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BOWRAL BRICKS

PROPOSED NEW BRICK FACTORY (SSD 10422)

416 & 524 BERRIMA ROAD, MOSS VALE, NSW 2577

AIR QUALITY IMPACT ASSESSMENT

DOCUMENT CONTROL

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Key Acronyms

AHD	Australian Height Datum
Airlabs	Airlabs Environmental Pty Ltd
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
Austral Bricks Quarry	Quarry owned and operated by The Austral Bricks NSW on the Mandurama land
Austral Masonry Plant	Development consent granted Masonry Plant on Site 1 – Chesley Park
AWS	Automatic Weather Station
Boral Cement Plant	Boral Cement Works at Berrima
BoM	Bureau of Meteorology
CALMET	California Meteorological Model
CALPUFF	California Puff Dispersion Model
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cumulative Impacts	Incremental impacts from the proposed facility + impacts from Austral Masonry Plant + impacts from Austral Bricks Quarry + impacts from Boral Cement Plant + background concentrations from the Bargo monitoring station
DA	Development Application
DOEE	Department of the Environment and Energy
DOP&E	Department of Planning and Environment
EET	Emission Estimation Technique
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act, 1979
HF	Hydrogen Fluoride
g/sec	Emission rate in grams per second
$g/m^2/month$	Units for deposited dust levels, grams per meter square per month
GHG	Greenhouse gas
Incremental Impacts	Impacts from the proposed facility
Level 2	A refined dispersion modelling technique using site-specific input data
LGA	Local Government Area
m^2	square metres
m/sec	metres per second
m^3/hr	cubic metre per hour
MVEC	Moss Vale Enterprise Corridor
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure – Ambient Air Quality
NGAF	National Greenhouse Account Factors
NOx	Oxides of Nitrogen
NO_2	Nitrogen dioxide
NSW – EPA	New South Wales Environment Protection Authority
NSW – OEH	New South Wales Office of Environment and Heritage
Plant 2	Austral Bricks Plant 2, Horsley Park, NSW
PM	Particulate matter
PM_{10}	Particulate matter with an equivalent diameter of 10 microns or less
$PM_{2.5}$	Particulate matter with an equivalent diameter of 2.5 microns or less
POEO	Protection of the Environment Operations Act 1997

SEARs	Secretary Environmental Assessment Requirements
SOx	Sulfur oxides
SO_2	Sulfur dioxide
SO_3	Sulfuric acid mist and sulfur trioxide as SO_3
SRC	Sigma Research Corporation (now Exponent)
SRTM	Shuttle Radar Topography Mission
SSD	State Significant Development
TAPM	The Air Pollution Model
Tpa	tonnes per annum
TSP	Total Suspended Particulates
tCO_2-e	Tonnes of CO_2 equivalent
$\mu g/m^3$	micrograms per cubic metre
US-EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator

EXECUTIVE SUMMARY

Introduction

Bowral Bricks – which are a part of the Brickworks Limited Group are proposing to develop a new brick manufacturing facility at 416 Berrima Road, Moss Vale, NSW 2577 ('the proposed facility').

The proposed facility is categorised as a State Significant Development (SSD - 10422), which is to be accompanied by an Environmental Impact Statement (EIS) suitable for submission to the Department of Planning and Environment (NSW- DOP&E) for seeking approval.

This air quality impact assessment report prepared by Airlabs Environmental forms a part of the EIS, informing the potential air quality impacts expected from the proposed facility operations.

Background

Historically, Bowral Bricks have manufactured bricks from a factory and a quarry located at Kiama Street, Bowral, which has been occupied by Brickworks for over 95 years. The equipment and the kiln and other infrastructure located on this site are old and inefficient and the quarry is nearing exhaustions with only 3 to 4 years of reserves left on site.

As-such, Bowral Bricks are planning to develop the proposed facility on the "Chesley Park" land site which was purchased in 2013 to provide the option of relocating factories to this site. Recently, development consent was granted for masonry manufacturing operations – Austral Masonry Plant, which would be developed on Site 1 of the "Chesley Park" and the proposed facility would be developed on Site 2.

Additionally, land parcel referred to as "Mandurama" was purchased in 2008 to provide a replacement quarry for the brick manufacturing operations. Development consent for the Austral Bricks Quarry was granted which would supply raw materials to the proposed facility for the brick manufacturing operations.

Key Features – Proposed Facility

The proposed facility is planning to incorporate a suite of measures which would considerably improve the performance with regards to air quality, in comparison with the existing facility at Kiama Street.

Some of the key features of the proposed facility include:

- *New Kiln:* The proposed facility would be a new plant, with a new kiln, which would improve fuel consumption and the emissions profile.
- *Improvements to Hydrogen Fluoride (HF) emissions from the kiln stack:* HF is a key pollutant released to the atmosphere from brick manufacturing operations. To ensure that all necessary measures are being implemented to minimise the level of HF emissions released to the atmosphere, Bowral Bricks are implementing best practice measures at the proposed facility site by proposing to limit the discharge concentration of HF from the kiln stack to a maximum of 20 mg/m^3, which is considerably lower than the 50 mg/m^3 as per the POEO Clean Air Regulation 2010 - Standards of Concentration, Schedule 3, ceramic works.
- *Stack Height:* Height of the kiln stack is designed to be 35m above ground level and well above the maximum height of the nearby buildings / structures (max. height of buildings ~ 20m) so as to avoid wake effects and improve pollutant dispersion.
- *Enclosed operations to minimise Fugitive Dust:* Raw materials from the Austral Bricks Quarry would be unloaded inside a building, which substantially minimises the potential for wind erosion emissions from stockpiles. Similarly, the crusher would be located in an enclosure which would limit fugitive dust emissions released to the atmosphere.
- *Sealed Haulage Surfaces:* Access / service roads within the proposed facility site used by haul trucks for delivering raw material and transporting product material would be paved, which

would limit the potential for wheel generated dust when compared to haulage on unsealed roads.

Assessment Methodology

To determine potential air quality impacts from the proposed facility, air dispersion modelling was conducted using the US-EPA non-steady state CALPUFF dispersion model. Meteorological model governing the pollutant dispersion was developed using the combination of TAPM and CALMET models with site-representative observations from the BoM Automatic Weather Station (AWS) at Moss Vale, integrated into the TAPM model.

The overall air quality impact assessment was conducted in accordance with the Level 2 impact assessment requirements specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) published by the NSW-EPA, January 2017.

Emissions from the Proposed Facility

Emissions from the proposed facility have been estimated for the following sources:

- Proposed facility kiln exhaust stack; and
- Fugitive dust emissions generated from various inventoried operational activities.

Pollutant emission rates from the proposed facility exhaust kiln stack were based on the design concentrations (i.e. the maximum concentrations expected from the stack post commissioning) supplied by the manufacturer and the corresponding volumetric flow rates.

Stack parameters critical to pollutant dispersion, such as exit velocity, discharge temperature, stack dimensions (height and diameter) have been provided to Airlabs.

Fugitive dust emission rates have been quantified through the application of emission factors listed in the Emission Estimation Technique (EET) manuals. Dust control measures proposed by Bowral Bricks have been taken into account for developing the fugitive dust emissions inventory.

Air Quality Goals

Air quality goals / limits to assess potential impacts from the proposal were referenced from the Approved Methods.

Based on previous air quality assessments conducted by Airlabs for Brickworks' brick manufacturing operations across various sites in NSW, key pollutants have been identified, which include - TSP, PM_{10}, $PM_{2.5}$, HF, SO_2, NO_2, sulfuric acid (sulfuric acid mist and / or sulfur trioxide) and deposited dust levels.

As per the Approved Methods, modelled maximum (100th percentile) cumulative concentrations have been predicted at the nearest sensitive receptor for all of the assessed pollutants (TSP, PM_{10}, $PM_{2.5}$, HF, SO_2, NO_2 and deposited dust levels), with the exception of sulfuric acid, for which the maximum (99.9th percentile) incremental impacts (i.e. proposed facility) have been predicted at or beyond the facility site boundary.

Characterisation of Existing Air Quality

The proposed facility is surrounded by general industrial and heavy industrial developments, which include the recently approved Austral Masonry Plant, the Austral Bricks Quarry, which is to the immediate north of the proposed facility and Boral's cement manufacturing operations – Boral Cement Plant which operates one (1) kiln and two (2) cement mills situated to the west of the proposed facility. As-such, cumulative assessment of air pollutants from all of these sources forms an integral component of this assessment.

Ambient concentrations measured at the Bargo monitoring station were also considered for the cumulative assessment.

Pollutant emission rates and source parameters for all of the aforementioned existing sources were quantified by referencing publicly available literature.

Model Predictions

Incremental (i.e. contribution from the proposed facility only) and cumulative (incremental + existing sources) concentrations have been predicted at all of the identified sensitive receptors for all the modelled pollutants and compared against their respective assessment criteria. For assessment of sulfuric acid concentrations, the 99.9th percentile incremental concentration predicted at / beyond the site boundary was predicted and compared against the assessment criteria.

Modelling shows that:

- Incremental concentrations of all the modelled pollutants (incl. particulates, gases – SO_2, NO_2 and sulfuric acid) are well below their respective assessment criteria. Comparison with the assessment criteria has been made not to assess compliance but to understand the contribution from the proposed facility with context to the assessment criteria.
- With regards to assessment of HF impacts (the key pollutant associated with brick manufacturing operations) – the measures proposed by Bowral Bricks to minimise HF emissions are clearly reflected in the modelling outputs. The maximum incremental HF concentrations listed below, predicted at the worst impacted receptor is well below the general land-use assessment criteria for all of the averaging periods.
    - 26% of the assessment criteria for the 90-day averaging period.
    - 18% of the assessment criteria for the 30-day averaging period.
    - 22% of the assessment criteria for the 7-day averaging period; and
    - 52% of the assessment criteria for the 24-hour averaging period
- The general land-use criteria have been used to evaluate HF impacts in this assessment, as the land-use surrounding the proposed facility is characterised by general industrial and heavy industrial developments in the surrounding environment and the application of the specialised land-use assessment criteria in this scenario would be considered very conservative.
- From the cumulative assessment, it is observed that with the exception of the 24-hour average cumulative PM_{10} concentrations, all of the remaining pollutants are found to be well in compliance with their relevant assessment criteria at all of the sensitive receptors. With respect to HF, it is noted that the proposed facility itself is the dominant source of HF emissions in the local vicinity.
- A refined assessment of the 24-hour average PM_{10} cumulative concentrations was undertaken, which showed that no additional exceedances are expected from the operations of the proposed facility.

In summation, modelling shows that all the assessed pollutants comply with the relevant assessment criteria at all the identified sensitive receptors at all times. Furthermore, the incremental contribution from the proposed facility's operations is not expected to have an adverse impact on the overall air quality levels.

Greenhouse Gas

Scope 1 and Scope 2 greenhouse gas emissions were quantified for fuel (diesel, natural gas) combustion and on-site electricity consumption using emission factors published for the 2017 year. The facility annual emissions are minimal, where in the contribution to state and national GHG emissions are approximately 0.02% and 0.004% respectively.

Conclusion

Dispersion modelling shows that the impacts from the proposed facility's operations would comply with the relevant ambient air quality limits / impact assessment criteria. Furthermore, modelling shows that impacts from the proposed facility in isolation will be low-level and are not expected to affect sustainability of the local airshed.

1. INTRODUCTION

Airlabs Environmental Pty. Ltd. (Airlabs) was commissioned by Willowtree Planning on behalf of Bowral Bricks to undertake an air quality impact assessment in support of a development application for a new brick factory at 416 Berrima Road, Moss Vale, NSW 2577 (hereafter 'the proposed facility').

The proposed facility would be developed on Title – Lot 1, Deposited Plan (DP) 785111 over a developable land area of 17.86 hectares (ha) within thee Moss Vale Enterprise Corridor.

It is expected that the proposed facility once approved and operational will have a production output of 50 million bricks per annum.

The Environmental Planning and Assessment Act 1979 (EP&A Act) stipulates the framework for all developments in NSW. The proposed facility is categorised as a State Significant Development (SSD) (SSD – 10422) pursuant to *Schedule 2 Part 5 of the State Environmental Planning Policy* (State and Regional Development) 2011, as the proposal has a capital investment value exceeds $10 million.

As per Section 78A (8A) of the EP&A Act, a development application for a State Significant Development is to be accompanied by an Environmental Impact Statement (EIS).

This air quality impact assessment report forms a part of the EIS, which would be submitted to the NSW Department of Planning and Environment (DOP&E) seeking approval for the proposed facility.

The air quality assessment has been prepared in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, Environment Protection Authority (EPA), 2016 (hereafter 'the Approved Methods'). As per Section 9 of the Approved Methods, the NSW – Environment Protection Authority (EPA) has listed out minimum requirements regarding information contained within an impact assessment report which are specified below. The relevant sections of this report which address the minimum requirements are mentioned alongside.

- Site plan – Section **2**
- Description of the activities carried out on the site – Section **2** and Section **8**
- Emissions inventory – Section **8**
- Meteorological data – Section **9**
- Background air quality data – Section **7**
- Dispersion modelling – Section **10**, Section **11**
- Bibliography – Section **14**

As the proposal is an SSD, Secretary Environmental Assessment Requirements (SEARs) have been issued by the NSW Department of Planning & Environment (DOP&E) (SSD 10422, 11 February 2020) for the EIS and the air quality and greenhouse gas assessment. The SEARs issued with respect to air quality and greenhouse gas and the sections of this report addressing those relevant SEARs are summarised in **Table 1**.

Table 1: Secretary Environmental Assessment Requirements issued for Air Quality and Greenhouse Gas

SEARs issued for Air Quality and Greenhouse Gas (SSD: 10422)	Sections of the Assessment Report Addressing the Relevant SEARs
Air Quality	
- a comprehensive air quality assessment of all potential point source and fugitive air emissions (including odour) and dust impacts from the development, including details of air quality impacts on private properties in accordance with relevant Environment Protection Authority guidelines;	All sections

SEARs issued for Air Quality and Greenhouse Gas (SSD: 10422)	Sections of the Assessment Report Addressing the Relevant SEARs
- details of mitigation, management and monitoring measures for preventing and / or minimising both point and fugitive emissions; and	Section **8**
- an assessment of the effectiveness of the proposed air quality mitigation measures.	Section **2**
Greenhouse Gas	
- a quantitative assessment of the potential Scope 1 and 2 greenhouse gas emissions of the development, and a qualitative assessment of the potential impacts of these emissions on the environment; and	Section **12**
- a detailed description of the measures that would be implemented on site to ensure that the development is energy efficient.	

In addition to the SEARs issued for air quality as outlined in **Table 1**, the NSW-EPA also provided specific requirements for the assessment of air quality impacts from the proposed facility (Ref: Attachment A – Environmental Assessment Requirements - DOC20/32079-3, issued 21 January 2020), which are summarised below.

- Environmental outcomes of the project should be to ensure:
    - Emissions do not cause adverse impact upon human health or the environment.
    - Compliance with the requirements of the POEO Act and its associated regulations.
    - No offensive odours are caused or permitted from the premises.
    - Emissions of dust from the premises (including material handling, storage, processing, haul roads, transport and material transfer systems) are prevented or minimised.
    - Maintains or improves air quality to ensure National Environment Protection Measures for ambient air quality are not compromised.
    - All relevant guidelines in regard to ambient air quality are satisfied.
- The EIS must include an Air Quality Impact Assessment (AQIA), which must be prepared in accordance with the Approved Methods and that the AQIA must describe the methodology used along with any assumptions made to predict the impacts. Pollutant emission rates, ambient air quality levels and meteorological data must be stated and justified.
- Emissions from all point sources are required to comply with the relevant Protection of the Environment Operations (POEO) Clean Air Regulations 2010 standards of concentration.
- Using best practice and technology for control and mitigation of emissions, emission concentrations are expected to be well below these standards for certain pollutants. The assessment should also include performance efficiency of the proposed scrubber and kiln and that the scrubber technology and performance should reflect international best practice and technology.
- The AQIA must identify and describe in detail all possible sources (construction and operational phases) of air pollution and activities / processes with the potential to cause air pollutants beyond the boundary of any premises proposed to be licensed by an EPL.
- The AQIA should include a cumulative assessment considering the background air quality of the region and other significant nearby emission sources. The cumulative assessment should also

include any developments having been granted development consent, but which have not yet commenced.

- The AQIA must also include management, mitigation and control measures which are benchmark against best practice.
- Measure for mitigating particulate matter emissions from the on-site activities should be outlined including crushing, storage, raw material handling and transport.
- The AQIA should confirm if the crusher will be enclosed as outlined in the draft concept plans.
- Any backup power supply systems should be documented including information on whether they will be diesel or gas fired engines. Such activities must be undertaken in accordance with the EPA's *Interim Nitrogen Oxide Policy for Cogeneration in Sydney and the Illawarra*.

This report addresses the aforementioned requirements listed by the EPA.

2. PROPOSED FACILITY SPECIFICS

2.1 Facility Location

The proposed facility will be located at 416 Berrima Road, Moss Vale, NSW 2577, within the Wingecarribee Shire Council ('the Council').

The proposed facility would be located on Lot 1 DP 785111 in the Moss Vale Enterprise Corridor (MVEC) and would be developed on a developable land area (Site 2) of 14.8 hectares (ha). An overall site plan of the proposed facility is illustrated in **Figure 1**. The land where the proposed facility would be built – "Chesley Park" was purchased in 2013 to provide the option of relocating factories to this site. The proposed facility would be developed on Site 2 at "Chesley Park".

A Notice of Determination of a Development Application (Application No: 18/0573) was issued by the Council for the development of a masonry manufacturing plant on Site 1 of Chesley Park (hereafter 'Austral Masonry Plant'). It is to be noted that Airlabs undertook the Air Quality Impact Assessment for the Austral Masonry Plant (Airlabs, 2018), determining potential impacts from the operations of the Masonry Plant site on the surrounding environment. Information from the Airlabs, 2018 report have been referenced in this report, where necessary, especially for determination of cumulative pollutant concentrations.

As per the Council, the MVEC is a significant area of land between Moss Vale and New Berrima set aside for employment generating development under the Wingecarribee Local Environmental Plan 2010. The MVEC is currently zoned *IN1 General* with some *IN3 Heavy Industrial* zoned land to the south of the proposed facility, which is the Boral Cement Works at Berrima (hereafter 'Boral Cement Plant').

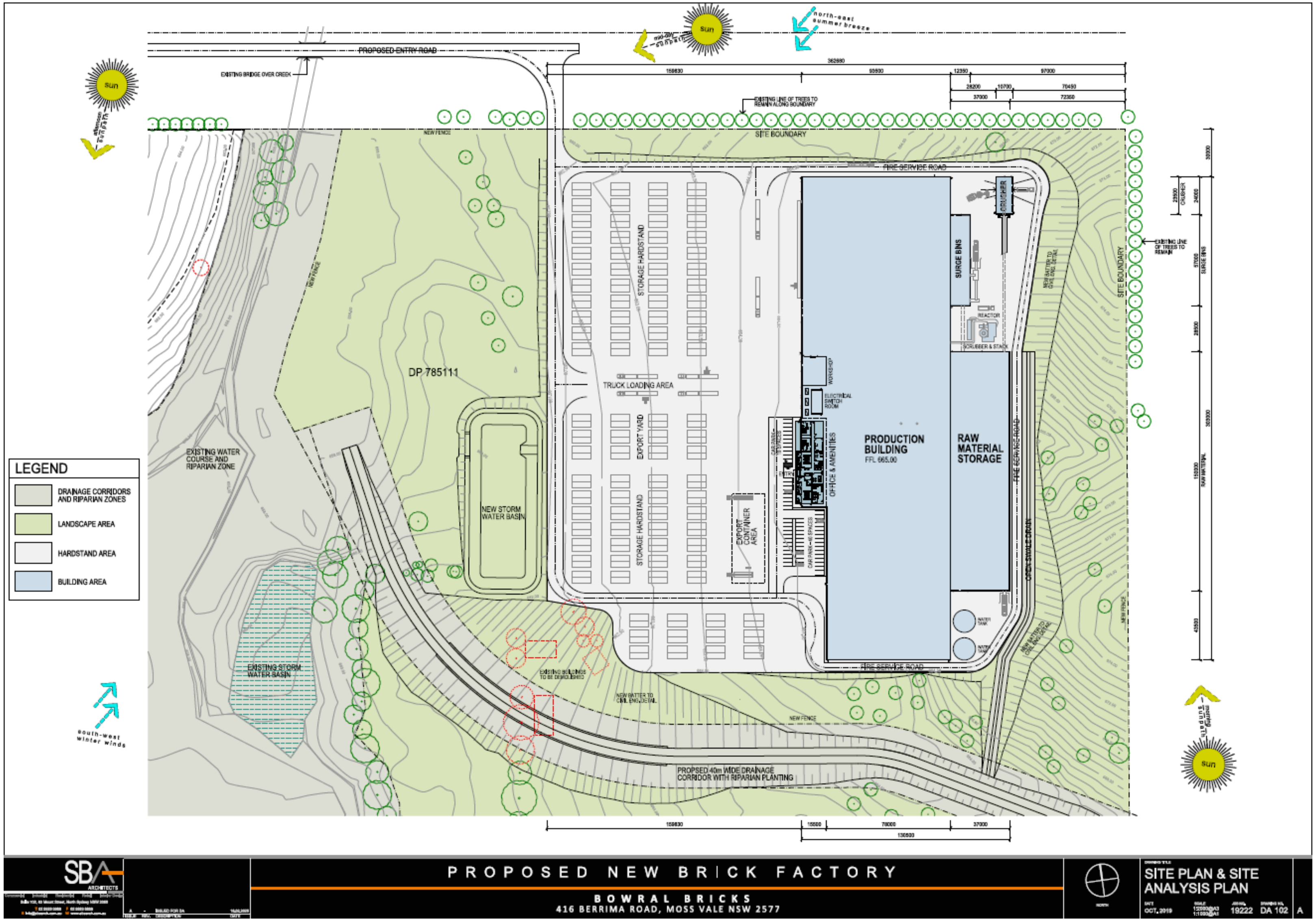
As per information provided to Airlabs, Austral Bricks NSW / Brickworks owns the land to the north of the proposed facility, known as "Mandurama", which is zoned rural and approved as a quarry (hereafter 'the Austral Bricks Quarry').

It is noted that Bowral Bricks, Austral Masonry and Austral Bricks are all part of the Brickworks Limited Group. As-such, these business names would be interchangeably used over the rest of the assessment report.

The geographical setting of the Boral Cement Plant, the Austral Masonry Plant and the Austral Bricks Quarry with context to the proposed facility is illustrated in **Figure 2**.

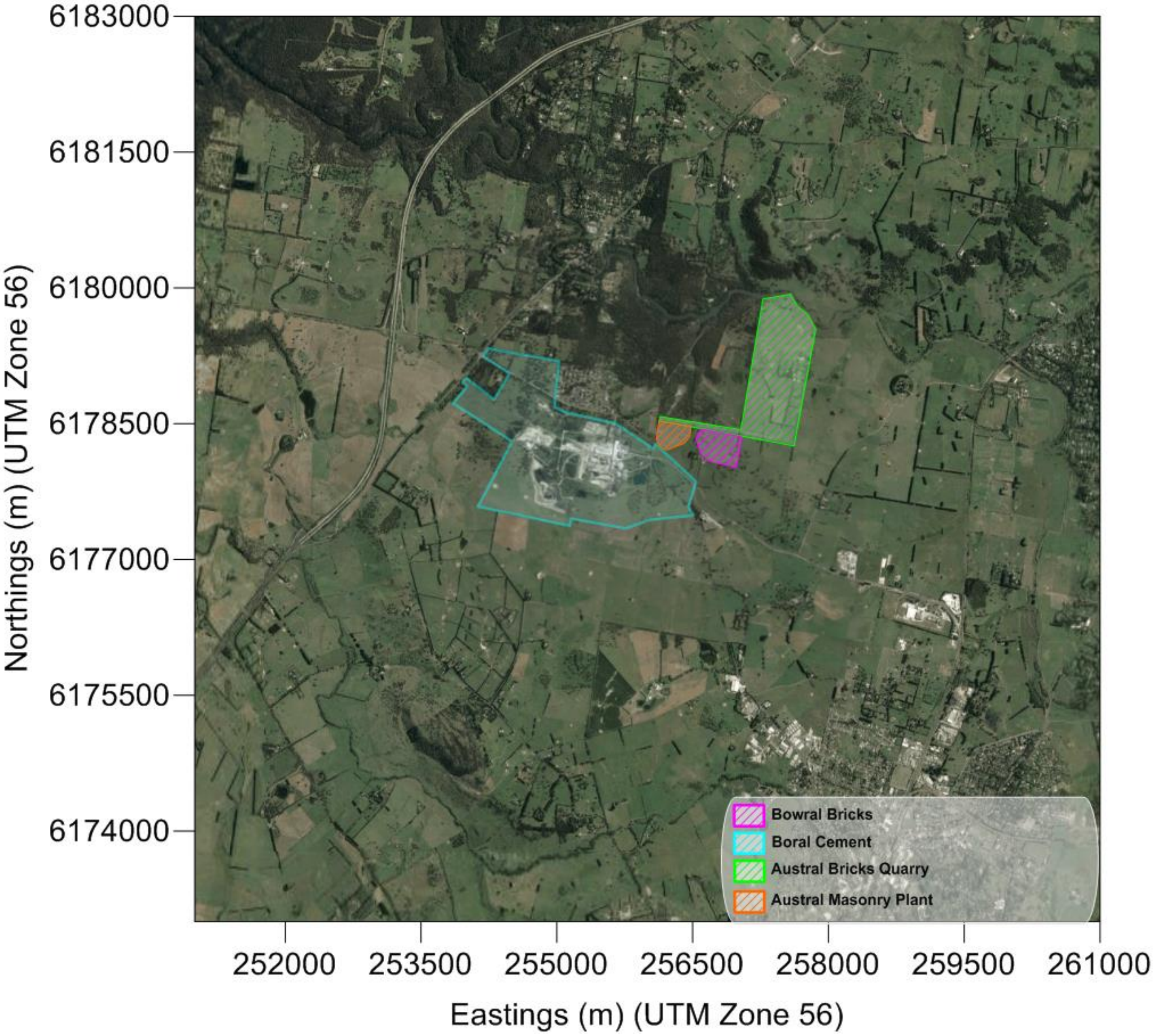
As seen from **Figure 1**, the production building, the raw material storage along with other key infrastructure such as the crusher and the brick kiln stack will be located towards the eastern façade of the proposed facility, whereas the hardstand areas and the truck-loading areas are towards the western end of the facility.

Figure 1: Site Plan – Bowral Bricks



Source: Willowtree Planning

Figure 2: Geographical Setting of Boral Cement, Austral Masonry and Austral Bricks Quarry in context to the Proposed Bowral Bricks Facility



2.2 Details of the Proposed Brick Manufacturing Operations

Historically, Bowral Bricks have manufactured bricks from a factory and a quarry located at Kiama Street, Bowral, which has been occupied by Brickworks for over 95 years and is approximately 6.5km north-east of the proposed facility. It is noted that that this factory is currently operational at the time of undertaking this assessment. The equipment and the kiln and other infrastructure located on this site are old and inefficient and the quarry is nearing exhaustions with only 3 to 4 years of reserves left on site.

The "Chesley Park" was purchased in 2013 to provide the option of relocating the brick manufacturing facility to this site (Site 2) and the "Mandurama" land was purchased in 2008 to provide a replacement quarry for Bowral Bricks. As noted in Section 2.1, the Austral Masonry Plant would be developed on Site 1 of the "Chesley Park" site adjacent to the proposed facility.

Specific details of the proposed brick manufacturing operations as provided to Airlabs are outlined below:

- The proposed facility site will be used for a brick manufacturing plant with a proposed production rate of 50 million Standard Brick Equivalents (SBEs) per annum, which equates to 190,000 tonnes per annum (tpa).
- The plant will operate as a dry press brick plant with a reduction kiln.
- The plant will produce premium dry pressed brick products including 'Bowral Blues'. This brick can only be made at Bowral as it relies on the oxidised (high oxygen) and reduced (high gas) firing techniques provided by a reduction kiln.
- A raw material shed (5,550 m^2) as shown in the site plan (refer **Figure 1**) would be built, which would store raw materials to be delivered by truck to the site from the "Mandurama" quarry on the adjacent site via the existing quarry road.
- Haul trucks entering the site with the raw material would unload the materials into the drive-over bin, before being conveyed to a crusher, which is in an enclosed building. Upon crushing, the crushed material is conveyed through to the raw materials bunkers in the storage shed, where they are temporarily stockpiled.
- The temporarily stockpiled raw materials are picked up by a front ed loader (FEL) before unloading them into the surge bins, which are then conveyed to the kiln.
- The bricks are processed in the production building (26,145 m^2), before being stored for customer dispatch in the designated hardstand area (60,595 m^2)
- It is estimated that up to 85 trucks would be accessing the proposed facility on a daily basis, of which 30% are expected to be B-doubles. Of the trucks accessing the facility, approximately:
  - 50 – 60 comprise material delivery trucks.
  - 10-15 trucks coming to pick up (ex-yard).
  - 5-10 courier / delivery trucks.
- Once approved and operational, the proposed facility would operate 24 hours, 7 days a week.

2.3 Key Features Corresponding to Air Quality Improvement

In comparison to the existing brick manufacturing plant at Kiama Street, Bowral, the proposed facility would incorporate the following features, which would improve the overall air quality performance.

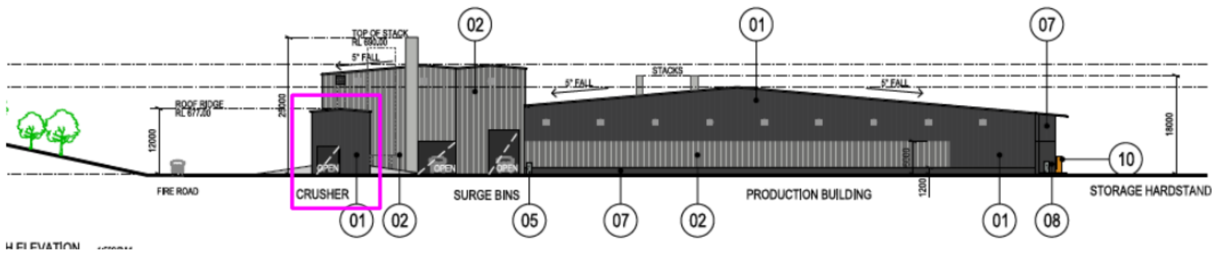
- **New Kiln**: The proposed facility would be a new plant, with a new kiln, which would improve fuel consumption and the emissions profile.
- **Improvements to Hydrogen Fluoride (HF) emissions from the kiln stack**: Bowral Bricks propose to considerably lower / improve hydrogen fluoride (HF) emissions released from the operations, which are outlined below.
  - It is acknowledged that HF is considered to be one of the key pollutants released from brick manufacturing processes. EPA, in their assessment requirements outlined in **Section 1**, state that emissions from all point sources must comply with the POEO Clean Air Regulations 2010 standards of concentration. It is further stated that with the use of best practice and technology for control and mitigation of emissions, concentrations are expected to well below the standards.
  - According to the POEO Clean Air Regulations 2010 Group 6 standards of concentration (applicable to facilities whose operations and the corresponding licence conditions have

been issued after 01 September 2005) for ceramic works (as brick manufacturing operations are licensed under ceramic works and others), the concentration limit for HF is 50 mg/m^3.

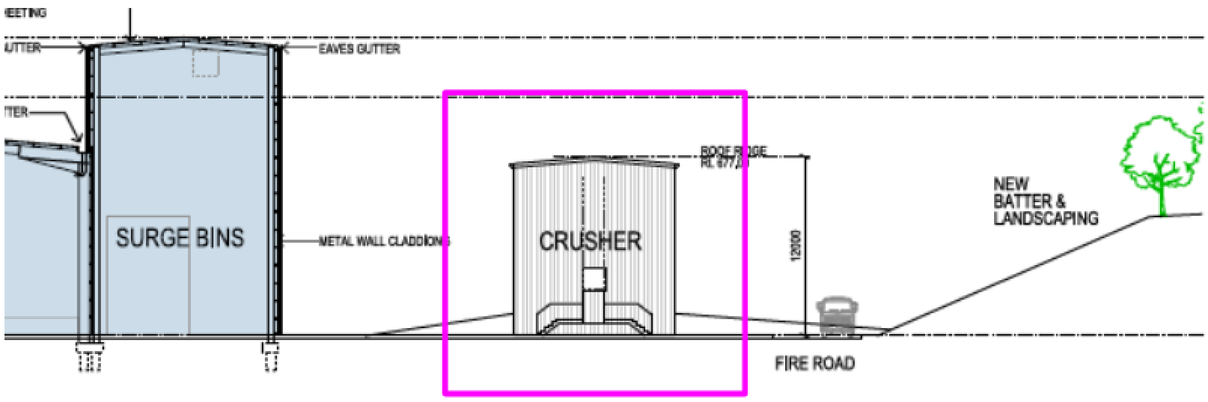
  - To ensure that the HF concentrations from the proposed kiln are well below the POEO limit and to reflect best practice measures adopted by Bowral Bricks, it is proposed that the maximum HF discharge concentration will be no greater than 20 mg/m^3, which is considerably lower (60% lower) than the limit of 50 mg/m^3. This lower concentration of 20 mg/m^3, is expected to be achieved through HF end-of-pipe emission mitigation measures.
  - Furthermore, through consultation with Bowral Bricks, it is noted that most of Austral Bricks' plants that have end-of-pipe HF abatement technologies, have a maximum discharge concentration of 20 mg/m^3, which include facilities at Golden Grove in South Australia and facilities in Bellevue, Cardup and Malaga, all of which are located in WA. As the proposed facility would also have similar discharge concentrations, it is considered to be in-line with best practice measures implemented by Austral Bricks.

- **Stack Height**: It is understood that the kiln stack for the proposed facility would be 35m above ground level. A higher stack would generally facilitate better dispersion of pollutants and minimise building wake effects that can potentially disrupt / impact the plume dispersion.
- **Enclosed Operations to minimise Fugitive Dust**: Based on advice from Bowral Bricks, it is noted that raw materials delivered to the site from the adjacent Austral Bricks Quarry would be conveyed and unloaded inside the raw material storage building, thereby considerably minimising wind erosion emissions from the stockpiles. Similarly, as shown in **Figure 3** below, the crusher infrastructure would be enclosed in a building, which significantly minimises the potential for airborne dust emissions resulting from the crushing and associated operations.
- **Sealed Haulage Surfaces**: Access / service roads within the proposed facility site used by haul trucks for delivering raw material and transporting product material would be paved and the potential for wheel generated dust would be limited as opposed to unpaved / unsealed road surfaces.

Figure 3: Site Drawings Illustrating Enclosed Crushing Operations



Source: - Overall Elevations, DA 201-A



Source: - Overall Sections, DA 202-A

3. ASSESSMENT OBJECTIVE

This air quality impact assessment principally aims to achieve the following objectives:

- Quantifying air quality impacts from the proposed facility's operational activities.
- Comprehensively address the SEARs issued for the proposed facility, along with the requirements outlined by the EPA.
- Determination of cumulative air quality impacts on the receiving environment (i.e. impacts from the proposed facility and impacts from nearby existing / approved sources)

The assessment has been informed by the following regulatory guideline documents:

- Secretary Environmental Assessment Requirements (SEARs) issued by the NSW Department of Planning & Environment (DOP&E) (SEAR No: 10422)
- NSW-EPA requirements outlined in Attachment A – Environmental Assessment Requirements - DOC20/32079-3, issued 21 January 2020.
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Environment Protection Authority, January 2017 (NSW-EPA, 2017).
- Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia' (NSW-OEH, 2011).
- National Greenhouse Accounts Factors – Australian National Greenhouse Accounts – 2019, Department of the Environment and Energy, August 2019 (NGAF, 2019).

4. ASSESSMENT STRUCTURE

A Level 2 impact assessment has been conducted to quantify operational impacts from the proposed facility. As per the Approved Methods, a Level 2 assessment is a refined dispersion modelling technique using site-specific input data.

- Quantifying air quality impacts from the proposed facility's operational activities.
- Comprehensively address the SEARs issued for the proposed facility, along with the requirements outlined by the EPA.
- Determination of cumulative air quality impacts on the receiving environment (i.e. impacts from the proposed facility and impacts from nearby existing / approved sources)

An overview of the air quality assessment undertaken is presented below:

- A detailed review of the brick manufacturing operations at the proposed facility have been determined through consultation with Bowral Bricks.
- Key pollutants of concern were identified based on previous assessments conducted by Airlabs for Brickworks.
- Determination of relevant ambient air quality assessment criteria referenced from the Approved Methods for the identified pollutants of concern.
- Development of site-specific meteorology. Meteorological data was prepared in accordance with the Level 2 assessment requirements as outlined in the Approved Methods.
- Characterisation of the geographical setting of the facility and the surrounding land uses and identification of sensitive receptors. Sensitive receptors representative of residential dwellings and non-residential/industrial developments have been identified.
- Estimating pollutant emission rates from the new kiln and associated operations.
- Modelling the estimated pollutant emission rates from the proposal and predicting incremental impacts (i.e. impacts from the proposed facility only) at the identified sensitive receptors / outside the facility site boundary depending on the requirements prescribed in the Approved Methods.
- For cumulative impact determination (i.e. impacts from the facility and considering existing sources), the assessment has quantified impacts from the following sources:
    - Ambient air quality levels from the nearest / representative ambient air quality monitoring stations.
    - Impacts from the Austral Bricks Quarry (Status: Approved and currently preparing the site for full time production of material).
    - Impacts from the Austral Masonry Plant (Status: Approved); and
    - Impacts from the Boral Cement Plant (Status: Currently operating)
- Model predicted incremental (proposed facility) and cumulative (sum total of impacts from the proposed facility + background levels from ambient air quality monitoring station + impacts from Boral Cement Plant + impacts from Austral Bricks Quarry + impacts from Austral Masonry Plant) pollutant concentrations were compared against the relevant assessment criteria to determine compliance.
- For estimating cumulative particulate (PM_{10} and $PM_{2.5}$) and NO_2 ground level concentrations, a Level 2 contemporaneous assessment was undertaken in accordance with the Approved Methods. Daily measured background levels recorded at the ambient air quality monitoring station were paired with the corresponding model predicted impacts for the proposed facility

along with impacts predicted from the Boral Cement Plant, the Austral Bricks Quarry site and the Austral Masonry Plant on Site 1.

- A detailed discussion on quantification of pollutant emission rates from the existing operations / facilities is presented in **Section 7** of this report.
- Presentation of modelled pollutant concentrations in the form of tables and concentration isopleths.
- Preparation of assessment report.

5. STUDY AREA AND SURROUNDS

5.1 Existing Land Use and Topography

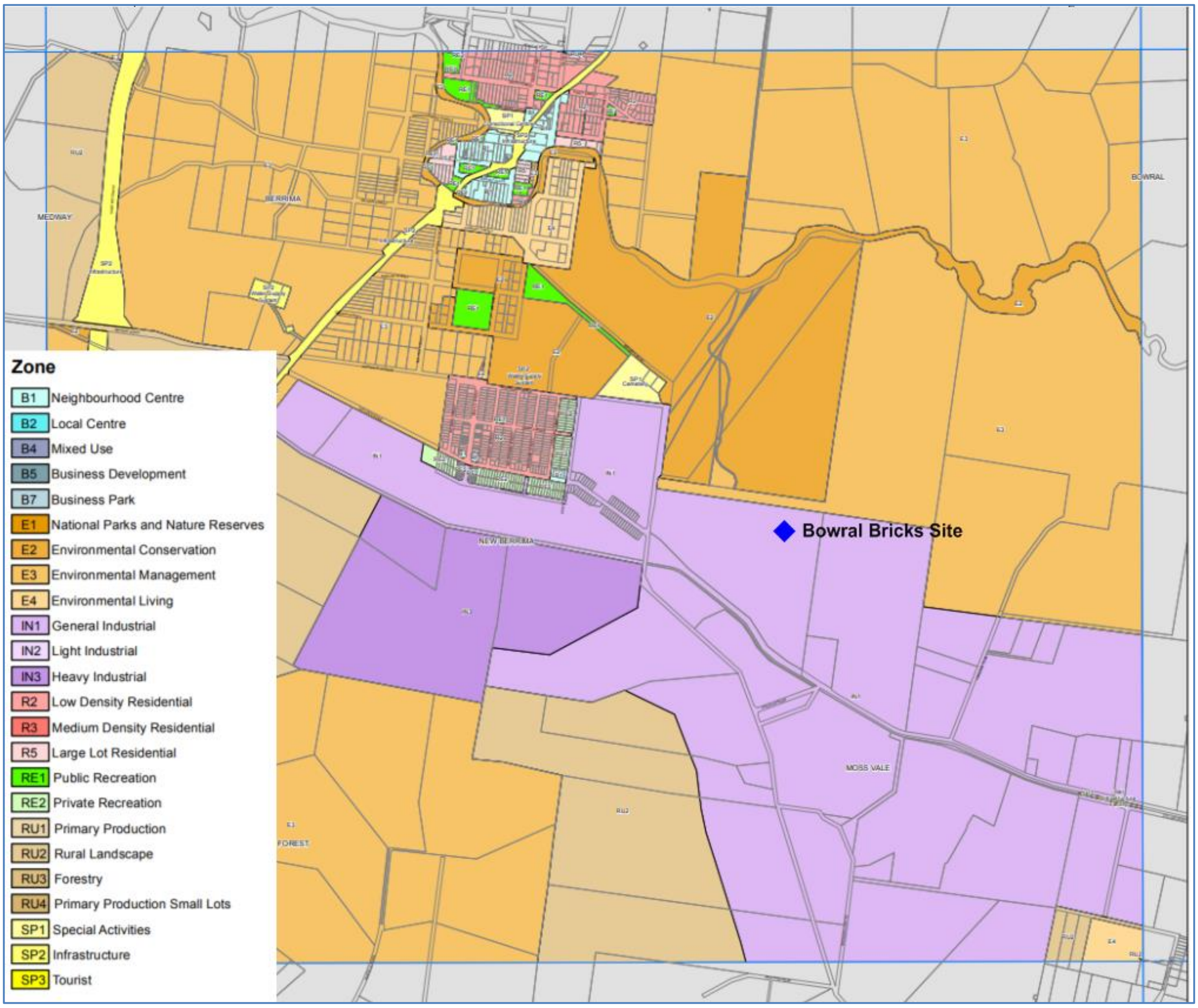
The proposed facility is located in the Moss Vale Enterprise Corridor (MVEC) and would be developed over a total area of 17.86 ha and is situated in the General Industrial (IN1) zone as per the Wingecarribee Local Environmental Plan 2010 (Land Zoning Map-Sheet LZN_007C) as shown in **Figure 4**.

There are scattered residential developments in the nearby vicinity of the proposed facility site boundary. The nearest residential zone from the proposed facility is the town of New Berrima, which is classified as Low Density Residential (R2) as shown in **Figure 4**.

A 3-dimensional representation of the topographical features surrounding the proposed facility over a 5km x 5km domain is illustrated in **Figure 5**.

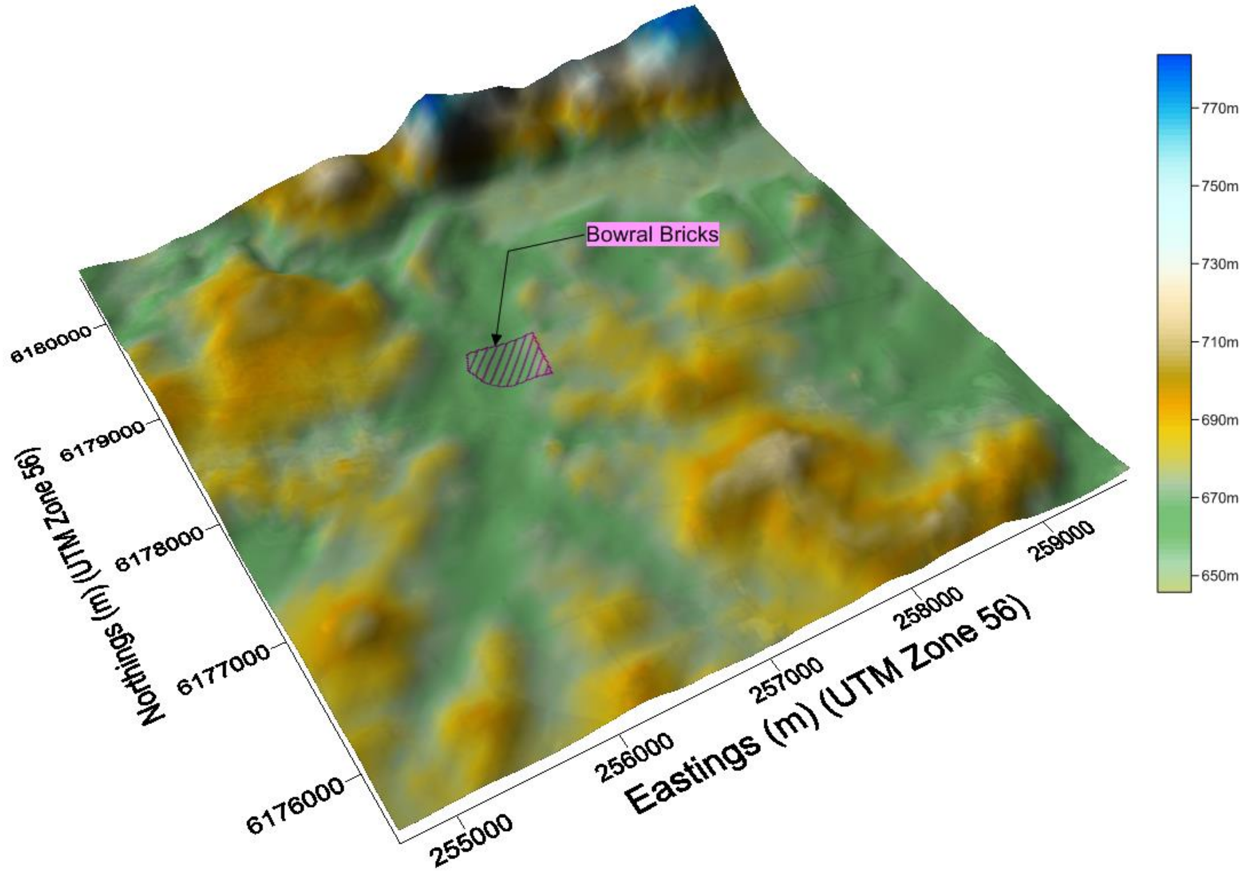
The terrain levels in the immediate surrounds of the proposed facility site is largely undulating with terrain gradually increasing towards the north. To the north of the Austral Bricks Quarry is the Wingecarribee River beyond which there are pronounced ridgelines, with levels peaking above 750m.

Figure 4: Land Use Zones Surrounding the Proposed Facility



Source: Wingecarribee Local Environmental Plan 2010 (Land Zoning Map-Sheet LZN_007C)

Figure 5: Topographical Features Surrounding the Bowral Bricks Facility



5.2 Sensitive Receptors

To predict air quality impacts from the proposed facility, a set of sensitive receptors representative of residential and non-residential / industrial development in the study area have been identified. Modelled incremental (proposed facility only) and cumulative (proposed facility + ambient background + contributions from Boral Cement Plant & Austral Bricks Quarry & Austral Masonry Plant) impacts have been predicted at each of the identified sensitive receptors.

It is to be noted that the identified sensitive receptors are not an exhaustive inventory of all residential / non-residential developments in the study area but have been selected to be representative of that particular land use.

Sensitive receptors selected for this assessment are summarised in **Table 2** and visually illustrated in **Figure 6**.

From the receptors summarised in **Table 2** and **Figure 6**, it is noted that receptor No. 53 and receptor No. 88 corresponds to the Austral Bricks Quarry site and the Boral Cement Plant site respectively. At each of these receptors, only the incremental (i.e. impacts from the proposed facility alone) impacts have been predicted and not the cumulative – as the Quarry site and the Boral Cement Plant are considered a source for the cumulative assessment.

Upon closer inspection of the aerial imagery, it is seen that receptor No. 57 represents three (3) existing buildings in close proximity of the proposed facility site, towards the south-west. As per the site plan provided to Airlabs (refer **Figure 1**), these three (3) buildings would be demolished prior to commencing operations at the proposed facility, and therefore, receptor 57 has been excluded from the air quality assessment – for both determination of incremental as well as cumulative impacts, and no further discussion of this receptor is made in the subsequent sections of this assessment report.

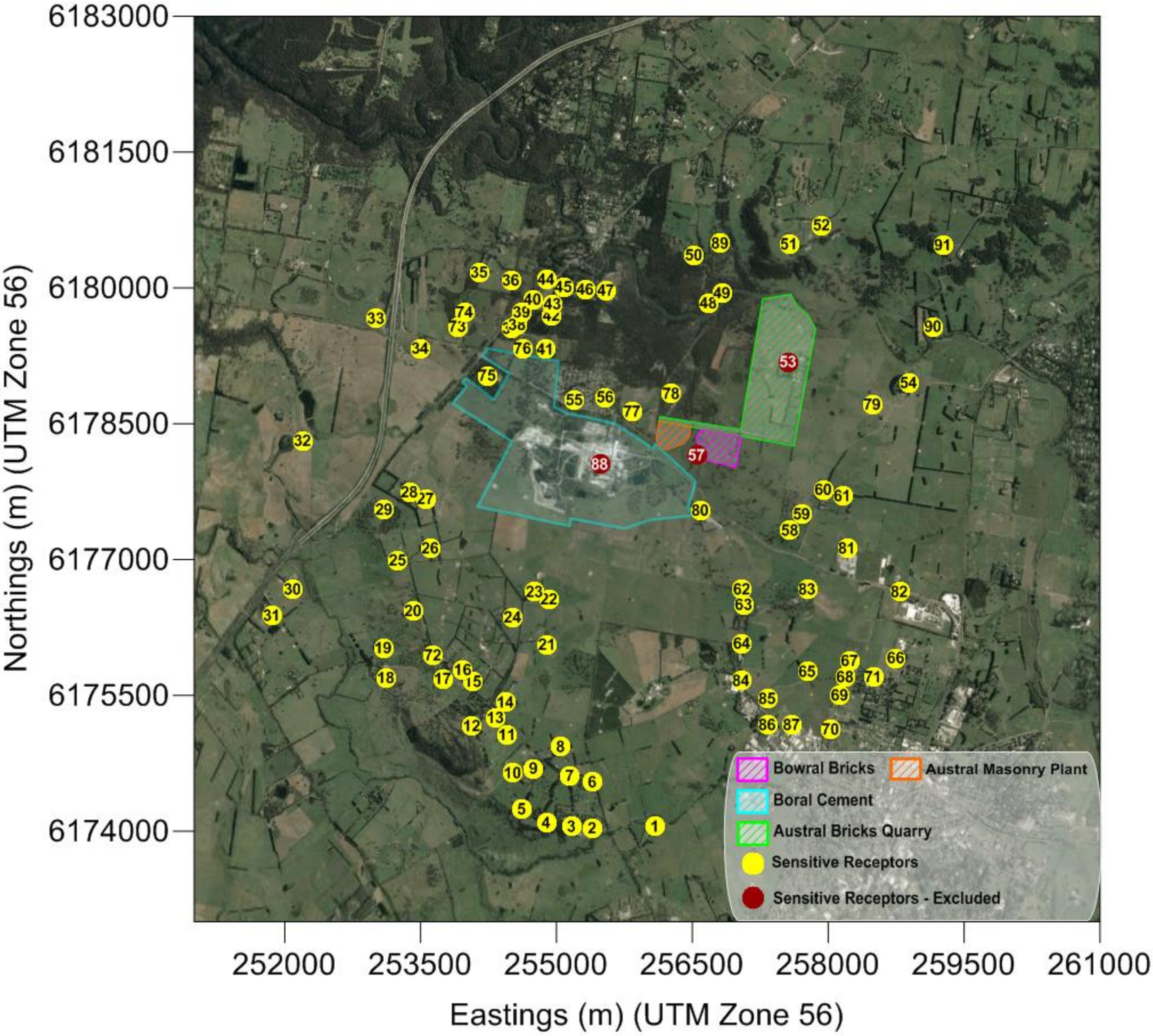
Table 2: Details of Identified Sensitive Receptors

Receptor I.D.	Receptor Type	Eastings (m) (UTM Zone 56)	Northings (m) (UTM Zone 56)
1	Residential Dwelling	256090	6174050
2	Residential Dwelling	255400	6174030
3	Residential Dwelling	255170	6174050
4	Residential Dwelling	254890	6174090
5	Residential Dwelling	254620	6174240
6	Residential Dwelling	255400	6174540
7	Residential Dwelling	255150	6174610
8	Residential Dwelling	255050	6174930
9	Residential Dwelling	254750	6174690
10	Residential Dwelling	254520	6174640
11	Residential Dwelling	254460	6175060
12	Residential Dwelling	254070	6175160
13	Residential Dwelling	254330	6175250
14	Residential Dwelling	254440	6175420
15	Residential Dwelling	254080	6175650
16	Residential Dwelling	253970	6175780
17	Residential Dwelling	253750	6175680
18	Residential Dwelling	253120	6175690
19	Residential Dwelling	253090	6176020
20	Residential Dwelling	253420	6176430
21	Residential Dwelling	254900	6176060
22	Residential Dwelling	254920	6176560
23	Residential Dwelling	254760	6176640
24	Residential Dwelling	254520	6176360
25	Residential Dwelling	253250	6176990
26	Residential Dwelling	253610	6177120
27	Residential Dwelling	253560	6177670
28	Residential Dwelling	253380	6177740
29	Residential Dwelling	253100	6177550
30	Residential Dwelling	252090	6176670
31	Residential Dwelling	251860	6176380
32	Residential Dwelling	252200	6178310
33	Residential Dwelling	253010	6179660
34	Residential Dwelling	253500	6179330
35	Residential Dwelling	254150	6180170
36	Residential Dwelling	254500	6180080
37	Residential Dwelling	254500	6179550
38	Residential Dwelling	254570	6179590
39	Residential Dwelling	254620	6179730
40	Residential Dwelling	254740	6179870

Receptor I.D.	Receptor Type	Eastings (m) (UTM Zone 56)	Northings (m) (UTM Zone 56)
41	Residential Dwelling	254880	6179320
42	Residential Dwelling	254950	6179690
43	Residential Dwelling	254960	6179820
44	Residential Dwelling	254890	6180090
45	Residential Dwelling	255080	6180010
46	Residential Dwelling	255320	6179980
47	Residential Dwelling	255550	6179970
48	Residential Dwelling	256680	6179830
49	Residential Dwelling	256830	6179940
50	Residential Dwelling	256520	6180360
51	Residential Dwelling	257570	6180480
52	Residential Dwelling	257930	6180690
53	Non-Residential / Industrial Development (Austral Bricks Quarry)	257560	6179180
54	Residential Dwelling	258890	6178950
55	Residential Dwelling	255200	6178760
56	Residential Dwelling	255540	6178790
57	Existing buildings to be demolished – refer site plan **Figure 1**	256550	6178150
58	Residential Dwelling	257710	6177500
59	Residential Dwelling	257950	6177770
60	Residential Dwelling	258160	6177700
61	Residential Dwelling	257050	6176670
62	Residential Dwelling	257070	6176500
63	Residential Dwelling	257050	6176070
64	Residential Dwelling	257770	6175760
65	Residential Dwelling	258750	6175910
66	Residential Dwelling	258240	6175880
67	Residential Dwelling	258190	6175700
68	Residential Dwelling	258130	6175500
69	Residential Dwelling	258030	6175120
70	Residential Dwelling	258500	6175700
71	Residential Dwelling	253640	6175940
72	Non-Residential / Industrial Development	253910	6179570
73	Non-Residential / Industrial Development	253990	6179730
74	Non-Residential / Industrial Development	254240	6179030
75	Non-Residential / Industrial Development	254630	6179330
76	Non-Residential / Industrial Development	255840	6178630
77	Non-Residential / Industrial Development	256270	6178830
78	Non-Residential / Industrial Development	258490	6178710
79	Non-Residential / Industrial Development	256590	6177540
80	Non-Residential / Industrial Development	258210	6177120
81	Non-Residential / Industrial Development	258790	6176640

Receptor I.D.	Receptor Type	Eastings (m) (UTM Zone 56)	Northings (m) (UTM Zone 56)
82	Non-Residential / Industrial Development	257770	6176670
83	Non-Residential / Industrial Development	257040	6175660
84	Non-Residential / Industrial Development	257330	6175460
85	Non-Residential / Industrial Development	257330	6175170
86	Non-Residential / Industrial Development	257600	6175170
87	Non-Residential / Industrial Development	258890	6178950
88	Non-Residential / Industrial Development (Boral Cement Plant)	255480	6178050
89	Residential Dwelling	256810	6180490
90	Residential Dwelling	259160	6179570
91	Residential Dwelling	259270	6180470

Figure 6: Location of the Identified Sensitive Receptors



6. REGULATORY GUIDELINES

6.1 Key Pollutants of Concern

Based on previous air quality assessments conducted by Airlabs for Brickworks' brick manufacturing operations across various sites in NSW, key pollutants have been identified, which include:

- Hydrogen fluoride (HF)
- Total solid particles (TSP)
- Nitrogen oxides (NOx)
- Sulfuric acid mist and sulfur trioxide (as SO_3); and
- Sulfur dioxide (SO_2)

It is to be noted that the aforementioned pollutants were the key pollutants under consideration for the assessment of air quality impacts from Brickworks' Horsley Park Plant 2 Upgrade SSD (SSD 9601) (Airlabs, 2019).

Therefore, with respect to air quality, the performance of the proposed facility would be determined based on assessing the impacts from these pollutants.

Based on Airlabs' understanding of the brick manufacturing operations at the proposed facility, the main pollutant sources that would release the identified pollutants of concern include:

- Exhaust emissions generated from the proposed kiln discharged to the atmosphere through the exhaust stack.
- Fugitive dust / particulate matter (PM) emissions generated from various operational activities including material handling (loading / unloading / conveying) activities, crushing operations, and wheel generated dust from haulage on paved surfaces. As mentioned in the facility specifics section (**Section 2**), stockpiles would be emplaced in enclosed facility (i.e. the raw material building) and there are no exposed areas, and therefore, no wind erosion emissions from exposed areas and stockpiles have been estimated.

Airborne particulate matter typically consists of dust particles of varying size fractions. From a health and nuisance perspective, particles are categorised primarily by size as total suspended particulates (TSP), PM_{10} and $PM_{2.5}$ and deposited dust levels.

Although, TSP is defined as the total mass of all particles suspended in air, an effective upper limit of 30 microns aerodynamic diameter is assigned. Within the TSP matter, lie two sub-categories; particulate matter with an equivalent diameter of 10 microns or less (PM_{10}) and particulate matter with an equivalent diameter of 2.5 microns or less ($PM_{2.5}$)

Dust deposition rate is the mass of particulate matter that collects over an area for a certain time period (usually monthly). Dust deposition is used as a measure of the potential for dust to affect amenity.

For the air quality assessment, impacts from all the particulate size fractions i.e. TSP, PM_{10} and $PM_{2.5}$ along with deposited dust levels have been assessed.

6.2 National Legislation

In June 1998 (revised in 2003), the National Environment Protection Council (NEPC) developed the Ambient Air Quality National Environmental Protection Measure (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 (NO_2), photochemical oxidants (as ozone – O_3), sulfur dioxide (SO_2), lead and particulate matter with a nominal aerodynamic diameter of less than or equal to 10 microns (PM_{10}). 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 ($PM_{2.5}$)

6.3 Legislation in New South Wales

In NSW, air pollution is regulated by *Part 5.4 – Air Pollution* of the Protection of the Environment Operations Act 1997 (POEO 1997). The impact assessment criteria for the identified pollutants of concern, namely HF, NO_X, SO_3, SO_2 and particulates (incl. TSP, PM_{10}, $PM_{2.5}$ and deposited dust) are outlined in the Approved Methods.

The Approved Methods specifies air quality assessment criteria to determine whether emissions from a particular premise will comply with the appropriate environmental outcomes adopted by the EPA.

As per the Approved Methods, cumulative impact of emissions from nearby sources and existing environment need to be considered along with the emissions from the facility for the following pollutants – sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), particles (PM_{10}, $PM_{2.5}$), total suspended particulates (TSP), deposited dust, carbon monoxide (CO) and hydrogen fluoride (HF).

As per the cumulative impact assessment guidelines provided in the Approved Methods, point and fugitive source emissions from the proposed facility and non-project related sources (which include background levels referenced from the nearest ambient air quality monitoring station + impacts from Boral Cement Plant + impacts from Austral Bricks Quarry + impacts from Austral Masonry Plant) are to be cumulatively assessed to determine compliance. For these pollutants, model predicted cumulative concentrations are to be presented as the 100^{th} percentile value (i.e. maximum) at the nearest sensitive receptor.

The Approved Methods also specifies assessment criteria for metals and individual VOCs which are categorised as individual air toxics. For the principal and individual air toxic pollutants, the model predicted concentrations are to be reported as 99.9^{th} percentile (Level 2 assessment) incremental (i.e. proposed facility only) impacts at or beyond the proposed facility site boundary. The only individual air toxic pollutant included in this assessment, is sulfuric acid, representing sulfuric acid mist and sulfur trioxide (SO_3) emissions.

6.4 Impact Assessment Criteria

The impact assessment criteria referenced from the Approved Methods for the identified pollutants are summarised in **Table 3**.

Table 3: Adopted Air Quality Impact Assessment Criteria for the Identified Pollutants

Pollutant	Assessment Criteria	Averaging Period	Assessment	Reporting Percentiles
TSP	90 µg/m³	Annual	Cumulative	n.a.
PM_{10}	50 µg/m³	24-hours	Cumulative	100th percentile
	25 µg/m³	Annual	Cumulative	n.a.
$PM_{2.5}$	25 µg/m³	24-hours	Cumulative	100th percentile
	8 µg/m³	Annual	Cumulative	n.a.
Hydrogen fluoride (HF) – general land-use assessment criteria	0.5 µg/m³	90-days	Cumulative	100th percentile
	0.84 µg/m³	30-days	Cumulative	100th percentile
	1.7 µg/m³	7-days	Cumulative	100th percentile
	2.9 µg/m³	24-hours	Cumulative	100th percentile
Sulfur dioxide (SO_2)	712 µg/m³	10-minutes	Cumulative	100th percentile
	570 µg/m³	1-hour	Cumulative	100th percentile
	228 µg/m³	24-hours	Cumulative	100th percentile
	60 µg/m³	Annual	Cumulative	n.a.
Nitrogen dioxide (NO_2)	246 µg/m³	1-hour	Cumulative	100th percentile
	62 µg/m³	Annual	Cumulative	n.a.
Sulfuric acid *(representing sulfuric acid mist and sulfur trioxide emissions)*	18 µg/m³	1-hour	Incremental	99.9th percentile, at or beyond the proposed facility site boundary
Deposited dust levels	2 g/m²/month – maximum increase in deposited dust level	Annual	Incremental	n.a.
	4 g/m²/month – maximum total deposited dust level	Annual	Cumulative	n.a.

For determination of HF impacts, the Approved Methods specifies assessment criteria for general land-use and for specialised land-use – i.e. which is applicable to all areas with vegetation sensitive to fluoride. At the time of preparing this assessment, it is unknown whether the land-use surrounding the proposed facility comes under the specialised land-use category. However, as per the Wingecarribee Local Environmental Plan 2010 – Land Zoning Map LZN_007C (refer **Figure 4**), the proposed facility is located in the General Industrial (IN1), with the Boral Cement Plant in the Heavy Industrial (IN3) zone and the Austral Bricks Quarry in the E3 – Environmental Management zone.

As the areas surrounding the proposed facility are characterised by the presence of existing and approved light to heavy industrial uses, it would be unreasonably conservative to apply the specialised land-use assessment criteria in this scenario. Therefore, assessment of HF impacts has been based on comparing the model predicted cumulative HF concentrations at the identified sensitive receptors with the general land-use impact assessment criteria.

7. EXISTING AIR QUALITY

Characterisation of the existing air quality levels / background air quality concentrations is essential in determination of cumulative air pollution concentrations and subsequently determining compliance with ambient air quality assessment criteria (refer **Table 3**).

Moreover, the EPA in their requirements issued for the air quality assessment for the proposed facility (refer **Section 1**) specify that the assessment should include a cumulative assessment considering the background air quality of the region and other significant nearby emission sources, including developments that have been granted development consent, but not yet commenced operations.

7.1 Existing Sources of Air Emissions

The proposed facility would be developed on Site 2 of the "Chesley Park" land, which was purchased by Bowral Bricks in 2013. The Austral Masonry Plant, which has been approved by the Council would be developed on Site 1 of the "Chesley Park" land. Location of the proposed facility in context with the Austral Masonry Plant has been presented in **Figure 2**.

Immediately to the north of the proposed facility site is the "Mandurama" land, which is the location for the Austral Bricks Quarry site. As per information provided to Airlabs, the quarry has been approved and works has commenced on preparing the site for full-time production of material. Raw material for the brick manufacturing operations would be sourced from this quarry.

To the west of the Austral Masonry Plant is the Boral Cement Plant, which is currently operational at the time of preparing the assessment.

In addition to the aforementioned sources, reference has been drawn to the National Environment Protection Measure (NEPM) ambient air quality monitoring station at Bargo, NSW (hereafter 'the Bargo air monitoring station'), which is approximately 31km northeast of the proposed facility. The Bargo air monitoring station is operated and managed by the NSW Office of Environment and Heritage (OEH).

Since the monitoring station at Bargo is not in the immediate vicinity of any significant air emission source, the observed ambient concentrations at the Bargo station are deemed to be suitable as estimates of background air quality levels.

In summary, the following sources have been accounted for to estimate existing air quality levels:

- Ambient air quality levels from the nearest / representative ambient air quality monitoring stations.
- Impacts from the Austral Bricks Quarry (Status: Approved and currently preparing the site for full time production of material).
- Impacts from the Austral Masonry Plant (Status: Approved); and
- Impacts from the Boral Cement Plant (Status: Currently operating).

The following sections provide additional details on the background concentrations recorded at the Bargo monitoring station along with pollutant emission rates and the source parameters estimated from the identified existing sources of air emissions for the cumulative impact assessment.

7.2 Monitoring Data from the OEH Bargo NEPM Station

The Bargo air quality monitoring station (Lat: 34^0 18^1 27^{11} South, Long: 150^0 34^1 48^{11} East) has been operational since January 1996 and measures ambient concentrations of the following pollutants – ozone (O_3), oxides of nitrogen (NO, NO_2 and NOx), sulfur dioxide (SO_2), visibility, $PM_{2.5}$, PM_{10} along with providing data on wind speed, direction and sigma-theta and ambient temperature and relative humidity.

The station is approximately 31km northeast of the proposed facility. Background concentrations measured in 2017 at the monitoring station for particulates, NO_2 and SO_2 are discussed below.

For a contemporaneous assessment, it is imperative that the selected year for estimating background concentration matches with the modelled meteorological year.

The justification for selecting 2017 as the modelled meteorological year is presented in **Appendix B**.

Particulate Concentrations

Daily observations of the particulate concentrations (PM_{10} and $PM_{2.5}$) for the calendar year 2017 have been downloaded from the OEH website and analysed.

Timeseries representation of the daily observed PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure 7** and **Figure 8** respectively.

Statistics for the top five (5) days of 24-hour average PM_{10} and $PM_{2.5}$ levels recorded at the Bargo monitoring station are presented in **Table 4**.

As seen from the time-series, the 24-hour average PM_{10} assessment criteria of 50 $\mu g/m^3$ was exceeded for one (1) day in the year 2017 – on the 24th of September. No exceedances were observed for the 24-hour average $PM_{2.5}$ concentrations.

The annual average concentration of PM_{10} of 13.9 $\mu g/m^3$ was below the criterion of 25 $\mu g/m^3$ and the annual average concentration of $PM_{2.5}$ of 6.3 $\mu g/m^3$ was below the assessment criteria of 8 $\mu g/m^3$.

For those 24-hour periods where data has been missing from the 2017 PM_{10} and $PM_{2.5}$ time-series, the missing data been substituted / replaced with the corresponding 70th percentile value for the 2017 calendar year.

Figure 7: 24-Hour Average PM_{10} Concentration Time-Series – OEH Monitoring Station at Bargo – 2017

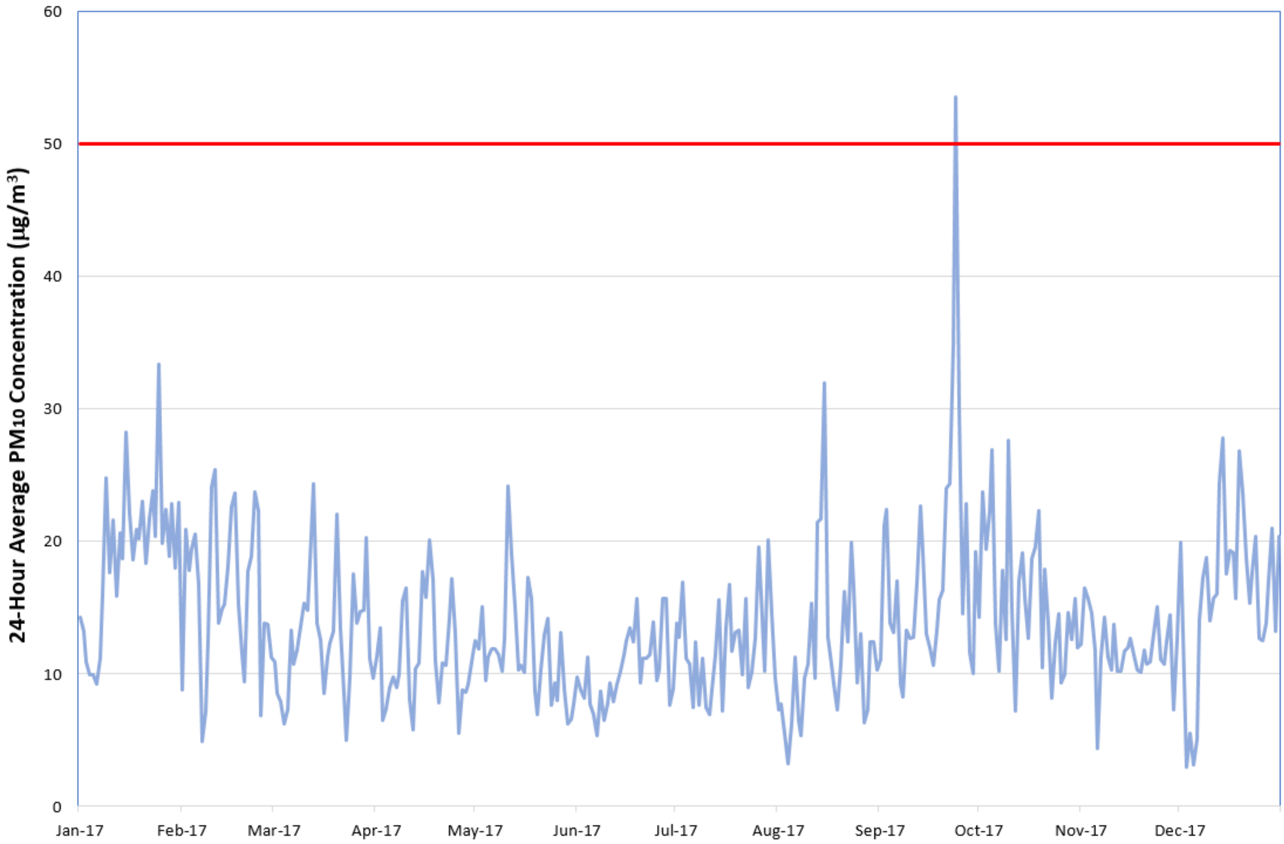


Figure 8: 24-Hour Average $PM_{2.5}$ Concentration Time-Series – OEH Monitoring Station at Bargo – 2017

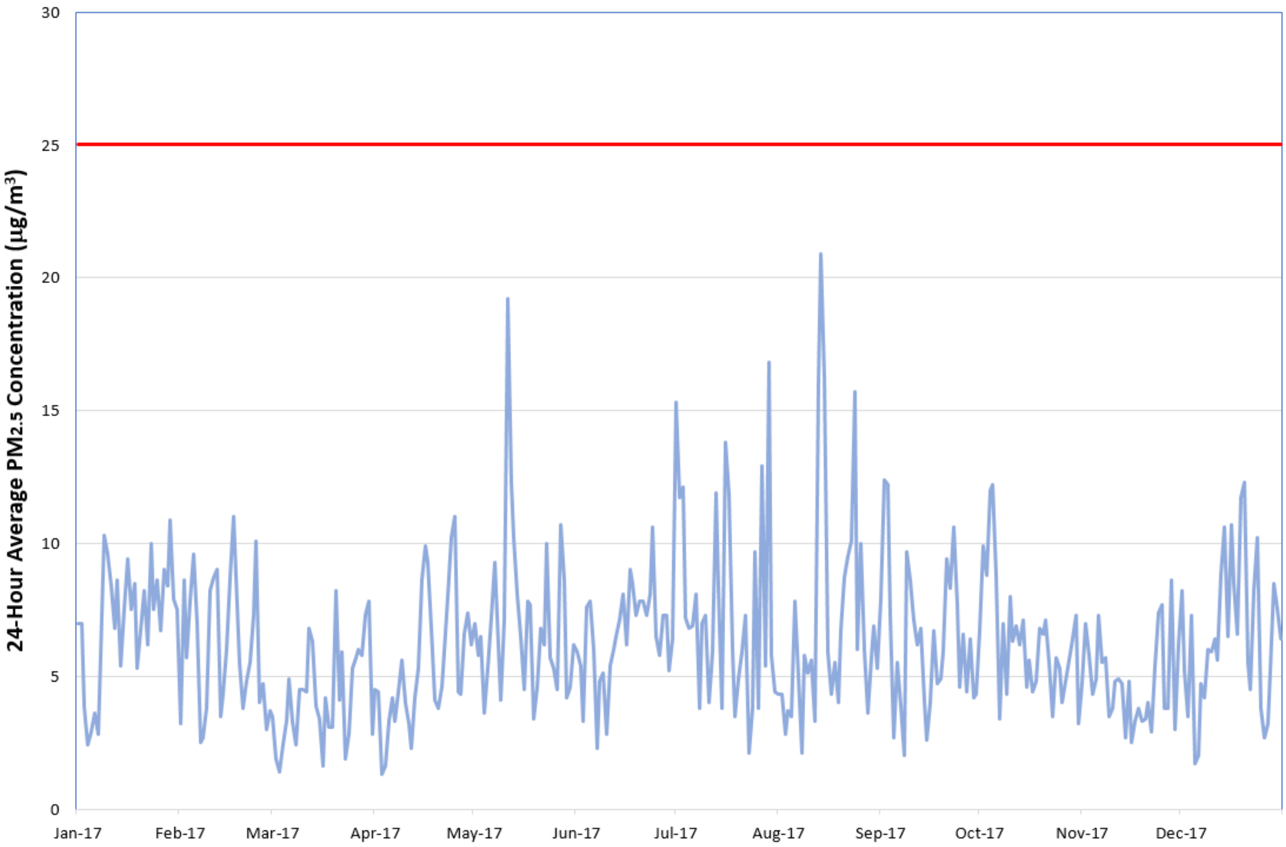


Table 4: Statistics for Top Five Days of Observed PM_{10} and $PM_{2.5}$ Concentrations at the Bargo Monitoring Station

Rank	24-Hour Average PM_{10} Concentration (µg/m³), Bargo 2017	24-Hour Average $PM_{2.5}$ Concentration (µg/m³), Bargo 2017
1st highest (Maximum Daily)	**53.5**	20.9
2nd highest	34.8	19.2
3rd highest	33.4	16.8
4th highest	31.9	16.3
5th highest	30.0	16.0

Nitrogen dioxide (NO_2) and Sulfur dioxide (SO_2) Concentrations

Statistics for the NO_2 and SO_2 ambient concentrations recorded at the Bargo station in 2017 are summarised in **Table 5**.

Measured NO_2 and SO_2 concentrations comply with the relevant assessment criteria (refer **Table 3**) and no exceedances have been reported for the 2017 calendar year.

Table 5: Summary of NO_2 and SO_2 Ambient Concentrations Recorded at Bargo Monitoring Station in 2017

Pollutant	Averaging Period	Measured Concentration at OEH Station - Bargo, 2017	Notes
Nitrogen dioxide (NO_2)	1-hour	135 µg/m³	Maximum 1-hour measured at Bargo – 2017
	Annual	11.56 µg/m³	Annual average, Bargo – 2017
Sulfur dioxide (SO_2)	10-minute	53.8	Determined from maximum 1-hour measured at Bargo – 2017 (10 min. avg = 1.88 x 1-hour avg.) – *CSIRO Peak-To-Mean Ratio for Point Sources*
	1-hour	28.6 µg/m³	Maximum 1-hour measured at Bargo – 2017
	24-hour	5.8 µg/m³	Maximum 24-hour measured at Bargo – 2017
	Annual	1.4 µg/m³	Annual average, Bargo – 2017

7.2.1 Background Concentrations from the Bargo Station Adopted for the Cumulative Assessment

A summary of the background concentrations measured in 2017 at the Bargo station for the cumulative assessment is summarised in **Table 6.**

Table 6: Background Air Quality Concentrations Adopted for the Cumulative Assessment from the Bargo Monitoring Station

Pollutant	Averaging Period	Adopted Background Concentration	Description
PM_{10}	24-hours	Daily Varying	Assessed contemporaneously with daily varying PM_{10} background levels measured at the Bargo monitoring station in 2017
	Annual	13.9 µg/m³	Annual average PM_{10} value measured at Bargo monitoring station in 2017
$PM_{2.5}$	24-hours	Daily Varying	Assessed contemporaneously with daily varying $PM_{2.5}$ background levels measured at the Bargo monitoring station in 2017
	Annual	6.3 µg/m³	Annual average $PM_{2.5}$ value measured at Bargo monitoring station in 2017
TSP	Annual	34.7 µg/m³	No monitoring data available, therefore TSP background concentration from the below assumption *TSP = Annual average PM_{10} / 0.4* Based on assumption that the PM_{10} particle size mass fraction is typically of the order of 40% of TSP mass.
Deposited Dust	Annual	2 g/m²/month	Conservative assumption based on similar projects undertaken by Airlabs
Nitrogen dioxide (NO_2)	1-hour	135 µg/m³	Maximum 1-hour measured at Bargo – 2017
	Annual	11.56 µg/m³	Annual average, Bargo – 2017
Sulfur dioxide (SO_2)	10-minute	53.8	Determined from maximum 1-hour measured at Bargo – 2017 (10 min. avg = 1.88 x 1-hour avg.) – *CSIRO Peak-To-Mean Ratio for Point Sources*
	1-hour	28.6 µg/m³	Maximum 1-hour measured at Bargo – 2017
	24-hour	5.8 µg/m³	Maximum 24-hour measured at Bargo – 2017
	Annual	1.4 µg/m³	Annual average, Bargo – 2017

7.3 Contribution from the Austral Bricks Quarry

The Austral Bricks Quarry, which would supply raw materials for the brick manufacturing operations is located immediately north of the proposed facility as shown in **Figure 2**.

It is understood that the quarry has been approved and works has commenced on preparing the site for full-time production of material.

As the quarry has the potential to release noticeable amounts of dust from its operations, this facility has been considered for the cumulative assessment of particulate matter impacts – i.e. TSP, PM_{10}, $PM_{2.5}$ and deposited dust levels.

Airlabs were able to obtain the following information on the public domain in order to determine dust emissions from the Austral Bricks Quarry:

- An air quality assessment was undertaken for the proposed Austral Bricks Quarry in 2010 - *Air Quality Assessment, New Berrima Clay / Shale Quarry, The Austral Brick Company Pty. Ltd.* (Heggies, 2010).
- As per Heggies, 2010 the quarry once operational was expected to have an annual production of 120,000 tonnes per annum (tpa) with a peak production rate of 150,000 tpa.
- Subsequently, a determination was made on the most recent Development Application concerning a change in the layout of the quarry. A revised air quality impact assessment - *Appendix 5 – Air Quality Assessment – The Austral Brick Company Pty. Ltd. Modified New Berrima Clay/Shale Quarry, PA08_0212* (SLR, 2015) accompanied the application.
- The updated assessment (SLR, 2015) informed of the potential air quality impacts associated with the proposed site layout changes and the findings of the assessment were presented in the updated report.

To estimate the impacts from the Austral Bricks Quarry, source characteristics and particulate matter emission rates have been sourced from Heggies, 2010 and SLR, 2015 and are summarised below in **Table 7**.

Seven (7) fugitive particulate emissions sources were identified and modelled in order to assess the cumulative impacts. TSP, PM_{10} and $PM_{2.5}$ emission rates associated with these sources are presented in **Table 7.**

All of the identified fugitive sources tabulated below were represented in the dispersion model as a series of volume sources.

Table 7: Emission Estimates – Austral Bricks Quarry

Source	Estimated Emissions (kg/annum)			Modelled Operational Hours
	TSP	PM_{10}	$PM_{2.5}$	
Wind erosion from stockpiles	5,256	2,628	394	Continuous
Scraper on topsoil	603	152	23	7AM to 5PM, 7 days of the week
Bulldozer on topsoil	14,733	3,999	600	
Bulldozer on shale	13,896	4,063	609	
Truck loading (front end loader)	13,000	6,240	936	
Vehicle movements - despatch trucks	86,337	22,723	3,408	
Vehicle movements - overburden trucks	2,849	750	113	

Source: SLR, 2015

7.4 Contribution from the Austral Masonry Plant

The Austral Masonry Plant, which has been approved by the Council would be developed on Site 1 of the "Chesley Park" land. Location of the proposed facility in context with the Austral Masonry Plant has been presented in **Figure 2**.

It is to be noted that Airlabs undertook the Air Quality Impact Assessment for the Austral Masonry Plant (Airlabs, 2018), accompanying the development application. The assessment quantified the potential impacts from the operations of the Masonry Plant site on the surrounding environment.

The main sources of air emissions considered from the masonry operations included:

- Off-gases generated as a result of combustion of natural gas from the boiler to heat up the air inside the curing chamber; and
- Fugitive dust emissions generated from various operational activities at the masonry plant.

It is mentioned in Airlabs, 2018 that Austral Masonry were proposing to install a Class 2 - Low NOx burner for the natural gas fired boiler to lower / reduce NOx emissions.

The maximum volume of natural gas used by the boiler in any given hour was 24 m^3/hour (Airlabs, 2018), which approximately translated to 147 tonnes per annum (based on a gas density of 0.7 kg/m^3 and continuous 8760 (24 hrs. x 365 days) hours of operations).

Boiler stack emissions were estimated based on the estimated gas consumption rates and the pollutant emission factors published in the National Pollutant Inventory (NPI), *Emission Estimation Technique Manual for Combustion in Boilers*, Version 3.6, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, December 2011.

Fugitive dust emissions were quantified for the following sources:

- Unloading raw materials into the drive over bins.
- Conveying / material transfer of raw, intermediate and product materials.
- Loading reject material to the crusher unit.
- Crushing operations.
- Loading / transfer of crushed material to the drive over bin.
- Paved surface vehicle haulage emissions.

Modelling was undertaken using the CALPUFF air dispersion model and impacts predicted at the nearest sensitive receptors.

Upon carefully reviewing the findings of the model simulations presented in Airlabs, 2018, it has been observed that the incremental concentrations from the masonry operations (which include the boiler stack emissions and fugitive dust emissions) were well below the impact assessment criteria, especially for gaseous pollutants, with NO_2 levels being the highest amongst the modelled gaseous pollutants. The maximum 1-hour average NO_2 incremental concentrations predicted at the worst impacted receptor was approximately 1% of the assessment criteria. For all the remaining gaseous pollutants, the impacts were less than 0.05% of the assessment criteria at the worst impacted receptors.

With respect to particulates, the maximum 24-hour average PM_{10} concentration from the masonry operations contributed to approximately 5% of the assessment criteria at the worst impacted receptor, whereas the corresponding $PM_{2.5}$ concentrations contributed to 3% of the assessment criteria. The annual average PM_{10} and $PM_{2.5}$ concentrations were less than 1% of their respective assessment criteria at the worst impacted receptor.

Based on the above findings, only the particulate matter emissions are considered to be of relevant significance, when compared to the other pollutants.

As-such, only particulate matter (TSP, PM_{10}, $PM_{2.5}$ and deposited dust) impacts from the Austral Masonry Plant were considered for the cumulative assessment.

Particulate matter emissions estimated from the Austral Masonry Plant are summarised in **Table 8**.

Table 8: Emission Estimates – Austral Masonry Plant

Specific Operations	TSP Emissions (g/sec)	PM_{10} Emissions (g/sec)	$PM_{2.5}$ Emissions (g/sec)
Delivery trucks unloading raw material into the underground drive over bins	0.002	0.001	0.0001
Raw, intermediate and product material transfer through conveyors	0.006	0.003	0.0004
Loading reject material to crusher	0.001	0.0003	0.00005
Crushing operations	0.0004	0.0002	0.00003
Loading crushed material to the drive over bin	0.001	0.0003	0.00005
Haulage of raw and product material on paved surfaces	0.133	0.026	0.006
Boiler stack emissions	0.001	0.001	0.001
Total (Point and Fugitive) Emissions	**0.14**	**0.03**	**0.008**

Source: Airlabs, 2018

7.5 Contribution from the Boral Cement Plant

The Boral Berrima Cement Works (Boral Cement Plant) is located west of the Austral Masonry Plant as shown in **Figure 2**. The plant has been operational since 1929. The site operates one (1) kiln and two (2) cement mills along with storage and stockpile facilities and produces approximately 1.3 million tonnes of clinker per year for grey cement.

Boral Cement holds a Development Consent (DA 401-11-2002-i) for Kiln 6 and its operations are licensed under Environment Protection Licence (EPL) No. 1698.

To determine the extent of pollutant emission rates from the Boral Cement Plant, Airlabs undertook an extensive desktop review and identified an air quality impact assessment conducted in 2015.

In 2015, Boral Cement was seeking a modification of their EPL and development consent for the use of non-standard fuels (NSF) and solid waste-derived fuel (SWDF). An air quality impact assessment - *Air Quality Impact Assessment, Boral Cement Berrima Works, Use of Solid Waste Derived Fuels in Kiln 6* (Air Quality Professionals, 2015) was undertaken to accompany the development application.

Information from Air Quality Professionals, 2015 was utilised in this assessment to define the point source parameters. A screenshot of the point sources referenced from Air Quality Professionals, 2015 is shown in **Figure 9**. Relevant source characteristics for the point sources obtained from Air Quality Professionals, 2015 is summarised in **Table 9**.

To estimate the pollutant emission rates for the cumulative assessment, reference was drawn to the 2017-18 National Pollutant Inventory (NPI) published emissions report for the Boral Cement Plant. The 2017-18 reporting year was selected for the contemporaneous assessment.

For the cumulative assessment of the gaseous pollutants, point source emissions from the 2017-18 NPI report were assigned to the No. 6 Kiln Stack. Particulate matter point emissions as published in the 2017-18 NPI report were assigned across all of the point sources identified in **Figure 9** and **Table 9**.

Particulate matter fugitive emissions published in the 2017-18 NPI report were assigned across a series of hypothetical volume sources which represented all of the key areas at the Boral Cement Plant site.

Pollutant emission rates estimated from the point and fugitive sources for the Boral Cement Plant are summarised in **Table 10** and **Table 11** respectively. For the sake of simplicity, all of the modelled point and fugitive sources were assumed to be continuously operational.

Figure 9: Description of Point Sources (reproduced from Air Quality Professionals, 2015)

Boral Berrima Air Quality Impact Assessment

air quality professionals

Table 3: Point sources at Berrima site

Name	Description	Type of particulate control equipment	EPL1698 stack reference number
No.6 Kiln Stack	Stack discharging exhaust gases from the kiln.	Full exhaust gas flow split between electrostatic precipitator (ESP) and bagfilter.	2
No.6 Cement Mill	Vent discharging from side of No.6 Cement Mill building.	Bagfilter	4
No.6 Kiln Cooler	Stack discharging large volumes of air used to cool clinker after it comes out of the kiln.	Bagfilter	5
No.7 Cement Mill	Vent at end of a large duct coming out of the side of the No.7 Cement Mill building.	Bagfilter	10

Source: Air Quality Professionals, 2015

Table 9: Point Source Characteristics – Boral Cement Plant

Source	Stack Height (m)	Diameter (m)	Exit Temperature (Kelvin)	Exit Velocity (m/sec)
No. 6 kiln stack	85	3	376.15	38
No. 6 cement mill	17	1.75	357.15	13
No. 6 kiln cooler	37	2.4	360.15	14
No. 7 cement mill	8	1.91	375.15	3.7

Source: Air Quality Professionals, 2015

Table 10: Pollutant Emission Rates – Point Sources – Boral Cement Plant

Pollutant	Source of Release	Estimated Emissions (kg / annum)	Reference
Nitrogen oxides (NOx)	No. 6 kiln stack	2,300,000	NPI 2017-18 Report
Hydrogen fluoride (HF)	No. 6 kiln stack	65	NPI 2017-18 Report
Sulfur dioxide (SO_2)	No. 6 kiln stack	4,000	NPI 2017-18 Report
PM_{10}	No. 6 kiln stack, No. 6 cement mill, No. 6 kiln cooler, No. 7 cement mill	25,000	NPI 2017-18 Report
$PM_{2.5}$	No. 6 kiln stack, No. 6 cement mill,	11,000	NPI 2017-18 Report

Pollutant	Source of Release	Estimated Emissions (kg / annum)	Reference
	No. 6 kiln cooler, No. 7 cement mill		
TSP	No. 6 kiln stack, No. 6 cement mill, No. 6 kiln cooler, No. 7 cement mill	33,440	Estimated value based on TSP / $PM_{2.5}$ ratio determined from the TSP and $PM_{2.5}$ emissions for the No. 6 kiln stack as provided in Air Quality Professionals, 2015

Table 11: Pollutant Emission Rates – Fugitive Sources – Boral Cement Plant

Pollutant	Estimated Emissions (kg / annum)	Reference
PM_{10}	32,000	NPI 2017-18 Report
$PM_{2.5}$	2,000	NPI 2017-18 Report
TSP	64,000	Estimated value based on assuming a PM_{10}/TSP ratio of 0.5

8. PROPOSED FACILITY EMISSIONS

This section quantifies the emissions generated from the proposed facility. Emissions have been estimated for the following sources:

- Proposed facility kiln exhaust stack; and
- Fugitive dust emissions generated from various operational activities at the proposed facility site.

The EPA in their requirements have listed that any backup power supply systems should be documented including information on whether they will be diesel or gas fired engines, and that such activities must be undertaken in accordance with the EPA's *Interim Nitrogen Oxide Policy for Cogeneration in Sydney and the Illawarra*. Airlabs have been advised by Brickworks that there would not be any backup power systems / generators at this stage, and therefore, no further investigation has been undertaken into this matter.

8.1 Emissions from the Kiln Exhaust Stack

As noted in the proposed facility specifics section (refer **Section 2**), the proposed facility would have a new kiln, which would improve fuel consumption rates and emissions profile as compared to the existing kiln at Kiama Street, Bowral.

Furthermore, to align the design of the proposed facility with best practice fluoride mitigation measures implemented by the Austral Bricks management across various sites in Australia, the discharge concentration of HF from the proposed kiln exhaust stack will be capped to a maximum of 20 mg/m^3, which is considerably lower than the fluorine Group 6 standards for ceramic works as per Schedule 3 of the POEO Clean Air Regulations 2010.

To accurately determine pollutant emission rates from the kiln exhaust, Airlabs through Bowral Bricks have requested the kiln manufacturer / supplier to provide the expected maximum discharge concentrations and corresponding volumetric flow details.

Expected maximum pollutant discharge concentrations (hereafter 'design concentrations') as provided from the from the kiln manufacturer / supplier are summarised in **Table 12**.

The design concentrations for all the other pollutants have also been compared against the concentration standards specified for ceramic works in Schedule 3 of the POEO Clean Air Regulations 2010. Reference has been made to *Group 6* standards as these standards are applicable for those facilities whose operations and the corresponding licence conditions have been issued after 01 September 2005.

Pollutant emission rates from the proposed kiln stack are summarised in **Table 12** along with critical stack parameters presented in **Table 13**.

Table 12: Pollutant Discharge Concentrations and corresponding Emissions Rates from the Proposed Facility Kiln Exhaust Stack

Pollutant	Design Concentration (as provided to Airlabs)	Units	Corresponding Standard of Concentration – Ceramic Works, Group 6, Schedule 3 POEO Clean Air Regulation 2010,	Compliance with Clean Air Regulation Standard of Concentration	Estimated Mass Emission Rate (g/sec) [(d)]
TSP	45	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	50 mg/m^3	Yes	1.05
PM_{10}	37 [(a)]	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	n.d.	n.d.	0.87
$PM_{2.5}$	22.5 [(b)]	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	n.d.	n.d.	0.53
HF	20	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	50 mg/m^3	Yes	0.47
SO_2	400	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	1,000 mg/m^3 [(c)]	Yes	9.37
NOx as NO_2	450	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	500 mg/m^3	Yes	10.54
Sulfuric acid mist	75	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	100 mg/m^3 [(c)]	Yes	1.76

(a) *Design concentrations for PM_{10} were not provided. As-such, PM_{10} concentrations have been estimated based on the PM_{10} / TSP ratio obtained from the design concentrations for the upgraded Plant 2 site at Horsley Park (SSD 9601)*
(b) *Design concentrations for $PM_{2.5}$ were not provided. As-such, $PM_{2.5}$ concentrations have been estimated assuming that they are approximately 50% of the design TSP concentration.*
(c) *Standards of concentration referenced from Schedule 4 – Standards of concentration for scheduled premises: general activities and plant*
(d) *Mass emission rate calculated based on provided design concentration and corresponding volumetric flow rate of 23.4 Nm^3/sec*
n.d. – no data

Table 13: Proposed Facility Kiln Stack Parameters

Parameter	Value	Units
Location – Easting (X)	256947	m
Location – Northing (Y)	6178300	m
Height above ground level	35	m
Stack diameter at exit	2.0	m
Design exit velocity	13.74	m/sec
Stack temperature at exit	453	Kelvin
Operational hours	Continuous (24 hours, 365 days)	

8.2 Fugitive Dust Emissions from the Operational Activities

Sources associated with the brick manufacturing operations at the proposed facility site that have the potential to generate fugitive dust emissions have been quantified through the application of emission factors listed in Emission Estimation Technique (EET) manuals. Fugitive dust emissions have been quantified for the following sources:

- Truck unloading raw materials into the drive-over bin
- Conveying raw material to the crusher hopper.
- Crushing operations.
- Conveying crushed material into the raw material storage building.
- Unloading of the materials in the raw material storage building.
- Loading and conveying operations – surge bin.
- Haulage on paved surfaces.

A notable air quality improvement feature at the proposed facility is to avoid external material stockpiles. Raw materials would be unloaded and handled inside the raw material storage building (height of the raw material storage building is 20m and maximum height of stockpile inside the building is 10m). This would considerably reduce / minimise the potential for wind-erosion emissions from stockpiles. Similarly, as shown in **Figure 3**, the crusher infrastructure would be enclosed in a building, which significantly minimises the potential for airborne dust emissions resulting from the crushing and associated operations.

For the material handling activities (loader operations, conveyor operations etc.), emissions have been spread over a 12-hour period every day of the year.

Another key feature with regards to minimising dust emissions is that the access / service roads within the proposed facility site used by haul trucks for delivering raw material and transporting product material would be paved and the potential for wheel generated dust would be limited as opposed to unpaved / unsealed road surfaces.

Fugitive dust emissions for the various size fractions – TSP, PM_{10} and $PM_{2.5}$ for each of the aforementioned sources were quantified by drawing reference to the following EET manuals:

- National Pollutant Inventory (NPI), *Emission Estimation Technique Manual for Mining*, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012 (NPI, 2012).
- AP-42 Emission Factors, *Chapter 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing*, United States Environmental Protection Agency (US-EPA 2004).

- AP-42 Emission Factors, *Chapter 13.2.4 Aggregate Handling and Storage Piles*, United States Environmental Protection Agency (US-EPA 2006); and
- AP-42 Emission Factors, *Chapter 13.2.1 Paved Roads*, United States Environmental Protection Agency (US-EPA 2011.

Particulate matter (TSP, PM_{10} and $PM_{2.5}$) emission rates have been quantified based on emission factors corresponding to specific operational activities referenced from the above EET manuals, production rates and estimation of vehicle kilometres travelled. Dust control measures have been accounted for while developing the emissions inventory.

Detailed calculations of the estimated fugitive dust emissions are presented in **Appendix A.**

Table 14: Estimated Annual Fugitive Dust Emission Rates from the Proposed Facility

Activity	Modelled Annual Emission Rates (kg/year)		
	TSP	PM_{10}	$PM_{2.5}$
Trucks unloading raw materials into the drive-over bin	8.1	3.8	0.6
Conveying raw material to the crusher hopper	8.1	3.8	0.6
Crusher operations	114.0	51.3	9.5
Conveying crushed material into the raw material storage building	8.1	3.8	0.6
Loading of crushed raw materials into temporary stockpiles in the raw materials storage building	8.1	3.8	0.6
Loading crushed raw material into the surge bin conveyor	8.1	3.8	0.6
Conveying raw materials to the surge bin	8.1	3.8	0.6
Heavy vehicle haulage – raw material delivery – paved surface	293.7	56.4	13.6
Heavy vehicle haulage – product dispatch – paved surface	364.1	69.9	16.9
Total	**820**	**200**	**44**

8.3 Fugitive Dust Emissions – Construction Phase

It is expected that there would be dust emissions generated during the construction phase of the proposed facility. However, it is expected that these activities would occur only for a limited period of time, as opposed to operational activities.

As dust emissions generated during construction phase would be temporary and short-term in nature, a quantitative assessment has not been undertaken. However, a brief qualitative description of construction related dust generating sources is presented below.

Construction based activities, which have a potential to generate dust emissions include:

- Earthwork operations such as excavation and topsoil stripping.

- Handling of spoil and structural fill material.
- Wind erosion from temporary exposed areas and stockpiles.
- Wheel generated dust from haulage on work areas.

Given that construction activities are progressive and transient in nature, the potential for the aforementioned activities to adversely impact the local air quality is low. Moreover, construction activities would take place sporadically over a large area which would significantly limit the potential for any adverse off-site impacts. Nonetheless, the following mitigation measures have been recommended by Airlabs to minimise dust emissions during construction activities.

Table 15: Construction Dust Mitigation Measures

Source of Dust	Mitigation Measure	Timing
General	Identify dust-generating activities and inform site personnel about location	Throughout construction
	Identify adverse weather conditions (dry and high wind blowing from dust source to sensitive receptors) and halt dust emitting activities if visible dust impacts are identified at sensitive receptors.	Throughout construction
Handling of spoil and structural fill material	Minimise drop height for material handling equipment.	Throughout construction
Wind generated dust from temporary stockpiles and exposed areas	Apply watering through water trucks or sprinklers.	As required
	Progressive staging of dust generating activities throughout the day to avoid concurrent dust emissions.	Throughout construction
	Minimise exposed area if possible.	Throughout construction
	Minimise amount of temporary material stockpiled if possible.	Throughout construction
Wheel generated dust during hauling	Restrict vehicle movement to haul routes that are watered regularly.	Throughout construction
	Cleaning of haul roads.	As required
	Speed restrictions	Throughout construction

Combustion of diesel or petrol fuels (from vehicle movements and mobile machinery) could generate emissions of particulate matter, CO, SO_2, NO_X and VOCs. Based on the relatively small amount of fuel burning during the construction phase, emissions from vehicle exhaust and mobile machinery are not likely to cause adverse impacts on surrounding sensitive receptors and therefore have been excluded from the assessment.

As per information provided to Airlabs, there would not be any backup power systems / generators at this stage, and as-such, pollutant emissions (especially NOx) released from the backup power generation systems are not considered as a concern for this assessment.

8.4 Odour Emissions

As per the SEARs issued (SSD 10422) (refer **Table 1**), any potential odour emissions generated from the proposal need to be assessed.

However, upon reviewing the operations at the proposed facility, no significant odour generating sources have been identified and therefore odour emissions have not been quantified as a part of this assessment.

9. METEOROLOGICAL MODELLING

9.1 Assessment Methodology

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 in order 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 proposed facility.

There is no weather station operated and managed by Brickworks management either at the proposed facility site location or at the Austral Masonry site and the Austral Bricks Quarry site. Due to non-availability of on-site meteorological data, reference was drawn to data from the nearest site-representative meteorological monitoring station, which is the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) at Moss Vale (Station No: 068239), which is approximately 6.7 km from the proposed facility.

As per the Approved Methods, in the absence of site-specific data for a Level 2 impact assessment, at least one year of site-representative data must be used and this data should be corelated against longer-duration site-representative meteorological database of at least five (5) years to be deemed acceptable.

As-such, in accordance with the Approved Methods, five (5) years of meteorological data recorded at the BoM Moss Vale AWS between 2013-2017 was collected and processed. The 2017 calendar year was selected based on analysis of five (5) years of trends in data recorded at the AWS.

Additional details of the selection of meteorological modelling year is presented in **Appendix B**.

Meteorological modelling for the 2017 calendar year was conducted using a combination of 'The Air Pollution Model (TAPM) (Version 4) and CALMET meteorological models. Analysis of the CALMET generated meteorological data at the proposed facility site location was undertaken to demonstrate that the meteorological data used in the dispersion model adequately describes the patterns expected at the site.

9.2 TAPM

For this modelling assessment, the meteorological model 'The Air Pollution Model (TAPM) (Version 4.0.5)' was used to generate the prognostic output. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which is used to predict three-dimensional meteorological data and air pollution concentrations. TAPM allows users to generate synthetic observations by referencing in-built databases (e.g. terrain information, synoptic scale meteorological observations, vegetation and soil type etc.) which are subsequently used in generating site-specific hourly meteorological data (Hurley P.J., 2008).

Technical details of the model equations, parameterisations and numerical methods are described in Hurley (2008).

TAPM simulation was setup using four (4) nested 25 x 25 grids, (30km, 10km, 3km and 1km) centred on latitude 34^0, 30.5' south, longitude 150^0, 21' east. Twenty-five (25) vertical levels were simulated with the lowest level being 10m and the highest level being 8km.

Technical details of the model equations, parameterisations, numerical methods and assimilation of observations are described in Hurley (2008).

Details of the TAPM model configuration are outlined in **Table 16**.

Table 16: TAPM Model Configuration

Parameter	Value
Year of Analysis	2017
Grid Centre Coordinates (latitude, Longitude) (degree)	-34deg -30.5min, 150deg 21min
Number of grids (spacing)	4 (30km, 10km, 3km, 1km)
Grid dimensions (nx, ny, nz)	25, 25, 25
Data Assimilation (Yes/ No)	Yes – BoM AWS at Moss Vale (AWS: 068239)

9.3 CALMET

CALMET (version 6.4.0) was used to derive meteorological fields at 400 m resolution over a 20km x 20km modelling domain centred over the proposed facility. CALMET was run in no-observations (NOOBS = 2) mode with prognostic output from TAPM used as an input to the CALMET model.

The CALMET model settings were in general accordance with the NSW - Environment Protection Agency (NSW-EPA) (formerly Office of Environment and Heritage – OEH) '*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).

Details of the CALMET model configuration are outlined in **Table 17**.

Table 17: CALMET Model Configuration

Parameter	Value
Year of Analysis	2017
No. X Grid Cells (NX), No. Y Grid Cells (NY)	51,51
Grid spacing (DGRIDKM) (km)	0.4
XORIG (km), YORIG (km)	246.034, 6168.278
No. of Vertical Levels	10
Meteorological Data Option	NOOBS=2
Upper Air and Surface Data	TAPM generated MM4/MM5/3D
Geophysical Datasets	USGS (Land-Use) & SRTM1 (Terrain)

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 20km x 20km modelling domain was derived from the USGS land global land cover dataset. The geotechnical parameters for the land use classification were adopted from the default CALMET corresponding land use categories.

A 3-dimensional representation of the topographical features surrounding the proposed facility has been presented in **Figure 5**.

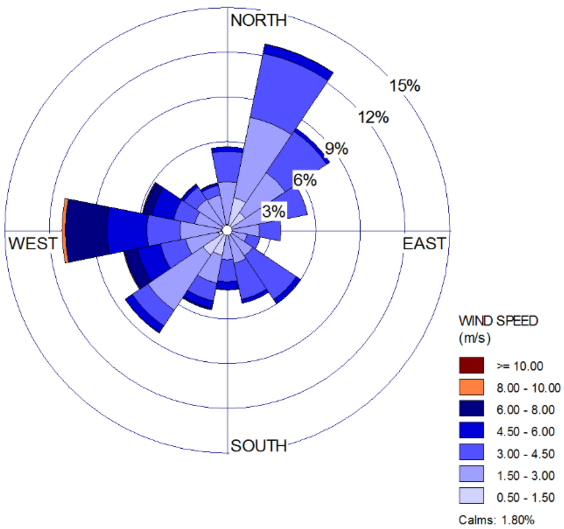
9.4 CALMET Model Outputs

Hourly wind speeds and direction for the 2017 calendar year were extracted from the CALMET output at the centre of the proposed facility site and are visually presented in the form of annual and seasonal wind roses in **Figure 10**.

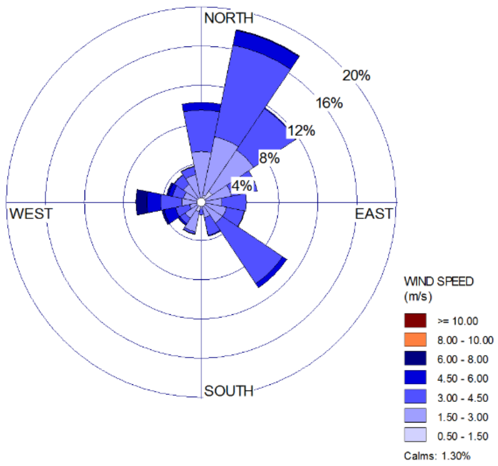
Annual wind roses for the 2017 calendar year shows light winds predominantly from the north-east- – which are prevalent for more than 12% of the yea, followed by moderate to lightly strong winds from due west. The average CALMET predicted wind speed for the 2017 calendar year was 3.2 m/sec and calm conditions (wind speeds less than 0.5 m/sec) were prevalent for about 1.5% of the time, as seen from the frequency distribution chart in **Figure 11**.

Seasonal variability in wind speed and direction is noticed in the CALMET seasonal predictions for 2017. Winds are most common from the north-east during summer and autumn, whereas, a strong westerly component is noticed during winter. During spring season, wind distribution is a lot more varied.

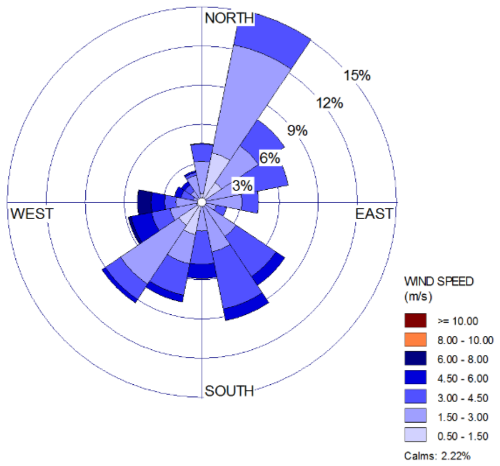
Figure 10: Annual and Seasonal CALMET Predicted Wind Roses - 2017



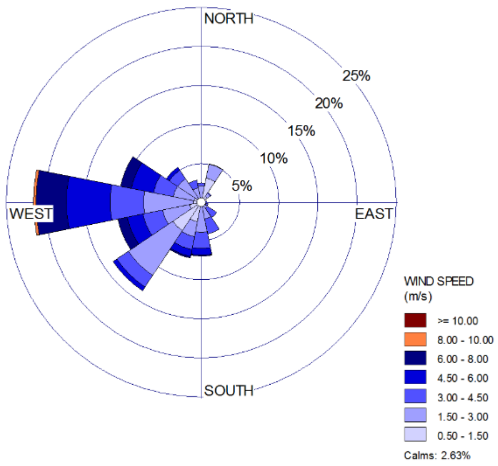
Annual



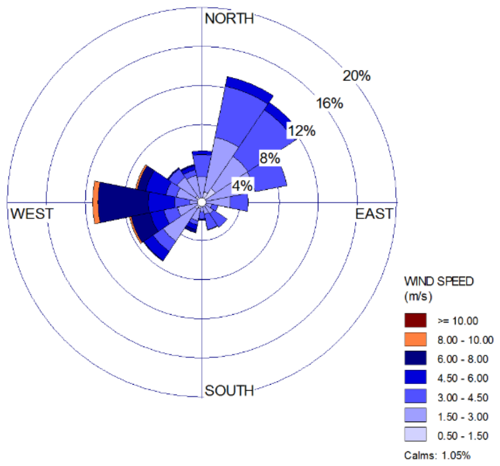
Summer



Autumn

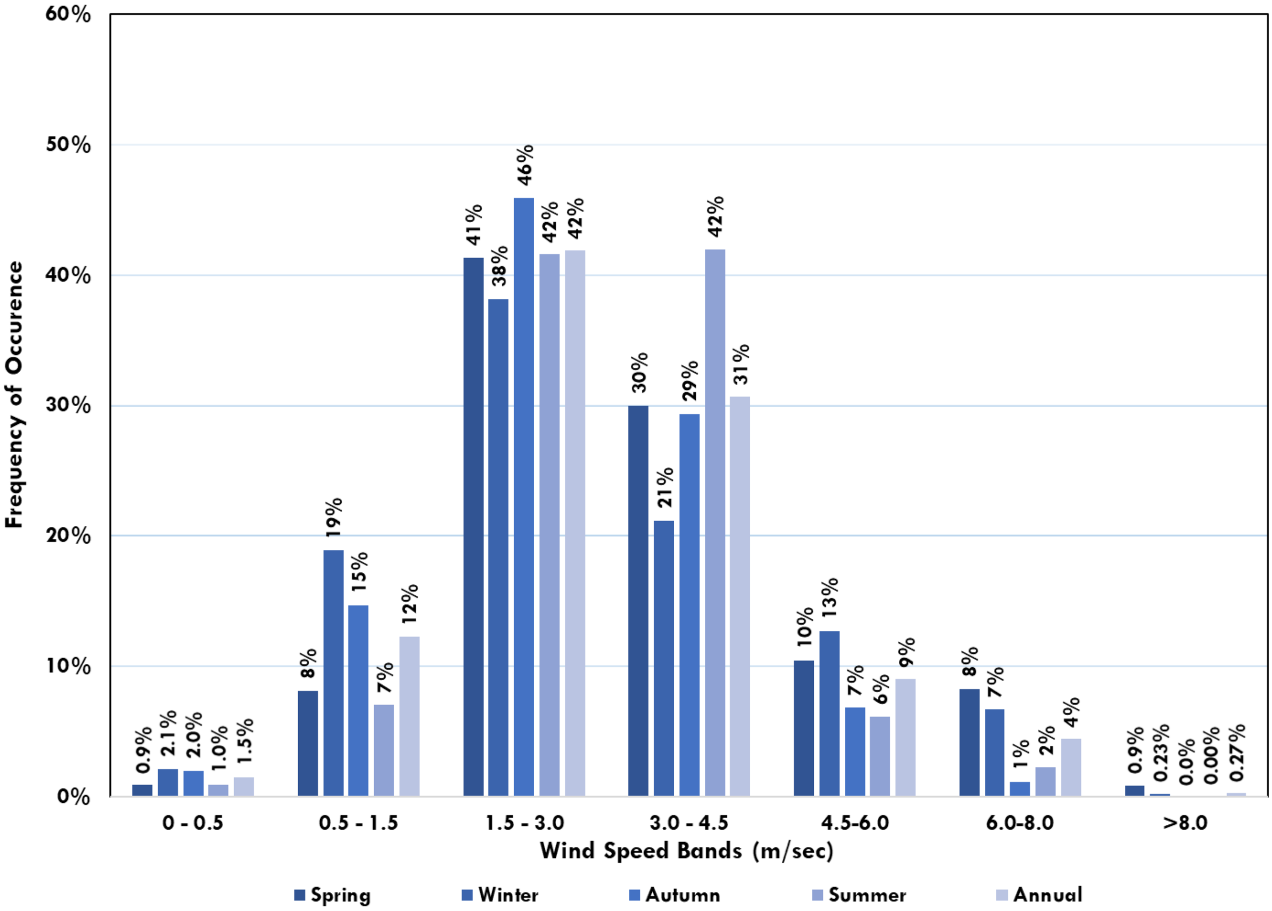


Winter



Spring

Figure 11: CALMET 2017 Wind Speed Frequency Distribution – Annual and Seasonal



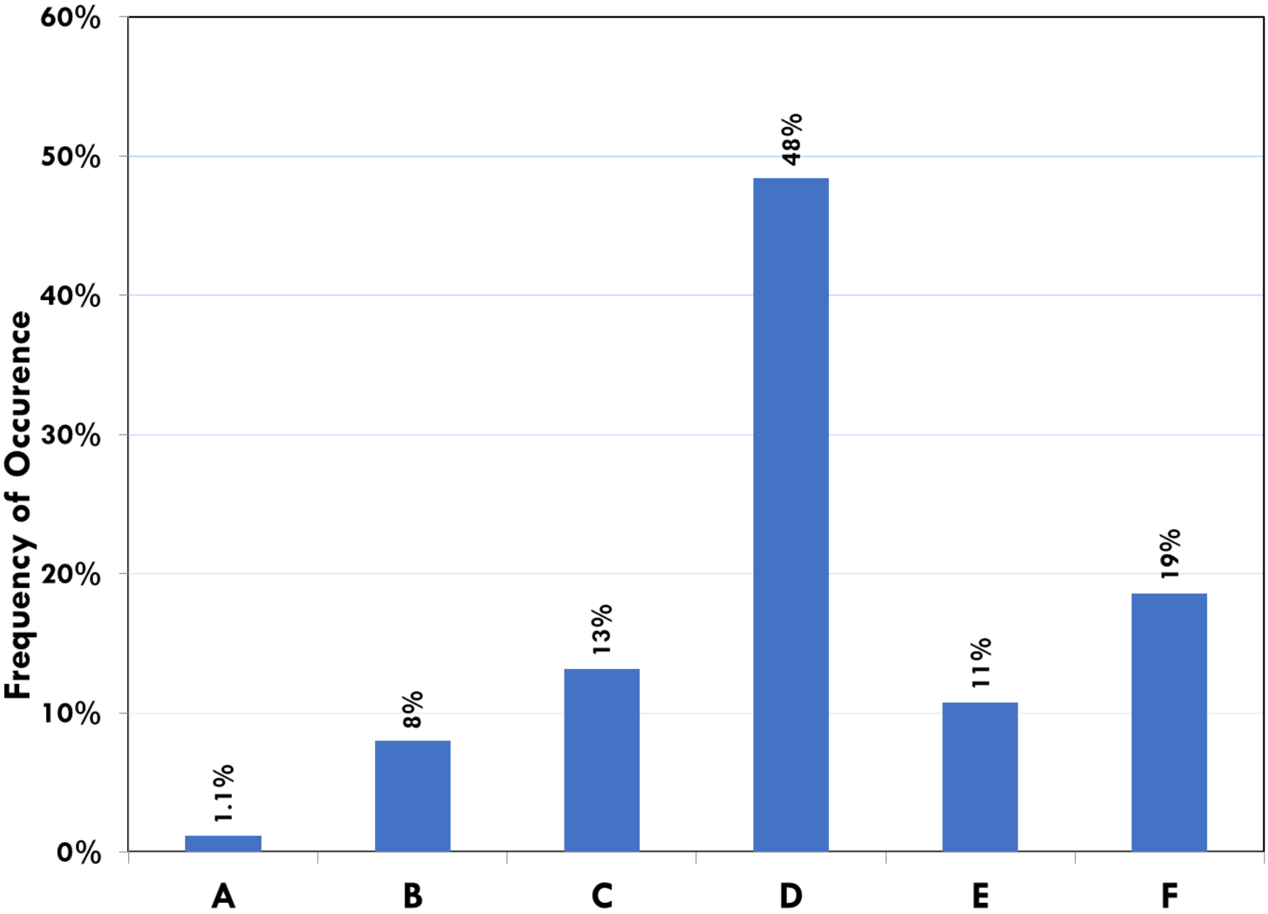
Additional analysis of the modelled meteorology is presented below.

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 the selected meteorological year (i.e. 2017) is presented in **Figure 12**. A higher frequency (48%) of stability class D was predicted by CALMET, followed by F class (19%) indicating dominant neutral to stable conditions, which can potentially lead to poor pollutant dispersion.

Figure 12: Frequency of Stability Class - 2017 CALMET

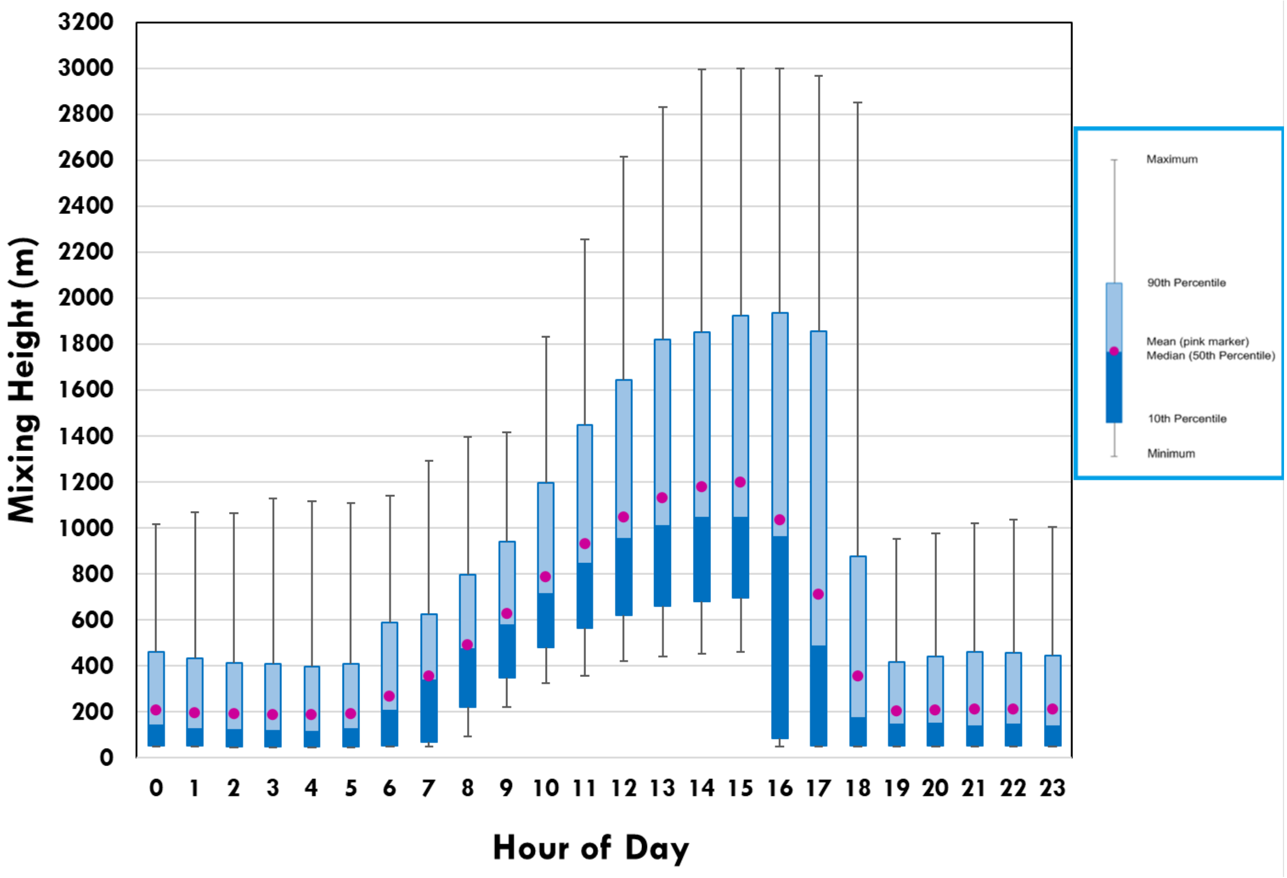


The mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that cannot be measured directly. The mixing height decreases in the late afternoon, particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight. Low 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 is presented in **Figure 13** for the modelled year - 2017.

Figure 13 shows the mixing height as a function of the hour of the day at the proposed facility location. 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 13: CALMET Predicted Diurnal Variations in Mixing Heights – 2017



10. OVERVIEW OF DISPERSION MODELLING

To determine air quality impacts from the proposed facility and the existing sources of air emissions in the immediate vicinity, air dispersion modelling was conducted using the US-EPA CALPUFF dispersion model.

CALPUFF is the dispersion model that calculates the dispersion of plumes within the three-dimensional (3D) meteorological field calculated by CALMET. CALPUFF is a non-steady state US-EPA approved dispersion model, which "advects" puffs of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so, it typically uses the wind fields generated by CALMET.

Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period (SRC, 2011).

The CALPUFF model domain was set up as a sub-set of the CALMET model domain, with a computational grid spanning 11km x 11km centred at the proposed facility location. The sampling grid had a resolution of 100m (using a nesting factor of 4). Additionally, ground level concentrations were also predicted at the identified sensitive receptors (refer **Table 2**) and for the assessment of sulfuric acid concentrations – the 99.9th percentile incremental 1-hour average concentrations were predicted at or beyond the proposed facility site boundary.

The impact of building wake effects on plume dispersion has been included in the modelling for buildings and structures located around the kiln stack. The heights and locations of these structures were entered into the Building Profile Input Program (BPIP) utility using the PRIME algorithm. The wind direction specific building dimensions calculated by BPIP for the kiln stack at their corresponding heights were then entered into the CALPUFF model.

Fugitive dust sources from the proposed facility and corresponding sources from the Austral Bricks Quarry and the Austral Masonry Plant and the Boral Cement Plant were all represented in the CALPUFF dispersion model as a series of volume sources.

Emissions from the proposed facility kiln stack and the Boral Cement Plant kiln were represented as point sources in the dispersion model.

All other 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).

11. DISPERSION MODELLING RESULTS

11.1 Incremental Impacts – Proposed Facility Only

Predicted ground level concentrations of all modelled pollutants from the proposed facility only (incremental concentrations) are discussed in this section. Incremental concentrations discussed in this section are a consequence of the following sources:

- Point source emissions from the kiln exhaust stack.
- Fugitive dust emissions estimated from the operational activities.

Predicted incremental pollutant concentrations have been extracted at the worst impacted sensitive receptor and are presented in **Table 18**. For the sulfuric acid concentrations, as per the Approved Methods, the 99.9th percentile 1-hour average incremental concentrations at or beyond the proposed facility site boundary was extracted and presented in **Table 18**.

As seen in **Table 18**, incremental concentrations have been compared against the relevant assessment criteria and expressed as a percentage of the assessment criteria. As per the Approved Methods, except for sulfuric acid concentrations and increment in deposited dust levels, the assessment criteria are relevant for cumulative impacts, however, for the sake of comparison they have been presented, nevertheless.

From the incremental concentrations summarised in **Table 18**, the following observations can be made:

- Incremental concentrations of all the modelled pollutants are well below their respective assessment criteria. Although the assessment criteria are applicable for cumulative concentrations, which are discussed in the subsequent sections, comparison with the assessment criteria provides a snapshot of the contribution from the proposed facility to the overall air quality levels.
- With respect to the annual averaging particulate concentrations (i.e. TSP, PM_{10} and $PM_{2.5}$) predicted at the worst impacted sensitive receptor amongst the identified receptors (refer **Table 2** and **Figure 6**), the contribution from the proposed facility's operations are quite minimal, with concentrations ranging from 0.2 % to 1.1% of the relevant assessment criteria. Similarly, deposited dust levels from the proposed facility are not considered to be a major source of concern.
- For the shorter time-averaging particulate concentrations (i.e. 24-hour average PM_{10} and $PM_{2.5}$ concentrations), the maximum predicted incremental concentrations at the worst impacted receptor are less than 10% of the respective assessment criteria.
- Based on the above observations, no sizeable contribution is expected from the proposed facility with respect to particulate matter impacts.
- It is acknowledged that HF is a key pollutant for brick manufacturing operations. Bowral Bricks have committed to align the proposed facility with their best practice measures, by ensuring that the HF discharge concentration from the kiln stack will be capped at a maximum of 20 mg/m^3. Along with limiting the maximum discharge concentrations to levels well below the

POEO Standards of Concentrations, Bowral Bricks have also implemented a series of design measures to ensure that pollutant dispersion is not inhibited. Measures include - constructing a new kiln stack to a height of 35m above ground level and maintaining an exit velocity of approximately 13 m/sec. The proposed stack height of 35m is well above the maximum height of the nearby buildings / structures (max. height of buildings ~ 20m) so as to avoid wake effects and therefore elevated ground-level concentrations in the near-field environment.

- The maximum incremental HF concentration predicted at the worst impacted receptor is in compliance with the general land-use assessment criteria for all of the averaging periods. The general land-use criteria have been applied in this assessment, as there are general industrial and heavy industrial developments in the surrounding environment.
- Overall contribution from the proposed facility to SO_2 and NO_2 ground level concentrations is not overly significant, with the 1-hour average NO_2 incremental concentration at the worst impacted receptor contributing to approximately 32% of the assessment criteria.
- For determination of the NO_2 ground level concentrations, it has been assumed in the dispersion model that all of the NOx released from the kiln stack is converted to NO_2 (i.e. 100% NOx to NO_2 conversion).
- With respect to assessment of sulfuric acid, the 99.9^{th} percentile 1-hour average incremental concentration has been predicted at or beyond the facility site boundary as per the Approved Methods and compared against the assessment criteria. Upon comparison, it is observed that the reported incremental concentration is approximately 84% of the assessment criteria, demonstrating compliance.

Summarising the above observations, it is unlikely that there would be adverse / significant contributions to the overall air quality levels from the proposed facility's operations.

Concentration isopleths for key pollutants, illustrating spatial variation in the predicted incremental concentrations are illustrated in **Appendix C**.

Cumulative assessment of the modelled pollutants is discussed in the following section.

Table 18: Summary of Predicted Incremental (Proposed Facility Only) Impacts – All Pollutants

Pollutant	Averaging Period	Assessment Criteria (µg/m³)	Reporting Requirements	Maximum Predicted Incremental Concentration (µg/m³) at the Worst Impacted Receptor	Worst Impacted Receptor Identification (I.D.)	% of Assessment Criteria - Maximum Predicted Incremental at the Worst Impacted Receptor
TSP	Annual	90	100th percentile (maximum) at sensitive receptor	0.18	No. 80	0.2%
PM_{10}	24-hour	50	100th percentile (maximum) at sensitive receptor	2.80	No. 80	5.6%
	Annual	25	100th percentile (maximum) at sensitive receptor	0.15	No. 80	0.6%
$PM_{2.5}$	24-hour	25	100th percentile (maximum) at sensitive receptor	1.69	No. 80	6.8%
	Annual	8	100th percentile (maximum) at sensitive receptor	0.09	No. 80	1.1%
HF	90-days	0.5	100th percentile (maximum) at sensitive receptor	0.13	No. 80	26%
	30-days	0.84	100th percentile (maximum) at sensitive receptor	0.15	No. 80	18%
	7-days	1.7	100th percentile (maximum) at sensitive receptor	0.37	No. 80	22%
	24-hours	2.9	100th percentile (maximum) at sensitive receptor	1.50	No. 80	52%
SO_2	10-minute	712	100th percentile (maximum) at sensitive receptor	131.3	No. 51	18%
	1-hour	570	100th percentile (maximum) at sensitive receptor	69.8	No. 51	12%
	24-hour	228	100th percentile (maximum) at sensitive receptor	30.0	No. 80	13%
	Annual	60	100th percentile (maximum) at sensitive receptor	1.5	No. 80	2.5%

Pollutant	Averaging Period	Assessment Criteria (µg/m³)	Reporting Requirements	Maximum Predicted Incremental Concentration (µg/m³) at the Worst Impacted Receptor	Worst Impacted Receptor Identification (I.D.)	% of Assessment Criteria - Maximum Predicted Incremental at the Worst Impacted Receptor
NO_2	1-hour	246	100th percentile (maximum) at sensitive receptor	78.6	No. 51	32%
	Annual	62	100th percentile (maximum) at sensitive receptor	1.7	No. 80	2.7%
Sulfuric acid	1-hour	18	99.9th percentile at or beyond site boundary	15.2	Maximum at or beyond site boundary	84%
Deposited Dust	Annual	2 g/m²/month (max increase in deposited dust levels)	100th percentile (maximum) at sensitive receptor	0.004	No. 78	0.2%

11.2 Assessment of Cumulative Impacts

Model predicted cumulative pollutant concentrations at the worst impacted sensitive receptor for all of the assessed pollutants (with the exception of sulfuric acid) are presented in **Table 19**.

The presented cumulative concentrations are a sum total of the following sources:

- Impacts from the proposed facility.
- Impacts from the Austral Bricks Quarry.
- Impacts from the Austral Masonry Plant.
- Impacts from the Boral Cement Plant; and
- Ambient air quality levels recorded from the Bargo monitoring station.

The method by which the cumulative concentrations have been determined for the modelled pollutants is also presented in **Table 19**. Contemporaneous assessment has been adopted to determine 24-hour average PM_{10} and $PM_{2.5}$ ground level concentrations. Ground-level cumulative 1-hour average NO_2 concentrations have also been assessed contemporaneously as the Boral Cement Plant is a major source of NOx emissions and extracting the maximum background and adding it to the maximum incremental at the sensitive receptors for determination of cumulative concentrations would be considered a very conservative approach.

From the cumulative concentrations presented in **Table 19**, the following observations have been made:

- With the exception of the 24-hour average cumulative PM_{10} concentrations, all of the remaining pollutants are found to be well in compliance with their relevant assessment criteria at the worst impacted receptor.
- To understand the exceedance reported for the 24-hour average PM_{10} concentrations, a refined assessment has been undertaken, which is demonstrated in the following section.
- For all of the remaining pollutants, the cumulative concentrations at the worst impacted receptor are well under their respective assessment criteria.
- As noted in the assessment of incremental impacts, to determine ground level NO2 concentrations, it was assumed that NOx emissions released from all of the modelled sources are immediately converted to NO_2 (i.e. 100% NOx to NO_2 conversion)

Taking into consideration the low-level incremental impacts expected from the proposed facility and compliance being achieved for the cumulative concentrations (with the exception of 24-hour average PM_{10} concentrations, which is explained in the subsequent section), it is unlikely that the brick manufacturing operations would have an adverse impact on the local air quality levels.

Concentration isopleths for key pollutants, illustrating spatial variation in the predicted cumulative concentrations are illustrated in **Appendix C**.

Table 19: Summary of Predicted Cumulative Impacts – All Pollutants

Pollutant	Averaging Period	Assessment Criteria (µg/m³)	Reporting Requirements	Method of determining Cumulative Concentration	Maximum Predicted Cumulative Concentration (µg/m³) at the Worst Impacted Receptor	Worst Impacted Receptor Identification (I.D.)	% of Assessment Criteria - Maximum Predicted Cumulative at the Worst Impacted Receptor
TSP	Annual	90	100th percentile (maximum) at sensitive receptor	Adding the incremental from the proposed facility to the background (contribution from Austral Bricks Quarry, Austral Masonry, Boral Cement and ambient conc.) at each receptor	38.5	No. 77	43%
PM_{10}	24-hour	50	100th percentile (maximum) at sensitive receptor	Contemporaneous analysis	**59.2**	No. 80	**118%**
	Annual	25	100th percentile (maximum) at sensitive receptor	Adding the incremental from the proposed facility to the background (contribution from Austral Bricks Quarry, Austral Masonry, Boral Cement and ambient conc.) at each receptor	19.1	No. 77	76%
$PM_{2.5}$	24-hour	25	100th percentile (maximum) at sensitive receptor	Contemporaneous analysis	22.7	No. 79	91%
	Annual	8	100th percentile (maximum) at sensitive receptor	Adding the incremental from the proposed facility to the background (contribution from Austral Bricks Quarry, Austral Masonry, Boral Cement and ambient conc.) at each receptor	6.8	No. 77	85%
HF	90-days	0.5	100th percentile (maximum) at sensitive receptor	Adding the max. incremental from the proposed facility to the max. background (contribution from Boral Cement) at each receptor	0.13	No. 80	26%
	30-days	0.84	100th percentile (maximum) at sensitive receptor		0.15	No. 80	18%

Pollutant	Averaging Period	Assessment Criteria (µg/m³)	Reporting Requirements	Method of determining Cumulative Concentration	Maximum Predicted Cumulative Concentration (µg/m³) at the Worst Impacted Receptor	Worst Impacted Receptor Identification (I.D.)	% of Assessment Criteria - Maximum Predicted Cumulative at the Worst Impacted Receptor
	7-days	1.7	100th percentile (maximum) at sensitive receptor		0.37	No. 80	22%
	24-hours	2.9	100th percentile (maximum) at sensitive receptor		1.50	No. 80	52%
SO_2	10-minute	712	100th percentile (maximum) at sensitive receptor	Adding the max. incremental from the proposed facility to the max. background (ambient conc. + contribution from Boral Cement) at each receptor	185.4	No. 51	26%
	1-hour	570	100th percentile (maximum) at sensitive receptor		98.6	No. 51	17%
	24-hour	228	100th percentile (maximum) at sensitive receptor		35.9	No. 80	16%
	Annual	60	100th percentile (maximum) at sensitive receptor		2.9	No. 80	5%
NO_2	1-hour	246	100th percentile (maximum) at sensitive receptor	Contemporaneous analysis	153.9	No. 20	63%
	Annual	62	100th percentile (maximum) at sensitive receptor	Adding the incremental from the proposed facility to the background (contribution from Austral Bricks Quarry, Austral Masonry, Boral Cement and ambient conc.) at each receptor	13.8	No. 80	22%
Deposited Dust	Annual	4 g/m²/month	100th percentile (maximum) at sensitive receptor	Adding the incremental from the proposed facility to the background (contribution from Austral Bricks Quarry, Austral Masonry, Boral Cement and ambient conc.) at each receptor	2.35	No. 77	59%

11.2.1 Investigation into the 24-Hour Average PM_{10} Cumulative Concentrations

As seen from the cumulative assessment, the 24-hour average PM_{10} concentration at the worst impacted sensitive receptor (No. 80) exceeds the assessment criteria of 50 $\mu g/m^3$.

Correspondingly, the 24-hour average incremental PM_{10} concentration at the worst impacted receptor, which also is No. 80 is 2.8 $\mu g/m^3$, which is approximately 5.6% of the assessment criteria.

It is also worth noting that the ambient 24-hour average PM_{10} concentration measured at the Bargo NEPM monitoring station exceeded the assessment criteria of 50 $\mu g/m^3$ on one (1) occasion – 24 September 2017. As this exceedance in the background concentration was included in the cumulative assessment, the maximum 24-hour average cumulative PM_{10} concentrations at each sensitive receptor would all have at least one (1) exceedance of the assessment criteria of 50 $\mu g/m^3$.

According to Section 5.1.3 of the Approved Methods (Dealing with elevated background concentrations), "*existing ambient air pollutant concentrations may exceed the impact assessment criteria from time to time in some locations. In such circumstances, a licensee must demonstrate that no additional exceedance of the impact assessment criteria will occur as a result of the proposed activity and that best management practices will be implemented to minimise emissions of air pollutants as far as is practical*".

To that extent, an investigation has been undertaken at all of the identified sensitive receptors to check for any additional exceedance due to the proposed facility's operations.

Findings of the investigation into the additional exceedance at each of the identified sensitive receptors is presented in **Table 20**.

As seen from **Table 20**, there are two (2) key columns, labelled A and B.

Column A in **Table 20** presents the number of exceedances of the 24-hour average PM_{10} concentrations at the identified sensitive receptors as a consequence of the existing environment only – i.e. impacts from Austral Bricks Quarry, Austral Masonry Plant, Boral Cement Plant and the ambient concentrations from the Bargo monitoring station.

Column B in **Table 20** presents the number of exceedances of the 24-hour average PM_{10} concentrations at each of the identified sensitive receptors arising due to the contributions from the proposed facility in addition to the existing environment.

If there is no increase in the number of exceedances reported in column B (i.e. additional exceedances), it means that no additional exceedances are reported due to the proposed facility's operations.

As seen from **Table 20**, no additional exceedances (Column B – Column A) are reported at any of the identified discrete sensitive receptors, therefore indicating that the proposed facility's operations are not expected to have an adverse impact on the overall 24-hour average PM_{10} concentrations.

Table 20: Assessment of Additional Exceedances of the 24-Hour Average PM_{10} Cumulative Concentrations

Receptor I.D.	A	B	Number of Additional Exceedances (B-A)
	Existing Environment	Existing Environment + Contributions from the Proposed Facility	
	Number of Days of Exceedance of the 24-Hour PM_{10} Concentrations	Number of Days of Exceedance of the 24-Hour PM_{10} Concentrations	
1	1	1	0
2	1	1	0
3	1	1	0
4	1	1	0
5	1	1	0
6	1	1	0
7	1	1	0
8	1	1	0
9	1	1	0
10	1	1	0
11	1	1	0
12	1	1	0
13	1	1	0
14	1	1	0
15	1	1	0
16	1	1	0
17	1	1	0
18	1	1	0
19	1	1	0
20	1	1	0
21	1	1	0
22	1	1	0
23	1	1	0
24	1	1	0
25	1	1	0
26	1	1	0
27	1	1	0
28	1	1	0
29	1	1	0
30	1	1	0
31	1	1	0
32	1	1	0
33	1	1	0
34	1	1	0
35	1	1	0
36	1	1	0
37	1	1	0
38	1	1	0
39	1	1	0
40	1	1	0
41	1	1	0

Receptor I.D.	A	B	Number of Additional Exceedances (B-A)
	Existing Environment	Existing Environment + Contributions from the Proposed Facility	
	Number of Days of Exceedance of the 24-Hour PM_{10} Concentrations	Number of Days of Exceedance of the 24-Hour PM_{10} Concentrations	
42	1	1	0
43	1	1	0
44	1	1	0
45	1	1	0
46	1	1	0
47	1	1	0
48	1	1	0
49	1	1	0
50	1	1	0
51	1	1	0
52	1	1	0
53 – excluded from cumulative assessment – Austral Bricks Quarry site			
54	1	1	0
55	1	1	0
56	1	1	0
58	1	1	0
59	1	1	0
60	1	1	0
61	1	1	0
62	1	1	0
63	1	1	0
64	1	1	0
65	1	1	0
66	1	1	0
67	1	1	0
68	1	1	0
69	1	1	0
70	1	1	0
71	1	1	0
72	1	1	0
73	1	1	0
74	1	1	0
75	1	1	0
76	1	1	0
77	2	2	0
78	1	1	0
79	1	1	0
80	1	1	0
81	1	1	0
82	1	1	0
83	1	1	0
84	1	1	0
85	1	1	0
86	1	1	0

Receptor I.D.	A	B	Number of Additional Exceedances (B-A)
	Existing Environment	Existing Environment + Contributions from the Proposed Facility	
	Number of Days of Exceedance of the 24-Hour PM_{10} Concentrations	Number of Days of Exceedance of the 24-Hour PM_{10} Concentrations	
87	1	1	0
88– excluded from cumulative assessment – Boral Cement Plant site			
89	1	1	0
90	1	1	0
91	1	1	0

12. GREENHOUSE GAS ASSESSMENT

Determination of greenhouse gas (GHG) emissions has been undertaken in accordance with:

- The World Resources Institute / World Business Council for Sustainable Development (WRI/WBCSD) *The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition* (WRI/WBSCD, 2004) (hereafter 'the GHG protocol')
- *National Greenhouse Account Factors August 2019*, Department of the Environment and Energy, (hereafter 'NGAF 2019')
- *State and Territory Greenhouse Gas Inventories 2017*, Australia's National Greenhouse Accounts, Department of the Environment and Energy, June 2019 (hereafter 'the 2017 State and Territory Inventory')

12.1 Overview of GHG Emissions

NGAF 2019 defines three (3) scopes for different emission categories based on whether the emissions generated are 'direct' or 'indirect' emissions. As per NGAF 2019 direct emissions *are produced from sources within the boundary of an organisation as a result of the organisations' activities*, whereas indirect emissions *are emissions generated in the wider economy as a consequence of an organisation's activities, but which are physically produced by the activities of another organisation.*

The 'scopes' of emissions (scope 1, 2 and 3) are defined for GHG reporting and are summarised below and presented in **Figure 14**.

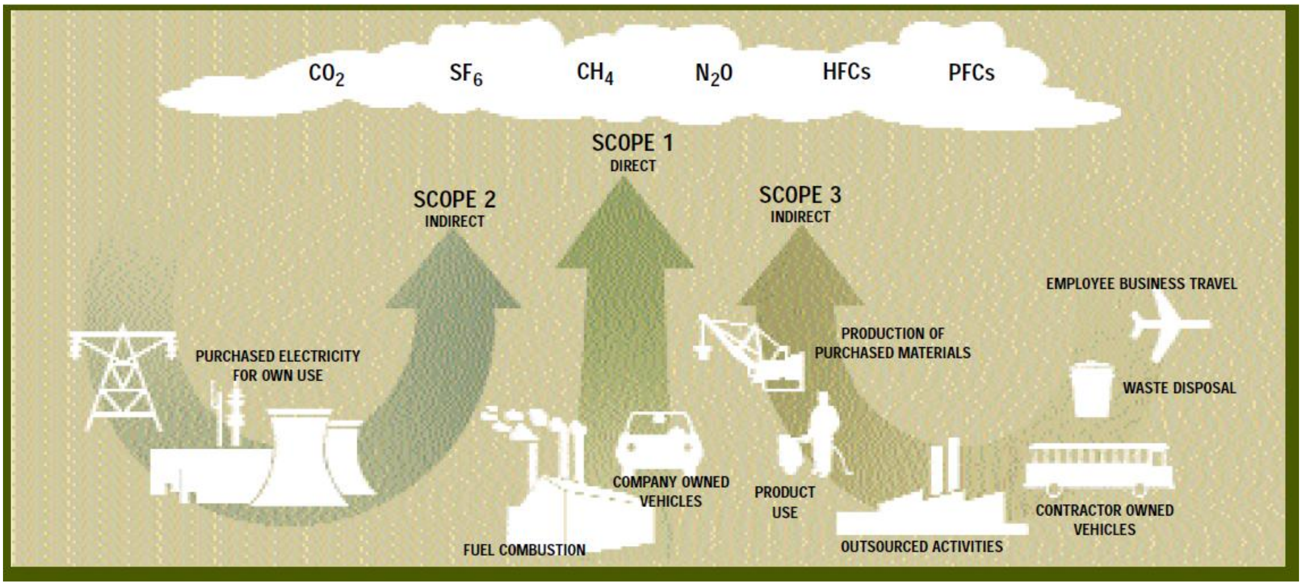
The three (3) scopes are:

- **Scope 1,** which covers direct emissions from sources within the boundary of an organisation, such as fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal etc.
- **Scope 2,** which covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation; and
- **Scope 3,** which includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation

According to the GHG protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services. Moreover, the SEARs issued for the greenhouse gas assessment (refer

Table 1) do not specify scope 3 emissions, and as-such quantification of the indirect scope 3 GHG emissions has been excluded from this assessment.

Figure 14: Overview of Scope 1, 2 and 3 GHG Emissions



Source: The Greenhouse Gas Protocol, WRI/WBSCD, 2004

12.2 GHG Emission Estimates

GHG emissions from a facility can be calculated using published emission factors. As per NGAF 2019, emission factors are used to calculate GHG emissions by multiplying a given quantity of GHG emitted per unit of energy or fuel or a similar measure with the activity data. Estimated GHG emissions are referred to in terms of carbon dioxide equivalent (CO_2-e).

Scope 1 and 2 GHG emissions from the proposed facility have been quantified for:

- Combustion of natural gas for kiln operations – Scope 1 emissions
- Diesel oil combustion for operational activities – Scope 1 emissions
- On-site consumption of electricity – Scope 2 emissions.

Natural gas is the principal fuel used at the site, which would be mains sourced natural gas. Estimates of natural gas to be used for firing up the kiln have been provided to Airlabs.

No estimates of diesel oil and electricity consumption were available to Airlabs at the time of preparing this assessment. As-such estimates for diesel oil and electricity consumption were referenced from the upgraded Plant 2 site at Horsley Park. The estimates were adjusted accordingly based on each plant's annual production throughputs (50 million SBE for the proposed facility as opposed to 80 million SBE for the upgraded Plant 2 site at Horsley Park).

Table 21: Estimates of Fuel and Electricity Consumption at the Bowral Bricks Facility

Parameter	Value	Units	Reference
Diesel Fuel	145.9	kL / annum	Estimated from the upgraded Plant 2 facility at Horsley Park, NSW
Natural Gas	376,200	GJ/annum	Site-specific value
Electricity usage	4176.3	MWh/annum	Estimated from the upgraded Plant 2 facility at Horsley Park, NSW

Estimated annual Scope 1 and 2 GHG emissions, expressed in tonnes of CO_2-e (t CO_2-e/annum) are summarised below in **Table 22**.

Table 22: Annual Scope 1 and 2 GHG Emissions for the Bowral Bricks Facility

Scope	Annual Emissions (t CO_2-e/annum)	Source of Emissions
Scope 1 GHG emissions	19,730.2	Diesel fuel and natural gas consumption
Scope 2 GHG emissions	3,508.1	Electricity consumption
Total Scope 1 and 2 GHG emissions	23,238.3	All sources

The total estimated annual operational GHG emissions from the proposed facility are expected to be approximately 23,238.3 tonnes of carbon dioxide equivalent (CO2-e).

In order to further understand the impacts on a larger scale, the total emissions have been compared against state (NSW) and national (Australia) GHG emissions.

The most recent annual GHG emissions for NSW and Australia have been reported for calendar year 2017. The information has been obtained from the *State and Territory Greenhouse Gas Inventories 2017 – Australia's National Greenhouse Accounts* compiled by the Department of the Environment and Energy, June 2019 (DOEE, 2018)

According to the estimates presented in the 2017 State and Territory inventory, the annual GHG emissions for NSW and Australia in 2017 were 131.5 Mt CO_2-e and 532.8 Mt CO_2-e. The proposed facility annual emissions contribute to approximately 0.02% and 0.004% of the state and national GHG emissions respectively.

Though the contribution of emissions from the proposed facility to the state and national GHG emissions is relatively minimal as observed from comparing the estimated emissions with the state and national inventories, the following recommendations are being made to further minimise the facility's GHG footprint:

- Ensuring proper maintenance and management of stationary and mobile equipment to improve fuel efficiency, which will result in lower fuel consumption.
- Periodic review and implementation of energy efficient measures to minimise electricity consumption.

13. CONCLUSION

Airlabs were commissioned by Willowtree Planning on behalf of Bowral Bricks to conduct an air quality impact assessment in support of a development application for a new brick factory at 416 Berrima Road, Moss Vale. This facility would be developed on Site 2 of the "Chesley Park" acquired by Brickworks in 2013.

As the proposed facility has been categorised an SSD (SSD – 10422), SEARs have been issued for the preparation of the EIS, which include requirements for determination of air quality impacts from the proposed brick manufacturing operations.

The proposed facility is surrounded by general industrial and heavy industrial developments, which include the recently approved Austral Masonry Plant that would be developed on Site 1 of the "Chesley Park" land, the Austral Bricks Quarry, which is to the immediate north of the proposed facility and would be supplying raw materials for the brick manufacturing operations. Boral's cement manufacturing operations which operates one (1 kiln and two (2) cement mills is to the west of the proposed facility. As-such, cumulative assessment of air pollutants from all of these sources forms an integral component of this assessment.

A suite of air quality improvement measures (in comparison to the existing facility) have been proposed, which include – adopting best practice measures to minimise HF emissions from the kiln. A maximum HF discharge concentration of 20 mg/m^3 is being proposed, which is substantially lower than the corresponding POEO standards of concentration. Oher notable improvements include – commissioning of a new kiln which will relatively improve fuel consumption and emissions profile; maintaining a design stack height of 35m, which will aid pollutant dispersion. Significant reduction in fugitive dust emissions is being achieved through raw material stockpile and crusher enclosures and providing sealed haulage surfaces.

Pollutant emission rates from the proposed facility exhaust kiln stack were based on the design concentrations (i.e. the maximum concentrations expected from the stack post commissioning) supplied by the manufacturer and the corresponding volumetric flow rates. Critical stack parameters which influence dispersion namely – exit velocity, stack temperature were provided to Airlabs.

In addition to evaluating impacts from the kiln stack, fugitive dust emissions generated from operational activities were also estimated.

For establishing background concentrations necessary for cumulative assessment, pollutant emission rates for all of the aforementioned existing sources were quantified by referencing publicly available literature. In addition to quantifying impacts from the existing sources, ambient concentrations measured at the Bargo monitoring station were also considered for the cumulative assessment.

Modelling was undertaken using the US-EPA non-steady state CALPUFF dispersion model.

Modelling shows that the incremental impacts (i.e. contribution from the proposed facility only) are not expected to have an adverse impact on the overall air quality levels in the surrounding region.

Cumulative assessment of the modelled pollutants demonstrate compliance with the assessment criteria at all of the identified sensitive receptors, with the exception of the 24-hour average PM_{10} cumulative concentrations. A refined assessment of the 24-hour average PM_{10} cumulative concentrations was undertaken, which showed that no additional exceedances are expected due to the commissioning of the proposed facility.

Scope 1 and 2 GHG emissions are low when compared to the state and national greenhouse gas inventories, with the operations contributing to approximately 0.02% and 0.004% of the state and national GHG emissions respectively.

Overall, the findings from the dispersion modelling show low-level impacts from the proposed Bowral Bricks facility.

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NSW-EPA (2017): Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, NSW- Environment Protection Authority, EPA 2016/0666, January 2017

NSW-EPA (2020): Attachment A – Environmental Assessment Requirements, Proposed New Berrima Brickworks Facility, 416 and 524 Berrima Road, Moss Vale, 21 January 2020

NSW-OEH (2011): 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 (2017) (a): Air Quality Monitoring Data from the Bargo Air Quality Monitoring Station

NSW-OEH (2017) (b): Clearing the Air – New South Wales Air Quality Statement 2017

POEO (1997): Part 5.4 – Air Pollution, Protection of the Environment Operations Act 1997

SLR (2015): Modified New Berrima Clay / Shale Quarry, PA08_0212, Air Quality Assessment, Report No: 744/16, SLR Global Environmental Solutions, March 2015

SRC (2000): A User's Guide for the CALMET Meteorological Model

SRC (2011): CALPUFF Modeling System Version 6 User Instructions, April 2011

SRTM (2000): Shuttle Radar Topography Mission SRTM 1 Arc-Second Global data, downloaded from USGS website.

US-EPA (2004) United States Environmental Protection Agency AP-42 Emission Factors – Chapter 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing

US-EPA (2011) United States Environmental Protection Agency AP-42 Emission Factors – Chapter 13.2.1 Paved Roads

US-EPA (2006) United States Environmental Protection Agency AP-42 Emission Factors – Chapter 13.2.4 Aggregate Handling and Storage Piles

Willowtree Planning (2020): Request for Secretary's Environmental Assessment Requirements, Proposed New Berrima Brickworks Facility, 416 and 524 Berrima Road, Moss Vale, January 2020

WRI/WBSCD (2004): The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition, published by the World Resources Institute / World Business Council for Sustainable Development (WRI/WBCSD)

APPENDIX A

Fugitive Dust Emissions Inventory Background

Fugitive Dust Emissions

Fugitive dust emissions (TSP, PM_{10} and $PM_{2.5}$) have been estimated based on site-specific operational activities provided by Bowral Bricks and utilising emission factors from emission estimation technique (EET) manuals listed below:

- National Pollutant Inventory (NPI), *Emission Estimation Technique Manual for Mining*, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012 (NPI, 2012).
- AP-42 Emission Factors, *Chapter 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing*, United States Environmental Protection Agency (US-EPA 2004).
- AP-42 Emission Factors, *Chapter 13.2.4 Aggregate Handling and Storage Piles*, United States Environmental Protection Agency (US-EPA 2006); and
- AP-42 Emission Factors, *Chapter 13.2.1 Paved Roads*, United States Environmental Protection Agency (US-EPA 2011).

Fugitive dust emissions and source parameters for the existing facilities / operations, have been referenced from the following:

- Austral Masonry Plant – Airlabs, 2018.
- Austral Bricks Quarry – SLR, 2015 & Heggies, 2010.
- Boral Cement Plant – 2017-18 NPI published emissions report & Air Quality Professionals, 2015.

Dust generating activities along with corresponding emission factor and key variables used to estimate annual TSP, PM_{10} and $PM_{2.5}$ emissions at the proposed facility are summarised in **Table A.1**.

Dust control efficiencies adopted in developing the emissions inventory operations are summarised in **Table A.2**.

Table A.1: Emission Factors and Key Variables for Estimating Fugitive Dust (TSP, PM_{10} and $PM_{2.5}$) Emissions

Activity	Emission Factor	Key Variables and Assumptions	Source of Emission Factor
Trucks unloading raw materials into the drive-over bin	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	k_{TSP} = 0.74 k_{PM10} = 0.35 $k_{PM2.5}$ = 0.053 U – mean wind speed predicted by CALMET – 3.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Conveying raw material to the crusher hopper	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	k_{TSP} = 0.74 k_{PM10} = 0.35 $k_{PM2.5}$ = 0.053 U – mean wind speed predicted by CALMET – 3.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Crushing operations	$E_{TSP} = 0.0006\ kg/t$ $E_{PM10} = 0.00027\ kg/t$ $E_{PM2.5} = 0.00005\ kg/t$	Controlled crushing – water sprays and enclosed operations	AP-42, Chapter 11.19.2 – Crushed Stone Processing and Pulverised Mineral Processing
Conveying crushed material into the raw material storage building	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	k_{TSP} = 0.74 k_{PM10} = 0.35 $k_{PM2.5}$ = 0.053 U – mean wind speed predicted by CALMET – 3.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Loading of crushed raw materials into temporary stockpiles in the raw materials storage building	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	k_{TSP} = 0.74 k_{PM10} = 0.35 $k_{PM2.5}$ = 0.053 U – mean wind speed predicted by CALMET – 3.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Loading crushed raw material into the surge bin conveyor	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	k_{TSP} = 0.74 k_{PM10} = 0.35 $k_{PM2.5}$ = 0.053 U – mean wind speed predicted by CALMET – 3.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Conveying raw materials to the surge bin	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	k_{TSP} = 0.74 k_{PM10} = 0.35 $k_{PM2.5}$ = 0.053 U – mean wind speed predicted by CALMET – 3.2 m/sec	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles

Activity	Emission Factor	Key Variables and Assumptions	Source of Emission Factor
		M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	
Heavy vehicle haulage on paved surface	$E = k\ (sl)^{0.91}(W)^{1.02}$	k_{TSP} = 3.23 g/VKT k_{PM10} = 0.62 g/VKT $k_{PM2.5}$ = 0.15 g/VKT sl – road surface silt loading (g/m²) – 0.6 g/m² (AP-42, Chapter 13.2.1 – Paved Roads, Table 13.2.1-2, silt loading for < 500 vehicles / day) W – Average vehicle weight – 34 tons (mean vehicle weight) VKT/annum • Raw material delivery – 4,013 • Product dispatch – 4,974	AP-42, Chapter 13.2.1 – Paved Roads

Table A.2: Fugitive Dust Control Measures and Quantifiable Emission Reduction Factors

Fugitive Dust Control Measure	Emission Reduction Efficiency	Source
Enclosed conveyors	70%	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012
Enclosed crushing operation	70%	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012
Total enclosure for stockpiles	99% (a)	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012

(a) As total enclosure of stockpiles provides 99% emission reduction efficiency, which is the case with the proposed facility, wind erosion emissions from stockpiles have not been estimated.

TSP, PM_{10} and $PM_{2.5}$ emission calculations for the proposed facility are illustrated in **Figure A.1** through to **FigureA.3**.

Figure A.1: Annual Fugitive TSP Emission Estimates – Proposed Facility

Activity	TSP Emissions (kg/year)	Intensity	Units	TSP Emission Factor	Units	Variable 1	Units	Variable 2	Units	Control Efficiency	Units	Operational Hours
Haul trucks unloading raw material - driver-over bin	8.1	190,000	tonnes per annum	0.00014	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Conveying raw material to crusher hopper	8.1	190,000	tonnes per annum	0.00014	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Crusher operations	114.0	190,000	tonnes per annum	0.0006	kg/t							6AM - 6PM, 7 days of the week
Conveying crushed raw materials to the raw material storage building	8.1	190,000	tonnes per annum	0.00014	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Loading of crushed raw materials into temporary stockpiles in the raw materials storage building	8.1	190,000	tonnes per annum	0.00014	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Loading crushed raw material into the surge bin conveyor	8.1	190,000	tonnes per annum	0.00014	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Conveying raw materials to the surge bin	8.1	190,000	tonnes per annum	0.00014	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Heavy vehicle haulage - raw material delivery - paved surface	293.7	4,013	vkt/annum	0.073	kg/vkt	0.60	silt loading (g/m2)	34	tons (avg wt of vehicle travelling)			6AM - 6PM, 7 days of the week
Heavy vehicle haulage - product dispatch - paved surface	364.1	4,974	vkt/annum	0.073	kg/vkt	0.60	silt loading (g/m2)	34	tons (avg wt of vehicle travelling)			6AM - 6PM, 7 days of the week
Total TSP Emissions (kg/year)	**820.2**											

Figure A.2: Annual Fugitive PM_{10} Emission Estimates – Proposed Facility

Activity	PM10 Emissions (kg/year)	Intensity	Units	PM10 Emission Factor	Units	Variable 1	Units	Variable 2	Units	Control Efficiency	Units	Operational Hours
Haul trucks unloading raw material - driver-over bin	3.8	190,000	tonnes per annum	0.00007	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Conveying raw material to crusher hopper	3.8	190,000	tonnes per annum	0.00007	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Crusher operations	51.3	190,000	tonnes per annum	0.00027	kg/t							6AM - 6PM, 7 days of the week
Conveying crushed raw materials to the raw material storage building	3.8	190,000	tonnes per annum	0.00007	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Loading of crushed raw materials into temporary stockpiles in the raw materials storage building	3.8	190,000	tonnes per annum	0.00007	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Loading crushed raw material into the surge bin conveyor	3.8	190,000	tonnes per annum	0.00007	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Conveying raw materials to the surge bin	3.8	190,000	tonnes per annum	0.00007	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Heavy vehicle haulage - raw material delivery - paved surface	56.4	4,013	vkt/annum	0.014	kg/vkt	0.60	silt loading (g/m2)	34	tons (avg wt of vehicle travelling)			6AM - 6PM, 7 days of the week
Heavy vehicle haulage - product dispatch - paved surface	69.9	4,974	vkt/annum	0.014	kg/vkt	0.60	silt loading (g/m2)	34	tons (avg wt of vehicle travelling)			6AM - 6PM, 7 days of the week
Total PM10 Emissions (kg/year)	**200**											

Figure A.3: Annual Fugitive $PM_{2.5}$ Emission Estimates – Proposed Facility

Activity	PM2.5 Emissions (kg/year)	Intensity	Units	PM2.5 Emission Factor	Units	Variable 1	Units	Variable 2	Units	Control Efficiency	Units	Operational Hours
Haul trucks unloading raw material - driver-over bin	0.6	190,000	tonnes per annum	0.00001	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Conveying raw material to crusher hopper	0.6	190,000	tonnes per annum	0.00001	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Crusher operations	9.5	190,000	tonnes per annum	0.00005	kg/t							6AM - 6PM, 7 days of the week
Conveying crushed raw materials to the raw material storage building	0.6	190,000	tonnes per annum	0.00001	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Loading of crushed raw materials into temporary stockpiles in the raw materials storage building	0.6	190,000	tonnes per annum	0.00001	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Loading crushed raw material into the surge bin conveyor	0.6	190,000	tonnes per annum	0.00001	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Conveying raw materials to the surge bin	0.6	190,000	tonnes per annum	0.00001	kg/t	1.64	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4	70	% Control	6AM - 6PM, 7 days of the week
Heavy vehicle haulage - raw material delivery - paved surface	13.6	4,013	vkt/annum	0.003	kg/vkt	0.60	silt loading (g/m2)	34	tons (avg wt of vehicle travelling)			6AM - 6PM, 7 days of the week
Heavy vehicle haulage - product dispatch - paved surface	16.9	4,974	vkt/annum	0.003	kg/vkt	0.60	silt loading (g/m2)	34	tons (avg wt of vehicle travelling)			6AM - 6PM, 7 days of the week
Total PM2.5 Emissions (kg/year)	**44**											

APPENDIX B

Selection of Meteorological Year

Analysis of the meteorological data recorded at the site-representative location – BoM Moss Vale AWS (AWS No: 068239) over a five (5) year period between 2013-2017 has been undertaken.

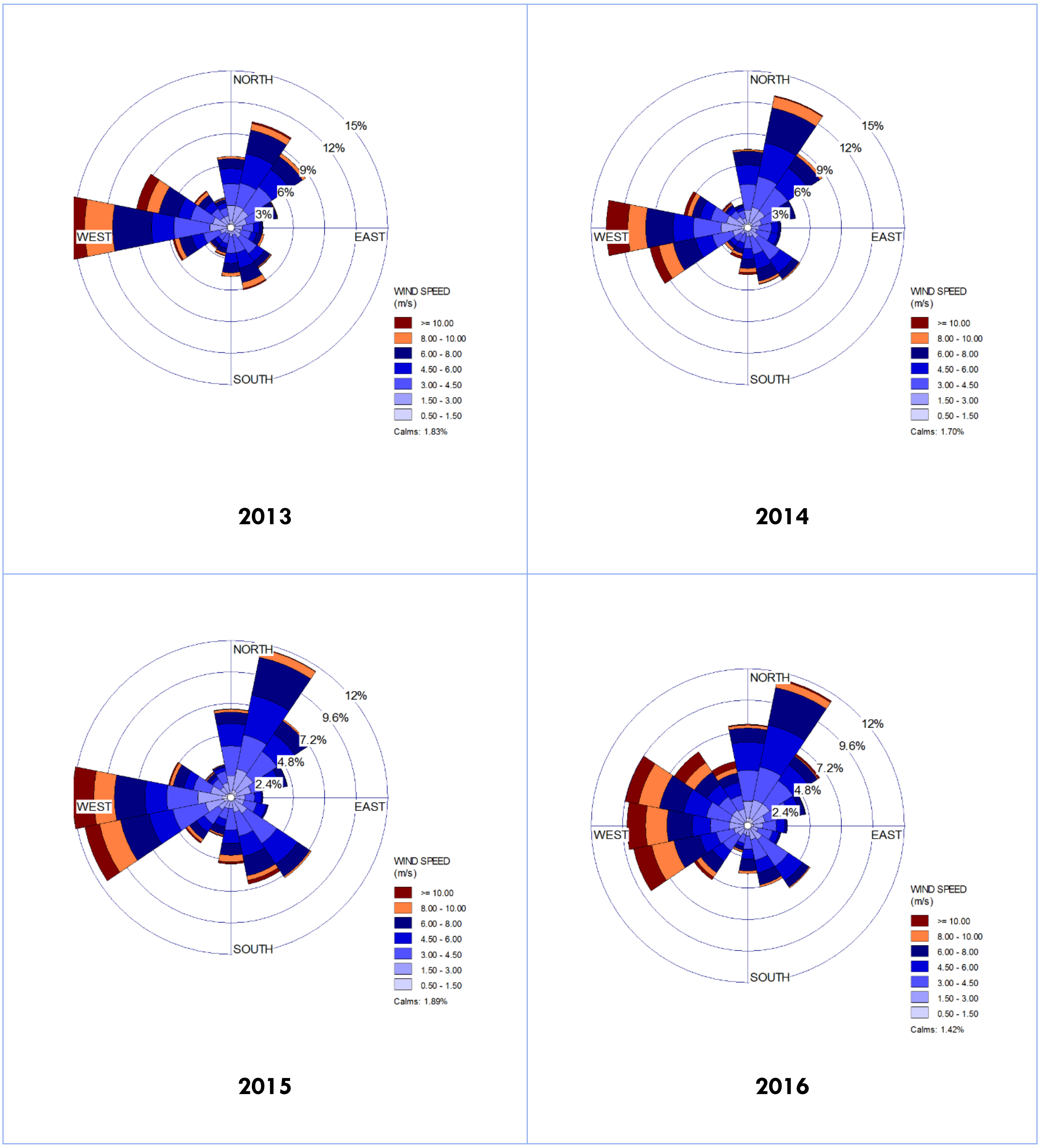
The following charts have been produced to compare the one-year site-representative data (2017) with five (5) year observations and to support the selection of the 2017 meteorological modelling year.

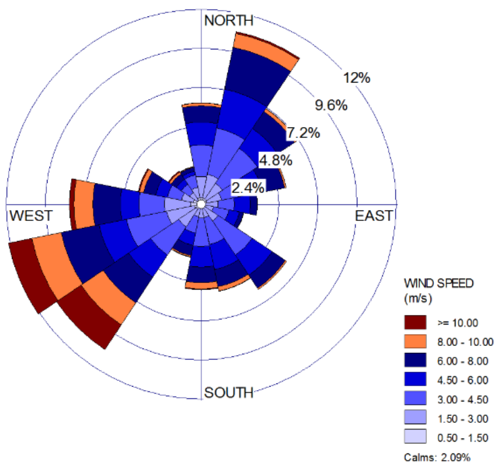
- Interannual (2013-2017) wind roses – BoM Moss Vale AWS.
- Interannual (2013-2017) mean maximum and mean minimum temperature profiles – BoM Moss Vale AWS
- Interannual (2013-2017) wind speed frequency distribution chart – BoM Moss Vale AWS.
- Interannual (2013-2017) percentage of calms – BoM Moss Vale AWS.

Additionally, the following metrics have been produced from the CALMET output at the centre of the proposed facility as these parameters are not readily measured by the BoM stations. It is to be noted that the distance between the BoM AWS and the proposed facility site is approximately 6.7km. As the separation distance is not large enough, the below parameters can be considered representative for the BoM location.

- 2013-17 stability class frequency distribution – extracted from the CALMET output at the centre of the proposed facility.
- 2013-17 mixing height frequency distribution – extracted from the CALMET output at the centre of the proposed facility.

Figure B.1: Inter-Annual Wind Roses – BoM Moss Vale AWS – 2013 to 2017





2017

Figure B.2: Inter-Annual Mean Maximum Temperature Profile – BoM Moss Vale AWS – 2013 to 2017

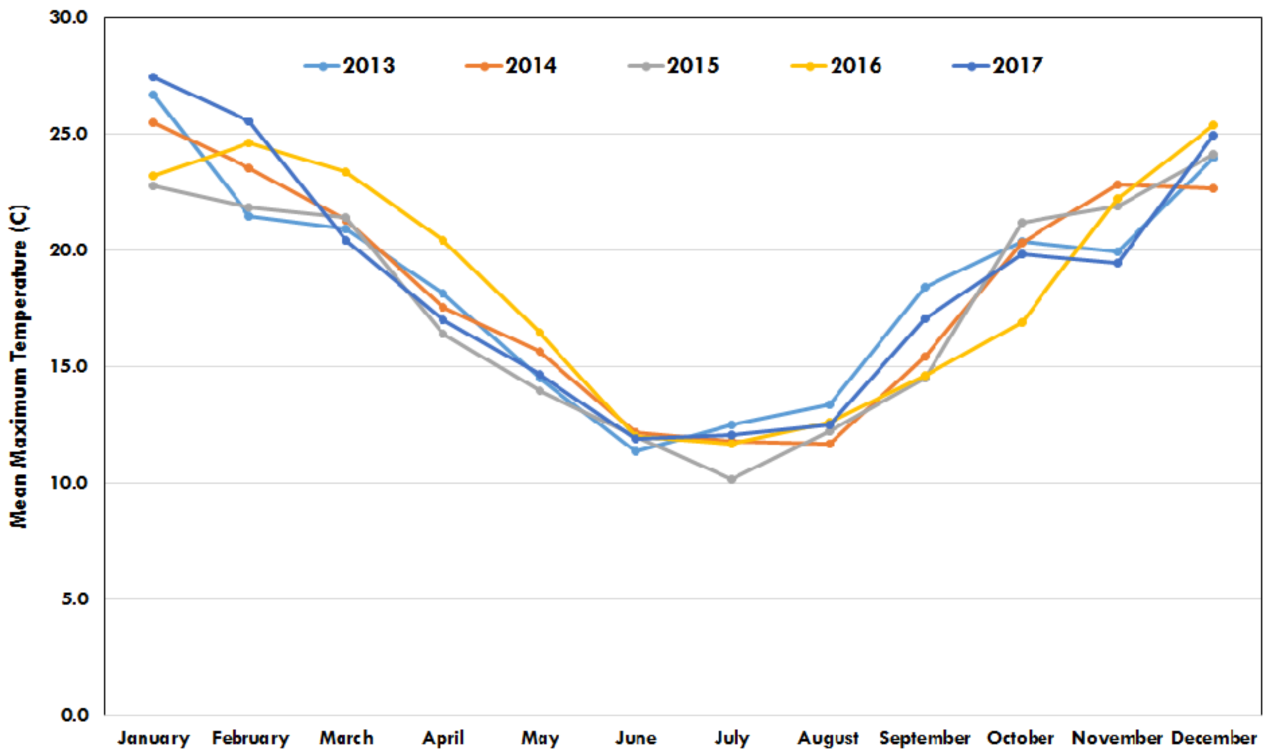


Figure B.3: Inter-Annual Mean Minimum Temperature Profile – BoM Moss Vale AWS – 2013 to 2017

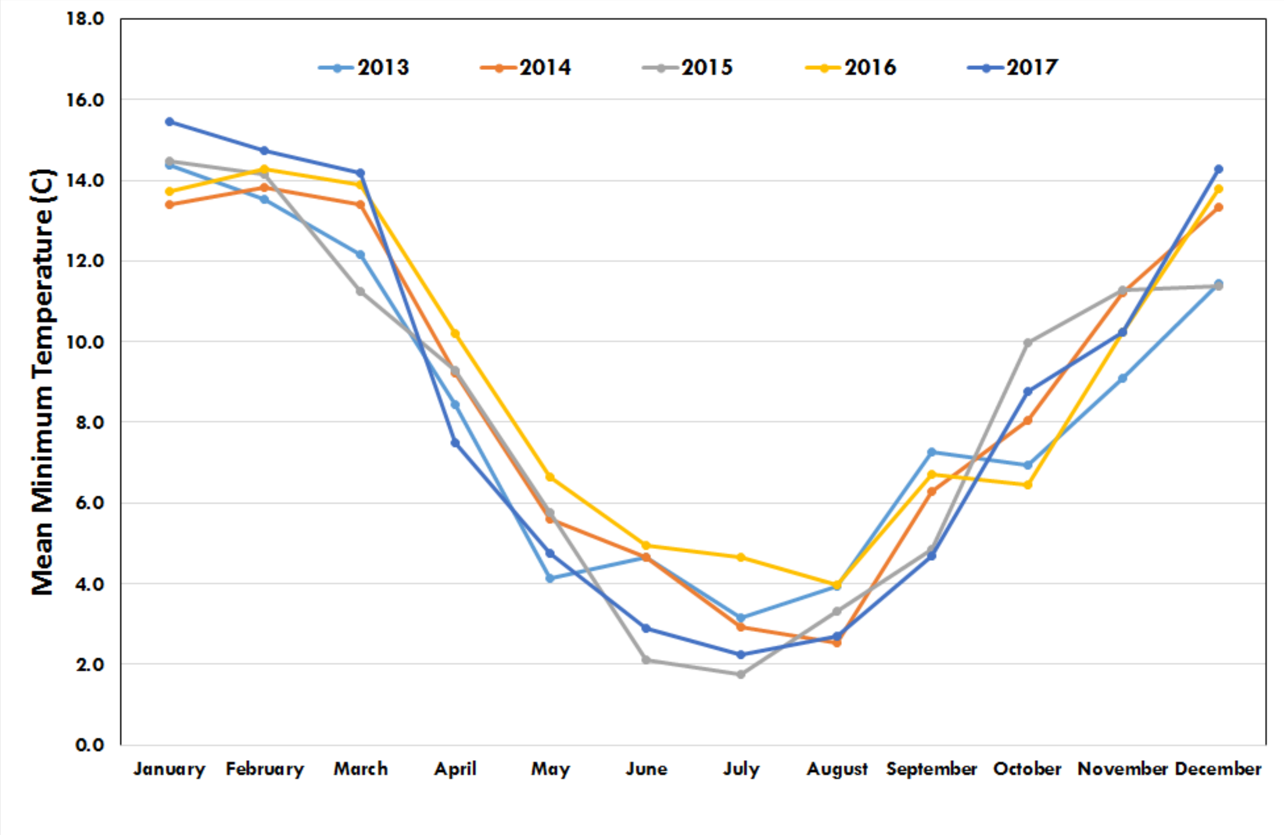


Figure B.4: Inter-Annual Wind Speed Frequency – BoM Moss Vale AWS – 2013 to 2017

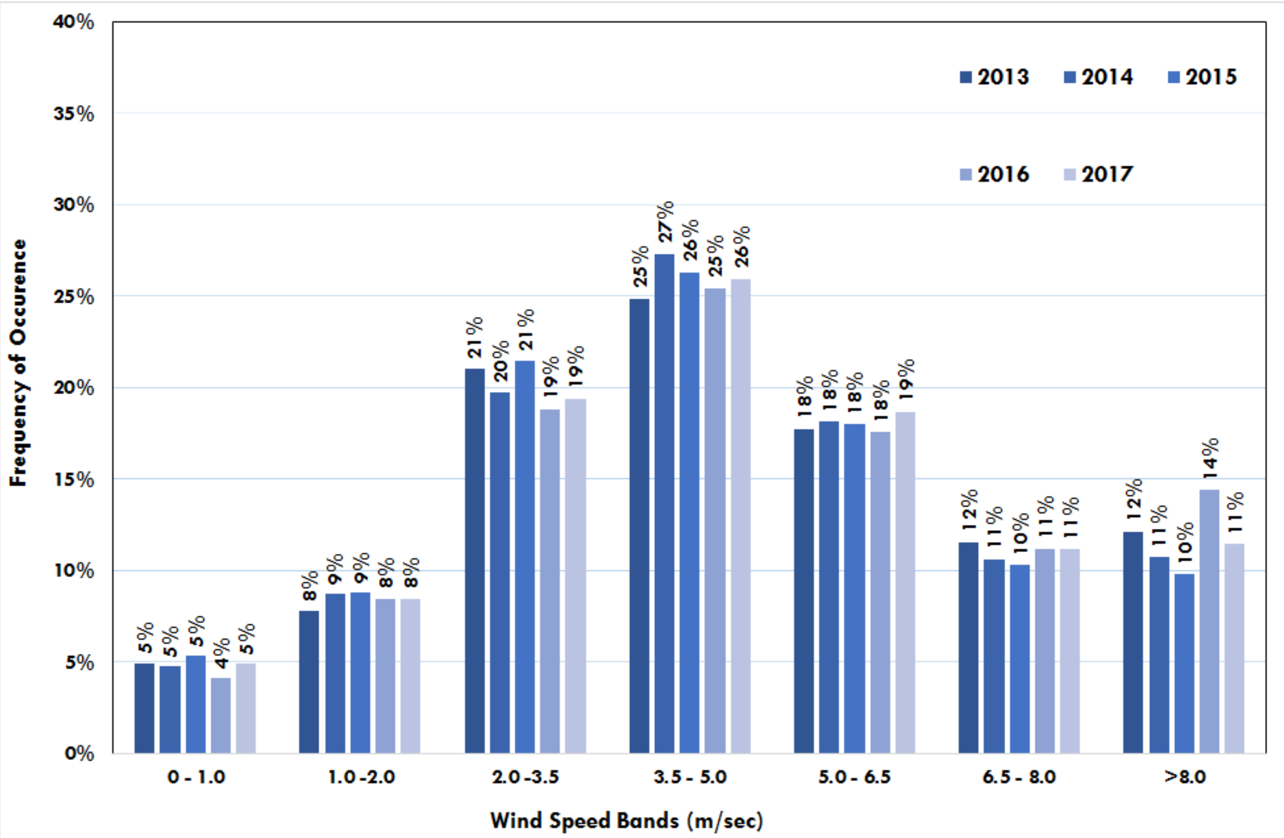


Figure B.5: Inter-Annual Calms Percentage – BoM Moss Vale AWS – 2013 to 2017

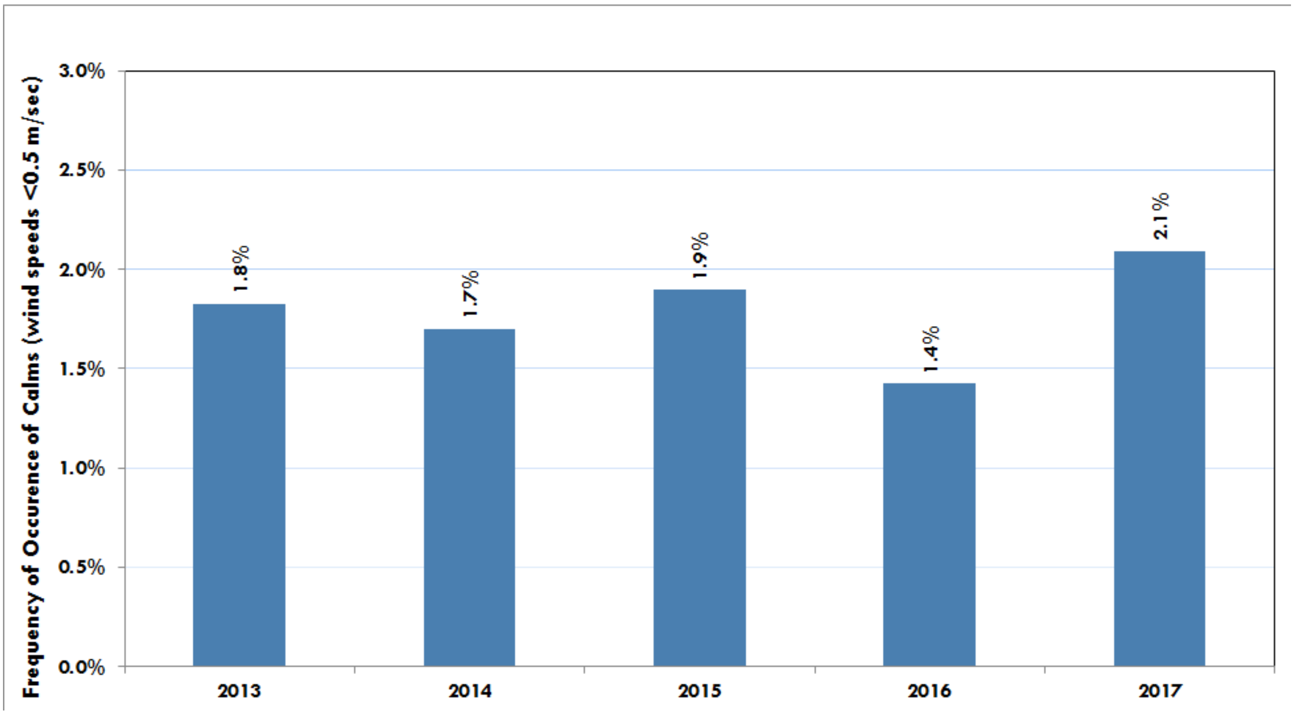
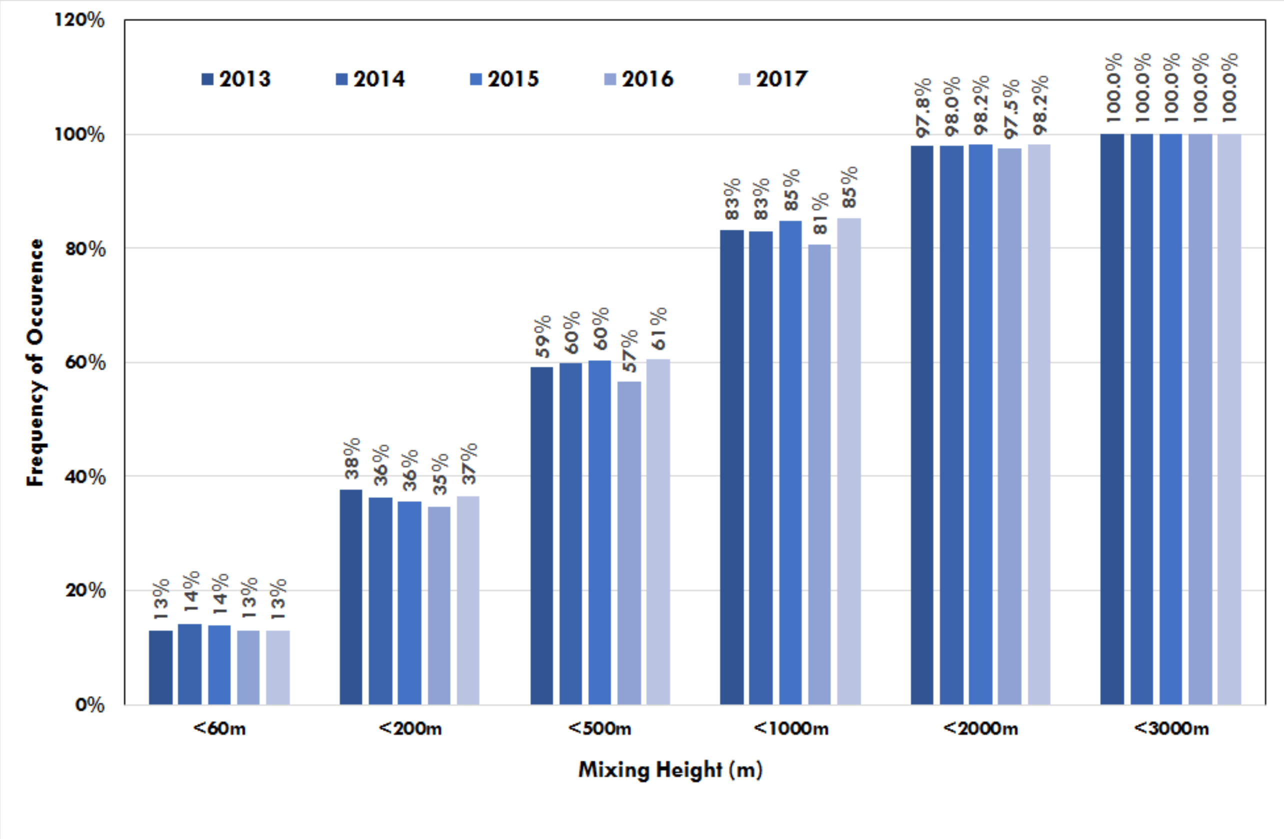


Figure B.6: Inter Annual CALMET Predicted Stability Class Frequency Distribution – extracted from the CALMET output at the centre of the proposed facility

Figure B.7: Inter Annual CALMET Mixing Height Profile Frequency Distribution – extracted from the CALMET output at the centre of the proposed facility



Interannual analysis presented in **Figure B.1** through to **Figure B.7** shows that there is minimal inter-annual variation in the winds measured across this period. Therefore, the 2017 calendar year is considered site representative.

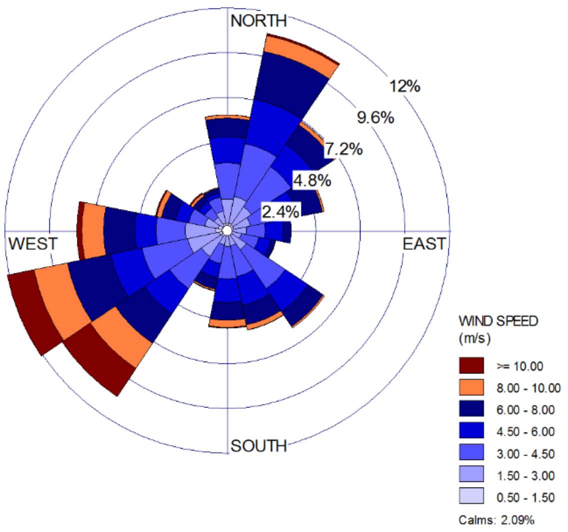
To demonstrate that the CALMET output for 2017 adequately represents the expected meteorological patterns at the site, the following charts have been produced:

- Comparison of the 2017 annual wind roses and percentage of calms for the BoM Moss Vale AWS and CALMET predicted output at the centre of the proposed facility.
- Comparison of the 2017 wind speed frequency distribution for BoM Moss Vale AWS and CALMET predicted output at the centre of the proposed facility.

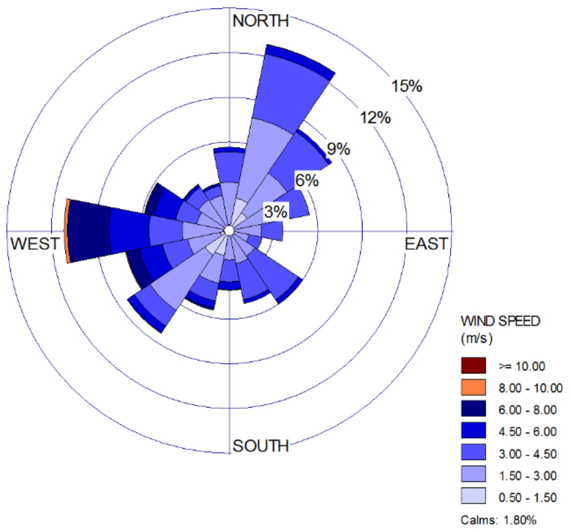
From the annual wind speed comparison, higher wind speeds were observed from the Moss Vale AWS as compared to CALMET predictions for the modelled year – i.e. 2017. It is to be noted that the Moss Vale AWS is located approximately 6.7 km east-south east of the proposed facility and the difference in local terrain features at both the sites may have led to slightly dissimilar wind profiles.

Moreover, lower wind speeds predicted by CALMET may result in poor dispersion of pollutants resulting in a conservative impact assessment

Figure B.8: Comparison of Annual Wind Roses for 2017 - BoM Moss Vale AWS Observations (Left) vs CALMET Predicted Wind Field (Right) at the centre of the Plant 2 site

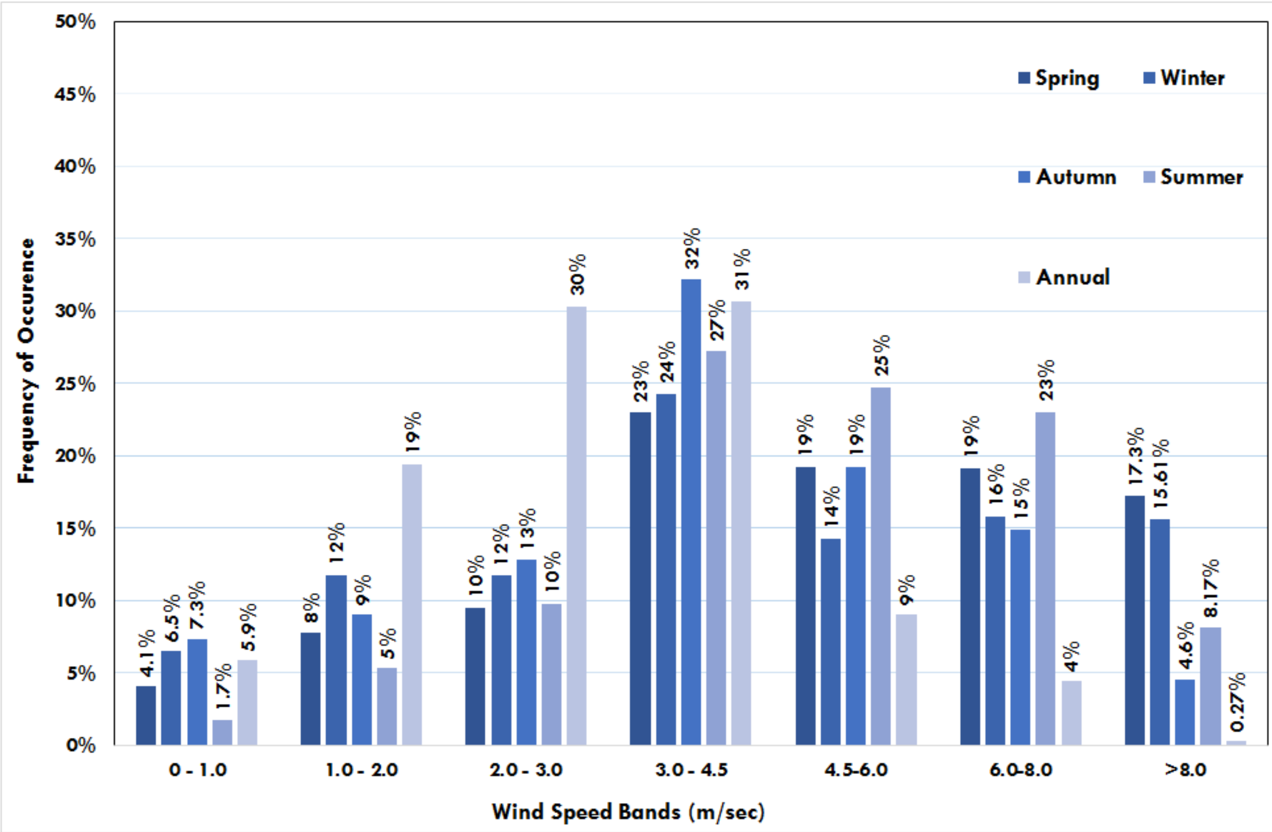


Annual Wind Rose – BoM Moss Vale AWS, 2017

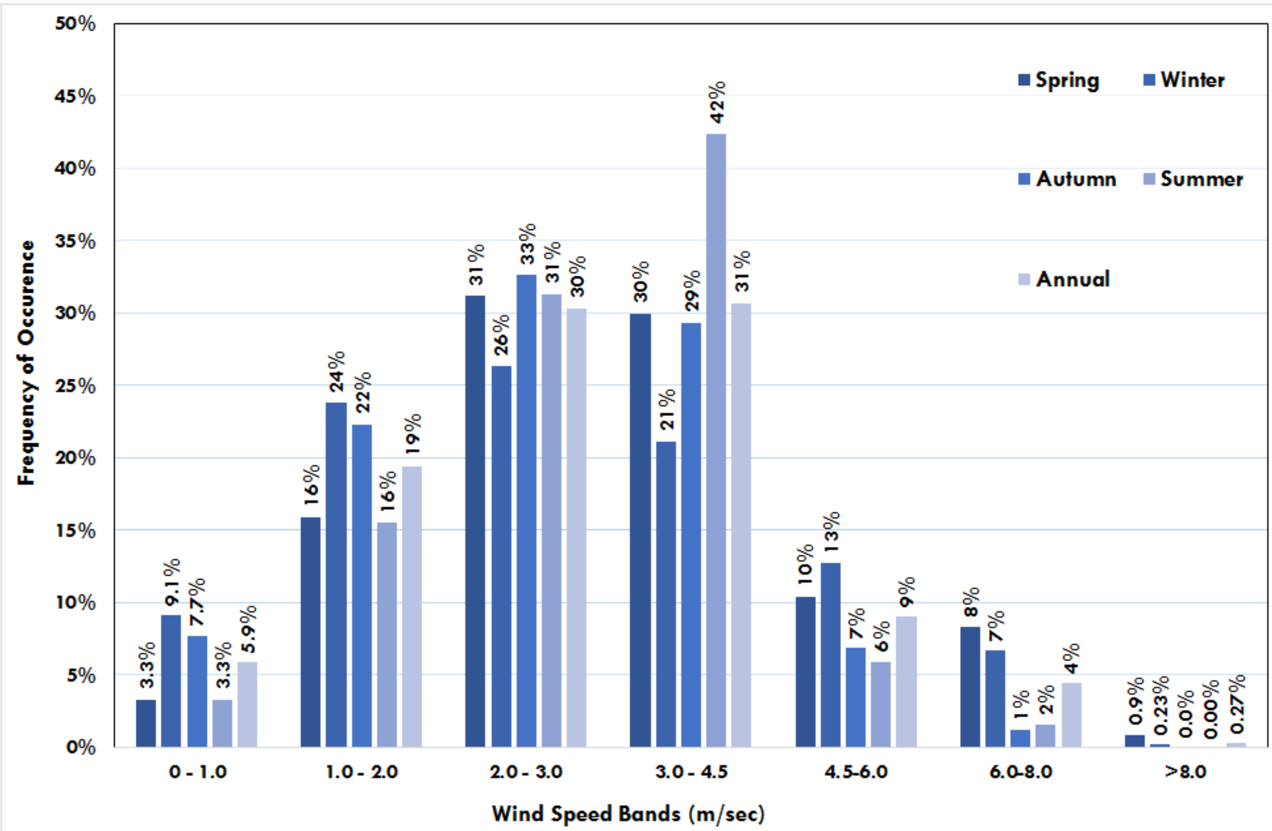


Annual Wind Rose – CALMET Predicted, 2017

Figure B.9: Comparison of 2017 Wind Speed Frequency Distribution for BoM Moss Vale AWS (Above) and CALMET predicted output (Below) at the centre of the proposed facility



BoM AWS Moss Vale - 2017



CALMET Predicted – 2017

APPENDIX C

Concentration Isopleths of Key Pollutants

Figure C.1: Incremental 1-hour average 99.9th percentile sulfuric acid concentrations (μg/m³) (Assessment criteria: 18 μg/m³)

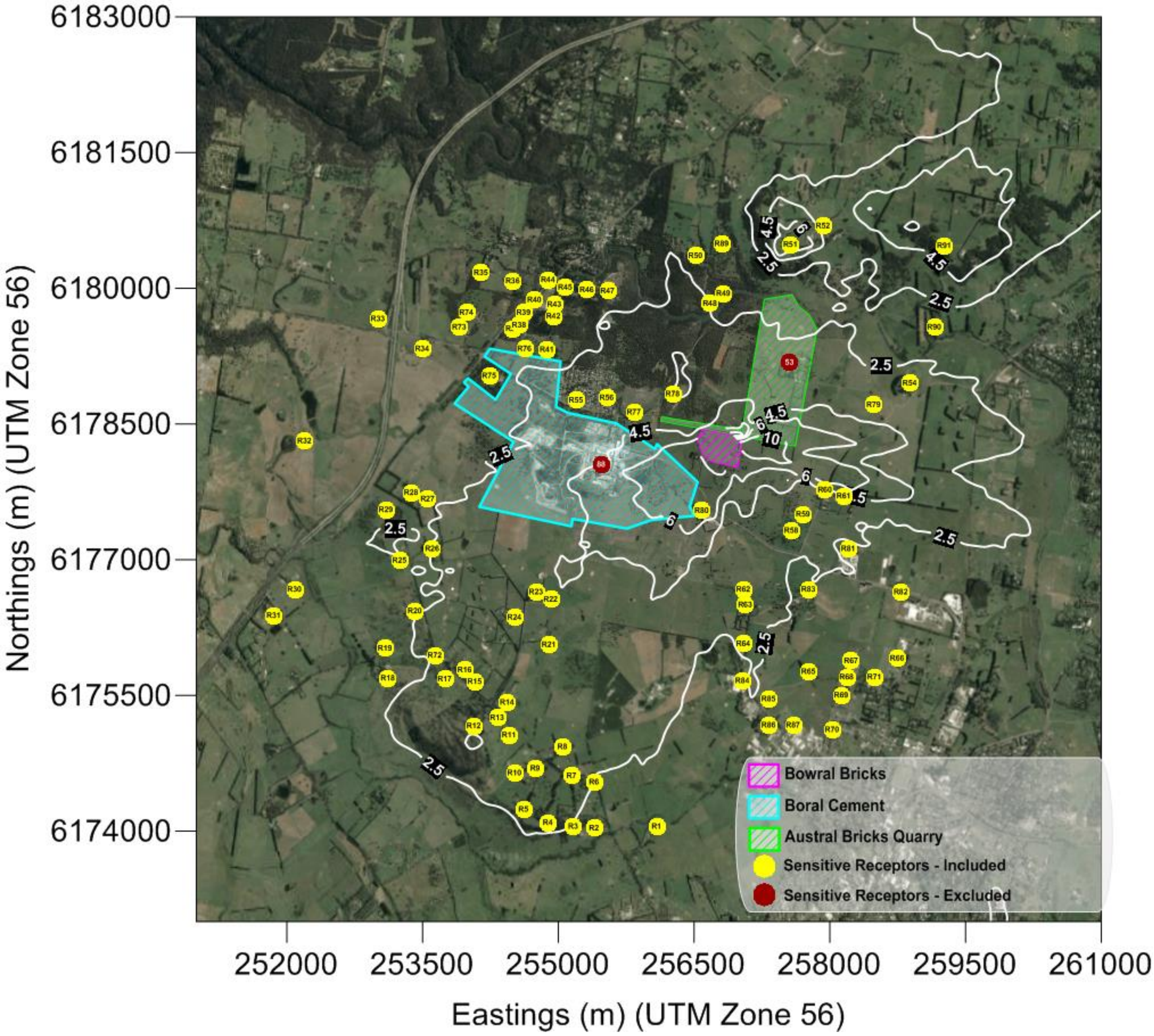


Figure C.2: Incremental 24-hour average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 2.9 μg/m³ – red contour)

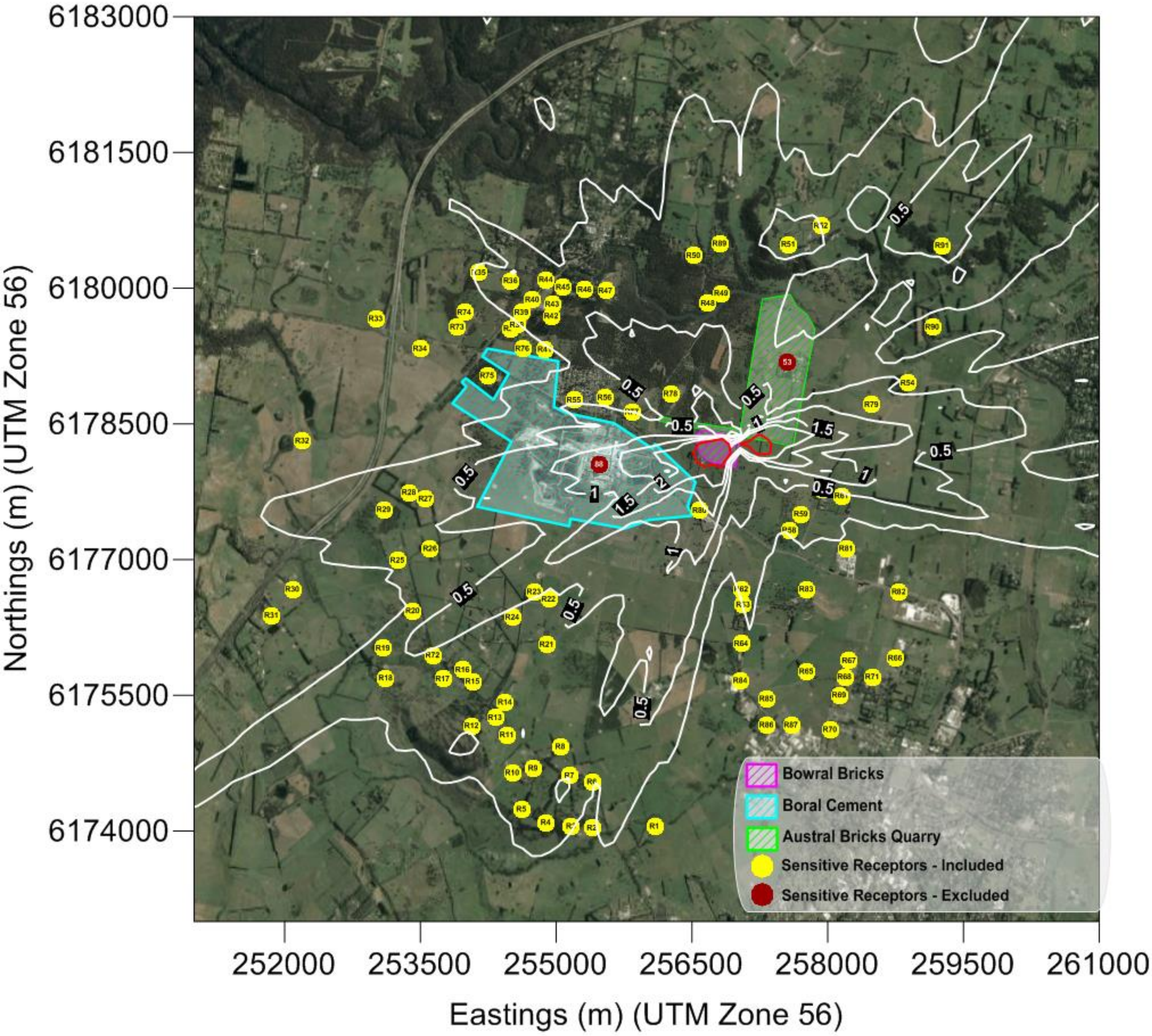


Figure C.3: Incremental 7-day average maximum HF concentrations (µg/m³) (General land-use assessment criteria: 1.7 µg/m³ – red contour)

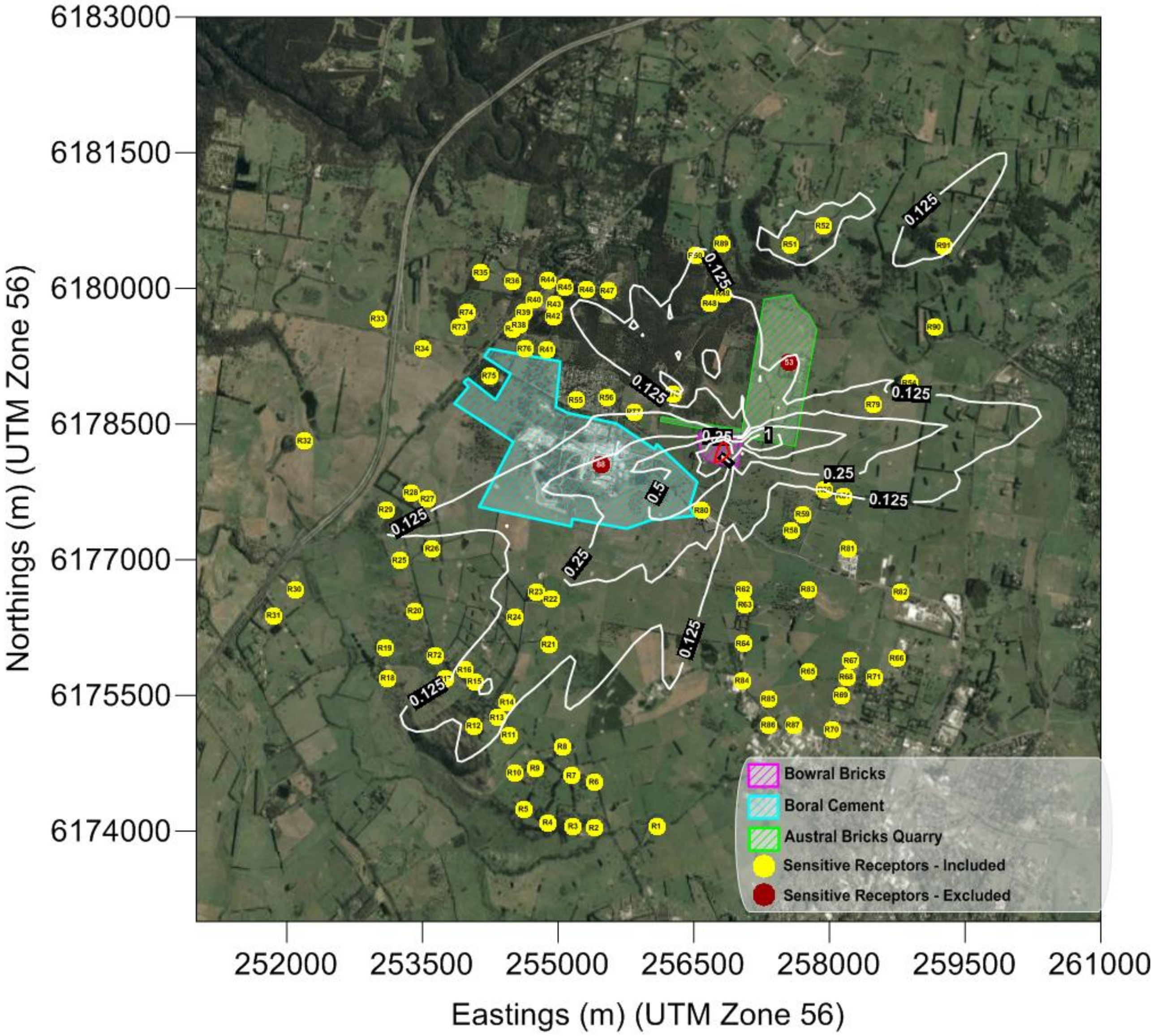


Figure C.4: Incremental 30-day average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 0.84 μg/m³ – red contour)

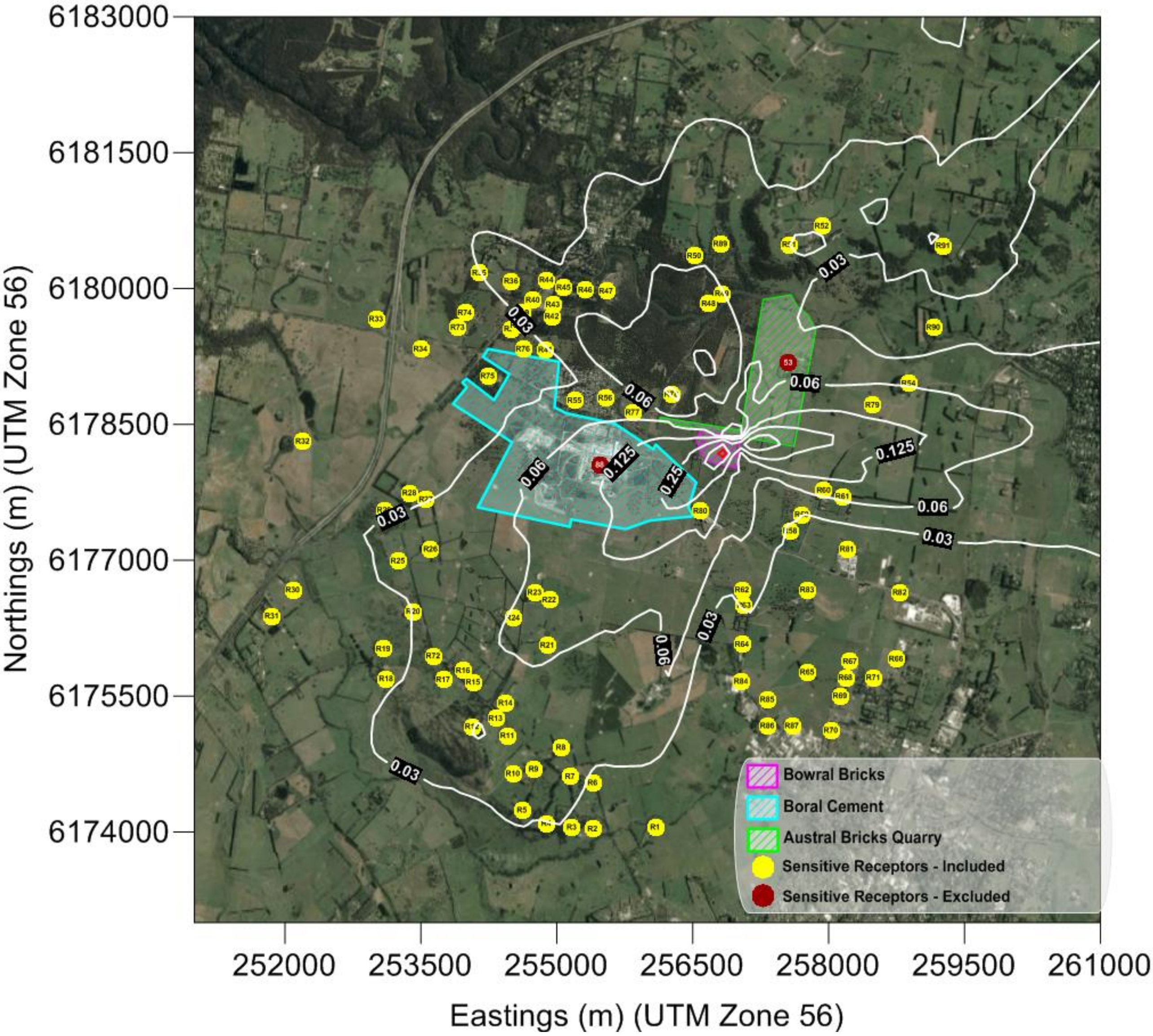


Figure C.5: Incremental 90-day average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 0.5 μg/m³ – red contour)

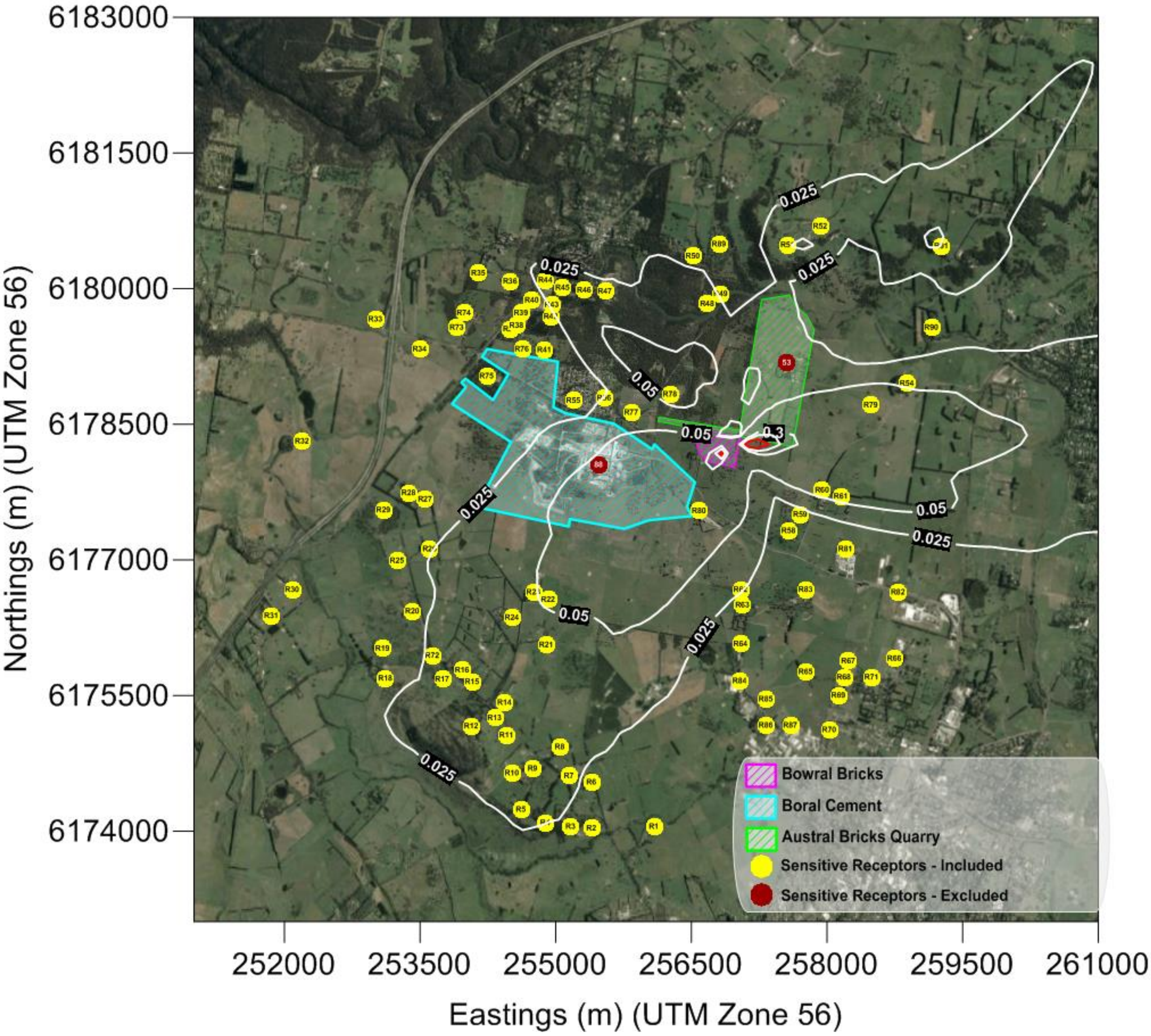


Figure C.5: Incremental 1-hour average maximum NO_2 concentrations ($\mu g/m^3$) (Assessment criteria: 246 $\mu g/m^3$ – red contour)

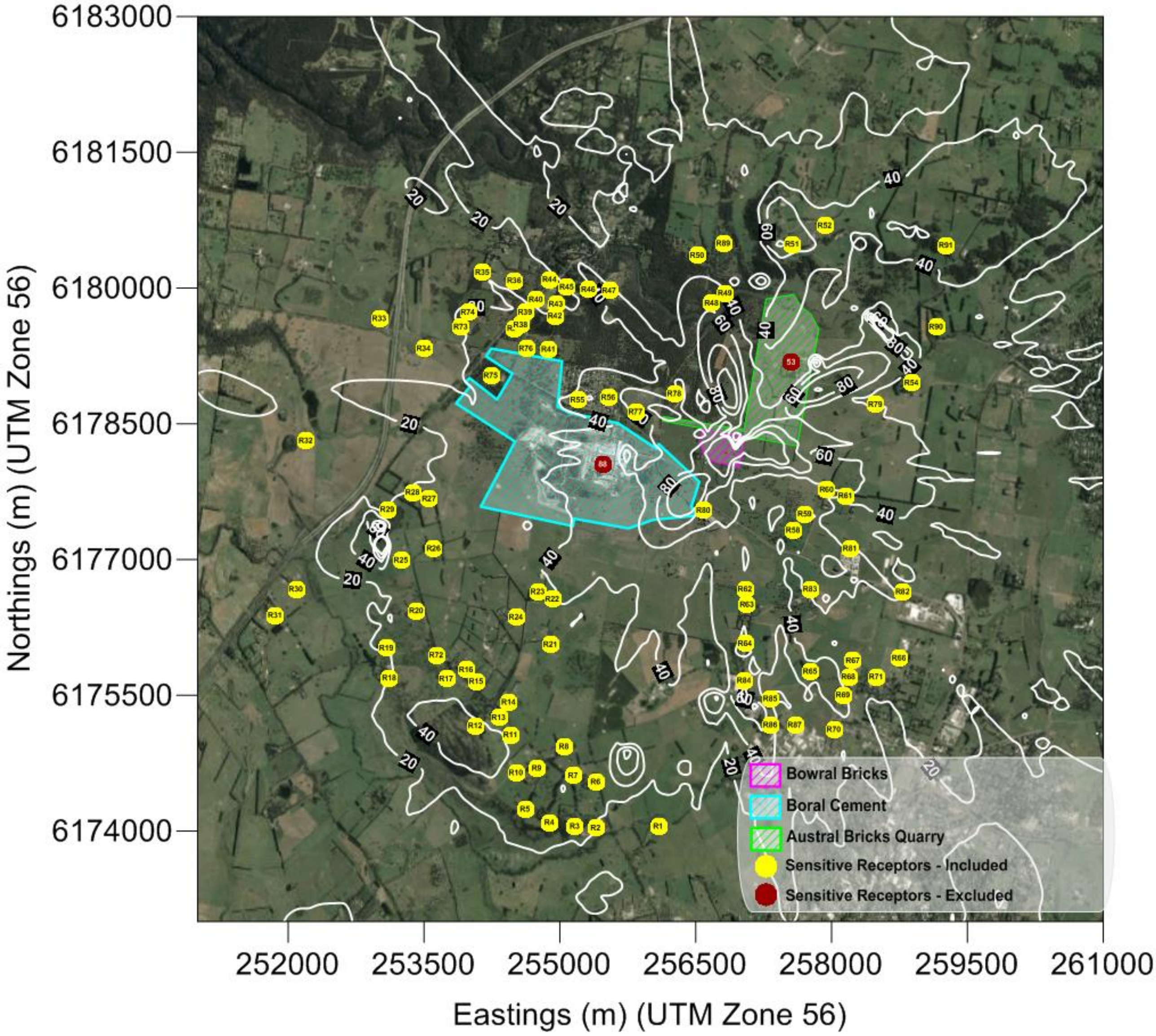


Figure C.6: Incremental 24-hour average maximum PM_{10} concentrations ($\mu g/m^3$) (Assessment criteria: 50 $\mu g/m^3$ – red contour)

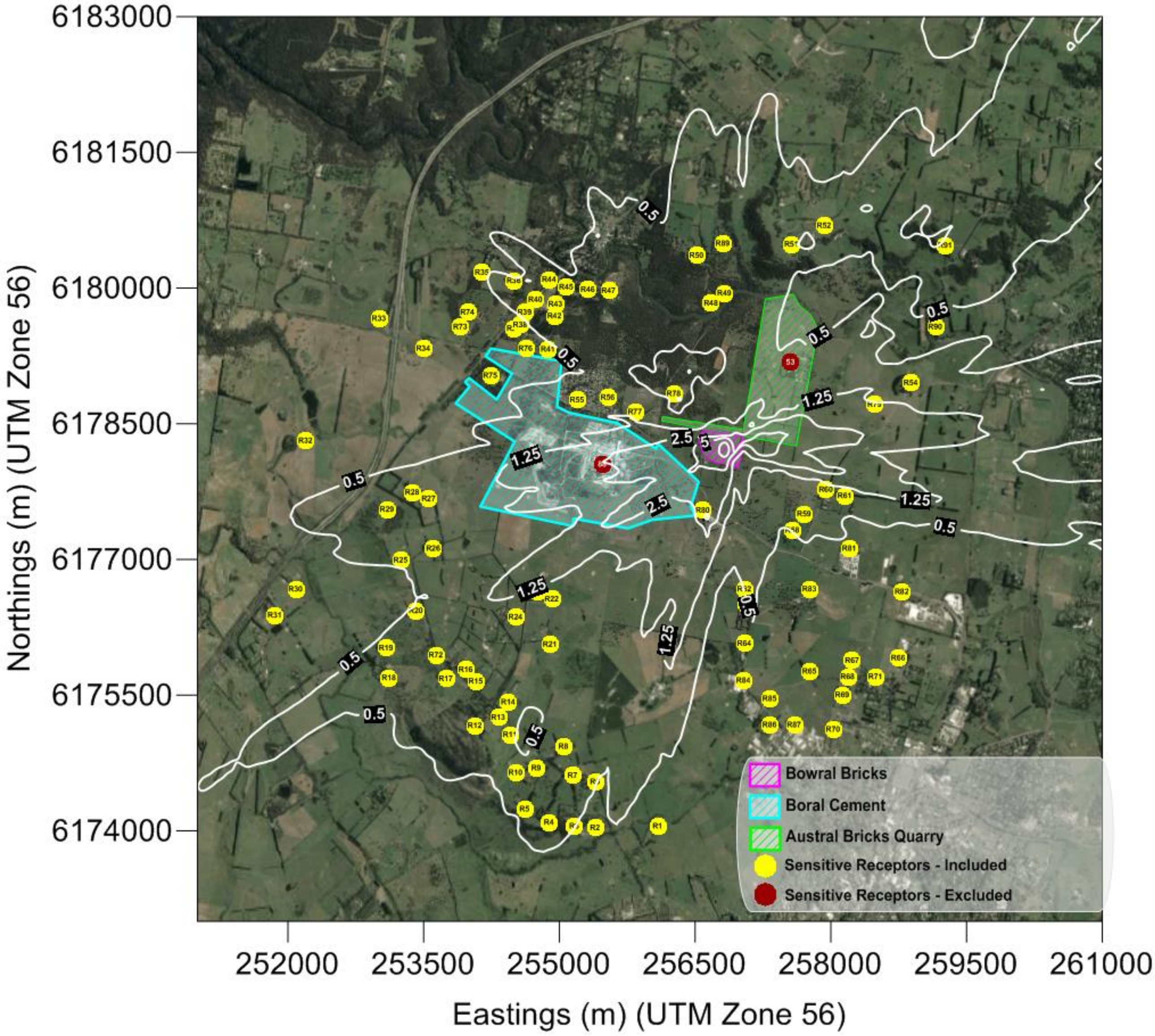


Figure C.7: Incremental 24-hour average maximum $PM_{2.5}$ concentrations (µg/m³) (Assessment criteria: 25 µg/m³ – red contour)

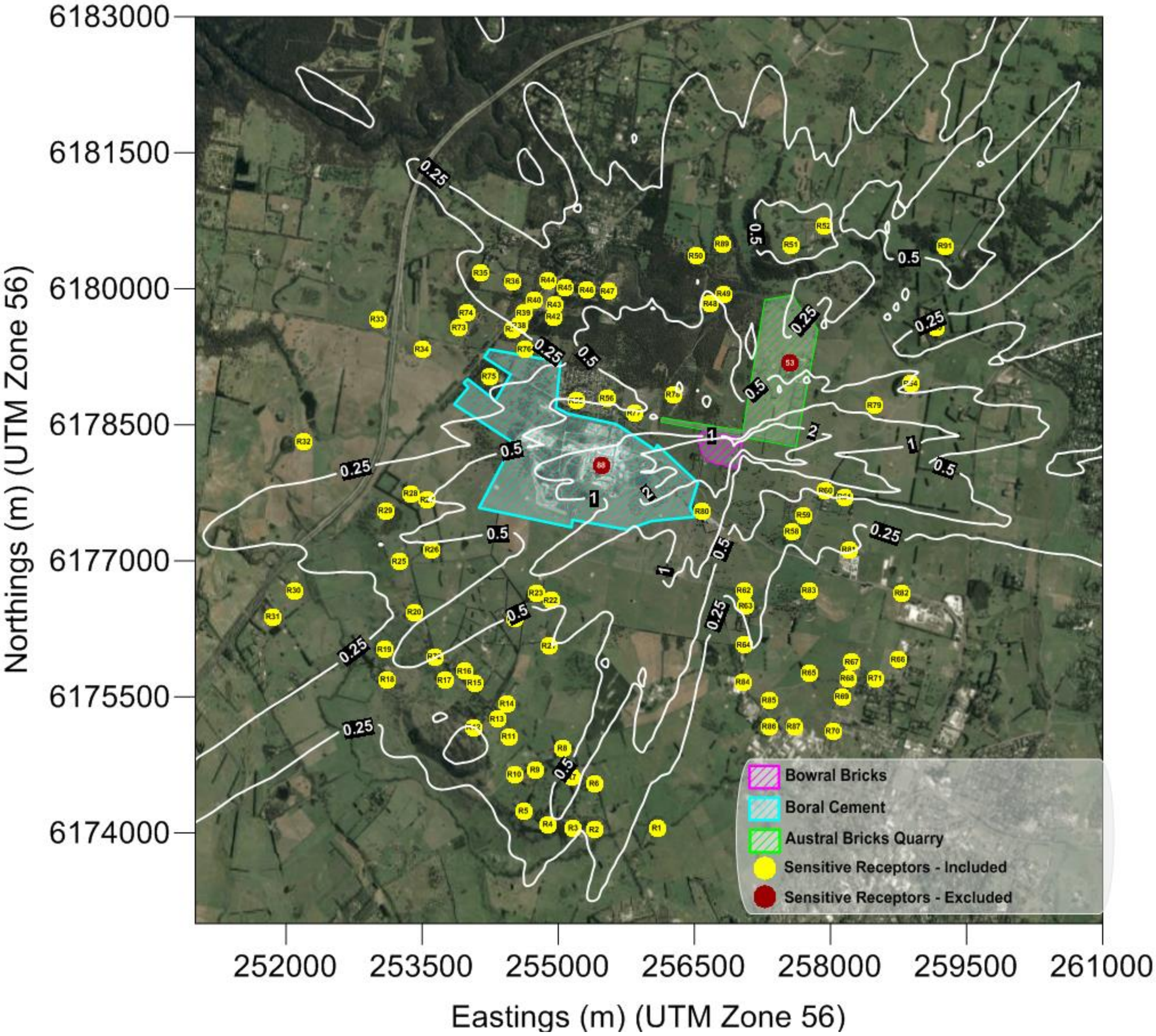


Figure C.8: Cumulative 24-hour average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 2.9 μg/m³ – red contour)

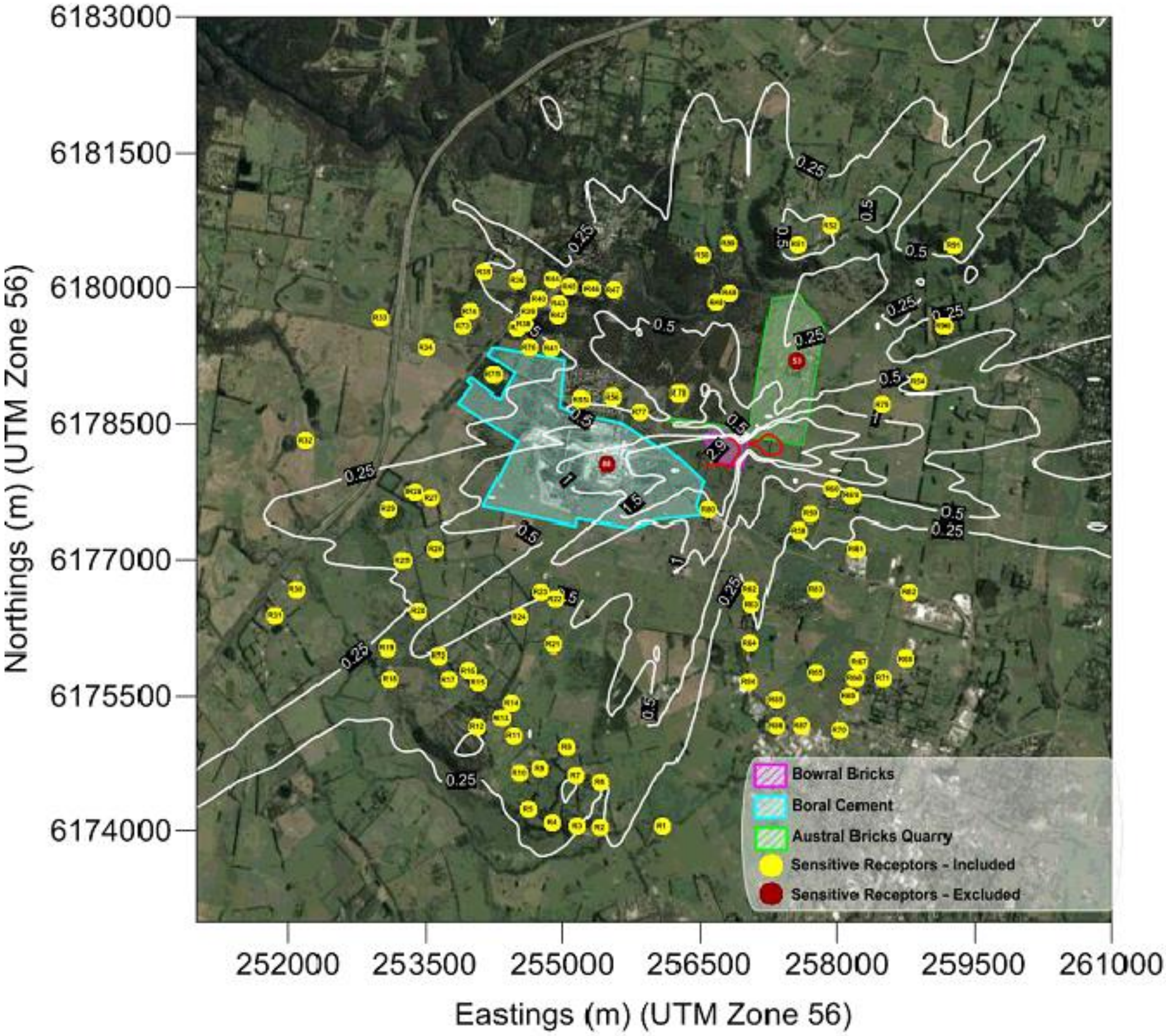


Figure C.9: Cumulative 7-day average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 1.7 μg/m³ – red contour)

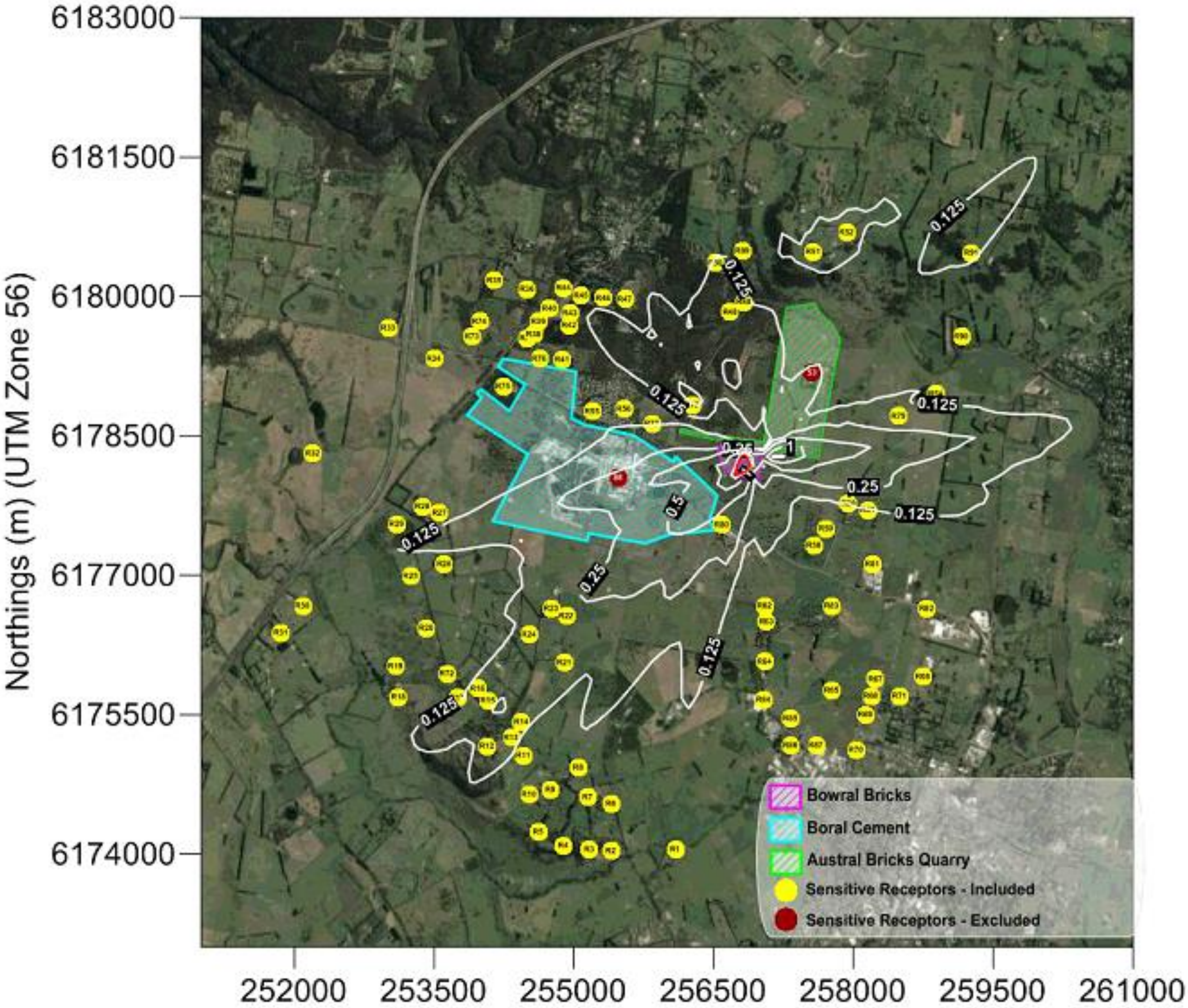


Figure C.10: Cumulative 30-day average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 0.84 μg/m³ – red contour)

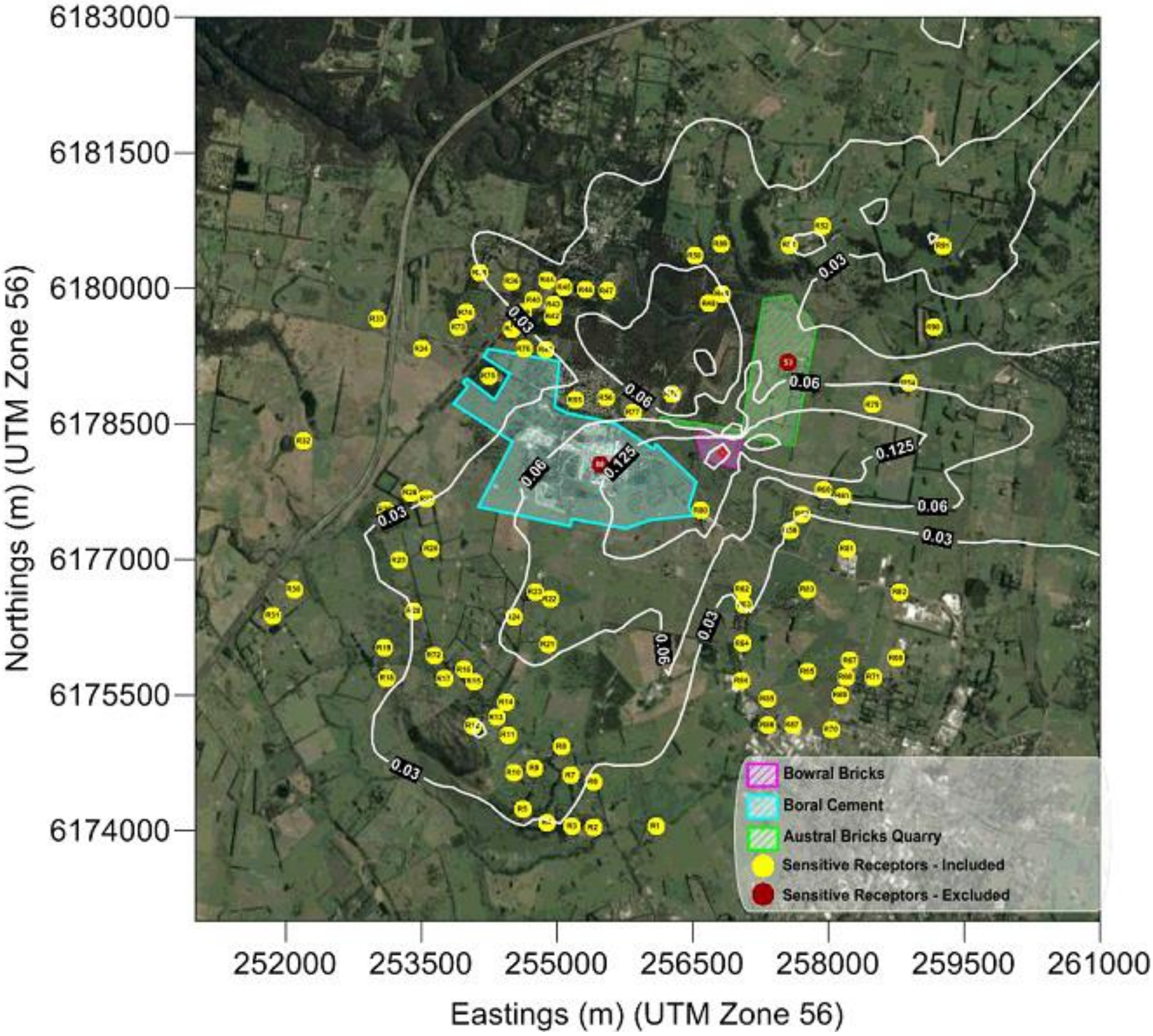


Figure C.11: Cumulative 90-day average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 0.5 μg/m³ – red contour)

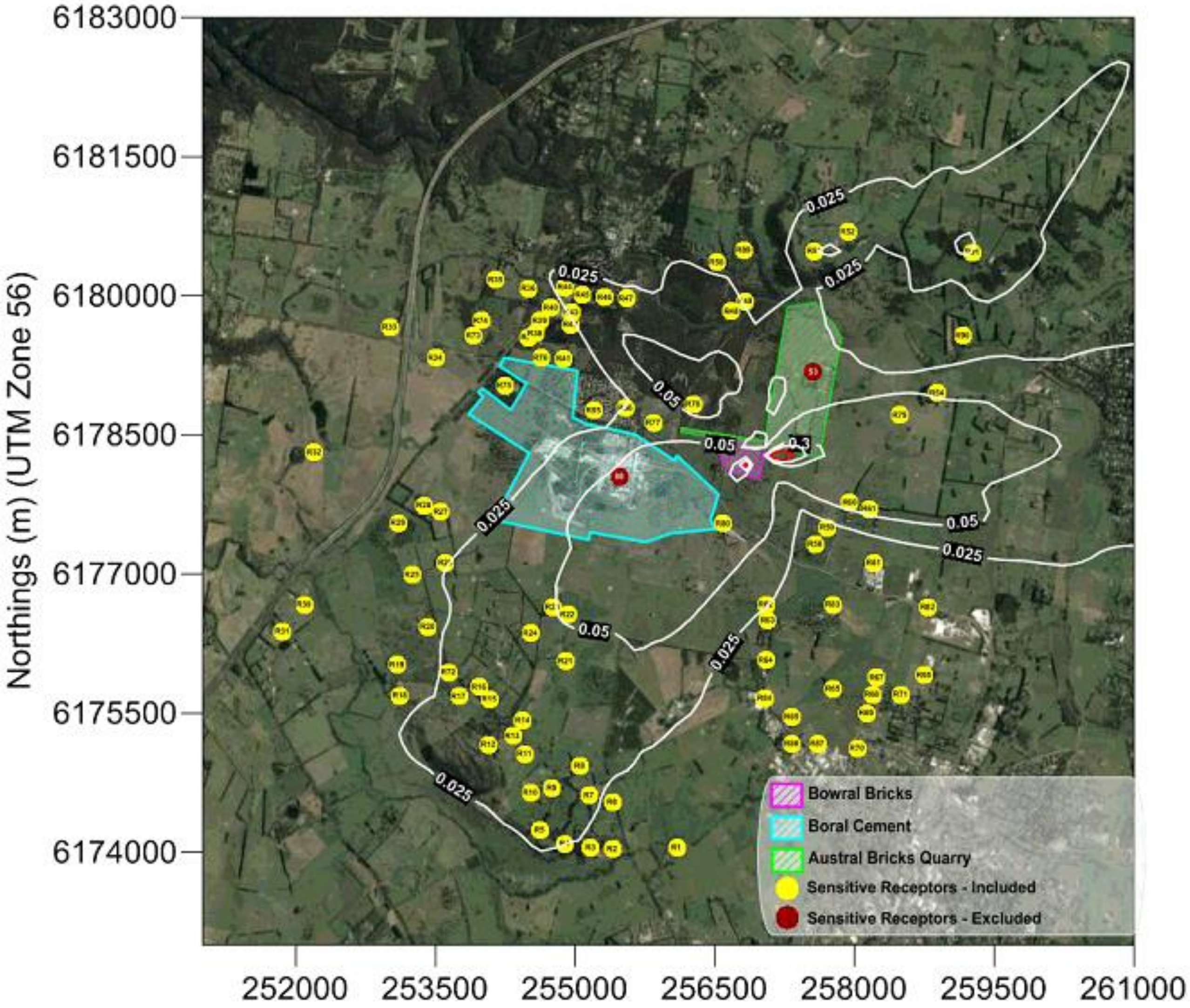


Figure C.12: Cumulative 1-hour average maximum NO_2 concentrations ($\mu g/m^3$) (Assessment criteria: 246 $\mu g/m^3$ – red contour)

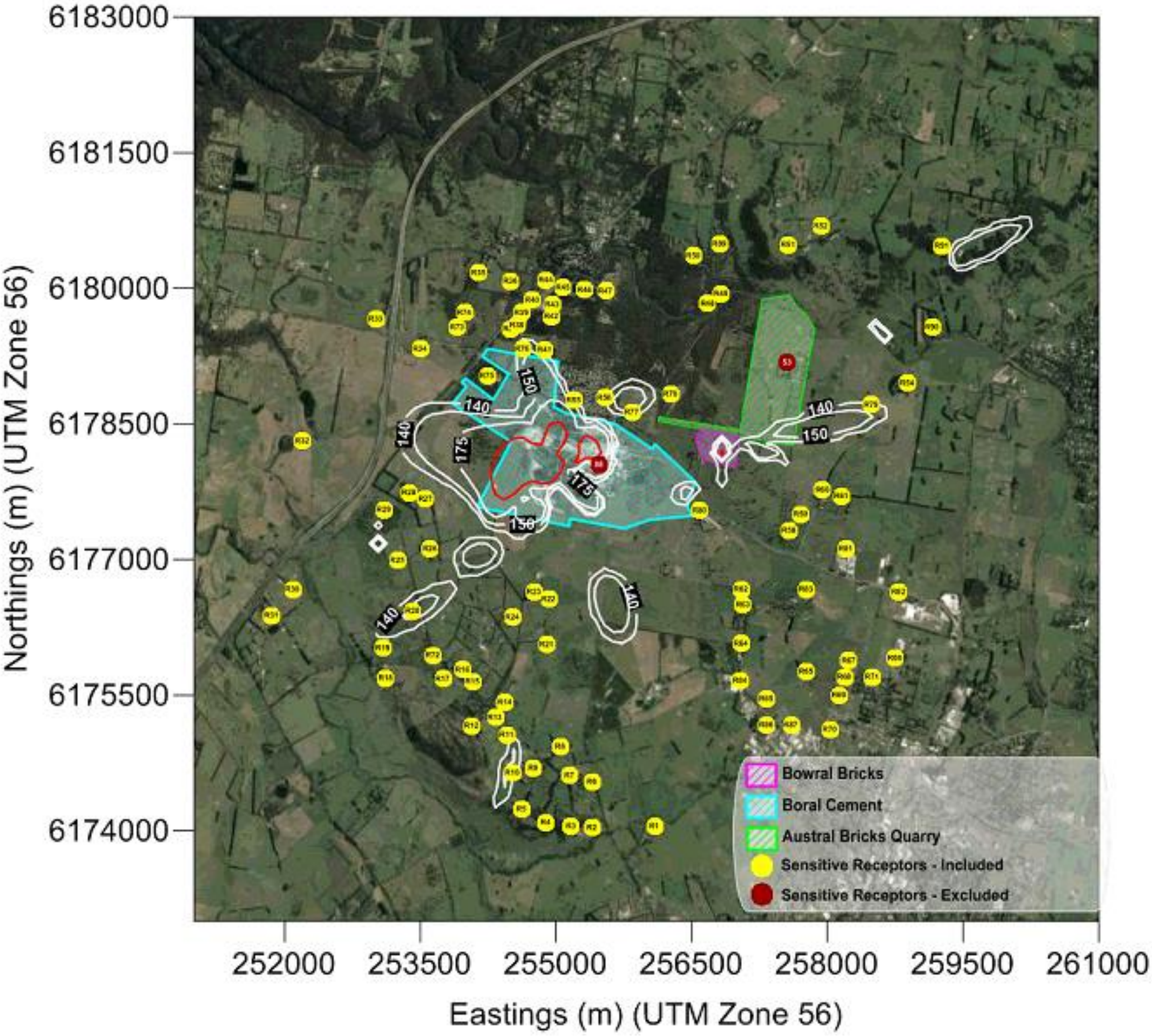
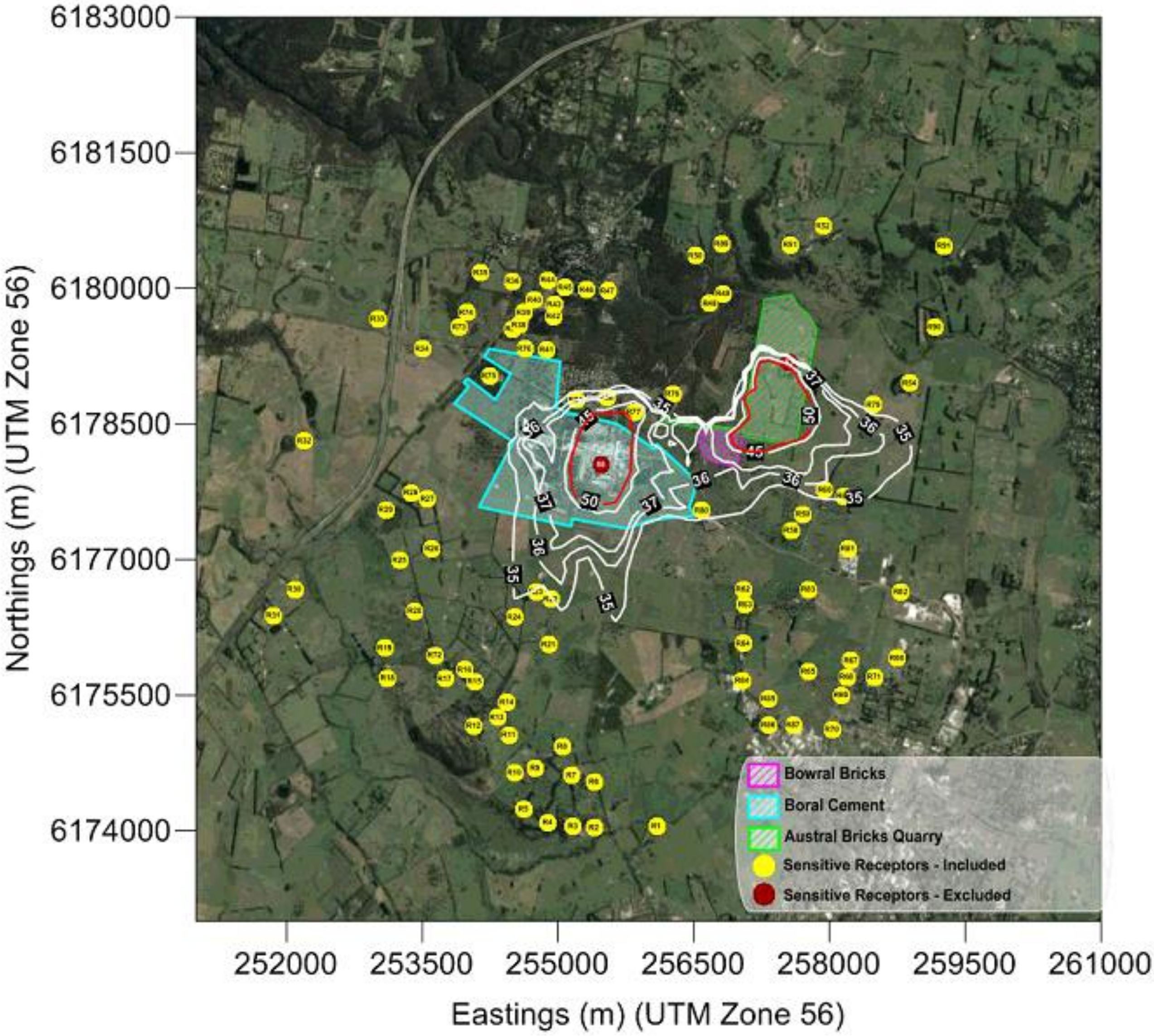


Figure C.13: Cumulative 24-hour average 3rd ranked PM_{10} concentrations (μg/m³) (Assessment criteria: 50 μg/m³ – red contour)



Note – The 3rd ranked cumulative 24-hour average PM_{10} concentration isopleth has been presented because there are two (2) days where the 24-hour average PM_{10} concentration exceeds the assessment criteria of 50 μg/m³ at least one (1) of the sensitive receptor.

Figure C.14: Cumulative annual average PM_{10} concentrations ($\mu g/m^3$) (Assessment criteria: 25 $\mu g/m^3$ – red contour)

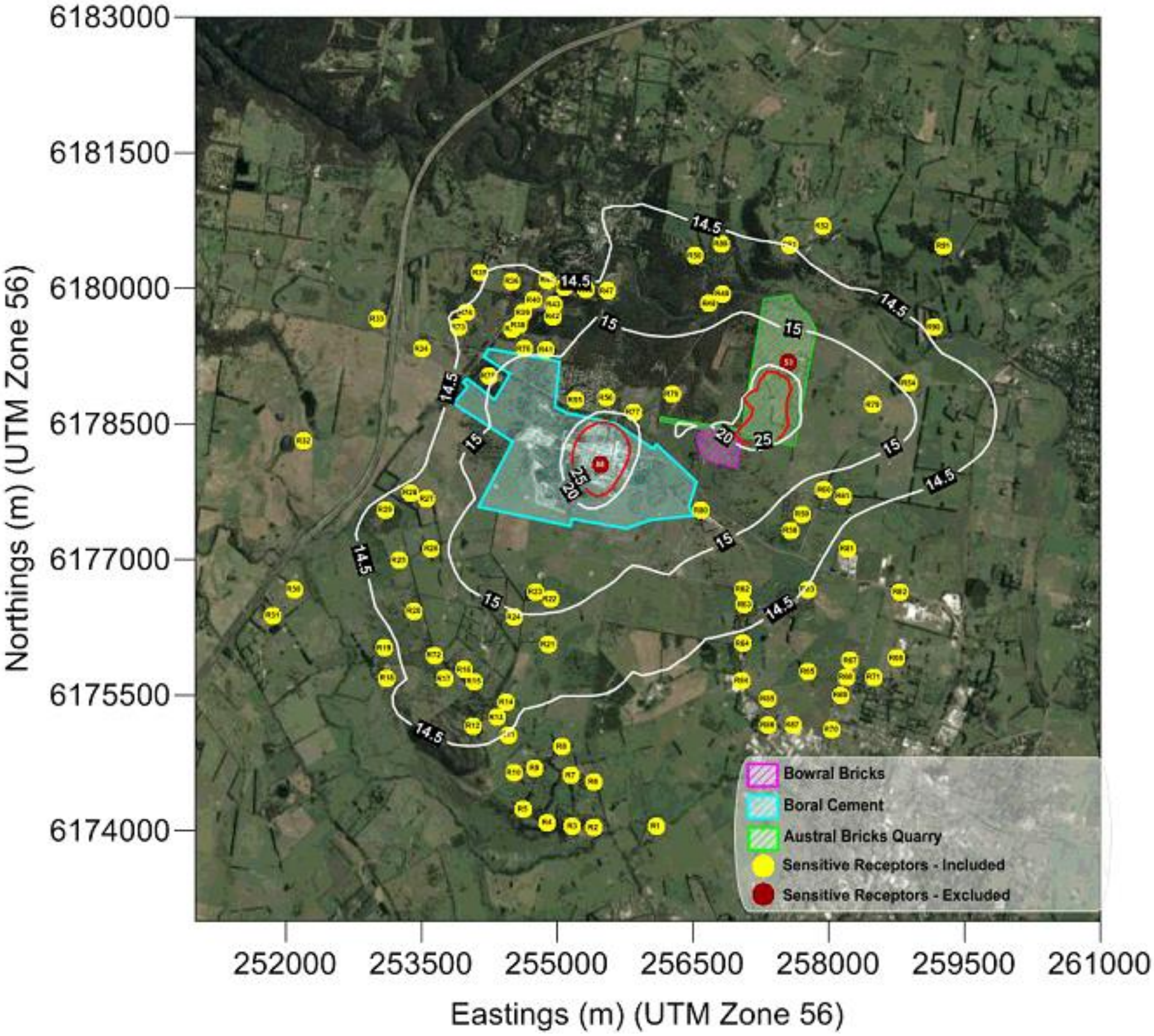


Figure C.15: Cumulative 24-hour average maximum $PM_{2.5}$ concentrations (µg/m³) (Assessment criteria: 25 µg/m³ – red contour)

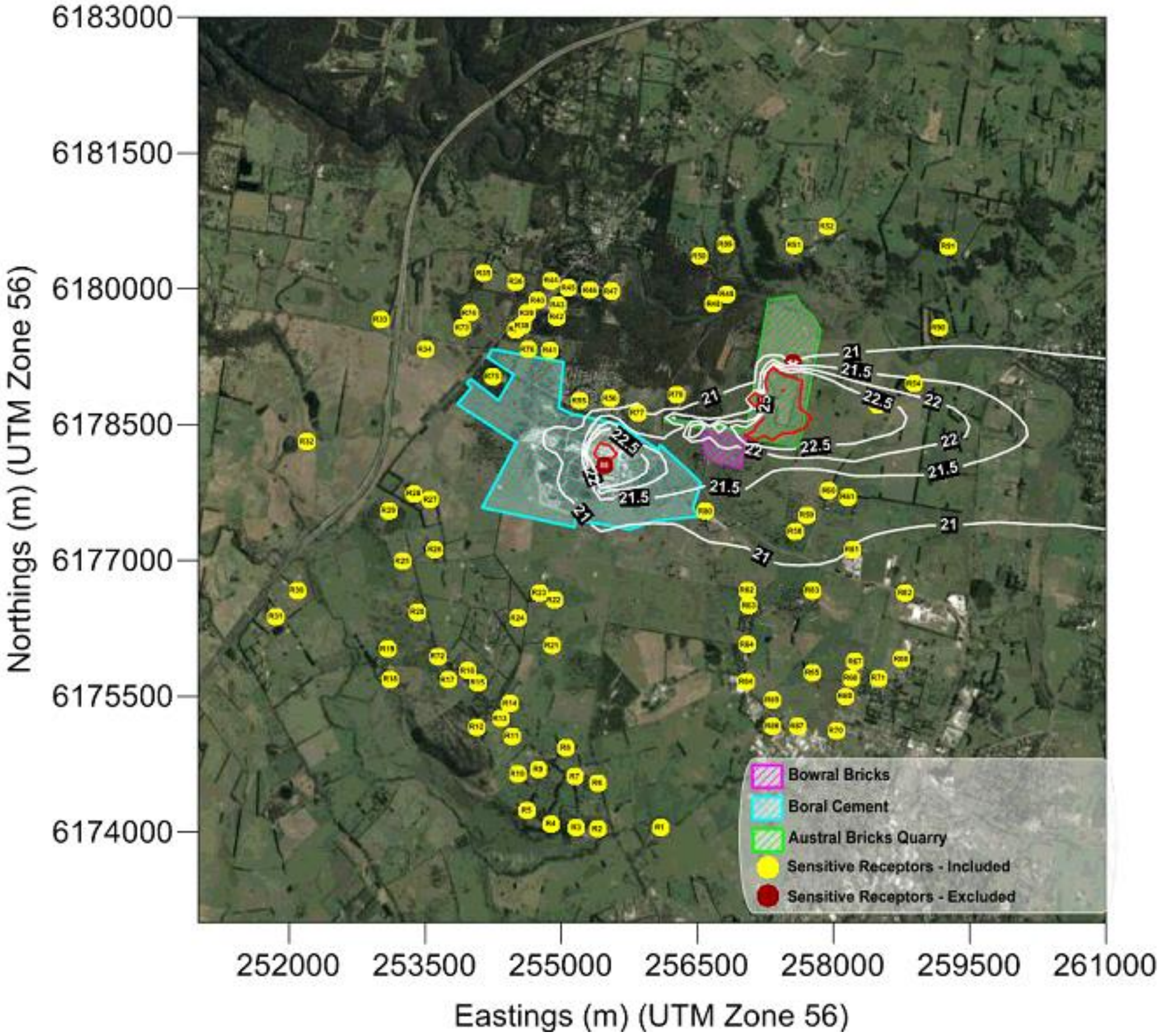


Figure C.16: Cumulative annual average $PM_{2.5}$ concentrations ($\mu g/m^3$) (Assessment criteria: 8 $\mu g/m^3$ – red contour)