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TRANSFIELD SERVICES PTY. LTD.

EastLink Ventilation Stack Emission Monitoring Report July-September 2014

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.
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The results of the tests, calibrations and/or measurements included in this
document are traceable to Australian/national standards.



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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, 2014 to 30th September, 2014 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	595419	595420
August	600673	600674
September	607659	607660

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.

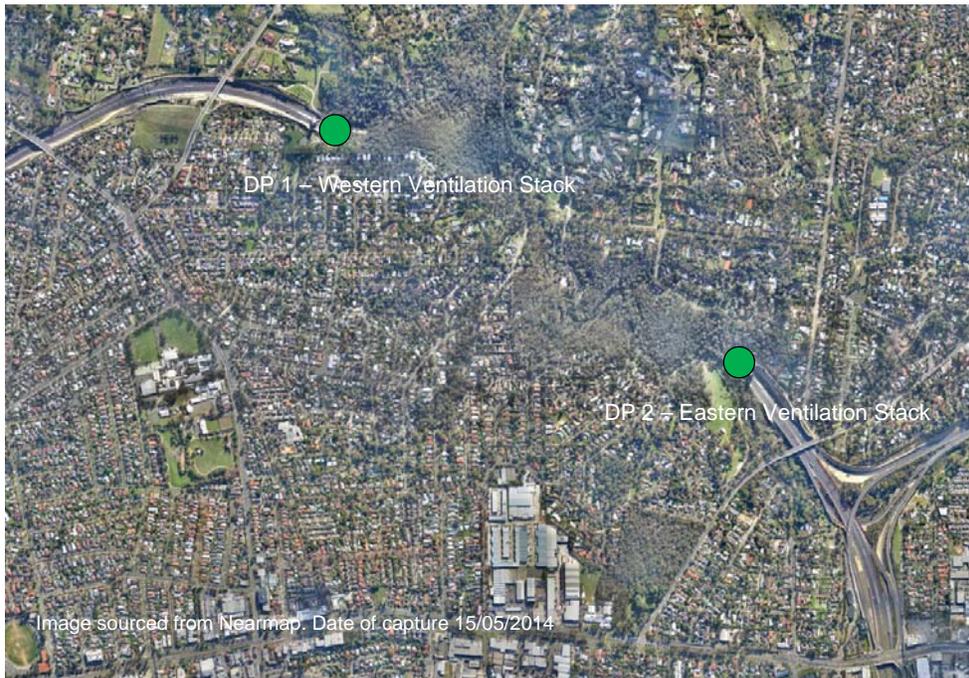


Figure 1: Ventilation Stack Locations



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: 01/07/2014 – 31/07/2014

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, 2014 are shown in Table 3. Averages were only collected for those periods where the 5 minute data constituted 75% data capture.

The PM_{2.5} sample inlet line in the western ventilation stack was found disconnected during a maintenance visit on the 11/07/2014, consequently all PM_{2.5} data back to the last valid flow check on the 10/6/2014 has been marked as invalid. The PM_{2.5} sample line is believed to have been disconnected during contractor cleaning works being conducted in the ventilation stack.

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	740	744	99.5%
	Western	490	744	65.9%
PM ₁₀	Eastern	735	744	98.8%
	Western	738	744	99.2%
NO, NO ₂	Eastern	672	744	90.3%
	Western	705	744	94.8%
CO	Eastern	709	744	95.3%
	Western	712	744	95.7%



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	0.25	0.20	0.19	0.17	0.15	0.12	0.045
Western	0.31	0.23	0.21	0.16	0.14	0.10	0.046

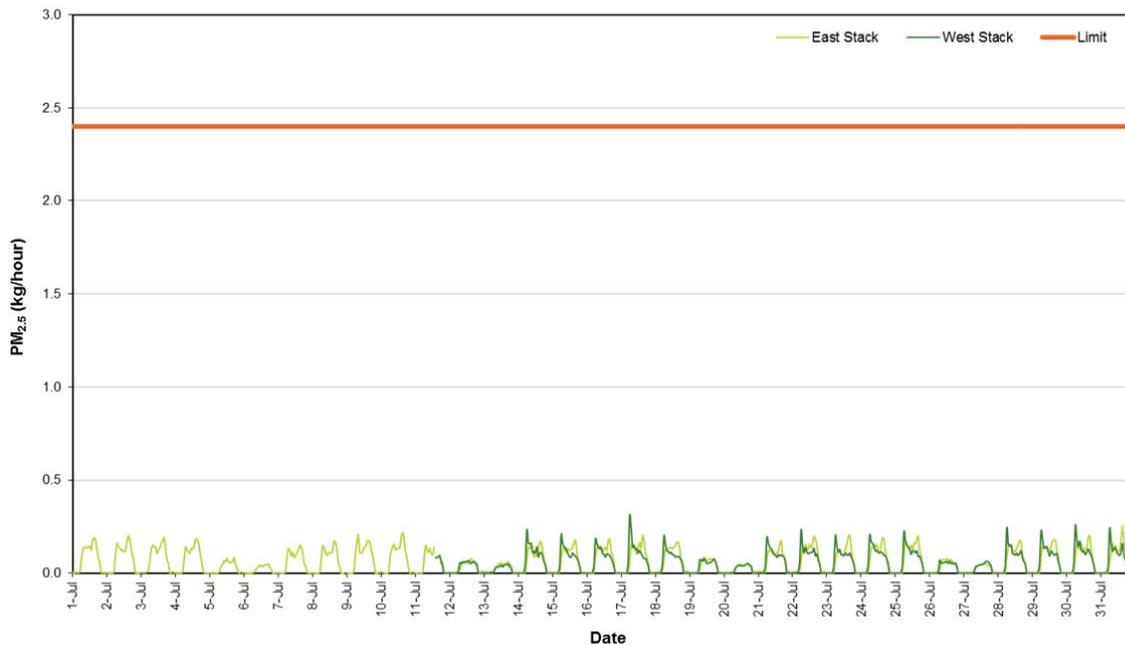


Figure 2: PM_{2.5} Mass Rate (1 Hour Average)



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	1.5	0.49	0.41	0.31	0.27	0.21	0.081
Western	1.3	0.76	0.61	0.42	0.34	0.23	0.099

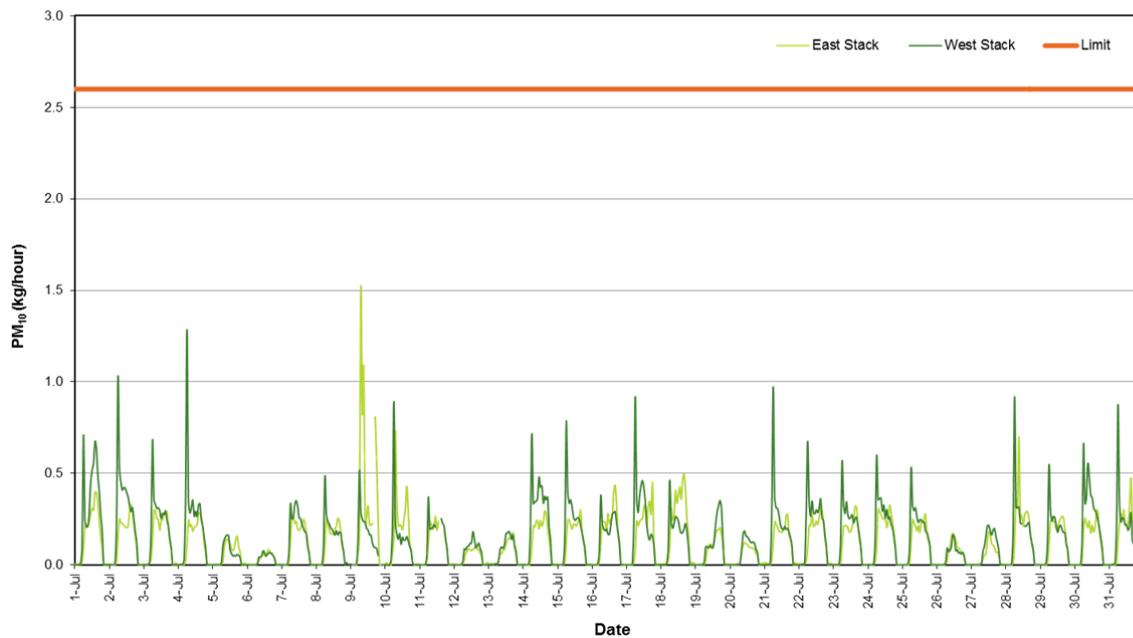


Figure 3: PM₁₀ Mass Rate (1 Hour Average)



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	25	16	15	13	10	7.9	5.6
Western	23	18	17	14	12	9.1	6.7

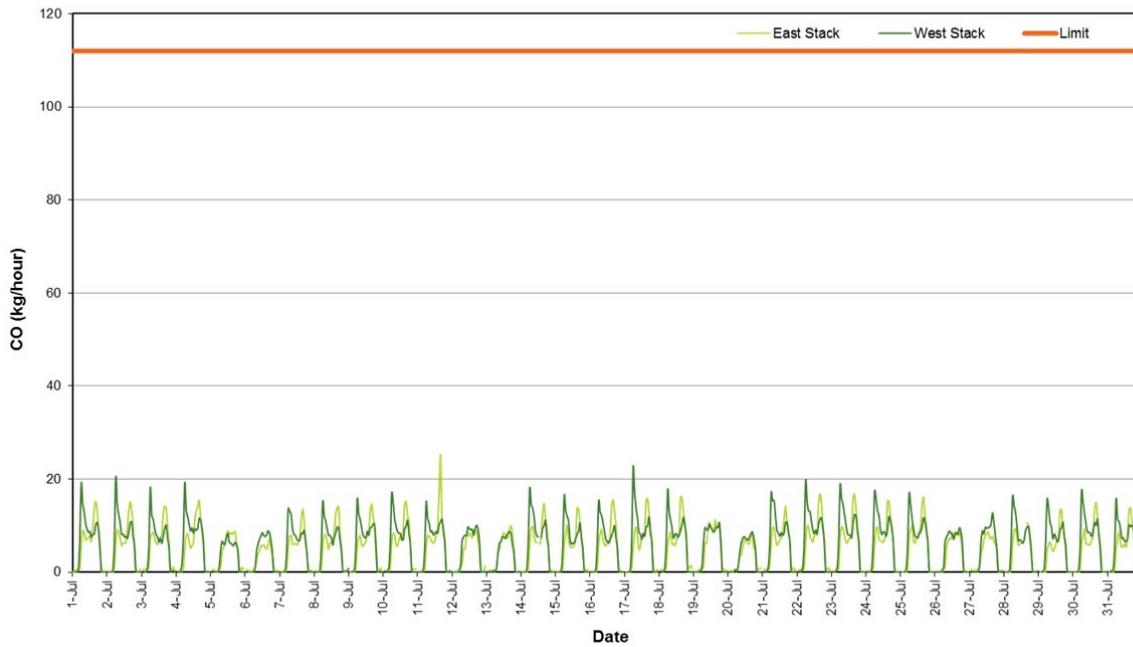


Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)



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	4.5	4.1	4.0	3.6	3.1	2.6	1.3
Western	6.3	4.7	4.3	3.3	2.7	2.1	1.3

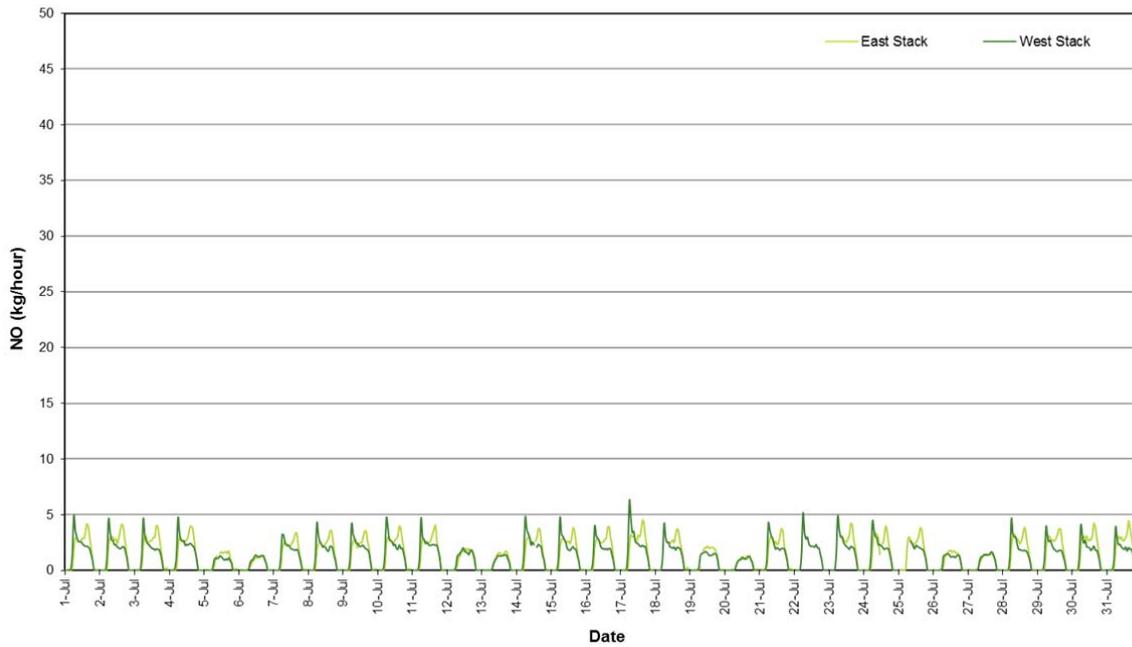


Figure 5: Nitric Oxide Mass Rate (1 Hour Average)



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	0.86	0.81	0.76	0.64	0.56	0.45	0.25
Western	1.2	0.87	0.81	0.59	0.46	0.40	0.26

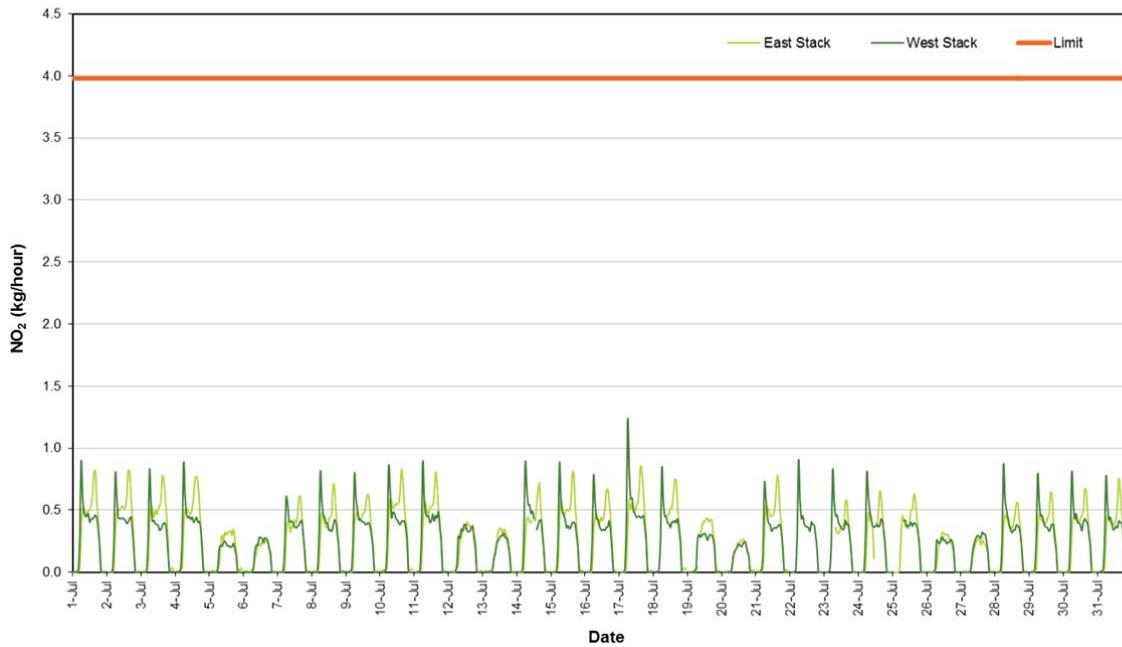


Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)



6.2.5 Stack Velocity

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

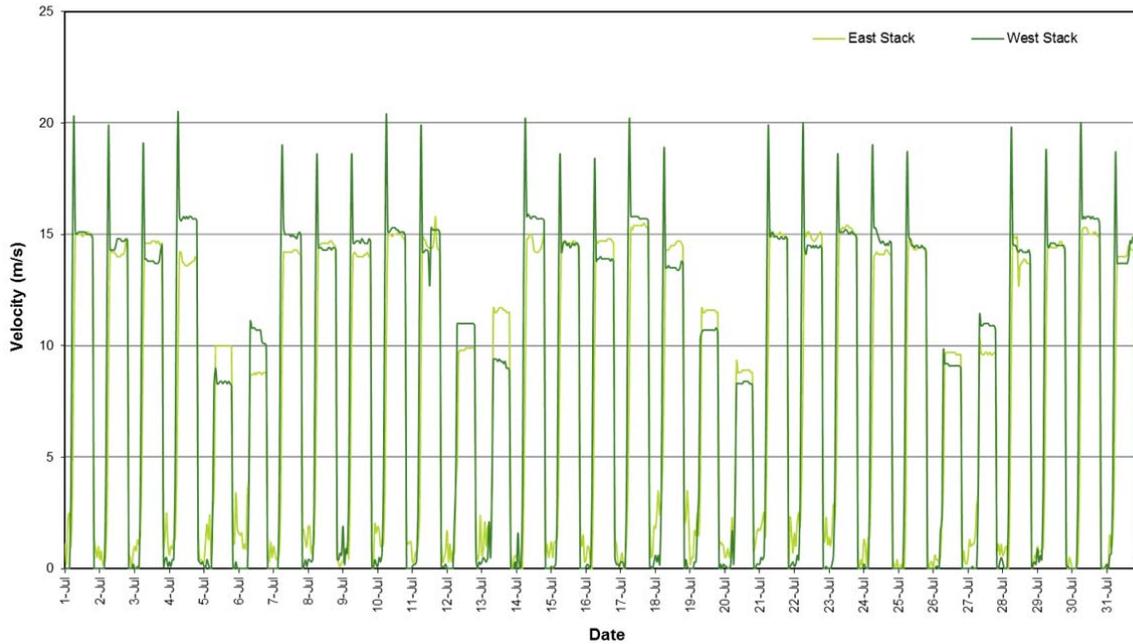


Figure 7: Stack Velocity (1 Hour Average)



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 2014

Start	End	Parameter	Reason
5/07/2014 09:50	5/07/2014 10:10	NO, NO ₂ , NO _x	Maintenance/ calibration
8/07/2014 20:10	8/07/2014 20:20	PM _{2.5}	Invalid data ²
8/07/2014 20:10	8/07/2014 21:20	PM ₁₀	Invalid data ²
8/07/2014 22:10	8/07/2014 23:55	PM ₁₀	Invalid data ²
8/07/2014 23:25	8/07/2014 23:50	PM _{2.5}	Invalid data ²
9/07/2014 16:20	9/07/2014 17:05	PM ₁₀	Invalid data ²
10/07/2014 01:00	10/07/2014 01:00	PM ₁₀	Invalid data ²
10/07/2014 01:55	10/07/2014 01:55	PM ₁₀	Invalid data ²
10/07/2014 02:10	10/07/2014 02:10	PM ₁₀	Invalid data ²
10/07/2014 03:05	10/07/2014 03:05	PM ₁₀	Invalid data ²
10/07/2014 03:35	10/07/2014 04:05	PM ₁₀	Invalid data ²
10/07/2014 19:35	10/07/2014 19:45	PM ₁₀	Invalid data ¹
11/07/2014 14:05	11/07/2014 17:05	PM _{2.5}	Maintenance/ calibration
11/07/2014 14:05	11/07/2014 17:05	PM ₁₀	Maintenance/ calibration
14/07/2014 12:25	14/07/2014 12:40	NO, NO ₂ , NO _x	Maintenance/ calibration
14/07/2014 12:25	14/07/2014 12:40	CO	Maintenance/ calibration
18/07/2014 00:40	18/07/2014 08:30	NO, NO ₂ , NO _x	Invalid data – span drift
19/07/2014 08:35	19/07/2014 09:05	NO, NO ₂ , NO _x	Maintenance/ calibration
22/07/2014 01:00	23/07/2014 07:50	NO, NO ₂ , NO _x	Invalid data – span drift
24/07/2014 11:25	24/07/2014 11:25	NO, NO ₂ , NO _x	Data logger error
24/07/2014 11:35	24/07/2014 11:35	NO, NO ₂ , NO _x	Data logger error
24/07/2014 12:00	24/07/2014 12:20	NO, NO ₂ , NO _x	Maintenance/ calibration
28/07/2014 13:00	28/07/2014 16:00	CO	Maintenance/ calibration
28/07/2014 23:55	28/07/2014 23:55	CO	Invalid data ¹
29/07/2014 01:35	29/07/2014 01:35	CO	Invalid data ¹
29/07/2014 21:10	29/07/2014 21:10	CO	Invalid data ¹
30/07/2014 02:15	30/07/2014 02:20	CO	Invalid data ¹

Notes: 1 – In the opinion of the reviewer
2 – Instrument malfunction as a result of cleaning ventilation attenuator



Table 10: Data Exceptions - Western Ventilation Stack: July 2014

Start	End	Parameter	Reason
1/07/2014 00:00	11/07/2014 12:05	PM _{2.5}	Invalid data - Flow fault
5/07/2014 09:45	5/07/2014 10:10	CO	Maintenance/ calibration
9/07/2014 20:00	9/07/2014 20:30	PM ₁₀	Invalid data ²
10/07/2014 02:00	10/07/2014 02:35	PM ₁₀	Invalid data ²
11/07/2014 12:05	11/07/2014 14:15	PM _{2.5}	Maintenance/ calibration
11/07/2014 12:20	11/07/2014 14:15	PM ₁₀	Maintenance/ calibration
14/07/2014 13:05	14/07/2014 13:30	NO, NO ₂ , NO _x	Maintenance/ calibration
14/07/2014 13:05	14/07/2014 13:25	CO	Maintenance/ calibration
17/07/2014 10:50	17/07/2014 11:10	PM ₁₀	Maintenance/ calibration
24/07/2014 06:20	24/07/2014 06:20	NO, NO ₂ , NO _x	Data logger error
24/07/2014 06:20	24/07/2014 06:20	CO	Data logger error
24/07/2014 06:20	24/07/2014 06:20	PM _{2.5}	Data logger error
25/07/2014 00:40	25/07/2014 07:15	NO, NO ₂ , NO _x	Invalid data – span drift
28/07/2014 12:25	28/07/2014 13:05	PM ₁₀	Maintenance/ calibration

Notes: 1 – In the opinion of the reviewer
2 – Instrument malfunction as a result of cleaning ventilation attenuator



7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/08/2014 – 31/08/2014

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, 2014 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	741	744	99.6%
	Western	742	744	99.7%
PM ₁₀	Eastern	742	744	99.7%
	Western	739	744	99.3%
NO, NO ₂	Eastern	682	744	91.7%
	Western	712	744	95.7%
CO	Eastern	711	744	95.6%
	Western	667	744	89.7%

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	0.25	0.21	0.19	0.17	0.15	0.12	0.043
Western	0.30	0.23	0.21	0.16	0.13	0.097	0.047

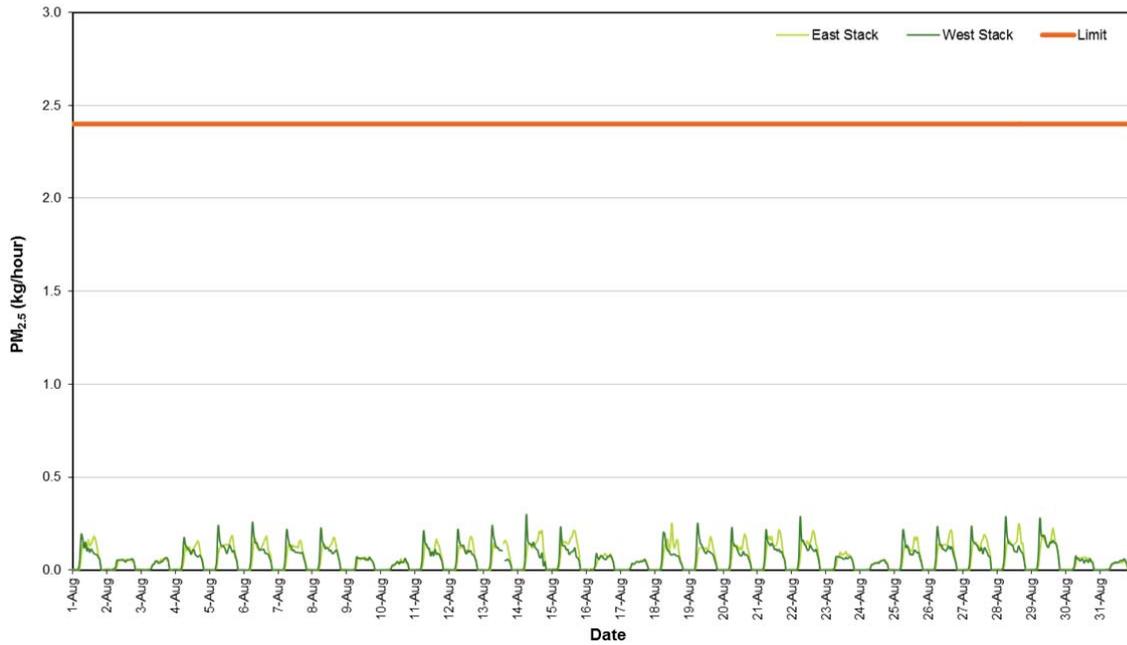


Figure 8: PM_{2.5} Mass Rate (1 Hour Average)

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	0.94	0.34	0.32	0.28	0.25	0.20	0.081
Western	0.90	0.63	0.53	0.37	0.30	0.21	0.11

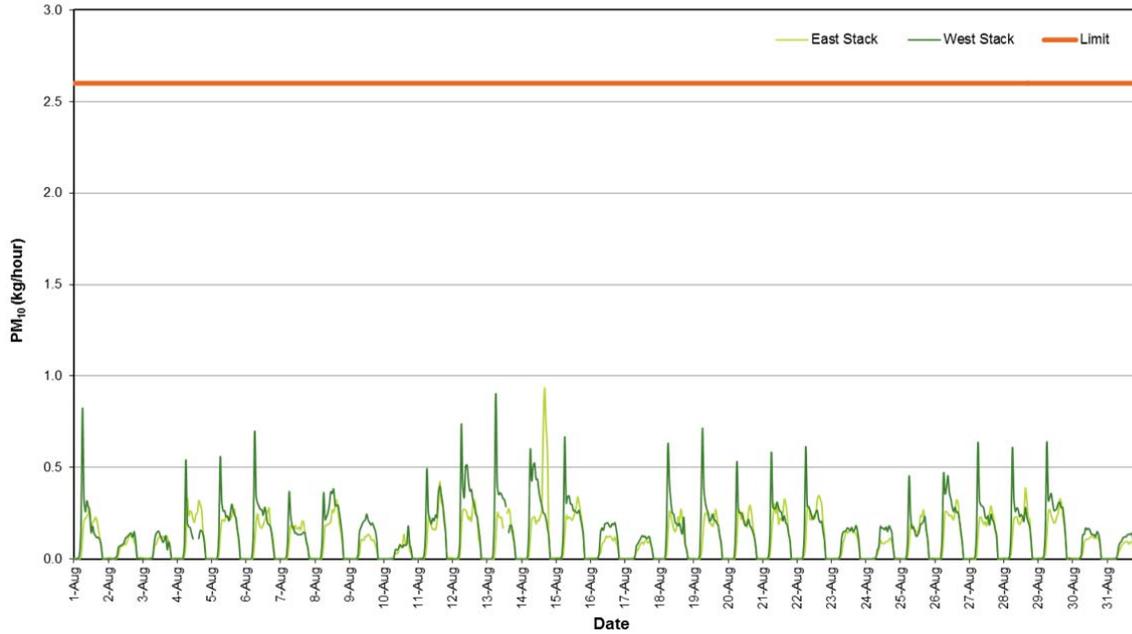


Figure 9: PM10 Mass Rate (1 Hour Average)

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	17	15	15	13	11	7.9	5.6
Western	18	17	16	14	11	8.4	5.8

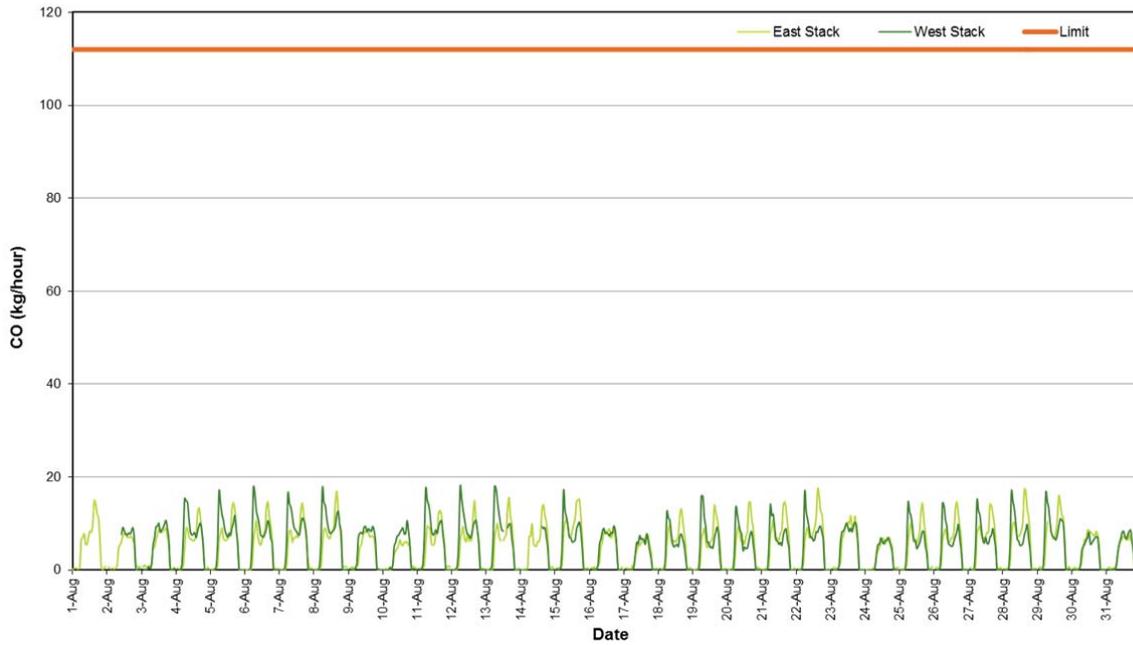


Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)

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	4.6	4.3	4.0	3.6	3.2	2.7	1.2
Western	5.4	4.5	4.1	3.2	2.7	2.0	1.2

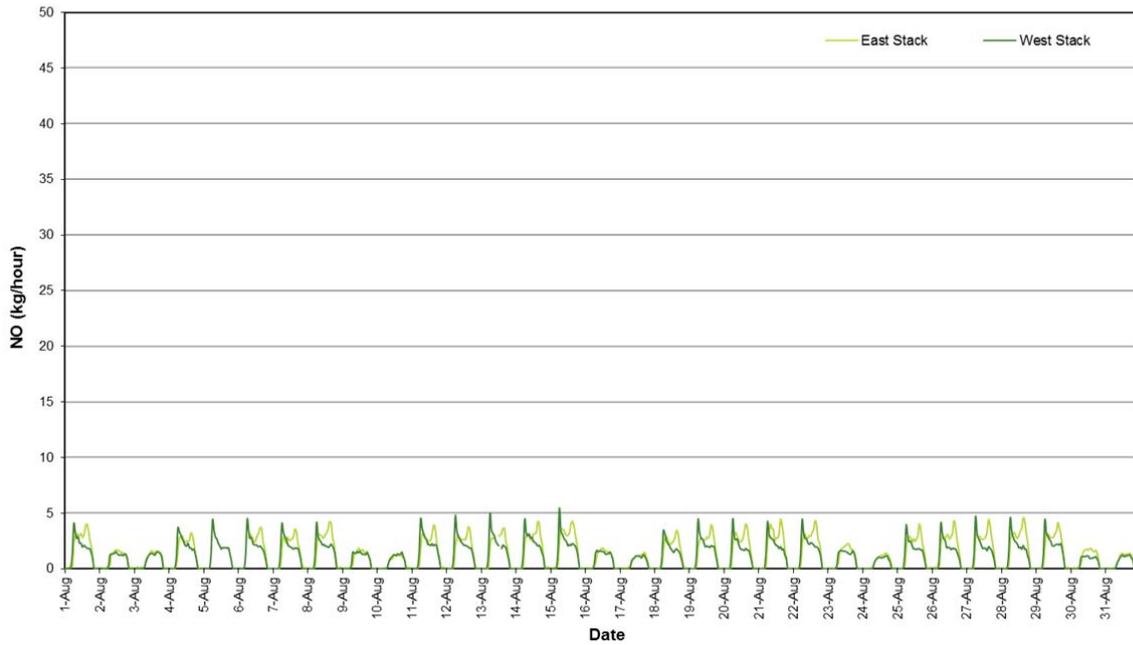


Figure 11: Nitric Oxide Mass Rate (1 Hour Average)

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	0.93	0.81	0.78	0.66	0.57	0.46	0.25
Western	0.89	0.83	0.76	0.54	0.45	0.39	0.25



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2014

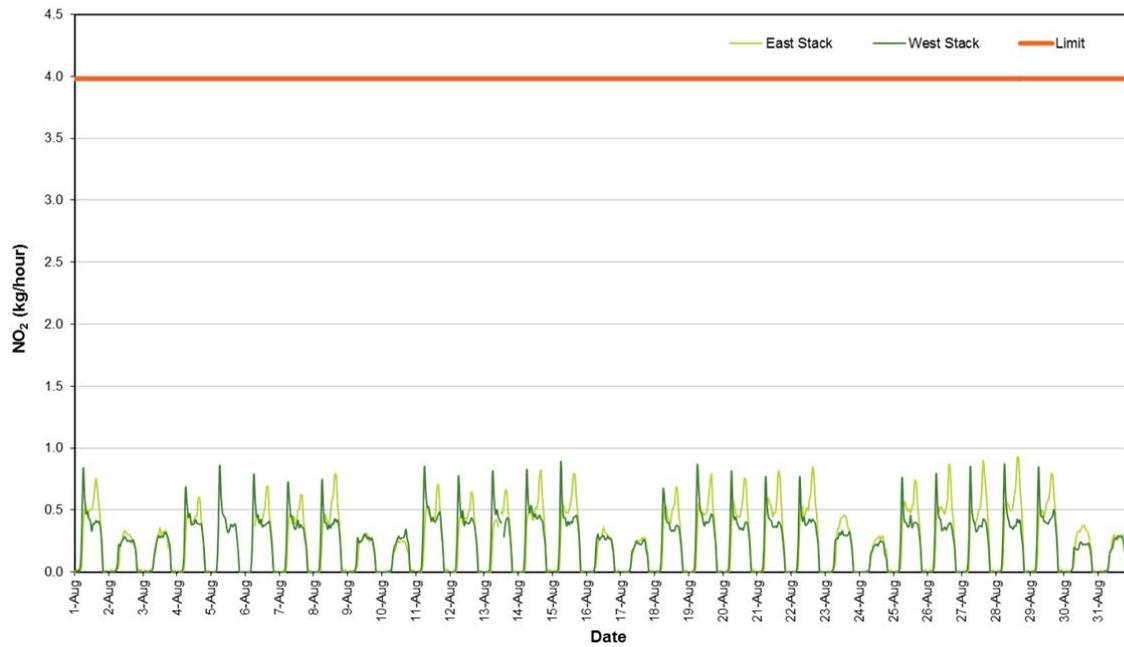


Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)



7.2.5 Stack Velocity

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

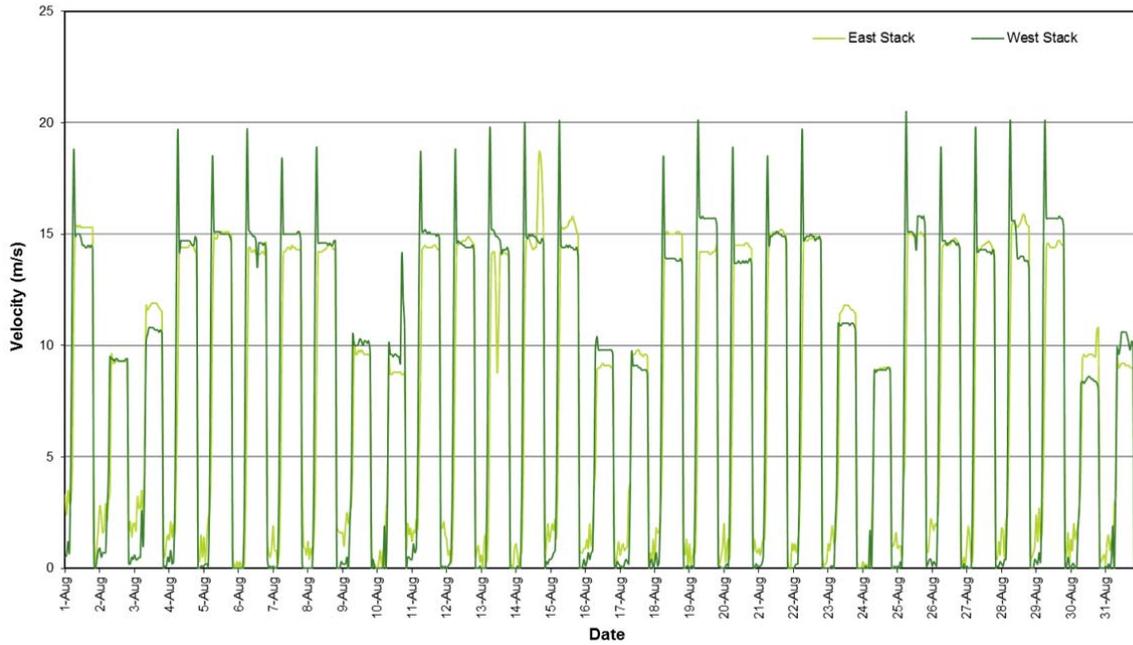


Figure 13: Stack Velocity (1 Hour Average)



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 2014

Start	End	Parameter	Reason
01/08/2014 11:45	01/08/2014 12:05	NO, NO ₂ , NO _x	Maintenance/ calibration
05/08/2014 00:40	06/08/2014 07:10	NO, NO ₂ , NO _x	Invalid data – span drift
10/08/2014 21:50	10/08/2014 21:50	CO	Maintenance/ calibration
12/08/2014 13:30	12/08/2014 13:30	CO	Maintenance/ calibration
13/08/2014 11:05	13/08/2014 11:30	NO, NO ₂ , NO _x	Maintenance/ calibration
13/08/2014 11:05	13/08/2014 11:25	CO	Maintenance/ calibration
13/08/2014 11:40	13/08/2014 13:50	PM _{2.5}	Maintenance/ calibration
13/08/2014 12:00	13/08/2014 13:15	PM ₁₀	Maintenance/ calibration
13/08/2014 12:30	13/08/2014 12:30	CO	Data logger error
15/08/2014 03:05	15/08/2014 03:05	CO	Invalid data ¹
15/08/2014 03:15	15/08/2014 03:15	CO	Invalid data ¹
15/08/2014 03:45	15/08/2014 03:45	CO	Invalid data ¹
27/08/2014 08:40	27/08/2014 09:05	NO, NO ₂ , NO _x	Maintenance/ calibration
29/08/2014 07:50	29/08/2014 08:25	CO	Maintenance/ calibration

Note: ¹ – In the opinion of the reviewer.



EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JULY-SEPTEMBER 2014

Table 18: Data Exceptions - Western Ventilation Stack: August 2014

Start	End	Parameter	Reason
01/08/2014 01:40	02/08/2014 08:50	CO	Maintenance/ calibration
01/08/2014 11:45	01/08/2014 12:10	NO, NO ₂ , NO _x	Maintenance/ calibration
02/08/2014 09:00	02/08/2014 09:25	CO	Maintenance/ calibration
02/08/2014 17:35	02/08/2014 17:40	PM ₁₀	Invalid data ¹
02/08/2014 18:15	02/08/2014 18:15	PM ₁₀	Invalid data ¹
02/08/2014 21:10	02/08/2014 21:25	PM ₁₀	Invalid data ¹
02/08/2014 22:10	02/08/2014 22:10	PM ₁₀	Invalid data ¹
02/08/2014 22:30	02/08/2014 22:35	PM ₁₀	Invalid data ¹
03/08/2014 17:20	03/08/2014 17:30	PM ₁₀	Invalid data ¹
04/08/2014 12:35	04/08/2014 14:55	PM ₁₀	Maintenance/ calibration
13/08/2014 13:35	13/08/2014 14:05	NO, NO ₂ , NO _x	Maintenance/ calibration
13/08/2014 13:35	13/08/2014 14:25	CO	Maintenance/ calibration
13/08/2014 13:55	13/08/2014 15:05	PM _{2.5}	Maintenance/ calibration
13/08/2014 14:15	13/08/2014 15:05	PM ₁₀	Maintenance/ calibration
13/08/2014 18:00	13/08/2014 18:00	PM _{2.5}	Invalid data ¹
14/08/2014 01:40	14/08/2014 11:00	CO	Invalid data – span drift
14/08/2014 11:00	14/08/2014 15:05	CO	Maintenance/ calibration
14/08/2014 18:25	14/08/2014 18:25	PM _{2.5}	Invalid data ¹
14/08/2014 20:45	14/08/2014 20:45	PM _{2.5}	Invalid data ¹
15/08/2014 03:30	15/08/2014 03:30	PM _{2.5}	Invalid data ¹
15/08/2014 23:05	15/08/2014 23:10	PM _{2.5}	Invalid data ¹
16/08/2014 01:35	16/08/2014 01:35	PM _{2.5}	Invalid data ¹
16/08/2014 02:30	16/08/2014 02:35	PM _{2.5}	Invalid data ¹
16/08/2014 02:45	16/08/2014 02:50	PM _{2.5}	Invalid data ¹
16/08/2014 03:15	16/08/2014 03:15	PM _{2.5}	Invalid data ¹
16/08/2014 05:55	16/08/2014 05:55	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 18/08/2014 09:15 – 09:20
- East Ventilation stack 18/08/2014 11:20 – 11:30
- East Ventilation stack 18/08/2014 12:00 – 12:15



8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/09/2014 – 30/09/2014

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, 2014 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	688	720	95.6%
	Western	719	720	99.9%
PM ₁₀	Eastern	681	720	94.6%
	Western	718	720	99.7%
NO, NO ₂	Eastern	623	720	86.5%
	Western	692	720	96.1%
CO	Eastern	650	720	90.3%
	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	0.36	0.22	0.20	0.18	0.16	0.13	0.045
Western	0.34	0.25	0.23	0.17	0.14	0.11	0.049

ND: No data available

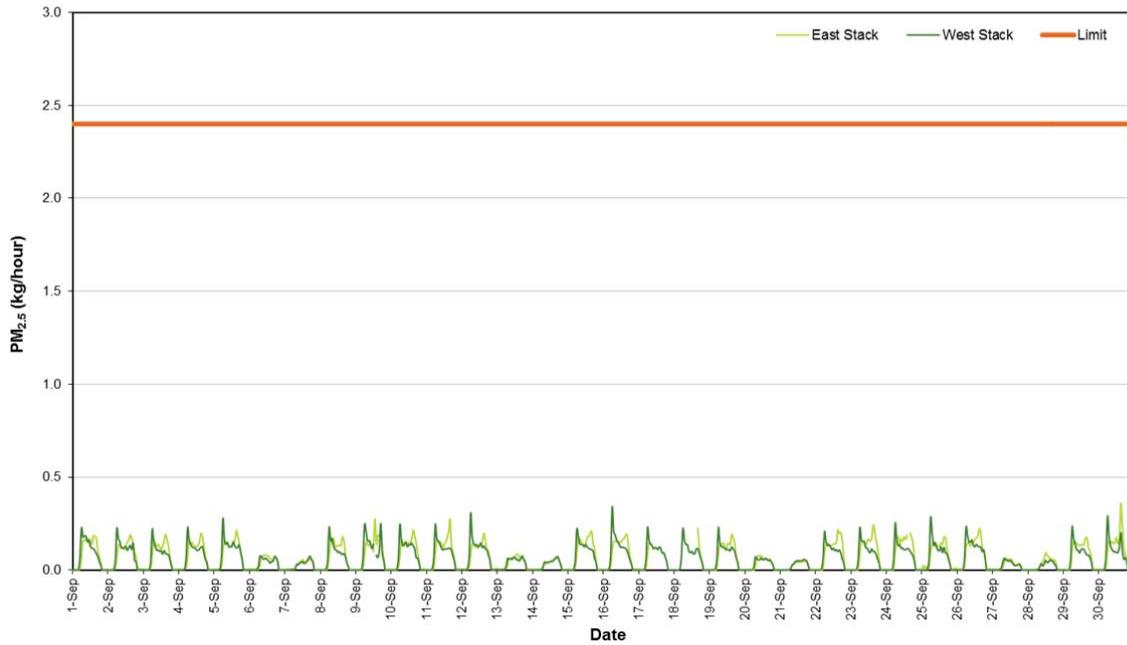


Figure 14: PM_{2.5} Mass Rate (1 Hour Average)

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	0.77	0.37	0.34	0.30	0.27	0.22	0.087
Western	1.0	0.72	0.50	0.34	0.29	0.22	0.10

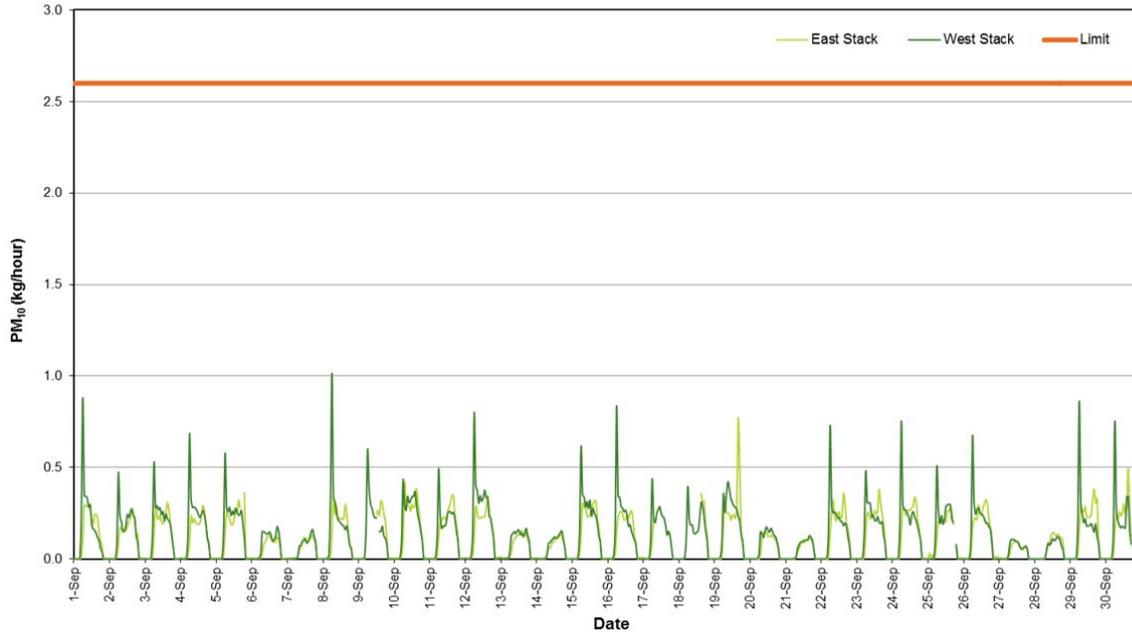


Figure 15: PM10 Mass Rate (1 Hour Average)

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	16	15	14	13	11	8.3	5.9
Western	18	16	15	12	10	7.9	5.8

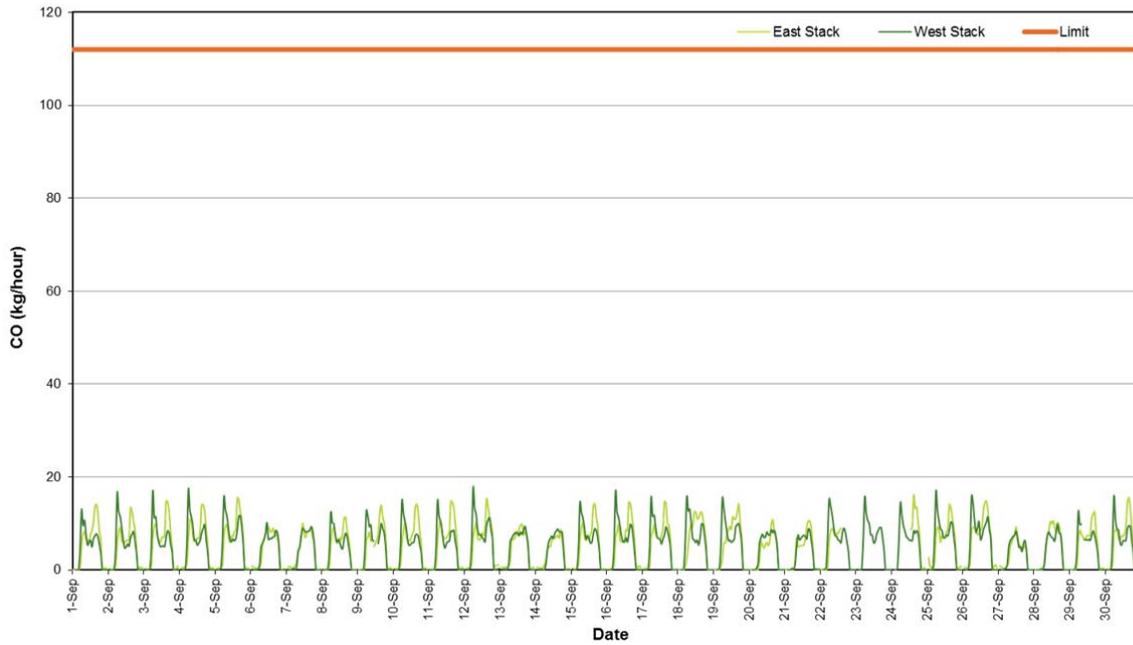


Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)

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	4.5	4.2	4.0	3.6	3.1	2.7	1.2
Western	5.4	4.3	3.9	2.9	2.4	1.9	1.1

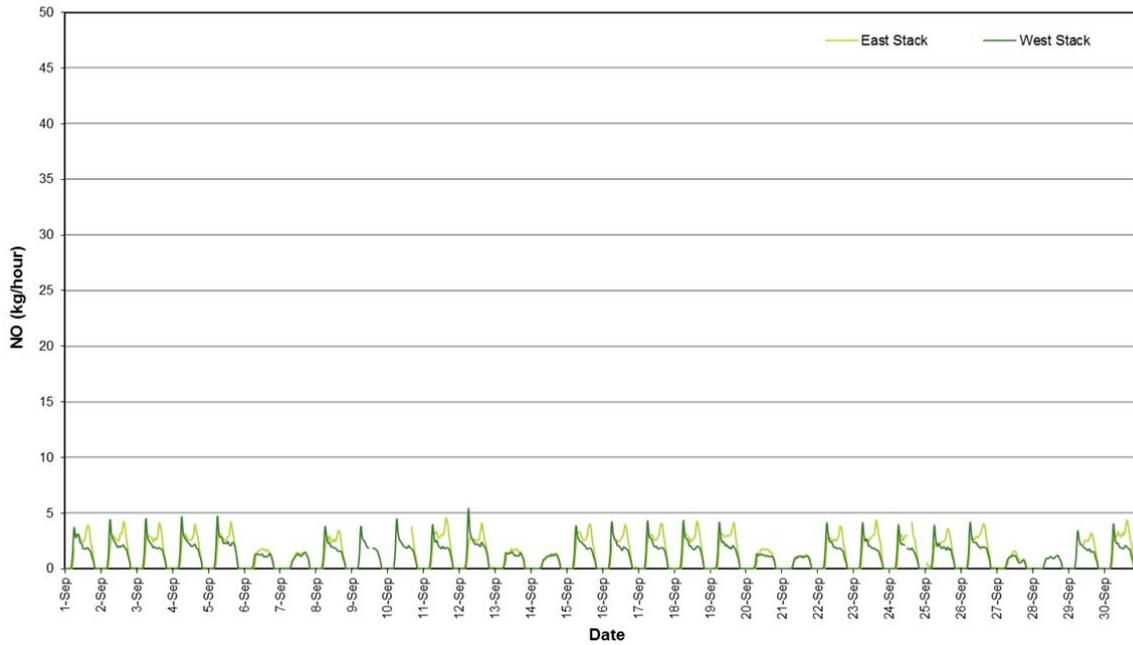


Figure 17: Nitric Oxide Mass Rate (1 Hour Average)

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	1.0	0.82	0.80	0.69	0.59	0.46	0.24
Western	0.86	0.77	0.72	0.51	0.43	0.38	0.24

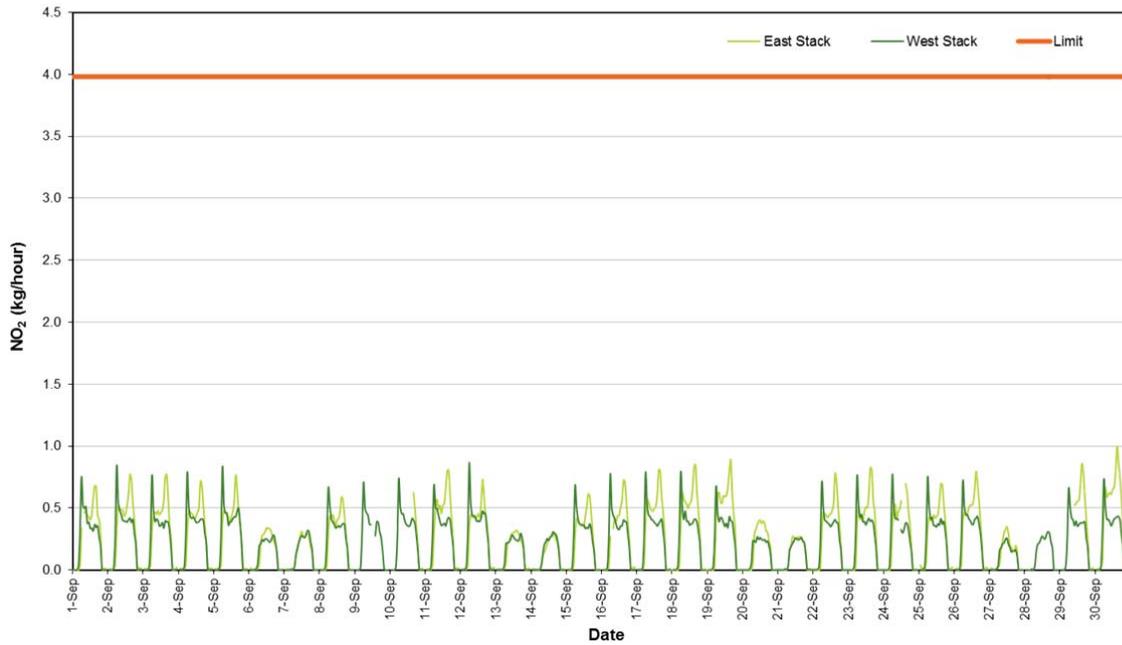


Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)

8.2.5 Stack Velocity

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

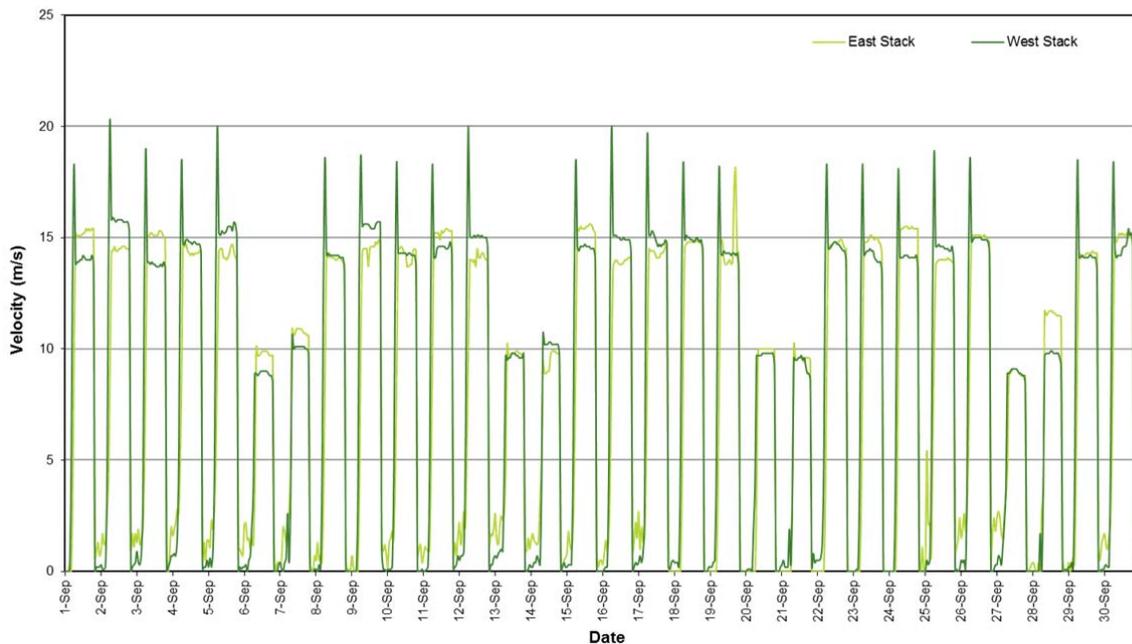


Figure 19: Stack Velocity (1 Hour Average)



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 2014

Start	End	Parameter	Reason
01/09/2014 07:20	01/09/2014 07:40	NO, NO ₂ , NO _x	Maintenance/ calibration
05/09/2014 17:25	05/09/2014 18:15	PM ₁₀	Invalid data ¹
09/09/2014 00:40	10/09/2014 15:15	NO, NO ₂ , NO _x	Invalid data – span drift
09/09/2014 5:40	09/09/2014 12:00	PM ₁₀	Invalid data ¹
09/09/2014 10:10	09/09/2014 10:45	CO	Maintenance/ calibration
09/09/2014 10:55	09/09/2014 11:50	PM _{2.5}	Maintenance/ calibration
16/09/2014 07:35	16/09/2014 07:55	NO, NO ₂ , NO _x	Maintenance/ calibration
17/09/2014 10:10	18/09/2014 15:35	PM _{2.5}	Data logger error
17/09/2014 10:10	18/09/2014 14:30	PM ₁₀	Data logger error
22/09/2014 15:25	24/09/2014 12:15	CO	Data logger error
24/09/2014 12:45	24/09/2014 14:55	NO, NO ₂ , NO _x	Data logger error
24/09/2014 15:05	24/09/2014 15:15	CO	Data logger error
24/09/2014 15:25	24/09/2014 16:10	PM _{2.5}	Data logger error
24/09/2014 16:15	24/09/2014 16:25	NO, NO ₂ , NO _x	Maintenance/ calibration
24/09/2014 16:15	24/09/2014 16:25	CO	Maintenance/ calibration
24/09/2014 16:25	24/09/2014 16:30	PM ₁₀	Data logger error
25/09/2014 18:05	25/09/2014 18:20	PM ₁₀	Invalid data ¹
28/09/2014 00:40	29/09/2014 09:50	NO, NO ₂ , NO _x	Invalid data – span drift

Note: ¹ – In the opinion of the reviewer.



Table 26: Data Exceptions - Western Ventilation Stack: September 2014

Start	End	Parameter	Reason
09/09/2014 12:35	09/09/2014 13:25	NO, NO ₂ , NO _x	Maintenance/ calibration
09/09/2014 12:35	09/09/2014 13:25	CO	Maintenance/ calibration
09/09/2014 12:50	09/09/2014 14:10	PM _{2.5}	Maintenance/ calibration
09/09/2014 13:00	09/09/2014 13:55	PM ₁₀	Maintenance/ calibration
24/09/2014 11:10	24/09/2014 11:40	NO, NO ₂ , NO _x	Data logger error
25/09/2014 17:55	25/09/2014 18:15	PM ₁₀	Invalid data ¹
29/09/2014 09:15	29/09/2014 09:45	CO	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:

- West Ventilation stack 9/09/2014 17:40 – 18:05
- East Ventilation stack 9/09/2014 13:20 – 13:40



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 (01/07/2014 - 30/09/2014)

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	PM _{2.5}	0.34	2.4
		PM ₁₀	1.0	2.6
		NO ₂	0.86	3.98
		CO	18	112
2	Eastern ventilation stack	PM _{2.5}	0.25	2.4
		PM ₁₀	0.94	2.6
		NO ₂	0.93	3.98
		CO	17	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 DP1 and DP2:

- 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 2014 year to date (01/01/2014 – 30/09/2014) are presented in Table 28.

Table 28: Data Capture Year to Date (%)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀	Velocity
Eastern	89.8	96.2	98.8	98.3	100
Western	95.1	96.5	80.4	98.3	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 (1/07/2014 to 30/09/2014) are shown in Table 29.



Table 29: Ventilation Stack Emissions 1/07/2014 – 30/09/2014 (tonnes/year)

Station	NO ₂	CO	PM _{2.5}	PM ₁₀
Eastern	0.56	11	0.14	0.24
Western	0.51	12	0.13	0.29
Total	1.1	23	0.27	0.53
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.

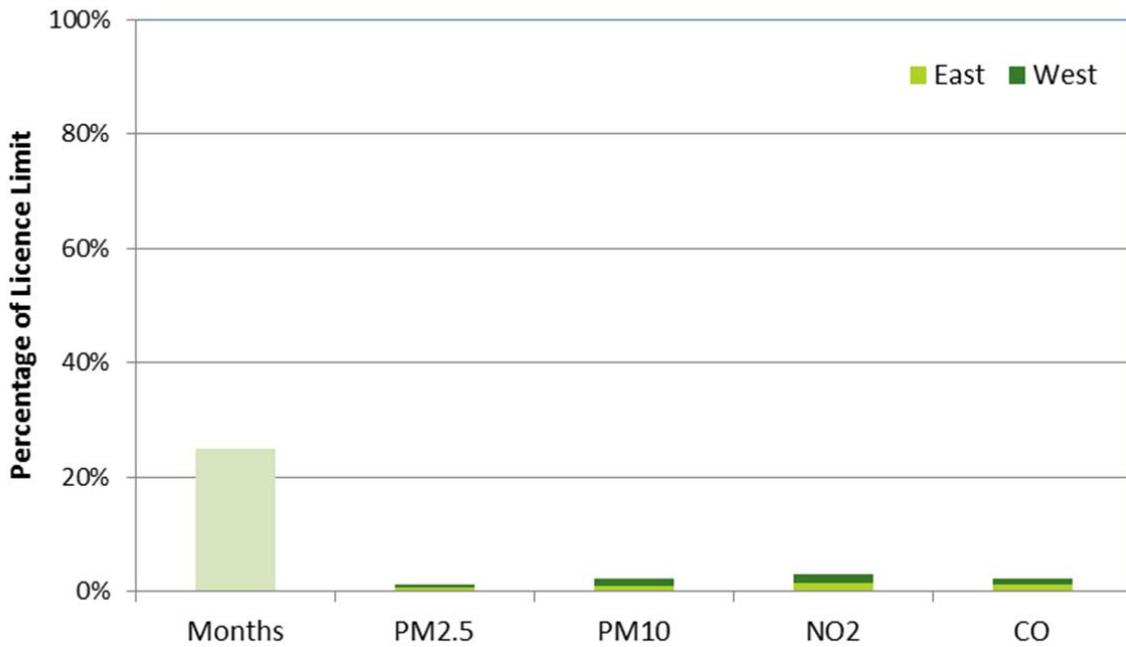


Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2013 - 30/06/2014)

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



Report Signature Page

GOLDER ASSOCIATES PTY LTD

A handwritten signature in black ink, appearing to read "M. Tulau".

Mark Tulau
Senior Air Quality Specialist

MDT/JSHEN/mdt

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APPENDIX A

Limitations



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