



May 2011

TRANSFIELD SERVICES PTY. LTD.

EastLink Ventilation Stack Emission Monitoring Report January-March 2011

Submitted to:
Transfield Services Pty. Ltd.,
EastLink Operations Centre,
2 Hillcrest Avenue,
Ringwood, 3134

This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this
document are traceable to Australian/national standards.



Report Number. 097613024-014-R-Rev0

Distribution:

- 1 Copy - Transfield Services Pty. Ltd.
- 1 Copy - Golder Associates Pty. Ltd.

REPORT





Record of Issue

Company	Client Contact	Version	Date Issued	Method of Delivery
Transfield Services Pty. Ltd., EastLink Operations Centre, 2 Hillcrest Avenue, Ringwood, 3134	Ms. Alex Monson	Revision 0	10/05/2011	Post/electronic



Table of Contents

1.0 INTRODUCTION	1
2.0 DISCHARGES TO AIR	2
3.0 VENTILATION STACK MONITORING PARAMETERS	3
4.0 METHODS	4
4.1 PM _{2.5}	4
4.2 PM ₁₀	4
4.3 Carbon Monoxide	4
4.4 Oxides of Nitrogen	5
4.5 Stack Velocity	5
5.0 MEASUREMENT UNCERTAINTY	6
6.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/01/2011 – 31/01/2011	7
6.1 Data Capture	7
6.2 Results	8
6.2.1 PM _{2.5}	8
6.2.2 PM ₁₀	9
6.2.3 Carbon Monoxide	10
6.2.4 Oxides of Nitrogen	11
6.2.4.1 Nitric Oxide	11
6.2.4.2 Nitrogen Dioxide	12
6.2.5 Stack Velocity	13
6.3 Data Validation and Exception	14
7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/02/2011 – 28/02/2011	15
7.1 Data Capture	15
7.2 Results	16
7.2.1 PM _{2.5}	16
7.2.2 PM ₁₀	17
7.2.3 Carbon Monoxide	18
7.2.4 Oxides of Nitrogen	19
7.2.4.1 Nitric Oxide	19
7.2.4.2 Nitrogen Dioxide	20



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JANUARY-MARCH 2011

7.2.5	Stack Velocity	21
7.3	Data Validation and Exception.....	22
8.0	VENTILATION STACK EMISSION MONITORING PERIOD: 01/03/2011 – 31/03/2011.....	23
8.1	Data Capture	23
8.2	Results.....	24
8.2.1	PM _{2.5}	24
8.2.2	PM ₁₀	25
8.2.3	Carbon Monoxide.....	26
8.2.4	Oxides of Nitrogen	27
8.2.4.1	Nitric Oxide	27
8.2.4.2	Nitrogen Dioxide	28
8.2.5	Stack Velocity	29
8.3	Data Validation and Exception.....	30
9.0	DISCUSSION.....	31
9.1	Comparison with Licence Limits	31

TABLES

Table 1: Discharges to Air.....	2
Table 2: Measurement Uncertainty	6
Table 3: Data Capture Statistics - 1 Hour Averages.....	7
Table 4: PM _{2.5} Mass Rate Percentiles (1 Hour Average).....	8
Table 5: PM ₁₀ Mass Rate Percentiles (1 Hour Average)	9
Table 6: Carbon Monoxide Mass Rate Percentiles (1 Hour Average).....	10
Table 7: Nitric Oxide Mass Rate Percentiles (1 Hour Average).....	11
Table 8: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average).....	12
Table 9: Data Exceptions - Eastern Ventilation Stack: January 2011	14
Table 10: Data Exceptions - Western Ventilation Stack: January 2011	14
Table 11: Data Capture Statistics - 1 Hour Averages.....	15
Table 12: PM _{2.5} Mass Rate Percentiles (1 Hour Average).....	16
Table 13: PM ₁₀ Mass Rate Percentiles (1 Hour Average)	17
Table 14: Carbon Monoxide Mass Rate Percentiles (1 Hour Average).....	18
Table 15: Nitric Oxide Mass Rate Percentiles (1 Hour Average).....	19
Table 16: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average).....	20
Table 17: Data Exceptions - Eastern Ventilation Stack: February 2011	22
Table 18: Data Exceptions - Western Ventilation Stack: February 2011	22



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JANUARY-MARCH 2011

Table 19: Data Capture Statistics - 1 Hour Averages.....	23
Table 20: PM _{2.5} Mass Rate Percentiles (1 Hour Average)	24
Table 21: PM ₁₀ Mass Rate Percentiles (1 Hour Average)	25
Table 22: Carbon Monoxide Mass Rate Percentiles (1 Hour Average).....	26
Table 23: Nitric Oxide Mass Rate Percentiles (1 Hour Average).....	27
Table 24: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average).....	28
Table 25: Data Exceptions - Eastern Ventilation Stack: March 2011	30
Table 26: Data Exceptions - Western Ventilation Stack: March 2011	30
Table 27: Maximum (1 Hour Average) Mass Rate (01/01/2011 – 31/03/2011)	31
Table 28: Data Capture Year to Date (%)	31

FIGURES

Figure 1: Ventilation Stack Locations	2
Figure 2: PM _{2.5} Mass Rate (1 Hour Average)	8
Figure 3: PM ₁₀ Mass Rate (1 Hour Average)	9
Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)	10
Figure 5: Nitric Oxide Mass Rate (1 Hour Average)	11
Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)	12
Figure 7: Stack Velocity (1 Hour Average)	13
Figure 8: PM _{2.5} Mass Rate (1 Hour Average)	16
Figure 9: PM ₁₀ Mass Rate (1 Hour Average)	17
Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)	18
Figure 11: Nitric Oxide Mass Rate (1 Hour Average)	19
Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)	20
Figure 13: Stack Velocity (1 Hour Average)	21
Figure 14: PM _{2.5} Mass Rate (1 Hour Average)	24
Figure 15: PM ₁₀ Mass Rate (1 Hour Average)	25
Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)	26
Figure 17: Nitric Oxide Mass Rate (1 Hour Average)	27
Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)	28
Figure 19: Stack Velocity (1 Hour Average)	29



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. Transfield Services, 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); and
- 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 January, 2011 to 31st March, 2011 inclusive are contained in the following report.



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 outbound tunnel (Mullum Mullum) – Ringwood

Monitoring equipment is housed in temperature controlled cabinets located at the base of each of the ventilation stacks. Particulate 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; and
- Ambient pressure.



4.0 METHODS

4.1 PM_{2.5}

PM_{2.5} concentrations in the tunnel ventilation stacks are determined using a 1400 Series Tapered Element Oscillating Microbalance (TEOM) analyser, located in the plenum chamber of the ventilation stacks.

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 3580.9.8, *“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”*.

4.2 PM₁₀

PM₁₀ concentrations in the tunnel ventilation stacks are determined using a 1400 Series Tapered Element Oscillating Microbalance (TEOM) analyser, located in the plenum chamber of the ventilation stacks.

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



6.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/01/2011 – 31/01/2011

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 January to 31st January, 2011 are shown in Table 3. Averages were only collected for those periods where the 5-minute data constituted 75% data capture.

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	694	744	93.3%
	Western	734	744	98.7%
PM ₁₀	Eastern	742	744	99.7%
	Western	743	744	99.9%
NO, NO ₂	Eastern	657	744	88.3%
	Western	643	744	86.4%
CO	Eastern	711	744	95.6%
	Western	712	744	95.7%



6.2 Results

6.2.1 PM_{2.5}

PM_{2.5} was continuously monitored and 5 minute averages logged. The 5 minute average data was then transformed to 1 hour averages for reporting.

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	0.39	0.24	0.22	0.19	0.16	0.11	0.04
Western	0.31	0.24	0.20	0.17	0.14	0.09	0.03

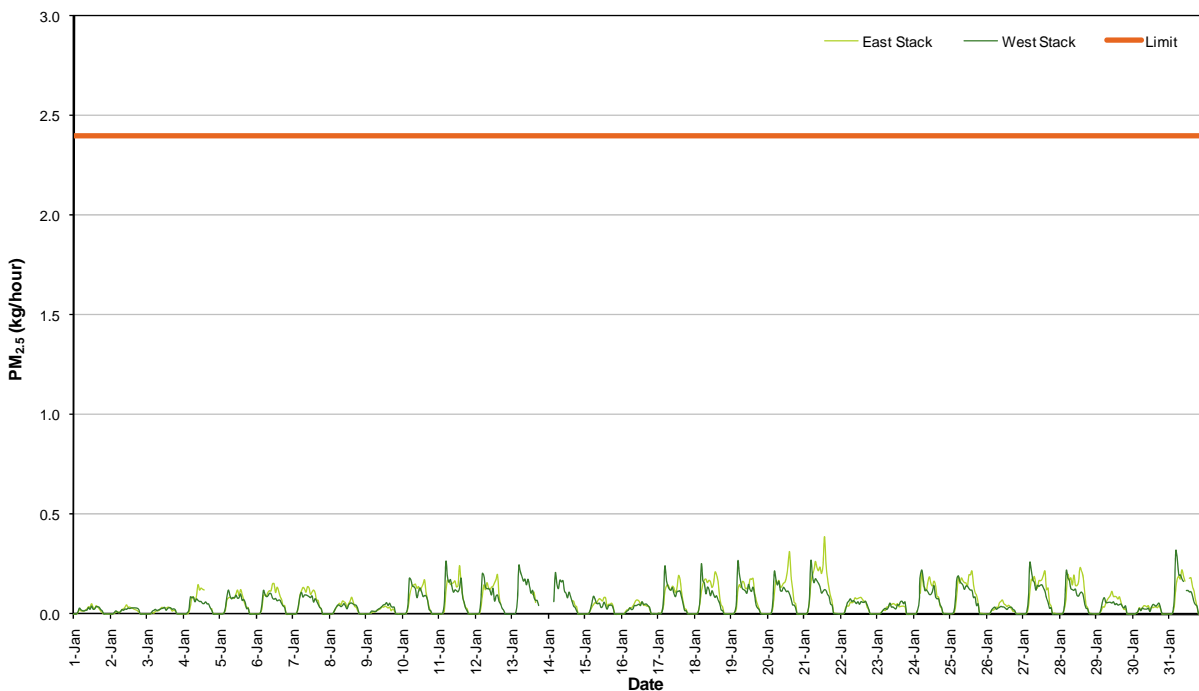


Figure 2: PM_{2.5} Mass Rate (1 Hour Average)



6.2.2 PM₁₀

PM₁₀ was continuously monitored and 5 minute averages logged. The 5 minute average data was then transformed to 1 hour averages for reporting.

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	0.72	0.34	0.30	0.26	0.23	0.16	0.06
Western	0.40	0.34	0.29	0.23	0.19	0.13	0.06

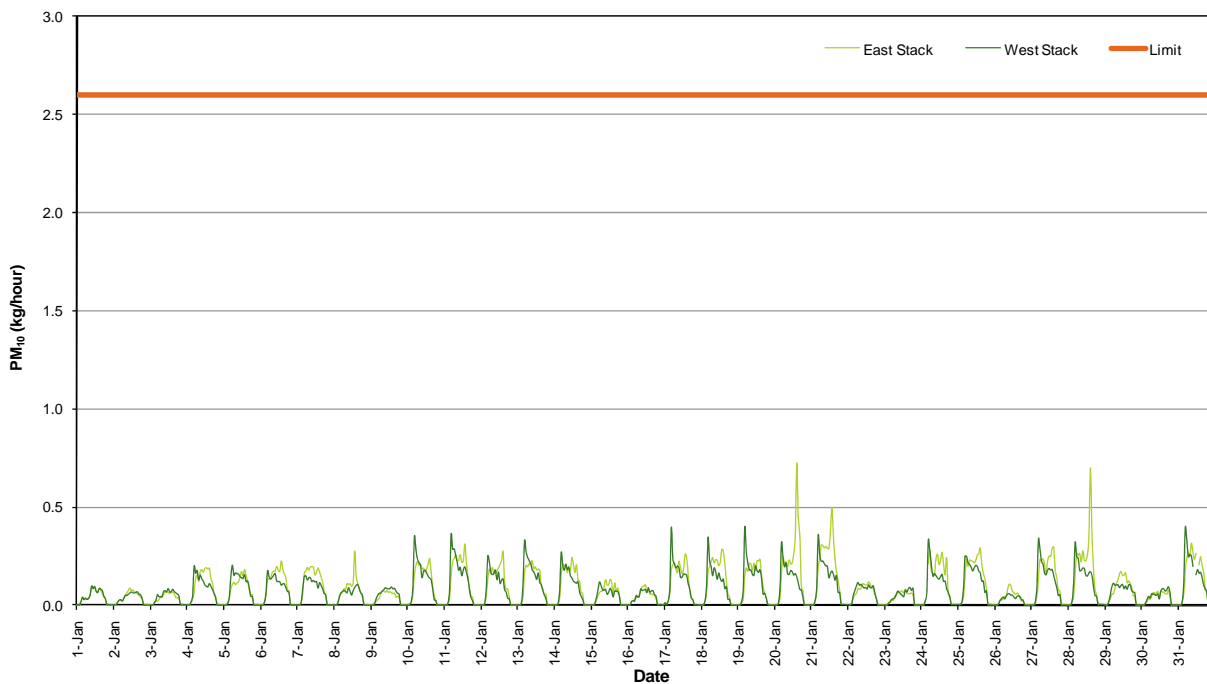


Figure 3: PM₁₀ Mass Rate (1 Hour Average)



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 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	25	21	20	16	13	10	6.4
Western	25	19	17	13	12	10	6.8

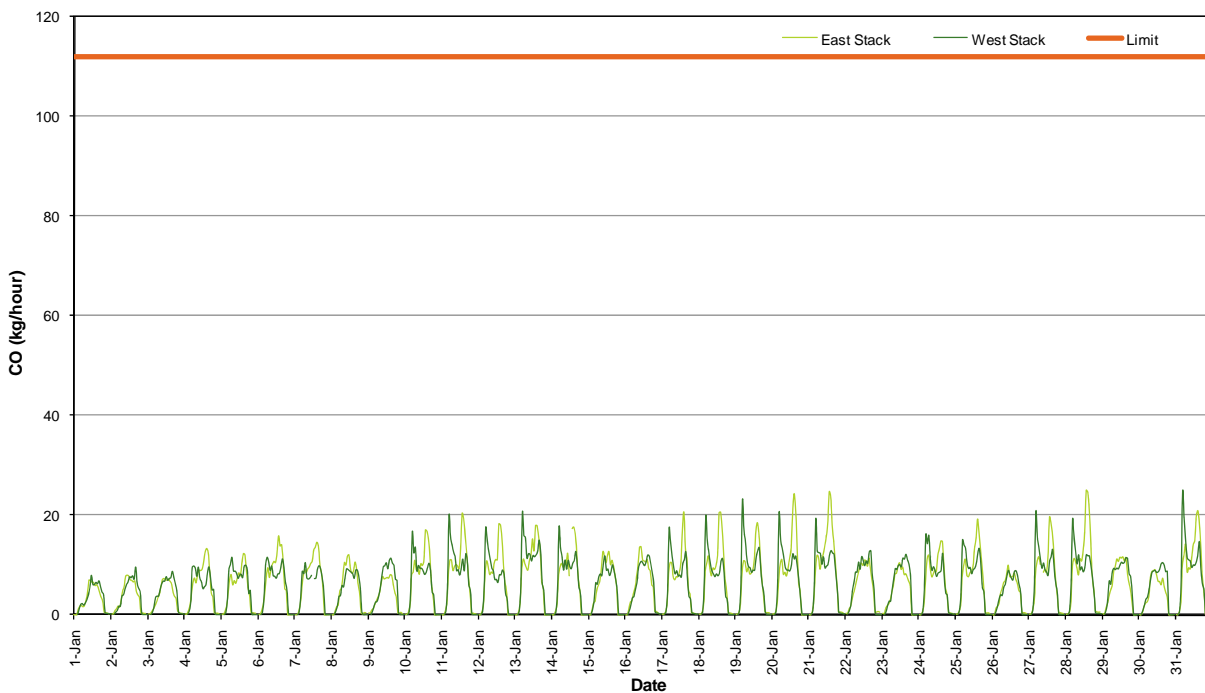


Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)



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 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	4.4	3.8	3.4	2.8	2.5	1.8	0.9
Western	4.9	4.0	3.3	2.8	2.4	1.8	1.1

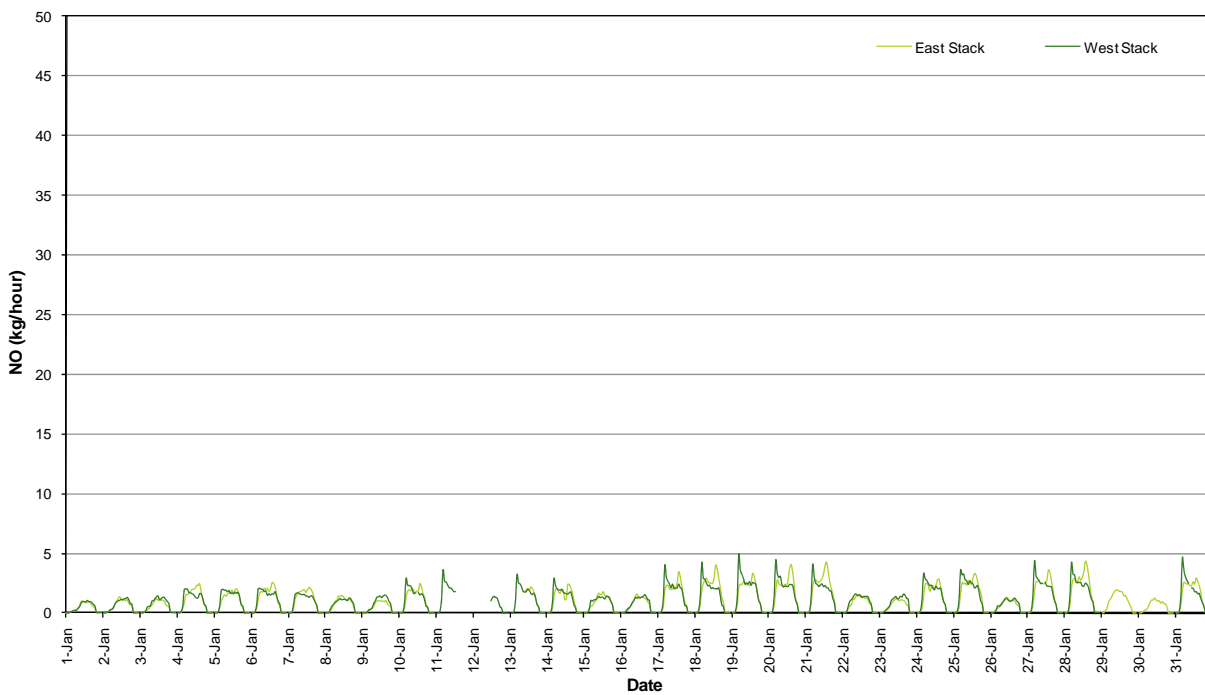


Figure 5: Nitric Oxide Mass Rate (1 Hour Average)



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 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	0.5	0.4	0.4	0.3	0.3	0.2	0.1
Western	0.4	0.3	0.3	0.2	0.2	0.2	0.1

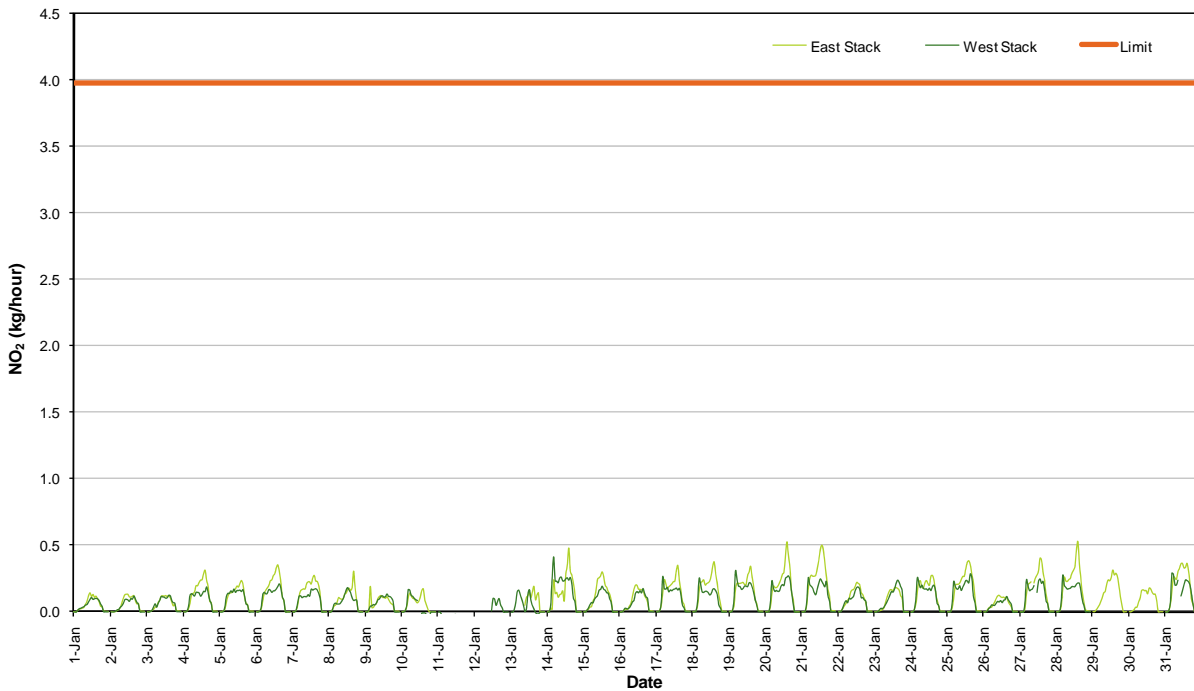


Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)



6.2.5 Stack Velocity

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

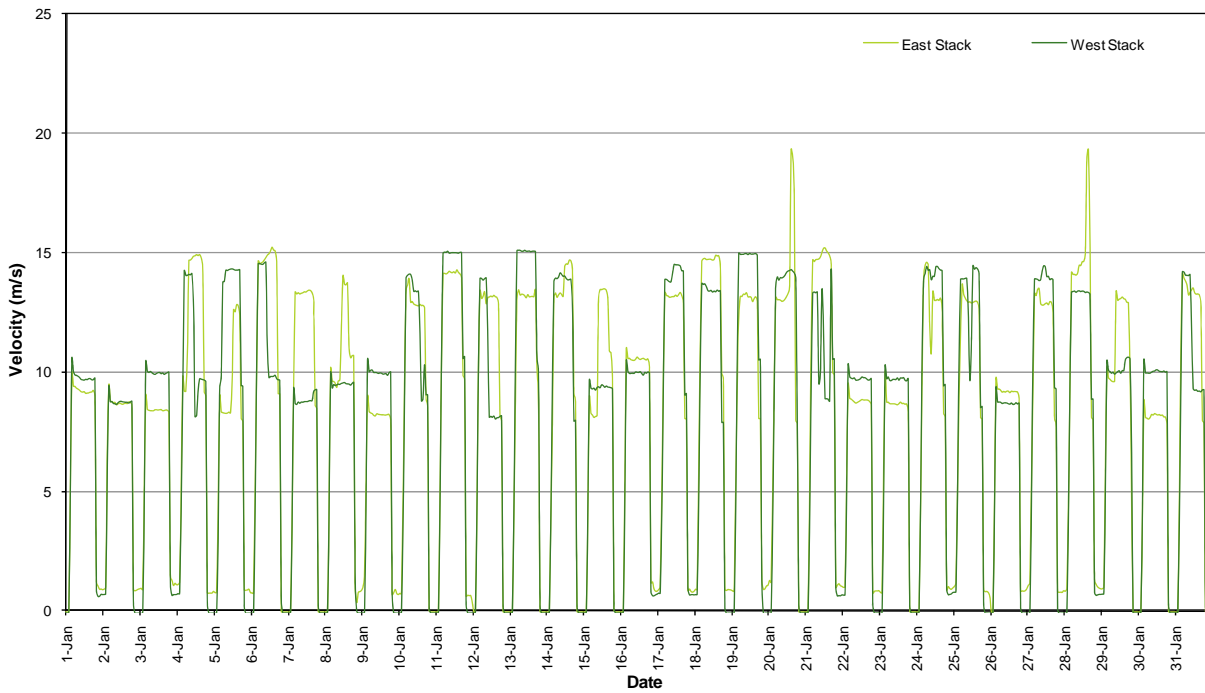


Figure 7: Stack Velocity (1 Hour Average)



6.3 Data Validation and Exception

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 respectively. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

Table 9: Data Exceptions - Eastern Ventilation Stack: January 2011

Start	End	Parameter	Reason
4/01/2011 15:40	4/01/2011 18:20	PM _{2.5}	Invalid data ¹
11/01/2011 00:40	13/01/2011 09:40	NO, NO ₂ , NO _x	Invalid data - Span drift
12/01/2011 18:05	13/01/2011 13:55	PM _{2.5}	Invalid data ¹
13/01/2011 17:25	14/01/2011 15:25	PM _{2.5}	Invalid data ¹
14/01/2011 13:00	14/01/2011 13:20	CO	Maintenance/calibration
24/01/2011 04:25	24/01/2011 04:40	PM _{2.5}	Invalid data ¹
24/01/2011 04:25	24/01/2011 04:40	PM ₁₀	Invalid data ¹
27/01/2011 09:35	27/01/2011 09:50	NO, NO ₂ , NO _x	Maintenance/calibration
27/01/2011 09:35	27/01/2011 09:50	CO	Maintenance/calibration
31/01/2011 12:35	31/01/2011 13:25	PM _{2.5}	Maintenance/calibration
31/01/2011 12:45	31/01/2011 13:40	PM ₁₀	Maintenance/calibration

Note: ¹ – In the opinion of the reviewer.

Table 10: Data Exceptions - Western Ventilation Stack: January 2011

Start	End	Parameter	Reason
7/01/2011 12:25	7/01/2011 12:45	CO	Maintenance/calibration
10/01/2011 12:15	10/01/2011 12:35	NO, NO ₂ , NO _x	Maintenance/calibration
11/01/2011 14:15	12/01/2011 12:00	NO, NO ₂ , NO _x	Invalid data - Span drift
13/01/2011 18:55	14/01/2011 04:05	PM _{2.5}	Invalid data ¹
27/01/2011 11:15	27/01/2011 11:30	NO, NO ₂ , NO _x	Maintenance/calibration
27/01/2011 10:55	27/01/2011 11:05	CO	Maintenance/calibration
29/01/2011 00:40	30/01/2011 10:30	NO, NO ₂ , NO _x	Invalid data - Span drift
31/01/2011 10:35	31/01/2011 11:05	NO, NO ₂ , NO _x	Maintenance/calibration
31/01/2011 10:55	31/01/2011 12:05	PM _{2.5}	Maintenance/calibration
31/01/2011 11:05	31/01/2011 12:05	PM ₁₀	Maintenance/calibration

Note: ¹ – In the opinion of the reviewer.



7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/02/2011 – 28/02/2011

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 February to 28th February, 2011 are shown in Table 11. Averages were only collected for those periods where the 5-minute data constituted 75% data capture.

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	652	672	97.0%
	Western	669	672	99.6%
PM ₁₀	Eastern	649	672	96.6%
	Western	671	672	99.9%
NO, NO ₂	Eastern	597	672	88.8%
	Western	560	672	83.3%
CO	Eastern	643	672	95.7%
	Western	643	672	95.7%



7.2 Results

7.2.1 PM_{2.5}

PM_{2.5} was continuously monitored and 5 minute averages logged. The 5 minute average data was then transformed to 1 hour averages for reporting.

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	0.34	0.29	0.25	0.22	0.19	0.16	0.05
Western	0.38	0.28	0.26	0.20	0.17	0.13	0.05

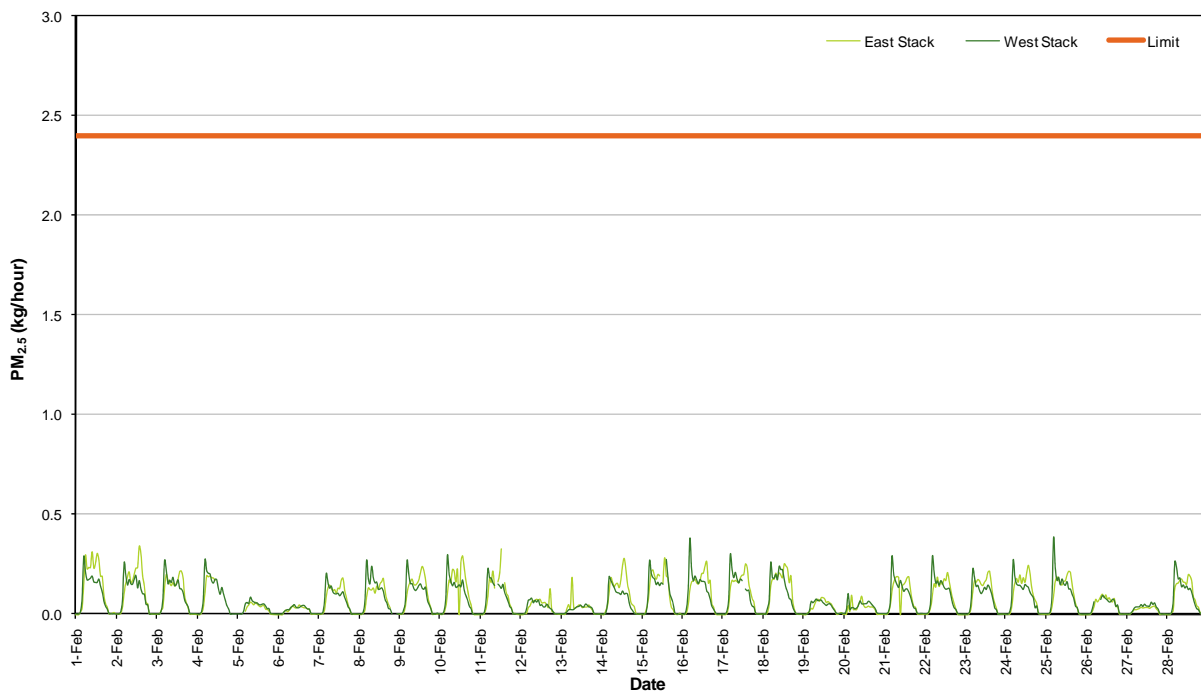


Figure 8: PM_{2.5} Mass Rate (1 Hour Average)



7.2.2 PM₁₀

PM₁₀ was continuously monitored and 5-minute averages logged. The 5 minute average data was then transformed to 1 hour averages for reporting.

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	0.51	0.39	0.37	0.31	0.27	0.22	0.07
Western	0.63	0.39	0.36	0.27	0.24	0.18	0.07

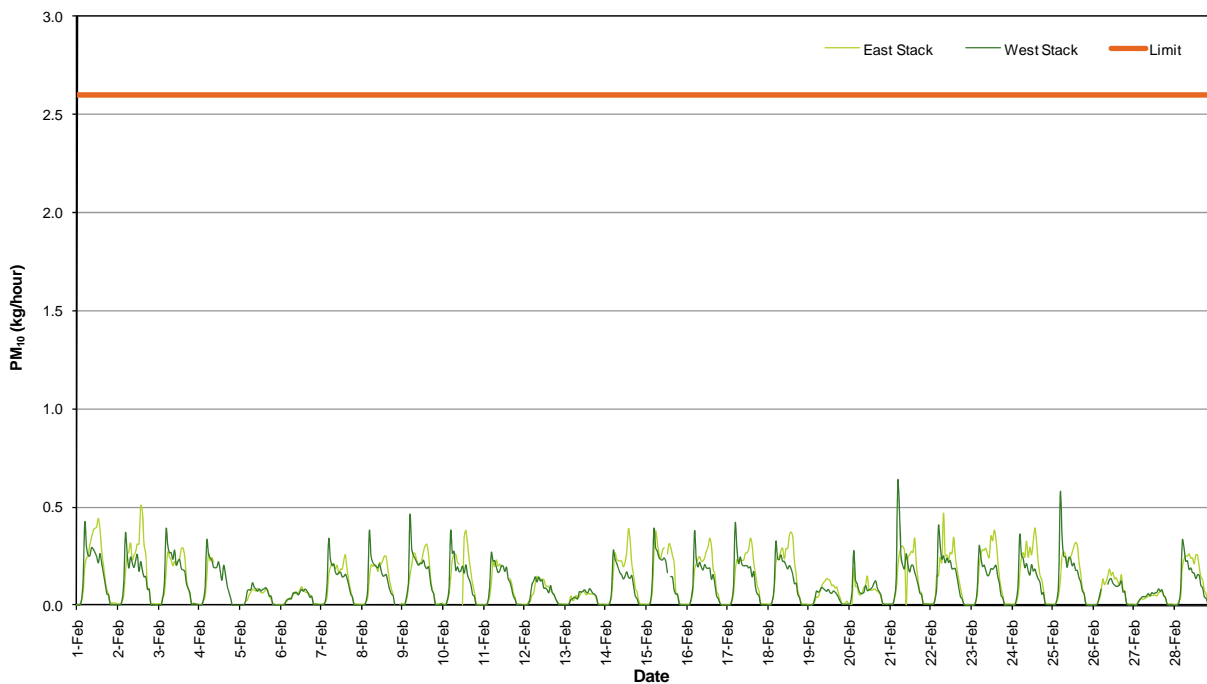


Figure 9: PM₁₀ Mass Rate (1 Hour Average)



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 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	30	25	24	22	16	11	7.9
Western	27	24	23	16	14	11	7.7

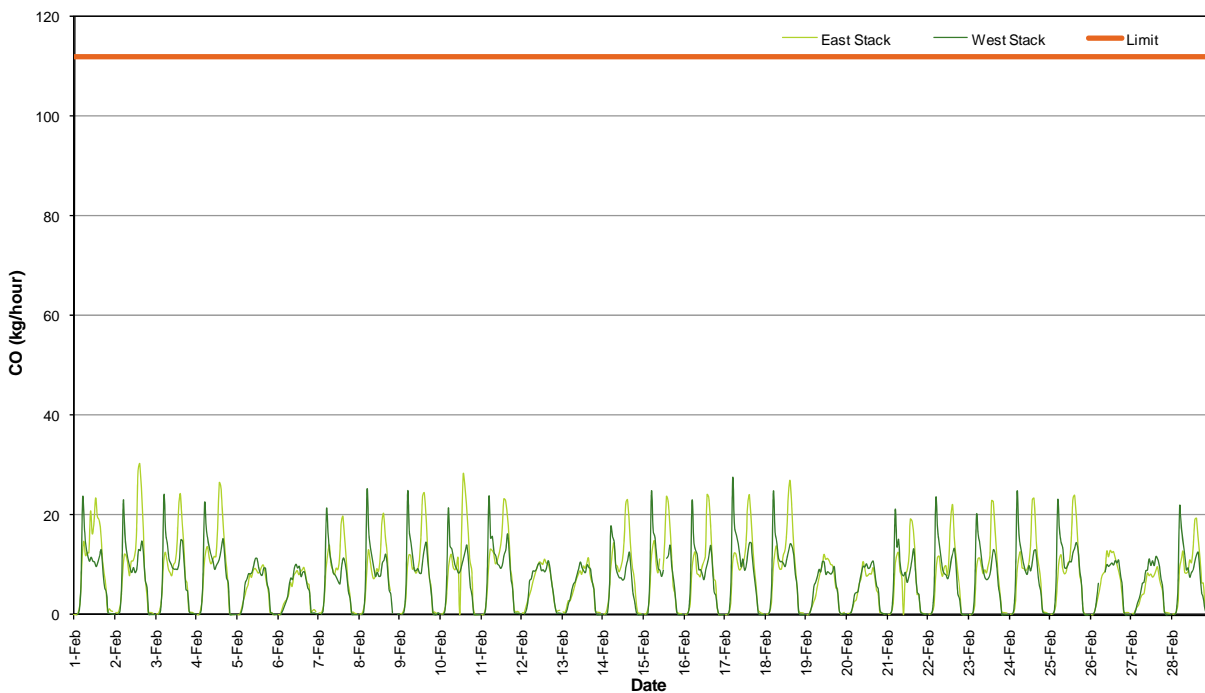


Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)



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 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	4.4	3.9	3.7	3.4	2.9	2.5	1.3
Western	5.1	4.5	4.1	3.1	2.6	2.1	1.3

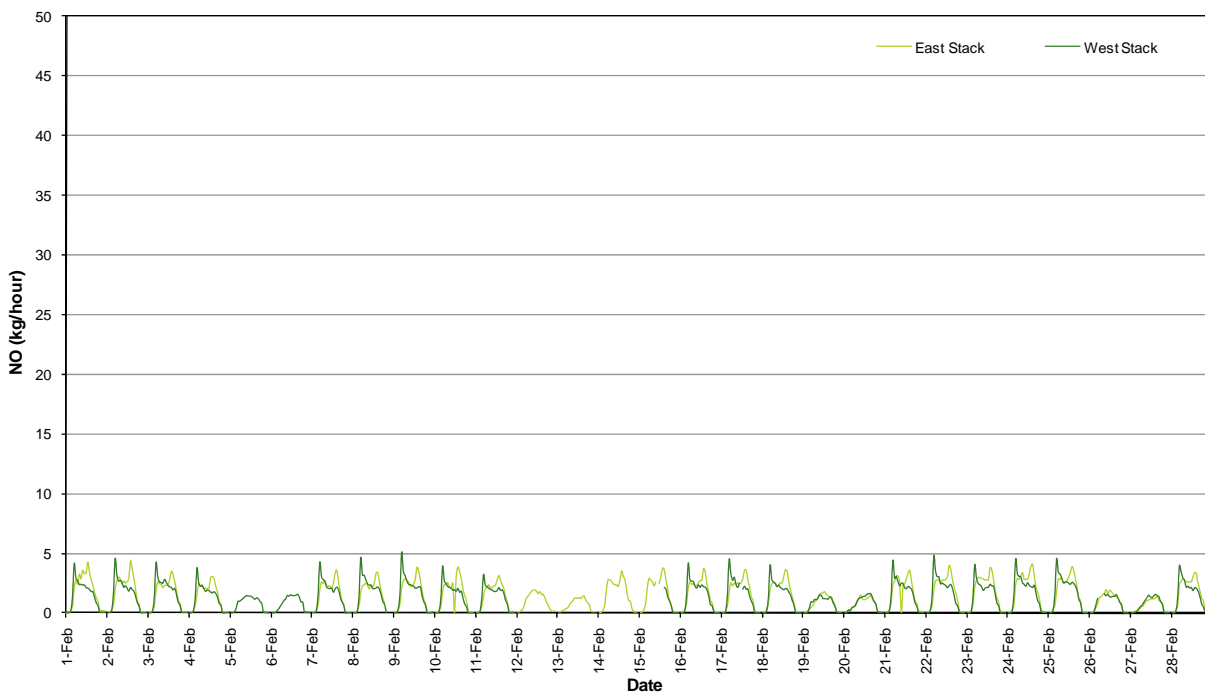


Figure 11: Nitric Oxide Mass Rate (1 Hour Average)



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 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	1.7	0.5	0.4	0.4	0.3	0.2	0.1
Western	0.4	0.3	0.3	0.3	0.2	0.2	0.1

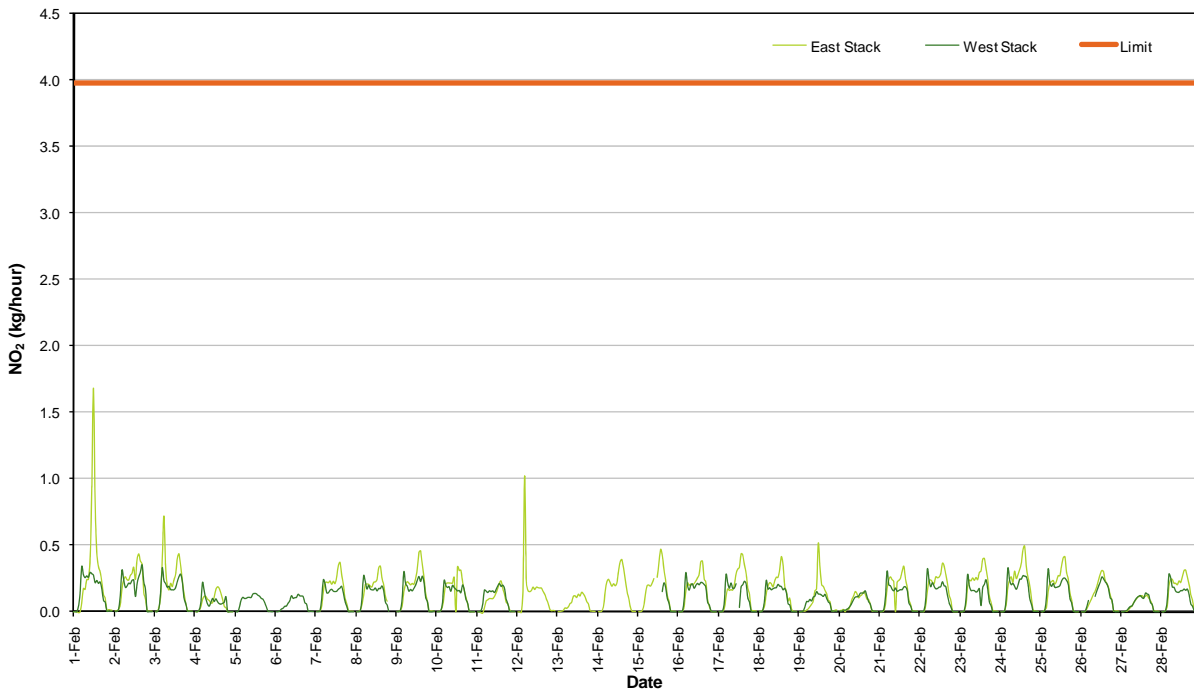


Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)



7.2.5 Stack Velocity

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

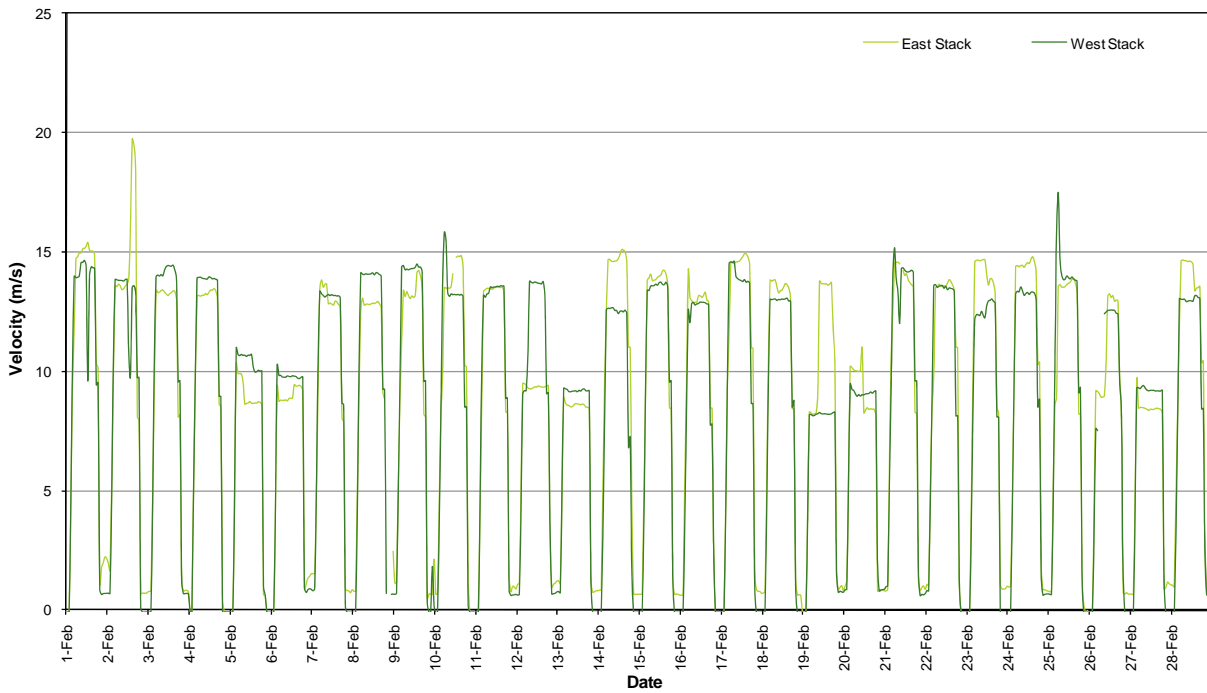


Figure 13: Stack Velocity (1 Hour Average)



7.3 Data Validation and Exception

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 respectively. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

Table 17: Data Exceptions - Eastern Ventilation Stack: February 2011

Start	End	Parameter	Reason
4/02/2011 10:40	5/02/2011 04:10	PM ₁₀	Invalid data ¹
4/02/2011 12:10	5/02/2011 04:20	PM _{2.5}	Invalid data ¹
5/02/2011 03:00	5/02/2011 23:55	NO, NO ₂ , NO _x	Invalid data - Span drift
6/02/2011 03:00	6/02/2011 23:55	NO, NO ₂ , NO _x	Invalid data - Span drift
8/02/2011 20:05	8/02/2011 23:35	Velocity	Maintenance/calibration
10/02/2011 11:25	10/02/2011 11:40	PM ₁₀	Invalid data ¹
11/02/2011 10:25	11/02/2011 10:55	PM _{2.5}	Invalid data ¹
11/02/2011 11:50	11/02/2011 12:10	PM _{2.5}	Invalid data ¹
11/02/2011 12:20	11/02/2011 12:55	PM ₁₀	Invalid data ¹
11/02/2011 13:45	11/02/2011 14:20	PM _{2.5}	Invalid data ¹
11/02/2011 14:40	11/02/2011 15:40	PM ₁₀	Invalid data ¹
15/02/2011 11:20	15/02/2011 11:55	NO, NO ₂ , NO _x	Maintenance/calibration
15/02/2011 11:20	15/02/2011 11:55	CO	Maintenance/calibration
15/02/2011 11:50	15/02/2011 12:45	PM _{2.5}	Maintenance/calibration
15/02/2011 12:15	15/02/2011 12:55	PM ₁₀	Maintenance/calibration
20/02/2011 11:35	20/02/2011 11:40	PM ₁₀	Invalid data ¹

Note: ¹ – In the opinion of the reviewer.

Table 18: Data Exceptions - Western Ventilation Stack: February 2011

Start	End	Parameter	Reason
8/02/2011 21:40	8/02/2011 22:30	Velocity	Maintenance/calibration
11/02/2011 10:25	11/02/2011 10:45	PM _{2.5}	Invalid data ¹
12/02/2011 03:00	15/02/2011 13:35	NO, NO ₂ , NO _x	Invalid data - Span drift
15/02/2011 13:35	15/02/2011 14:35	NO, NO ₂ , NO _x	Maintenance/calibration
15/02/2011 13:35	15/02/2011 14:10	CO	Maintenance/calibration
15/02/2011 14:10	15/02/2011 14:45	PM ₁₀	Maintenance/calibration
17/02/2011 12:30	17/02/2011 13:05	NO, NO ₂ , NO _x	Maintenance/calibration
17/02/2011 12:45	17/02/2011 13:15	PM _{2.5}	Maintenance/calibration
23/02/2011 12:45	23/02/2011 13:10	NO, NO ₂ , NO _x	Maintenance/calibration
26/02/2011 06:20	26/02/2011 08:50	Velocity	Invalid data ¹

Note: ¹ – In the opinion of the reviewer.



8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/03/2011 – 31/03/2011

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 March to 31st March, 2011 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	740	744	99.5%
	Western	742	744	99.7%
PM ₁₀	Eastern	743	744	99.9%
	Western	742	744	99.7%
NO, NO ₂	Eastern	672	744	90.3%
	Western	559	744	75.1%
CO	Eastern	711	744	95.6%
	Western	710	744	95.4%



8.2 Results

8.2.1 PM_{2.5}

PM_{2.5} was continuously monitored and 5-minute averages logged. The 5-minute average data was then transformed to 1-hour averages for reporting.

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	0.27	0.25	0.22	0.20	0.18	0.14	0.04
Western	0.47	0.26	0.23	0.18	0.16	0.11	0.04

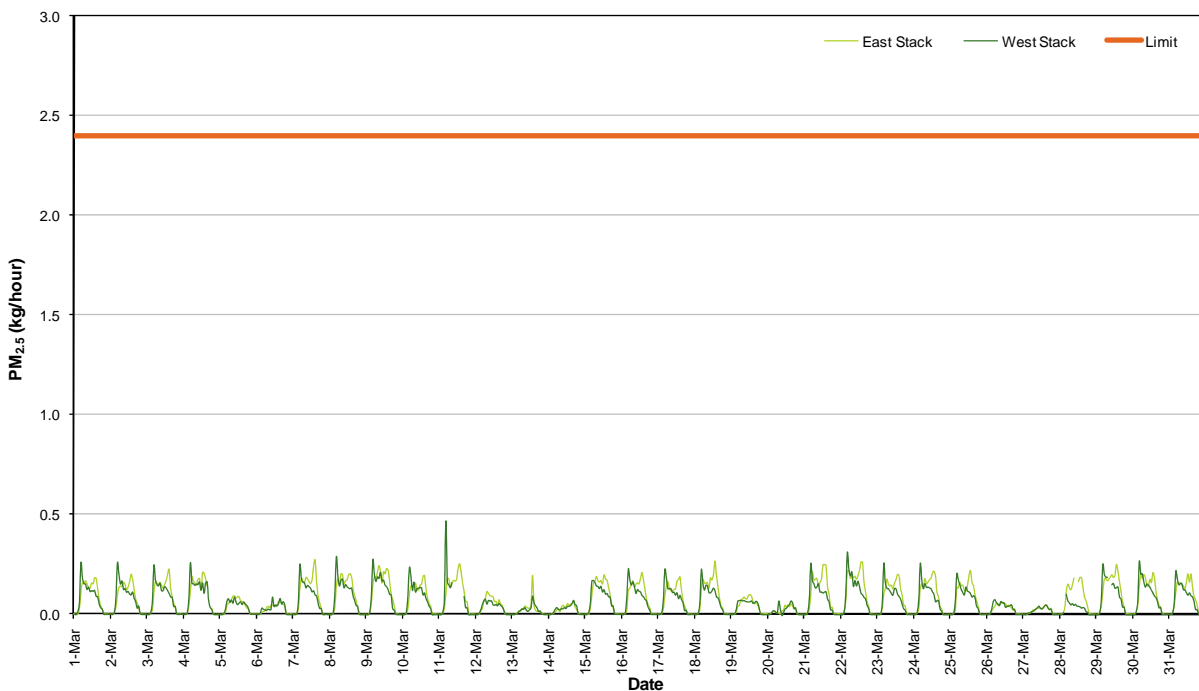


Figure 14: PM_{2.5} Mass Rate (1 Hour Average)



8.2.2 PM₁₀

PM₁₀ was continuously monitored and 5 minute averages logged. The 5 minute average data was then transformed to 1-hour averages for reporting.

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	0.68	0.40	0.34	0.30	0.27	0.22	0.07
Western	0.46	0.36	0.35	0.26	0.21	0.16	0.07

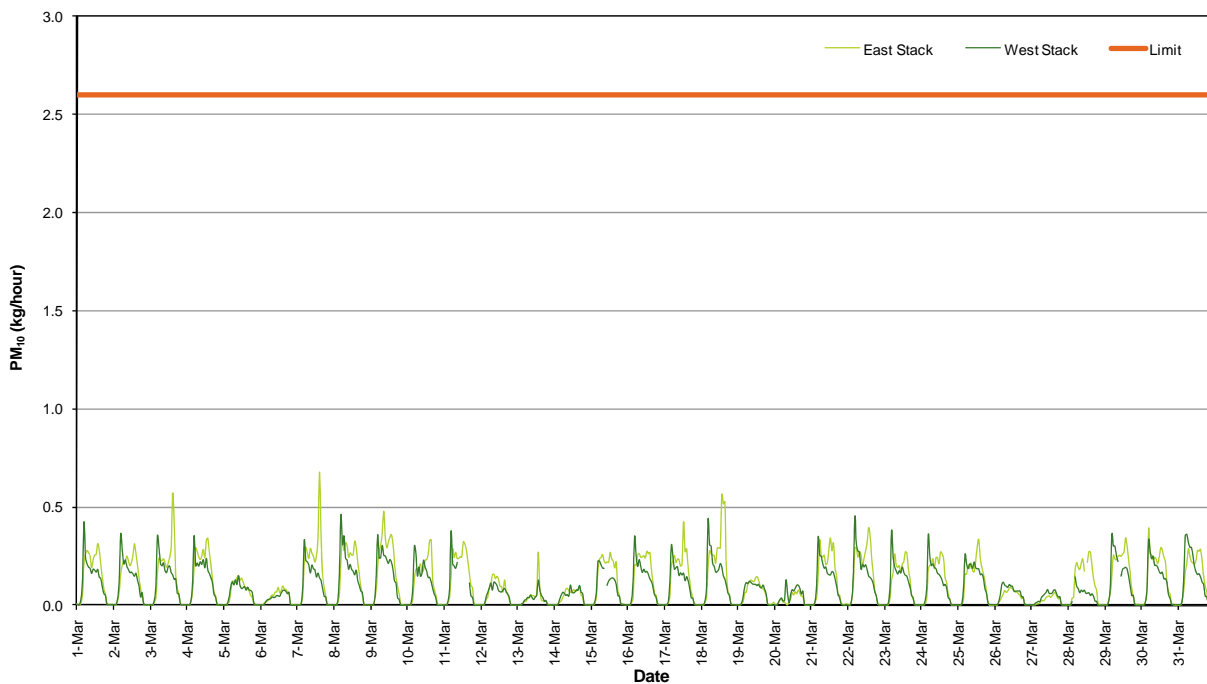


Figure 15: PM₁₀ Mass Rate (1 Hour Average)



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 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	28	24	23	20	15	12	8.2
Western	26	22	21	16	13	10	7.2

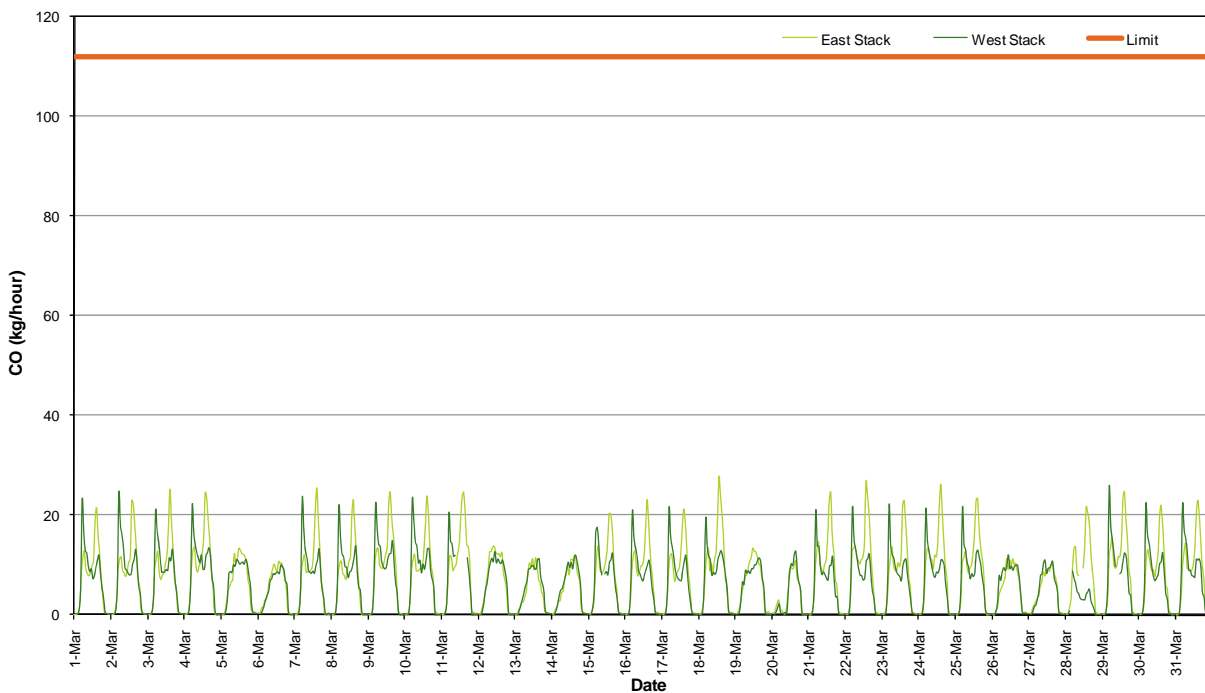


Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)



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 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	5.1	4.3	4.0	3.6	3.1	2.6	1.3
Western	6.6	4.8	4.4	3.3	2.9	2.3	1.3

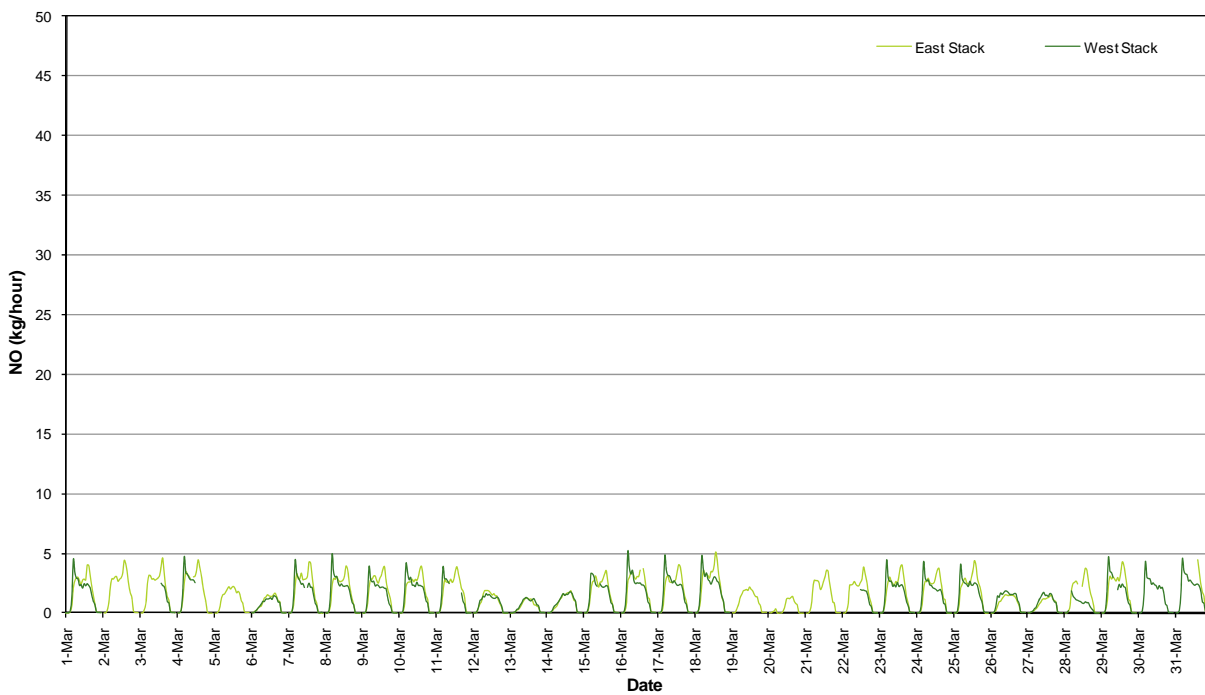


Figure 17: Nitric Oxide Mass Rate (1 Hour Average)



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 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	0.6	0.5	0.4	0.4	0.3	0.3	0.1
Western	0.5	0.4	0.3	0.3	0.3	0.2	0.1

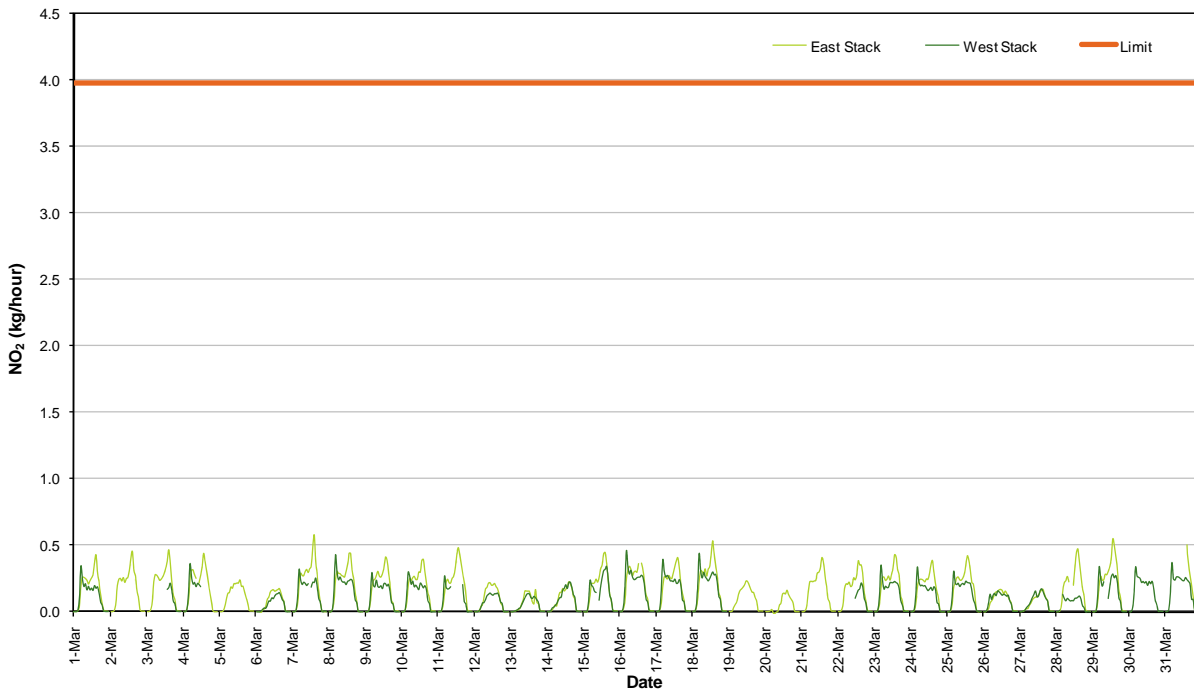


Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)



8.2.5 Stack Velocity

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

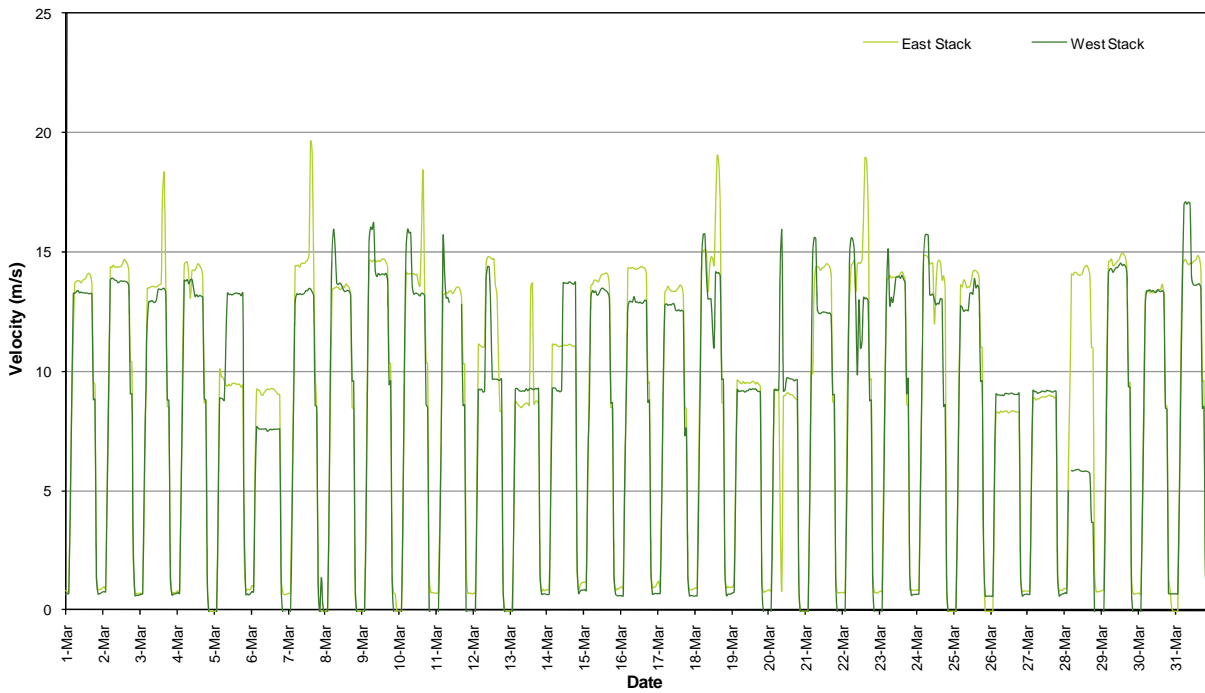


Figure 19: Stack Velocity (1 Hour Average)



8.3 Data Validation and Exception

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 respectively. Data during automatic calibrations of the gaseous atmospheric contaminants has also been removed from the data sets.

Table 25: Data Exceptions - Eastern Ventilation Stack: March 2011

Start	End	Parameter	Reason
4/03/2011 10:40	4/03/2011 11:05	NO, NO ₂ , NO _x	Maintenance/calibration
4/03/2011 17:30	4/03/2011 19:00	PM _{2.5}	Invalid data ¹
16/03/2011 14:10	16/03/2011 14:35	NO, NO ₂ , NO _x	Maintenance/calibration
28/03/2011 10:25	28/03/2011 11:45	NO, NO ₂ , NO _x	Maintenance/calibration
28/03/2011 10:25	28/03/2011 10:50	CO	Maintenance/calibration
28/03/2011 10:45	28/03/2011 12:05	PM _{2.5}	Maintenance/calibration
28/03/2011 11:15	28/03/2011 11:45	CO	Maintenance/calibration
28/03/2011 11:55	28/03/2011 12:55	PM ₁₀	Maintenance/calibration
28/03/2011 12:45	28/03/2011 12:55	PM _{2.5}	Invalid data ¹
30/03/2011 00:40	31/03/2011 14:15	NO, NO ₂ , NO _x	Invalid data - Span drift
31/03/2011 06:00	31/03/2011 06:05	PM ₁₀	Invalid data ¹

Note: ¹ – In the opinion of the reviewer.

Table 26: Data Exceptions - Western Ventilation Stack: March 2011

Start	End	Parameter	Reason
2/03/2011 00:40	5/03/2011 23:55	NO, NO ₂ , NO _x	Invalid data - Span drift
7/03/2011 12:00	7/03/2011 12:25	NO, NO ₂ , NO _x	Maintenance/calibration
11/03/2011 10:15	11/03/2011 16:30	Velocity	Maintenance/calibration
15/03/2011 10:00	15/03/2011 10:45	NO, NO ₂ , NO _x	Maintenance/calibration
15/03/2011 10:00	15/03/2011 11:05	CO	Maintenance/calibration
15/03/2011 10:10	15/03/2011 10:45	PM ₁₀	Maintenance/calibration
19/03/2011 00:40	22/03/2011 11:40	NO, NO ₂ , NO _x	Invalid data - Span drift
28/03/2011 04:30	28/03/2011 04:55	Velocity	Invalid data ¹
29/03/2011 09:15	29/03/2011 10:25	NO, NO ₂ , NO _x	Maintenance/calibration
29/03/2011 10:30	29/03/2011 11:15	CO	Maintenance/calibration
29/03/2011 09:35	29/03/2011 10:20	PM _{2.5}	Maintenance/calibration
29/03/2011 09:50	29/03/2011 10:35	PM ₁₀	Maintenance/calibration

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) Waste Discharge Licence No. EA 63607.

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 (01/01/2011 – 31/03/2011)

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	PM _{2.5}	0.47	2.4
		PM ₁₀	0.63	2.6
		NO ₂	0.50	3.98
		CO	27	112
2	Eastern ventilation stack	PM _{2.5}	0.39	2.4
		PM ₁₀	0.72	2.6
		NO ₂	1.7	3.98
		CO	30	112

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

Data capture statistics for 2011 year to date (01/01/2011 – 31/3/2011) are presented in Table 28.

Table 28: Data Capture Year to Date (%)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀
Eastern	90.9	97.5	96.8	98.9
Western	83.2	97.3	99.4	99.8



Report Signature Page

Mark Tulau
Senior Environmental Scientist

Frank Fleer
Principal

MT/FF/SLH

A.B.N. 64 006 107 857

Golder, Golder Associates and the GA globe design are trademarks of Golder Associates Corporation.

- End of Report -

j:\air\2009\097613024 - eastlink stack\correspondence\correspondence out\097613024-014-r-rev0-transfield services.docx

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Pty Ltd
Building 7, Botanicca Corporate Park, 570 – 588 Swan Street
Richmond Victoria 3121
Australia
T: +61 3 8862 3500

