

OUR REF: 803400.140429  
YOUR REF: Email 110320/JH-RP

16 March 2020

Justin Hazelbrook  
Community and Conditions Coordinator  
PO Box 6008  
Silverwater, NSW 2128

**RE: Tunnel Air Quality Management Systems Effectiveness Report  
11 February 2020**

Dear Justin,

SNC-Lavalin Atkins Australia (SNC-Lavalin Atkins) have been appointed by Fulton Hogan EGIS Operation and Maintenance (FHEOM) Joint Venture to perform the Independent Air quality specialist roles and were approved by the NSW Department of Environment and Planning (DPE) on 14 May 2019.

The SNC-Lavalin Atkins Environment team members, have undertaken a review of the Tunnel Air Quality Management Systems Effectiveness Report (TAQMSER) that was prepared under the Minister's Condition of Approval (MCoA) E7 by WestConnex Transurban.

Condition E7 states:

*"Within 20 working days of any request by the Secretary a Tunnel Air Quality Management Systems Effectiveness Report on the overall system performance and cause and major contributor of any exceedances, detailing the following:*

- The overall performance and concentration levels in the tunnel for the preceding six-month period (or since commencement of operation, where the SSI has operated for under 6 months), including average and maximum level and time periods*
- Details of any instances throughout the operation of the SSI where pollutant concentration levels in the tunnel have exceeded the limits specified in conditions E2, E3 and E4; and*
- Consideration of improvement to the tunnel air quality management systems*

*The Tunnel Air Quality Management Systems Effectiveness Report is to be prepared by the Proponent and reviewed by a suitably qualified and experienced independent specialist(s). The Secretary must approve the independent specialist /organisation.*

*The Proponent must comply with any requirements arising from the Secretary's review of the Tunnel Air Quality Management Systems Effectiveness Report."*

The TAQMSER has been prepared following the notification provided to the Secretary, EPA and NSW Health of Above Limit Reading recorded on 11 February 2020 relating to in-tunnel visibility in the eastbound tunnel.



It is noted that TAQMSERs have been prepared to address the occurrence of the previous visibility Above Limit Readings on both 1 August 2019 and 3 September 2019, which SNC-Lavalin Atkins provided comments on.

SNC-Lavalin Atkins has reviewed the detailed TAQMSE and provides the following comments:

1. The monitoring data shown in chapter 2, as well as the real time data provided on the WestConnex M4 Linkt website, includes two other visibility above-limit readings that have been recorded since operation of the tunnel began. These were recorded on 1 August and 3 September 2019, and as mentioned above SNC-Lavalin has previously provided comments on these readings. The comments supported the conclusions that the data provided in the TAQMSE reports for these occurrences was invalid. On the first occasion, the cause of the above-limit reading was attributed to a sensor being affected by direct sunlight and subsequently reporting invalid data and on the second occasion, mis-reporting by an air quality sensor during a maintenance period.
2. The TAQMSE states that maintenance works including manual updates to firmware on air quality sensors (AQSs) were being undertaken on 10, 11, 12 and 13 February 2020 to address issues associated with invalid recording of NO<sub>2</sub> due to interference caused by bushfire events in and surrounding Sydney.
3. The exceedances recorded in the eastbound tunnel on 11 February 2020 occurred at 1:15am – 2:30am, during a scheduled maintenance tunnel closure to carry out the manual upgrades to the in-tunnel air quality sensors.
4. Chapter 3 of the TAQMSE includes a summary of the Operations Management Control System (OMCS) event report. Data from the OMCS was reviewed by the proponent for both the eastbound and westbound tunnels, for the period of the exceedance as well as two hours pre and post the recorded above-limit reading. The eastbound tunnel was closed for maintenance and upgrades of the air quality monitoring sensors. Therefore, it is unlikely that the above-limit reading in the eastbound tunnel was caused by excessive vehicular traffic or an abnormal event such as a breakdown within the tunnel. The data review by the proponent indicated that no incidents (traffic jams or accidents) or plant operations (for example jet fan operations) occurred that would account for the visibility over-limit data on 11 February 2020. The TAQMSE also outlines that no emergencies were occurring within the tunnel at the time of the exceedance.
5. The TAQMSE also includes confirmation by Ecotech (the monitoring equipment technical supplier) that during the works outlined above on the evening of 10 February and morning of 11 February, one of the air quality sensors within the tunnel (sensor number AQS11001) was identified to be incorrectly reporting monitoring data to the Linkt website while in maintenance mode.
6. The ventilation outlet data provided in the TAQMSE report shows concentrations for all pollutants, including those within the ventilation outlets, were below specified limits during the periods of the in-tunnel visibility exceedance. Typically, the expectation would be for higher concentrations to be measured within the outlet compared to the average in the tunnel itself due to the build-up of pollution up to the point of release, however, this does not occur. As such, the lower ventilation outlet concentrations to in-tunnel concentrations, supports the likelihood that exceedances were attributed to calibration issues.
7. While the role of SNC-Lavalin Atkins is not to inspect or verify that the corrective actions identified have been implemented, we request a copy of appropriate evidence that demonstrates the successful rectification of the issue by SICE in the recent upgrade works as well as confirmation that the issue has been resolved during the next maintenance period.



Based on the information presented in the TAQM SER, and further review of publicly available monitoring data, the cause of the above limit reading as stated in the TAQM SER i.e. solely due to the air quality sensor AQS11001 reporting invalid data while in maintenance mode, is the most probable cause of the recorded above-limit reading. It is highly unlikely that the cause of the above goal reading is due to malfunction of the tunnel ventilation system or abnormal traffic events.

Should you have any queries regarding our comment, please do not hesitate to contact me by telephone on 0429 227 775 or email at Richard.Peterson@snc-lavalin.com.

Yours sincerely,

**SNC-LAVALIN ATKINS**



**Richard Peterson**

Director

*Environment & Geoscience  
Infrastructure*



No.	SNC Lavalin Comment	Response/Action
1	The monitoring data shown in chapter 2, as well as the real time data provided on the WestConnex M4 Linkt website, includes two other visibility above-limit readings that have been recorded since operation of the tunnel began. These were recorded on 1 August and 3 September 2019, and as mentioned above SNC-Lavalin has previously provided comments on these readings. The comments supported the conclusions that the data provided in the TAQM SER reports for these occurrences was invalid. On the first occasion, the cause of the above-limit reading was attributed to a sensor being affected by direct sunlight and subsequently reporting invalid data and on the second occasion, misreporting by an air quality sensor during a maintenance period.	Noted. No action required.
2	The TAQM SER states that maintenance works including manual updates to firmware on air quality sensors (AQSs) were being undertaken on 10, 11, 12 and 13 February 2020 to address issues associated with invalid recording of NO2 due to interference caused by bushfire events in and surrounding Sydney.	Noted. No action required.
3	The exceedances recorded in the eastbound tunnel on 11 February 2020 occurred at 1:15am – 2:30am, during a scheduled maintenance tunnel closure to carry out the manual upgrades to the in-tunnel air quality sensors.	Noted. No action required
4	Chapter 3 of the TAQM SER includes a summary of the Operations Management Control System (OMCS) event report. Data from the OMCS was reviewed by the proponent for both the eastbound and westbound tunnels, for the period of the exceedance as well as two hours pre and post the recorded above-limit reading. The eastbound tunnel was closed for maintenance and upgrades of the air quality monitoring sensors. Therefore, it is unlikely that the above-limit reading in the eastbound tunnel was caused by excessive vehicular traffic or an abnormal event such as a breakdown within the tunnel. The data review by the proponent indicated that no incidents (traffic jams or accidents) or plant operations (for example jet fan operations) occurred that would account for the visibility over-limit data on 11 February 2020. The TAQM SER also outlines that no emergencies were occurring within the tunnel at the time of the exceedance.	Noted. No action required.

No.	SNC Lavalin Comment	Response/Action
5	The TAQM SER also includes confirmation by Ecotech (the monitoring equipment technical supplier) that during the works outlined above on the evening of 10 February and morning of 11 February, one of the air quality sensors within the tunnel (sensor number AQS11001) was identified to be incorrectly reporting monitoring data to the Linkt website while in maintenance mode.	Noted. No action required.
6	The ventilation outlet data provided in the TAQM SER report shows concentrations for all pollutants, including those within the ventilation outlets, were below specified limits during the periods of the in-tunnel visibility exceedance. Typically, the expectation would be for higher concentrations to be measured within the outlet compared to the average in the tunnel itself due to the build-up of pollution up to the point of release, however, this does not occur. As such, the lower ventilation outlet concentrations to in-tunnel concentrations, supports the likelihood that exceedances were attributed to calibration issues.	Noted. No action required.
7	While the role of SNC-Lavalin Atkins is not to inspect or verify that the corrective actions identified have been implemented, we request a copy of appropriate evidence that demonstrates the successful rectification of the issue by SICE in the recent upgrade works as well as confirmation that the issue has been resolved during the next maintenance period.	Noted. Updated patch notes from SICE will be provided to SNC Lavalin.

## Tunnel Air Quality Management Systems Effectiveness Report

WestConnex M4 East

To be submitted to DPE within 20 days of receiving a request from the Secretary in accordance with E7

<b>Details of the exceedance</b> Attach relevant Notification of Above-limit Reading	<p>This report has been prepared to address the requirements under MCoA E7:</p> <p>"Within 20 working days of any request by the Secretary a Tunnel Air Quality Management Systems Effectiveness Report on the overall system performance and cause and major contributor of any exceedances, detailing the following:</p> <ul style="list-style-type: none"> <li>a) The overall performance and concentration levels in the tunnel for the preceding six month period (or since commencement of operation, where the SSI has operated for under 6 months), including average and maximum level and time periods</li> <li>b) Details of any instances throughout the operation of the SSI where pollutant concentration levels in the tunnel have exceeded the limits specified in conditions E2, E3 and E4; and</li> <li>c) Consideration of improvement to the tunnel air quality management systems"</li> </ul> <p>The following parameter was reported with above-limit reading on 11/02/2020:</p> <ul style="list-style-type: none"> <li>- Visibility – 15 min Maximum reading of 0.0069 m<sup>-1</sup></li> </ul> <p>The notification of In-tunnel above-limit reading was issued to Secretary, EPA and NSW Health as required under MCoA E6 (refer to Section 1 of this report).</p>	
<b>Was the data valid?</b> If invalid, include any details or justifications for the invalidity	<p>The data was invalid.</p> <p>It has been identified that rectification work in relation to the air quality sensors, including a firmware upgrade to help eliminate interferences caused from recent bushfires, resulted in a full scale reading being exported directly to the website for the In-Tunnel visibility, even though all monitors were placed in maintenance mode.</p> <p>Section 2 of this report is the website records for the required parameters for in-tunnel and ventilation facilities.</p> <p>Section 3 of this report is the event report extracted from the M4 Operations Management Control Systems (OMCS).</p> <p>Section 5 of this report is the correspondence from the maintenance contractor, Ecotech.</p>	
<b>The overall performance and concentration levels in the tunnel for the preceding six month period, including average and maximum levels and time periods</b>	<p>The in-tunnel concentration levels since commencement of operations can be seen in Section 2.</p>	
<b>Details of any instances throughout the operation of the SSI where pollutant concentration levels in the tunnel have exceeded the limits specified in conditions E2, E3 and E4</b>  Attach relevant previous Notification of Above-Limit Reading	<p>In-tunnel NO<sub>2</sub> concentrations recorded 8 prior above limit readings, which has been attributed to high ambient particulate concentrations due to exceptional bush fire events in Sydney. . These readings were recorded on the:</p> <ul style="list-style-type: none"> <li>- 19<sup>th</sup> November 2019</li> <li>- 21<sup>st</sup> November 2019</li> <li>- 2<sup>nd</sup> December 2019</li> <li>- 3<sup>rd</sup> December 2019</li> <li>- 4<sup>th</sup> December 2019</li> <li>- 5<sup>th</sup> December 2019</li> <li>- 10<sup>th</sup> December 2019</li> <li>- 19<sup>th</sup> December 2019</li> </ul> <p>In-tunnel visibility has exceeded above limit readings due to calibration issues on the:</p> <ul style="list-style-type: none"> <li>- 2<sup>nd</sup> August 2019</li> <li>- 3<sup>rd</sup> September 2019</li> </ul>	
<b>Consideration of improvements to the tunnel air quality management system</b>		
This is to include consideration of improvements to the tunnel air quality management system so as to achieve compliance with the In-tunnel limits.		
The issue with monitor AQS11001 failing to stop reporting data when in maintenance mode has been rectified by SICE, as outlined in the letter from the Ecotech's national Tunnel Service Manager (Section 4). This should prevent the issue from re-occurring.		
<b>Person responsible for report</b>	Name	Peter Redwin
	Position	Head of Operations and Maintenance
	Organisation	WestConnex Transurban
	Date	11.3.2020

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## 1. Initial Notification

<b>Notification of In-Tunnel above-limit reading</b> WestConnex M4 East		
<p>To be notified immediately to Project Company and RMS. Project Company is to notify DPE, EPA and NSW Health within 24 hours.</p>		
Date	11 <sup>th</sup> February 2020	
Time (start and finish)	01:15 – 02:30 hrs	
Relevant location within the tunnel	Eastbound	
Relevant limit	<input type="checkbox"/> CO – Rolling 15-minute average of 87 ppm	
	<input type="checkbox"/> CO – Rolling 30-minute average of 50 ppm	
	<input type="checkbox"/> CO – Rolling 3-minute average of 200 ppm (single point)	
	<input type="checkbox"/> NO <sub>2</sub> – Rolling 15-minute average of 0.5 ppm	
	<input checked="" type="checkbox"/> Visibility – Rolling 15-minute average of 0.005 m <sup>-1</sup>	
Above-limit reading Detail the above-limit reading that was received	Eastbound: 0.0069 m <sup>-1</sup>	
Duration Detail the duration of the above-limit reading or event	1 hour 15 minutes	
Nature of event Detail nature of the event that contributed to the above-limit reading	Routine maintenance was being carried out on in-tunnel AQS on the eastbound mainline, during the tunnel closure.	
Was the data valid? If unknown at this stage, please indicate.	No. Eastbound AQS were undergoing routine maintenance and calibration.	
Was there an emergency? Refer section 6.5 of this Plan. If this is unknown at this stage, please indicate.	No.	
Measures employed Detail measures employed to minimise the concentration levels		
<b>Commitment to prepare and submit a Tunnel Air Quality Management Systems Effectiveness Report</b> A Report on Above-limit Reading will be prepared following any request by the Secretary in accordance with E7 for this notification. Please note that a Report is not required in the event of an emergency.		
Person responsible for notification	Name	Peter Redwin
	Position	Head of Operations and Maintenance
	Organisation	WestConnex Transurban

## 2. Air Quality Monitoring Results

The following diagrams were captured from the official website for the Air Monitoring on M4E.

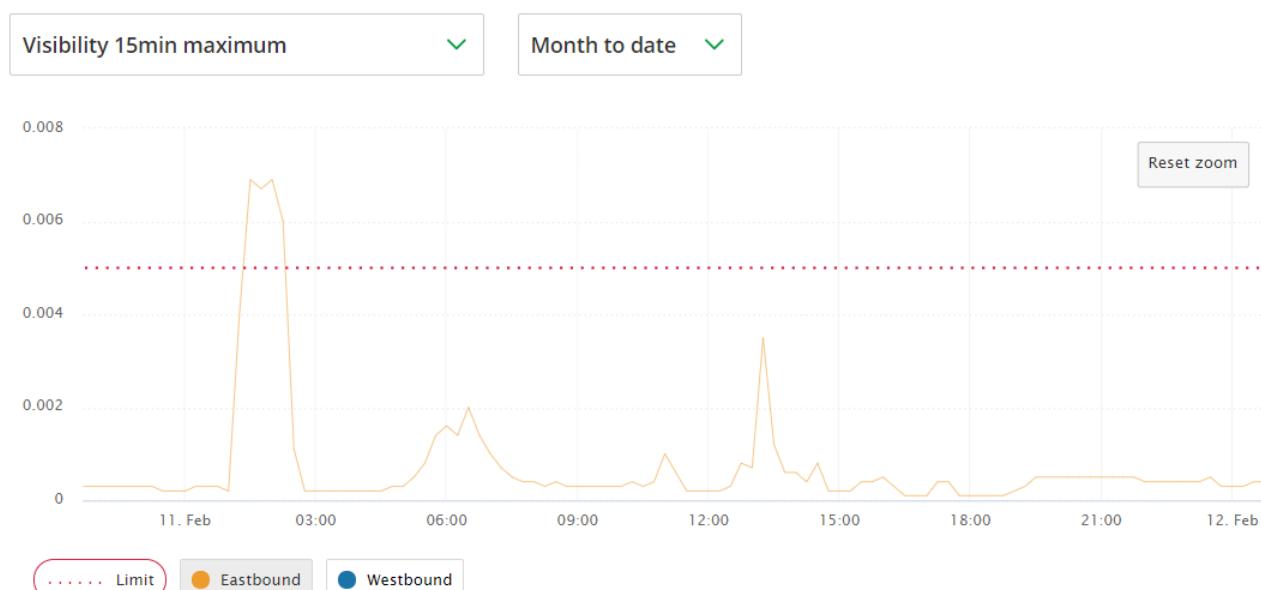
(<https://www.linkt.com.au/sydney/using-toll-roads/about-sydney-toll-roads/westconnex-m4/tunnel-air-quality>). The overall performance and concentration levels displayed below include the In-tunnel parameters (Section 2.1) and Ventilation facility monitoring parameters (Section 2.2) for the preceding six month period from February 2020, in accordance with the MCoA E7.

### 2.1 In-Tunnel Conditions

The pollutants measured throughout the M4East tunnel (SSI 6307) are nitrogen dioxide and carbon monoxide, the two primary pollutants of combustion engines. For driver safety, visibility is also measured throughout the tunnel to ensure drivers vision is uninhibited.

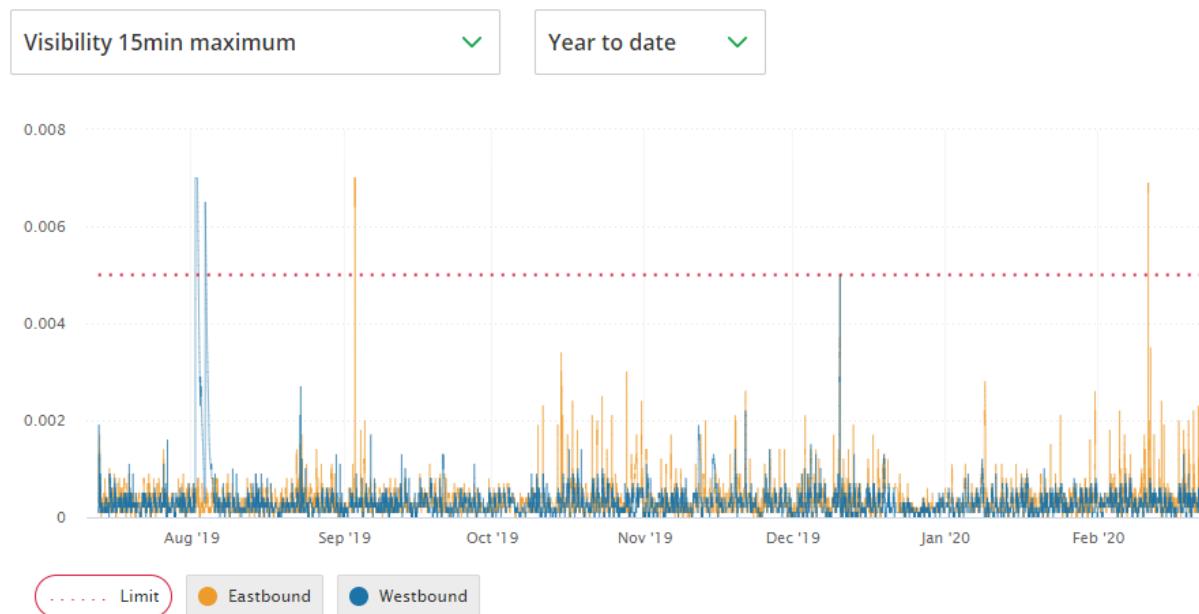
#### 2.1.1 Visibility 15 min maximum – Above-limit reading 11<sup>th</sup> February 2020

##### Air quality over time



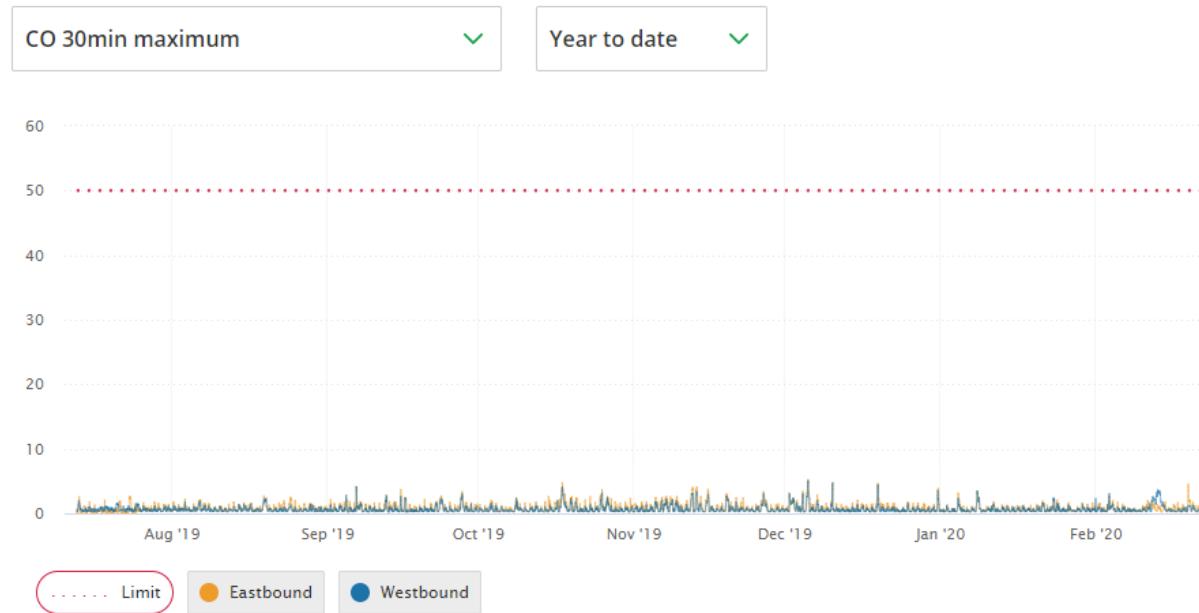
### 2.1.2 Visibility 15 min maximum – Commencement of operations: 13<sup>th</sup> July 2019 to present

#### Air quality over time



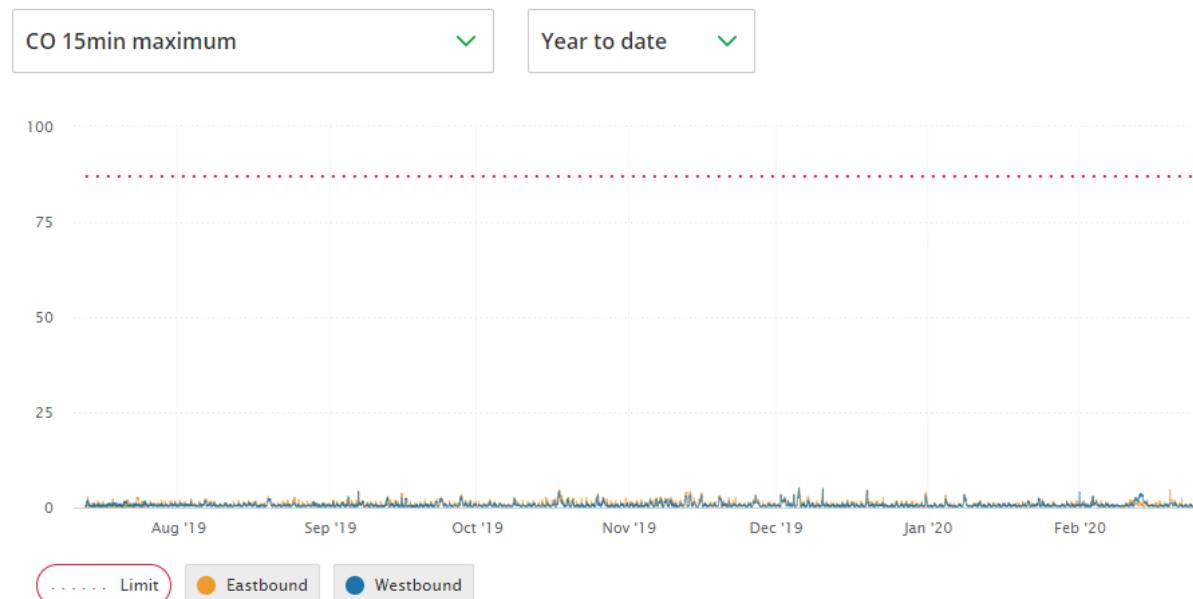
### 2.1.3 CO 30min maximum – Commencement of operations: 13<sup>th</sup> July 2019 to present

#### Air quality over time



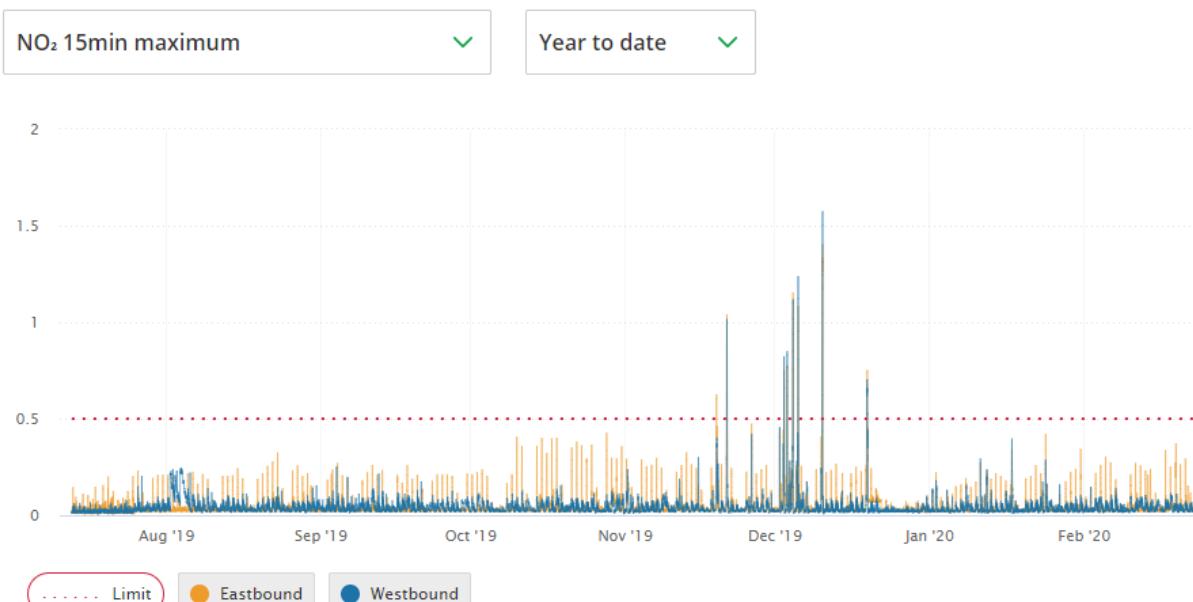
#### 2.1.4 CO 15min maximum – Commencement of operations: 13<sup>th</sup> July 2019 to present

##### Air quality over time



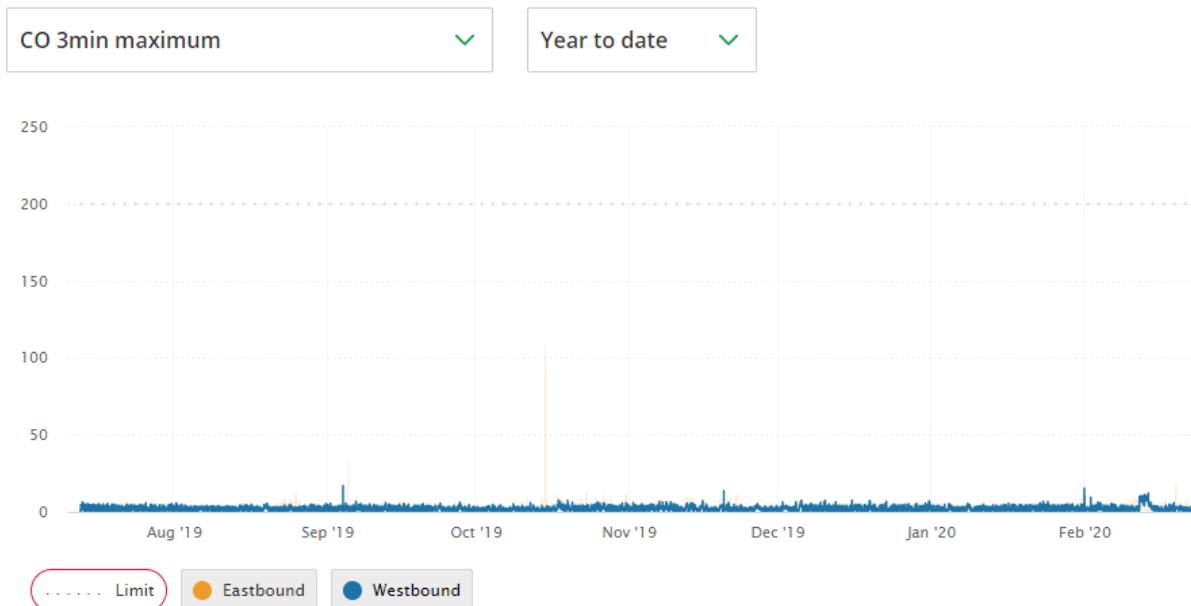
#### 2.1.4. NO<sub>2</sub> 15 min maximum – Commencement of operations: 13<sup>th</sup> July 2019 to present

##### Air quality over time



### 2.1.5 CO 3min maximum – Commencement of operations: 13<sup>th</sup> July 2019 to present

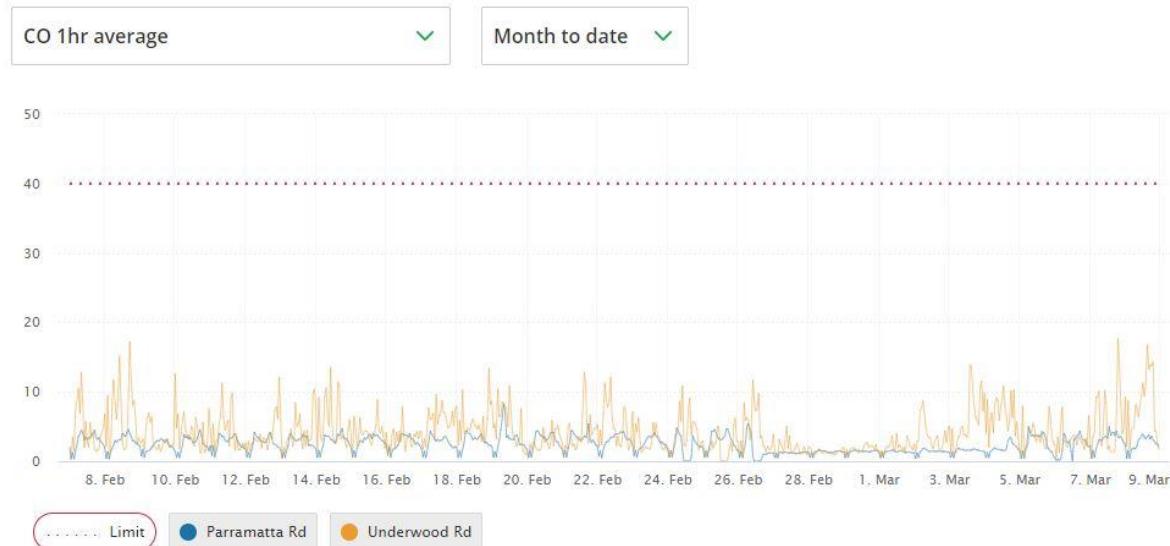
#### Air quality over time



## 2.2 Ventilation Monitoring (Parramatta Road and Underwood Rd Ventilation Facilities)

### 2.3.1 CO 1 hour average (February 2020)

#### Air quality over time



### 2.3.2 NO<sub>2</sub> 1 hour average (February 2020)

## Air quality over time



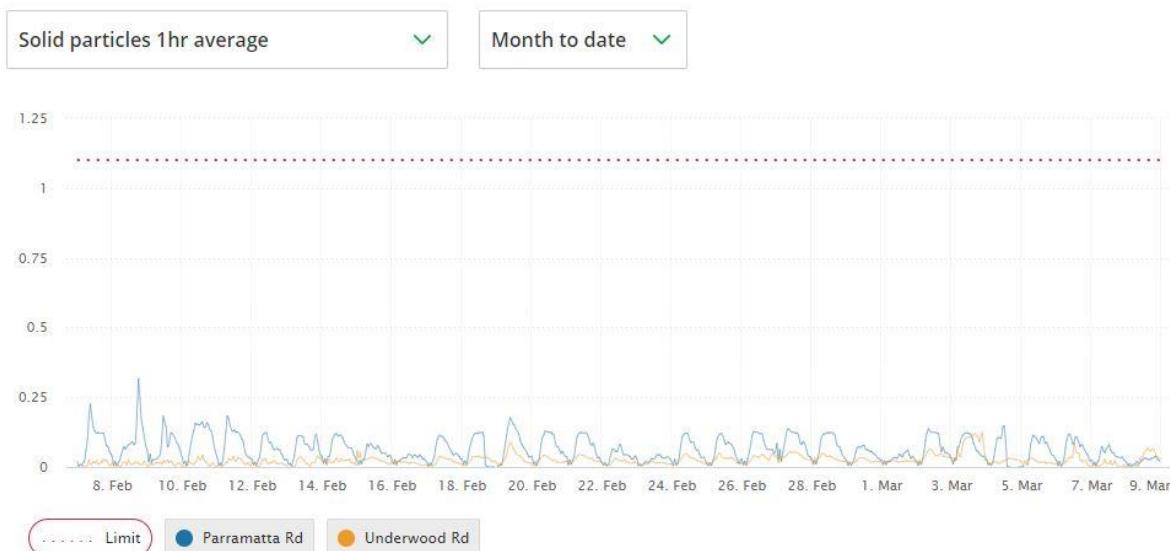
### 2.3.3. NO<sub>x</sub> 1 hour average (February 2020)

## Air quality over time



### 2.3.4 Solid Particles 1 hour average (February 2020)

## Air quality over time



### 2.3.5 VOC 1 hour average (February 2020)

## Air quality over time



### **3. Operations Management Control System (OMCS)**

The Operations Management Control System (OMCS) is the overall governing control system that ensures; the motorway operates safely, mitigates the effects of incidents, safeguards from damage and improve situational awareness. The OMCS controls the road closure as an automated and orderly integrated process and ensures the sequencing of actions on multiple devices. The OMCS encompasses the following.

- Plant Management Control System (PMCS) - represents the hardware and software systems that monitor and control Motorway plant, sub-systems and equipment in real time. The PMCS enables the operators to observe the status and control of the tunnel, including pumps, lighting, ventilation, drainage and fire protection systems as required to provide effective response to incidents.
- Traffic Management Control System (TMCS) – represents the hardware and software systems that monitor and control all traffic-related devices on the Motorway, in real time. The TMCS enables the operators to control and observe the status of traffic control devices.
- Incident Management System (IMS) – provides part of the PMCS/TMCS control system software. The IMS provides the interface through which operators will manage events.

#### **3.1 Event Report**

Review of data from the OMCS, both eastbound and westbound, from a two hour post, during and two hour pre- exceedance time revealed that no incidents (traffic jams or accidents) or plant operations (for example jet fan operations) occurred that would account for the visibility over-limit data on 11<sup>th</sup> February.

## 4. SS1 – 6307 Conditions of Approval: E7

### 4.1 Overall performance and cause and major Contribution of Exceedances -E7(a) and E7(b)

A total of 10 prior in-tunnel air quality above limit readings have been recorded in the last six months.

There have been 8 above-limit NO<sub>2</sub> recordings and two visibility exceedances. Details of the above-limit NO<sub>2</sub> in-tunnel air quality exceedances are as follows:

- 19th November 2019 – Eastbound reading of 0.626 ppm
- 21st November 2019 – Eastbound reading of 1.041 ppm – Westbound reading of 1.017 ppm
- 2nd December 2019 – Eastbound reading of 0.753 ppm – Westbound reading of 0.824 ppm
- 3rd December 2019 – Eastbound reading of 0.775 ppm – Westbound reading of 0.848 ppm
- 4th December 2019 – Eastbound reading of 1.153 ppm – Westbound reading of 1.120 ppm
- 5th December 2019 – Eastbound reading of 1.082 ppm – Westbound reading of 1.236 ppm
- 10th December 2019 – Eastbound reading of 0.751 ppm – Westbound reading of 0.703 ppm
- 19<sup>th</sup> December 2019 – Eastbound reading of 0.751 ppm - Westbound reading of 0.703 ppm

The cause and major contributing factor of the 8 above limit NO<sub>2</sub> recordings were hazardous smoke levels recorded across the Sydney basin during the time of the exceedances. Initial investigations have shown the high ambient smoke levels were interfering with in tunnel NO<sub>2</sub> sensors. Ventilation outlet monitoring of NO<sub>2</sub> remained well below the 2.0 mg/m<sup>3</sup> limit. At the time of in-tunnel above limit reading, both ventilation outlet NO<sub>2</sub> levels recorded readings of below 0.40g/m<sup>3</sup>. As the AQS in tunnel are different to the ventilation outlet, it was thought smoke interference was the primary driver for the high readings.

Details of the two in tunnel visibility exceedances recorded are as follows:

- 2nd August 2019: 15-minute maximum reading of 0.007 m-1
- 3rd September 2019: 15-minute maximum reading of 0.007 m-1

Previous investigations of the in-tunnel visibility exceedances attributed the location of the visibility sensors within M4 East and interference of ambient light on the sensors as the cause and major contributing factor causing misreadings.

### 4.2 Considerations of Improvements – E7 (c)

The M4East tunnel (SSI 6307) has 27 AQS throughout, designed to constantly monitor air quality to ensure levels are maintained within a safe range. The pollutants measured are nitrogen dioxide and carbon monoxide, the two primary pollutants of combustion engines. For driver safety, visibility is also measured throughout the tunnel to ensure drivers vision is uninhibited.

Maintenance work on sensors to rectify interferences of NO<sub>2</sub> readings caused by recent bushfire events in Sydney were scheduled for 10<sup>th</sup> February to 13<sup>th</sup> February 2020 by Ecotech. During the process, Sensor number AQS11001 was identified as having a problem in that it failed to stop reporting data when set to maintenance mode. This problem has since been rectified by SICE in recent upgrade works. Ecotech will check that the issue has been resolved during the next maintenance work (closure) period.

## 5. Ecotech Correspondence

The below letter of correspondence relates to maintenance work conducted by the Specialist Contractor, Ecotech, on 10/02/20 during the M4 East tunnel closure. The system was changed from the available mode to maintenance/unavailable mode prior to midnight on the 10<sup>th</sup> February and the device continued to report data early hours of the morning on 11/02/2020.



Wilf Gray  
ECOTECH  
40/65 Marigold Street  
Revesby  
NSW 2212

19/02/2020

Mr Justin Hazelbrook  
Fulton Hogan Egis  
10 Homebush Bay Dr  
Homebush  
NSW 2140

### RE – Visibility Exceedance on AQS11001 XP02 Eastbound 10/02/2020

Dear Justin,

During the recent M4 East tunnel closure, a visibility exceedance occurred on sensor number AQS11001 during maintenance. The work being performed included a firmware upgrade to eliminate the cross interferences of NO<sub>2</sub> caused by the very high PM<sub>2.5</sub> particulates levels from recent bushfires.

During this exercise, all AQS' were placed in 'maintenance mode' prior to the works being undertaken which should force the SCADA to stop any data from been recorded and exported to the live website.

Unfortunately, a full scale reading on the visibility channel was recorded on this instrument during maintenance, which subsequently was displayed on the project website. This was noticed approximately 1 hour after the incident. We understand that the issue of 'maintenance mode' data not being filtered has now been rectified by SICE in the latest patch upgrade, and this issue should not reoccur.

Ecotech technicians will ensure that this system upgrade is working correctly prior to proceeding with any maintenance works on the next closure.

We apologise for any inconvenience this may have caused. Please do not hesitate to contact the undersigned for any further information.

Yours sincerely,

Wilf Gray  
National Tunnel Service Manager

## 6. Conclusion

Initial findings indicate that the visibility over-limit reported on 11<sup>th</sup> February 2020 was not due to an in-tunnel incident such as traffic congestion or accidents. The data presented in Section 2 and 3 show at the time and date of the in-tunnel visibility exceedance, ventilation monitoring sensors for all reportable pollutants were below the concentration limits specified under the M4 East, SSI-6307 Conditions of Approval, E2, E3 and E4.

The immediate notification of In-tunnel above-limit reading was issued to the Secretary, EPA and NSW Health on 11<sup>th</sup> February 2020 as required under MCoA E6.

The root cause of the above-limit visibility reading was attributed to maintenance work on in-tunnel Air Quality Analysers on the night of February 10<sup>th</sup> to 11<sup>th</sup> 2020. All analysers were placed in maintenance mode which prevents data from being reported to the website, however, it was noticed that AQS11001 still reported data to the system when in maintenance mode. This problem has since been rectified and should no longer occur. The AQS will be checked by Ecotech during future scheduled maintenance work.

The overall air quality system performance and concentration levels in the tunnel for the preceding six months have been included in Section 4.1, as required under SSI-6307 Conditions of Approval, E7.

Investigations into the notification of in-tunnel over-limit reading for visibility on 11<sup>th</sup> February 2020 concludes that the data was invalid.

## 7. Definition and Acronyms

	Description
AQA	Air Quality Analyser
AQS	Air Quality Sensor
IMS	Incident Management System
NOx	The total concentration of all nitrogen oxide gases.
NO2	Nitrogen Dioxide
OMCS	Operation Management Control System
PMCS	Plant Monitoring and Control System
TMCS	Traffic Monitoring and Control System

## 8. Reference Documents

Document Number	Document Title	Rev.
M4E-CP-OPM-PWD-09062	M4 East Operation & Maintenance Manual (Vol. 5) - Part 1. OMCS – SIDERA	B
M4E-CP-OPM-PWD-09950	M4 East Operation & Maintenance Manual (Vol. 5) - Part 4.1. PMCS – Tunnel Ventilation System	B
M4E-CP-OPM-PWD-08774	M4 East Operation & Maintenance Manual (Vol. 4) - Part 6. Tunnel Ventilation System	B
M4E-CP-OPM-PWD-08726	M4 East Operation & Maintenance Manual (Vol. 2) - Part 11. Air Quality Monitoring System	B
M4E-60-657a-T015-00003-A-PD6	Operation and Maintenance Manual (Tunnel Sensors)	V1.5

