



March 2014

TRANSFIELD SERVICES PTY. LTD.

EastLink Ventilation Stack Emission Monitoring Report July-September 2013

Submitted to:

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

REPORT

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. 097613024-032-R-Rev1

Distribution:

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





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	20/11/2013	Electronic/Post
Transfield Services Pty. Ltd., EastLink Operations Centre, 2 Hillcrest Avenue, Ringwood, 3134	Ms. Alex Monson	Revision 1	04/03/2014	Electronic/Post



Table of Contents

1.0 INTRODUCTION	1
2.0 DISCHARGES TO AIR	1
3.0 VENTILATION STACK MONITORING PARAMETERS	3
4.0 METHODS	3
4.1 PM _{2.5}	3
4.2 PM ₁₀	3
4.3 Carbon Monoxide	4
4.4 Oxides of Nitrogen	4
4.5 Stack Velocity	4
5.0 MEASUREMENT UNCERTAINTY	4
6.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/07/2013 – 30/07/2013	5
6.1 Data Capture	5
6.2 Results	6
6.2.1 PM _{2.5}	6
6.2.2 PM ₁₀	7
6.2.3 Carbon Monoxide	8
6.2.4 Oxides of Nitrogen	9
6.2.4.1 Nitric Oxide	9
6.2.4.2 Nitrogen Dioxide	10
6.2.5 Stack Velocity	11
6.3 Data Validation and Exceptions	12
7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/08/2013 – 31/08/2013	14
7.1 Data Capture	14
7.2 Results	14
7.2.1 PM _{2.5}	14
7.2.2 PM ₁₀	15
7.2.3 Carbon Monoxide	16
7.2.4 Oxides of Nitrogen	17
7.2.4.1 Nitric Oxide	17
7.2.4.2 Nitrogen Dioxide	18



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2013

7.2.5	Stack Velocity	20
7.3	Data Validation and Exceptions	21
8.0	VENTILATION STACK EMISSION MONITORING PERIOD: 01/09/2013 – 30/09/2013.....	23
8.1	Data Capture	23
8.2	Results.....	23
8.2.1	PM _{2.5}	23
8.2.2	PM ₁₀	24
8.2.3	Carbon Monoxide.....	25
8.2.4	Oxides of Nitrogen	26
8.2.4.1	Nitric Oxide	26
8.2.4.2	Nitrogen Dioxide	27
8.2.5	Stack Velocity	29
8.3	Data Validation and Exceptions	30
9.0	DISCUSSION.....	31
9.1	Comparison with Licence Limits	31
9.2	Data Capture Year to Date	31
9.3	Bubble Licence	31

TABLES

Table 1:	Discharges to Air	1
Table 2:	Measurement Uncertainty	4
Table 3:	Data Capture Statistics - 1 Hour Averages.....	5
Table 4:	PM _{2.5} Mass Rate Percentiles (1 Hour Average).....	6
Table 5:	PM ₁₀ Mass Rate Percentiles (1 Hour Average)	7
Table 6:	Carbon Monoxide Mass Rate Percentiles (1 Hour Average).....	8
Table 7:	Nitric Oxide Mass Rate Percentiles (1 Hour Average).....	9
Table 8:	Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average).....	10
Table 9:	Data Exceptions - Eastern Ventilation Stack: July 2013.....	12
Table 10:	Data Exceptions - Western Ventilation Stack: July 2013.....	13
Table 11:	Data Capture Statistics - 1 Hour Averages.....	14
Table 12:	PM _{2.5} Mass Rate Percentiles (1 Hour Average).....	14
Table 13:	PM ₁₀ Mass Rate Percentiles (1 Hour Average)	15
Table 14:	Carbon Monoxide Mass Rate Percentiles (1 Hour Average).....	16
Table 15:	Nitric Oxide Mass Rate Percentiles (1 Hour Average).....	17
Table 16:	Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average).....	18



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2013

Table 17: Data Exceptions - Eastern Ventilation Stack: August 2013	21
Table 18: Data Exceptions - Western Ventilation Stack: August 2013	21
Table 19: Data Capture Statistics - 1 Hour Averages.....	23
Table 20: PM _{2.5} Mass Rate Percentiles (1 Hour Average)	23
Table 21: PM ₁₀ Mass Rate Percentiles (1 Hour Average)	24
Table 22: Carbon Monoxide Mass Rate Percentiles (1 Hour Average).....	25
Table 23: Nitric Oxide Mass Rate Percentiles (1 Hour Average).....	26
Table 24: Nitrogen Dioxide Mass Rate Percentiles (1 Hour Average).....	27
Table 25: Data Exceptions - Eastern Ventilation Stack: September 2013.....	30
Table 26: Data Exceptions - Western Ventilation Stack: September 2013.....	30
Table 27: Maximum (1 Hour Average) Mass Rate (01/07/2013 - 30/09/2013)	31
Table 28: Data Capture Year to Date (%)	31
Table 29: Ventilation Stack Emissions 1/07/2013 – 30/09/2013 (tonnes/year).....	32

FIGURES

Figure 1: Ventilation Stack Locations	2
Figure 2: PM _{2.5} Mass Rate (1 Hour Average)	6
Figure 3: PM ₁₀ Mass Rate (1 Hour Average)	7
Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)	8
Figure 5: Nitric Oxide Mass Rate (1 Hour Average).....	9
Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average).....	10
Figure 7: Stack Velocity (1 Hour Average).....	11
Figure 8: PM _{2.5} Mass Rate (1 Hour Average).....	15
Figure 9: PM ₁₀ Mass Rate (1 Hour Average)	16
Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)	17
Figure 11: Nitric Oxide Mass Rate (1 Hour Average).....	18
Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average).....	19
Figure 13: Stack Velocity (1 Hour Average).....	20
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
Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2013 - 30/09/2013).....	32



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2013

APPENDICES

APPENDIX A

Limitations



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)
- 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, 2013 to 30th September, 2013 inclusive are contained in the following report.

The work was conducted under the following Transfield Services Work Order numbers:

Month	Western Stack	Eastern Stack
July	526167	526168
August	530298	530299
September	535683	535684

Your attention is drawn to the document - "Limitations" (LEG04, RL1), 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 these 'Limitations'.

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.

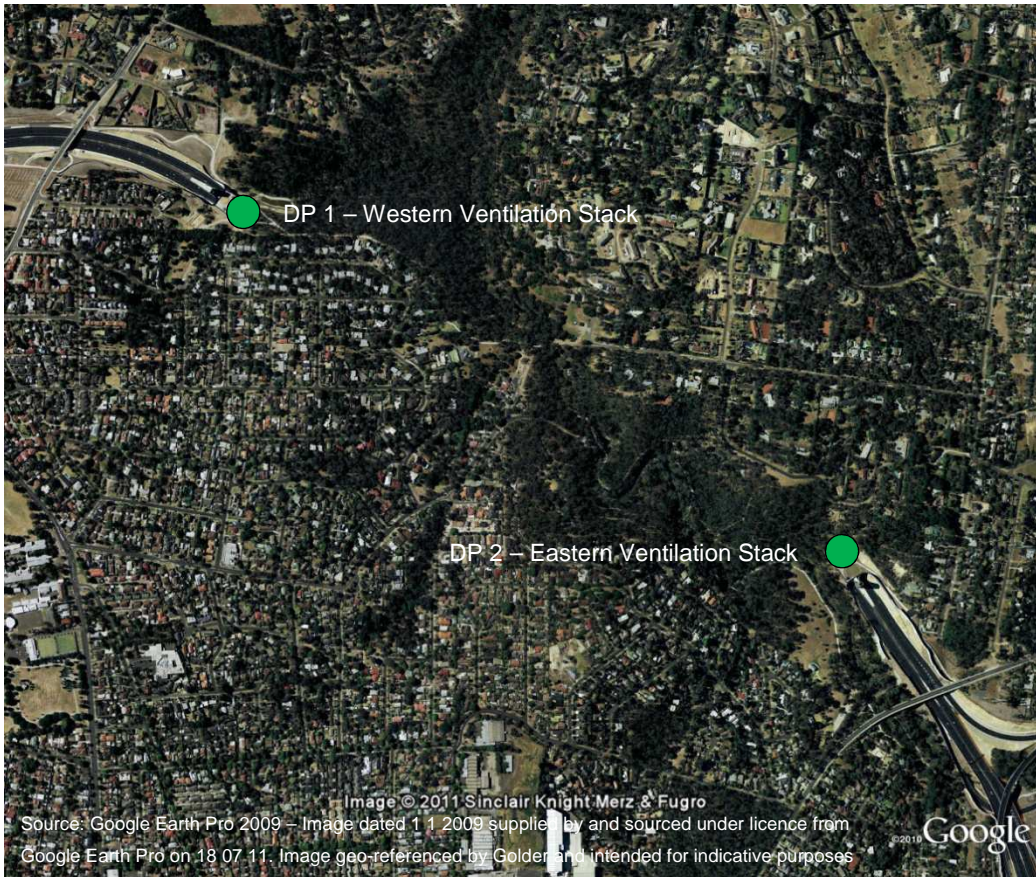


Figure 1: Ventilation Stack Locations



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: 01/07/2013 – 30/07/2013

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, 2013 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	738	744	99.2%
	Western	740	744	99.5%
PM ₁₀	Eastern	742	744	99.7%
	Western	740	744	99.5%
NO, NO ₂	Eastern	583	744	78.4%
	Western	707	744	95.0%
CO	Eastern	701	744	94.2%
	Western	709	744	95.3%



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	0.40	0.22	0.21	0.18	0.15	0.12	0.040
Western	0.27	0.24	0.22	0.18	0.14	0.098	0.044

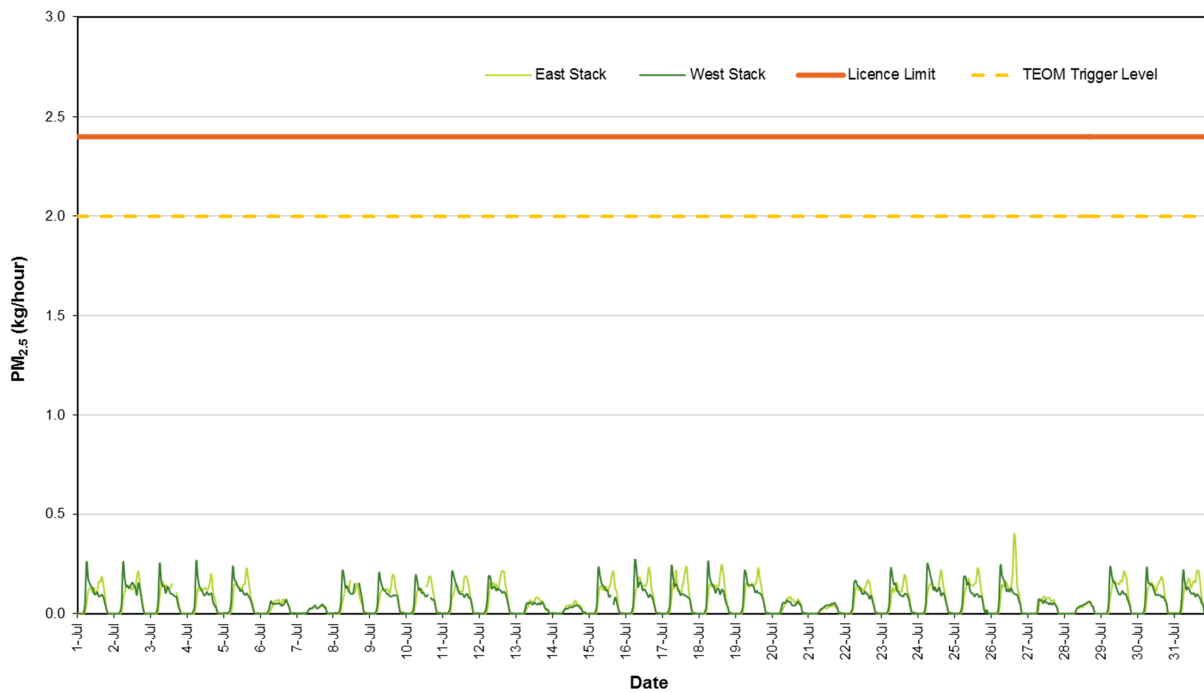


Figure 2: PM_{2.5} Mass Rate (1 Hour Average)



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	0.43	0.36	0.34	0.30	0.27	0.21	0.072
Western	0.71	0.46	0.39	0.30	0.26	0.18	0.078

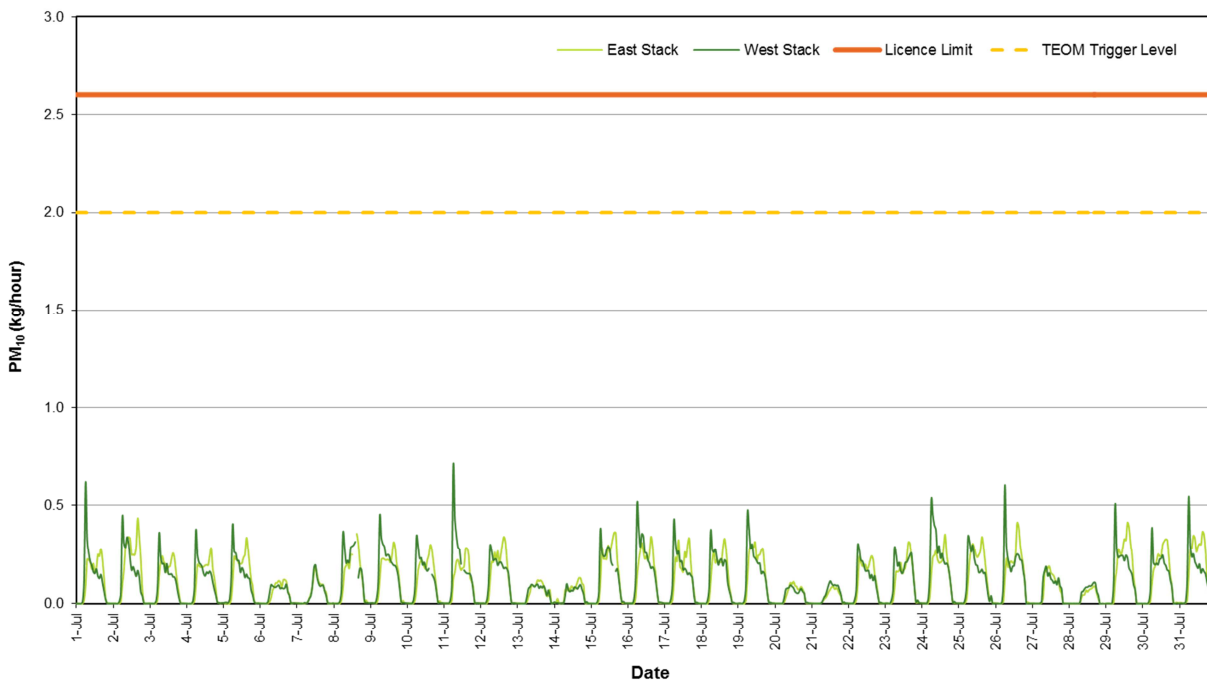


Figure 3: PM₁₀ Mass Rate (1 Hour Average)



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	19	18	17	16	12	9.1	5.9
Western	23	21	20	17	14	10	7.8

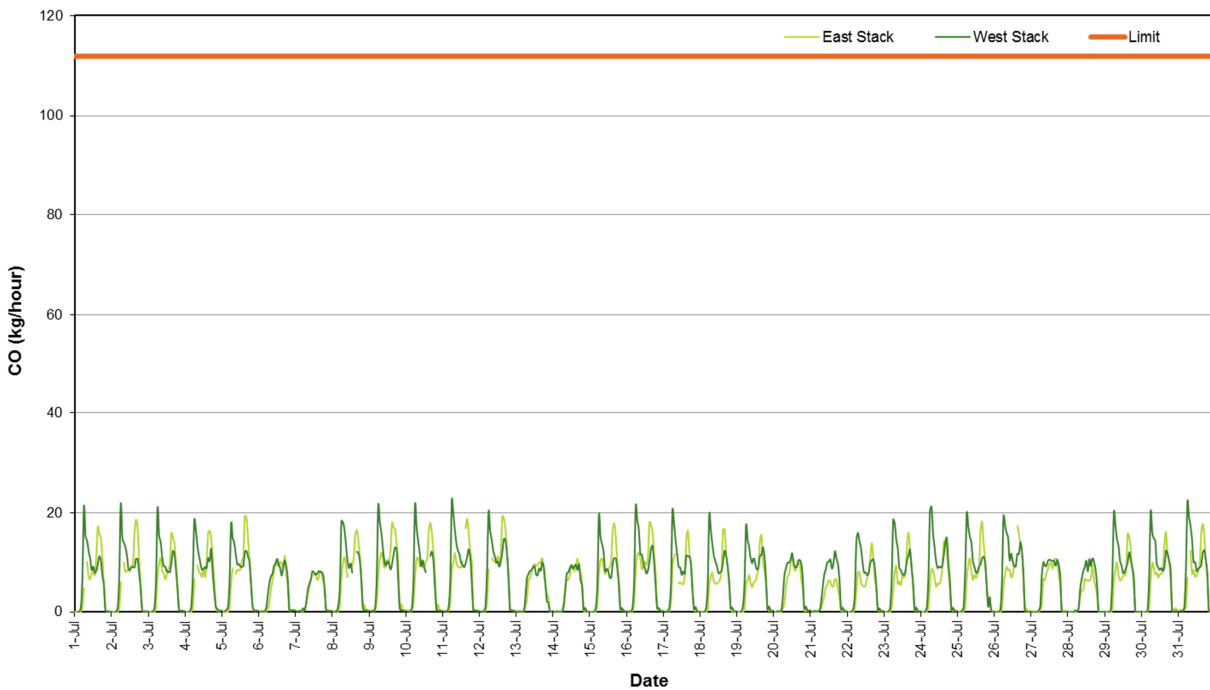


Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)



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 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	4.7	4.2	4.1	3.7	3.1	2.6	1.3
Western	5.3	4.8	4.2	3.2	2.7	2.0	1.2

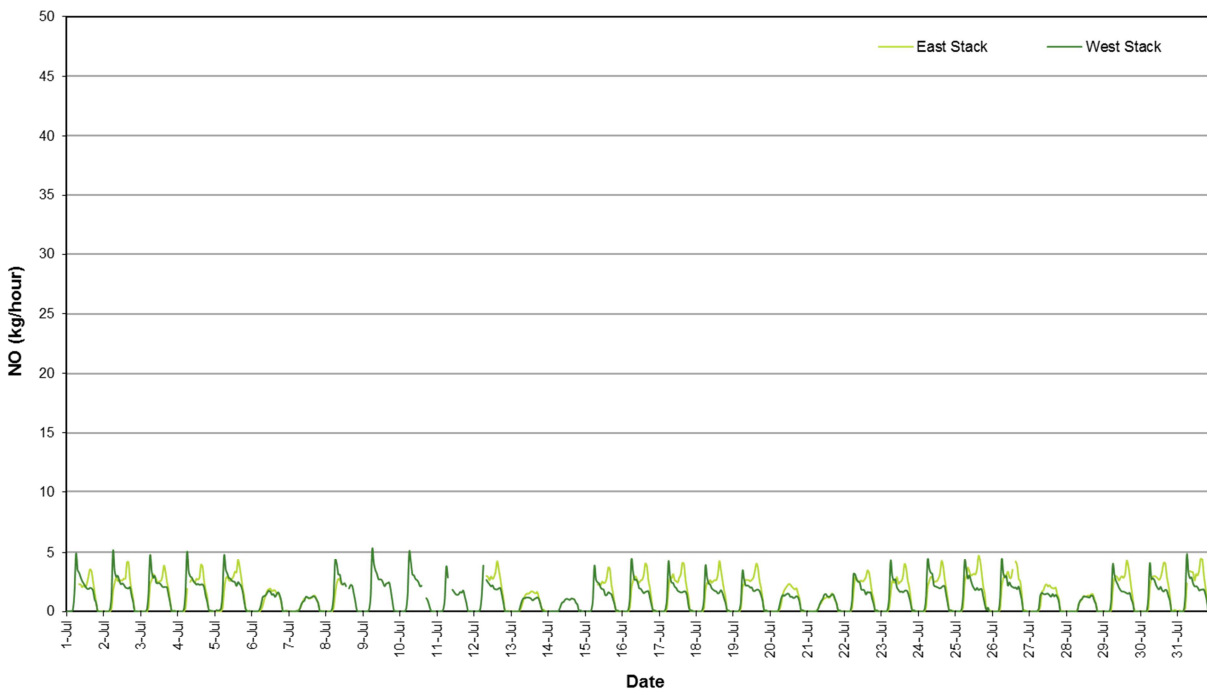


Figure 5: Nitric Oxide Mass Rate (1 Hour Average)



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	0.75	0.71	0.68	0.60	0.50	0.41	0.23
Western	0.67	0.60	0.56	0.41	0.34	0.28	0.17

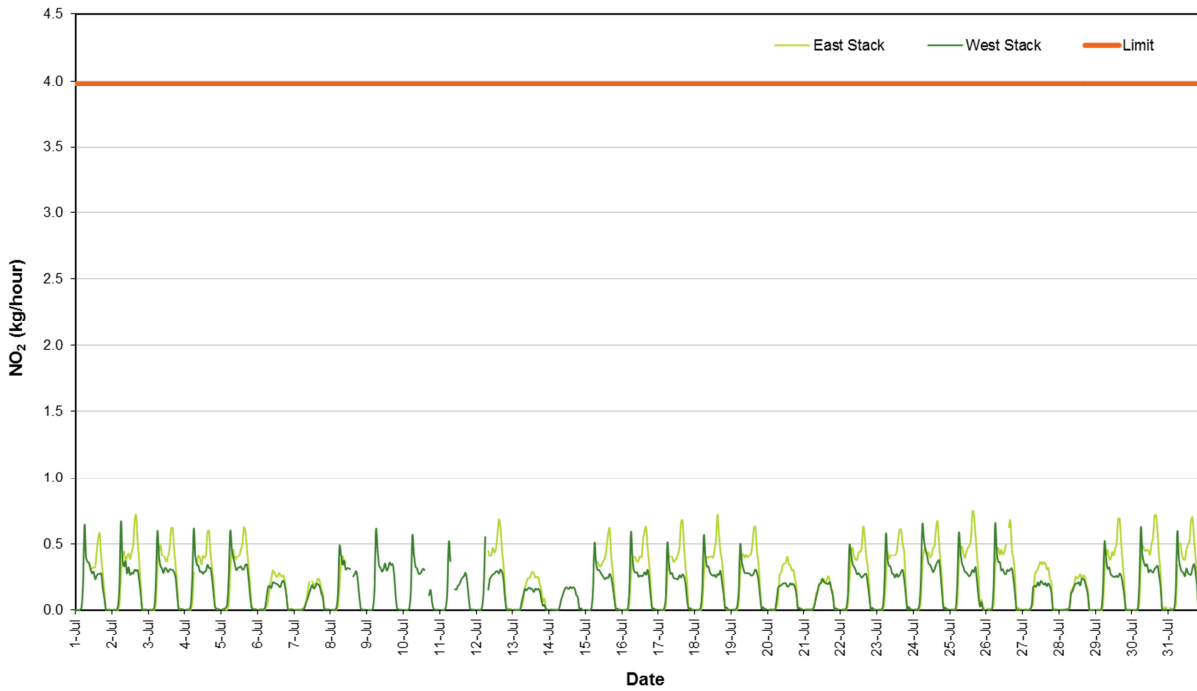


Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)



6.2.5 Stack Velocity

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

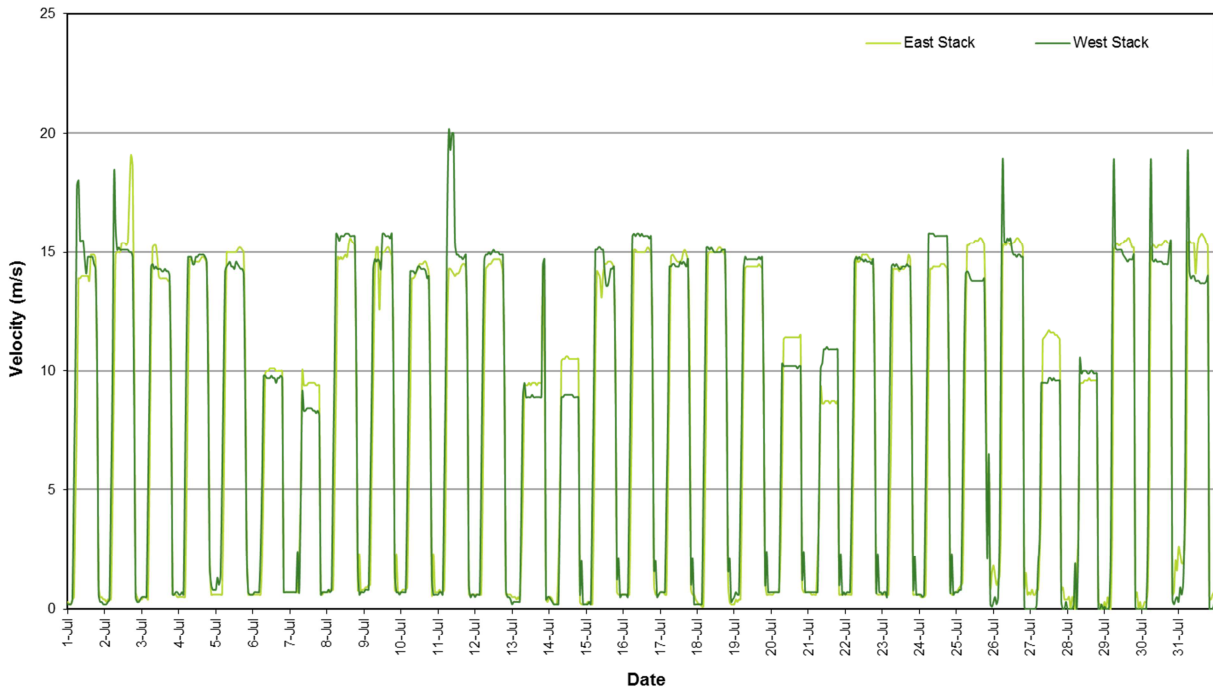


Figure 7: Stack Velocity (1 Hour Average)



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 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: July 2013

Start	End	Parameter	Reason
01/07/2013 00:40	01/07/2013 07:55	NO, NO ₂ , NO _x	Invalid data - Span drift
01/07/2013 07:30	01/07/2013 07:50	CO	Maintenance/ calibration
02/07/2013 07:40	02/07/2013 07:55	CO	Maintenance/ calibration
03/07/2013 12:10	03/07/2013 13:10	PM _{2.5}	Invalid data
03/07/2013 15:10	03/07/2013 16:20	PM _{2.5}	Invalid data
04/07/2013 07:40	04/07/2013 08:00	NO, NO ₂ , NO _x	Maintenance/ calibration
04/07/2013 07:40	04/07/2013 08:00	CO	Maintenance/ calibration
05/07/2013 08:15	05/07/2013 08:50	CO	Maintenance/ calibration
07/07/2013 11:25	07/07/2013 11:45	NO, NO ₂ , NO _x	Maintenance/ calibration
07/07/2013 11:30	07/07/2013 11:50	CO	Maintenance/ calibration
08/07/2013 11:05	08/07/2013 12:05	NO, NO ₂ , NO _x	Maintenance/ calibration
08/07/2013 11:05	08/07/2013 11:20	CO	Maintenance/ calibration
08/07/2013 11:50	08/07/2013 14:10	PM _{2.5}	Maintenance/ calibration
08/07/2013 12:15	12/07/2013 08:00	NO, NO ₂ , NO _x	Invalid data - Span drift
08/07/2013 12:20	08/07/2013 13:05	CO	Maintenance/ calibration
08/07/2013 13:30	08/07/2013 14:20	PM ₁₀	Maintenance/ calibration
10/07/2013 07:20	10/07/2013 07:30	PM _{2.5}	Invalid data
10/07/2013 12:40	10/07/2013 12:55	PM _{2.5}	Invalid data
11/07/2013 14:20	11/07/2013 14:35	CO	Maintenance/ calibration
12/07/2013 07:20	12/07/2013 07:40	CO	Maintenance/ calibration
14/07/2013 00:40	15/07/2013 08:00	NO, NO ₂ , NO _x	Invalid data - Span drift
17/07/2013 09:10	17/07/2013 09:40	CO	Maintenance/ calibration
24/07/2013 15:10	24/07/2013 15:10	CO	Maintenance/ calibration
26/07/2013 14:35	26/07/2013 14:55	NO, NO ₂ , NO _x	Maintenance/ calibration
26/07/2013 14:35	26/07/2013 14:50	CO	Maintenance/ calibration



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2013

Start	End	Parameter	Reason
31/07/2013 07:35	31/07/2013 07:55	NO, NO ₂ , NO _x	Maintenance/ calibration
31/07/2013 07:35	31/07/2013 07:50	CO	Maintenance/ calibration

Note: 1 – In the opinion of the reviewer.

Table 10: Data Exceptions - Western Ventilation Stack: July 2013

Start	End	Parameter	Reason
08/07/2013 14:15	08/07/2013 14:55	NO, NO ₂ , NO _x	Maintenance/ calibration
08/07/2013 14:40	08/07/2013 15:10	CO	Maintenance/ calibration
08/07/2013 15:15	08/07/2013 16:15	PM _{2.5}	Maintenance/ calibration
08/07/2013 15:25	08/07/2013 16:10	PM ₁₀	Maintenance/ calibration
10/07/2013 03:05	10/07/2013 03:10	PM ₁₀	Maintenance/ calibration
10/07/2013 14:40	10/07/2013 15:20	CO	Maintenance/ calibration
10/07/2013 14:55	10/07/2013 15:25	NO, NO ₂ , NO _x	Maintenance/ calibration
10/07/2013 14:55	10/07/2013 16:05	PM _{2.5}	Maintenance/ calibration
10/07/2013 14:55	10/07/2013 15:40	PM ₁₀	Maintenance/ calibration
10/07/2013 15:50	10/07/2013 17:00	NO, NO ₂ , NO _x	Maintenance/ calibration
11/07/2013 08:40	11/07/2013 09:45	NO, NO ₂ , NO _x	Maintenance/ calibration
11/07/2013 12:20	11/07/2013 13:05	PM ₁₀	Maintenance/ calibration
12/07/2013 07:20	12/07/2013 07:55	NO, NO ₂ , NO _x	Maintenance/ calibration
15/07/2013 14:55	15/07/2013 15:55	PM _{2.5}	Maintenance/ calibration
15/07/2013 14:55	15/07/2013 15:25	PM ₁₀	Maintenance/ calibration

Note: 1 – In the opinion of the reviewer.



7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/08/2013 – 31/08/2013

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, 2013 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	737	744	99.1%
	Western	737	744	99.1%
PM ₁₀	Eastern	741	744	99.6%
	Western	741	744	99.6%
NO, NO ₂	Eastern	612	744	82.3%
	Western	667	744	89.7%
CO	Eastern	711	744	95.6%
	Western	711	744	95.6%

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	0.24	0.21	0.20	0.18	0.16	0.13	0.045
Western	0.28	0.25	0.22	0.17	0.14	0.095	0.043

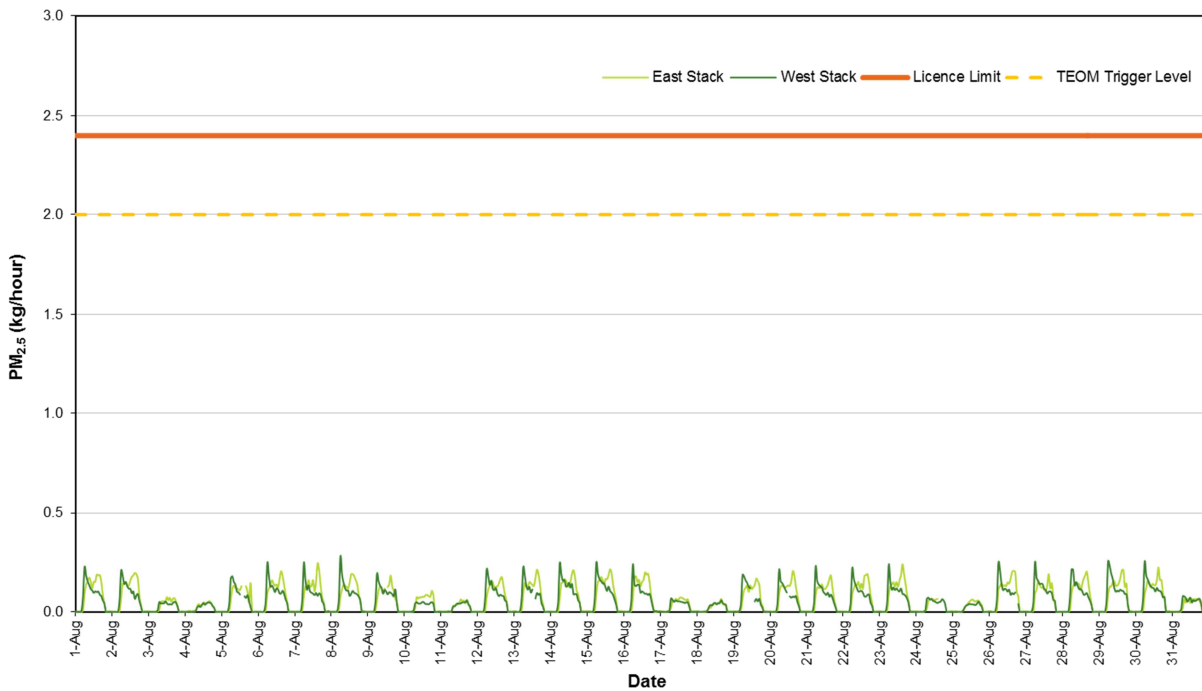


Figure 8: PM_{2.5} Mass Rate (1 Hour Average)

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	0.59	0.34	0.32	0.29	0.27	0.20	0.078
Western	0.71	0.54	0.44	0.30	0.24	0.17	0.091

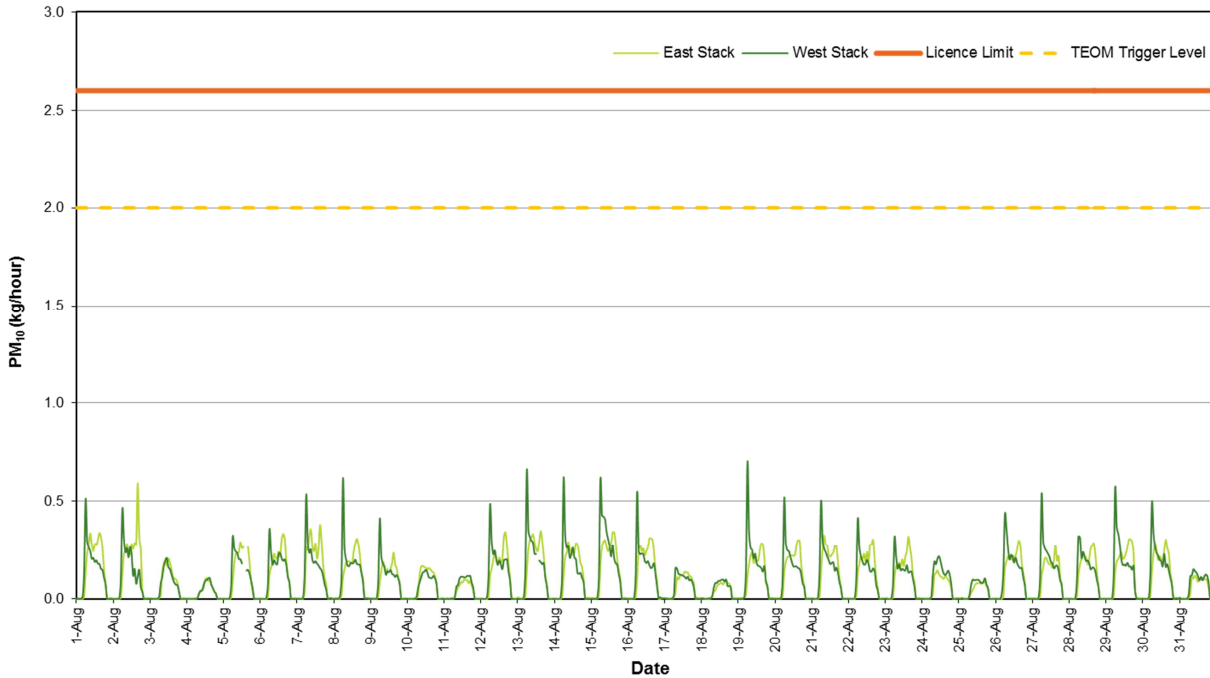


Figure 9: PM₁₀ Mass Rate (1 Hour Average)

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	19	18	17	15	11	8.8	6.3
Western	25	21	20	17	14	10.5	8.3

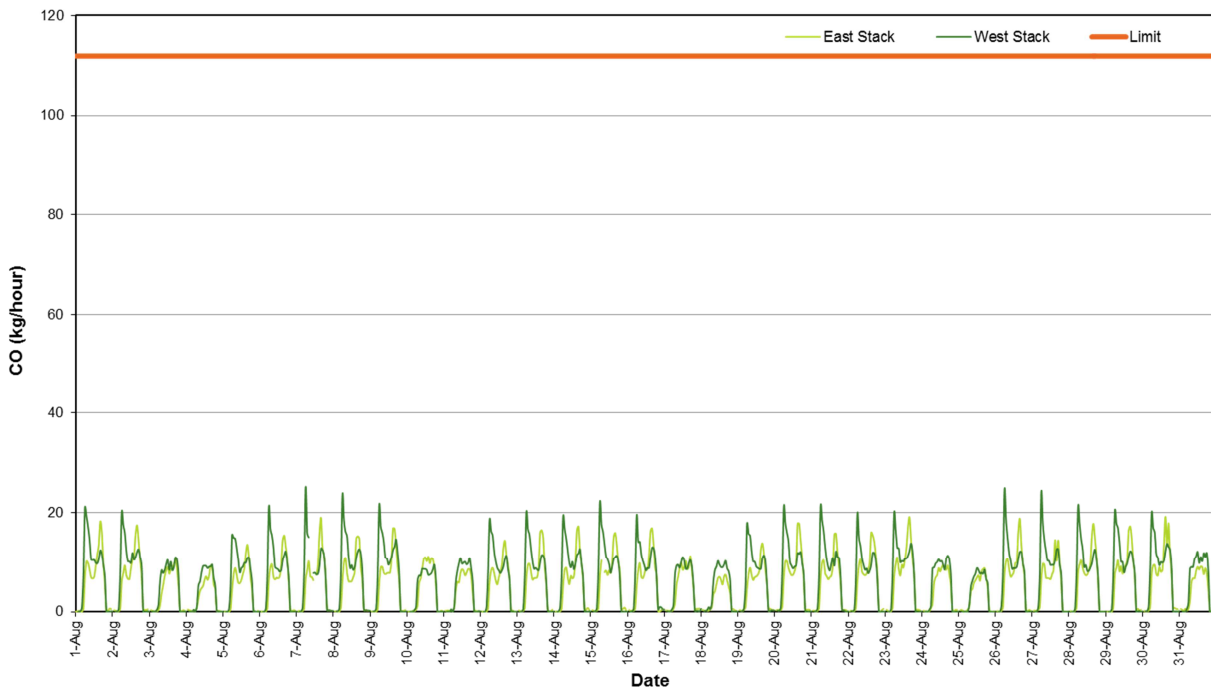


Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)

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	4.4	3.7	3.5	3.1	2.8	2.2	1.2
Western	5.4	4.8	4.4	3.4	2.8	2.1	1.3

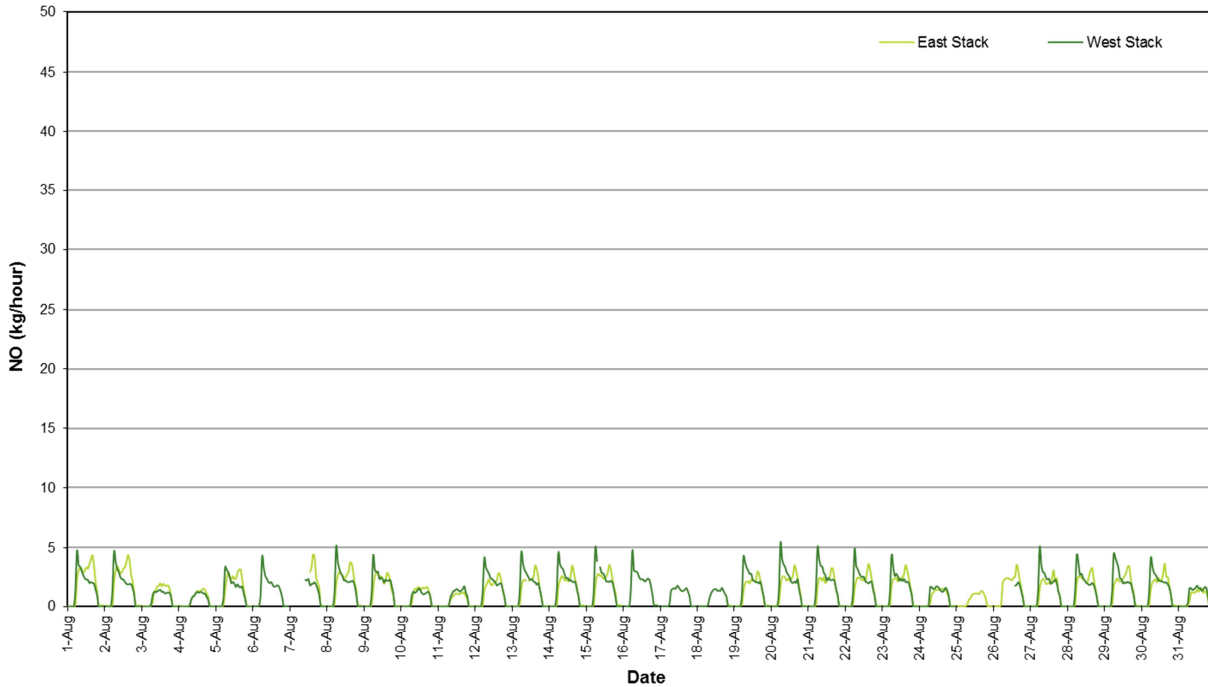


Figure 11: Nitric Oxide Mass Rate (1 Hour Average)

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 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	0.72	0.64	0.59	0.53	0.46	0.37	0.21
Western	0.72	0.64	0.61	0.43	0.36	0.31	0.19



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2013

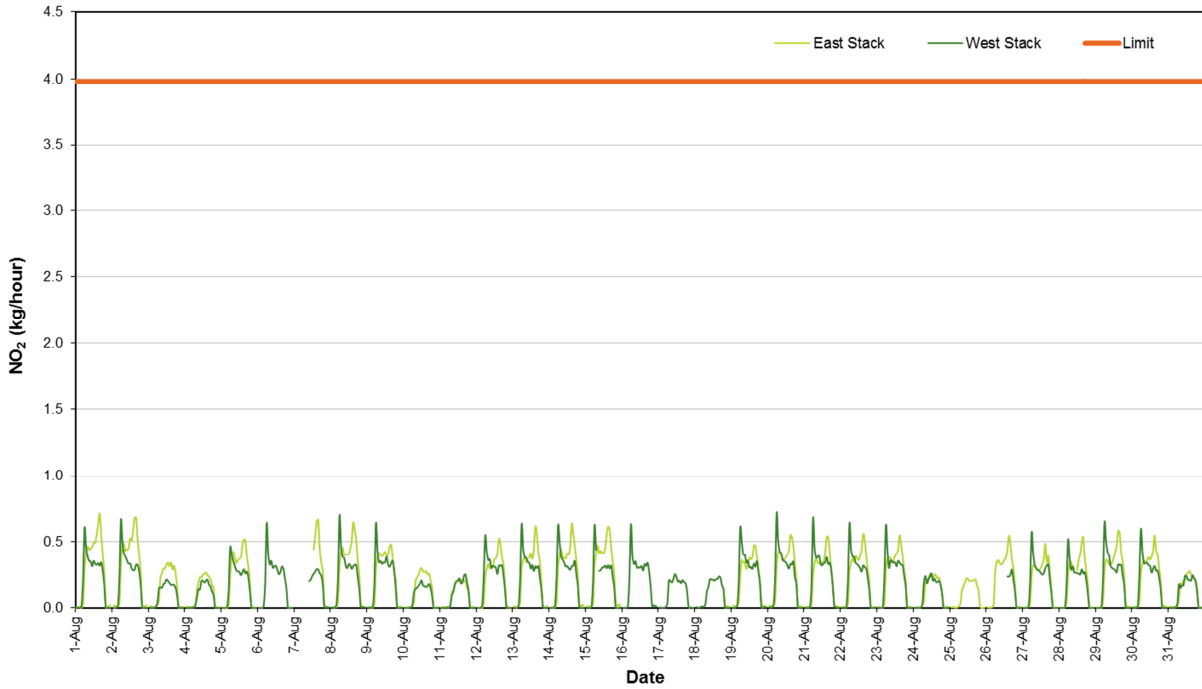


Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)



7.2.5 Stack Velocity

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

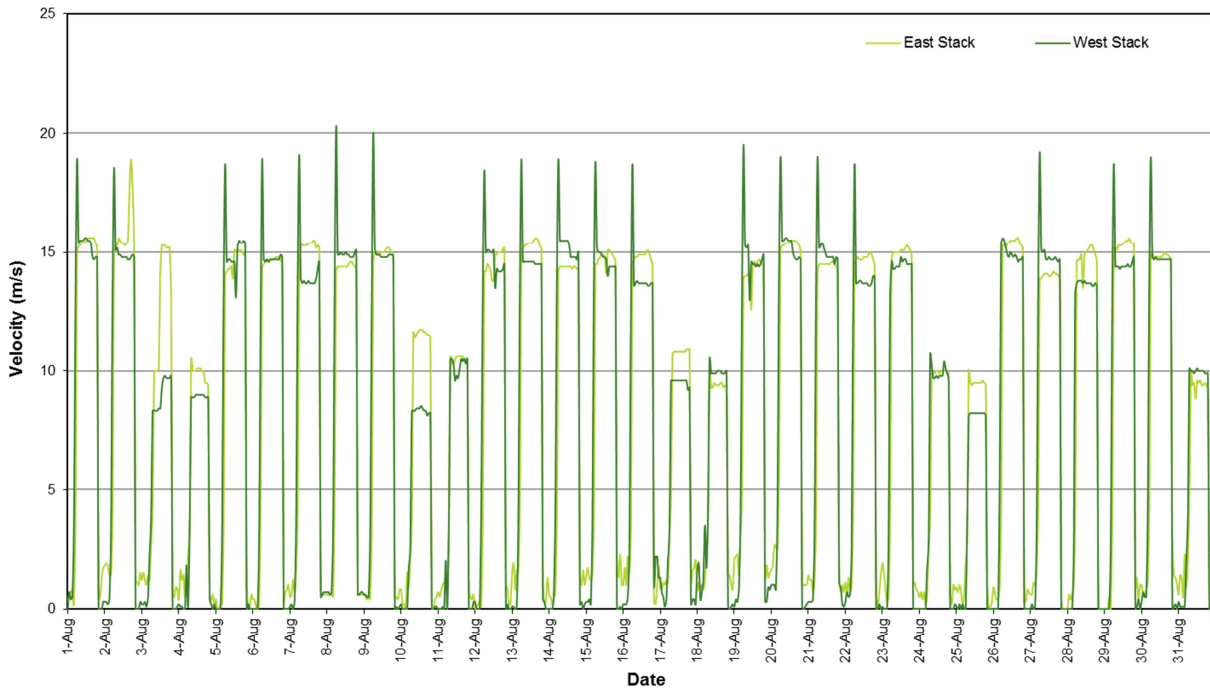


Figure 13: Stack Velocity (1 Hour Average)



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 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: August 2013

Start	End	Parameter	Reason
03/08/2013 08:35	03/08/2013 08:40	CO	Maintenance/ calibration
05/08/2013 14:25	05/08/2013 15:15	PM _{2.5}	Maintenance/ calibration
05/08/2013 14:30	05/08/2013 15:20	PM ₁₀	Maintenance/ calibration
06/08/2013 00:40	07/08/2013 12:40	NO, NO ₂ , NO _x	Invalid data - Span drift
07/08/2013 04:50	07/08/2013 04:50	CO	Invalid data ¹
07/08/2013 05:00	07/08/2013 05:00	CO	Invalid data ¹
07/08/2013 12:20	07/08/2013 12:35	CO	Maintenance/ calibration
08/08/2013 06:45	08/08/2013 07:10	CO	Maintenance/ calibration
09/08/2013 12:20	09/08/2013 13:05	PM _{2.5}	Maintenance/ calibration
09/08/2013 12:25	09/08/2013 13:10	PM ₁₀	Maintenance/ calibration
13/08/2013 10:25	13/08/2013 10:50	NO, NO ₂ , NO _x	Maintenance/ calibration
15/08/2013 08:00	15/08/2013 08:20	CO	Maintenance/ calibration
16/08/2013 00:40	18/08/2013 18:55	NO, NO ₂ , NO _x	Invalid data - Span drift
19/08/2013 06:40	19/08/2013 06:45	PM ₁₀	Invalid data ¹
24/08/2013 14:45	24/08/2013 15:05	PM _{2.5}	Invalid data ¹
24/08/2013 15:45	24/08/2013 15:50	PM _{2.5}	Invalid data ¹
24/08/2013 17:05	24/08/2013 19:30	PM _{2.5}	Invalid data ¹
28/08/2013 11:20	28/08/2013 11:50	NO, NO ₂ , NO _x	Maintenance/ calibration

Note: ¹ – In the opinion of the reviewer.

Table 18: Data Exceptions - Western Ventilation Stack: August 2013

Start	End	Parameter	Reason
05/08/2013 13:10	05/08/2013 14:15	PM _{2.5}	Maintenance/ calibration
05/08/2013 13:25	05/08/2013 14:20	PM ₁₀	Maintenance/ calibration
07/08/2013 00:40	07/08/2013 09:50	NO, NO ₂ , NO _x	Invalid data - Span drift
07/08/2013 09:20	07/08/2013 10:20	CO	Maintenance/ calibration
13/08/2013 13:20	13/08/2013 14:00	PM ₁₀ , PM _{2.5}	Maintenance/ calibration
15/08/2013 07:55	15/08/2013 08:25	NO, NO ₂ , NO _x	Maintenance/ calibration
19/08/2013 12:30	19/08/2013 13:35	PM _{2.5}	Maintenance/ calibration



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2013

20/08/2013 11:55	20/08/2013 12:35	PM _{2.5}	Maintenance/ calibration
25/08/2013 00:40	26/08/2013 13:35	NO, NO ₂ , NO _x	Invalid data - Span drift
26/08/2013 18:40	26/08/2013 19:10	PM _{2.5}	Invalid data ¹

Note: ¹ – In the opinion of the reviewer.

A number of periods occurred where PM_{2.5} concentrations were greater than the corresponding PM₁₀ concentrations. If no valid reason was found to exclude the data, the data was left unchanged in the data set. Examples of such occurrences are listed below:

- East Ventilation stack 4/8/2013 02:40 – 07:30
- East Ventilation stack 5/8/2013 18:55 – 23:30



8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/09/2013 – 30/09/2013

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, 2013 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	719	720	99.9%
	Western	714	720	99.2%
PM ₁₀	Eastern	718	720	99.7%
	Western	718	720	99.7%
NO, NO ₂	Eastern	658	720	91.4%
	Western	628	720	87.2%
CO	Eastern	688	720	95.6%
	Western	689	720	95.7%

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	0.36	0.22	0.21	0.18	0.15	0.12	0.040
Western	0.65	0.26	0.24	0.18	0.14	0.10	0.042

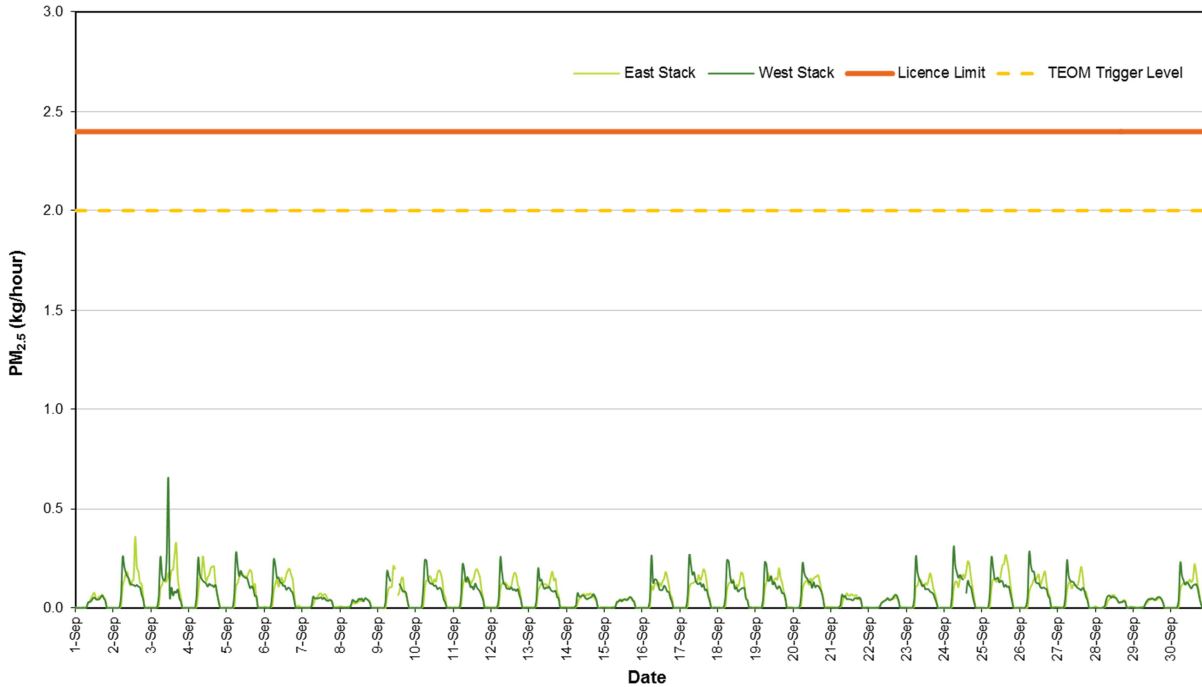


Figure 14: PM_{2.5} Mass Rate (1 Hour Average)

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	0.50	0.34	0.31	0.27	0.25	0.19	0.069
Western	0.82	0.54	0.42	0.29	0.23	0.17	0.083

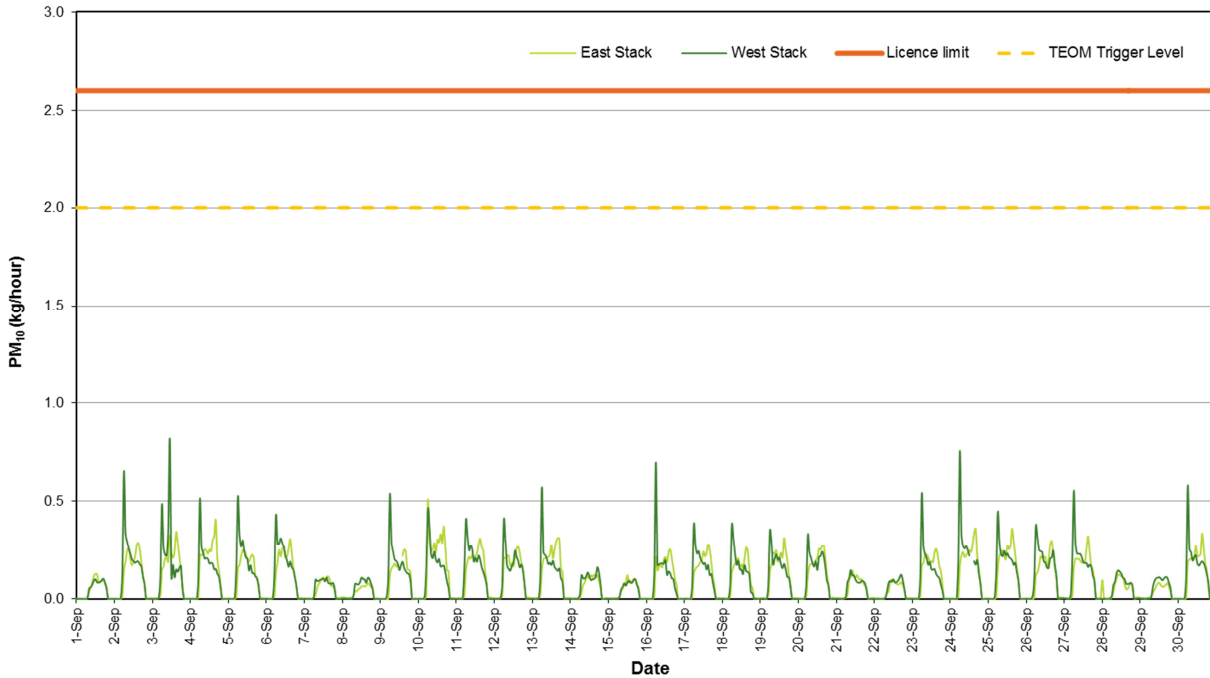


Figure 15: PM₁₀ Mass Rate (1 Hour Average)

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	18	17	17	15	11	8.9	6.8
Western	25	23	21	16	14	11	8.0

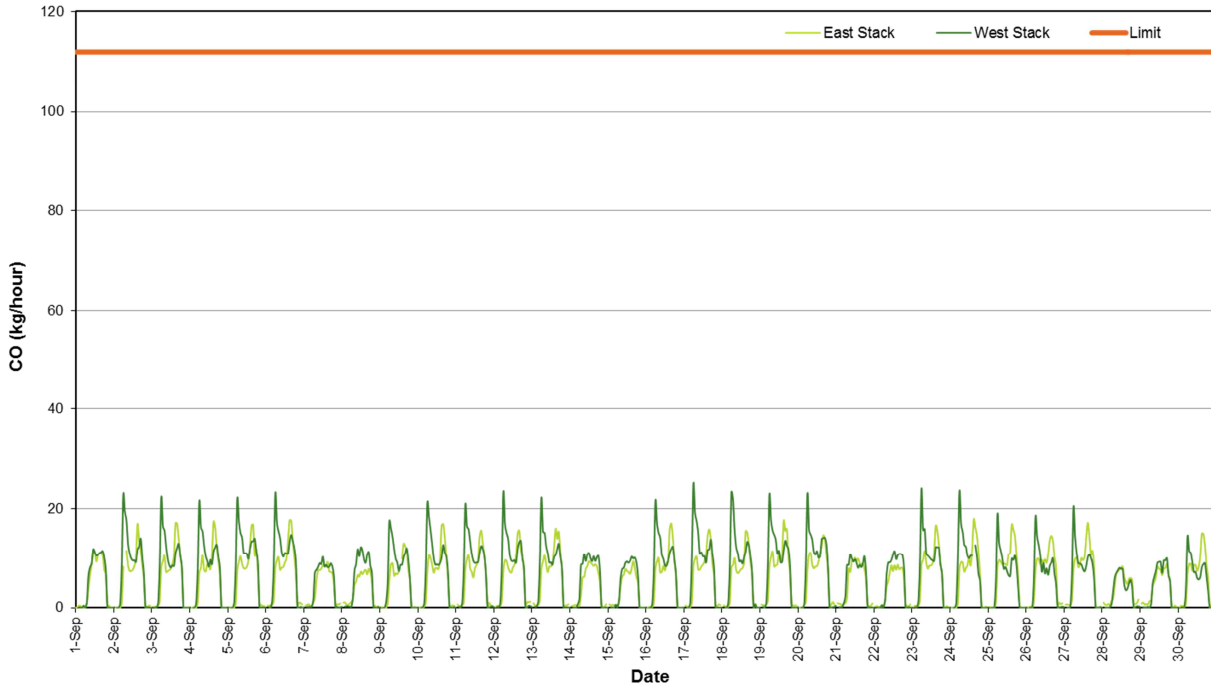


Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)

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	3.7	3.4	3.2	2.9	2.5	2.1	0.97
Western	5.3	4.7	4.5	3.2	2.7	2.1	1.2

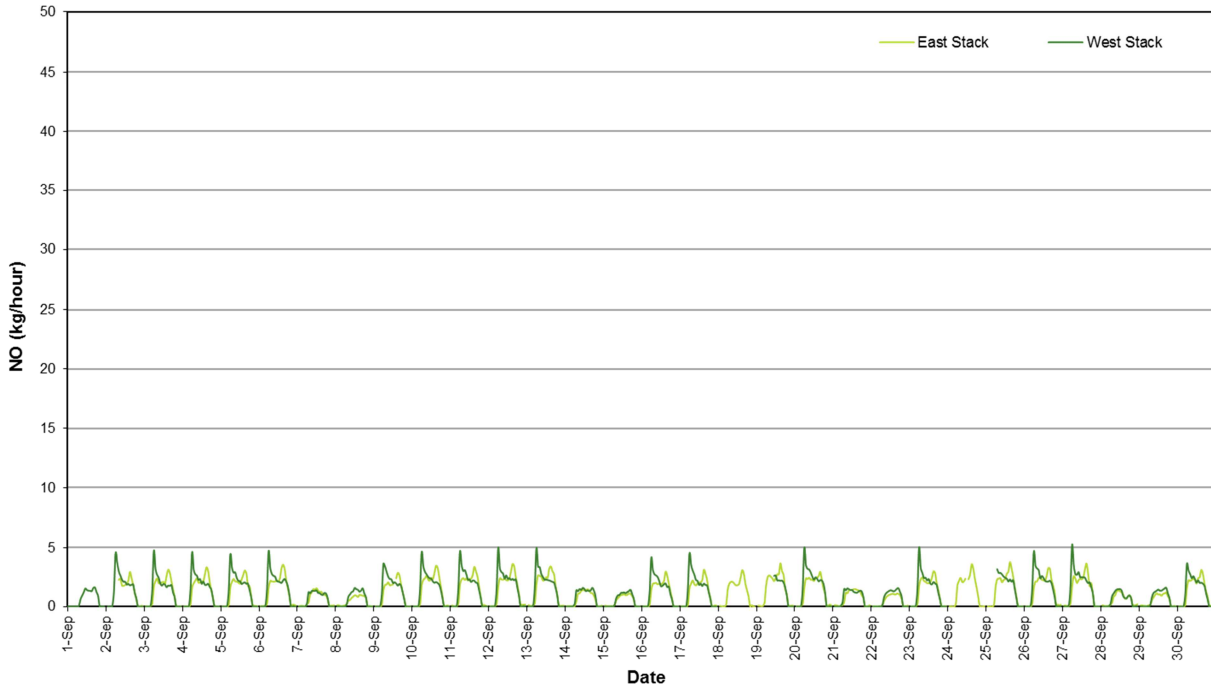


Figure 17: Nitric Oxide Mass Rate (1 Hour Average)

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	0.60	0.58	0.54	0.48	0.41	0.34	0.18
Western	0.67	0.61	0.55	0.39	0.35	0.30	0.18



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2013

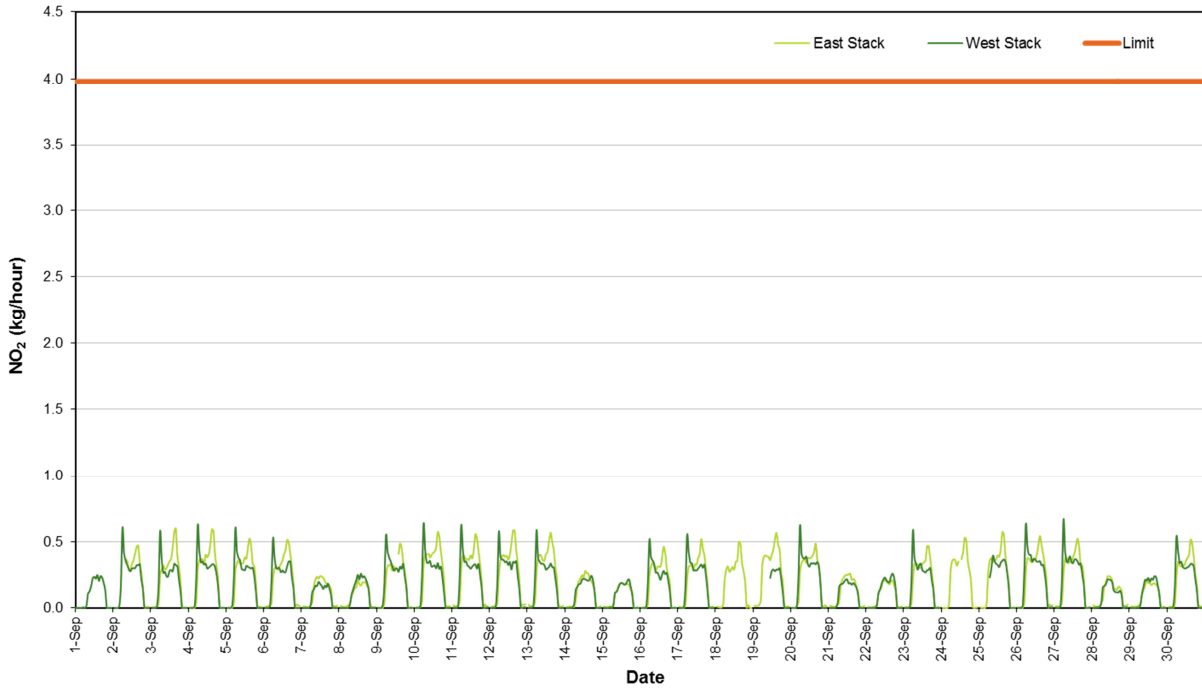


Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)



8.2.5 Stack Velocity

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

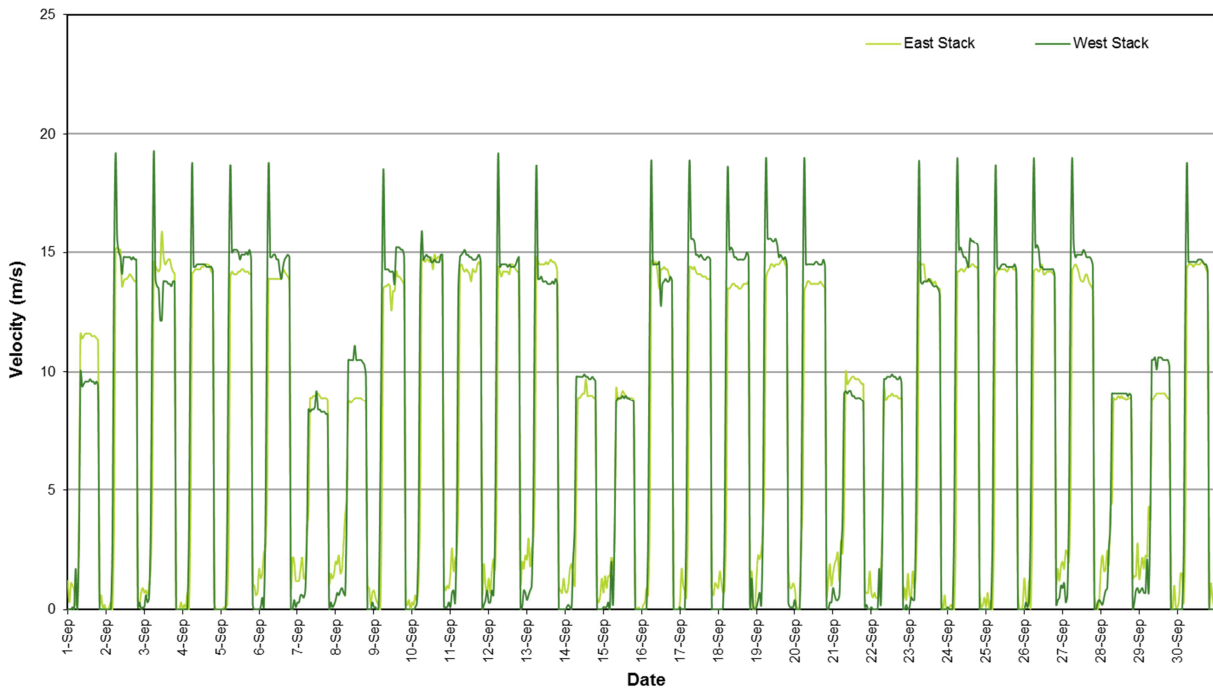


Figure 19: Stack Velocity (1 Hour Average)



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 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: September 2013

Start	End	Parameter	Reason
01/09/2013 00:40	02/09/2013 07:30	NO, NO ₂ , NO _x	Invalid data - Span drift
02/09/2013 07:10	02/09/2013 07:30	CO	Maintenance/calibration
07/09/2013 04:50	07/09/2013 04:50	CO	Invalid data ¹
07/09/2013 05:00	07/09/2013 05:00	CO	Invalid data ¹
09/09/2013 12:05	09/09/2013 13:10	PM _{2.5}	Maintenance/calibration
09/09/2013 12:30	09/09/2013 13:20	PM ₁₀	Maintenance/calibration
09/09/2013 12:55	09/09/2013 13:40	NO, NO ₂ , NO _x	Maintenance/calibration
09/09/2013 12:55	09/09/2013 13:40	CO	Maintenance/calibration
24/09/2013 12:15	24/09/2013 12:30	NO, NO ₂ , NO _x	Maintenance/calibration

Note: ¹ – In the opinion of the reviewer.

Table 26: Data Exceptions - Western Ventilation Stack: September 2013

Start	End	Parameter	Reason
04/09/2013 13:35	04/09/2013 13:40	PM ₁₀	Invalid data ¹
09/09/2013 09:30	09/09/2013 14:10	PM _{2.5}	Invalid data ¹
18/09/2013 00:40	19/09/2013 10:40	NO, NO ₂ , NO _x	Invalid data - Span drift
24/09/2013 00:40	25/09/2013 06:55	NO, NO ₂ , NO _x	Invalid data - Span drift
24/09/2013 13:15	24/09/2013 14:10	PM _{2.5}	Maintenance/calibration
24/09/2013 13:20	24/09/2013 14:40	PM ₁₀	Maintenance/calibration
24/09/2013 15:00	24/09/2013 15:55	CO	Maintenance/calibration
24/09/2013 17:15	24/09/2013 17:15	Velocity	Maintenance/calibration

Note: ¹ – In the opinion of the reviewer.

A number of periods occurred where PM_{2.5} concentrations were greater than the corresponding PM₁₀ concentrations. If no valid reason was found to exclude the data, the data was left unchanged in the data set. Examples of such occurrences are listed below:

- East Ventilation stack 2/9/2013 15:15 – 15:10
- East Ventilation stack 2/9/2013 18:35 – 19:05



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 (01/07/2013 - 30/09/2013)

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	PM _{2.5}	0.65	2.4
		PM ₁₀	0.82	2.6
		NO ₂	0.72	3.98
		CO	25	112
2	Eastern ventilation stack	PM _{2.5}	0.40	2.4
		PM ₁₀	0.59	2.6
		NO ₂	0.75	3.98
		CO	19	112

There were no exceedences 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 DP 1 and DP 2:

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

There were no exceedences of the TEOM mass rate compliance levels for DP1 and DP2 during the reporting period

9.2 Data Capture Year to Date

Data capture statistics for 2013 year to date (01/01/2013 – 30/09/2013) are presented in Table 28.

Table 28: Data Capture Year to Date (%)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀	Velocity
Eastern	88.5	95.0	99.6	96.0	100
Western	94.4	97.0	99.5	99.7	100

9.3 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 (1/07/2013 to 30/09/2013) are shown in Table 29.



Table 29: Ventilation Stack Emissions 1/07/2013 – 30/09/2013 (tonnes/year)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀
Eastern	0.40	12	0.14	0.22
Western	0.34	15	0.13	0.23
Total	0.74	27	0.27	0.45
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.

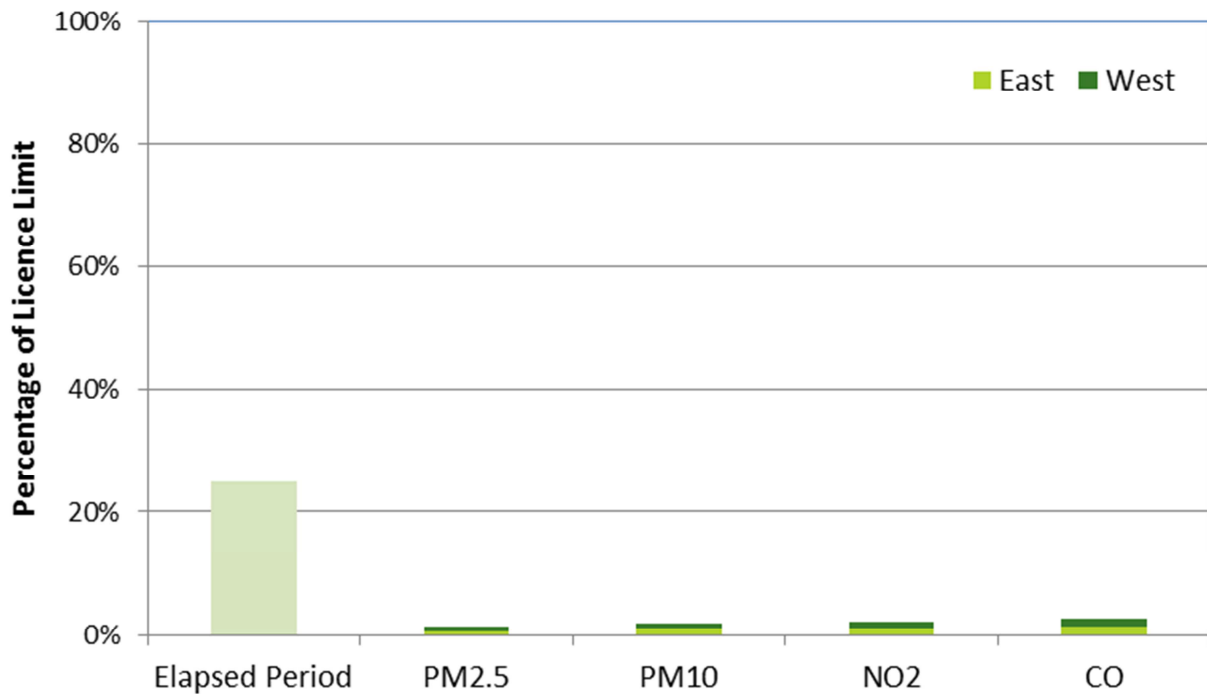


Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2013 - 30/09/2013)

The bubble limit for the uncorrected TEOM data for both DP 1 and DP 2 are:

- PM_{2.5} (DP1, DP2): 17.5 tonnes/year
- PM₁₀ (DP1, DP2): 22.8 tonnes/year



Report Signature Page

GOLDER ASSOCIATES PTY LTD

Handwritten signature of Mark Tulau in black ink.

Mark Tulau
Senior Air Quality Specialist

Handwritten signature of Frank Fleer in black ink.

Frank Fleer
Principal Air and Noise Group

MT/FEF/mdt

A.B.N. 64 006 107 857

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

j:\env\2009\097613024 - eastlink stack\correspondence\correspondence out\097613024-032-r-rev1.docx



APPENDIX A

Limitations



LIMITATIONS

This Document has been provided by Golder Associates Pty Ltd (“Golder”) subject to the following limitations:

This Document has been prepared for the particular purpose outlined in Golder’s proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

The scope and the period of Golder’s Services are as described in Golder’s proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

Conditions may exist which were not detected given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between assessment locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder’s opinions are based upon information that existed at the time the information is collected. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

Any assessments, designs, and advice provided in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

Golder may have retained subconsultants affiliated with Golder to provide Services for the benefit of Golder. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any direct legal recourse to, and waives any claim, demand, or cause of action against, Golder’s affiliated companies, and their employees, officers and directors.

This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Document.

Golder Associates Pty Ltd GAP Form No. LEG04 RL1

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

