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REPORT

EastLink Ventilation Stack Emission Monitoring Report July 2021

Submitted to:

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Distribution List

1 Electronic copy - Ventia Pty Ltd

1 Electronic Copy - Golder Associates Pty. Ltd.

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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. Ventia Pty Ltd, who are responsible for operation and maintenance of the road, commissioned Golder Associates Pty. Ltd. to provide continuous emission monitoring services for the EastLink motorway project. The services provided include:

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

Monitoring commenced on the 29th June 2008 with the opening of the EastLink motorway. Results for the sampling period 1st July 2021 to 31th July 2021 inclusive are contained in the following report.

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

Month	Western Stack	Eastern Stack
July	123776	1237502

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 a temperature controlled cabinet 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 (PM_{10})
- Total oxides of nitrogen (NO_x)
- Nitric oxide (NO)
- Nitrogen dioxide (NO_2)
- 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 (PM_{10} WINS head fitted with a $PM_{2.5}$ sharp cut cyclone (SCC)) at 1 m^3/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 PM_{10}

PM_{10} 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_{10} size selective inlet (PM_{10} WINS head) at 1 m^3/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_{10} 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_{10} 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_2 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: 01/07/2021 – 31/07/2021

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 31th July 2021 are shown in Table 3. Averages were only collected for those periods where the 5 minute data constituted 75% data capture. Reduced data capture for NO_x eastern ventilation system was due to analyser span drift out of tolerance.

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

Table 3: Data Capture Statistics - 1 Hour Averages

Parameter	Station	Collected Periods	Available Periods	Data Capture
$PM_{2.5}$	Eastern	730	744	98.1%
	Western	727	744	97.7%
PM_{10}	Eastern	710	744	95.4%
	Western	740	744	99.5%
NO, NO_2	Eastern	619	744	83.2%
	Western	711	744	95.6%
CO	Eastern	711	744	95.6%
	Western	705	744	94.8%

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	99th	98th	95th	90th	75th	50th
Eastern	0.11	0.086	0.081	0.072	0.062	0.043	0.016
Western	0.18	0.10	0.095	0.082	0.062	0.040	0.029

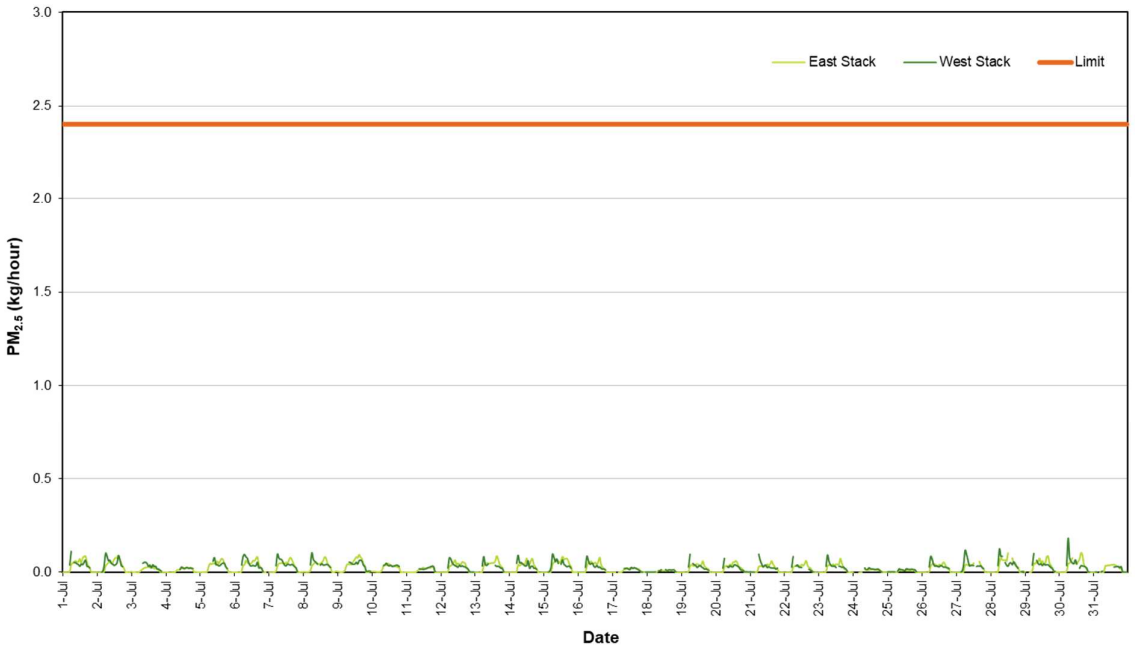

Figure 2: $PM_{2.5}$ Mass Rate (1 Hour Average)

6.2.2 PM_{10}

PM_{10} (1 hour average) mass rate of emission statistics for the reporting period are given in Table 5. A plot of PM_{10} (1 hour average) mass rate of emission for the reporting period is presented in Figure 3.

Table 5: PM_{10} Mass Rate Percentiles (1 Hour Average)

Station	PM_{10} Mass Rate (kg/h) (1 Hour Average)						
	Maximum	99th	98th	95th	90th	75th	50th
Eastern	0.36	0.16	0.15	0.13	0.11	0.077	0.032
Western	0.35	0.29	0.24	0.16	0.12	0.084	0.057

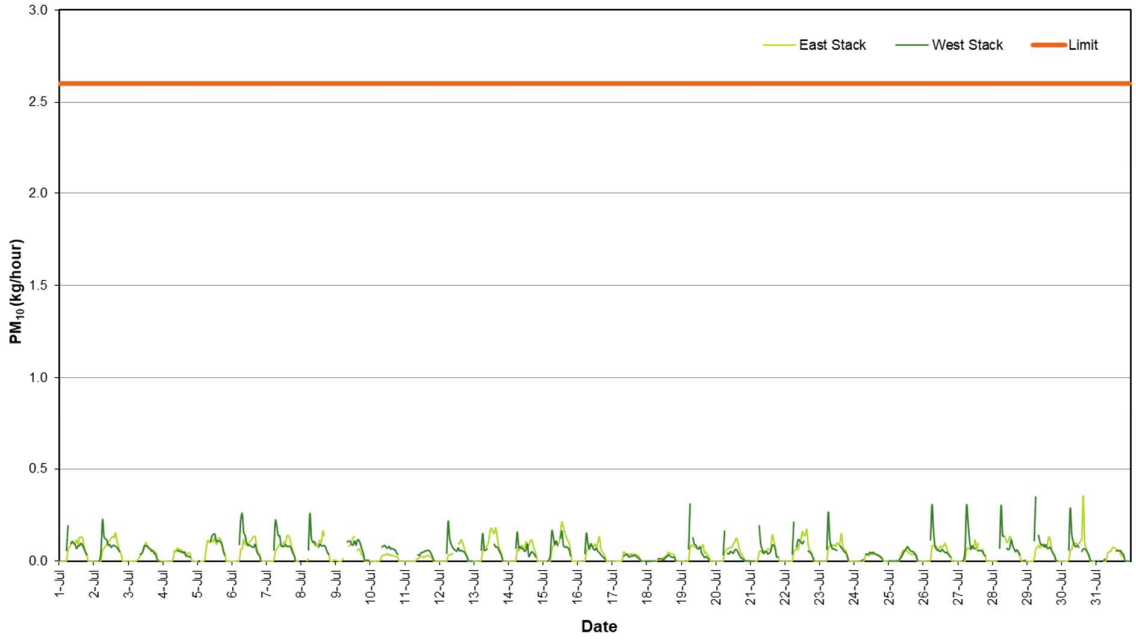

Figure 3: PM_{10} Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	5.3	5.0	4.6	4.0	3.2	2.4	1.6
Western	7.2	6.6	5.9	5.1	4.1	3.0	2.2

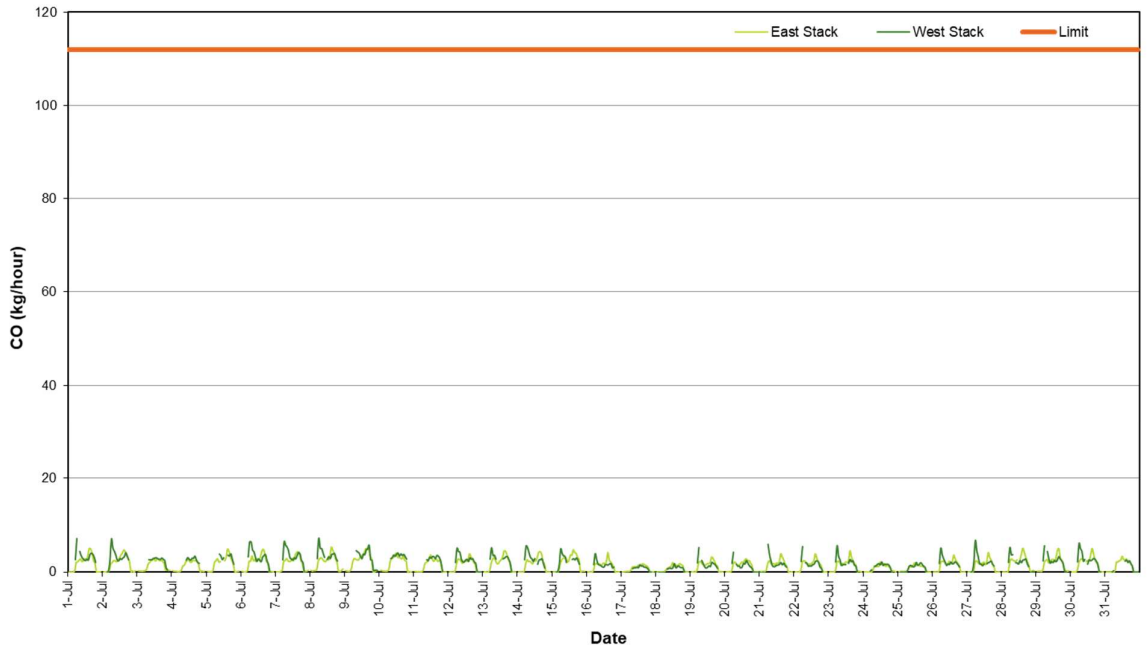

Figure 4: Carbon Monoxide Mass Rate (1 Hour Average)

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	99th	98th	95th	90th	75th	50th
Eastern	2.0	1.8	1.6	1.4	1.2	0.97	0.33
Western	3.9	3.8	3.6	2.7	1.9	1.3	0.88

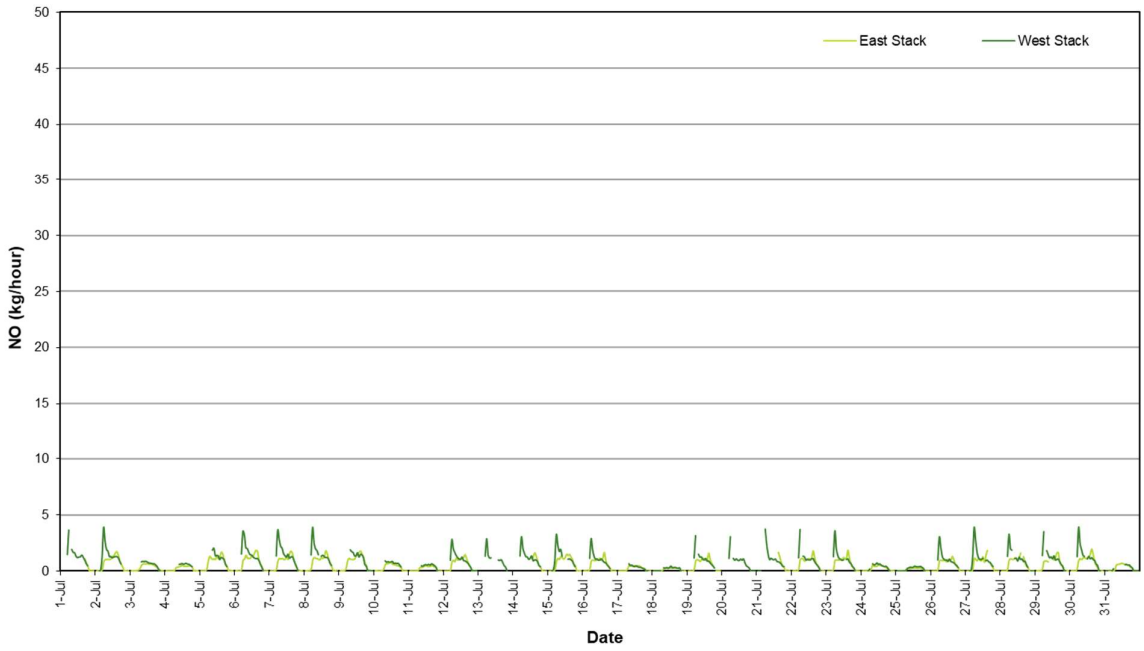

Figure 5: Nitric Oxide Mass Rate (1 Hour Average)

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	**99th**	**98th**	**95th**	**90th**	**75th**	**50th**
Eastern	0.45	0.39	0.37	0.30	0.24	0.19	0.086
Western	0.32	0.28	0.25	0.19	0.12	0.091	0.069

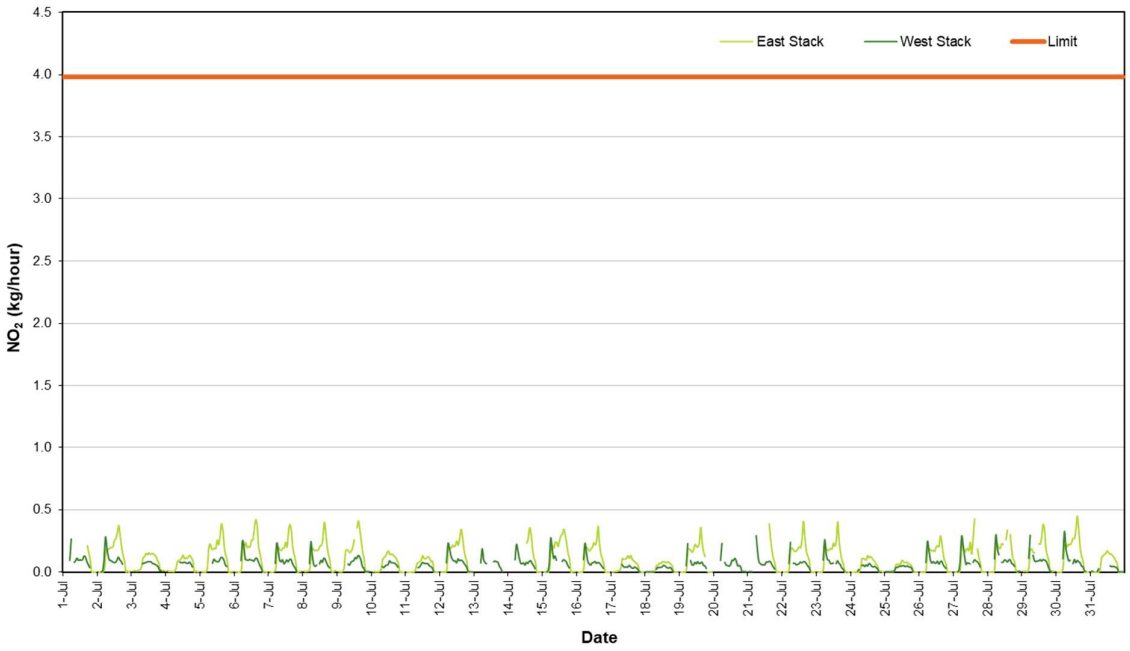

Figure 6: Nitrogen Dioxide Mass Rate (1 Hour Average)

6.2.5 Stack Velocity

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

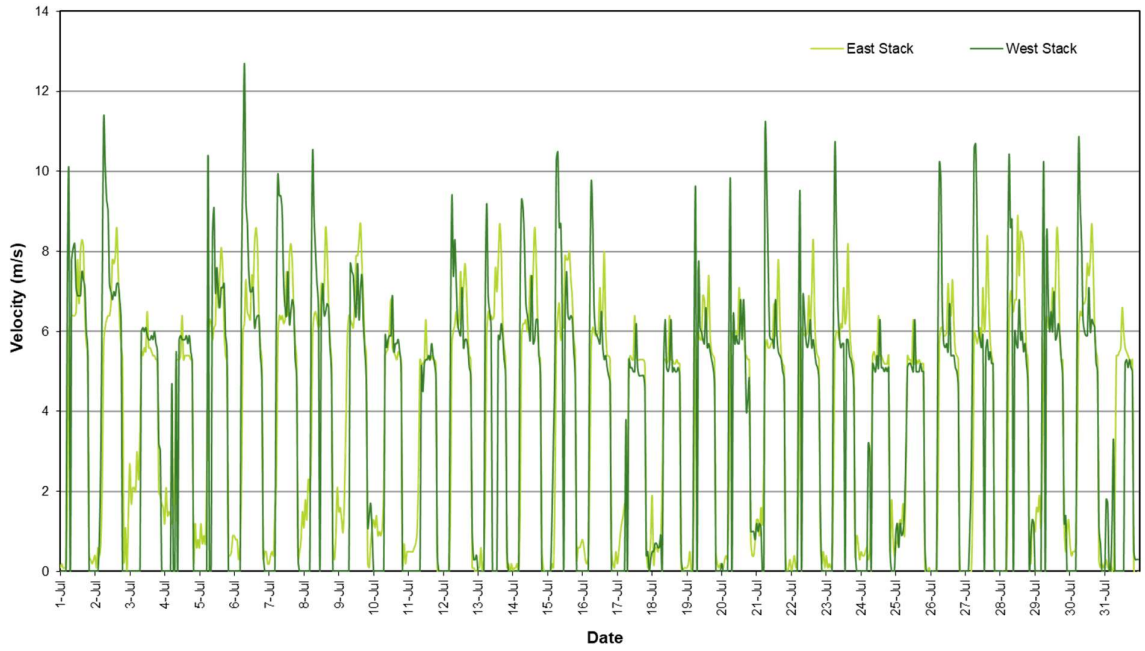

Figure 7: Stack Velocity (1 Hour Average)

6.3 Data Validation and Exceptions

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

Table 9: Data Exceptions - Eastern Ventilation Stack: July 2021

Start	End	Parameter	Reason
5/04/2021 01:00	6/04/2021 13:30	NO, NO_2, NO_x	Span drift out of tolerance
1/07/2021 01:00	1/07/2021 16:55	NO, NO_2, NO_x	Span drift out of tolerance
7/07/2021 23:30	8/07/2021 03:15	PM_{10}	Invalid[1]
9/07/2021 05:50	9/07/2021 08:30	PM_{10}	Invalid[1]
9/07/2021 13:00	9/07/2021 13:25	NO, NO_2, NO_x	Maintenance / calibration
12/07/2021 10:00	12/07/2021 12:45	PM_{10}	Maintenance / calibration
13/07/2021 01:00	14/07/2021 13:05	NO, NO_2, NO_x	Span drift out of tolerance
17/07/2021 23:00	18/07/2021 03:10	PM_{10}	Invalid[1]
19/07/2021 19:05	19/07/2021 19:20	NO, NO_2, NO_x	Maintenance / calibration
20/07/2021 01:00	21/07/2021 14:50	NO, NO_2, NO_x	Span drift out of tolerance
27/07/2021 13:10	27/07/2021 15:20	$PM_{2.5}$	Maintenance / calibration
27/07/2021 14:50	27/07/2021 16:35	PM_{10}	Maintenance / calibration
27/07/2021 15:55	27/07/2021 16:25	NO, NO_2, NO_x	Maintenance / calibration
27/07/2021 17:30	27/07/2021 17:40	PM_{10}	Maintenance / calibration
28/07/2021 04:05	28/07/2021 06:45	PM_{10}	Invalid[1]
28/07/2021 12:25	28/07/2021 13:00	CO, NO, NO_2, NO_x	Maintenance / calibration
28/07/2021 13:20	28/07/2021 14:35	$PM_{2.5}$	Maintenance / calibration
28/07/2021 14:00	28/07/2021 15:15	PM_{10}	Maintenance / calibration
28/07/2021 14:50	28/07/2021 14:55	CO, NO, NO_2, NO_x	Maintenance / calibration
29/07/2021 01:15	29/07/2021 03:00	$PM_{2.5}$	Invalid[1]
29/07/2021 09:50	29/07/2021 11:35	NO, NO_2, NO_x	Maintenance / calibration
30/07/2021 10:30	30/07/2021 11:10	$PM_{2.5}$	Maintenance / calibration

30/07/2021 10:45	30/07/2021 10:55	CO, NO, NO_2, NO_x	Maintenance / calibration

Table 10: Data Exceptions - Western Ventilation Stack: July 2021

Start	End	Parameter	Reason
1/07/2021 01:00	1/07/2021 04:30	Stack velocity	Low signal
1/07/2021 20:20	2/07/2021 -3:00	Stack velocity	Low signal
1/07/2021 22:15	2/07/2021 -3:00	$PM_{2.5}$	Invalid[1]
2/07/2021 19:15	3/07/2021 -6:30	Stack velocity	Low signal
3/07/2021 03:30	3/07/2021 -4:35	$PM_{2.5}$	Invalid[1]
3/07/2021 21:45	4/07/2021 -4:20	Stack velocity	Low signal
4/07/2021 01:00	4/07/2021 -2:30	$PM_{2.5}$	Invalid[1]
4/07/2021 20:30	5/07/2021 05:25	Stack velocity	Low signal
5/07/2021 07:15	5/07/2021 08:35	Stack velocity	Low signal
5/07/2021 20:10	6/07/2021 4:30	Stack velocity	Low signal
6/07/2021 10:20	6/07/2021 10:30	PM_{10}	Invalid[1]
6/07/2021 21:15	7/07/2021 04:30	Stack velocity	Low signal
7/07/2021 20:45	8/07/2021 04:35	Stack velocity	Low signal
8/07/2021 20:10	9/07/2021 04:35	Stack velocity	Low signal
9/07/2021 05:40	9/07/2021 07:30	Stack velocity	Low signal
10/07/2021 00:00	10/07/2021 04:35	Stack velocity	Low signal
10/07/2021 05:40	10/07/2021 07:30	Stack velocity	Low signal
10/07/2021 20:30	11/07/2021 07:30	Stack velocity	Low signal
11/07/2021 21:00	12/07/2021 04:30	Stack velocity	Low signal
12/07/2021 23:45	13/07/2021 04:30	Stack velocity	Low signal
13/07/2021 10:10	13/07/2021 13:30	Stack velocity	Low signal
13/07/2021 20:50	14/07/2021 04:15	Stack velocity	Low signal

Start	End	Parameter	Reason
14/07/2021 13:10	14/07/2021 14:00	CO	Maintenance / calibration
14/07/2021 20:15	15/07/2021 02:55	Stack velocity	Low signal
15/07/2021 13:30	15/07/2021 14:10	CO, NO, NO_2, NO_x	Maintenance / calibration
15/07/2021 20:20	16/07/2021 04:30	Stack velocity	Low signal
16/07/2021 20:30	17/07/2021 06:05	Stack velocity	Low signal
17/07/2021 21:50	17/07/2021 23:05	Stack velocity	Low signal
18/07/2021 11:30	18/07/2021 12:50	$PM_{2.5}$	Invalid[1]
18/07/2021 21:05	19/07/2021 04:30	Stack velocity	Low signal
19/07/2021 20:15	20/07/2021 04:25	Stack velocity	Low signal
21/07/2021 3:50	21/07/2021 05:30	Stack velocity	Low signal
21/07/2021 20:10	22/07/2021 04:35	Stack velocity	Low signal
22/07/2021 13:00	22/07/2021 16:55	$PM_{2.5}$	Maintenance / calibration
22/07/2021 13:50	22/07/2021 15:50	PM_{10}	Maintenance / calibration
22/07/2021 21:35	23/07/2021 04:30	Stack velocity	Low signal
23/07/2021 21:35	24/07/2021 04:40	Stack velocity	Low signal
24/07/2021 2:55	24/07/2021 06:05	$PM_{2.5}$	Invalid[1]
24/07/2021 21:05	24/07/2021 23:55	Stack velocity	Low signal
25/07/2021 20:55	26/07/2021 04:30	Stack velocity	Low signal
26/07/2021 20:00	27/07/2021 02:45	Stack velocity	Low signal
27/07/2021 20:05	28/07/2021 04:30	Stack velocity	Low signal
29/07/2021 0:00	29/07/2021 04:30	Stack velocity	Low signal
29/07/2021 21:50	30/07/2021 04:30	Stack velocity	Low signal
30/07/2021 11:30	30/07/2021 12:05	CO, NO, NO_2, NO_x	Maintenance / calibration
30/07/2021 13:45	30/07/2021 13:45	$PM_{2.5}$ / PM_{10}	Maintenance / calibration
30/07/2021 21:45	31/07/2021 05:10	Stack velocity	Low signal

Start	End	Parameter	Reason
31/07/2021 07:00	31/07/2021 13:20	Stack velocity	Low signal

There were instances where $PM_{2.5}$ concentration was greater than the corresponding PM_{10} concentration. 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 9/07/2021 14:10 – 11/07/2021 08:10
- West Ventilation stack 25/04/2021 11:35 – 25/04/2021 12:40

7.0 DISCUSSION

7.1 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 11: Maximum (1 Hour Average) Mass Rate (01/07/2021 - 31/07/2021)

Discharge Point No.	Discharge Description	Compound	Mass Rate (kg/h)	Licence Limit (kg/h)
1	Western ventilation stack	$PM_{2.5}$	0.18	2.4
		PM_{10}	0.35	2.6
		NO_2	0.32	3.98
		CO	7.2	112
2	Eastern ventilation stack	$PM_{2.5}$	0.11	2.4
		PM_{10}	0.36	2.6
		NO_2	0.45	3.98
		CO	5.3	112

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

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

- $PM_{2.5}$ (DP1, DP2): 2.0 kg/h
- PM_{10} (DP1, DP2): 2.0 kg/h

There were no exceedances of the PM_{10} or $PM_{2.5}$ TEOM mass rate compliance levels for DP1 during the reporting period.

There were no exceedances of the PM_{10} or $PM_{2.5}$ TEOM mass rate compliance levels for DP2 during the reporting period.

7.2 Data Capture Year to Date

Data capture statistics for 2021 year to date (01/01/2021 – 31/07/2021) are presented in Table 28.

Table 12: Data Capture Year to Date (%)

Station	NO_2	CO	$PM_{2.5}$	PM_{10}	Velocity
Eastern	84.9%	97.4%	98.7%	96.5%	100%
Western	97.0%	96.9%	97.9%	99.5%	67.7%

7.3 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 (1/07/2021 to 31/07/2021) are shown in Table 29.

Table 13: Ventilation Stack Emissions 1/07/2021 – 31/07/2021 (tonnes/year)

Station	NO_2	CO	$PM_{2.5}$	PM_{10}
Eastern	0.074	1.1	0.018	0.031
Western	0.037	1.2	0.016	0.033
Total	0.11	2.3	0.034	0.064
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.

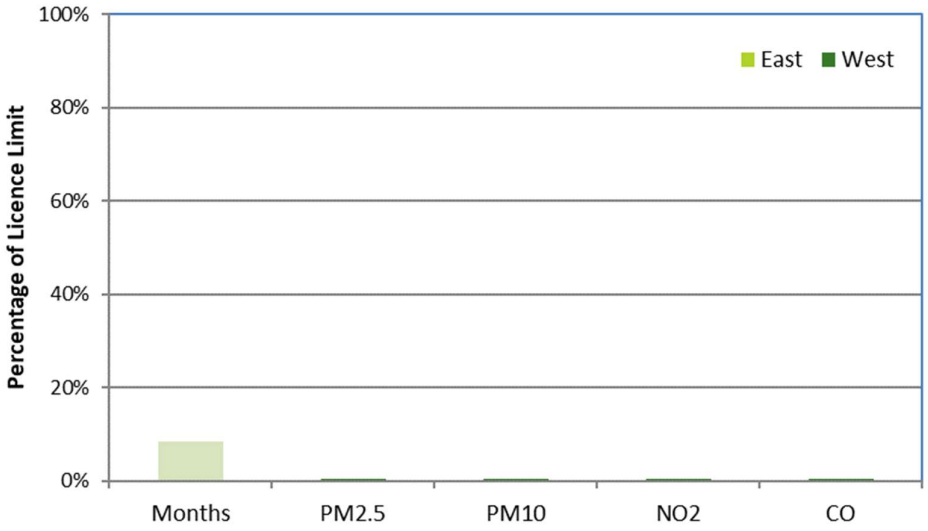

Figure 8: Ventilation Stack Emissions as Percentage of Licence Limit (1/07/2021 – 31/07/2021)

The corresponding bubble limits for uncorrected $PM_{2.5}$ and PM_{10} TEOM data are:

- $PM_{2.5}$ (DP1 and DP2): 17.5 tonnes/year
- PM_{10} (DP1 and DP2): 17.5 tonnes/year

Signature Page

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Anthony Myszka
Environmental Technician

Mark Tulau
Senior Air Quality Specialist

AM/MDT/am

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APPENDIX A

Important Information Relating to this Report

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At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification

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