UPGRADE OF MAMRE AND ABBOTTS ROAD INTERSECTION

Air Quality Impact Assessment

Prepared for:

LOG-E c/- AT&L
Level 7 153 Walker Street
North Sydney NSW 2060

SLR Ref: 610.31166-R04
Version No: -v1.1
April 2023

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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 LOG-E c/- AT&L (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
610.31166-R04-v1.1	20 April 2023	S Bagheri	V Marwaha	V Marwaha
610.31166-R04-v1.0	6 April 2023	S Bagheri	V Marwaha	V Marwaha

CONTENTS

CONTENTS

DOCUMENT REFERENCES

TABLES

FIGURES

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by The Log-E to prepare an Air Quality Impact Assessment (AQIA) for the proposed Mamre Road and Abbotts Road intersection Upgrade Project (the Project).

The Project involves upgrades to the Mamre Road and Abbotts Road intersection and aims to provide for the development of land within the Mamre Road Precinct. The upgrade is being progressed by the developer group known as the Land Owners Group – East (LOG-E) and is linked to their proposed developments which are accessed via Abbotts Road and Aldington Road.

Approach to the Air Quality Impact Assessment

SLR has performed a quantitative assessment of operational impacts associated with traffic changes due to the Project. The methodology applied in assessing the potential for air quality related impacts included:

- Identification of key risks on nearby sensitive receptors of the Project, as well as suitable criteria for the evaluation of these risks.
- Characterisation of key features of the surrounding environment, including prevailing climate and meteorological conditions and background air quality.
- A screening level quantitative assessment of the potential for impacts to occur during operations using NSW Roads and Maritime Services' (now TfNSW) Tool for Roadside Air Quality (TRAQ) prediction model.

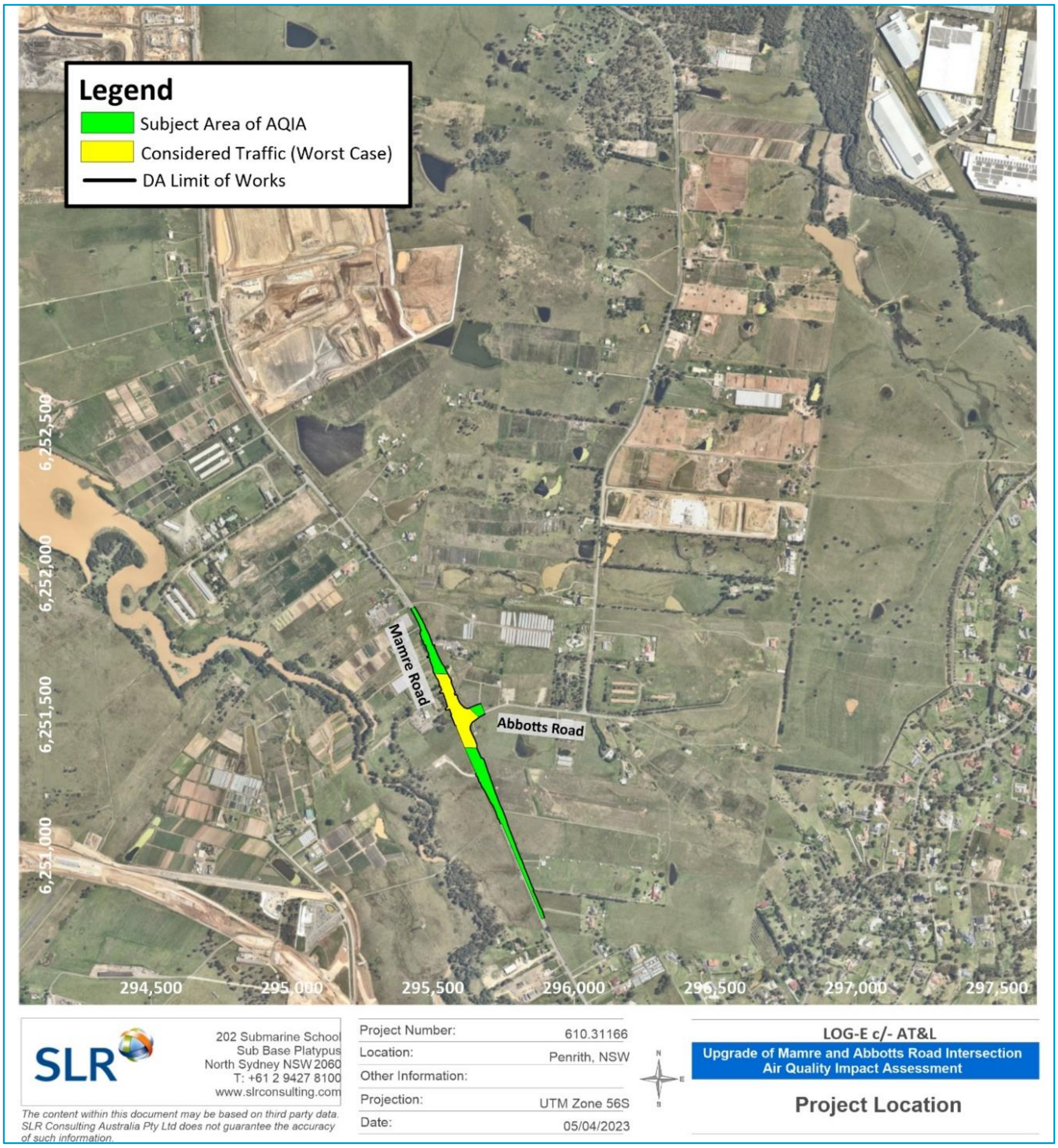
Based on the outcomes of the above, mitigation measures have been recommended to effectively manage identified risks to air quality for nearby receptors.

2 Project Description

2.1 The Project

The concept design for the upgrade of Mamre Road (for TfNSW) /Abbotts Road intersection is expected to include widening 600 m south of the intersection and 200 m north of the intersection. This area is defined as the Subject Area of this AQIA. The Project includes widening within the western end of Lot 1 DP250002 (north of Abbotts Road). There is no widening within the private property to the south of Abbotts Road (Lot 2 DP250002). This assessment considers traffic data on Mamre Road including traffic flow from Abbots Road. This is a conservative worst-case assessment and is applicable to the entire Subject Area. The location of the Project is shown in **Figure 1.**

Figure 1 Project Layout



At the time of writing this report, the construction of the Project is currently at concept design stage and includes:

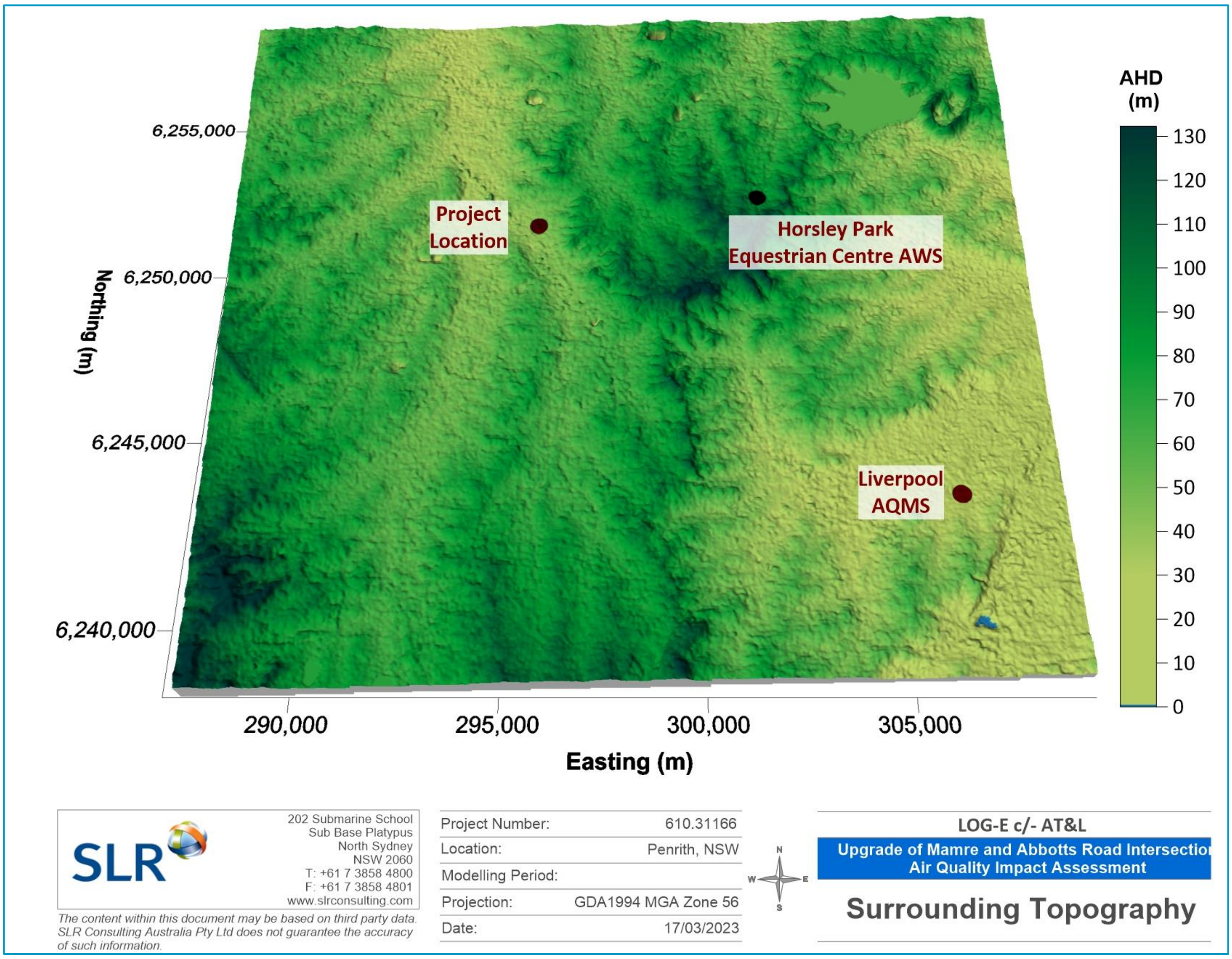
- widening the road beyond the existing road reserve,
- signalised intersection,
- earthworks including raising road,
- stormwater (new and larger culverts under and adjacent to road),
- relocation of services (above and underground),
- new services (incl water, power, comms).
- Site sheds, material storage as required for road construction project.
- Temporary works as necessary to facilitate construction.

2.2 Local Topography

Topography is important in air quality studies, as local atmospheric dispersion can be influenced by night-time katabatic (downhill) drainage flows from elevated terrain or channelling effects in valleys or gullies.

A three-dimensional representation of the region is shown in **Figure 2**. The topography of the local area within the illustrated area ranges from an approximate elevation of 0 m to 130 m Australian Height Datum (AHD). The Project area is reasonably flat without any high rise buildings, which will facilitate the dispersion of emissions to air and prevent accumulation of air pollutants.

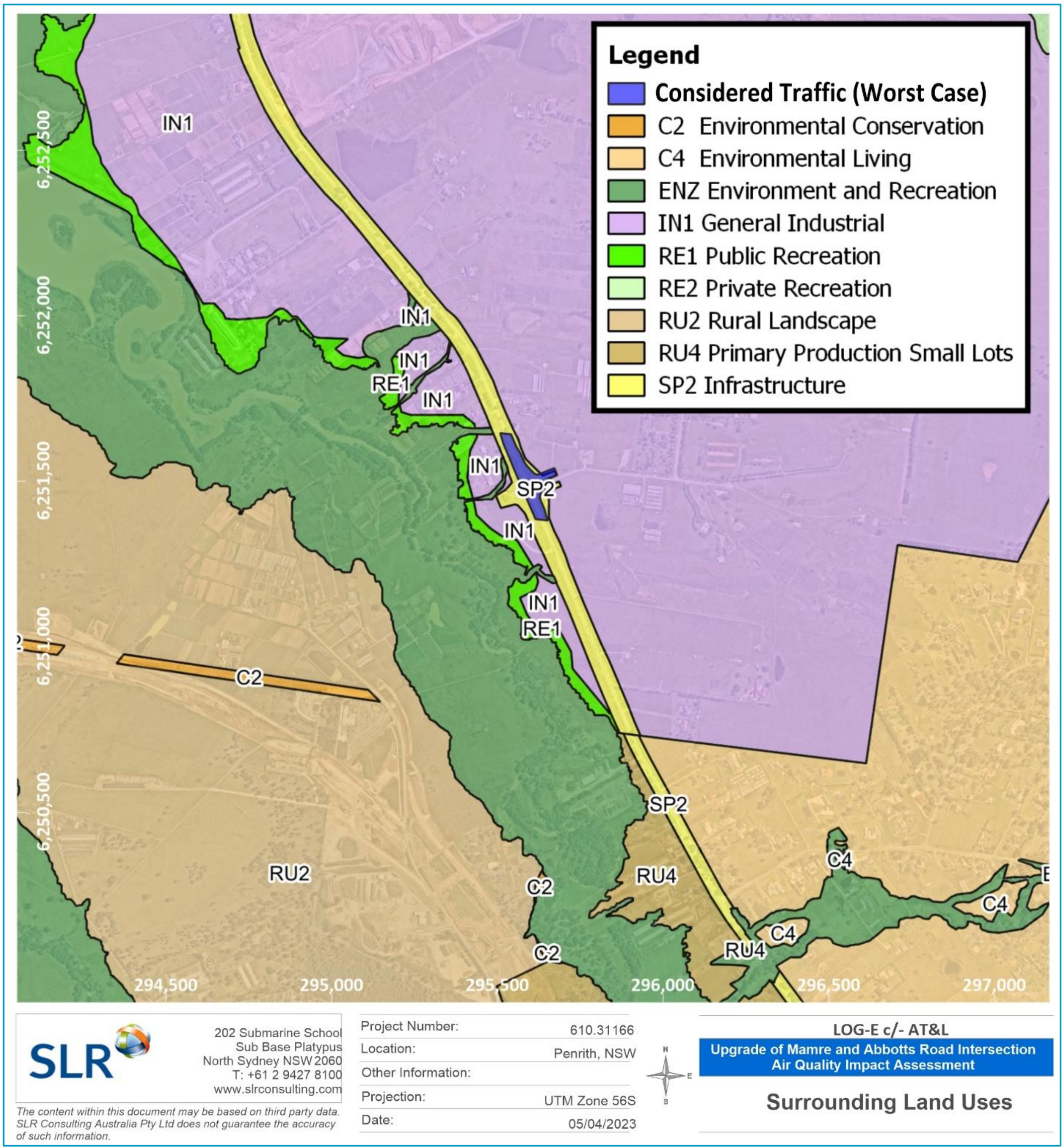
Figure 2 Topography of Area Surrounding the Project



2.3 Surrounding Land Use

As illustrated in **Figure 3**, most of the land on east of the Project is zoned as General Industrial (IN1) and the land to its west and south is zoned as Infrastructure (SP2) or General Industrial (IN1), with some Public Recreational (RE1) and Environment and recreation (ENZ) beyond the industrial lands. At the northern end of the Project, the land is predominantly zoned Infrastructure (SP2) and General Industrial (IN1).

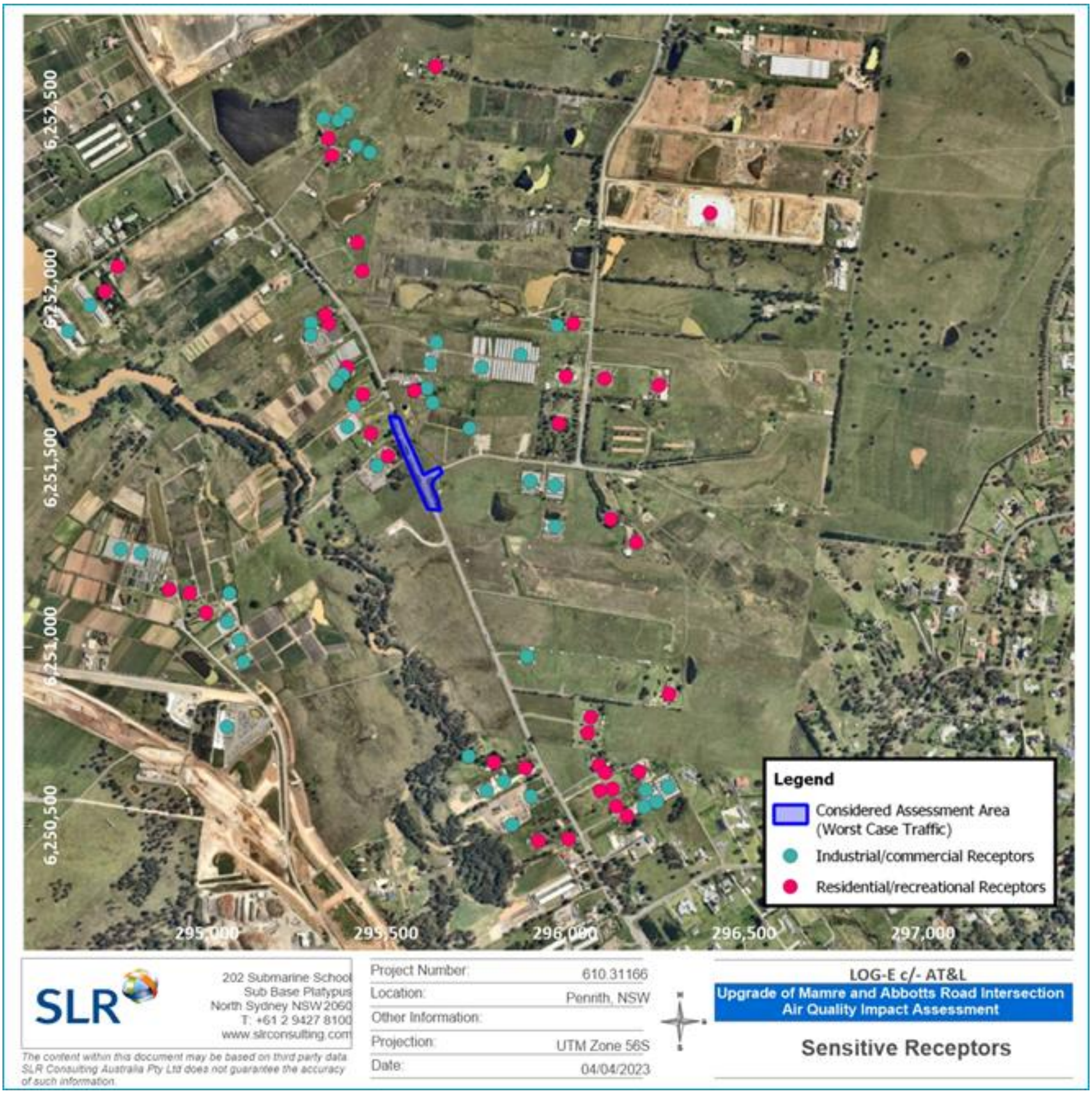
Figure 3 Surrounding Land Uses



2.4 Sensitive Receptors

The closest residential receptors are identified to be located approximately 30 m and the closest industrial receptors are located approximately 80 m from the kerbside of Mamre Road. The closest residential and industrial receptors are located respectively 110 m and 120 m from the kerbside of Abbotts Road. The identified sensitive receptors including residential and industrial/commercial receptors are shown in **Figure 4**.

Figure 4 Surrounding Sensitive Receptors



2.5 Local Meteorology

Local wind speed and direction influence the dispersion of air pollutants. Wind speed determines both the distance of downwind transport and the rate of dilution as a result of 'plume' stretching. Wind direction, and the variability in wind direction, determines the general path pollutants will follow and the extent of crosswind spreading. Surface roughness (characterised by features such as the topography of the land and the presence of buildings, structures and trees) affects the degree of mechanical turbulence, which also influences the rate of dispersion of air pollutants.

The Bureau of Meteorology (BoM) maintains and publishes data from weather stations across Australia. The closest such station recording hourly wind speed and wind direction data is the Horsley Park Equestrian Centre Automatic Weather Station (AWS), which is located approximately 6.0 km east-northeast of the Project. Considering the distance between the Project and Horsley Park Equestrian Centre AWS, for the purpose of this assessment it has been assumed that the wind conditions recorded at the Horsley Park Equestrian Centre AWS are a reasonable representation of the wind conditions experienced at the Project site. Annual and seasonal wind roses for the years 2018-2022 inclusive, compiled from data recorded by the Horsley Park Equestrian Centre AWS, are presented in **Figure 5**.

The wind roses show the frequency of occurrence of winds by direction and strength. The bars correspond to the 16 compass points (degrees from north). The bar at the top of each wind rose diagram represents winds blowing from the north (i.e. northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds. Thus it is possible to visualise how often winds of a certain direction and strength occur over a long period, either for all hours of the day, or for particular periods during the day.

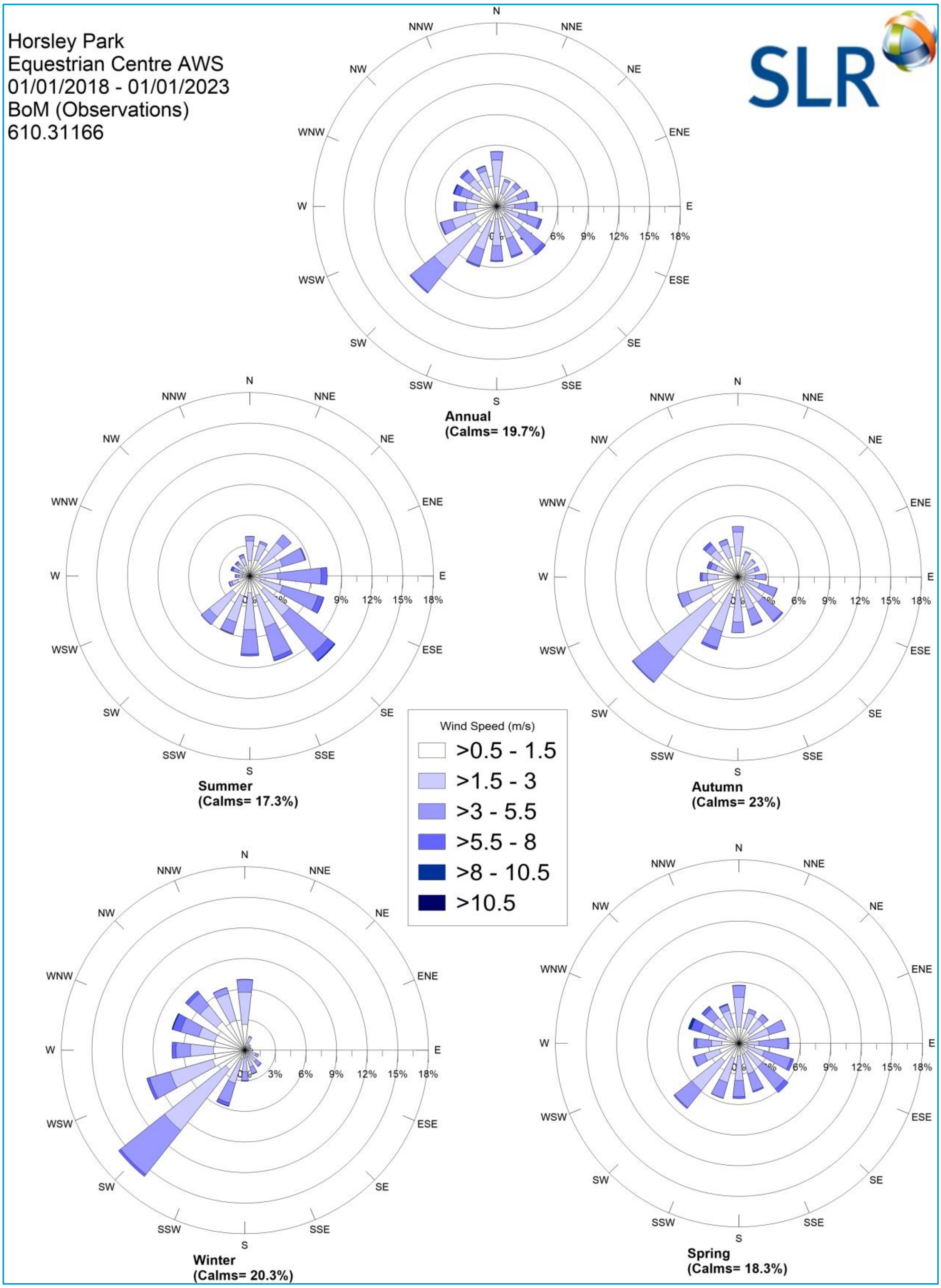
The annual wind roses for the years 2018 to 2022 (**Figure 5**) indicate that the predominant wind directions in the area are from the southwest direction. The annual average frequency of calm wind conditions was recorded to be approximately 19.7% for the 2018 to 2022 period.

The seasonal wind roses for the years 2018-2022 indicate that:

- In summer, the majority of winds blew from eastern and southern quadrants, with very few winds from the north-western quadrant. Calm wind conditions were observed to occur approximately 17.3% of the time during summer.
- In autumn and winter, the majority of winds blew from southwest direction with very few winds from north-eastern quadrant. Calm wind conditions occur approximately 23% and 20.3%% of the time during autumn and winter respectively.
- In spring, the winds blew almost evenly from all directions. Calm wind conditions occur approximately 18.3% of the time during spring.

Winds from the west, east, and south directions, which would blow air emissions from the Project towards the nearest sensitive receptors (located to the east, west, and north respectively), occur approximately 9%.

Figure 5 Annual and Seasonal Wind Roses – Horsley Park Equestrian Centre AWS (2018-2022)



3 Relevant Air Quality Policy and Guidance

A number of legislative instruments and guidelines apply to air pollution from road transport, including specific requirements for road tunnels (not relevant to the Project). These include:

- National emission standards that apply to new vehicles
- Emission regulations, checks and policies that apply to in-service vehicles
- Fuel quality regulations
- In-tunnel limits on pollutant concentrations for tunnel ventilation design and operational control
- Ambient air quality standards and assessment criteria, which define levels of pollutants in the outside air that should not be exceeded over a specific time period (ie, averaging period) to protect public health.

The focus of this assessment, which is limited to the assessment of potential operational phase impacts once the Project is constructed, is on assessing the expected level of compliance with relevant ambient air quality standards based on the proposed road design and projected operational parameters.

An ambient air quality standard defines a metric relating to the concentration of an air pollutant in the ambient air. Standards are usually designed to protect human health, including sensitive populations such as children, the elderly, and individuals suffering from respiratory disease, but may relate to other adverse effects such as amenity (odour), or damage to buildings and vegetation. The form of an air quality standard is typically a concentration limit for a given averaging period (e.g. annual average, 24-hour average), which may be stated as a ‘not-to-be-exceeded’ value or with some exceedances permitted. Several different averaging periods may be used for the same pollutant to address varying impacts of long-term and short-term exposure.

3.1 Approved Methods

State air quality guidelines adopted by the NSW EPA are published in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW EPA, 2022) (hereafter the Approved Methods). The Approved Methods lists the statutory methods for modelling and assessing air pollutants from stationary sources and specifies criteria which reflect the environmental outcomes adopted by the EPA. The Approved Methods are referred to in the *Protection of the Environment Operations (Clean Air) Regulation 2010* for assessment of impacts of air pollutants. The air quality criteria set out in the Approved Methods relevant to the Project are reproduced and discussed in **Section 4.2**.

It is noted that the NSW Approved Methods are designed mainly for the assessment of industrial point sources, and do not contain specific information on the assessment of (for example), transport schemes and land use changes.

3.2 TfNSW Air Quality Management Guideline

TfNSW document DMS-SD-107 provides guidance with regard to managing air quality and emissions on Infrastructure and Place (IP) project sites, acknowledging that the inappropriate management of emissions has the potential to result in adverse health impacts, loss of amenity and community dissatisfaction and environmental degradation. Such impacts are identified in the Guideline as primarily being associated with fugitive dust from construction activities and exhaust emissions from vehicles, plant and equipment used during construction. Construction-related air quality impacts from the Project will be addressed through the Construction Air Quality Management Plan (CAQMP) once information related to construction (e.g. schedules, constraints or opportunities) is confirmed by the contractor and are outside the scope of this report.

4 Identification of Air Emissions and Relevant Criteria

4.1 Identification of Pollutants of Concern

The primary source of air pollutant emissions associated with the operational phase of the Project will be vehicles travelling along Mamre Road and Abbotts Road. Mamre Road is classified as a "Main Road" (Gazetted Road Number: 629). A review of the *National Pollutant Inventory Emission Estimation Technique Manual* (NPI EET) *for Combustion Engines* (DEWHA , 2008) identifies the primary pollutants from combustion engines as:

- Particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$)
- Particulate matter less than 10 µm in aerodynamic diameter (PM_{10})
- Oxides of nitrogen (NO_x)
- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Volatile Organic Compounds (VOCs)

Other substances that are also emitted from vehicle exhausts in trace amounts include products of incomplete combustion, such as metallic additives which contribute to the particulate content of the exhaust (DEWHA , 2008). In addition, ozone (O_3) is formed as a secondary pollutant from atmospheric reactions between VOCs and NO_X, and is used as a key indicator of smog in urban environments.

The rate and composition of air pollutant emissions from road vehicles is a function of a number of factors, including the type, size and age of vehicles within the fleet, the type of fuel combusted, number and speed of vehicles and the road gradient. Information on the potential health impacts of the pollutants identified above is provided in the following sections.

Suspended Particulate Matter

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter. In common usage, the terms "dust" and "particulates" are often used interchangeably. The term "particulate matter" refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is termed total suspended particulate (TSP).

The annual criterion for TSP recommended by the NSW EPA is 90 micrograms per cubic metre of air ($\mu g/m^3$). The TSP criterion was developed before the more recent results of epidemiological studies which suggested a relationship between health impacts and exposure to concentrations of finer particulate matter.

Emissions of particulate matter less than 10 µm and 2.5 µm in diameter (referred to as PM_{10} and $PM_{2.5}$ respectively) are considered important pollutants due to their ability to penetrate into the respiratory system. In the case of the $PM_{2.5}$ category, recent health research has shown that this penetration can occur deep into the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

Oxides of Nitrogen

NO_X is a general term used to describe any mixture of nitrogen oxides formed during combustion. In atmospheric chemistry NO_X generally refers to the total concentration of nitric oxide (NO) and nitrogen dioxide (NO_2). NO will be converted to NO_2 in the atmosphere after leaving a car exhaust.

NO is a colourless and odourless gas that does not significantly affect human health. However, in the presence of oxygen, NO can be oxidised to form NO_2 which can have significant health effects including damage to the respiratory tract and increased susceptibility to respiratory infections and asthma. Long term exposure to NO_2 can lead to lung disease.

Carbon Monoxide

CO is an odourless, colourless gas formed from the incomplete burning of fuels in motor vehicles. CO bonds to the haemoglobin in the blood and reduces the oxygen carrying capacity of red blood cells, thus decreasing the oxygen supply to the tissues and organs, in particular the heart and the brain.

It can be a common pollutant at the roadside and highest concentrations are found at the kerbside with concentrations decreasing rapidly with increasing distance from the road. CO in urban areas results almost entirely from vehicle emissions and its spatial distribution follows that of traffic flow.

Sulphur Dioxide

SO_2 is a colourless, pungent gas with an irritating smell. When present in sufficiently high concentrations, exposure to SO_2 can lead to impacts on the upper airways in humans (i.e. the noise and throat irritation). SO_2 can also mix with water vapour to form sulphuric acid (acid rain) which can damage vegetation, soil quality and corrode materials.

The main sources of SO_2 in the air are industries that process materials containing sulphur (i.e. wood pulping, paper manufacturing, metal refining and smelting, textile bleaching, wineries etc.). SO_2 is also present in motor vehicle emissions, however since Australian fuels are relatively low in sulphur, high ambient concentrations are not common.

Volatile Organic Compounds

VOCs are organic compounds (i.e. contain carbon) that have high vapour pressure at normal room-temperature conditions. Their high vapour pressure leads to evaporation from liquid or solid form and emission release to the atmosphere.

VOCs are emitted by a variety of sources, including motor vehicles, chemical plants, automobile repair services, painting/printing industries, and rubber/plastics industries. VOCs that are often typical of these sources include benzene, toluene, ethylbenzene and xylenes (often referred to as 'BTEX'). Biogenic (natural) sources of VOC emissions (e.g. vegetation) are also significant.

Impacts due to emissions of VOCs can be health or nuisance (odour) related. Benzene is a known carcinogen and a key VOC linked with the combustion of motor vehicle fuels.

4.2 Relevant Air Quality Criteria

As discussed in **Section 3.1**, Section 7.1 of the Approved Methods set out impact assessment criteria for the air pollutants identified in **Section 4**. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, WHO, ANZEEC and DoE). The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW and are considered to be appropriate for the setting. The following sections outline the potential health impacts of each of the identified pollutants, and the relevant criteria from the Approved Methods are summarised in **Table 1**.

Table 1 Air Quality Assessment Criteria

Pollutant	Averaging Period	Ambient Air Quality Criterion	
		µg/m³ (mg/m³ for CO)	pphm
Total suspended particulate (TSP)	Annual	90	-
Particulate matter less than 10 microns (PM_{10})	24-Hour	50	-
	Annual	25	-
Particulate matter less than 2.5 microns ($PM_{2.5}$)	24-Hour	25	-
	Annual	8	-
Nitrogen dioxide (NO_2)	1-hour	164	8
	Annual	31	1.5
Carbon monoxide (CO)	1-hour	30	2,500
	8-hour	10	900
Sulfur dioxide (SO_2)	1-hour	286	10
	24-hour	57	2
Benzene	1-hour	29	0.9
Toluene	1-hour	360	9
Ethylbenzene	1-hour	8,000	180
Xylenes	1-hour	190	4

5 Background Air Quality

5.1 Regional Air Quality

Air quality monitoring is performed by the NSW Department of Planning and Environment (DPE) at a number of monitoring stations across NSW. The nearest DPIE-operated air quality monitoring stations (AQMS) to the Project is located at St Marys. The St Marys AQMS was commissioned in 1992, and is located on a residential property 8.4 km northwest of the Project at an elevation of 29 m, and monitors the concentration levels of following air pollutants:

- Oxides of nitrogen (NO, NO_2 and NO_X)
- Fine particles ($PM_{2.5}$ and PM_{10})

Due to unavailability of ambient concentrations for CO and SO_2 from St Marys AQMS, data is being sought from Liverpool AQMS. The Liverpool AQMS is located 13 km to the southeast of the Project. It was commissioned in 1991 and is located on Rose St at an elevation of 22 m.

The available air monitoring data from the St Marys AQMS are summarised in **Table 2** (red font indicates an exceedance of the relevant criterion) and presented graphically in **Figure 6** to **Figure 8** . Air monitoring data from the Liverpool AQMS are summarised in **Table 3** and presented graphically in **Figure 9** to **Figure 12**.

In summary, a review of the ambient air quality data presented in the following tables and graphs shows:

- In regard to the short term averages, the 24-hour average PM_{10} and $PM_{2.5}$ concentrations recorded by the St Marys AQMS are below the relevant 24-hour average guidelines, however isolated exceedances (normally on less than ten days per year) have been recorded in most years. The exception to this was the November 2019 to January 2020 period, when unprecedented and extensive bushfires within NSW resulted in an extended period of very elevated particulate concentrations across Sydney that were significantly above the 24-hour average PM_{10} and $PM_{2.5}$ guidelines. A review of the available compliance monitoring reports indicates that the intermittent exceedance days recorded during other years were also primarily due to exceptional events such as bushfire emergencies, dust storms and hazard reduction burns.
- In regard to the long term averages, no exceedances of the annual average PM_{10} criterion were recorded at St Marys during the five years investigated, however the annual average $PM_{2.5}$ criterion was exceeded in 2019 due to the bushfire event that started in November 2019.
- Ambient concentrations of the gaseous pollutants NO_2, CO and SO_2 were all well below the relevant criteria for all years investigated.

Table 2 Summary of Ambient PM_{10}, $PM_{2.5}$ and NO_2 Data - St Marys AQMS (2018 – 2022)

Pollutant	PM_{10}		$PM_{2.5}$		NO_2	
Averaging Period	Maximum 24-hour	Annual	Maximum 24-hour	Annual	Maximum 1-hour	Annual
Units	µg/m³	µg/m³	µg/m³	µg/m³	pphm	pphm
2018	100.5	19.4	80.5	7.8	6.2	1.2
2019	159.8	24.7	88.3	9.8	5.0	1.2
2020	260.3	18.9	82.5	7.6	4.8	1.1
2021	54.9	16.2	40.3	5.8	4.2	1.0
2022	29.7	12.0	12.6	3.9	3.6	0.8
Criterion	**50**	**25**	**25**	**8**	**8**	**1.5**

Figure 6 Measured 1-Hour Average NO_2 Concentrations at St Marys AQMS (2018-2022)

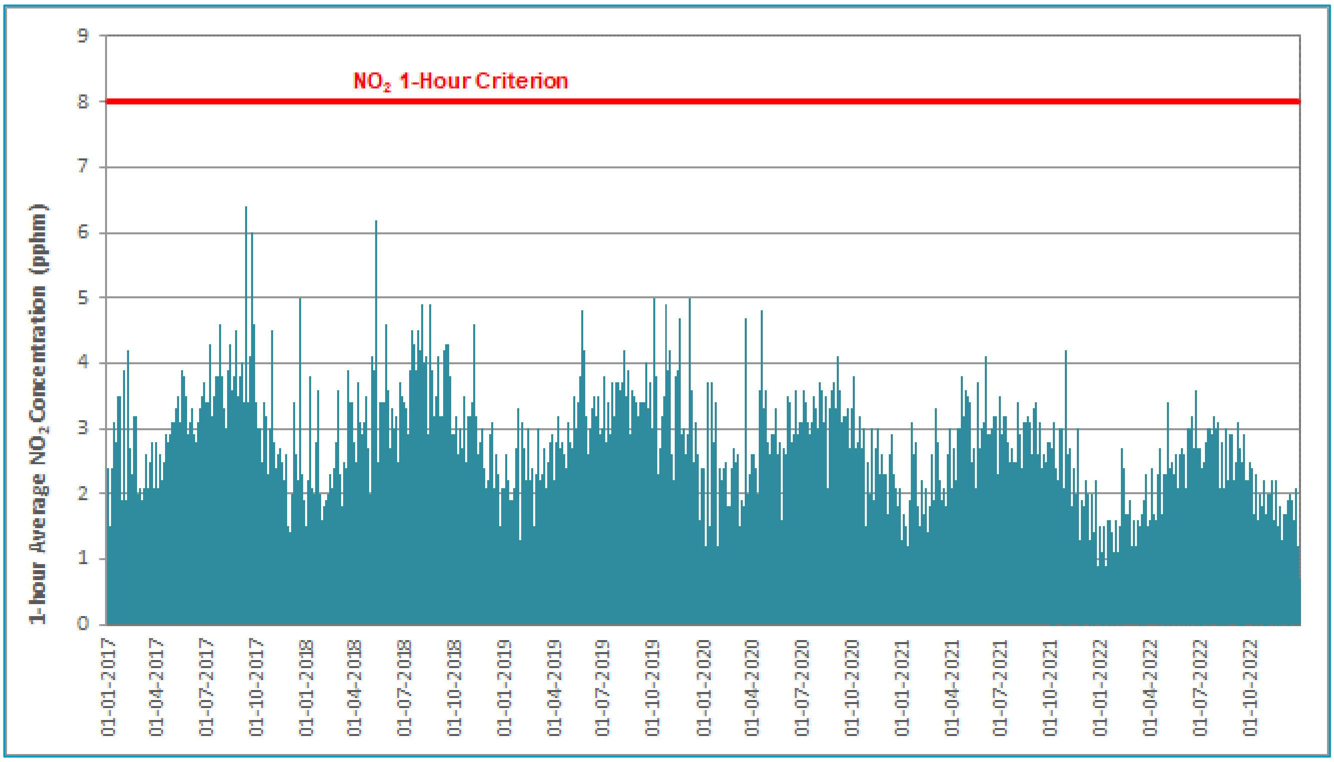


Figure 7 Measured 24-Hour Average PM_{10} Concentrations at St Marys AQMS (2018-2022)

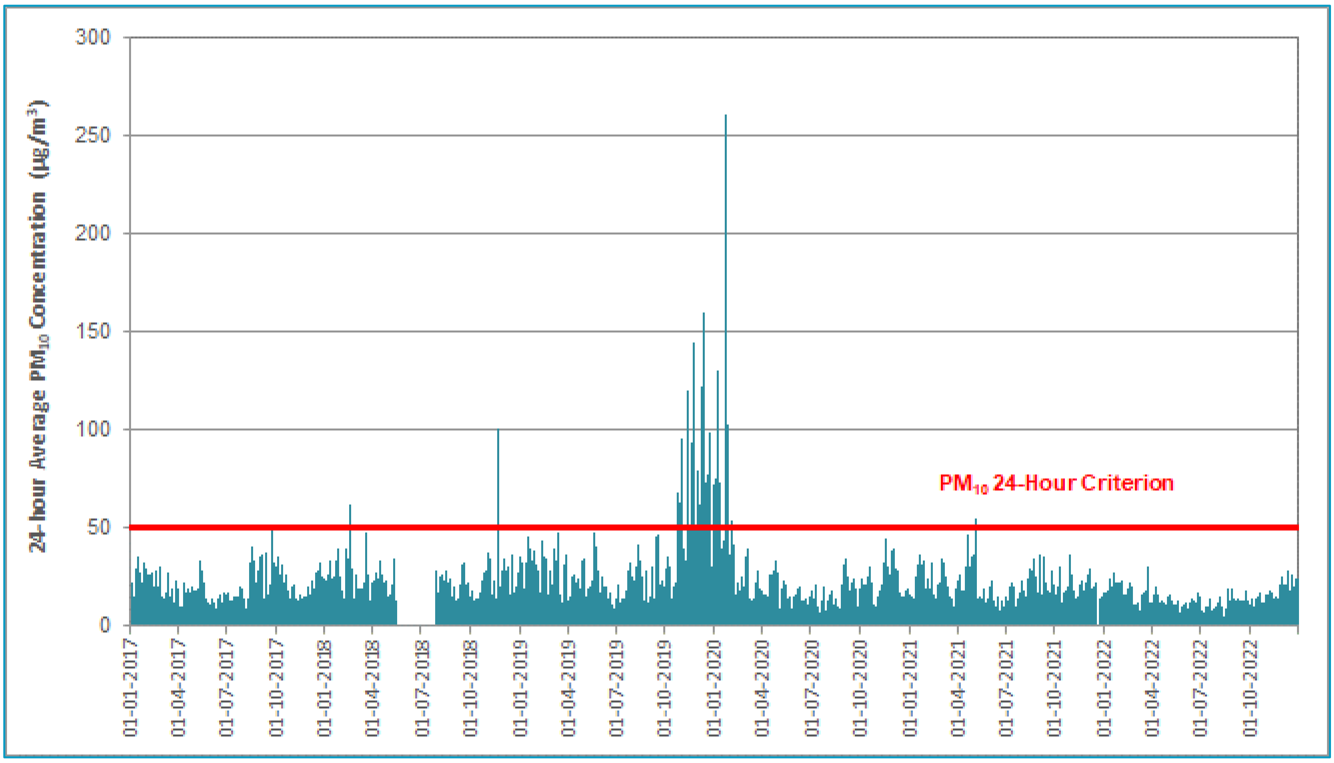


Figure 8 Measured 24-Hour Average PM_{10} Concentrations at St Marys AQMS (2018-2022)

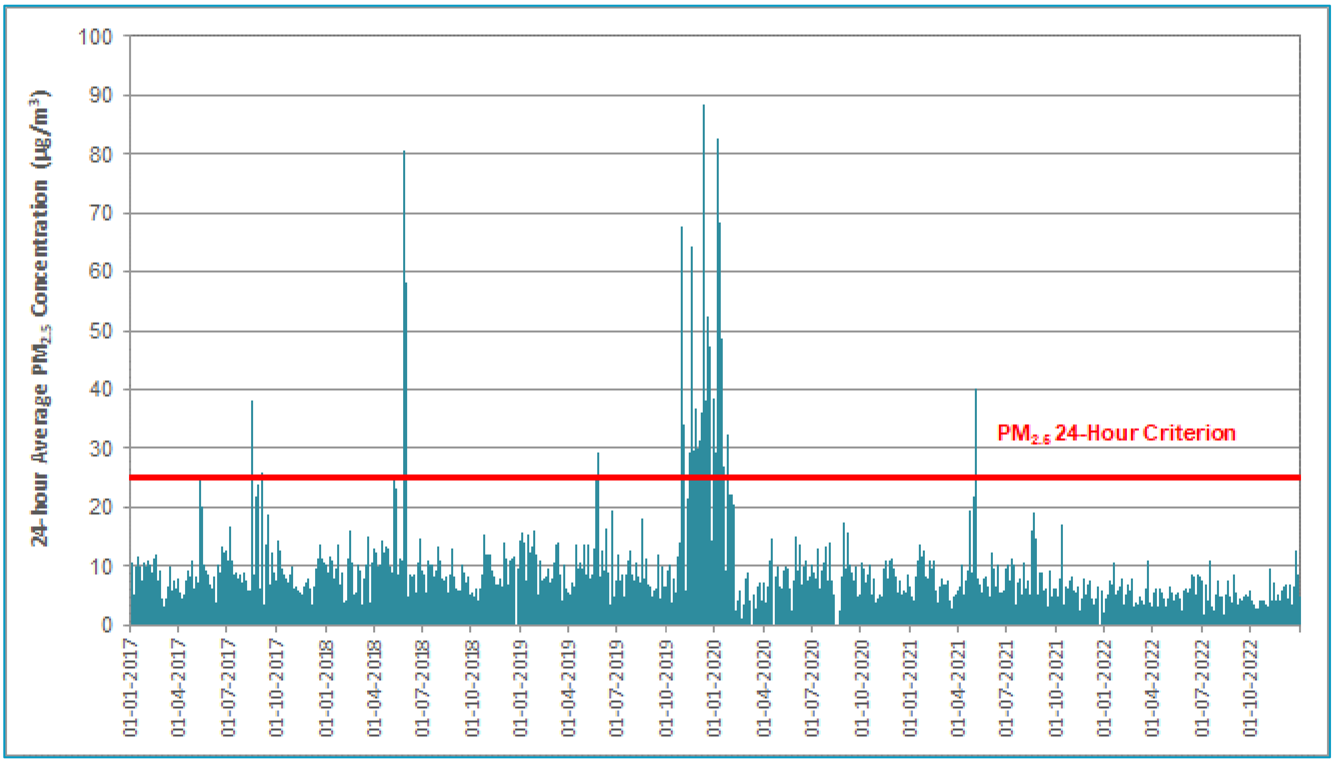


Table 3 Summary of Air Quality Monitoring Data at Liverpool AQMS (2018-2022)

Pollutant	CO		SO_2	
Averaging Period	Maximum 1-hour	Maximum 8-hour	Maximum 1-hour	Maximum 24-hour
Units	pphm	pphm	pphm	pphm
2018	2.4	1.9	2.0	0.07
2019	3.7	1.8	1.6	0.07
2020	2.4	2.1	1.5	0.05
2021	2.1	1.2	1.7	0.04
2022	1.4	1.1	1.3	0.03
Criterion	**25,00**	**9,00**	**10**	**2**

Figure 9 Measured 1-Hour Average CO Concentrations at Liverpool AQMS (2018-2022)

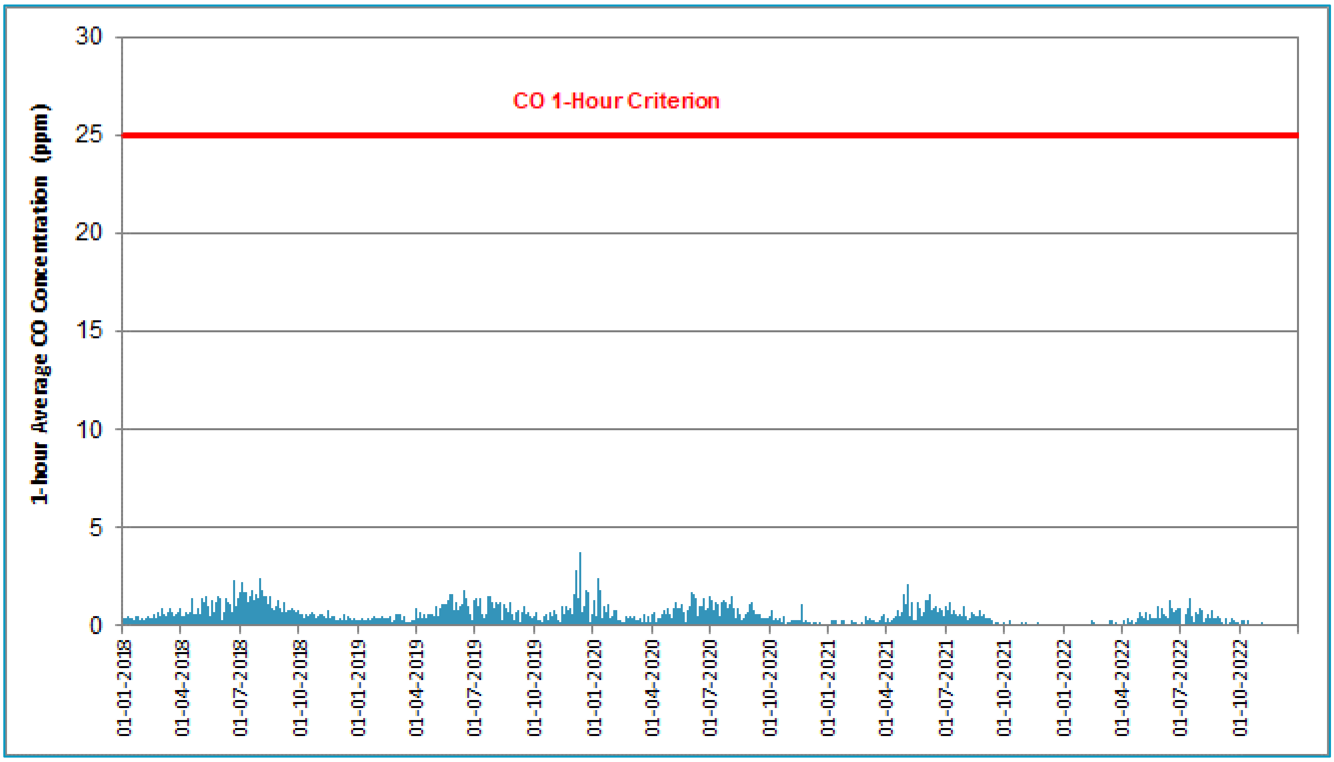


Figure 10 Measured 8-Hour Average CO Concentrations at Liverpool AQMS (2018-2022)

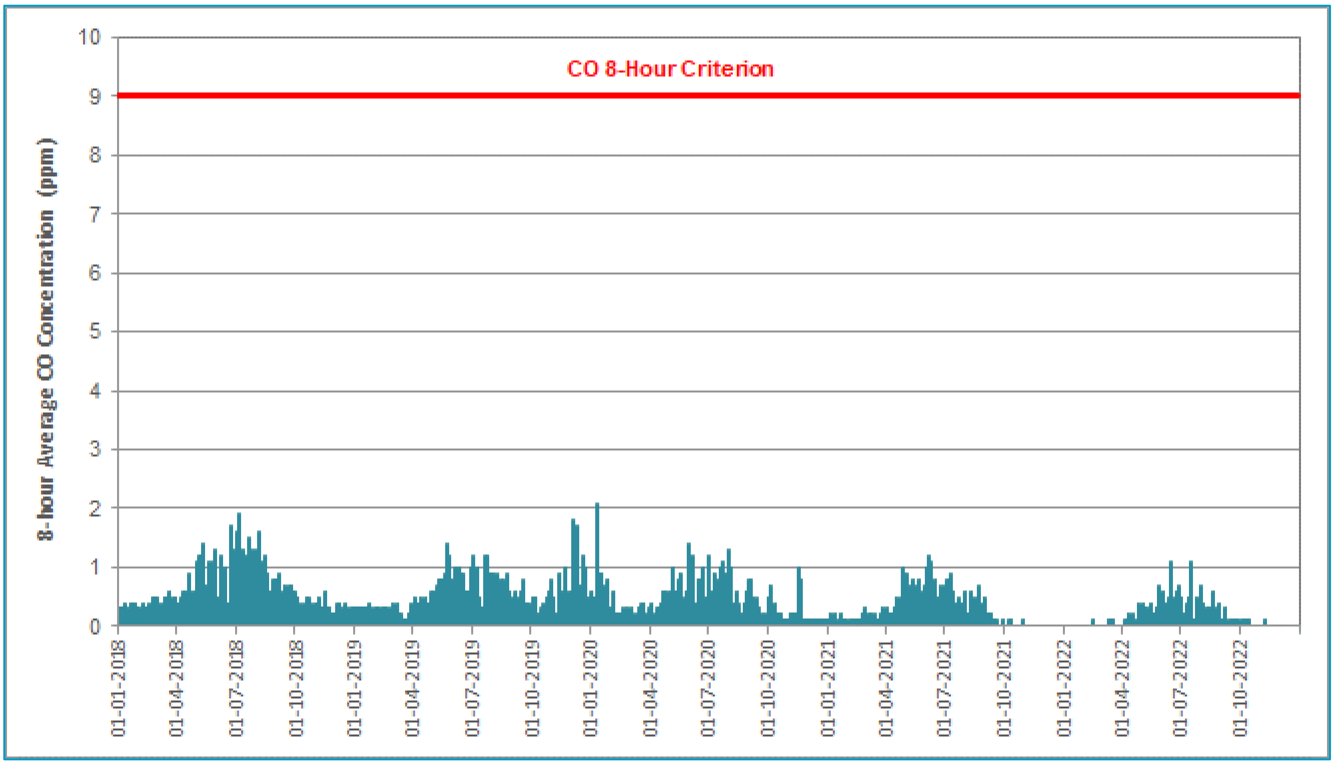


Figure 11 Measured 1-Hour Average SO_2 Concentrations at Liverpool AQMS (2018-2022)

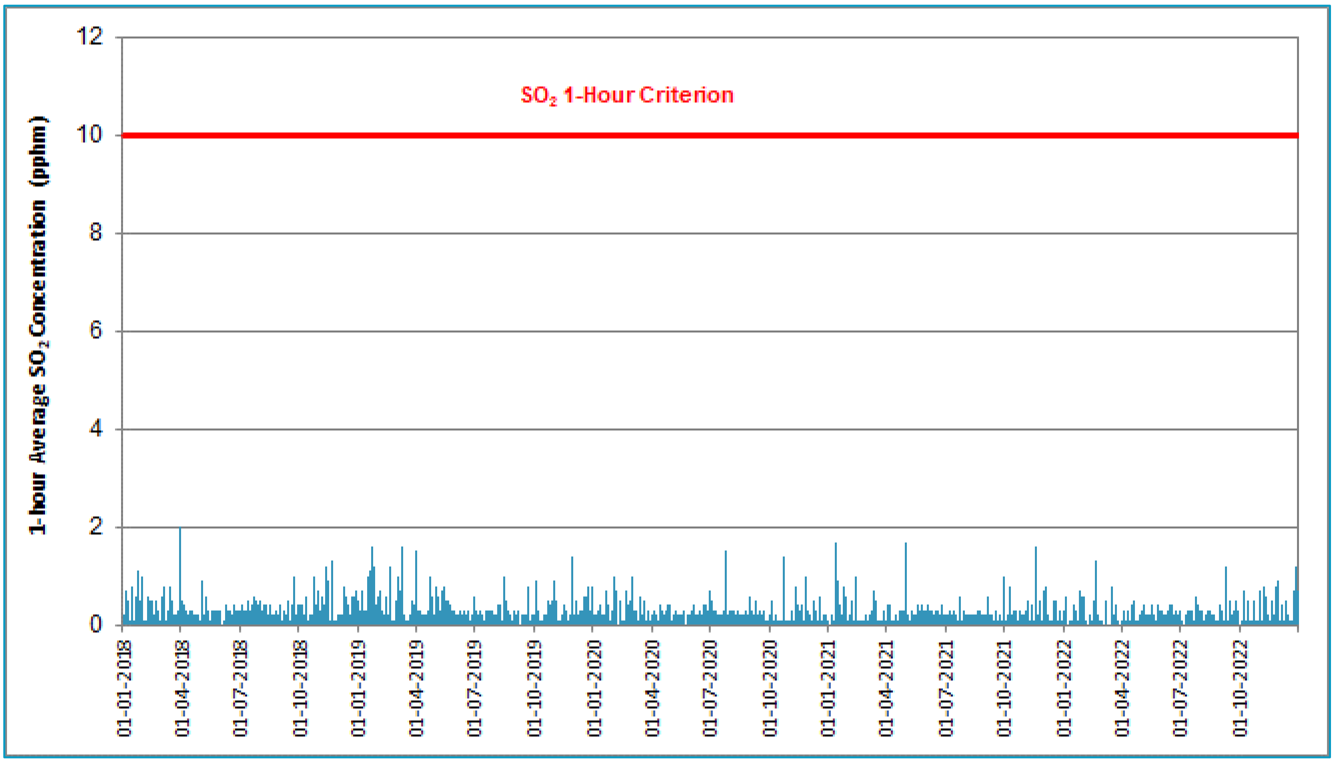
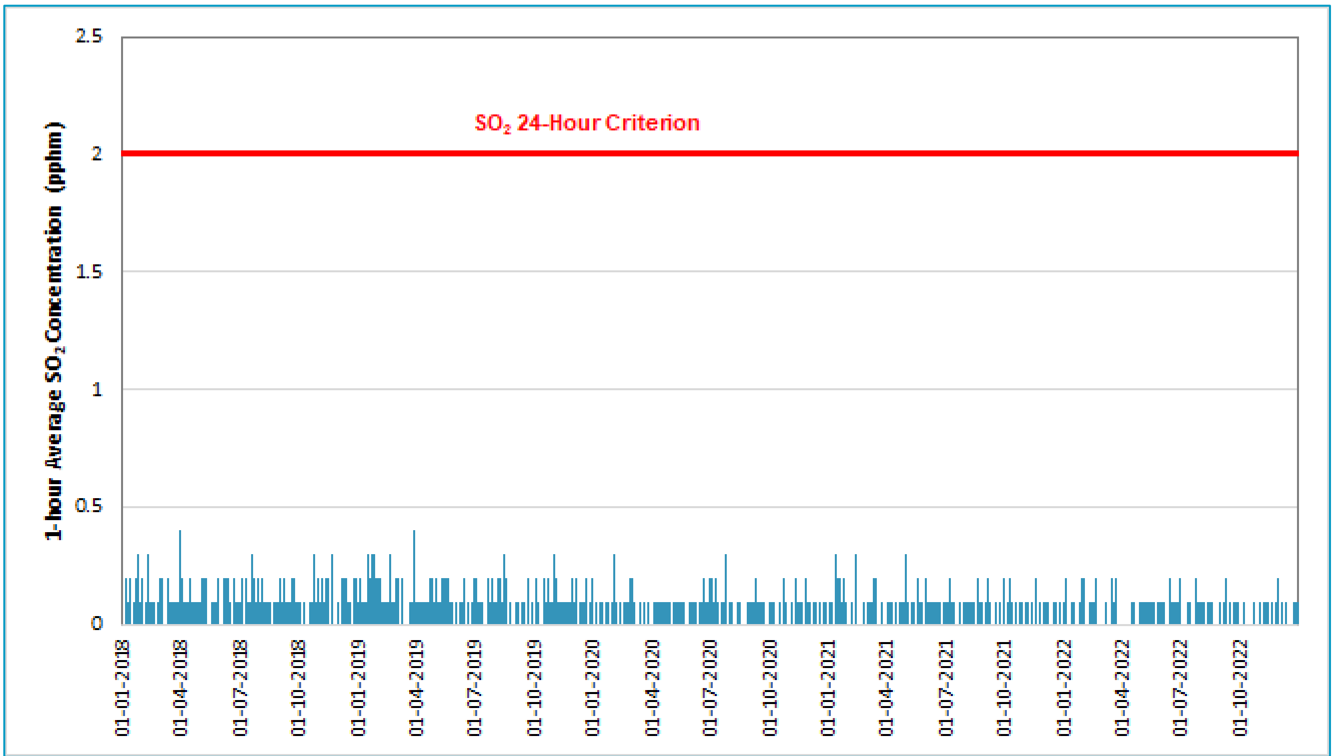


Figure 12 Measured 24-Hour Average SO_2 Concentrations at Liverpool AQMS (2018-2022)



5.2 Local Air Emission Sources

Industrial sites surrounding the Project with the potential to be significant emitters of air pollutants of interest in this assessment were identified through a review of facilities required to report to the National Pollutant Inventory (NPI).

The NPI database provides details on industrial emissions of over 4,000 facilities across Australia. The requirement to return annual reports to the NPI quantifying a facility's emissions is determined by the activities/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). It is not intended to make a statement that the emissions associated with those activities will be significant in terms of their potential for impact and/or generation of complaint, however it provides a tool to identify significant emission sources in a specific area that then may be investigated further to assess their potential to impact on local air quality.

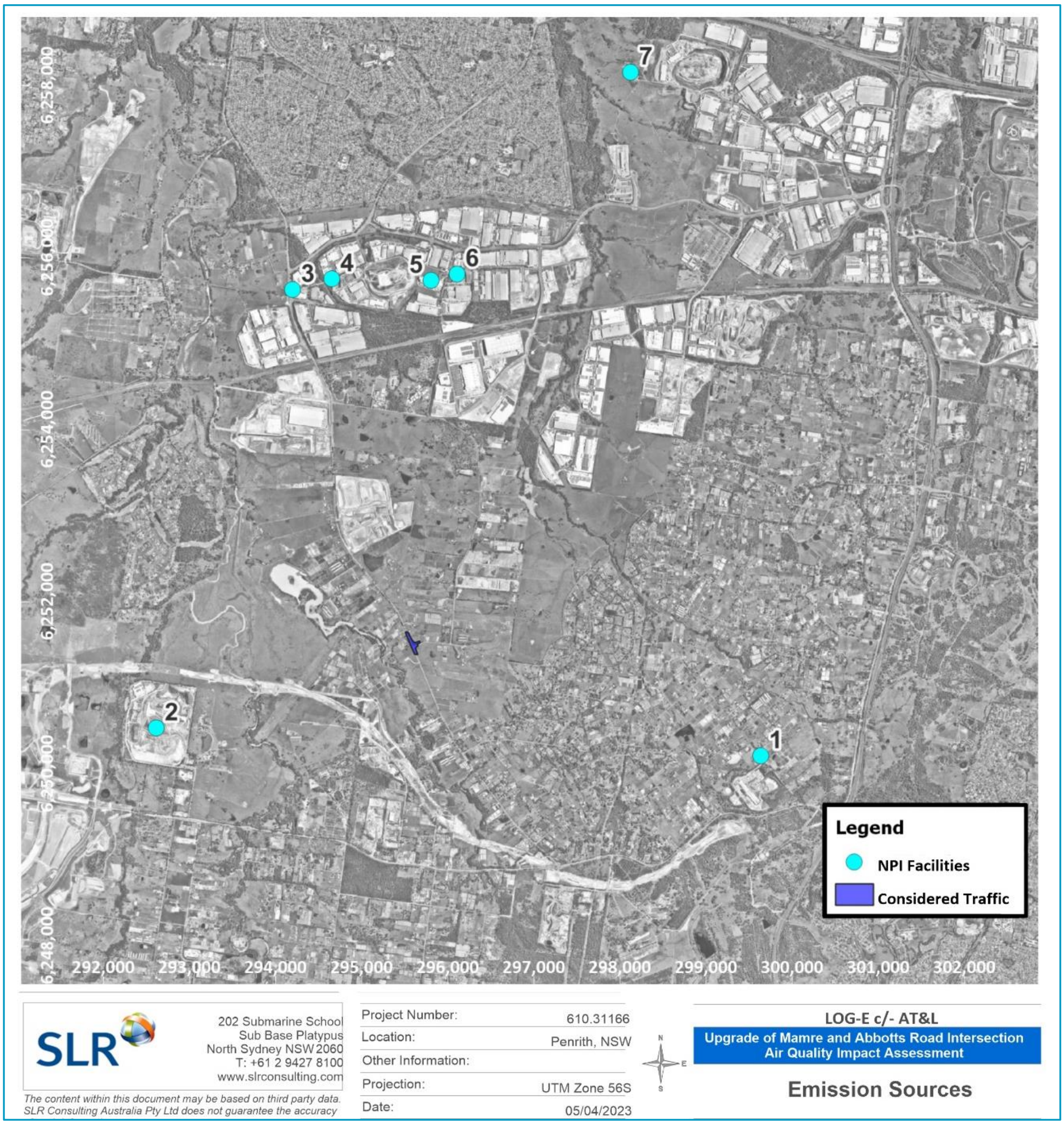
A search of the NPI database identified several sources of combustion-related air emissions and emissions of VOCs within the Penrith LGA, as listed in **Table 4** and shown in **Figure 13**.

Table 4 Emissions to Air Reported to the NPI by Industries in the Penrith LGA (2020-21 Reporting Year)

ID	Facility	CO (kg/year)	NO_2 (kg/year)	PM_{10} (kg/year)	$PM_{2.5}$ (kg/year)	SO_2 (kg/year)	VOCs (kg/year)
1	PGH Bricks and Pavers	92,000	26,000	51,000	230	36,000	3,000
2	Elizabeth Drive Landfill	-	-	-	-	-	2,500
3	Saputo Dairy Australia	900	320	80	80	12	60

ID	Facility	CO (kg/year)	NO_2 (kg/year)	PM_{10} (kg/year)	$PM_{2.5}$ (kg/year)	SO_2 (kg/year)	VOCs (kg/year)
4	Enviroguard Erskine Park Landfill	8,600	1,400	32,000	170	71	880
5	Western Sydney Service Centre	23,000	4,000	3,600	350	2,400	8,100
6	Goodman Fielder Consumer Foods	2,300	1,800	130	130	19	180
7	Eastern Creek Asphalt Plant	29,000	68,000	3,200	2,900	5,500	6,000

Figure 13 Local Air Emission Sources



Annual emissions from these facilities from the most recent available reporting year (2020-21) are also shown in **Table 4**. The only potentially significant emission sources identified, considering the regional monitoring data presented in **Section 5.1**, are the $PM_{2.5}$ emissions from the Eastern Creek Asphalt Plant and PM_{10} emissions from the PGH Bricks and Pavers and Enviroguard Erskine Park Landfill.

The Eastern Creek Asphalt Plant is located approximately 7.0 km northeast of the Project area and the conducive winds blowing emissions from the plant towards the Project occur less than 6% of the time, so there is a low likelihood of cumulative impacts with emissions from the Project.

The PGH Bricks and Pavers and the Enviroguard Erskine Park Landfill are located approximately 4.0 km southeast and north of the Project respectively. Considering the distance from the Project and the very low frequency of conductive winds (less than 8% northerly winds and less than 11% south-easterly winds) (see **Section 2.5**), the emissions from these facilities are unlikely to have a material impact on cumulative impacts.

Base on the above, neither of these operations are considered likely to have a significant impact on local air quality that would not be captured by the regional monitoring data presented above.

6 Assessment of Air Quality Impacts

6.1 Assessment Methodology

The key potential air quality issue identified for the operational phase of the Project is emissions of combustion products and particulate matter from vehicles travelling along Mamre Road and Abbotts Road. To assess the potential air quality impacts of the Project from vehicular emissions on surrounding sensitive receptors, the Tool for Roadside Air Quality (TRAQ) assessment tool developed by Roads and Maritime Services (RMS) (now TfNSW) has been used.

TRAQ is a US-EPA CALINE 4 based modelling tool designed for the first-pass screening of air quality impacts associated with new or existing roads. TRAQ uses worst-case scenarios to determine whether or not a more detailed assessment is required. TRAQ is considered to provide conservative predictions of potential incremental impacts. The model has been used extensively in NSW and is currently accepted by regulatory agencies as an appropriate conservative screening-level model for predicting near field ground level pollutant concentrations from traffic.

6.1.1 Pollutants Assessed

TRAQ provides predictions of CO, NO_2 and PM_{10} concentrations at various distances from the road kerb. It does not provide predictions of the other traffic-related pollutants identified in **Section 4.1**, namely $PM_{2.5}$, SO_2 and VOCs. Given the low level of SO_2 emissions from vehicles and the low ambient concentrations recorded in the region (see **Section 5**), it is reasonable to assume that SO_2 emissions from road traffic are unlikely to result in any exceedances of the relevant criteria at locations beyond the road kerb. SLR's experience in modelling VOC emissions from roads has also shown that kerbside concentration of VOCs are typically well below the relevant air quality guidelines.

Given the above, SO_2 and VOC traffic emissions have not been considered further in this assessment. $PM_{2.5}$ emissions, however, have been assessed based on the PM_{10} concentrations given by TRAQ using a conservative $PM_{2.5}/PM_{10}$ ratio estimated from COPERT Australia derived emission factors (see **Section 6.1.3**).

6.1.2 Modelling Assumptions and scenarios

The traffic modelling for the Project was carried out by ASON (ASON, 2022) and included two scenarios as follows:

- **Scenario 1:** The road network currently proposed or under construction by Landowners Group members can support a GFA of 900,000 m^2.
- **Scenario 2:** To support the additional GFA (up to 1,291,584 m^2) some additional upgrades to the road network would be required to retain the operating thresholds set by TfNSW.

For the purpose of this assessment, traffic numbers for Scenario 2 are adopted for estimating the pollutant concentrations after the Project.

Given that no existing traffic volume is available for Abbotts Road, it has been conservatively assumed that the results (ie pollutant concentrations vs distance from kerbside) for Mamre Road are applicable to Abbotts Road as well. This is considered worst case to apply the highest traffic numbers to the entire Subject Area of the Project. The existing and modelled traffic numbers are presented in **Table 5**.

Table 5 Mamre Road Hourly Traffic Volumes – Before and After the Project

Modelling Scenario		Peak hour traffic volume (vph)	%HV
Before Project – 2022[a]	NB[c]	770	25.80%
	SB	982	
After Project – 2026[b]	NB	1,684	12.90%
	SB	2,077	11.40%

[a] Provided by the client

[b] Obtained from ASON traffic modelling report, PM peak movement summary for Site 4 in scenario 2.

[c] NB- northbound, SB - southbound

Based on the data presented in **Table 5**, modelling was performed for two scenarios:

- Existing 2022 traffic flows without the Project
- Projected 2026 traffic flows with the Project (ie after the new intersection comes into operation)

The detailed monitored and modelled traffic numbers are located in **Appendix A**.

A summary of the change in projected peak hourly traffic numbers associated with the Project is provided in **Table 6**. This table shows that the Project results in significant increase in vehicle numbers.

Table 6 Change in Projected Peak Hourly Traffic Volumes Due to the Project

Modelling Scenario		Percentage Change Post Project Completion[1]
After the Project - 2026	NB	119%
	SB	112%

[1] ('With Project' -'Without Project ')/'With Project '

6.1.3 Dispersion Model Configuration

TRAQ requires a number of inputs to describe the Project environment and emissions to air, including:

- Background pollutant concentrations
- Peak hour traffic volumes and vehicle speeds
- Traffic mix (heavy vehicle percentage)
- Road type, number of lanes and gradient
- Year of assessment (vehicle fleet)
- Location land use
- Season

The sources of the required data and assumptions made for the purpose of this assessment are summarised in **Table 7**.

Table 7 TRAQ Input Data

Parameter	Value	Description
Background pollutant concentrations	PM_{10} 24-Hour: 31.3 µg/m^3 PM_{10} Annual: 18.2 µg/m^3 $PM_{2.5}$ 24-Hour: 11.9 µg/m^3 $PM_{2.5}$ Annual: 7.0 µg/m^3 NO_2 1-Hour: 47.2 µg/m^3 NO_2 Annual: 21.5 µg/m^3 CO 1-Hour: 0.5 mg/m^3 CO 8-Hour: 0.5 mg/m^3	The 1-, 8- and 24-hour average values are the 90th percentile background air quality concentrations recorded by the St Marys and Liverpool AQMSs as per TRAQ guidance. The values are based on records from 2018-2022 inclusive (refer **Section 5**)
Road Grade	0.5%	Average gradient estimated from terrain elevations
Peak hour speeds	38 km/hr	TRAQ default for peak periods on commercial arterial and arterial roads
Peak hour traffic volumes	**2022 - Before Project** Northbound: 681 Southbound: 982 **2026** - **After Project** Northbound: 1,684 Southbound: 2,077	Highest projected peak hourly traffic volumes from any link within each scenario.
Peak hour percentage of daily traffic	10%	TRAQ default
Traffic mix (Percent Heavy Vehicles)	**Before Project:** 25.8% **After Project:** Northbound: 12.90% Southbound: 11.40%	Traffic volumes BEFORE the Project for both Mamre Road Abbotts Road were based on monitored traffic counts. Traffic volumes AFTER the Project for both Mamre Road Abbotts Road were based on modelled traffic counts (ASON 2022).
Road type	**Mamre Road:** Commercial Arterial **Abbotts Road:** Arterial	-
Year of assessment (vehicle fleet)	**2022:** 2021 vehicle fleet **2026:** 2026 vehicle fleet	-
Location land use	Rural	-
Season	Worst-case	TRAQ default worst-case season
Cold start emissions	Included	-

The TRAQ default traffic mix for commercial arterial roads have combined total of 10.8 per cent heavy vehicles. As shown in **Table 5**, the heavy vehicle proportion assumed in the modelling was assumed to be 25.8% before the Project and 11.4% after the Project. To do this, the default traffic mix was adjusted as shown in **Table 8**. The proportions of individual heavy and light vehicle classes within each group remained the same but the overall split between the two groups was modified to have the relevant values.

Table 8 Adopted Traffic Mix Used in TRAQ

Vehicle Category		TRAQ Default Traffic Mix (%)*	Traffic Mix Used in this Assessment (%)		
			Before the Project	After the Project	
				Northbound	Southbound
CP	Petrol passenger vehicles	72.8	60.6	71.1	72.3
CD	Diesel passenger vehicles	2.1	1.7	2.1	2.1
LDCP	Light-duty commercial petrol vehicles less than 3.5 tonnes	10.2	8.5	10.0	10.1
LDCD	Light-duty commercial diesel vehicles less than 3.5 tonnes	3.5	2.9	3.4	3.5
MC	Motorcycles	0.6	0.5	0.6	0.6
Percentage Light Vehicles		***89.2%***	***74.20%***	***88.60%***	***87.10%***
HDCP	Heavy-duty commercial petrol vehicles greater than 3.5	0.2	0.5	0.2	0.2
RT	Rigid trucks, 3.5-25 tonnes, diesel only	6.5	15.5	7.8	6.9
AT	Articulated trucks greater than 25 tonnes, diesel only	3.6	8.6	4.3	3.8
BusD	Heavy public transport buses, diesel only	0.5	1.2	0.6	0.5
Percentage Heavy Vehicles		***10.8%***	***25.80%***	***11.40%***	***12.90%***

Default TRAQ traffic mix for 'Commercial Arterial' road type

The TRAQ screening tool does not include emission factors for $PM_{2.5}$. For the purposes of this assessment therefore, an estimated $PM_{2.5}/PM_{10}$ ratio was derived from the COPERT Australia emission factor database tool (COPERT). Vehicle speeds of 10 km/hr and 65 km/hr were modelled using COPERT to derive PM_{10} and $PM_{2.5}$ emission factors for the 2021 NSW vehicle fleet. The $PM_{2.5}/PM_{10}$ ratio for each vehicle speed scenario was estimated and a ratio of 85% (calculated based on the lower 10 km/hr vehicle speeds, which was worst-case) was adopted as a conservative measure (accounts for both exhaust and non-exhaust emissions). This ratio was applied to the PM_{10} concentrations predicted by TRAQ to derive estimated $PM_{2.5}$ concentrations. It is noted that the ambient $PM_{2.5}$ and PM_{10} concentration ratio recorded by the St Marys AQMS is approximately 45%.

6.2 Modelling Results

The air quality impacts predicted by the screening model TRAQ due to vehicle emissions from Mamre Road, based on the anticipated peak hour traffic volumes and the adopted TRAQ settings (see **Table 7**), are presented below. As outlined in **Section 2.4**, after the upgrade the closest residential property boundaries will be approximately 30 m from the Mamre Road kerbside and 110 m from the Abbotts Road kerbside. As shown in the results plots, pollutant concentrations decrease with increasing distance from the road.

6.2.1 Carbon Monoxide

The CO concentrations predicted by TRAQ at varying distances for the Mamre Road are shown in **Figure 14**. As mentioned in Section **6.1.2**, the same results are assumed to be valid for Abbotts Road. These are cumulative concentrations, including the background levels listed in **Table 7**. As shown by the plots, the predicted concentrations are far below the relevant ambient air quality criteria. There is no significant difference in the downwind concentrations predicted before and after the Project.

Figure 14 Maximum Predicted CO Concentrations Versus Distance from Mamre Road and Abbotts Road (TRAQ)

6.2.2 Nitrogen Dioxide

The maximum cumulative 1-hour average and annual average NO_2 concentrations predicted by TRAQ at varying distances from Mamre Road and Abbotts Road are shown in **Figure 15**. As shown by the plots, the predicted concentrations are well below the current ambient air quality criteria for NO_2. The modelled results show that the concentrations are anticipated to be slightly lower after the Project although the traffic numbers are higher. This is mainly due to the more advanced fleet used for modelling the emissions after the Project.

Figure 15 Maximum Predicted NO_2 Concentrations Versus Distance from Mamre Road and Abbotts Road (TRAQ)

6.2.3 PM_{10}

The maximum cumulative 24-hour average and annual average PM_{10} concentrations predicted by TRAQ at varying distances from Mamre Road and Abbotts Road are shown in **Figure 16**. As shown by the plots, the predicted concentrations are below both the 24-hour average and annual average criteria at distances greater than 10 m from the kerbside. The results also indicate that the concentrations are slightly higher after the Project due to the higher traffic numbers used for this scenario. However, all predicted concentrations are below the relevant 24-hour average and annual average criteria at distances greater than 10 m from the kerbside.

Figure 16 Maximum Predicted PM_{10} Concentrations Versus Distance from Mamre Road and Abbotts Road (TRAQ)

6.2.4 $PM_{2.5}$

$PM_{2.5}$ concentrations have been estimated from the PM_{10} concentrations given by TRAQ using a $PM_{2.5}/PM_{10}$ ratio of 85% (estimated from COPERT Australia derived emission factors). The maximum cumulative 24-hour average and annual average $PM_{2.5}$ concentrations derived using this approach are shown in **Figure 17**.

Figure 17 Estimated $PM_{2.5}$ Maximum Concentrations Versus Distance from Mamre Rd

As shown by **Figure 17**, the predicted 24-hour average concentrations are below the current 24-hour average ambient air quality criterion for $PM_{2.5}$ at all distances from the kerbside. However, the annual average $PM_{2.5}$ concentrations are predicted by TRAQ to be above the current annual average guideline up to 20 m from the kerbside.

6.3 Summary

The predicted concentrations at 30 m from the kerbside of Mamre Road and 100 m from the kerbside of Abbotts Road are summarised in **Table 9** for all pollutants and averaging periods assessed. As shown in the table and discussed above, all concentrations comply with the relevant criteria at the nearest sensitive receptor locations. However, the predicted downwind CO, $PM_{2.5}$, and PM_{10} concentrations slightly increase after the Project, NO2 concentrations slightly decrease after the Project.

In addition, the upgrade may improve traffic flows and minimise congestion levels that might otherwise be expected to occur before the Project, which would assist in minimising air pollutant emissions from the associated stop/start and acceleration driving patterns. This has potential to reduce pollutant concentrations at the nearest receptors.

Table 9 TRAQ Model Results

Pollutant and Averaging Period	Units	Incremental Impact		Background Concentration	Cumulative Impact*		Change due to the Project	Criteria
		Before Project	After Project		Before Project	After Project		
30 m from the Kerbside								
Maximum 1-hour CO	mg/m³	0.1	0.1	0.5	0.6	0.6	<1%	**25**
Maximum 8-hour CO	mg/m³	0.1	0.1	0.5	0.6	0.6	<1%	**9**
Maximum 1-hour NO_2	µg/m³	22.0	17.4	47.2	69.2	64.6	-7%	**164**
Annual NO_2	µg/m³	4.4	3.5	21.5	25.9	25.0	-3%	**31**
Maximum 24-hour PM_{10}	µg/m³	5.1	6.0	31.3	36.4	37.3	2%	**50**
Annual PM_{10}	µg/m³	2.0	2.4	18.2	20.2	20.6	2%	**25**
Maximum 24-hour $PM_{2.5}$	µg/m³	1.9	2.3	11.9	13.8	14.2	3%	**25**
Annual $PM_{2.5}$	µg/m³	0.8	0.9	7.0	7.8	7.9	1%	**8**
100 m from the kerbside								
Maximum 1-hour CO	mg/m³	0.1	0.1	0.5	0.6	0.6	<1%	**25**
Maximum 8-hour CO	mg/m³	0	0.1	0.5	0.5	0.6	0%	**9**
Maximum 1-hour NO_2	µg/m³	11.6	9.4	47.2	58.8	56.6	20%	**164**
Annual NO_2	µg/m³	2.3	1.9	21.5	23.8	23.4	-4%	**31**
Maximum 24-hour PM_{10}	µg/m³	2.7	3.2	31.3	34.0	34.5	-2%	**50**
Annual PM_{10}	µg/m³	1.1	1.3	18.2	19.3	19.5	1%	**25**
Maximum 24-hour $PM_{2.5}$	µg/m³	1.0	1.2	11.9	12.9	13.1	1%	**25**
Annual $PM_{2.5}$	µg/m³	0.4	0.5	7.0	7.4	7.5	2%	**8**

* Predicted incremental impact plus assumed background concentration.

7 Conclusions

SLR was commissioned by AT&L to perform an Air Quality Impact Assessment (AQIA) for the proposed upgrade of Mamre Road and Abbotts Road in Kemps Creek, NSW.

The primary source of air pollutant emissions associated with the operational phase of the Project will be vehicles travelling along Mamre Road and Abbotts Road. To assess the potential air quality impacts from these vehicular emissions on surrounding sensitive receptors, the Tool for Roadside Air Quality (TRAQ) assessment developed by Roads and Maritime Services (RMS) (now Transport for NSW) has been used. TRAQ is a US-EPA CALINE 4 based modelling tool designed for the screening of air quality impacts associated with new or existing roads, and is considered to provide conservative predictions of potential incremental impacts.

The results of the cumulative assessment indicate that all the predicted cumulative PM_{10}, NO_2 and CO concentrations are below the relevant air quality criteria at the nearest sensitive receptors. Based on a $PM_{2.5}/PM_{10}$ ratio of 85% for the downwind concentrations (based on emission factors from COPERT Australia), compliance with the current 24-hour average and annual average criteria for $PM_{2.5}$ is also predicted to be achieved at the nearest sensitive receptors.

Based on the results of this assessment, which is based on a conservative screening level assessment tool, SLR concludes that the Project would not result in an unacceptable increase in incremental or cumulative air quality impacts at the nearest sensitive receptors, and air quality is not considered to be a constraint for the Project. In addition, the upgrade may improve traffic flows and minimise congestion levels that may otherwise be expected to occur before the Project, which would assist in minimising air pollutant emissions and downwind impacts, particularly at the nearest receptors.

8 References

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Appendix A

DETAILED MONITORED AND MODELLED TRAFFIC NUMBERS

Figure A - 1 Mamre Road Northbound Traffic Numbers Before the Project

CfeIT **bob.white@cfeit.com** **(02) 9740 8600**

Traffic Count Summary Report

Count Number **1736** Ref : **ATL**
Street **MAMRE ROAD, KEMPS CREEK : From ELIZABETH DRIVE to GREAT WESTERN HIGHWAY : NORTH BOUND**
Location Combined Counts (1734,1735) south of Abbotts, House No. 1050 *Carriageway*

TOTAL COUNT MATRIX

Start Date 25-AUG-22
Start Time 100
Duration 7 DAYS
Interval 1 HOUR

Weekly 50th Percentile Speed 75
Weekly 85th Percentile Speed 83
Five Day AADT 9033
Seven Day AADT 7720

	MON *29TH*	TUE *30TH*	WED *31ST*	THU *25TH*	FRI *26TH*	SAT *27TH*	SUN *28TH*	5 Day Total	5 Day Average	7 Day Total	7 Day Average
Midnight - 1am	33	31	25	48	32	57	98	**169**	**34**	**324**	**46**
1am - 2am	31	34	33	39	24	43	48	**161**	**32**	**252**	**36**
2am - 3am	35	45	47	36	39	36	17	**202**	**40**	**255**	**36**
3am - 4am	102	103	123	89	100	51	27	**517**	**103**	**595**	**85**
4am - 5am	250	292	270	315	277	136	34	**1404**	**281**	**1574**	**225**
5am - 6am	569	560	549	574	526	201	72	**2778**	**556**	**3051**	**436**
6am - 7am	669	743	758	760	717	196	87	**3647**	**729**	**3930**	**561**
7am - 8am	714	**809**	**783**	777	765	297	161	**3848**	**770**	**4306**	**615**
8am - 9am	**725**	739	728	**804**	**804**	**335**	173	**3800**	**760**	**4308**	**615**
9am - 10am	456	537	489	515	538	330	235	**2535**	**507**	**3100**	**443**
10am - 11am	385	423	386	417	437	330	228	**2048**	**410**	**2606**	**372**
11am - Midday	361	370	413	382	437	307	**257**	**1963**	**393**	**2527**	**361**
Midday - 1pm	430	403	435	417	454	**369**	252	**2139**	**428**	**2760**	**394**
1pm - 2pm	512	492	470	521	550	366	280	**2545**	**509**	**3191**	**456**
2pm - 3pm	548	640	551	581	619	312	295	**2939**	**588**	**3546**	**507**
3pm - 4pm	605	**672**	647	648	621	292	268	**3193**	**639**	**3753**	**536**
4pm - 5pm	**692**	657	**655**	**717**	**685**	283	**309**	**3406**	**681**	**3998**	**571**
5pm - 6pm	649	605	653	671	558	232	293	**3136**	**627**	**3661**	**523**
6pm - 7pm	313	377	369	343	370	216	206	**1772**	**354**	**2194**	**313**
7pm - 8pm	133	176	192	214	181	156	161	**896**	**179**	**1213**	**173**
8pm - 9pm	125	127	127	144	131	113	116	**654**	**131**	**883**	**126**
9pm - 10pm	104	120	128	127	131	114	90	**610**	**122**	**814**	**116**
10pm - 11pm	90	74	91	75	131	131	98	**461**	**92**	**690**	**99**
11pm - Midnight	62	64	62	57	98	105	59	**343**	**69**	**507**	**72**
Total	**8593**	**9093**	**8984**	**9271**	**9225**	**5008**	**3864**	**45166**	**9033**	**54038**	**7719**

Page : 1

Data displayed has been compiled from pneumatic traffic count processes and is subject to the documented limitations

Figure A - 2 Mamre Road Southbound Traffic Numbers Before the Project

CfeIT bob.white@cfeit.com (02) 9740 8600

Traffic Count Summary Report

Count Number 1736 Ref : ATL

Street **MAMRE ROAD, KEMPS CREEK : From GREAT WESTERN HIGHWAY to ELIZABETH DRIVE : SOUTH BOUND**

Location Combined Counts (1734,1735) south of Abbotts, House No. 1050 *Carriageway*

TOTAL COUNT MATRIX

Start Date 25-AUG-22
Start Time 100
Duration 7 DAYS
Interval 1 HOUR

Weekly 50th Percentile Speed 76
Weekly 85th Percentile Speed 85
Five Day AADT 9846
Seven Day AADT 8422

	MON *29TH*	TUE *30TH*	WED *31ST*	THU *25TH*	FRI *26TH*	SAT *27TH*	SUN *28TH*	5 Day Total	5 Day Average	7 Day Total	7 Day Average
Midnight - 1am	24	56	52	53	60	60	56	**245**	**49**	**361**	**52**
1am - 2am	17	30	27	33	44	50	37	**151**	**30**	**238**	**34**
2am - 3am	28	38	39	41	43	34	27	**189**	**38**	**250**	**36**
3am - 4am	47	59	51	62	59	38	27	**278**	**56**	**343**	**49**
4am - 5am	139	177	188	182	170	89	25	**856**	**171**	**970**	**139**
5am - 6am	372	397	407	386	385	156	53	**1947**	**389**	**2156**	**308**
6am - 7am	**706**	**755**	726	740	**687**	230	86	**3614**	**723**	**3930**	**561**
7am - 8am	639	695	**748**	**763**	635	225	88	**3480**	**696**	**3793**	**542**
8am - 9am	620	653	660	600	591	267	169	**3124**	**625**	**3560**	**509**
9am - 10am	397	493	512	483	479	343	234	**2364**	**473**	**2941**	**420**
10am - 11am	380	399	380	383	437	**394**	**303**	**1979**	**396**	**2676**	**382**
11am - Midday	396	383	359	420	465	367	299	**2023**	**405**	**2689**	**384**
Midday - 1pm	407	414	404	427	510	406	333	**2162**	**432**	**2901**	**414**
1pm - 2pm	520	528	585	529	643	**450**	303	**2805**	**561**	**3558**	**508**
2pm - 3pm	767	738	710	723	772	368	268	**3710**	**742**	**4346**	**621**
3pm - 4pm	865	915	861	918	923	378	353	**4482**	**896**	**5213**	**745**
4pm - 5pm	**940**	**1007**	**1033**	**977**	**952**	334	**362**	**4909**	**982**	**5605**	**801**
5pm - 6pm	912	873	922	972	778	445	347	**4457**	**891**	**5249**	**750**
6pm - 7pm	426	448	512	499	583	336	218	**2468**	**494**	**3022**	**432**
7pm - 8pm	221	252	228	238	242	187	146	**1181**	**236**	**1514**	**216**
8pm - 9pm	133	150	182	205	178	132	140	**848**	**170**	**1120**	**160**
9pm - 10pm	138	140	169	208	158	149	89	**813**	**163**	**1051**	**150**
10pm - 11pm	146	135	131	165	165	120	82	**742**	**148**	**944**	**135**
11pm - Midnight	78	68	77	77	102	85	37	**402**	**80**	**524**	**75**
Total	**9318**	**9803**	**9963**	**10084**	**10061**	**5643**	**4082**	**49229**	**9845**	**58954**	**8422**

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Figure A - 3 Mamre Road Traffic Numbers After the Project – AM Peak

MOVEMENT SUMMARY

Site: 4 [ID [4]. Mamre Road / Abbotts Road - AM (Site Folder: 2026 - AM - Scenario 2)]

Mamre Road / Abbotts Road
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 120 seconds (Site User-Given Phase Times)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Mamre Road (500m)														
2	T1	1076	146	1133	13.6	* 0.425	1.9	LOS A	1.1	9.5	0.04	0.03	0.04	79.4
3	R2	121	55	127	45.5	0.512	45.0	LOS D	2.8	31.3	0.98	0.77	0.98	35.5
Approach		1197	201	1260	16.8	0.512	6.2	LOS A	2.8	31.3	0.13	0.11	0.13	72.8
East: Abbotts Road (400m)														
4	L2	31	17	33	54.8	0.063	35.9	LOS C	0.9	11.5	0.70	0.68	0.70	32.8
6	R2	23	8	24	34.8	* 0.066	55.7	LOS D	0.6	6.6	0.89	0.69	0.89	33.2
Approach		54	25	57	46.3	0.066	44.3	LOS D	0.9	11.5	0.78	0.68	0.78	33.0
North: Mamre Road (800m)														
7	L2	138	27	145	19.6	0.170	19.9	LOS B	3.9	36.0	0.49	0.72	0.49	53.3
8	T1	918	160	966	17.4	0.353	8.8	LOS A	5.7	50.7	0.33	0.29	0.33	70.0
Approach		1056	187	1112	17.7	0.353	10.3	LOS A	5.7	50.7	0.35	0.34	0.35	67.4
All Vehicles		2307	413	2428	17.9	0.512	9.0	LOS A	5.7	50.7	0.25	0.23	0.25	68.7

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance

Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
South: Mamre Road (500m)												
P1	Full	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	234.8	234.8	1.00
East: Abbotts Road (400m)												
P2	Full	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	221.3	217.2	0.98
P2B	Slip/ Bypass	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	215.3	209.4	0.97
North: Mamre Road (800m)												
P3	Full	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	231.6	230.7	1.00
P3B	Slip/ Bypass	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	212.0	205.2	0.97
All Pedestrians		50	53	54.2	LOS E	0.0	0.0	0.95	0.95	223.0	219.5	0.98

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

Figure A - 4 Mamre Road Traffic Numbers After the Project – PM Peak

MOVEMENT SUMMARY

Site: 4 [ID [4]. Mamre Road / Abbotts Road - PM - With Ped (Site Folder: 2026 - PM - Scenario 2)]

Abbotts Road / Mamre Road
Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 120 seconds (Site User-Given Phase Times)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] veh/h	DEMAND FLOWS [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% BACK OF QUEUE [Veh. veh	Dist] m	Prop. Que	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Mamre Road (500m)														
2	T1	1232	131	1297	10.6	0.445	3.0	LOS A	1.3	10.8	0.04	0.04	0.04	79.5
3	R2	368	51	387	13.9	* 0.837	70.1	LOS E	12.4	105.3	1.00	0.93	1.26	28.3
Approach		1600	182	1684	11.4	0.837	18.4	LOS B	12.4	105.3	0.26	0.24	0.32	60.5
East: Abbotts Road (400m)														
4	L2	126	24	133	19.0	0.190	45.7	LOS D	3.9	32.8	0.77	0.73	0.77	35.1
6	R2	112	36	118	32.1	* 0.526	68.6	LOS E	3.5	37.9	1.00	0.77	1.00	30.7
Approach		238	60	251	25.2	0.526	56.4	LOS D	3.9	37.9	0.88	0.75	0.88	32.6
North: Mamre Road (800m)														
7	L2	30	18	32	60.0	0.048	17.2	LOS B	0.7	8.7	0.40	0.67	0.40	54.0
8	T1	1943	236	2045	12.1	* 0.639	9.0	LOS A	13.4	109.1	0.36	0.33	0.36	71.6
Approach		1973	254	2077	12.9	0.639	9.1	LOS A	13.4	109.1	0.36	0.34	0.36	71.3
All Vehicles		3811	496	4012	13.0	0.837	16.0	LOS B	13.4	109.1	0.35	0.32	0.38	62.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
Vehicle movement LOS values are based on average delay per movement.
Intersection and Approach LOS values are based on average delay for all vehicle movements.
Delay Model: SIDRA Standard (Geometric Delay is included).
Queue Model: SIDRA Standard.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

* Critical Movement (Signal Timing)

Pedestrian Movement Performance

Mov ID	Crossing	Input Vol. ped/h	Dem. Flow ped/h	Aver. Delay sec	Level of Service	AVERAGE BACK OF QUEUE [Ped ped	Dist] m	Prop. Que	Effective Stop Rate	Travel Time sec	Travel Dist. m	Aver. Speed m/sec
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P1	Full	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	234.8	234.8	1.00
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P2	Full	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	221.3	217.2	0.98
P2B	Slip/ Bypass	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	215.3	209.4	0.97
North: Mamre Road (800m)												
P3	Full	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	231.6	230.7	1.00
P3B	Slip/ Bypass	10	11	54.2	LOS E	0.0	0.0	0.95	0.95	212.0	205.2	0.97
All Pedestrians		50	53	54.2	LOS E	0.0	0.0	0.95	0.95	223.0	219.5	0.98

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)

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