



Proposed Service Station – 88 Mountain Ridge Road, South MacLean

Air Quality and Odour Impact Assessment

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Abbreviations

Abbreviation	Full Term
AO	Acceptable Outcome
AWS	Automatic Weather Station
BAAQMD	Bay Area Air Quality Management District
BoM	Bureau of Meteorology
BPIP	Buildings Profile Input Program
CO	Carbon Monoxide
DA	Development Application
DETSI	Department of Environment, Tourism, Science & Innovation
EETM	Emission Estimation Technique Manual
LGA	Local Government Area
LPS	Logan Planning Scheme
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measures
NOOBS	No-observations
NO ₂	Nitrogen Dioxide
NPI	National Pollutant Inventory
O ₃	Ozone
OU	Odour Units
PM _{2.5}	Particulate Matter ≤2.5 micrometres
PM ₁₀	Particulate Matter ≤10 micrometres
PO	Performance Outcome
SO ₂	Sulphur Dioxide
SRTM	Shuttle Radar Topography Mission
TAPM	'The Air Pollution Model'
ULP	Unleaded Petrol
VOC	Volatile Organic Compounds
VR	Vapour Recovery

1 Introduction

A Development Application (DA) for a proposed service station located at 88 Mountain Ridge Road, South MacLean QLD 4280 is being lodged with the Logan City Council ('the Council'). The proposed service station will be located on Lot 1 RP 193885 ('the site').

An air quality assessment is required in support of the DA to demonstrate compliance with Performance Outcome (PO1) and Acceptable Outcome (AO1) of the *9.4.5 Management of Emissions and Hazardous Activities Code* of the Logan Planning Scheme 2015, (Version 9.2; commenced 1 July 2025) (Logan Planning Scheme (LPS), 2015). Details of the PO1 and AO1 from LPS 2015 have been provided in **Table 1**.

ViridAU have been commissioned by Kepnock Pty Ltd to undertake an air quality / odour impact assessment as part of the DA, to assess the impacts from the proposed service station on the surrounding air quality and demonstrate compliance with PO1 and AO1 of the *9.4.5 Management of Emissions and Hazardous Activities Code* of LPS 2015.

To assess air quality impacts from the proposed service station, air dispersion modelling has been conducted, details of which are presented in the following sections of this assessment report. Modelling has been conducted in accordance with the Department of Environment, Tourism, Science and Innovation (DETSI) publication – *Application to requirements for activities with impacts to air*.

ViridAU previously had conducted an air quality and odour impact assessment for a similar service station at the same site address. However, ViridAU was informed the owners for the facility have now changed and the site plan for the proposed service station was amended. This assessment refers to the previous assessment conducted by ViridAU where required.

Table 1: AO1 of the Logan Planning Scheme

Performance Outcome	Acceptable Outcome
<p><i>PO1</i></p> <p><i>A sensitive land use is not exposed to air, noise and odour emissions from Industry activities, Major sport, recreation and entertainment facility, Motor sport facility or Outdoor sport and recreation that have the potential to adversely impact on human health, amenity and wellbeing.</i></p>	<p><i>AO1</i></p> <p><i>An Industry activity, Major sport, recreation and entertainment facility, Motor sport facility or Outdoor sport and recreation is designed, constructed and operated to ensure that:</i></p> <ul style="list-style-type: none"> <i>a. the indoor objectives of the Environmental Protection (Noise) Policy 2008 are met;</i> <i>b. the requirements identified in Table 3.2.1.1 – Noise emission standards for the protection of residential amenity are met;</i> <i>c. the requirements identified in Table 3.2.1.2 – Noise emission standards for the protection of general amenity are met;</i> <i>d. the air quality objectives in the Environmental Protection (Air) Policy 2008 are met;</i> <i>e. the requirements identified in Table 3.2.2.1 – Air emission standards are met;</i> <i>f. noxious and offensive odours are not experienced at the boundary of a sensitive land use.</i>

2 Facility Specifics

The proposed service station is located at 88 Mountain Ridge Road, South MacLean and is described as Lot 1 on RP193885. The site is zoned as Rural Residential under LPS 2015. A site plan of the proposed service station is shown in **Figure 1**.

As per the information provided to Virid AU, the site has a total area of 2.04 hectares (ha) with total developable area to be 5,752 m².

The proposed service station (T1) comprises 8 multi-product fuel dispensing bowsers and will accommodate a maximum of 16 cars at any given time. Operational hours of the service station are unknown at the time of preparing this assessment report and it has been assumed that the service station would operate continuously – 24 hours (hrs), 7 days of the week.

Virid AU have been informed that the proposed service station will use Stage 1 & Stage 2 vapour recovery systems (VR1 & VR2), and this emission control technology has been incorporated in the development of the emissions profile. Additional details about the VR1 & VR2 system are provided in subsequent sections of this report.

The key pollutants generated from the proposed service station are outlined in the following section.

2.1 Potential Source of Air Emissions from the Proposed Service Station

Service station emissions can occur from several sources and activities which includes:

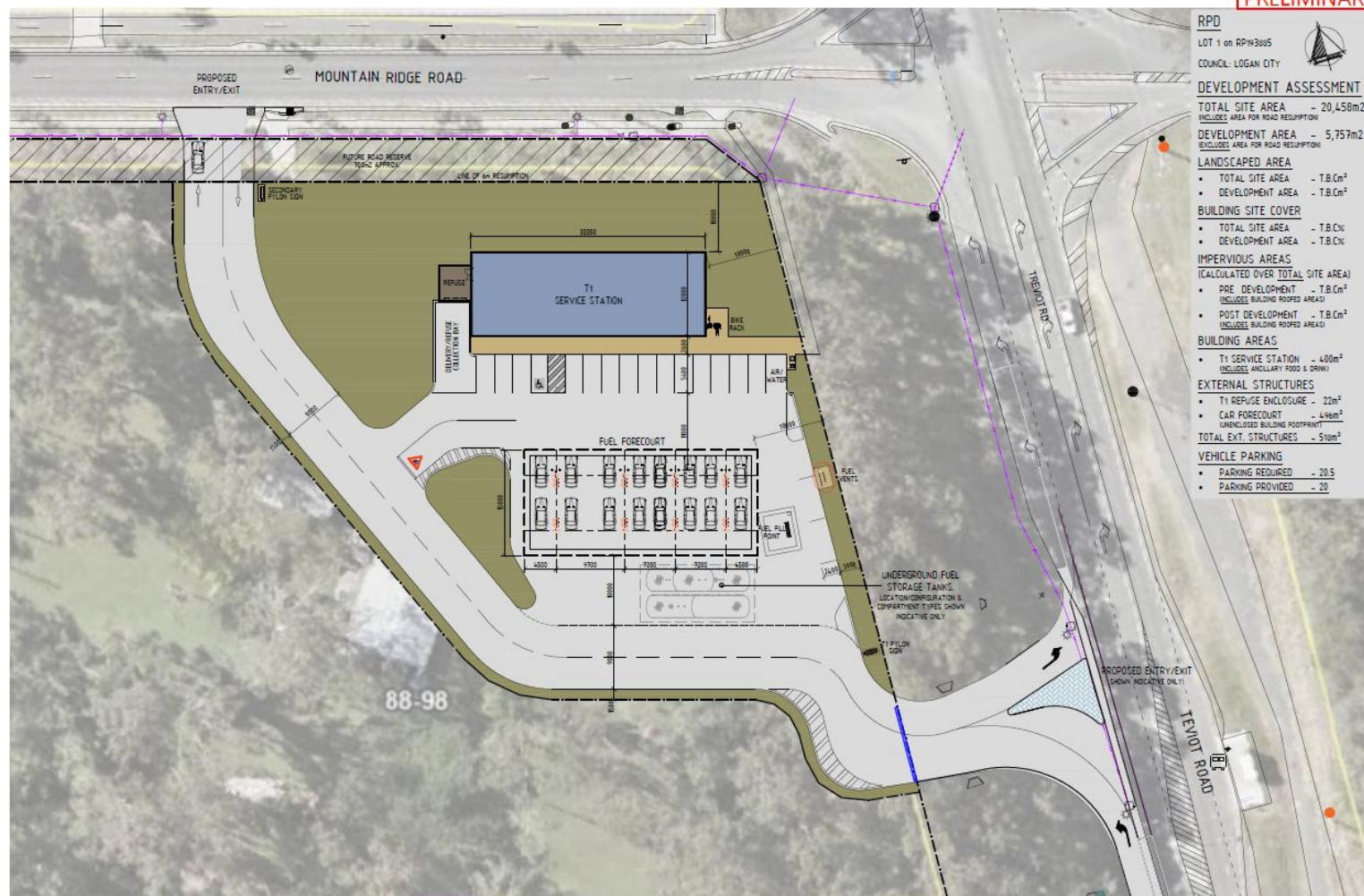
- Bulk filling of underground tanks,
- Tank breathing from underground tanks via the vent pipes,
- Vehicle refuelling; and
- Other fugitive emissions such as spillage, nozzle drips and fuel spit back.

The key pollutants released from the above sources are general odours and Volatile Organic Compounds (VOCs) which include compounds such as benzene, toluene, xylene, styrene, cyclohexane, n-hexane and ethylbenzene.

Regarding bulk filling, when a vapour recovery system is installed, the vapour returns to the tanker rather than allowing them to be emitted to the atmosphere, which reduces emissions by about 95%. This type of mitigation is known as Stage 1 Vapour Recovery or VR1, whereas Stage 2 Vapour Recovery or VR2 system reduces emissions during vehicle refuelling. As per the information provided to Virid AU, the proposed service station under assessment would have a VR1 and VR2 system installed.

Additional details on the modelled sources are provided in the following sections of this report.

PRELIMINARY



RPD
 LOT 1 on RP193005
 COUNCIL: LOGAN CITY

DEVELOPMENT ASSESSMENT

TOTAL SITE AREA - 20,458m²
(INCLUDES AREA FOR ROAD RESUMPTION)

DEVELOPMENT AREA - 5,757m²
(EXCLUDES AREA FOR ROAD RESUMPTION)

LANDSCAPED AREA

- TOTAL SITE AREA - T.B.Cm²
- DEVELOPMENT AREA - T.B.Cm²

BUILDING SITE COVER

- TOTAL SITE AREA - T.B.Cm²
- DEVELOPMENT AREA - T.B.Cm²

IMPERVIOUS AREAS
(CALCULATED OVER TOTAL SITE AREA)

- PRE DEVELOPMENT - T.B.Cm²
(INCLUDES BUILDING FOOTPRINT)
- POST DEVELOPMENT - T.B.Cm²
(INCLUDES BUILDING FOOTPRINT)

BUILDING AREAS

- T1 SERVICE STATION - 400m²
(INCLUDES AUXILIARY FOOD & DRINK)

EXTERNAL STRUCTURES

- T1 REFUELLING ENCLOSURE - 22m²
- CAR FORECOURT - 4,966m²
(UNENCLOSED BUILDING FOOTPRINT)

TOTAL EXT. STRUCTURES - 5186m²

VEHICLE PARKING

- PARKING REQUIRED - 20.5
- PARKING PROVIDED - 20

Client: Bigner

commercial service stations
 mixed-use quick service restaurants
 self storage child care centres
 industrial large format retail

1. This site plan is a preliminary design and is subject to change without notice.
 2. All dimensions are in millimeters unless otherwise stated.
 3. Check all dimensions on site prior to construction of work.

Drawn	Checked	Approved

Project description: PROPOSED SERVICE STATION
 88-98 MOUNTAIN RIDGE RD SOUTH MACLEAN

Scale	Version	Date
1:1000	1	25/11/2023

Sheet No: 25213-SK02
 Title: CONCEPT SITE PLAN OPTION 2
 Issue: P1

Figure 1: Proposed service station Site Plan

Source: Kepnock Pty Ltd

3 Assessment Methodology

To assess impacts from the proposed service station, air dispersion modelling has been undertaken, which includes the following:

- Development of a meteorological model to simulate transportation of pollutants from the source to the receptors,
- Estimating pollutant emission rates from the various activities at the service station including – bulk filling, tank breathing / emptying, vehicle refuelling, spillage and whoosh,
- Dispersion modelling of emissions from the service station. The CALPUFF dispersion model has been utilised to simulate the transportation of pollutants from the source to the receptors,
- Predicting impacts at the site boundary and the nearest sensitive receptors and comparing the model predictions against the Council objectives to assess compliance.

The overall assessment has been undertaken in accordance with the following guidelines:

- Department of Environment, Tourism, Science & Innovation (DETSI) publication – *Application to requirements for activities with impacts to air*, Environmental Protection Act 1994,
- *Environmental Protection (Air) Policy 2019* (EPP Air 2019),
- *Environment (Air) Protection Amendment Policy 2024* (EPP Air 2024),
- Performance Outcome (PO1) and Acceptable Outcome (AO1) of the 9.4.5 *Management of Emissions and Hazardous Activities Code* of the Logan Planning Scheme 2015 (Version 9.2; commenced 1 July 2025) (LPS, 2015),
- *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales*, NSW-EPA, August 2022; and
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia* published by the NSW – Environment Protection Authority (NSW-EPA) (formerly the Office of Environment and Heritage – OEH), 2011

4 Study Area and Surrounds

This section presents a brief overview of the land-use and topographical features surrounding the proposed service station. Sensitive receptors identified for the quantitative assessment are also discussed in this section.

4.1 Existing Land Use and Topography

The proposed service station is located at 88 Mountain Ridge Road, South MacLean on Lot 1 on RP193885. The proposed service station is zoned as Rural Residential. The site is located adjacent to the Mountain Ridge Road to the north and the Teviot Road to the east. There are scattered residential dwellings in the immediate surrounds of the development site, representing a rural residential landscape. The suburb of Flagstone which has dense residential developments is approximately 700 m south-west of the development site.

A desktop review was conducted by Virid AU to identify whether there are any existing service stations surrounding the proposed service station site that may contribute to cumulative impacts. Upon conducting the review, it was understood that there are no additional service stations within 5 km study area which could contribute towards cumulative air quality impacts.

A 3-dimensional representation of the topographic features surrounding the proposed service station mapped over 8 km x 8 km domain is as shown in **Figure 2**.

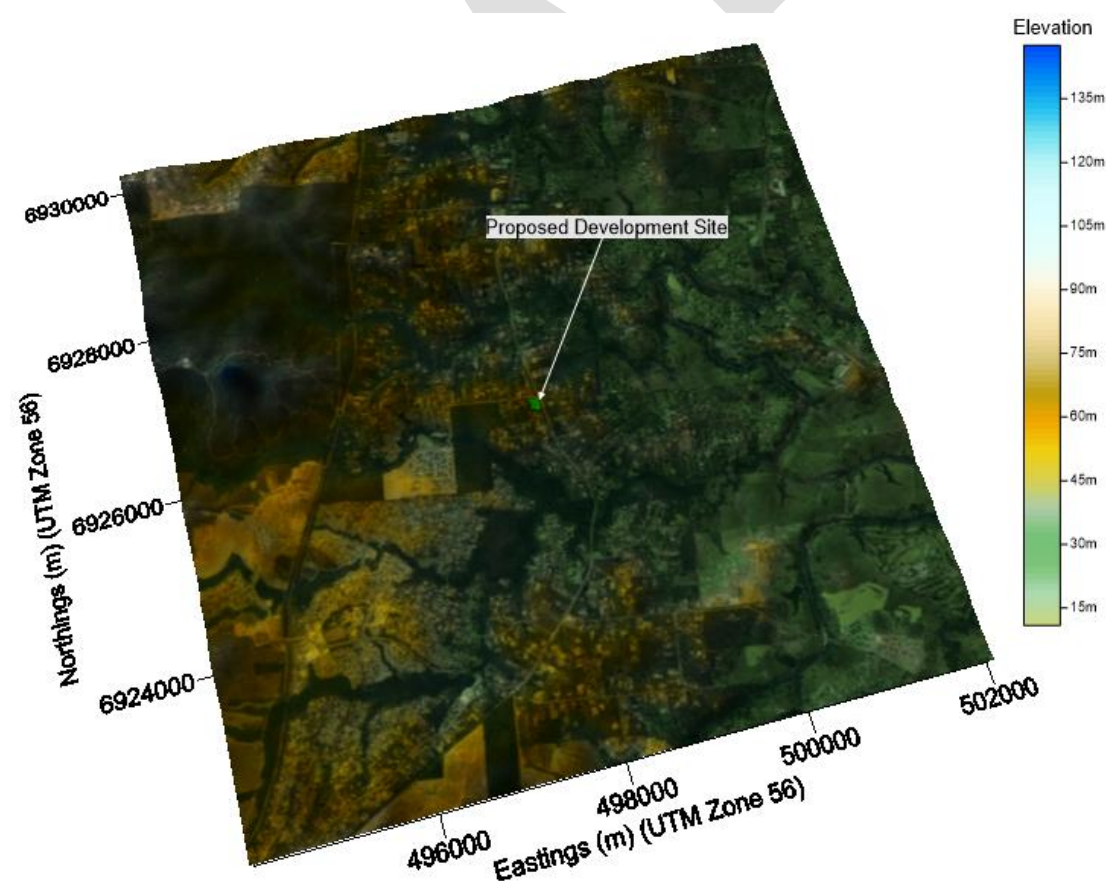


Figure 2: 3-Dimensional Representation of Terrain Features Surrounding the Proposed service station

4.2 Receptors Identified for the Assessment

Impacts from the proposed service station have been assessed at and beyond the boundaries of the proposed service station. A total of 108 receptors has been identified, and these receptors are representative of the boundary of the proposed service station and sensitive uses beyond the site boundary.

Selection of the receptors has been done to be able to assess pollutant concentrations from the modelled sources at and beyond the boundary premises of the site as per Table 3.2.2.1 – *Air emission standards of Logan Planning Scheme 2015 (Version 9.2) SC6.2.3 Environmental management*. Impacts at each of the 108 discrete receptors have been assessed vertically to represent impacts for high-rise developments. Impacts from the proposed service station have been predicted vertically from 0 m all the way through to 6 m with 1 m increments at each receptor.

A visual representation of all the discrete receptors considered for the impact assessment at and beyond the site boundary is presented in **Figure 3**. The pink-coloured receptors shown below are for determining impacts from the service station.

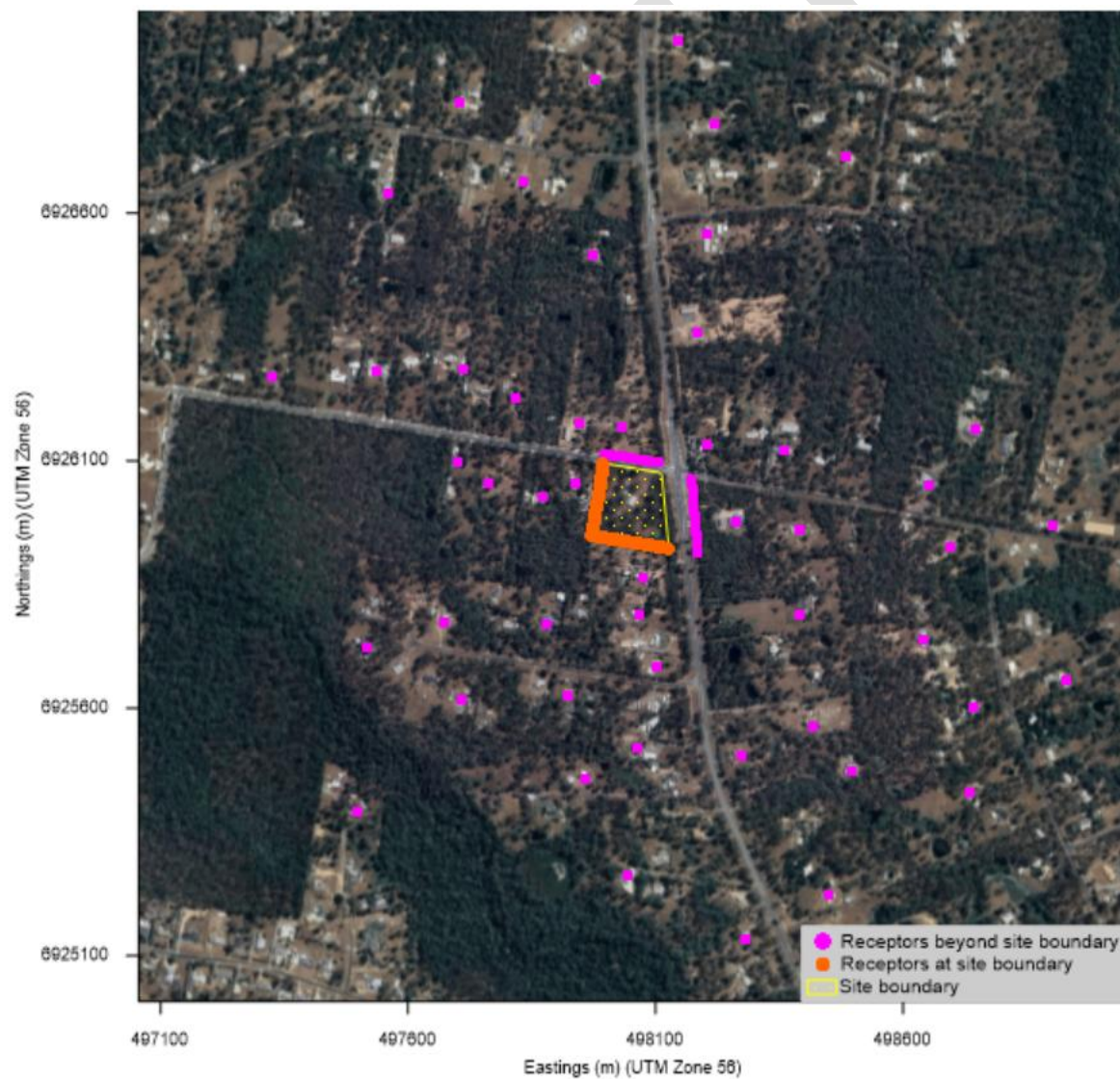


Figure 3: Visual Overview of Selected Discrete Receptors

5 Relevant Legislations

5.1 National Legislation

In June 1998 (revised in 2003), the National Environment Protection Council (NEPC) developed the Ambient Air Quality NEPM which sets out uniform standards for air quality at the national levels and has included ambient air quality standards for carbon monoxide (CO), nitrogen dioxide (NO₂), photochemical oxidants (as ozone – O₃), sulfur dioxide (SO₂), lead, and particulate matter with a nominal aerodynamic diameter of less than or equal to 10 microns (PM₁₀). The NEPM was revised in 2003 to include an advisory reporting goal for particulate matter with a nominal aerodynamic diameter of less than or equal to 2.5 microns (PM_{2.5}).

5.2 State Legislations

In Queensland, air quality is managed under the *Environment Protection Act 1994* and the *Environmental Protection (Air) Policy 2019* (the 'EPP Air 2019') which came into effect on 1st September 2019. On 30th August 2024, the *Environmental Protection (Air) Amendment Policy 2024* (the 'EPP Air 2024') was enacted, amending the EPP Air 2019.

The Act provides for long-term protection for the environment in Queensland in a manner that is consistent with the principles of ecologically sustainable development. The primary purpose of the EPP Air 2019 and EPP Air 2024 is to achieve the objectives of the Act in relation to Queensland's air environment.

Schedule 1 of the EPP Air 2019 (as amended) specifies the air quality objectives that are to be (progressively) achieved though no timeframe for achievement of these objectives is specified. The Schedule includes objectives designed to protect the environmental values of:

- Health and well-being,
- Aesthetic environment,
- Health and biodiversity of ecosystems, and
- Agriculture.

The 2024 amendment updates objectives for key pollutants such as PM_{2.5}, SO₂, NO₂, and ozone to reflect national standards.

5.3 Relevant Assessment Criteria

To assess air quality impacts from the proposed service station, relevant assessment criteria has been referenced from the Logan Planning Scheme 2015 - SC6.2.3 *Environmental management – Table 3.2.2.1 – Air emission standards*. Where criteria are unavailable in the *Logan Planning Scheme, 2015 (LPS, 2015)*, reference was drawn to information presented in the *EPP Air 2019, EPP Air 2024* and the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales, NSW-EPA, August 2022* ('Approved Methods') have been adopted.

Service stations typically emit VOCs into the atmosphere through various operational activities – underground tank filling, tank breathing / emptying resulting from changes in day-to-day temperature and pressure profiles, vehicle refuelling and any spillages. Based on the National Pollutant Inventory – *Emission Estimation Technique Manual (EETM) for Aggregated Emissions from Service Stations* (NPI, 1999), pollutants that may be typically emitted from service stations include:

- Benzene,
- Cyclohexane,
- Ethylbenzene,
- N-Hexane,

- Styrene,
- Toluene; and
- Xylene.

Table 2 presents a summary of the assessment criteria adopted for this assessment.

Table 2: Summary of Assessment Criteria

Pollutant	Averaging Period	Assessment Criteria	Unit	Reference
Benzene	3-minute	53	µg/m ³	LPS, 2015
Cyclohexane	1-hour	19,000	µg/m ³	Approved Methods
Ethylbenzene	3-minute	14,500	µg/m ³	LPS, 2015
n-Hexane	1-hour	3,200	µg/m ³	Approved Methods
Styrene	3-minute	210	µg/m ³	LPS, 2015
Toluene	3-minute	650	µg/m ³	LPS, 2015
	24-hour	4,112	µg/m ³	LPS, 2015
Xylene	3-minute	350	µg/m ³	LPS, 2015
	24-hour	1184	µg/m ³	LPS, 2015
Odours (Design criterion for an air emission sensitive use locating in proximity to an existing use that is likely to emit odour)	3-minute	1	OU	LPS, 2015

6 Meteorological Modelling

Meteorological mechanisms govern the generation, dispersion, transformation, and eventual removal of pollutants from the atmosphere. The local meteorology at the site plays a significant role in understanding the pollutant transport and dispersion mechanisms, and to adequately characterise the local meteorological conditions, information is needed on key parameters such as prevailing wind regime, mixing depth, atmospheric stability, ambient temperatures, rainfall, and relative humidity.

The following sections outline the methodology for characterising the meteorological conditions at the project site. Meteorological modelling was conducted using a combination of 'The Air Pollution Model' (TAPM) (Version 4.0.5) and CALMET meteorological models.

6.1 TAPM

For this modelling assessment, the meteorological model TAPM (Version 4.0.5) was used to generate the prognostic output. TAPM facilitates the development of localised meteorological datasets based on synoptic weather conditions. The model predicts the regional flows that are important to atmospheric dispersion of pollutants, such as sea breezes and terrain induced flows, against a background of larger-scale meteorology provided by synoptic analyses. The TAPM output provides a meteorological dataset suitable for use in a diagnostic meteorological model (CALMET for this assessment).

The 3D prognostic data was derived using TAPM (Version 4.0.5). The model was configured with a series of nested grids chosen to provide an appropriate communication and transfer of information from the broad synoptic to the local scale. The model was configured to use a domain consisting of 30 x 30 x 25 grid points with nesting spacings of 30 km, 10 km, 3 km and 1 km.

TAPM model allows for inclusion of observational data to be input into the model for the development of the three-dimensional meteorological model. The nearest Automatic Weather Station (AWS) managed and operated by the Bureau of Meteorology (BoM) is Greenbank (Defence) (140009) is located approximately 11 km north from the subject site. As the BoM AWS station is located more than 5 km from the proposed service station, the data from the AWS station may not be representative and therefore, TAPM model was run without any observational data.

TAPM modelling was conducted for a period of three (3) years – 2020 through to 2022. Data was analysed for three (3) calendar years 2020 through to 2022 and the 2022 year was selected as a representative model year. Additional details regarding selection of the meteorological modelling year are presented in **Appendix A**.

A summary of the TAPM settings is presented in **Table 3**.

Table 3: Summary of TAPM settings

Parameter	Value
Year of Analysis	2020-2022
Grid Centre Coordinates (lat, long)	-27deg 47.5min, 152deg 59min
Number of grids (spacing)	4 (30km, 10km, 3km, 1km)
Grid dimensions (nx, ny, nz)	30, 30, 25
Data assimilation	None

6.2 CALMET

CALMET (version 6.4.0) was used to derive higher resolution meteorological fields at 100 m resolution over an 8 km x 8 km modelling domain centred over the proposed service station site. CALMET was run in no-observations mode (NOOBS = 2) with prognostic output from TAPM used as an input to the CALMET model. The CALMET model settings were in general accordance with the '*Generic Guidance and Optimum Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia'*' (OEH, 2011) (hereafter 'Approved Methods').

The geophysical dataset for CALMET contains terrain and land use information for the modelling domain. For this assessment, terrain data for the CALMET grid was extracted from 1- arc second (30m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000 (downloaded from USGS website). The land use or land cover data for the modelling domain was based on the USGS Global Land Cover Classification (USGS GLCC). The geotechnical parameters for the land use classification were adopted from the default CALMET corresponding land use categories. A summary of the CALMET settings is given in **Table 4**.

Table 4: Summary of CALMET settings

Parameter	Value
Year of Analysis	2022
Number of Grid Cells (NX, NY)	81, 81
Grid Spacing (DGRIDKM) (km)	0.1
XORIG (km), YORIG (km)	494.005, 6921.958
Vertical Levels (NZ)	12
Meteorological Data Option	NOOBS = 2
Upper Air and Surface Data	TAPM generated MM4/MM5/3D
Geophysical Datasets	USGS GLCC (land use) & SRTM 1 – arc second terrain

6.3 Modelled Meteorology

Wind roses plotted using hourly wind data and direction for the calendar year 2022 are visually represented in **Figure 4**. The annual wind rose in **Figure 4** shows that winds are predominantly from the south-east, south-west direction and to a lesser extent from remaining directions. Calm conditions (wind speeds < 0.5 m/sec) are predicted to occur for 3.2% of the year. Modelled meteorology shows distinct variations in the seasonal patterns whereby the south-easterlies are more prevalent during the warmer months and south-westerlies during winter.

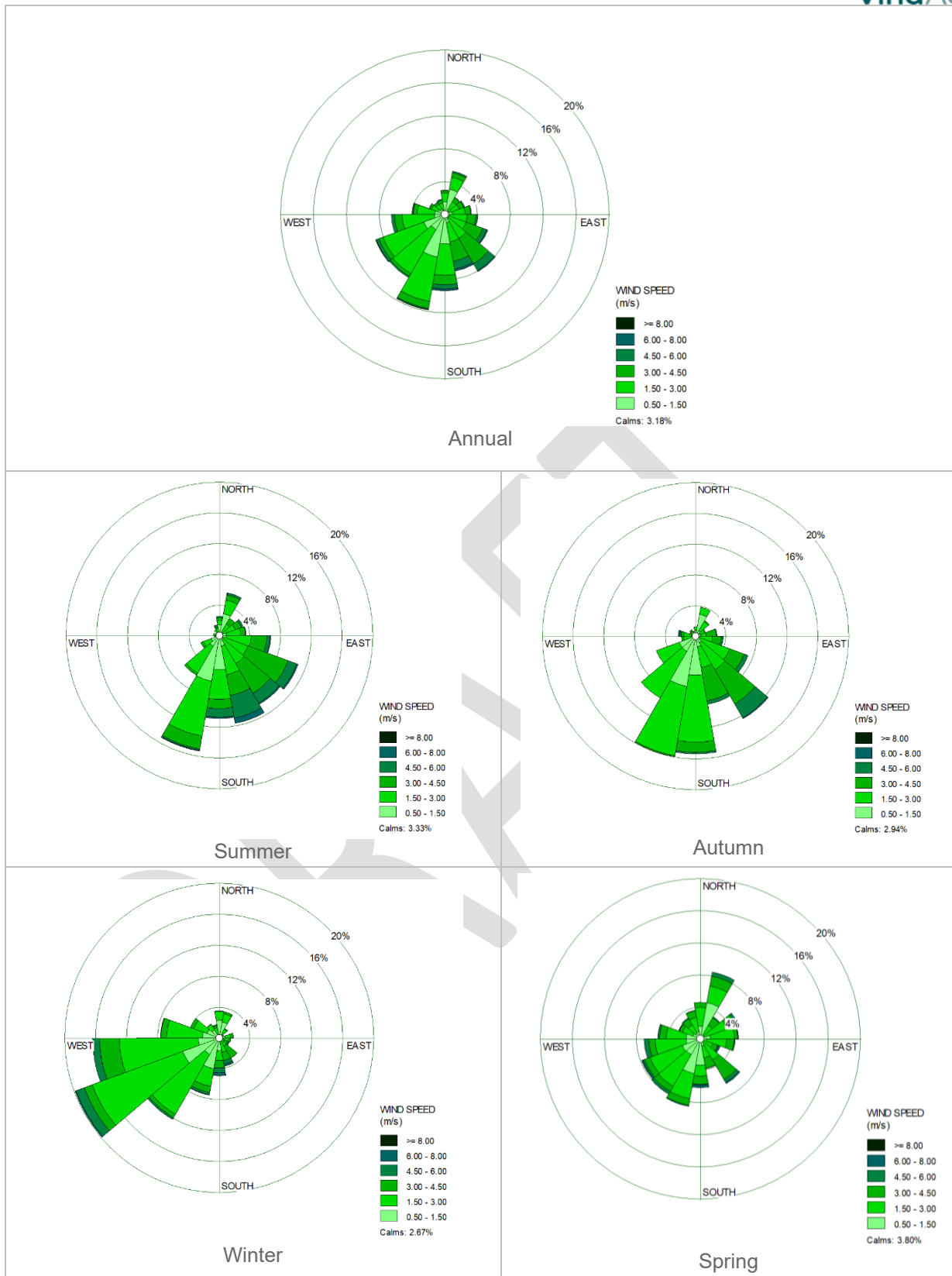


Figure 4: CALMET Predicted Annual and Seasonal Wind Roses – 2022

6.3.1 Stability

Stability of the atmosphere is determined by a combination of horizontal turbulence caused by the wind and vertical turbulence caused by the solar heating of the ground surface. Stability cannot be measured directly; instead, it must be inferred from available data, either measured or numerically simulated. The Pasquill-Gifford scale defines stability on a scale from A to G, with stability class A being the least stable, occurring during strong daytime sun and stability class G being the most stable condition, occurring during low wind speeds at night. For any given wind speed, the stability category may be characterised by two or three categories depending on the time of day and the amount of cloud present. In meteorological models such as CALMET, the stability classes F and G are combined.

A summary of the numerically simulated hourly stability class data using CALMET for 2022 is presented in **Figure 5**. A higher frequency (42%) of stability class D followed by 33% for F class indicating that the dominant conditions are moderately to very stable, with very little lateral and vertical diffusion.

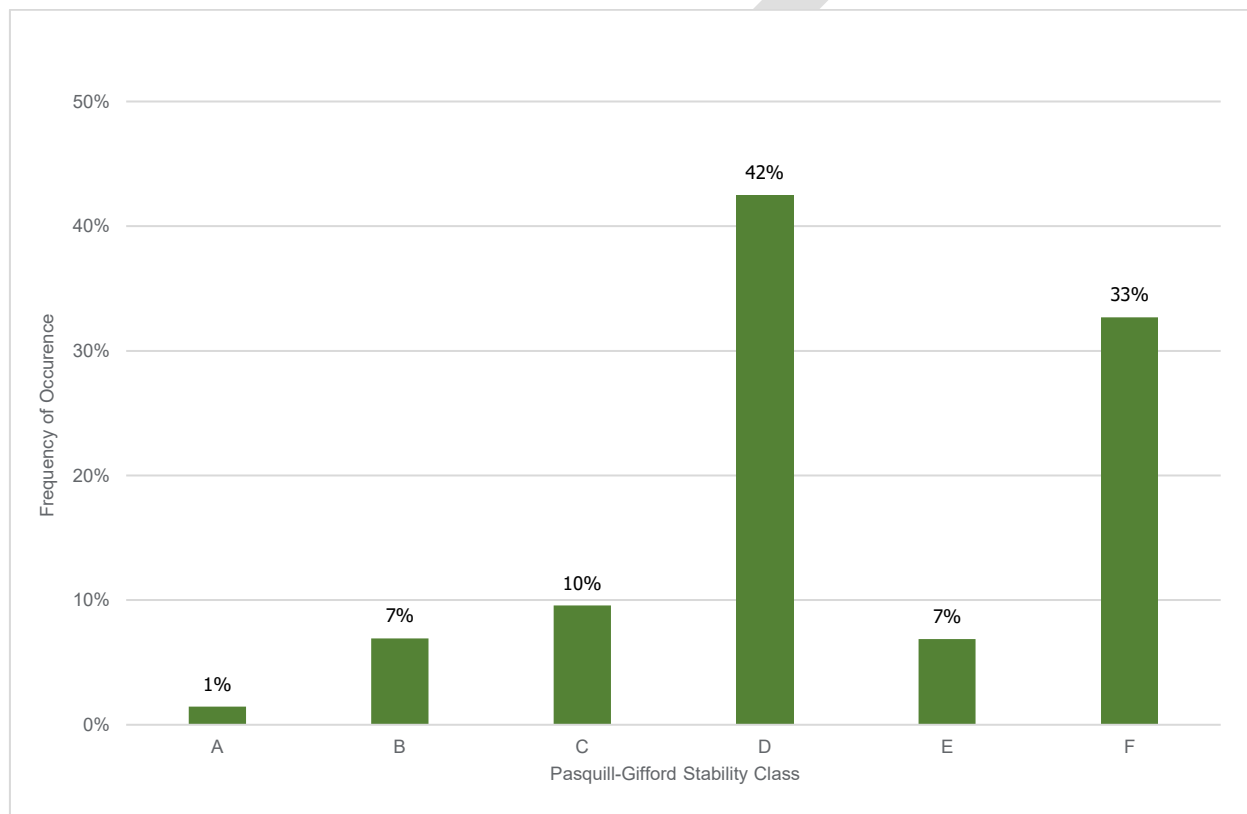


Figure 5: CALMET Predicted Frequency of Atmospheric Stability – 2022

6.3.2 Mixing Height

The mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that cannot be measured directly. The mixing height decreases in the late afternoon, particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight. Low mixing heights typically translate to stagnant air with little vertical motion, while high mixing heights allow vertical mixing and good dispersion of pollutants.

CALMET simulated hourly mixing height data for the year 2022 is shown in **Figure 6**. The data presented in **Figure 6** shows the mixing height as a function of the hour of the day at the proposed location of the subject site. The graph represents the typical growth of the boundary layer, whereby the mixing height is generally lowest during the night and into the early morning and highest during the late afternoon.

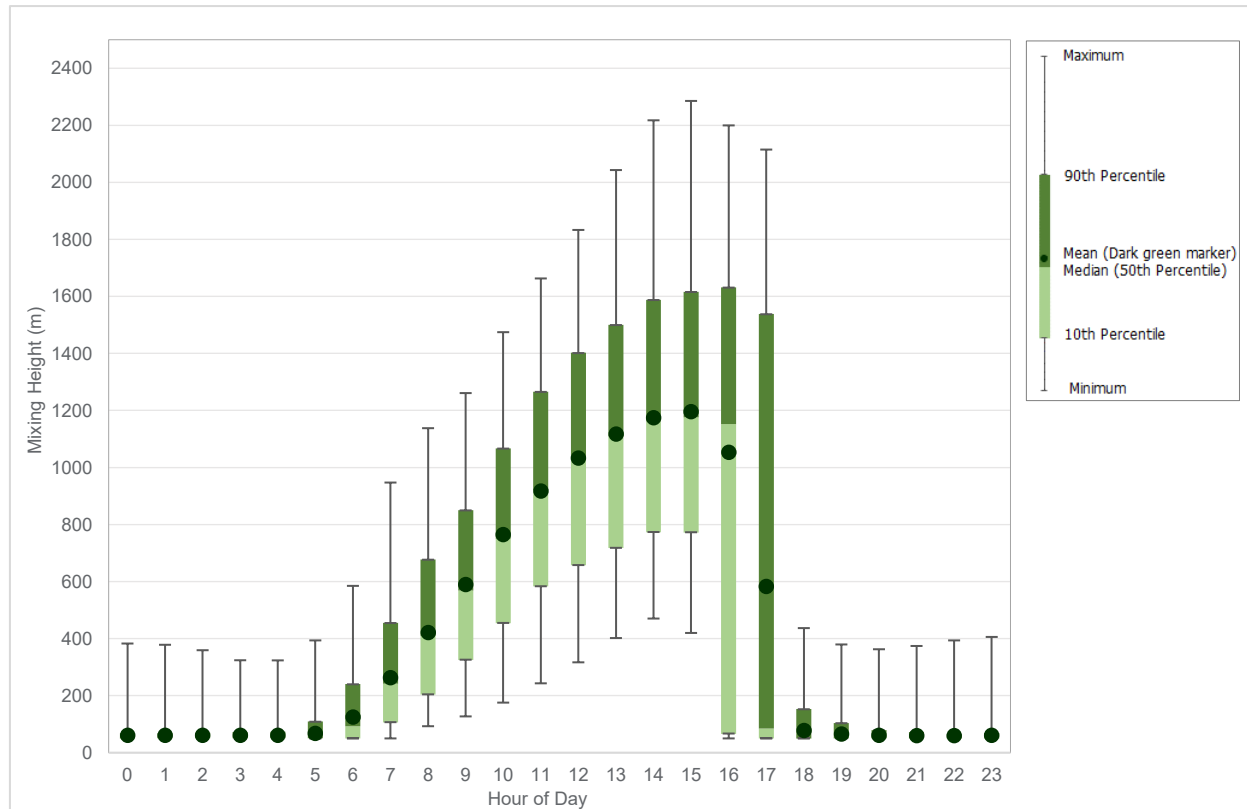


Figure 6: CALMET Predicted Mixing Height Profile - 2022

7 Determination of Process Emissions

This section outlines the methodology adopted to determine air emissions from the proposed service station operations.

7.1 Estimation of Service Station Emissions

Pollutant emission rates from the proposed service station considered in this assessment were estimated using Emission Estimation Technique Manuals (EETMs). To estimate emission rates, reference was drawn to the following EETMs:

- National Pollutant Inventory – EETM for Aggregated Emissions from Service Stations, November 1999,
- *Gasoline Service Station Industrywide Risk Assessment Guidelines*, Toxics Committee of the California Air Pollution Control Officers Association (CAPCOA), November 1997,
- *Transportation and Marketing of Petroleum Liquids*, AP-42 Compilation of Air Emission Factor, United States Environmental Protection Agency, June 2008; and
- Colorado Government – Gasoline Stations Emissions Calculator provided as a part of the Guide to Air Regulations for Gasoline Fuel Dispensing Stations, 2015.

An overview of the proposed service station emission sources and the estimated emission rates is presented in the following sections.

7.1.1 Sources of Emissions at Service Station

As discussed previously in **Section 2.1**, emissions from service station can occur from several sources including emissions generated from the unloading of fuel from tankers to underground storage tanks, underground storage tanks breathing losses, and vehicle refuelling.

Bulk Filling:

Service station fuel tanks in Australia are usually filled by either splash filling or by submerged loading.

As per the NPI EETM for *Aggregated Emissions from Service Stations*, splash filling involves lowering a fill pipe from the fuel tanker into the storage tank (above the level of the fuel). Fuel is then dispensed under gravity into the underground tank. This type of filling creates considerable amount of turbulence which subsequently results in a higher level of emissions released to the atmosphere.

On the other hand, submerged loading involves lowering the fill pipe below the fuel level, prior to commencement of fuel filling. This form of loading results in about 36% less vapour loss as compared to splash filling.

During the loading of underground tank, fuel displaces vapour. If this vapour is freely released to the atmosphere during filling operation, it is described as uncontrolled. However, if the vapour is contained and returned to the tanker, emissions to the atmosphere are reduced by about 95%, and the remaining emissions are directed through a vent stack on site. This type of mitigation/recovery is known as Phase 1 Vapour Recovery or VR1.

Tank Breathing:

Tank breathing or venting is a daily occurrence that is a result of fuel evaporation because of changes in temperature and pressure. The breathing emissions are directed through a vent stack on site.

Vehicle Refuelling:

Filling of motor vehicles comprises a major source of emissions at a service station. Typically, refuelling emissions can be categorised into – refuelling of motor vehicle emissions and whoosh emissions. Additionally, fugitive emissions can also be released from accidental spillages, overfilling, nozzle drips and fuel spit-back.

Vehicle filling emissions occur due to the displacement of vapours in the vehicle fuel tank as it is filled with fuel and also due to evaporative emissions from the fuel entering the tank.

As per the information provided to Virid AU, the proposed service station would have both Stage 1 and Stage 2 vapour recovery.

“Whoosh” emissions are the emissions released when the fuel cap on the car tank is removed prior to refilling. The term ‘Whoosh’ has been coined by the San Francisco Bay Area Air Quality Management District (BAAQMD), which relates to the sound of vapours rushing out of the tank when the fuel cap is removed. It is acknowledged that additional information is needed on the whoosh emissions as there are a lot of variables that affect the emission rate, including the age of the car, ambient temperature and pressure, the time and average speed the car has been driven prior to filling up, condition of the fuel cap and so on.

Fugitive emissions from service stations can occur because of accidental spillages, nozzle drips and fuel spit-back. These emissions are likely to occur where the vehicles are being refuelled at the service stations.

7.1.2 Characteristics of Emissions from Service Station

Fuels such as petrol and diesel contain a mixture of VOCs. Principal VOCs regulated by the National Pollutant Inventory (NPI) that may be released from the storage and handling of fuels include – benzene, cyclohexane, ethylbenzene, n-hexane, styrene, toluene and xylene. Though the NPI reports lead as a substance emitted at a service station, it has not been considered for the assessment as lead-based fuels have been progressively phased out.

Based on information provided, it is noted that majority of the fuels sold at the service station in consideration would be unleaded petrol (ULP) and its variants, namely *ULPE-10* – unleaded petrol blended with 10% ethanol, premium unleaded fuel and the remaining would comprise diesel.

The NPI EETM for *Aggregated Emission from Service Stations* provides speciation of individual VOCs typically present in petrol which is presented in **Table 5**. Speciation of individual VOCs present in diesel listed in **Table 6** have been referenced from the *Colorado Government – Gasoline Stations Emissions Calculator provided as a part of the Guide to Air Regulations for Gasoline Fuel Dispensing Stations, 2015*.

Table 5: VOC Speciation for Petrol Liquid and Vapour

Speciated VOCs	Petrol Liquid (% weight)	Petrol Vapour (% weight)
Benzene ⁽¹⁾	1.0	0.3275
Cyclohexane	0.2	0.0637
Ethylbenzene	2.03	0.0791
n-Hexane	3.5	1.73
Styrene	0.1	0.00282
Toluene	10.4	1.08
Xylene	12.2	0.433

Note (1): Benzene percentage modified from 2.9% to 1% as per Fuel Standard (Petrol) Determination 2001 (as amended 1 January 2006)

Table 6: VOC Speciation for Diesel Fuel

Speciated VOCs	Petrol Liquid (% weight)	Petrol Vapour (% weight)
Benzene	1.0	0.3275
n-Hexane	3.5	1.73
Toluene	10.4	1.08

Odours associated with VOCs are generated from the handling and storage of fuels at the service station. To estimate odour emissions, reference has been drawn to results obtained from odour and VOC sampling completed at a service station (ANE, 2016). The study involved taking simultaneous VOC and odour samples from a fuel storage contained containing unleaded petrol. The samples were then analysed for total VOCs and odour concentrations for use in determining a correlation factor. The sampling was conducted in accordance with AS 4323.4:2009 *Stationary source emissions – Area source sampling – Flux chamber technique* and AS 4323.3:2001 *Station source emissions – Determination of odour concentration by dynamic olfactometry*. The reported correlation factor 439 Odour Units (OU) per 1 g/m³ of VOCs was used, where in the total VOC emission data was factored by 439 to establish odour emission rates.

7.1.3 Fuel Throughputs

Brisbane City Council recommends two (2) methods of calculating fuel dispensing throughputs for a service station, details of which are presented below:

Method 1: This is applicable, if site-specific data is available. The methodology comprises:

- Estimating the daily petrol dispensing rate (preferably the peak rate not average),
- Using the daily profile presented in **Table 7** to estimate the amount of fuel dispensed per hour.

Method 2: If no site-specific fuel sales data is available, then the following methodology is to be considered for throughput determination:

- It is assumed that each vehicle takes an average 15 minutes at the pump which includes refuelling, payment and other activities. This means that during a busy hour period, each product dispensing pump will be used by 4 vehicles (60 minutes divided by 15 minutes/vehicle),
- The proposed service station has 8 multi-products dispensing bowsers, comprising 16 pumps, implying 16 x 15 = 64 vehicles / hour or 4 vehicles/minute,
- It is assumed that the average amount of fuel pumped into each vehicle would be approximately 30L (30 L/vehicle), and therefore the total amount of fuel dispensed during a peak hour, where in all

the bowsers would be occupied is approximately 1,920 L/hour (30 L/vehicle x 64 vehicles/ hour); and

- The hourly profile data shown in **Table 7** is applied to the estimated amount of fuel dispensed during the peak hour and extrapolated to other hours of the day.

Table 7: Representative Service Station Fuel Throughput Profile for Brisbane Area

Hour	Hourly Profile
1	1.2%
2	0.8%
3	0.6%
4	0.8%
5	1.9%
6	4.6%
7	5.5%
8	5.7%
9	5.5%
10	5.7%
11	6.0%
12	6.0%
13	5.7%
14	5.6%
15	5.9%
16	6.1%
17	6.0%
18	5.8%
19	5.1%
20	4.0%
21	3.5%
22	3.4%
23	2.6%
24	1.8%

For this assessment, Method 2 has been adopted as there is no site-specific information.

As there is no further breakdown of the type of fuel sold (i.e., ULP, E10, diesel), reference was drawn to the *Australian Motor Vehicle Emissions Inventory for the NPI*, August 2014, which provides a breakdown of road transport fuel consumption by fuel type in each state/territory.

From analysing the data in the below figure, it is observed in QLD that approximately 40% of the fuel consumed corresponds to ULP an premium ULP blends, 43% corresponds to diesel, 14% corresponds to E10 and the remaining 3% is attributed to other fuels including biofuels, CNG etc. This information was utilised to determine the amounts of each fuel type dispensed at the service station from the throughputs determined as per Method 2.

Table 2 2010 Road transport fuel consumption by fuel type and state/territory (million litres/year)

Fuel type	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
ULP	3,314	4,320	2,276	1,126	1,654	341	111	177	13,307
PULP	766	408	350	88	235	54	21	41	1,975
Diesel	2,774	2,799	2,731	717	1,585	250	164	67	11,087
LPG	527	874	188	227	165	12	7	59	2,059
CNG	109	7	55	80	36	0	0	0	287
Biodiesel	25	6	8	14	20	0	1	0	74
E10	1,675	134	904	0	0	0	0	89	2,803
Total	9,190	8,550	6,512	2,252	3,696	657	304	433	31,593

Figure 7: Screenshot from Australian Motor Vehicle Emissions Inventory for the NPI showing Road Transport Fuel Consumption by Fuel Type and State/Territory for 2010

7.1.4 Relevant Emission Factors

As noted earlier, EETMs have been used to determine emission rates from the various operational activities at the service station. Source specific factors relevant for this assessment and the literature from which these emission factors have been sources is summarised in **Table 8**.

Table 8: Source Specific Emission Factor Inventory

Source	Relevant Emission Factor	Source	Comments
Petrol			
Underground Tank Filling (Bulk Filling) – submerged filling and vapour balance (VR1)	40 mg/L for petrol fuels	NPI EETM for Aggregated Emissions from Service Stations	As the service station has VR1, using the submerged filling and vapour balance emission factor
Underground Tank Breathing	120 mg/L		-
Vehicle Refuelling – uncontrolled displacement losses	132 mg/L		-
Spillage	80 mg/L		-
Whoosh	0.46 lbs/1000 gallons ~ 55 mg/L	Gasoline Service Station Industrywide Risk Assessment Guidelines (CAPCOA)	The literature provides a range of 0.26-0.66 lbs/1000 gallons. Considered the average value for the assessment (approx..0.46 lbs/1000 gallons)
Diesel Fuel			
Underground Tank Breathing	0.002 lbs/1000 gallons ~ 0.24 mg/L	Colorado Government – Gasoline Stations Emissions Calculator provided as a part of the Guide to Air Regulations for Gasoline Fuel Dispensing Stations	-
Vehicle Refuelling	0.012 lbs/1000 gallons ~ 1.4 mg/L		-
Spillage	0.001 lbs/1000 gallons ~ 0.12 mg/L		-
Odours			
Total VOC emissions estimated from the aforementioned activities for petrol and diesel fuel have been multiplied by 439.			

From **Table 8**, it is seen that emission factors have not been provided for underground bulk filling of diesel fuel. As petrol fuel and its variants (ULP, E10, premium) contain a higher volatile fraction when compared to diesel, for the sake of this assessment, it has been assumed that all the fuel stored in the underground tanks is petroleum fuel.

7.1.5 Operational Data and Assumptions

This section outlines the assumptions that have been made to estimate pollutant emission rates from the service station operations:

- Total number of bowsers – 8,
- Number of vehicles at each bowser at any time – 2,
- Vapour Recovery – VR1 & VR2,
- A maximum 1-hour throughput emission rate has been assumed for bulk filling operations, where it has been assumed that 20,000 L of unleaded petroleum (ULP) fuel would be filled every hour. As petrol is more volatile than diesel, it has been assumed that all the fuel filled into the underground tanks is ULP,
- Method 2 has been employed to determine fuel throughputs,
- For estimating vehicle refuelling emissions, it has been assumed that 43% of the fuel sold is ULP, 43% is diesel and 14% is E10; and
- Petrol and diesel emissions estimated for bulk filling, breathing, vehicle refuelling, spillage and whoosh were scaled by 439 to determine the corresponding odour emission rates.

7.1.6 Estimated Emission Rates

Estimated total VOC emission rates for tank filling and breathing are presented in **Table 9**. Fugitive emission rates estimated as per Method 2 prescribed by the Brisbane City Council is presented in **Table 10**.

Table 9: Estimated Total VOC and Odour Emissions - Tank Filling and Breathing - All Fuels

Source	Estimated Total VOC Emission Rate (g/sec)	Estimated Odour Emission Rate (OU.m ³ /sec)
Bulk filling	0.56	244
Tank breathing	0.04	18

Table 10: Estimated Fugitive (Refuelling, Spillage and Whoosh) Total VOC and Odour Emissions - All Fuels - Method 2

Hour	Hourly Profile	Estimated Total VOC Emission Rate (g/sec)	Estimated Odour Emission Rate (OU.m ³ /sec)
1	1.2%	0.02	8
2	0.8%	0.01	5
3	0.6%	0.01	4
4	0.8%	0.01	5
5	1.9%	0.03	12
6	4.6%	0.07	29
7	5.5%	0.08	35
8	5.7%	0.08	36
9	5.5%	0.08	35
10	5.7%	0.08	36
11	6.0%	0.09	38
12	6.0%	0.09	38

Hour	Hourly Profile	Estimated Total VOC Emission Rate (g/sec)	Estimated Odour Emission Rate (OU.m ³ /sec)
13	5.7%	0.08	36
14	5.6%	0.08	36
15	5.9%	0.09	38
16	6.1%	0.09	40
17	6.0%	0.09	38
18	5.8%	0.08	37
19	5.1%	0.07	33
20	4.0%	0.06	26
21	3.5%	0.05	22
22	3.4%	0.05	22
23	2.6%	0.04	17
24	1.8%	0.03	11

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8 CALPUFF Dispersion Model Configuration

To predict impacts from the proposed service station dispersion modelling was conducted using the CALPUFF non-steady state puff dispersion model. The CALPUFF model is an approved and an accepted dispersion model and widely used to determine impacts from sources of air emissions including service stations.

The CALPUFF model treats emissions as a series of puffs. These puffs are then dispersed throughout the modelling area and allowed to grow and bend with spatial variations in meteorology. This method allows the model to retain a memory of the plume's movement throughout each hour while approximating the effects of complex air flows.

CALPUFF uses the meteorological processing and prediction model CALMET to provide 3D wind field predictions for the modelled area. The final wind field developed by the model includes an approximation of the effects of local topography, the effects of varying surface temperatures (as is observed in land and sea bodies) and surface roughness (resulting from varied land uses and vegetation cover in an area). The CALPUFF model simulates complex terrain influences on local wind fields including consideration of katabatic flows and terrain blocking.

CALPUFF model settings were referenced from the '*Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia*' (NSW-OEH, 2011).

General run control parameters and technical options that were selected in the CALPUFF model are summarised in **Table 11**.

To predict impacts from proposed service station, CALPUFF computational grid size was set as a subset of CALMET domain of 4 km x 4 km with a 100 m grid spacing. In addition to the identified sensitive receptors (refer **Figure 3**), gridded receptors were sampled over a 2 km x 2 km sampling grid with a nesting factor of 4.

Tank breathing and filling emissions were represented as a single point source and the activities under the canopy (i.e., vehicle refuelling, spillage and whoosh) were represented as a volume source. All service station sources were modelled as a continuous emitting source – i.e., 24 hours, 365 days of the year.

Vent stack parameters (i.e. point source) for emissions released from bulk filling and tank breathing operations that have been incorporated into the modelling are listed below.

- Exhaust vent height from ground: 4.5 m,
- Exhaust vent stack diameter: 0.1 m; and
- Exhaust vent stack exit velocity: 0.1 m/sec.

Table 11: Summary of CALPUFF Settings

Parameter	Value
CALPUFF version	6.42
Year modelled	2022
Sources modelled as	Point and Volume Sources
Computational grid size	4 km x 4 km
Computation grid resolution	100 m
Gridded receptors used (LSAMP)	Yes
Nesting factor for gridded receptor (MESH DN)	4
Number of discrete receptors	108
Pollutants modelled	Refer Table 2

The impact of building downwash effect on plume dispersion has been included in the modelling for buildings and structures located around the point source (i.e., exhaust vent stack). The main building of concern was the fuel canopy which is 5.2 m and is taller than the modelled fuel vent stack. The heights and locations of these structures were entered into the Buildings Profile Input Program (BPIP) utility using PRIME algorithm. The wind direction-specific building dimensions calculated BPIP for the stack at their corresponding heights were entered into the CALPUFF model.

The location of the fuel canopy with context to the exhaust vent stack is presented in **Figure 8**.

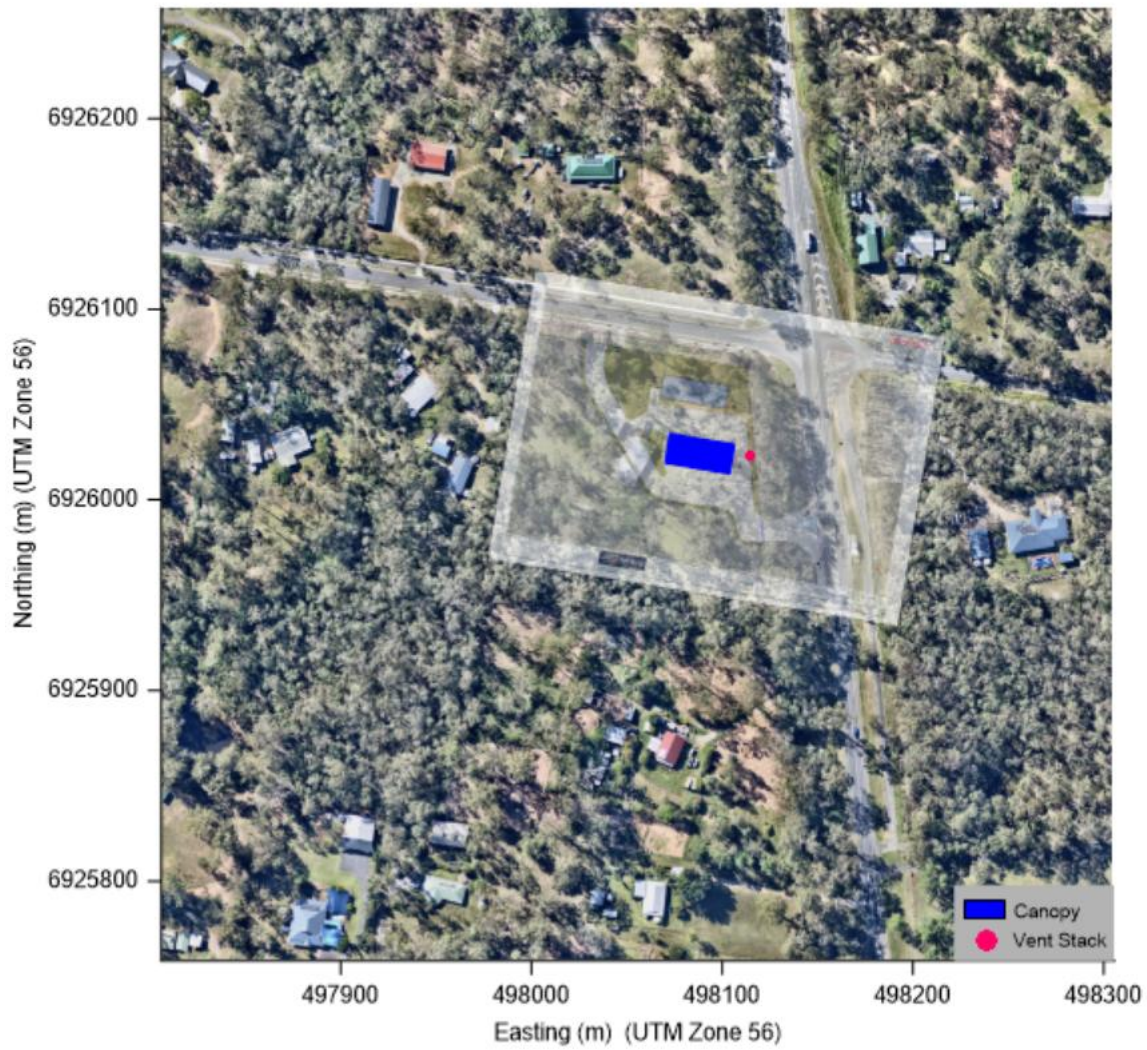


Figure 8: Visual Illustration of the Structures considered for Downwash Effects

9 Results and Discussion

This section outlines the modelling results predicted at the identified sensitive receptors from the proposed service station.

Predicted maximum (1st rank) ground level concentrations have been reported for all modelled pollutants for all averaging periods. For pollutants with a 3-minute averaging period, a peak-to-mean ratio of 2.88 has been used to scale the results predicted for 1-hour averaging period.

Model predicted maximum incremental (i.e., impacts from the proposed service station) and cumulative (incremental + background) concentrations across all of the identified receptors for the assessed pollutants are summarised in **Table 12**.

9.1 Impacts from the Proposed Service Station

Concentrations for all pollutants emitted from the service station have been assessed at varying heights from 0 m all the way through to 6 m in 1 m increments. In **Table 12**, the receptor ID corresponding to the maximum predicted concentration has been identified.

From the modelling results presented in **Table 12**, it is observed that the predicted concentrations for all assessed pollutants from the proposed service station comply with their relevant assessment criteria, indicating that the tank breathing, bulk filling, vehicle refuelling and other fugitive emissions would not have any significant bearing on the ambient air quality levels. Compliance is largely attributed to the provision of Stage 1 and 2 vapour recovery systems.

Table 12: Predicted Maximum Pollutant Concentrations Across All Receptors and Elevations

Pollutant	Criteria	Unit	Averaging Period	Maximum Predicted Incremental Concentration at the Worst Impacted Receptor ($\mu\text{g}/\text{m}^3$)	Incremental (% of Assessment Criteria)	Adopted Background Concentration ($\mu\text{g}/\text{m}^3$)	Maximum Predicted Cumulative Concentration at the Worst Impacted Receptor ($\mu\text{g}/\text{m}^3$)	Cumulative (% of Assessment Criteria)	Details of Worst Impacted Receptor			Compliance (Yes/No)
									ID	Easting (m)	Northing (m)	
Benzene	53	$\mu\text{g}/\text{m}^3$	3-minute	14.6	27.6%	n.a.	n.a.	n.a.	R88 at 0m	498078	6926100	Yes
Cyclohexane	19,000	$\mu\text{g}/\text{m}^3$	1-hour	1.0	0.01%	n.a.	n.a.	n.a.	R89 at 0m	498089	6926098	Yes
Ethylbenzene	14,500	$\mu\text{g}/\text{m}^3$	3-minute	3.5	0.02%	n.a.	n.a.	n.a.	R88 at 0m	498078	6926100	Yes
n-Hexane	3,200	$\mu\text{g}/\text{m}^3$	1-hour	26.8	0.8%	n.a.	n.a.	n.a.	R88 at 0m	498078	6926100	Yes
Styrene	210	$\mu\text{g}/\text{m}^3$	3-minute	0.1	0.1%	n.a.	n.a.	n.a.	R88 at 0m	498078	6926100	Yes
Toluene	650	$\mu\text{g}/\text{m}^3$	3-minute	48.1	7.4%	n.a.	n.a.	n.a.	R88 at 0m	498078	6926100	Yes
	4,112	$\mu\text{g}/\text{m}^3$	24-hour	1.6	0.04%	n.a.	n.a.	n.a.	R97 at 5m	498177	6926017	Yes
Xylene	350	$\mu\text{g}/\text{m}^3$	3-minute	19.3	5.5%	n.a.	n.a.	n.a.	R88 at 0m	498078	6926100	Yes
	1,184	$\mu\text{g}/\text{m}^3$	24-hours	0.6	0.1%	n.a.	n.a.	n.a.	R97 at 5m	498177	6926017	Yes
Odours	1	OU	3-minute	0.5	53.8%	n.a.	n.a.	n.a.	R86 at 0m	498056	6926103	Yes

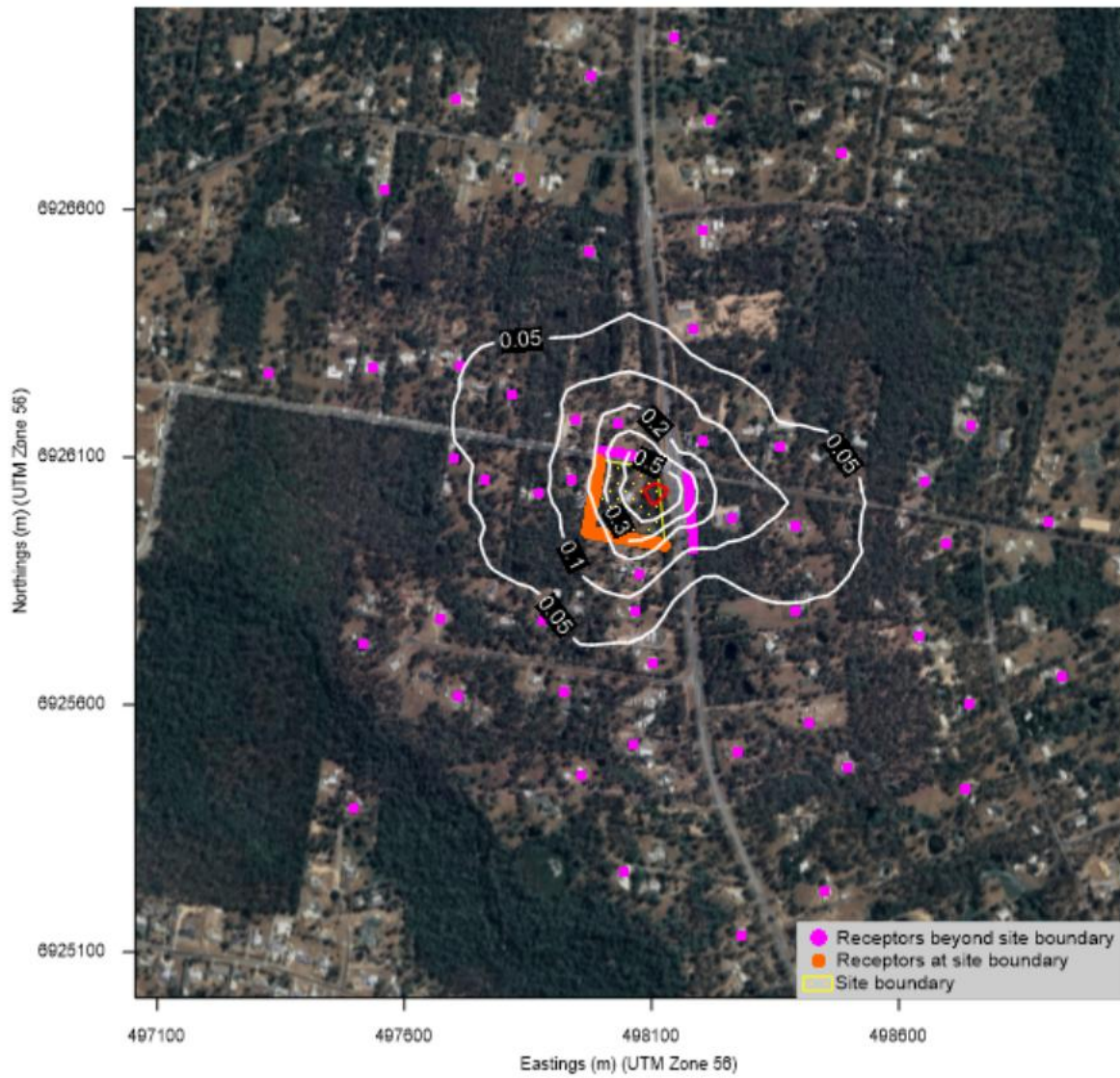


Figure 9: Predicted Maximum 3-minute Average Ground Level Odour Concentration Emitted from the Proposed Service Station (Criteria: 1 OU)

10 Conclusion

An air quality / odour impact assessment has been conducted for a development application at 88 Mountain Ridge Road, South MacLean QLD 4280, which comprises development and construction of a service station.

Kepnock Pty Ltd engaged Virid AU to conduct an air quality / odour impact assessment to ascertain impacts on the receiving environment from the service station operations.

VR1 and VR2 systems would be incorporated into the service station demonstrating best practice measures.

Modelling has been conducted using the CALPUFF dispersion model and predicted impacts have been compared at the air quality objectives outlined by the Logan City Council to assess compliance.

Modelling clearly shows that the pollutants released from the service station will not have any adverse impacts on the surrounding air quality levels and the pollutant levels are well in compliance with the relevant air quality objectives.

Therefore, in conclusion, it can be summarised that the proposed service station would not pose any major concerns as far as ambient air quality is concerned.

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11 References

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Appendix A

Meteorological Modelling

Analysis of the TAPM model over 3 years between 2020 – 2022 has been undertaken.

The following charts have been produced to compare the 1 – year site representative data (2022) with 3 years observations and to support the selection of the 2022 meteorological modelling year.

- Interannual (2020-2022) wind roses – TAPM Processed.
- Interannual (2020-2022) mean maximum and mean minimum temperature profile – TAPM Processed.
- Interannual (2020-2022) wind speed frequency distribution chart - TAPM Processed.
- Interannual analysis in **Figure A 1** through to **Figure A 4** shows that there is minimal interannual variation in the winds measured across this period. Therefore, the 2022 calendar year is considered the site representative.

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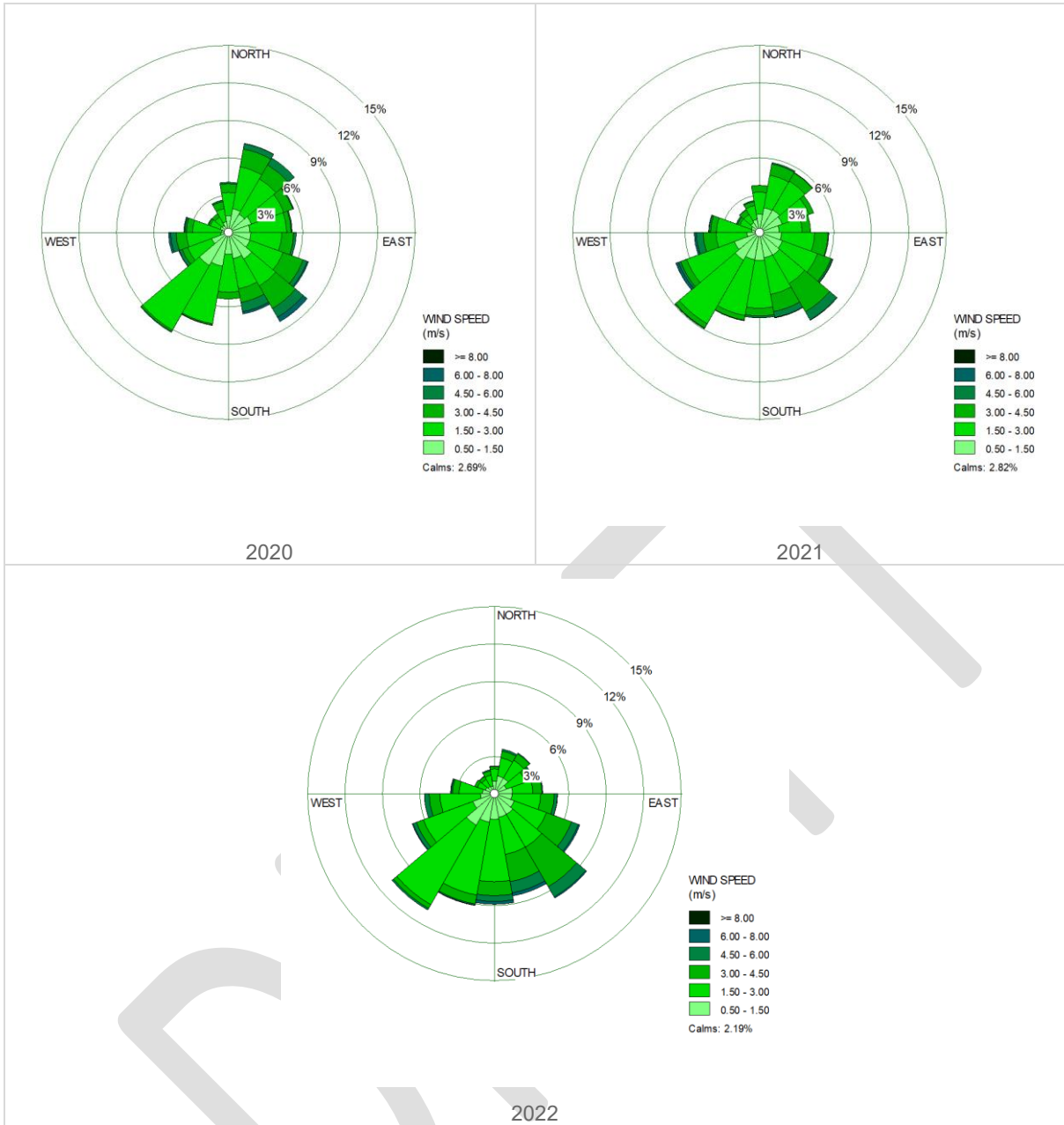


Figure A 1: TAPM Processed Interannual Wind Roses – 2020 to 2022

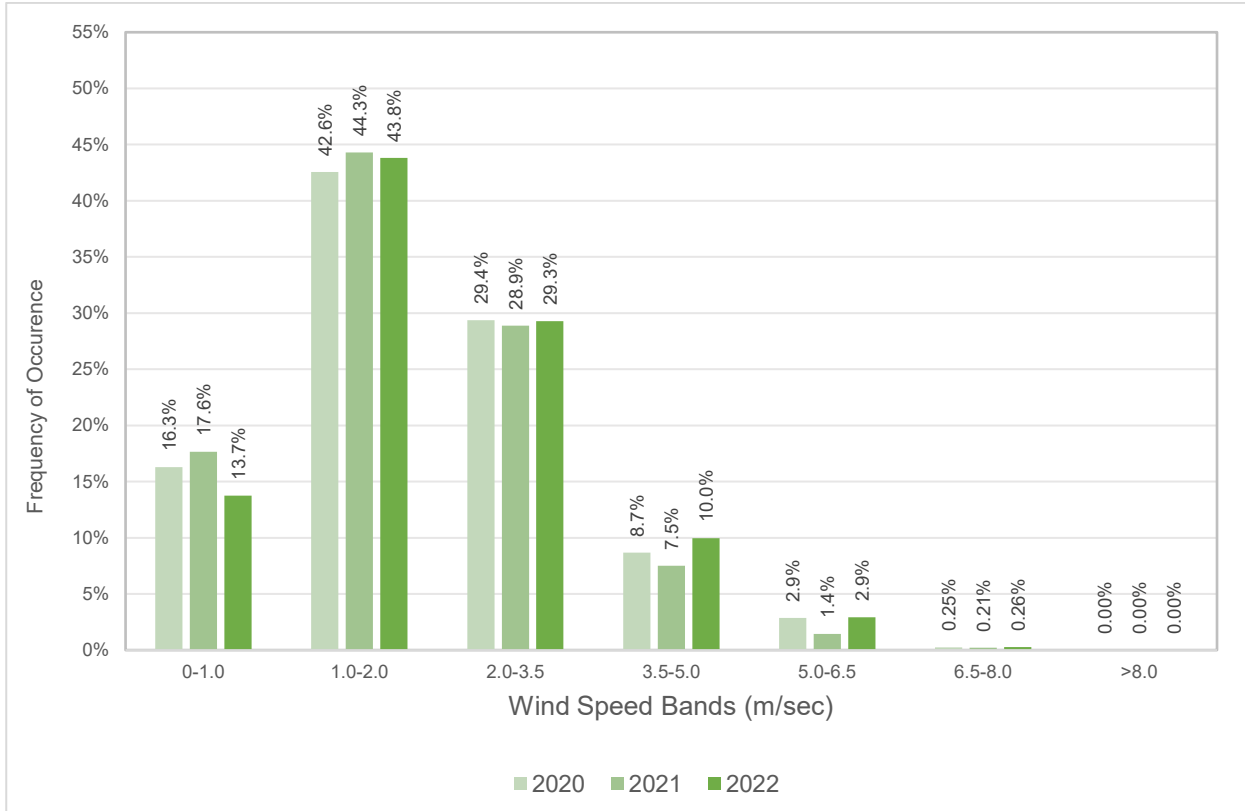


Figure A 2: TAPM Processed Interannual Wind Speed Distribution – 2020 to 2022

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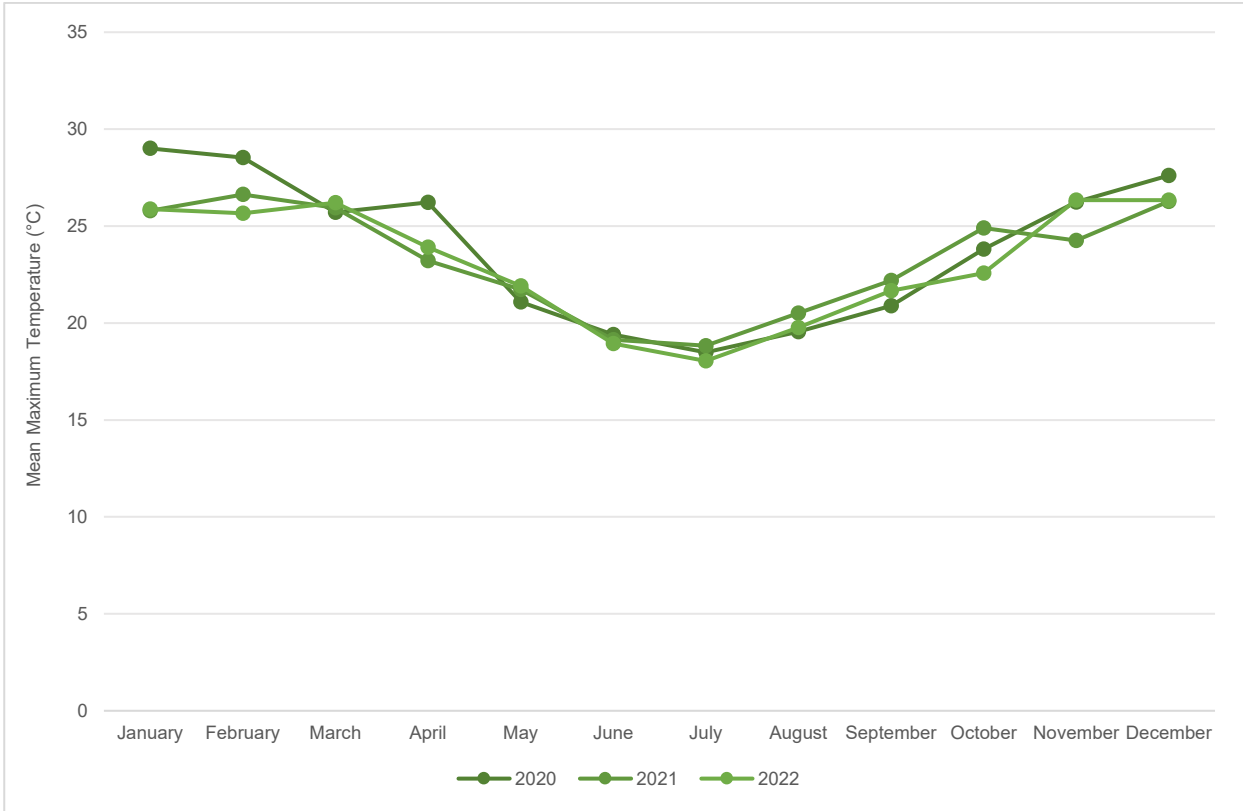


Figure A 3: TAPM Processed Interannual Mean Maximum Temperature Profile – 2020 to 2022

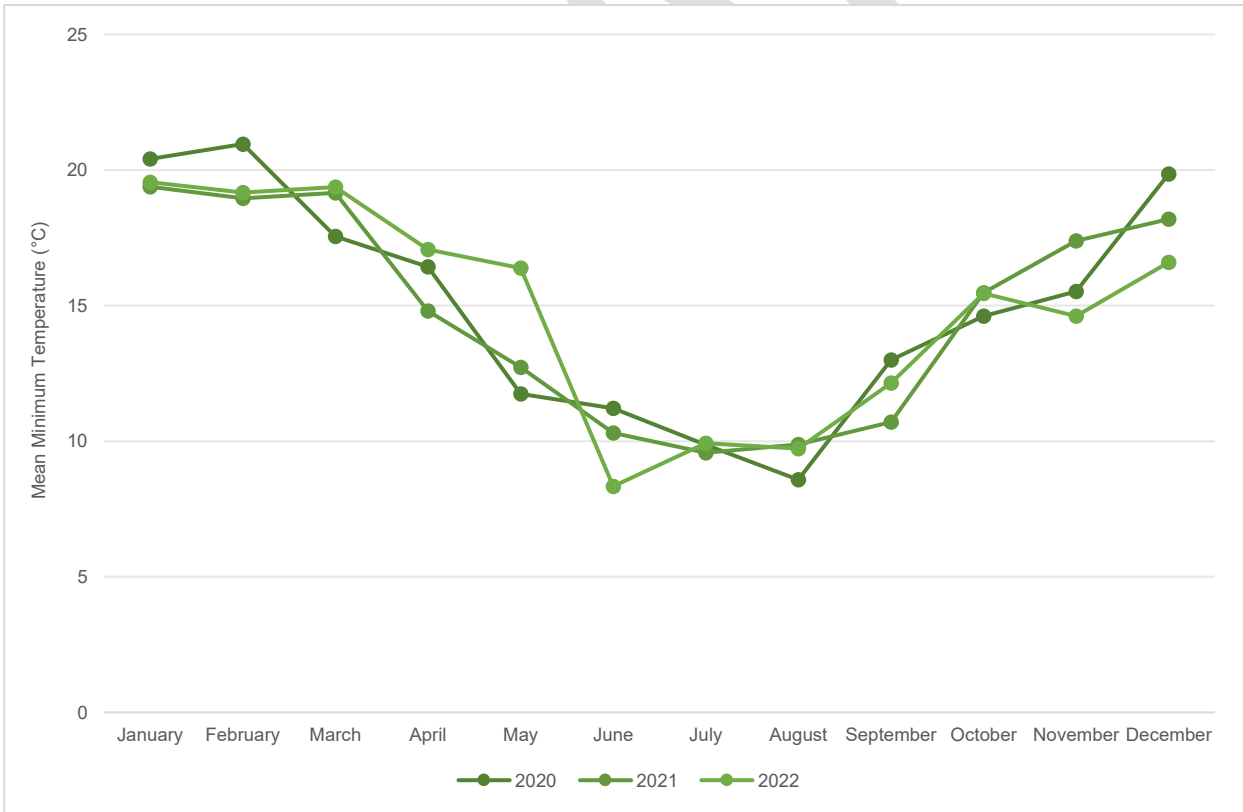


Figure A 4: TAPM Processed Interannual Mean Minimum Temperature Profile – 2020 to 2022