DM Roads – NorthConnex Tunnel

In-tunnel Air Quality Monitoring Validated Data Report

1 April 2022 to 31 April 2022

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Report prepared by: Tim Allfrey

Norditech Pty Ltd
Unit 2/87 Station Road
Seven Hills NSW 2147

1300 572 822

info@norditech.com.au

www.norditech.com.au

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Prepared by

Tim Allfrey
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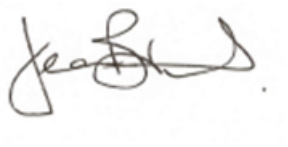
Approved by



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12 May 2022

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1 Executive Summary

This report presents the monthly validated NorthConnex tunnel In-tunnel air quality data for April 2022 to DMRoads for the NorthConnex Tunnel.

Norditech commenced the maintenance of the In-tunnel air quality sensors on the date of tunnel opening on 31st October 2020.

1.1 Compliance to limits

The Instrument of Approval designates limits to which pollutant levels within the tunnel must not exceed. (Conditions E2, E3, E4).

There were nil above goal readings of the relevant concentration limits during the reporting period.

For further information relating to exceedance reporting please refer to sections 8 Exceptions and Exceedances.

2 Introduction

2.1 Project Background

The NorthConnex Project includes:

- Two new dual-lane carriageways (one northbound, and one southbound) generally located beneath Pennant Hills Road and the Northern Railway in Sydney linking the M1 Freeway and the Hills M2 Motorway;
- An interchange at the northern end of the Motorway that provides vehicular access between the Motorway, Pennant Hills Road and the Pacific Highway;
- An interchange at the southern end of the Motorway that provides vehicular access between the Motorway, the Hills M2 Motorway and Pennant Hills Road;
- A Motorway Control Centre including operation and maintenance facilities; and
- Ventilation systems and other facilities for the operation of the motorway. The ventilation system includes for the provision of monitoring devices to continuously measure air speed and quality at key locations in the tunnel and ventilation outlets.

Norditech were contracted by DMRoads Pty Ltd from November 2020 to provide in-tunnel air quality monitoring and reporting services for NorthConnex Tunnel.

Addresses of relevant parties:

Norditech Pty Ltd
2/87 Station Rd
Seven Hills NSW 2147

DMRoads Pty Ltd
610 Pennant Hills Rd
West Pennant Hills, NSW 2125

This report presents the validated in tunnel air quality sensor data for April 2022.

- Describes air quality measurements.
- Reports any readings above the NorthConnex Limits.
- Compares monitoring results.
- Has been quality assured.

2.2 Purpose

This report provides the monthly air quality data recorded on the NorthConnex project within the tunnel. This report addresses the criteria required by the Instrument of Approval E17 and E18. Whilst the data is to be provided in real time on a website, the report is to be prepared on a monthly basis and made publicly available.

A similar report is prepared for the Ambient Air Quality Monitoring stations that are located externally to the tunnel and do not form part of the permanent air quality monitoring systems.

The Instrument of Approval is available at Infrastructure approval (northconnex.com.au)

3 Scope

3.1 Scope

The equipment included in this report includes the following:

a) In-tunnel air quality sensors (26 off-combined Visibility/Nitrogen Dioxide/Carbon Monoxide);

The data from these devices is continuously monitored by the Operation and Management Control System (OMCS) and the data captured within the system. This data is made available in real time on the NorthConnex website (www.northconnex.com.au) and is collated on a monthly basis to form part of this report. This report is then checked for quality prior to public release.

The Instrument of Approval condition E22, required an independent expert approved by the Secretary to be engaged by the NorthConnex Project Company to approve the quality assurance and quality control procedures to be used during air quality monitoring, prior to monitoring commencing.

Also required by Instrument of Approval condition E21, the air quality monitoring system will also be audited on a 6 monthly basis by an independent expert approved by the Secretary.

4 Air Quality Limits

The following limits are extracted from the Instrument of Approval

Pollutant / Parameter	Type of Measurement	Concentration Limit
CO (ppm)	Rolling Average – 3 min	200
CO (ppm)	Rolling Average – 15 min	87
CO (ppm)	Rolling Average – 30 min	50
NO_2 (ppm)	Rolling Average – 15 min	0.5
Visibility (m^{-1})	Rolling Average – 15 min	0.0050

Table 1: In-tunnel Air Quality Limits

5 Monitoring Equipment

5.1 In-tunnel Monitors

The Instrument of Approval requires the tunnel to be continuously monitored using Special Method 1 for NO_2, CO and Visibility. This is achieved using the following instruments.

Pollutant / Parameter	Instrument and Measurement Technology	Units of Measure	Range	Resolution	Accuracy
Visibility	Tunnel Sensors VICONOX 3 - Light Transmission Obscuration Method	m^{-1}	0 – 0.1	0.0001	±0.0005 at 10m path length
Carbon Monoxide (CO)	Tunnel Sensors VICONOX 3 - Nondispersive Infrared (NDIR) Spectroscopy	ppm	0 - 500	0.1	±5% of reading
Nitrogen Dioxide (NO_2)	Tunnel Sensors VICONOX 3 - Differential Optical Absorption Spectroscopy (DOAS) Method	ppm	0 – 10	0.01	±5% of reading

Table 2: In-tunnel Measured Parameters and Instruments

6 Data Validation and Reporting

6.1 Validation

The OMCS monitors the status of the air quality measurement devices and provides alarms to the operators should equipment failures be detected. Control room staff monitor the motorway on a 24/7 basis and will report equipment failures to the maintenance team for rectification. The faulty device will be isolated in the OMCS.

Two air quality monitors are typically included in each tunnel ventilation section and each reading is used to calculate an overall average. In the event of an air quality monitor fault, the OMCS will substitute a default value for the faulty device. Once the device has been rectified, the operators will return the device to service on the OMCS.

In the event that the device is in a healthy state but there are anomalies with the readings, or devices have been taken out of service for routine maintenance and calibration checks, these details will be shown in the exceptions tables in section 8 of this report.

Data validation is performed as per Norditech's data validation procedure TP.022. The data validation process identifies any data that is deemed not to be valid. This data is flagged as invalid in the database and is removed from the reported data.

Data may be deemed invalid for several reasons, including but not limited to:

- Instrument fault
- Instrument calibration out of tolerance
- Maintenance activities

For further details and explanations of reasons for invalidating data, please refer to Appendix 1 – Data Validation Explanations.

Initial visual inspection of data is performed by inspection of graphs to identify any anomalies in the data set.

Site visit logs and maintenance and calibration certificates are cross referenced to the data set and any data affected by maintenance activities are flagged.

Instrument drift and calibration tolerances are checked and data flagged in the database as necessary as per NATA compliance requirements.

6.2 Reporting

The data is reported in real time at the NorthConnex website (URL. http://northconnex.com.au/)

a) Air Speed Northbound
b) Air Speed Southbound
c) Air Quality Northbound
d) Air Quality Southbound
e) Air Quality Northern Outlet
f) Air Quality Southern Outlet

Averages are based on all readings within the averaging period.

In addition to this, the OMCS can generate ad hoc reports for specific events or periods, and these will be included in the report as required, to provide additional detail for an abnormal event or incident.

Data reported via the OMCS has not been validated. This report provides validated data for the in-tunnel and VSO sensors.

All data within this report is reported as 'End Time'. Ie the 30 minute average result for 2:00 is the average of the 1 minute data from 1:30 through to 2:00.

6.3 Data Collection

In-tunnel Air Quality Sensor data is provided to Norditech on a weekly basis, and imported into data collection and reporting software.

6.3.1 Data Availability

Data availability refers to the amount of available data for the reporting period. Data availability is calculated using the following formula:

$$Data\ availability\ \% = \frac{sum\ of\ available\ data\ points}{sum\ of\ possible\ data\ points} * 100$$

Where:

- Sum of available data points is the number of validated 30 minute average data points for the reporting period
- Sum of possible data points is the number of theoretically available data points for the reporting period

7 Calibrations and Maintenance

7.1 Maintenance

Device	Frequency
Tunnel Air Speed Sensor	3 monthly and annually
Tunnel Air Quality Sensor	3 monthly, 6 monthly and annually

Table 3: Indicative Maintenance Requirements

7.2 Calibration

The in-tunnel air speed sensors are to be calibrated at annual intervals as described in the Operation and Maintenance manuals prepared for the project.

A list of all the devices and the latest calibration details are included in the table below, and in an excel spreadsheet (See Section 9 for details).

NorthConnex Tunnel In-tunnel Last Calibration Dates - April 2022					
Northbound			**Southbound**		
Sensor	Last Calibrated Date	Calibration Type	Sensor	Last Calibrated Date	Calibration Type
AQS101	7/02/2022	6 Monthly	AQS201	16/02/2022	6 Monthly
AQS102	7/02/2022	6 Monthly	AQS202	15/02/2022	6 Monthly
AQS103	7/02/2022	6 Monthly	AQS203	15/02/2022	6 Monthly
AQS104	7/02/2022	6 Monthly	AQS204	15/02/2022	6 Monthly
AQS105	8/11/2021	6 Monthly	AQS205	16/02/2022	6 Monthly
AQS106	8/11/2021	6 Monthly	AQS206	16/11/2021	6 Monthly
AQS107	8/11/2021	6 Monthly	AQS207	15/11/2021	6 Monthly
AQS108	9/11/2021	6 Monthly	AQS208	15/11/2021	6 Monthly
AQS109	9/11/2021	6 Monthly	AQS209	15/11/2021	6 Monthly
AQS110	11/11/2021	6 Monthly	AQS210	15/02/2022	6 Monthly
AQS701	6/02/2022	6 Monthly	AQS801	18/11/2021	6 Monthly
AQS702	7/02/2022	6 Monthly	AQS802	14/02/2022	6 Monthly
AQS703	11/11/2021	6 Monthly	AQS803	14/02/2022	6 Monthly

Table 4: Last Calibration Dates

8 Exceptions and Above Goal Readings

8.1 Data exceptions

This section outlines any issues noted with the monitoring equipment during the reporting period.

NorthConnex Tunnel In-tunnel Northbound Data Validation Table - April 2022					
Date From	Date To	Sensors Affected	Reason	Validation By	Date
1/04/2022 00:00	30/04/2022 23:59	-	No data removed from dataset	TA	12/05/2022

Table 5: In-tunnel Northbound Data Validation Table

NorthConnex Tunnel In-tunnel Southbound Data Validation Table - April 2022					
Date From	Date To	Sensors Affected	Reason	Validation By	Date
5/04/2022 22:40	6/04/2022 17:39	AQS208 NO2	Instrument drift	TA	12/05/2022

Table 6: In-tunnel Southbound Data Validation Table

8.2 Above Goal Readings

Any instances of exceedances of the in tunnel air quality levels beyond the Instrument of Approval goals as set out in Section 4 are noted in the tables below.

NorthConnex Tunnel - Northbound In-tunnel Above Goal Readings - April 2022						
Pollutant	Concentration Limit	Units	Averaging Period	Number of Above Goal Readings	Date Time of Above Goal Reading	Above Goal Reading
CO	200.0	ppm	Rolling 3-minute[2]	0	-	-
	87.0	ppm	Rolling 15-minute[1]	0	-	-
	50.0	ppm	Rolling 30-minute[1]	0	-	-
NO_2	0.5	ppm	Rolling 15-minute[1]	0	-	-
Visibility	0.005	m^{-1}	Rolling 15-minute[1]	0	-	-

Table 7: In-tunnel Northbound Above Goal Readings

NorthConnex Tunnel - Southbound In-tunnel Above Goal Readings - April 2022						
Pollutant	Concentration Limit	Units	Averaging Period	Number of Above Goal Readings	Date Time of Above Goal Reading	Above Goal Reading
CO	200.0	ppm	Rolling 3-minute[2]	0	-	-
	87.0	ppm	Rolling 15-minute[1]	0	-	-
	50.0	ppm	Rolling 30-minute[1]	0	-	-
NO_2	0.5	ppm	Rolling 15-minute[1]	0	-	-
Visibility	0.005	m^{-1}	Rolling 15-minute[1]	0	-	-

Table 8: In-tunnel Southbound Above Goal Readings

[1] Length Of Tunnel measurement - Results calculated from the average of the rolling averages of all sensors in relevant tunnel direction at 1 minute intervals
[2] Single Point Exposure Measurement - Results calculated from the individual sensor 3 minute rolling averages in relevant tunnel direction

9 Documentation

Validated data for in-tunnel sensors is presented in the Excel workbook named “202204 NCX In-Tunnel Validated data.xlsx”

The workbook consists of the following sheets:

1. Cover
2. NB 3m Rolling Avg
3. NB 15m Rolling Avg
4. NB 30m Rolling Avg
5. SB 3m Rolling Avg
6. SB 15m Rolling Avg
7. SB 30m Rolling Avg
8. NB Data Validation Table
9. SB Data Validation Table

Latest Calibration Dates for all sensors are presented in the Excel workbook name “202204 NCX Latest Calibration Dates.xlsx”

The workbook consists of the following sheets:

1. Cover
2. In-tunnel
3. VSO

10 Results

10.1 Data Availability

Data availability for the in-tunnel and ventilation stack outlet sensors are provided in the tables 9 and 10 below.

NorthConnex Tunnel - Northbound In-tunnel Data Availability - April 2022			
Sensor	CO (%)	NO_2 (%)	Visibility (%)
AQS101	100.0	100.0	100.0
AQS102	100.0	100.0	100.0
AQS103	100.0	100.0	100.0
AQS104	100.0	100.0	100.0
AQS105	100.0	100.0	100.0
AQS106	100.0	100.0	100.0
AQS107	100.0	100.0	100.0
AQS108	100.0	100.0	100.0
AQS109	100.0	100.0	100.0
AQS110	100.0	100.0	100.0
AQS701	100.0	100.0	100.0
AQS702	100.0	100.0	100.0
AQS703	100.0	100.0	100.0

Table 9: In-tunnel Northbound data availability

NorthConnex Tunnel - Southbound In-tunnel Data Availability - April 2022			
Sensor	CO (%)	NO_2 (%)	Visibility (%)
AQS201	100.0	100.0	100.0
AQS202	100.0	100.0	100.0
AQS203	100.0	100.0	100.0
AQS204	100.0	100.0	100.0
AQS205	100.0	100.0	100.0
AQS206	100.0	100.0	100.0
AQS207	100.0	100.0	100.0
AQS208	100.0	97.3	100.0
AQS209	100.0	100.0	100.0
AQS210	100.0	100.0	100.0
AQS801	100.0	100.0	100.0
AQS802	100.0	100.0	100.0
AQS803	100.0	100.0	100.0

Table 10: In-tunnel Southbound data availability

10.2 Tabulated Results

10.2.1 Summary of In-tunnel Data

The following tables present 3, 15 and 30 minute average minimum, maximum and monthly average data for the in-tunnel sensors Northbound and Southbound.

3, 15 and 30-minute averages are calculated from 1 minute average data.

NorthConnex Tunnel - Northbound In-tunnel Summary - April 2022					
	CO			NO_2	Visibility
	ppm			ppm	m^{-1}
	30 minute rolling average[1]	15 minute rolling average[1]	3 minute rolling average[2]	15 minute rolling average[1]	15 minute rolling average[1]
Minimum	0.0	0.0	0.0	0.01	0.00000
Maximum	4.1	4.2	10.7	0.32	0.00110
Average	0.3	0.3	0.3	0.06	0.00017
Limit	50	87	200	0.5	0.005

Table 11: Summary of 1 hour average data In-tunnel Northbound

NorthConnex Tunnel - Southbound In-tunnel Summary - April 2022					
	CO			NO_2	Visibility
	ppm			ppm	m^{-1}
	30 minute rolling average[1]	15 minute rolling average[1]	3 minute rolling average[2]	15 minute rolling average[1]	15 minute rolling average[1]
Minimum	0.0	0.0	0.0	0.01	0.00000
Maximum	1.8	2.5	10.2	0.23	0.00052
Average	0.2	0.2	0.3	0.05	0.00010
Limit	50	87	200	0.5	0.005

Table 12: Summary of 1 hour average data In-tunnel Southbound

[1] Length Of Tunnel measurement - Results calculated from the average of the rolling averages of all sensors in relevant tunnel direction at 1 minute intervals
[2] Single Point Exposure Measurement - Results calculated from the individual sensor 3 minute rolling averages in relevant tunnel direction

10.3 Graphical Representations

10.3.1 In-tunnel Monthly Charts

The following charts present 3, 15 and 30 minute average in-tunnel data for CO, NO_2, and Visibility for the North and Southbound tunnels.

30 and 15 minute rolling average charts are plotted as the average of the rolling averages of all sensors in the relevant tunnel direction at 1 minute intervals

3 minute rolling average charts are plotted as the individual sensor data.

Averages are calculated from 1 minute average data.

10.3.1.1 CO 30 minute Rolling Averages

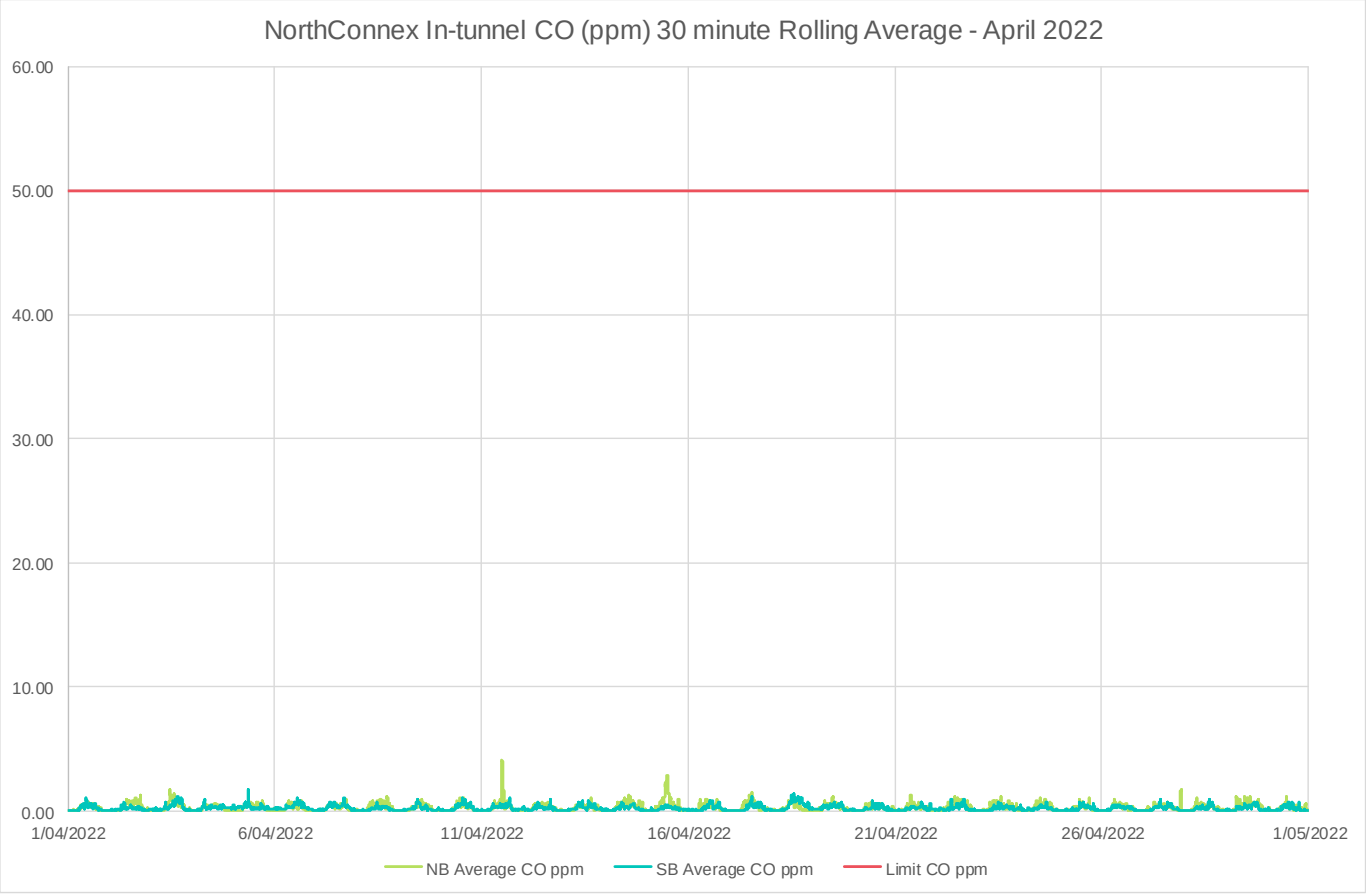

Figure 1: In-tunnel CO 30 minute rolling averages

10.3.1.2 CO 15 minute Rolling Averages

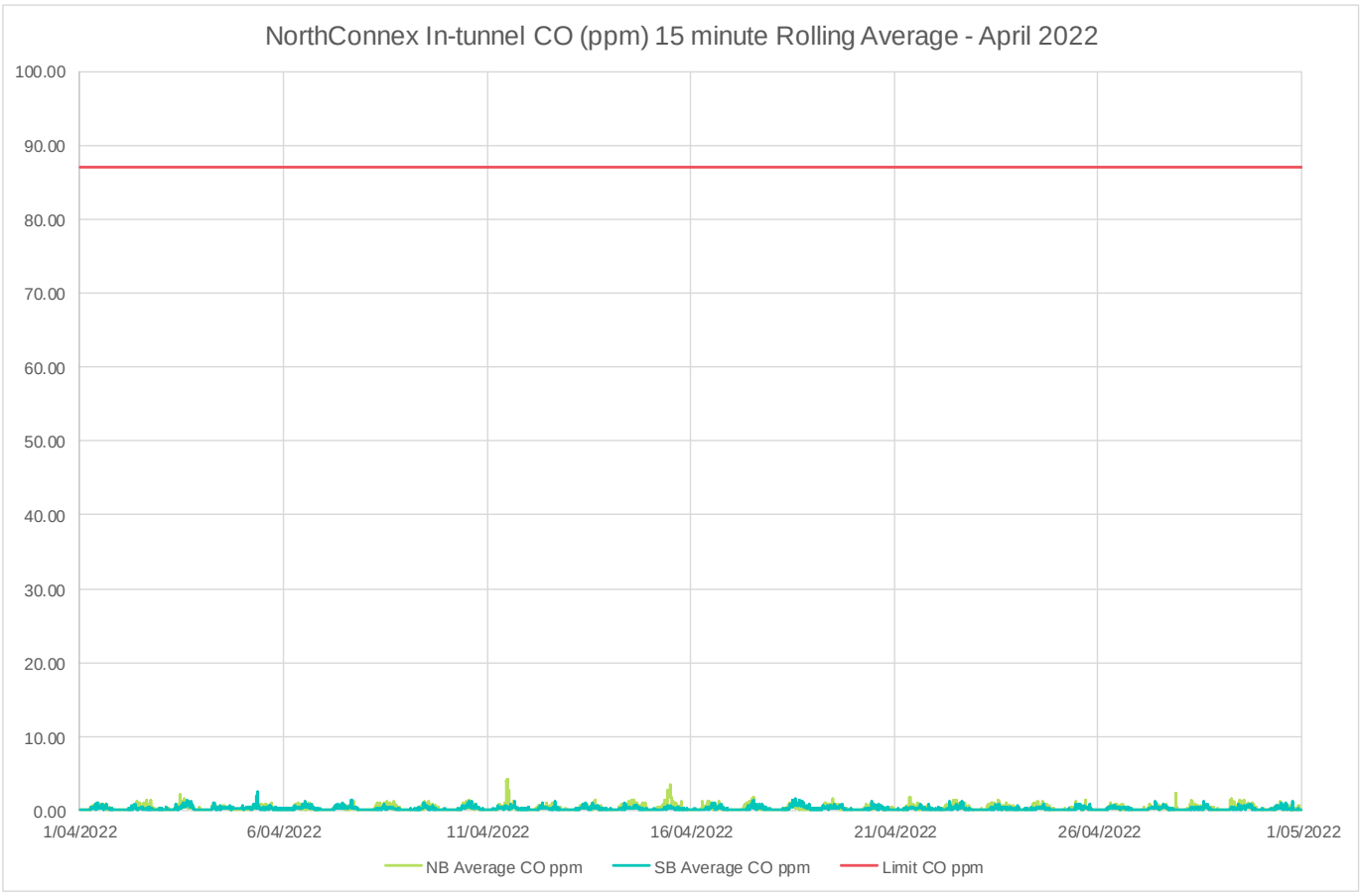

Figure 2: In-tunnel CO 15 minute rolling averages

10.3.1.3 CO 3 minute Rolling Averages Northbound

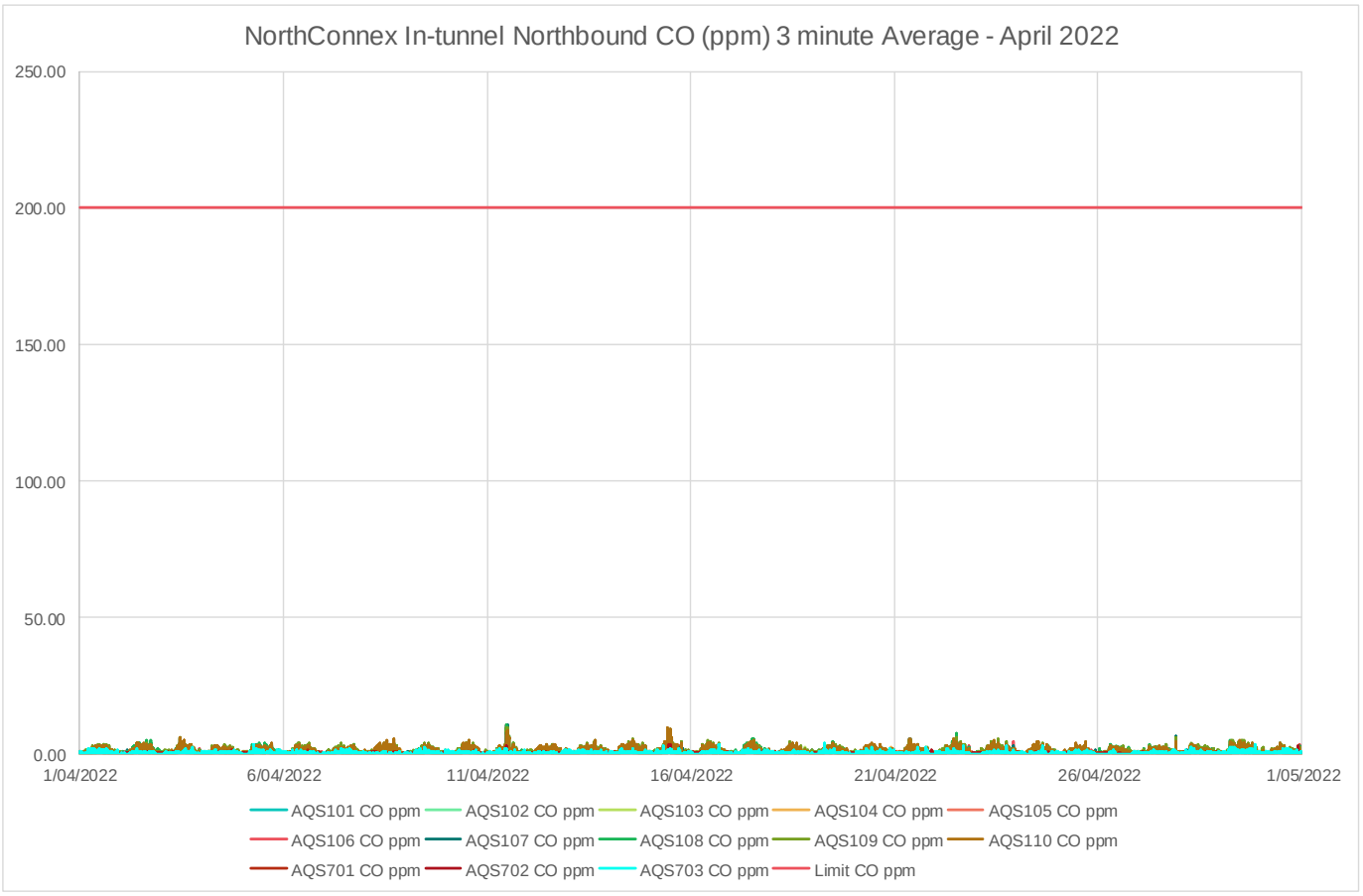

Figure 3: In-tunnel CO 3 minute rolling averages Northbound

10.3.1.4 CO 3 minute Rolling Averages Southbound

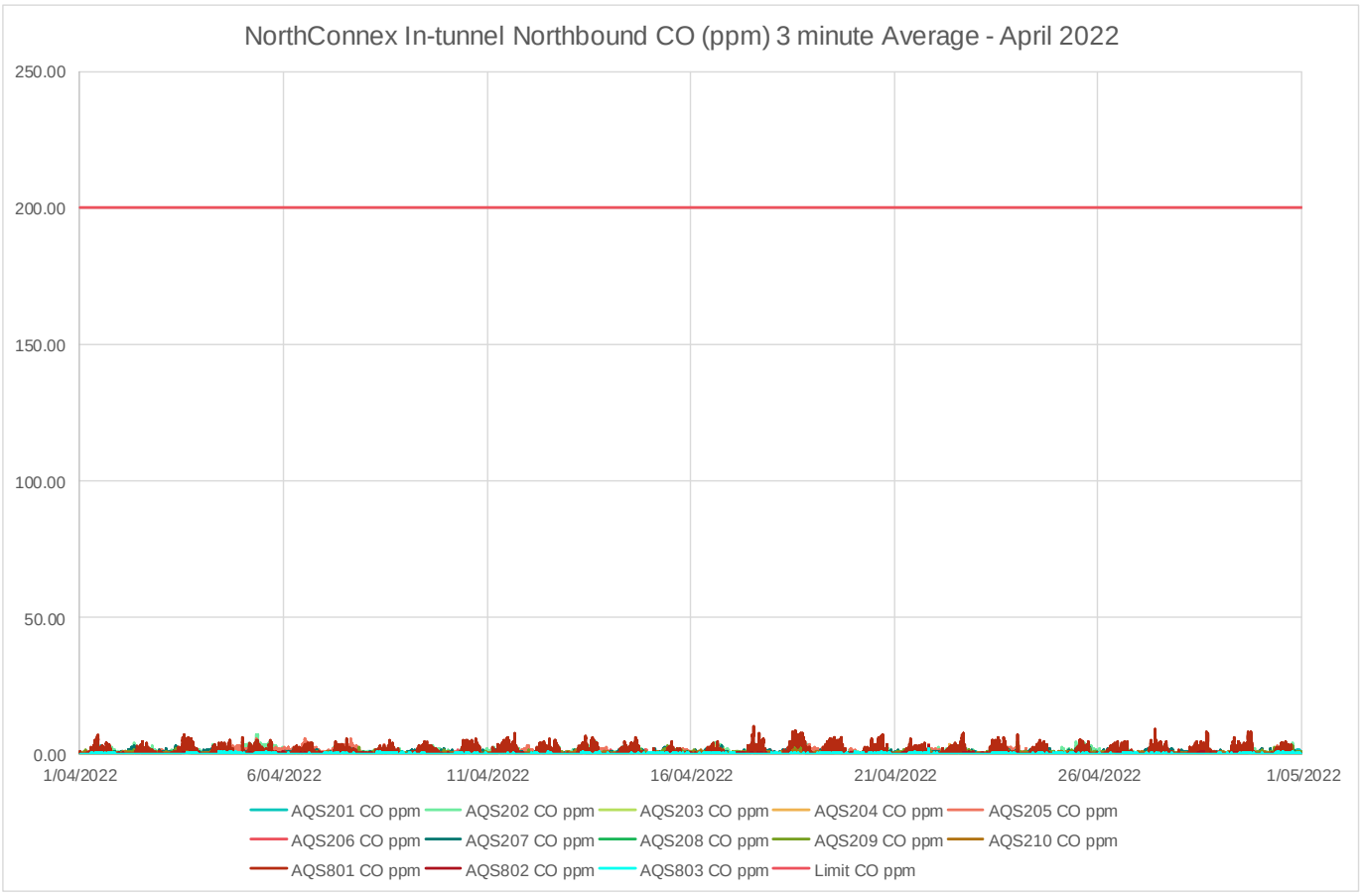

Figure 4: In-tunnel CO 3 minute rolling averages Southbound

10.3.1.5 NO_2 15 minute Rolling Averages

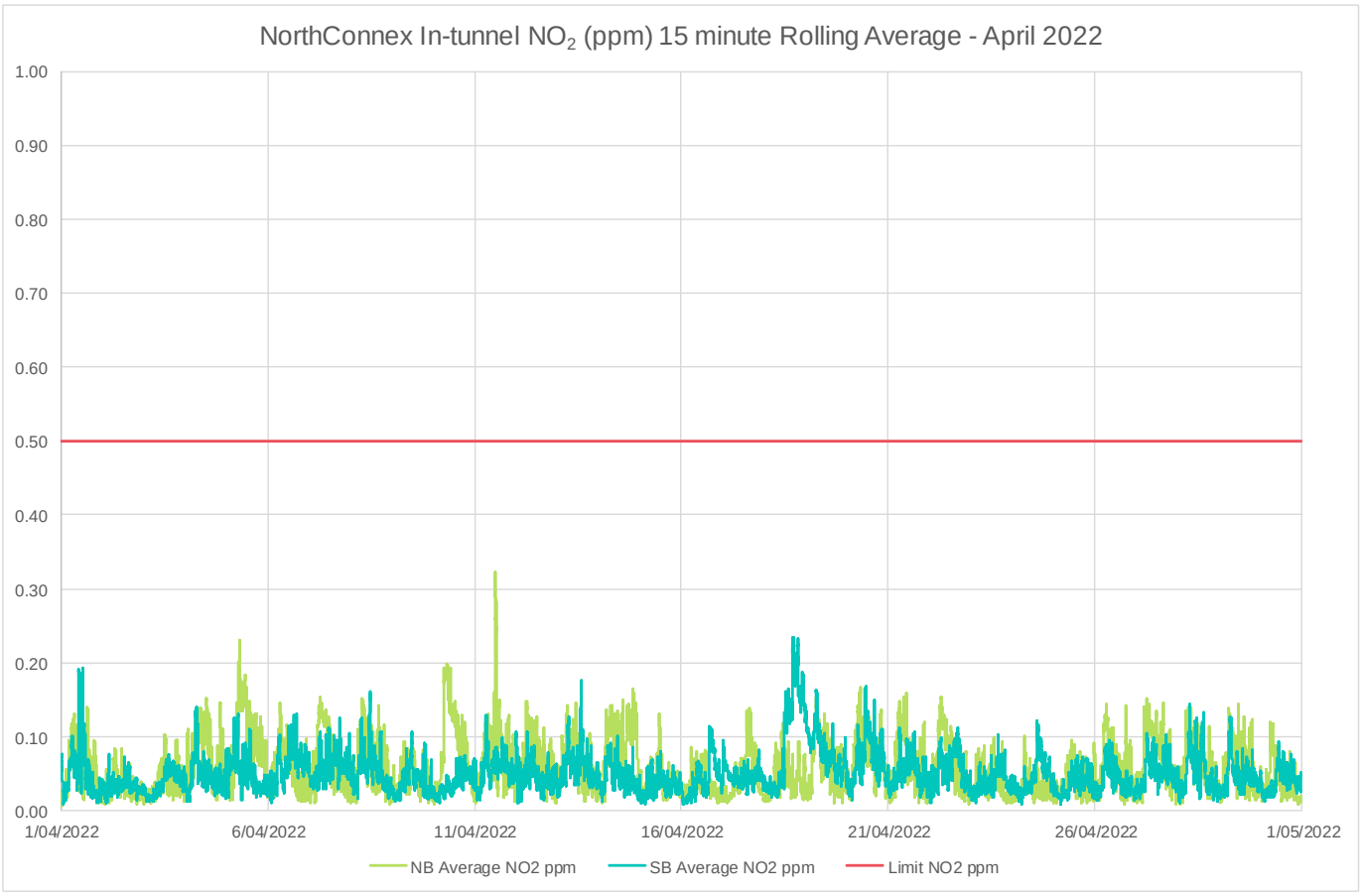

Figure 5: In-tunnel NO_2 15 minute rolling averages

10.3.1.6 Visibility 15 minute Rolling Averages

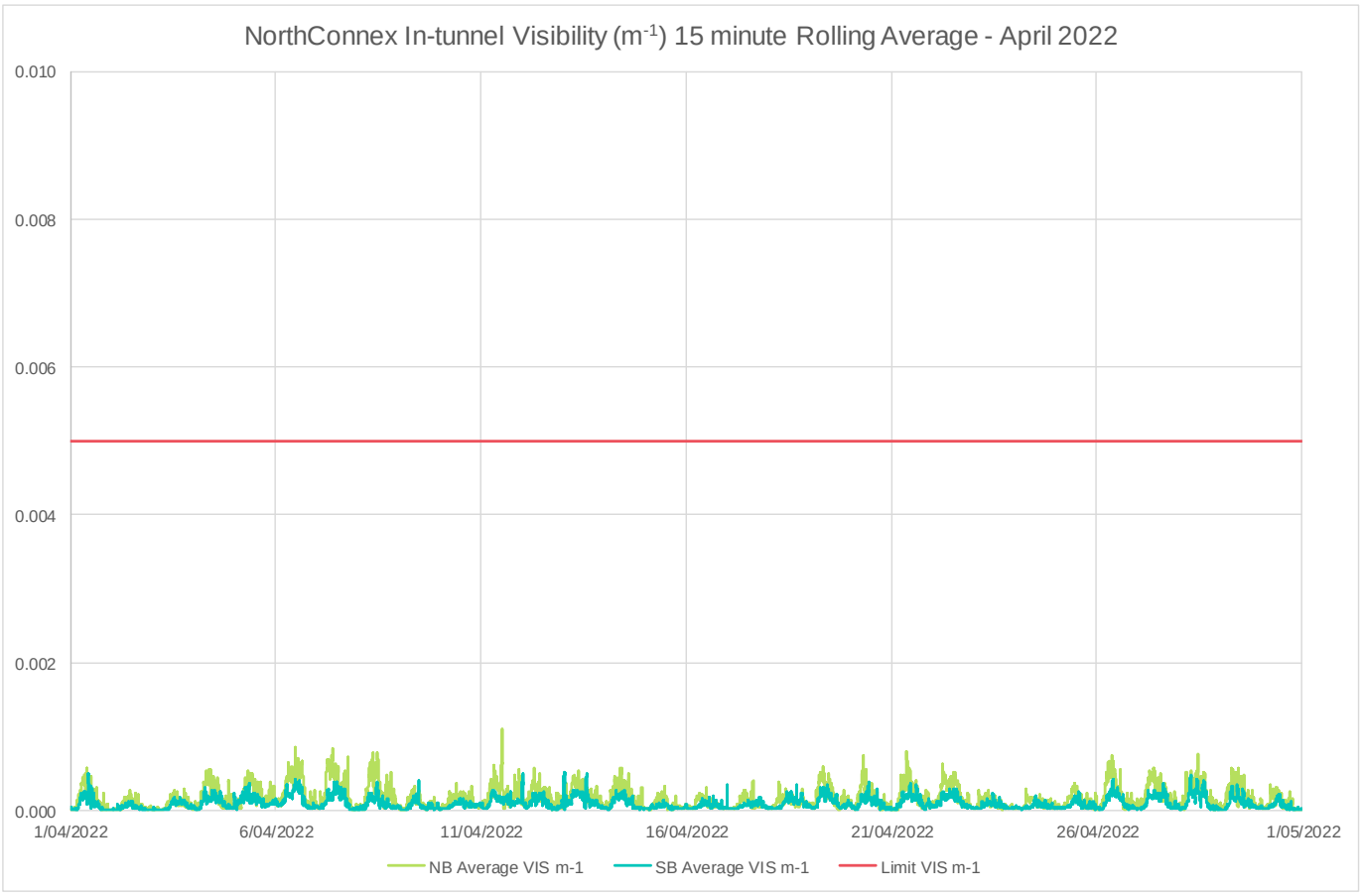

Figure 6: In-tunnel Visibility 15 minute rolling averages

11 Report Summary

There were nil above goal readings of the relevant concentration limits during the reporting period.

For further information relating to exceedance reporting please refer to sections 8 Exceptions and Exceedances.

Glossary

The following terms and abbreviations are used in this report

°C	Degrees Celsius
%	Percent
AQS	Air Quality Sensor
CH_4	Methane
CO	Carbon monoxide
eq.	Equivalents
mbar	millibar
mg/m^3	Milligrams per cubic meter at dry, standard temperature and pressure (0°C and 101.3 kPa)
NMHC	Non-methane hydrocarbons
NO	Nitric oxide
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
RH	Relative Humidity
TSP	Total Suspended Particulate
VOC	Volatile organic compounds
VSO	Ventilation Stack Outlet

Data Validation Explanations

Automatic background check refers to when analyser samples zero air and measures the level of the concentration voltage. This voltage is taken as the zero signal level and this value is subtracted from any subsequent readings as an active zero compensation. This is the analyser's fine zero measurement.

Calibration check outside tolerance refers to when the calibration values are outside the tolerance limits set for the precision check.

Offset or Multiplier Applied to data refers to an offset or multiplier applied to the data. This operation may be performed for a number of reasons including: (a) when a clear trend / drift outside the tolerance limit can be demonstrated by repeated operation precision checks, (b) when a correction is required on previously logged data due to a calibration check being outside the allowable tolerance

Data transmission error refers to a period of time when the instrument could not transmit data. This may be due to a communication fault between the logger and instrument.

Equipment malfunction/instrument fault refers to a period of time when the instrument was not in the normal operating mode and did not measure a representative value of the existing conditions.

Missing data/data not available refers to a period of time when either data has been lost or could not be collected.

Instrument Alarm refers to an alarm produced by the instrument. A range of alarms can be produced depending on how operation of the instrument is being affected.

Instrument out of service refers to an unavailability of data due to an instrument being shut down for repair, maintenance, or factory calibration.

Logger error refers to when an error occurs and instrument readings are not correctly recorded by the logger.

Maintenance refers to a period of time when the logger / instrument was unavailable due to maintenance.

Overnight span/zero out of tolerance refers to when the span/zero reading measured by the analyser during an automatic precision check falls outside of the expected concentration limits.

Power Interruption refers to no power to the station therefore no data was collected at this time.

Remote Calibration refers to when a technician remotely connects to the station and manually performs a span check.

Warm up after power interruption refers to the start up period of an instrument after power has been restored.