

TUNNEL VENTILATION SYSTEM

EMISSION DATA – AIR QUALITY MODELLING

NORMAL AND INCIDENT CASES

FOR

EastLink

FOR

THIESS JOHN HOLLAND JOINT VENTURE (TJHJV)

DESIGN LOT NUMBER:	VE03
DOCUMENT NUMBER:	AL-M04-RPT-VE03-0002
REVISION:	A-06

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UNITED GROUP RAIL

ABN 30-097-323-852

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0.2 Approval Record

Function	Position	Name	Signature	Date
Report and calculation review	Senior Ventilation Engineer Design Engineer	S. Messenger J. Cura	Refer to attached DVR's	/
Reviewed by	Design Manager (Mech)	K. Dobrich	<i>K. Dobrich</i>	23/02/06
Approved by	Project Manager	J McDonald	<i>J McDonald</i>	23/02/06

0.3 Amendment Record

Changes made to this document since its last revision, which affect its scope or sense, are marked in the right margin by a vertical bar (|).

DATE	REV	AMENDMENT DESCRIPTION	BY	INITIALS
04/07/05	A-01	Original Issue	J. Fincher	JGF
17/08/05	A-02	Text revisions to section 2.3 Minor text and format revisions.	J. Fincher	JGF
18/11/05	A-03	Polynuclear Aromatic Hydrocarbons (PAH) total added to calculations	J. Fincher	JGF
25/11/05	A-04	Minor text and format revisions. Calc method revised.	J. Fincher	JGF
25/01/06	A-05	Minor table revisions and the addition of formaldehyde emissions.	J. Fincher	JGF
31/01/06	A-06	Text revisions to incorporate EPA review comments.	J. Fincher	JGF

0.4 Distribution Record

The Project Manager ensures that the current version of this document is available to all UNITED Project Team Members and issues maintained or unmaintained copies to applicable external organisations.

Issue details are recorded in the EastLink Document Register. When issued, it is the responsibility of the user to replace superseded material with the current issue. Superseded material should be DESTROYED or marked "SUPERSEDED" as appropriate by the user.

0.5 Master Documents

The MASTER of this document is stored as a signed electronic PDF file attached to the following document register record.

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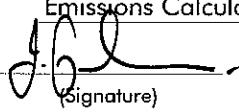
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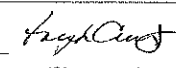
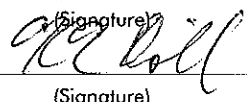
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"MASTER's" that have been superseded are attached to the relevant database record and are located in the "Documents with History" view of the above database.

1 CUSTOMER: TJH
PROJECT: EASTLINK PROJECT

2 VERIFICATION OF: Tunnel Air Quality Monitoring - Emissions Calculations
DMP/DAN N^o: VE03-04
VERIFICATION TYPE: DESIGN CHECK INDEPENDENT REVIEW IDV

3 DOCUMENT PACKAGE:
DESIGN INPUTS: Hyder report 5002-VCO1933-VCR-00
PIARC.11.05.14.B
AusVeh Vehicle Emission Factors (EPA)
PREVIOUS REPORTS:
DESIGN OUTPUTS: Emissions Calculations (Calc. No. VE03-005)
PREPARED BY:  J. Fincher Design Engineer 23/2/06
(Signature) (Name) (Position) (Date)

4 DESIGN CHECK REPORT/SUMMARY:
The emission calculation (Calc. No. VE03-005) follows the correct methodology. The calculation follows the logic of PIARC for emission calculations
CHECKING ENGINEER:  J. Cura 23/02/06
(Signature) (Name) (Date)
APPROVED BY PROJECT ENGINEER:  K. Dobrich 23/02/06
(Signature) (Name) (Date)

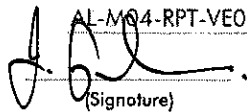
5 INDEPENDENT REVIEW REPORT/SUMMARY:
REVIEWING ENGINEER: _____
(Signature) (Name) (Date)
APPROVED BY CHIEF ENGINEER: _____
(Signature) (Name) (Date)
ACCEPTED BY PROJECT ENGINEER: _____
(Signature) (Name) (Date)

6 IDV REPORT/SUMMARY:
IDV METHOD(S) REVIEW SIMULATION DIMENSIONAL AND MATERIAL CHECK
 PROTOTYPE TEST PROVEN DESIGN COMPARISON ALTERNATIVE ANALYSIS
IDV ENGINEER: _____
(Signature) (Name) (Date)
APPROVED BY CHIEF ENGINEER: _____
(Signature) (Name) (Date)
ACCEPTED BY PROJECT ENGINEER: _____
(Signature) (Name) (Date)

- Completion Notes**
- 1 Report to be registered in accordance with QSP 05.3 and number and date issued recorded on the DMP/DAN or Project Programme.
 - 2 Sections 1 to 3 to be completed by Project Engineer or delegate after design output activities have been completed.
 - 3 Section 4 to be completed by the Engineer conducting the Design Check.
 - 4 Section 5 to be completed by the the Reviewing Engineer and Approved by the Chief Engineer.
 - 5 Section 6 to be completed by the IDV Engineer and approved by the Chief Engineer.
 - 6 Section 5 & 6 The Chief Engineer may nominate a Reviewing Engineer or IDV Engineer or the Chief Engineer may assume these functions
 - 7 Continuation sheets should be used for recording details of Checks/Reviews/IDV

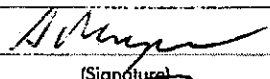
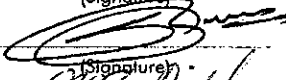

1 CUSTOMER: TJH
PROJECT: EASTLINK PROJECT

2 VERIFICATION OF: Tunnel Air Quality Monitoring - Emissions Calculations
DMP/DAN N^o: VE03-04
VERIFICATION TYPE: DESIGN CHECK INDEPENDENT REVIEW IDV

3 DOCUMENT PACKAGE:
DESIGN INPUTS: Hyder report 5002-VCO1933-VCR-00
PIARC.11.05.14.B
AusVeh Vehicle Emission Factors (EPA)
PREVIOUS REPORTS: _____
DESIGN OUTPUTS: AL-M04-RPT-VE03-003-003-A-06
PREPARED BY:  J. Fincher Design Engineer 23/2/06
(Signature) (Name) (Position) (Date)

4 DESIGN CHECK REPORT/SUMMARY:

CHECKING ENGINEER: _____
(Signature) (Name) (Date)
APPROVED BY PROJECT ENGINEER: _____
(Signature) (Name) (Date)

5 INDEPENDENT REVIEW REPORT/SUMMARY:
General review of consistency and clarity of Report (Output data checked sperately)
REVIEWING ENGINEER:  S. Messenger 23/02/06
(Signature) (Name) (Date)
APPROVED BY CHIEF ENGINEER:  R. Thomson 23/02/06
(Signature) (Name) (Date)
ACCEPTED BY PROJECT ENGINEER:  K. Dobrich 23/02/06
(Signature) (Name) (Date)

6 IDV REPORT/SUMMARY:
IDV METHOD(S) REVIEW SIMULATION DIMENSIONAL AND MATERIAL CHECK
 PROTOTYPE TEST PROVEN DESIGN COMPARISON ALTERNATIVE ANALYSIS

IDV ENGINEER: _____
(Signature) (Name) (Date)
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(Signature) (Name) (Date)
ACCEPTED BY PROJECT ENGINEER: _____
(Signature) (Name) (Date)

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1.0 PURPOSE

UNITED is responsible for the design and installation of the tunnel ventilation system for this project, and for the preparation of input data (stack emissions) for air quality dispersion modelling to be carried out by others.

Previous reports have been prepared based on vehicle emission factors calculated from limited EPA data. More extensive vehicle emission factor data has now been sourced from EPA. This report presents stack emission data based on this more detailed information for normal and incident cases.

Stack emission data for the following incident cases is presented this report:

Design Year 2008:

- 3 lanes operational at 80 km/hr.(Normal Outbound)
- 3 lanes operational at 80 km/hr.(Normal Inbound)
- 3 lanes operational at 20 km/hr.(Incident)
- 2 lanes operational at 20 km/hr.(Incident)
- 3 lanes operational at 10 km/hr.(Incident)
- 2 lanes operational at 10 km/hr.(Incident)

Design Year 2011:

- 3 lanes operational at 80 km/hr.(Normal Outbound)
- 3 lanes operational at 80 km/hr.(Normal Inbound)
- 3 lanes operational at 20 km/hr.(Incident)
- 2 lanes operational at 20 km/hr.(Incident)
- 3 lanes operational at 10 km/hr.(Incident)
- 2 lanes operational at 10 km/hr.(Incident)

Stack emissions for design years 2021, and 2031 have not been calculated as these will not be worst case scenarios because although vehicle volume increases by approximately 25% between 2011 and 2021 the combined vehicle emission factors decrease by approximately 50% over the same period, the net effect being a reduction in overall emissions.

2.0 BASE DATA

2.1 Tunnel Arrangement:

The EastLink tunnels comprise dual three lane tunnels (eastbound and westbound) under the Mullum Mullum Creek valley; approximately 1600m in length and 96m² finished cross section. Vertical profile is 5.5% grades either side of a sag curve under Mullum Mullum creek.

For the purposes of calculation of dispersion modelling input data, the tunnel vertical profile has been modelled as follows:

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Eastbound Tunnel

Location	Section 1	Section 2	Section 3	Section 4	Section 5
From Chainage	19900	20360	20538	20743	21370
To Chainage	20360	20538	20743	21370	21550
Length (km)	0.460	0.178	0.205	0.627	0.180
Gradient	-5.50%	-5.50%	0.00%	5.50%	0.00%
Number of lanes	3	3	3	3	3
Gross cross section area (approx)	100	100	100	100	100
Perimeter	39.2	39.2	39.2	39.2	39.2
Section Height	8.7	8.7	8.7	8.7	8.7

Westbound Tunnel

Location	Section 1	Section 2	Section 3	Section 4	Section 5
From Chainage	21550	21370	20743	20538	20000
To Chainage	21370	20743	20538	20000	19900
Length (km)	0.180	0.627	0.205	0.538	0.100
Gradient	0.00%	-5.50%	0.00%	5.50%	5.50%
Number of lanes	3	3	3	3	3
Gross cross section area (approx)	100	100	100	100	100
Perimeter	39.2	39.2	39.2	39.2	39.2
Section Height	8.7	8.7	8.7	8.7	8.7

2.2 Ventilation System:

The ventilation system within each tunnel is a longitudinal system comprising tunnel jet fans and a main vent station at the downstream portal. Main vent station capacity is nominally 600m³/sec (4 fans operating). System turndown is 4, 3, 2 and 1 fans.

The ventilation control system will be based on zero portal emissions (nominal 0.75 – 1.0 m/sec average inflow velocity on a 15 minute rolling average).

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Stack airflow for all incident cases is assumed to be the maximum vent station capacity of 600m³/sec for the duration of the incident (stack efflux velocity: 17.1 m/sec. based on a design stack tip cross section of 35m² as agreed with TJH).

Stack air flows for normal operation for both the outbound and citybound tunnels have been taken as follows:

8pm to 5am	2 fans operational	300m ³ /s stack flow	8.6 m/sec efflux velocity
5am to 10am	4 fans operational	600m ³ /s stack flow	17.1 m/sec efflux velocity
10am to 3pm	3 fans operational	450m ³ /s stack flow	12.6 m/sec efflux velocity
3pm to 8pm	4 fans operational	600m ³ /s stack flow	17.1 m/sec efflux velocity

(Note that actual flows for reduced fan numbers will be greater than the figures listed above as a result of the reduced fan pressure required. This leads to some conservatism in the stack efflux velocity)

2.3 Traffic Volumes and Mix:

Traffic volumes and vehicle mix for relevant design years 2008 and 2011 have been adopted as follows:

Predicted hourly traffic profiles are as estimated by Hyder Consulting (Refer Hyder Consulting report: EastLink Project – Traffic and Emissions Data – Report No. 5002-VCO1933-VCR-00 – 9 June 2005). For incident cases, traffic volumes assumed are the PIARC nominated maximums for the applicable speeds: 2008, 2011, 2021, and 2031.

Vehicle traffic volumes through the tunnels as a function of traffic speed have been derived in accordance with PIARC recommendations. (PIARC.11.05.14.B-2004 Table II.1-2 Average peak traffic density Table).

Note that the Hyder Consulting data provides traffic mix numbers for the following vehicle categories only:

- Passenger vehicles (PV's)
- Light commercial vehicles (LCV's)
- Heavy commercial vehicles (HCV's)

The AusVeh vehicle emission factor data provided by EPA (refer 2.4 below) includes additional categories; the following approach has been adopted to distribute the 3 Hyder categories into the AusVeh categories for the purposes of emissions calculations:

Australian Bureau of Statistics vehicle registration data (ABS Motor Vehicle Census, 31 March 2004 – Document 9309.0) have been combined as necessary into the slightly lesser number of EPA categories. National rather than state figures have been used. This will have negligible effect on the results as the actual numbers of passenger vehicles, and light and heavy commercial vehicles are nominated in the Hyder traffic data and fuel type split in the ABS data is on national figures, not by state. (refer to the Attachments for a comparison of national and state data).

The ABS data has then been used to estimate the total number of registered vehicles within each of the EPA categories.

The EPA categories are then combined into the 3 Hyder categories.

For the normal diurnal flow scenario, the number of EPA category vehicles (and hence vehicle emissions) in the tunnel at each hour of the day can be calculated by simple proportion.

For incident cases, tunnel traffic volumes are in accordance with the PIARC speed/volume tables. Traffic volume for the purposes of emissions calculations are as per the Hyder Consulting traffic

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data for normal operation and for incident cases are in accordance with the PIARC speed/volume tables, i.e. the maximum number of vehicles at each speed considered).

Refer to the attachments for details of speed – capacity curves.

The following table shows the adopted correlation of ABS, AusVeh and Hyder vehicle categories:

Hyder Consulting Vehicle Category	ABS Vehicle Category	AusVeh Vehicle Category
Passenger Vehicle	Passenger Vehicle - Leaded	Passenger Vehicle - Petrol
Passenger Vehicle	Passenger Vehicle - Unleaded	Passenger Vehicle - Petrol
Passenger Vehicle	Campervan - Leaded	Passenger Vehicle - Petrol
Passenger Vehicle	Campervan - Unleaded	Passenger Vehicle - Petrol
Passenger Vehicle	Motorcycle - Leaded	Motorcycle
Passenger Vehicle	Motorcycle - Leaded	Motorcycle
Passenger Vehicle	Motorcycle – Diesel	Motorcycle
Passenger Vehicle	Motorcycle – LPG/other	Motorcycle
Passenger Vehicle	Passenger Vehicle - Diesel	Passenger Vehicle - Diesel
Passenger Vehicle	Campervan - Diesel	Passenger Vehicle - Diesel
Passenger Vehicle	Passenger Vehicle – LPG/other	Passenger Vehicle - LPG
Passenger Vehicle	Campervan – LPG/other	Passenger Vehicle - LPG
Light Commercial Vehicle	Light Commercial Vehicle - Leaded	Light Commercial Vehicle - Petrol
Light Commercial Vehicle	Light Commercial Vehicle - Unleaded	Light Commercial Vehicle - Petrol
Light Commercial Vehicle	Light Commercial Vehicle - Diesel	Light Commercial Vehicle - Diesel
Light Commercial Vehicle	Light Commercial Vehicle – LPG/other	Light Commercial Vehicle - LPG
Heavy Commercial Vehicle	Light Rigid Truck - Leaded	Rigid Truck - Petrol
Heavy Commercial Vehicle	Light Rigid Truck - Unleaded	Rigid Truck - Petrol
Heavy Commercial Vehicle	Heavy Rigid truck - Leaded	Rigid Truck - Petrol
Heavy Commercial Vehicle	Heavy Rigid truck - Unleaded	Rigid Truck - Petrol
Heavy Commercial Vehicle	Light Rigid truck - Diesel	Rigid Truck - Diesel
Heavy Commercial Vehicle	Heavy Rigid truck - Diesel	Rigid Truck - Diesel
Heavy Commercial Vehicle	Light Rigid truck – LPG/other	Rigid Truck - LPG
Heavy Commercial Vehicle	Heavy Rigid truck – LPG/other	Rigid Truck - LPG
Heavy Commercial Vehicle	Articulated Truck - Leaded	Articulated Truck - Petrol
Heavy Commercial Vehicle	Articulated Truck - Unleaded	Articulated Truck - Petrol
Heavy Commercial Vehicle	Articulated Truck – LPG/other	Articulated Truck - Petrol
Heavy Commercial Vehicle	Articulated Truck – Diesel	Articulated Truck - Diesel
Heavy Commercial Vehicle	Non Freight Carrying Truck - Leaded	Non Freight Carrying Truck - Petrol
Heavy Commercial Vehicle	Non Freight Carrying Truck - Unleaded	Non Freight Carrying Truck - Petrol
Heavy Commercial Vehicle	Non Freight Carrying Truck - Diesel	Non Freight Carrying Truck - Diesel
Heavy Commercial Vehicle	Non Freight Carrying Truck – LPG/other	Non Freight Carrying Truck – LPG
Heavy Commercial Vehicle	Bus - Leaded	Bus - Petrol
Heavy Commercial Vehicle	Bus - Unleaded	Bus - Petrol
Heavy Commercial Vehicle	Bus - Diesel	Bus - Diesel

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Hyder Consulting Vehicle Category	ABS Vehicle Category	AusVeh Vehicle Category
Heavy Commercial Vehicle	Bus – LPG/other	Bus - LPG

Note that buses are included as HCV's and motorcycles as petrol PV's. (Whilst motorcycle emissions per unit are likely to be higher than for PV's, the low number of motorcycles expected to use the tunnels will mean that there is negligible overall impact on emissions resulting from this assumption)

2.4 Vehicle Emission Factors:

Vehicle emission factors (in g/km) used are those prepared by EPA using the AusVeh system for conversion for speed.

The EPA data covers vehicle speeds from 10km/hr to 110 km/hr in 10km/hr increments. No attempt has been made to manipulate the EPA data to produce factors for speeds other than those provided.

Vehicle emission factors used for the purposes of this report are appended as Tables A1 to A6.

Stack emission calculations for each of the design years are based on the following:

Year 2008:

Hyder Consulting traffic volume and mix data.

EPA/AusVeh emission factors at 10 km/hr.

EPA/AusVeh emission factors at 20 km/hr.

EPA/AusVeh emission factors at 80 km/hr.

Year 2011:

Hyder Consulting traffic volume and mix data.

EPA/AusVeh emission factors at 10 km/hr.

EPA/AusVeh emission factors at 20 km/hr.

EPA/AusVeh emission factors at 80 km/hr.

Note: Emission factors for VOC and SO₂ are not provided in the EPA data and stack emissions for those pollutants are not calculated.

2.5 Ambient Air Quality

Allowance for tunnel intake ambient air quality has been made using recorded pollution levels for car derived emissions as measured in EPA Victoria Publication 974, April 2005 – Air Monitoring Alongside the Westgate Freeway in Brooklyn – March to November 2004.

This study measured the levels of motor vehicle derived pollutants alongside a major freeway and is the most recent study undertaken on a major urban freeway carrying similar traffic volumes and mixes at similar average speeds to those predicted for EastLink. In the absence of any similar major freeway studies near the proposed EastLink tunnels site, this study was considered a conservative but appropriate data source for tunnel intake ambient air quality for use in stack emission calculations.

Average concentration levels for PM₁₀, PM_{2.5}, NO₂, CO, 1,3-Butadiene, Benzene and Toluene are taken directly from the Westgate study. O-xylene was taken as representative of xylenes, and Benzo a pyrene was used for PAH levels, as per EPA Publication 974. Total PAH levels are the summation

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of all PAH constituents that are listed in EPA Publication 974. The levels of pollutants have been converted to kg/hr at the listed stack diurnal airflow and are listed in Table A7.

Formaldehyde readings have been adopted as per advice from Air Noise Environment ($9.3\mu\text{g}/\text{M}^3$), as this pollutant is not covered in EPA Victoria Publication 974.

Note:

The Westgate study, and the calculated pollutant levels are for year 2004 and have been used unadjusted for years 2008 and 2011; this is a conservative approach.

Average, rather than peak figures from the Westgate study for the various pollutants have been used. This approach is considered reasonable, as all other criteria in the application of the study data are conservative.

2.6 Grade correction Multipliers for Vehicle Emission Factors

Grade correction multipliers have been derived from the PIARC emissions tables for the 10 km/hr and 20 km/hr speed cases for CO and NO_x. Grade correction for other pollutants; benzene, 1,3-butadiene, formaldehyde, toluene, xylenes, All types of PAH, PM_{2.5}, and PM₁₀, have been made using the NO_x multiplier. (This leads to slightly lower multiplication over the speed range than would be the case if, for example, the CO multiplier was used. This is considered appropriate as the subject pollutants are not necessarily only products of combustion and hence are not necessarily fully subject to grade influence)

Grade correction multipliers for the 80 km/hr normal operation case are as provided by Professor Harry Watson of the University of Melbourne (Part of data provided with the Hyder Consulting report referred to above). These multipliers are used for CO, NO_x and particulates (PM_{2.5} and PM₁₀). All other emissions are corrected using the NO_x multiplier where no explicit multiplier is provided.

Grade correction multipliers are listed in Tables B-1, B-2, B-3, B-4 and B-5.

3.0 OUTPUTS

The following data has been calculated. Data is applicable for both the East and West stacks and is in g/hr. Stack efflux volume is based on the figures listed in section 2.2 of this report. The following emission constituents are listed:

Carbon monoxide

Nitrogen oxides

Benzene

PAH as BAP

Total PAH

Formaldehyde

Toluene

Xylenes

1,3-butadiene

PM₁₀

PM_{2.5}

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Output Tables:

Year 2008:

- Stack Emissions: Normal Operation Inbound 3 lanes operational at 80 km/hr (Table D-1)
- Stack Emissions: Normal Operation Outbound 3 lanes operational at 80 km/hr (Table D-2)
- Stack Emissions: Incident Case 3 lanes operational at 20 km/hr (Table D-3)
- Stack Emissions: Incident Case 2 lanes operational at 20 km/hr (Table D-4)
- Stack Emissions: Incident Case 3 lanes operational at 10 km/hr (Table D-5)
- Stack Emissions: Incident Case 2 lanes operational at 10 km/hr (Table D-6)

Year 2011:

- Stack Emissions: Normal Operation Inbound 3 lanes operational at 80 km/hr (Table D-7)
- Stack Emissions: Normal Operation Outbound 3 lanes operational at 80 km/hr (Table D-8)
- Stack Emissions: Incident Case 3 lanes operational at 20 km/hr (Table D-9)
- Stack Emissions: Incident Case 2 lanes operational at 20 km/hr (Table D-10)
- Stack Emissions: Incident Case 3 lanes operational at 10 km/hr (Table D-11)
- Stack Emissions: Incident Case 2 lanes operational at 10 km/hr (Table D-12)

The following should be noted:

Each table lists stack emissions for the applicable normal and incident cases. The period of any day during which the causal incidents for the incident cases are likely to occur (i.e. the period during which there is likely to be sufficient traffic to result in the level of congestion contemplated) is discussed below.

Congested traffic at speeds of 20km/hr and below can only occur as the result of a peak hour incident in year 2008 or 2011. Each case should last only as long as the period required for the operator to clear the causal incident and for free traffic flow to re-establish. A period of 2 hours duration for any incident is recommended as a reasonable period for modelling purposes.

20km/hr flowing traffic is the lowest speed that a tunnel would be expected to be allowed to operate with all lanes open. Below this speed a lane closure would normally be expected to be implemented. Data has however been calculated for both 10km/hr and 20km/hr with 2 and 3 lanes operating.

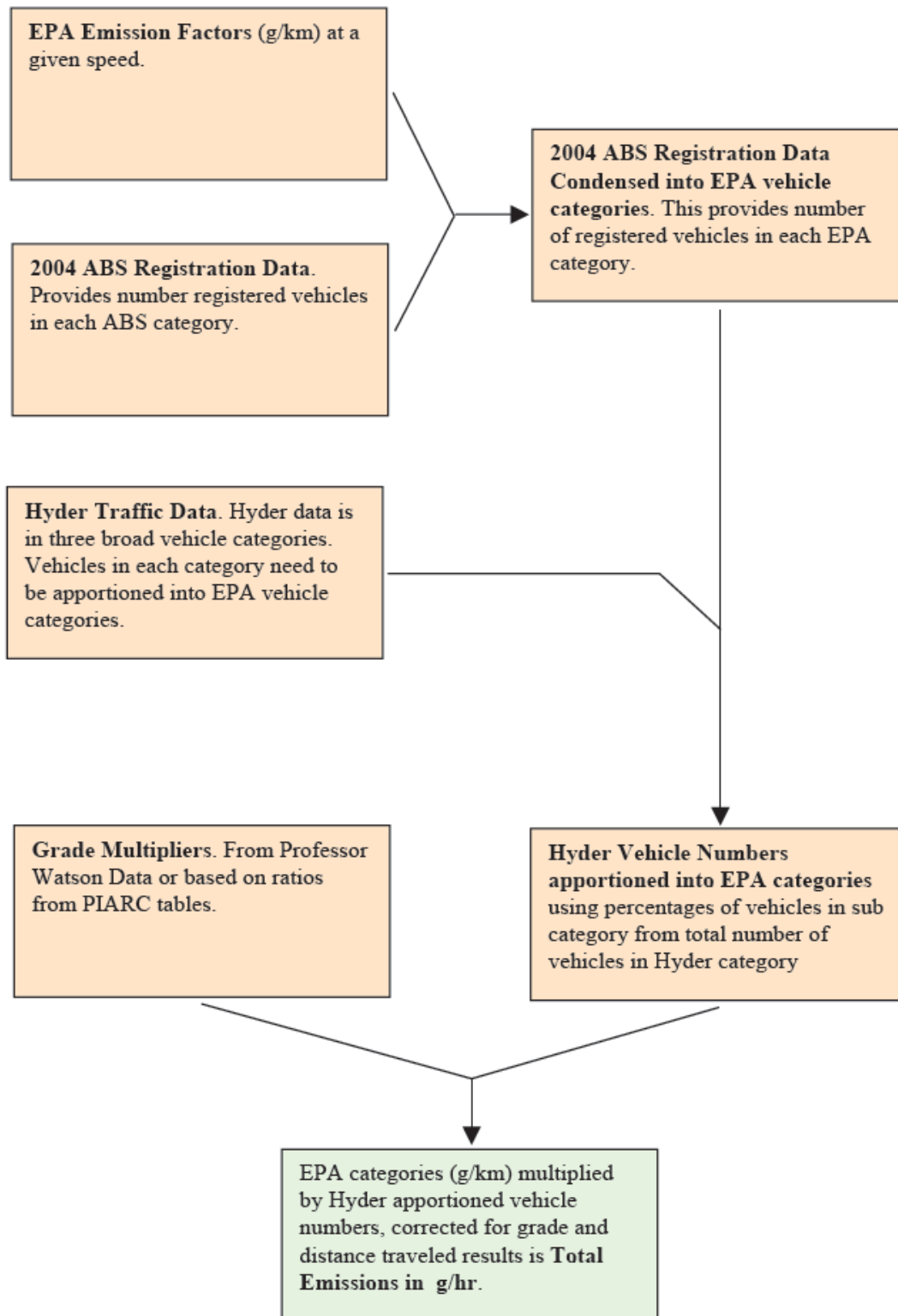
For the incident cases, calculations of stack pollutant levels are on the basis of traffic flowing at the nominated speeds with no allowance made for stop/start conditions.

4.0 CALCULATION METHOD

The output data nominated above has been calculated using the base data detailed in this document.

Calculations are carried out as shown below using a stack emissions design spreadsheet developed for this purpose.

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5.0 ATTACHMENTS

The following attachments are included with this report for the purposes of information and clarification:

ATTACHMENT 1	ABS VEHICLE REGISTRATION DATA COMPARISON – NATIONAL:STATE
ATTACHMENT 2	VEHICLE SPEED:CAPACITY CURVE
ATTACHMENT 3	ESTIMATED STACK EMISSIONS USING PIARC DATA

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Emission factor (g/km) at 80 kph													
Year	Vehicle	Fuel	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle
													Bound
2008	passenger vehicle	petrol	1.04	5.45	0.0155	0.0237	0.00241	0.00321	0.0349	0.0215	0.0134	1.50E-07	4.50E-06
2008	passenger vehicle	diesel	1.35	1.09	0.253	7.20E-04	1.23E-04	0.00122	4.11E-04	6.08E-04	0.180	2.04E-06	8.35E-06
2008	passenger vehicle	LPG	2.18	12.2	0.0146	0.00228	5.42E-04	0.00564	0.00441	0.00365	0.0133	1.46E-08	1.18E-06
2008	light commercial vehicle	petrol	1.09	8.87	0.0184	0.0464	0.00467	0.00778	0.0702	0.0457	0.0151	3.63E-07	1.09E-05
2008	light commercial vehicle	diesel	1.81	2.66	0.271	6.87E-04	1.17E-04	0.00116	3.92E-04	5.80E-04	0.193	2.19E-06	8.98E-06
2008	light commercial vehicle	LPG	2.26	13.2	0.0173	0.00317	7.54E-04	0.00785	0.00614	0.00508	0.0155	2.03E-08	1.65E-06
2008	rigid truck	petrol	4.11	21.9	0.0513	0.137	0.0141	0.0121	0.195	0.109	0.0343	5.66E-07	1.70E-05
2008	rigid truck	diesel	6.99	1.53	0.434	0.00379	6.46E-04	0.00640	0.00216	0.00320	0.308	3.58E-06	1.46E-05
2008	rigid truck	LPG	7.22	5.25	0.0949	0.0252	0.00600	0.0624	0.0488	0.0404	0.0797	1.62E-07	1.31E-05
2008	rigid truck	CNG	7.22	5.25	0.0949	0.00366	8.72E-04	0.00907	0.00709	0.00587	0.0797	2.35E-08	1.90E-06
2008	articulated truck	petrol	4.28	20.1	0.0516	0.174	0.0180	0.0118	0.243	0.130	0.0354	5.50E-07	1.65E-05
2008	articulated truck	diesel	15.8	1.85	0.338	0.00402	6.86E-04	0.00680	0.00229	0.00339	0.241	2.74E-06	1.12E-05
2008	non-freight carrying truck	petrol	2.95	9.07	0.0252	0.0354	0.00356	0.00607	0.0537	0.0352	0.0191	2.84E-07	8.53E-06
2008	non-freight carrying truck	diesel	6.52	1.23	0.387	0.00343	5.85E-04	0.00580	0.00196	0.00290	0.274	3.18E-06	1.30E-05
2008	non-freight carrying truck	LPG	5.08	2.34	0.0719	0.0152	0.00361	0.0375	0.0293	0.0243	0.0607	9.73E-08	7.88E-06
2008	bus	petrol	3.09	9.86	0.0263	0.0353	0.00354	0.00653	0.0542	0.0363	0.0197	3.05E-07	9.17E-06
2008	bus	diesel	11.2	1.64	0.358	0.00354	6.05E-04	0.00599	0.00202	0.00299	0.254	2.93E-06	1.20E-05
2008	bus	LPG	7.32	2.19	0.0534	0.0138	0.00328	0.0341	0.0267	0.0221	0.0455	8.85E-08	7.17E-06
2008	bus	CNG	7.32	2.19	0.0534	0.00200	4.77E-04	0.00496	0.00388	0.00321	0.0455	1.29E-08	1.04E-06
2008	motorcycle	petrol	0.748	6.05	0.0254	0.158	0.0162	0.0192	0.231	0.138	0.0184	8.96E-07	2.69E-05

TABLE A-1

Vehicle Emission Factors for year 2008 (EPA Victoria Data)

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 15 of 31

Emission factor (g/km) at 20 kph													
Year	Vehicle	Fuel	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
2008	passenger vehicle	petrol	1.47	8.53	0.0169	0.0522	0.00528	0.00819	0.0784	0.0501	0.0142	3.82E-07	1.15E-05
2008	passenger vehicle	diesel	1.96	1.79	0.336	0.00150	2.55E-04	0.00253	8.53E-04	0.00126	0.238	2.74E-06	1.12E-05
2008	passenger vehicle	LPG	2.98	23.8	0.0151	0.00587	0.00140	0.0145	0.0114	0.00941	0.0137	3.77E-08	3.05E-06
2008	light commercial vehicle	petrol	1.53	15.9	0.0210	0.106	0.0106	0.0197	0.162	0.109	0.0166	9.17E-07	2.76E-05
2008	light commercial vehicle	diesel	2.42	3.59	0.342	0.00185	3.16E-04	0.00313	0.00105	0.00156	0.243	2.79E-06	1.14E-05
2008	light commercial vehicle	LPG	3.08	25.8	0.0184	0.00804	0.00191	0.0199	0.0156	0.0129	0.0165	5.16E-08	4.18E-06
2008	rigid truck	petrol	3.04	66.2	0.0506	0.364	0.0366	0.0659	0.558	0.371	0.0339	3.08E-06	9.25E-05
2008	rigid truck	diesel	7.81	3.46	0.563	0.00964	0.00164	0.0163	0.00549	0.00813	0.398	4.67E-06	1.91E-05
2008	rigid truck	LPG	8.10	9.13	0.0967	0.0645	0.0153	0.160	0.125	0.103	0.0812	4.14E-07	3.35E-05
2008	rigid truck	CNG	8.10	9.13	0.0967	0.00937	0.00223	0.0232	0.0182	0.0150	0.0812	6.02E-08	4.87E-06
2008	articulated truck	petrol	3.17	60.6	0.0471	0.395	0.0399	0.0640	0.596	0.384	0.0327	2.99E-06	8.99E-05
2008	articulated truck	diesel	15.5	3.43	0.415	0.00979	0.00167	0.0165	0.00558	0.00826	0.295	3.40E-06	1.39E-05
2008	non-freight carrying truck	petrol	2.18	27.4	0.0273	0.149	0.0148	0.0330	0.236	0.167	0.0203	1.54E-06	4.64E-05
2008	non-freight carrying truck	diesel	7.27	3.09	0.531	0.00879	0.00150	0.0148	0.00501	0.00741	0.375	4.40E-06	1.80E-05
2008	non-freight carrying truck	LPG	5.69	5.10	0.0942	0.0380	0.00905	0.0941	0.0736	0.0609	0.0792	2.44E-07	1.98E-05
2008	bus	petrol	2.28	29.8	0.0277	0.158	0.0157	0.0355	0.250	0.178	0.0205	1.66E-06	4.99E-05
2008	bus	diesel	14.1	3.14	0.440	0.00590	0.00101	0.00996	0.00336	0.00498	0.311	3.62E-06	1.48E-05
2008	bus	LPG	9.76	4.54	0.0692	0.0226	0.00539	0.0560	0.0438	0.0363	0.0585	1.45E-07	1.18E-05
2008	bus	CNG	9.76	4.54	0.0692	0.00329	7.83E-04	0.00815	0.00637	0.00527	0.0585	2.11E-08	1.71E-06
2008	motorcycle	petrol	0.476	25.1	0.0341	0.285	0.0286	0.0492	0.433	0.284	0.0234	2.30E-06	6.91E-05

TABLE A-2

Vehicle Emission Factors for year 2008 (EPA Victoria Data)

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 16 of 31

Emission factor (g/km) at 10 kph													
Year	Vehicle	Fuel	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
2008	passenger vehicle	petrol	1.61	13.0	0.0193	0.0822	0.00826	0.0145	0.125	0.0827	0.0156	6.75E-07	2.03E-05
2008	passenger vehicle	diesel	2.44	2.38	0.435	0.00207	3.54E-04	0.00350	0.00118	0.00175	0.308	3.58E-06	1.47E-05
2008	passenger vehicle	LPG	3.30	37.0	0.0166	0.0102	0.00244	0.0254	0.0198	0.0164	0.0150	6.58E-08	5.33E-06
2008	light commercial vehicle	petrol	1.67	24.5	0.0254	0.175	0.0174	0.0350	0.271	0.186	0.0192	1.64E-06	4.92E-05
2008	light commercial vehicle	diesel	3.01	4.43	0.412	0.00268	4.56E-04	0.00452	0.00152	0.00226	0.292	3.38E-06	1.39E-05
2008	light commercial vehicle	LPG	3.42	40.0	0.0221	0.0143	0.00339	0.0353	0.0276	0.0229	0.0195	9.15E-08	7.41E-06
2008	rigid truck	petrol	2.87	107	0.0615	0.548	0.0547	0.109	0.850	0.582	0.0403	5.11E-06	1.53E-04
2008	rigid truck	diesel	8.87	4.82	0.703	0.0139	0.00236	0.0234	0.00790	0.0117	0.496	5.86E-06	2.40E-05
2008	rigid truck	LPG	9.26	12.1	0.104	0.0930	0.0221	0.230	0.180	0.149	0.0876	5.97E-07	4.83E-05
2008	rigid truck	CNG	9.26	12.1	0.104	0.0135	0.00322	0.0335	0.0262	0.0217	0.0876	8.68E-08	7.03E-06
2008	articulated truck	petrol	2.98	98.2	0.0494	0.573	0.0575	0.106	0.880	0.590	0.0340	4.96E-06	1.49E-04
2008	articulated truck	diesel	17.3	4.58	0.516	0.0143	0.00243	0.0241	0.00813	0.0120	0.365	4.25E-06	1.74E-05
2008	non-freight carrying truck	petrol	2.05	44.3	0.0321	0.242	0.0239	0.0548	0.383	0.273	0.0231	2.56E-06	7.70E-05
2008	non-freight carrying truck	diesel	8.24	4.37	0.684	0.0126	0.00216	0.0214	0.00721	0.0107	0.483	5.70E-06	2.33E-05
2008	non-freight carrying truck	LPG	6.47	7.04	0.116	0.0545	0.0130	0.135	0.105	0.0873	0.0971	3.50E-07	2.83E-05
2008	bus	petrol	2.15	48.2	0.0295	0.257	0.0254	0.0590	0.408	0.292	0.0216	2.75E-06	8.28E-05
2008	bus	diesel	16.4	4.12	0.518	0.00759	0.00130	0.0128	0.00433	0.00641	0.366	4.28E-06	1.75E-05
2008	bus	LPG	11.6	6.03	0.0826	0.0289	0.00687	0.0715	0.0559	0.0463	0.0696	1.85E-07	1.50E-05
2008	bus	CNG	11.6	6.03	0.0826	0.00420	0.00100	0.0104	0.00813	0.00673	0.0696	2.69E-08	2.18E-06
2008	motorcycle	petrol	0.508	53.3	0.0499	0.463	0.0462	0.0915	0.717	0.490	0.0327	4.27E-06	1.28E-04

TABLE A-3

Vehicle Emission Factors for year 2008 (EPA Victoria Data)

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 17 of 31

Emission factor (g/km) at 80 kph													
Year	Vehicle	Fuel	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle
													Bound
2011	passenger vehicle	petrol	0.914	4.87	0.0148	0.0186	0.00190	0.00259	0.0276	0.0171	0.0130	1.21E-07	3.63E-06
2011	passenger vehicle	diesel	1.29	0.855	0.187	6.66E-04	1.14E-04	0.00113	3.80E-04	5.62E-04	0.134	1.48E-06	6.06E-06
2011	passenger vehicle	LPG	2.18	12.1	0.0146	0.00227	5.40E-04	0.00561	0.00439	0.00363	0.0133	1.45E-08	1.18E-06
2011	light commercial vehicle	petrol	0.929	7.04	0.0173	0.0364	0.00367	0.00615	0.0552	0.0360	0.0145	2.87E-07	8.63E-06
2011	light commercial vehicle	diesel	1.60	2.18	0.197	5.95E-04	1.02E-04	0.00101	3.39E-04	5.02E-04	0.141	1.56E-06	6.39E-06
2011	light commercial vehicle	LPG	2.27	12.8	0.0166	0.00327	7.78E-04	0.00810	0.00633	0.00524	0.0150	2.10E-08	1.70E-06
2011	rigid truck	petrol	3.78	14.7	0.0409	0.0987	0.0102	0.00876	0.140	0.0786	0.0283	4.09E-07	1.23E-05
2011	rigid truck	diesel	6.01	1.14	0.315	0.00310	5.29E-04	0.00524	0.00177	0.00262	0.224	2.57E-06	1.05E-05
2011	rigid truck	LPG	7.09	4.96	0.0921	0.0244	0.00580	0.0603	0.0472	0.0391	0.0775	1.56E-07	1.27E-05
2011	rigid truck	CNG	7.09	4.96	0.0921	0.00354	8.44E-04	0.00877	0.00686	0.00568	0.0775	2.27E-08	1.84E-06
2011	articulated truck	petrol	4.18	11.3	0.0423	0.118	0.0123	0.00682	0.163	0.0850	0.0299	3.18E-07	9.57E-06
2011	articulated truck	diesel	13.4	1.31	0.236	0.00341	5.82E-04	0.00577	0.00195	0.00288	0.169	1.87E-06	7.67E-06
2011	non-freight carrying truck	petrol	2.93	6.24	0.0228	0.0281	0.00282	0.00491	0.0428	0.0282	0.0177	2.29E-07	6.89E-06
2011	non-freight carrying truck	diesel	5.43	0.974	0.274	0.00284	4.84E-04	0.00480	0.00162	0.00240	0.195	2.22E-06	9.09E-06
2011	non-freight carrying truck	LPG	3.99	1.93	0.0592	0.0121	0.00289	0.0300	0.0235	0.0194	0.0502	7.78E-08	6.30E-06
2011	bus	petrol	2.87	7.68	0.0236	0.0295	0.00295	0.00550	0.0453	0.0304	0.0181	2.57E-07	7.71E-06
2011	bus	diesel	9.03	1.29	0.240	0.00295	5.04E-04	0.00499	0.00168	0.00249	0.171	1.92E-06	7.88E-06
2011	bus	LPG	5.81	1.64	0.0428	0.0106	0.00252	0.0263	0.0205	0.0170	0.0367	6.81E-08	5.51E-06
2011	bus	CNG	5.81	1.64	0.0428	0.00154	3.67E-04	0.00382	0.00299	0.00247	0.0367	9.90E-09	8.02E-07
2011	motorcycle	petrol	0.748	6.07	0.0254	0.158	0.0162	0.0193	0.231	0.139	0.0183	8.99E-07	2.70E-05

TABLE A-4

Vehicle Emission Factors for year 2011 (EPA Victoria Data)

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 18 of 31

Emission factor (g/km) at 20 kph													
Year	Vehicle	Fuel	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle
													Bound
2011	passenger vehicle	petrol	1.30	6.93	0.0158	0.0427	0.00432	0.00667	0.0641	0.0409	0.0135	3.11E-07	9.36E-06
2011	passenger vehicle	diesel	1.80	1.70	0.300	0.00135	2.30E-04	0.00227	7.67E-04	0.00114	0.213	2.43E-06	9.97E-06
2011	passenger vehicle	LPG	2.99	23.7	0.0150	0.00584	0.00139	0.0145	0.0113	0.00937	0.0137	3.75E-08	3.04E-06
2011	light commercial vehicle	petrol	1.30	12.3	0.0196	0.0840	0.00842	0.0156	0.129	0.0865	0.0158	7.28E-07	2.19E-05
2011	light commercial vehicle	diesel	2.14	3.10	0.258	0.00165	2.81E-04	0.00279	9.40E-04	0.00139	0.184	2.09E-06	8.54E-06
2011	light commercial vehicle	LPG	3.10	25.1	0.0176	0.00829	0.00197	0.0205	0.0160	0.0133	0.0158	5.32E-08	4.31E-06
2011	rigid truck	petrol	2.80	44.3	0.0411	0.263	0.0264	0.0476	0.403	0.268	0.0283	2.22E-06	6.69E-05
2011	rigid truck	diesel	6.73	2.74	0.431	0.00779	0.00133	0.0132	0.00444	0.00657	0.305	3.55E-06	1.45E-05
2011	rigid truck	LPG	7.96	8.84	0.0964	0.0622	0.0148	0.154	0.121	0.0998	0.0810	4.00E-07	3.24E-05
2011	rigid truck	CNG	7.96	8.84	0.0964	0.00905	0.00216	0.0224	0.0175	0.0145	0.0810	5.81E-08	4.71E-06
2011	articulated truck	petrol	3.09	34.1	0.0423	0.246	0.0249	0.0371	0.368	0.233	0.0299	1.73E-06	5.21E-05
2011	articulated truck	diesel	13.2	2.65	0.301	0.00823	0.00140	0.0139	0.00469	0.00694	0.214	2.42E-06	9.92E-06
2011	non-freight carrying truck	petrol	2.17	18.8	0.0251	0.120	0.0119	0.0267	0.190	0.134	0.0190	1.25E-06	3.75E-05
2011	non-freight carrying truck	diesel	6.05	2.44	0.364	0.00729	0.00124	0.0123	0.00415	0.00615	0.258	2.98E-06	1.22E-05
2011	non-freight carrying truck	LPG	4.48	3.95	0.0741	0.0305	0.00727	0.0756	0.0591	0.0489	0.0625	1.96E-07	1.59E-05
2011	bus	petrol	2.12	23.2	0.0253	0.133	0.0132	0.0299	0.210	0.149	0.0191	1.40E-06	4.19E-05
2011	bus	diesel	11.6	2.51	0.294	0.00490	8.36E-04	0.00828	0.00279	0.00413	0.209	2.38E-06	9.76E-06
2011	bus	LPG	7.66	3.38	0.0538	0.0174	0.00415	0.0432	0.0338	0.0279	0.0458	1.12E-07	9.06E-06
2011	bus	CNG	7.66	3.38	0.0538	0.00254	6.04E-04	0.00628	0.00491	0.00406	0.0458	1.63E-08	1.32E-06
2011	motorcycle	petrol	0.476	25.2	0.0341	0.285	0.0287	0.0494	0.434	0.285	0.0234	2.31E-06	6.93E-05

TABLE A-5

Vehicle Emission Factors for year 2011 (EPA Victoria Data)

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 19 of 31

Emission factor (g/km) at 10 kph													
Year	Vehicle	Fuel	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
2011	passenger vehicle	petrol	1.43	10.5	0.0175	0.0672	0.00676	0.0117	0.102	0.0673	0.0146	5.47E-07	1.64E-05
2011	passenger vehicle	diesel	2.29	2.34	0.391	0.00192	3.27E-04	0.00324	0.00109	0.00162	0.277	3.21E-06	1.31E-05
2011	passenger vehicle	LPG	3.30	36.9	0.0165	0.0102	0.00243	0.0253	0.0198	0.0164	0.0149	6.55E-08	5.30E-06
2011	light commercial vehicle	petrol	1.42	18.9	0.0235	0.139	0.0139	0.0277	0.216	0.148	0.0181	1.29E-06	3.89E-05
2011	light commercial vehicle	diesel	2.68	3.91	0.318	0.00241	4.11E-04	0.00407	0.00137	0.00203	0.226	2.59E-06	1.06E-05
2011	light commercial vehicle	LPG	3.44	39.0	0.0208	0.0147	0.00350	0.0364	0.0285	0.0236	0.0184	9.44E-08	7.65E-06
2011	rigid truck	petrol	2.63	71.7	0.0490	0.396	0.0395	0.0791	0.615	0.421	0.0330	3.69E-06	1.11E-04
2011	rigid truck	diesel	7.64	3.84	0.546	0.0112	0.00190	0.0189	0.00636	0.00942	0.386	4.53E-06	1.85E-05
2011	rigid truck	LPG	9.09	11.7	0.106	0.0897	0.0214	0.222	0.174	0.144	0.0887	5.76E-07	4.66E-05
2011	rigid truck	CNG	9.09	11.7	0.106	0.0130	0.00311	0.0323	0.0253	0.0209	0.0887	8.37E-08	6.78E-06
2011	articulated truck	petrol	2.91	55.3	0.0460	0.350	0.0351	0.0616	0.533	0.352	0.0321	2.87E-06	8.64E-05
2011	articulated truck	diesel	14.9	3.59	0.377	0.0119	0.00204	0.0202	0.00680	0.0101	0.268	3.07E-06	1.26E-05
2011	non-freight carrying truck	petrol	2.04	30.5	0.0283	0.195	0.0193	0.0443	0.309	0.220	0.0209	2.07E-06	6.22E-05
2011	non-freight carrying truck	diesel	6.86	3.46	0.466	0.0105	0.00179	0.0177	0.00598	0.00885	0.330	3.85E-06	1.57E-05
2011	non-freight carrying truck	LPG	5.10	5.40	0.0890	0.0438	0.0104	0.108	0.0848	0.0702	0.0749	2.81E-07	2.28E-05
2011	bus	petrol	2.00	37.6	0.0271	0.216	0.0214	0.0496	0.343	0.245	0.0202	2.32E-06	6.96E-05
2011	bus	diesel	13.6	3.30	0.345	0.00629	0.00107	0.0106	0.00359	0.00531	0.245	2.82E-06	1.15E-05
2011	bus	LPG	9.10	4.48	0.0632	0.0223	0.00530	0.0551	0.0431	0.0357	0.0536	1.43E-07	1.16E-05
2011	bus	CNG	9.10	4.48	0.0632	0.00324	7.71E-04	0.00802	0.00627	0.00519	0.0536	2.08E-08	1.68E-06
2011	motorcycle	petrol	0.508	53.4	0.0499	0.464	0.0463	0.0918	0.719	0.491	0.0327	4.28E-06	1.29E-04

TABLE A-6

Vehicle Emission Factors for year 2011 (EPA Victoria Data)

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 20 of 31

Ambient Air Emission Factor													
Emission type		NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound	
Emission value		325.0	1.00	27.00	0.80	0.20	9.3	6.00	0.50	9.00	0.20	27.4	
Emission unit		ppb	ppm	ug/m ³	ppb	ppb**	ug/m ³	ppb	ppb	ug/m ³	ng/m ³	ng/m ³	
EPA document reference		fig. 4	table 5	table 2	table 6	table 6	-	table 6	table 6	table 1	table 7	table 7	
Formula	-	NO	CO	PM ₁₀	C ₆ H ₆	C ₄ H ₆	H ₂ CO	C ₆ H ₅ .CH ₃	C ₆ H ₄ .(CH ₃) ₂	PM _{2.5}	-	-	
Mole weight	(g/mole)	30.00	28.00	-	78.11	54.09	30.01	92.13	106.16	-	-	-	
Mass flow**	(kg/hr)	0.9071	2.6050	5.83E-02	5.814E-03	1.006E-03	2.01E-02	5.143E-02	4.938E-03	1.944E-02	4.320E-07	5.9184E-05	

** Calculated for an airflow rate of 600m³/sec.

TABLE A-7

Induct Ambient Air Quality for all years (EPA Victoria Data)

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 21 of 31

POLLUTANT MULTIPLIERS (Grade Correction Factor at 20 km/hr)												
		NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH All	
Level Multiplier	1. ALL VEHICLES	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upgrade Multiplier	1. CARS + LCVs	2.32	1.38	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
	2. TRUCKS	2.32	1.43	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32	2.32
Downgrade	1. CARS + LCVs	0.26	0.65	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Multiplier	2. TRUCKS	0.26	0.50	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26

TABLE B-1

Grade Correction Factors 2008

POLLUTANT MULTIPLIERS (Grade Correction Factor at 10 km/hr)												
		NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH All	
Level Multiplier	1. ALL VEHICLES	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upgrade Multiplier	1. CARS + LCVs	1.99	1.20	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99
	2. TRUCKS	1.99	1.23	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99	1.99
Downgrade	1. CARS + LCVs	0.26	0.64	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Multiplier	2. TRUCKS	0.26	0.50	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26

TABLE B-2

Grade Correction Factors 2008

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 22 of 31

POLLUTANT MULTIPLIERS (Grade Correction Factor at 20 km/hr)												
		NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH All	
Level Multiplier	1. ALL VEHICLES	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upgrade Multiplier	1. CARS + LCVs	2.30	1.43	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
	2. TRUCKS	2.30	1.43	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30	2.30
Downgrade	1. CARS + LCVs	0.26	0.65	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Multiplier	2. TRUCKS	0.26	0.50	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26

TABLE B-3

Grade Correction Factors 2011

POLLUTANT MULTIPLIERS (Grade Correction Factor at 10 km/hr)												
		NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH All	
Level Multiplier	1. ALL VEHICLES	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upgrade Multiplier	1. CARS + LCVs	2.00	1.26	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
	2. TRUCKS	2.00	1.23	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Downgrade	1. CARS + LCVs	0.28	0.63	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Multiplier	2. TRUCKS	0.28	0.50	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28

TABLE B-4

Grade Correction Factors 2011

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 23 of 31

POLLUTANT MULTIPLIERS (Grade Correction Factor at 80 km/hr)												
		NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH All	
Level Multiplier	1. ALL VEHICLES	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upgrade Multiplier	1. CARS + LCVs	2.78	2.64	1.46	2.78	2.78	2.78	2.78	2.78	1.46	2.78	
	2. TRUCKS	2.25	1.90	1.41	2.25	2.25	2.25	2.25	2.25	1.41	2.25	
Downgrade	1. CARS + LCVs	0.68	0.76	0.78	0.68	0.68	0.68	0.68	0.68	0.78	0.68	
Multiplier	2. TRUCKS	0.68	0.71	0.80	0.68	0.68	0.68	0.68	0.68	0.80	0.68	

TABLE B-5

Hyder Consulting - Grade Correction Factors All Years

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 24 of 31

Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
0	340	Inbound	300m ³ /sec	1544.7	6007.4	49.6	22.7	2.5	13.0	54.9	20.5	2.56E+01	4.66E-04	3.39E-02
1	199	Inbound	300m ³ /sec	1010.9	4123.0	38.6	14.7	1.7	11.8	43.2	13.3	1.72E+01	3.39E-04	3.21E-02
2	159	Inbound	300m ³ /sec	1096.3	3497.7	44.4	12.2	1.5	11.5	39.4	11.0	2.11E+01	3.95E-04	3.19E-02
3	171	Inbound	300m ³ /sec	1173.5	3654.5	46.9	12.9	1.5	11.7	40.4	11.6	2.30E+01	4.23E-04	3.21E-02
4	314	Inbound	300m ³ /sec	1629.4	5673.1	56.1	21.4	2.4	13.0	53.0	19.4	3.00E+01	5.38E-04	3.40E-02
5	1,133	Inbound	600m ³ /sec	4630.1	18450.1	133.1	72.6	7.8	30.2	150.0	66.0	7.70E+01	1.35E-03	7.41E-02
6	4,708	Inbound	600m ³ /sec	15257.2	68556.2	320.3	283.0	29.4	61.0	460.8	258.2	2.25E+02	3.72E-03	1.19E-01
7	5,644	Inbound	600m ³ /sec	17440.4	81533.0	340.1	337.0	34.9	68.3	540.7	307.2	2.43E+02	4.01E-03	1.29E-01
8	4,618	Inbound	600m ³ /sec	14492.7	67156.5	291.0	276.7	28.7	59.5	451.6	252.2	2.04E+02	3.38E-03	1.16E-01
9	4,084	Inbound	600m ³ /sec	13357.0	59759.6	284.8	246.0	25.6	55.5	406.1	224.3	1.97E+02	3.27E-03	1.11E-01
10	3,135	Inbound	450m ³ /sec	10452.1	45854.8	227.7	189.0	19.6	42.5	311.2	172.5	1.58E+02	2.62E-03	8.45E-02
11	2,777	Inbound	450m ³ /sec	9407.7	40858.9	210.3	168.1	17.5	39.5	280.3	153.4	1.44E+02	2.40E-03	8.01E-02
12	2,682	Inbound	450m ³ /sec	9233.5	39534.0	210.3	162.6	16.9	38.8	272.2	148.4	1.44E+02	2.39E-03	7.92E-02
13	2,579	Inbound	450m ³ /sec	8945.9	38079.8	205.6	156.5	16.3	37.9	263.1	142.8	1.40E+02	2.33E-03	7.79E-02
14	2,562	Inbound	450m ³ /sec	8734.3	37877.2	197.8	155.6	16.2	37.6	261.8	141.9	1.34E+02	2.24E-03	7.74E-02
15	2,811	Inbound	600m ³ /sec	9557.8	42005.7	219.0	171.5	18.0	44.6	296.1	156.4	1.45E+02	2.45E-03	9.50E-02
16	3,081	Inbound	600m ³ /sec	10060.2	45699.0	218.0	186.7	19.5	46.5	318.7	170.1	1.46E+02	2.45E-03	9.75E-02
17	3,675	Inbound	600m ³ /sec	12291.9	54169.1	272.7	222.7	23.2	52.3	371.8	203.3	1.87E+02	3.12E-03	1.06E-01
18	3,006	Inbound	600m ³ /sec	10393.5	44667.5	239.3	182.8	19.1	46.5	312.7	166.7	1.60E+02	2.68E-03	9.78E-02
19	2,253	Inbound	600m ³ /sec	7377.8	33953.7	162.4	137.2	14.4	39.0	245.4	124.6	1.03E+02	1.76E-03	8.63E-02
20	1,552	Inbound	300m ³ /sec	4895.9	22920.3	100.5	93.5	9.8	23.1	159.5	85.0	6.69E+01	1.13E-03	4.83E-02
21	1,386	Inbound	300m ³ /sec	4401.2	20581.5	91.6	83.7	8.8	21.6	145.0	76.0	5.98E+01	1.01E-03	4.62E-02
22	1,182	Inbound	300m ³ /sec	3870.5	17724.7	84.3	71.7	7.5	19.9	127.3	65.1	5.38E+01	9.15E-04	4.38E-02
23	761	Inbound	300m ³ /sec	2668.5	11887.4	65.4	47.3	5.0	16.4	91.2	42.9	3.86E+01	6.75E-04	3.88E-02

* Note: 1. Ambient air pollution contribution data corrected for variable stack flow rate.
2. Stack exit cross section: 35m².

TABLE C-1

Derived Stack Emissions (g/hr) – Normal Case: 3 Lanes at 80km/hr

Inbound Tunnel 2008

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 25 of 31

Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
0	632	Outbound	300m ³ /sec	2232.0	10133.4	57.4	39.9	4.3	15.4	80.4	36.2	3.24E+01	5.80E-04	3.72E-02
1	319	Outbound	300m ³ /sec	1339.5	5774.8	43.2	21.6	2.4	12.7	53.4	19.6	2.10E+01	3.98E-04	3.35E-02
2	199	Outbound	300m ³ /sec	1018.9	4082.0	38.3	14.6	1.7	11.7	42.9	13.1	1.70E+01	3.33E-04	3.20E-02
3	146	Outbound	300m ³ /sec	882.5	3364.4	36.7	11.6	1.4	11.3	38.5	10.4	1.57E+01	3.13E-04	3.14E-02
4	177	Outbound	300m ³ /sec	1004.6	3799.9	39.9	13.4	1.6	11.6	41.3	12.1	1.81E+01	3.51E-04	3.19E-02
5	370	Outbound	600m ³ /sec	2013.0	7847.5	78.9	27.9	3.3	23.4	84.0	25.1	3.56E+01	6.95E-04	6.40E-02
6	1,308	Outbound	600m ³ /sec	4829.0	21050.1	130.4	83.4	8.9	31.5	166.0	75.9	7.59E+01	1.35E-03	7.59E-02
7	3,006	Outbound	600m ³ /sec	10263.6	45014.9	239.4	184.4	19.3	46.8	315.2	168.5	1.60E+02	2.71E-03	9.84E-02
8	3,675	Outbound	600m ³ /sec	12002.2	54130.9	259.1	222.3	23.1	52.0	371.3	202.8	1.77E+02	2.96E-03	1.06E-01
9	2,355	Outbound	600m ³ /sec	8070.3	35820.8	192.8	145.5	15.3	40.8	257.9	132.9	1.24E+02	2.13E-03	8.95E-02
10	2,177	Outbound	450m ³ /sec	7316.7	32697.9	169.3	133.7	14.0	34.3	229.8	122.2	1.13E+02	1.91E-03	7.26E-02
11	2,334	Outbound	450m ³ /sec	7781.2	34902.3	177.5	143.0	14.9	35.7	243.4	130.7	1.19E+02	2.02E-03	7.45E-02
12	2,511	Outbound	450m ³ /sec	8265.8	37374.8	184.6	153.3	16.0	37.1	258.7	140.1	1.25E+02	2.11E-03	7.66E-02
13	2,648	Outbound	450m ³ /sec	8666.2	39289.2	191.6	161.4	16.8	38.3	270.6	147.4	1.30E+02	2.20E-03	7.83E-02
14	3,043	Outbound	450m ³ /sec	9989.5	44816.3	218.6	184.7	19.2	41.9	305.0	168.7	1.51E+02	2.53E-03	8.35E-02
15	4,203	Outbound	600m ³ /sec	13918.0	61521.6	302.0	253.6	26.4	56.9	417.4	231.5	2.10E+02	3.48E-03	1.13E-01
16	5,052	Outbound	600m ³ /sec	16585.2	73282.3	350.5	303.0	31.4	64.2	490.2	276.5	2.47E+02	4.08E-03	1.23E-01
17	5,644	Outbound	600m ³ /sec	17805.2	81273.6	352.0	336.1	34.8	68.3	539.0	306.1	2.51E+02	4.12E-03	1.29E-01
18	4,618	Outbound	600m ³ /sec	14718.3	66980.9	298.1	276.1	28.6	59.5	450.4	251.4	2.09E+02	3.45E-03	1.16E-01
19	3,212	Outbound	600m ³ /sec	10214.1	47471.1	213.3	194.0	20.2	47.3	329.4	176.6	1.43E+02	2.41E-03	9.84E-02
20	2,093	Outbound	300m ³ /sec	6465.9	30562.4	128.1	125.6	13.0	27.8	207.0	114.4	8.87E+01	1.48E-03	5.51E-02
21	1,926	Outbound	300m ³ /sec	6001.2	28202.7	120.4	115.7	12.0	26.3	192.3	105.3	8.25E+01	1.38E-03	5.30E-02
22	1,769	Outbound	300m ³ /sec	5556.8	25981.2	113.1	106.4	11.1	25.0	178.5	96.8	7.66E+01	1.29E-03	5.11E-02
23	1,394	Outbound	300m ³ /sec	4447.0	20757.1	94.0	84.5	8.8	21.8	146.2	76.8	6.15E+01	1.04E-03	4.65E-02

Note: 1. Ambient air pollution contribution data corrected for variable stack flow rate.
2. Stack exit cross section: 35m².

TABLE C-2

Derived Stack Emissions (g/hr) – Normal Case: 3 Lanes at 80km/hr

Outbound Tunnel 2008

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
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Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
7	4,800	Either	600m ² /sec	16206.5	72463.3	376.5	489.9	50.2	101.6	778.7	472.0	2.66E+02	5.33E-03	1.72E-01

TABLE C-3

Derived Stack Emissions (g/hr) – Incident Case: 3 Lanes at 20km/hr

Outbound/Inbound Tunnel 2008

Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
7	3,200	Either	600m ² /sec	11106.7	49177.2	270.5	328.5	33.8	74.4	536.3	316.3	1.84E+02	3.69E-03	1.35E-01

TABLE C-4

Derived Stack Emissions (g/hr) – Incident Case: 2 Lanes at 20km/hr

Outbound/Inbound Tunnel 2008

Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH	PAH Particle Bound
7	3,000	Either	600m ² /sec	10349.5	64464.4	272.5	432.3	44.1	100.0	701.7	435.9	1.81E+02	4.90E-03	1.69E-01

TABLE C-5

Derived Stack Emissions (g/hr) – Incident Case: 3 Lanes at 10km/hr

Outbound/Inbound Tunnel 2008

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
A-06	TUNNEL VENTILATION SYSTEM Emission Data – Air Quality Modelling Normal and Incident Cases	Page 27 of 31

Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
7	2,000	Either	600m ² /sec	7202.0	43844.6	201.1	290.2	29.7	73.4	485.0	292.2	1.27E+02	3.41E-03	1.33E-01

TABLE C-6

Derived Stack Emissions (g/hr) – Incident Case: 2 Lanes at 10km/hr

Outbound/Inbound Tunnel 2008

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
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Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
0	390	Inbound	300m ³ /sec	1567.6	6111.3	48.8	20.7	2.3	12.8	52.1	18.9	2.53E+01	4.37E-04	3.35E-02
1	228	Inbound	300m ³ /sec	1022.3	4187.3	38.5	13.6	1.6	11.7	41.6	12.4	1.73E+01	3.26E-04	3.19E-02
2	183	Inbound	300m ³ /sec	1109.6	3516.2	43.2	11.3	1.4	11.5	38.1	10.2	2.04E+01	3.72E-04	3.16E-02
3	196	Inbound	300m ³ /sec	1188.5	3665.9	45.4	11.9	1.4	11.6	39.0	10.8	2.21E+01	3.97E-04	3.19E-02
4	360	Inbound	300m ³ /sec	1653.7	5717.5	54.2	19.6	2.2	12.8	50.4	17.9	2.90E+01	4.98E-04	3.36E-02
5	1,299	Inbound	600m ³ /sec	4707.0	18730.4	129.4	66.0	7.2	29.6	140.6	60.6	7.55E+01	1.24E-03	7.28E-02
6	5,398	Inbound	600m ³ /sec	15553.7	69983.3	312.3	255.9	26.7	58.5	422.4	236.1	2.23E+02	3.35E-03	1.14E-01
7	6,362	Inbound	600m ³ /sec	17464.9	82095.8	328.9	299.5	31.2	64.4	487.2	276.1	2.39E+02	3.55E-03	1.22E-01
8	5,205	Inbound	600m ³ /sec	14510.9	67610.9	281.4	246.0	25.7	56.4	407.8	226.7	2.01E+02	3.00E-03	1.11E-01
9	4,682	Inbound	600m ³ /sec	13614.4	61011.2	277.9	222.5	23.3	53.3	372.8	205.2	1.96E+02	2.96E-03	1.06E-01
10	3,594	Inbound	450m ³ /sec	10653.8	46752.1	221.0	170.9	17.9	40.8	285.6	157.7	1.56E+02	2.36E-03	8.12E-02
11	3,183	Inbound	450m ³ /sec	9587.7	41628.6	203.9	152.0	15.9	38.0	257.5	140.3	1.42E+02	2.16E-03	7.71E-02
12	3,074	Inbound	450m ³ /sec	9409.8	40243.3	203.3	147.1	15.4	37.3	250.2	135.7	1.41E+02	2.15E-03	7.63E-02
13	2,956	Inbound	450m ³ /sec	9116.3	38754.7	198.5	141.6	14.9	36.5	242.0	130.6	1.37E+02	2.10E-03	7.51E-02
14	2,938	Inbound	450m ³ /sec	8900.3	38582.2	191.8	140.7	14.8	36.2	240.8	129.8	1.32E+02	2.02E-03	7.47E-02
15	3,222	Inbound	600m ³ /sec	9736.3	42827.0	213.6	155.3	16.4	43.1	273.1	143.2	1.44E+02	2.22E-03	9.20E-02
16	3,532	Inbound	600m ³ /sec	10249.9	46711.3	214.4	169.0	17.8	44.9	293.6	155.7	1.46E+02	2.23E-03	9.44E-02
17	4,273	Inbound	600m ³ /sec	12723.5	55968.3	269.3	204.4	21.4	50.8	346.0	188.7	1.88E+02	2.86E-03	1.03E-01
18	3,496	Inbound	600m ³ /sec	10757.4	46124.9	235.8	167.8	17.7	45.3	291.6	154.7	1.60E+02	2.46E-03	9.52E-02
19	2,582	Inbound	600m ³ /sec	7513.0	34794.8	161.6	124.3	13.2	37.8	227.2	114.2	1.04E+02	1.62E-03	8.41E-02
20	1,779	Inbound	300m ³ /sec	4988.6	23497.7	100.0	84.6	8.9	22.2	147.0	77.8	6.79E+01	1.03E-03	4.68E-02
21	1,589	Inbound	300m ³ /sec	4483.8	21109.7	91.3	75.8	8.0	20.9	133.8	69.6	6.08E+01	9.29E-04	4.49E-02
22	1,355	Inbound	300m ³ /sec	3942.0	18167.0	83.8	65.0	6.9	19.3	117.8	59.7	5.45E+01	8.41E-04	4.27E-02
23	873	Inbound	300m ³ /sec	2714.9	12167.0	65.0	42.9	4.6	16.0	85.1	39.4	3.90E+01	6.26E-04	3.81E-02

Note: 1. Ambient air pollution contribution data corrected for variable stack flow rate.
2. Stack exit cross section: 35m².

TABLE C-7

Derived Stack Emissions (g/hr) – Normal Case: 3 Lanes at 80km/hr

Inbound Tunnel 2011

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
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Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
0	724	Outbound	300m ³ /sec	2268.9	10367.8	57.3	36.3	3.9	15.0	75.3	33.3	3.29E+01	5.42E-04	3.66E-02
1	365	Outbound	300m ³ /sec	1357.8	5891.7	43.2	19.8	2.2	12.6	50.8	18.1	2.13E+01	3.79E-04	3.31E-02
2	228	Outbound	300m ³ /sec	1030.7	4154.4	38.2	13.4	1.6	11.6	41.3	12.2	1.72E+01	3.21E-04	3.18E-02
3	168	Outbound	300m ³ /sec	891.3	3410.3	36.6	10.7	1.3	11.2	37.3	9.7	1.57E+01	3.02E-04	3.13E-02
4	203	Outbound	300m ³ /sec	1015.9	3844.9	39.5	12.4	1.5	11.5	39.8	11.3	1.79E+01	3.36E-04	3.17E-02
5	424	Outbound	600m ³ /sec	2035.5	7949.9	78.3	25.7	3.1	23.2	81.0	23.4	3.54E+01	6.66E-04	6.36E-02
6	1,499	Outbound	600m ³ /sec	4909.3	21428.5	128.3	75.8	8.2	30.8	155.3	69.8	7.56E+01	1.25E-03	7.45E-02
7	3,496	Outbound	600m ³ /sec	10617.7	46421.0	236.0	169.4	17.8	45.6	294.1	156.5	1.61E+02	2.49E-03	9.57E-02
8	4,273	Outbound	600m ³ /sec	12417.0	56017.3	257.2	204.1	21.4	50.5	345.5	188.2	1.79E+02	2.73E-03	1.02E-01
9	2,699	Outbound	600m ³ /sec	8216.9	36473.8	188.3	131.9	14.0	39.6	238.6	121.8	1.23E+02	1.94E-03	8.70E-02
10	2,496	Outbound	450m ³ /sec	7452.3	33288.3	165.0	121.1	12.7	33.1	211.9	111.9	1.11E+02	1.73E-03	7.02E-02
11	2,676	Outbound	450m ³ /sec	7926.4	35541.6	173.0	129.5	13.6	34.4	224.3	119.6	1.18E+02	1.83E-03	7.20E-02
12	2,879	Outbound	450m ³ /sec	8421.1	38086.6	180.2	138.8	14.6	35.8	238.1	128.2	1.24E+02	1.91E-03	7.39E-02
13	3,035	Outbound	450m ³ /sec	8829.7	40045.0	187.1	146.1	15.3	36.9	248.9	134.9	1.29E+02	1.99E-03	7.55E-02
14	3,489	Outbound	450m ³ /sec	10180.4	45666.3	212.7	167.1	17.5	40.2	280.0	154.4	1.50E+02	2.28E-03	8.03E-02
15	4,818	Outbound	600m ³ /sec	14186.3	62730.5	293.4	229.4	24.0	54.6	383.0	211.7	2.07E+02	3.14E-03	1.08E-01
16	5,792	Outbound	600m ³ /sec	16909.4	74765.8	340.2	273.9	28.6	61.4	448.9	252.7	2.45E+02	3.66E-03	1.18E-01
17	6,362	Outbound	600m ³ /sec	17818.5	81828.7	338.4	298.6	31.1	64.5	485.6	275.1	2.46E+02	3.64E-03	1.22E-01
18	5,205	Outbound	600m ³ /sec	14729.6	67435.3	287.1	245.4	25.6	56.4	406.8	226.0	2.05E+02	3.05E-03	1.11E-01
19	3,682	Outbound	600m ³ /sec	10407.4	48602.7	211.2	175.6	18.4	45.6	303.3	161.6	1.44E+02	2.19E-03	9.53E-02
20	2,400	Outbound	300m ³ /sec	6590.7	31307.6	127.1	113.6	11.9	26.6	190.0	104.7	8.98E+01	1.35E-03	5.31E-02
21	2,209	Outbound	300m ³ /sec	6116.6	28893.4	119.4	104.7	10.9	25.3	176.7	96.4	8.34E+01	1.26E-03	5.11E-02
22	2,027	Outbound	300m ³ /sec	5663.0	26617.2	112.1	96.3	10.1	24.0	164.2	88.6	7.75E+01	1.17E-03	4.94E-02
23	1,598	Outbound	300m ³ /sec	4530.1	21266.0	93.4	76.5	8.1	21.0	134.9	70.3	6.24E+01	9.56E-04	4.51E-02

Note: 1. Ambient air pollution contribution data corrected for variable stack flow rate.
2. Stack exit cross section: 35m².

TABLE C-8

Derived Stack Emissions (g/hr) – Normal Case: 3 Lanes at 80km/hr

Outbound Tunnel 2011

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Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
7	4,800	Either	600m ³ /sec	14552.0	59992.4	339.1	401.4	41.2	87.0	645.4	386.0	2.41E+02	4.43E-03	1.51E-01

TABLE C-9

Derived Stack Emissions (g/hr) – Incident Case: 3 Lanes at 20km/hr

Outbound/Inbound Tunnel 2011

Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
7	3,200	Either	600m ³ /sec	10003.7	40863.2	245.5	269.5	27.8	64.7	447.4	259.0	1.67E+02	3.10E-03	1.21E-01

TABLE C-10

Derived Stack Emissions (g/hr) – Incident Case: 2 Lanes at 20km/hr

Outbound/Inbound Tunnel 2011

Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
7	3,000	Either	600m ³ /sec	9448.7	53898.0	247.6	357.7	36.6	86.0	587.2	359.1	1.65E+02	4.11E-03	1.49E-01

TABLE C-11

Derived Stack Emissions (g/hr) – Incident Case: 3 Lanes at 10km/hr

Outbound/Inbound Tunnel 2011

EPC 0385	EASTLINK	AL-M04-RPT-VE03-0002
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Hour	Traffic	Tunnel	Airflow	NO _x	CO	PM ₁₀	Benzene	1,3-Butadiene	Formaldehyde	Toluene	Xylenes	PM _{2.5}	PAH as BAP	PAH Particle Bound
7	2,000	Either	600m ³ /sec	6601.5	36800.3	184.5	240.4	24.7	64.0	408.6	241.0	1.16E+02	2.88E-03	1.19E-01

TABLE C-12

Derived Stack Emissions (g/hr) – Incident Case: 2 Lanes at 10km/hr

Outbound/Inbound Tunnel 2011

ATTACHMENT 1

ABS VEHICLE REGISTRATION DATA COMPARISON – NATIONAL:STATE (Based on ABS Motor Vehicle Census 17 November 2004)

Vehicle Class	National	% of total	Victoria	% of total
Passenger Vehicles	10629401	78.54	2873351	80.6
Campervans	39347	0.30	8701	0.24
Light Commercial Vehicles	1952486	14.42	452190	12.68
Light Rigid Trucks	83212	0.60	17331	0.47
Heavy Rigid Trucks	274405	2.76	69310	1.94
Articulated Trucks	66300	0.49	20241	0.57
Non Freight Carrying Trucks	19697	0.15	5878	0.16
Busses	71314	0.53	15685	0.44
Motorcycles	396309	2.93	102463	2.87

Note:

For Eastlink, passenger vehicles represent about 98% of the tunnel traffic. These vehicles include the ABS categories: passenger vehicles, campervans and motorcycles. A comparison of the national and Victorian figures for the passenger vehicle class follows (emissions calculated on Victorian and national data will differ by a very small amount):

National

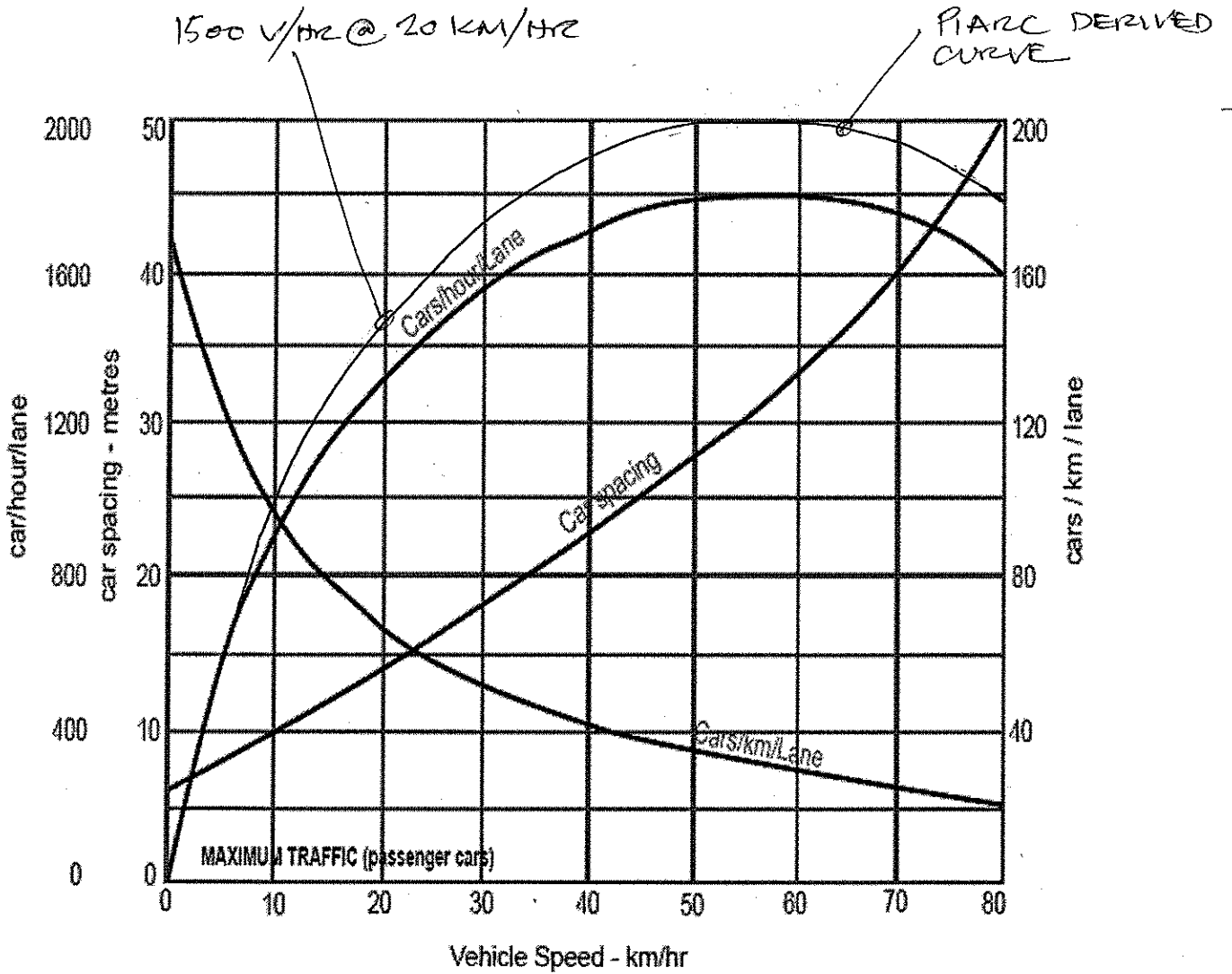
Class	No.	%
Passenger vehicles	10629401	96.29
Campervans	39947	0.35
Motorcycles	369309	3.36

Victoria

Class	No.	%
Passenger vehicles	2873351	96.28
Campervans	8701	0.29
Motorcycles	102463	3.43

ATTACHMENT 2

Speed/Capacity curve (Derived from Woods Fans Ventilation Guide)



ATTACHMENT 3

STACK EMISSIONS BASED ON PIARC

Stack emissions calculated using PIARC vehicle emission factors follow.
Please note:

1. The PIARC publications include calculation recommendations for the purposes of tunnel ventilation system sizing, rather than for determination of whole of tunnel emissions for modelling purposes.
2. PIARC does not include vehicle categories other than petrol and diesel cars and diesel trucks and busses. A vehicle mix has been assumed in order to estimate emissions. This mix is based on the PIARC categories and is as follows:

Traffic mix cars (petrol)

	Percentage	PIARC Emission Standard
2004 1997-2004 year 1986 - 1996 year pre 1986	3.0%	Euro 4
	6.0%	Euro 3
	15.0%	Euro 2
	30.0%	US83
	42.0%	ECE/04
	3.0%	ECE/00

Traffic mix trucks

	Percentage	PIARC Emission Standard
Pre 1988	0.00%	Pre-Euro
1989-1994	10.00%	Euro 0
1995-2001	20.00%	Euro 1
2002-2004 LCVs	0.00%	Euro 2
2002-2004 HCVs	30.00%	Euro 3
2005-2008	40.00%	Euro 4

3. CO and NO_x emissions only are calculated as the PIARC tables do not include factors for particulates.
4. Emissions have been calculated for the 3 lanes full/10km;hr case

RESULTS (PIARC):

Traffic	Tunnel	Airflow	NO _x	NO _x (ppm)	CO	CO (ppm)
3000	Either	600m ³ /sec.	2.0kg/hr.	0.71	58.3kg/hr.	23.88

RESULTS (AusVeh):

Traffic	Tunnel	Airflow	NO _x	NO _x (ppm)	CO	CO (ppm)
3000	Either	600m ³ /sec.	11.5kg/hr.	4.07	69.4kg/hr.	28.49

Note that NO_x and CO concentrations are below the PS&PR 15 minute limits wether calculated using the PIARC or AusVeh emission factors.