ARTC INLAND RAIL T2A

Preliminary Air Quality Assessment
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Prepared for:

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Australian Rail Track Corporation Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
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EXECUTIVE SUMMARY

Emissions to air from the operation of T2A Project freight trains for existing operations and future year (2025 and 2040) operation scenarios are estimated based on emission factors derived from (USEPA) Tiered Emission Standards. Hourly emission rates of PM_{10}, $PM_{2.5}$ and NO_X from T2A Project locomotives were estimated based on the number of locomotives per train, and their assumed power ratings and duty cycles.

Annual emissions were estimated for Local Government Areas from the hourly emission rates, the proposed frequency of different types of train, the length of track and an assumed average speed. Increases in emissions over current operations were estimated for 2025 and 2040 operations based on projected increases in the number of trains and an assumed increase in the average locomotive duty cycle required to move future heavier loads (proposed double stacked containers). The annual emissions estimations indicate that the T2A Project has the potential to increase PM_{10} $PM_{2.5}$ emissions from the freight trains by approximately 25% and 49% in 2025 and 2040 respectively, and for NO_X, 20% and 33%, respectively.

Emissions from an individual train are conservatively estimated to contribute minimal incremental increases to ambient concentrations of PM_{10}, $PM_{2.5}$ and NO_2 (0.3%, 0.8% and 7.8%, respectively) corresponding to small fractions of representative ambient criteria adopted by the assessment for comparison (0.1%, 0.2% and 1.4%, respectively).

It is concluded that the emissions do not have the potential to result in significant increases in ambient PM_{10} and NO_2 concentrations in the vicinity of the T2A Project. With regard to the referral criteria provided in the Ministerial Guidelines for assessment of environmental effects under the *Environment Effects Act 1978* relative to the existing operations, the potential for extensive or major health effects on the health, safety or well-being of a human community due to the T2A Project is considered to be unlikely.

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1 Introduction

SLR was engaged by Australian Rail Track Corporation Limited (ARTC) to provide a preliminary desktop air quality assessment (AQA) of the potential impacts on ambient air quality as a result of the Tottenham to Albury (T2A) Project's rail operations. The T2A Project is an enhancement of 305 km of existing rail between metropolitan Melbourne and the Victoria-NSW border at Albury-Wodonga.

This report presents the findings of the preliminary AQA.

2 Scope

Based on SLR's review of the T2A Air Quality Scope of Work provided by ARTC, the following scope of works was proposed for the preliminary AQA:

- Estimate emissions from the operation of double-stacked containers based on:
    - existing emissions from current freight trains (based on published emission factors for types of engines, frequency of trains to be provided by ARTC)
    - projected emissions for 2025 and 2040 operational scenarios (based on emission factors for types of engines, frequency of trains, and assumptions about potential load and speed of double-stacked containers to be provided by ARTC).
- Review publicly available data on ambient air quality in relevant areas along the T2A Project and compare with State Environment Protection Policy (Ambient Air Quality) criteria for nitrogen dioxide (NO_2) and for particulate matter with an aerodynamic diameter of less than 10 microns (PM_{10}), and 2.5 microns ($PM_{2.5}$).
- Characterise the background air quality along key sections of the rail corridor based on available monitoring data, land use information, and information on any major air emissions sources identified in the vicinity of the rail line (e.g. transport corridors, industrial facilities, commercial operations or agricultural developments).
- Prepare a report that provides:
    - the assumptions, emission factors and results of the engine emissions calculations
    - a semi-quantitative assessment of the background air concentrations of NO_2, PM_{10} and $PM_{2.5}$ and characterisation along the key sections of the T2A Project corridor
    - a statement about the estimated emissions from the T2A Project with regards to the referral criteria provided in the Ministerial Guidelines for assessment of environmental effects under the *Environment Effects Act 1978*.

It is noted that emission factors for the existing and future trains were not provided by ARTC. In the absence of this information, SLR has derived emission factors from United States Environmental Protection Agency (USEPA) Tiered Emission Standards.

3 Pollutants Considered

Air pollutants of most relevance to operation of the T2A Project are:

- PM_{10} and $PM_{2.5}$
- oxides of nitrogen (NO_X) as NO_2.

The locomotive engines will also emit sulfur dioxide (due to sulfur contained in the fuel) and volatile organic compounds. These emissions will be minor compared to particulate and NO_X emissions, therefore provided that no significant impacts are anticipated as a result of the pollutants listed above, it can be concluded that there would be no adverse air quality impacts associated with these other minor emissions.

4 Legislation

The legislative context for the T2A Project AQA is described below.

4.1 Commonwealth Legislation

The National Environment Protection Council (NEPC) was established under the *National Environment Protection Council Act 1994* with the primary function of:

- developing National Environment Protection Measures (NEPMs)
- assessing and reporting on the implementation and effectiveness of the NEPMs in each State and Territory.

4.1.1 National Environment Protection (Ambient Air Quality) Measure

The National Environment Protection (Ambient Air Quality) Measure February 2016 (Air NEPM) contains standards and goals for key pollutants that are required to be achieved nationwide, with due regard to population exposure. Note that as of 2025, the $PM_{2.5}$ criteria are to be reduced. **Table 1** presents the standards for pollutants relevant to the T2A Project.

Air NEPM standards apply at performance monitoring locations, with each station located in such a manner that it obtains a representative measure of air quality likely to be experienced by the general population in a region or sub-region of 25,000 people or more.

The standards are not intended to be applied as modelling criteria for assessing air emissions from individual sources, specific industries or roadside locations.

Table 1 Ambient Air Quality Standards and Goals

Pollutant	Averaging Period	Air Quality Standard	Maximum Allowable Exceedances
PM_{10}	1 day 1 year	50 µg/m^3 25 µg/m^3	None
$PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3	None

Pollutant	Averaging Period	Air Quality Standard	Maximum Allowable Exceedances
$PM_{2.5}$ (2025)	1 day 1 year	20 µg/m^3 7 µg/m^3	None
NO_2	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year None

The NEPC 'Draft Variation to the National Environment Protection (Ambient Air Quality) Measure for Sulfur Dioxide, Nitrogen Dioxide and Ozone (May 2019) recommends updated standards and goals which may be relevant for the T2A Project, should the recommendations be accepted in a future variation to the Air NEPM. The recommendations for NO_2 are summarised in **Table 2**.

Table 2 Draft Variation Air NEPM (May 2019) NO_2 Recommendations

Pollutant	Averaging Period	Air Quality Standard	Maximum Allowable Exceedances
NO_2	1 hour 1 year	0.090 ppm 0.019 ppm	None None
NO_2 (2025)	1 hour 1 year	0.080 ppm 0.015 ppm	None None

4.2 Victorian Legislation

The *Environment Protection Act 1970* (EP Act) is the primary legislative instrument that governs protection of the environment in Victoria. It sets environmental objectives for air, water and land and regulates the discharge of emissions to these environments. Pursuant to the EP Act, beneficial uses of the air environment are principally protected by the following subordinate regulations and policies:

- Environment Protection (Scheduled Premises and Exemptions) Regulations 2017
- State Environment Protection Policy (Ambient Air Quality) [SEPP(AAQ)] as amended in July 2016 to incorporate changes to the Air NEPM particle standards (February 2016)
- State Environment Protection Policy (Air Quality Management) December 2001 [SEPP(AQM)].

The T2A Project does not include any scheduled premises, hence the Environment Protection (Scheduled Premises and Exemptions) Regulations 2017 does not apply and is not discussed further.

4.2.1 SEPP(AAQ)

In general, the SEPP(AAQ) adopts the requirements of the Air NEPM, with environmental quality objectives (EQOs) for carbon monoxide (CO), NO_2, photochemical oxidants (as ozone (O_3)), sulphur dioxide (SO_2), lead and particles (as PM_{10} and $PM_{2.5}$, together with an additional objective for visibility-reducing particles). The SEPP(AAQ) EQOs apply to air quality within a region or sub-region considered to be representative of exposure of the general population in Victoria. That is, the EQOs are not intended to assess the air quality at individual receptors impacted by a local industrial source.

In accordance with the Air NEPM, the SEPP(AAQ) includes $PM_{2.5}$ objectives of 7 µg/m^3 (annual average) and 20 µg/m^3 (24-hour average) to be implemented by 2025. This future change is linked to the expected improvement in background air quality resulting from improved vehicle emission control technologies.

As distinct from the Air NEPM, SEPP(AAQ) adopts a more stringent PM_{10} annual average objective of 20 µg/m^3.

4.2.2 SEPP(AQM)

The SEPP(AQM) sets out legislative requirements for managing and assessing air emissions in Victoria. The aim of the SEPP(AQM) is to

- Ensure that prescribed air quality objectives are met.
- Drive continual improvement in air quality, whist having regard to the social and economic development of Victoria.
- Support the Victorian Government's other environmental goals.

Schedule A of the SEPP(AQM) lists air quality indicators and their design criteria '*to be used in the assessment of the design of new or expanded sources of emissions'*, with the inference being that they are to be applied to stationary sources. The SEPP(AQM) does not contain guidance, nor specific criteria, for the assessment of impacts from transport corridors. Schedule B lists intervention levels 'used to assess air quality monitoring data'. An intervention level is '*numerically greater than the design criteria for a given pollutant as it does not apply to an individual source but to all sources of the pollutant within a defined area*'. In the absence of clear guidance, the Schedule B intervention levels have previously been considered appropriate to assist with understanding the impacts of transport corridors, e.g. surface roads[1], however, more recently, EPA Victoria has indicated that this is no longer considered acceptable[2], requiring *comparison* with SEPP(AAQ) EQOs. It should be emphasised, however, that in this regard, SEPP(AAQ) EQOs have no regulatory status. They are therefore not considered appropriate for the T2A Project.

5 Quantification of Locomotive Emissions

5.1 Emission Factors

The locomotive trains relevant to the operation of the T2A Project are line-haul, diesel-electric trains. A diesel-electric train uses a diesel engine to drive an electrical generator that provides power to the wheels. Switch locomotives, which are used in rail yards but may be used to power local and regional service trains, are not considered here.

Emissions standards are not applied in Australia, either nationally or by states, to address air emissions from locomotives.

United States (US) and European Union (EU) emission standards for diesel locomotives are the most widely referenced and applied standards internationally.

[1] Environmental Effects Statement, West Gate Tunnel, West Gate Tunnel Authority, Victoria, 2016
[2] Environmental Effects Statement, North East Link, North East Link Authority, Victoria, 2018

Table 3 presents the USEPA Tiered Emission Standards for locomotives which were introduced in the US in 2000. Tier 0 was applied retrospectively to in-service locomotives built after 1973 at the next major engine overhaul (remanufacture; estimated to be typically after approximately 20 to 30 years operation). The emissions standards were updated in 2008 to more stringent Tier 0+, Tier 1+ and Tier 2+ standards, accompanied by the introduction of Tier 3 and 4 for new locomotives.

Table 3 USEPA Tiered Standards for Line-haul Locomotives

Tier Classification	Year	Emission Standard (g/kWh)	
		PM_{10}	NO_X
Uncontrolled	NA	0.43	17.4
0	1973 – 2001	0.43	11.5
0+	1973 – 1992	0.27	9.7
1	2002 – 2004	0.43	9.0
1+	1993 – 2004	0.27	9.0
2	2005 or later	0.24	6.6
2+	2005 – 2011	0.11	6.6
3	2012 – 2015	0.11	6.6
4	2015 or later	0.02	1.3

Table 4 presents the EU Stage IIIA Standards for locomotive engines greater than 3,000 kW. In relation to the USEPA Tiered Standards, the EU IIIA Standard is approximately equivalent to Tier 1+ or Tier 2.

Table 4 EU Stage IIIA Standards for Locomotive Engines

Category	Emission Standard (g/kWh)	
	PM_{10}	NO_X
>2,000 kW and >5 l/cylinder locomotives	0.2	7.4

The average age of diesel-electric locomotives in Australia is much older than the average age of the US fleet. A 2013 study reported that the average age of diesel-electric locomotives in Australia is about 35 years and half the existing fleet is more than 26 years old. In comparison, the average age of the US fleet is 8 years. It was further reported that 80.7% of the existing locomotive fleet in Australia do not meet any US emission standards, 2.7% meet Tier 0, 16.1% meet Tier 1 and 0.3% meet Tier 2 emission standards[3]. Recent fuel efficiency and emissions testing of a *NR class* (NR121) and a *93 class* (9317) locomotive commissioned by the NSW EPA[4] concluded that both achieved emission results below the Tier 0+ standard for PM_{10}, however both exceeded Tier 0+ standard for NO_X (**Table 5**).

[3] *Locomotive Emissions Project Scoping Study of Potential Measures to Reduce Emissions from New and In-Service Locomotives in NSW and Australia*, Environ Australia, March 2013.
[4] *Diesel Locomotive Fuel Emissions and Efficiency Testing*, ABMARC, November 2016

Table 5 NR Class and 93 Class Locomotive Difference to Tier 0+ Emission Standards

Pollutant	Locomotive	
	NR121	9317
PM_{10}	-66%	-63%
NO_X	+55%	+13%

These results indicate that both locomotives would have achieved emission results below the EU Stage IIIA PM_{10} standard, however, both would exceed the NO_X standard.

In the absence of information about the age or emissions performance of locomotives relevant to the T2A Project for either current or future years, and for the purposes of this preliminary assessment, the current and future year freight trains relevant to the T2A Project have been conservatively assumed to have emissions equivalent to USEPA Tier 0+ for PM_{10} (with $PM_{2.5}$ emissions taken to comprise 97% of PM_{10} emissions[5]) and USEPA *uncontrolled* for NO_X.

5.2 Locomotive Power

5.2.1 Power Rating

The types of locomotives relevant to the T2A Project operation and considered in the preliminary AQA are the *NR* class and *SCT* class locomotives. Specifications for these classes of locomotives[6,7] are provided in **Table 6**.

Table 6 Locomotive Specifications

Parameter	SCT	NR Class
Model	GT46C-ACe	Cv40-9i
Power Type	Diesel-electric	Diesel-electric
Build date	2007-2013	1996-1998
Max speed (km/h)	115	115
Power output (kW)	3350	3000

5.2.2 US EPA Cycle Weighting Factors

Line-haul locomotives are powered by an engine with a maximum rated power, but do not operate at 100% of that rating at all times. The US EPA defines different duty cycles (i.e. the time spent at each notch level [throttle position]) for line-haul locomotives to represent typical operating conditions (**Table 7**). It is noted that the actual operating cycle of locomotives relevant to the T2A Project operation may vary substantially from the US EPA averages.

[5] Emission Factors for Locomotives, USEPA-420-F-09-025, April 2009.
[6] https://en.wikipedia.org/wiki/Downer_EDI_Rail_GT46C_ACe
[7] https://en.wikipedia.org/wiki/National_Rail_NR_class

Table 7 USEPA Cycle Weighting Factors

Notch	% of time in notch	% of full power in notch	% of full power x % time
Dynamic Brake	12.5%	2.1%	0.3%
Idle	38.0%	0.4%	0.2%
Notch 1	6.5%	5.0%	0.3%
Notch 2	6.5%	11.4%	0.7%
Notch 3	5.2%	23.5%	1.2%
Notch 4	4.4%	34.3%	1.5%
Notch 5	3.8%	48.1%	1.8%
Notch 6	3.9%	64.3%	2.5%
Notch 7	3.0%	86.6%	2.6%
Notch 8	16.2%	102.5%	16.6%
Average load			28 %

It is assumed that the duty cycle of line-haul locomotives relevant to the T2A Project operation will be characterised by reduced idle times and an increase in utilisation at high power notch levels due to the distances covered between infrequent stops. Therefore, the average load is likely to be much more than the USEPA average of 28%. For the purposes of this preliminary air quality assessment, duty cycles of 28%, 40%, 50%, 75% and 100% have been considered when calculating emissions rates (**Section 5.5**).

5.3 Number and Type of Locomotives

The multiple-working configuration of locomotives used by freight trains relevant to the T2A Project (provided by ARTC) varies by train type and is provided in **Table 8**.

Table 8 Multiple-Working Locomotive Configurations

Service Group	Class of Locomotives	Number of Locomotives
Inland Rail Express	NR	3
Melbourne-Sydney Intermodal	NR	3
Inland Rail Superfreighter	SCT	2
Griffith Export Containers	SCT	2
Central New South Wales Grain (Tottenham to Junee)	SCT	2

5.4 Frequency of Trains

The frequencies of various freight trains relevant to the T2A Project (provided by ARTC) are provided in **Table 9**. Note it has been assumed that there will be no increase between the existing train frequency and the 2025 train frequency.

Table 9 Train Frequency

Service Group	Existing and 2025		2040	
	Day	Night	Day	Night
Inland Rail Express, Tottenham to Acacia Ridge	2	0	2	0
Inland Rail Express, Tottenham To Bromelton	1	1	1	1
Melbourne-Sydney Intermodal, Tottenham to Cootamundra	1	0	2	0
Melbourne-Sydney Intermodal, Tottenham to Junee	1	0	1	0
Inland Rail Superfreighter, Tottenham to Acacia Ridge	1	1	1	1
Inland Rail Superfreighter, Tottenham To Bromelton	3	1	4	1
Griffith Export Containers	1	1	1	1
Central New South Wales Grain, Tottenham to Junee	0	1	0	2

5.5 Emission Rates

Hourly emission rates estimated for the individual *NR* and *SCT* class locomotives based on the information in **Table 3** and **Table 6** are provided in **Table 10**. Total hourly emission rates estimated for the typical locomotive configurations presented in **Table 8** are provided in **Table 11**.

Table 10 Individual Locomotive Emission Rates (kg/hr)

Class	Pollutant	Average Duty Cycle (%)				
		28	40	50	75	100
NR	PM_{10}	0.23	0.32	0.41	0.61	0.81
	$PM_{2.5}$	0.22	0.31	0.39	0.59	0.78
	NO_X	14.6	21	26	39	52
SCT	PM_{10}	0.25	0.36	0.45	0.68	0.90
	$PM_{2.5}$	0.24	0.35	0.44	0.65	0.87
	NO_X	16.3	23	29	44	58

Table 11 Multiple-Working Locomotive Emission Rates (kg/hr)

Class	Number of Locomotives per Train	Pollutant	Average Duty Cycle (%)				
			28	40	50	75	100
NR	3	PM_{10}	0.68	1.0	1.2	1.8	2.4
		$PM_{2.5}$	0.66	0.9	1.2	1.8	2.3
		NO_X	44	63	78	117	157
SCT	2	PM_{10}	0.50	0.72	0.9	1.4	1.8
		$PM_{2.5}$	0.49	0.70	0.9	1.3	1.7
		NO_X	33	47	58	87	117

6 Existing Ambient Air Quality

6.1 Monitoring Data

Environment Protection Authority Victoria (EPA Victoria) operate 19 air quality monitoring stations (AQMSs) across Victoria, each providing information on the concentrations of up to six key pollutants, assessed against Air NEPM standards (refer Section **4.1.1**), and reported annually. Of these, Footscray AQMS is most relevant to the T2A Project, being located near Tottenham.

EPA Victoria also operates campaign AQMSs at various locations, results from which do not form part of EPA Victoria's annual air quality monitoring reports, as the data they record reflects conditions specific to local issues and emergency events. Campaign monitoring of this nature has been conducted at Wangaratta for several years as part of EPA Victoria's *Air Watch* network in response to bushfires, planned fuel reduction and domestic burning. Its location is therefore relevant to the T2A Project.

The NSW Office of Environment and Heritage (OEH) operates over 80 AQMS, including several as part of a rural network that covers areas with relatively low population density and no significant industrial sources of air pollution. Albury AQMS is part of the rural campaign monitoring network and is relevant to the T2A Project.

Details of the three monitoring stations corresponding to areas relevant to the T2A Project are provided in **Table 12**.

Table 12 T2A Relevant AQMS

AQMS	Location	Pollutants Monitored		
		PM_{10}	$PM_{2.5}$	NO_2
Footscray	Hansen Reserve, Footscray 0.5 km from T2A at Tottenham Station	Yes	Yes	Yes
Wangaratta	Bullivant Street, Wangaratta 1.0 km from T2A through Wangaratta	No	Yes	No
Albury	Jelbert Park, Albury 5.7 km from T2A at Albury Station	Yes	Yes	No

6.1.1 Footscray AQMS

The most recent annual compliance air monitoring report for Victoria (2017) [8] states that Victoria's air quality in 2017 was generally good and that at Footscray, the Air NEPM standards and goals were met for PM_{10} and NO_2. The $PM_{2.5}$ 24-hour average standard of 25 µg/m³ was exceeded on four occasions during 2017. It is noted that the 24-hour $PM_{2.5}$ standard was exceeded at all monitoring stations at which it is monitored during 2017, attributed to wood heater smoke, highlighting that urban sources such as domestic wood heaters are a major source of $PM_{2.5}$ in the Victorian airshed, and fuel reduction burns (planned and unplanned). Summary statistics for Footscray for the years 2012 to 2017 are provided in **Table 13**. It is noted that the PM_{10} standard was only narrowly met in 2017, and was exceeded in 2012, 2013, 2014 and 2015.

[8] Air monitoring report 2017 – Compliance with the National Environment Protection (Ambient Air Quality) Measure, EPA Victoria, Publication 1703, July 2018.

Table 13 Footscray AQMS Statistics

Pollutant (Averaging Period; Units)	Year	Annual Average	Maximum	Percentiles					
				99th	98th	95th	90th	75th	50th
PM_{10} (24-hour; µg/m³)	2012	18.6	**57.7**	45.1	38.7	33.7	28.6	23.6	17.1
	2013	18.1	**50.5**	43.0	38.9	34.4	28.8	22.5	16.6
	2014	21.1	**79.2**	63.0	42.2	36.5	30.6	23.0	18.0
	2015	17.7	**71.8**	44.7	35.7	32.5	28.8	21.9	16.4
	2016	15.7	42.7	37.9	35.1	29.3	25.9	20.2	14.1
	2017	18.1	49.8	39.5	36.6	31.0	28.1	23.0	17.4
	Standard	25	50	-	-	-	-	-	-
$PM_{2.5}$ (24-hour; µg/m³)	2012	6.1	23.1	16.2	14.9	11.2	10.0	7.2	5.5
	2013	6.2	17.1	16.6	15.5	12	10.8	7.7	5.5
	2014	7.2	**39.1**	26.8	21.9	17.4	11.4	7.9	5.9
	2015	6.2	20.8	19.0	14.0	12.3	10.5	7.8	5.5
	2016	6.9	**27.0**	23.0	17.4	14.0	11.6	9.0	5.8
	2017	7.4	**29.2**	26.2	19.5	16.0	11.8	8.6	6.4
	Standard	8	25	-	-	-	-	-	-
NO_2 (1-hour; ppm)	2012	0.010	0.058	0.042	0.040	0.036	0.032	0.027	0.020
	2013	0.011	0.051	0.045	0.040	0.037	0.035	0.028	0.022
	2014	0.011	0.064	0.045	0.040	0.036	0.033	0.027	0.021
	2015	0.011	0.046	0.040	0.038	0.035	0.032	0.028	0.021
	2016	0.010	0.052	0.042	0.038	0.035	0.032	0.026	0.020
	2017	0.011	0.050	0.047	0.042	0.039	0.035	0.029	0.023
	Standard	0.03	0.12	-	-	-	-	-	-

Exceedances in bold font.

6.1.2 Wangaratta AQMS

EPA Victoria is not required to publish the results from Wangaratta in its annual air quality monitoring reports. From time to time, EPA Victoria publishes results from its campaign monitoring stations on its website, however no publicly available data could be found at this time, other than the previous 48 hours of the 1-hour average $PM_{2.5}$ concentration on EPA Victoria's *AirWatch* website[9].

[9] https://www.epa.vic.gov.au/our-work/monitoring-the-environment/epa-airwatch

Elevated $PM_{2.5}$ concentrations are not uncommon in Wangaratta and surrounds due to bushfires in the summer months and planned fuel reduction and domestic burning in the cooler months. For example, in May 2017, EPA Victoria warned that weather conditions were causing a build-up of pollution and smoke from household sources including domestic wood heaters and private burns[10] and more recently, in March 2019, the *VicEmergency* service issued a warning for poor air quality in the North East, including Wangaratta, attributed to smoke from the South East fires[11].

6.1.3 Albury AQMS

The most recent NSW annual compliance air monitoring report (2017) [12] includes $PM_{2.5}$ monitoring at Albury for the first time. Although a campaign monitoring station, the report assesses Albury AQMS results against the Air NEPM standards and goals, which were met for PM_{10} and $PM_{2.5}$ in 2017. The PM_{10} 24-hour average standard of 25 µg/m³ was exceeded on several occasions in the preceding years (**Table 14**) with comments on reasons provided by OEH. Summary statistics for Albury for the years 2012 to 2017 are provided in **Table 15**.

Table 14 Albury AQMS NEPM Exceedances

Pollutant	Year	Exceedances of 24-hour Average Criterion	
		No.	OEH Comments
PM_{10} (24-hour; µg/m³)	2012	1	Regional dust event[13]
	2013	2	Non-exceptional event[14]
	2014	5	NA
	2015	2	Due to broad-scale agricultural activities. Result of a state-wide dust storm that originated from the Victorian Mallee and Southern NSW regions and travelled throughout NSW during the 5 & 6 May.[15]
	2016	1	Non-exceptional event[16]
	2017	0	None

Non-exceptional event infers that the exceedance is 'real' and is not attributed to e.g. a bushfire event.

NA Not available from OEH website

Table 15 Albury AQMS Statistics

Pollutant (Averaging Period; Units)	Year	Annual Average	Maximum	Percentiles					
				99th	98th	95th	90th	75th	50th
PM_{10} (24-hour; µg/m³)	2012	14.3	**54.4**	38.7	32.3	25.8	21.3	16.7	12.8
	2013	15.8	**59.2**	47.8	42.5	30.7	26.4	18.8	13.6
	2014	15.9	**159.6**	**88.2**	37.8	29.4	22.8	17.4	13.4
	2015	14.6	**92.5**	35.4	30.2	26.0	23.3	17.5	13.0

[10] Wangaratta Chronicle 23 May 2017, https://wangarattachronicle.com.au/2017/05/23/poor-air-quality-warning-for-wangaratta/, accessed 7 June 2019.
[11] VicEmergency, http://emergency.vic.gov.au/
[12] NSW Annual Compliance Report 2017: National Environment Protection (Ambient Air Quality) Measure, OEH, Feb. 2019.
[13] NSW Annual Compliance Report 2012: National Environment Protection (Ambient Air Quality) Measure, OEH, Nov. 2013
[14] NSW Annual Compliance Report 2013: National Environment Protection (Ambient Air Quality) Measure, OEH, Nov. 2014
[15] NSW Annual Compliance Report 2015: National Environment Protection (Ambient Air Quality) Measure, OEH, May 2017
[16] NSW Annual Compliance Report 2016: National Environment Protection (Ambient Air Quality) Measure, OEH, Feb. 2018

Pollutant (Averaging Period; Units)	Year	Annual Average	Maximum	Percentiles					
				99th	98th	95th	90th	75th	50th
	2016	15.1	**51.0**	47.2	43.5	32.4	25.6	18.7	13.1
	2017	15.8	48.8	37.8	33.4	28.6	24.2	19.3	14.7
	Standard	25	50	-	-	-	-	-	-
$PM_{2.5}$ (24-hour; µg/m^3)	2017	7.3	18.7	17.7	16.9	14.8	13.1	9.5	6.3
	Standard	8	25	-	-	-	-	-	-

6.2 Local Emission Sources - National Pollutant Inventory Reporting

The National Pollutant Inventory (NPI) is an online database that provides information to the public regarding estimated emissions of 93 substances in Australia, together with the source and location of these emissions. The NPI is implemented cooperatively by the Australia Government and, in Victoria, by EPA Victoria.

The NPI contains 17 years of emissions data from more than 4,000 industrial facilities nationwide. Only facilities for which an NPI pollutant reporting threshold has been exceeded are required to report to the NPI. The NPI guide provides further direction on reporting requirements. The NPI also includes estimated emissions data for non-industrial (diffuse) sources such as motor vehicle exhausts, wood heaters, lawn mowers and commercial and leisure boating. Major source types and emissions are identified for regions such as local government areas (LGAs).

The requirement to report emissions estimates to the NPI is determined by the processes being undertaken at the facility, and also whether those processes exceed process-specific thresholds, in terms of activity rates (i.e. throughput and/or consumption). The requirement to report emissions to the NPI does not necessarily mean that these activities will be significant in terms of their potential for impact. Conversely, the NPI database does not list all the sources of industrial emissions e.g. those that operate below the activity threshold specified for the industry and those that are inconsistent with the parameters specified for reporting under the NPI program.

6.2.1 Industrial Sources

During the 2014/2015 reporting period, the most recent data set available, over 800 facilities in Victoria emitted 80 different air pollutants. These facilities are required to submit NPI data on an annual basis. A search of the NPI database was undertaken for those in each of the 12 LGAs that the T2A Project passes through (**Figure 1**). The number of industrial facilities and the dominant types of industries that reported within each of those LGAs in the 2017/18 reporting year are provided in **Table 16**.

Figure 1 T2A Project LGAs

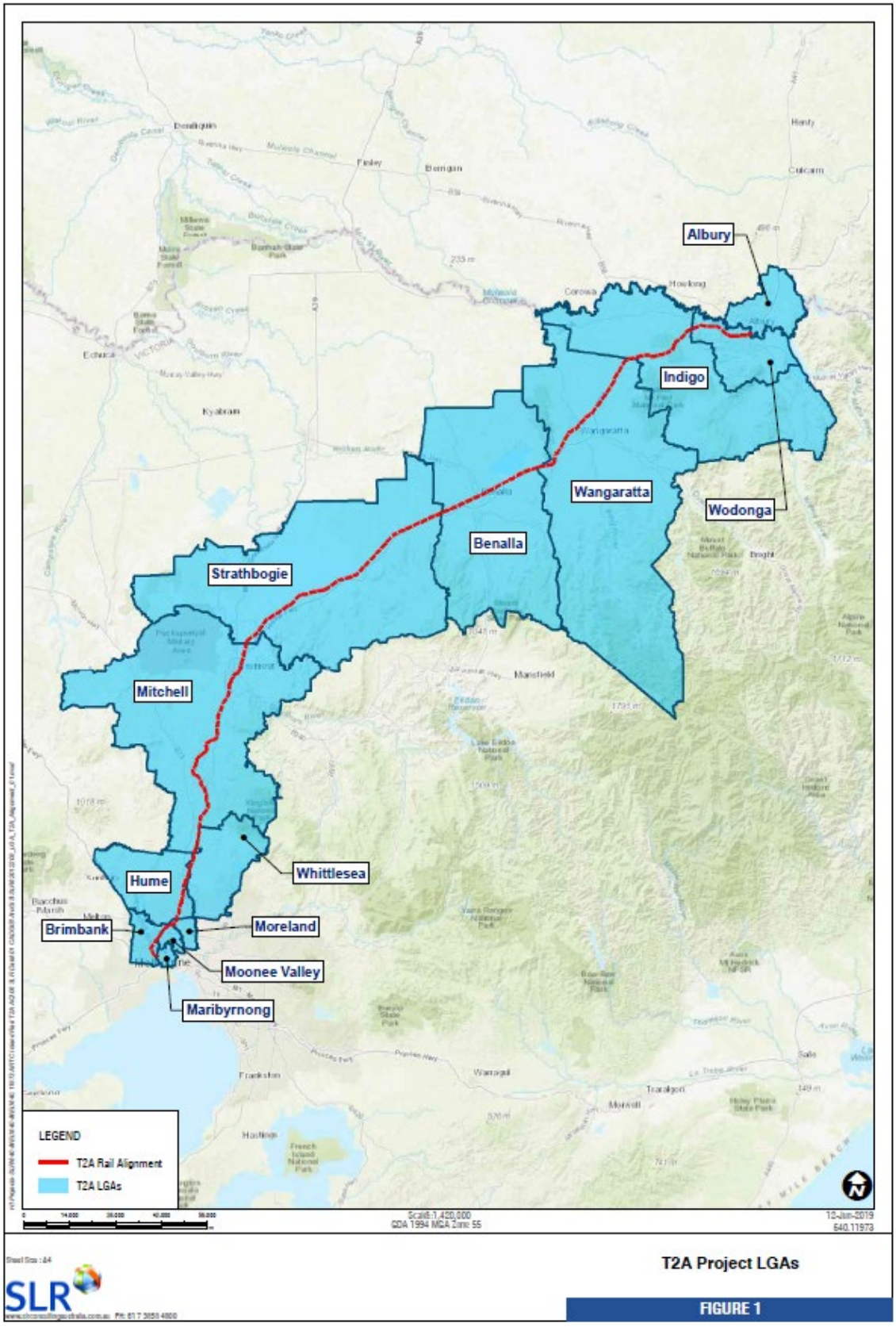


Table 16 T2A Project LGAs and Associated NPI Reporting Facilities with Potential Air Emissions

LGA	Number of Sources	NPI Sources
Maribyrnong	12	Oil and Fat Manufacturing Cement, Lime, Plaster and Concrete Product Manufacturing Sugar and Confectionery Manufacturing Other Non-Metallic Mineral Product Manufacturing Pulp, Paper and Paperboard Manufacturing Warehousing and Storage Services
Brimbank	13	Gas Supply Meat and Meat Product Manufacturing Waste Treatment, Disposal and Remediation Services Electricity Generation Printing and Printing Support Services Petroleum and Coal Product Manufacturing
Mooney Valley	0	NA
Moreland	4	Metal Container Manufacturing Dairy Product Manufacturing Polymer Product Manufacturing Funeral, Crematorium and Cemetery Services
Hume	21	Converted Paper Product Manufacturing Electricity Generation Airport Operations and Other Air Transport Support Services Construction Material Mining Other Transport Equipment Manufacturing Waste Treatment, Disposal and Remediation Services Construction Material Mining Cement, Lime, Plaster and Concrete Product Manufacturing Converted Paper Product Manufacturing Petroleum and Coal Product Manufacturing
Whittlesea	13	Waste Treatment, Disposal and Remediation Services Ceramic Product Manufacturing Construction Material Mining Gas Supply Electricity Generation
Mitchell	3	Construction Material Mining Sugar and Confectionery Manufacturing
Strathbogie	1	Gas Supply
Benalla	2	Other Wood Product Manufacturing Other Basic Chemical Product Manufacturing

LGA	Number of Sources	NPI Sources
Wangaratta	4	Other Wood Product Manufacturing Textile Product Manufacturing Hospital Waste Treatment, Disposal and Remediation Services
Indigo	3	Meat and Meat Product Manufacturing Dairy Product Manufacturing Grain Mill and Cereal Product Manufacturing
Wodonga	8	Other Food Product Manufacturing Meat and Meat Product Manufacturing Basic Ferrous Metal Product Manufacturing Converted Paper Product Manufacturing Petroleum and Coal Product Manufacturing Cement, Lime, Plaster and Concrete Product Manufacturing
Albury	3	Pulp, Paper and Paperboard Manufacturing Electricity Generation Iron and Steel Forging

The annual aggregated emissions of PM_{10}, $PM_{2.5}$ and NO_X reported in each of the LGAs relevant to the T2A Project in the 2017/18 reporting year, is provided in **Table 17**.

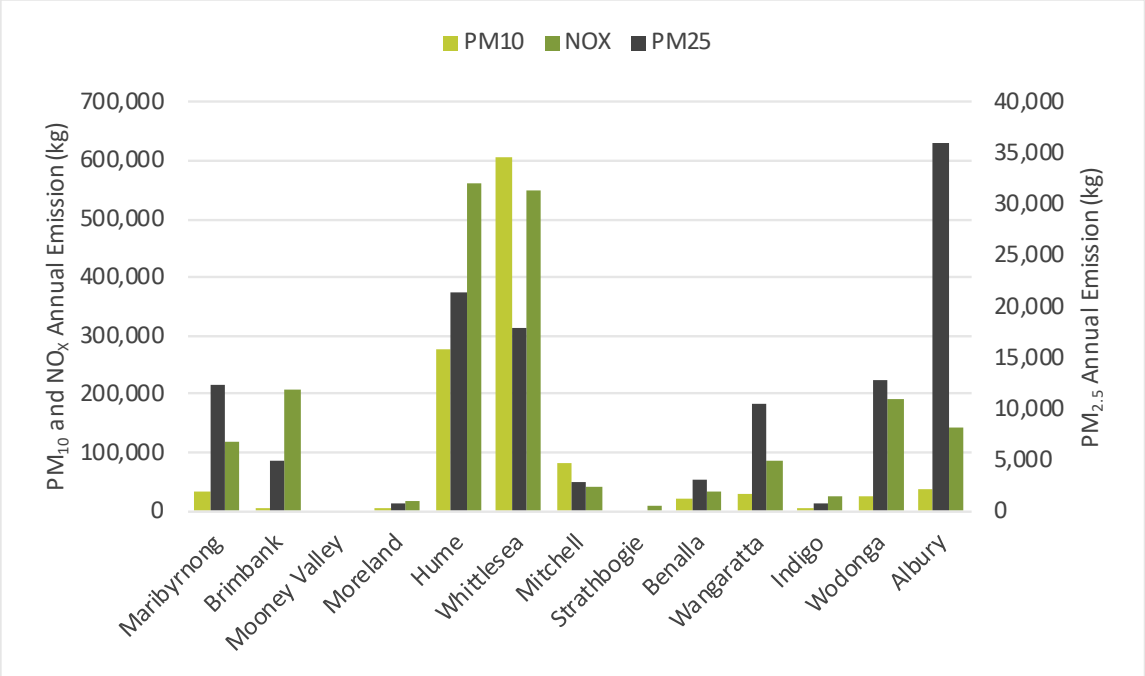
Table 17 NPI Reporting Emissions 2017/18: Industrial Emissions

LGA	Annual Emission (kg)		
	PM_{10}	$PM_{2.5}$	NO_X
Maribyrnong	34,200	12,400	120,000
Brimbank	5880	4,950	210,000
Mooney Valley	NR	NR	NR
Moreland	706	692	16,100
Hume	275,000	21,500	559,000
Whittlesea	606,000	18,000	547,000
Mitchell	83,600	2,880	42,100
Strathbogie	NR	NR	7,520
Benalla	22,300	2,980	34,100
Wangaratta	30,900	10,500	86,400
Indigo	1,000	851	23,800
Wodonga	25,100	12,800	191,000
Albury	39,600	36,100	142,000
Total	1,120,000	123,700	1,980,000

NR Not reported

Figure 2 presents a chart of the data in **Table 17** illustrating the relative differences in total emissions between the LGAs that the T2A Project passes through. Hume and Whittlesea are characterised by much greater industry emissions of PM_{10} and NO_X than the other LGAs. Albury's emissions are dominated by a single industry, *Pulp, Paper and Paperboard Manufacturing*. The $PM_{2.5}$ reported emission from this single facility is almost as great as the combined emissions from the 26 reporting facilities within Hume and Whittlesea.

Figure 2 NPI Reporting 2017/18: Industrial Emissions



A search of the NPI database focusing on the dominant industrial emissions sources in the vicinity of the T2A Project is summarised in **Table 18.**

Table 18 Significant NPI Reported Industrial Sources in the Vicinity of the T2A Project.

LGA	Significant Source(s)	Distance from T2A Project	Notes
Maribyrnong	Oil and Fat Manufacturing	< 0.5 km	West Footscray Fats and Oils is adjacent to Tottenham station emitting approximately 10% of the LGAs reported NO_X.
Brimbank	NA	NA	There are no notable emission sources in the vicinity of the T2A Project. Those sources that have significant contributions to the LGA are at some distance, e.g. Brooklyn Compressor Station reports 45% of the LGAs NO_X and is approximately 2.5 km to the south of Tottenham Station.
Mooney Valley	NA	NA	NA
Moreland	NA	NA	There are no significant industrial sources in the vicinity of the T2A Project.

LGA	Significant Source(s)	Distance from T2A Project	Notes
Hume	Converted Paper Product Manufacturing	<0.5 km	Visy Paper is a significant source (20%) of NO_X and $PM_{2.5}$ emissions to the LGA and is in close proximity to the T2A Project. Note that Oaklands Quarry dominates the reported PM_{10} and $PM_{2.5}$ emissions (89% and 31% respectively) for Hume but is over 7 km from the T2A Project.
Whittlesea	Ceramic Product Manufacturing	< 2 km	Austral Bricks reports greater than 60% contribution to the Ceramic Product Manufacturing annual PM_{10} and NO_X emissions, and over 95% of the $PM_{2.5}$ emissions. Overall in the LGA, this amounts to approximately 20% and 34% respectively. Its relative proximity to the T2A Project suggests it would a dominant source compared to the other Construction Material Mining and Waste Treatment, Disposal and Remediation Services sources.
Mitchell	Construction Material Mining	< 0.5 km	Quarrying dominates the NPI reported emissions in this LGA. Hanson Kilmore Quarry dominates these and is adjacent to the T2A Project at Kilmore East.
Benalla	Other Wood Product Manufacturing	< 0.5 km	D & R Henderson is the major contributor with greater than 95% of all NPI reported PM_{10}, $PM_{2.5}$ and NO_X emissions and is adjacent to the T2A Project at Benalla.
Wangaratta	Other Wood Product Manufacturing	< 2 km	Alpine MDF Industries dominates the NPI reporting for the LGA, responsible for over 95% of PM_{10}, $PM_{2.5}$ and over 85% of the NO_X emissions and is located within 2 km of the T2A Project.
Wodonga	Other Food Product Manufacturing	> 5 km	Vitasoy Australia Products dominates the NO_X and $PM_{2.5}$ emissions for the LGA (>80%) and contributes 44% of the PM_{10}.
	Basic Ferrous Metal Product Manufacturing	> 0.2 km	Bradken Resources contributes 45% of the PM_{10} emissions and is very close to the T2A Project.
	Meat and Meat Product Manufacturing	< 1 km	Wodonga Rendering contributes 8% of the NO_X and $PM_{2.5}$ emissions for the LGA in close vicinity to the T2A Project.
Albury	Pulp, Paper and Paperboard Manufacturing	> 5 km	The Norske Skog Albury Papermill dominates the NPI reporting for the LGA, responsible for over 90% of PM_{10}, $PM_{2.5}$ and NO_X emissions but is not adjacent to the T2A Project.

6.2.2 Diffuse and Non-Industrial Emissions

Non-industrial emission sources identified in the NPI reporting data include:

- motor vehicles
- railways
- aeroplanes
- fuel combustion (sub-reporting threshold facilities)
- gaseous fuel burning (domestic)
- solid fuel burning (domestic)
- burning (fuel reduction, regeneration, agriculture) / wildfires
- lawn mowing
- liquid fuel burning (domestic)
- barbeques
- backyard incinerators
- windblown dust
- paved / unpaved roads
- commercial shipping / boating

Emissions to air from all sources (industrial and non-industrial) within the LGAs that the T2A Project passes through for the 2017/2018 NPI reporting period are summarised in **Table 19**.

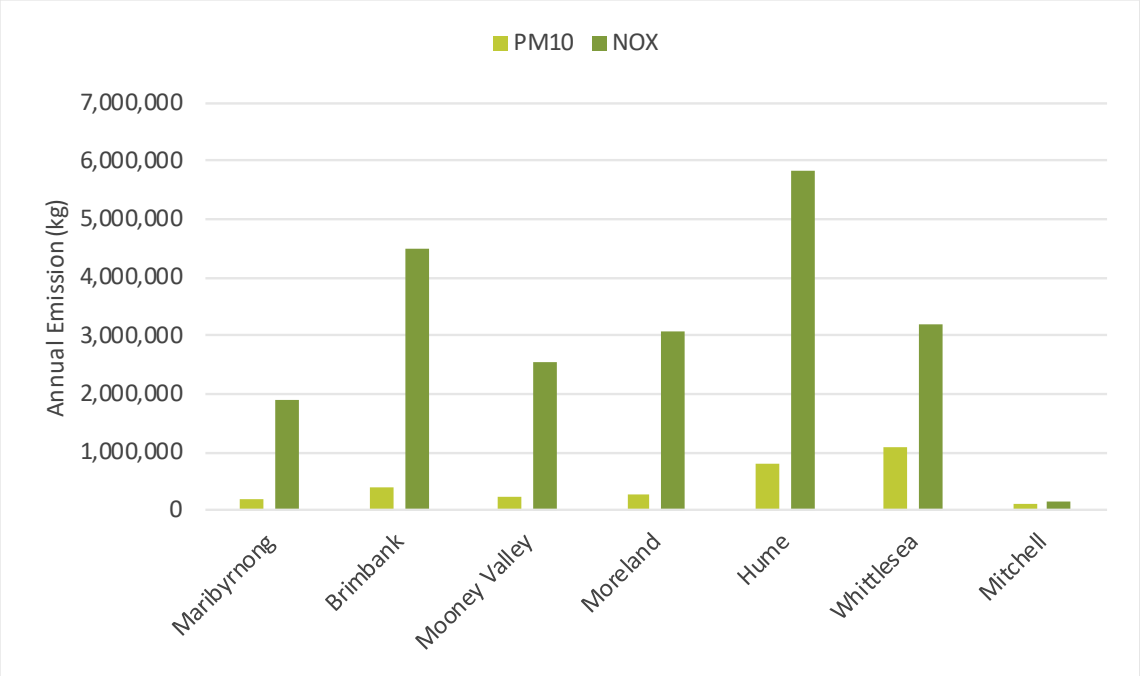
Figure 3 presents a chart of the data in **Table 19** for those LGAs that report diffuse and non-industrial emissions, illustrating the relative difference in the reported emissions of the different LGAs that the T2A Project passes through.

Table 19 NPI Reporting Emissions 2017/18: Non-Industrial and Diffuse Emissions

LGA	Annual Emission (kg)		
	PM_{10}	$PM_{2.5}$	NO_X
Maribyrnong	154,000	NR	1,790,000
Brimbank	398,000	NR	4,270,000
Mooney Valley	225,000	NR	2,540,000
Moreland	263,000	NR	3,050,000
Hume	524,000	NR	5,270,000
Whittlesea	490,000	NR	2,650,000
Mitchell	44,000	NR	99,800
Strathbogie	NR	NR	NR
Benalla	NR	NR	NR
Wangaratta	NR	NR	NR
Indigo	NR	NR	NR
Wodonga	NR	NR	NR
Albury	NR	NR	NR
Total	2,100,000	0	19,700,000

NR Not reported

Figure 3 NPI Reporting 2017/18: Non-Industrial and Diffuse Emissions



Diffuse Emissions – Railways

Table 20 presents the annual emissions reported for railways in the LGAs that the T2A Project passes through (where provided for the 2017/2018 NPI reporting period) and provides a comparison with the overall non-industrial and diffuse emissions presented in **Table 19**. Overall, the reported annual emissions to air from existing railways are a fraction of 1 % of the overall reported non-industrial and diffuse emissions in these LGAs. However, SLR believes that the railway emissions may be under-reported and therefore not considered appropriate in relation to characterising the impacts of existing railway operations on air quality, nor for comparison with the emission estimations provided in **Section 5**.

Table 20 NPI Reporting Emissions 2017/18: Railways

LGA	Annual Emission (kg)		Contribution to Non-Industrial and Diffuse Emissions (%)	
	PM_{10}	NO_X	PM_{10}	NO_X
Maribyrnong	244	10,800	0.16	0.60
Brimbank	280	12,400	0.07	0.29
Mooney Valley	110	4850	0.05	0.19
Moreland	109	4830	0.04	0.16
Hume	364	16,100	0.07	0.31
Whittlesea	288	12,800	0.06	0.48
Mitchell	78	3430	0.18	3.4
Total	1,470	62,500	0.07	0.33

The techniques for calculating the diffuse emissions of railways as presented in the NPI Emissions Estimation Technique Manual for Aggregated Emissions from Railways[17] (Railway EETM) are based on the fuel consumption of trains in the air shed (e.g. the LGA). Where that fuel consumption is only available for the State, the fuel consumption is scaled by the length of railway in the LGA. A line haul locomotive emission factor of 1.39 g/L is provided in the Railway EETM, which for the reported annual emission for Mitchell (**Table 21**) suggests a daily fuel consumption of 153 L over the approximately 70 km of track, or based on the assumed daily number of locomotives (**Table 9**), less than 10 L per train (each with two or three locomotives). This does not account for the three or four daily passenger trains on the line, travelling in both directions. A similar calculation for NO_X using the provided emission factor of 59.1 g/L gives the same result.

Typical fuel consumption for a NR class locomotive is approximately 200 g of diesel per kWh[18]. For three locomotives, conservatively assuming 115 km/h and Notch 8 over 70 km of track, this would give a total fuel consumption per train of approximately 1,100 kg (900 L) of diesel, which is approximately ten times higher than the consumption rate that appears to have been used in the NPI calculations.

This indicates that the NPI reported emissions from Railways may be substantially underestimated, most likely because they are calculated from State fuel consumption figures as described above, not LGA fuel consumption figures. If this is the case, any future amendment in the NPI estimation method for railway emissions in LGAs could potentially result in substantial increases of the reported railway emissions in several of the LGAs relevant to the T2A Project. However, this increase would only be in the context of the correction, rather than due to the T2A Project.

This finding is based on simple calculations relying on a number of assumptions and while the issue may warrant further investigation, it is not considered to be within the scope of this preliminary AQA.

7 Potential Effects of the T2A Project Operational Air Emissions

Emissions of PM_{10}, $PM_{2.5}$ and NO_X associated with the T2A Project freight trains are not expected to increase significantly over the existing emissions, primarily due to the use of the same number of locomotives per service group (**Section 5.3**) and only a slight increase in train frequency (**Section 5.4**). However, an increase over existing emission rates is likely to occur if the T2A Project line-haul locomotives operate with increased time at high power notch levels, as may be the case with greater loads.

Conservatively assuming that existing trains operate with an average duty cycle of 40%, and 2025 and 2040 trains operate with an average duty cycle of 50%, the annual emissions due to the T2A Project freight trains in the Hume and Mitchell LGAs, estimated from the frequency of freight trains (**Section 5.4**), the estimated emission rates (**Section 5.5)** and an estimate of the journey times within the LGAs, is provided in **Table 21**. Hume LGA has been selected as an example of a relatively high NPI emission reporting LGA (refer **Figure 2** and **Figure 3**), with a relatively short length of T2A Project rail passing through it, such that the T2A Project is likely to have a relatively small impact on the total emissions reported for the LGA. Mitchell LGA has been selected as an example of a relatively low NPI emission reporting LGA with a relatively long length of T2A Project rail passing through it, such that the T2A Project has the potential to have a relatively large impact on the total emissions reported for the LGA.

[17] NPI Emissions Estimation Technique Manual for Aggregated Emissions from Railways, V1.0, November 1999
[18] *Diesel Locomotive Fuel Emissions and Efficiency Testing*, ABMARC, November 2016

Table 21 Annual Emission Estimates

LGA	Approx. T2A Project Distance (km)	Assumed Average Speed (km/h)	Existing Annual Emission (kg)[1]		2025 Annual Emission (kg)[2]		2040 Annual Emission (kg)[2]	
			PM_{10}	NO_X	PM_{10}	NO_X	PM_{10}	NO_X
Hume	15	50	1,350	87,000	1,690	109,000	2,020	130,000
		115	590	37,900	730	47,300	880	56,600
Mitchell	75	50	6,310	407,000	7,880	508,000	9,430	608,000
		115	2,740	177,000	3,430	221,000	4,100	264,000

1 Assuming 40% average duty cycle.

2 Assuming 50% average duty cycle.

Based on the assumptions stated above, the estimated annual emissions in **Table 21** indicate that the T2A Project has the potential to increase PM_{10} (and $PM_{2.5}$, assumed to be 97% of PM_{10}) emissions from the freight trains by approximately 25% and 49% in 2025 and 2040 respectively. For NO_X, the corresponding potential increases are 20% and 33%.

As discussed in **Section 6.2.2**, due to the suspected under reporting of the existing contribution of railways (**Table 20**), the potential increase in the total (industrial, non-industrial and diffuse) LGA annual emission of PM_{10} and NO_X due to T2A Project emissions cannot be confidently estimated.

The Ministerial Guidelines for assessment of environmental effects under the *Environment Effects Act 1978* provide referral criteria for individual potential environmental effects that might of regional or State significance and therefore warrant referral of a project state. The following criteria are relevant to air quality:

- potential extensive or major effects on the health, safety or well-being of a human community, due to emissions to air or water or chemical hazards or displacement of residences
- potential exposure of a human community to severe or chronic health or safety hazards over the short or long term, due to emissions to air or water or noise or chemical hazards or associated transport.

The impacts of emissions due to the T2A Project on local air quality are not expected to change (increase) significantly over impacts from existing freight trains, such that there is unlikely to be a significant change in the air quality. The example annual emission loads estimated in **Table 21** will be spread along the length of track. For example, the estimated PM_{10} emissions overall represent only 0.01 kg/km/h for the existing operations and 0.015 kg/km/h for the 2040 operations. The corresponding NO_X emissions are 0.66 kg/km/h and 0.99 kg/km/h.

An individual train with three NR class locomotives travelling at 50 km/h at 50% duty cycle (assumed for 2040 operations) will emit 0.024 kg/km/h of PM_{10}, 0.023 kg/km/h of $PM_{2.5}$ and 1.57 kg/km/h of NO_X. Assuming conservatively that these hourly emissions are dispersed into a volume corresponding to a cross-section of 10 m high and 50 m wide, along 1 km of track (a volume of 500,000 m^3), the corresponding incremental increase in 1-hour average PM_{10}, $PM_{2.5}$ and NO_X concentrations would be 0.049 $\mu g/m^3$, 0.047 $\mu g/m^3$ and 3.1 $\mu g/m^3$ (approximately 0.0016 ppm as NO_2), respectively. In reality the emissions would continue to disperse into a much greater volume, tens of meters high and potentially many hundreds of meters wide, reducing the incremental increase in concentration by orders of magnitude.

Table 22 presents and compares these conservative incremental increases to typical ambient concentrations (based on Footscray, 50th percentile concentrations, **Section 6.1**) and SEPP(AAQ) EQOs (**Section 4.2.1**). Note it is highly conservative to compare 1-hour average incremental impacts with 24-hour average PM_{10} and $PM_{2.5}$ ambient concentrations and EQOs.

Table 22 Estimated Incremental Impact of Project T2A Freight Train (2040; 50 km/h; 50% Duty Cycle)

Pollutant	Units	Incremental Increase due to Single Train	Ambient Concentrations		SEPP(AAQ)	
			Typical Concentration[1]	Incremental Increase due to Single Train	EQOs	Incremental Increase due to Single Train
PM_{10}	µg/m^3	0.049	16.6 [2]	0.3%	50 [2]	0.1%
$PM_{2.5}$	µg/m^3	0.047	5.8 [2]	0.8%	20 (2025) [2]	0.2%
NO_2	ppm	0.0016	0.021	7.8%	0.12 0.08 (2025)[3]	1.4% 2.1%

1 Average of 2012-2017 Footscray 50th percentile values 2012-2017.

2 24-hour average.

3 Recommendation only.

In comparison to typical ambient concentrations (**Section 6.1**), even these conservatively estimated incremental increases in concentration are minor. The emissions loadings do not have the potential to result in significant increases in ambient PM_{10}, $PM_{2.5}$ and NO_2 concentrations in the vicinity of the rail line. Relative to the existing situation, therefore, the potential for extensive or major health effects on the health, safety or well-being of a human community could be considered unlikely.

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