



TODOROSKI
AIR SCIENCES

NORTHCONNEX
IN-TUNNEL AIR QUALITY MONITORING
INDEPENDENT AUDIT

Transurban

13 October 2021

Job Number 20071149

Prepared by

Todoroski Air Sciences Pty Ltd

Suite 2B, 14 Glen Street

Eastwood, NSW 2122

Phone: (02) 9874 2123

Fax: (02) 9874 2125

Email: info@airsciences.com.au

NorthConnex

In-Tunnel Air Quality Monitoring

Independent Audit

DOCUMENT CONTROL

Report Version	Date	Prepared by	Reviewed by
DRAFT - 001	11/10/2021	K Trahair & A Todoroski	A Todoroski
FINAL - 001	13/10/2021	K Trahair & A Todoroski	

This report has been prepared in accordance with the scope of works between Todoroski Air Sciences Pty Ltd (TAS) and the client. TAS relies on and presumes accurate the information (or lack thereof) made available to it to conduct the work. If this is not the case, the findings of the report may change. TAS has applied the usual care and diligence of the profession prevailing at the time of preparing this report and commensurate with the information available. No other warranty or guarantee is implied in regard to the content and findings of the report. The report has been prepared exclusively for the use of the client, for the stated purpose and must be read in full. No use of this or report or part thereof by any third party is permitted without prior written agreement by Todoroski Air Sciences. No responsibility is accepted for the use of the report or part thereof in any other context or by any third party in any circumstance. Copyright is reserved by Todoroski Air Sciences.

TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	SCOPE OF WORK.....	1
2.1	Project Requirements.....	1
3	IN-TUNNEL MONITORING.....	2
4	AIR QUALITY GOALS.....	2
4.1	Nitrogen dioxide.....	2
4.2	Carbon monoxide.....	2
4.3	Visibility.....	2
4.4	NorthConnex in-tunnel air quality limits.....	2
5	IN-TUNNEL MONITORING DATA.....	4
5.1	Pollutant monitoring data.....	4
5.2	Visibility monitoring data.....	7
6	DISCUSSION AND RECOMMENDATIONS.....	A-1
7	REFERENCES.....	A-2

LIST OF APPENDICES

Appendix A –Monitoring Locations

Appendix B – Rolling 3-minute CO Monitoring Data (Graphical)

LIST OF TABLES

Table 2-1: In-tunnel monitoring methodologies required under Condition E1	1
Table 4-1: NorthConnex in-tunnel average limits along length of tunnel	2
Table 4-2: NorthConnex in-tunnel single point exposure limits	2
Table 4-3: NorthConnex in-tunnel visibility limits along length of tunnel	3
Table 5-1: Percentage of data capture available for the review period – Northbound tunnel	4
Table 5-2: Percentage of data capture available for the review period – Southbound tunnel	4
Table 5-3: Summary of measured pollutant levels for review period (ppm)	5
Table 5-4: In-tunnel single exposure point rolling 3-minute CO data for the review period – Northbound tunnel	7
Table 5-5: In-tunnel single exposure point rolling 3-minute CO data for the review period – Southbound tunnel	7
Table 5-6: Summary of rolling 15-minute visibility levels along the length of the tunnels for the review period	8

LIST OF FIGURES

Figure 5-1: Rolling 15-minute average CO levels along the length of tunnel	5
Figure 5-2: Rolling 30-minute average CO levels along the length of tunnel	6
Figure 5-3: Rolling 15-minute average NO ₂ levels along the length of tunnel	6
Figure 5-4: Rolling 15-minute average visibility levels along the length of tunnel	8

1 INTRODUCTION

Todoroski Air Sciences have conducted an independent audit of the in-tunnel air quality monitoring data collected for the NorthConnex Motorway (hereafter referred to as the Project).

This independent audit reviews the available in-tunnel air quality data collected for the Project during 31 October 2020 to 30 April 2021.

The auditor has previously conducted an independent review of the NorthConnex Project Air Quality Impact Assessment report for the NSW Department of Planning and Environment and an independent audit of the in-tunnel air quality monitoring locations and monitoring methods. The auditor is also conducting the 6-monthly NorthConnex audits for the ventilation outlet monitoring data, ambient air quality data and air quality monitoring operating procedures and equipment.

2 SCOPE OF WORK

Condition E1 of Infrastructure Approval SSI-6136 requires an audit of the in-tunnel monitoring data collected for the Project. The relevant part of the condition reads as follows:

In-tunnel Air Quality

E1 ...

Verification and compliance auditing is to be undertaken by an independent person(s) or organisation(s) approved by the Secretary... Monitoring shall take place in accordance with this condition throughout operation of the SSI.

2.1 Project Requirements

Under Condition E1 of Infrastructure Approval SSI-6136, the Project is required to monitor the following in-tunnel air quality pollutants and parameters set out in **Table 2-1** below, following the specified sampling method, units of measure, and sampling frequency.

The in-tunnel pollutants/parameters must not exceed the respective limits specified under Conditions E2, E3 and E4.

Under condition E5, should the results of monitoring show that any of the in-tunnel limits specified in Conditions E2, E3 and E4 have been exceeded, the Project will immediately notify the Secretary, EPA and Ministry of Health.

Table 2-1: In-tunnel monitoring methodologies required under Condition E1

Pollutant/Parameter	Unit of measurement	Frequency	Method ¹
CO	ppm	Continuous	Special Method 1 ¹
NO ₂	ppm	Continuous	Special Method 1 ¹
Visibility	m ⁻¹	Continuous	Special Method 1 ¹

Notes

1. Special Method 1 means a method approved by the Secretary in consultation with the EPA.

3 IN-TUNNEL MONITORING

Continuous in-tunnel monitoring, data collection and reporting was conducted by Norditech Pty Ltd, a NATA accredited organisation. Monthly validation reports are prepared by Norditech (**Norditech, 2020 & Norditech, 2021a-e**).

The in-tunnel monitoring involves using 26 in-tunnel combined air quality sensors (AQS) which measure CO, NO₂ and visibility, (13 in the northbound tunnel and 13 in the southbound tunnel).

The AQS monitor locations are presented in **Appendix A**.

4 AIR QUALITY GOALS

4.1 Nitrogen dioxide

Nitrogen dioxide (NO₂) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO₂ belongs to a family of reactive gases called oxides of nitrogen (NO_x). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**US EPA, 2011**). It is important to note that when formed, NO₂ is generally a small fraction of the total NO_x generated in a combustion process.

4.2 Carbon monoxide

Carbon monoxide (CO) is an odourless, colourless gas. CO can be produced during incomplete combustion of carbon based materials such as fuel, coal or wood etc. It can inhibit the capacity of blood to transport oxygen in humans resulting in symptoms of headache, nausea and fatigue.

4.3 Visibility

The NSW Government (**2014**) states that a visibility limit is applied in most tunnels for the purposes of safety, but this also provides some protection against the impacts of particulate matter on the health of tunnel users.

4.4 NorthConnex in-tunnel air quality limits

Table 4-1 summarises the in-tunnel air quality limits set out for the Project per Condition E2.

Table 4-1: NorthConnex in-tunnel average limits along length of tunnel

Pollutant	Concentration limit	Units of measurement	Averaging Period
CO	87	ppm	Rolling 15-minute
CO	50	ppm	Rolling 30-minute
NO ₂	0.5	ppm	Rolling 15-minute

Table 4-2 summarises the in-tunnel air quality limits set out for the Project per Condition E3.

Table 4-2: NorthConnex in-tunnel single point exposure limits

Pollutant	Concentration limit	Units of measurement	Averaging Period
CO	200	ppm	Rolling 3-minute

Table 4-3 summarises the in-tunnel air quality limits set out for the Project per Condition E4.

Table 4-3: NorthConnex in-tunnel visibility limits along length of tunnel

Parameter	Average extinction coefficient limit	Units of measurement	Averaging Period
Visibility	0.005	m ⁻¹	Rolling 15-minute

5 IN-TUNNEL MONITORING DATA

The monitoring data in this report are presented as provided to Todoroski Air Sciences.

Table 5-1 and **Table 5-2** present the percentage of data capture for the northbound and southbound tunnels respectively available over the review period. The data indicate that there was greater than 90% data capture rate for all parameters at all AQS monitoring locations over the review period.

Table 5-1: Percentage of data capture available for the review period – Northbound tunnel

Northbound monitors	Data Capture %				
	Rolling 3-minute CO	Rolling 15-minute CO	Rolling 30-minute CO	Rolling 15-minute NO ₂	Rolling 15-minute visibility
AQS101	99	100	100	100	100
AQS102	99	100	100	100	100
AQS103	99	100	100	100	100
AQS104	99	100	100	100	100
AQS105	99	100	100	100	100
AQS106	99	100	100	100	100
AQS107	99	100	100	100	100
AQS108	99	100	100	100	100
AQS109	99	100	100	100	100
AQS110	99	100	100	100	100
AQS701	99	100	100	100	100
AQS702	99	100	100	100	100
AQS703	98	99	99	99	99

Table 5-2: Percentage of data capture available for the review period – Southbound tunnel

Southbound monitors	Data Capture %				
	Rolling 3-minute CO	Rolling 15-minute CO	Rolling 30-minute CO	Rolling 15-minute NO ₂	Rolling 15-minute visibility
AQS201	99	100	100	100	100
AQS202	99	100	100	100	100
AQS203	99	100	100	100	100
AQS204	99	100	100	100	100
AQS205	99	100	100	100	100
AQS206	99	100	100	100	100
AQS207	99	100	100	100	100
AQS208	99	100	100	100	100
AQS209	99	100	100	100	100
AQS210	99	100	100	100	100
AQS801	99	100	100	100	100
AQS802	98	99	99	99	99
AQS803	98	99	99	99	99

5.1 Pollutant monitoring data

Table 5-3 presents a summary of the in-tunnel average pollutant levels occurring along the length of the tunnel during the review period from 31 October 2020 to 30 April 2021. The data indicates that the recorded tunnel average rolling 15-minute NO₂, rolling 15-minute CO and rolling 30-minute CO levels



were below the relevant air quality limits during the review period in the northbound and southbound tunnels.

Table 5-3: Summary of measured pollutant levels for review period (ppm)

Site	CO	CO	NO ₂
	Rolling 15-minutes	Rolling 30-minutes	Rolling 15-minutes
	In-tunnel average limits along the length of tunnel		
	87	50	0.5
Maximum pollutant level			
Northbound tunnel average	5.87	5.25	0.34
Southbound tunnel average	3.55	3.00	0.42
Minimum pollutant level			
Northbound tunnel average	0.01	0.01	0.01
Southbound tunnel average	0.02	0.02	0.01
Number of times recorded above criterion			
Northbound tunnel average	0	0	0
Southbound tunnel average	0	0	0

Figure 5-1, Figure 5-2 and **Figure 5-3** graphically presents the rolling 15-minute average CO, rolling 30-minute average CO and rolling 15-minute average NO₂ monitoring data respectively recorded for the Project during the review period.

The data indicates that the recorded tunnel average rolling 15-minute NO₂, rolling 15-minute CO and rolling 30-minute CO levels were below the relevant air quality limits during the review period in the northbound and southbound tunnels.

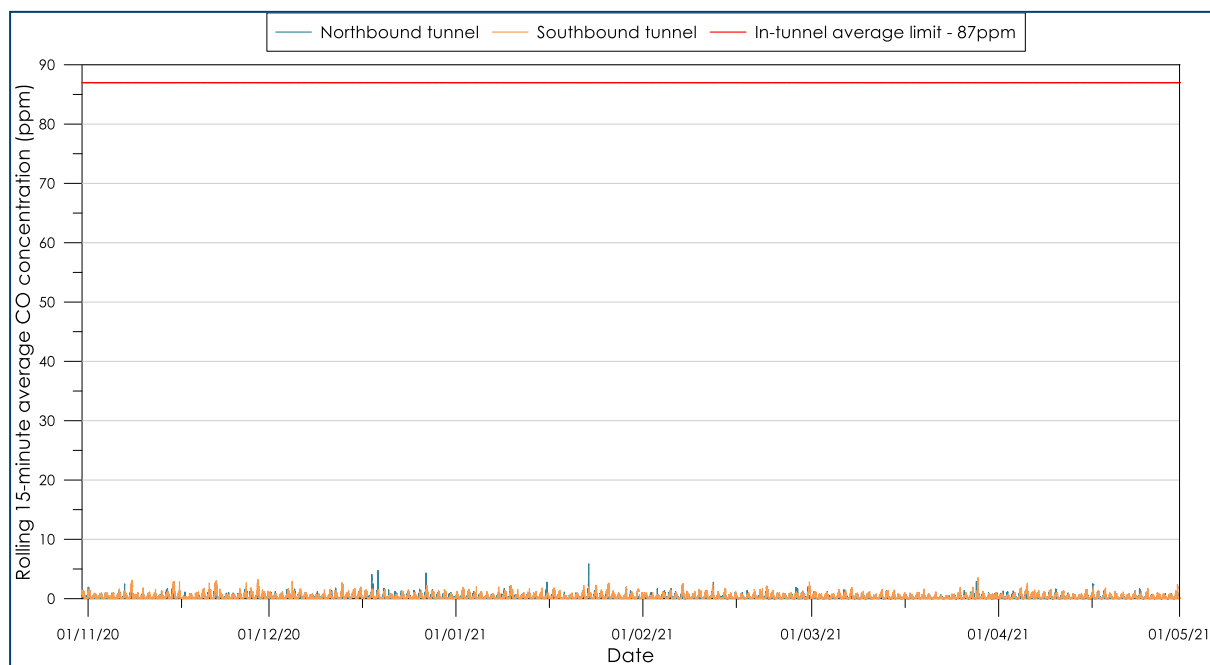


Figure 5-1: Rolling 15-minute average CO levels along the length of tunnel

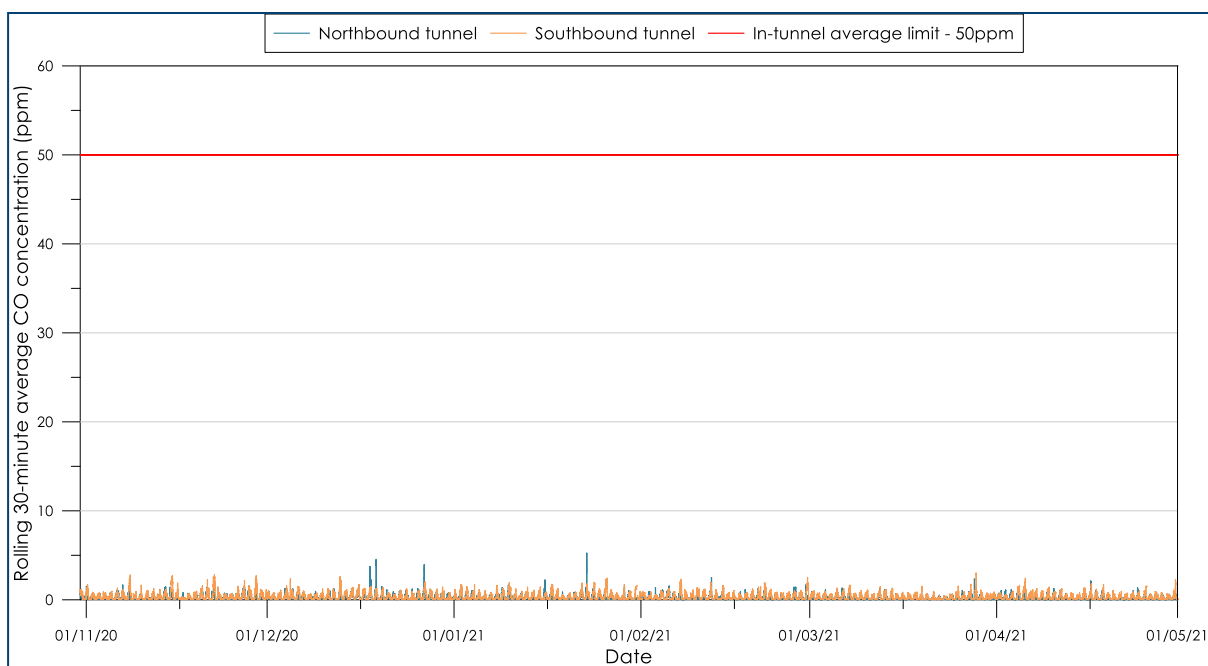


Figure 5-2: Rolling 30-minute average CO levels along the length of tunnel

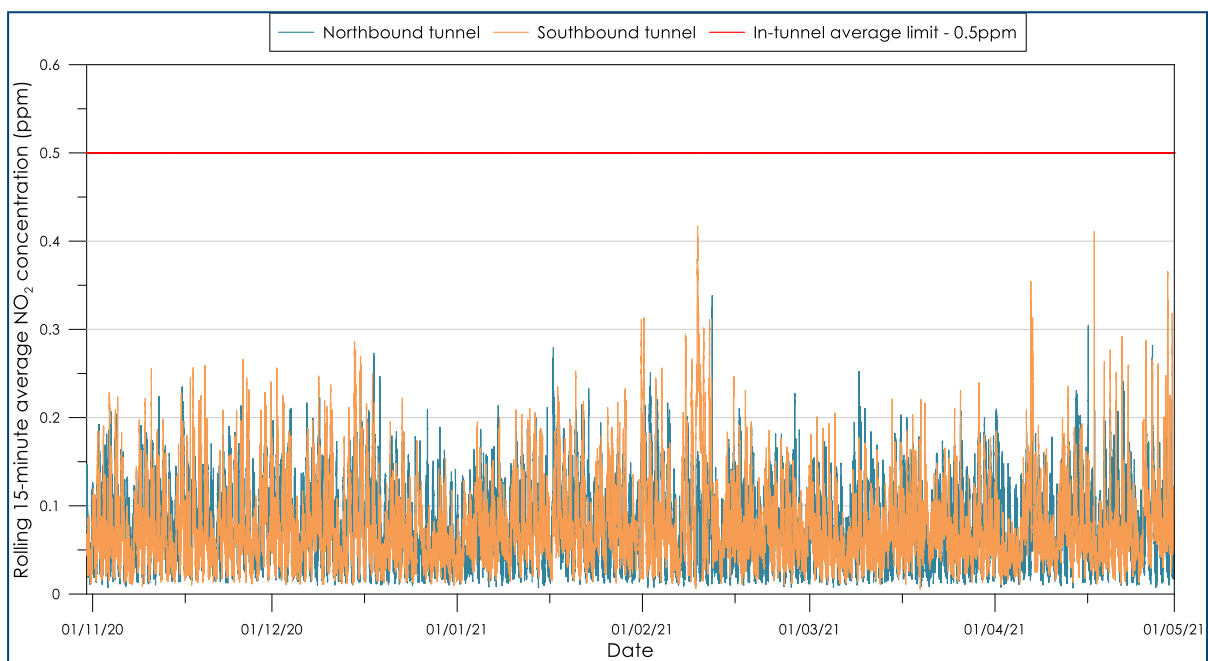


Figure 5-3: Rolling 15-minute average NO₂ levels along the length of tunnel

Table 5-4 and **Table 5-5** presents a summary of the rolling 3-minute CO levels occurring at each AQS monitoring location for the northbound and southbound tunnels respectively during the review period from 31 October 2020 to 30 April 2021. The data indicate that the rolling 3-minute CO levels were below the relevant criterion during the review period.

The rolling 3-minute CO data for each AQS monitor are presented in graphical format in **Appendix B**. A relatively large spike was recorded in the AQS206 rolling 3-minute CO data at the end of November 2020. While this single reading is not likely to be valid, it is nevertheless below half the relevant criterion.

Table 5-4: In-tunnel single exposure point rolling 3-minute CO data for the review period – Northbound tunnel

Northbound monitors	Maximum rolling 3-minute CO level (ppm)	Minimum rolling 3-minute CO level (ppm)	Number of times recorded above 200ppm criterion
AQS101	2.13	0.00	0
AQS102	8.20	0.00	0
AQS103	10.37	0.00	0
AQS104	20.77	0.00	0
AQS105	8.37	0.00	0
AQS106	13.97	0.00	0
AQS107	15.70	0.00	0
AQS108	16.97	0.00	0
AQS109	14.90	0.00	0
AQS110	15.00	0.00	0
AQS701	2.07	0.00	0
AQS702	16.55	0.00	0
AQS703	6.90	0.00	0

Table 5-5: In-tunnel single exposure point rolling 3-minute CO data for the review period – Southbound tunnel

Southbound monitors	Maximum rolling 3-minute CO level (ppm)	Minimum rolling 3-minute CO level (ppm)	Number of times recorded above 200ppm criterion
AQS201	12.20	0.00	0
AQS202	12.80	0.00	0
AQS203	24.93	0.00	0
AQS204	6.23	0.00	0
AQS205	7.50	0.00	0
AQS206	95.67*	0.00	0
AQS207	9.63	0.00	0
AQS208	3.40	0.00	0
AQS209	5.87	0.00	0
AQS210	3.37	0.00	0
AQS801	27.70	0.00	0
AQS802	6.27	0.00	0
AQS803	3.10	0.00	0

*Reading not likely to be valid

5.2 Visibility monitoring data

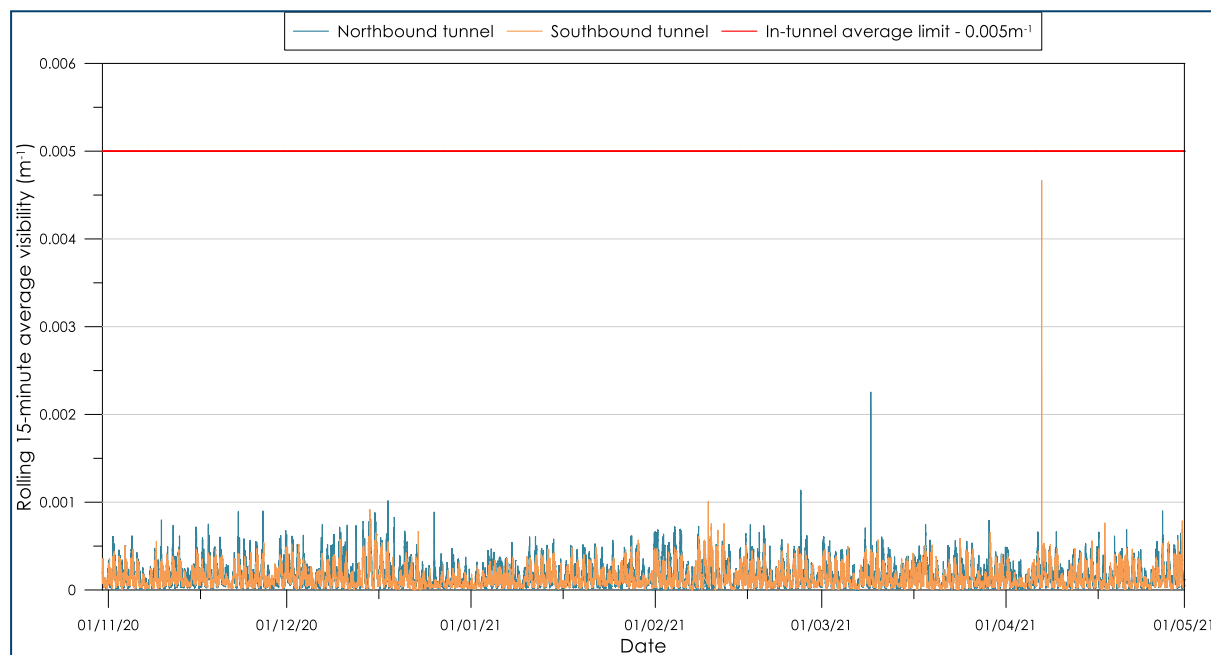
Table 5-6 presents a summary of the rolling 15-minute visibility levels along the length of the northbound and southbound tunnels for the review period.

Figure 5-4 graphically presents the rolling 15-minute average visibility monitoring data recorded for the Project during the review period.

The data indicate that there were no exceedances of the in-tunnel visibility limits during the review period.

Table 5-6: Summary of rolling 15-minute visibility levels along the length of the tunnels for the review period

Visibility	Northbound tunnel average	Southbound tunnel average
Maximum (m^{-1})	0.002	0.005
Minimum (m^{-1})	0.000	0.000
Number of times recorded above the 0.005m^{-1} criterion	0	0

**Figure 5-4: Rolling 15-minute average visibility levels along the length of tunnel**

6 DISCUSSION AND RECOMMENDATIONS

Todoroski Air Sciences have conducted an independent audit of the in-tunnel monitoring data collected for the NorthConnex Project.

The data capture rate is high and the overall data quality is good with only one potentially invalid 3-minute reading, that was nevertheless below half of the relevant criterion.

The recorded in-tunnel monitoring data between 31 October 2020 and 30 April 2021 were below their respective air quality limits as outlined in **Table 4-1**.

The rolling 15-minute CO, rolling 30-minute CO, rolling 15-minute NO₂ and rolling 15-visibility average levels along the length of the tunnels during the review period were below their respective in-tunnel air quality limits. The rolling 3-minute CO levels at all AQS monitors were below the relevant criterion during the review period.



7 REFERENCES

Norditech (2020)

"DM Roads - NorthConnex Tunnel In-tunnel Air Quality Monitoring Validated Data Report 31 October 2020 to 30 November 2020", prepared by Norditech, December 2020

Norditech (2021a)

"DM Roads - NorthConnex Tunnel In-tunnel Air Quality Monitoring Validated Data Report 1 December 2020 to 31 December 2020", prepared by Norditech, January 2021

Norditech (2021b)

"DM Roads - NorthConnex Tunnel In-tunnel Air Quality Monitoring Validated Data Report 1 January 2021 to 31 January 2021", prepared by Norditech, February 2021

Norditech (2021c)

"DM Roads - NorthConnex Tunnel In-tunnel Air Quality Monitoring Validated Data Report 1 February 2021 to 28 February 2021", prepared by Norditech, March 2021

Norditech (2021d)

"DM Roads - NorthConnex Tunnel In-tunnel Air Quality Monitoring Validated Data Report 1 March 2021 to 31 March 2021", prepared by Norditech, April 2021

Norditech (2021e)

"DM Roads - NorthConnex Tunnel In-tunnel Air Quality Monitoring Validated Data Report 1 April 2021 to 30 April 2021", prepared by Norditech, May 2021

NSW Government (2014)

"Criteria for In-Tunnel and Ambient Air Quality", prepared by Ian Longley for the NSW Government Advisory Committee on Tunnel Air Quality, July 2014

US EPA (2011)

"Health Effects of Pollution", United States Environmental Protection Agency website
<http://www.epa.gov/region07/air/quality/health.htm>, 2011



Appendix A

Monitoring Locations



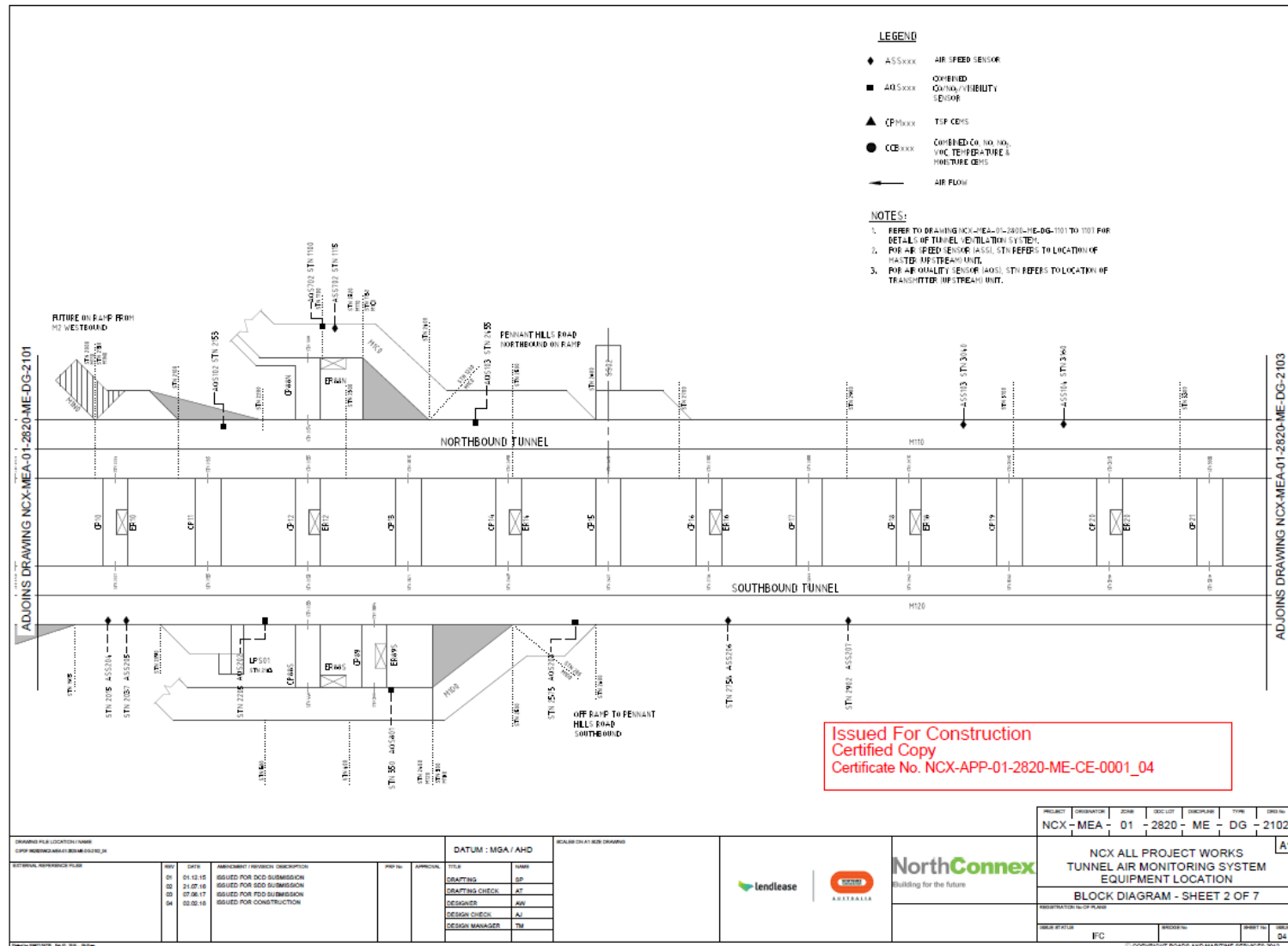


Figure A-2: In-tunnel air monitoring locations – Sheet 2 (AQS102, AQS103, AQS202, AQS203, AQS702, AQS801)



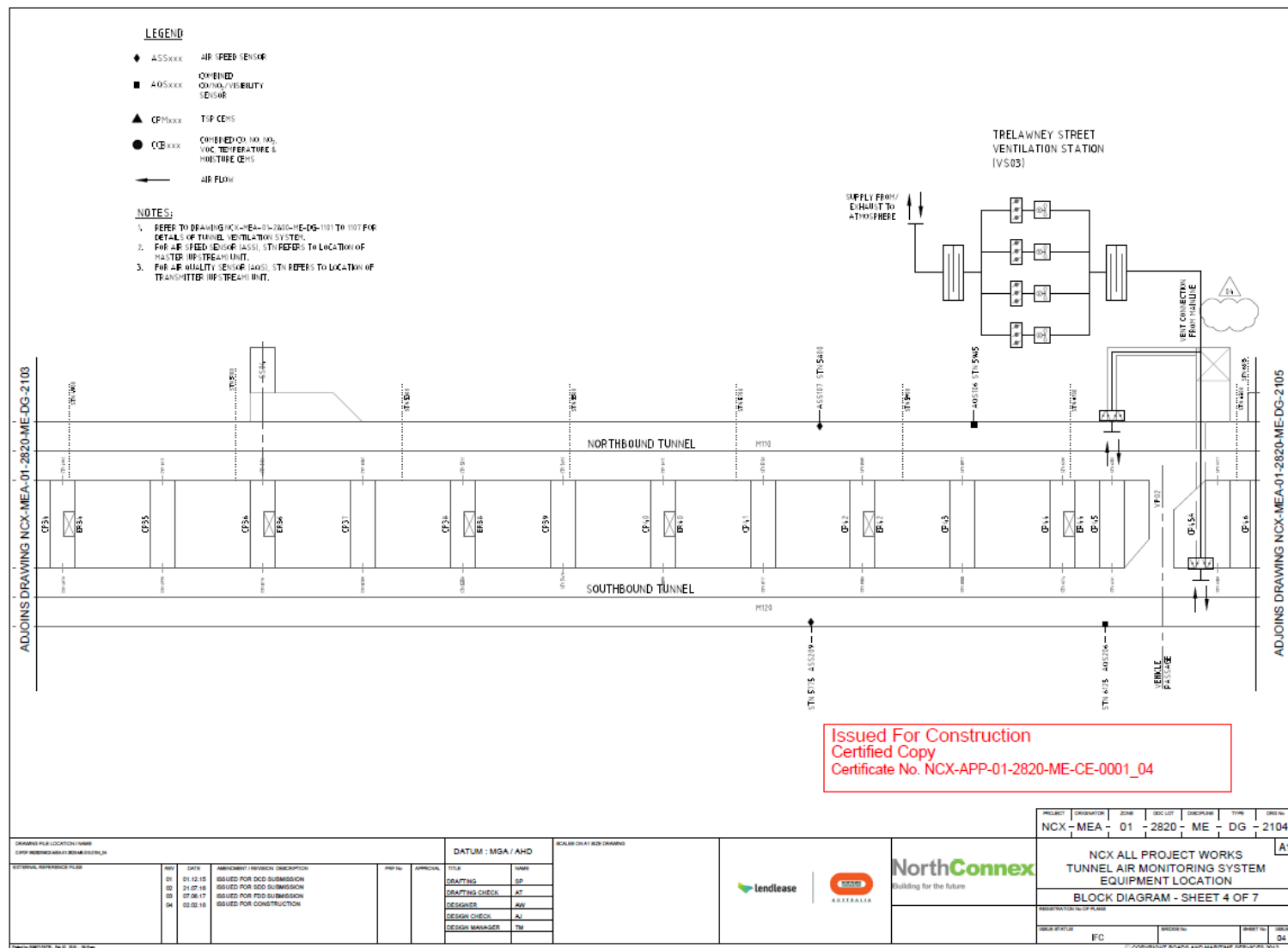


Figure A-4: In-tunnel air monitoring locations – Sheet 4 (AQ5106, AQ5206)



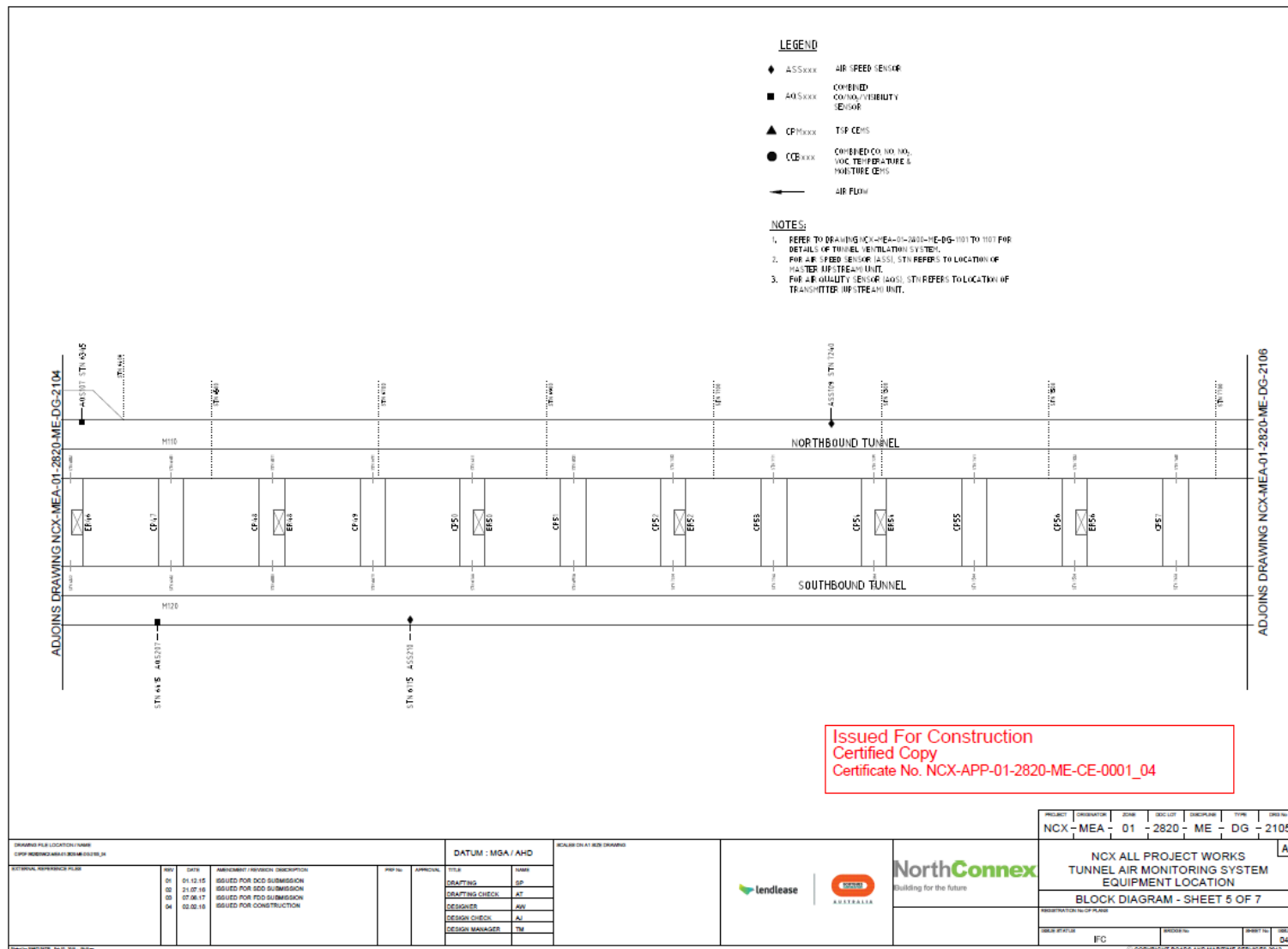


Figure A-5: In-tunnel air monitoring locations – Sheet 5 (AQS107, AQS207)



Appendix B

Rolling 3-minute CO Monitoring Data (Graphical)



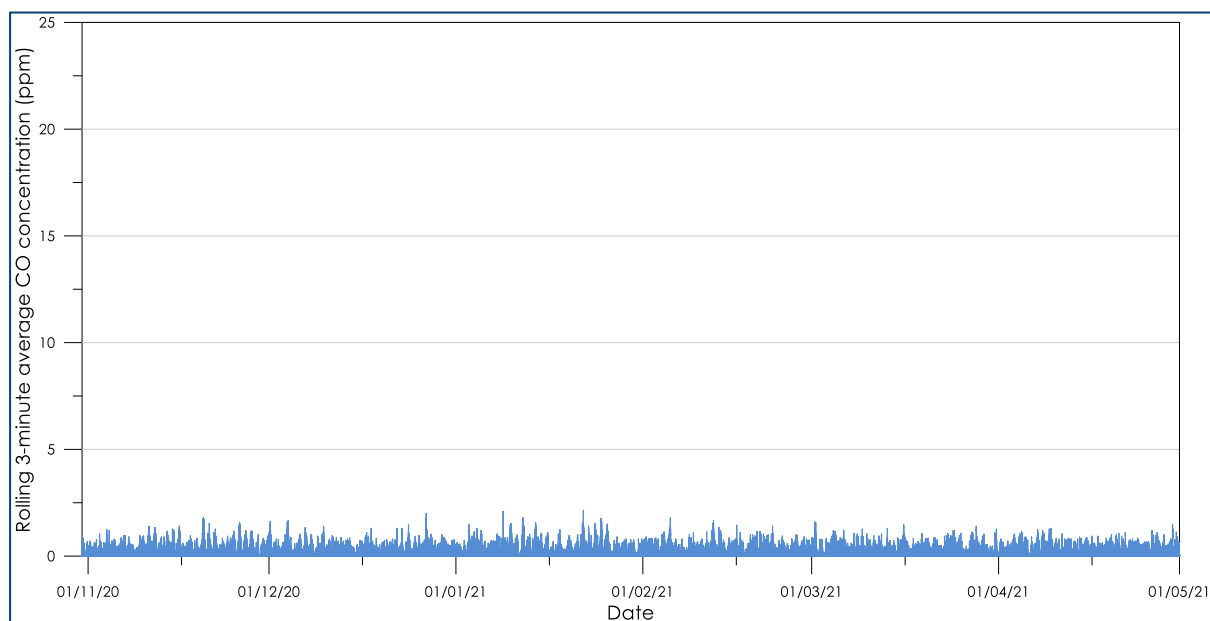


Figure B-1: AQ5101 rolling 3-minute CO monitoring data

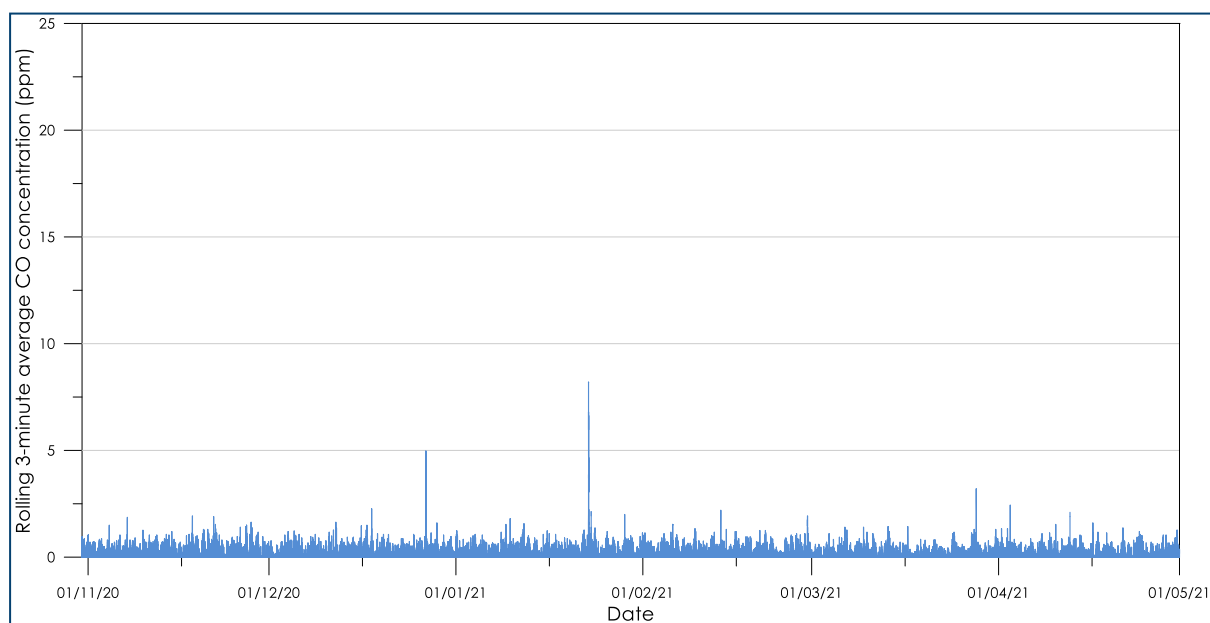


Figure B-2: AQ5102 rolling 3-minute CO monitoring data

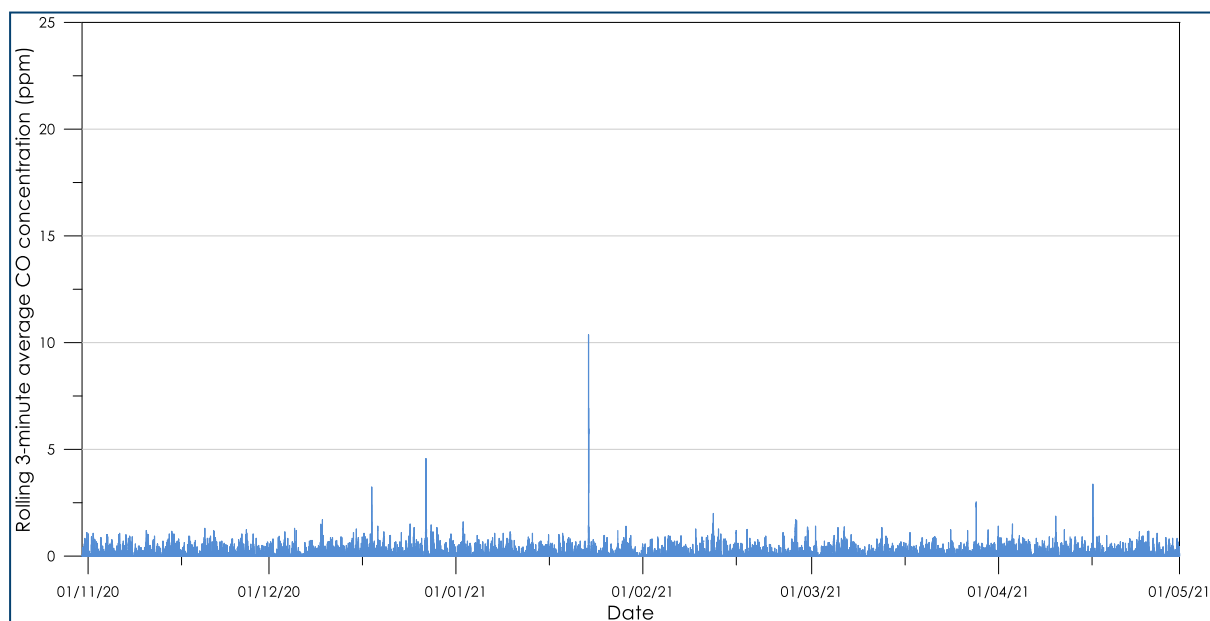


Figure B-3: AQ5103 rolling 3-minute CO monitoring data

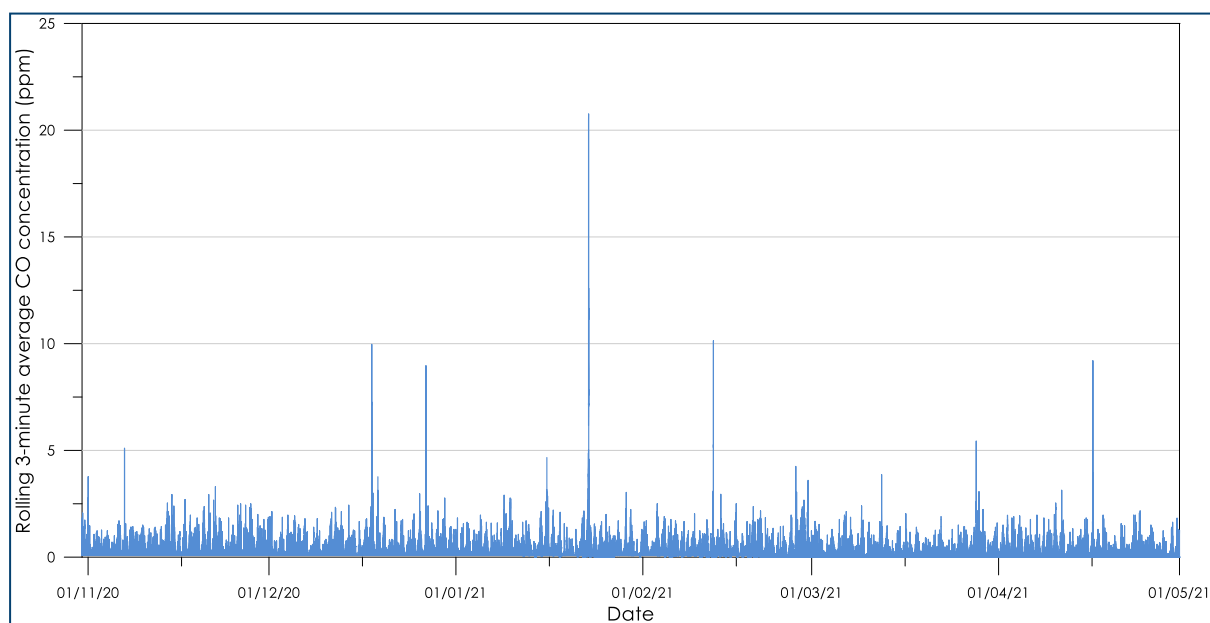


Figure B-4: AQ5104 rolling 3-minute CO monitoring data

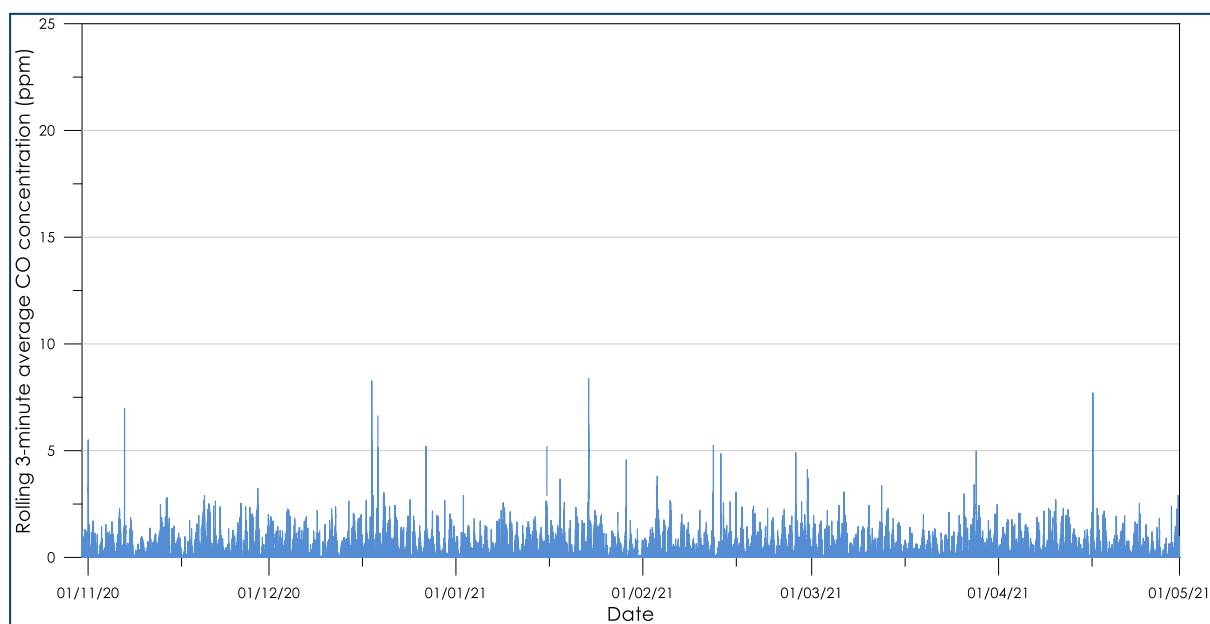


Figure B-5: AQ5105 rolling 3-minute CO monitoring data

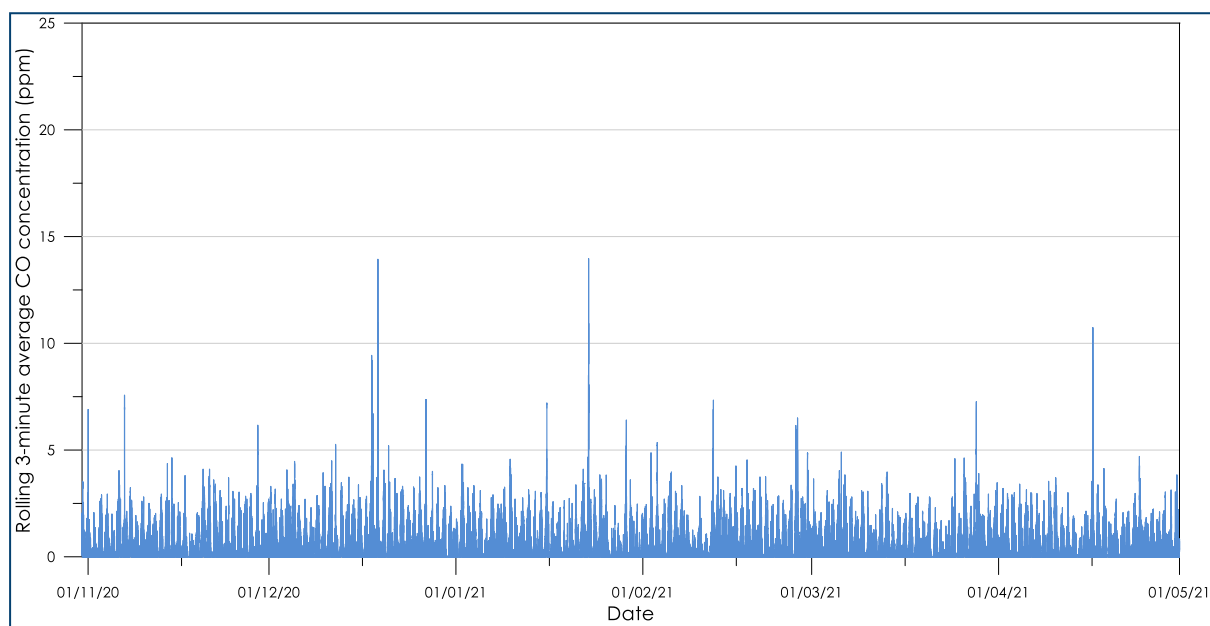


Figure B-6: AQ5106 rolling 3-minute CO monitoring data

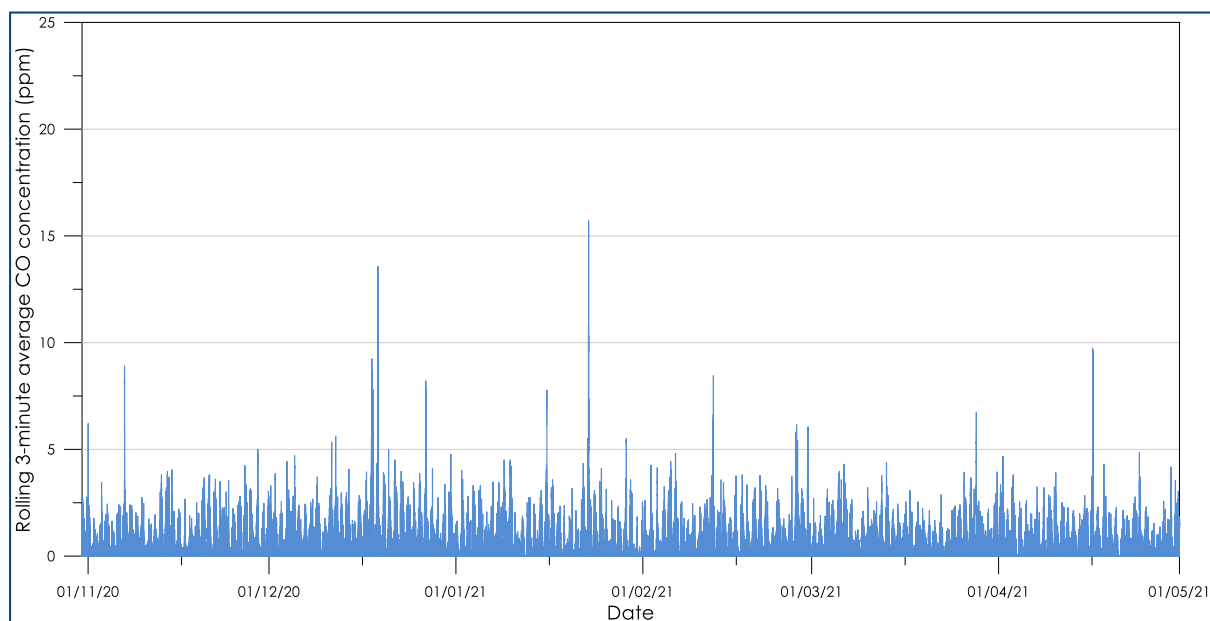


Figure B-7: AQS107 rolling 3-minute CO monitoring data

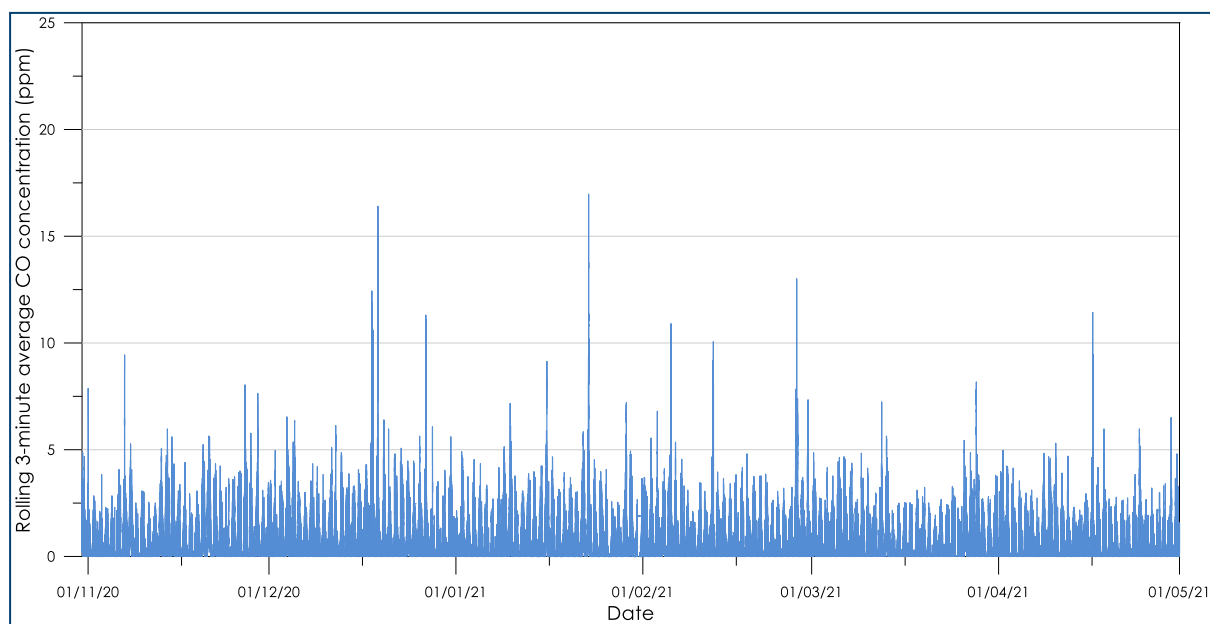


Figure B-8: AQS108 rolling 3-minute CO monitoring data

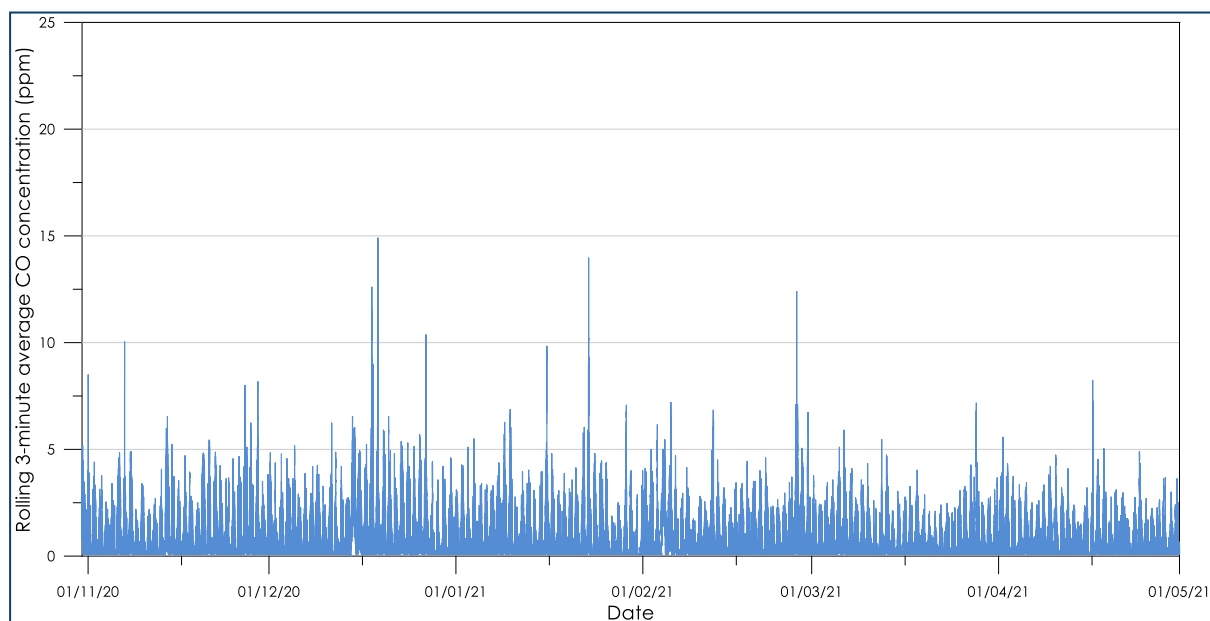


Figure B-9: AQS109 rolling 3-minute CO monitoring data

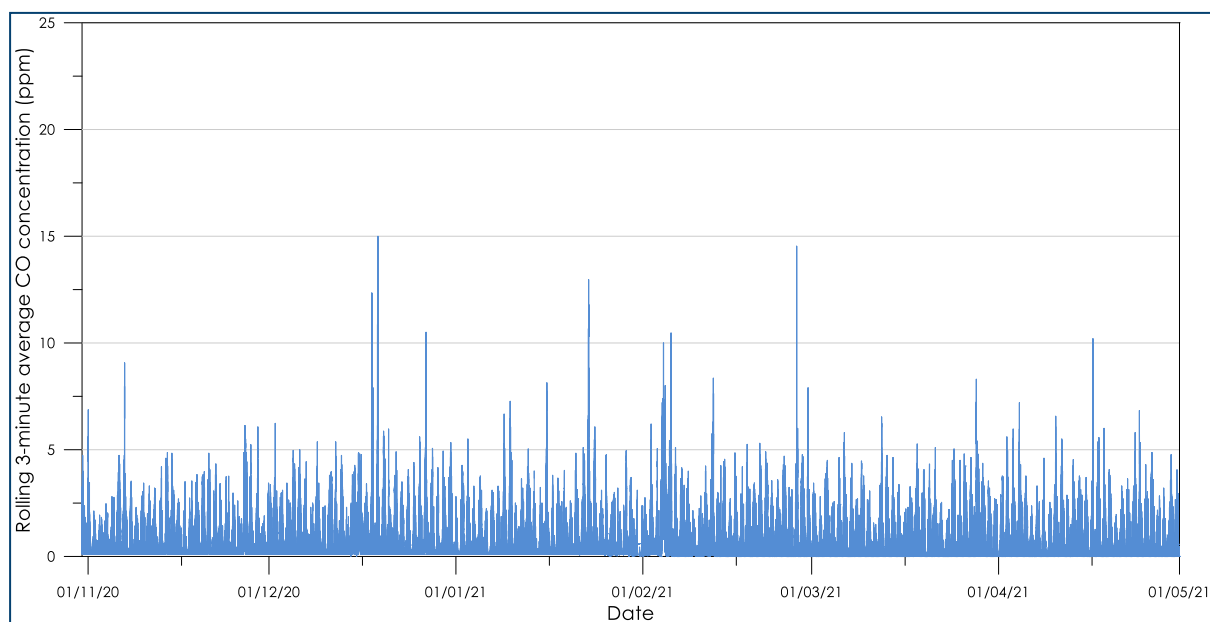


Figure B-10: AQS110 rolling 3-minute CO monitoring data

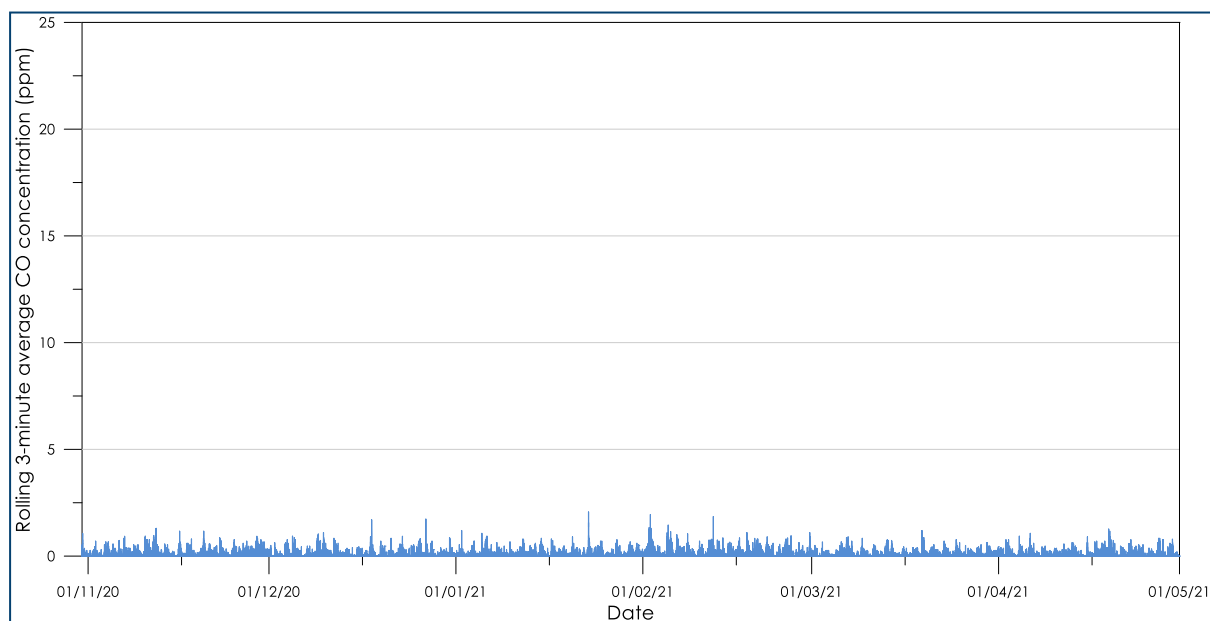


Figure B-11: AQ5701 rolling 3-minute CO monitoring data

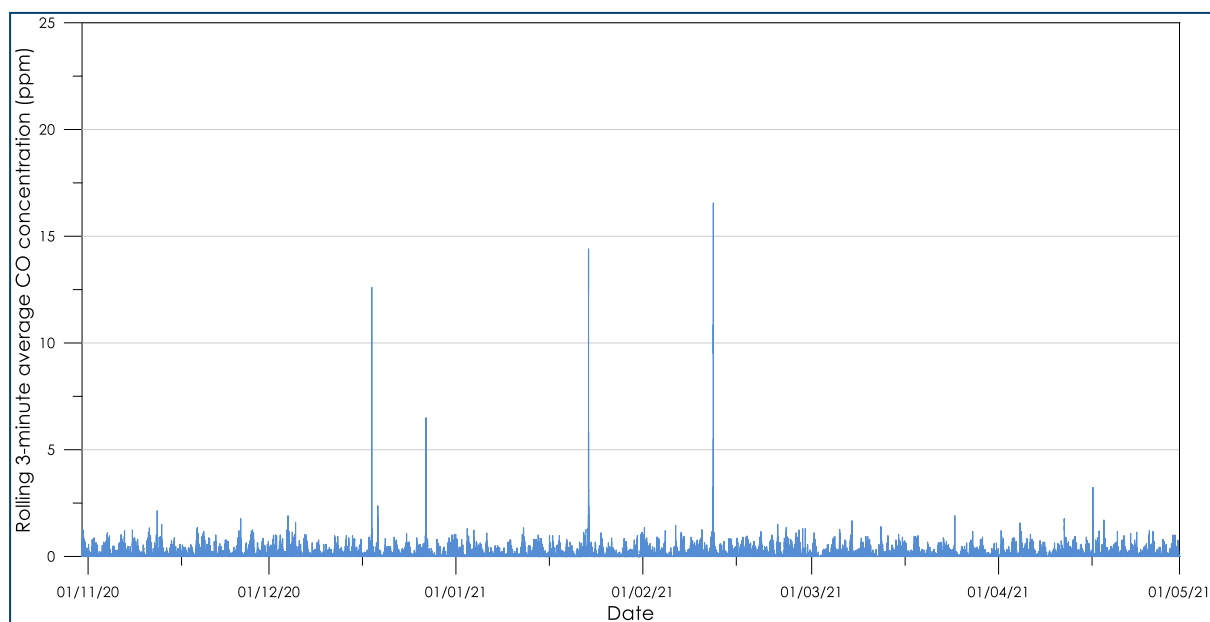


Figure B-12: AQ5702 rolling 3-minute CO monitoring data

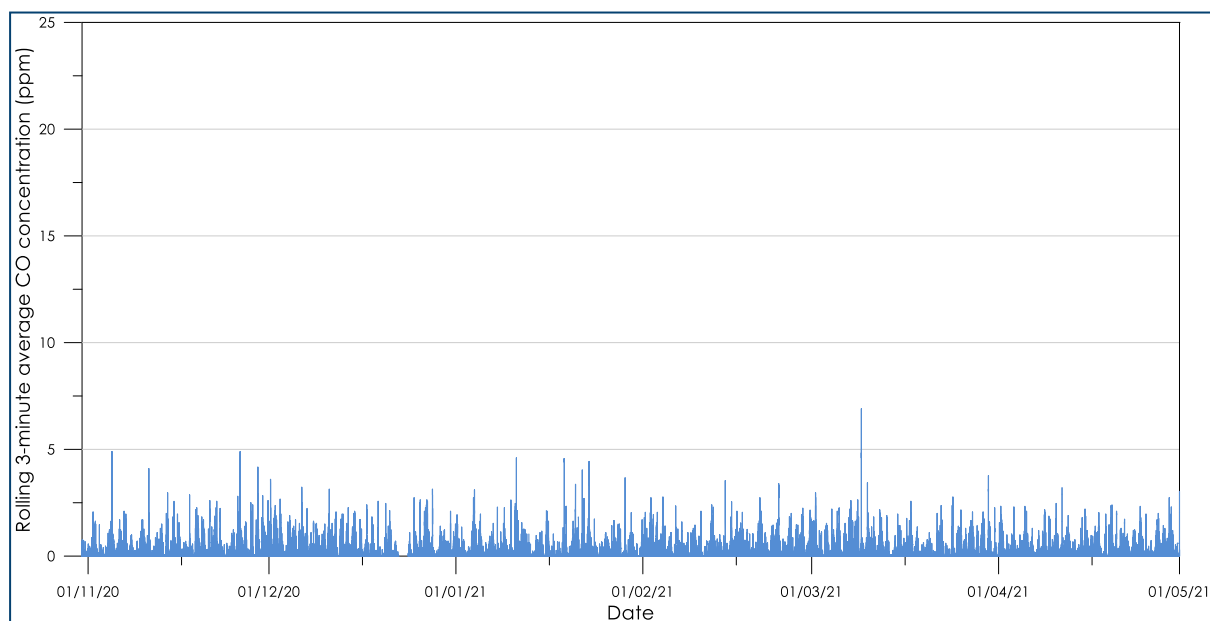


Figure B-13: AQS703 rolling 3-minute CO monitoring data

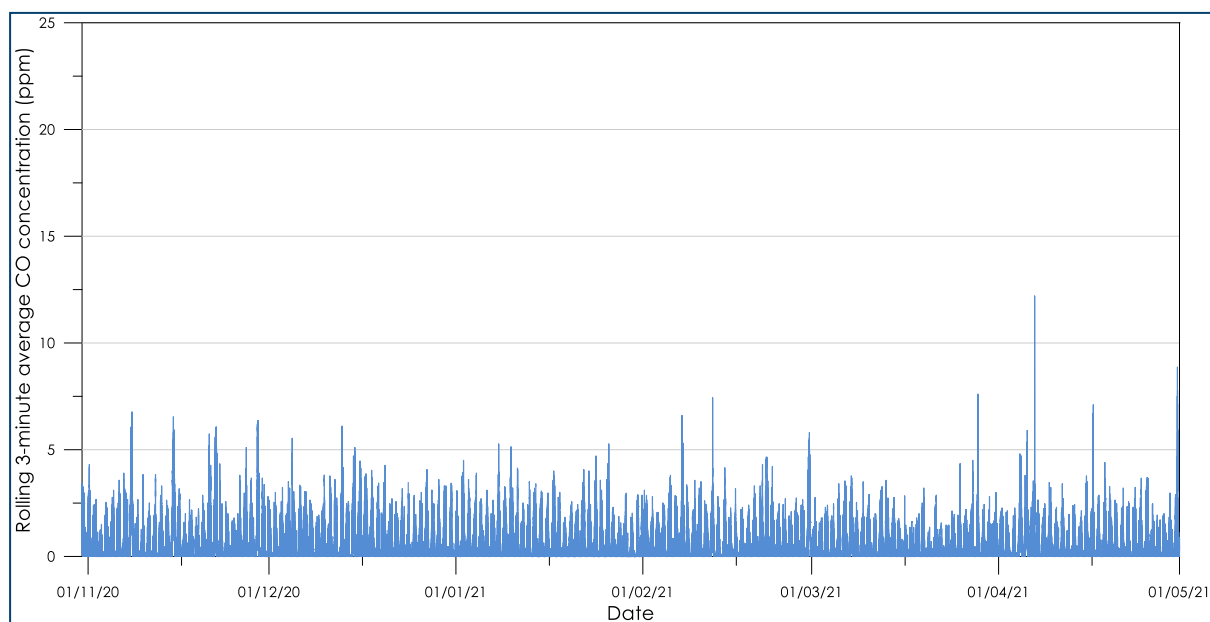


Figure B-14: AQS201 rolling 3-minute CO monitoring data

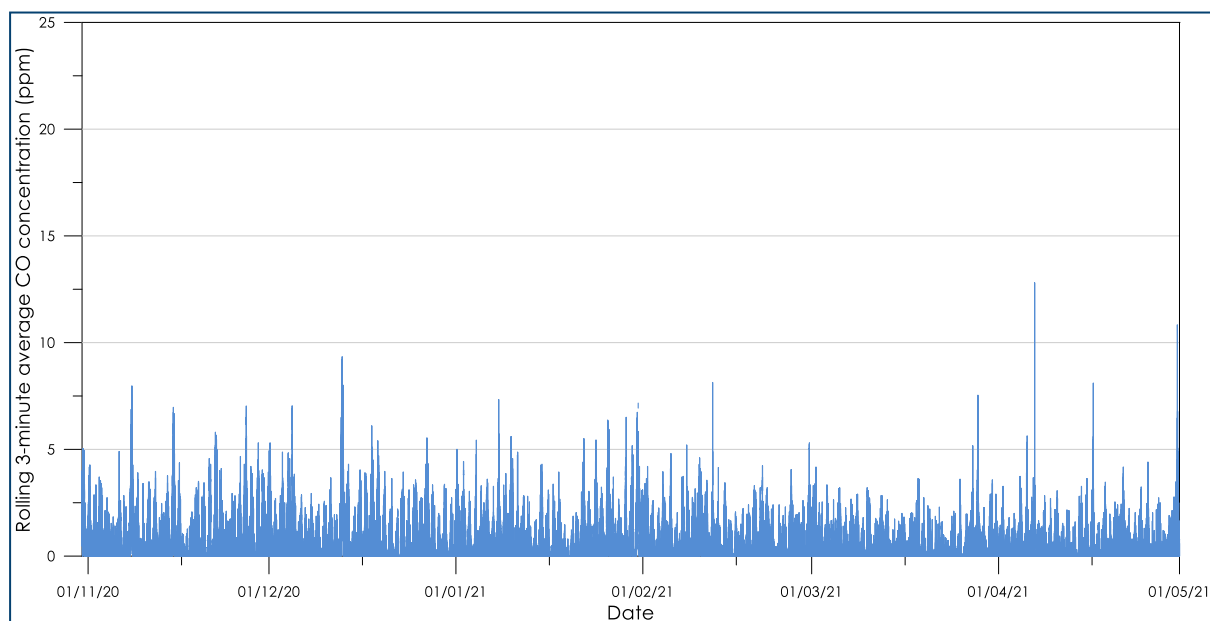


Figure B-15: AQS202 rolling 3-minute CO monitoring data

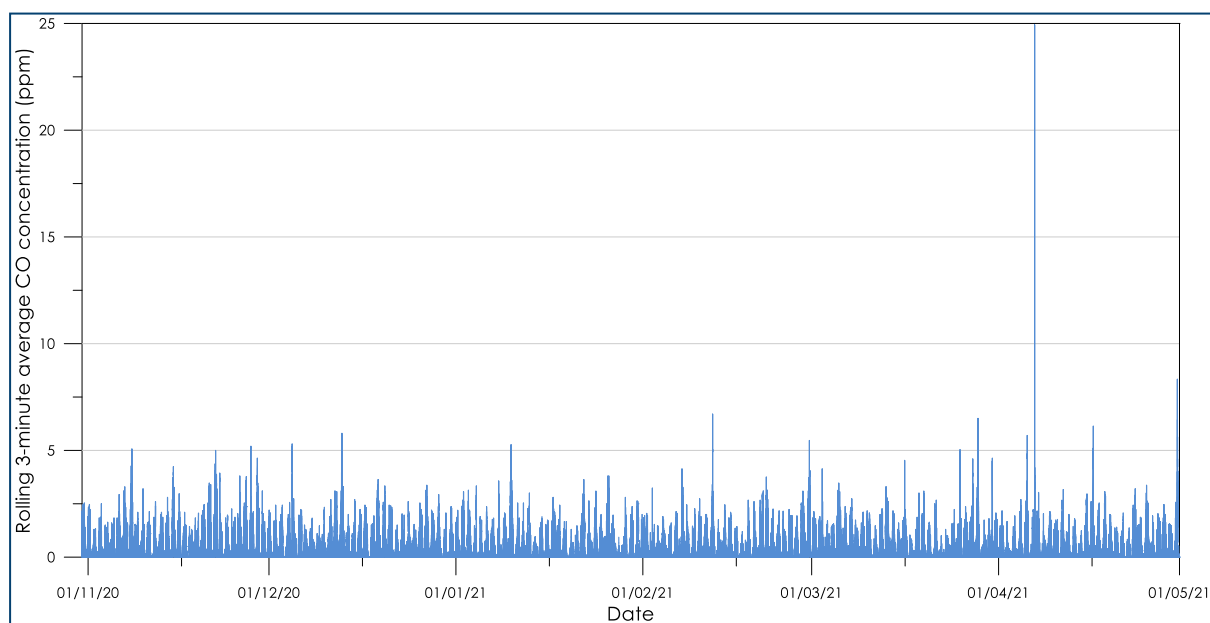


Figure B-16: AQS203 rolling 3-minute CO monitoring data

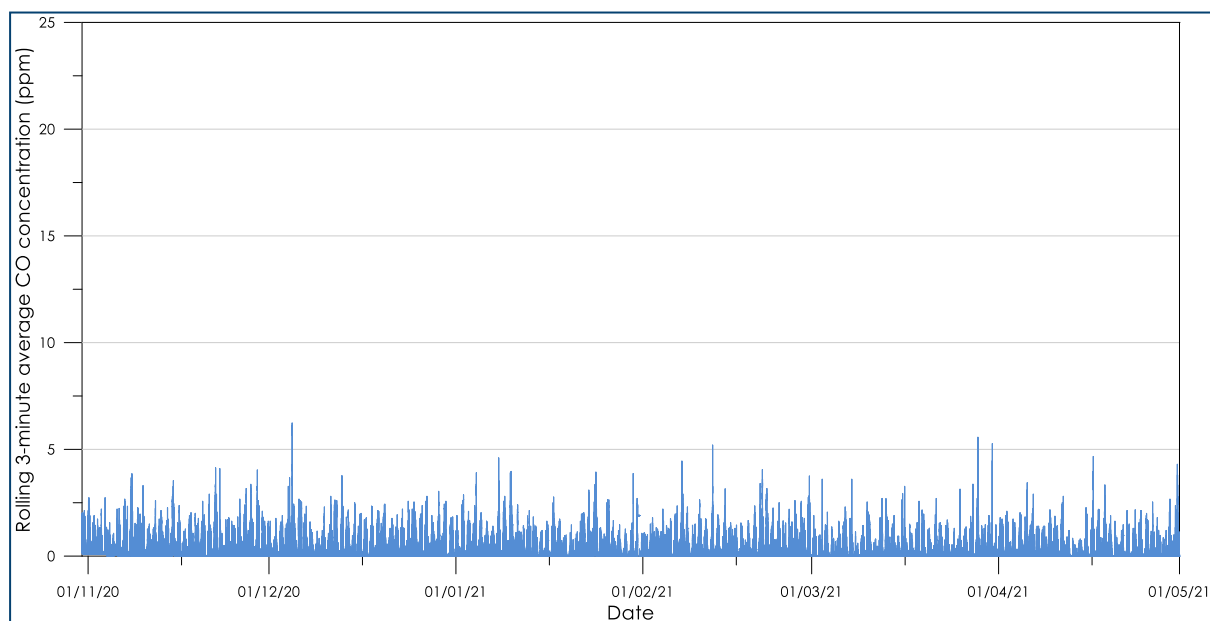


Figure B-17: AQS204 rolling 3-minute CO monitoring data

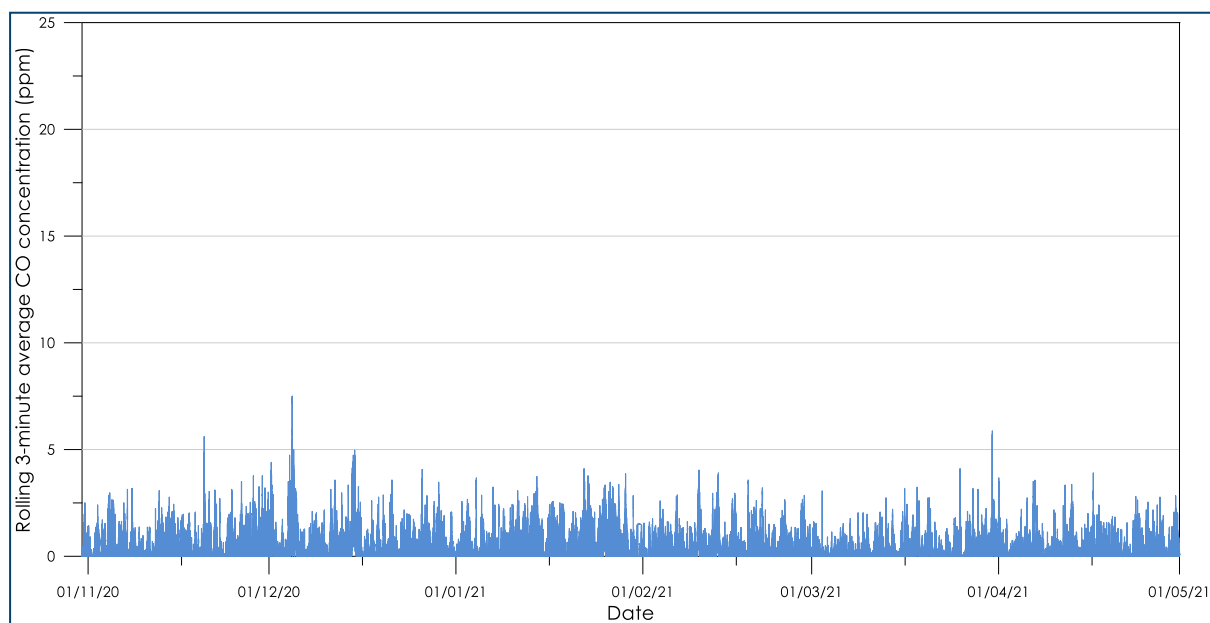


Figure B-18: AQS205 rolling 3-minute CO monitoring data



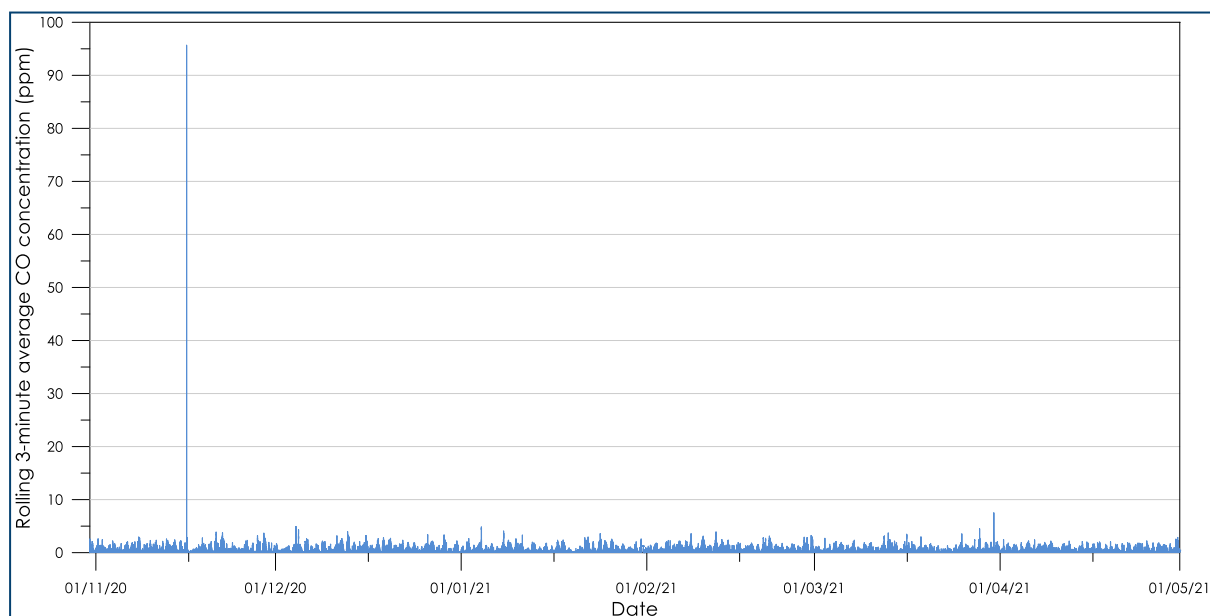


Figure B-19: AQS206 rolling 3-minute CO monitoring data

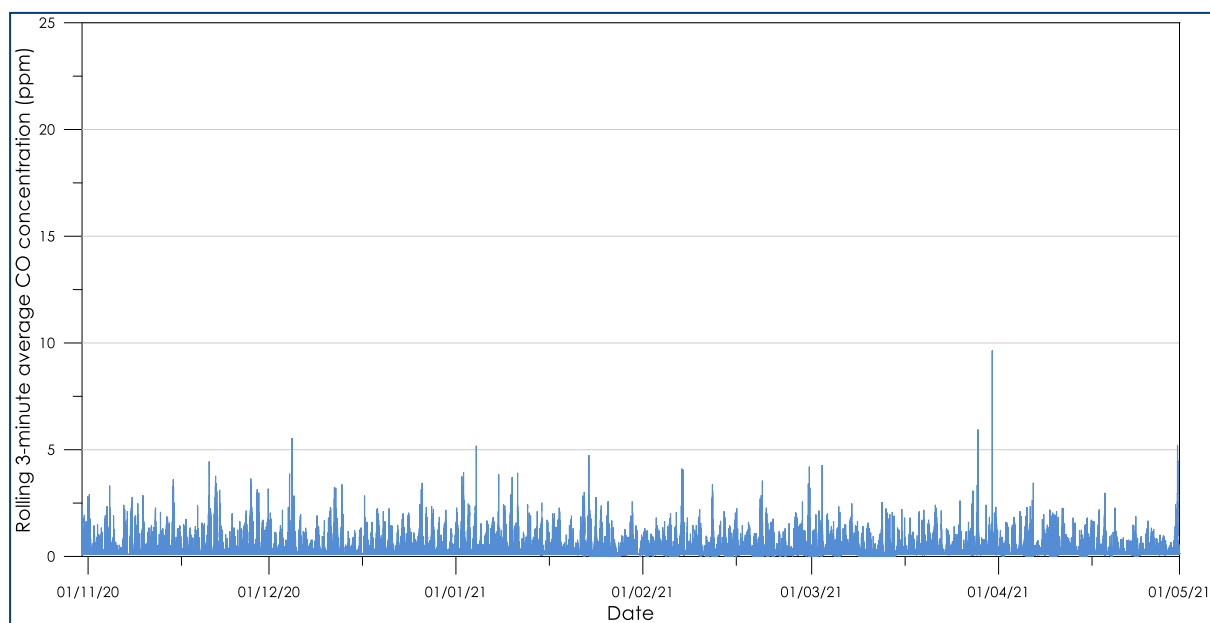


Figure B-20: AQS207 rolling 3-minute CO monitoring data

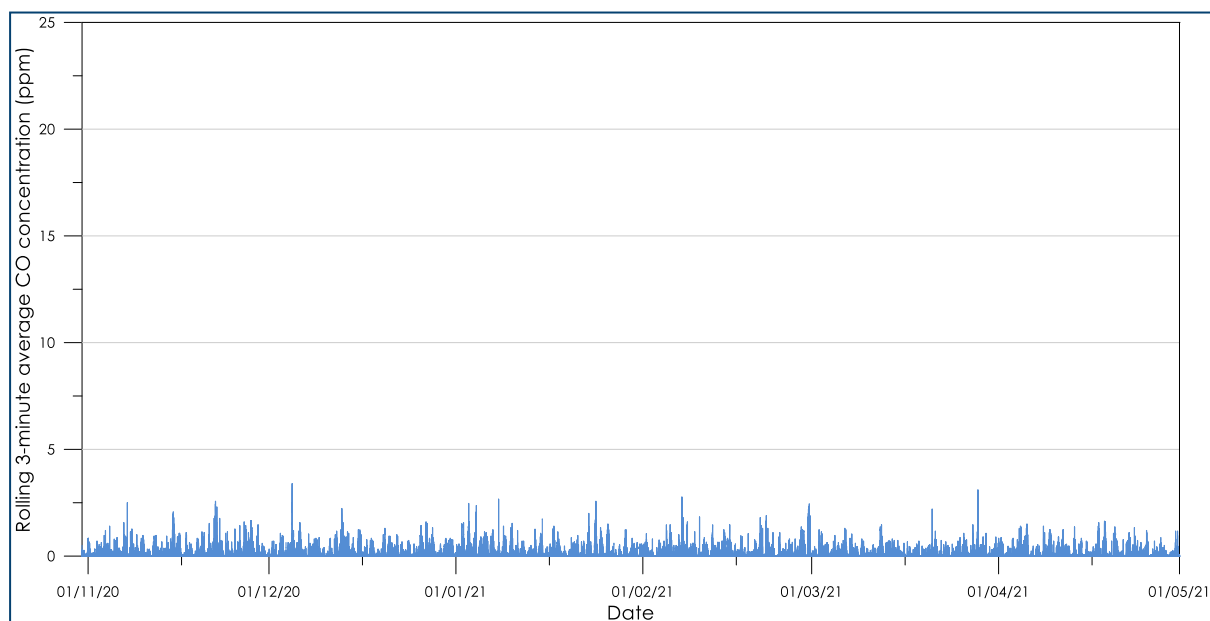


Figure B-21: AQS208 rolling 3-minute CO monitoring data

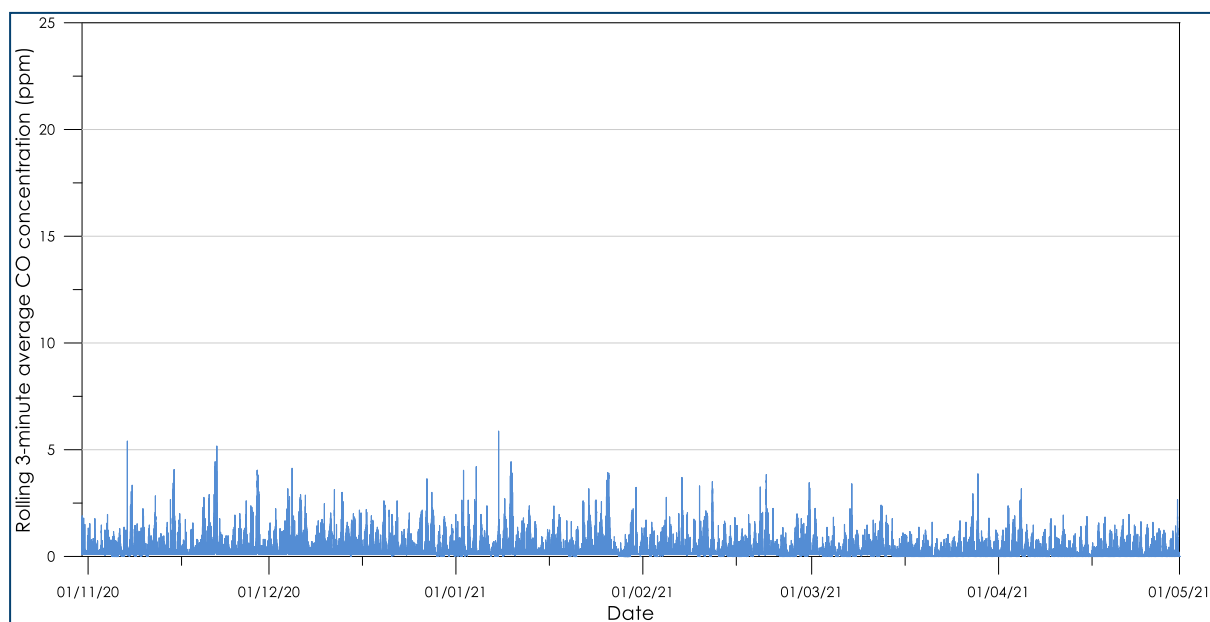


Figure B-22: AQS209 rolling 3-minute CO monitoring data

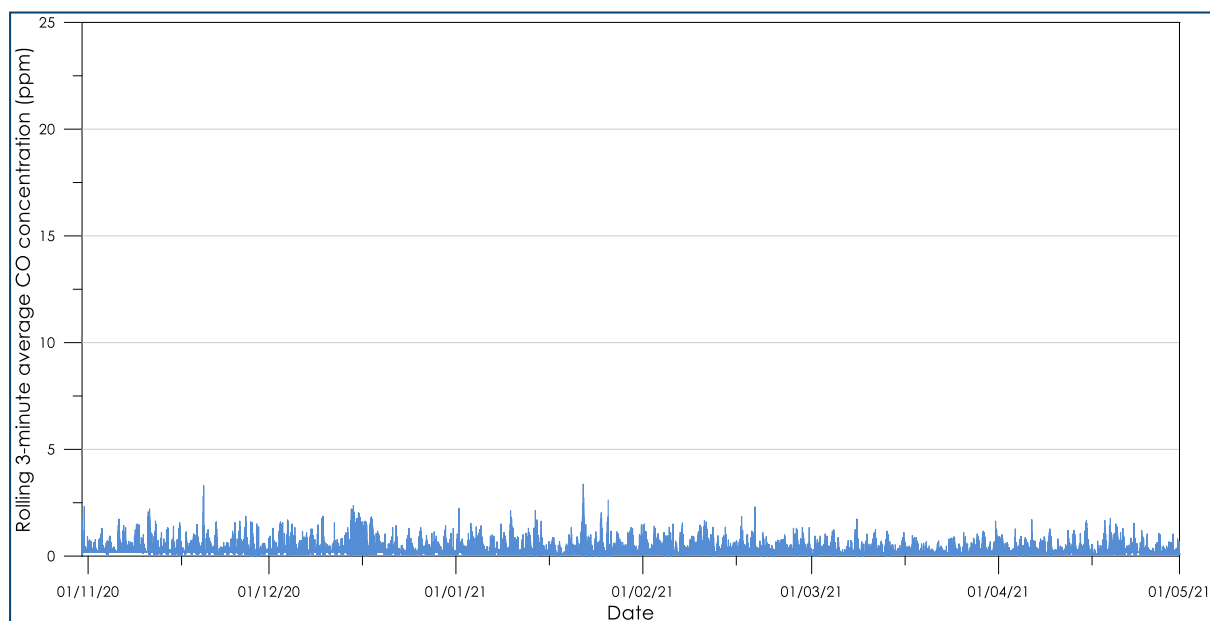


Figure B-23: AQS210 rolling 3-minute CO monitoring data

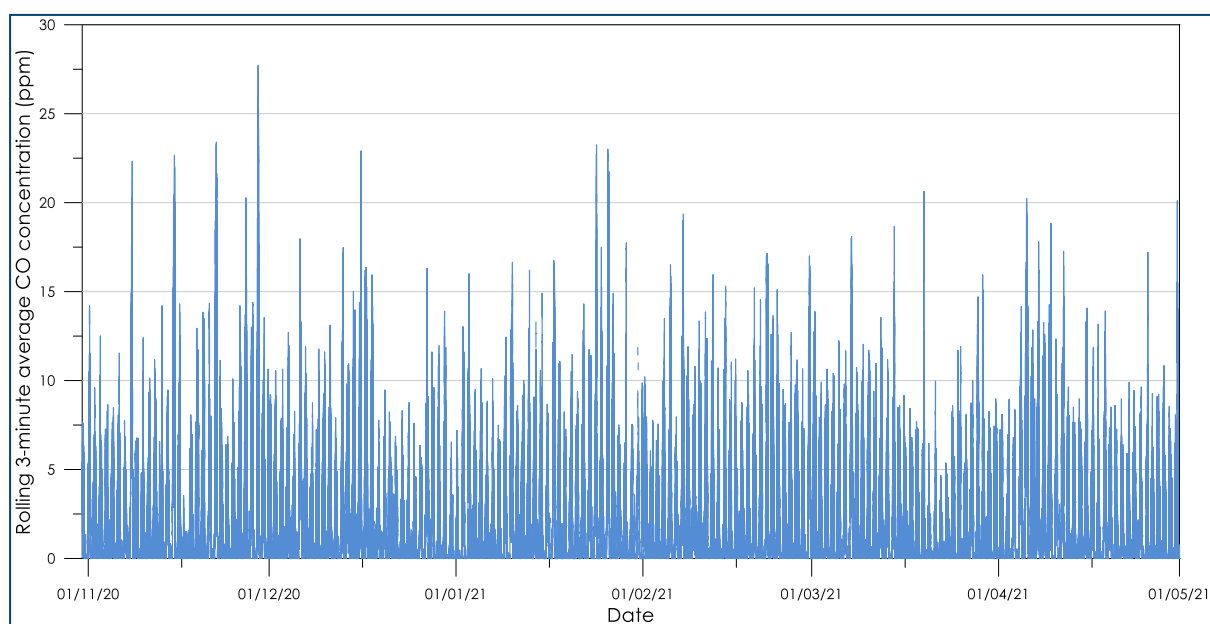


Figure B-24: AQS801 rolling 3-minute CO monitoring data

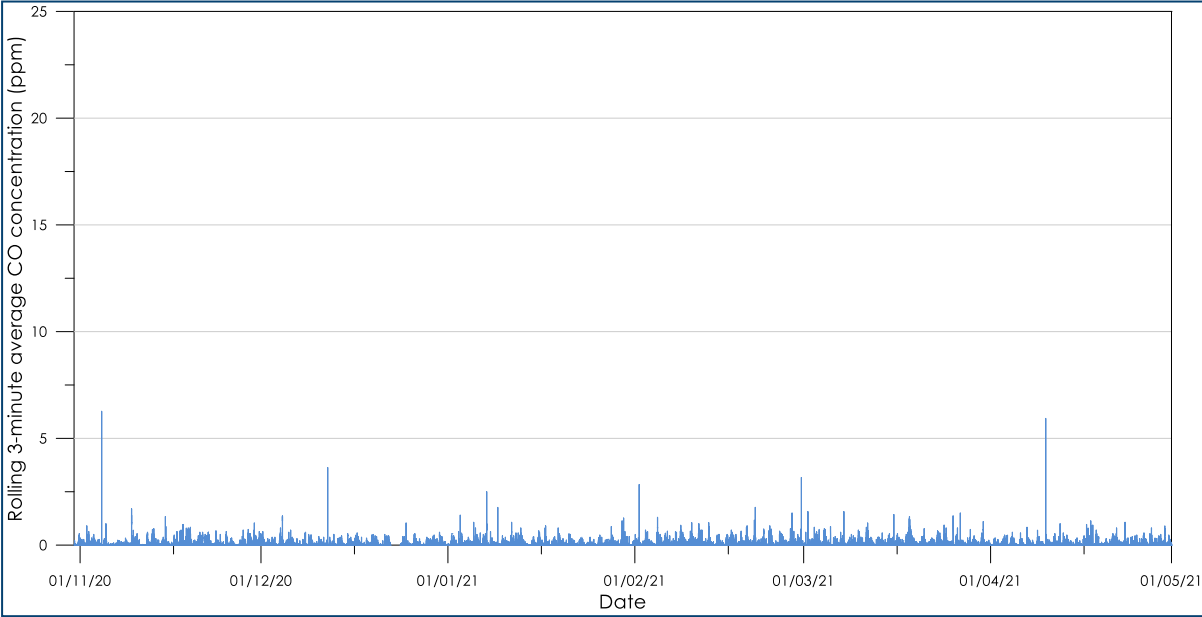


Figure B-25: AQS802 rolling 3-minute CO monitoring data

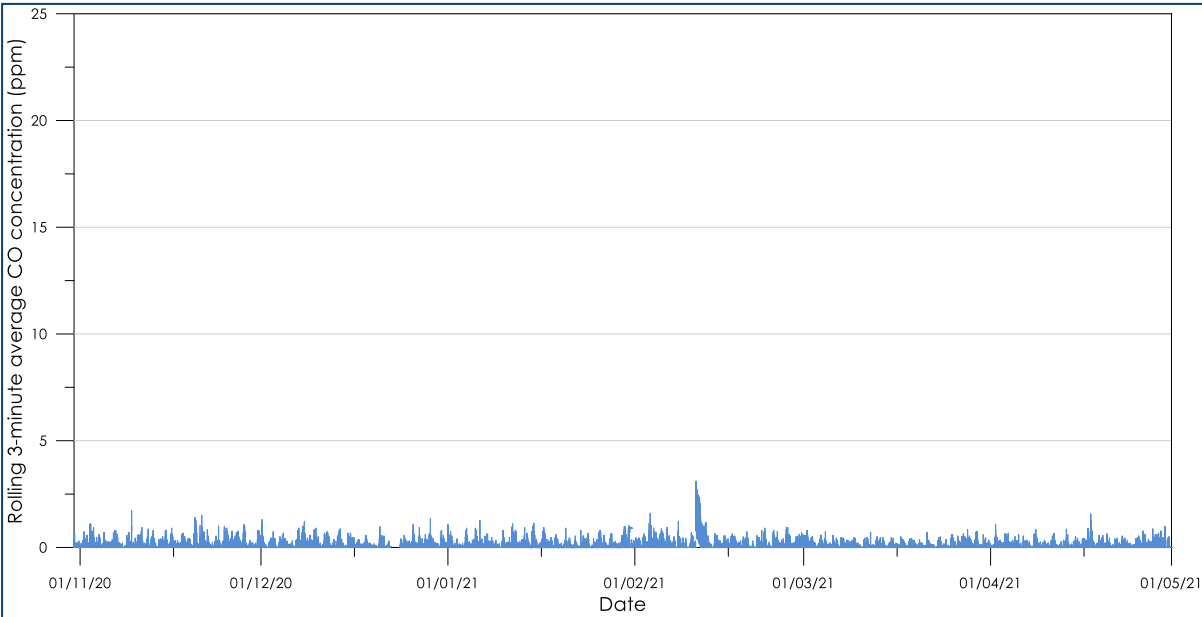


Figure B-26: AQS803 rolling 3-minute CO monitoring data