



Quarterly Report Fence line Monitoring Report for the Bazan Fence line Monitoring System– Quarter 4 – 2021





Bazan Group
Haifa, Israel

Subject: Quarterly Report for Open-Path UV Air Monitoring

This report summarizes the data collected by the four open-path UV air monitoring systems that were installed at the Bazan refinery during the time period of October to December 2021 (Quarter 4 2021). During this time, the four systems continuously collected and quantified the concentration of Benzene, Toluene, Ethyl Benzene and Xylene (BTEX) gas in the ambient air. Information from the analyzers was reported along with meteorological data to a secured website, and alarm notifications were generated in the event target gases were detected above preset levels. Summary information is included for each beam path. The following report presents the summary results of the measurement period.

Operational Performance Events

As of the end of Q4 2021 the onstream efficiency for the systems was 97.2%.

Maintenance Activities

Routine maintenance and quality assurance/quality control (QA/QC) for the open-path UV monitoring systems occurred on 18 October, 21 October, 25 October, 26 October, 22 November, 23 November, 30 November, 14 December, 26 December, 27 December, 28 December, 29 December and 30 December 2021. Annual maintenance was performed on the systems from 14 to 23 November 2021 and on 17 December 2021.



Summary Findings

From the results of the report the following were noted:

- The sample paths detected compounds at different times. This was expected as the paths (due to their orientation) were affected by sources from the refinery under different weather conditions.
- Winds were predominantly from the South-East during the period under review.

Please do not hesitate to contact me if you have questions or need additional information regarding the report.



Report Details

Reference	Bazan_Quarterly report_ Q4_2021
Report Title	Quarterly Report Fence line Monitoring Report for the Bazan Fence line Monitoring System– Quarter 4 – 2021
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Status	Singed
ISRAC ISO 17025 accreditation	<p>The use of ISRAC symbol relates to tests/calibrations which are included in the organization scope of accreditation, and performed according to the accreditation rules as detailed in the accreditation certificate. <u>The scope of accreditation is for Benzene results only</u>, any other information is not part of the accreditation.</p> <p>ISRAC is not responsible for the testing results conducted by the CAB and the CAB's accreditation is not considered as an approval of ISRAC or a different party related to the assessed. ISRAC accreditation is not considered as an approval of either the CAB's procedures or its personnel.</p> <p>This document must be referred to entirely and copying of any part of it to other documents is forbidden.</p>
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Section 1 – Introduction

The purpose of the Argos open-path UV air monitoring project at the Bazan Refinery in Haifa, Israel is to measure Benzene, Toluene, Ethylbenzene and Xylene (BTEX) gases on a real-time basis and to present this information via a secured website. The system also send alerts for detection levels defined by Israeli authorities. The fence-line monitoring equipment is installed along four portions of the fence line at the Bazan refinery, these locations are shown in Figure 1.1. The beam paths covered are referenced as: Refinery Northeastern line 867 meters (UV_1); Gadiv Eastern line 428 meters (UV_2); Western Line (UV_5) 311 m and Refinery Southwestern line (UV_4) 822 meters.

Figure 1.1 - Location Map Showing Fence Lines Covered by Argos Open-path UV Air Monitoring Systems



Each site is equipped with a meteorological station measuring the following parameters:



- Wind speed
- Wind direction
- Temperature
- Relative humidity

The purpose of meteorological station is to help locate pollution source direction only on the Fenceline system height.

The quarterly summary of the measurements performed by the system for Q4-2021, are presented in the sections that follow. The measurements for Benzene were performed using an in-house validated method FLM-QLT-MET-001 Determination of BTEX by UV DOAS based on TO-16 and EPA 301 methods.

During November the system had maintenance audit under which the UV and the Met systems were checked and calibrated, these resulted better performance of the systems.



Section 2 - Quality Assurance Quality Control Checks

The Argos Open-path UV air monitoring systems employ a number of methods to check the data quality of the system. Table 2.1 summarizes the routine data quality checks employed during the project. Each data quality check is described below.

Table 2.1 –Quality Checks

Data Quality Check	Frequency
Continuous Data Quality Checks	Continuous
System Check	Daily
Challenge of System with Known Quantity of Gas	Every two weeks
Independent Check of Gas Detects	As Needed

Continuous Data Quality Checks (Frequency – Continuous)

Data generated by the fence-line monitoring equipment undergoes review throughout the measurement and reporting process. This includes automated QA/QC checks that occur before data is reported on the real-time website. Automated data checks are listed in Table 2.2

System Check (Frequency Daily)

During the measurement period Argos provided continual on-call support for the fence-line monitoring network. This includes an alarm system that notifies a support team in the event of instrument malfunction or high detections of gases, loss of Internet connections and other issues that might impact on the performance of the monitoring equipment. The support team includes staff scientists who are experts in the field for UV spectroscopy. In addition, each day Argos staff remotely access the local instrument computers and perform data checks to ensure the system is operating properly. This includes but was not limited to:

- Troubleshooting software issues
- Checking light signals
- Perform validation checks on gas detections



Table 2.2 – Real-time Data Quality Checks

Real-Time Check	Check	Action
Low Signal Alarm	Signal threshold test	If signal is below threshold value: 1) Real-time website reports "Low Signal" to analyzer. Automated email is sent to notify support staff of the issue.
Instrument Error Code	Instrument Error Code	Real-time website reports "off-line" message. Automated email is sent to notify support staff of the issue.
Instrument Workstation Off-line	Instrument Communication Check	Real-time website reports "off-line" message. Automated email is sent to notify support staff of the issue.
Internet Connection Lost	Backup Connection enabled	Automated email is sent to notify support staff of the issue.
High Detection	Valid Data Detection Above Threshold	Real-time website indicates detection above alarm threshold. Automated email is sent to notify support staff of the issue.

Challenge of System with Known Quantity of Gas (Frequency – Every two weeks)

The UV systems are calibrated by inserting a known concentration of a target gas into the beam and then measuring the system response. The target gas is held inside a sealed cell with windows that minimize absorption of UV light. The measure will be considered passing if the quantified result is within 15% of the expected value.



Tables 2.3, 2.4, 2.5 and 2.6 below summarises the QA check results for the system for Q4 2021.

Table 2.3: Summary of Q4 2021 Benzene Challenge Gas Checks at UV1

Date	Times	Expected (ppb)	Measured (ppb)	% Difference	Status
18 October 2021	17:19	126.29	132.21	4.7	Passed
18 October 2021	17:24	13.49	15.45	14.5	Passed
18 October 2021	17:29	6.38	7.33	14.9	Passed
25 October 2021	12:22	126.29	125.55	0.6	Passed
25 October 2021	12:41	10.53	11.72	11.3	Passed
25 October 2021	12:34	5.38	5.99	11.5	Passed
22 November 2021	13:00	126.29	135.02	6.9	Passed
22 November 2021	13:05	12.46	13.87	11.3	Passed
22 November 2021	13:10	6.45	7.10	10.0	Passed
30 November 2021	15:53	126.29	135.88	7.6	Passed
30 November 2021	15:58	15.80	17.75	12.3	Passed
30 November 2021	16:03	6.63	7.51	13.2	Passed
14 December 2021	14:09	126.29	134.95	6.9	Passed*
14 December 2021	14:14	13.71	15.07	10.0	Passed*
14 December 2021	14:19	6.54	7.19	10.0	Passed*
30 December 2021	14:27	126.29	135.42	7.2	Passed
30 December 2021	14:32	14.65	16.48	12.5	Passed
30 December 2021	14:37	6.83	7.75	13.5	Passed

*Passed/Failed using a 95% confidence interval for the expected value



Table 2.4: Summary of Q4 2021 Benzene Challenge Gas Checks at UV2

Date	Times	Expected (ppb)	Measured (ppb)	% Difference	Status
18 October 2021	18:27	185.61	157.73	15.0	Passed
18 October 2021	18:32	20.71	21.02	1.5	Passed
18 October 2021	18:37	10.27	10.36	0.9	Passed
26 October 2021	08:48	185.61	161.57	13.0	Passed
26 October 2021	08:55	20.78	19.83	4.6	Passed
26 October 2021	09:02	9.64	9.29	3.6	Passed
23 November 2021	11:23	185.61	167.73	9.6	Passed
23 November 2021	11:28	16.64	17.19	3.3	Passed
23 November 2021	11:33	7.95	8.14	2.4	Passed**
30 November 2021	12:33	185.61	176.23	5.1	Passed
30 November 2021	12:38	16.53	17.57	6.3	Passed
30 November 2021	12:43	9.04	9.64	6.7	Passed
14 December 2021	14:51	185.61	175.60	5.4	Passed
14 December 2021	14:56	26.87	26.54	1.2	Passed
14 December 2021	15:01	13.11	12.81	2.3	Passed
26 December 2021	17:05	173.94	159.19	8.5	Passed
26 December 2021	17:15	22.22	20.11	9.5	Passed
27 December 2021	08:16	8.96	8.95	0.1	Passed

**Poor correlation coefficient



Table 2.5: Summary of Q4 2021 Benzene Challenge Gas Checks at UV4

Date	Times	Expected (ppb)	Measured (ppb)	% Difference	Status
21 October 2021	09:51	109.27	109.97	0.6	Passed
21 October 2021	10:03	14.09	15.56	10.4	Passed*
21 October 2021	09:57	4.43	7.30	64.8	Failed*
25 October 2021	10:41	109.27	111.25	1.8	Passed
25 October 2021	10:01	10.44	8.17	21.7	Failed
25 October 2021	09:55	2.57	2.67	4.2	Passed*
22 November 2021	14:59	109.27	96.45	11.7	Passed
22 November 2021	15:04	12.48	13.30	6.6	Passed*
22 November 2021	15:09	6.48	7.44	15.0	Passed*
30 November 2021	13:50	98.58	87.21	11.5	Passed
30 November 2021	13:55	9.98	10.36	3.8	Passed**
30 November 2021	14:00	3.73	3.96	6.2	Passed*
14 December 2021	15:47	109.27	90.19	17.5	Failed
14 December 2021	15:52	12.53	11.54	7.9	Passed*
14 December 2021	15:57	4.78	5.45	14.2	Passed**
29 December 2021	11:39	109.27	105.75	3.2	Passed
29 December 2021	11:44	13.35	12.82	4.0	Passed*,**
29 December 2021	11:50	6.70	6.49	3.1	Passed*,**

*Passed/Failed using a 95% confidence interval for the expected value

**Poor correlation coefficient



Table 2.6: Summary of Q4 2021 Benzene Challenge Gas Checks at UV5

Date	Times	Expected (ppb)	Measured (ppb)	% Difference	Status
18 October 2021	19:03	307.09	364.12	18.6	Failed
18 October 2021	19:08	34.49	39.60	14.8	Passed
18 October 2021	19:13	14.96	16.75	12.0	Passed
26 October 2021	08:56	307.09	348.41	13.5	Passed
26 October 2021	09:02	21.10	20.77	1.6	Passed*
26 October 2021	09:14	9.91	9.10	8.1	Passed*
22 November 2021	14:01	307.09	336.51	9.6	Passed
22 November 2021	14:06	16.16	17.86	10.5	Passed*
22 November 2021	14:11	7.08	8.14	15.0	Passed
30 November 2021	15:05	307.09	328.22	6.9	Passed
30 November 2021	15:10	16.30	17.02	4.4	Passed*
30 November 2021	15:15	6.69	7.60	13.5	Passed*
14 December 2021	16:38	307.09	359.05	16.9	Failed
14 December 2021	16:43	13.44	15.32	14.0	Passed*
14 December 2021	16:48	7.45	7.83	5.1	Passed*
26 December 2021	16:23	379.53	405.56	6.9	Passed
26 December 2021	16:29	35.58	40.53	13.9	Passed
26 December 2021	16:35	19.08	17.35	9.1	Passed

*Passed/Failed using a 95% confidence interval for the expected value



Independent Check of Gas Detects

In addition to automated features in the software, Argos technical data analysts have the ability to check the system performance by carrying out independent quantification of target gases. Depending on the specific application, these activities are performed on a routine basis to ensure the automated data collection and verification process is functioning correctly. An example of this process is presented below:

- Collect a data spectrum in the atmosphere when the target gas is not present. Define this as the background spectrum.
- Collect a data spectrum in the atmosphere when the target gas is present. Define this as the data spectrum.
- Subtract the logarithms of the two spectra. This resulting spectrum is defined as an absorbance spectrum.
- Compare this spectrum to a quantitative absorbance spectrum of the target gas.

Minimum Detection Limit Checks

The minimum detection limits for the system were calculated for Q4-2021 and are shown in Table 2.7 below:

Table 2.7: Minimum Detection Limits for Systems for Q4 2021

Location	October MDL (ppb)	November MDL (ppb)	December MDL (ppb)
UV_1	0.38	0.245	0.68
UV_2	0.69	0.298	0.45
UV_4	3.80	0.705	0.32
UV_5	0.46	0.627	0.74



Section 3 - Summary of Field Data

As mentioned in Section 1, the air monitoring equipment operated continuously during Q4 2021. The following figures and tables summarize the data collected during this time period for BTEX gases. Each system collected data at five-minute averages. Table 3.1 lists the time periods that valid data was collected at each location.

Table 3.1 – Data Collection periods

Location	Data Start	Data End	Onstream (%)
UV_1	1/10/2021	31/12/2021	98.93
UV_2	1/10/2021	31/12/2021	98.08
UV_4	1/10/2021	31/12/2021	96.62
UV_5	1/10/2021	31/12/2021	99.17

The following alarms were set by the client and were used to measure the performance of the system:

- Benzene:
 - 20 microgram/m³ half hour average. (30 min alarm)
 - 2 consecutive measurements of 10 microgram/m³ half hour average. (1 hr alarm)
 - 3.9 microgram/m³ daily average. (24 hr alarm)
- Toluene: 3,770 microgram/m³ daily average.
- Total Xylenes: 4,800 microgram/m³ daily average (Almog value).
- Ethyl Benzene: 54,000 microgram/m³ 15-minute average (Almog value)



UV1 – Summary of Daily Average Field Data

Figures 3.1 to 3.5 show the daily average data collected from the UV1 system

Figure 3.1 – Benzene 24 Hour Average Data for UV1 for Q4 2021

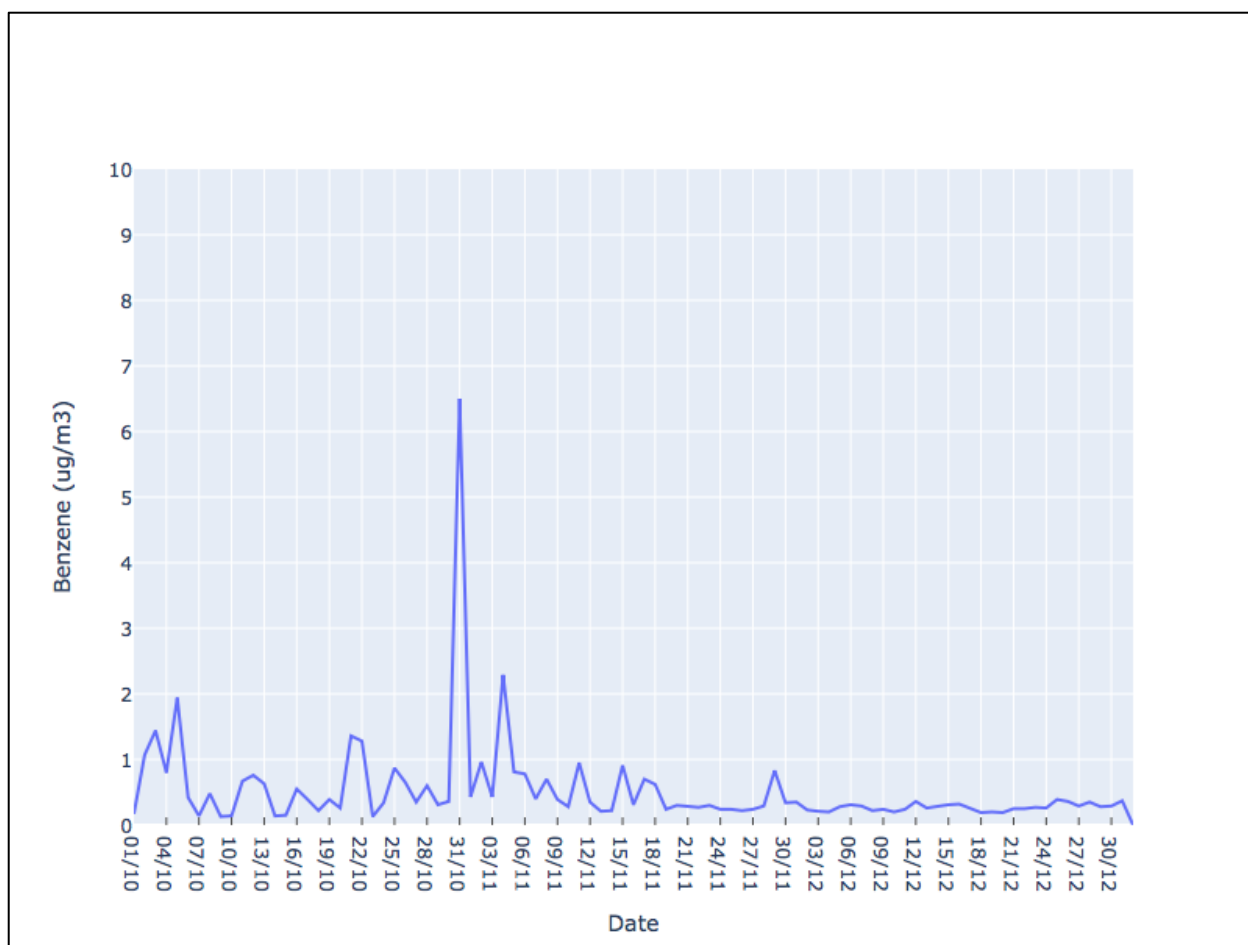




Figure 3.2 – Toluene 24 Hour Average Data for UV1 for Q4 2021

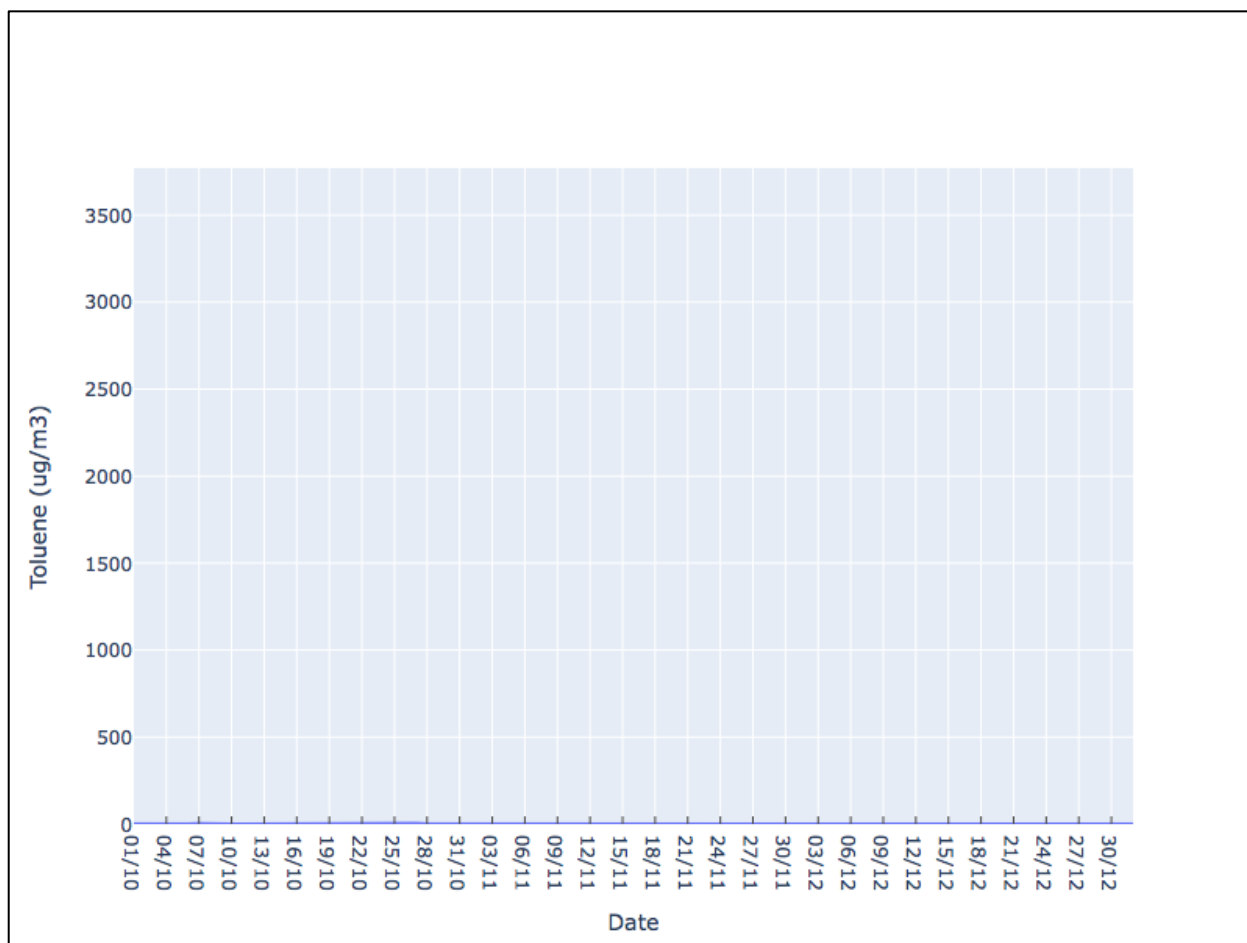




Figure 3.3 – Xylene 24 Hour Average Data for UV1 for Q4 2021

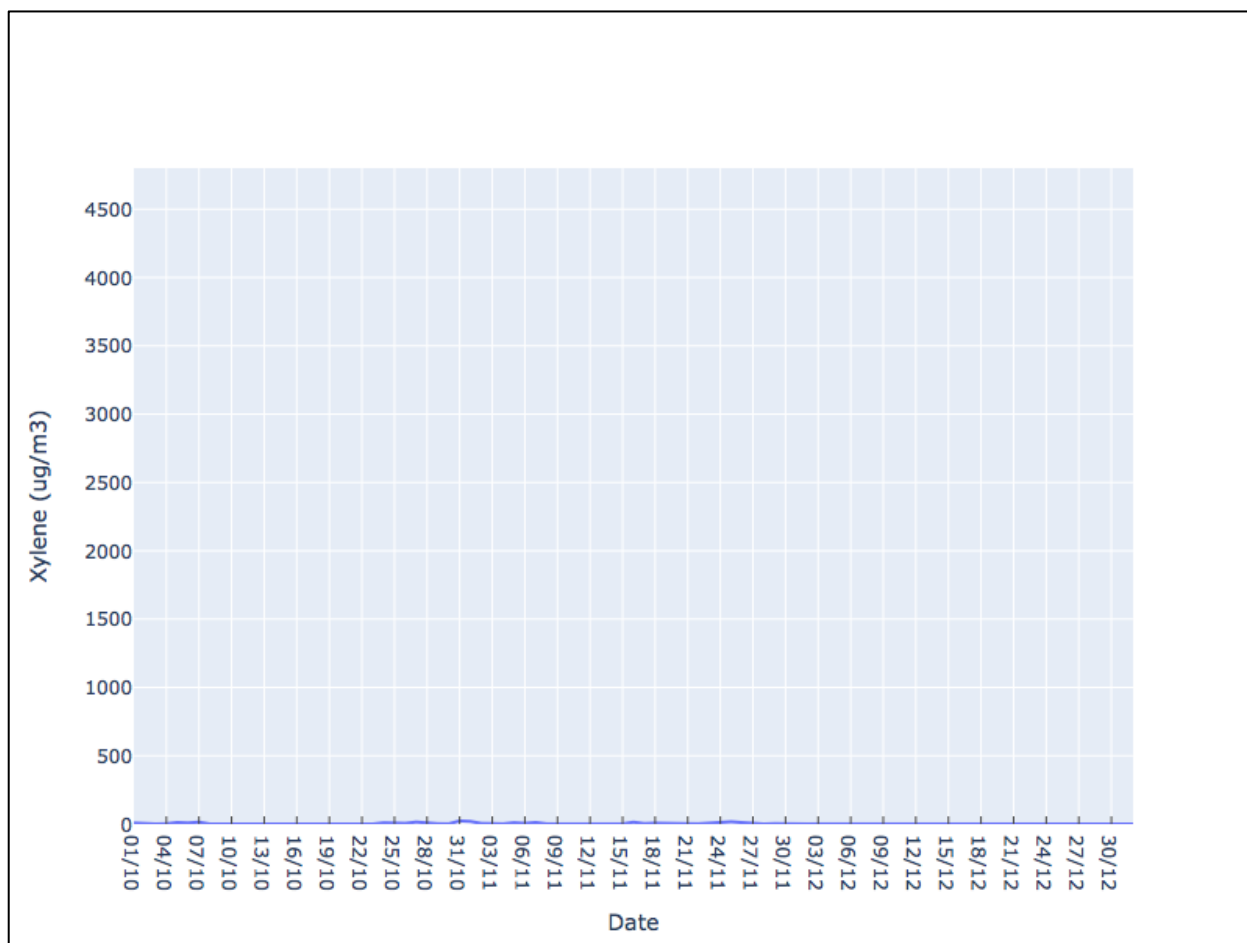




Figure 3.4 - Ethyl Benzene 24 Hour Average Data for UV1 for Q4 2021

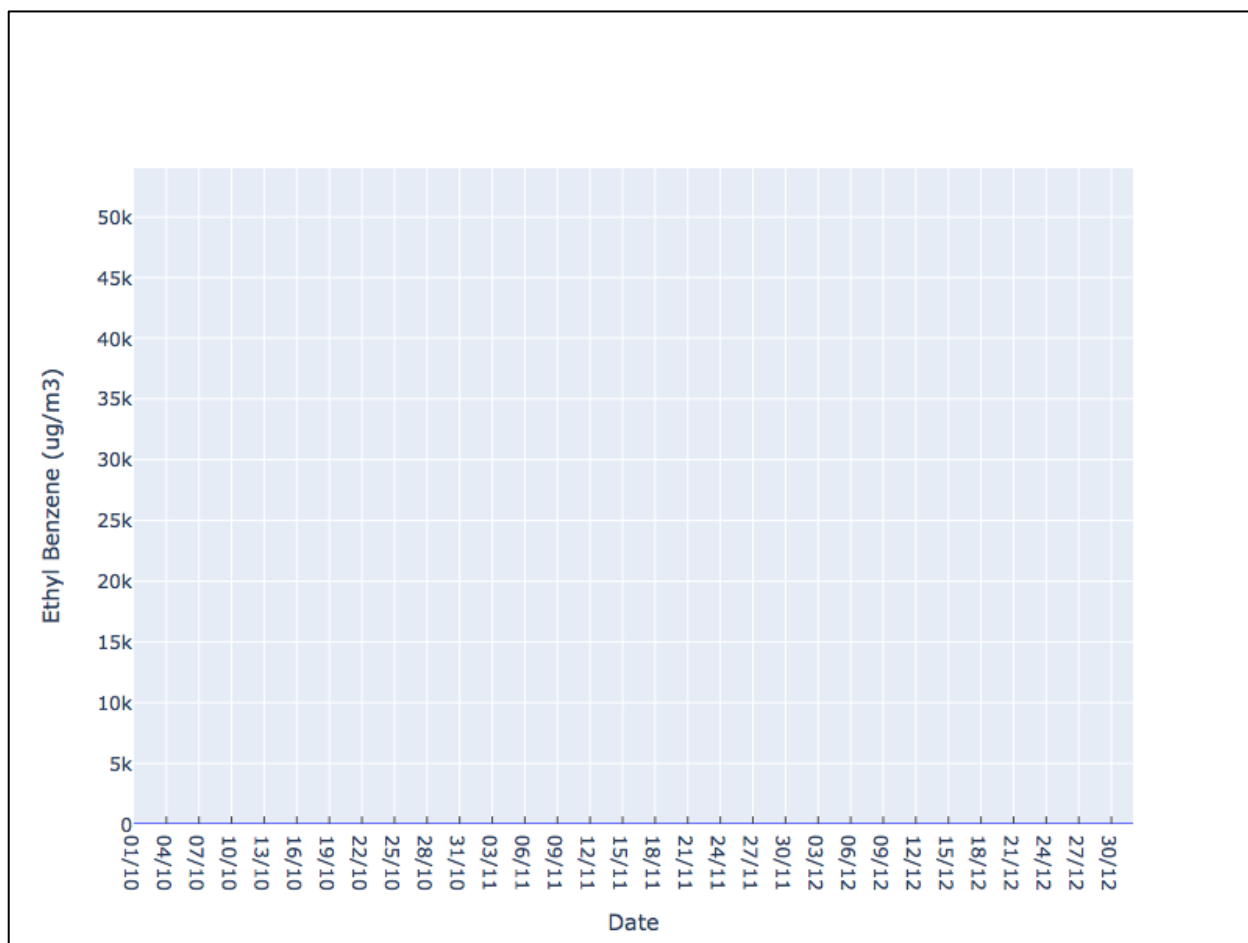
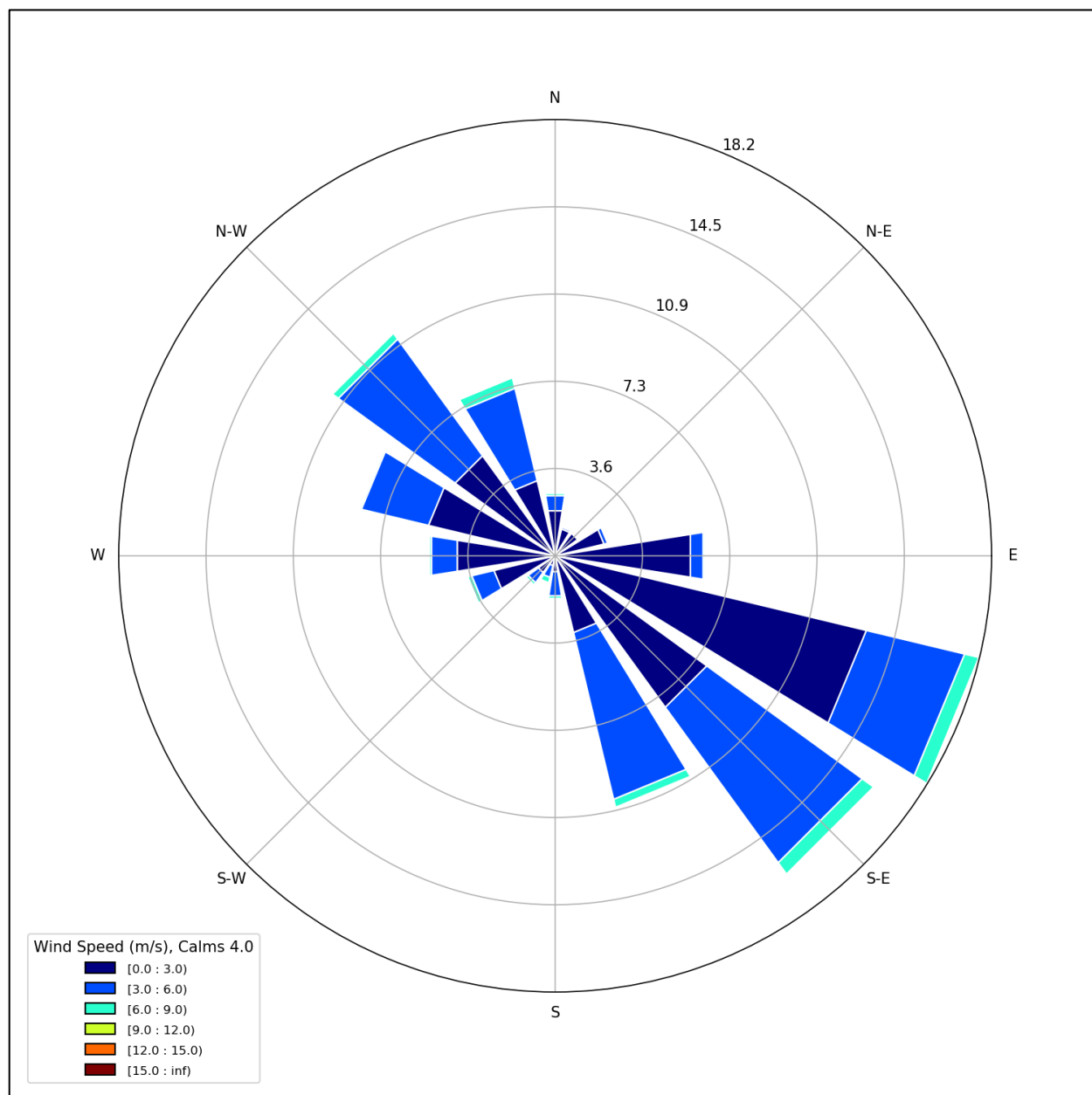


Figure 3.5 – Wind Speed and Wind Direction for UV1 for Q4 2021





UV2 – Summary of Realtime Field Data

Figures 3.6 to 3.10 show the daily average data collected from the UV2 system

Figure 3.6 – Benzene 24 Hour Average Data for UV2 for Q4 2021

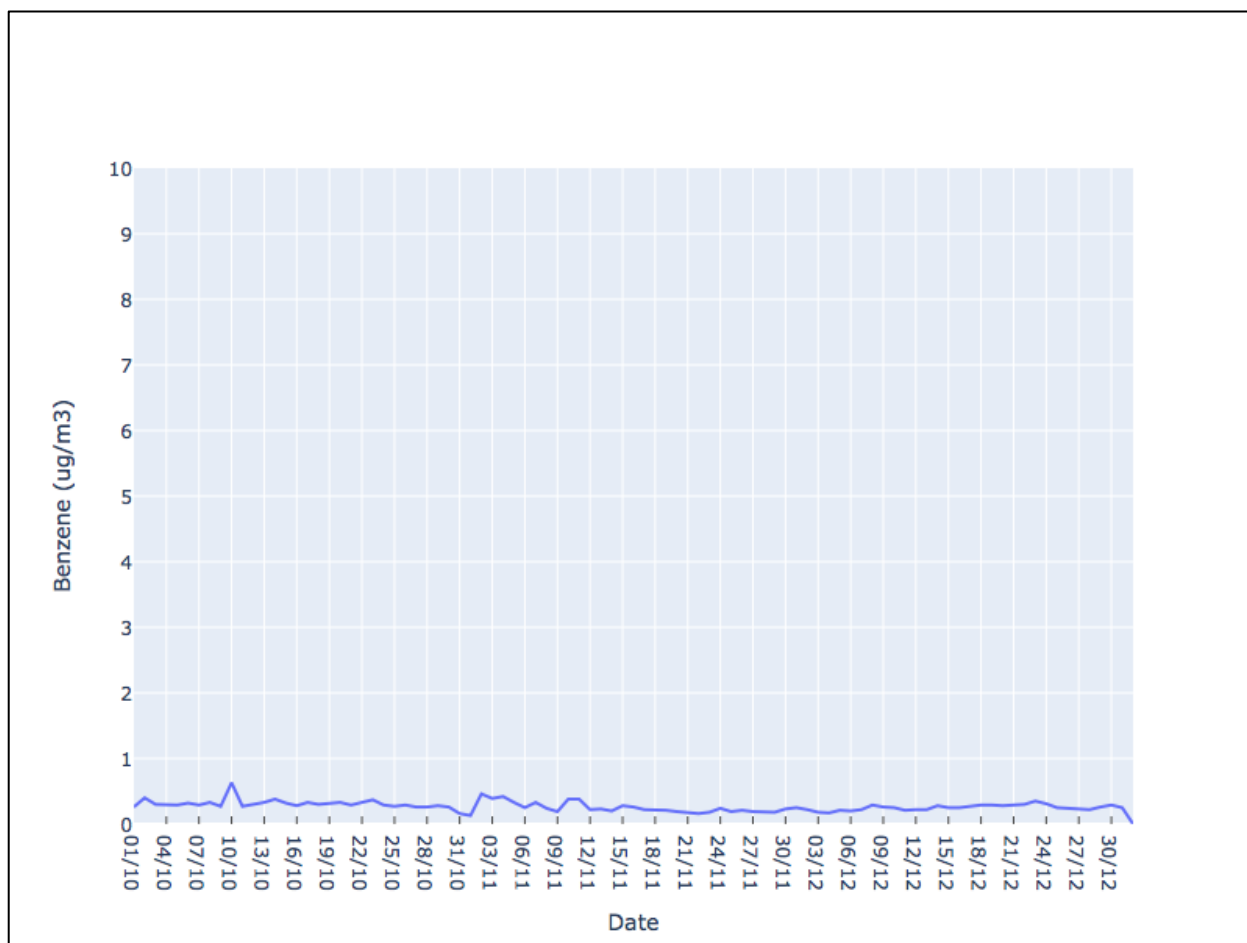




Figure 3.7 – Toluene 24 Hour Average Data for UV2 for Q4 2021

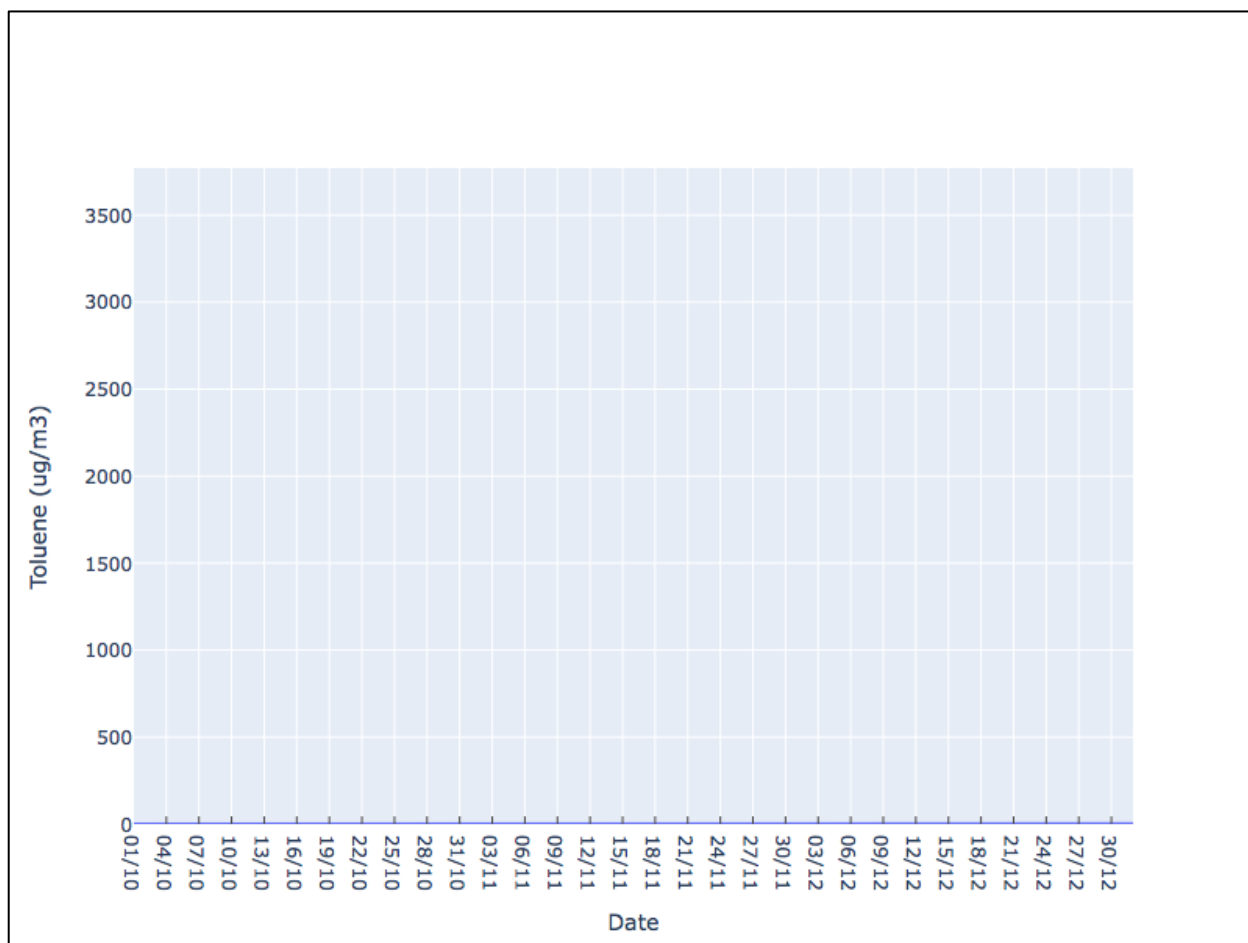




Figure 3.8 – Xylene 24 Hour Average Data for UV2 for Q4 2021

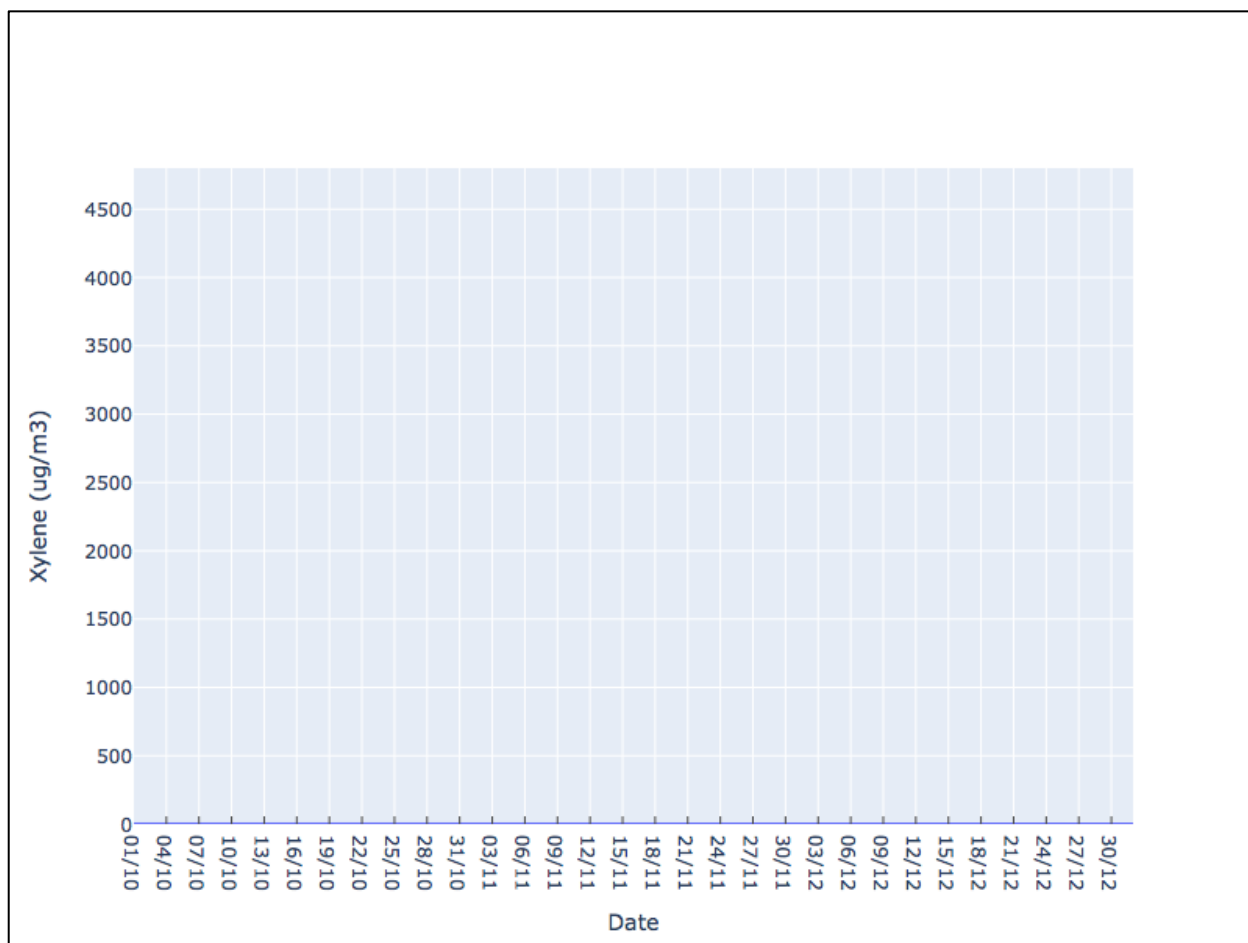




Figure 3.9 – Ethyl Benzene 24 Hour Average Data for UV2 for Q4 2021

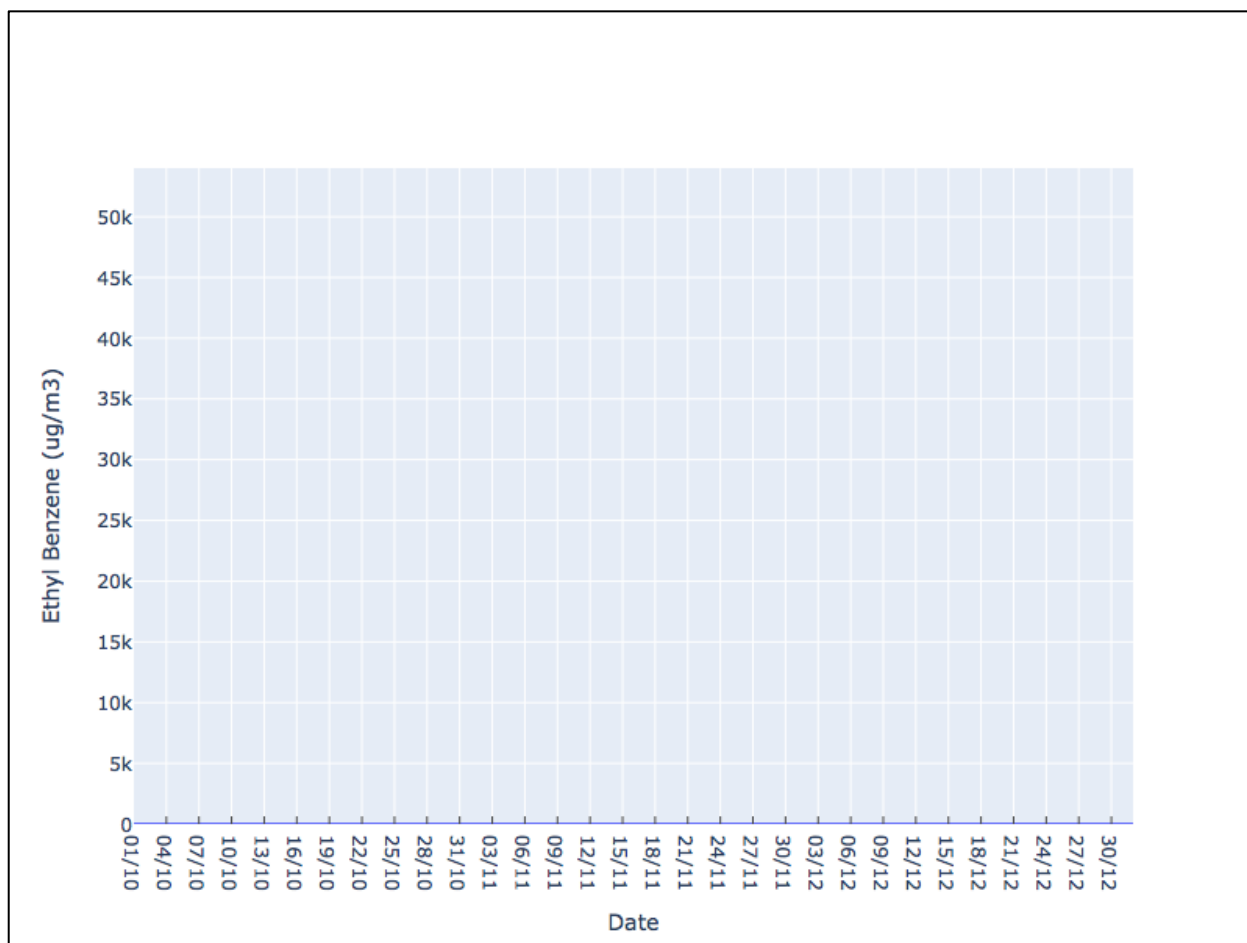
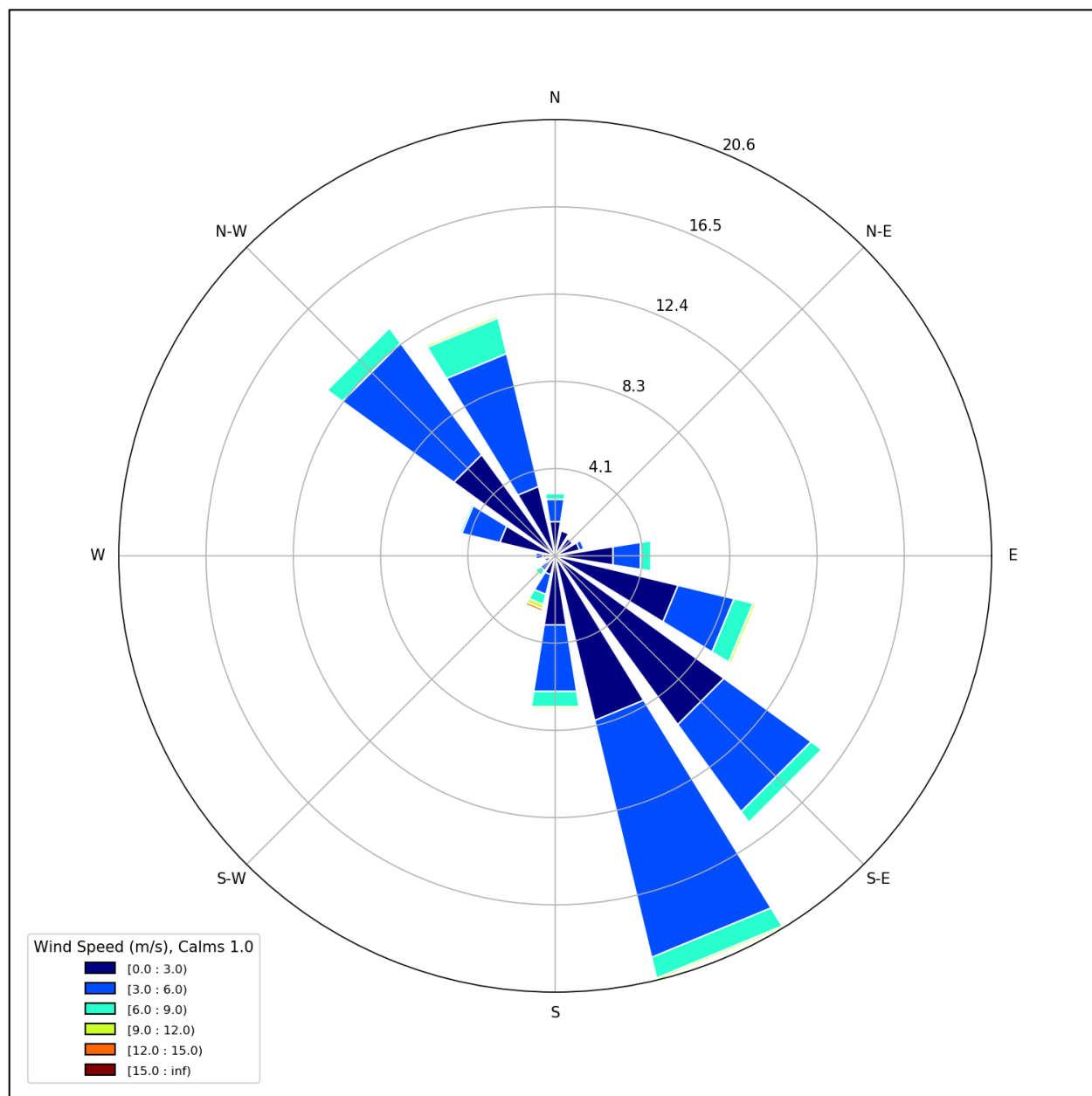




Figure 3.10 – Wind Speed and Wind Direction for UV2 for Q4 2021





UV4 – Summary of Realtime Field Data

Figures 3.11 to 3.15 show the daily average data collected from the UV4 system

Figure 3.11 – Benzene 24 Hour Average Data for UV4 for Q4 2021

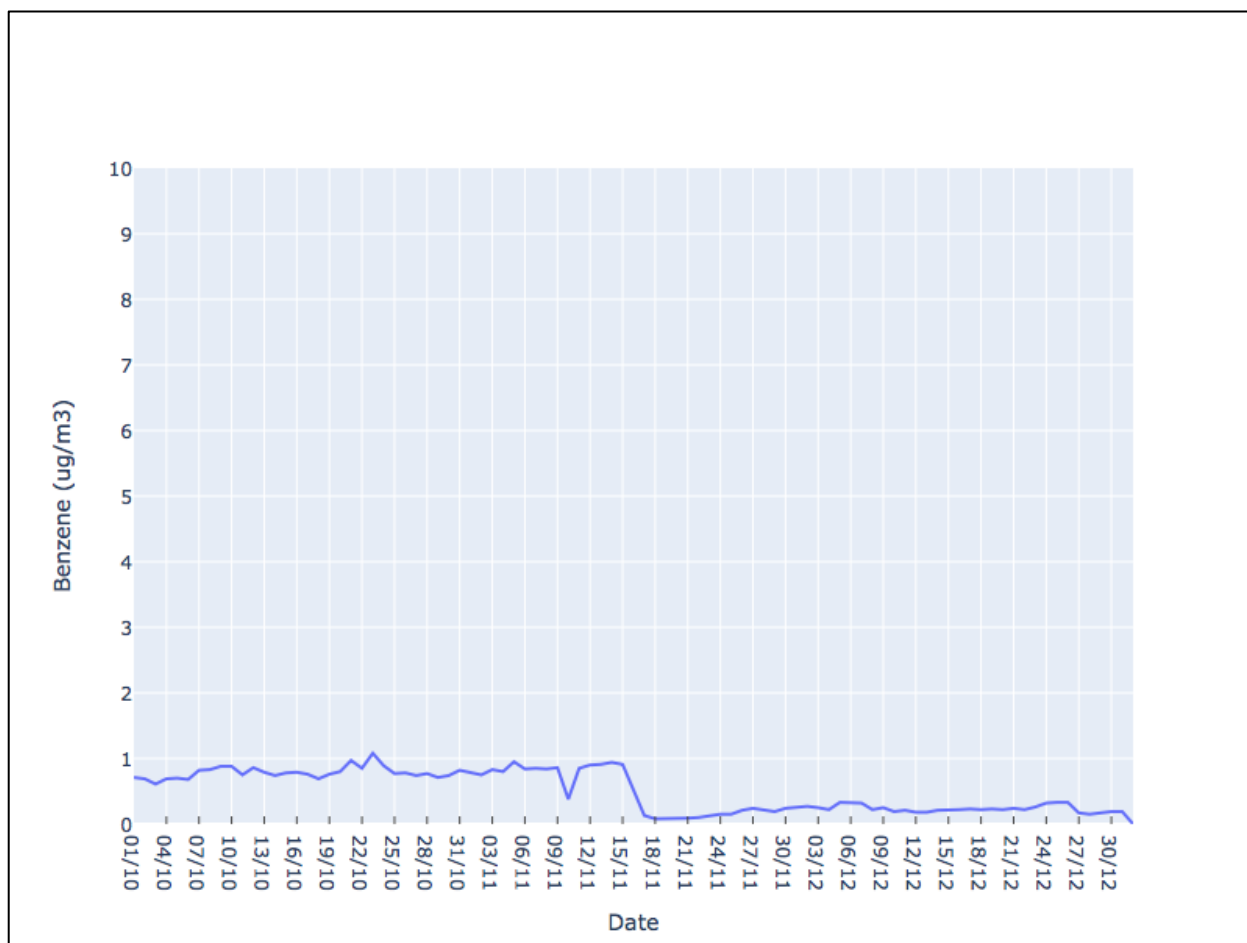




Figure 3.12 – Toluene 24 Hour Average Data for UV4 for Q4 2021

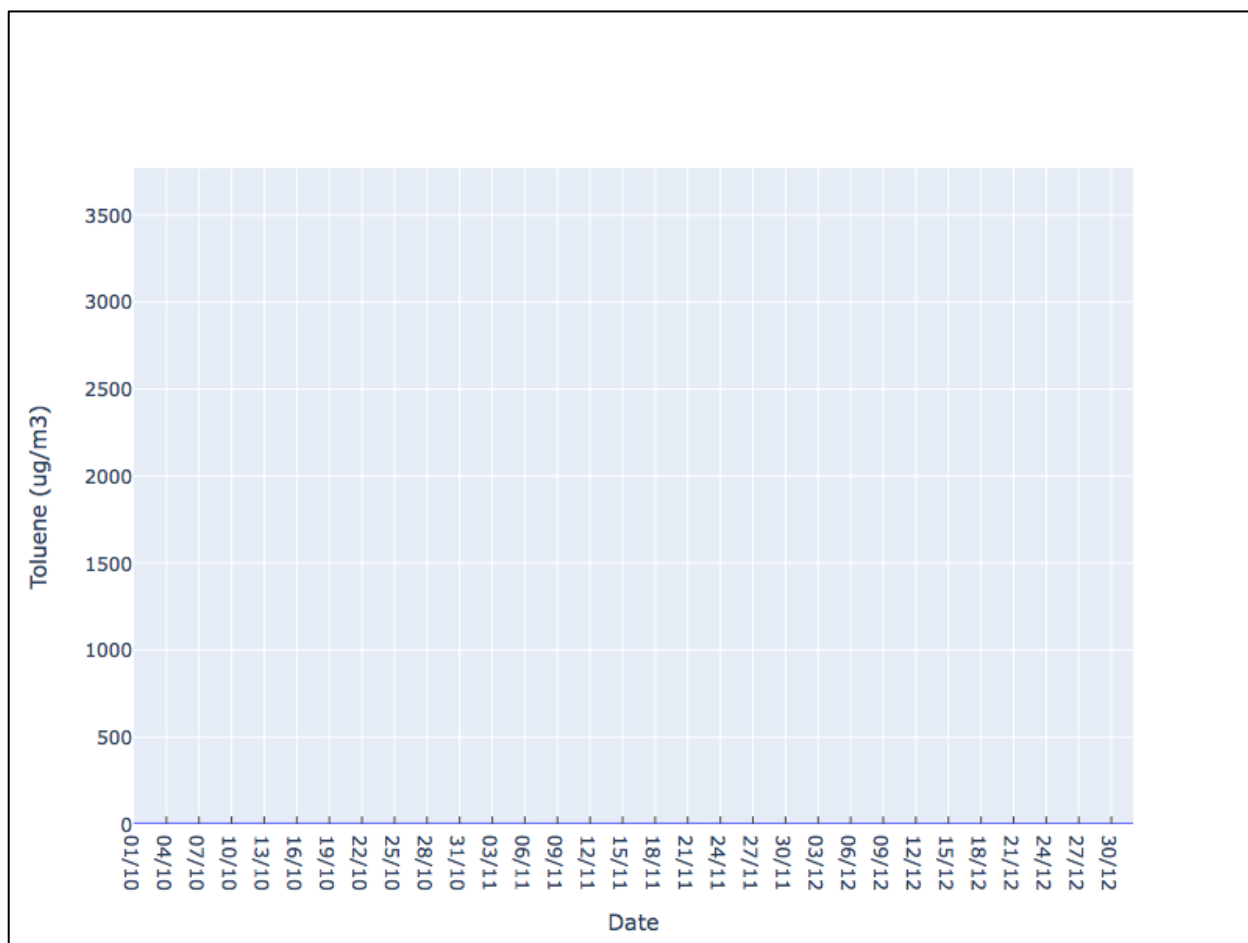




Figure 3.13 – Xylene 24 Hour Average Data for UV4 for Q4 2021

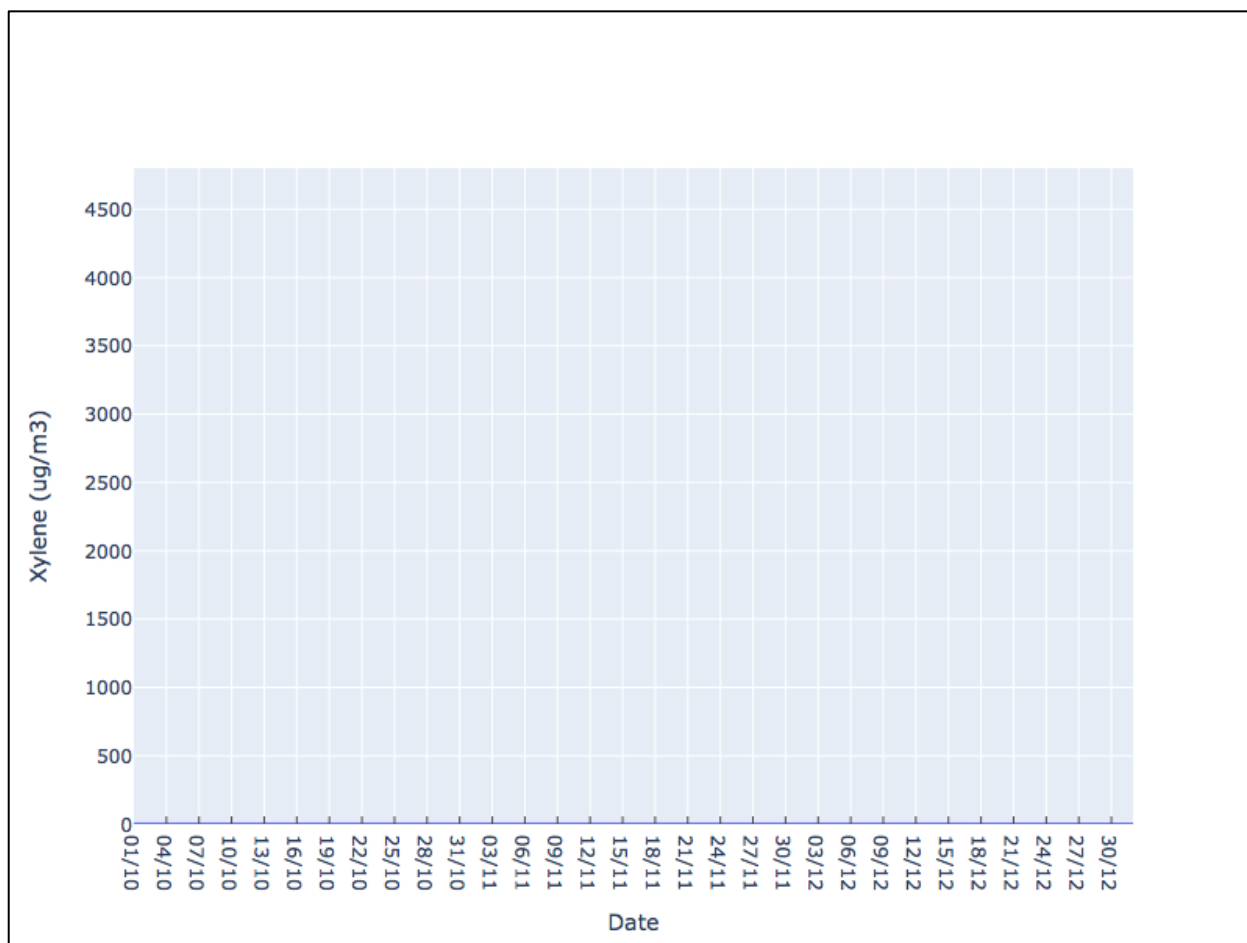




Figure 3.14 – Ethyl Benzene 24 Hour Average Data for UV4 for Q4 2021

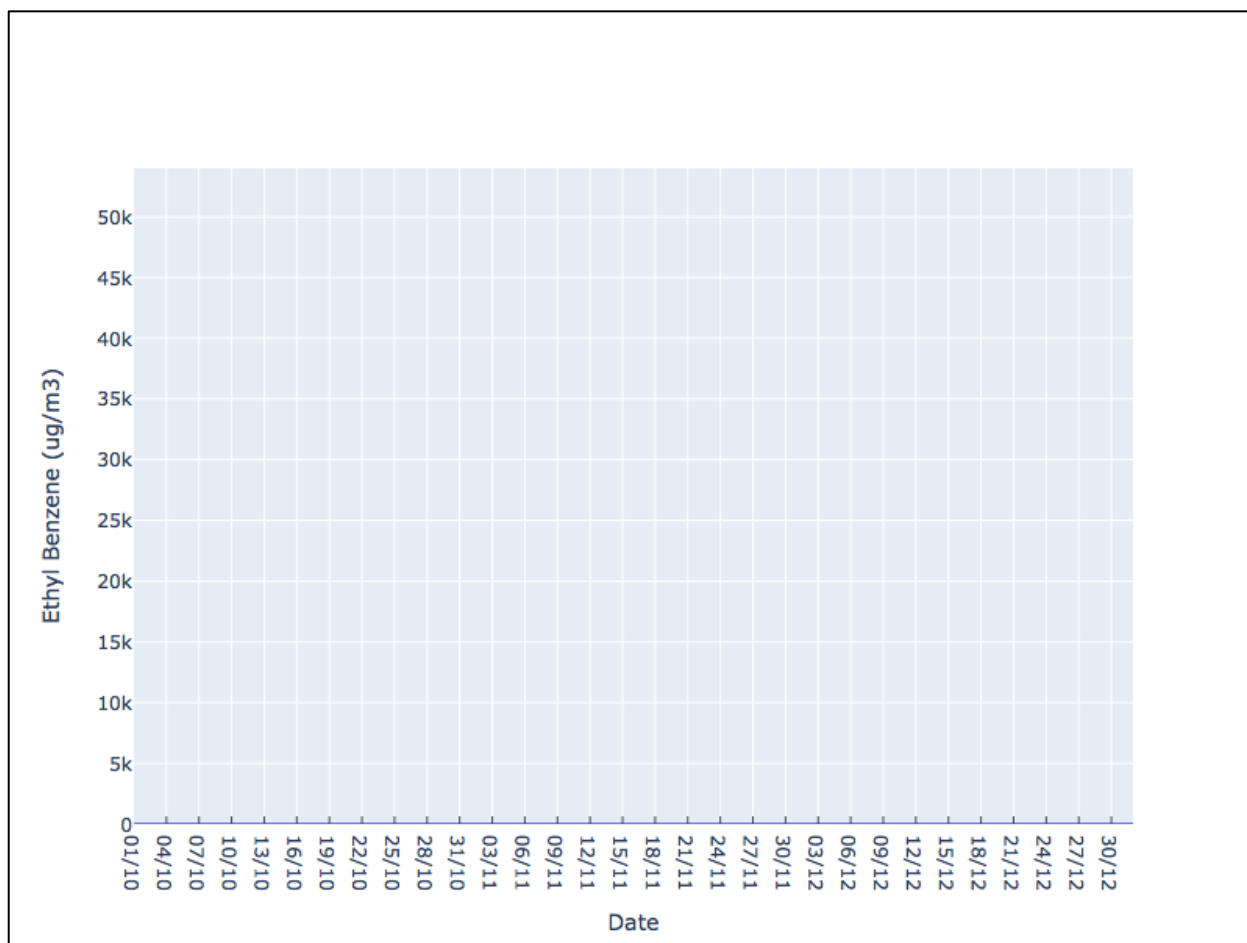
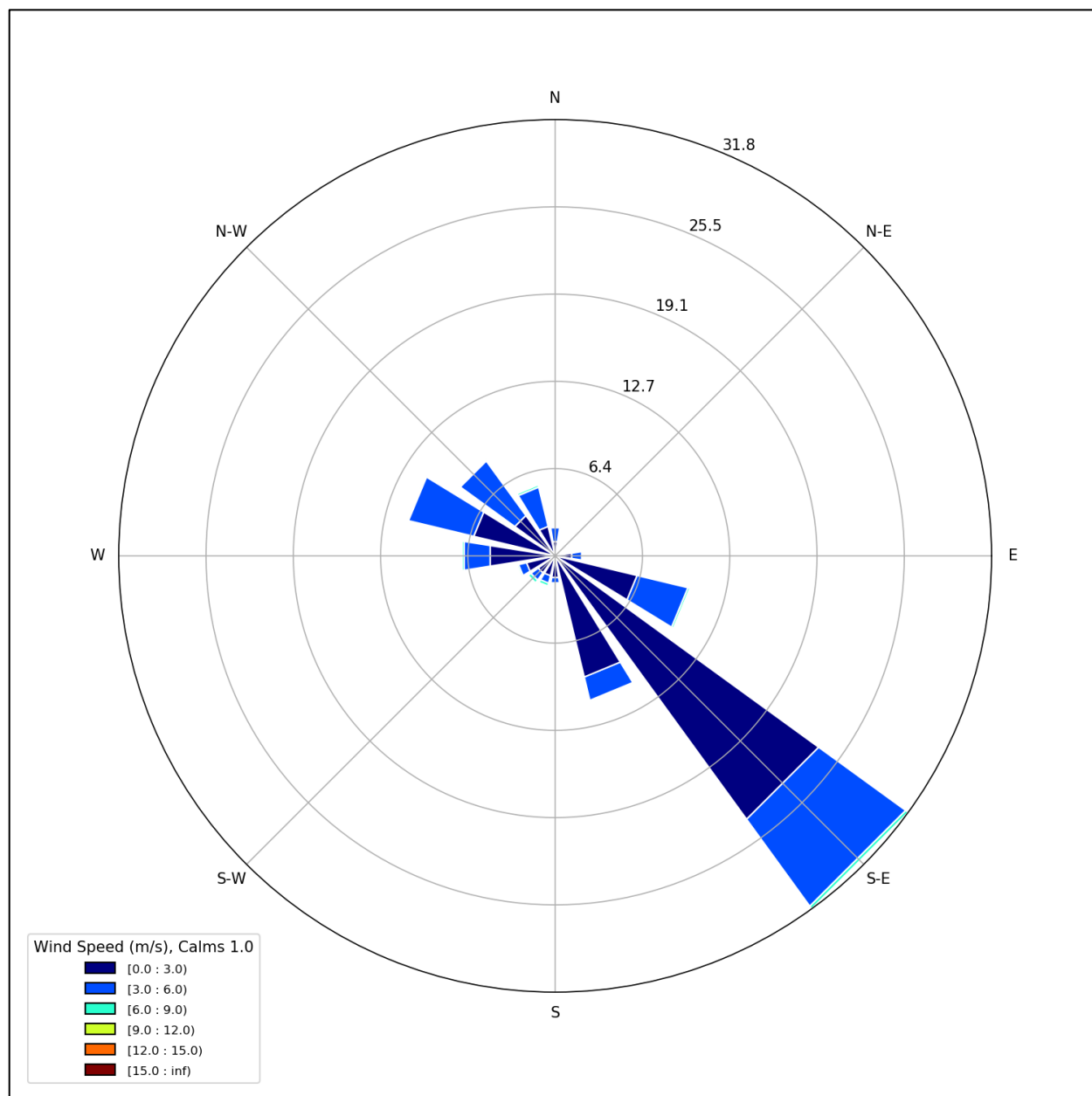




Figure 3.15 – Wind Speed and Wind Direction for UV4 for Q4 2021





UV5 – Summary of Realtime Field Data

Figures 3.16 to 3.20 show daily average data collected from the UV5 system

Figure 3.16 – Benzene 24 Hour Average Data for UV5 for Q4 2021

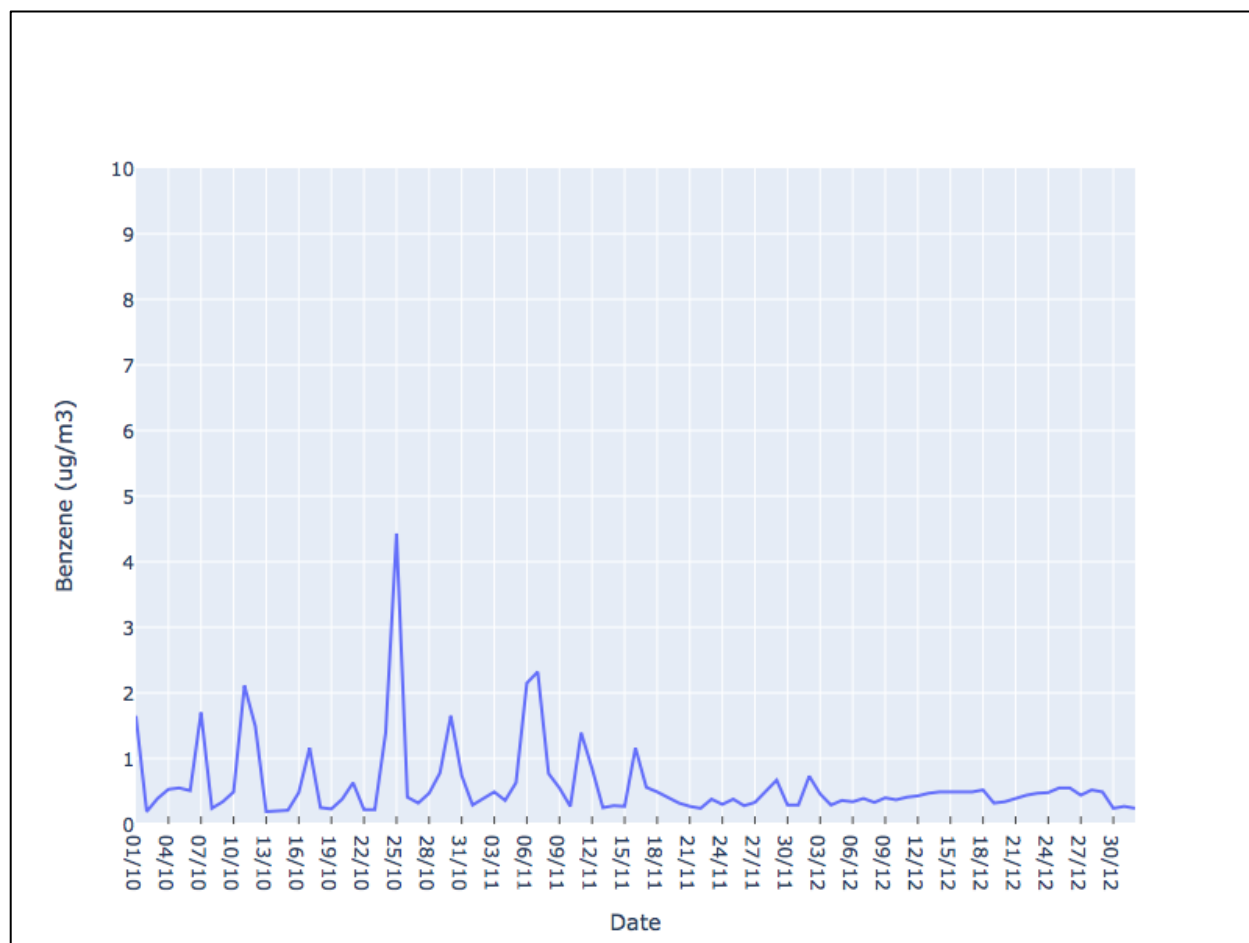




Figure 3.17 – Toluene 24 Hour Average Data for UV5 for Q4 2021

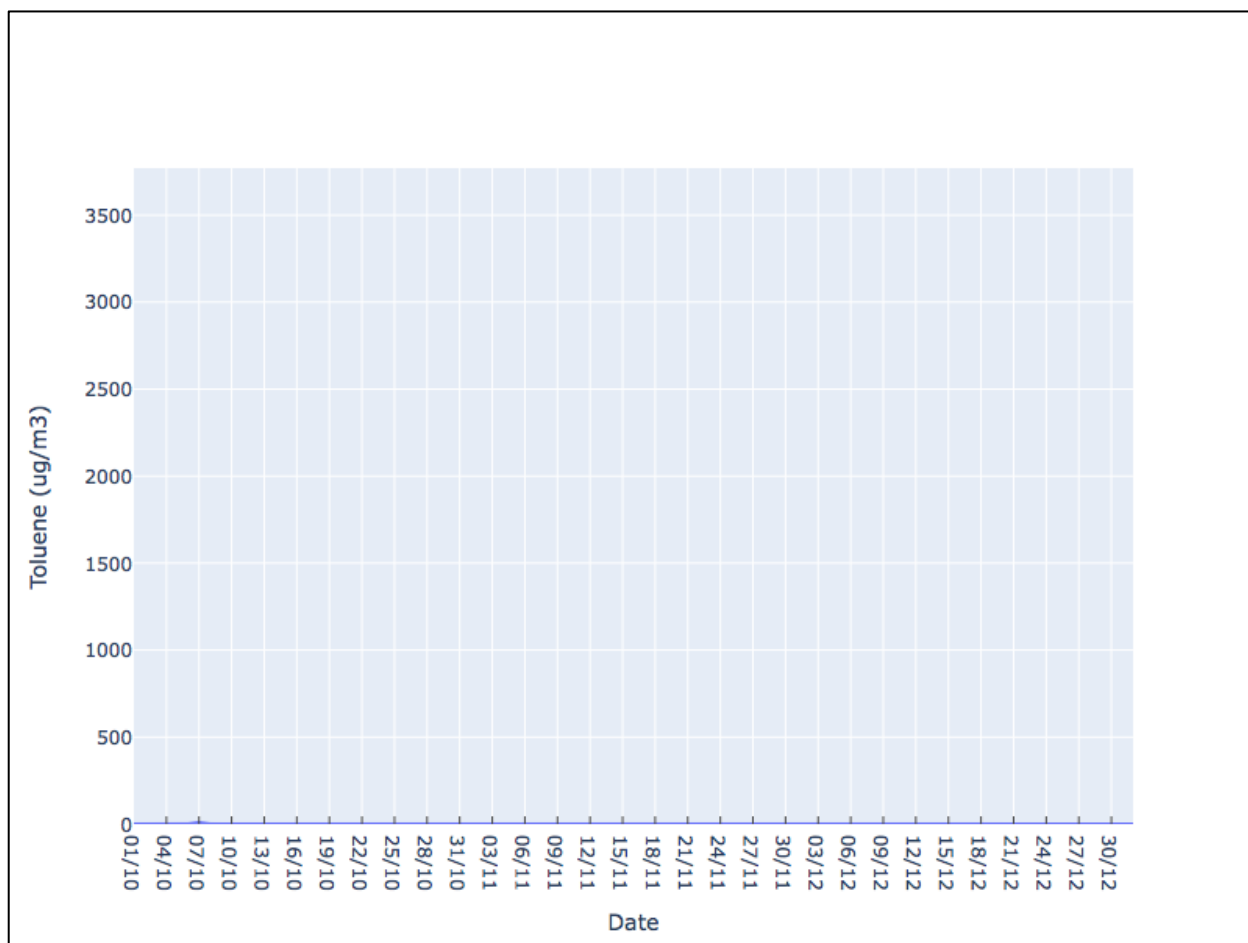




Figure 3.18 – Xylene 24 Hour Average Data for UV5 for Q4 2021

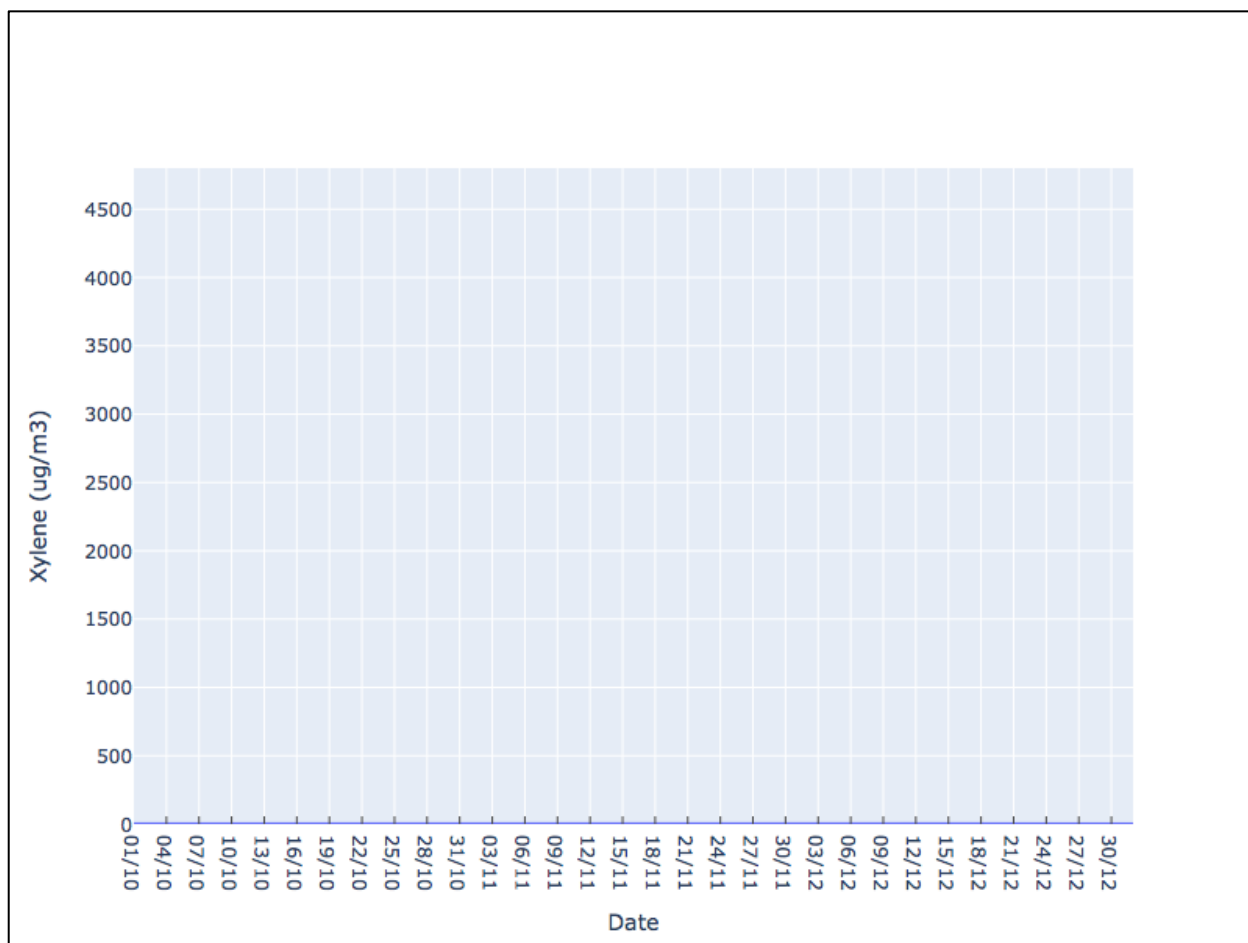




Figure 3.19 – Ethyl Benzene 24 Hour Average Data for UV5 for Q4 2021

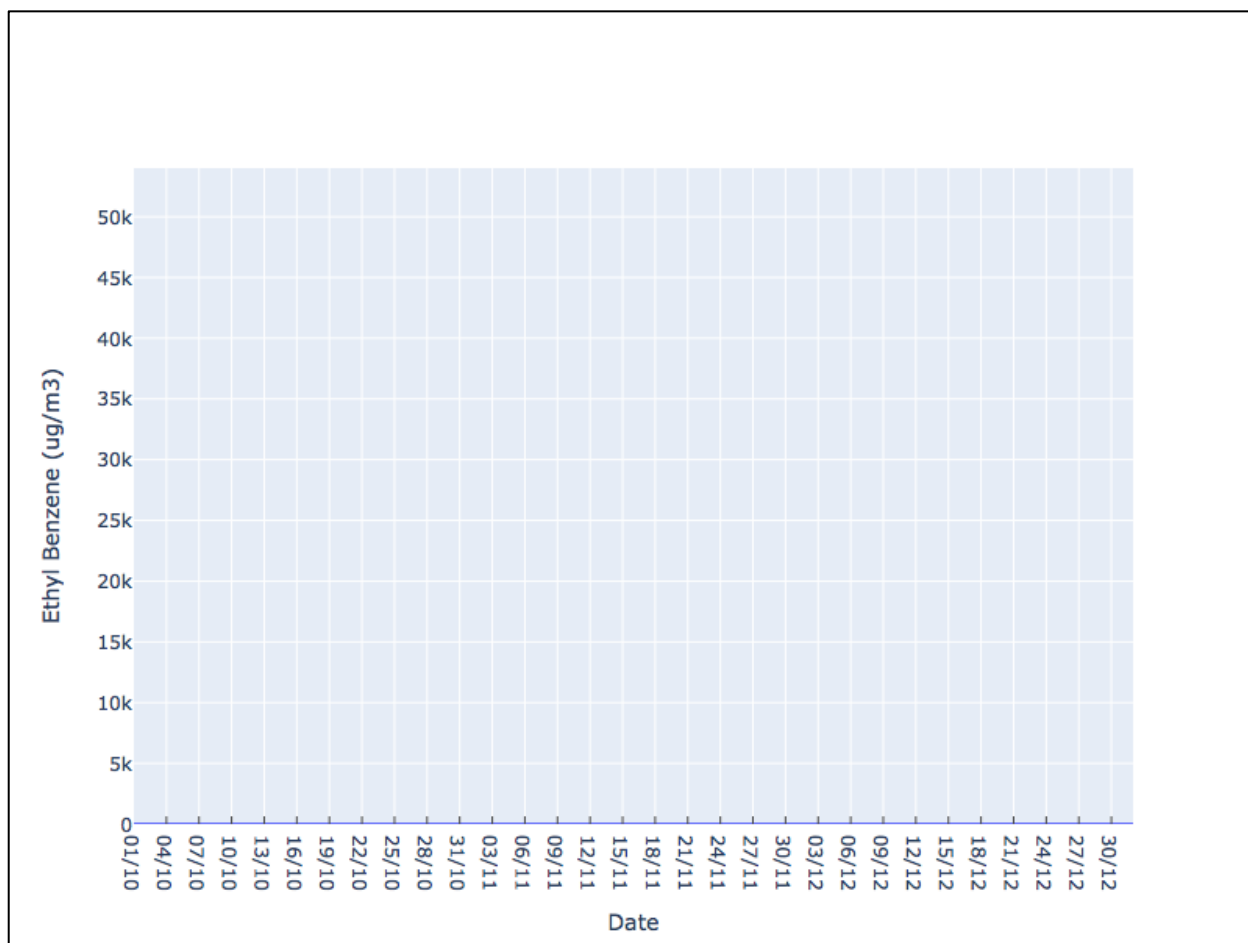
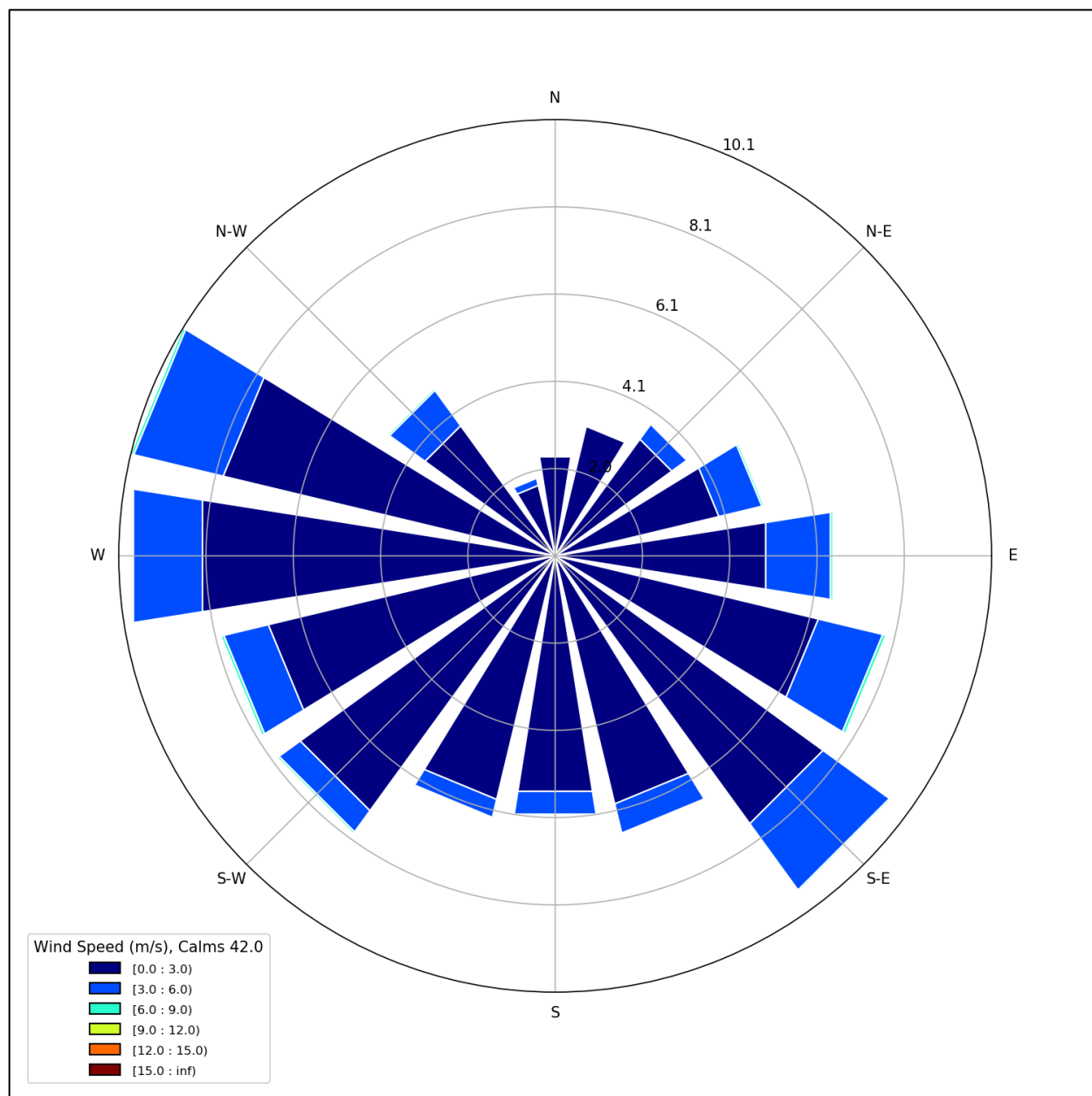


Figure 3.20 – Wind Speed and Wind Direction Data for UV5 for Q4 2021





The 24-hr alarm level was exceeded for benzene at UV1 and UV5 for Q4 2021:

- UV1 recorded $6.5 \mu\text{g}/\text{m}^3$ on 31 October 2021 00:00:00
- UV5 recorded $4.43 \mu\text{g}/\text{m}^3$ on 25 October 2021 00:00:00



Section 4 – Summary Notes

From the results in Section 3 above the following were noted:

- The sample paths detected compounds at different times. This was expected as the paths (due to their orientation) were affected by sources from the refinery under different weather conditions.
- Winds were predominantly from the South-East during the period under review.

The results of the measurements indicate the Argos Open-path UV air monitoring systems were able to detect and quantify BTEX emissions from sources both within and outside of the Bazan Refinery. Specific activities associated with detections by the fence-line systems could be identified based on the specific gases being detected, the wind speed and direction, and the specific time of day when the detection occurred.



Appendix A: Calibration Certificates



Sealed Calibration Cell

Certificate of Calibration

This calibration cell was individually calibrated by spectroscopic analysis using ultra-violet reference libraries created by permeation tubes traceable to N.I.S.T standards.

Permeation Tube Serial Number: 46797

Permeation Fluid: Benzene

Calibration Cell Serial # Benz 010921-01

Reference Spectra Concentration: 106.8 ppm-m

95% confidence \pm 1.93%

Correlation Coefficient: .960

Laboratory Manager:

Date: July 01, 2021

Brentley S. Olive Ph.D.



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Sealed Calibration Cell

Certificate of Calibration

This calibration cell was individually calibrated by spectroscopic analysis using ultra-violet reference libraries created by permeation tubes traceable to N.I.S.T standards.

Permeation Tube Serial Number: 46797

Permeation Fluid: Benzene

Calibration Cell Serial # Benz 010921-02

Reference Spectra Concentration: 80.6 ppm-m

95% confidence \pm 0.88%

Correlation Coefficient: .972

Laboratory Manager:

Date: July 01, 2021

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Sealed Calibration Cell

Certificate of Calibration

This calibration cell was individually calibrated by spectroscopic analysis using ultra-violet reference libraries created by permeation tubes traceable to N.I.S.T standards.

Permeation Tube Serial Number: 46797

Permeation Fluid: Benzene

Calibration Cell Serial # Benz 010921-03

Reference Spectra Concentration: 100.2 ppm-m

95% confidence \pm 0.53%

Correlation Coefficient: .939

Laboratory Manager: 

Date: July 01, 2021

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Sealed Calibration Cell

Certificate of Calibration

This calibration cell was individually calibrated by spectroscopic analysis using ultra-violet reference libraries created by permeation tubes traceable to N.I.S.T standards.

Permeation Tube Serial Number: 46797

Permeation Fluid: Benzene

Calibration Cell Serial # Benz 010921-04

Reference Spectra Concentration: 90.8 ppm-m

95% confidence \pm 0.80%

Correlation Coefficient: .978

Laboratory Manager: _____

Date: July 01, 2021

Brentley S. Olive Ph.D.



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