitoring was accomplished through three separate technical approaches: (1) continuous, near real-time monitoring for the following analytes¹: carbon monoxide (CO), sulfur dioxide (SO₂), hydrogen sulfide (H₂S), nitrogen oxide or nitric oxide (NO), nitrogen dioxide (NO₂), particulate matter (PM_{2.5}), and total volatile organic compounds (VOCs); (2) periodic collection and laboratory analysis for the presence of specific VOCs from 6-liter evacuated stainless steel (“Summa”) canisters; and (3) periodic real-time air monitoring throughout neighborhoods using a mobile monitoring van to detect the presence of specific VOCs. This report details approach number one, continuous near real-time air monitoring and a screening health risk analysis. Periodic collection and analysis of Summa canister air samples and mobile monitoring van data are presented in separate reports.

Continuous air monitoring sensors were operating at 10 locations across the CCND neighborhoods. The second quarter of 2023 air monitoring preliminary data was made available in near real-time at ccnd-air.com from April 1 – June 30, 2023, and final data is presented in this report. The sensors used in this program integrate different technologies including a photoionization detector for VOCs; an electrochemical sensor for CO, NO, NO₂, H₂S, and SO₂; laser scattering for PM_{2.5}; and a sonic anemometer for wind speed and direction. All sensor monitoring was conducted in accordance with the Quality Assurance Project Plan (QAPP) available at ccnd-air.com/documents.

Health scientists from CTEH, LLC (CTEH®) (a subsidiary company of Montrose Environmental Group) evaluated the air monitoring data and compared them to air quality standards, health-based reference values, and previously published regional data to determine if the measured air quality may have the potential for adverse effects on community health.

The results of this assessment indicate the following:

- The monitored analyte levels at each location were below their respective acute health-based reference levels, if available, or within the range of previously published regional data provided by the Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD).
- PM_{2.5} measurements were above the 24-hour daily average NAAQS concentration for approximately one week in this quarter. These measurements were likely due to the long-range transport of PM_{2.5} from the Canadian wildfire smoke to Colorado during this time.

¹ An “analyte” is a material that a measuring device is designed to detect and measure. It may be a chemical gas, an airborne particle, or other type of material.

These measurements also align with data seen on other PM_{2.5} measurements systems managed by CDPHE.

- It should be noted that the National Ambient Air Quality Standards (NAAQS) comparisons are used in the CCND Air Monitoring program for reference use only and may not be used to determine air quality compliance. This is because NAAQS compliance must be determined through the use of regulatory-certified instrumentation and required calculation methodology further discussed in section 2.

1.0 INTRODUCTION

In response to feedback received by Suncor Energy (U.S.A.) Inc. (Suncor) through community engagement conducted in the fall of 2020, Suncor voluntarily committed to developing a continuous, near real-time air monitoring program to gain insight into air quality for neighborhoods in the vicinity of the Suncor refinery in Commerce City, Colorado. Montrose Environmental Group-Air Quality Services, LLC (Montrose) was contracted by Suncor to deploy, operate, and maintain the network in the Commerce City and North Denver (CCND) neighborhoods. Air monitoring was accomplished through three separate technical approaches: (1) continuous, near real-time monitoring for the following analytes: carbon monoxide (CO), sulfur dioxide (SO₂), hydrogen sulfide (H₂S), nitric oxide (NO), nitrogen dioxide (NO₂), particulate matter (PM_{2.5}), and total volatile organic compounds (VOCs); (2) periodic collection and laboratory analysis for the presence of specific VOCs from Summa canisters; and (3) periodic real-time air monitoring throughout neighborhoods using a mobile monitoring van to detect presence of specific VOCs. An “analyte” is a material that a measuring device is designed to detect and measure. It may be a chemical gas, an airborne particle, or other type of material. This report details approach number one, the continuous, near real-time monitoring for the analytes listed. The Summa canister sampling and mobile monitoring van data are presented in separate reports. Air monitoring, sampling, and analysis from approaches (1) and (2) were conducted in accordance with the Quality Assurance Project Plan (QAPP) that can be found online at <https://www.ccnd-air.com/Documents/>.

1.1 Air Monitoring Site Description

Continuous air monitoring sensors were installed at ten locations across CCND neighborhoods within a three-mile radius of refinery operations in July 2021 (CM1-CM8). Two additional monitoring sensors were installed in December 2021 (CM9) and March 2022 (CM10). The monitor locations are shown in Figure 1-1 and described in Table 1-1; and were selected based on the following criteria:

- Historical wind pattern data
- Proximity to the refinery and non-refinery sources
- Existing infrastructure, as well as site access and safety
- Community feedback

**FIGURE 1-1
MAP OF CCND MONITOR LOCATIONS**



**TABLE 1-1
CCND MONITORS AND SUMMA CANISTER SAMPLING LOCATIONS**

Location ID	Secondary ID	GPS Coordinates	Distance from Refinery Center (miles)	Cross Streets
CM1	Rose Hill Elementary School	39.80164, -104.90882	2.0	E. 58 th Ave. & Oneida St., Commerce City
CM2	Suncor Refinery Business Center	39.79630, -104.95727	0.70	Brighton Blvd. & York St., Commerce City
CM3	Adams City High School	39.82736, -104.90193	2.9	E. 72 nd Ave. & Quebec Pkwy, Commerce City
CM4	Adams City Middle School	39.82893, -104.93499	1.9	Birch St. & E. 72 nd Ave., Commerce City
CM5	Central Elementary School	39.81457, -104.91928	1.7	Holly St. & E. 64 th Ave., Commerce City
CM6	Focus Points Family Resource Center	39.78436, -104.95663	1.4	Columbine St. & 48 th Ave., Denver
CM7	Kearney Middle School	39.80888, -104.91545	1.7	E 62 nd Ave. & Kearney St., Commerce City
CM8	Monroe	39.81560, -104.94503	0.85	Monroe St. & E 64 th Ave., Denver
CM9	48 th and Race	39.78455, -104.96264	1.7	East 48 th Ave. & Race St., Denver
CM10	Alsup Elementary School	39.820268, -104.936616	1.2	East 68 th Ave. & Birch St., Commerce City

2.0 METHODS

2.1 Continuous Monitoring

The sensors used in the CCND network were manufactured by Lunar Outpost (Canary-S sensor), a Colorado-based company, and AQMesh (Pod), a United Kingdom-based company. The near-Federal Equivalency Method (FEM) AQM65 monitors used for quality assurance of the network were manufactured by Aeroqual, a New Zealand-based company. Each sensor is solar powered and transmits data to the data platform via Long Term Evolution (LTE) cell technology. The monitoring in the community is being performed using a variety of technology, as described in Table 1-2.

**TABLE 1-2
CCND MONITORING TECHNOLOGY**

Air Pollutant/Parameter Category	Principle of Operation	Sensor Manufacturer
Total VOC	Photoionization Detector	Lunar Outpost
SO ₂	Electrochemical Sensor	AQMesh
CO	Electrochemical Sensor	AQMesh
NO	Electrochemical Sensor	AQMesh
NO ₂	Electrochemical Sensor	AQMesh
H ₂ S	Electrochemical Sensor	AQMesh
PM _{2.5}	Laser Scattering	Lunar Outpost
Wind Speed, Wind Direction	Sonic Anemometer	Lunar Outpost
Temperature, Relative Humidity, Barometric Pressure	Solid State	Lunar Outpost

The sensors monitor the ambient air by allowing it to passively enter each sensor's exterior housing via small holes and pass over the surface of the sensor. The AQM65 monitors the ambient air via a pump that pulls the sample into the individual analyte specific gas modules for analysis. Each device used in this project is solar-powered and transmits data via cellular communication.

The Photoionization Detector (PID) sensors used to measure VOCs contain a lamp that produces photons that carry enough energy to break molecules into ions. The PID responds to molecules that have an ionization energy at or below the energy of the lamp; the PID used on this project employs a 10.6 electron-volt lamp. The produced ions then generate an electrical current that is measured as the output of the detector. PIDs are known to drift with ambient temperature and humidity variation. The PIDs used in this program mitigate the humidity issue by having a hydrophobic filter installed between the lamp and the ambient air. This deters water molecules

from entering the ion-producing chamber and absorbing radiation. The PIDs are also heated slightly above ambient temperature to improve the stability of the detector.

Electrochemical sensors measure the concentration of a specific gas (SO₂, CO, NO, NO₂, and H₂S) within an external circuit via oxidation or reduction reactions. These reactions generate the positive or negative current flow through the external circuit. An electrochemical sensor is made up of a working, counter, and reference electrode. All these components sit inside of a sensor housing along with a liquid electrolyte that is specific to the compound of interest. Temperature and relative humidity are known to affect the electrochemical sensors being used and could influence data quality. The AQMesh Pods collect sensor temperature and ambient relative humidity data to mitigate the impact of these interferences via algorithms that were developed during extensive [global comparisons with reference data](#). AQMesh Pod non-zero readings that are below the instrument's detection limit are artifacts of AQMesh's algorithm. Extreme temperature and humidity conditions can cause the liquid electrolyte to dry up and cause erratic readings on the monitors. The AQMesh Pod monitors conditions that can cause these erratic readings and automatically invalidates this data to improve the overall quality of the data the sensors are reporting.

Additionally, electrochemical sensors have known cross-sensitivity to other compounds. For example, ozone causes a response in the NO₂ sensor. This issue is mitigated by using an ozone filter on the face of the NO₂ sensor. Similarly, the SO₂ sensor can have a response caused by the presence of H₂S. Again, the SO₂ sensor has a built-in filter to mitigate the H₂S interference. The SO₂ sensor has additional interference from NO₂. The AQMesh data processing algorithms incorporate any data correction for these interferences.

The sensor data are intended to be used for informational purposes only and cannot be used for official compliance determinations. The accuracy of sensors used in the program are not as high as certified ambient air monitoring equipment used by federal and local officials for NAAQS compliance monitoring. The sensors' detection limits and accuracy can be found in the QAPP online at <https://www.ccnd-air.com/Documents/>. State regulatory compliance data can be found on the CDPHE air quality website at <https://www.colorado.gov/airquality>.

The sampled particles are measured by the physical principle of light scattering. Each single particle is illuminated by a defined laser light and each scattering signal is detected at an angle of 90° by a photo diode. In accordance with the Mie theory, each measured pulse height is directly proportional to the particle size whereas each pulse is classified in an electronic register of 32 different size channels.

Sensors like the Lunar Outpost Canary-S and AQMesh Pod are also known to produce data that is noisier (lower signal-to-noise ratio) than traditional regulatory reference method quality ambient air monitoring equipment. To mitigate this issue, the data were averaged at one or 24-hours to improve the signal-to-noise of the instrument readings.

All sampling and quality assurance procedures were performed by Montrose.

2.2 Assessment of Community Health Implications

Health scientists from CTEH, LLC (CTEH®) (a subsidiary company of Montrose) evaluated the air monitoring data collected by Montrose from April 1, 2023, through June 30, 2023. Results were compared to various standards, health-based reference levels, and previously published regional

data to determine if the measured air quality may have the potential for adverse health effects within the surrounding communities.

The analytes CO, NO₂, SO₂, and PM_{2.5} are all listed by the United States Environmental Protection Agency (USEPA) as “criteria air pollutants”. These analytes were identified in the U.S. federal Clean Air Act as airborne pollutants that, at certain levels, may adversely impact public health and welfare and for which NAAQS would be established and updated based on the periodically reviewed scientific data associating criteria pollutant levels and public health impacts. Unlike chemical-specific health reference values, the NAAQS provide air quality standards designed to protect public health at the regional level.

The determination that a criteria pollutant is at a level legally required to be mitigated comes from evaluation of one year (CO) to three years (NO₂, SO₂, and PM_{2.5}) of air monitoring data² collected by regulatory-grade instrumentation. If the maximum or average analyte levels in this report are higher than their respective NAAQS, it does not indicate a violation of the NAAQS or that adverse health effects are likely. Any measurement of a criteria air pollutant over its respective NAAQS reference concentration must be evaluated in the context of one to three years of data previously collected. For example, a 1-hour average value above the NO₂ standard concentration would not constitute an exceedance of the NO₂ NAAQS. To be a NAAQS exceedance, a measurement must be made by a regulatory grade instrument and compared to one-hour daily maximum concentration measurements, averaged over three years, to determine whether it is part of the 98th percentile or higher. However, the data reported herein may be used to determine trends in criteria pollutant levels in the CCND communities.

H₂S and NO are not criteria air pollutants but were selected to be monitored because of the potential to produce reactive nitrogen compounds in the air (NO), or because of presence in some grades of crude oil and its refined products (H₂S). Although NO does not have a health-based reference value, average and maximum NO levels for the Front Range region have been previously measured and reported by the CDPHE Air Pollution Control Division (APCD)³. The maximum and average NO levels measured by Montrose from January 1 to March 31, 2023 were compared to the regional values reported by APCD. The health reference values for H₂S were developed by the Agency for Toxic Substances and Disease Registry (ATSDR)⁴. The ATSDR acute health-based reference levels (one day to two weeks of continuous exposure) is a health reference value below which continuous exposure is likely to be without risk of developing adverse health effects, even in sensitive sub-populations. Maximum one-hour rolling average H₂S levels recorded in each CCND neighborhood were compared to an ATSDR acute-health-based reference level.

Finally, the USEPA has established values for use in emergency situations, termed Acute Exposure Guideline Levels (AEGs). Unlike health-based reference levels that can be thousands of times below exposure levels where adverse effects are observed, AEGs values are levels at which different acute adverse health effects may be anticipated to occur. According to USEPA, “AEG-1 represent exposure levels that could produce mild and progressively increasing but transient and non-disabling odor, taste, and sensory irritation or certain asymptomatic, non-sensory effects. With increasing airborne concentration above each AEG, there is a progressive increase in the likelihood of occurrence and the severity of effects described for each

² USEPA NAAQS Table, available online at <https://www.epa.gov/criteria-air-pollutants/naaqs-table>

³ CO APCD 2020 Air Quality Data Report, available online at https://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=2020AnnualDataReport.pdf

⁴ ATSDR MRL List available online at <https://wwwn.cdc.gov/TSP/MRLS/mrlsListing.aspx>

corresponding AEGL [i.e., AEGL-2 or AEGL-3].” The AEGL-1 60-minute value, if available for the applicable compound, was also used for comparison purposes because it is more precautionary (than AEGL-2 or AEGL-3) as the AEGL-1 level reflects potential health impacts that are reversible upon cessation of exposure. The AEGL-1 60-minute values for H₂S (510 ppb), NO₂ (500 ppb), and SO₂ (200 ppb) were also listed for comparison purposes. The USEPA did not derive an AEGL-1 value for CO, therefore an AEGL-2 (83 ppm) was selected.

2.3 Summary of Downtime or Equipment Malfunction

Data recovery is a percentage of the number of data points collected divided by the expected number of data points. For example, if a data point is expected every five minutes, 12 data points would be expected over a one-hour period. If only 11 data points were received, the data recovery for that hour would be 92%. The data recovery during the reporting period meets the QAPP targets and are presented in Table 1-3.

**TABLE 1-3
CCND MONITORING DATA RECOVERY**

Location ID	AQMesh (excludes periods of adverse atmospheric conditions)	AQMesh (includes periods of adverse atmospheric conditions)	Lunar Outpost
CM1	99.9%	97.9%	99.8%
CM2	99.9%	96.0%	99.9%
CM3	99.9%	97.9%	99.9%
CM4	99.9%	98.5%	99.9%
CM5	99.9%	98.2%	99.9%
CM6	99.9%	97.4%	97.9%
CM7	99.9%	98.4%	99.3%
CM8	99.9%	96.9%	99.9%
CM9	99.9%	97.1%	99.9%
CM10	99.9%	96.9%	99.9%

Data recovery may be below 100% for several reasons, including instrument malfunction, instrument communication issues, monitor downtime when performing quality assurance procedures, etc. In alignment with the QAPP, data recovery does not include downtime when adverse atmospheric conditions such as extreme humidity, extreme temperature, and other conditions can affect a monitor’s ability to provide reliable data.

The AQMesh Pod’s internal quality assurance and procedures automatically invalidates this data to improve the overall quality of the data the sensors are reporting.

3.0 RESULTS

3.1 Results Summary

The one-hour rolling average results for CO, NO, NO₂, PM_{2.5}, H₂S, SO₂, and VOCs during this reporting period can be found in Table 1-4 and Figures 1-3 through 1-9. The gaseous (CO, NO, NO₂, H₂S, SO₂, and VOC) data is reported on a one-hour rolling average updated every 5 minutes. The PM_{2.5} data presented on the website is a one-hour block average to align with the other PM_{2.5} sensor-based monitoring programs around the local community. The 24-hour block average for PM_{2.5} and rolling average for H₂S are also reported. Values reported as zero do not necessarily mean that the analyte is not present, but instead indicates that the analytes' concentration, if present, is below the detectable level of the instrument.

This evaluation includes screening values from the USEPA NAAQS, EPA AEGL, and ATSDR Minimal Risk Level (MRL). The Clean Air Act requires USEPA to set NAAQS for criteria air pollutants. AEGLs are used by emergency planners and responders worldwide as guidance for emergency response situations. Health reference levels, such as MRLs provided by the ATSDR, are intended to serve as a screening tool to help public health professionals determine where further evaluation may be needed. As explained above in Section 2.2, if the maximum or average analyte levels in this report are higher than their respective NAAQS reference level, it does not indicate an exceedance of the NAAQS or that adverse health effects are likely. Table 1-4 and Figures 1-3 to 1-9 indicate readings for the monitoring period relative to the NAAQS and MRLs (if applicable).

**TABLE 1-4
CCND MONITORS RESULTS SUMMARY**

Analyte	Range Across Network ⁵	NAAQS Reference Values	Health-based Reference Value (Source)
CO	<0.1 – 1.1 ppm (1-hour average)	35 ppm (1-hour average not to be exceeded more than one per year)	83 ppm (1-hour USEPA AEGL-2)
NO	<10 - 132 ppb (1-hour average)	NA	NA
NO ₂	<10 - 59 ppb (1-hour average)	100 ppb (98 th percentile of 1-hour daily maximum, averaged over 3 years)	500 ppb (1-hour USEPA AEGL-1)
SO ₂	<30 ppb (1-hour average)	75 ppb (99 th percentile of 1-hour daily maximum concentrations, averaged over 3 years)	200 ppb (1-hour USEPA AEGL-1)
H ₂ S	<30 ppb (1-hour and 24-hour average)	NA	70 ppb (acute ⁶ ATSDR MRL) 510 ppb (1-hour USEPA AEGL-1)
PM _{2.5}	<3 - 59 µg/m ³ (24-hour average)	35 µg/m³ (98 th percentile of 24-hour daily average concentrations, averaged over 3 years)	NA
Total VOC	<0.3 – 0.5 ppm (1-hour average)	NA	NA

⁵ The "<" symbol indicates that the recorded concentration was less than the instrument's detection limit

⁶ An acute exposure is defined by ATSDR as 1-14 days

3.2 Carbon Monoxide (CO)

Figure 1-3 shows the one-hour rolling averages of CO from April 1, 2023, through June 30, 2023. The USEPA NAAQS for CO is 35 ppm as a one-hour average not to be exceeded twice in one year. Figure 1-3 shows that all the measured one-hour average CO values in all CCND neighborhoods were more than 31-times lower (maximum 1-hour average: 1.1 ppm) than the CO NAAQS reference level. Further, the maximum one-hour measured CO values in the CCND neighborhoods were more than 75-times lower than the one-hour USEPA AEGL-2 of 83 ppm.

3.3 Nitric Oxide (NO)

Figure 1-4 shows the one-hour rolling averages of NO from April 1, 2023, through June 30, 2023. There are no established USEPA NAAQS, health-based reference level, or USEPA AEGL-1 value for NO since NO demonstrates low toxicity and is naturally occurring in the human body⁷. Thus, measured NO levels were compared to NO levels published by APCD in 2021⁸. The annual average NO levels reported by APCD for Denver (four locations), Jefferson County, and Weld County ranged from 0.7 to 30 ppb, (maximum levels ranged from 32 to 386 ppb), while the maximum one-hour rolling average NO values by site measured by Montrose in the CCND neighborhoods concentration ranged from 48 - 132 ppb.

3.4 Nitrogen Dioxide (NO₂)

Figure 1-5 shows the one-hour rolling averages of NO₂ from April 1, 2023, through June 30, 2023. The USEPA NAAQS for NO₂ is 100 ppb as the 98th percentile of one-hour daily maximum concentrations, averaged over three years. Figure 1-5 shows that all measured 1-hour average NO₂ values in all CCND neighborhoods (maximum 1-hour average: 59 ppb) were at least 41% lower than the NO₂ NAAQS concentration. Thus, NO₂ levels such as those measured in the CCND neighborhoods would not contribute to an annual exceedance of the NAAQS. Further, the maximum measured one-hour average NO₂ concentration across all the CCND neighborhoods was at least eight times lower than the one-hour USEPA AEGL-1 for NO₂ of 500 ppb.

3.5 Sulfur Dioxide (SO₂)

Figure 1-6 shows the one-hour rolling averages of SO₂ from April 1, 2023, through June 30, 2023. The USEPA NAAQS for SO₂ is 75 ppb as 99th percentile of one-hour daily maximum concentrations, averaged over three years. Figure 1-6 shows a maximum one-hour average SO₂ value was less than the instrument detection limit of 30 ppb from all CCND neighborhoods, approximately 2.5-times lower than the NAAQS concentration. Further, the maximum measured one-hour average SO₂ concentrations measured across all the CCND neighborhoods are more than 6-times lower than the one-hour USEPA AEGL-1 for SO₂ of 200 ppb.

3.6 Hydrogen Sulfide (H₂S)

Figures 1-7A and 1-7B show the one-hour and 24-hour rolling averages of H₂S, respectively, from April 1, 2023, through June 30, 2023. The maximum 24-hour average was less than the instrument detection limit of 30 ppb from all CCND neighborhoods and is below the ATSDR acute-duration MRL of 70 ppb, thus, it is unlikely that H₂S levels measured in the CCND neighborhoods

⁷ https://www.epa.gov/sites/default/files/2014-11/documents/nitrogen_oxides_volume_11.pdf

⁸ Colorado Air Pollution Control Division. 2021 Air Quality Data Report, dated November 4, 2022. Available online at: https://www.colorado.gov/airquality/tech_doc_repository.aspx?action=open&file=2021AnnualDataReport.pdf

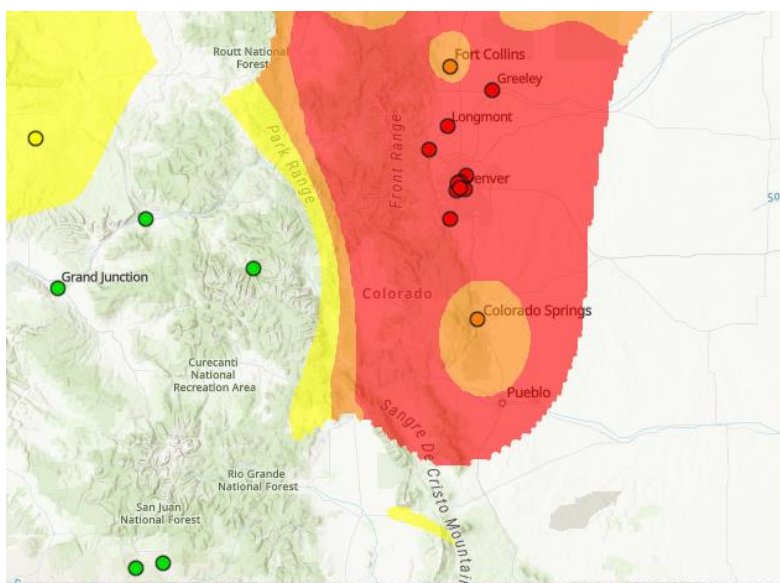
would result in an increased risk of adverse acute health effects. Further, the maximum measured one-hour average H₂S values (below the 30 ppb detection limit) in the CCND neighborhoods are more than 17-times lower than the one-hour USEPA AEGL-1 for H₂S of 510 ppb.

3.7 Particulate Matter (PM_{2.5})

Figures 1-8A and 1-8B show the one-hour and 24-hour block averages of PM_{2.5}, respectively, from April 1, 2023, through June 30, 2023. The USEPA NAAQS for PM_{2.5} is 35 µg/m³ as 98th percentile of 24-hour daily (block) average concentrations, averaged over 3 years. The measured 24-hour averages from May 19-25 were above the NAAQS concentration at all CCND sensor locations. However, the measured PM_{2.5} data collected outside of this date range would not contribute to an annual exceedance of the NAAQS.

Based on data collected by CDPHE or other state and federal air quality monitoring groups, and presented on the website, AirNow⁹, the wildfire smoke from Canada likely resulted in the long-range transport of PM_{2.5} to Colorado, thus contributing to an *unhealthy* U.S. Air Quality Index (AQI) along the Northern Front Range (Figure 1-2). On May 19th, 2023, all CDPHE PM_{2.5} monitoring stations across Colorado measured 24-hour averages above the NAAQS concentration level¹⁰.

Figure 1-2. AirNow PM_{2.5} U.S. Air Quality Index on May 19, 2023, across Colorado. Red indicates an *unhealthy* AQI (151-200).



3.8 Total Volatile Organic Compounds (VOC)

Figure 1-9 shows the one-hour rolling averages of total VOCs from April 1, 2023, through June 30, 2023. The measured maximum one-hour average across this reporting period was 0.5 ppm. There are no NAAQS or health-based reference values for total VOCs because this measurement may be made of one to thousands of different chemical compounds having various thresholds of toxic effects.

⁹ <https://www.airnow.gov>

¹⁰ <https://www.colorado.gov/airquality/report.aspx>

VOC sensor-triggered samples were collected automatically when instantaneous total VOCs were detected at an airborne concentration of 1 part per million (ppm) or higher for one minute or longer. During the second quarter of 2023, total VOC levels went above 1 ppm once, which triggered the capture of one air sample. The results of the sensor-triggered events and health risk evaluations are presented in separate reports found at ccnd-air.com/Documents.

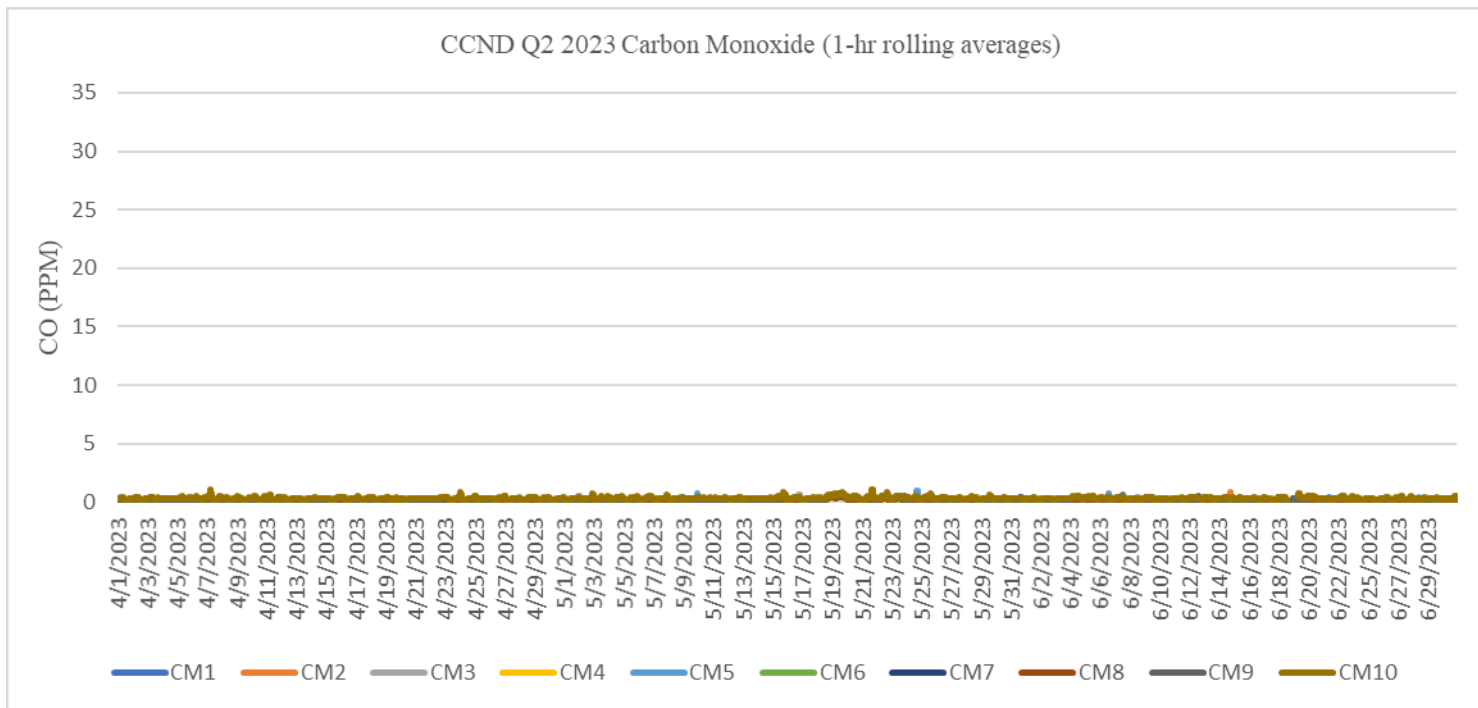
4.0 CONCLUSIONS

Continuous air monitoring sensors were operating at ten locations across the CCND neighborhoods during the monitoring period. The air monitoring data from April-June 2023 was compared to air quality standards, health-based reference values, and previously published regional data to determine if the measured air quality may have the potential for adverse effects on community health.

The results of this assessment indicate the following:

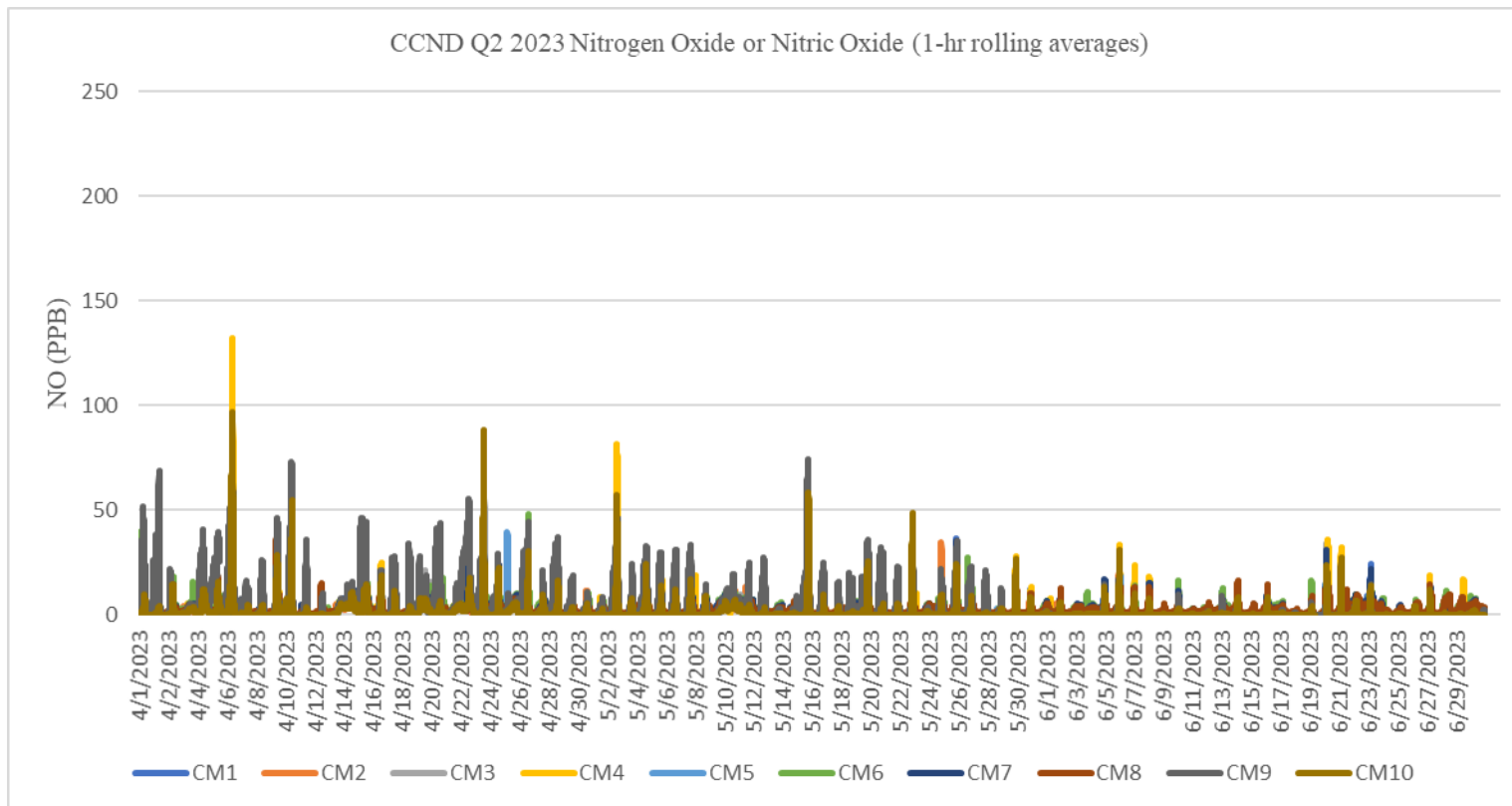
- The monitored analyte levels at each location were below their respective acute health-based reference levels, if available, or within the range of previously published regional data provided by the CDPHE APCD.
- PM_{2.5} measurements were above the 24-hour daily average NAAQS concentration for approximately one week in this quarter. These measurements were likely due to the long-range transport of PM_{2.5} from the Canadian wildfire smoke to Colorado during this time. These measurements also align with data seen on other PM_{2.5} measurements systems managed by CDPHE.
 - It should be noted that the NAAQS comparisons are used in the CCND Air Monitoring program for reference use only and may not be used to determine air quality compliance. This is because NAAQS compliance must be determined through the use of regulatory certified instrumentation and required calculation methodology further discussed in section 2 of this report.

FIGURE 1-3
CCND COMMUNITY MONITORING CARBON MONOXIDE (CO) DATA¹¹
(ONE-HOUR ROLLING AVERAGES)



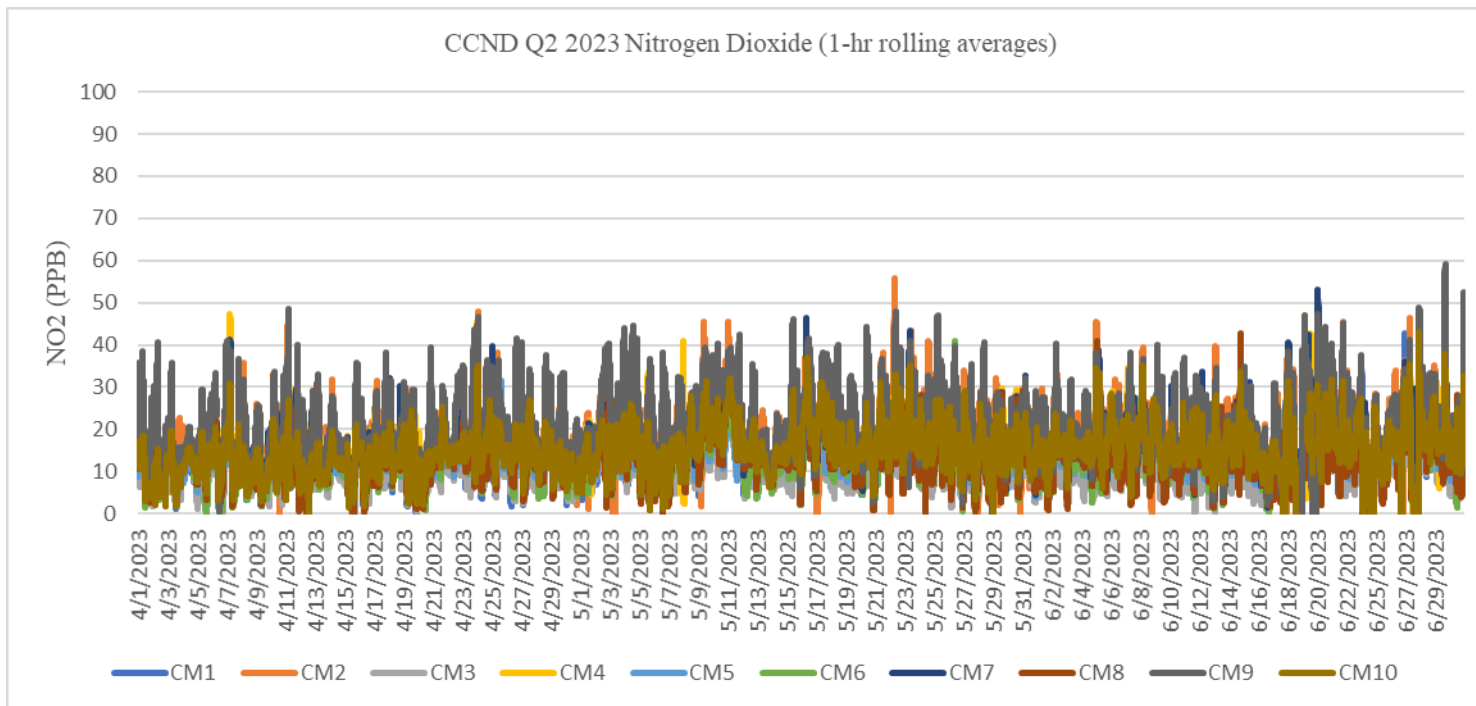
¹¹ The AQMesh Pod's detection limit for carbon monoxide is 0.1 ppm.

FIGURE 1-4
CCND COMMUNITY MONITORING NITRIC OXIDE (NO) DATA¹²
(ONE-HOUR ROLLING AVERAGES)



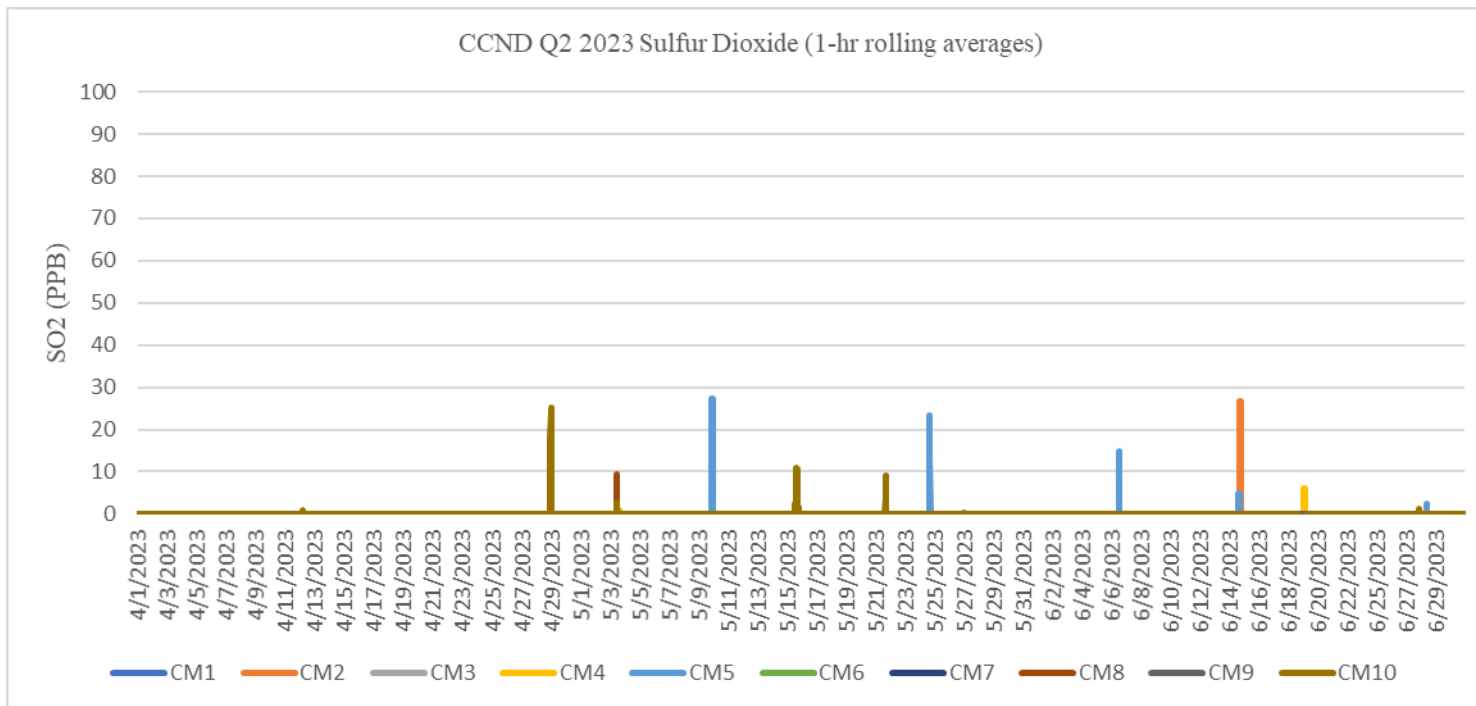
¹² The AQMesh Pod's detection limit for nitrogen oxide or nitric oxide is 10 ppb.

FIGURE 1-5
CCND COMMUNITY MONITORING NITROGEN DIOXIDE (NO₂) DATA¹³
(ONE-HOUR ROLLING AVERAGES)



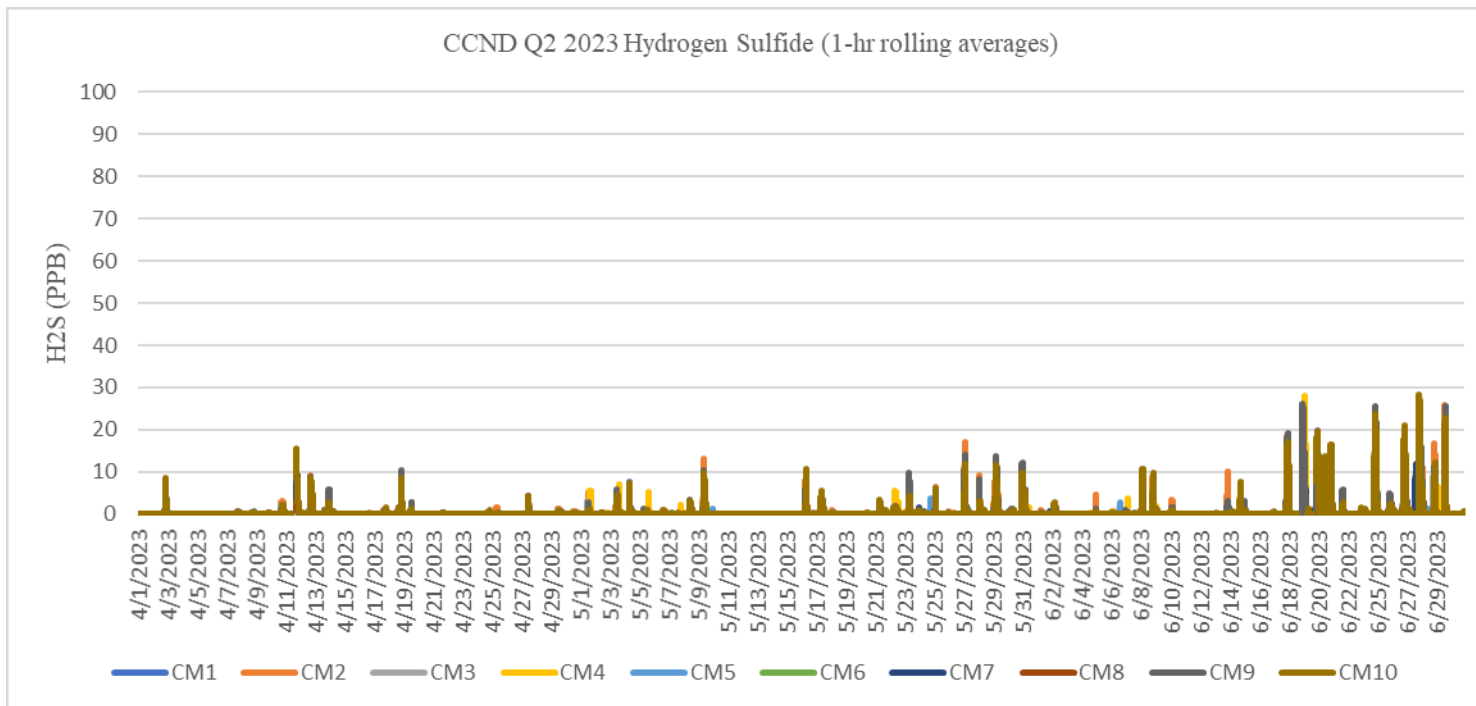
¹³ The AQMesh Pod's detection limit for nitrogen dioxide is 10 ppb.

FIGURE 1-6
CCND COMMUNITY MONITORING SULFUR DIOXIDE (SO₂) DATA¹⁴
(ONE-HOUR ROLLING AVERAGES)



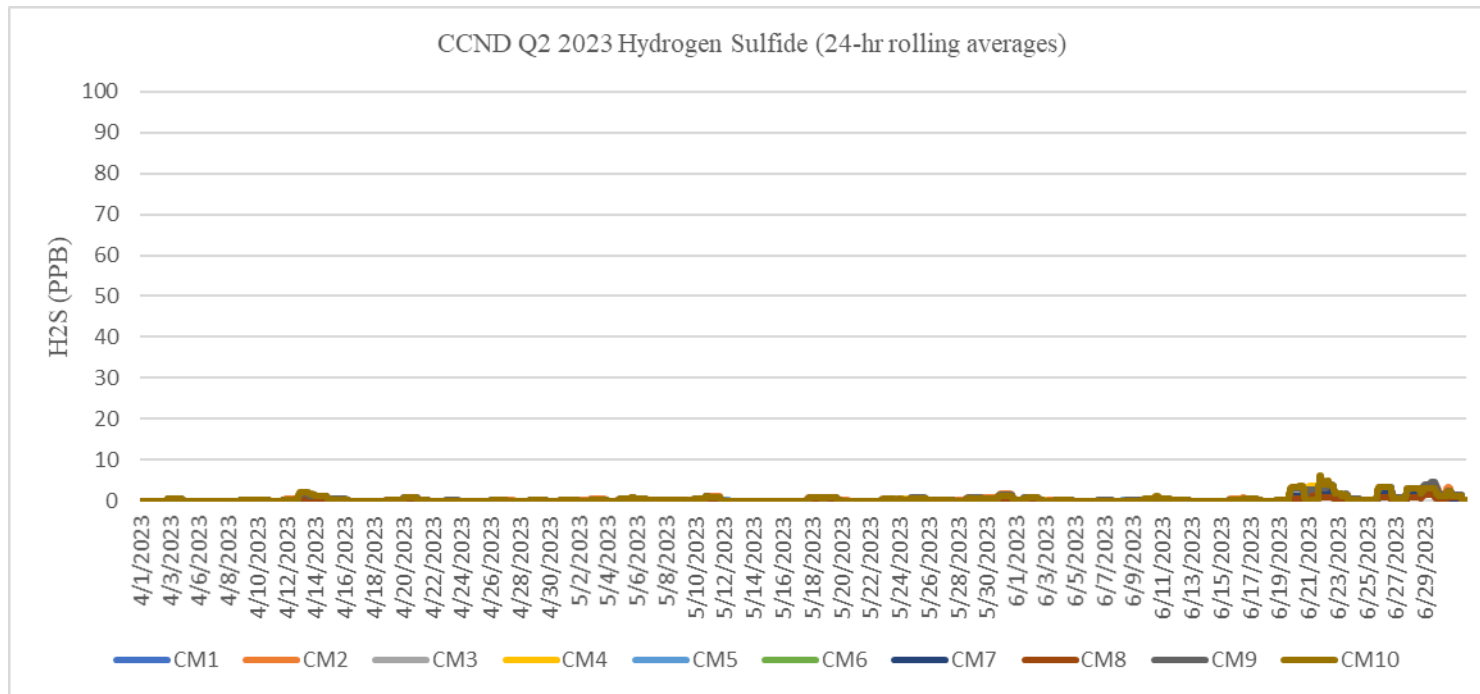
¹⁴ The AQMesh Pod's detection limit for sulfur dioxide is 30 ppb.

FIGURE 1-7A
CCND COMMUNITY MONITORING HYDROGEN SULFIDE (H₂S) DATA¹⁵
(ONE-HOUR ROLLING AVERAGES)



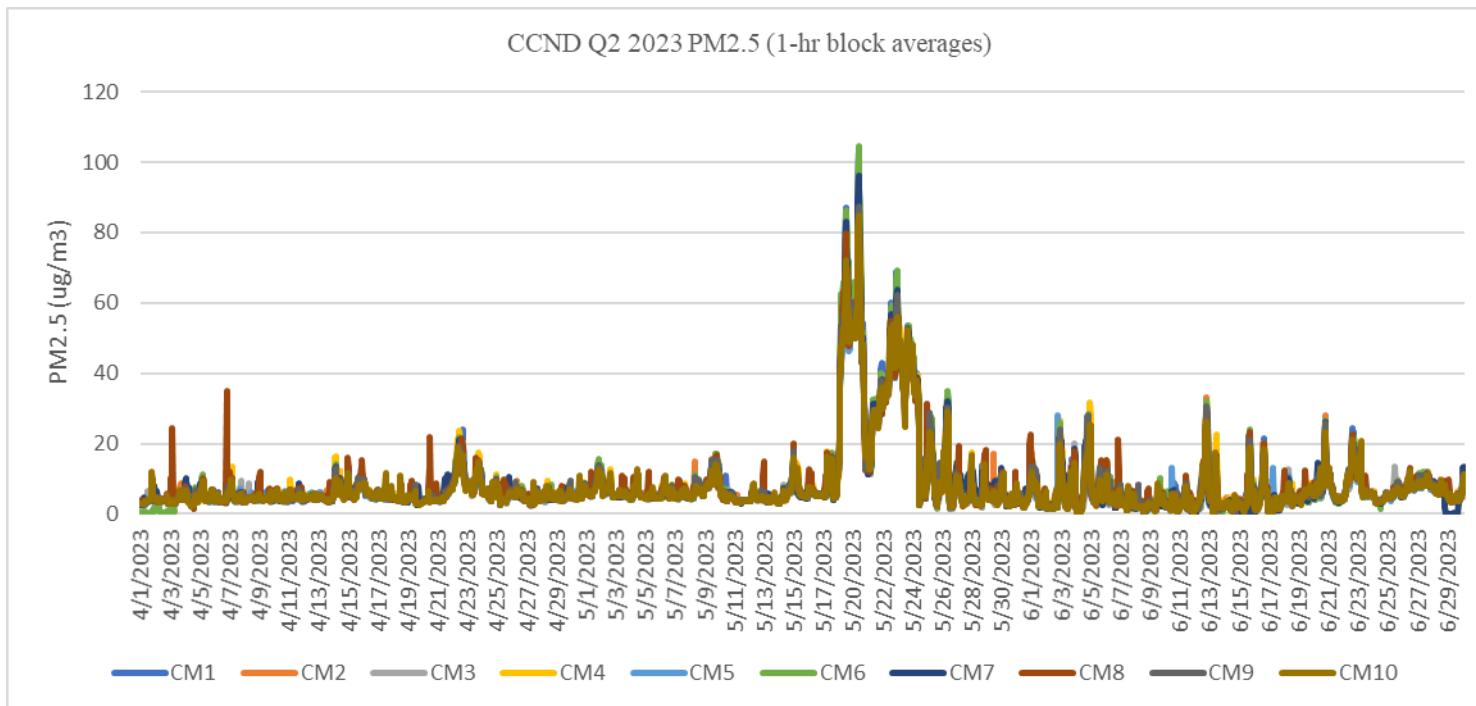
¹⁵ The AQMesh Pod's detection limit for hydrogen sulfide is 30 ppb.

FIGURE 1-7B
CCND COMMUNITY MONITORING HYDROGEN SULFIDE (H₂S) DATA¹⁶
(24-HOUR ROLLING AVERAGES)



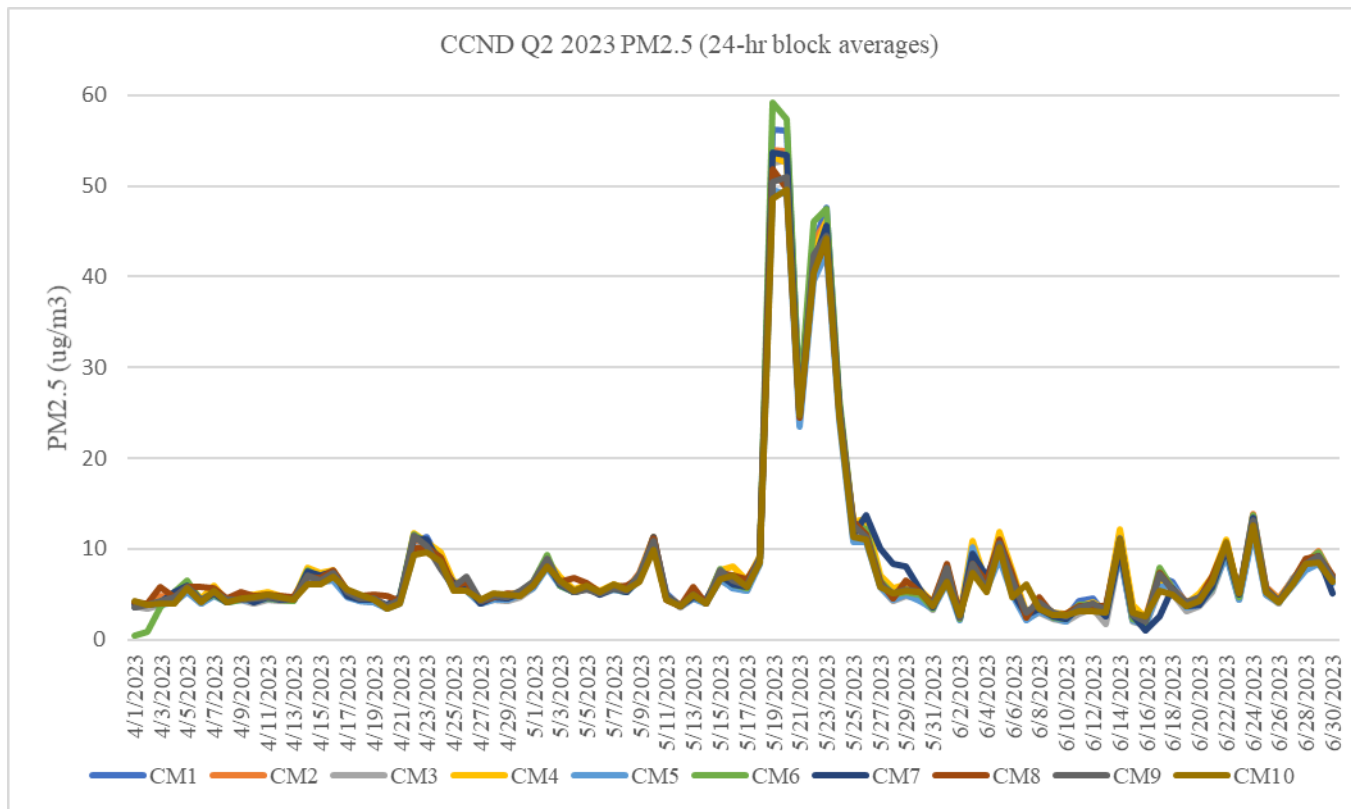
¹⁶ The AQMesh Pod's detection limit for hydrogen sulfide is 30 ppb.

FIGURE 1-8A
CCND COMMUNITY MONITORING PM_{2.5} DATA¹⁷
(ONE-HOUR BLOCK AVERAGES)



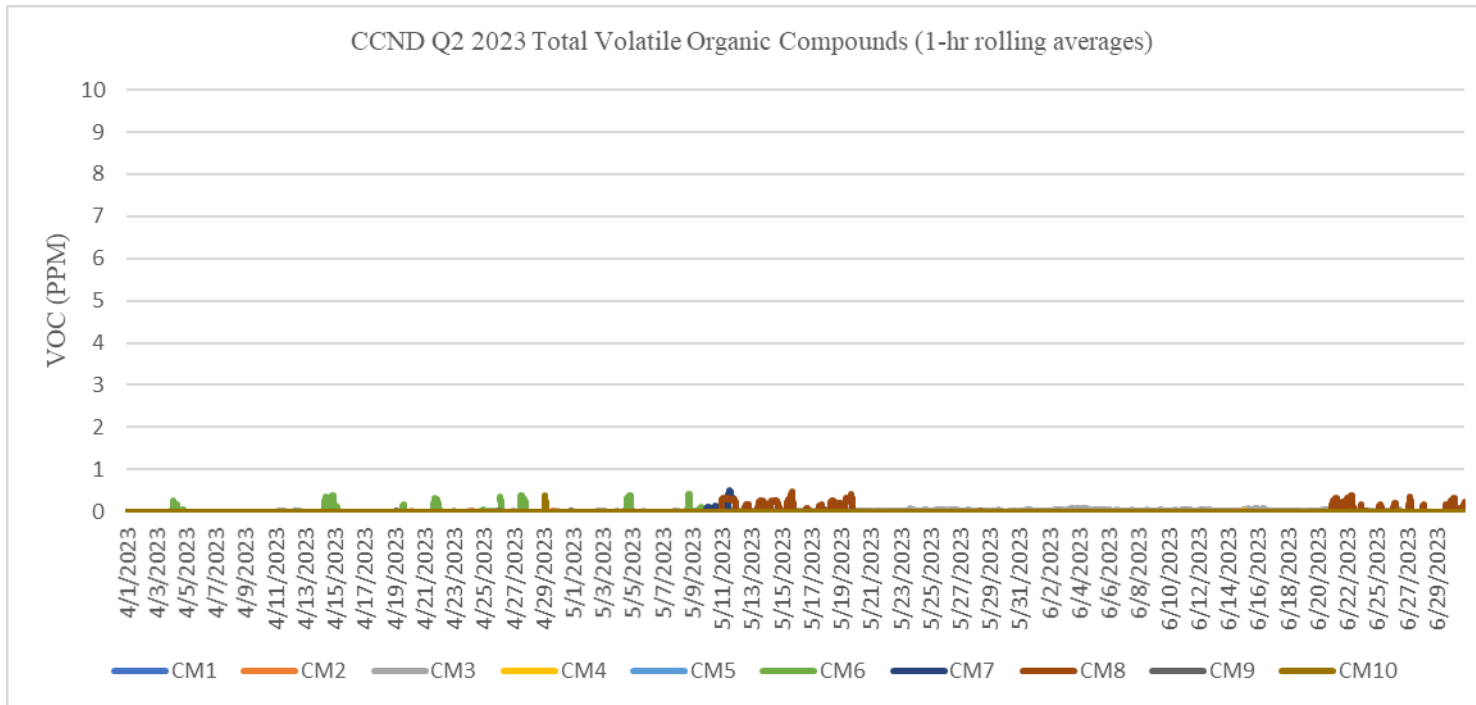
¹⁷ The Lunar Outpost Canary-S's detection limit for PM_{2.5} is 3 µg/m³.

FIGURE 1-8B
CCND COMMUNITY MONITORING PM_{2.5} DATA¹⁸
(24-HOUR BLOCK AVERAGES)



¹⁸ The Lunar Outpost Canary-S's detection limit for PM_{2.5} is 3 µg/m³.

FIGURE 1-9
CCND COMMUNITY MONITORING VOC DATA¹⁹
(ONE-HOUR ROLLING AVERAGES)



¹⁹ The Lunar Outpost Canary-S's detection limit for VOC is 0.3 ppm.

5.0 PROGRAM CHANGES

1. There were no instrument issues during Q2 2023.
2. As described in the previous Sensor Reports, Montrose developed a deployment plan to switch the network over from AQMesh to ENVEA devices. During the pre-deployment quality assurance inspections a number of the ENVEA SO₂ gas sensors failed to meet the requirements of the sensor and near-FEM collocation study described in the programs QAPP due to an unknown reason. Montrose is currently working with the manufacturer to resolve the issue before new monitoring equipment is used to collect data in the CCND program.

Prepared by:



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Director - Emerging Technology
Montrose Air Quality Services, LLC



Michael Lumpkin, PhD, DABT
Senior Toxicologist
CTEH®, LLC

APPENDIX A CALIBRATION AND QA/QC DATA

Rose Hill

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450728	Mon_Dutch_004	CM1	4/10/2023	5%	0%	34%	1%	33%	48%	0%	26%	33%	2%	6%	10%	0%	11%	30%	0%	12%	5%
2450728	Mon_Dutch_004	CM1	5/9/2023	0%	4%	38%	0%	17%	33%	0%	39%	31%	0%	2%	11%	0%	14%	20%	0%	23%	14%
2450728	Mon_Dutch_004	CM1	6/20/2023	0%	2%	40%	0%	10%	22%	0%	25%	38%	0%	14%	7%	0%	45%	17%	0%	21%	18%

RBC

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450729	Mon_Dutch_003	CM2	4/13/2023	3%	13%	24%	0%	50%	17%	0%	47%	8%	0%	49%	19%	0%	42%	29%	6%	21%	14%
2450729	Mon_Dutch_003	CM2	5/22/2023	3%	2%	22%	0%	49%	33%	1%	43%	39%	0%	48%	45%	0%	48%	25%	5%	17%	7%
2450729	Mon_Dutch_003	CM2	6/23/2023	1%	12%	12%	1%	40%	48%	0%	37%	18%	4%	41%	46%	0%	50%	34%	4%	22%	12%

Adams High

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450730	Mon_Dutch_005	CM3	4/17/2023	1%	30%	39%	0%	22%	25%	0%	33%	1%	0%	11%	6%	0%	43%	50%	2%	23%	4%
2450730	Mon_Dutch_005	CM3	5/15/2023	3%	5%	28%	1%	46%	18%	0%	18%	26%	0%	13%	6%	0%	49%	25%	2%	18%	12%
2450730	Mon_Dutch_005	CM3	6/26/2023	3%	14%	24%	2%	37%	33%	0%	47%	39%	7%	26%	20%	1%	40%	7%	3%	23%	9%

Adams Middle

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450732	Mon_Dutch_006	CM4	4/18/2023	2%	24%	45%	0%	33%	35%	0%	23%	42%	2%	40%	1%	0%	38%	5%	0%	18%	11%
2450732	Mon_Dutch_006	CM4	5/10/2023	1%	20%	46%	0%	15%	18%	0%	21%	26%	0%	29%	26%	1%	36%	6%	0%	14%	8%
2450732	Mon_Dutch_006	CM4	6/7/2023	2%	0%	38%	0%	21%	37%	0%	18%	49%	0%	30%	47%	1%	24%	39%	5%	11%	7%

Central

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450734	Mon_Dutch_007	CM5	4/6/2023	1%	8%	32%	0%	35%	43%	0%	47%	40%	0%	38%	47%	0%	48%	34%	4%	17%	13%
2450734	Mon_Dutch_007	CM5	5/11/2023	2%	4%	20%	0%	36%	16%	0%	49%	9%	0%	33%	44%	0%	49%	40%	4%	18%	11%
2450734	Mon_Dutch_007	CM5	6/8/2023	2%	15%	28%	0%	39%	32%	0%	46%	4%	0%	29%	29%	0%	48%	36%	6%	20%	12%

Focus Points

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450737	Mon_Dutch_009	CM6	4/5/2023!	3%	23%	36%	1%	36%	40%	0%	30%	34%	0%	2%	47%	0%	31%	39%	0%	17%	11%
2450737	Mon_Dutch_009	CM6	5/18/2023	2%	21%	39%	2%	37%	40%	0%	39%	46%	1%	25%	25%	0%	27%	40%	0%	7%	12%
2450737	Mon_Dutch_009	CM6	6/27/2023	2%	13%	41%	1%	40%	31%	0%	36%	38%	0%	25%	6%	0%	38%	16%	0%	15%	5%

Kearney

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450735	Mon_Dutch_008	CM7	4/19/2023	1%	23%	36%	1%	20%	21%	0%	18%	19%	0%	24%	14%	0%	11%	50%	0%	8%	18%
2450735	Mon_Dutch_008	CM7	5/23/2023	2%	7%	8%	1%	19%	30%	0%	25%	5%	0%	17%	34%	0%	16%	25%	1%	21%	19%
2450735	Mon_Dutch_008	CM7	6/22/2023	3%	11%	41%	1%	40%	42%	1%	27%	46%	5%	39%	35%	0%	6%	25%	0%	14%	22%

Monroe

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450731	Mon_Dutch_010	CM8	4/20/2023	0%	1%	38%	0%	0%	28%	0%	41%	36%	0%	5%	11%	0%	34%	47%	0%	12%	9%
2450731	Mon_Dutch_010	CM8	5/24/2023	0%	5%	4%	1%	22%	28%	0%	34%	27%	0%	9%	2%	0%	13%	47%	0%	21%	9%
2450731	Mon_Dutch_010	CM8	6/19/2023	4%	1%	36%	3%	32%	43%	0%	18%	11%	0%	46%	30%	0%	25%	34%	0%	22%	7%

48th and Race

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450736	Mon_Dutch_001	CM9	4/6/2023!	3%	27%	41%	1%	30%	37%	0%	17%	21%	0%	20%	12%	0%	30%	43%	0%	15%	11%
2450736	Mon_Dutch_001	CM9	5/30/2023	4%	1%	44%	0%	46%	16%	0%	27%	28%	0%	1%	27%	1%	49%	32%	0%	17%	3%
2450736	Mon_Dutch_001	CM9	6/28/2023	2%	13%	49%	0%	31%	47%	0%	41%	9%	0%	22%	2%	0%	38%	40%	5%	3%	18%

Alsop

				Validation Results Table																	
				CO Error			NO Error			NO2 Error			SO2 Error			H2S Error			VOC Error		
AQMesh Monitor Serial Number	Lunar Outpost Monitor Serial Number	Community Monitor Location	Validation Date	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<50%)	Span (<50%)	Zero (<10%)	Precision (<25%)	Span (<25%)
2450730	Mon_Dutch_009	CM10	4/26/2023	2%	17%	28%	0%	42%	36%	0%	43%	26%	0%	40%	25%	0%	34%	2%	0%	14%	15%
2450730	Mon_Dutch_009	CM10	5/31/2023	1%	24%	19%	0%	27%	32%	0%	43%	33%	0%	37%	1%	0%	28%	44%	0%	9%	2%
2450730	Mon_Dutch_009	CM10	6/30/2023	2%	47%	10%	0%	24%	28%	0%	40%	19%	0%	18%	26%	0%	39%	27%	5%	0%	6%

APPENDIX B FIELD DATA SHEETS

AQM Serial Number	831	831	831
Community Monitor Location	6	6	6
Date	4/18/2023	5/18/2023	6/19/2023
Operator	RK	RK	RK

Monthly Checks

SO2 bottle (psi)	400	300	200
H2S bottle (psi)	400	300	200
Gas Validation Checks (weekly, reviewed Monthly)	Pass	Pass	Pass

Quarterly Checks

Gas Inlet

Flow Rate	NA	NA	Pass
Filter Change	NA	NA	Pass
Field Calibration	NA	NA	Pass

Particulate Monitor

Flow Rate	NA	NA	Pass
Filter Change	NA	NA	Pass
Check for Leaks	NA	NA	Pass
Check Zero	NA	NA	Pass
Check laser and detector	NA	NA	Pass
Clean Cyclone	NA	NA	Pass

Notes:

AQM Serial Number	830	830	830
Community Monitor Location	7	7	7
Date	4/19/2023	5/23/2023	6/20/2023
Operator	RK	RK	RK

Monthly Checks

SO2 bottle (psi)	100	0 (replaced)	450
H2S bottle (psi)	350	250	100
Gas Validation Checks (weekly, reviewed Monthly)	Pass	Pass	Pass

Quarterly Checks

Gas Inlet

Flow Rate	NA	NA	Pass
Filter Change	NA	NA	Pass
Field Calibration	NA	NA	Pass

Particulate Monitor

Flow Rate	NA	NA	Pass
Filter Change	NA	NA	Pass
Check for Leaks	NA	NA	Pass
Check Zero	NA	NA	Pass
Check laser and detector	NA	NA	Pass
Clean Cyclone	NA	NA	Pass

Notes:

AQM Serial Number	829	829	829
Community Monitor Location	2	2	2
Date	4/13/2023	5/22/2023	6/23/2023
Operator	RK	RK	RK

Monthly Checks

SO2 bottle (psi)	350	275	150
H2S bottle (psi)	400	325	250
Gas Validation Checks (weekly, reviewed Monthly)	Pass	Pass	Pass

Quarterly Checks

Gas Inlet

Flow Rate	NA	NA	Pass
Filter Change	NA	NA	Pass
Field Calibration	Pass (per revised QAPP)	NA	Pass

Particulate Monitor

Flow Rate	NA	NA	Pass
Filter Change	NA	NA	Pass
Check for Leaks	NA	NA	Pass
Check Zero	NA	NA	Pass
Check laser and detector	NA	NA	Pass
Clean Cyclone	NA	NA	Pass

Notes:

APPENDIX C CALIBRATION GAS CERTIFICATION SHEETS



GASCO AFFILIATES, LLC.

320 Scarlet Blvd.
Oldsmar, FL 34677
(800) 910-0051
fax: (866) 755-8920
www.gascogas.com

CERTIFICATE OF ANALYSIS

Date: January 24, 2023
Order Number: 22070361
Lot Number: 304-402645914-1

Customer: Cal Gas Direct Inc.
Use Before: 01/24/2027

<u>Component</u>	<u>Requested Concentration</u>	<u>Analytical Result (+/- 2%)</u>
Carbon Monoxide	500 PPM	486 PPM
Air	Balance	Balance

Cylinder Size: 2.0 Cu. Ft.
Contents: 58 Liter

Valve: 5/8" -18UNF
Pressure: 500 psig

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/ or N.I.S.T. Gas Mixture reference materials.

Analyst:


Glenn Velez



GASCO AFFILIATES, LLC.

320 Scarlet Blvd.
Oldsmar, FL 34677
(800) 910-0051
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www.gascogas.com

CERTIFICATE OF ANALYSIS

Date: January 24, 2023
Order Number: 22070361
Lot Number: 304-402645915-1

Customer: Cal Gas Direct Inc.

Use Before: 01/24/2027

<u>Component</u>	<u>Requested Concentration</u>	<u>Analytical Result (+/- 2%)</u>
Isobutylene	200 PPM	208 PPM
Air	Balance	Balance

Cylinder Size: 2.0 Cu. Ft.
Contents: 58 Liter

Valve: 5/8" -18UNF
Pressure: 500 psig

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

Analyst:


Glenn Velez



GASCO AFFILIATES, LLC.

320 Scarlet Blvd.
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www.gascogas.com

CERTIFICATE OF ANALYSIS

Date: January 24, 2023
Order Number: 22070361
Lot Number: 304-402645912-1

Customer: Cal Gas Direct Inc.

Use Before: 01/24/2025

<u>Component</u>	<u>Requested Concentration</u>	<u>Analytical Result (+/- 2%)</u>
Hydrogen Sulfide	20 PPM	21.5 PPM
Air	Balance	Balance

Cylinder Size: 2.0 Cu. Ft.
Contents: 58 Liter

Valve: 5/8" -18UNF
Pressure: 500 psig

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

Analyst:

Glenn Velez



GASCO AFFILIATES, LLC.

320 Scarlet Blvd.
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fax: (866) 755-8920
www.gascogas.com

CERTIFICATE OF ANALYSIS

Date: January 24, 2023
Order Number: 22070361
Lot Number: 304-402650509-1

Customer: Cal Gas Direct Inc.
Use Before: 01/24/2025

<u>Component</u>	<u>Requested Concentration</u>	<u>Analytical Result (+/- 2%)</u>
Sulfur Dioxide	20 PPM	21.5 PPM
Nitrogen	Balance	Balance

Cylinder Size: 2.0 Cu. Ft.
Contents: 58 Liter

Valve: 5/8" -18UNF
Pressure: 500 psig

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/ or N.I.S.T. Gas Mixture reference materials.

Analyst:


Glenn Velez



GASCO AFFILIATES, LLC.

320 Scarlet Blvd.
Oldsmar, FL 34677
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CERTIFICATE OF ANALYSIS

Date: January 9, 2023
Order Number: 22069817
Lot Number: 304-402636244-1

Customer: Cal Gas Direct Inc.

Use Before: 01/09/2024

<u>Component</u>	<u>Requested Concentration</u>	<u>Analytical Result (+/- 2%)</u>
Nitric Oxide	100 PPM	99.2 PPM
Nitrogen	Balance	Balance

Cylinder Size: 2.0 Cu. Ft.
Contents: 58 Liter

Valve: 5/8" -18UNF
Pressure: 500 psig

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

Analyst:


Glenn Velez

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