



May 2018

**BROADSPECTRUM PTY LTD**

# EastLink Ventilation Stack Emission Monitoring Report January - March 2018

**Submitted to:**

Broadspectrum Pty Ltd  
EastLink Operations Centre,  
2 Hillcrest Avenue,  
Ringwood, 3134

Accredited for compliance with ISO/IEC 17025 - Testing.

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



Accreditation No. 1910

**Report Number.** 097613024-062-R-Rev0

**Distribution:**

Electronic Copy - Broadspectrum

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REPORT



## Record of Issue

Company	Client Contact	Version	Date Issued	Method of Delivery
Broadspectrum Pty Ltd, EastLink Operations Centre, 2 Hillcrest Avenue, Ringwood, 3134	Ms. Alex Monson	Revision 0	28/05/2018	Electronic



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**APPENDICES**

**APPENDIX A**

Important Information Relating to this Report



## 1.0 INTRODUCTION

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

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

Monitoring commenced on the 29<sup>th</sup> June, 2008 with the opening of the EastLink motorway. Results for the sampling period 1<sup>st</sup> January, 2018 to 31<sup>st</sup> March, 2018 inclusive are contained in the following report.

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

Month	Western Stack	Eastern Stack
January	TBA	TBA
February	TBA	TBA
March	TBA	TBA

TBA – To be advised

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



## 2.0 DISCHARGES TO AIR

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

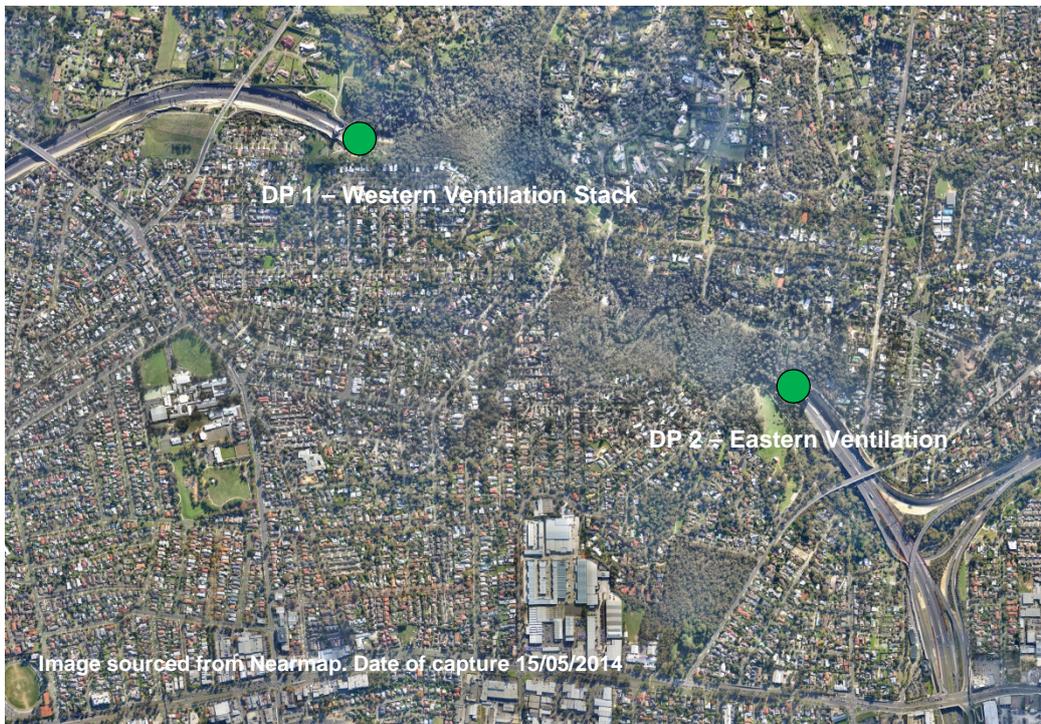
The locations of the discharges to air are described in Table 1 and presented in Figure 1.

**Table 1: Discharges to Air**

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

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

*Figure 1: Ventilation Stack Locations*





### **3.0 VENTILATION STACK MONITORING PARAMETERS**

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

-  Particulate matter with an equivalent aerodynamic diameter less than 2.5 microns (PM<sub>2.5</sub>)
-  Particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM<sub>10</sub>)
-  Total oxides of nitrogen (NO<sub>x</sub>)
-  Nitric oxide (NO)
-  Nitrogen dioxide (NO<sub>2</sub>)
-  Carbon monoxide (CO)
-  Stack velocity
-  Stack temperature
-  Ambient pressure.



## **4.0 METHODS**

### **4.1 PM<sub>2.5</sub>**

PM<sub>2.5</sub> 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<sub>2.5</sub> size selective inlet (PM<sub>10</sub> WINS head fitted with a PM<sub>2.5</sub> sharp cut cyclone (SCC)) at 1 m<sup>3</sup>/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<sub>2.5</sub> 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<sub>2.5</sub> Continuous Direct Mass Method Using a Tapered Element Oscillating Microbalance Monitor”*.

### **4.2 PM<sub>10</sub>**

PM<sub>10</sub> 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<sub>10</sub> size selective inlet (PM<sub>10</sub> WINS head) at 1 m<sup>3</sup>/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<sub>10</sub> 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 – PM<sub>10</sub> 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, NO<sub>2</sub> and NO<sub>x</sub>) 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 <sub>10</sub>	TEOM	± 5%
PM <sub>2.5</sub>	TEOM	± 5%
NO, NO <sub>2</sub> , NO <sub>x</sub>	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: 01/01/2018 – 31/01/2018

### 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 1<sup>st</sup> January to 31<sup>st</sup> January, 2018 are shown in Table 3. Averages were only collected for those periods where the 5 minute data constituted 75% data capture. Reduced data capture for PM<sub>10</sub> eastern ventilation system was due to a sensor unit fault. Reduced data capture for NO<sub>x</sub> eastern ventilation system was due to instrument span drift.

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 <sub>2.5</sub>	Eastern	741	744	99.6%
	Western	726	744	97.6%
PM <sub>10</sub>	Eastern	656	744	88.2%
	Western	742	744	99.7%
NO, NO <sub>2</sub>	Eastern	709	744	95.3%
	Western	617	744	82.9%
CO	Eastern	712	744	95.7%
	Western	710	744	95.4%

## 6.2 Results

### 6.2.1 PM<sub>2.5</sub>

PM<sub>2.5</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 4. A plot of PM<sub>2.5</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 2.

**Table 4: PM<sub>2.5</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>2.5</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.37	0.29	0.26	0.23	0.19	0.13	0.048
Western	0.34	0.26	0.21	0.17	0.15	0.096	0.048

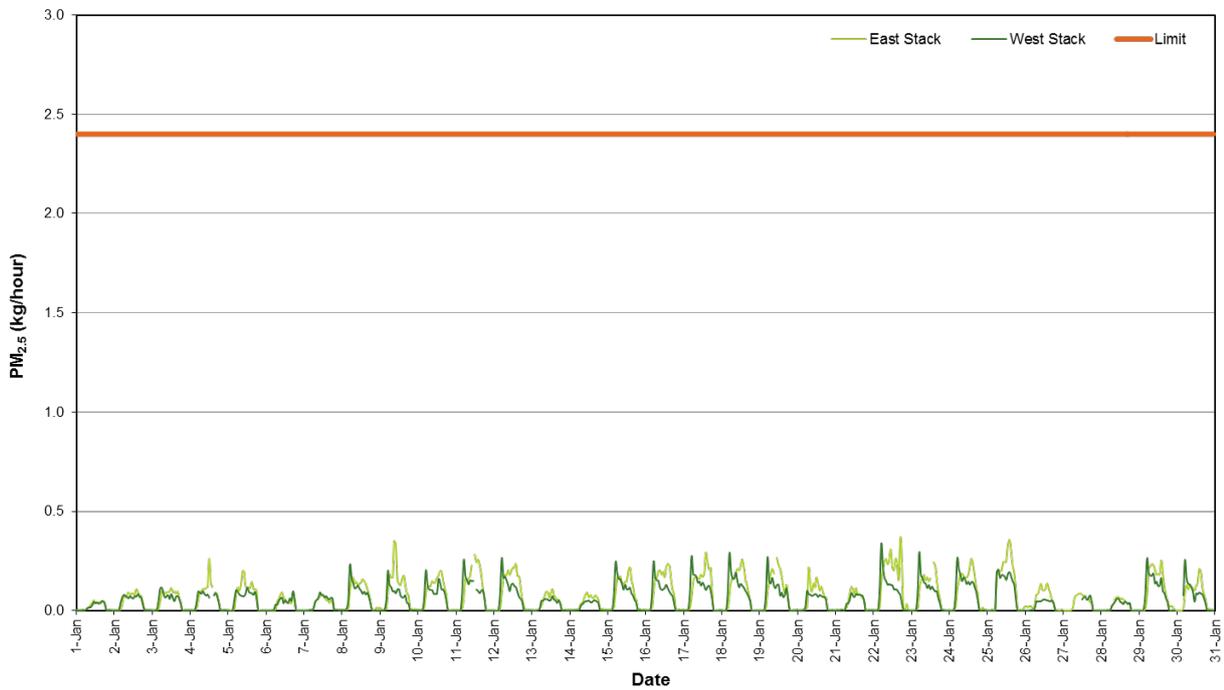


Figure 2: PM<sub>2.5</sub> Mass Rate (1 Hour Average)

### 6.2.2 PM<sub>10</sub>

PM<sub>10</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 5. A plot of PM<sub>10</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 3.

**Table 5: PM<sub>10</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>10</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.53	0.44	0.41	0.35	0.30	0.22	0.098
Western	1.0	0.57	0.43	0.30	0.25	0.18	0.086

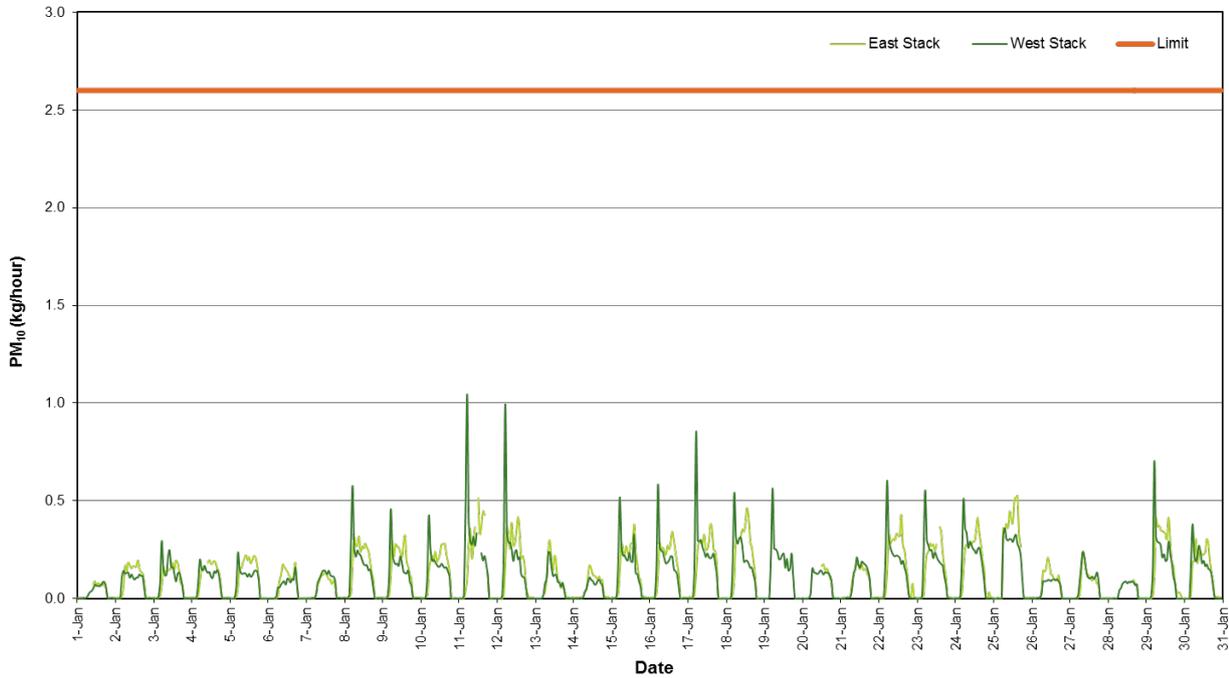


Figure 3: PM<sub>10</sub> Mass Rate (1 Hour Average)

### 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	14	12	11	9.7	8.1	6.2	4.1
Western	12	11	10	9.1	7.9	6.4	4.8

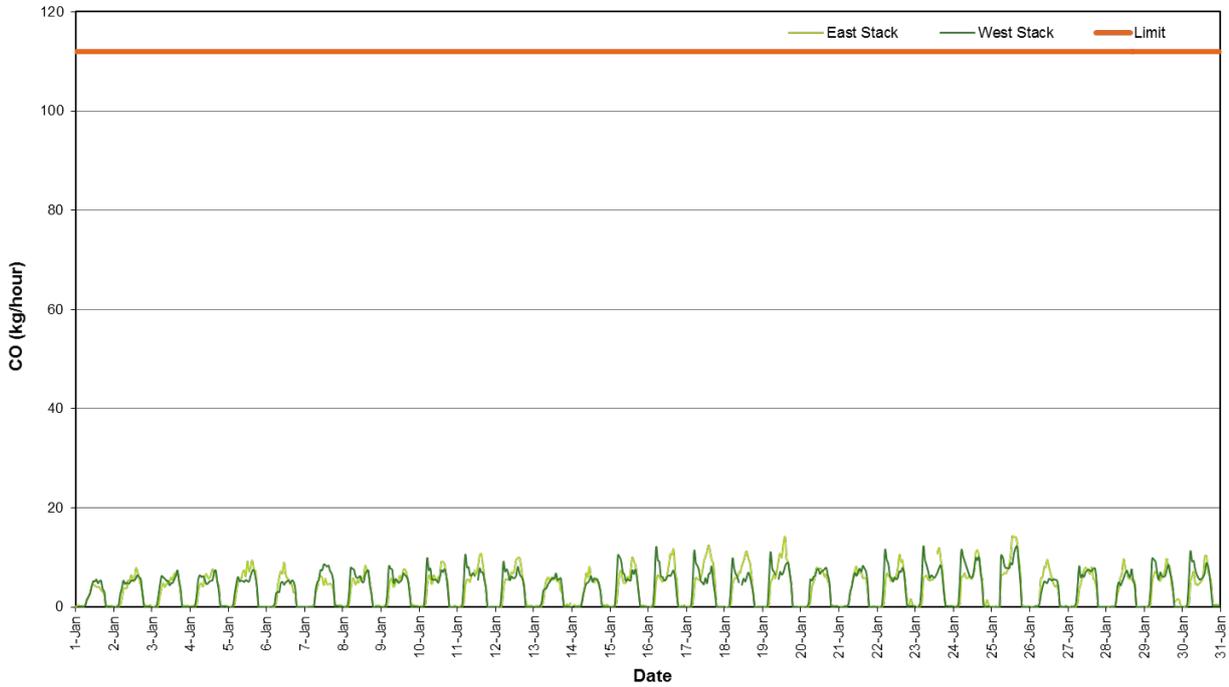


Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)

## 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	4.6	4.3	3.8	3.2	2.6	1.9	0.85
Western	4.9	4.1	3.4	2.7	2.3	1.9	0.95

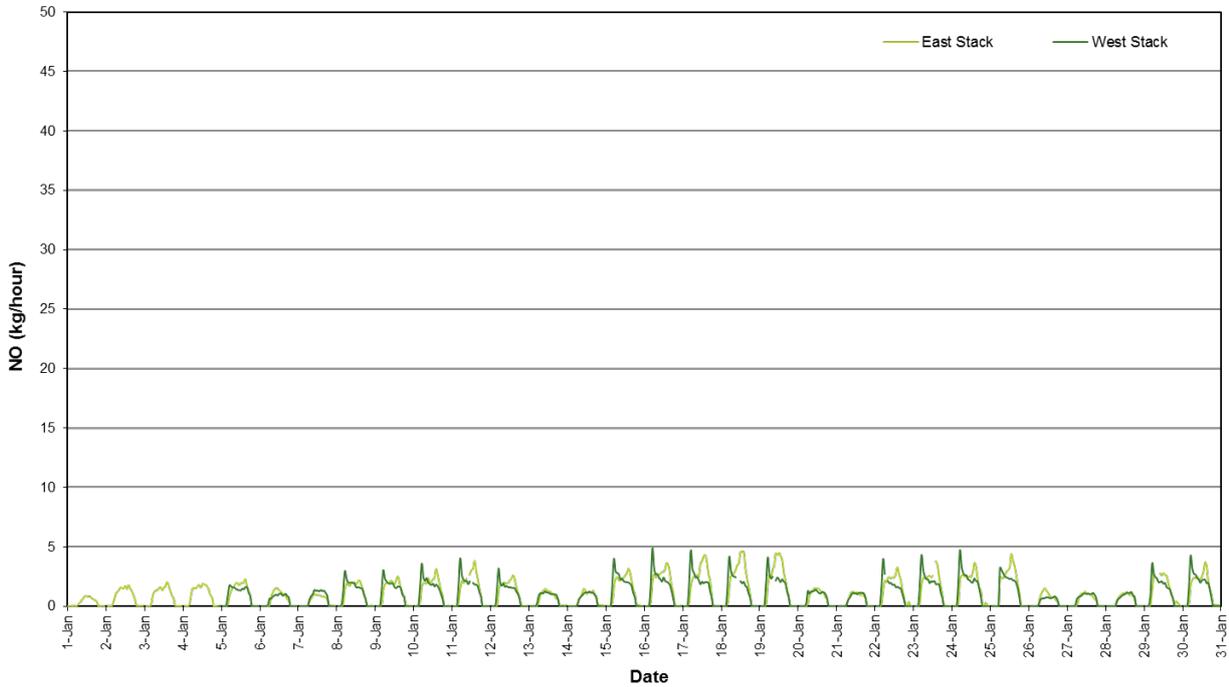


Figure 5: Nitric Oxide Mass Rate (1 Hour Average)

### 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	1.3	1.1	1.0	0.75	0.57	0.39	0.20
Western	0.92	0.83	0.70	0.58	0.50	0.39	0.24

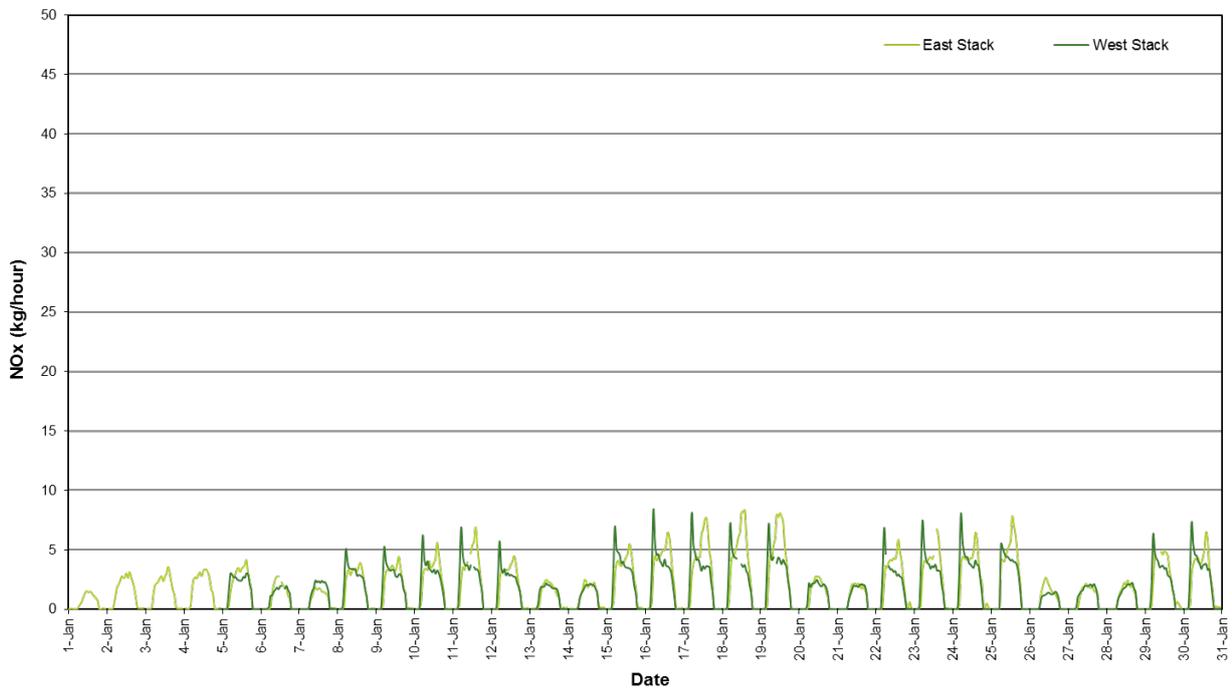


Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)

## 6.2.5 Stack Velocity

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



# EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JANUARY - MARCH 2018

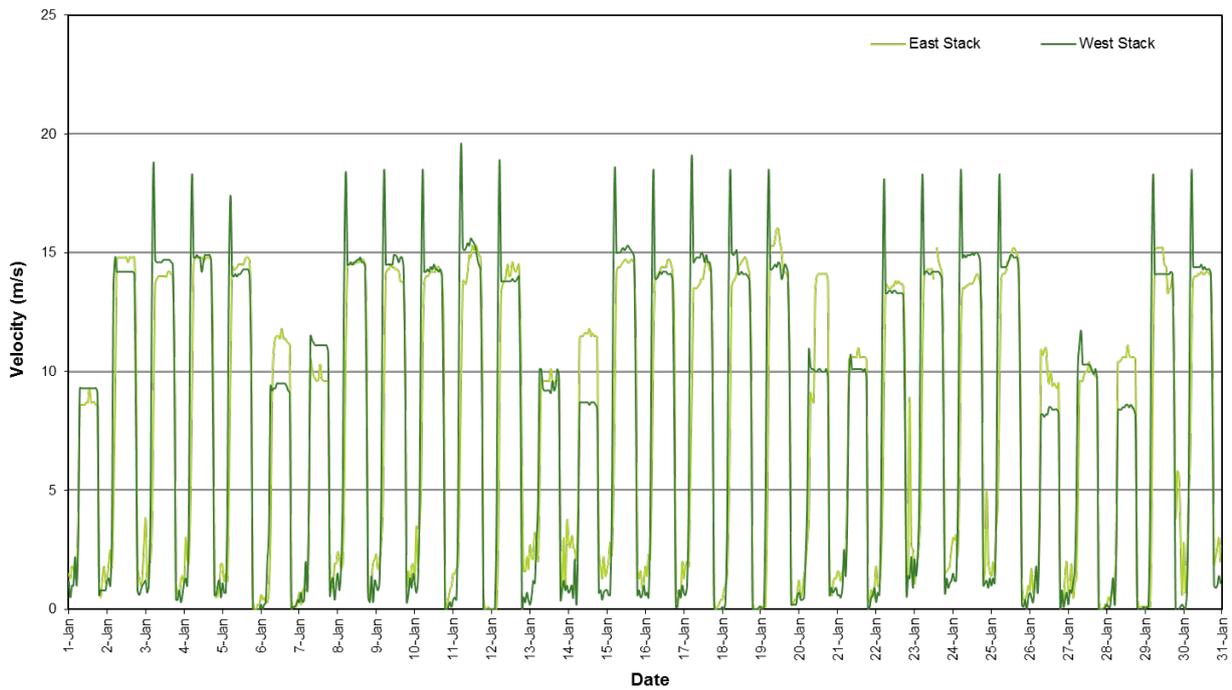


Figure 7: Stack Velocity (1 Hour Average)



### 6.3 Data Validation and Exceptions

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

**Table 9: Data Exceptions - Eastern Ventilation Stack: January 2018**

Start	End	Parameter	Reason
1/01/2018 5:40	1/01/2018 9:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
3/01/2018 22:55	3/01/2018 23:00	PM <sub>10</sub>	Invalid data <sup>1</sup>
4/01/2018 8:55	4/01/2018 9:15	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/01/2018 1:00	6/01/2018 3:40	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/01/2018 13:40	6/01/2018 13:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
10/01/2018 23:05	10/01/2018 23:40	PM <sub>10</sub>	Invalid data <sup>1</sup>
11/01/2018 10:35	11/01/2018 11:10	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
11/01/2018 10:35	11/01/2018 11:00	CO	Maintenance / calibration
11/01/2018 11:20	11/01/2018 11:50	PM <sub>2.5</sub>	Maintenance / calibration
11/01/2018 11:25	11/01/2018 11:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
11/01/2018 17:00	11/01/2018 17:15	PM <sub>10</sub>	Invalid data <sup>1</sup>
11/01/2018 21:55	11/01/2018 22:15	PM <sub>10</sub>	Invalid data <sup>1</sup>
11/01/2018 23:55	11/01/2018 23:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
12/01/2018 1:00	12/01/2018 2:10	PM <sub>10</sub>	Invalid data <sup>1</sup>
13/01/2018 1:00	13/01/2018 6:00	PM <sub>10</sub>	Invalid data <sup>1</sup>
14/01/2018 22:45	14/01/2018 23:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
15/01/2018 19:35	15/01/2018 19:40	PM <sub>10</sub>	Invalid data <sup>1</sup>
16/01/2018 1:05	16/01/2018 1:10	PM <sub>10</sub>	Invalid data <sup>1</sup>
16/01/2018 20:35	16/01/2018 21:10	PM <sub>10</sub>	Invalid data <sup>1</sup>
17/01/2018 10:50	17/01/2018 10:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
18/01/2018 20:50	20/01/2018 12:05	PM <sub>10</sub>	Invalid data <sup>1</sup>
19/01/2018 10:20	19/01/2018 10:35	PM <sub>2.5</sub>	Maintenance / calibration
20/01/2018 21:30	21/01/2018 12:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
23/01/2018 12:50	23/01/2018 13:25	Velocity	Invalid data <sup>1</sup>
25/01/2018 18:10	25/01/2018 18:30	PM <sub>10</sub>	Invalid data <sup>1</sup>
26/01/2018 20:00	27/01/2018 3:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
27/01/2018 5:20	27/01/2018 5:25	PM <sub>10</sub>	Invalid data <sup>1</sup>
27/01/2018 15:05	27/01/2018 15:20	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
28/01/2018 4:05	28/01/2018 15:45	PM <sub>10</sub>	Invalid data <sup>1</sup>
29/01/2018 7:15	29/01/2018 9:45	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
30/01/2018 7:45	30/01/2018 7:55	PM <sub>10</sub>	Invalid data <sup>1</sup>

Notes: <sup>1</sup> – In the opinion of the reviewer



**Table 10: Data Exceptions - Western Ventilation Stack: January 2018**

Start	End	Parameter	Reason
1/01/2018 1:00	4/01/2018 22:00	NO, NO <sub>2</sub> , NO <sub>x</sub>	Invalid data – span drift
11/01/2018 12:00	11/01/2018 12:35	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
11/01/2018 12:00	11/01/2018 12:35	CO	Maintenance / calibration
11/01/2018 12:35	11/01/2018 13:10	PM <sub>2.5</sub>	Maintenance / calibration
11/01/2018 12:40	11/01/2018 13:15	PM <sub>10</sub>	Maintenance / calibration
18/01/2018 10:35	18/01/2018 11:15	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
18/01/2018 10:35	18/01/2018 11:00	CO	Maintenance / calibration
18/01/2018 13:35	18/01/2018 13:40	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
19/01/2018 9:10	19/01/2018 9:40	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
22/01/2018 7:15	22/01/2018 7:40	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
26/01/2018 21:20	27/01/2018 11:45	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
29/01/2018 23:55	29/01/2018 23:55	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
30/01/2018 1:00	30/01/2018 3:25	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
30/01/2018 3:40	30/01/2018 3:45	PM <sub>10</sub>	Invalid data <sup>1</sup>
31/01/2018 5:00	31/01/2018 5:45	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
30/01/2018 3:40	30/01/2018 3:45	PM <sub>10</sub>	Invalid data <sup>1</sup>

**Notes:** <sup>1</sup> – In the opinion of the reviewer

A number periods occurred where PM<sub>2.5</sub> concentrations were greater than the corresponding PM<sub>10</sub> 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 04/01/2018 12:20 – 13:05
-  East Ventilation stack 23/01/2018 17:00 – 19:10
-  West Ventilation stack 10/01/2018 13:30 – 14:00



## 7.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/02/2018 – 28/02/2018

### 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 1<sup>st</sup> February to 28<sup>th</sup> February, 2018 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 <sub>2.5</sub>	Eastern	668	672	99.4%
	Western	670	672	99.7%
PM <sub>10</sub>	Eastern	656	672	97.6%
	Western	670	672	99.7%
NO, NO <sub>2</sub>	Eastern	644	672	95.8%
	Western	642	672	95.5%
CO	Eastern	644	672	95.8%
	Western	642	672	95.5%

## 7.2 Results

### 7.2.1 PM<sub>2.5</sub>

PM<sub>2.5</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 12. A plot of PM<sub>2.5</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 8.

**Table 12: PM<sub>2.5</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>2.5</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	1.1	0.34	0.32	0.26	0.21	0.17	0.058
Western	0.37	0.32	0.29	0.20	0.16	0.12	0.055

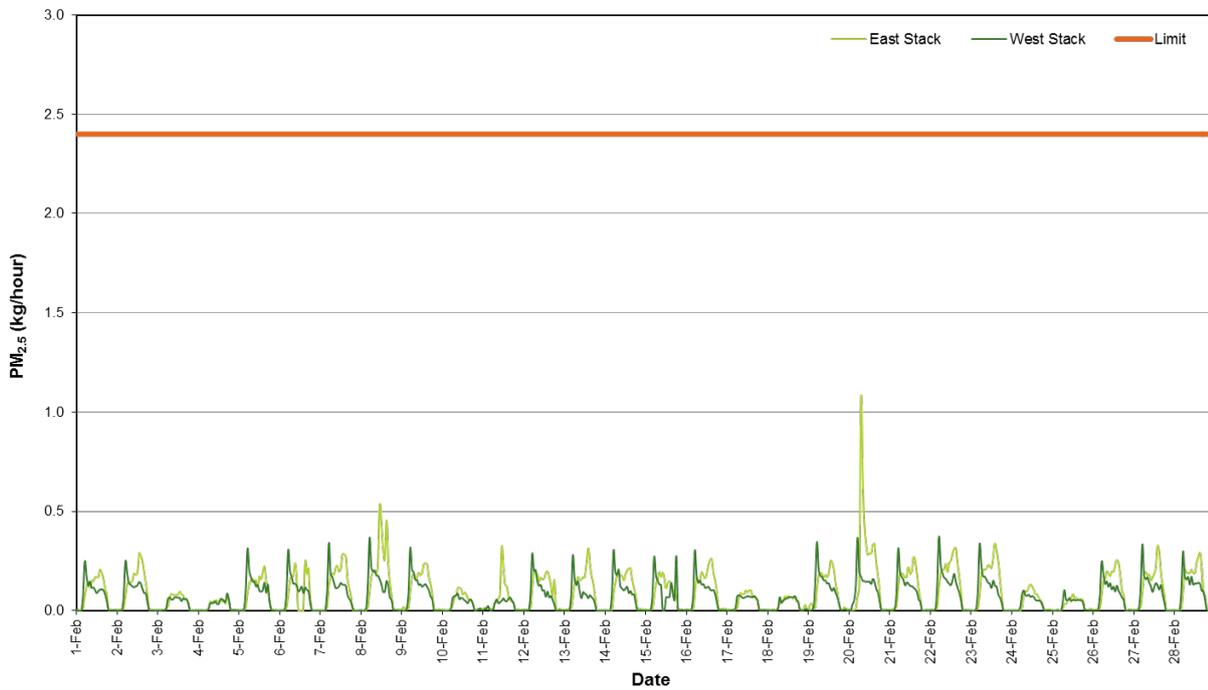


Figure 8: PM<sub>2.5</sub> Mass Rate (1 Hour Average)

### 7.2.2 PM<sub>10</sub>

PM<sub>10</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 13. A plot of PM<sub>10</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 9.

**Table 13: PM<sub>10</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>10</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.71	0.52	0.50	0.46	0.40	0.30	0.11
Western	1.4	0.83	0.71	0.36	0.30	0.23	0.12

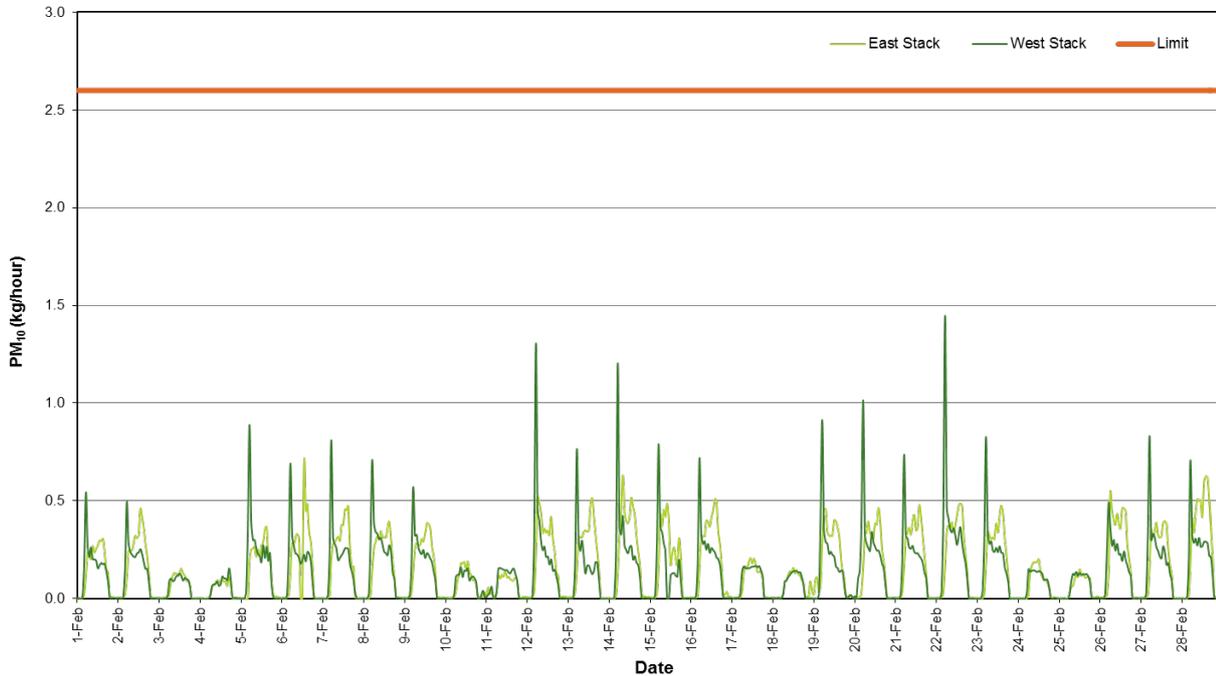


Figure 9: PM<sub>10</sub> Mass Rate (1 Hour Average)

### 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	16	14	13	11	9.0	6.6	4.7
Western	15	14	12	11	9.7	7.6	5.6

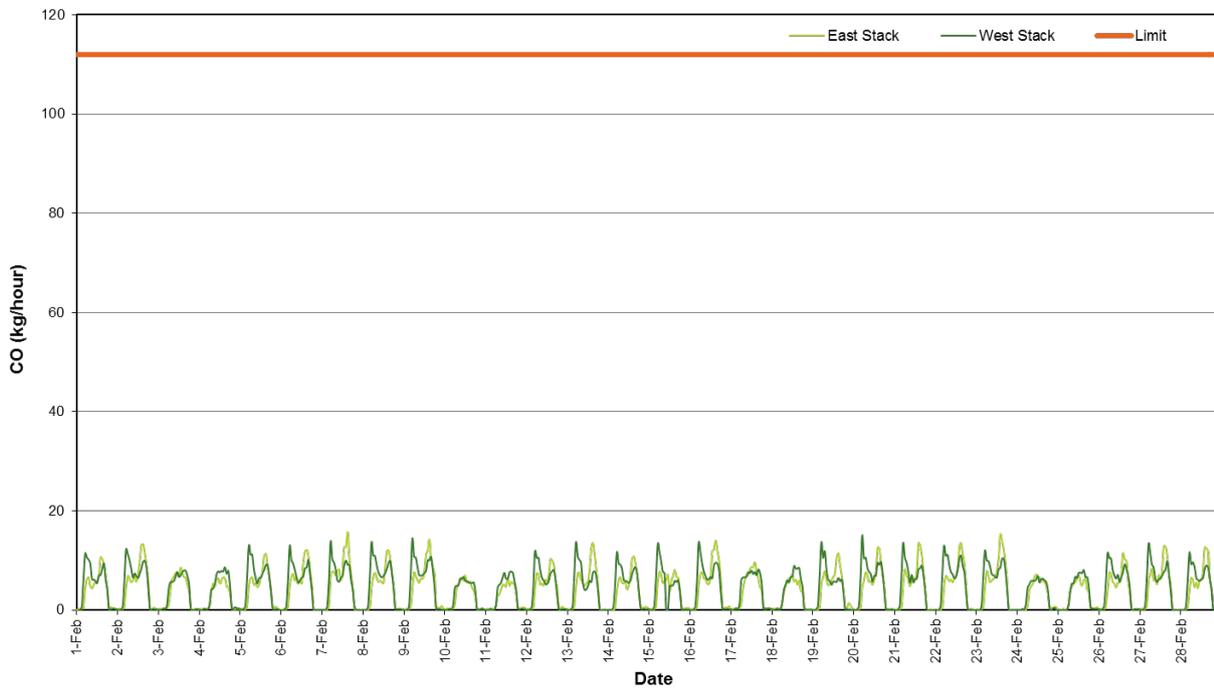


Figure 10: Carbon Monoxide Mass Rate (1 Hour Average)

## 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	5.4	4.4	4.2	3.8	3.2	2.6	1.1
Western	5.5	5.1	4.5	3.2	2.8	2.3	1.2

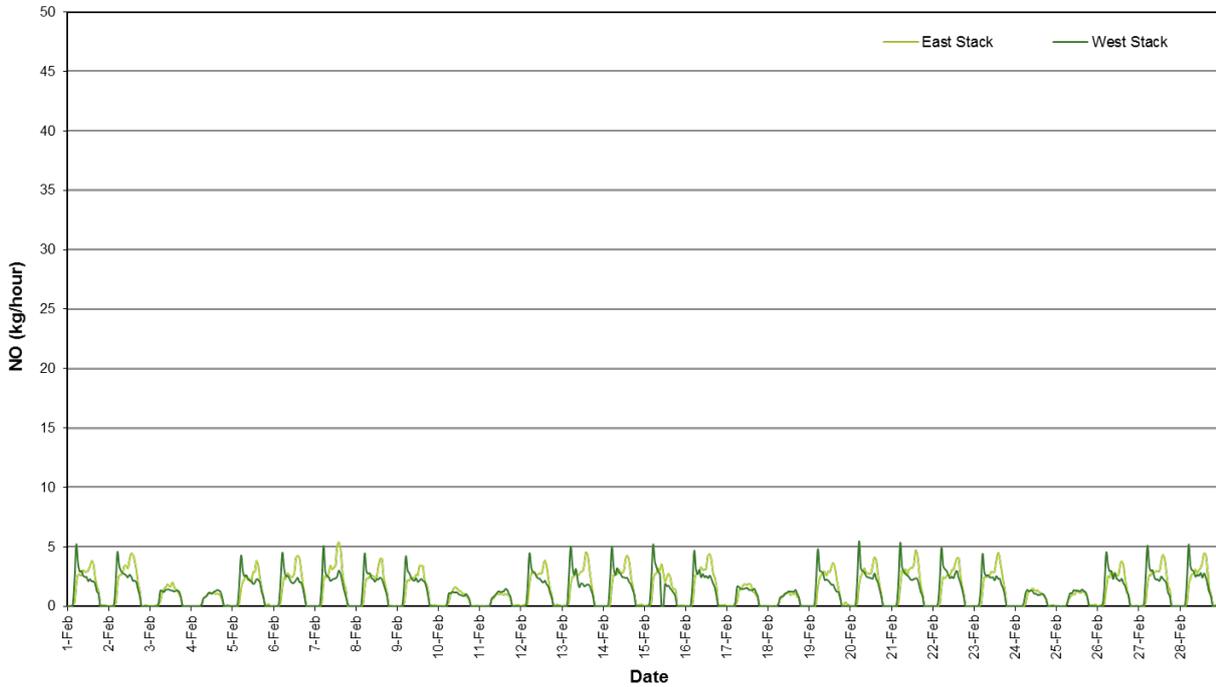


Figure 11: Nitric Oxide Mass Rate (1 Hour Average)

### 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	1.5	1.1	1.0	0.85	0.68	0.46	0.24
Western	1.6	1.0	0.97	0.69	0.56	0.47	0.27

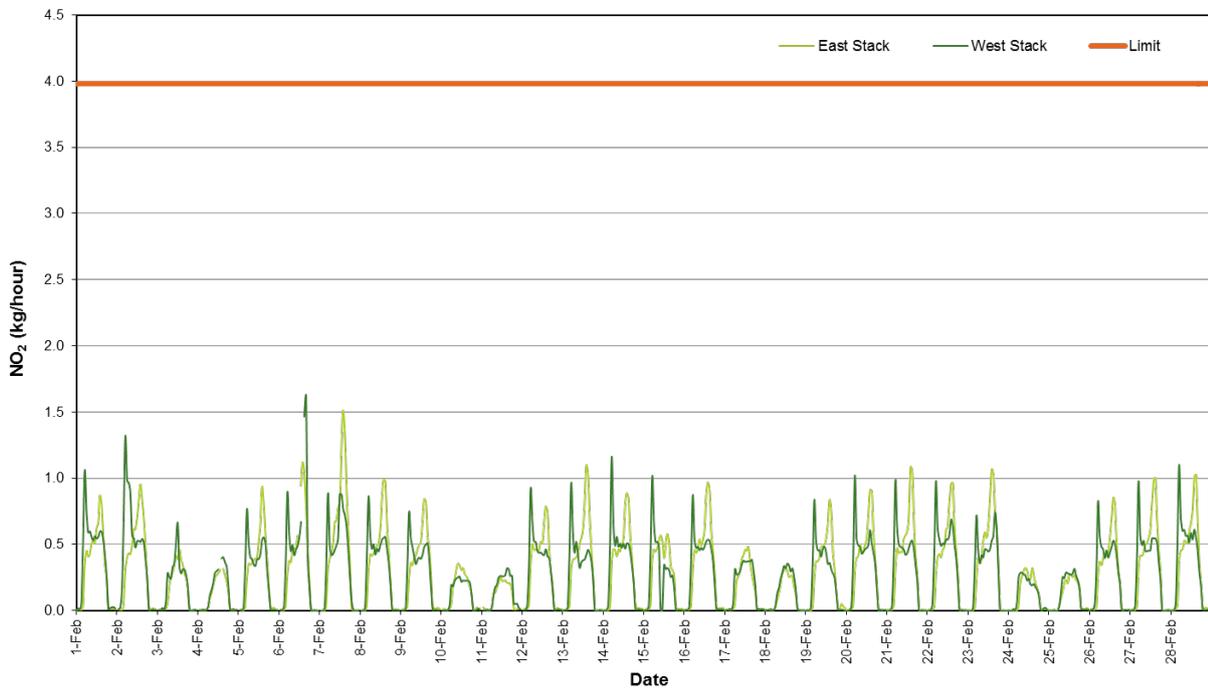


Figure 12: Nitrogen Dioxide Mass Rate (1 Hour Average)

### 7.2.5 Stack Velocity

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

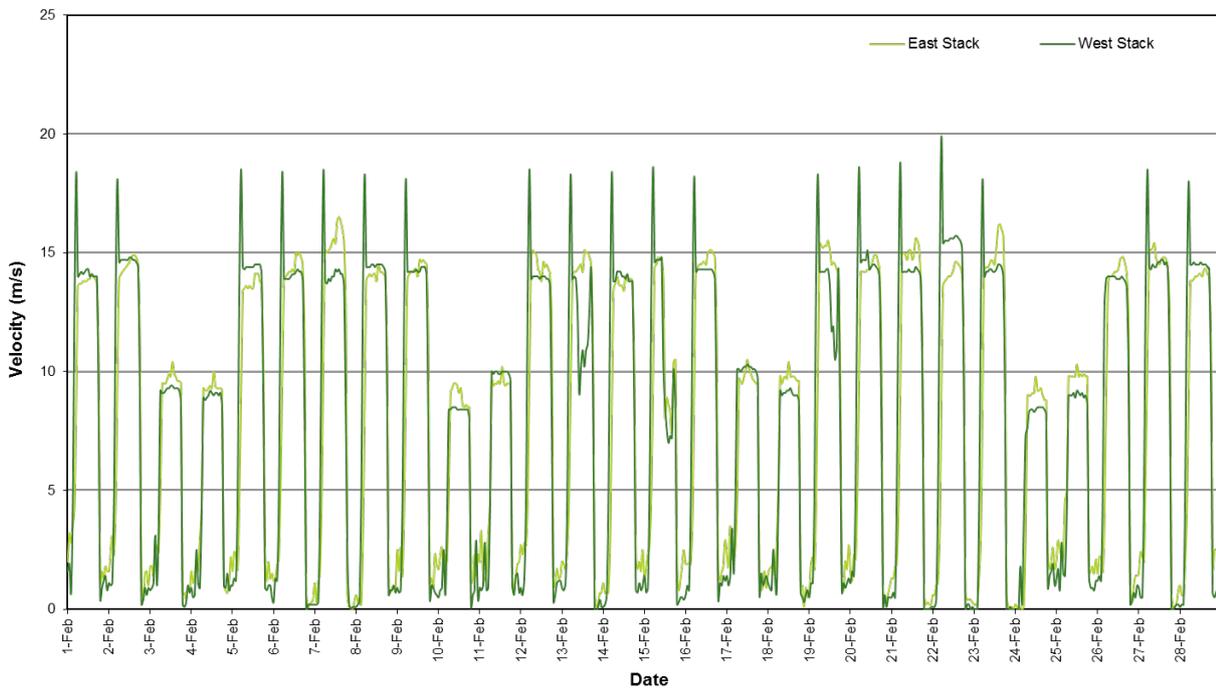


Figure 13: Stack Velocity (1 Hour Average)

### 7.3 Data Validation and Exceptions

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

**Table 17: Data Exceptions - Eastern Ventilation Stack: February 2018**

Start	End	Parameter	Reason
4/02/2018 19:20	5/02/2018 4:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
5/02/2018 21:55	5/02/2018 21:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
5/02/2018 22:20	5/02/2018 22:25	PM <sub>10</sub>	Invalid data <sup>1</sup>
5/02/2018 22:45	5/02/2018 22:45	PM <sub>10</sub>	Invalid data <sup>1</sup>
5/02/2018 23:00	5/02/2018 23:00	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/02/2018 1:10	6/02/2018 1:20	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/02/2018 2:10	6/02/2018 2:15	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/02/2018 2:25	6/02/2018 2:25	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/02/2018 2:35	6/02/2018 2:35	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/02/2018 3:00	6/02/2018 3:00	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/02/2018 3:15	6/02/2018 3:15	PM <sub>10</sub>	Invalid data <sup>1</sup>
6/02/2018 10:50	6/02/2018 10:55	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration



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Start	End	Parameter	Reason
6/02/2018 10:50	6/02/2018 10:55	CO	Maintenance / calibration
6/02/2018 11:10	6/02/2018 14:20	PM <sub>2.5</sub>	Maintenance / calibration
6/02/2018 11:30	6/02/2018 12:15	PM <sub>10</sub>	Maintenance / calibration
7/02/2018 2:35	7/02/2018 3:00	PM <sub>10</sub>	Invalid data <sup>1</sup>
11/02/2018 10:50	11/02/2018 10:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
11/02/2018 15:30	11/02/2018 15:30	PM <sub>10</sub>	Invalid data <sup>1</sup>
12/02/2018 14:20	12/02/2018 14:25	PM <sub>10</sub>	Invalid data <sup>1</sup>
19/02/2018 18:55	19/02/2018 19:05	PM <sub>10</sub>	Invalid data <sup>1</sup>
23/02/2018 3:35	23/02/2018 3:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
24/02/2018 23:50	24/02/2018 23:55	PM <sub>10</sub>	Invalid data <sup>1</sup>

**Note:** <sup>1</sup> – In the opinion of the reviewer.

**Table 18: Data Exceptions - Western Ventilation Stack: February 2018**

Start	End	Parameter	Reason
15/02/2018 10:00	15/02/2018 11:20	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
15/02/2018 10:00	15/02/2018 11:20	CO	Maintenance / calibration
15/02/2018 10:25	15/02/2018 11:35	PM <sub>2.5</sub>	Maintenance / calibration
15/02/2018 10:40	15/02/2018 11:30	PM <sub>10</sub>	Maintenance / calibration
20/02/2018 6:55	20/02/2018 6:55	Velocity	Invalid data <sup>1</sup>

**Note:** <sup>1</sup> – In the opinion of the reviewer.

A number of periods occurred where PM<sub>2.5</sub> concentrations were greater than the corresponding PM<sub>10</sub> 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 8/02/2018 11:25 – 13:05
-  East Ventilation stack 9/02/2018 00:50 – 01:50
-  East Ventilation stack 11/02/2018 10:50 – 12:55
-  East Ventilation stack 20/02/2018 07:10 – 10:10
-  West Ventilation stack 15/02/2018 15:45 – 16:05



## 8.0 VENTILATION STACK EMISSION MONITORING PERIOD: 01/03/2018 – 31/03/2018

### 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 1<sup>st</sup> March to 31<sup>st</sup> March, 2018 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 <sub>2.5</sub>	Eastern	671	744	90.2%
	Western	715	744	96.1%
PM <sub>10</sub>	Eastern	736	744	98.9%
	Western	743	744	99.9%
NO, NO <sub>2</sub>	Eastern	710	744	95.4%
	Western	707	744	95.0%
CO	Eastern	711	744	95.6%
	Western	712	744	95.7%

## 8.2 Results

### 8.2.1 PM<sub>2.5</sub>

PM<sub>2.5</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 20. A plot of PM<sub>2.5</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 14.

**Table 20: PM<sub>2.5</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>2.5</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.27	0.24	0.23	0.20	0.17	0.092	0.027
Western	0.49	0.30	0.25	0.19	0.15	0.092	0.047

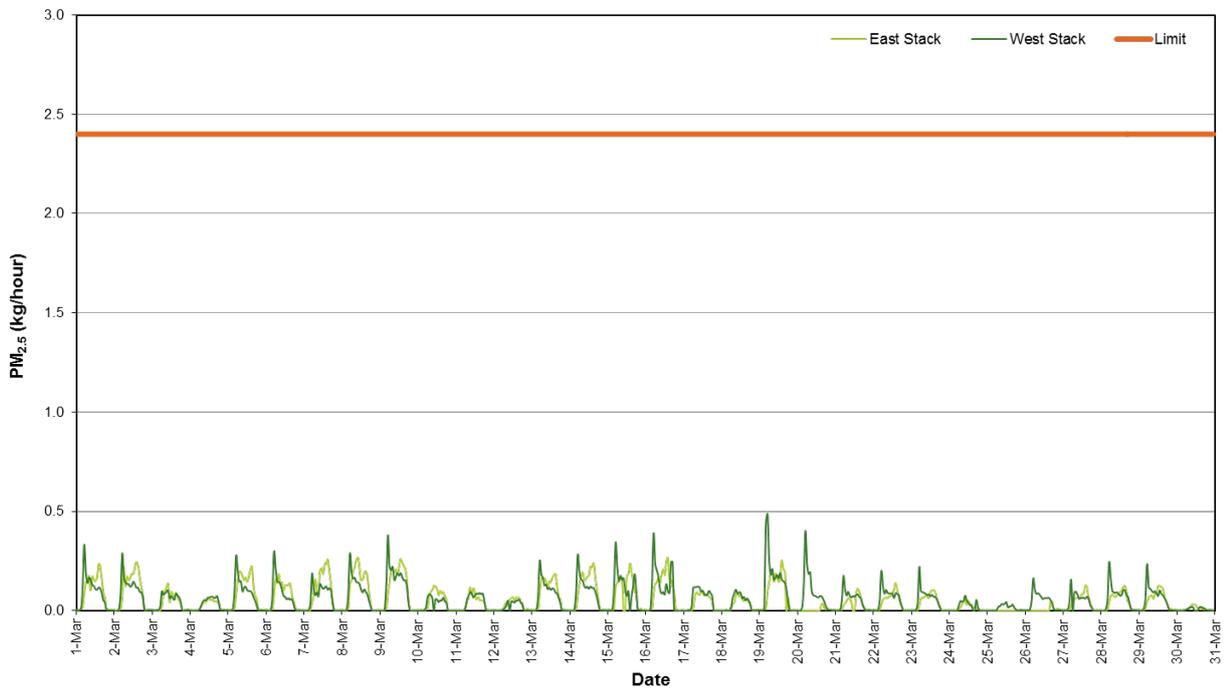


Figure 14: PM<sub>2.5</sub> Mass Rate (1 Hour Average)

### 8.2.2 PM<sub>10</sub>

PM<sub>10</sub> (1 hour average) mass rate of emission statistics for the reporting period are given in Table 21. A plot of PM<sub>10</sub> (1 hour average) mass rate of emission for the reporting period is presented in Figure 15.

**Table 21: PM<sub>10</sub> Mass Rate Percentiles (1 Hour Average)**

Station	PM <sub>10</sub> Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	0.83	0.56	0.52	0.41	0.35	0.17	0.042
Western	1.5	0.67	0.43	0.32	0.26	0.15	0.064

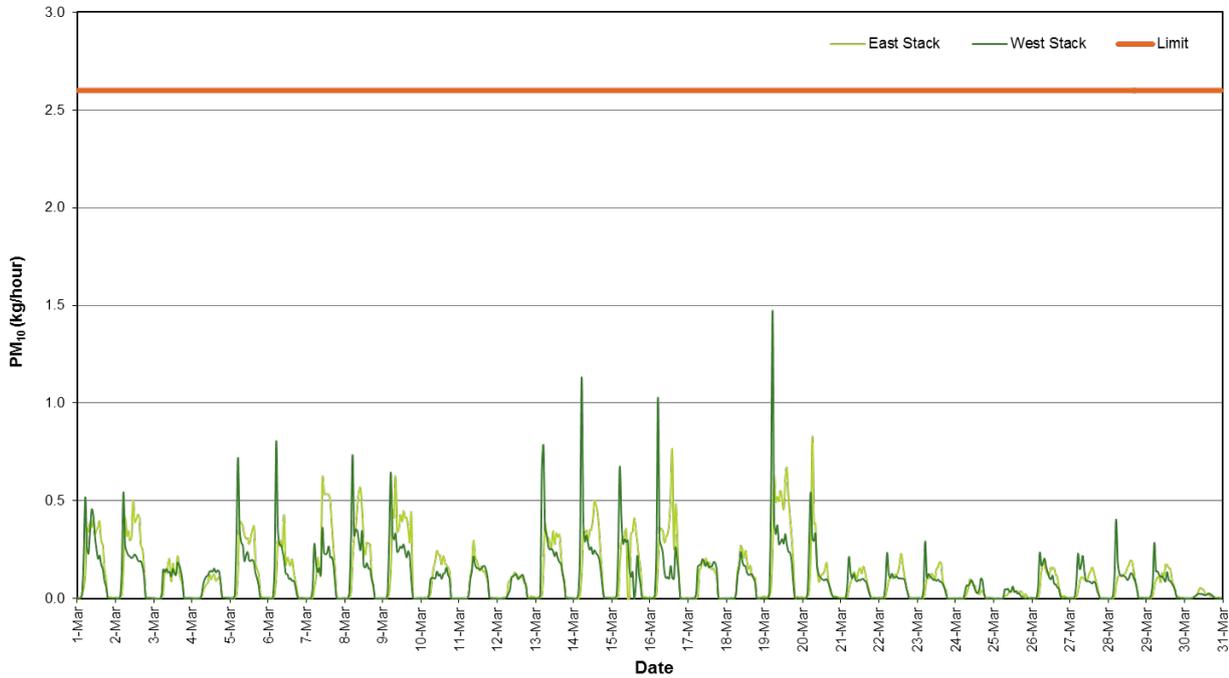


Figure 15: PM<sub>10</sub> Mass Rate (1 Hour Average)

### 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	14	13	12	9.7	7.7	5.8	2.1
Western	16	13	12	9.5	8.5	6.3	2.5

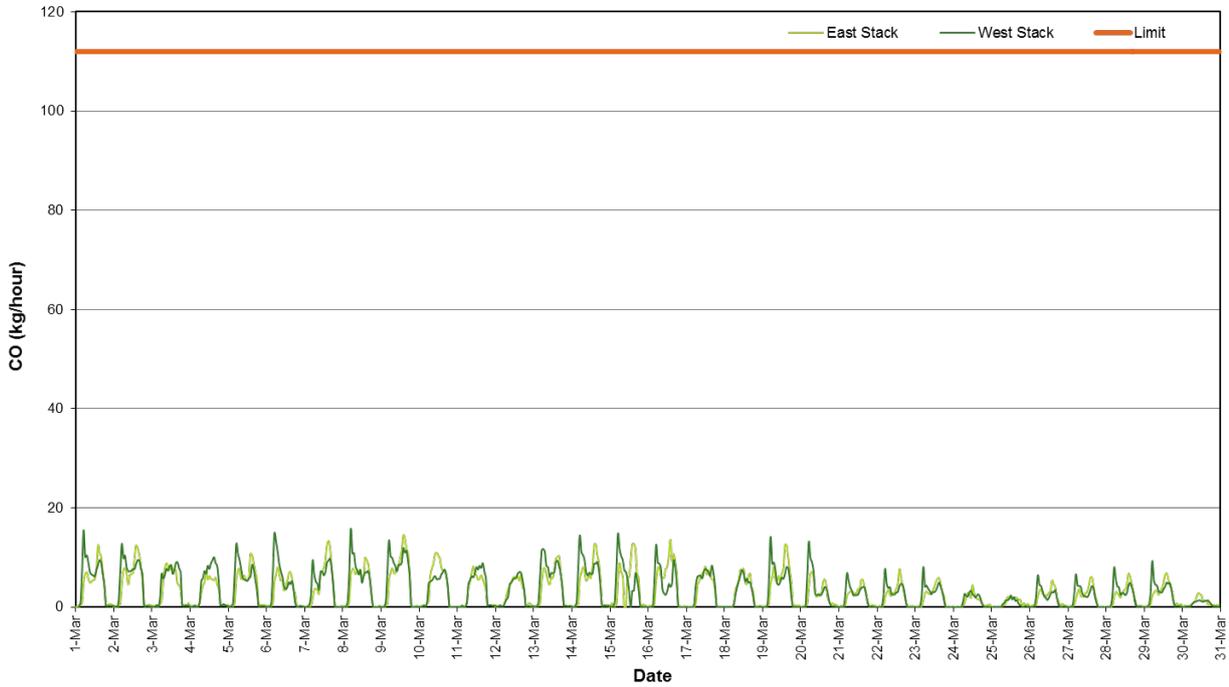


Figure 16: Carbon Monoxide Mass Rate (1 Hour Average)

## 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	4.8	4.2	4.0	3.3	2.9	1.7	0.52
Western	6.0	4.9	3.6	3.1	2.6	1.6	0.76

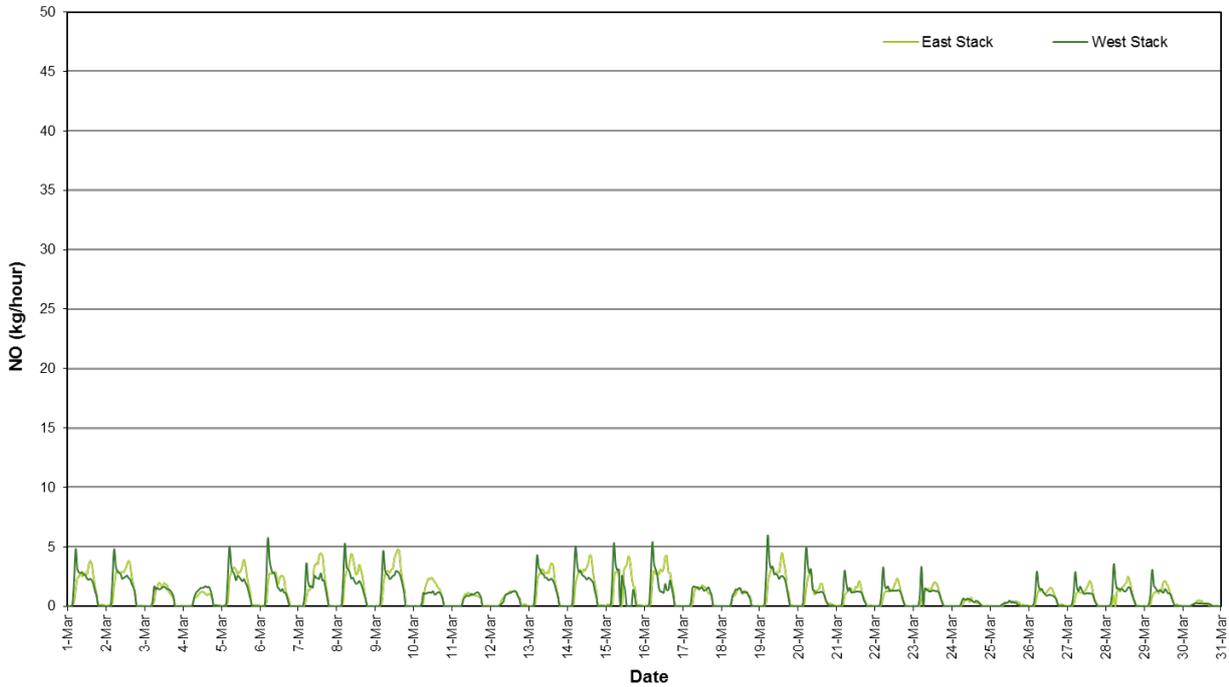


Figure 17: Nitric Oxide Mass Rate (1 Hour Average)

### 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 <sup>th</sup>	98 <sup>th</sup>	95 <sup>th</sup>	90 <sup>th</sup>	75 <sup>th</sup>	50 <sup>th</sup>
Eastern	1.1	0.92	0.84	0.67	0.51	0.36	0.098
Western	1.2	0.90	0.72	0.56	0.49	0.33	0.16

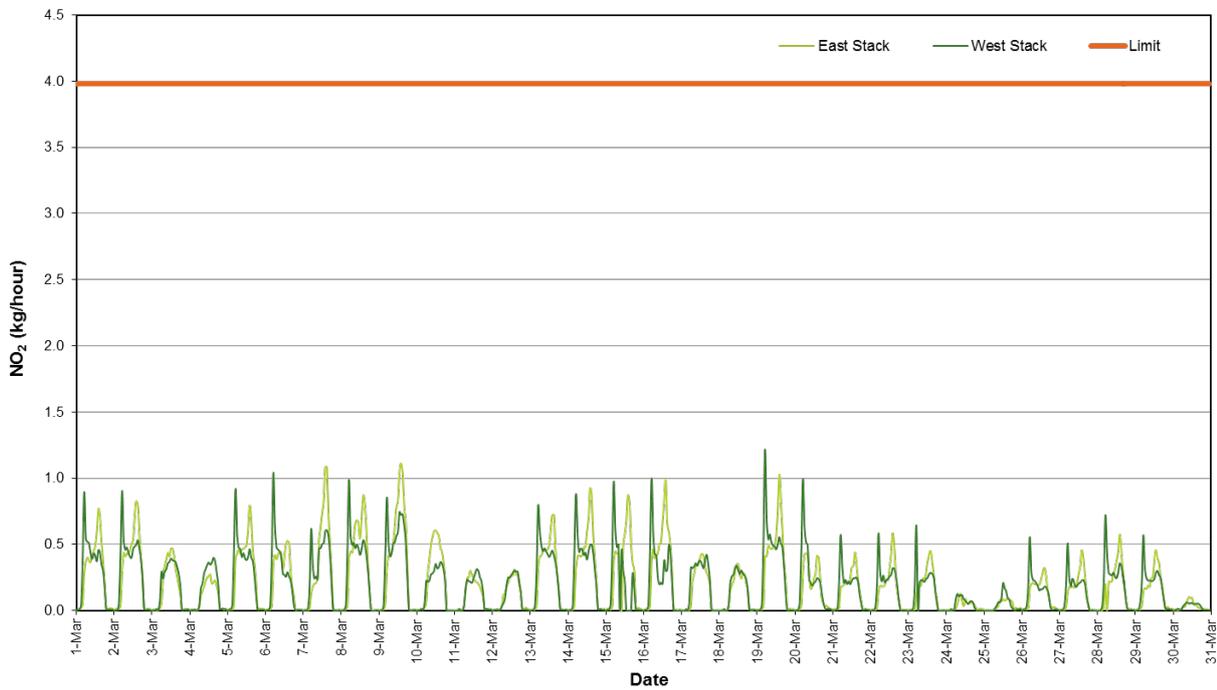


Figure 18: Nitrogen Dioxide Mass Rate (1 Hour Average)

## 8.2.5 Stack Velocity

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



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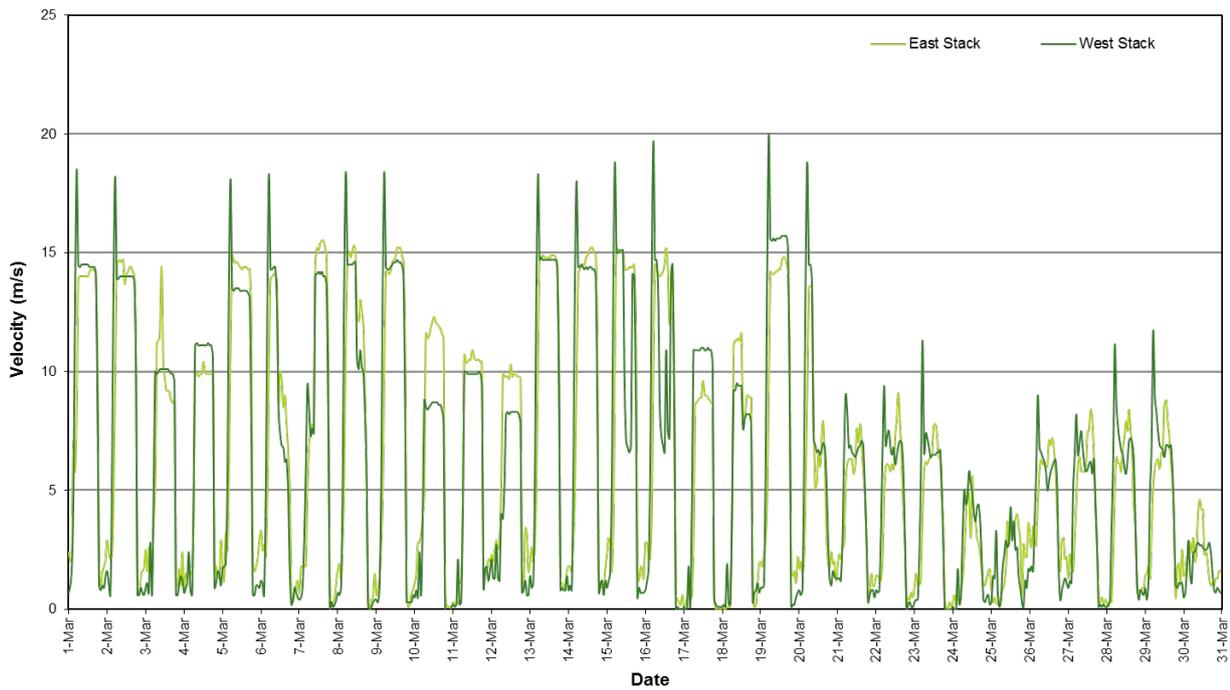


Figure 19: Stack Velocity (1 Hour Average)



### 8.3 Data Validation and Exceptions

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

**Table 25: Data Exceptions - Eastern Ventilation Stack: March 2018**

Start	End	Parameter	Reason
1/03/2018 19:50	1/03/2018 19:55	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
2/03/2018 01:00	2/03/2018 01:50	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
3/03/2018 01:45	3/03/2018 05:30	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
5/03/2018 04:15	5/03/2018 04:20	PM <sub>10</sub>	Invalid data <sup>1</sup>
12/03/2018 15:40	12/03/2018 15:50	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
12/03/2018 19:55	12/03/2018 20:05	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
14/03/2018 02:25	14/03/2018 03:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
15/03/2018 09:15	15/03/2018 10:35	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
15/03/2018 09:15	15/03/2018 10:35	CO	Maintenance / calibration
15/03/2018 09:45	15/03/2018 11:30	PM <sub>2.5</sub>	Maintenance / calibration
15/03/2018 09:55	15/03/2018 11:35	PM <sub>10</sub>	Maintenance / calibration
15/03/2018 12:45	15/03/2018 12:45	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
15/03/2018 22:50	15/03/2018 22:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
16/03/2018 10:35	16/03/2018 10:45	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
18/03/2018 19:10	18/03/2018 19:10	PM <sub>10</sub>	Invalid data <sup>1</sup>
19/03/2018 17:35	19/03/2018 17:50	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
19/03/2018 20:05	20/03/2018 15:05	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
21/03/2018 06:45	21/03/2018 06:45	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
21/03/2018 10:10	21/03/2018 10:10	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
21/03/2018 11:10	21/03/2018 12:20	PM <sub>2.5</sub>	Maintenance / calibration
23/03/2018 21:05	23/03/2018 21:20	PM <sub>10</sub>	Invalid data <sup>1</sup>
24/03/2018 13:15	24/03/2018 13:20	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
24/03/2018 14:20	24/03/2018 14:20	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
24/03/2018 15:25	24/03/2018 15:30	PM <sub>10</sub>	Invalid data <sup>1</sup>
24/03/2018 16:05	24/03/2018 16:05	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
24/03/2018 19:20	24/03/2018 19:20	PM <sub>10</sub>	Invalid data <sup>1</sup>
24/03/2018 20:00	26/03/2018 15:30	PM <sub>2.5</sub>	Invalid data <sup>1</sup>



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24/03/2018 20:05	24/03/2018 20:05	PM <sub>10</sub>	Invalid data <sup>1</sup>
25/03/2018 01:10	25/03/2018 01:25	PM <sub>10</sub>	Invalid data <sup>1</sup>
25/03/2018 09:10	25/03/2018 09:20	PM <sub>10</sub>	Invalid data <sup>1</sup>
25/03/2018 20:50	25/03/2018 20:50	PM <sub>10</sub>	Invalid data <sup>1</sup>
25/03/2018 23:40	25/03/2018 23:55	PM <sub>10</sub>	Invalid data <sup>1</sup>
26/03/2018 01:05	26/03/2018 01:15	PM <sub>10</sub>	Invalid data <sup>1</sup>
26/03/2018 01:55	26/03/2018 02:05	PM <sub>10</sub>	Invalid data <sup>1</sup>
28/03/2018 06:00	28/03/2018 06:30	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
29/03/2018 03:55	29/03/2018 03:55	PM <sub>10</sub>	Invalid data <sup>1</sup>

**Note:** <sup>1</sup> – In the opinion of the reviewer.

**Table 26: Data Exceptions - Western Ventilation Stack: March 2018**

Start	End	Parameter	Reason
8/03/2018 22:50	8/03/2018 23:25	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
9/03/2018 1:45	9/03/2018 2:25	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
9/03/2018 19:25	10/03/2018 8:35	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
10/03/2018 10:00	10/03/2018 10:20	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
11/03/2018 5:45	11/03/2018 5:50	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
11/03/2018 20:40	11/03/2018 23:55	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
12/03/2018 3:00	12/03/2018 3:35	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
12/03/2018 5:00	12/03/2018 5:05	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
12/03/2018 10:05	12/03/2018 10:25	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
15/03/2018 9:00	15/03/2018 9:20	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
15/03/2018 12:50	15/03/2018 16:25	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
15/03/2018 12:50	15/03/2018 14:05	CO	Maintenance / calibration
15/03/2018 13:45	15/03/2018 15:10	PM <sub>2.5</sub>	Maintenance / calibration
15/03/2018 14:00	15/03/2018 14:45	PM <sub>10</sub>	Maintenance / calibration
15/03/2018 22:55	15/03/2018 23:10	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
16/03/2018 18:35	16/03/2018 18:50	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
18/03/2018 15:20	18/03/2018 15:30	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
23/03/2018 6:25	23/03/2018 6:55	NO, NO <sub>2</sub> , NO <sub>x</sub>	Maintenance / calibration
24/03/2018 15:40	24/03/2018 16:15	PM <sub>2.5</sub>	Invalid data <sup>1</sup>



## EASTLINK VENTILATION STACK EMISSION MONITORING REPORT: JANUARY - MARCH 2018

24/03/2018 21:05	24/03/2018 23:55	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
27/03/2018 06:35	27/03/2018 06:50	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
28/03/2018 02:15	28/03/2018 02:45	PM <sub>2.5</sub>	Invalid data <sup>1</sup>
30/03/2018 10:45	30/03/2018 13:40	PM <sub>2.5</sub>	Invalid data <sup>1</sup>

**Note:** <sup>1</sup> – In the opinion of the reviewer.

A number of periods occurred where PM<sub>2.5</sub> concentrations were greater than the corresponding PM<sub>10</sub> 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 11/03/2018 11:40 – 11:45
-  West Ventilation stack 15/03/2018 17:30 – 20:55
-  West Ventilation stack 19/03/2018 04:25 – 04:35



## 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 (01/01/2018 - 31/03/2018)**

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	PM <sub>2.5</sub>	0.49	2.4
		PM <sub>10</sub>	1.5	2.6
		NO <sub>2</sub>	1.2	3.98
		CO	16	112
2	Eastern ventilation stack	PM <sub>2.5</sub>	0.27	2.4
		PM <sub>10</sub>	0.83	2.6
		NO <sub>2</sub>	1.1	3.98
		CO	14	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<sub>2.5</sub> (DP1, DP2): 2.0 kg/h

 PM<sub>10</sub> (DP1, DP2): 2.0 kg/h

There was no exceedences of the PM<sub>10</sub> or PM<sub>2.5</sub> TEOM mass rate compliance levels for DP1 during the reporting period.

There was no exceedences of the PM<sub>10</sub> or PM<sub>2.5</sub> TEOM mass rate compliance levels for DP2 during the reporting period.

### 9.2 Data Capture Year to Date

Data capture statistics for 2018 year to date (01/01/2018 – 31/03/2018) are presented in Table 28.

**Table 28: Data Capture Year to Date (%)**

Station	NO <sub>2</sub>	CO	PM <sub>2.5</sub>	PM <sub>10</sub>	Velocity
Eastern	97.0%	97.4%	90.3%	99.2%	100%
Western	96.6%	97.0%	96.8%	99.9%	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 1<sup>st</sup> July to 30<sup>th</sup> June each year to coincide with the Annual Performance Statement (APS) reporting period. Ventilation stack emission rates year to date (1/07/2017 to 31/03/2018) are shown in Table 29.

**Table 29: Ventilation Stack Emissions 1/07/2017 – 31/03/2018 (tonnes/year)**

Station	NO <sub>2</sub>	CO	PM <sub>2.5</sub>	PM <sub>10</sub>
Eastern	0.88	22	0.35	0.78
Western	1.3	21	0.28	0.63
<b>Total</b>	<b>2.1</b>	<b>43</b>	<b>0.63</b>	<b>1.4</b>
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.

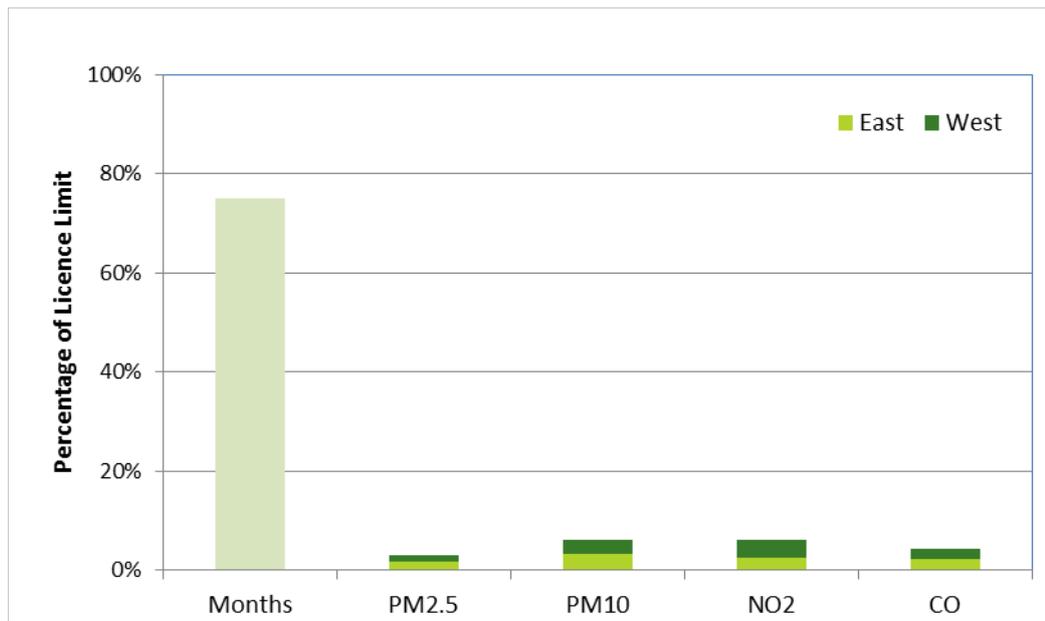


Figure 20: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2017 – 31/03/2018)

The corresponding bubble limits for uncorrected PM<sub>2.5</sub> and PM<sub>10</sub> TEOM data are:

- PM<sub>2.5</sub> (DP1 and DP2): 17.5 tonnes/year
- PM<sub>10</sub> (DP1 and DP2): 17.5 tonnes/year



## Report Signature Page

### GOLDER ASSOCIATES PTY LTD

Handwritten signature of Anthony Myszka in blue ink.

Anthony Myszka  
Environmental Technician

Handwritten signature of Mark Tulau in blue ink.

Mark Tulau  
Senior Air Quality Specialist

AM/MDT/am

A.B.N. 64 006 107 857

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# **APPENDIX A**

## **Important Information Relating to this Report**



## IMPORTANT INFORMATION RELATING TO THIS REPORT

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