

# RIDER 7 OZONE TASK: ANALYSIS OF O<sub>3</sub> DATA MEASURED IN HOOD COUNTY



November 2025







**Prepared for:**  
**Texas Commission on Environmental Quality**

Jeremy Johnson  
Texas A&M Transportation Institute

Michelle McKenzie  
Hood County Clean Air Coalition

Daniela Tower  
North Central Texas Council of Governments

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# 1. Introduction

Under the Clean Air Act, the United States Environmental Protection Agency (US EPA) oversees setting the National Ambient Air Quality Standards (NAAQS) for six specific pollutants to protect public health as well as the environment. The standards set a level for each pollutant that, if an area goes over that level, it is classified as non-attainment for the specific pollutant. Once an area is designated as non-attainment, they must develop plans and put actions in place to improve the air quality in the area to get the levels under the NAAQS target.

Currently, while not designated as non-attainment, Hood County is approaching levels that would put it in the non-attainment designation area for Ozone ( $O_3$ ). Critical strategies to assist in improving air quality include air quality monitoring and emissions reduction strategies, which will assist Hood County in improving air quality and maintaining the current attainment status. The regulatory monitor that is in Hood County is the Continuous Air Monitoring System (CAMS 073), shown in Exhibit 1, has shown increasing ozone concentration values beginning around 2022.

Exhibit 1 EPA Monitoring Site in Granbury<sup>1</sup>



If the current  $O_3$  levels measured at the CAMS 073 site do not improve, Hood County is in danger of failing to meet the 2015 standards, as well as the 2008 standards, and becoming classified as non-attainment. A non-attainment designation would have regulatory and subsequently economic impacts, in addition to potential health and environmental consequences due to higher pollutant concentrations. The goal of this study is to install monitors at strategic locations around Hood County that will measure  $O_3$  levels. This data will be used to better understand the regional ozone

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<sup>1</sup> Image from Texas Commission on Environmental Quality,  
[https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=report.view\\_site&siteID=96](https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=report.view_site&siteID=96)

levels, characterize how specific point sources impact the O<sub>3</sub> pollution levels, and track the spatial distribution of ground-level O<sub>3</sub> in the region.

This project was a collaboration with multiple agencies contributing to the project under the Rider 7 Ozone grant. Members of the project included the Texas A&M Transportation Institute (TTI), the North Central Texas Council of Governments (NCTCOG) and the Hood County Clean Air Coalition (HCCAC).

## 2. Project Overview

To meet the overall goals the project was conducted in three major tasks, described in the following section.

### 2.1 SITE SELECTION

To collect the data required for the project the research team first needed to determine the locations that would be used for the monitoring sites. A total of five sites were identified as locations where the monitors would be installed for this project. An approximate location was selected with the goal of creating a network of locations that surrounded the CAMS 073 site in all wind directions. The fifth site was selected for its proximity to the Wolf Hollow Power Plant (Wolf Hollow), one of the highest sources of emissions in the past years in the area.

After determining the general layout for the sites, NCTCOG and the HCCAC began identifying specific locations for the installations. Sites were selected based on a range of criteria<sup>2</sup>, including the location relative to the layout of all five sites and the following criteria:

- Access to 110-volt AC Power
- Security
- Accessibility
- Geographic location
- Proximity to major transportation corridors
- Relation to area wind patterns

Once the location was confirmed, the placement of each monitor was determined based on the criteria below:

- Samplers should be separated from any obstruction, such as buildings at least twice the height that the obstruction protrudes above the sampling inlet.
- Monitors should be placed at an adequate distance from roadways<sup>3</sup>.
- Inlet probes should be placed at least 20 meters from the drip line of trees to minimize interferences. Large trees or stands of trees should be treated as large obstructions (e.g., as

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<sup>2</sup> [A Guide to Siting and Installing Air Sensors | US EPA](#)

<sup>3</sup> For roads with 10,000 or less vehicles per day, monitors should be at least 10 meters away from the roadway; for roads with 10,000 to 15,000 vehicles per day, monitors must be at least 20 meters from the roadway; for roads with 15,000 to 20,000 vehicles per day, monitors must be at least 30 meters away; for roads with 20,000 to 40,000 vehicles per day, monitors should be at least 50 meters from the roadway; for roads with 40,000 to 70,000 vehicles per day, monitors should be at least 100 meters from the roadway; and for roads with 70,000 vehicles per day or more, monitors should be sited at least 250 meters away from the roadway.

buildings). However, the probe must not be located less than 10 meters from the drip line of such trees treated as obstructions.

The following five sites were selected for monitor installation:

1. Northern Site: The northern site is located on a ranch on Tin Top Highway near the northern Hood County line.

**Exhibit 2 Installation of Monitors at Northern Site**



2. Western Site: The western site is located on a private driveway on Colony Road just outside of Tolar Texas.

**Exhibit 3 Installation of Monitor at Western Site**



3. Eastern Site: The eastern site is located at a community center in Acton Texas, just east of Granbury.

**Exhibit 4 Installation of Monitor at Eastern Site**



4. Southern Site: The southern site is located near the Wheeler Branch Reservoir in Somervell County.

**Exhibit 5 Installation of Monitor at Southern Site**



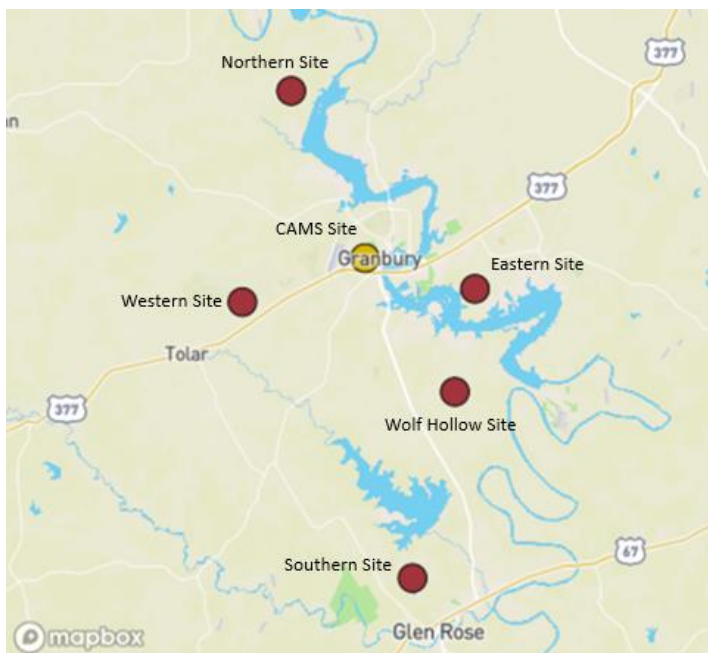
5. Wolf Hollow Site: The Wolf Hollow site is located at a private residence on Contrary Creek Road in Granbury Texas.

**Exhibit 6 Installation of Monitor at Wolf Hollow Site**



The Eastern, Southern, and Wolf Hollow Site had to be mounted to existing buildings due to space or mounting restrictions. Exhibit 7 shows the locations of the sites that were selected. The CAMS 073 site is the yellow site in the center of Granbury; the five sites selected for this study are shown in red.

**Exhibit 7 Sites for Monitor Installation**



## 2.2 MONITORING EQUIPMENT

Once the sites were selected the team began procuring the monitors that would be used for the study. Since the focus of the study was O<sub>3</sub>, the monitors selected for data collection were required to be EPA monitors on the designated Federal Equivalent Methods (FEM) list as of June 2024. The monitors also had to meet other criteria, such as the availability for remote logging of data to a cloud-based service, and they should also be capable of running off solar powered batteries in the event a site did not have power available. In addition to the FEM O<sub>3</sub> monitors, each site would also have a weather station installed on site. The project was also able to install non-regulatory monitors that measured particulate matter (PM<sub>2.5</sub>) and Nitrogen Dioxide (NO<sub>2</sub>) at four of the five selected sites. The non-regulatory monitors were used for reference only since they were not FEM quality devices.

### 2.2.1 O<sub>3</sub> Monitors

The O<sub>3</sub> monitors selected for this study are the AQLite monitors from 2B Technologies. The AQLite monitors use the FEM approved OEM-108-L (4) ozone monitors for measurements. The AQLite uses UV absorption at 254 nm to measure concentrations in the 0-500 parts per billion (ppb) range. The

Exhibit 8 AQLite O<sub>3</sub> Monitor



AQLite automatically uploads the data to the 2B Technologies data portal in near real time (~ every 5 minutes). Exhibit 8 shows the AQLite monitor on a tripod in the field (top) and the internal parts of the unit (bottom).

### 2.2.2 Non-Regulatory Monitors

The non-regulatory monitors selected for this project are the AQY-R from Aeroqual. The AQY-R units measure three different pollutants, O<sub>3</sub>, NO<sub>2</sub> and PM<sub>2.5</sub>. The AQY-R units were installed at four of the five projects sites. The western location will not get an AQY-R monitor due to availability of the AQY-R units. Prior to being installed in the field the units were calibrated using the co-location method at a TCEQ reference site located in Dallas Texas. Exhibit 9 shows an AQY-R unit.

Exhibit 9 Aeroqual AQY-R Unit<sup>5</sup>



### 2.2.3 Weather Stations

The weather stations used for the project were ATMOS 41W units from Meter Group. The 41W measures weather data including temperature, wind speed, wind direction, total precipitation, and solar radiation. The unit is powered by integrated solar panels that do not require any additional power source. Exhibit 10 shows an ATMOS 41W weather station.

Exhibit 10 ATMOS 41W Weather Station



### 3. Data Collection and Analysis

#### 3.1 DATA COLLECTION

Data collection efforts began when the monitors were installed the week of February 3, 2025. Each of the monitors that were used for this project can send data to a cloud-based data service using cellular connections. This allowed for the data to be retrieved in real time for the duration of the project. This not only allowed for easy retrieval of the data but also allowed for monitors to be checked for problems, such as the loss of power, on a regular basis.

Since each of the monitors was sending data to a different cloud-based database, it was important to bring all the data together in one place for analysis. The research team developed and implemented a function application within Microsoft Azure that utilized the API capabilities of each instrument to retrieve all the data from the respective cloud applications and put the data into a single SQL Server database. Using the application the data was retrieved from each instrument every 15 minutes for the duration of the project.

#### Data Validation

Each of the AQLite and ATMOS 41W instruments were calibrated by the manufacturer before the beginning of the project. All units were calibrated in January 2025, just prior to the field installation, and the calibrations were good, following the manufacturers recommendation, for the duration of the project (January 2026 for the AQLite and January 2027 for the ATMOS 41W). The AQY-R units were calibrated by the manufacturer but were also calibrated by the research team using the co-location method. The co-location calibration was conducted at the Dallas Hinton Street TCEQ monitor in Dallas Texas (CAMS: 0401) in January 2025. Each of the four AQY-R units were placed at the Hinton site where regulatory monitors collect data.<sup>6</sup> The data sets were then compared to each

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<sup>6</sup> Information from the TCEQ, Dec 9, 2025: In January 2025 the continuous PM<sub>2.5</sub> FEM monitor was a Teledyne T640X. Teledyne and EPA have reported that during evaluation of collocated FRM data comparability over the past several years, the T640/x instruments have demonstrated a consistent positive bias relative to the FRM sampler data. EPA approved correction factors

other, and new calibration factors were calculated and used for each of the pollutants. This is all done using the Aeroqual cloud-based system where the new calibration factors can be entered. Graphs for each of the calibrations are included in Appendix A.

Throughout the duration of the project the research team implemented data validation checks on the AQLite monitors in the field. This was done approximately once every 6 weeks. The calibration was conducted using zero filters to check the zero measurement and the Model 306 Ozone Calibrator from 2B Technologies. Exhibit 11 shows a Model 306 Ozone Calibrator that was used for the project.

**Exhibit 11 Model 306 Ozone Calibrator**



During the first field calibration of the units the research team discovered a bug in the AQLite software that reported data to the cloud. When the AQLite is being manually zeroed, the monitor correctly reads and reports the data as 0 to the cloud. The AQLite devices read the O<sub>3</sub> levels in real time, approximately every second. These real time readings are shown on a small LED screen inside the device, or they can be seen by directly connecting a computer, via a USB port, to the AQLite. During the first calibration, the Model 306 Ozone Calibrator was set to a value of 450 ppb and applied to the AQLite. Upon connection, it was discovered that the LED screen would freeze at a number below the target value of 450, reading approximately 230 ppb. When this occurred, the team called 2B Technologies to troubleshoot. During this session, a laptop was connected to the device and the real time data was visually checked via the USB connection. The live data showed that the AQLite was measuring the concentration levels correctly around 450 ppb, but was not accurately reported on the LED screen, or to the cloud. The lower values of ~230 were being sent to the cloud.

By watching the data live, the research team was able to see that the device was measuring correctly, but it was not reporting accurately. The team worked with 2B Technologies to assist in trouble shooting the problem. Eventually it was determined that a firmware update was needed to correct the communications problem with the data. This fix could not be implemented for this project, so the team manually did the calibration checks for all devices for this project. The problem

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were applied to the T640X data, but TCEQ has observed a consistent positive bias at the Dallas Hinton site when the monitor is operated under FEM conditions.

The authors of this report have been made aware of this potential bias when evaluating PM<sub>2.5</sub> data.

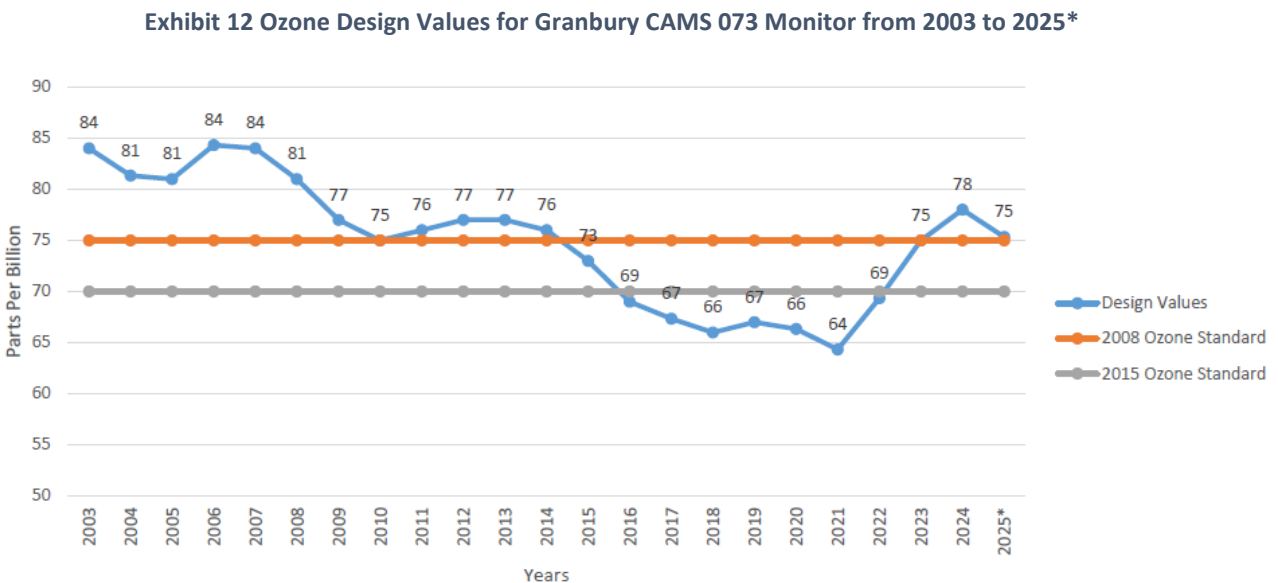
only occurred when the device was being calibrated, it did not have an impact on ambient data being collected during the project period.

### Data Collection Period

As previously discussed, the instruments were installed at their selected locations the week of February 3, 2025. The data used in this analysis covers the period from February 3, 2025, through September 1, 2025. As for the writing of this report, data collection is still on-going. Data collected during the reporting period but not included in the analysis can be made available upon request.

## 3.2 AIR QUALITY DATA ANALYSIS

Hood County has made continuous improvements to the air quality since the start of producing a valid Ozone Design Value in 2003. While there have been upticks in the design value in 2006 and 2012, the overall trend showed improving ozone pollution and led to meeting federal air quality standards for both the 2008 and 2015 Standards between 2016 and 2022, when the design value started to rise again. Between 2023 and 2025 (preliminary data for 2025) the design value resided between 75 and 78 ppb, bringing the county into measured non-attainment with the 2015 standard and scratching at the 2008 standard. Current developments, which include permitting additional power plants and data centers will bring activity into the county that could further lead to a decrease in future air quality (Exhibit 12).



Source: TCEQ, \*data from 2025 not yet validated

Exhibit 13 shows an overview of the four highest values at the end of the ozone season between 2010 and 2025, as well as the number of exceedance days in the respective calendar year as of November 30, 2025.

Exhibit 13 Fourth Highest Maximum Ozone Values and Exceedance Days in Hood County

Year	Number of Exceedance Days	First Max	Second Max	Third Max	Fourth Max
2025*	4	77	76	73	71
2024	6	87	83	77	76
2023	11	83	79	79	79
2022	10	85	84	83	81
2021	1	77	68	66	65
2020	0	70	65	63	62
2019	1	80	67	67	66
2018	5	80	78	74	71
2017	3	81	72	71	66
2016	1	80	63	63	63
2015	2	86	80	75	73
2014	2	91	87	74	73
2013	3	93	83	78	75
2012	8	82	80	80	80
2011	4	82	80	77	76
2010	4	80	80	79	77

\*not yet validated

Exhibit 14 Number of Exceedance Days at the Granbury Monitor CAMS 073

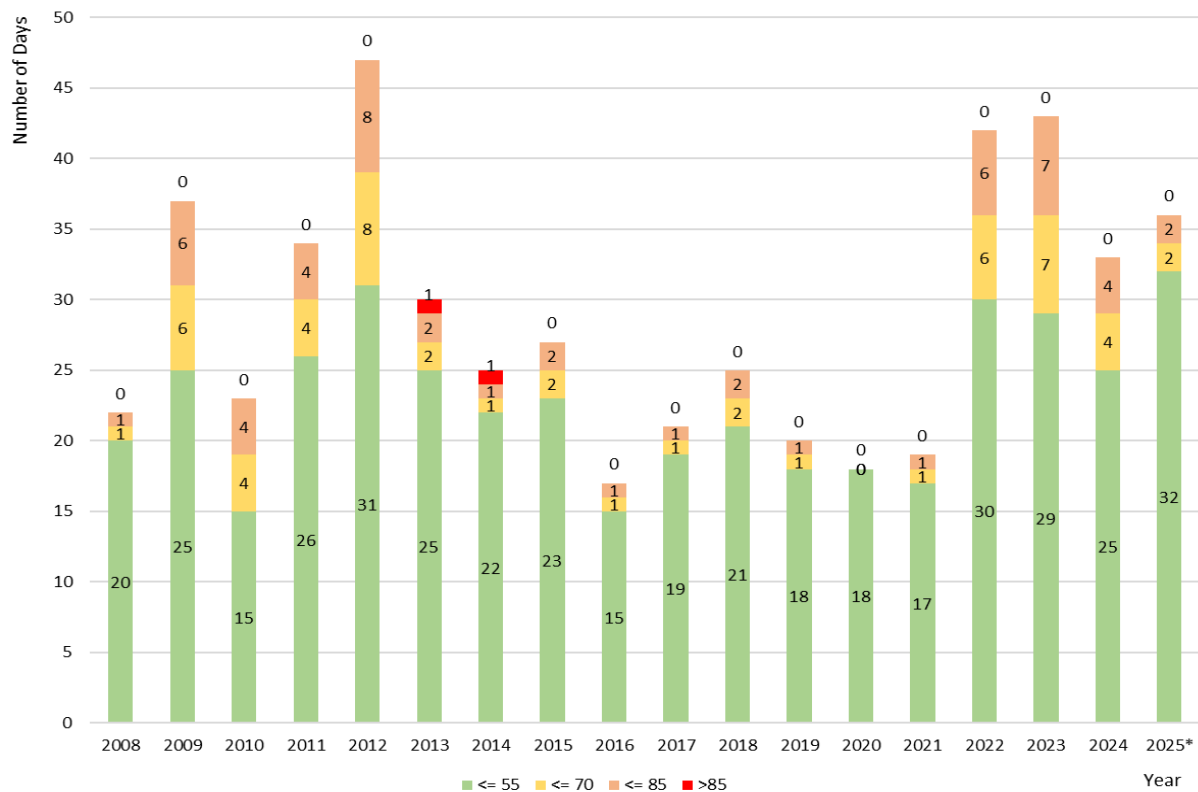
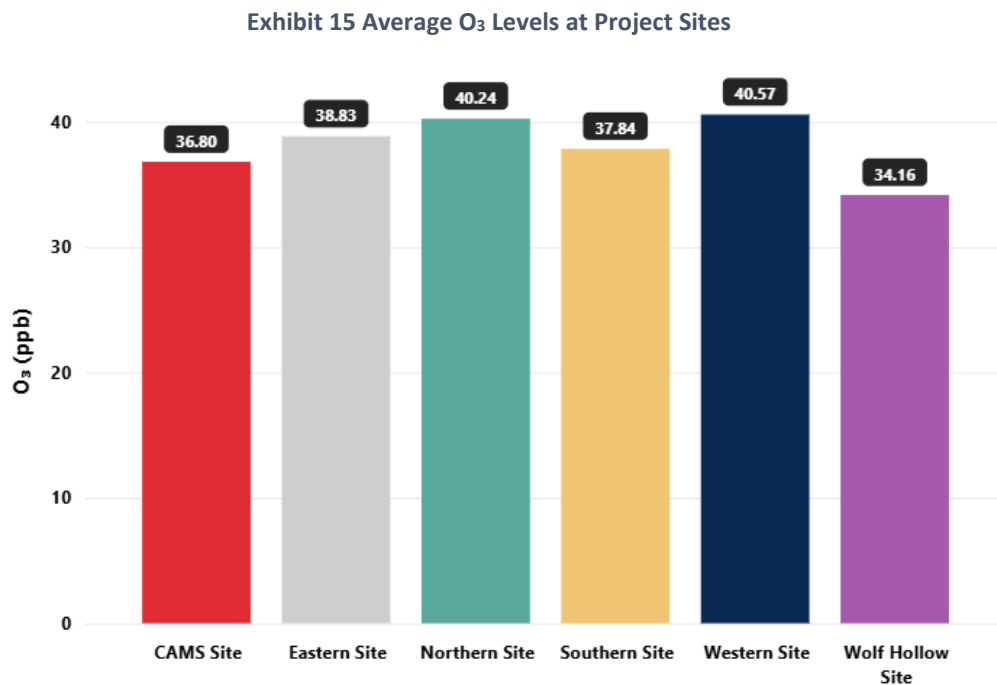


Exhibit 14 shows the number of exceedance days recorded between 2008 and 2025, with an overall decreasing trend in the days with high ozone values until 2022, when these days increased significantly and seem to stabilize on a higher level between 2022 and 2025.

Exhibit 15 shows the average O<sub>3</sub> levels measured during the project. The data included in the table below is the hourly readings taken from each site but only includes data when all six sites (five project sites and the CAMS 073 site) reported data. During the duration of the project, sites would periodically lose data due to issues such as power outages, dead batteries, or instrumentation issues. During these times the data from each of other sites was still used in the site-specific analysis but are not included in the overall comparison.



The data shows that on average the O<sub>3</sub> levels were slightly higher at each site compared to the CAMS 073 site, except for the Wolf Hollow site, which was the only site with lower O<sub>3</sub> levels. More detailed information is included in Exhibit 16.

**Exhibit 16 O<sub>3</sub> Statistics from Project Sites**

Site	Average O <sub>3</sub> (ppb)	Max O <sub>3</sub> (ppb)	Standard Deviation O <sub>3</sub> (ppb)
CAMS 73	36.93	93	14.51
Eastern Site	38.97	113.45	13.60
Wolf Hollow Site	34.28	109.92	15.21
Northern Site	40.40	90.54	13.19
Southern Site	37.95	137.51	15.14

Western Site	40.69	95.57	13.88
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Data from the non-regulatory AQY-R monitors also collected PM<sub>2.5</sub> and NO<sub>2</sub> data at four of the five project sites (the Western Site did not have an AQY-R installed). Additionally, the CAMS 073 site only reported O<sub>3</sub> data, therefore the PM<sub>2.5</sub> and NO<sub>2</sub> data cannot be compared to the CAMS data. Exhibit 17 shows the average PM<sub>2.5</sub> readings at 3 sites with an AQY-R monitor and Exhibit 18 shows the NO<sub>2</sub> readings. The PM sensors at the Northern Site had multiple failures during the study and are not being used in the analysis. Unlike the O<sub>3</sub> readings, where the data was relatively similar at each of the sites, the Eastern site saw elevated levels of both PM<sub>2.5</sub> compared to the other sites, and the Northern site had elevated NO<sub>2</sub> levels.

**Exhibit 17 Average PM<sub>2.5</sub> Levels at Project Sites**

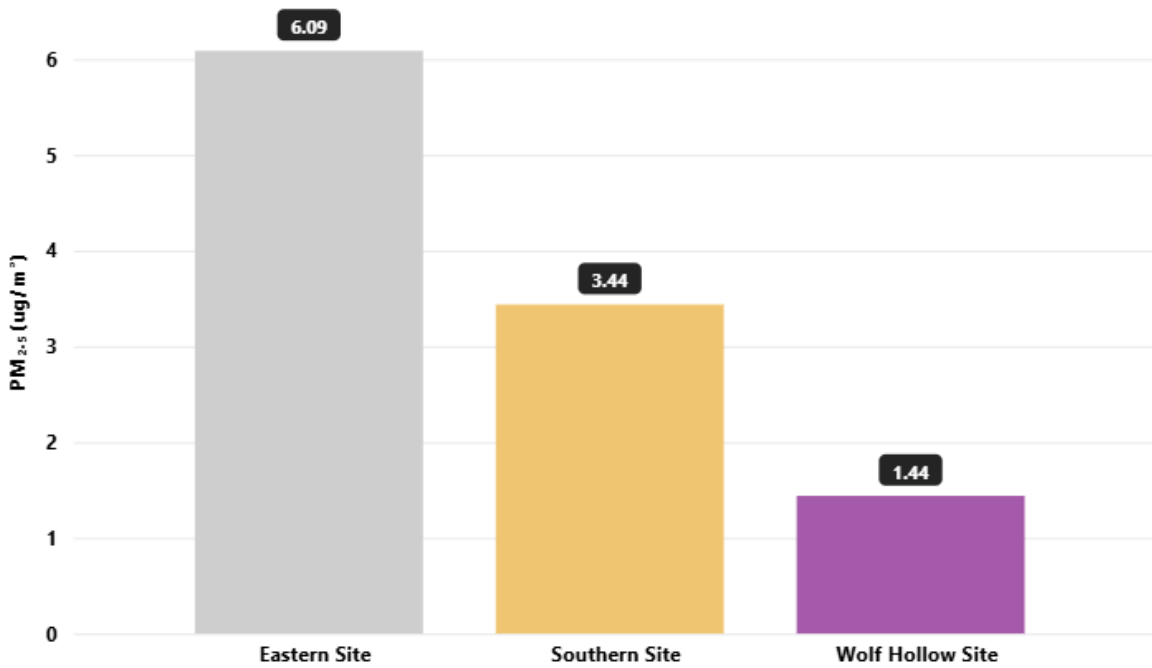


Exhibit 18 Average NO<sub>2</sub> Levels at Project Sites

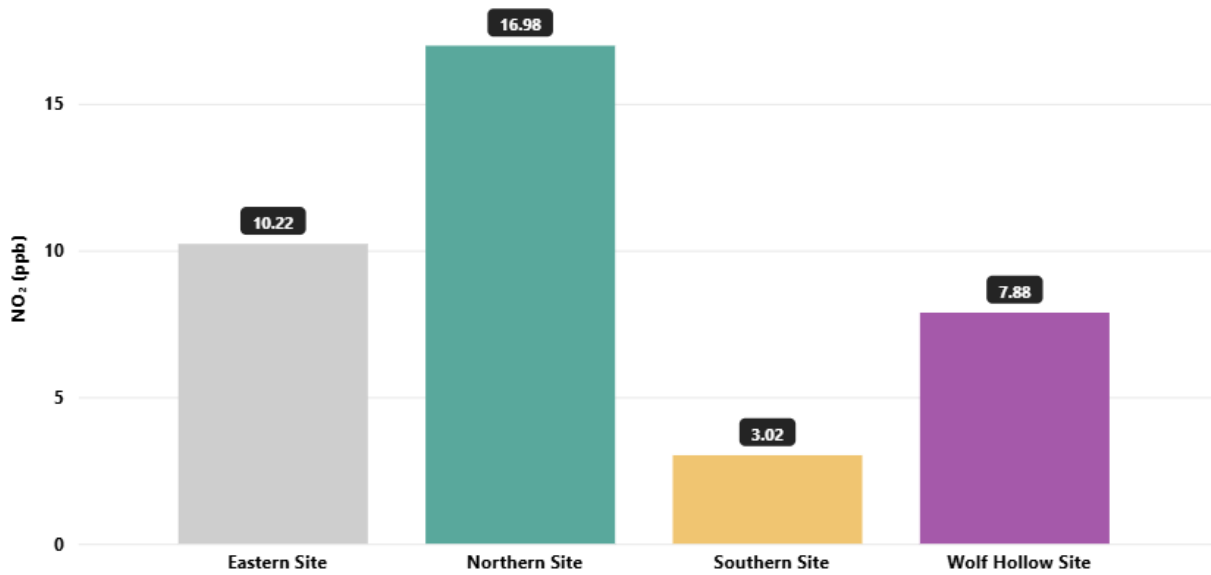


Exhibit 19 PM<sub>2.5</sub> Statistics from Project Sites\*

Site	Average PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Max PM <sub>2.5</sub> (µg/m <sup>3</sup> )	Standard Deviation PM <sub>2.5</sub> (µg/m <sup>3</sup> )
Eastern Site	6.09	153.95	13.84
Wolf Hollow Site	1.44	47.07	3.2
Southern Site	3.43	69.65	6.11

\*The PM<sub>2.5</sub> data from the Southern Site showed flawed readings and was removed from the analysis.

Exhibit 20 NO<sub>2</sub> Statistics from Project Sites

Site	Average NO <sub>2</sub> (ppb)	Max NO <sub>2</sub> (ppb)	Standard Deviation NO <sub>2</sub> (ppb)
Eastern Site	10.22	60.71	4.19
Wolf Hollow Site	7.87	38.96	4.27
Northern Site	16.99	47.60	9.08
Southern Site	3.02	30.8	3.37

Another way to compare the air quality at each of the sites is using the Air Quality Index (AQI) from the U.S. EPA. The AQI was created by the EPA to communicate information about outdoor air quality and health to the public, in a manner that is easy to understand. The AQI has 6 categories of AQI values, ranging from “Good” to “Hazardous”, each represented by a different color. The AQI

can be calculated for any pollutant using the EPA guidelines for calculating the values. Exhibit 21<sup>7</sup> shows the different AQI values, the label of each value, and the description of the air quality for each given category.

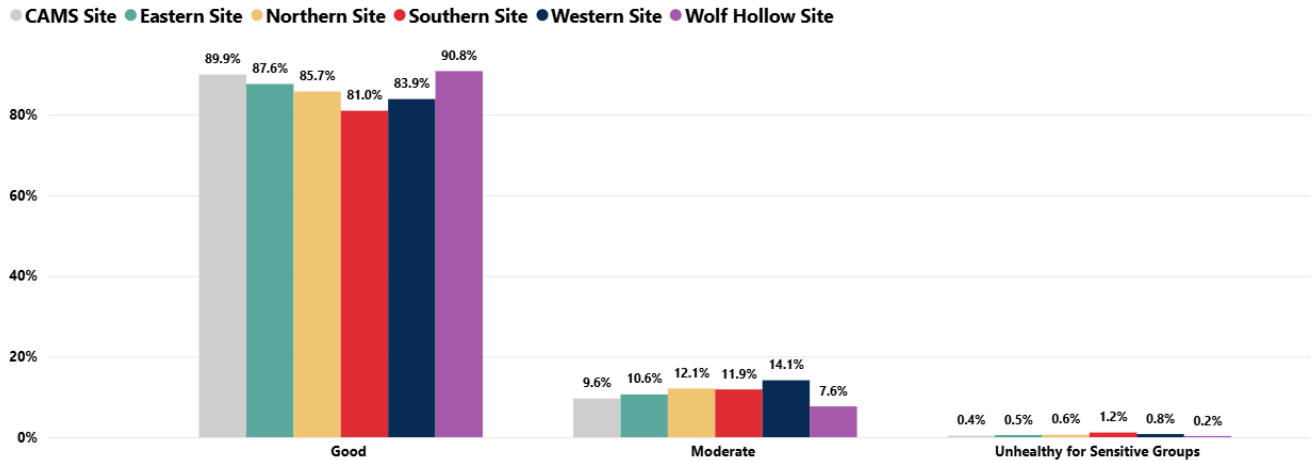
Exhibit 21 AQI Values

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

For O<sub>3</sub>, the AQI is calculated based on 8-hour averages values. Exhibit 22 shows the total percentages that each site was in the AQI categories. Each site was in the “Good” air quality category for at least 81% of the time. The western site had the highest average O<sub>3</sub> and the highest number of readings outside of “Good”, with 14.1% being in the “Moderate” category and 0.8% being in the “Unhealthy for Sensitive Groups” category. The Southern site had the highest days in the “Unhealthy for Sensitive Groups” data at 1.2%. No data was measured at any site that fell above an AQI of 147. Not included in the graph were days when there was no data available.

<sup>7</sup> AQI Image from AirNow.gov, <https://www.airnow.gov/aqi/aqi-basics/>

Exhibit 22 AQI Percentages for O<sub>3</sub> Data



### 3.3 SITE ANALYSIS

The following section outlines the site-specific data collected during this project. The data includes all data collected at each site, even if other sites were missing data.

The data was analyzed for the February 3<sup>rd</sup>, 2025 – September 1<sup>st</sup>, 2025, but also by day of the week (Monday-Sunday) as well as the time-of-day. For the time-of-day analysis the data was separated into five distinct time periods (using local times), capturing peak AM and PM traffic periods and arranging the other times around them:

- Morning: 6:00 AM – 9:00 AM
- Midday: 9:01 AM – 12:00 PM
- Afternoon: 12:01 PM – 3:00 PM
- Evening: 3:01 PM – 7:00 PM
- Overnight: 7:01 PM – 6:00 AM

#### 3.3.1 Northern Site

The northern site selected for this project is located on Tin Top Highway approximately five miles north of the CAMS 073 site. The site had an AQLite installed measuring O<sub>3</sub> as well as an AQY-R that measured O<sub>3</sub>, PM<sub>2.5</sub>, and NO<sub>2</sub>. During the project the PM<sub>2.5</sub> sensors for the AQY-R had multiple malfunctions and incorrect readings, and therefore that data is not included in this report. Exhibit 23 shows the summary of the data measured at the northern site.

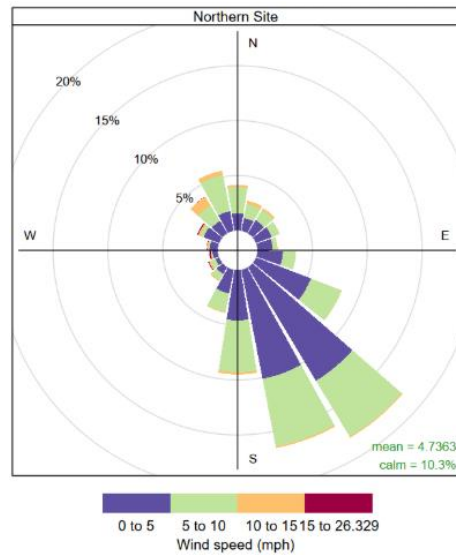
Time series plots of pollutants for all stations can be found in Appendix A.

Exhibit 23 Summary of Northern Site Air Quality Data

Pollutant	Average	Max	Standard Deviation	FEM Data
1-Hour O <sub>3</sub> (ppb)	35.22	90.54	13.12	Yes
8-Hour O <sub>3</sub> (ppb)	35.30	81.25	11.9	Yes
1-Hour NO <sub>2</sub> (ppb)	17.14	47.97	10.85	No
1-Hour Wind Speed (mph)	4.74	26.33	2.61	NA

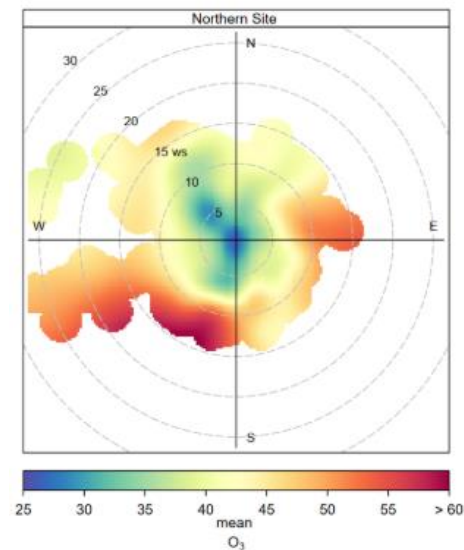
Exhibit 24 shows a wind rose plot for the northern site. The winds were predominantly out of the southeast between 0-10 miles per hour (mph), with an overall average of 4.74 mph.

**Exhibit 24 Wind Rose for Northern Site**



While the wind was generally out of the southeast, the highest O<sub>3</sub> measurements came when the winds were out of the southwest and east, seen in Exhibit 25.

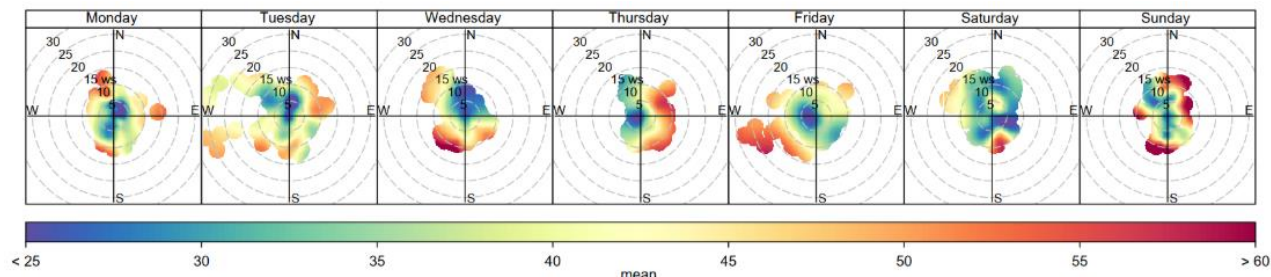
**Exhibit 25 Average O<sub>3</sub> by Wind Speed and Direction at Northern Site**



The data was also analyzed by the day of the week (Exhibit 26) and the time of day (Exhibit 27). Most of the days at the northern site had similar trends for the O<sub>3</sub> based on wind speed and direction, with the highest levels being measured from the south/southwest. However, the data from Thursday showed much higher readings coming from the east, and Sunday showing some very high readings with winds coming out of the northeast. The higher readings on these two weekdays

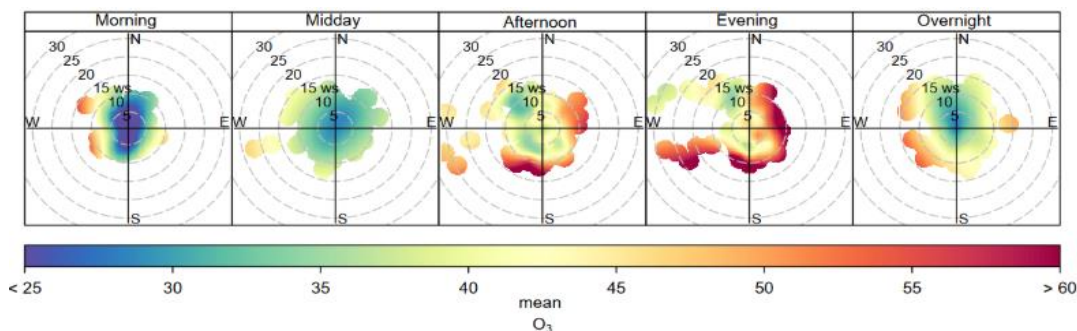
currently have no clear explanation. No regular activities are scheduled at the site. A potential reason could be increased recreational activity on the Brazos River and Lake Granbury could contribute.

**Exhibit 26 Average O<sub>3</sub> by Wind Speed and Direction by Day of the Week at Northern Site**



The time of day when the northern site had the highest readings were in afternoon (41.55 ppb) and evening (45.69 ppb) time periods. During the rest of the day the readings were generally below 32 ppb. The northern site did have the highest overnight average readings at 34.29 ppb.

**Exhibit 27 Average O<sub>3</sub> by Wind Speed and Direction by Time of the Day at Northern Site**



### 3.3.2 Eastern Site

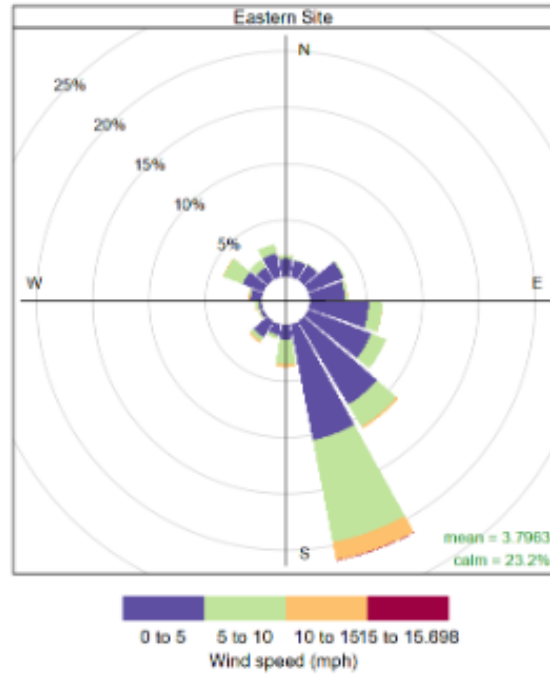
The eastern site selected for this project is located almost 4.5 miles East/Southeast of the CAMS 073 site at a community center. The eastern site had an AQLite installed measuring O<sub>3</sub> as well as an AQY-R that measured O<sub>3</sub>, PM<sub>2.5</sub>, and NO<sub>2</sub>. Exhibit 28 shows the summary of the data measured at the eastern site.

**Exhibit 28 Summary of Eastern Site Air Quality Data**

Pollutant	Average	Max	Standard Deviation	FEM Data
1-Hour O <sub>3</sub> (ppb)	34.94	113.45	14.06	Yes
8-Hour O <sub>3</sub> (ppb)	34.98	78.95	12.55	Yes
1-Hour NO <sub>2</sub> (ppb)	9.65	60.71	4.17	No
1-Hour PM <sub>2.5</sub> (µg/m <sup>3</sup> )	6.38	153.95	13.79	No
1-Hour Wind Speed (mph)	3.8	15.7	2.41	NA

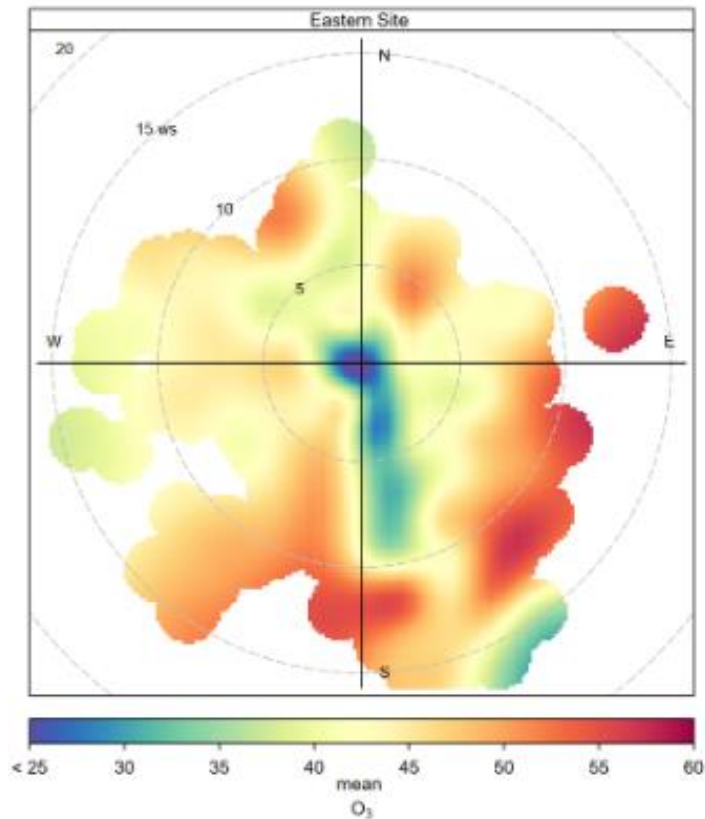
Exhibit 29 shows a wind rose plot for the eastern site. The winds were predominantly out of the south/southeast between 0-10 mph, with an overall average of 3.79 mph.

Exhibit 29 Wind Rose for Eastern Site



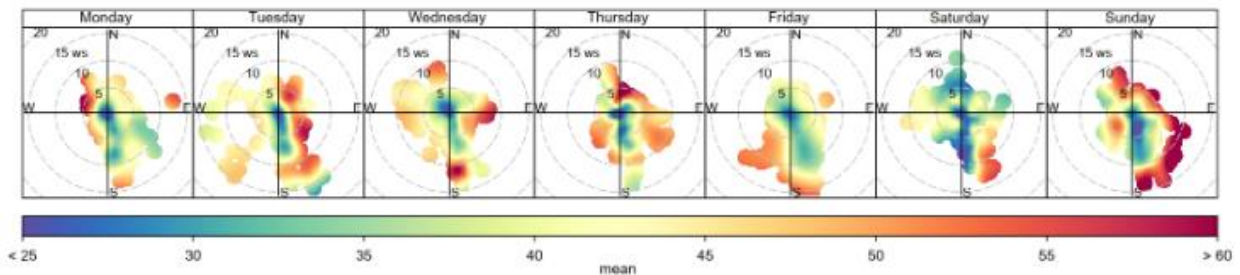
The highest O<sub>3</sub> measurements came when the winds were due south as well as coming from the southeast, seen in Exhibit 30.

Exhibit 30 Average O<sub>3</sub> by Wind Speed and Direction at Eastern Site



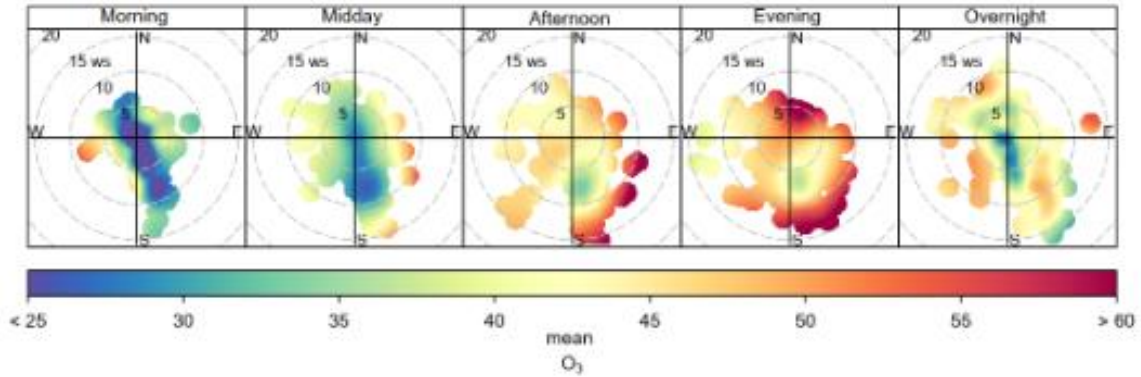
The data was also analyzed by the day of the week (Exhibit 30) and the time of day (Exhibit 31). Most of the days at the eastern site had similar trends for the O<sub>3</sub> based on wind speed and direction, with the highest levels being measured from the south/southwest. However, the data from Thursday showed higher readings with wind coming from the north, Sunday showing higher readings with winds coming out of the northeast, and Mondays with elevated readings with western winds.

Exhibit 31 Average O<sub>3</sub> by Wind Speed and Direction by Day of the Week at Eastern Site



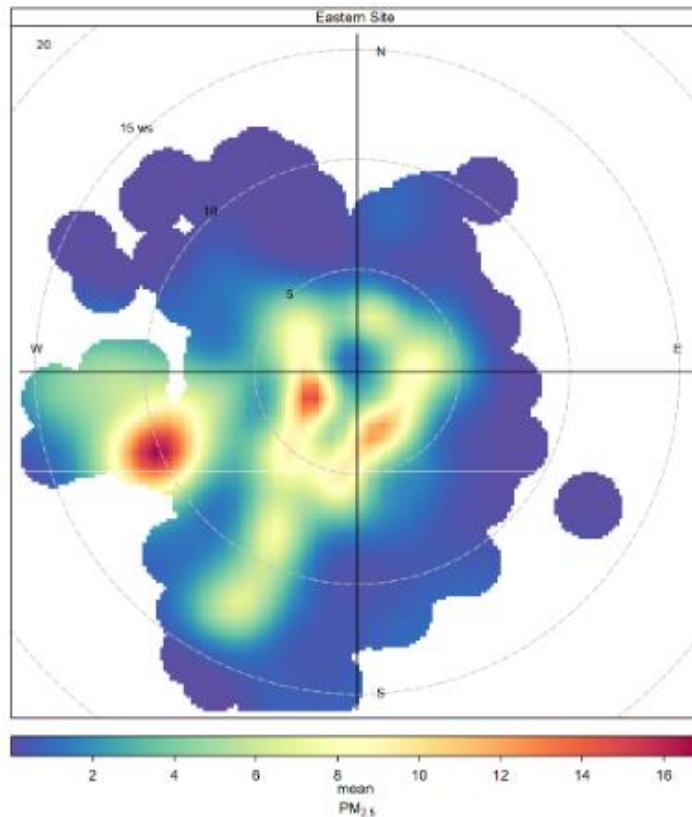
The time of day when the eastern site had the highest readings were in afternoon (42.29 ppb) and evening (47.02 ppb) time periods. During the rest of the day the readings were generally below 32 ppb.

Exhibit 32 Average O<sub>3</sub> by Wind Speed and Direction by Time of the Day at Eastern Site



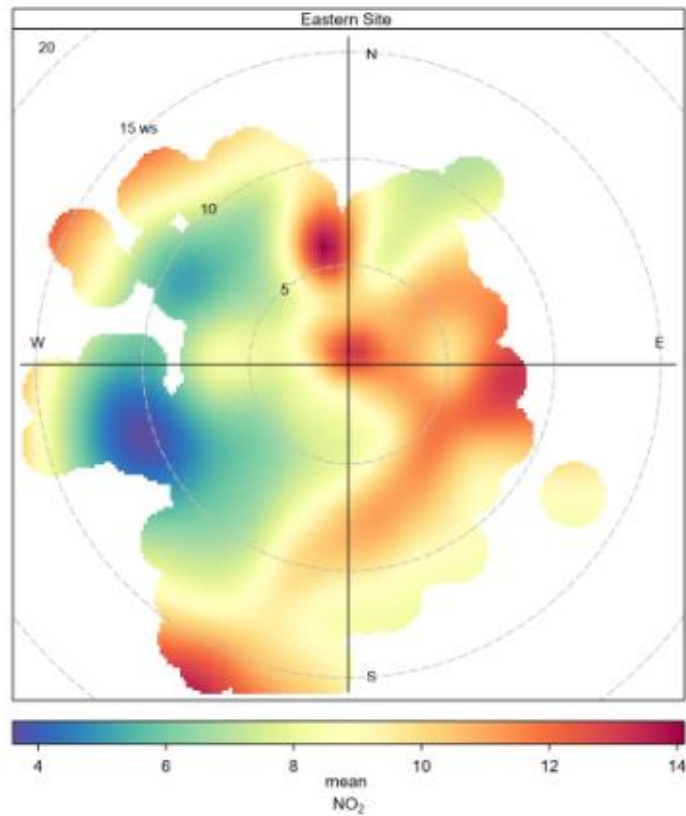
While the O<sub>3</sub> measurements at the eastern site were higher with southern winds, the PM<sub>2.5</sub> data saw the highest concentrations with winds out of the West around 10 mph, shown in Exhibit 33.

Exhibit 33 Average PM<sub>2.5</sub> by Wind Speed and Direction at Eastern Site



The NO<sub>2</sub> data (Exhibit 34) from the eastern site was similar to the O<sub>3</sub> data (Exhibit 30) with the higher readings coming with eastern and southern winds. However, the NO<sub>2</sub> readings were also higher at the site with calm winds, or winds out of the north between 5-10 mph.

**Exhibit 34 Average NO<sub>2</sub> by Wind Speed and Direction at Eastern Site**



**3.3.3 Southern Site**

The southern site selected for this project is located the furthest from the CAMS 073 site, approximately 12.5 miles South near the Wheeler Branch Reservoir. The location had an AQLite installed measuring O<sub>3</sub> as well as an AQY-R that measured O<sub>3</sub>, PM<sub>2.5</sub>, and NO<sub>2</sub>. Exhibit 35 shows the summary of the data measured at the location.

**Exhibit 35 Summary of Southern Site Air Quality Data**

Pollutant	Average	Max	Standard Deviation
1-Hour O <sub>3</sub> (ppb)	35.55	137.51	15.01
8-Hour O <sub>3</sub> (ppb)	35.63	81.88	13.44
1-Hour NO <sub>2</sub> (ppb)	2.96	30.80	3.98
1-Hour PM <sub>2.5</sub> (µg/m <sup>3</sup> )	3.96	229.64	8.13
1-Hour Wind Speed (mph)	1.66	8.51	1.025

Exhibit 36 shows a wind rose plot for the southern site. The winds were predominantly out of the south/southeast between 0-5 mph, with an overall average of just 1.66 mph. The southern location was surrounded by trees, which likely contributed to the lower wind speeds measured at the site compared to the other monitoring locations. The highest O<sub>3</sub> measurements came when the winds were due south as well as coming from the east, seen in Exhibit 37.

Exhibit 36 Wind Rose for Southern Site

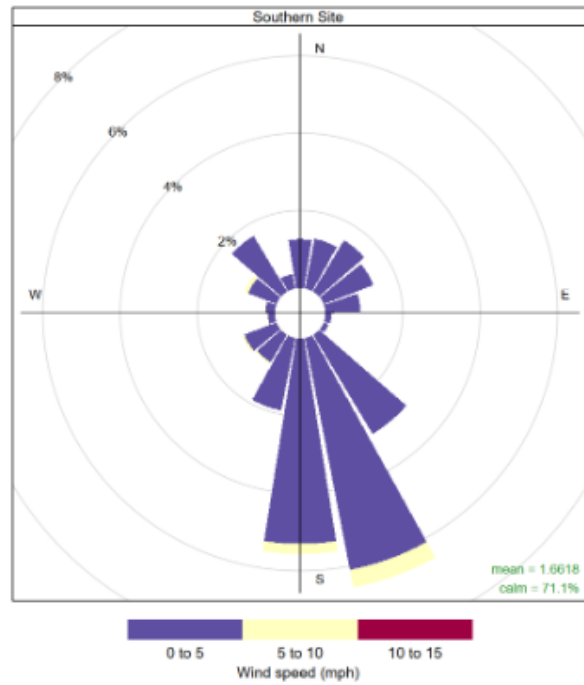
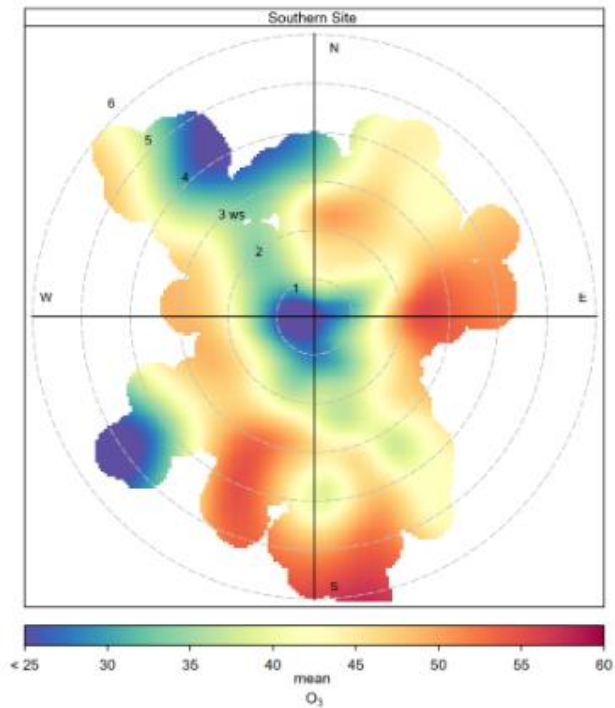


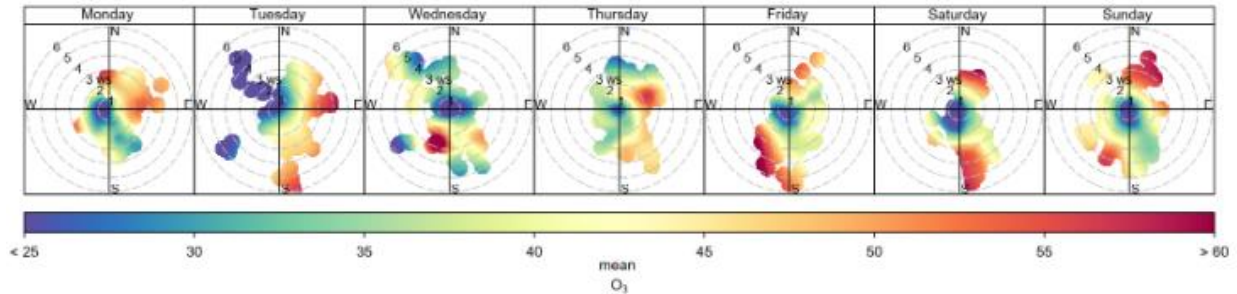
Exhibit 37 Average O<sub>3</sub> by Wind Speed and Direction at Southern Site



The day of the week (Exhibit 38 **Error! Reference source not found.**) data at the southern site show a lot of variability in the daily averages. Tuesday had the highest average of any day, with the highest levels occurring with winds from the east or south. Friday, Saturday, and Sunday saw high

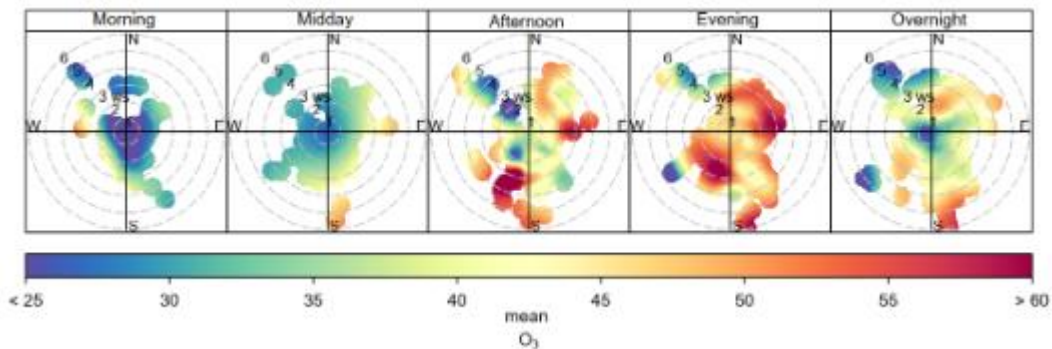
readings with both southern and northern winds, while Wednesday the highest concentrations were from the southwest direction.

**Exhibit 38 Average O<sub>3</sub> by Wind Speed and Direction by Day of the Week at Southern Site**



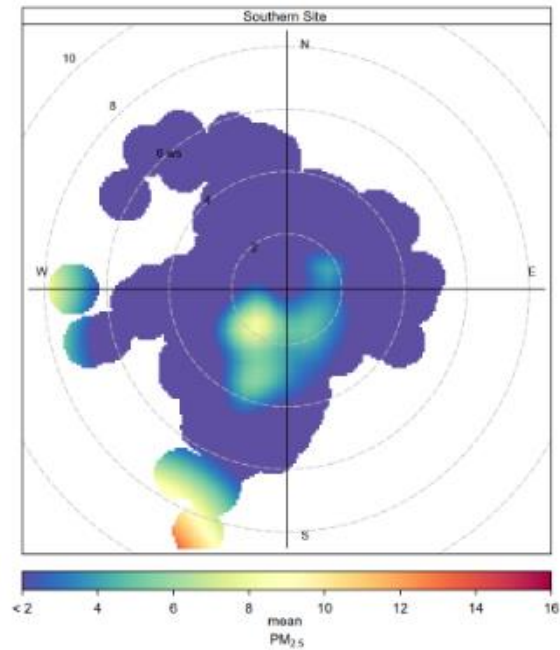
The time-of-day data for the southern site (Exhibit 39) show the highest readings were in afternoon (43.15 ppb) and evening (49.04 ppb) time periods. The evening O<sub>3</sub> readings at the southern site were the highest of any time period measured at any of the sites.

**Exhibit 39 Average O<sub>3</sub> by Wind Speed and Direction by Time of the Day at Southern Site**



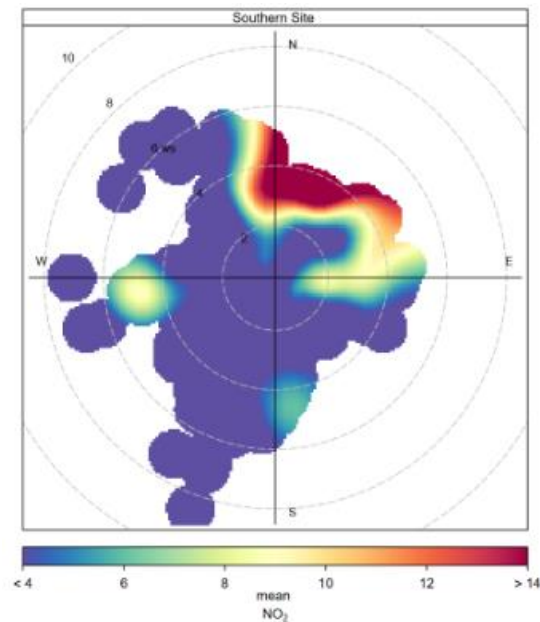
The PM<sub>2.5</sub> data at the southern site (Exhibit 40) were very similar to the O<sub>3</sub> data, with the highest readings with winds out of the south/southwest.

Exhibit 40 Average PM<sub>2.5</sub> by Wind Speed and Direction at Southern Site



The NO<sub>2</sub> data (Exhibit 41) from the location had much higher readings coming with winds from the north/northeast.

Exhibit 41 Average NO<sub>2</sub> by Wind Speed and Direction at Southern Site



### 3.3.4 Western Site

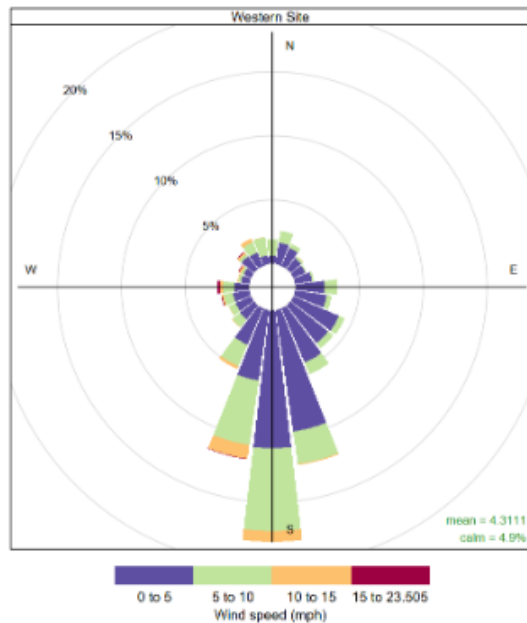
The western site for the project is located 4.8 miles west of the CAMS 073 site on a private driveway on Colony Road. The location had an AQLite installed measuring O<sub>3</sub> but did not have an AQY-R. Exhibit 42 shows the summary of the data measured at the location.

**Exhibit 42 Summary of Western Site Air Quality Data**

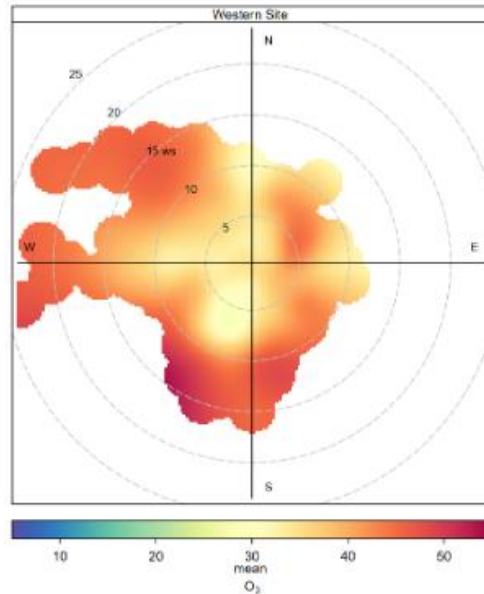
Pollutant	Average	Max	Standard Deviation
1-Hour O <sub>3</sub> (ppb)	34.91	95.57	13.69
8-Hour O <sub>3</sub> (ppb)	34.95	84.13	12.44
1-Hour Wind Speed (mph)	4.31	23.50	2.67

Exhibit 43 shows a wind rose plot for the western site. The winds were predominantly out of the south between 0-10 mph, with an overall average of 4.31 mph. The O<sub>3</sub> measurements at the western site, which had the highest average of all the locations in the study, were highest when the winds were from the south shown in Exhibit 44. The western site had the lowest variation of measurements as well, with the O<sub>3</sub> readings averaging over 20 ppb no matter what direction the wind was blowing.

**Exhibit 43 Wind Rose for Western Site**

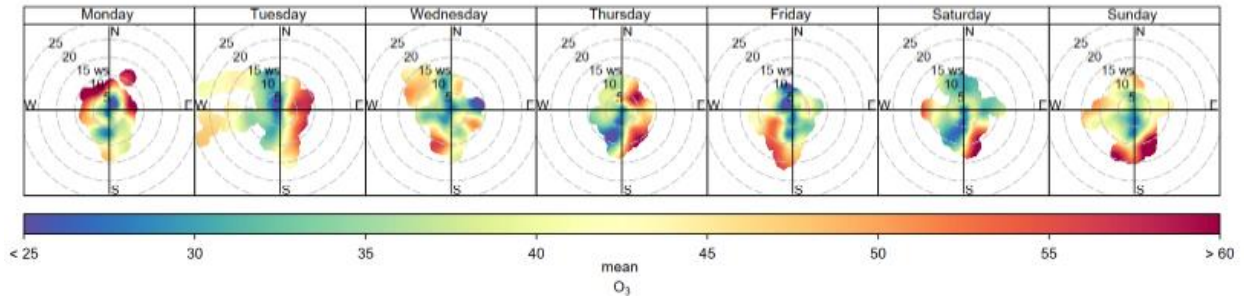


### Exhibit 44 Average O<sub>3</sub> by Wind Speed and Direction at Western Site

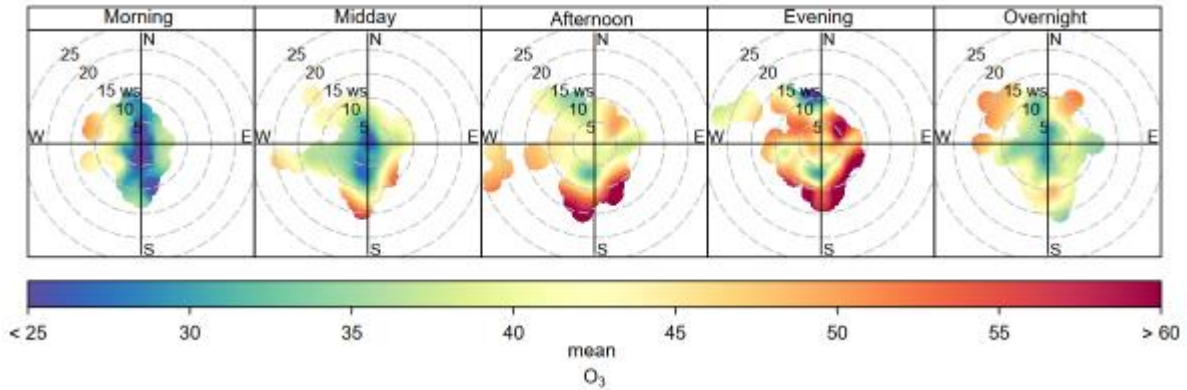


The day of the week (Exhibit 45) data for the western site shows that the wind direction related to the higher O<sub>3</sub> concentrations varied daily. On Monday the highest values were with winds out of the north, Tuesday and Thursday when winds were from the east, and the remaining days when winds were from the south. The time of day (Exhibit 46) data for the western site were similar to the other sites, with the highest readings in the afternoon and evenings.

### Exhibit 45 Average O<sub>3</sub> by Wind Speed and Direction by Day of the Week at Western Site



**Exhibit 46 Average O<sub>3</sub> by Wind Speed and Direction by Time of the Day at Western Site**



**3.3.5 Wolf Hollow Site**

The Wolf Hollow site selected for this project is located approximately 6.1 miles Southeast of the CAMS 073 site at a private residence. The site is 2.4 miles Northwest of the Wolf Hollow Power plant. The location had an AQLite installed measuring O<sub>3</sub> as well as an AQY-R that measured O<sub>3</sub>, PM<sub>2.5</sub>, and NO<sub>2</sub>. Exhibit 47 shows the summary of the data measured at the location.

**Exhibit 47 Summary of Wolf Hollow Site Air Quality Data**

Pollutant	Average	Max	Standard Deviation
1-Hour O <sub>3</sub> (ppb)	29.16	109.9	15.25
8-Hour O <sub>3</sub> (ppb)	29.29	73.92	13.55
1-Hour NO <sub>2</sub> (ppb)	7.1	31.35	4.17
1-Hour PM <sub>2.5</sub> (µg/m <sup>3</sup> )	1.84	57.54	4.27
1-Hour Wind Speed (mph)	2.05	11.58	1.52

Exhibit 48 shows a wind rose plot for the Wolf Hollow site. The winds were predominantly out of the south/southeast between 0-10 mph, with an overall average of 2.05 mph. The O<sub>3</sub> measurements at the location, seen in Exhibit 49, show the highest levels of O<sub>3</sub> coming with south winds. The site had the lowest overall average O<sub>3</sub> readings, at just 29.16 ppb.

Exhibit 48 Wind Rose for Wolf Hollow Site

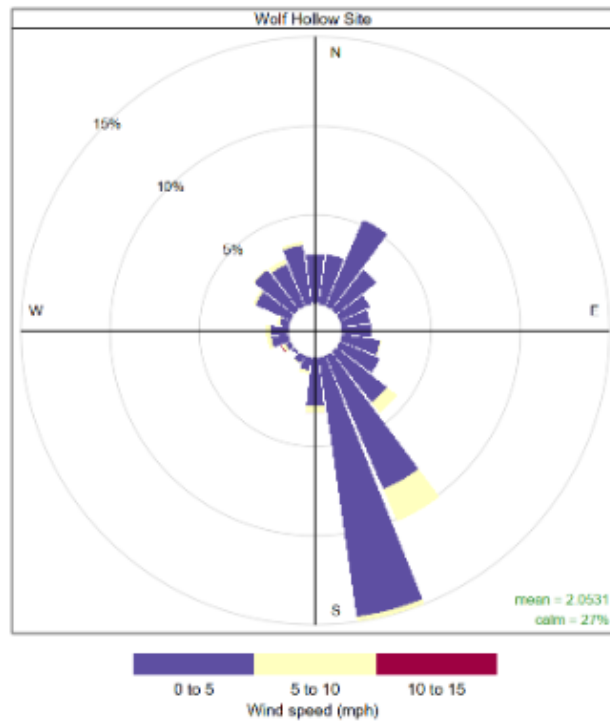
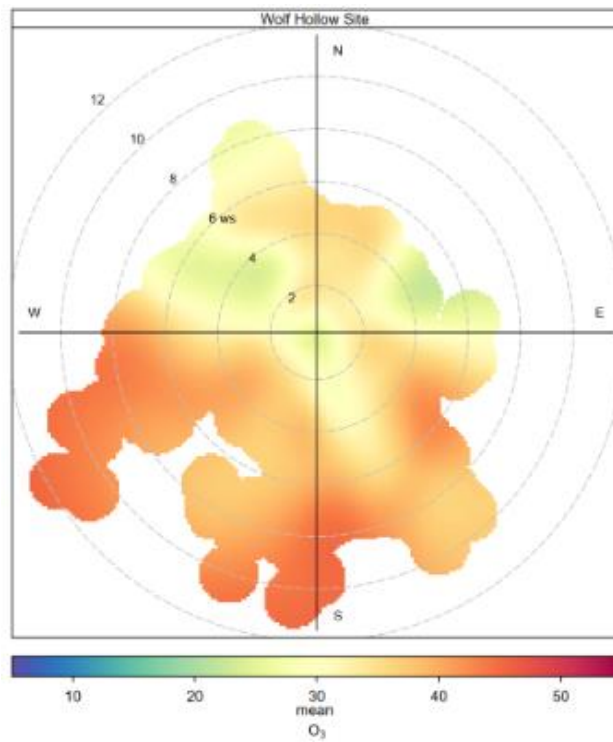
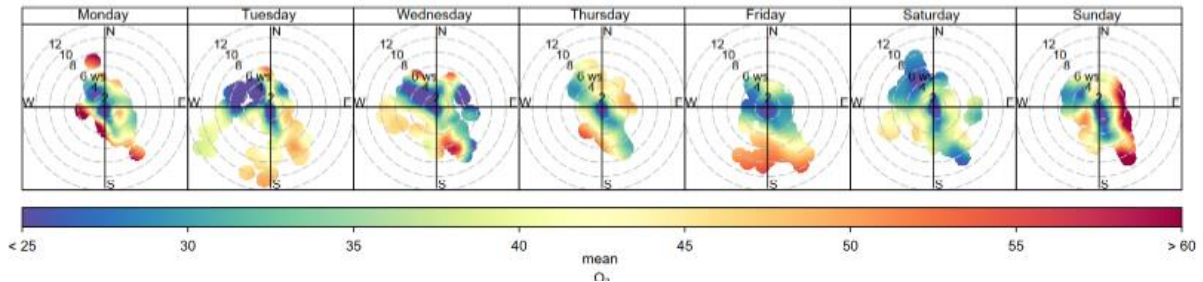


Exhibit 49 Average O<sub>3</sub> by Wind Speed and Direction at Wolf Hollow Site



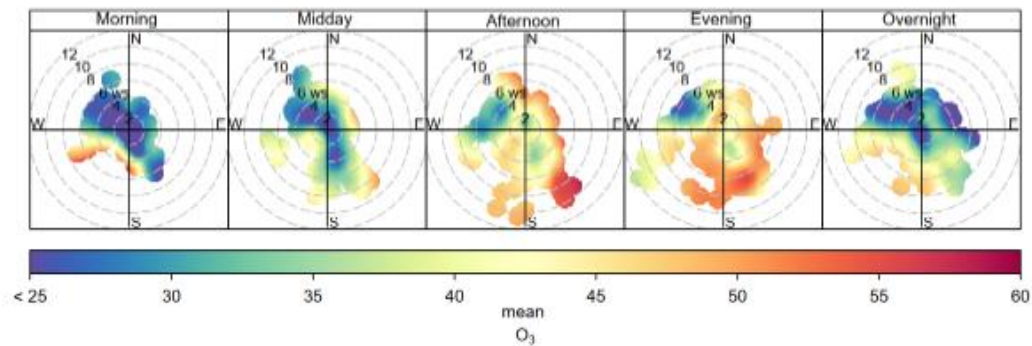
The day of the week (Exhibit 50) data at the Wolf Hollow site show that most days had higher rates of O<sub>3</sub> with winds out of the south. The major exception was Sundays, which saw the highest overall rates coming with winds from the East.

**Exhibit 50 Average O<sub>3</sub> by Wind Speed and Direction by Day of the Week at Wolf Hollow Site**



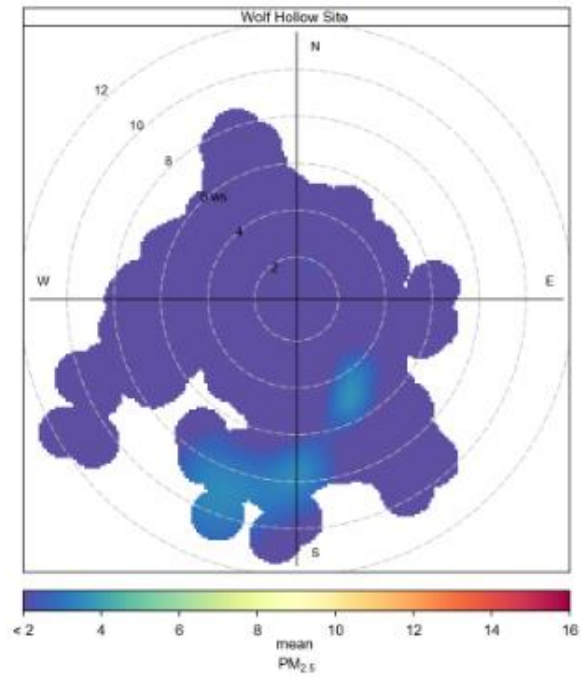
The time-of-day data for the Wolf Hollow site (Exhibit 51) show the highest readings were in afternoon (39.35 ppb) and evening (42.76 ppb) time periods, both the lowest readings for any of the sites during these times. The Wolf Hollow site also had the lowest overall average of any time of day and site, with an average of only 17.29 ppb in the morning time period.

**Exhibit 51 Average O<sub>3</sub> by Wind Speed and Direction by Time of the Day at Wolf Hollow Site**



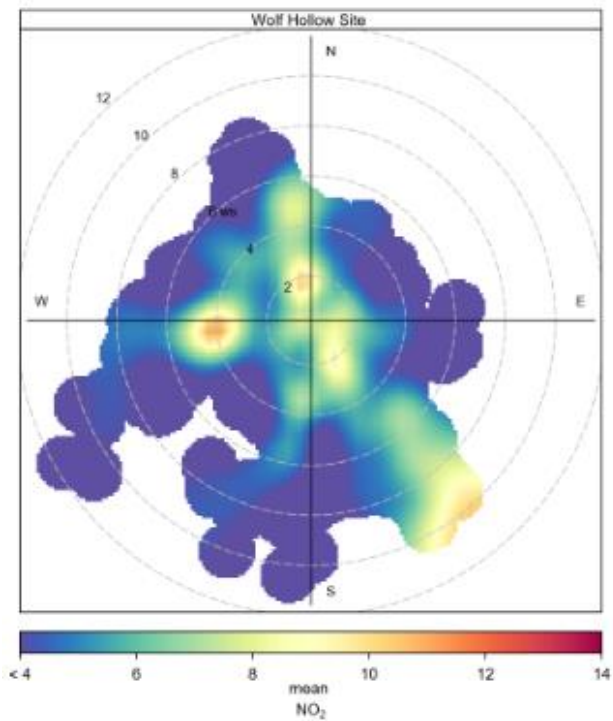
The PM<sub>2.5</sub> data at the Wolf Hollow site (Exhibit 52) was the lowest PM<sub>2.5</sub> readings from any of the sites, and showed little variability based on the wind.

Exhibit 52 Average PM<sub>2.5</sub> by Wind Speed and Direction at Wolf Hollow Site



The NO<sub>2</sub> data (Exhibit 53) shows some increase in NO<sub>2</sub> with winds from the southeast or due west and was slightly higher with calm winds.

Exhibit 53 Average NO<sub>2</sub> by Wind Speed and Direction at Wolf Hollow Site



## 3.4 EXCEEDENCE DAYS

### 3.4.1 Ozone Exceedances

An ozone exceedance day is a day when the daily maximum value recorded for the 8-hour average O<sub>3</sub> levels are higher than allowed by the NAAQS value of 70 ppb. At these levels of pollution, the air quality is defined as unhealthy, especially for some groups that are more at risk, such as those that have respiratory issues.

During this project the CAMS 073 site recorded O<sub>3</sub> exceedances twice, on April 10<sup>th</sup> and on August 26<sup>th</sup>. On these dates the other sites also had high O<sub>3</sub> readings. On April 10<sup>th</sup>, all five project sites also measured levels that would be considered as an exceedance, seen in Exhibit 54. The second date that measured an exceedance at the CAMS 073 site three of the five sites also measured exceedances, and the other two sites (the northern and southern sites) were down that day for battery failures.

Days surrounding the April 10<sup>th</sup> exceedance at the CAMS 073 site, some of the project sites also measured exceedances, with the southern site above the level on April 9<sup>th</sup> and April 12<sup>th</sup>. The northern site was above 70 on April 11<sup>th</sup> and 12<sup>th</sup>, the western site April 11<sup>th</sup> and 12<sup>th</sup>, and the eastern site on April 12<sup>th</sup>. On April 12<sup>th</sup>, when 3 of the 5 project sites were over the NAAQS allowed value, the CAMS 073 site measured 70, falling just under the level to be considered an exceedance. The Northern site also measured 70 on that day, falling just short of the threshold.

Exhibit 54 O<sub>3</sub> Exceedance Days

Exceedance Date	Location	O <sub>3</sub> Level
April 9 <sup>th</sup>	Southern Site	77
April 10 <sup>th</sup>	CAMS 73	78
	Northern Site	81
	Eastern Site	78
	Southern Site	82
	Western Site	84
	Wolf Hollow Site	74
April 11 <sup>th</sup>	Northern Site	73
	Western Site	73
April 12 <sup>th</sup>	Eastern Site	72
	Southern Site	74
	Western Site	72
August 26 <sup>th</sup> *	CAMS 73	79
	Eastern Site	79
	Wolf Hollow Site	73
	Western Site	78

*\*The Northern and Southern sites were offline during the August 26<sup>th</sup> Exceedance.*

### 3.4.2 PM<sub>2.5</sub> and NO<sub>2</sub> Exceedances

PM<sub>2.5</sub> exceedances are defined by the NAAQS as days when the 24-hour PM<sub>2.5</sub> levels are above 35 µg/m<sup>3</sup> while the daily NO<sub>2</sub> levels are 100 ppb. While not federal reference or equivalent monitors, data from the AQY-R was used to determine exceedances for PM<sub>2.5</sub> and NO<sub>2</sub>. This project saw only two days when the PM<sub>2.5</sub> levels reached exceedance values, both at the eastern site on August 19<sup>th</sup> and 20<sup>th</sup>. The highest values the site recorded on these days were 49.9 µg/m<sup>3</sup> on the 19<sup>th</sup> and 49.9 µg/m<sup>3</sup> on the 20<sup>th</sup>. There were no exceedances for the NO<sub>2</sub> levels, with the highest value recorded at any of the sites being only 60.7 ppb.

## 4. Conclusions

Overall, there were no major differences in the O<sub>3</sub> levels measured at each of the sites compared to the CAMS 073 regulatory site. Most sites had similar readings for the duration of the project, and all had exceedances on the same days as the CAMS 073 site (disregarding sites that were down during exceedances). The data shows that generally (>98% of measured values) were in the AQI group that were either “Good” or “Moderate” air quality levels for O<sub>3</sub> at each site, and none reached the “Unhealthy” level for the duration of the current monitoring period.

More data is needed to include at least the fall and winter months to do a full year’s analysis, including all seasons, of the air quality at each site. Ideally, the monitoring campaign should be extended to be able to include local and seasonal trends for the selected monitoring sites.

# Appendix A: Aeroqual Co-Location Calibration Data

Appendix A includes all the graphs from the co-location calibration completed in January 2025. For all graphs green is the regulatory data, red is the raw pre-calibration data, and yellow is the calibrated data.

## AQY-R AB 0318 – SOUTHERN SITE

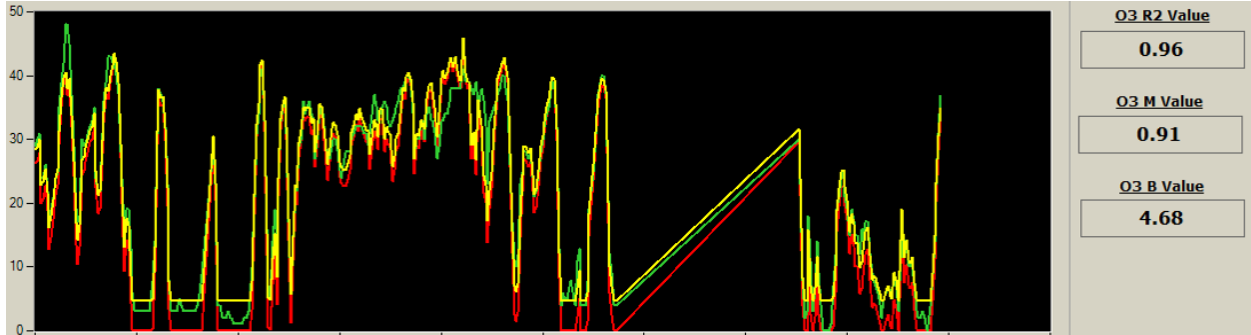


Figure A-1: Southern Site AQY-R O<sub>3</sub> Calibration

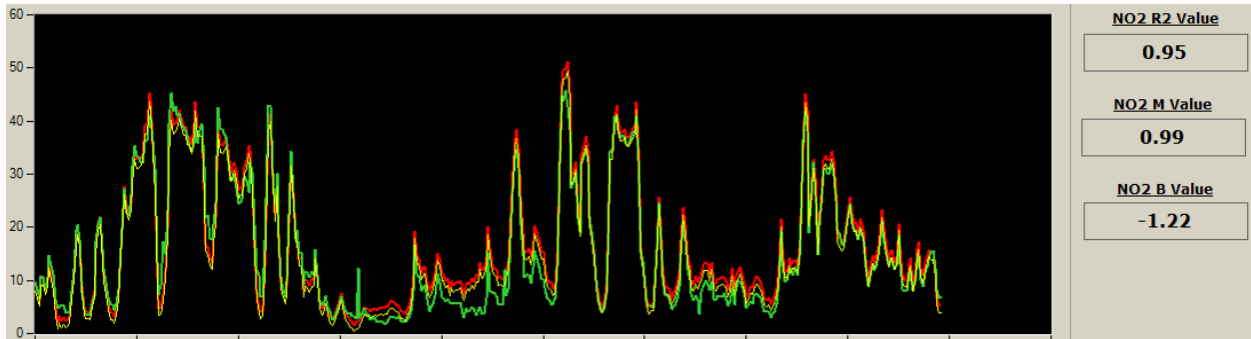


Figure A-2: Southern Site AQY-R NO<sub>2</sub> Calibration

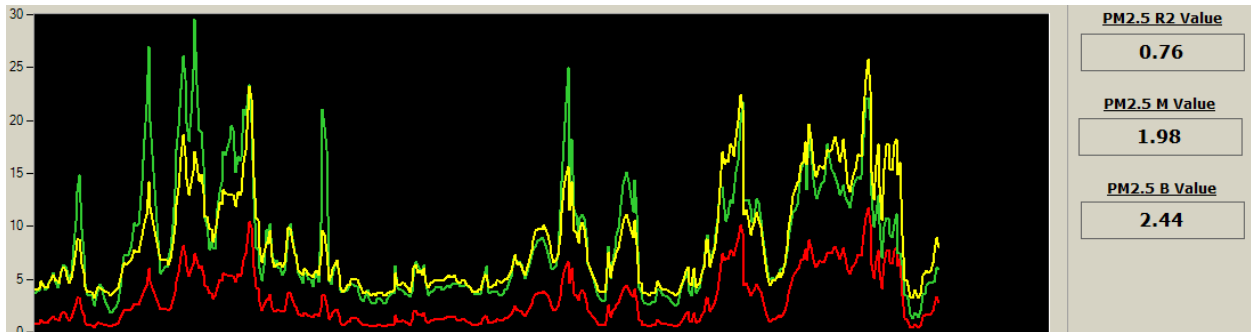


Figure A-3: Southern Site AQY-R PM<sub>2.5</sub> Calibration

# AQY-R AB 0319 – EASTERN SITE

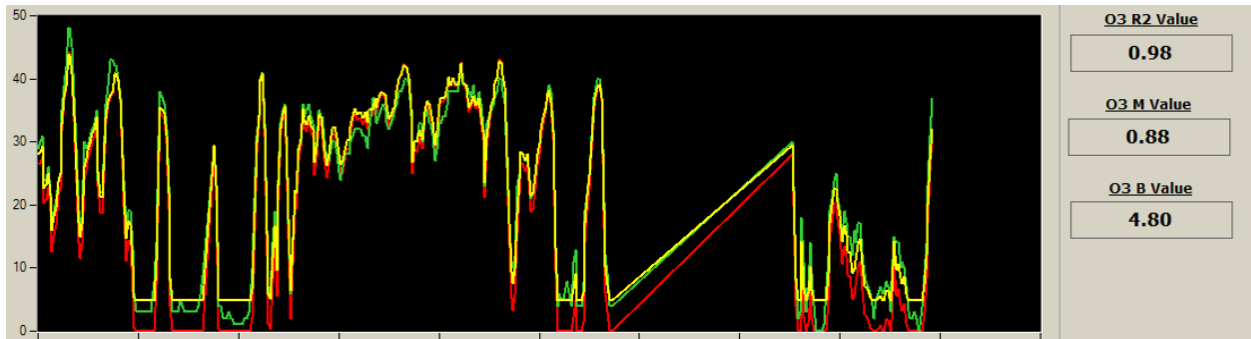


Figure A-4: Eastern Site AQY-R O<sub>3</sub> Calibration

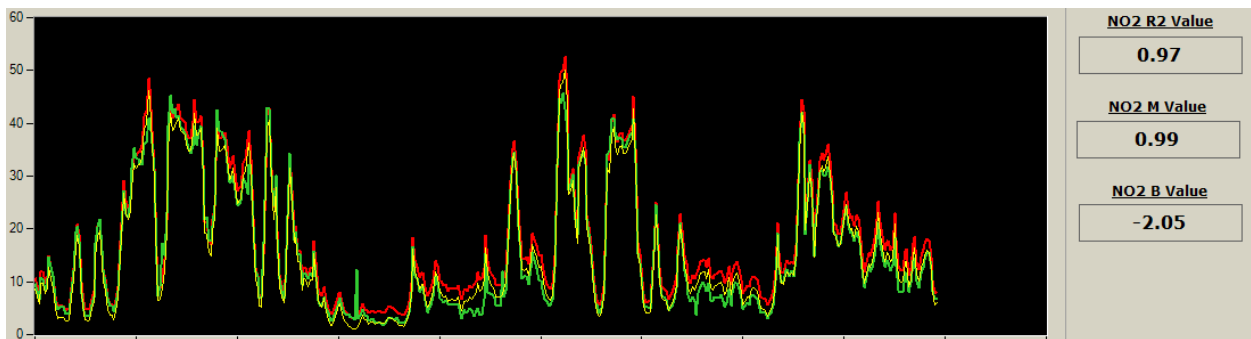


Figure A-5: Eastern Site AQY-R NO<sub>2</sub> Calibration

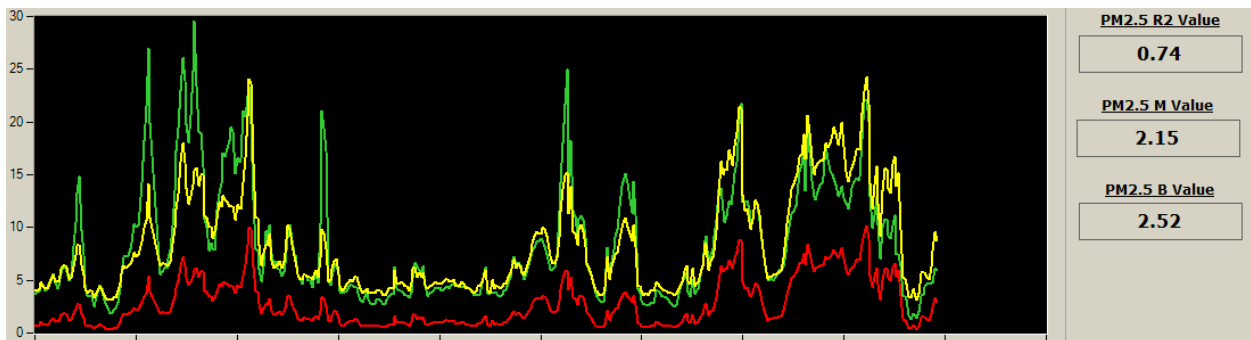


Figure A-6: Eastern Site AQY-R PM<sub>2.5</sub> Calibration

# AQY-R AB 0320 – NORTHERN SITE

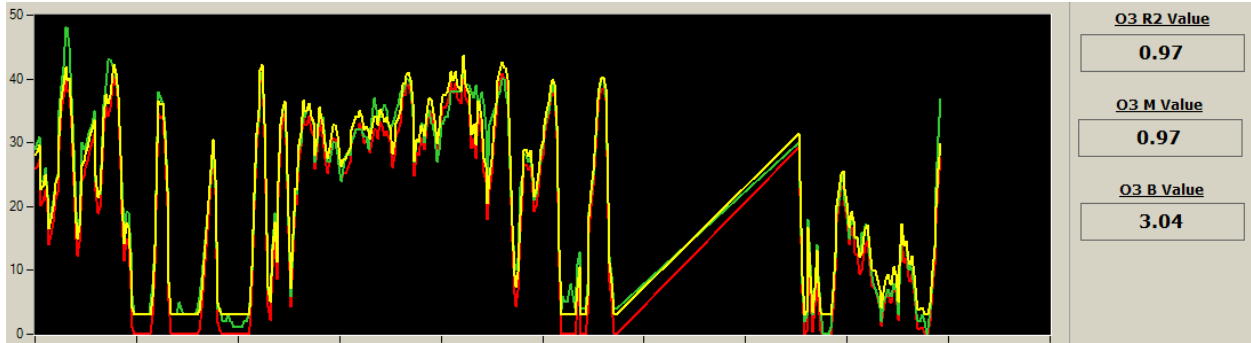


Figure A-7: Northern Site AQY-R O<sub>3</sub> Calibration

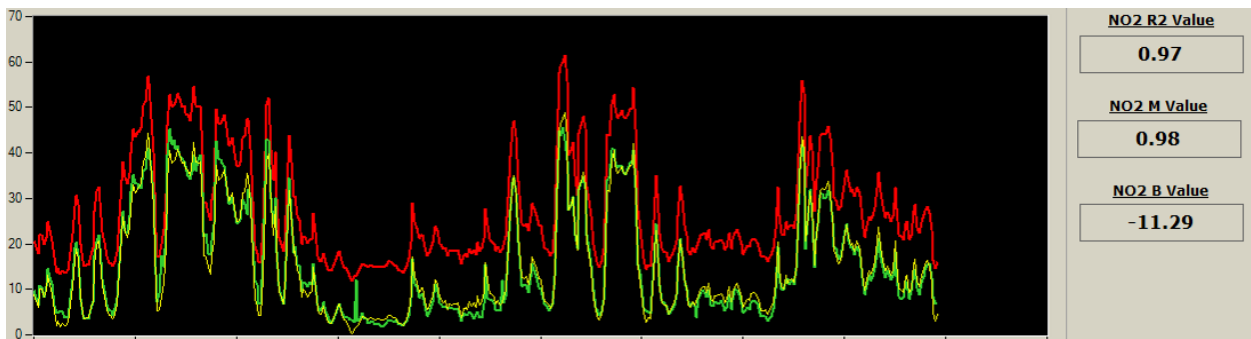


Figure A-8: Northern Site AQY-R NO<sub>2</sub> Calibration

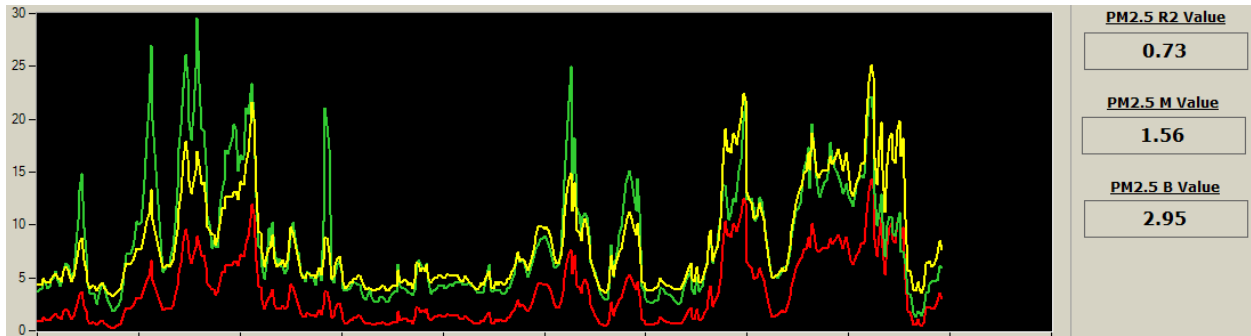


Figure A-9: Northern Site AQY-R PM<sub>2.5</sub> Calibration

# AQY-R AB 0320 – WOLF HOLLOW SITE

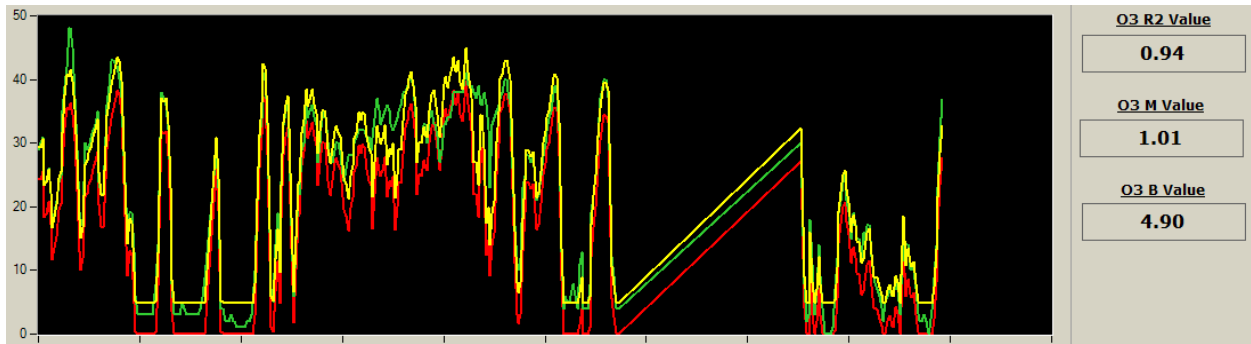


Figure A-10: Wolf Hollow Site AQY-R O<sub>3</sub> Calibration

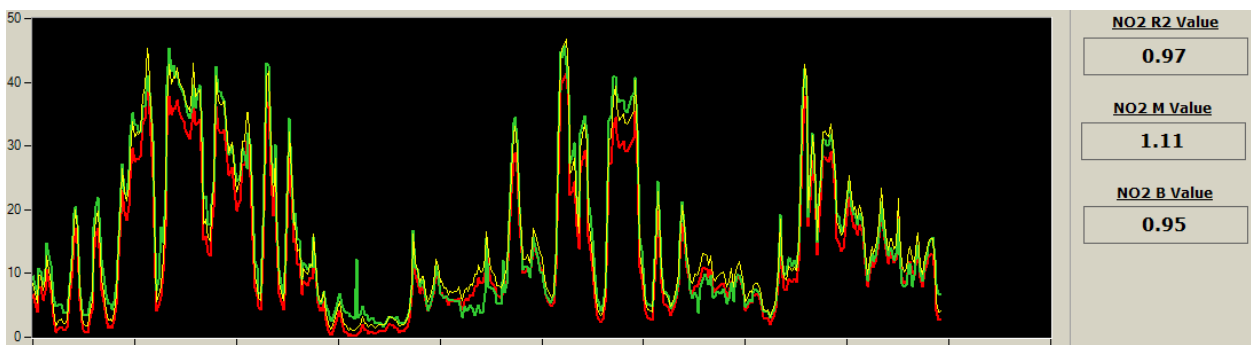


Figure A-11: Wolf Hollow Site AQY-R NO<sub>2</sub> Calibration

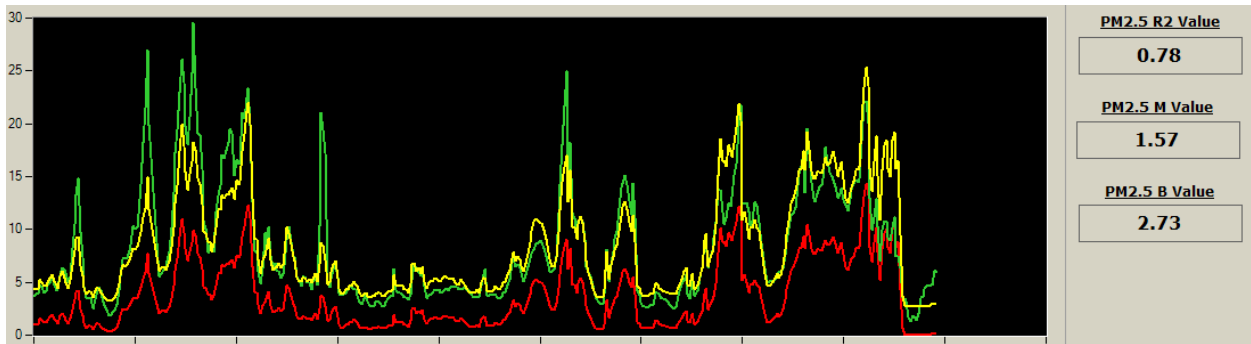


Figure A-12: Wolf Hollow Site AQY-R PM<sub>2.5</sub> Calibration

## Appendix B: Additional Data Summaries

Table B-1: Summary of O<sub>3</sub> Data by Time of Day

Site	O <sub>3</sub> Hourly Average (ppb)				
	Morning	Midday	Afternoon	Evening	Overnight
CAMS 73	21.89	34.2	41.94	44.18	27.59
Eastern	22.7	31.23	42.29	47.20	33.73
Northern	24.95	31.63	41.55	45.69	34.29
Southern	23.04	32.45	43.15	49.04	33.33
Western	24.43	31.56	41.02	45.47	33.77
Wolf Hollow	17.29	28.43	39.35	42.76	26.02

Table B-2: Summary of O<sub>3</sub> Data by Day of the Week

Site	O <sub>3</sub> Hourly Average (ppb)						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
CAMS 73	31.35	33.23	33.40	31.90	30.23	30.86	31.93
Eastern	33.79	37.37	37.11	34.78	34.36	33.63	33.83
Northern	35.23	35.47	36.72	35.42	34.67	34.14	34.84
Southern	35.93	37.87	35.69	36.40	34.43	34.69	34.14
Western	34.67	36.02	36.51	35.48	33.99	33.38	34.28
Wolf Hollow	37.65	30.35	30.25	29.48	28.70	28.72	29.02

Table B-3: Summary of PM<sub>2.5</sub> Data by Time of Day

Site	PM <sub>2.5</sub> Hourly Average (µg/m <sup>3</sup> )				
	Morning	Midday	Afternoon	Evening	Overnight
Eastern	1.42	4.03	13.67	17.78	2.99
Southern	2.41	4.64	8.81	6.01	2.36
Wolf Hollow	1.67	2.01	1.9	2.16	1.73

Table B-4: Summary of PM<sub>2.5</sub> Data by Day of the Week

Site	PM <sub>2.5</sub> Hourly Average (µg/m <sup>3</sup> )						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Eastern	5.54	7.17	5.41	7.79	6.64	7.1	5.03
Southern	3.39	3.63	4.75	4.2	4.29	4.09	3.25
Wolf Hollow	1.61	1.25	1.7	1.5	2.72	2.54	1.46

Table B-5: Summary of NO<sub>2</sub> Data by Time of Day

Site	PM <sub>2.5</sub> Hourly Average (µg/m <sup>3</sup> )				
	Morning	Midday	Afternoon	Evening	Overnight
Eastern	11.62	10.07	8.08	7.32	10.12
Northern	21.53	17.6	13.43	12.12	18.38
Southern	3.3	3.18	3.58	2.47	2.82
Wolf Hollow	6.62	6.6	7.32	7.94	7.04

Table B-6: Summary of NO<sub>2</sub> Data by Day of the Week

Site	PM <sub>2.5</sub> Hourly Average (µg/m <sup>3</sup> )						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Eastern	9.6	9.81	10.15	9.99	9.61	9.05	9.36
Northern	17.07	17.16	17.93	17.64	17.28	16.32	16.5
Southern	2.48	2.77	3.27	3.27	3.57	2.79	2.52
Wolf Hollow	6.9	7.01	6.86	7.59	7.37	6.8	7.15

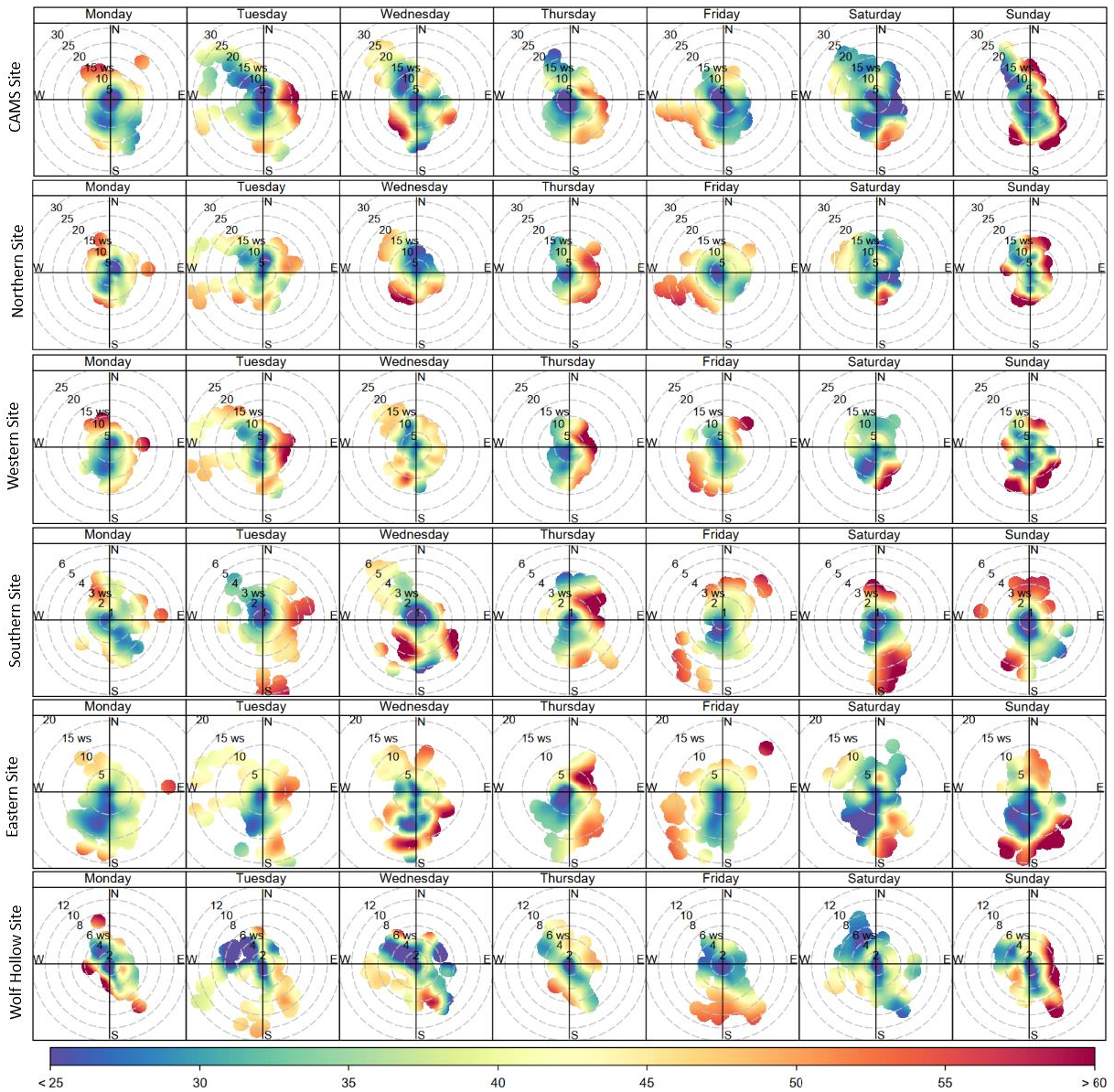


Figure B-1: Daily Average O<sub>3</sub> by Wind Speed and Direction

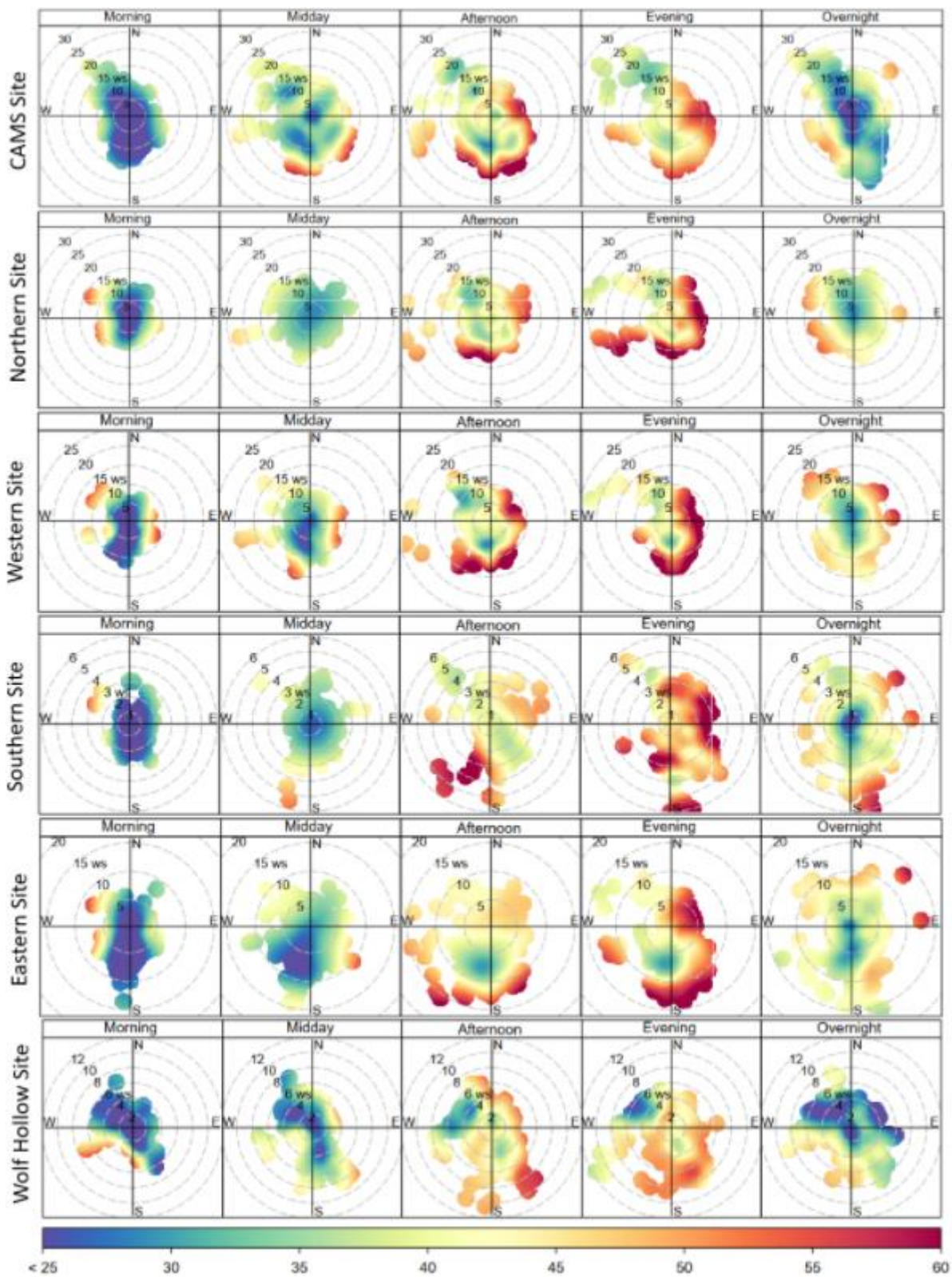


Figure B-2: Time of Day Average O<sub>3</sub> by Wind Speed and Direction

### Western Site O3 AQI Values



Figure B-3: Western Site Daily AQI Levels

### Southern Site O3 AQI Values



Figure B-4: Southern Site Daily AQI Levels

### Northern Site O3 AQI Values

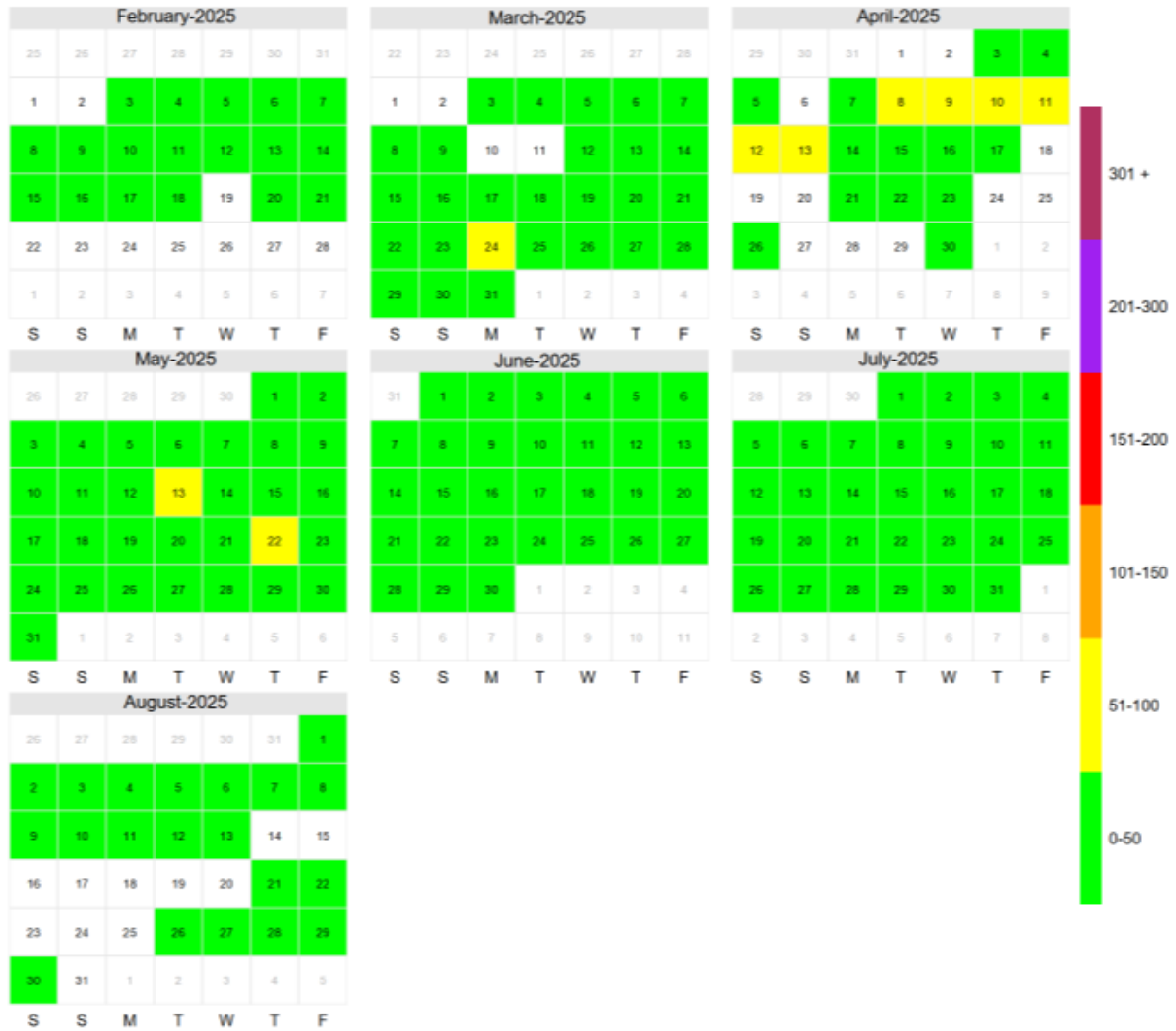


Figure B-5: Northern Site Daily AQI Levels

### Northern Site O3 AQI Values

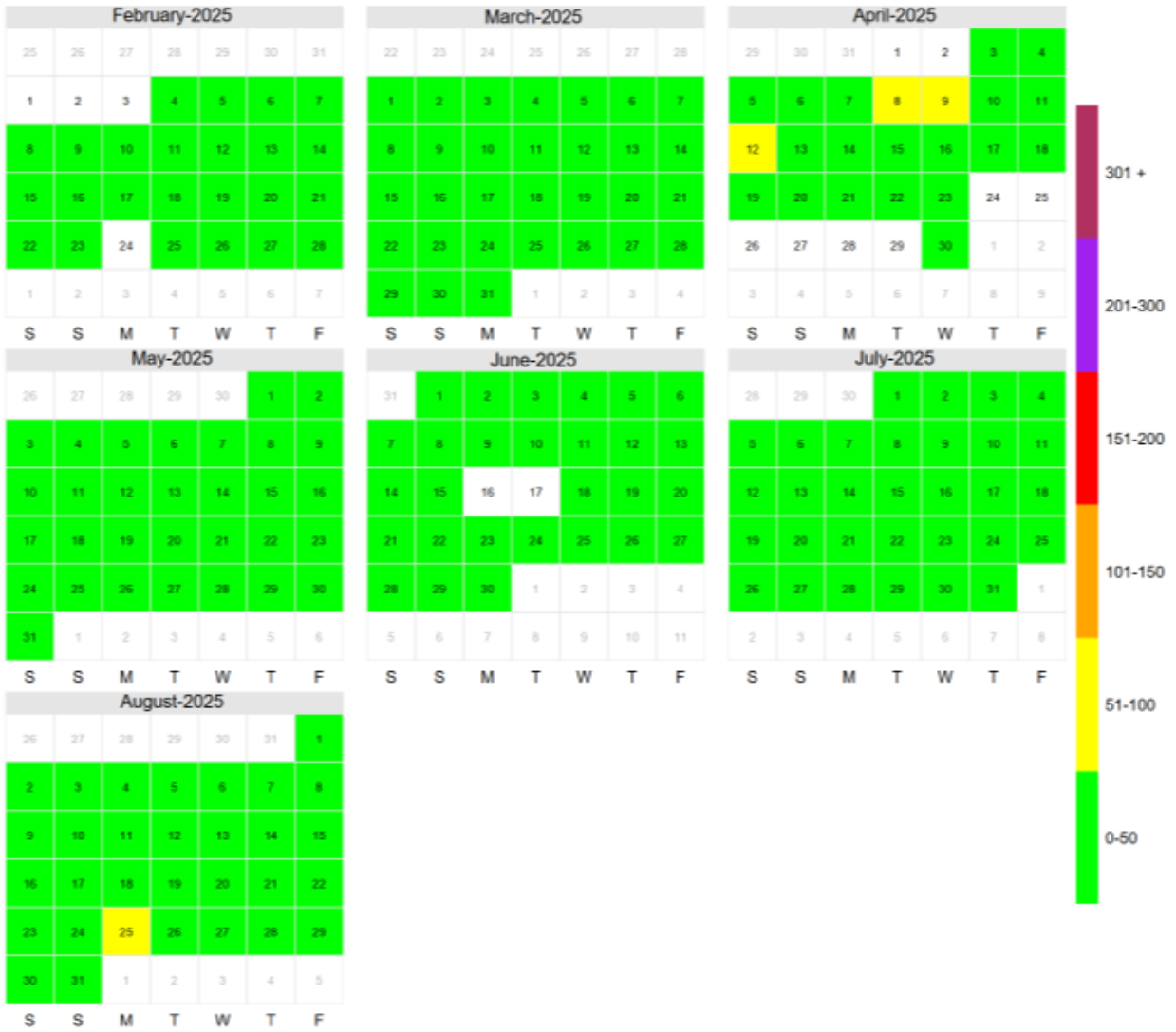


Figure B-6: Wolf Hollow Site Daily AQI Levels

### Eastern Site O3 AQI Values

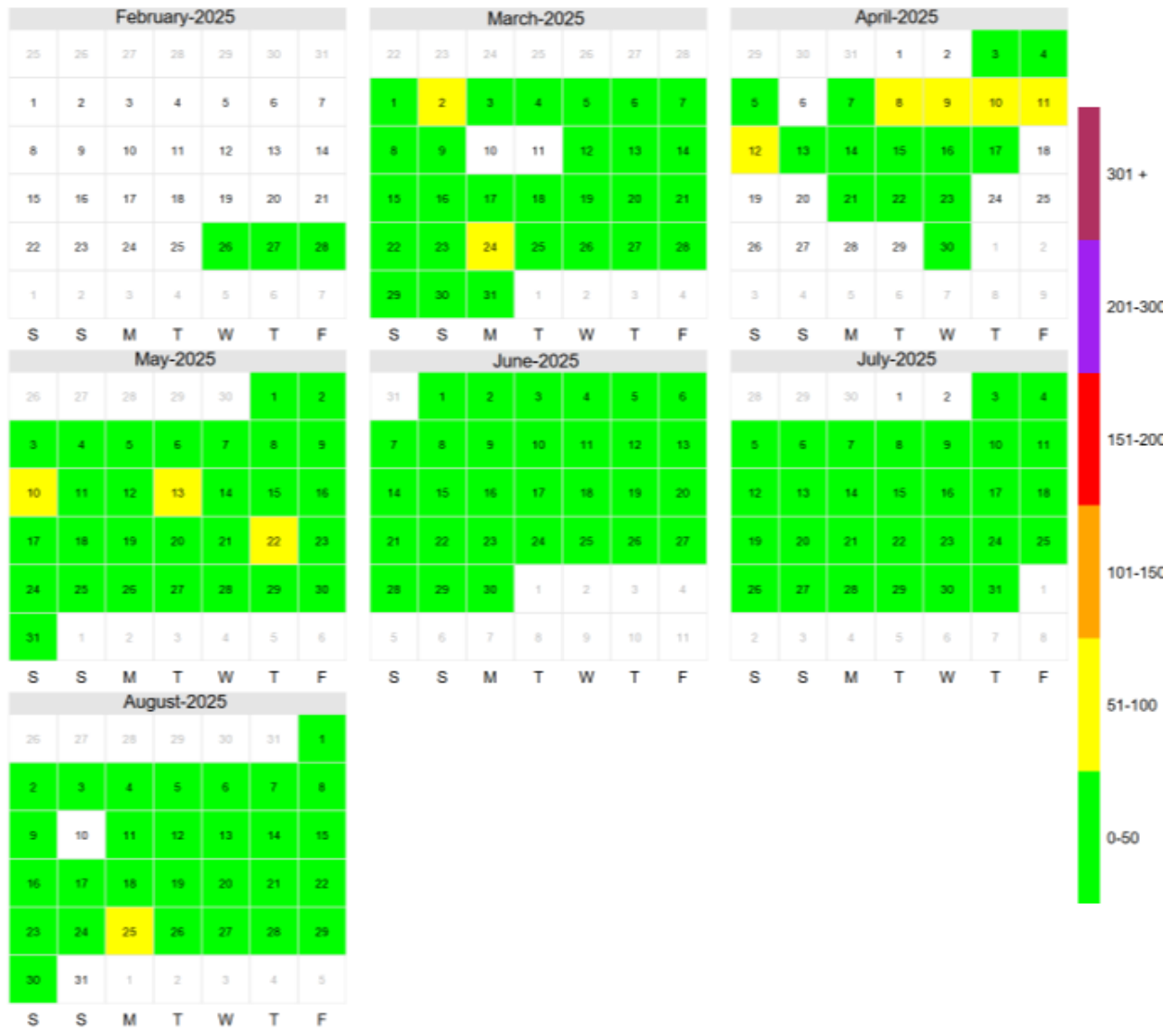


Figure B-7: Eastern Site Daily AQI Levels

### CAMS 73 Site O3 AQI Values

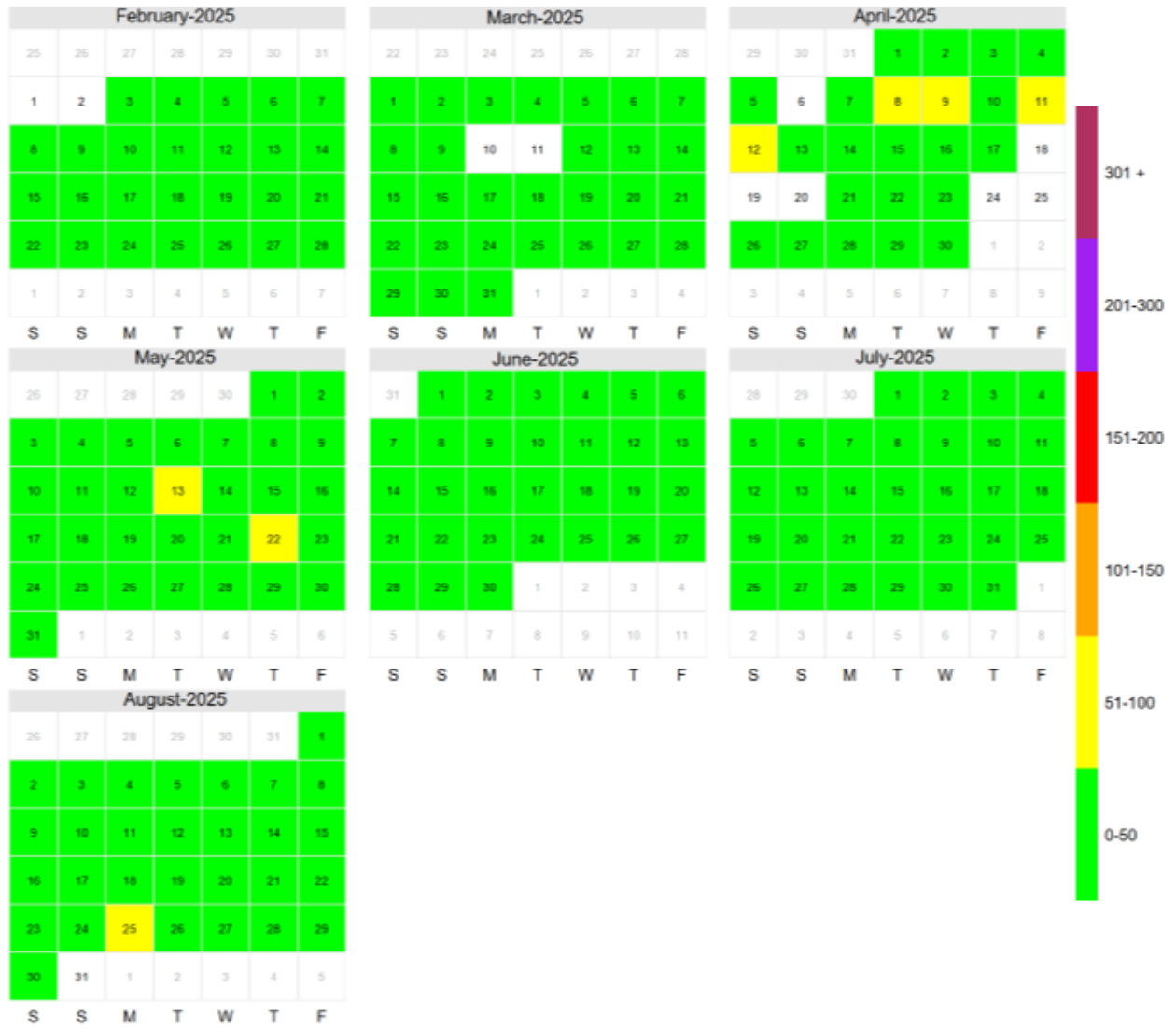
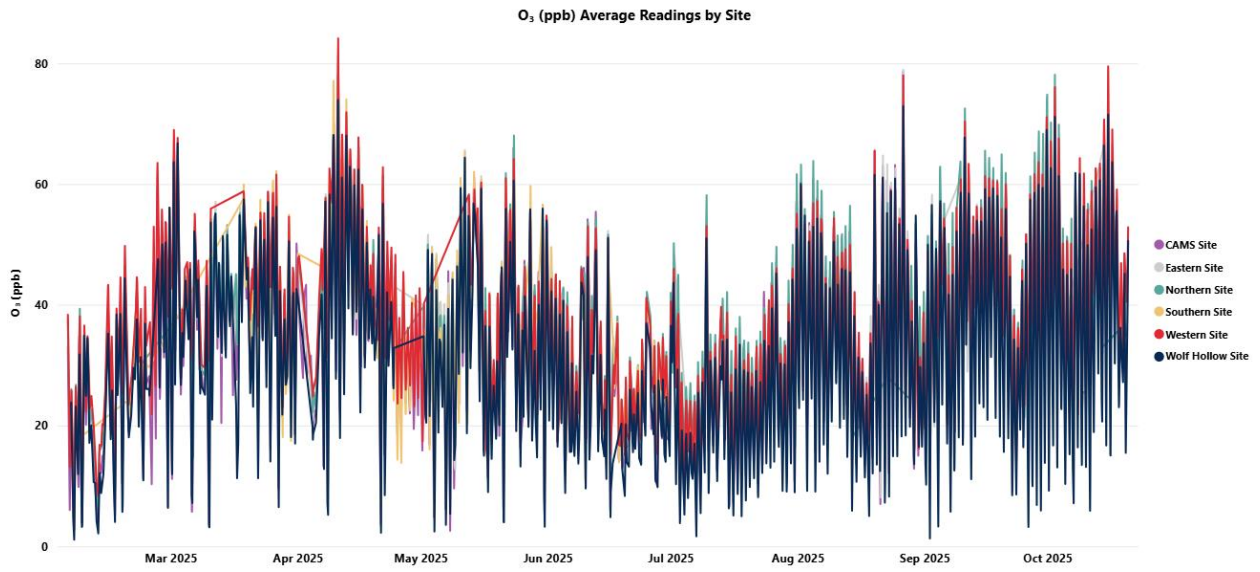
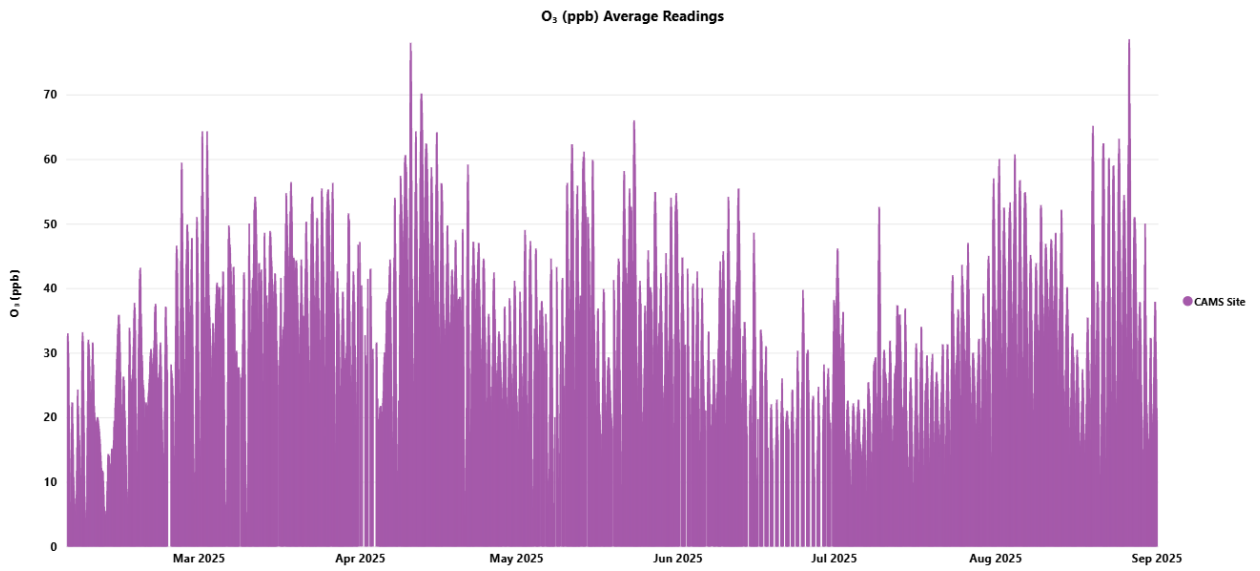


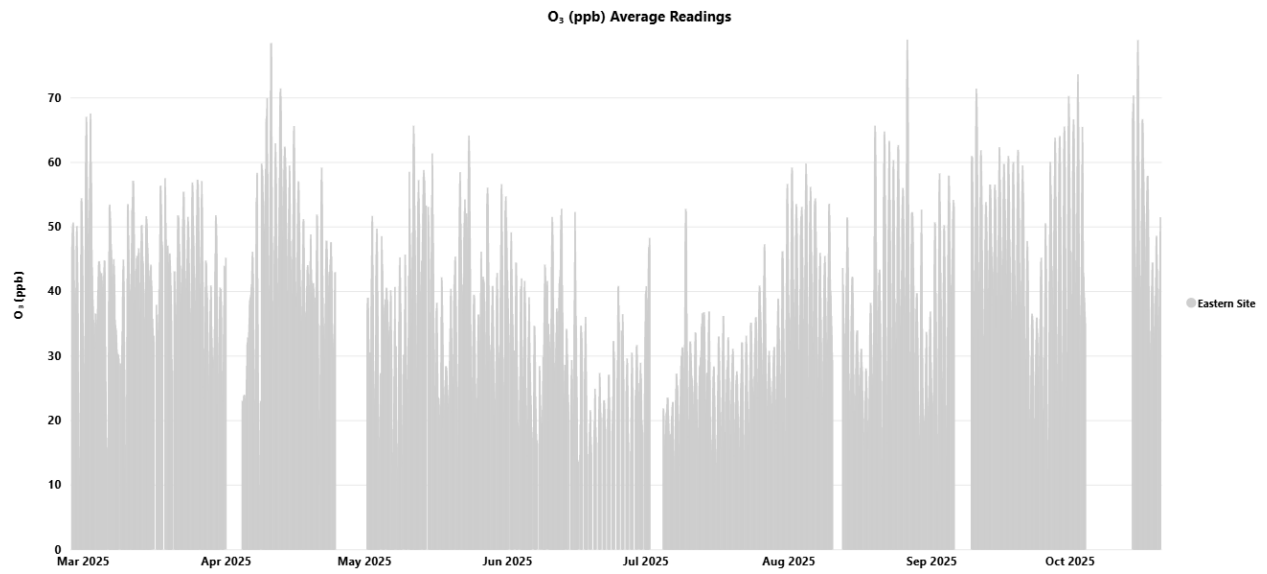
Figure B-8: CAMS 73 Site Daily AQI Levels



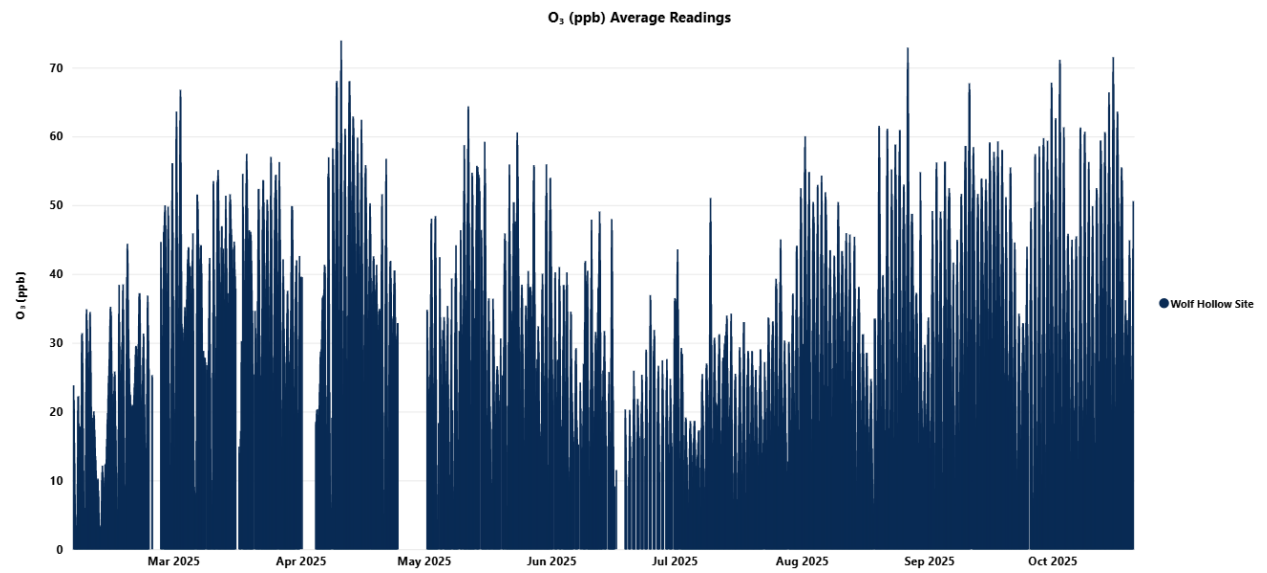
**Figure B-9: 8-hour Average O<sub>3</sub> by Site**



**Figure B-10: 8 Hour Average O<sub>3</sub> for CAMS Site**



**Figure B-11: 8 Hour Average O<sub>3</sub> for Eastern Site**



**Figure B-12: 8 Hour Average O<sub>3</sub> for Wolf Hollow Site**

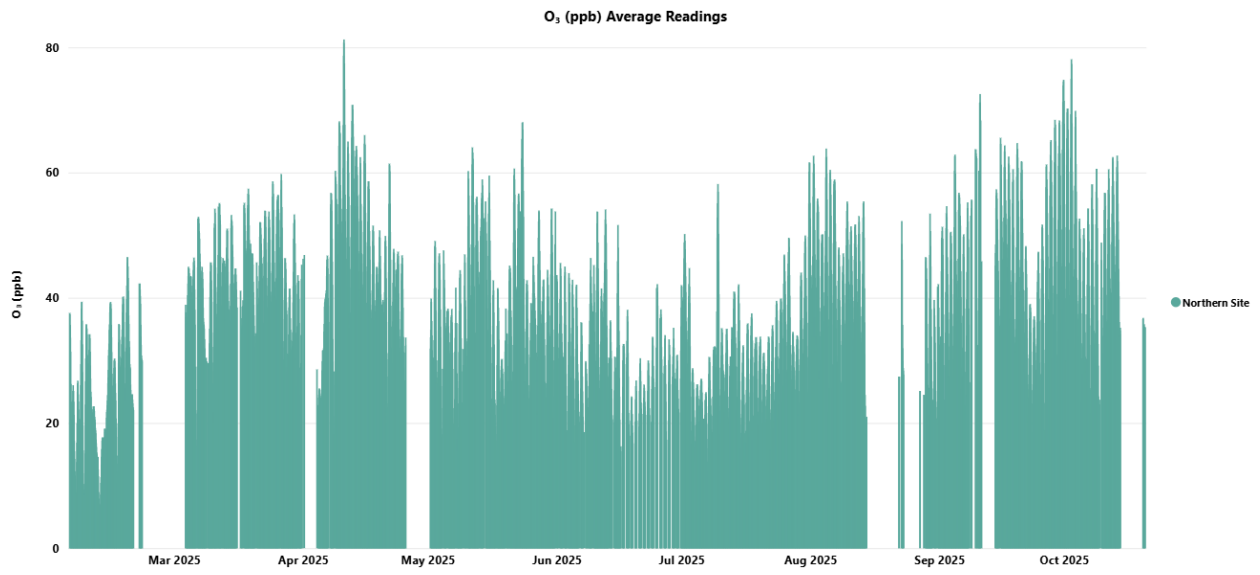


Figure B-13: 8 Hour Average O<sub>3</sub> for Northern Site

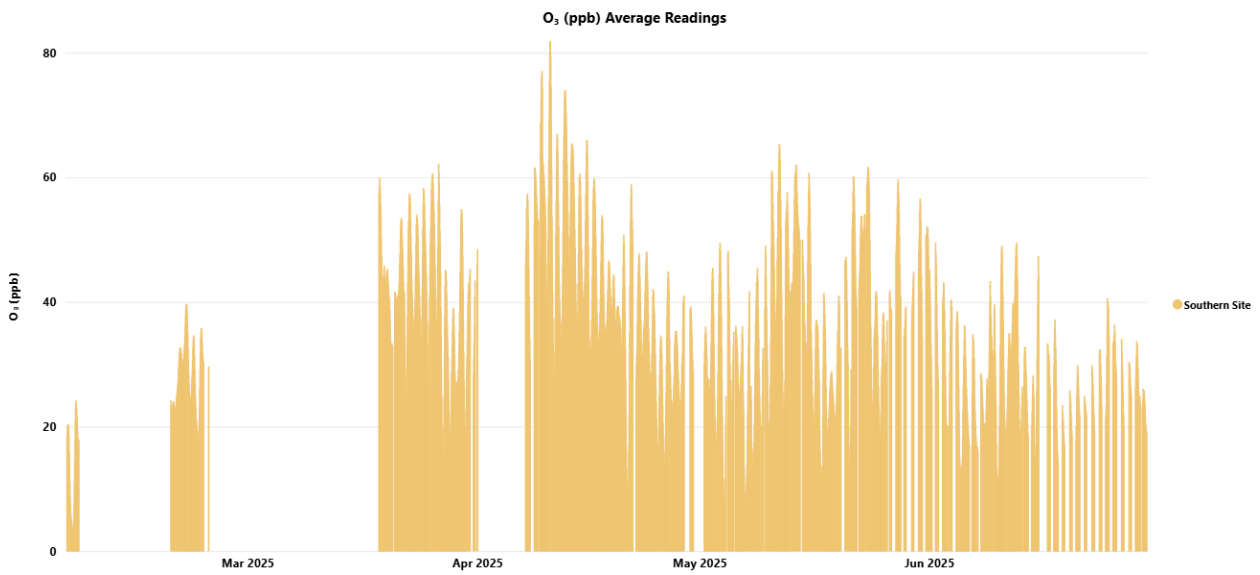
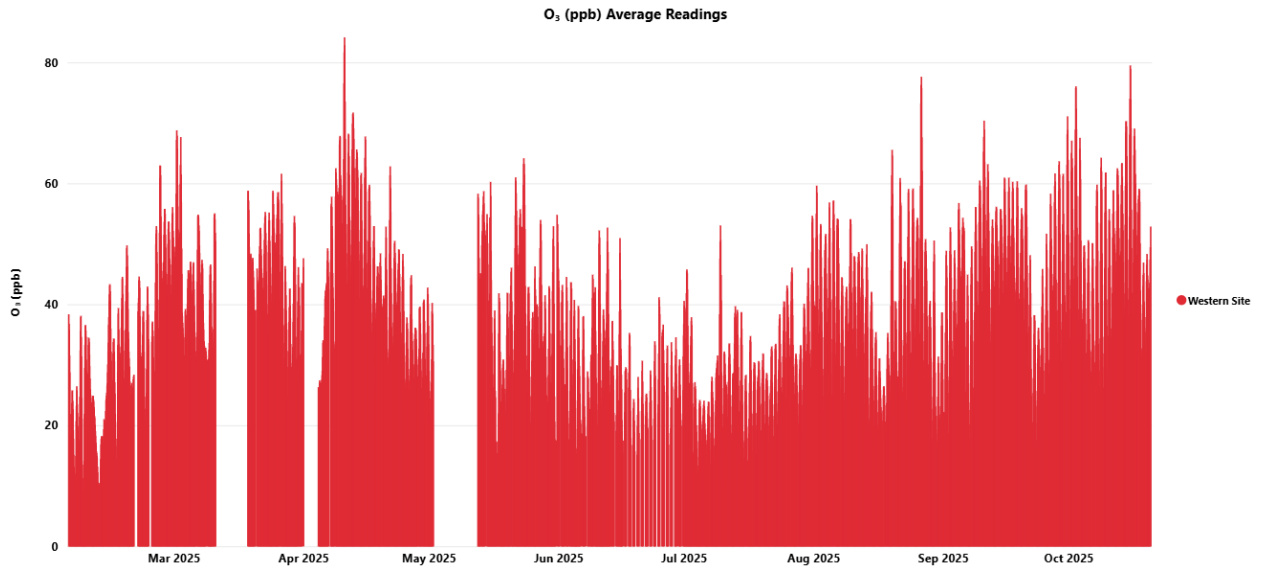


Figure B-14: 8 Hour Average O<sub>3</sub> for Southern Site



**Figure B-15: 8 Hour Average O<sub>3</sub> for Western Site**