South Cell at Woy Woy Waste Management Facility

Technical Report 4 – Air Quality Impact Assessment

Central Coast Council

06 December 2023

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Executive summary

The project

Central Coast Council (Council) is proposing to develop a new 'South Cell' at the existing Woy Woy Waste Management Facility (WMF) ('the project'). The project would optimise the remaining landfill air space at the WMF and ensure that the WMF remains open for as long as possible to accept putrescible waste from the Local Government Area (LGA). The construction of the proposed new South Cell is required to be completed and able receive waste when the current tipping area reaches capacity in mid to late 2024.

The project is deemed to be regionally significant development (RSD) and is subject to approval by the Hunter and Central Coast Regional Planning Panel under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

This report

This Air Quality Impact Assessment report has been prepared on behalf of Council to support the environmental impact statement (EIS) for the project and responds to the Secretary's Environmental Assessment Requirements (SEARs) for air quality.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.5 and the assumptions and qualifications contained throughout the report.

Existing environment

The nearest residential receptors are located within the urban development approximately 440 metres east of the WMF and 810 metres east of the project. No significant sources of dust or odour emissions were identified in the vicinity of the WMF with potential to contribute to ambient air quality concentrations.

Impacts from the project during construction, closure and rehabilitation

Particulate emissions during construction, closure and rehabilitation of the project are expected to be relatively minor and due to the significant separation distance between construction works and identified sensitive receptors, it is considered that there is low risk of particulate impacts.

Impacts from the project during operation

Future WMF operations (due to the project) would be consistent with current operations including types of waste accepted, WMF throughputs and operational methods. Therefore, total odour emissions from future WMF operations were estimated to remain relatively consistent compared with existing operations, the primary change due to the project would be relocation of some odour sources (active landfilling area) from the centre of the WMF to the new proposed South Cell.

Odour dispersion modelling predicted compliance with the adopted odour assessment criteria for both existing operations and project operations. A comparative analysis of existing operations and project operations identified relatively neutral impact on offsite odour concentrations due to the project (odour concentrations were predicted to increase at some receptors and decrease at others). A general spatial shift in the pattern of odour dispersion to the south was predicted due to the project compared with existing operations.

Mitigation and management measures

General air quality management and mitigation measures were recommended to reduce emissions to air from the project and minimise any potential air quality impacts during construction, closure and rehabilitation, and operation. These management and mitigation measures align with those outlined in the *Landfill Management Plan (incorporating Pollution Incident Response Management Plan) Woy Woy Waste Depot* (URS, 2012) and are consistent with current measures undertaken on-site.

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1. Introduction

1.1 Overview

Central Coast Council (Council) owns and operates the existing Woy Woy Waste Management Facility (WMF) located on Nagari Road, Woy Woy. The WMF is the primary waste disposal facility for the southern Central Coast community and has operated since 1974. The WMF operates in accordance with Environment Protection Licence (EPL) No. 6053. The EPL permits resource recovery, waste disposal (application to land) and waste storage and authorises landfilling of up to 100,000 tonnes per year of putrescible and non-putrescible general solid waste, tyres and asbestos.

Key components of the existing WMF include:

– Weighbridge and office/education centre
– Current active landfill cell and tipping area
– Transfer station
– Garden organics (GO) facility
– Excavation and stockpiling area
– Stormwater and leachate management infrastructure

In 2020 Council commissioned the *Woy Woy Waste Management Facility – Development Strategy* (SMEC, 2020) (the 'Development Strategy') to guide the future use and development of the facility. The Development Strategy identified the existing excavation and stockpile area at the southern end of the WMF site as the location for the next waste cell (known as the new 'South Cell').

Council is now proposing to develop the new South Cell to optimise the remaining landfill air space at the WMF and ensure that the WMF remains open for as long as possible to accept putrescible waste from the Local Government Area (LGA).

The construction of the proposed new South Cell is required to be completed and able to receive waste when the current tipping area reaches capacity in mid to late 2024. Construction would commence following receipt of planning approval and be completed in two stages. Each stage is expected to take four to six months.

The project is deemed regionally significant development (RSD) and is subject to approval by the Hunter and Central Coast Regional Planning Panel under the *NSW Environmental Planning and Assessment Act 1979* (EP&A Act).

This report has been prepared by GHD Pty Ltd (GHD) as part of the environmental impact statement (EIS) for the project. The EIS has been prepared to support the application for approval of the project and address the environmental assessment requirements of the Secretary of the NSW Department of Planning and Environment (the SEARs) dated 24 August 2023.

1.2 The project

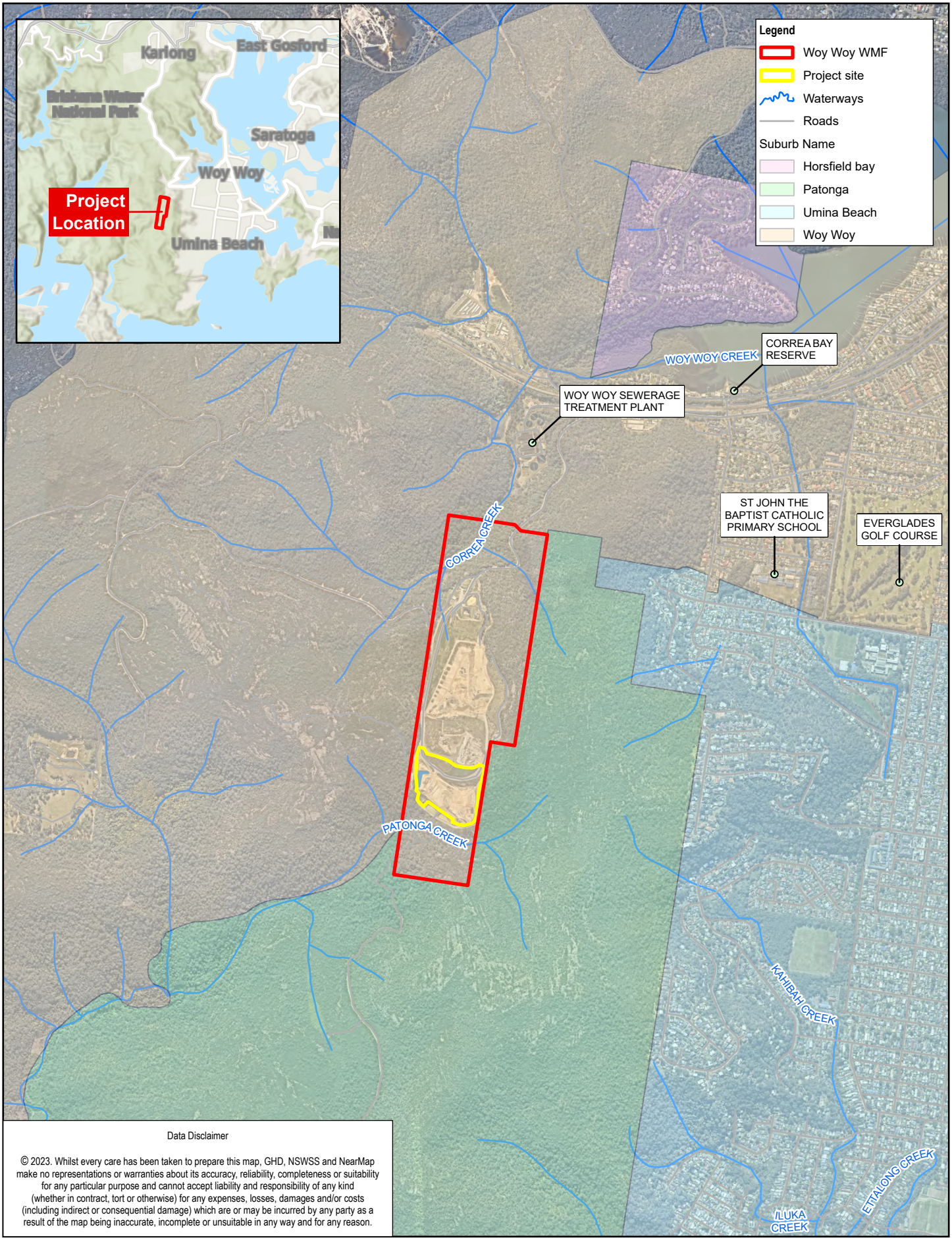
1.2.1 Location

The project would be located within the existing WMF. The WMF is about 10 kilometres south of Gosford across Brisbane Water, within the Central Coast LGA (refer Figure 1.1).

The WMF site consists of:

– Lot 110 DP 755251
– Lot 1 DP 126813
– Lot 1 DP 654885

The project site is about five hectares in area and located on the southern portion of the WMF. It comprises part of Lot 110 DP 755251.



Data Disclaimer

Paper Size ISO A4

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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South Cell at Woy Woy WMF
Air Quality Assessment

Project No. **12595244**
Revision No. **0**
Date **10/10/2023**

Site location

FIGURE 1.1

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Data source: GHD: Site Boundary (2023), Survey Data (2023). World Topographic Map: Esri, HERE, Garmin, Foursquare, METI/NASA, USGS
World Hillshade: Esri, Geoscience Australia, NASA, NGA, USGS
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1.2.3 Key features

Key features of the project include:

– Cell construction including excavation and earthworks to form the base of the cell and lining installation
– Development of associated access, stormwater and leachate management infrastructure
– Continuation of current landfilling operations in the new cell location
– Capping, closure and rehabilitation

The project is expected to provide up to approximately an additional 920,000 cubic metres of airspace or 7.7 years of filling capacity (based on current filling rates). It is also expected to generate additional cell construction and cover materials for the ongoing landfilling operations.

No change is proposed to the existing approved annual disposal capacity or waste types as per EPL 6053.

The other existing operations (weighbridge and office/education centre, transfer station, GO facility etc) at the WMF would continue to be operated in conjunction with the project.

Further information on the project is provided in the EIS.

The project site layout is shown in **Error! Reference source not found.**.

1.2.4 Construction overview

Construction of the project would be subject to the methods proposed by the construction contractor, but is expected to involve the following:

– Site establishment: establishment of site environmental controls including sediment and erosion controls
– Earthworks: excavation and grading along the base of the landfill cell in accordance with the requirements of the *Environmental Guidelines: Solid waste landfills* (NSW EPA, 2016)
– Lining and gravel placement: installation of basal, batter and sidewall liners systems
– Development of ancillary infrastructure including access roads and leachate and water management infrastructure

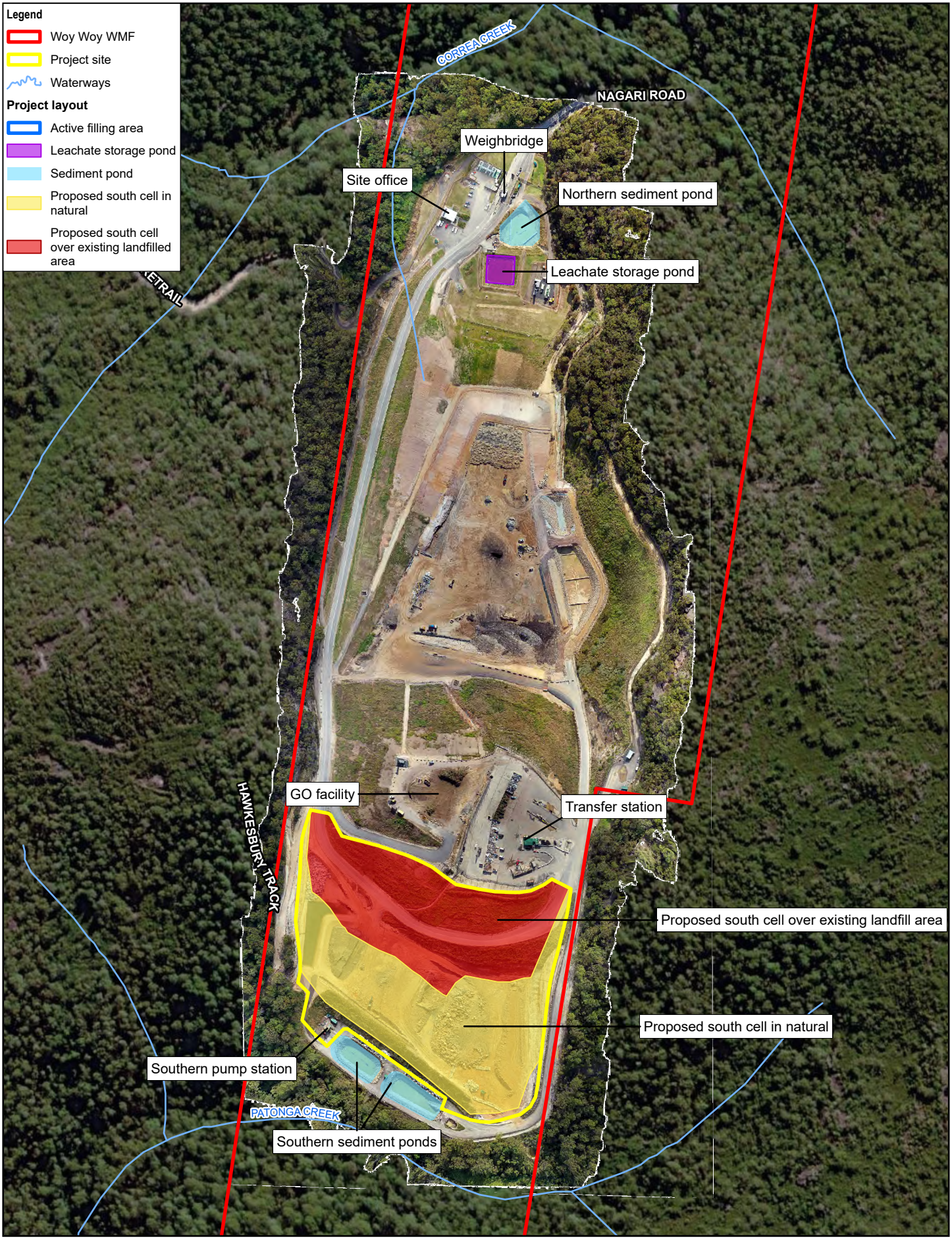
Construction is expected to take about three months to complete.

The construction activities would be carried out during the following hours, consistent with the recommended standard hours of the *Interim Construction Noise Guideline* (NSW DECC, 2009):

– 7 am to 6 pm Monday to Friday
– 8 am to 1 pm Saturdays
– No work on Sundays or Public Holidays

The construction workforce is expected to range between five and ten workers per day.

Further information on the construction of the project is provided in the EIS.



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Project layout

FIGURE 1.2

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1.3 Secretary's Environmental Assessment Requirements

The specific SEARs addressed in this report are summarised in Table 1.1

Table 1.1 SEARs relevant to this assessment

Requirement	Where addressed in this report
A description of all potential sources of air and odour emissions during construction and operation	Section 5.2, 5.3 and 6.3
An air quality impact assessment in accordance with relevant Environment Protection Authority guidelines	Section 5.4, 6.4 and 6.5
A description and appraisal of air quality impact mitigation and monitoring measures	Chapter 7

1.4 Purpose of this report

The purpose of this report is to assess potential air quality impacts including odour from the project. The report:

– Addresses the SEARs listed in Table 1.1
– Assesses the impacts from construction and operation of the project
– Recommends measures to mitigate and manage the potential impacts identified

The specific SEARs addressed in this report are summarised in Table 1.1.

1.5 Scope and limitations

1.5.1 Scope

The scope of this Air Quality Impact Assessment (AQIA) included:

– A review of relevant site details such as the proposed construction and operation of the South Cell.
– A review of the surrounding environment was undertaken including terrain, vegetation, land use and receptor locations. This included a review of local meteorology, available ambient air quality in the region and existing odour and dust complaint data.
– A qualitative risk-based assessment was undertaken to assess dust emissions to air during construction, closure and rehabilitation of the project in accordance with *Guidance on the assessment of dust from demolition and construction*, Institute of Air Quality Management (2016) (IAQM Guidance).
– Preparation of odour emissions inventories for the existing and proposed operations of the WMF including the proposed South Cell. The odour emissions inventories were based on a literature review of odour sampling undertaken at similar existing facilities to determine representative odour emission rates for modelling purposes.
– Preparation of a meteorological model of the project site using the CALMET model.
– Odour dispersion modelling for existing and proposed operations of the WMF.
– Prediction of odour concentrations as 99th percentile odour concentrations at nearby sensitive receptors and in a grid surrounding the site contours.
– Evaluation of the predicted odour concentrations at receptors were compared against the criteria in the *NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (2022) (the Approved Methods).
– A qualitative assessment of potential for cumulative odour impacts was undertaken given consideration to nearby odour sources including the nearby Woy Woy Sewage Treatment Plant.
– A qualitative assessment of dust emissions during operation of the project was undertaken.

– Identification of potential mitigation measures to minimise potential dust and odour impacts during construction and operation of the project.
– Preparation of this standalone air quality report outlining the methodology and findings of the assessment (including odour contours).

1.5.2 Limitations

This report: has been prepared by GHD for Central Coast Council and may only be used and relied on by Central Coast Council for the purpose agreed between GHD and Central Coast Council as set out in Section 1.4 of this report.

GHD otherwise disclaims responsibility to any person other than Central Coast Council arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section(s) 1.6 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.6 Assumptions

This air quality assessment relied upon the following assumptions:

– Key pollutants from a landfill are primarily odour and dust. While dust is an important issue, detailed assessment has not been undertaken due to the site's existing performance. A qualitative assessment of dust impacts has been undertaken.
– In order to effectively account for the worst-case scenario, a number of conservatisms have been included in the assessment which may result in greater predicted odour levels, these include the landfill operating standard hours over the weekend, emission rates from larger landfills and assuming a large tipping face area to account for worst case operations. Odour sampling has not been conducted of the existing WMF, therefore GHD reviewed historic odour sampling at a selection of waste facilities in NSW to select representative odour sampling data to estimate odour emissions from WMF. In order to be conservative, odour emission rates from much larger operating landfills have been used.
– There is no site weather station and therefore dispersion modelling relied on meteorological modelling prepared following guidance in the Approved Methods.

2. Method

2.1 General

This AQIA of the construction and operation of the project was completed in accordance with EPA and contemporary guidance to assess air quality impacts from the project. Atmospheric dispersion modelling was undertaken to evaluate the potential worst-case impacts from the project under routine operations and inform recommendations of appropriate mitigation measures to minimise any potential impacts.

2.2 Approach

2.2.1 Key pollutants

Key pollutants were identified based on review of proposed construction methodology, and existing and proposed operations of the WMF. The air pollutants assessed in this report include:

During construction

– Dust – consisting of deposited dust, airborne particulate matter ('particulates'), including Total Suspended Particulates (TSP) and particulate matter with a diameter smaller than 10 microns (PM_{10}) and 2.5 microns ($PM_{2.5}$).

During operation

– Odour
– Dust

2.2.2 Construction assessment method

Based on a review of the proposed construction method, agency requirements, and identification of emissions to air that could occur during construction, a qualitative risk-based approach that focused on management was adopted to assess the construction of the project. A risk-based approach in accordance with IAQM guidance was adopted to assess potential particulate matter impacts during the construction of the project.

2.2.3 Operation assessment method

A quantitative air quality assessment utilising dispersion modelling was undertaken to assess potential worst-case odour impacts from operation of the project in accordance with the Approved Methods. The modelling method adopted for this assessment is outlined in Section 2.3.

Odour dispersion modelling was undertaken for two scenarios:

– Existing operations (Existing Scenario)
– Future operations (Project Scenario)

It is industry standard practice to assume a negligible background odour level for odour assessment purposes. However should odour emitting facilities be located in proximity to the project, consideration should be given to potential cumulative odour impacts (i.e. where odour emissions from the project 'add' to existing odour emissions from a nearby facility to result in a worst odour impact). Consequently, a review of odour emissions from nearby industry and facilities was undertaken to assess potential cumulative odour impacts.

Dust generated from operations of the project is anticipated to remain similar to that of existing operations. Therefore no change of operational dust impacts is expected and a qualitative assessment was considered suitable to assess dust from operation of the project.

2.2.4 Closure and rehabilitation

Based on a review of the proposed closure and rehabilitation method, a qualitative risk-based approach consistent with that adopted for construction was considered appropriate to assess closure and rehabilitation of the project. It is anticipated emissions from closure and rehabilitation of the project would be similar in nature to those during construction but of lesser magnitude.

2.3 Modelling method

Air quality dispersion modelling was undertaken to quantitatively assess odour emissions from operation of the project. A level 2 air quality assessment (refined dispersion modelling) as defined in the Approved Methods has been undertaken using representative odour emissions data.

2.3.1 Dispersion model selection

A review of the surrounding terrain, air quality emission sources and distance to nearby receptors was undertaken to inform the choice of dispersion model used for this assessment.

Due to the complex terrain and coastal environment, GHD found CALPUFF to be the most appropriate dispersion modelling software to use for the project. CALPUFF is an advanced non-steady-state, Gaussian puff dispersion model that uses a three dimensions spatially varying wind field that is capable of accounting for complex terrain features and varying wind fields.

2.3.2 Emission inventory development

A detailed odour emissions inventory was prepared for the existing and proposed operations of the WMF. Site specific odour sampling data was not available, therefore odour emissions were estimated based on representative odour sampling data undertaken at similar waste management facilities. The development of the odour emissions inventory is summarised in Section 6.3.

2.3.3 Dispersion modelling

Predicted air quality impacts were modelled in accordance with the Approved Methods using an approved computer software model CALPUFF.

CALPUFF model settings were generally selected based on the recommendations provided in 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* (J Barclay and J Scire, Atmospheric Studies Group TRC Environmental Corporation, 2011), with the exception of the MDISP parameter for which the model default value was used.

For this assessment, the CALPUFF dispersion model was used to predict ground-level concentrations from the project. The CALPUFF dispersion model utilised a meteorological dataset of one year in duration. The grid size used in the CALPUFF model was equivalent to the CALMET domain (use of CALMET further discussed in Section 2.3.4). The same grid resolution of 200 metres used for the CALMET model was used in CALPUFF.

The source properties and emission rates utilised in the dispersion modelling are detailed in Section 6.3.

The dispersion model was configured to predict odour concentrations at identified sensitive receptor locations and for a sampling grid centred on the site. Impacts at any location (not just sensitive receptor locations) can be inferred from the odour contour plots presented in Section 6.4.

2.3.4 Meteorological modelling

Local meteorology including long term wind speed and direction, as well as atmospheric stability, influence how air pollutants are dispersed into the local environment.

Site representative meteorological data used to drive the dispersion model was generated by use of the TAPM and CALMET meteorological models to produce a three-dimensional wind field which also accounts for local variations in the terrain. Prognostic TAPM data was used as an 'initial guess field' for the CALMET meteorological model.

A representative year was chosen for modelling purposes based on review of Southern Oscillation Index (SOI) for the past 10 years and an analysis of BoM data recorded at Gosford Automatic Weather Station (AWS) for 5 calendar years (2017 – 2021). The review resulted in the selection of the 2020 calendar year (01/01/2020 – 01/01/2021) as the representative year for modelling purposes.

Details of the procedure undertaken to produce the site-specific meteorology are provided in Appendix A.

3. Legislative and policy context

3.1 Legislative and policy context

The relevant legislation and guidance for the AQIA of the project are:

– NSW *Protection of the Environment Operations Act 1997* (POEO Act) - The POEO Act provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as waste, air, water, and noise pollution control. The POEO Act requires that no occupier of any premises causes air pollution (including odour) through a failure to maintain or operate equipment or deal with materials in a proper and efficient manner. For point source emissions where no standard of concentration and/or rate has been set, and for non-point source emissions, the operator must also take all practicable means to minimise and prevent air pollution (sections 124, 125, 126 and 128 of the POEO Act). The POEO Act includes the concept of 'offensive odour' (section 129) and states it is an offence for scheduled activities to emit 'offensive odour', subject to limited defences.

– NSW Protection of the Environment Operations (Clean Air) Regulation 2021 (POEO Clean Air Regulation) - The POEO Clean Air Regulation provides regulatory measures to control emissions from motor vehicles, fuels, and industry.

– National Environment Protection Council (NEPC) National Environment Protection (Ambient Air Quality) Measure 2021 (the Air NEPM) - The National Environment Protection Council of Environmental Ministers, now the National Environment Protection Council (NEPC), set uniform national standards for ambient air quality in February 2016. The document containing these standards is known as the Air NEPM, which also contains goals for the identified relevant pollutants inclusive of particulates and concentration limits, averaging periods, and number of allowed exceedances for each of the identified pollutants.

– Technical framework – Assessment and management of odour from stationary sources in NSW (the Technical Framework), NSW Department of Environment and Conservation (DECC 2006) - The Technical Framework provides a legislative context for the control of odour and presents odour assessment criteria guidelines. It provides a framework for different levels of odour assessment, strategies to mitigate odour, and guidance for performance monitoring, regulation, and enforcement.

– *NSW EPA Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (the Approved Methods) - The Approved Methods lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in NSW. It considers the above-mentioned legislation and guidance to provide pollutant assessment criteria.

– Guidance on the assessment of dust from demolition and construction 2014 (IAQM) - The IAQM guidance provides guidance on the assessment of dust from demolition and construction activities. It provides a qualitative step by step process to assess the risk of dust impacts.

3.2 Odour assessment criteria

The assessment criteria for odour are applied at the nearest existing or likely future off-site sensitive receptor. The Approved Methods defines odour assessment criteria (measured in odour units (OU))[1] and specifies how they should be applied in dispersion modelling to assess the likelihood of nuisance impact arising from the emission of odour.

Odour impact is a subjective experience and has been found to depend on many factors, the most important of which are:

– Frequency of the exposure

– Intensity of the odour

– Duration of the odour episodes

– Offensiveness of the odour

[1] The number of odour units is the concentration of a sample divided by the odour threshold or the number of dilutions required for the sample to reach the threshold. This threshold is the numerical value equivalent to when 50 per cent of a testing panel correctly detect an odour

– Location of the source.

These factors are often referred to as the 'FIDOL' factors.

The odour assessment criteria are defined to take account of two of these factors (F is set at 99th percentile; I is set at between 2 to 7 OU). The choice of assessment criteria is also dependent on the population of the affected area, as shown in Table 3.1.

Table 3.1 Odour assessment criteria in the Approved Methods

Population of the affected community	Odour performance criteria (OU, nose response odour certainty units at 99th percentile[2])
Single residence (≤ ~2)	7
~ 10	6
~ 30	5
~ 125	4
~ 500	3
Urban (≥~2,000)	2

The criteria assume that 7 OU at the 99th percentile would be acceptable to the average person, but as the number of exposed people increases, there is a chance that more sensitive individuals would be encountered. The criterion of 2 OU at the 99th percentile is considered to be acceptable for large populations (more than 2,000 people).

The criteria have also been specified at an averaging time of nominally one second. The choice of the short averaging time recognises that the human nose has a response time of less than one second, so that modelling of odour impact should allow for the short-term concentration fluctuations in an odour plume due to turbulence.

An urban development consisting of more than 2,000 residential dwellings is located east of the WMF. Therefore an odour impact assessment criteria of 2 OU was adopted to determine compliance of the project.

3.3 Dust assessment criteria

Dust assessment criteria for the project were taken from the NSW EPA's Approved Methods. The outcome of the criteria is ambient air quality that minimises the risk of adverse health impacts from exposure to air pollution. Achieving compliance with the impact assessment criteria would help demonstrate the project operate in a manner that protects human and environmental health.

The dust assessment criteria are summarised in Table 3.2. The assessment criteria are provided as cumulative impacts, where the predicted impact of the project (incremental) is added to the existing levels (background) in order to assess the pollutants impacts. The assessment criteria are assessable at sensitive receptor locations. No detailed quantitative dust assessment was undertaken in this AQIA however the criteria would apply to this project and any air quality monitoring would be compared to these criteria.

Table 3.2 Air quality impact assessment criteria

Pollutant	Averaging period and statistic	Assessment criteria
TSP	Annual average	90 µg/m^3
PM_{10}	24 hour maximum	50 µg/m^3
	Annual average	25 µg/m^3
$PM_{2.5}$	24 hour maximum	25 µg/m^3
	Annual average	8 µg/m^3

[2] This is a prediction of the odour level that may occur 99 per cent of the time, or that is below these criteria for 99 hours in every 100. Odour performance criteria are designed to be precautionary, so that impacts on sensitive receivers can be minimised.

Pollutant	Averaging period and statistic	Assessment criteria
Deposited dust	Annual	2 g/m^2/month (maximum increase) 4 g/m^2/month (maximum total)

4. Existing environment

4.1 Receiving environment

The receiving environment plays a critical role in the potential for air emissions to lead to air impacts. The terrain and land use within the receiving environment have an influence on the local meteorological conditions and subsequently impact how air pollutants disperse within an environment. The location and densities of land uses sensitive to air quality impacts (sensitive receptors) relative to the source of air emissions also play a significant role in the magnitude and extent of potential impacts.

The land use, terrain and sensitive receptors surrounding the project location are discussed in the following report sections.

4.1.1 Land use

The WMF is located on land zoned SP1 Special Activities under *Central Coast Local Environmental Plan 2022*. Adjacent lands to the west, south and east are zoned C1 National Parks and Nature Reserves. Lands to the north are zoned SP2 Infrastructure. The closest urban developments to the project site are zoned R2 General Residential and are located approximately 800 metres to the east.

4.1.2 Topography

The WMF is situated inside of a valley with a natural ridgeline and heavy vegetation provides a physical barrier between the WMF and the residential areas to the east. Broken Bay is located approximately 3 kilometres southeast of the WMF which opens into the Pacific Ocean.

The terrain surrounding the WMF is shown in Figure 4.1.

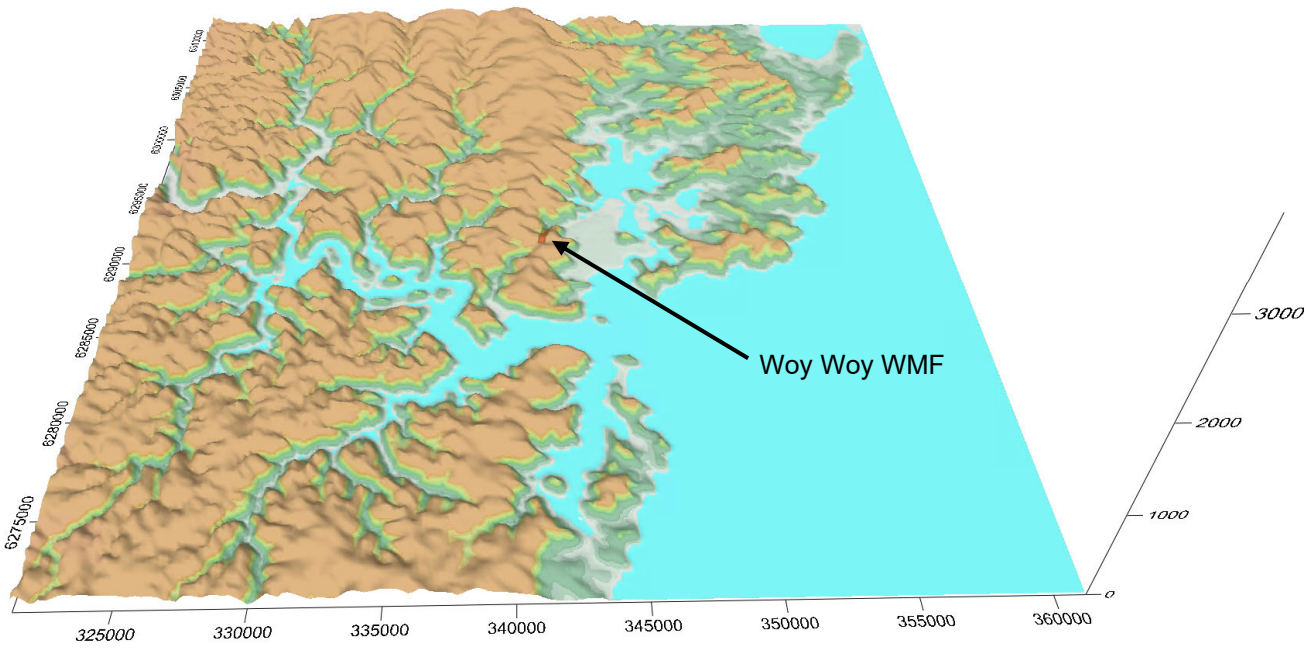


Figure 4.1 *Terrain data used for CALMET modelling (terrain exaggerated by a factor of 5) (data sources from Lakes Environmental)*

4.1.3 Sensitive receptors

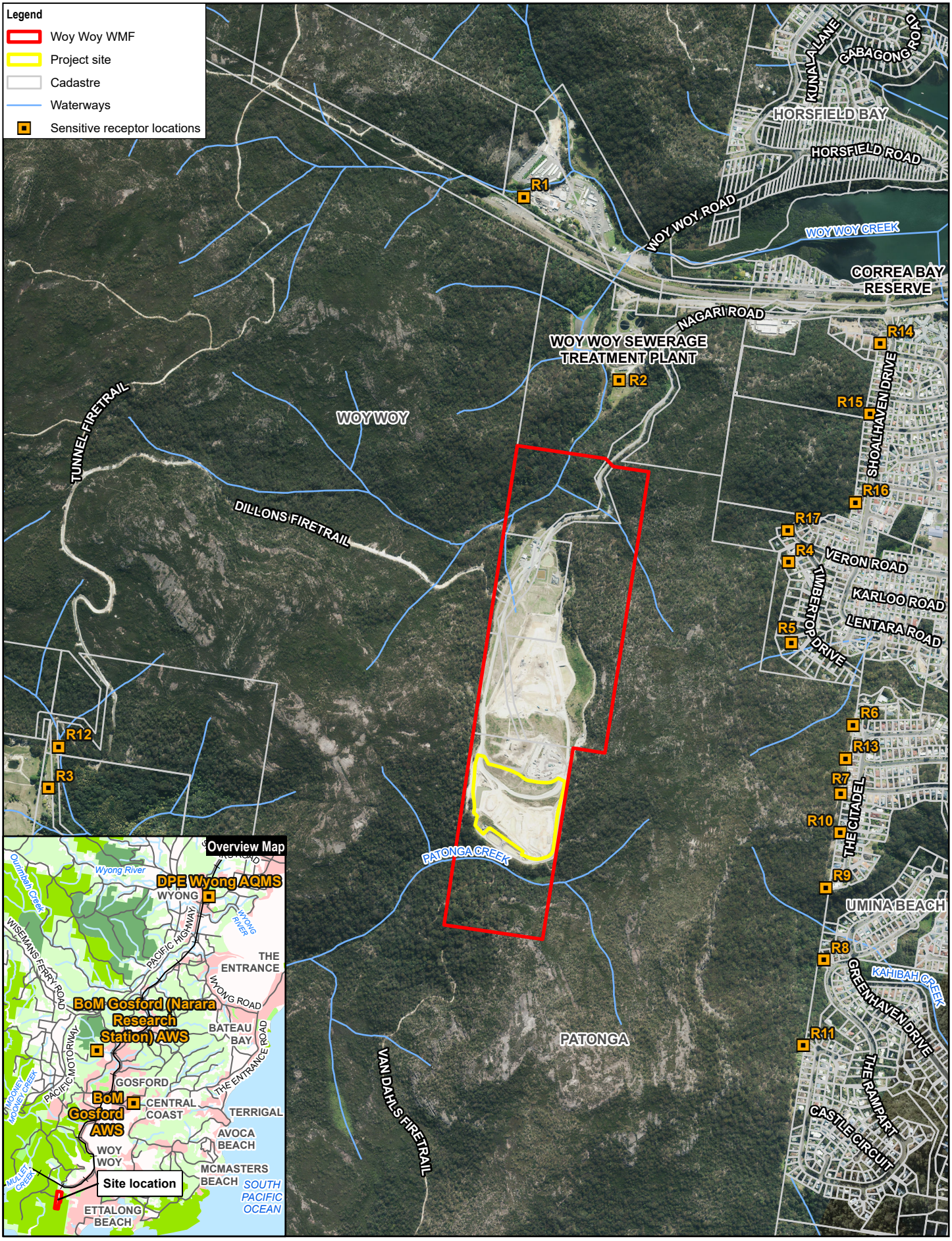
The Approved Methods defines sensitive receptors as:

"A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors."

A summary of nearby sensitive receptors is provided below in Table 4.1 and shown in Figure 4.2.

Table 4.1 Sensitive Receptors

Receptor ID	UTM coordinates (m)		Receptor type	Direction from WMF	Approximate distance from project (m)	Approximate distance from WMF (m)
	Easting	Northing				
R1	341,252	6,292,584	Residential	North	1,800	740
R2	341,539	6,292,032	Sewage Treatment Plant	North	1,300	240
R3	339,820	6,290,803	Park / Nature Reserve	West	1,300	1,240
R4	342,058	6,291,241	Residential	East	1,000	460
R5	342,050	6,291,484	Residential	East	840	500
R6	342,245	6,290,993	Residential	East	910	710
R7	342,207	6,290,786	Residential	East	840	720
R8	342,156	6,290,286	Residential	East	850	840
R9	342,162	6,290,503	Residential	East	810	810
R10	342,206	6,290,668	Residential	East	840	840
R11	342,094	6,290,028	Residential	Southeast	840	930
R12	339,850	6,290,927	Park / Nature Reserve	West	1,240	1,240
R13	342,222	6,290,892	Residential	East	870	720
R14	342,326	6,292,143	Residential	Northeast	1,660	800
R15	342,296	6,291,931	Residential	Northeast	1,530	700
R16	342,251	6,291,664	Residential	East	1,270	630
R17	342,048	6,291,580	Residential	East	1,070	440



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Grid: GDA 1994 MGA Zone 56

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Date 4/09/2023

Site and sensitive receptor locations

FIGURE 4.2

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4.1.4 Ecological receptors

National parks and nature reserves surround the WMF to the west, south and east, consequently there is potential of emissions to air to impact upon nearby ecological receptors including flora and fauna. A review of aerial imagery and the findings of the biodiversity assessment was undertaken to identify sensitive ecological (flora and fauna) receptors. No endangered or vulnerable species were identified to inhabit the area.

Primary emissions to air from the project are expected to include particulate matter from construction, closure, and rehabilitation of the project, and odour from operation of the project. It is noted that the toxicological relationship between air emissions and the impact on ecological receptors (flora and fauna) is not well understood. However it is anticipated that the key pollutants emitted from the project, and the relatively minor magnitude of emissions, constitutes a relatively low risk of potential impact on ecological receptors.

As no vulnerable ecological receptors were identified and the emitted pollutants are considered low risk, no further consideration to ecological receptors was included in this AQIA.

4.2 Existing and future sources of air pollutants

4.2.1 Facilities reporting to the NPI

The National Pollutant Inventory (NPI), operated under the *National Environment Protection (National Pollutant Inventory) Measure 1998*, provides publicly available information about emissions of 93 pollutants throughout Australia. Facilities that exceed prescribed threshold values are required to report their emissions to the NPI on a yearly basis.

No facilities reporting to the NPI (other than the WMF) were identified within a 5 kilometre radius from the WMF.

4.2.2 State significant projects

A review of the NSW Government Planning Portal was undertaken to identify nearby State Significant Projects that could result in emissions to air.

No nearby State Significant Projects were identified with potential to result in cumulative air quality impacts with the project.

4.3 Background air quality

4.3.1 Background DPE AQMS data

The Department of Planning and Environment (DPE) operates air quality monitoring stations (AQMS) in many locations across NSW. It has been noted that no DPE AQMS are located near to the WMF, however the nearest DPE AQMS that was considered suitable was the Wyong monitoring station, located approximately 28 kilometres northeast of the project. The location of the Wyong AQMS is shown on Figure 4.2.

A summary of the ambient air quality recorded at Wyong over the last 5 years is provided in Table 4.2.

Table 4.2 5 year summary of available background air quality data recorded by the DPE Wyong monitoring station

Pollutant	Averaging period	Recorded background concentration by year (µg/m^3)				
		2018	2019	2020	2021	2022
PM_{10}	24 hour maximum	138.3	128.4	90.5	44.9	27.4
	Maximum 24 hour (below assessment criteria)	48.0	49.4	47.7	44.9	27.4
	70th percentile	20.1	21.8	16.9	15.1	13.5
	Annual average	18.0	21.1	15.9	13.5	11.7
$PM_{2.5}$	24 hour maximum	18.1	202.1	63.9	14.8	11.5
	Maximum 24 hour (below assessment criteria)	18.1	23.2	22.7	14.8	11.5

Pollutant	Averaging period	Recorded background concentration by year (µg/m^3)				
		2018	2019	2020	2021	2022
	70th percentile	7.8	9.0	5.9	5.7	4.8
	Annual average	6.8	10.5	5.6	4.7	4.0

4.3.2 Background odour

Potential odour sources located in proximity to the project that were identified include:

– Existing operation of the WMF
– Woy Woy Sewage Treatment Plant (STP).

Implementation of the project would replace some current odour sources associated with the existing operation of the WMF (such as the tipping face, daily cover area and intermediate cover area). Therefore total odour emissions from the WMF are expected to remain relatively constant compared to current emissions as a result of the project. A cumulative odour assessment was undertaken to include assessment of the project and other WMF odour sources.

The Woy Woy STP is located approximately 500 metres north of the WMF boundary and 1.4 kilometres north of the project. It is understood that Council has received one odour complaint in 2019 from operation of the STP involving odour detected at the rail line approximately 50 metre north of the STP. Investigation of this complaint revealed it was likely not attributed to STP operation but rather caused by odour from agricultural business on the northern side of the rail line (including a fish farm and mushroom farm) and/or odour from low tide in the mangroves of Brisbane Water.

It was therefore inferred that odour emissions from the STP are minimal or managed so that off-site impacts are avoided. Based on the location of the STP in relation to the WMF, cumulative odour impacts would only be expected when winds are blowing from the north or from the south. No receptors were identified to the south of the WMF.

Results of the odour dispersion modelling (refer Section 6.4) predicted low odour concentrations (< 1 OU) at the STP.

Due to the good management of the STP, the narrow range of meteorological conditions conducive of cumulative impacts and predicted low odour concentration from the WMF at the STP location, cumulative odour impacts are not anticipated and therefore no further assessment of cumulative odour was considered necessary.

4.4 Historic complaints

It is understood that no air quality (dust) or odour complaints have been received about the operation of the WMF.

4.5 Climate and meteorology

The local climate and meteorology (weather) within the study area is of critical importance when assessing the potential for air quality impacts at sensitive receptors.

The meteorological environment relevant to a project site is best understood through review of data collected from long-running monitoring weather stations, most commonly operated by the Bureau of Meteorology (BoM) as well as state authorities (such as the DPE). Simulation of the meteorological environment (modelling) is a useful tool in understanding the environment where suitable meteorological observations are not available.

4.5.1 Available observations

The BoM operates a network of Automatic Weather Stations (AWS) across Australia. A BoM AWS typically measure critical meteorological parameters including wind speed, wind direction, temperature, relative humidity, and pressure, with some stations also measuring cloud coverage.

The nearest AWS to the project site include:

– Gosford AWS (061425) – 10 km northeast north
– Gosford Narara Research Station AWS (061087) – 13 km north

The location of the BoM AWS's is shown on Figure 4.2.

It is noted that long term climate statistics are not available from the closest BoM station (Gosford AWS) as it began operation in 2013. Due to the insufficient data required to analyse long term climate trends, climate statistics was sourced from the Gosford (Narara Research Station) AWS.

4.5.2 Climate trends

4.5.2.1 Temperature

Figure 4.3 shows monthly temperature statistics for data measured at BoM Gosford (Narara Research Station) AWS for the period 1954 to 2013. The median monthly maximum temperature and median monthly minimum temperature are used to show the typical temperature range for each month of the year. This is shown along with the monthly average temperature.

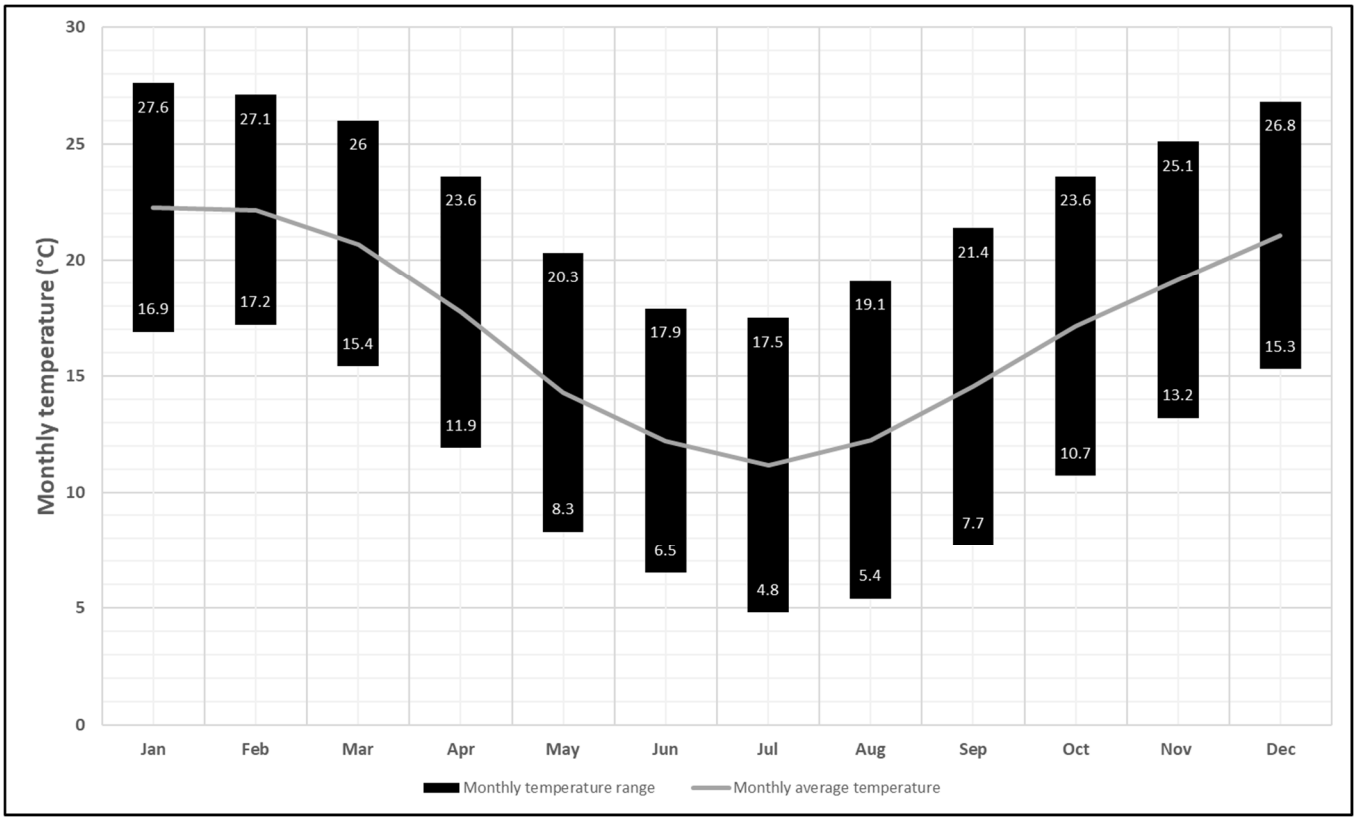


Figure 4.3 Monthly climate temperature statistics from BoM Gosford (Narara Research Station) AWS (1954-2013)

4.5.2.2 Rainfall

Figure 4.4 shows monthly rainfall statistics for data measured at BoM Gosford (Narara Research Station) AWS for the period 1917 through 2013. The statistics shown include average monthly rainfall amount (mm) and average number of days per month where rainfall is greater than 1 mm (number of 'rain days').

The data shows that the number of rain days and the total rainfall amounts are greater during the summer and autumn months.

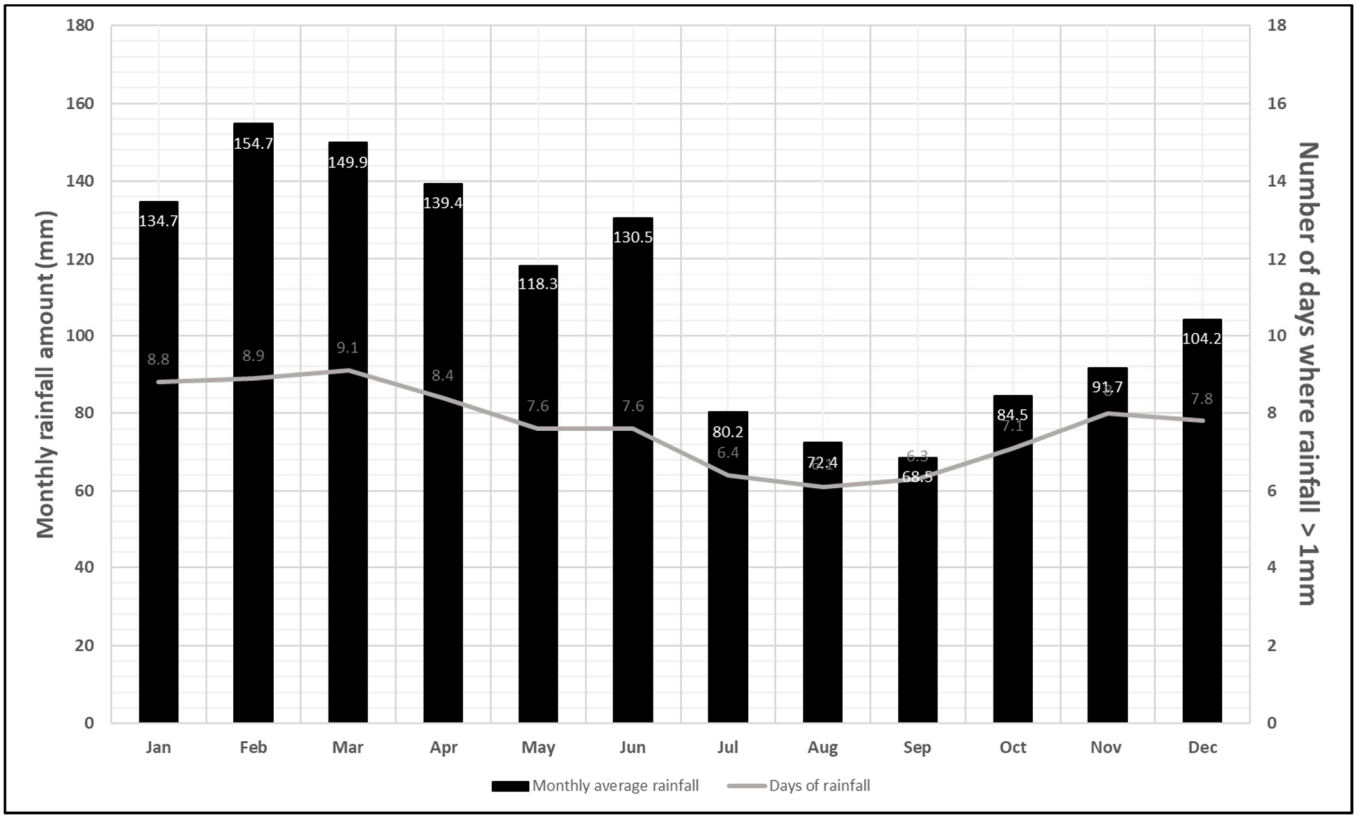


Figure 4.4 Monthly climate rainfall statistics from BoM Gosford (Narara Research Station) AWS (1917-2013)

4.5.3 Meteorology

Meteorological modelling has been used to synthesise site-representative meteorology for the project. An overview of the meteorological modelled methodology is provided in Section 2.3.4 and further details are provided in Appendix A.

Use of meteorological modelled data to examine meteorological conditions at the project site is considered valuable due to the high temporal resolution of the data (hourly data) and 3D gridded nature of the dataset such that meteorological conditions can be exported from any location within the modelling domain.

Wind conditions extracted at the site location from the meteorological model are shown in Figure 4.5.

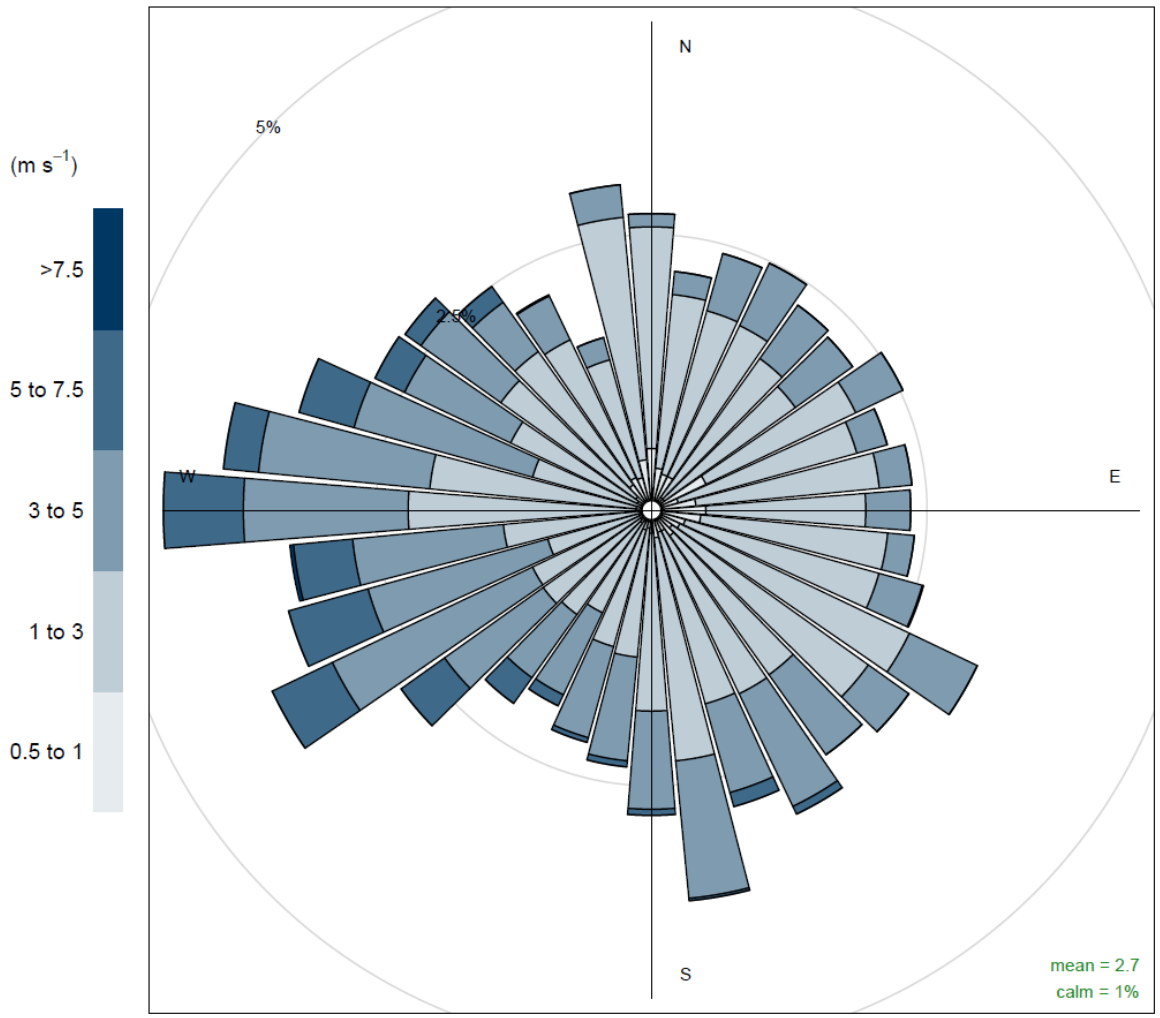


Figure 4.5 *Wind rose at site from CALMET (2020)*

5. Construction, closure and rehabilitation air quality assessment

5.1 Overview

Due to the relative similarities between the construction, closure, and rehabilitation of the project with respect to potential air quality impacts, both phases of the project were assessed in this section.

Construction of the project is assessed in Sections 5.2 and 5.3. Closure and rehabilitation of the project is assessed in Sections 5.3 and 5.4.

5.2 Construction overview and emissions

Construction of the project would be subject to the methods proposed by the construction contractor, however a summary of the expected construction methodology and potential emissions to air is provided in Table 5.1.

Table 5.1 Construction methodology and emissions to air

Construction stage	Description of works	Potential emissions to air
Site establishment	Establishment of site environmental controls including sediment and erosion controls.	Dust emissions from: – Land clearing and implementation of sediment and erosion controls – Vehicular movements on unsealed roads/track
Earthworks	Excavation to a depth of about RL105 m AHD and grading along the base of the landfill cell	Dust emissions from: – Earth working and excavation of landfill cell – Vehicular movements on unsealed roads/track
Lining and gravel placement	Installation of basal, sidewall, steep wall and piggyback liners systems	Dust emissions from: – Placement of gravel – Installation of basal, sidewall, steep wall, and piggyback liners systems – Vehicular movements on unsealed roads/track
Development of ancillary infrastructure	Development of ancillary infrastructure including access ramp, and leachate and water management infrastructure	Dust emissions from: – Construction of ancillary infrastructure – Earth working and excavation of leachate and water management infrastructure – Vehicular movements on unsealed roads/track

5.3 Closure and rehabilitation overview and emissions

Site closure and rehabilitation would include the following activities:

– Site capping and revegetation
– Monitoring after closure and maintenance

Throughout site capping works, minor dust emissions are anticipated from:

– Delivery of materials to the project site
– Mechanical plant placing and compacting the subsoil and topsoil layers

– Vehicular movements on unsealed roads/track
– Wind-blown dust emissions from the exposed landform and stockpiles

Once vegetation has been established on the landform, it is expected that top soils would be stabilised and wind-blown dust emissions would be minimal. Therefore negligible dust emissions are expected from post-closure monitoring and maintenance works.

5.4 Construction, closure and rehabilitation assessment

A risk-based approach in accordance with IAQM guidance was adopted to assess potential dust impacts during the construction of the project as well as during the closure and rehabilitation of the project.

The IAQM guidance recommends a detailed risk assessment be undertaken where there is a human receptor located within 350 metres, or an ecological receptor within 50 metres of the construction footprint, or where there is a human or ecological receptor within 50 metres of any haulage routes up to 500 metres from the site entrance.

The locations of identified sensitive receptors with respect to the project boundary and WMF site boundary are provided in Table 4.1. No sensitive human or ecological receptors were located within the separation distances stipulated by the IAQM guidance to trigger the need for a detailed risk assessment.

As all identified sensitive receptors are located outside the IAQM guidance separation distances and particulate emissions during construction, closure and rehabilitation are expected to be relatively minor (refer Section 5.2 and 5.3 respectively), it is considered that there is low risk of particulate impacts and no further assessment is considered necessary in accordance with IAQM guidance.

Emissions to air should be managed and reduced by implementation of the mitigation measures recommended in Section 7.1 during construction, closure and rehabilitation to minimise the likelihood and severity of any potential air quality impacts.

6. Operation air quality assessment

6.1 Operational overview

Future WMF operations (due to the project) would be consistent with current operations. No changes to WMF throughputs or operational methods have been proposed as part of the project.

The primary change relevant to air quality would be the relocation of the active landfilling area from the centre of the WMF to the new proposed South Cell. The proposed alterations to the WMF layout would change the location of some significant odour sources which has the potential to change odour impacts on nearby sensitive receptors.

6.2 Operation assessment overview

A quantitative air quality assessment utilising dispersion modelling was undertaken to assess potential worst-case odour impacts from operation of the project in accordance the Approved Methods. Odour dispersion modelling was undertaken for two scenarios:

– Existing operations (Existing scenario)
– Future operations (Project scenario)

A review of WMF operations and received waste types was undertaken to identify sources of odour on site. A summary of all identified odour sources and their location for existing and project scenarios is provided in Section 6.3.1.

Site specific odour sampling data was not available, therefore odour emissions were estimated based on sampling undertaken at representative waste management facilities. A review of representative data is provided in Section 6.3.2 based on adopted data and odour emissions inventories for existing and project scenarios are provided in Section 6.3.3.

Odour dispersion modelling based on the assumptions outlined in Section 6.3.3 was undertaken to predict offsite odour concentrations for existing and project scenarios. A comparative analysis was undertaken to assess the expected relative change in odour impacts due to the project.

6.3 Odour emissions inventory

6.3.1 Odour emission sources

6.3.1.1 Waste types

Under EPL 6053 the landfill currently accepts and would continue to accept mixed putrescible waste. The Waste Classification Guidelines Part 1: Classifying waste (NSW EPA, 2014) defines putrescible waste to include:

– Household waste that contains putrescible organics
– Waste from litter bins collected by or on behalf of local councils
– Manure and night soil
– Disposable nappies, incontinence pads or sanitary napkins
– Food waste
– Animal waste
– Grit or screenings from sewage treatment systems that have been dewatered so that the grit or screenings do not contain free liquids
– Any mixture of the wastes referred to above.

The GO facility currently and would continue to accept garden organics and garden waste. The *Waste Classification Guidelines Part 1: Classifying waste* (NSW EPA, 2014) defines garden waste to include branches,

grass, leaves, plants, loppings, tree trunks, tree stumps and similar materials, and includes any mixture of those materials.

The WMF also accepts special waste including asbestos waste and tyres.

6.3.1.2 WMF odour emission sources

Identified odour emission sources included:

– Landfilling activities:
  - Active tipping area
  - Daily cover
  - Intermediate cover
– GO handling:
  - Receipt, storage and transfer of GO including GO storage at the transfer station bays and at the storage platform.
– Other WMF sources:
  - Leachate pond

6.3.2 Representative odour emission data

A review of odour sampling data undertaken at similar facilities was undertaken to inform the selection of representative data suitable for inclusion in odour emissions estimation. The adopted odour data used in this assessment is summarised in Table 6.1.

It is noted that tipping face odour emissions varies significantly and use of an appropriate odour sampling methodology is considered critical to accurately quantify odour emissions from a tipping face. Therefore, in lieu of site-specific odour sampling data, a conservative Specific Odour Emission Rate (SOER) was adopted to account for worst case operations of the WMF. Should odour sampling be undertaken at the WMF, it is considered likely that the measured SOER would be significantly lower than the value adopted in the assessment.

Table 6.1 Section of representative odour sampling data

Odour source	SOER range (mean)	Adopted SOER	Reference of adopted odour data
Active Tip Face	0.25 – 72 (27.65)	26	Odour sampling of an active tip face undertaken at Lucas Heights Resource Recovery Park (Ektimo, 2014) referenced from LHRRP Modification – Organics Facility Odour Assessment (GHD, 2023). This SOER was calculated from upwind and downwind odour samples and includes odour from trucks dumping waste, and a compactor moving waste around.
Daily Cover	0.03 – 1.74 (0.492)	0.03	Odour sampling of daily cover undertaken at Lucas Heights Resource Recovery Park (Ektimo, 2014) referenced from LHRRP Modification – Organics Facility Odour Assessment (GHD, 2023)
Intermediate Cover	0 – 0.05 (0.031)	0.04	Odour sampling of intermediate cover area undertaken at Eastern Creek landfill (The Odour Unit, 2009) referenced from Air Quality Assessment – Odour and Dust: Proposed Modification to the Northern Extension Landfill at Eastern Creek (PAE Holmes, 2010)
Leachate Pond	0.15 – 0.28 (0.23)	0.26	Odour sampling of a quiescent leachate pond undertaken at Lucas Heights Resource Recovery Park (Ektimo, 2014) referenced from LHRRP Modification – Organics Facility Odour Assessment (GHD, 2023)
GO Storage	2 – 4 (2.55)	2.1	Odour sampling of GO undertaken at Horsley Park Waste Management Facility (Ektimo, 2018) referenced from Horsley Park Waste Management Facility Development of Final Landform Air Quality Impact Assessment (GHD, 2018)

6.3.3 Assessed scenarios

The following assumptions were used for odour emission estimation:

– Representative odour emission rate data was adopted based on sampling undertaken at similar facilities as outlined in Section 6.3.2
– Source areas were estimated based on inspection of aerial imagery for the existing scenario and design documentation for the project scenario. It is noted that a large tipping face area was assumed to conservatively assess worst case operating conditions. Typical landfill operations aim to minimise the tipping face area as much as practicable to minimise amenity impacts (air quality, noise, surface water, etc) and reduce operational requirements (cover material usage).
– The leachate pond was identified to be an un-aerated pond based on aerial imaging. Therefore representative odour sampling data of a quiescent leachate pond (un-aerated) was adopted.
– Diurnal variable emissions cycles were modelled for the active tip face and daily cover based on operational hours. All other sources were modelled as active 24 hours a day, 7 days per week.
– Peak to Mean factors (P/M60) were applied in accordance with the Approved Methods to estimate peak 1 second odour concentrations based on hourly model predictions.

Odour emissions inventories are provided in:

– Table 6.2 – Existing scenario
– Table 6.3 – Project scenario

Table 6.2 Existing scenario odour emissions inventory

Source	Surface Area (m^2)	SOER (OU/m^2s)	OER (OU/s)	P/M60 Factor	Diurnal Cycle 2400 time	Modelled SOER (OU/m^2s)	Modelled OER (OU/s)
Active Tip Face	1,600	26	41,600	2.5	0700 – 1700	65	104,000
Daily Cover	1,600	0.03	48	2.5	1700 – 0700	0.075	120
Intermediate Cover	31,445	0.04	1,258	2.5	N/A	0.10	3,145
Leachate Pond	879	0.26	229	2.5	N/A	0.65	571
Transfer Station GO Storage	254	2.1	533	2.5	N/A	5.25	1,331
Storage platform GO Storage	578	2.1	1,213	2.5	N/A	5.25	3,032
TOTAL (During operations)							**112,079**
TOTAL (Outside of operations)							**8,199**

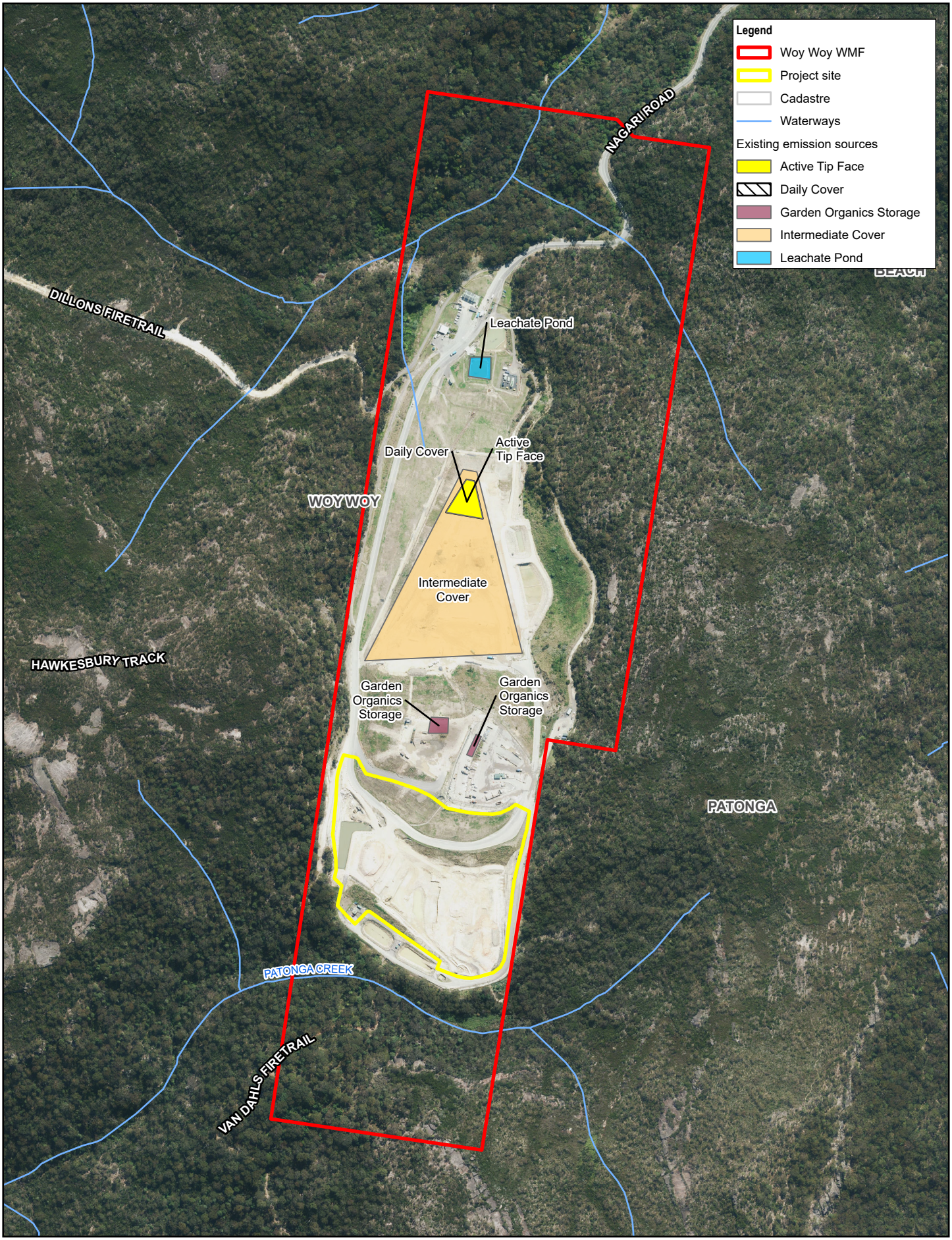
Table 6.3 Project scenario odour emissions inventory

Source	Surface Area (m^2)	SOER (OU/m^2s)	OER (OU/s)	P/M60 Factor	Diurnal Cycle (active hours)	Modelled SOER (OU/m^2s)	Modelled OER (OU/s)
Active Tip Face	1,600	26	41,600	2.5	0700 – 1700	65	104,000
Daily Cover	1,600	0.03	48	2.5	1700 – 0700	0.075	120
Intermediate Cover	10,824	0.04	433	2.5	N/A	0.1	1,082
Leachate Pond	879	0.26	229	2.5	N/A	0.65	571
Transfer Station GO Storage	254	2.1	533	2.5	N/A	5.25	1,331
Storage platform GO Storage	578	2.1	1,213	2.5	N/A	5.25	3,032
TOTAL (During operations)							**110,017**
TOTAL (Outside of operations)							**6,137**

The location of the modelled odour emission sources are shown below in:

– Figure 6.1 – Existing scenario
– Figure 6.2 – Future scenario

The placement of future scenario odour emission sources was done in accordance with the concept design, *South Cell at Woy Woy Waste, Management Facility Concept Design Report* (GHD, 2023). The location of the active tipping face was chosen to be the worst-case scenario and was adjusted to be on the easternmost area of the south cell. This location was chosen as it is the closest tipping face location to sensitive receptors and is anticipated to result in worst case odour impacts. Other stages of the project would result in the tipping face being located further away from sensitive receptors and therefore lower odour impacts are expected.



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Air Quality Assessment

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Emission sources for existing scenario

FIGURE 6.1

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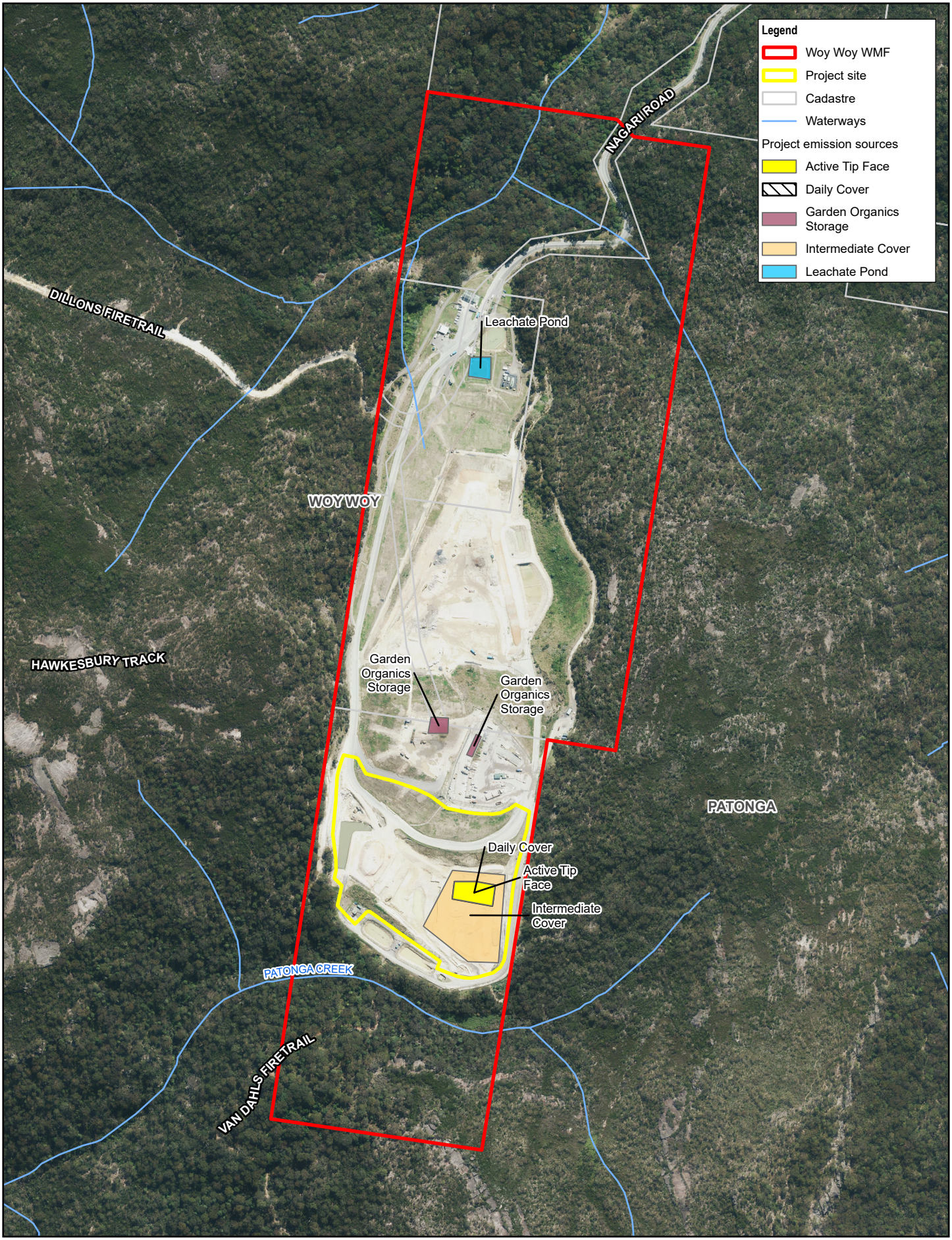

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Map Projection: Transverse Mercator
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Grid: GDA 1994 MGA Zone 56

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Air Quality Assessment

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Date **4/09/2023**

Emission sources for project scenario

FIGURE 6.2

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6.4 Odour modelling results

The model predictions are presented as tabulated results providing ground level concentrations at each sensitive receptor and as contour plots to illustrate the predicted pattern of dispersion and allow interpretation of the model predictions at any point of the sampling grid. The model results were presented as peak 1 second averaged 99th percentile odour concentration in accordance with the Approved Methods. The predicted model results were compared against the adopted odour assessment criteria of 2 OU to determine regulatory compliance.

The predicted odour concentrations for the existing and future scenarios are presented in Table 6.4 alongside a qualitative comparative assessment to identify the relative 'change in odour impact' due to the proposed project.

Predicted odour contour dispersion plots are provided in:

– Figure 6.3 – Existing scenario
– Figure 6.4 – Project scenario

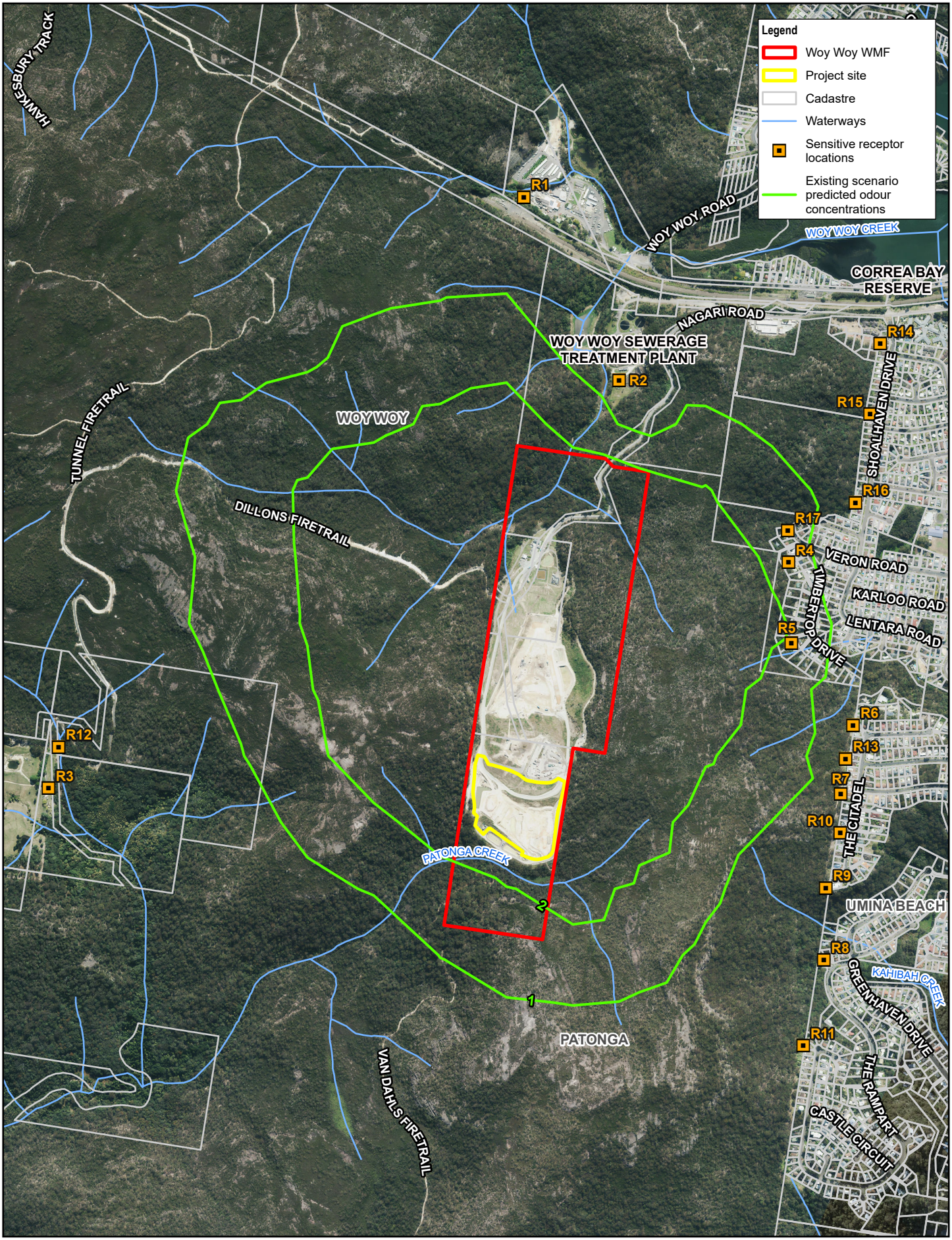
Modelled odour levels at all receptors were below the 2 OU assessment criteria for both the existing and future scenarios for the project site indicating that the compliance would be achieved for the proposed South Cell.

Predicted odour concentrations from the existing scenario are compliant with the assessment criteria which aligns with public observations as no odour complaints have been recorded against the WMF.

A decrease in the maximum odour concentration predicted at a sensitive receptor was observed comparing the existing scenario to the project scenario. In additional a general spatial shift in odour concentrations to the south was observed due to the project. This is attributed to a decrease in total odour emissions from the WMF due to a smaller intermediate cover area caused by logistical constraints and relocation of key sources (tipping face) to the southern end of the WMF which is further from sensitive receptors.

Table 6.4 Predicted odour concentration at receptor locations

Receptor	Predicted odour concentration (OU, 99th percentile, 1 second average)		Comparative assessment	
	Existing scenario	Project scenario	% change (from Existing to Project)	Qualitative change
R1	0.4	0.2	-53	Decrease
R2	0.7	0.3	-62	Decrease
R3	0.3	0.4	41	Increase
R4	1.9	0.8	-56	Decrease
R5	1.4	0.6	-61	Decrease
R6	0.6	0.6	3	Increase
R7	0.8	1.1	38	Increase
R8	0.3	0.5	64	Increase
R9	0.6	0.9	62	Increase
R10	0.6	1.1	81	Increase
R11	0.3	0.5	97	Increase
R12	0.3	0.4	20	Increase
R13	0.7	0.8	7	Increase
R14	0.4	0.2	-56	Decrease
R15	0.5	0.2	-52	Decrease
R16	0.6	0.3	-56	Decrease
R17	1.3	0.5	-65	Decrease



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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Existing scenario predicted odour concentrations (1 second peak, 99th percentile OU)

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FIGURE 6.3

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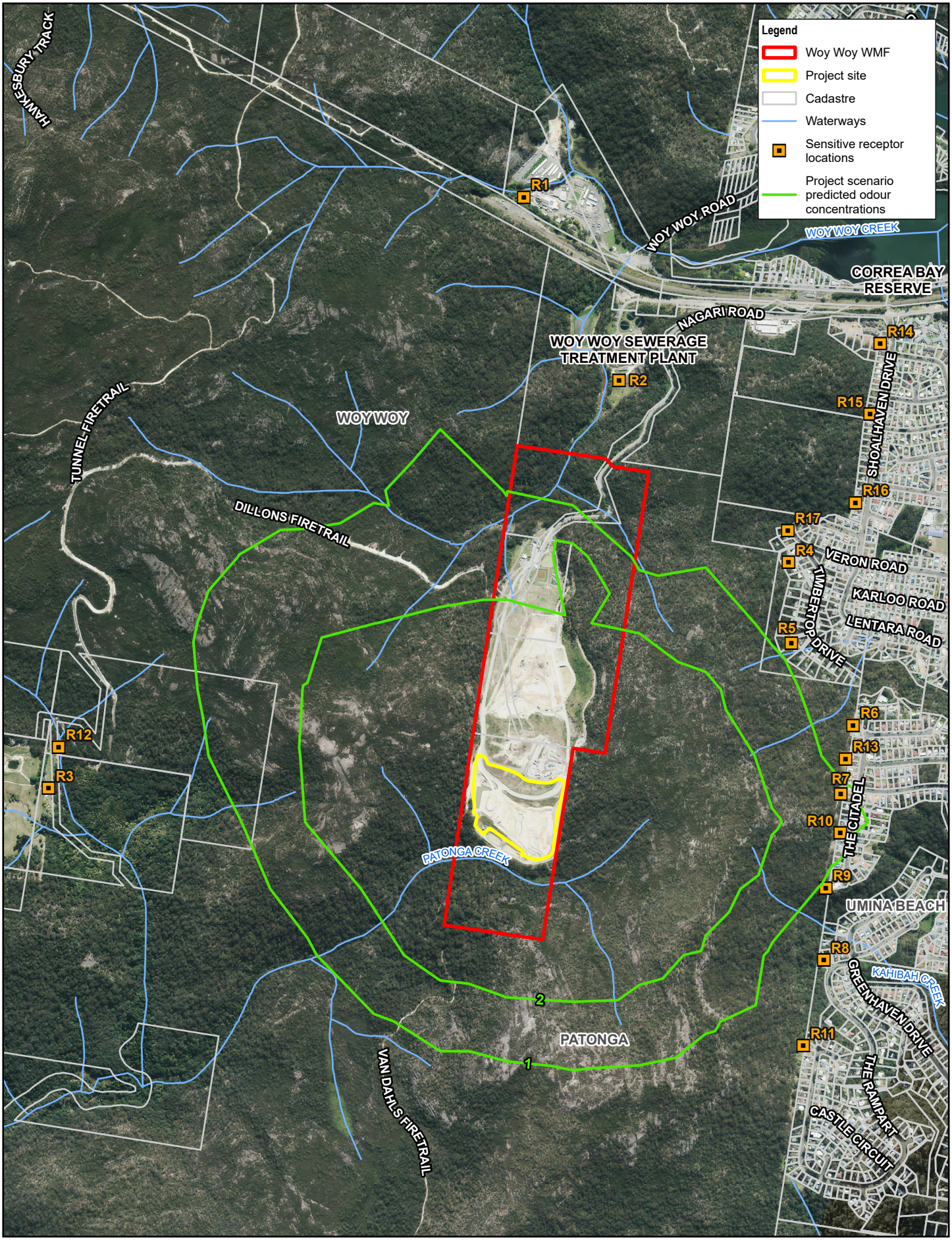

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
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GHD

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South Cell at Woy Woy WMF
Air Quality Assessment

Project scenario predicted odour concentrations (1 second peak, 99th percentile OU)

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FIGURE 6.4

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Data source: LPI: DCDB / DTDB, 2023; Aerial Imagery: Metromap Tile Service: . Created by: pfield

6.5 Dust impacts

There is potential for dust emissions during future operation of the project if not managed appropriately. Future operations at the project site would continue much the same as currently undertaken and therefore dust emissions are not expected to increase at any offsite sensitive receptors.

Sources of dust during operation would be wheel generated dust from trucks travelling on unpaved surfaces, vehicles moving on the landform, covering waste, minor regrading works to enable capping, wind erosion from unsealed surfaces and stockpiles, and GO loading/unloading.

There have been no dust complaints received at the WMF inferring existing dust emissions during operation are minor or adequately managed such that dust concentrations at receptors are low. Proposed operations of the project would remain similar to that of existing operations, therefore no significant change in dust emissions and offsite concentrations are expected.

General dust mitigation measures are provided in Section 7.2.

7. Management and mitigation

Air quality management and mitigation measures to reduce emissions to air from the project and minimise any potential air quality impacts are provided in the sections below.

Air pollution management measures that focus on preventing, detecting and remediating air emissions outlined in the *Landfill Management Plan (incorporating Pollution Incident Response Management Plan) Woy Woy Waste Depot* (URS, 2012) (LMP) should continue to be implemented during the project.

7.1 Construction

While general construction activities are not expected to exceed air quality goals at nearby receptors, the following mitigation measures are recommended:

– Prepare a dust management plan for use during construction activities.
– Reduce or cease dust generating activities if clearly visible plumes of dust go off the site.
– Operations conducted in areas of low moisture content material would be suspended during high wind speed events and water sprays would be used.
– Aim to minimise the size of storage piles where possible.
– Limit cleared areas of land and stockpiles and clear only when necessary to reduce fugitive dust emissions. All material stockpiles would have appropriate stormwater and dust controls in place.
– Control on-site traffic by designating specific routes for haulage and access. Traffic on any unpaved construction areas should be limited to 25 kilometres per hour.
– All trucks carrying dry bulk material that is loaded on site must be loaded and operated so as to prevent spillage of any material from the load (which generates dust). Trucks must be covered prior to leaving the licenced site boundary.

7.2 Operation

Odour

While the project is not expected to exceed odour goals at nearby receptors, the following management and mitigation measures are recommended to reduce odorous emissions and minimise any potential odour impacts:

– Continue implementation of odour control measures outlined in the LMP including
  - Section 4.6 – Continue upkeep of the complaints register
  - Section 8 – air monitoring programs including subsurface gas monitoring, surface gas monitoring and gas accumulation monitoring
  - Section 9.8 – includes minimisation of exposed waste areas and fast identification and attention to odorous waste loads
– Cover odorous wastes as soon as possible after delivery
– Minimise the size of the active landfill tipping face, taking into account the practicalities, safety, access, traffic management, etc.
– Inspect and monitor the covered landfill areas regularly
– Cover all areas subject to minor regraded at the end of each day
– Train staff (internal and contractors) on odour management strategy and all relevant procedures
– Continue to install and operate a landfill gas collection system progressively with filling to minimise odour as a result of landfill gas seepage

Dust

– Continue implementation of dust control measures outlined in the LMP including:
  - Section 9.6 – use of a watering cart to spray water of roadways 3 to 4 times per day during operating hours and revegetating finished landfill areas as soon as practicable

    - Section 9.12 – bitumen sealing of road used to delivery waste within a minimum of 100 metres of the tipping face
- Control on-site traffic by designating specific routes for haulage and access. Traffic on any unpaved construction areas should be limited to 25 kilometres per hour.
- All trucks carrying dry bulk material that is loaded on site must be loaded and operated so as to prevent spillage of any material from the load (which generates dust). Trucks must be covered prior to leaving the licenced site boundary.
- Any long-term stockpiles would be stabilised using fast-seeding grass or synthetic cover spray to minimise wind blown dust emissions.

7.3 Closure and rehabilitation

Management and mitigation measure recommended for construction of the project (refer Section 7.1) are relevant and should be implemented during closure and rehabilitation of the project.

8. Evaluation and conclusions

GHD has conducted an air quality assessment to assess the construction, operation, closure and rehabilitation of the proposed South Cell at the WMF. The assessment was undertaken in accordance with relevant legislation and government guidance.

A qualitative approach was adopted to assess the construction, closure and rehabilitation of the project. The assessment identified a low risk of potential dust impacts as there would be a large separation distance between activities and sensitive receptors, and emissions to air during construction, closure and rehabilitation are expected to be minor.

A quantitative assessment utilising dispersion modelling was adopted to assess odour emission during operation of the project. Odour emissions inventories were prepared for the existing and proposed future operation of the WMF due to the project based on representative odour sampling data from similar facilities. It is recognised that odour emission rates can vary significantly and that use of an appropriate odour sampling methodology is considered critical to accurately quantify odour emissions. Therefore a number of conservatisms were adopted in preparation of the odour emissions inventory and odour dispersion modelling to account for any uncertainty in odour emission rates. The results of the dispersion modelling predicted compliance with the selected odour assessment criteria for both existing and future operations of the WMF.

Odour emissions from the WMF due to the project would be relatively unchanged from existing operation. A comparative assessment examining predicted existing and future odour concentration concluded that the project would have a neutral effect on offsite odour impacts. A decrease in the maximum odour concentration predicted at a sensitive receptor was observed and a general spatial shift in odour concentrations to the south was observed due to the project.

Mitigation and management measures were recommended to reduce emissions to air and minimise any potential air quality impacts.

9. References

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Appendix A

Meteorological modelling methodology

A-1 Overview

Local meteorology, including long term wind speed and direction as well as atmospheric stability, can influence how pollutants are dispersed into the local environment.

This appendix outlines the methodology used to synthesise site-representative meteorology for the project. The meteorology is used in CALPUFF to drive the dispersion model.

A-2 Methodology

The meteorology modelling methodology is summarised below:

– Selection of a model period
– Development of coarsely gridded prognostic meteorological data set using The Air Pollution Model (TAPM).
– Development of refined gridded meteorological data set which takes into account local terrain features using the CALMET diagnostic meteorological model
– Verification of model performance using data measured at BoM meteorological monitoring stations
– Extraction of predicted meteorological parameters from the CALMET model

A-2-1 Nearby BoM station review

A review of nearby BoM station is provided in Table A.1.

Table A.1 Nearby BoM station review

BoM station	Approximate distance from project site	Availability of meteorological data	BoM station setting
Gosford AWS (BoM ID: 061425)	10.4 km northeast of the project site	Began operation in June 2013. All desired meteorological parameters except cloud data available.	Located in park with a buffer distance of 120 m to the nearest tree and a creek located to the south.
Gosford Narara Research Station AWS (BoM ID: 061087)	13 km north of the project site	Decommissioned in 2013	
Terrey Hills AWS (BoM ID: 066059)	21 km south of the project site	Began operation in September 2004. All desired meteorological parameters except cloud data available.	Located in park with a buffer distance of 30 m to the nearest tree.

Due to close proximity to the project, the Gosford AWS was selected for inclusion in the representative year analysis.

A-2-2 Representative year selection

A representative year was chosen for modelling purposes based on review of Southern Oscillation Index (SOI) for the past 10 years and an analysis BoM data recorded Gosford AWS for the last year calendar years (01/01/2017 – 31/12/2021).

The SOI indicates the intensity of El Nino or La Nina events in the Pacific Ocean. A value of less than -7 often indicates El Nino episodes (typically accompanied by sustained warming of the central and eastern tropical Pacific Ocean, a decrease in the strength of the Pacific Trade Winds, and a reduction in winter and spring rainfall over much of eastern Australia and the Top End) while a value of greater than 7 often indicates La Nina episodes (typically associated with stronger Pacific trade winds and warmer sea temperatures to the north of Australia, waters in the central and eastern tropical Pacific Ocean become cooler during this time). Together, these give an increased probability that eastern and northern Australia will be wetter than normal[3].

[3] SOI data and description of El Nino and La Nina episodes sourced from Australian Government BoM, available online: **http://www.bom.gov.au/climate/current/soi2.shtml**

The SOI for the past 10 years is shown in Figure A.1.

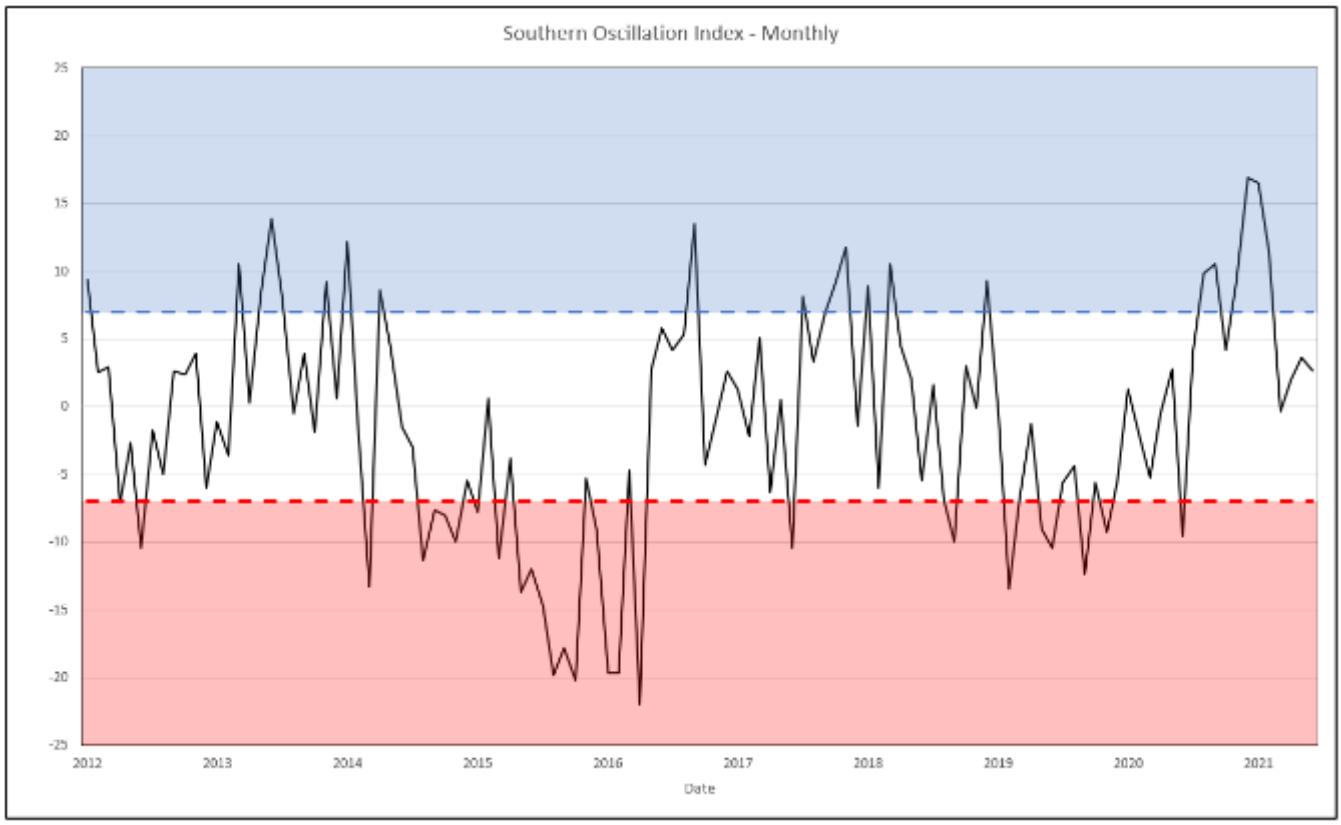

Figure A.1 Southern Oscillation Index for last 10 years (2012 – 2021)

Probability density function plots of Gosford AWS (2017-2021) for wind speed, wind direction and temperature are provided in Figure A.2, Figure A.3 and Figure A.4 respectively.

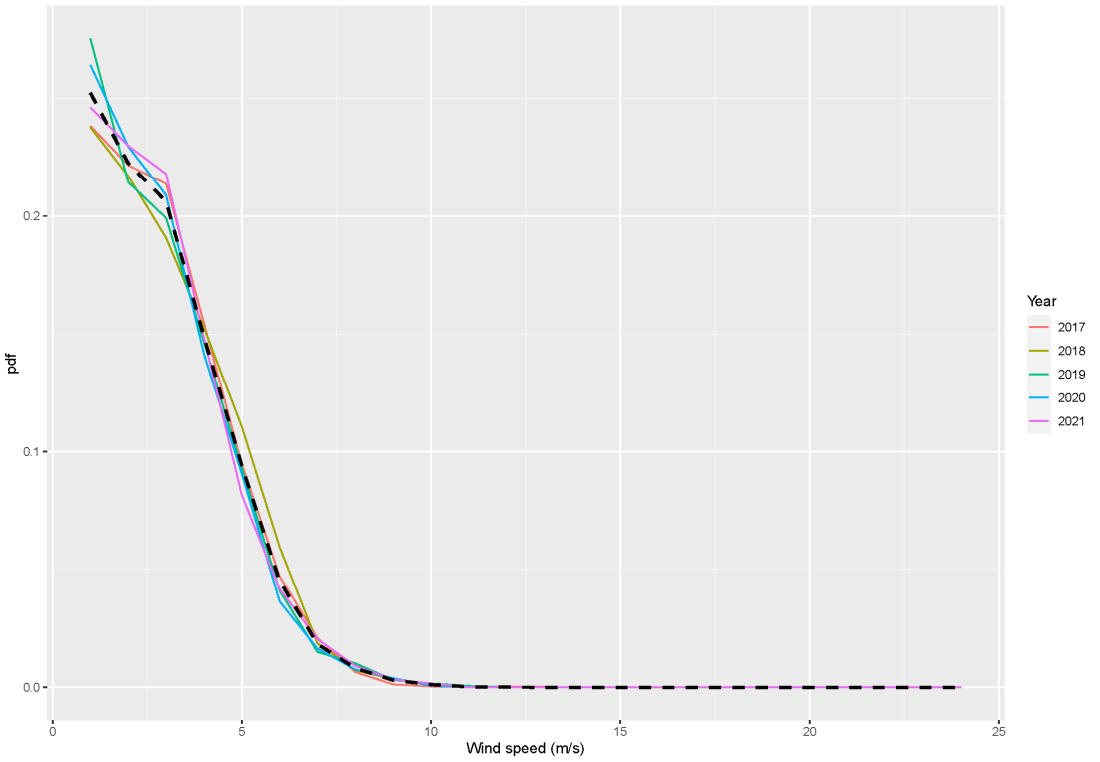

Figure A.2 Wind speed, degrees (Gosford AWS, 2017 – 2021)

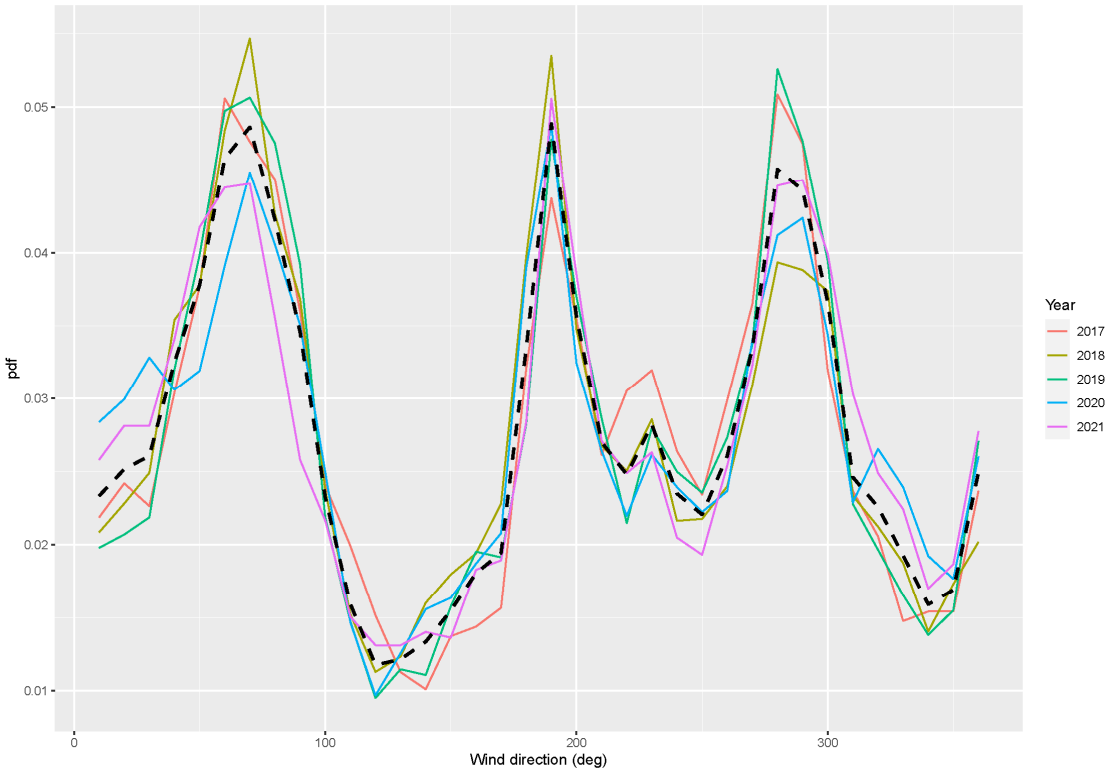

Figure A.3 Wind direction, degrees (Gosford AWS, 2017 – 2021)

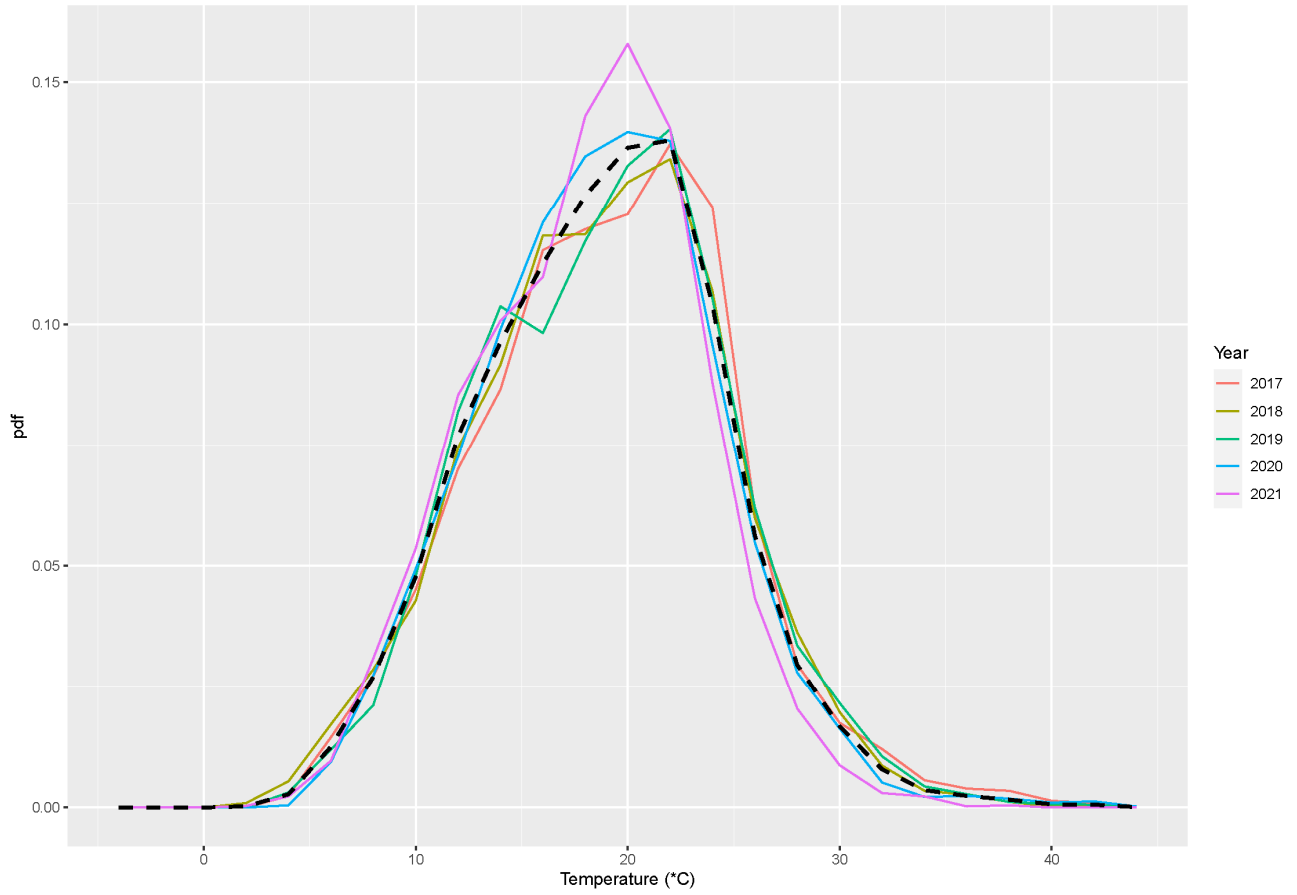

Figure A.4 Temperature , degrees Celsius (Gosford AWS, 2017 – 2021)

Based on the review of SOI data and meteorological conditions recorded at Gosford AWS, the representative year selected for modelling purposes was 01 January 2020 through 01 January 2021.

A-2-3 Prognostic meteorology

The parameters for the prognostic TAPM model are summarised in Table A.2.

Table A.2 TAPM model parameters

Parameter	Value
Modelled period	1 December 2019 to 02 January 2021
Domain centre	Latitude: 33.500 S Longitude: 151.283 E UTM: 341300, 6291000
Number of vertical levels	25
Number of northing grid points	45
Number of easting grid points	45
Number of grid levels	4
Grid level horizontal resolution	Level 1 – 30,000m Level 2 – 10,000m Level 3 – 3,000m Level 4 – 1000m

A-3 CALMET modelling

CALMET (Version 7) was used to resolve the wind field around the project site to 200 metres spatial resolution. The application of CALMET for this purpose is an approved modelling approach in NSW as per the Approved Methods with model guidance documentation provided.

Upon completion of the broad scale TAPM modelling runs, a CALMET simulation was set up to run for the model period using the three-dimensional gridded data output from the CALMET model as an initial guess field. This approach is consistent with guidance documentation.

CALMET was run using the 'No-Obs' mode (i.e. surface observational data was not included in the model). Given the project site is located within a complex land-sea interface, it was deemed that introduction of observational data into the model would lead to inconsistencies/irregularities in the predicted wind field, where blending of the observations and initial guess field is carried out. This is especially true at wind field levels above the surface level on the coastline, which are critical in this instance when assessing dispersion of pollutants from the ship loading vent sources.

All model settings were selected based on the recommendations provided in 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 (J Barclay and J Scire, Atmospheric Studies Group TRC Environmental Corporation, 2011) except for MDISP (parameter for dispersion coefficients) for which the default value was used.

The centre of the CALMET domain, or the origin, was located at UTM Zone 56 coordinates 341 kilometres east and 6291 kilometres north. The CALMET domain extended 40 kilometres to the east and north.

The CALMET domain consisted of 200 grids in both the east and north directions, with a grid resolution of 0.20 kilometre.

The CALMET model parameters are summarised in Table A3. The TERRAD value was selected based on inspection of the terrain elevations in the immediate vicinity of the project site. It should be noted that multiple TERRAD values were tested and the value producing the best results was selected.

Terrain and land use data used for the CALMET modelling are presented in Figure A5 and Figure A6.

Table A.3 Summary of CALMET model parameters

Parameter	Value
Modelled period	1 January 2020 to 31 December 2020
Mode	No obs (NOOBS = 2)
UTM zone	56
Domain origin (south-west corner)	Easting: 341 km Northing: 6291 km
Domain size	200 x 200 at 0.20 km resolution (40.0 km x 40.0 km)
Number of vertical levels	11
Vertical levels (m)	0, 20, 40, 80, 160, 320, 640, 1200, 2000, 3000, 4000,
CALMET settings for hybrid mode Settings selected in accordance with (OEH, 2011)	TERRAD = 2.5 km
Initial guess field	TAPM .m3d file used as an initial guess field for CALMET
Surface data	N/A
Upper air data	No site-specific upper air data is used. Upper air data is included within the TAPM .m3d initial guess field.
Land use and terrain data	Land use data was manually developed through assessment of aerial imagery to accurately reflect the land

Parameter	Value
	use in the area. High-resolution terrain data was sourced from the STRM 1-second (~30 m) database.

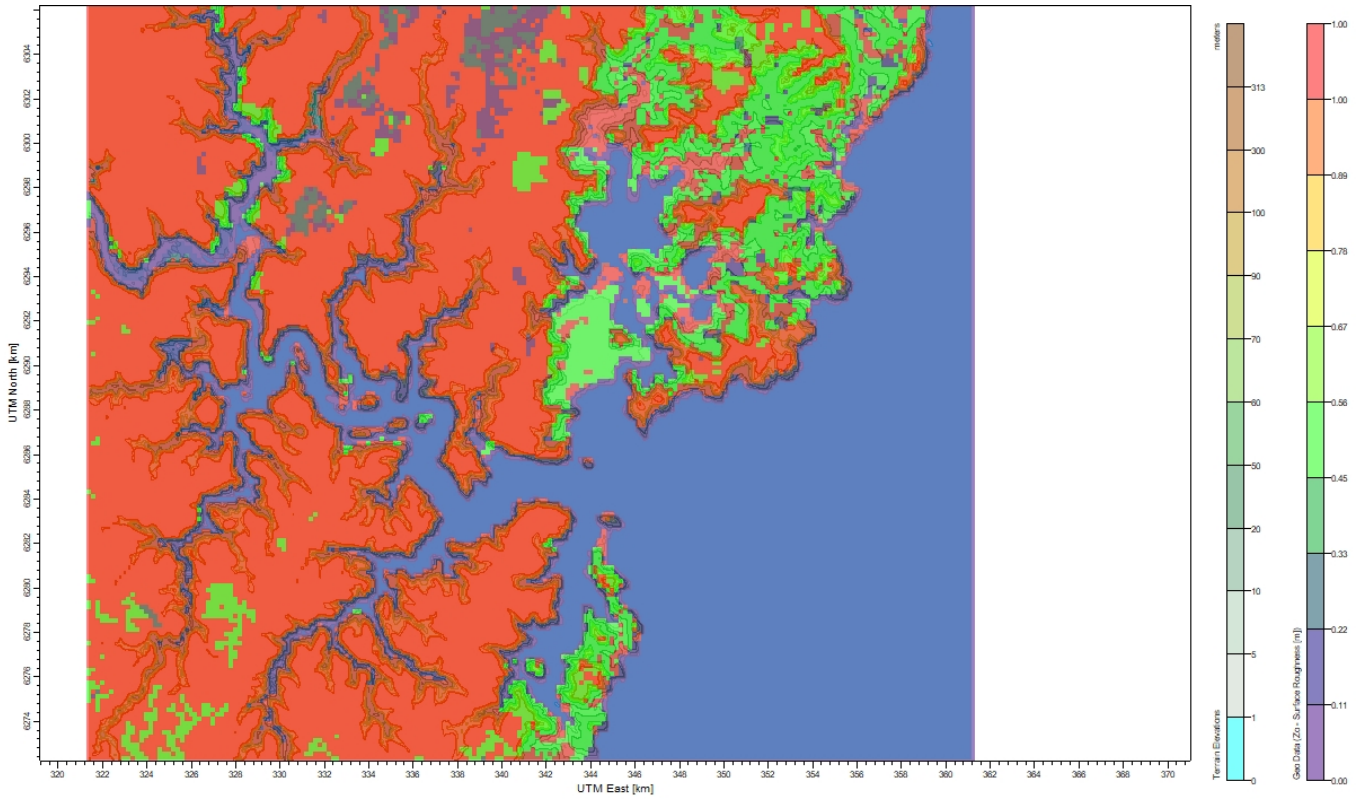

Figure A.5 Terrain data used for CALMET modelling

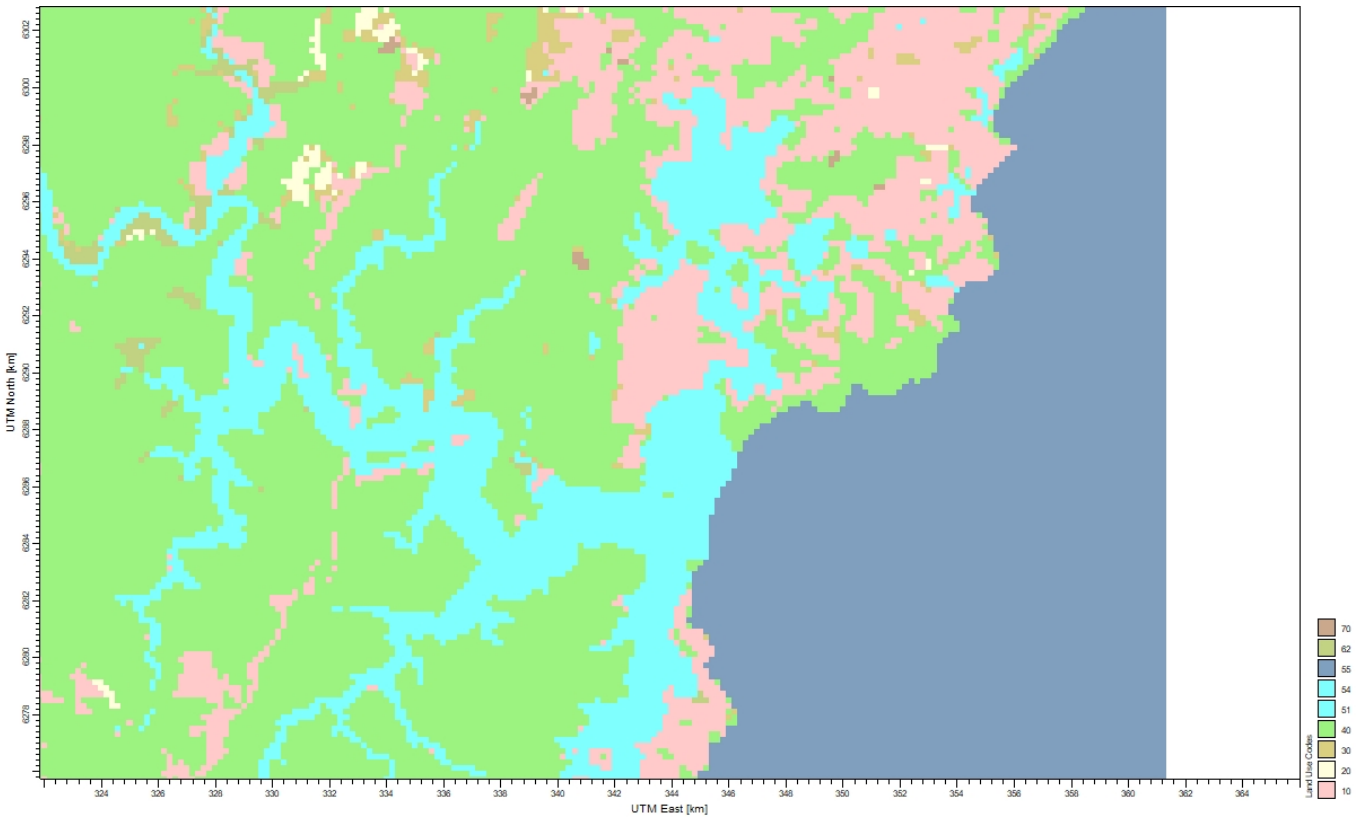

Figure A.6 Land use data used for CALMET modelling

The local meteorology largely determines the pattern of off-site air quality impact on receptors (houses, businesses and industry). The effect of wind on dispersion patterns can be examined using the wind and stability class distributions at the project site from the dataset that is produced by CALMET. The winds at the project site are most readily displayed by means of wind rose plots, giving the distribution of winds and the wind speeds from these directions.

The features of particular interest in this assessment are (i) the dominant wind directions and (ii) the relative incidence of stable light wind conditions that yield minimal mixing (defines peak impacts from ground-based sources).

A-3-1 Annual wind patterns

The wind rose for the entire data period taken at the project site is shown in Figure A7 and shows the following features:

– Lower wind speeds (0.5 – 1 m/s) are rare and mostly occur from the north and east.
– The average wind speed predicted was 2.7 metres per second.
– Calm conditions (wind speeds less than 0.5 m/s) occurred 1 per cent of the time.

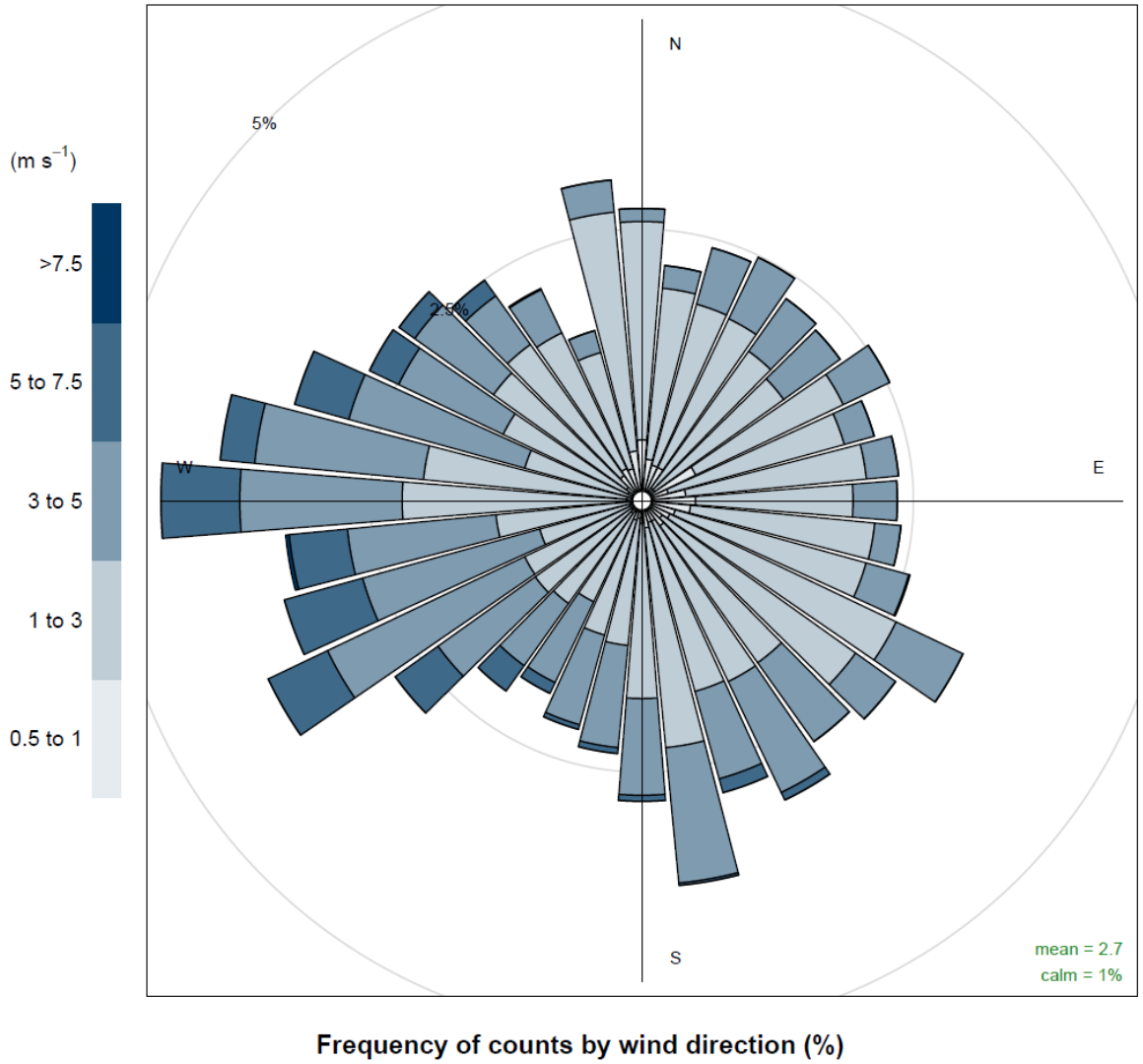

Figure A.7 Wind rose at site from CALMET (2020)

A-3-2 Pattern of atmospheric stability

Atmospheric stability substantially affects the capacity of a pollutant such as gas, particulate matter or odour to disperse into the surrounding atmosphere upon discharge and is a measure of the amount of turbulent energy in the atmosphere.

There are six Pasquill-Gifford classes (A-F) used to describe atmospheric stability and these classes are grouped into three stability categories; stable (classes E-F), neutral (class D), and unstable (classes A-C). The climate parameters of wind speed, cloud cover and insolation (solar radiation) are used to define the stability category as shown in Table A4. As these parameters vary from day to night, there is a corresponding variation in the occurrence of each stability category.

Stability is most readily displayed by means of stability rose plots, giving the frequency of winds from different directions for various stability classes A to F.

Table A.4 Stability category relationship to wind speed and stability characteristics

Stability category	Wind speed range (m/s)[a]	Stability characteristics
A	0 – 2.8	Extremely unstable atmospheric conditions, occurring near the middle of day, with very light winds, no significant cloud.
B	2.9 – 4.8	Moderately unstable atmospheric conditions occurring during mid-morning/mid-afternoon with light winds or very light winds with significant cloud.
C	4.9 – 5.9	Slightly unstable atmospheric conditions occurring during early morning/late afternoon with moderate winds or lighter winds with significant cloud.
D	≥6	Neutral atmospheric conditions. These occur during the day or night with stronger winds, during periods of total cloud cover or during the twilight period.
E	3.4 – 5.4 b	Slightly stable atmospheric conditions occurring during the night-time with significant cloud and/or moderate winds.
F	0 – 3.3 [b]	Moderately stable atmospheric conditions occurring during the night-time with no significant cloud and light winds.

Note: a Data sourced from the Turner's Key to the P-G Stability Categories, assuming a Net Radiation Index of +4 for daytime conditions (between 10:00 am and 6:00 pm) and –2 for night-time conditions (between 6:00 pm and 10:00 am)

b Assumed to only occur at night, during Net Radiation Index categories of –2.

Figure A.8 shows the frequency of stability class for all hours of the model generated dataset. The following observations were made:

– Unstable atmospheres (classes A, B and C) occur 38 per cent of the time
– Neutral atmosphere conditions (class D) occurred 14 per cent of the time
– Stable conditions (classes E and F) occur 48 per cent of the time

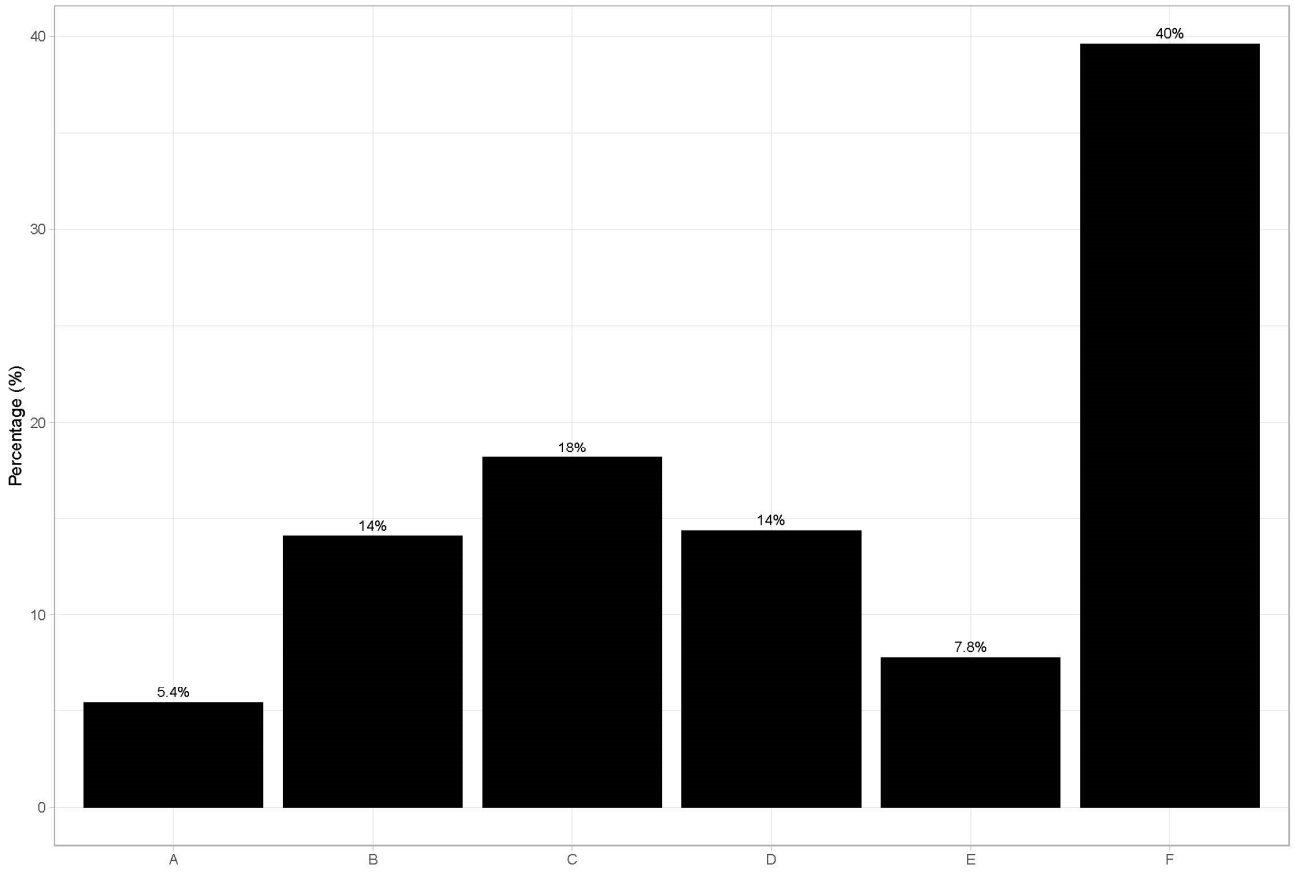

Figure A.8 Distribution of stability class for the model period

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