



REPORT

EastLink Ventilation Stack Emission Monitoring Report July - September 2019

Submitted to:

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APPENDIX A

Important Information Relating to this Report

1.0 INTRODUCTION

EastLink is a 39 kilometre motorway running between Donvale in Melbourne's north-east to Frankston in Melbourne's south-east with two tunnels under the Mullum Mullum Valley. Broadspectrum Pty Ltd, who are responsible for operation and maintenance of the road, commissioned Golder Associates Pty. Ltd. to provide continuous emission monitoring services for the EastLink motorway project. The services provided include:

- Operations and maintenance services for the EastLink ventilation stack continuous emission monitoring systems (CEMS)
- NATA endorsed emission monitoring reports.

Monitoring commenced on the 29th June, 2008 with the opening of the EastLink motorway. Results for the sampling period 1st July, 2019 to 30th September, 2019 inclusive are contained in the following report.

The work was conducted under the following Broadspectrum Pty Ltd Work Order numbers:

Month	Western Stack	Eastern Stack
July	1121463	1121270
August	1128652	1127664
September	1133142	1132792

TBA – To be advised

Your attention is drawn to the document - "Important Information Relating to this Report" (LEG04, RL2), which is included in Appendix A of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. We would be pleased to answer any questions the reader may have regarding this document.

2.0 DISCHARGES TO AIR

EastLink has discharges to air servicing two road tunnels. Discharge Point No. 1 (DP1) services the inbound (Melba) tunnel and Discharge Point No. 2 (DP2) services the outbound (Mullum Mullum) tunnel.

The locations of the discharges to air are described in Table 1 and presented in Figure 1.

Table 1: Discharges to Air

Discharge Point No.	Station Name	Location
1	Western ventilation stack	Western end of inbound tunnel (Melba) - Donvale
2	Eastern ventilation stack	Eastern end of outbound tunnel (Mullum Mullum) – Ringwood

Monitoring equipment is housed in temperature controlled cabinets located at the base of each of the ventilation stacks. Particulate matter and gaseous sample inlets are installed inside the plenum chamber of each of the ventilation stacks.

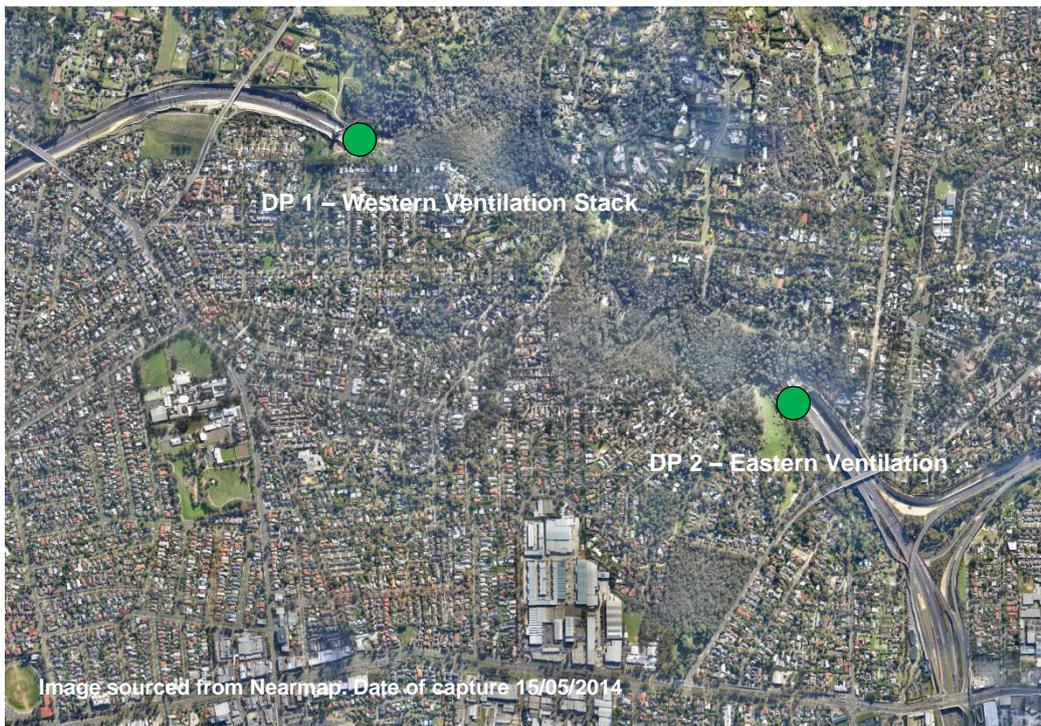


Figure 1: Ventilation Stack Locations

3.0 VENTILATION STACK MONITORING PARAMETERS

The following parameters are monitored continuously, with averages logged at 5 minute intervals:

- Particulate matter with an equivalent aerodynamic diameter less than 2.5 microns (PM_{2.5})
- Particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM₁₀)
- Total oxides of nitrogen (NO_x)
- Nitric oxide (NO)
- Nitrogen dioxide (NO₂)
- Carbon monoxide (CO)
- Stack velocity
- Stack temperature
- Ambient pressure.

4.0 METHODS

4.1 PM_{2.5}

PM_{2.5} concentrations in the tunnel ventilation stacks are determined using 1400 Series Tapered Element Oscillating Microbalance (TEOM) analysers. Sample inlets are located inside the plenum chamber of each ventilation stack.

Exhaust gas is drawn through a PM_{2.5} size selective inlet (PM₁₀ WINS head fitted with a PM_{2.5} sharp cut cyclone (SCC)) at 1 m³/h. The flow is then isokinetically split into two streams; 1 l/min stream which passes through the filter on the mass transducer and a 15.7 l/min bypass stream.

The sample stream is heated to 50°C to maintain a low and therefore relatively constant humidity.

Measurements are made in real-time (2 s intervals) with the 5 minute averages logged. 1 hour averages are then calculated from the logged data.

The PM_{2.5} monitoring method is based on the requirements of Australian Standard AS 3580.9.13, "*Methods for Sampling and Analysis of Ambient Air: Determination of Suspended Particulate Matter – PM_{2.5} Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance Monitor*".

4.2 PM₁₀

PM₁₀ concentrations in the tunnel ventilation stacks are determined using 1400 Series Tapered Element Oscillating Microbalance (TEOM) analysers. Sample inlets are located inside the plenum chamber of each ventilation stack.

Exhaust gas is drawn through a PM₁₀ size selective inlet (PM₁₀ WINS head) at 1 m³/h. The flow is then isokinetically split into two streams; 1 l/min stream which passes through the filter on the mass transducer and a 15.7 l/min bypass stream.

The sample stream is heated to 50°C to maintain a low and therefore relatively constant humidity.

Measurements are made in real-time (2 s intervals) with the 5 minute averages logged. 1 hour averages are then calculated from the logged data.

The PM₁₀ monitoring method is based on the requirements of Australian Standard AS 3580.9.8, "*Methods for Sampling and Analysis of Ambient Air: Determination of Suspended Particulate Matter – PM₁₀ Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance Analyser*".

4.3 Carbon Monoxide

Carbon monoxide concentrations in the tunnel ventilation stacks are determined by infra-red gas filter correlation analysers.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The carbon monoxide monitoring method is based on the requirements of Australian Standard AS 3580.7.1, "*Determination of Carbon Monoxide – Direct Reading Instrumental Method*".

4.4 Oxides of Nitrogen

Oxides of nitrogen concentrations in the tunnel ventilation stacks are determined by chemiluminescence gas analysers.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The oxides of nitrogen (NO, NO₂ and NO_x) monitoring method is based on the requirements of Australian Standard AS 3580.5.1, "Determination of Oxides of Nitrogen – Chemiluminescence Method".

4.5 Stack Velocity

Stack gas velocity was determined using an optical flow sensor that complies with USEPA Code of Federal Regulations (CFR 40) Part 75, "Continuous Emission Monitoring" requirements.

5.0 MEASUREMENT UNCERTAINTY

Table 2: Measurement Uncertainty

Parameter	Method	Estimated Uncertainty
PM ₁₀	TEOM	± 5%
PM _{2.5}	TEOM	± 5%
NO, NO ₂ , NO _x	Chemiluminescence	± 10%
CO	Infra-red gas filter correlation	± 10%
Stack velocity	Optical flow sensor	± 0.1 m/s or 5% of reading, whichever is greater
Ambient temperature	Thermocouple (TEOM)	± 2°C
Ambient pressure	TEOM pressure transducer	± 1.5%

6.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/07/2019 – 31/07/2019

6.1 Data Capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

The data capture statistics for the reporting period 1st July to 31st July, 2019 are shown in Table 3. Averages were only collected for those periods where the 5 minute data constituted 75% data capture. Reduced data capture for NO_x eastern ventilation system was due to analyser span drift out of tolerance.

Section 6.3 provides further information on the reasons for invalid data periods.

Table 3: Data Capture Statistics - 1 Hour Averages

Parameter	Station	Collected Periods	Available Periods	Data Capture
PM _{2.5}	Eastern	733	744	98.5%
	Western	742	744	99.7%
PM ₁₀	Eastern	727	744	97.7%
	Western	742	744	99.7%
NO, NO ₂	Eastern	668	744	89.8%
	Western	698	744	93.8%
CO	Eastern	705	744	94.8%
	Western	710	744	95.4%

6.2 Results

6.2.1 PM_{2.5}

PM_{2.5} (1 hour average) mass rate of emission statistics for the reporting period are given in Table 4. A plot of PM_{2.5} (1 hour average) mass rate of emission for the reporting period is presented in Figure 2.

Table 4: PM_{2.5} Mass Rate Percentiles (1 Hour Average)

Station	PM _{2.5} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.11	0.098	0.090	0.077	0.052	0.048	0.022
Western	0.13	0.11	0.10	0.072	0.052	0.036	0.021

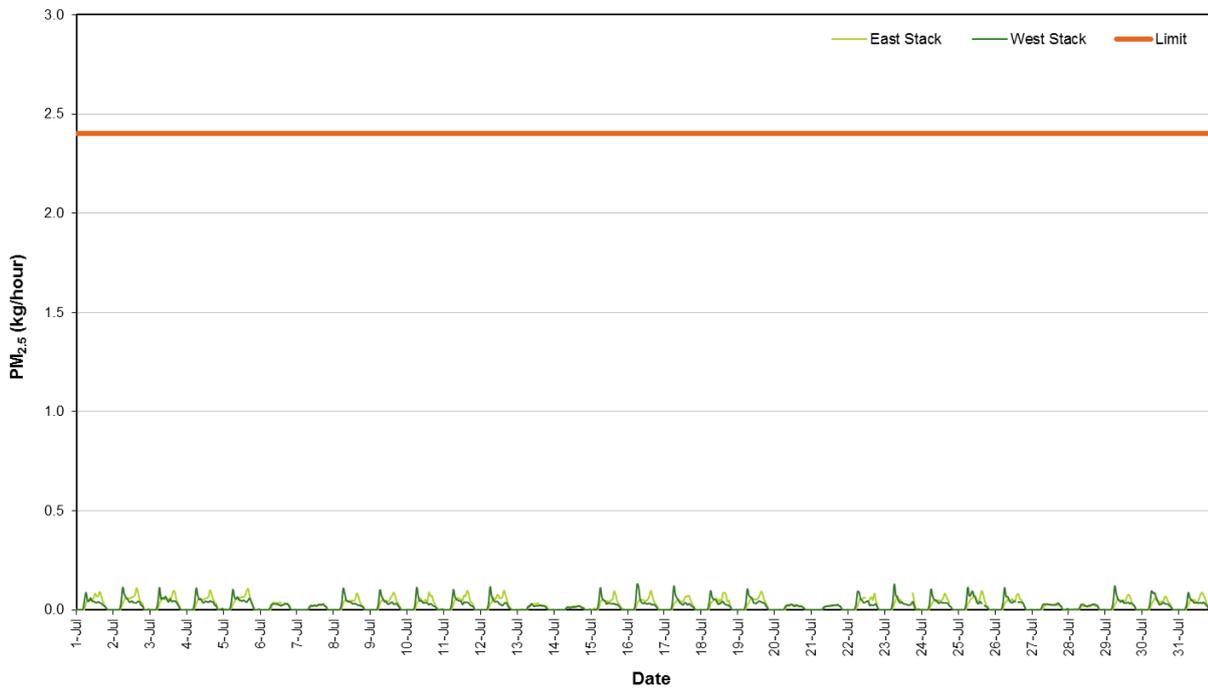


Figure 2: PM_{2.5} Mass Rate (1 Hour Average)

6.2.2 PM₁₀

PM₁₀ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 5. A plot of PM₁₀ (1 hour average) mass rate of emission for the reporting period is presented in Figure 3.

Table 5: PM₁₀ Mass Rate Percentiles (1 Hour Average)

Station	PM ₁₀ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.20	0.16	0.15	0.13	0.10	0.078	0.034
Western	0.33	0.24	0.21	0.15	0.11	0.079	0.041

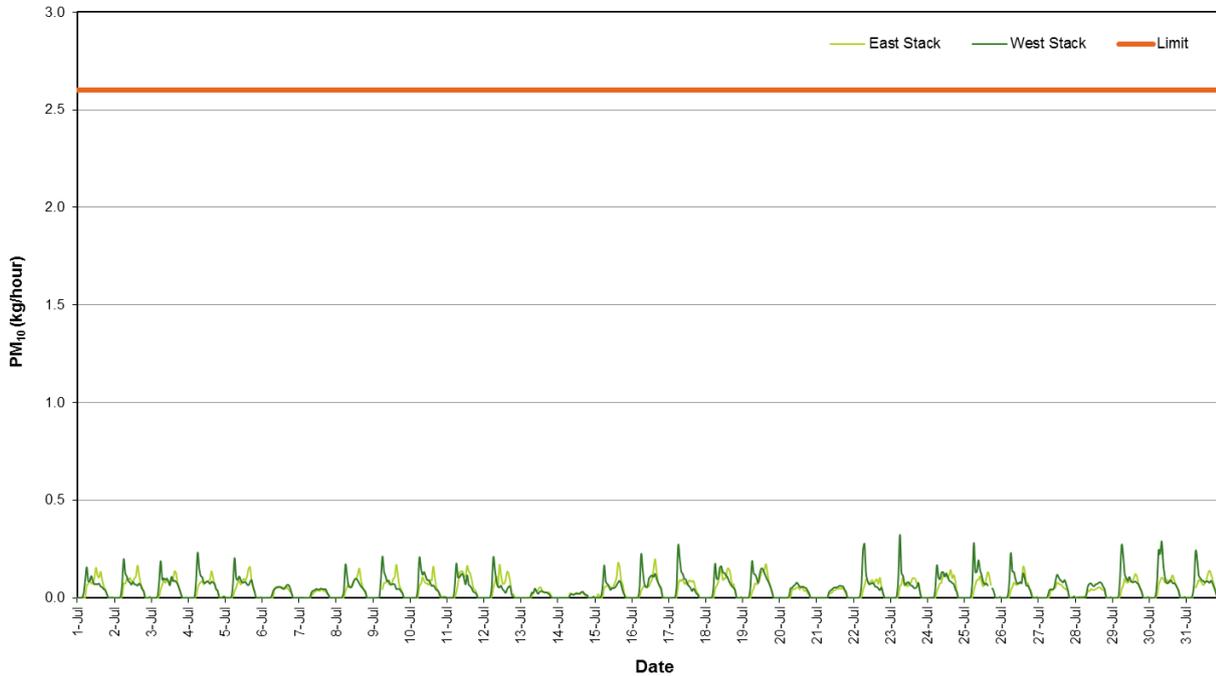


Figure 3: PM₁₀ Mass Rate (1 Hour Average)

6.2.3 Carbon Monoxide

Carbon monoxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 6. A plot of carbon monoxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 4.

Table 6: Carbon Monoxide Mass Rate Percentiles (1 Hour Average)

Station	Carbon Monoxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	7.5	6.2	5.7	4.8	4.0	3.0	2.2
Western	8.2	6.7	6.2	5.2	4.0	3.1	2.3

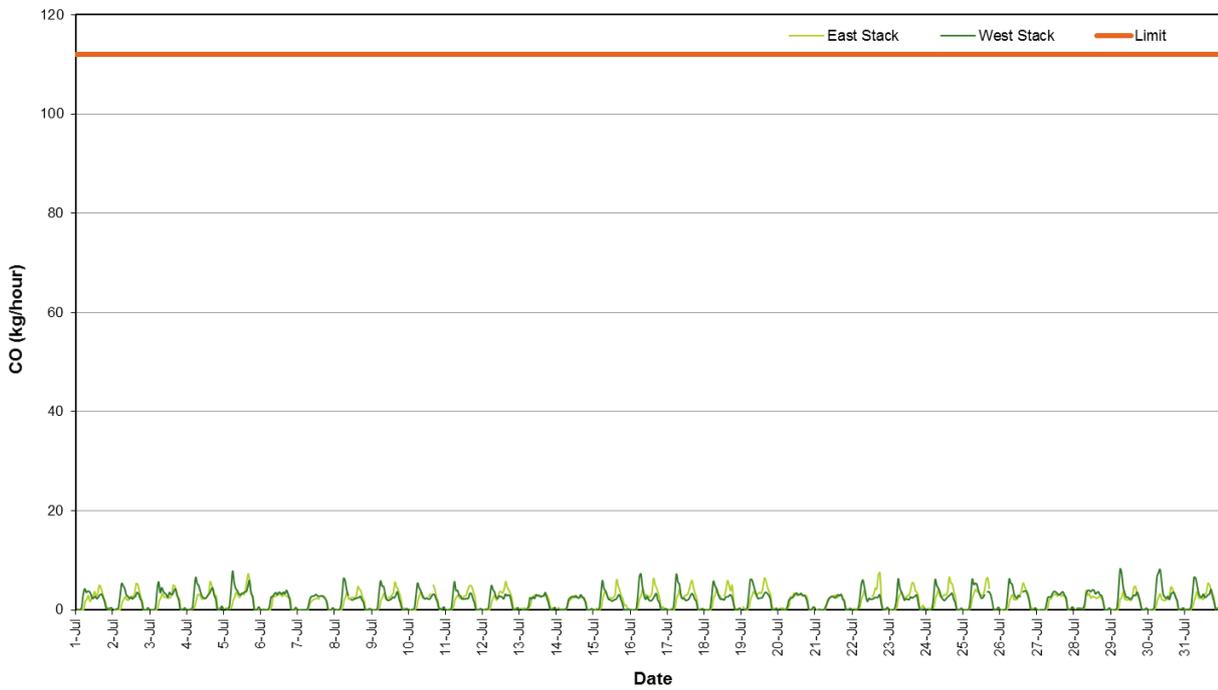


Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)

6.2.4 Oxides of Nitrogen

6.2.4.1 Nitric Oxide

Nitric oxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 7. A plot of nitric oxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 5.

Table 7: Nitric Oxide Mass Rate Percentiles (1 Hour Average)

Station	Nitric Oxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	2.3	1.9	1.7	1.4	1.3	0.97	0.40
Western	3.6	3.1	2.9	2.0	1.4	1.0	0.54

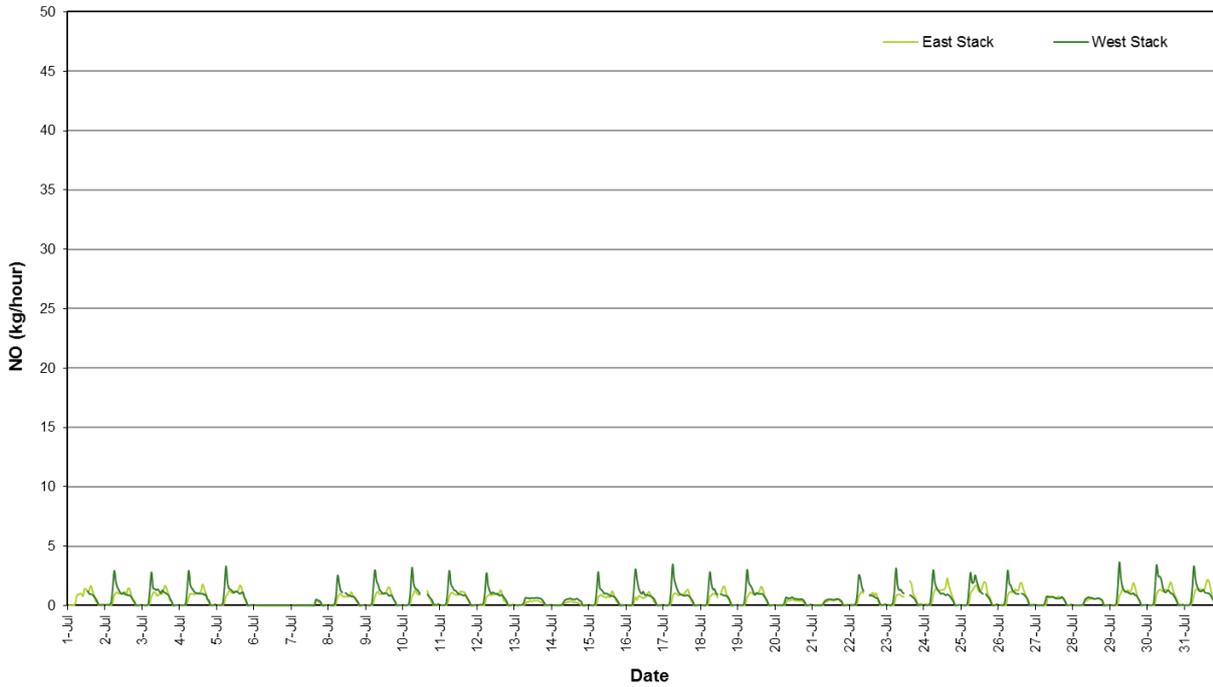


Figure 5: Nitric Oxide Mass Rate (1 Hour Average)

6.2.4.2 Nitrogen Dioxide

Nitrogen dioxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 8. A plot of nitrogen dioxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 6.

Table 8: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average)

Station	Nitrogen Dioxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.51	0.43	0.41	0.34	0.27	0.20	0.10
Western	0.56	0.50	0.47	0.29	0.20	0.16	0.095

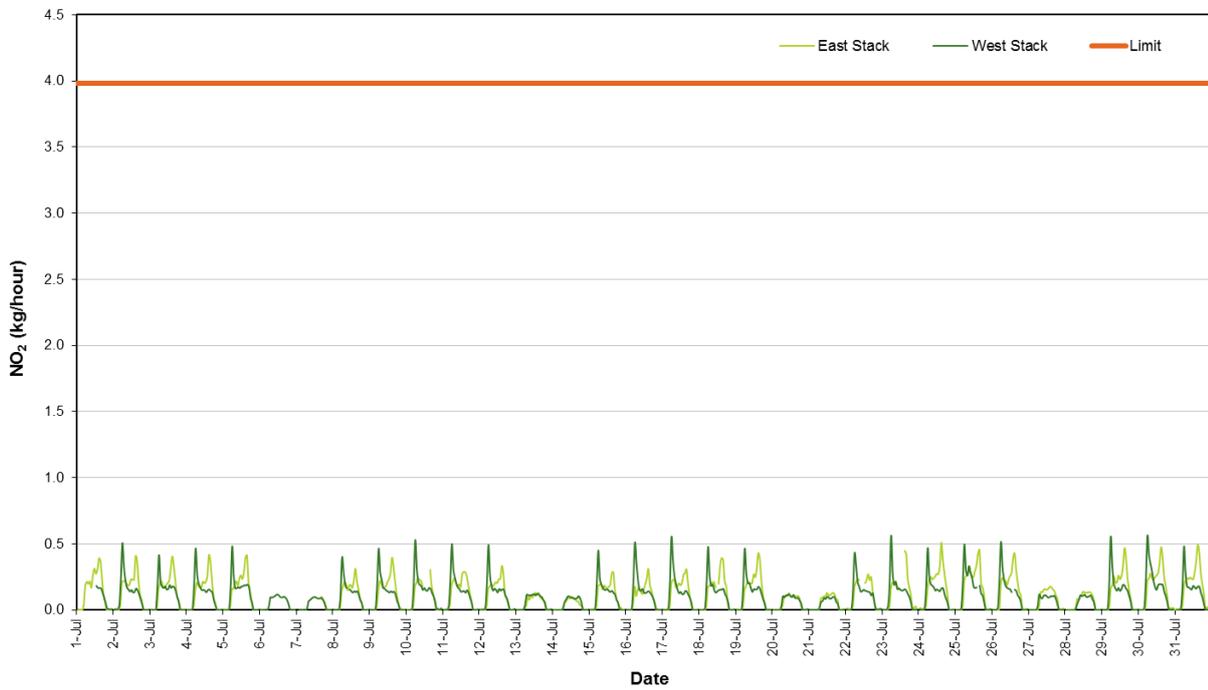


Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)

6.2.5 Stack Velocity

The stack velocity (1 hour average) plot for the reporting period is presented in Figure 7.

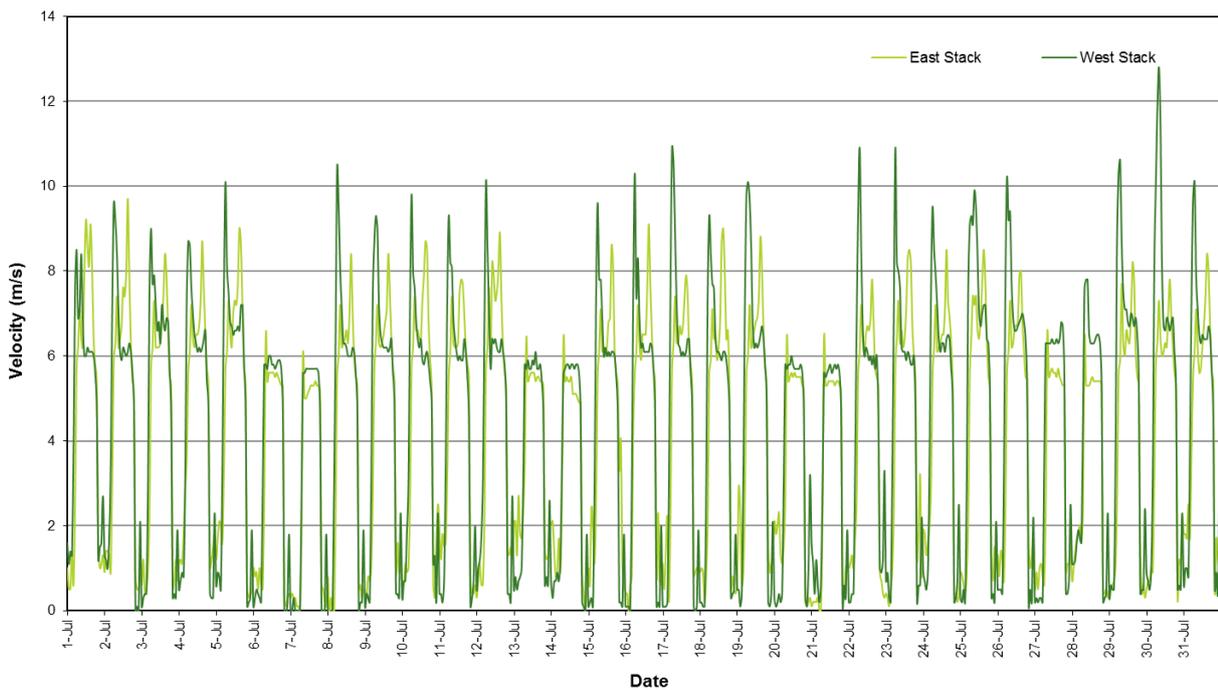


Figure 7: Stack Velocity (1 Hour Average)

6.3 Data Validation and Exceptions

Data contained in the report has been validated against performance and calibration requirements for each instrument. Data during maintenance and calibration periods has been removed from the validated data sets. Tables 9 and 10 list the data exceptions for the eastern and western ventilation stacks, where valid data is less than 75% of the one hour average. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

Table 9: Data Exceptions - Eastern Ventilation Stack: July 2019

Start	End	Parameter	Reason
5/07/2019 01:00	5/07/2019 01:05	PM ₁₀	Invalid ¹
5/07/2019 11:10	5/07/2019 11:20	PM ₁₀	Invalid ¹
5/07/2019 20:05	5/07/2019 20:20	PM ₁₀	Invalid ¹
6/07/2019 00:40	7/07/2019 15:25	NO, NO ₂ , NO _x	Invalid - span drift
7/07/2019 01:00	7/07/2019 20:30	PM ₁₀	Invalid ¹
7/07/2019 15:00	7/07/2019 15:30	CO	Maintenance / calibration
9/07/2019 03:10	9/07/2019 05:45	PM ₁₀	Invalid ¹
10/07/2019 11:50	10/07/2019 12:40	CO	Maintenance / calibration
10/07/2019 11:50	10/07/2019 15:30	NO, NO ₂ , NO _x	Maintenance / calibration
10/07/2019 14:55	10/07/2019 15:30	CO	Maintenance / calibration
10/07/2019 22:50	10/07/2019 23:15	PM ₁₀	Invalid ¹
11/07/2019 01:55	11/07/2019 02:55	PM ₁₀	Invalid ¹
14/07/2019 14:50	14/07/2019 14:55	PM ₁₀	Invalid ¹
14/07/2019 22:25	14/07/2019 22:35	PM ₁₀	Invalid ¹
17/07/2019 12:30	17/07/2019 12:40	PM ₁₀	Invalid ¹
18/07/2019 02:50	18/07/2019 03:45	PM ₁₀	Invalid ¹
18/07/2019 12:15	18/07/2019 12:50	NO, NO ₂ , NO _x	Maintenance / calibration
18/07/2019 12:20	18/07/2019 12:55	CO	Maintenance / calibration
19/07/2019 05:40	19/07/2019 05:45	PM ₁₀	Invalid ¹

Notes: ¹ – In the opinion of the reviewer

Table 10: Data Exceptions - Western Ventilation Stack: July 2019

Start	End	Parameter	Reason
20/07/2019 13:30	20/07/2019 13:35	PM ₁₀	Invalid ¹
22/07/2019 10:25	22/07/2019 12:25	NO, NO ₂ , NO _x	Maintenance / calibration
22/07/2019 10:35	22/07/2019 10:55	CO	Maintenance / calibration
22/07/2019 11:50	22/07/2019 12:25	CO	Maintenance / calibration
22/07/2019 12:40	22/07/2019 13:10	PM _{2.5}	Invalid ¹
23/07/2019 12:30	23/07/2019 14:40	NO, NO ₂ , NO _x	Maintenance / calibration
23/07/2019 12:35	23/07/2019 12:45	CO	Maintenance / calibration
23/07/2019 12:35	23/07/2019 13:10	PM _{2.5}	Maintenance / calibration
23/07/2019 13:50	23/07/2019 17:40	PM _{2.5}	Maintenance / calibration
24/07/2019 02:20	24/07/2019 03:45	PM ₁₀	Invalid ¹
24/07/2019 19:30	24/07/2019 20:40	PM _{2.5}	Invalid ¹
25/07/2019 18:00	25/07/2019 19:45	PM ₁₀	Power failure
25/07/2019 18:30	25/07/2019 19:15	CO	Maintenance / calibration
26/07/2019 01:05	26/07/2019 01:35	PM _{2.5}	Invalid ¹
26/07/2019 10:45	26/07/2019 11:05	CO, NO, NO ₂ , NO _x	Maintenance / calibration
26/07/2019 13:45	26/07/2019 14:05	PM ₁₀	Invalid ¹
26/07/2019 20:55	26/07/2019 21:20	PM ₁₀	Invalid ¹
28/07/2019 23:35	28/07/2019 23:55	PM _{2.5}	Invalid ¹
31/07/2019 05:25	31/07/2019 06:10	PM ₁₀	Invalid ¹
31/07/2019 08:45	31/07/2019 09:00	PM ₁₀	Invalid ¹

Notes: ¹ – In the opinion of the reviewer

There was one instance where PM_{2.5} concentration was greater than the corresponding PM₁₀ concentration. If no valid reason was found to exclude the data, the data was left unchanged in the data set. An example of such an occurrence is listed below:

- East Ventilation stack 5/07/2019 20:15 – 6/07/2019 07:40

7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/08/2019 – 31/08/2019

7.1 Data Capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

The data capture statistics for the reporting period 1st August to 31st August, 2019 are shown in Table 11. Averages were only collected for those periods where the 5 minute data constituted 75% data capture. Reduced data capture for CO eastern ventilation system was due to analyser span out of tolerance.

Section 7.3 provides further information on the reasons for invalid data periods.

Table 11: Data Capture Statistics - 1 Hour Averages

Parameter	Station	Collected Periods	Available Periods	Data Capture
PM _{2.5}	Eastern	735	744	98.8%
	Western	728	744	97.8%
PM ₁₀	Eastern	738	744	99.2%
	Western	731	744	98.3%
NO, NO ₂	Eastern	701	744	94.2%
	Western	700	744	94.1%
CO	Eastern	711	744	95.6%
	Western	662	744	89.0%

7.2 Results

7.2.1 PM_{2.5}

PM_{2.5} (1 hour average) mass rate of emission statistics for the reporting period are given in Table 12. A plot of PM_{2.5} (1 hour average) mass rate of emission for the reporting period is presented in Figure 8.

Table 12: PM_{2.5} Mass Rate Percentiles (1 Hour Average)

Station	PM _{2.5} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.13	0.095	0.088	0.072	0.050	0.047	0.023
Western	0.12	0.11	0.091	0.071	0.050	0.035	0.021

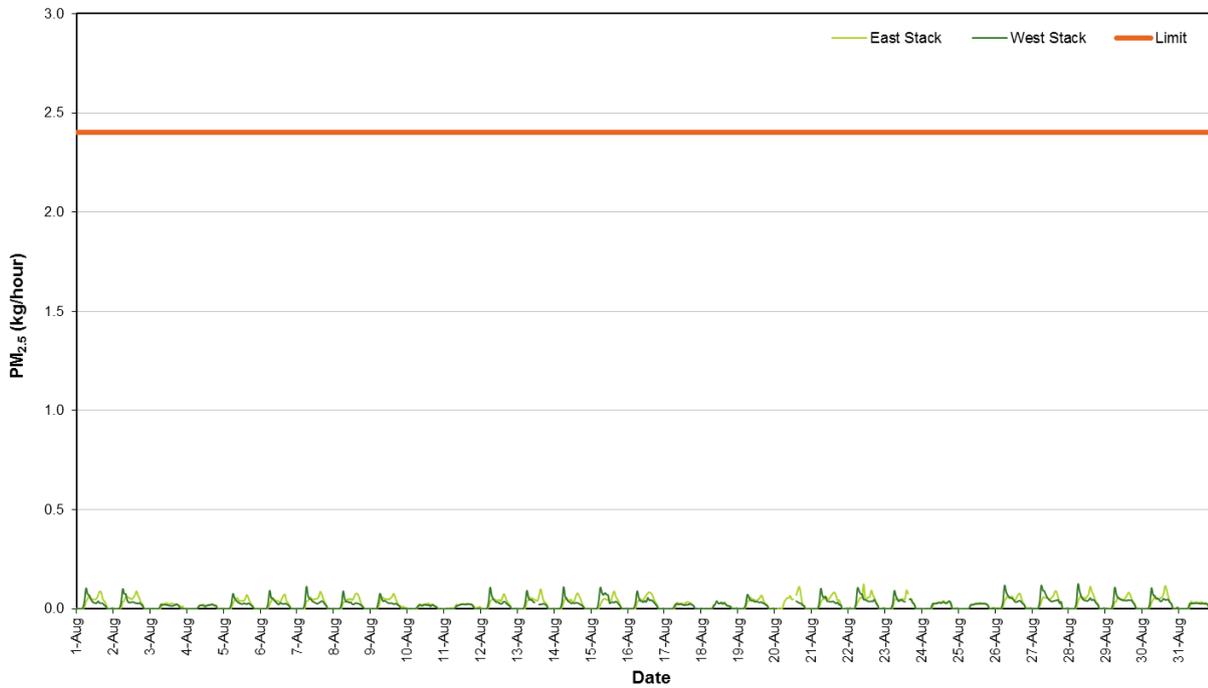


Figure 8: PM_{2.5} Mass Rate (1 Hour Average)

7.2.2 PM₁₀

PM₁₀ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 13. A plot of PM₁₀ (1 hour average) mass rate of emission for the reporting period is presented in Figure 9.

Table 13: PM₁₀ Mass Rate Percentiles (1 Hour Average)

Station	PM ₁₀ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	2.1	0.16	0.15	0.13	0.11	0.084	0.042
Western	0.51	0.29	0.25	0.16	0.12	0.086	0.047

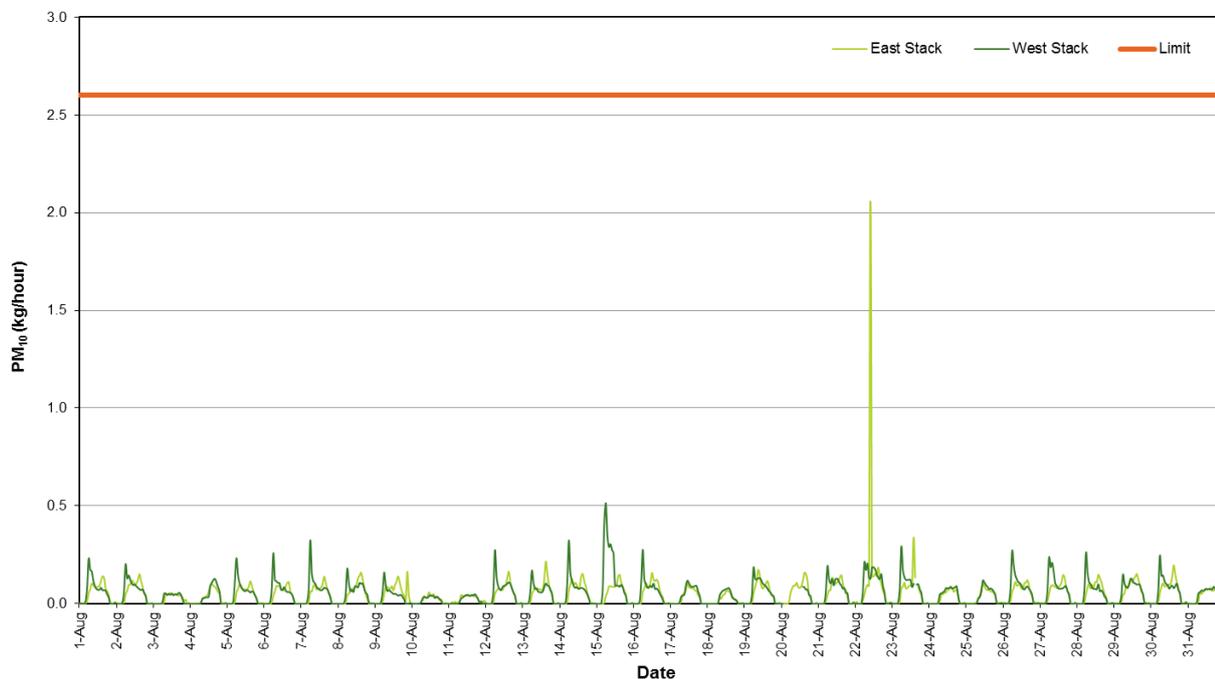


Figure 9: PM₁₀ Mass Rate (1 Hour Average)

7.2.3 Carbon Monoxide

Carbon monoxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 14. A plot of carbon monoxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 10.

Table 14: Carbon Monoxide Mass Rate Percentiles (1 Hour Average)

Station	Carbon Monoxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	7.4	5.7	5.3	4.6	3.7	2.8	2.1
Western	9.4	7.5	6.4	5.2	3.9	3.1	2.1

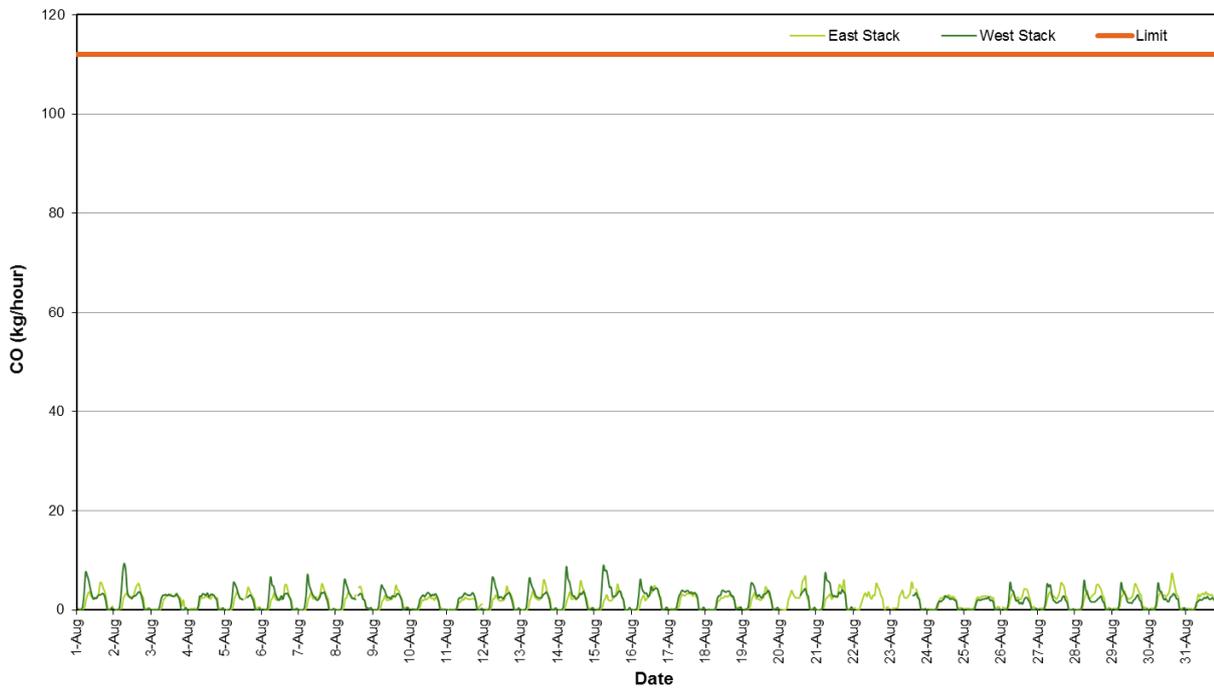


Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)

7.2.4 Oxides of Nitrogen

7.2.4.1 Nitric Oxide

Nitric oxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 15. A plot of nitric oxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 11.

Table 15: Nitric Oxide Mass Rate Percentiles (1 Hour Average)

Station	Nitric Oxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	2.6	2.3	2.2	1.9	1.6	1.3	0.56
Western	3.9	3.3	3.0	2.1	1.4	1.0	0.57

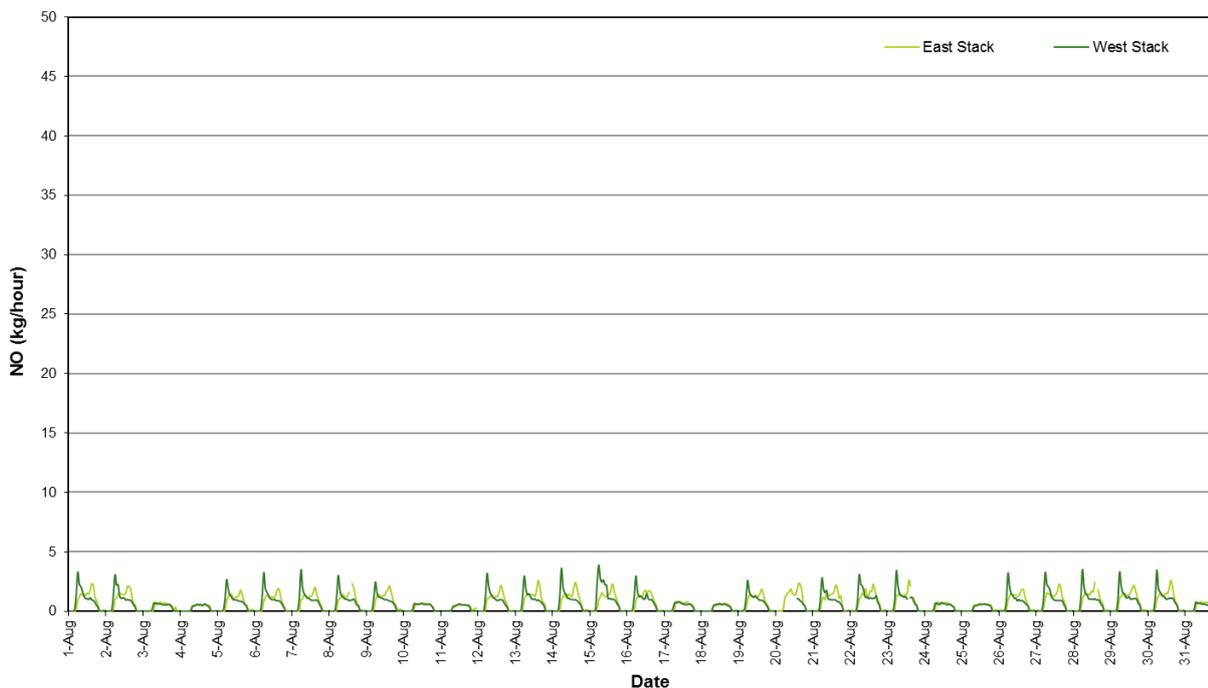


Figure 11: Nitric Oxide Mass Rate (1 Hour Average)

7.2.4.2 Nitrogen Dioxide

Nitrogen dioxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 16. A plot of nitrogen dioxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 12.

Table 16: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average)

Station	Nitrogen Dioxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.59	0.52	0.48	0.41	0.32	0.25	0.14
Western	0.64	0.53	0.50	0.31	0.22	0.16	0.10

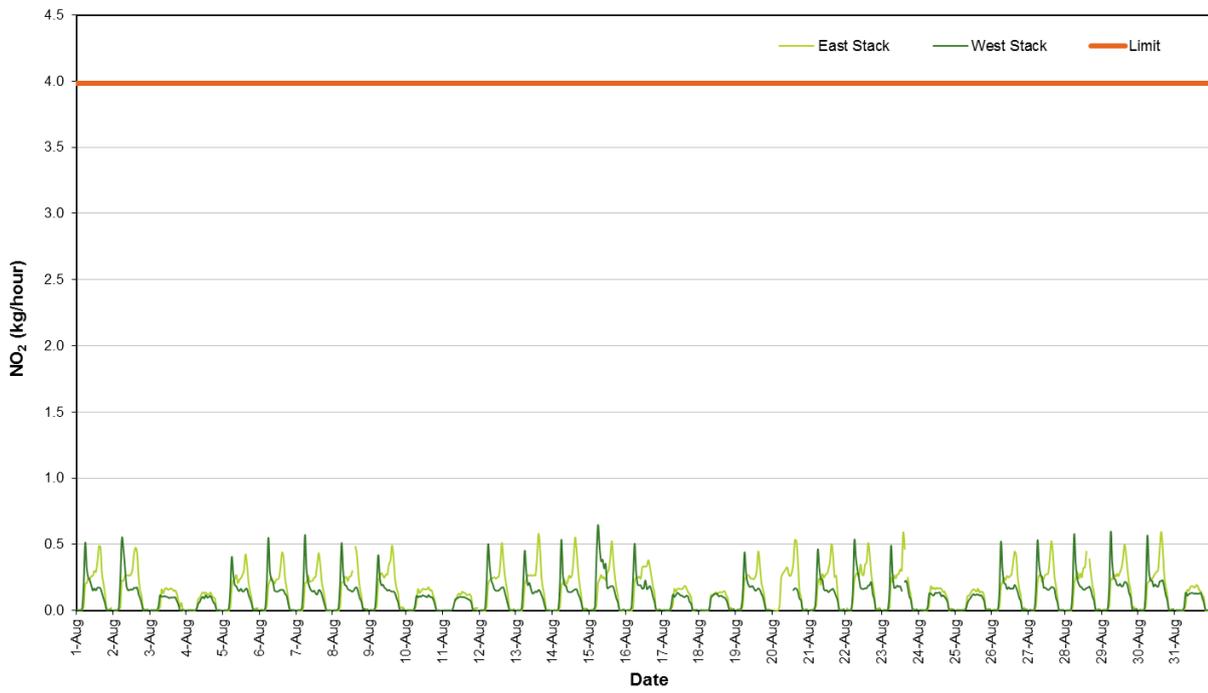


Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)

7.2.5 Stack Velocity

The stack velocity (1 hour average) plot for the reporting period is presented in Figure 13.

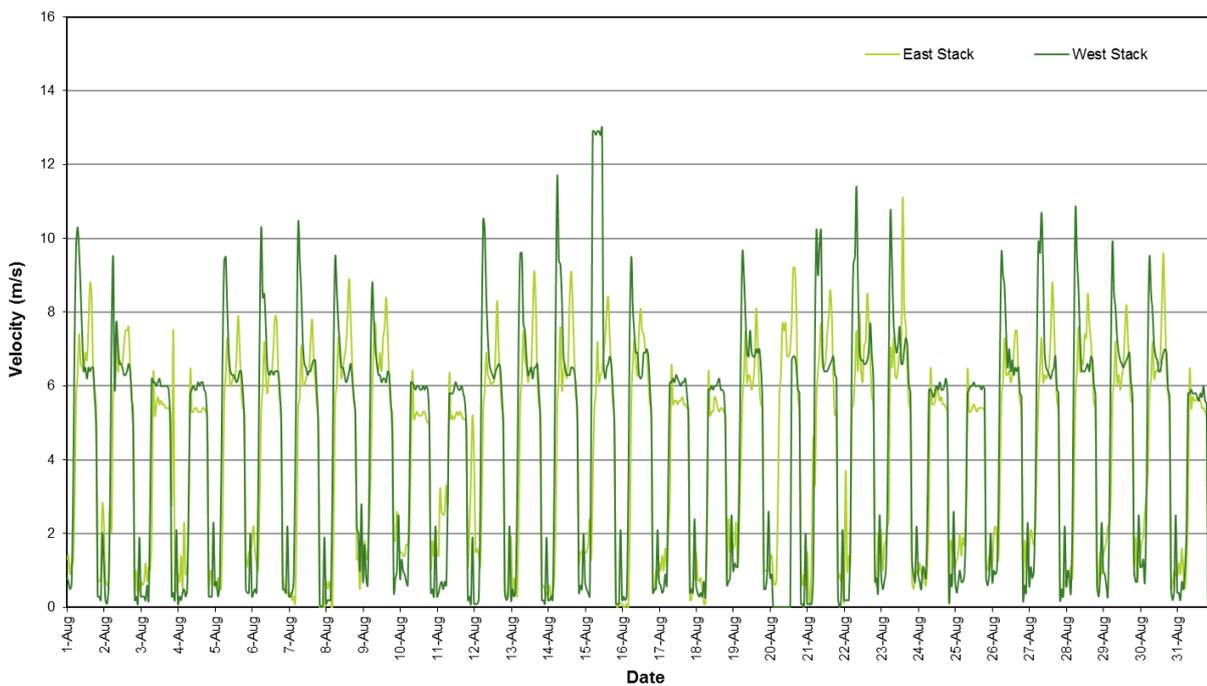


Figure 13: Stack Velocity (1 Hour Average)

7.3 Data Validation and Exceptions

Data contained in the report has been validated against performance and calibration requirements for each instrument. Data during maintenance and calibration periods has been removed from the validated data sets. Tables 17 and 18 list the data exceptions for the eastern and western ventilation stacks, where valid data is less than 75% of the one hour average. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

Table 17: Data Exceptions - Eastern Ventilation Stack: August 2019

Start	End	Parameter	Reason
8/08/2019 13:55	8/08/2019 15:00	CO, NO, NO ₂ , NO _x	Maintenance / calibration
10/08/2019 00:20	10/08/2019 01:00	PM ₁₀	Invalid ¹
10/08/2019 04:25	10/08/2019 06:55	PM ₁₀	Invalid ¹
10/08/2019 21:15	11/08/2019 07:35	NO, NO ₂ , NO _x	Invalid – zero drift
16/08/2019 23:05	16/08/2019 23:20	PM ₁₀	Invalid ¹
17/08/2019 19:30	17/08/2019 21:45	PM _{2.5}	Invalid ¹
18/08/2019 01:00	18/08/2019 01:10	PM _{2.5}	Invalid ¹
18/08/2019 08:45	18/08/2019 10:05	PM _{2.5}	Invalid ¹
18/08/2019 11:00	18/08/2019 11:25	PM _{2.5}	Invalid ¹
19/08/2019 01:45	19/08/2019 02:55	PM _{2.5}	Invalid ¹
20/08/2019 13:20	20/08/2019 13:50	PM _{2.5}	Invalid ¹
23/08/2019 15:55	23/08/2019 16:20	CO, NO, NO ₂ , NO _x	Maintenance / calibration
23/08/2019 16:10	23/08/2019 16:50	PM _{2.5} / PM ₁₀	Maintenance / calibration
24/08/2019 19:15	24/08/2019 19:25	PM ₁₀	Invalid ¹

Note: ¹ – In the opinion of the reviewer.

Table 18: Data Exceptions - Western Ventilation Stack: August 2019

Start	End	Parameter	Reason
8/08/2019 13:55	8/08/2019 14:55	CO	Maintenance / calibration
13/08/2019 12:10	13/08/2019 13:35	PM _{2.5}	Maintenance / calibration
20/08/2019 01:50	20/08/2019 13:45	All parameters	Power failure
23/08/2019 13:45	23/08/2019 14:55	CO, NO, NO ₂ , NO _x	Maintenance / calibration
23/08/2019 14:15	23/08/2019 15:25	PM _{2.5}	Maintenance / calibration
23/08/2019 14:50	23/08/2019 16:00	PM ₁₀	Maintenance / calibration

Note: ¹ – In the opinion of the reviewer.

8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/09/2019 – 30/09/2019

8.1 Data Capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

The data capture statistics for the reporting period 1st September to 30th September, 2019 are shown in Table 19. Averages were only collected for those periods where the 5 minute data constituted 75% data capture.

Section 8.3 provides further information on the reasons for invalid data periods.

Table 19: Data Capture Statistics - 1 Hour Averages

Parameter	Station	Collected Periods	Available Periods	Data Capture
PM _{2.5}	Eastern	691	720	96.0%
	Western	711	720	98.8%
PM ₁₀	Eastern	716	720	99.4%
	Western	715	720	99.3%
NO, NO ₂	Eastern	685	720	95.1%
	Western	653	720	90.7%
CO	Eastern	687	720	95.4%
	Western	687	720	95.4%

8.2 Results

8.2.1 PM_{2.5}

PM_{2.5} (1 hour average) mass rate of emission statistics for the reporting period are given in Table 20. A plot of PM_{2.5} (1 hour average) mass rate of emission for the reporting period is presented in Figure 14.

Table 20: PM_{2.5} Mass Rate Percentiles (1 Hour Average)

Station	PM _{2.5} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.13	0.12	0.11	0.089	0.065	0.051	0.022
Western	0.31	0.14	0.12	0.094	0.065	0.043	0.023

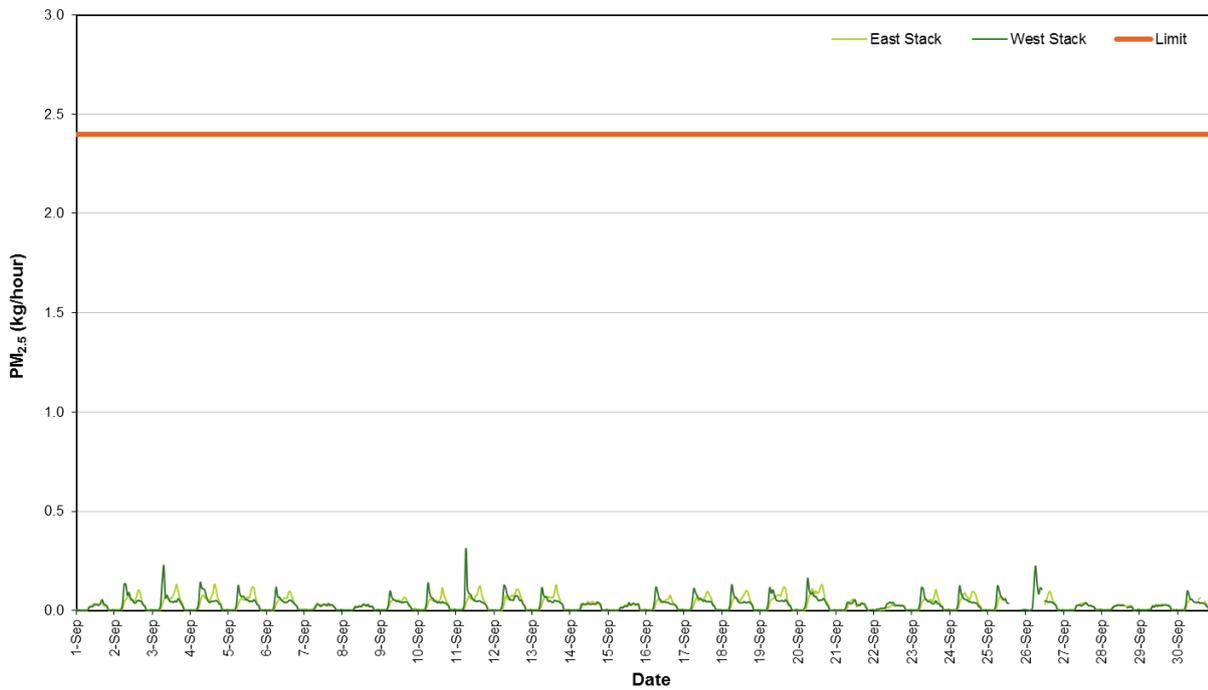


Figure 14: PM_{2.5} Mass Rate (1 Hour Average)

8.2.2 PM₁₀

PM₁₀ (1 hour average) mass rate of emission statistics for the reporting period are given in Table 21. A plot of PM₁₀ (1 hour average) mass rate of emission for the reporting period is presented in Figure 15.

Table 21: PM₁₀ Mass Rate Percentiles (1 Hour Average)

Station	PM ₁₀ Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.24	0.21	0.18	0.15	0.12	0.089	0.042
Western	0.42	0.25	0.23	0.16	0.12	0.084	0.046

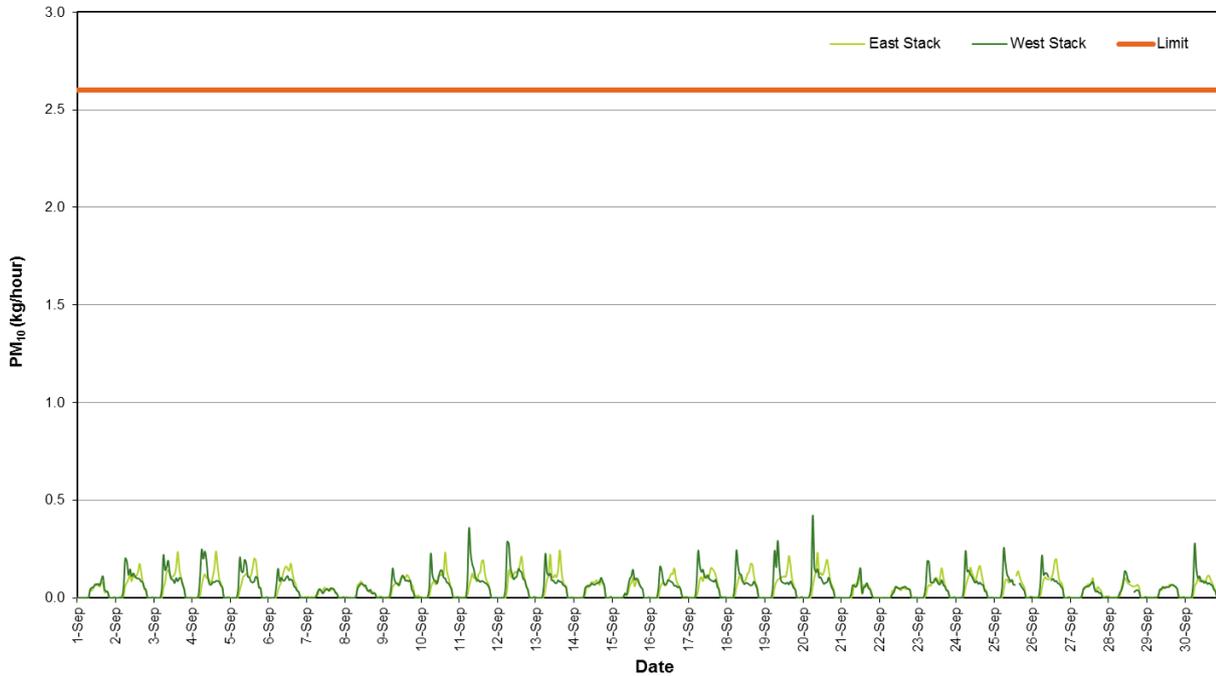


Figure 15: PM₁₀ Mass Rate (1 Hour Average)

8.2.3 Carbon Monoxide

Carbon monoxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 22. A plot of carbon monoxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 16.

Table 22: Carbon Monoxide Mass Rate Percentiles (1 Hour Average)

Station	Carbon Monoxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	7.7	6.7	6.1	4.9	3.9	3.0	2.3
Western	6.7	5.8	5.3	4.0	3.1	2.2	1.6

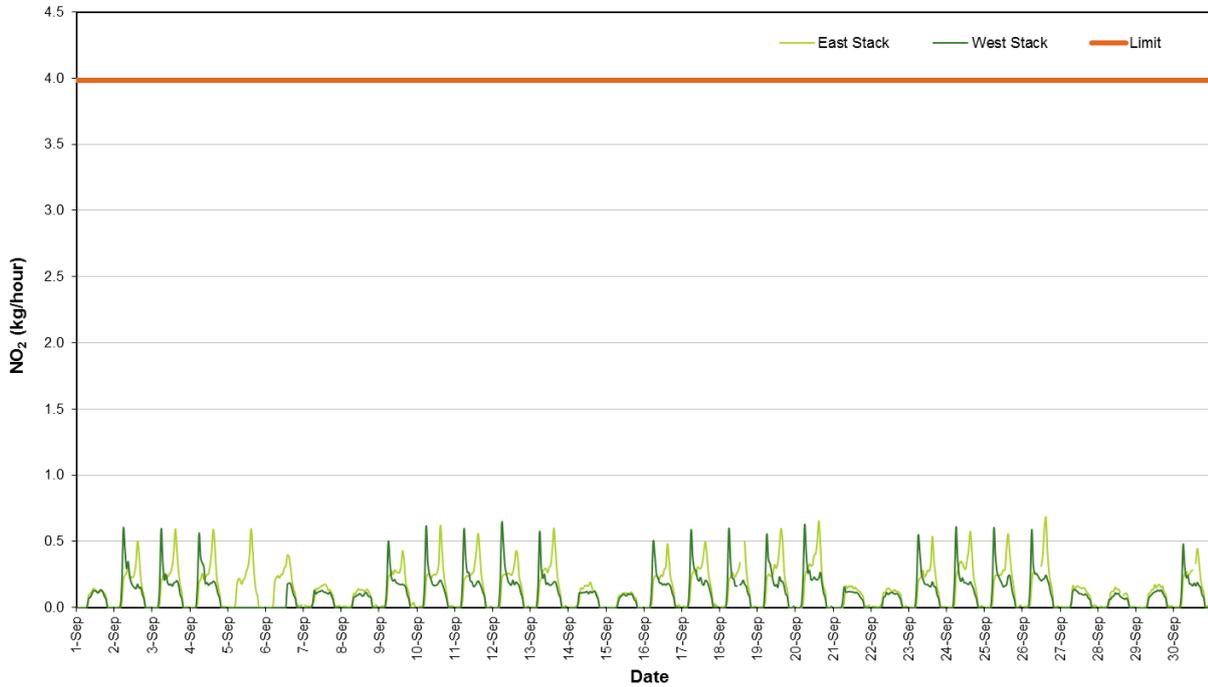


Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)

8.2.4 Oxides of Nitrogen

8.2.4.1 Nitric Oxide

Nitric oxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 23. A plot of nitric oxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 17.

Table 23: Nitric Oxide Mass Rate Percentiles (1 Hour Average)

Station	Nitric Oxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	2.9	2.5	2.3	1.9	1.6	1.2	0.51
Western	3.8	3.4	3.2	2.1	1.5	1.0	0.51

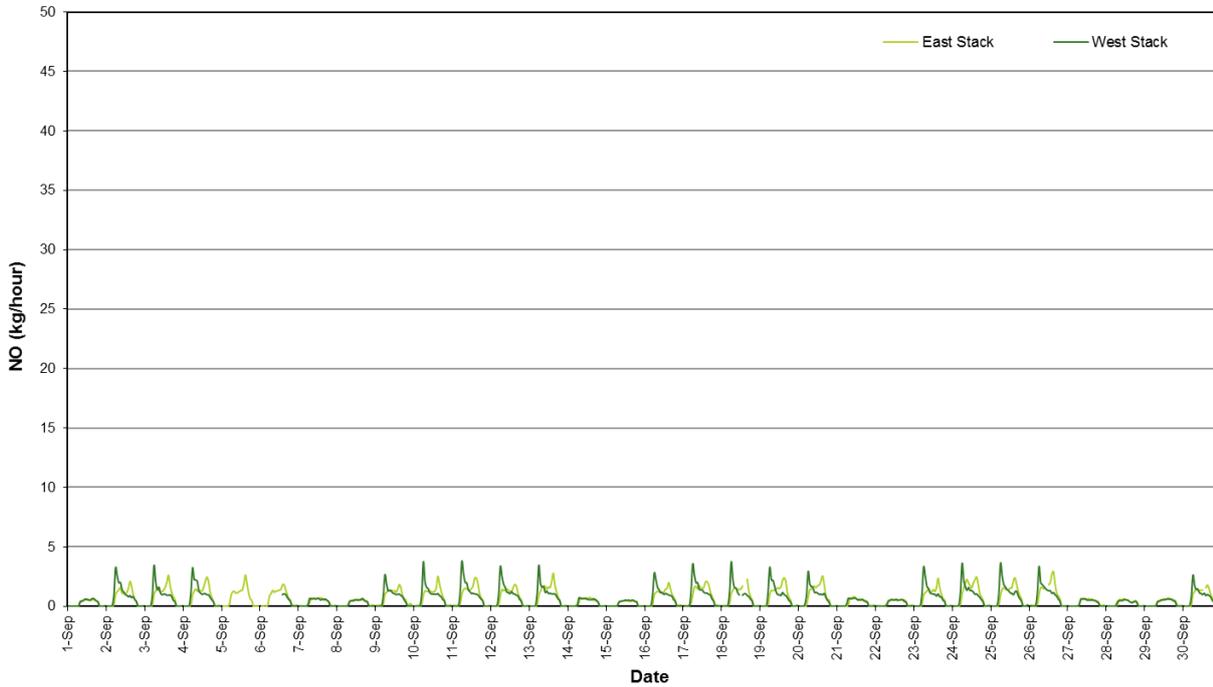


Figure 17: Nitric Oxide Mass Rate (1 Hour Average)

8.2.4.2 Nitrogen Dioxide

Nitrogen dioxide (1 hour average) mass rate of emission statistics for the reporting period are given in Table 24. A plot of nitrogen dioxide (1 hour average) mass rate of emission for the reporting period is presented in Figure 18.

Table 24: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average)

Station	Nitrogen Dioxide Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th
Eastern	0.68	0.60	0.51	0.43	0.32	0.24	0.12
Western	0.64	0.60	0.55	0.34	0.24	0.18	0.099

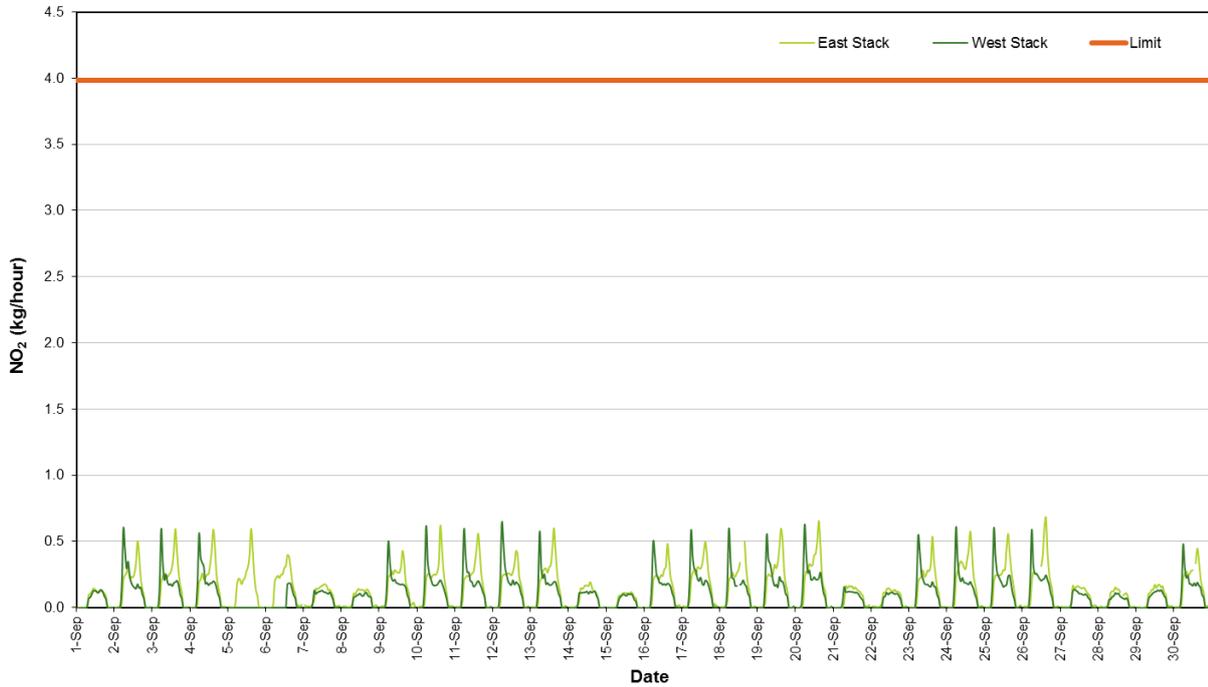


Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)

8.2.5 Stack Velocity

The stack velocity (1 hour average) plot for the reporting period is presented in Figure 19.

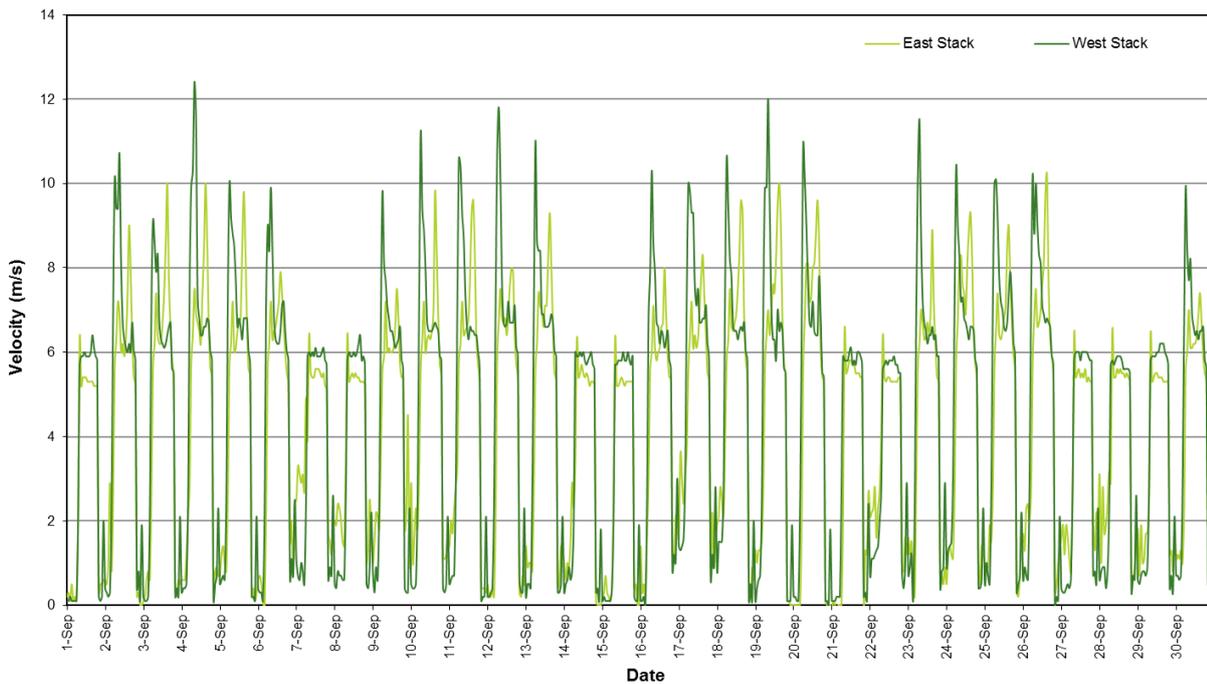


Figure 19: Stack Velocity (1 Hour Average)

8.3 Data Validation and Exceptions

Data contained in the report has been validated against performance and calibration requirements for each instrument. Data during maintenance and calibration periods has been removed from the validated data sets. Tables 25 and 26 list the data exceptions for the eastern and western ventilation stacks, where valid data is less than 75% of the one hour average. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

Table 25: Data Exceptions - Eastern Ventilation Stack: September 2019

Start	End	Parameter	Reason
3/09/2019 01:05	3/09/2019 01:20	PM ₁₀	Invalid ¹
13/09/2019 17:50	13/09/2019 17:55	PM ₁₀	Invalid ¹
15/09/2019 05:45	15/09/2019 06:00	PM ₁₀	Invalid ¹
15/09/2019 19:40	15/09/2019 19:55	PM ₁₀	Invalid ¹
18/09/2019 14:05	18/09/2019 15:40	CO, NO, NO ₂ , NO _x	Maintenance / calibration
24/09/2019 03:05	24/09/2019 03:25	PM ₁₀	Invalid ¹
24/09/2019 13:50	24/09/2019 14:30	CO	Maintenance / calibration
25/09/2019 12:00	26/09/2019 11:25	PM _{2.5}	Instrument out of service
25/09/2019 13:00	25/09/2019 14:05	PM ₁₀	Maintenance / calibration
26/09/2019 10:10	26/09/2019 11:50	NO, NO ₂ , NO _x	Maintenance / calibration
28/09/2019 18:55	28/09/2019 19:10	PM ₁₀	Invalid ¹
30/09/2019 10:30	30/09/2019 11:30	PM _{2.5}	Invalid ¹
30/09/2019 12:20	30/09/2019 12:40	PM _{2.5}	Invalid ¹
30/09/2019 13:20	30/09/2019 13:40	NO, NO ₂ , NO _x	Maintenance / calibration
30/09/2019 15:35	30/09/2019 16:30	PM _{2.5}	Invalid ¹

Note: ¹ – In the opinion of the reviewer.

Table 26: Data Exceptions - Western Ventilation Stack: September 2019

Start	End	Parameter	Reason
3/09/2019 01:05	3/09/2019 01:20	PM ₁₀	Invalid ¹
13/09/2019 17:50	13/09/2019 17:55	PM ₁₀	Invalid ¹
15/09/2019 05:45	15/09/2019 06:00	PM ₁₀	Invalid ¹
15/09/2019 19:40	15/09/2019 19:55	PM ₁₀	Invalid ¹

Start	End	Parameter	Reason
18/09/2019 14:05	18/09/2019 15:40	CO, NO, NO ₂ , NO _x	Maintenance / calibration
24/09/2019 03:05	24/09/2019 03:25	PM ₁₀	Invalid ¹
24/09/2019 13:50	24/09/2019 14:30	CO	Maintenance / calibration
25/09/2019 12:00	26/09/2019 11:25	PM _{2.5}	Instrument out of service
25/09/2019 13:00	25/09/2019 14:05	PM ₁₀	Maintenance / calibration
26/09/2019 10:10	26/09/2019 11:50	NO, NO ₂ , NO _x	Maintenance / calibration
28/09/2019 18:55	28/09/2019 19:10	PM ₁₀	Invalid ¹
30/09/2019 10:30	30/09/2019 11:30	PM _{2.5}	Invalid ¹
30/09/2019 12:20	30/09/2019 12:40	PM _{2.5}	Invalid ¹
30/09/2019 13:20	30/09/2019 13:40	NO, NO ₂ , NO _x	Maintenance / calibration
30/09/2019 15:35	30/09/2019 16:30	PM _{2.5}	Invalid ¹

Note: ¹ – In the opinion of the reviewer.

9.0 DISCUSSION

9.1 Comparison with Licence Limits

EastLink emissions to air from the road tunnel ventilation stacks DP1 and DP2 are subject to the licence requirements contained in Environment Protection Authority (Victoria) Environmental Licence No. 2043 (The Licence).

The maximum measured 1 hour average mass rate for each parameter is compared with the applicable licence limit in Table 27.

Table 27: Maximum (1 Hour Average) Mass Rate (01/07/2019 - 30/09/2019)

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	PM _{2.5}	0.31	2.4
		PM ₁₀	0.51	2.6
		NO ₂	0.64	3.98
		CO	9.4	112
2	Eastern ventilation stack	PM _{2.5}	0.13	2.4
		PM ₁₀	2.1	2.6
		NO ₂	0.68	3.98
		CO	7.7	112

There were no exceedances of the licence limits for DP1 and DP2 during the reporting period.

The procedure for reporting of particulate matter results from the TEOMs and assessment of licence compliance is outlined in the EastLink Particulate Matter Protocol (PMP) dated 17/6/2013 (Golder Reference 107613157-020-R-Rev0). The PMP requires validated uncorrected TEOM one hour clock average data to be reported and compared to the following TEOM mass rate compliance limits for both DP1 and DP2:

- PM_{2.5} (DP1, DP2): 2.0 kg/h
- PM₁₀ (DP1, DP2): 2.0 kg/h

There were no exceedances of the PM₁₀ or PM_{2.5} TEOM mass rate compliance levels for DP1 or the PM_{2.5} TEOM mass rate compliance level for DP2 during the reporting period.

There was one exceedance of the PM₁₀ TEOM mass rate compliance level for DP2 during the reporting period. A mass rate of 2.1 kg/h for PM₁₀ was measured on 22/08/2019 at 10:00 hours, this corresponds with an increase in stack velocity from 6.4 m/s to 16 m/s between 10:05 am and 10:15 am.

9.2 Data Capture Year to Date

Data capture statistics for 2019 year to date (01/01/2019 – 30/09/2019) are presented in Table 28.

Table 28: Data Capture Year to Date (%)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀	Velocity
Eastern	90.9%	95.2%	97.8%	98.8%	100%
Western	92.9%	93.3%	98.8%	99.1%	99.5%

1.1 Bubble Licence

The Licence contains a Bubble Limit which specifies the annual discharge limits of each parameter for each ventilation stack. Annual emission rates are calculated from 1st July to 30th June each year to coincide with the Annual Performance Statement (APS) reporting period. Ventilation stack emission rates year to date (1/07/2019 to 30/09/2019) are shown in Table 29.

Table 29: Ventilation Stack Emissions 1/07/2019 – 30/09/2019 (tonnes/year)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀
Eastern	0.29	4.1	0.060	0.11
Western	0.23	3.9	0.055	0.12
Total	0.51	8.0	0.11	0.22
Licence limit	35	980	21	23

Figure 20 presents the ventilation stack emissions of each parameter as a percentage of the Licence limit compared with the percentage of APS reporting period elapsed.

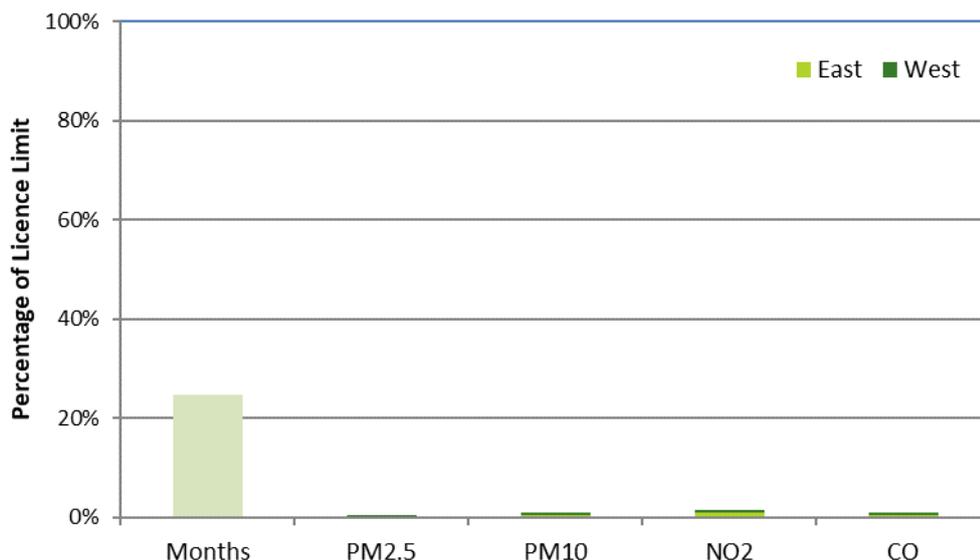


Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2019 – 30/09/2019)

The corresponding bubble limits for uncorrected PM_{2.5} and PM₁₀ TEOM data are:

- PM_{2.5} (DP1 and DP2): 17.5 tonnes/year
- PM₁₀ (DP1 and DP2): 17.5 tonnes/year

Signature Page

Golder Associates Pty Ltd



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Environmental Technician



Mark Tulau
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AM/MDT/am

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APPENDIX A

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this Report**

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