ACOUSTICS AND AIR

BREEN RESOURCES

AIR QUALITY IMPACT ASSESSMENT

REPORT NO. 18132-AA
REVISION 0

APRIL 2021

PREPARED FOR

BREEN RESOURCES
330 CAPTAIN COOK DRIVE
KURNELL NSW 2231

WILKINSON MURRAY

DOCUMENT CONTROL

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50 YEARS
1962–2012

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GLOSSARY OF AIR QUALITY TERMS

Air Pollution – The presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects.

Air Quality Standards – The level of pollutants prescribed by regulations that are not to be exceeded during a given time in a defined area.

Air Toxics – Any air pollutant for which a national ambient air quality standard (NAAQS) does not exist (i.e. excluding ozone, carbon monoxide, PM-10, sulphur dioxide, nitrogen oxide) that may reasonably be anticipated to cause cancer; respiratory, cardiovascular, or developmental effects; reproductive dysfunctions, neurological disorders, heritable gene mutations, or other serious or irreversible chronic or acute health effects in humans.

Airborne Particulates – Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. Chemical composition of particulates varies widely, depending on location and time of year. Sources of airborne particulates include dust, emissions from industrial processes, combustion products from the burning of wood and coal, combustion products associated with motor vehicle or non-road engine exhausts, and reactions to gases in the atmosphere.

Area Source – Any source of air pollution that is released over a relatively small area, but which cannot be classified as a point source. Such sources may include vehicles and other small engines, small businesses and household activities, or biogenic sources, such as a forest that releases hydrocarbons, may be referred to as nonpoint source.

Concentration – The relative amount of a substance mixed with another substance. Examples are 5 ppm of carbon monoxide in air and 1 mg/l of iron in water.

Emission – Release of pollutants into the air from a source. We say sources emit pollutants.

Emission Factor – The relationship between the amount of pollution produced and the amount of raw material processed. For example, an emission factor for a blast furnace making iron would be the number of pounds of particulates per ton of raw materials.

Emission Inventory – A listing, by source, of the amount of air pollutants discharged into the atmosphere of a community; used to establish emission standards.

Flow Rate – The rate, expressed in gallons -or litres-per-hour, at which a fluid escapes from a hole or fissure in a tank. Such measurements are also made of liquid waste, effluent, and surface water movement.

Fugitive Emissions – Emissions not caught by a capture system.

Hydrocarbons (HC) – Chemical compounds that consist entirely of carbon and hydrogen.

Hydrogen Sulphide (H_2S) – Gas emitted during organic decomposition. Also, a by-product of oil refining and burning. Smells like rotten eggs and, in heavy concentration, can kill or cause illness.

Inhalable Particles – All dust capable of entering the human respiratory tract.

Landfill – A landfill is an engineered, in-ground facility for the safe and secure disposal of waste by applying the waste to the land.

Nitric Oxide (NO) – A gas formed by combustion under high temperature and high pressure in an internal combustion engine. NO is converted by sunlight and photochemical processes in ambient air to nitrogen oxide. NO is a precursor of ground-level ozone pollution, or smog.

Nitrogen Dioxide (NO_2) – The result of nitric oxide combining with oxygen in the atmosphere; major component of photochemical smog.

Nitrogen Oxides (NO_x) – A criteria air polluant. Nitrogen oxides are produced from burning fuels, including gasoline and coal. Nitrogen oxides are smog formers, which react with volatile organic compounds to form smog. Nitrogen oxides are also major components of acid rain.

Mobile Sources – Moving objects that release pollution; mobile sources include cars, trucks, buses, planes, trains, motorcycles and gasoline-powered lawn mowers.

Particulates; Particulate Matter (PM-10) – A criteria air pollutant. Particulate matter includes dust, soot and other tiny bits of solid materials that are released into and move around in the air. Particulates are produced by many sources, including burning of diesel fuels by trucks and buses, incineration of garbage, mixing and application of fertilizers and pesticides, road construction, industrial processes such as steel making, mining operations, agricultural burning (field and slash burning), and operation of fireplaces and woodstoves. Particulate pollution can cause eye, nose and throat irritation and other health problems.

Parts Per Billion (ppb)/Parts Per Million (ppm) – Units commonly used to express contamination ratios, as in establishing the maximum permissible amount of a contaminant in water, land, or air.

PM10/PM2.5 – PM10 is measure of particles in the atmosphere with a diameter of less than 10 or equal to a nominal 10 micrometres. PM2.5 is a measure of smaller particles in the air.

Point Source – A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g. a pipe, ditch, ship, ore pit, factory smokestack.

Scrubber – An air pollution device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Source – Any place or object from which pollutants are released.

Stack – A chimney, smokestack, or vertical pipe that discharges used air.

Stationary Source – A place or object from which pollutants are released and which does not move around. Stationary sources include power plants, gas stations, incinerators, houses etc.

Temperature Inversion – One of the weather conditions that are often associated with serious smog episodes in some portions of the country. In a temperature inversion, air does not rise because it is trapped near the ground by a layer of warmer air above it. Pollutants, especially smog and smog-forming chemicals, including volatile organic compounds, are trapped close to the ground. As people continue driving and sources other than motor vehicles continue to release smog-forming pollutants into the air, the smog level keeps getting worse.

1 INTRODUCTION

1.1 Background

The Proposal is comprised of the delivery of a new resource management facility, including the Embellished Marang Parklands, the continuation of landfilling on the residual parts of Lot 5 and the construction of the New Resource Recovery Facility.

Specifically, the Proposal involves the following key integrated components:

- Construction and operation of a resource management facility, comprising:
  - A New Resource Recovery Facility on the eastern part of the Proposal Site (Lot 5), including consolidation of existing waste management activities within this part of the Proposal Site; and
  - A waste disposal facility, being the continuation of current land restoration, landfilling and contouring operations at the Proposal Site by permanent application of some of the residual waste materials from the New Resource Recovery Facility to land on Lot 5;
- Use of suitable material processed by the New Resource Recovery Facility to cap, contour and re-profile areas of the Proposal Site and to construct the Embellished Marang Parklands on Lots 1122, 1123 and Lot 6;
- Re-profiling of parts of the Proposal Site within Lots 1122, 1123 and 6, with some existing waste materials from those lots;
- Delivery of an activated and integrated community space in the form of the Embellished Marang Parklands on Lots 1122,1123 and Lot 6, to provide a superior parkland to that proposed under the VPA as detailed in Section 4.4.3 of the EIS (referred to as the Embellished Marang Parklands). This will include, among other things, integrated water usage and management and utilising personnel, plant, material and infrastructure across the whole of the Site.

To enable the above Proposal, the Existing Breen Resources Facility on Lots 1122, 1123 and 6 (this includes those parts of Lots 1122, 1123 and 6 that will comprise the Playing Fields) will be demolished and/or relocated (as required) to Lot 5.

The proposed Embellished Marang Parklands include the following improvements and benefits to the community over and above those contemplated by the 2010 VPA:

- A cleared 'Village Green' area in the middle of the parklands with amphitheatre, providing a place for the community to hold events and celebrations in a semi natural setting;
- Associated picnic areas for all members of the local and wider community to use and enjoy;
- A playground;
- A network of accessible paths, including key pedestrian and cycle links between Quibray Bay and Cronulla Beach, to allow visitors to easily access the parklands for pedestrians and cycling, reinforcing the Sydney Green Grid; and,
- An elevated landscape, including a panoramic look out in the western part of the parklands, that offers spectacular all-round regional views that will assist in a better understanding of the varied landscapes of this part of Sydney.

1.2 Purpose of this report

Ethos Urban has been engaged by Breen to author an Environmental Impact Statement (EIS) to support a development application for approval of the Proposal under Part 4 of the New South Wales (NSW) Environmental Planning and Assessment Act 1979 (the EP&A Act). The EIS is being prepared in accordance with the provisions of the EP&A Act.

This report has been prepared by Wilkinson Murray to provide an assessment of potential air quality and greenhouse gas impacts as an input to the EIS. This report addresses the Secretary of the NSW Department of Planning and Environment's Environmental Assessment Requirements (SSD-10412) dated 14 February 2020.

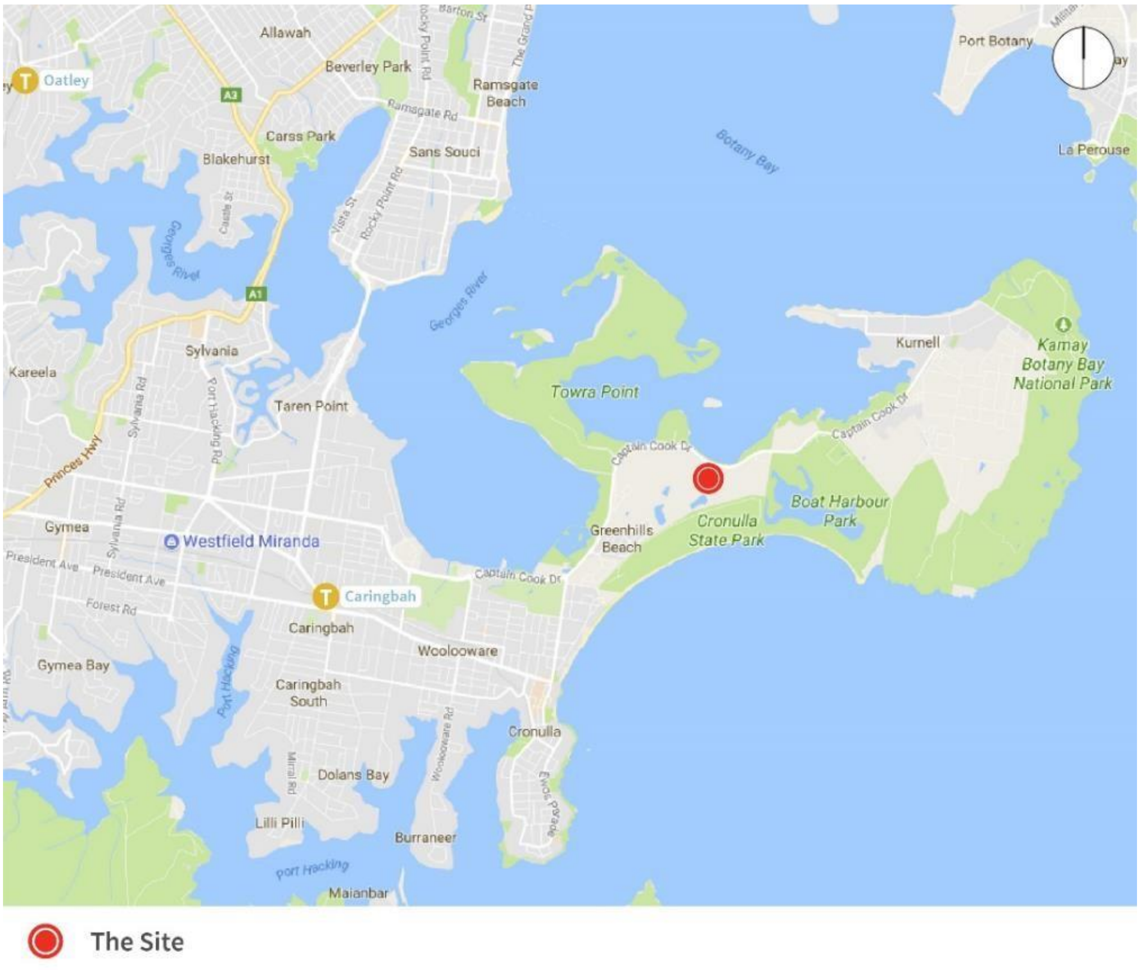
2 THE PROPOSAL SITE

2.1 Location

The Proposal site is located within the Sutherland Shire Local Government Area, approximately 12 kilometres south of the Sydney Kingsford Smith Airport. The Proposal site is situated on the Kurnell Peninsula, positioned between Quibray Bay (within Botany Bay) to the north and Bate Bay (being Cronulla and Wanda beaches) to the south. It is currently accessible from Captain Cook Drive and Lindum Road.

Figure 2-1 shows the location of the Proposal site.

Figure 2-1 Proposal site location



2.2 Site context

The Proposal Site is generally bounded to the north by Captain Cook Drive, which provides access from North Cronulla through to the village of Kurnell, as well as the main access to the Existing Breen Resources Facility. Further to the north of Captain Cook Drive are the foreshores and waters of Botany Bay, including the Towra Point Nature Reserve.

Near the eastern end of the Proposal site, Sporting Field No. 1 and the Skate Park have recently been constructed on Lot 1 DP 1101922 and are now operational. This new recreational area represents the closest existing sensitive receptor to the eastern part of the Proposal site, where the New Resource Recovery Facility is proposed to be located.

An electricity transmission line easement runs along this boundary, between the Proposal site and the Sporting Field No. 1 and Skate Park recreational area. The easement contains Ausgrid 132kV overhead electricity transmission lines. Further to the west, Hockey Fields No. 2 and No. 3 have also already been constructed on Lot 111 DP777967 and part of Lot 1123, and are now operational.

To the south, the Proposal site adjoins the Heritage Sand Dune and Cronulla State Park, which leads to Wanda Beach, fronting onto Bate Bay.

To the east, the Proposal site is bounded by an unconstructed extension of Lindum Road, within which a pedestrian footpath has been constructed for beach and foreshore access. Beyond the Lindum Road road reserve is a sand mining site that is being progressively mined for construction sand and backfilled with virgin excavated natural materials.

To the west, the Proposal site adjoins Charlotte Breen Memorial Reserve and Sydney Water's Cronulla wastewater treatment plant. Beyond Charlotte Breen Memorial Reserve to the south west is the new residential suburb of Greenhills Beach, comprising low density residential housing.

2.3 Proposal overview

Key features of the Proposal include:

- Construction and operation of a resource management facility to process approximately 650,000 tonnes per year of construction and demolition (C&D) and commercial and industrial (C&I) wastes, comprising:
  - A New Resource Recovery Facility on the eastern part of the Proposal Site (Lot 5), including consolidation of existing waste management activities within this part of the Proposal Site; and
  - A waste disposal facility, being the continuation of current land restoration, landfilling and contouring operations at the Proposal Site by permanent application of some of the residual waste materials from the New Resource Recovery Facility to land on Lot 5;
- Use of suitable material processed by the New Resource Recovery Facility to cap, contour and re-profile areas of the Proposal Site and to construct the Embellished Marang Parklands on Lots 1122, 1123 and Lot 6;
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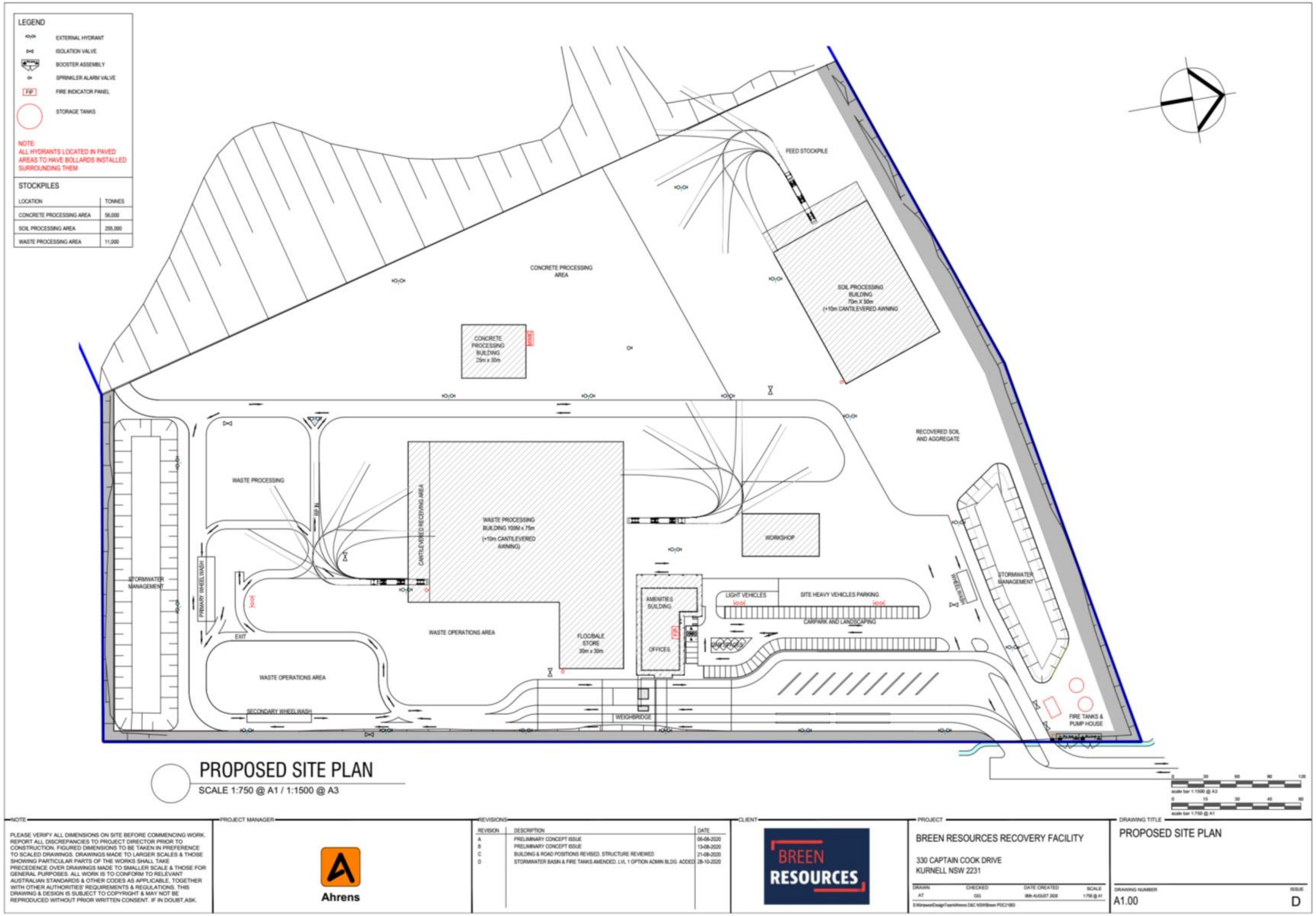
Figure 2-2 shows the key components of the Proposal. Figure 2-3 shows the proposed layout of the New Resource Recovery Facility.

Figure 2-2 Proposal – key components

LEGEND
- Project Boundary
- Landscape Boundary
- Landform contours
- Shared pathways
- Recycled scuptures/ Interpretative trail
- Kurnell Dune Forest
- Coastal Dune Heath
- Modified Kurnell Dune Heath (Low Heath)
- Informal native grass (Indicative Area)
- Managed native grass (Indicative Area)
- Trees
- Picnic shelters (x3)
- Picnic tables (x11)

KEY
1. Amphitheatre
2. Potential Installation Art
3. Village green
4. Drop off, turn around area & coach parking
5. Disabled parking
6. Pedestrian entry zone
7. Main plaza
8. Panoramic lookout
9. Stabilised embankment
10. Slide
11. Lookout/ peak
12. General carparking
13. Open grassed picnic area
14. Nature play/trail connection
15. Playground
16. Vehicular access point
17. Pedestrian access points
18. Picnic facilities
19. Future amenities block
20. Existing amenities block
21. Infiltration area

Figure 2-3 Proposed Site Plan – New Resource Recovery Facility



3 AIR QUALITY CRITERIA

3.1 Introduction

The NSW EPA's *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (the Approved Methods) sets out applicable impact assessment criteria for a number of air pollutants.

Air quality criteria are benchmarks set to protect the general health and amenity of the community in relation to air quality. The sections below identify the pollutants of interest in this study and the application air quality criteria for each pollutant.

3.2 Particulate matter

The EPA Approved Methods specifies air quality assessment criteria for assessing impacts from dust generating activities. These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (NEPC, 1998).

Table 3-1 summarises the air quality goals for dust and particulate matter that are relevant to this study. The air quality goals relate to the total concentrations of dust and particulate matter in the air and not just that from the Proposal. Therefore, some consideration of background levels needs to be made when using these goals to assess impacts.

Table 3-1 Impact assessment criteria –particulate matter

Pollutant	Averaging period	Impact	Criteria
Total suspended particulates (TSP)	Annual	Total	90 µg/m³
Particulate matter ≤10 µm (PM_{10})	Annual	Total	25 µg/m³
	24-hour	Total	50 µg/m³
Particulate matter ≤2.5 µm ($PM_{2.5}$)	Annual	Total	8 µg/m³
	24-hour	Total	25 µg/m³
Deposited dust (DD)	Annual	Total	4 g/m²/month
	Annual	Incremental	2 g/m²/month

3.3 Odour

NSW legislation prohibits emissions that cause offensive odour to occur at any off-site receptor. Offensive odour is evaluated in the field by authorised officers, who are obliged to consider the odour in the context of its receiving environment, frequency, duration, character and so on and to determine whether the odour would unreasonably interfere with the comfort and repose of the normal person. In this context, the concept of offensive odour is applied to operational facilities and relates to actual emissions in the air.

However, in the approval and planning process for proposed new operations or modifications to existing projects, no actual odour exists and it is necessary to consider hypothetical odour. In this context, odour concentrations are used and are defined in odour units. The number of odour units represents the number of times that the odour would need to be diluted to reach a level that is just detectable to the human nose. Thus, by definition, odour less than one odour unit (1 OU), would not be detectable to most people.

The range of a person's ability to detect odour varies greatly in the population, as does their sensitivity to the type of odour. Therefore, there can be a wide range of variability in the way odour response is interpreted.

It should be noted that odour refers to complex mixtures of odours, and not "pure" odour arising from a single chemical. Odour from a single, known chemical very rarely occurs (when it does, it is best to consider that specific chemical in terms of its concentration in the air). In most situations, odour will be comprised of a cocktail of many substances that is referred to as a complex mixture of odorous pollutants, or more simply odour.

For developments with potential for odour it may be necessary to predict the likely odour impact that may arise. This is done by using air dispersion modelling which can calculate the level of dilution of odours emitted from the source at the point that it reaches surrounding receptors. This approach allows the air dispersion model to produce results in terms of odour units.

The NSW criteria for acceptable levels of odour range from 2 to 7 OU, with the more stringent 2 OU criteria applicable to densely populated urban areas and the 7 OU criteria applicable to sparsely populated rural areas, as outlined below.

Table 3-2 presents the relevant impact assessment criteria for complex mixtures of odorous pollutants.

Table 3-2 Impact assessment criteria – complex mixtures of odorous pollutants

Population of affected community	Impact assessment criteria (OU)*
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

Note: * 99th percentile nose-response time.

4 EXISTING ENVIRONMENT

4.1 Sensitive receptors

The nearest and most potentially affected residential receptors near the Proposal Site are located in Greenhills Beach, approximately 1.5 km south west of the Proposal Site and Kurnell, approximately 2 km north east of the site. Additionally, a number of recreational facilities, hockey fields and a soccer field, are located immediately north of the site and several commercial land uses are located approximately 750 metres north east of the Proposal Site. These receptors are shown on Figure 4-1.

4.2 Local meteorology

Meteorological conditions strongly influence air quality. Most significantly, wind speed, wind direction, temperature, relative humidity, and rainfall affect the dispersion of air pollutants, and are key inputs into dispersion models. The following sub-sections discuss the local meteorology near the Proposal site and identify a representative set of meteorological data for use in the dispersion modelling to be undertaken for this assessment.

Long term meteorological data for the area surrounding the Proposal Site is available from the Bureau of Meteorology (BoM) operated weather stations at Kurnell and Sydney Airport. The Kurnell BoM station is located approximately 3.5 km north east of the Proposal site and records observations of wind speed and direction. The Sydney Airport BoM station is located approximately 9 km north of the Proposal site and records observations of a number of meteorological data including wind speed, wind direction, temperature, humidity, and rainfall. Since the Kurnell BoM station is located closer to the site than the Sydney Airport BoM station, wind speed and direction observations from the Kurnell BoM station are considered more representative of wind conditions near the Proposal site.

As recommended by the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, meteorological data from the Kurnell and Sydney Airport BoM stations have been reviewed over a period of at least five consecutive years (2015 to 2019).

4.2.1 Wind

Figure 4-2 to Figure 4-7 present annual and seasonal “wind rose” plots for Kurnell BoM station for the period 2015 to 2019, inclusive. The plots show similar patterns of wind speed and wind direction over the five-year period, with strong north-easterly winds being prevalent in summer and spring, moderate to strong westerly and south easterly winds being prevalent in autumn and moderate to strong southerly and south easterly winds being prevalent in winter. Wind speed and wind direction during 2018 are generally representative of the five-year period, and have therefore been adopted for assessment purposes.

Figure 4-1 Sensitive Receptors

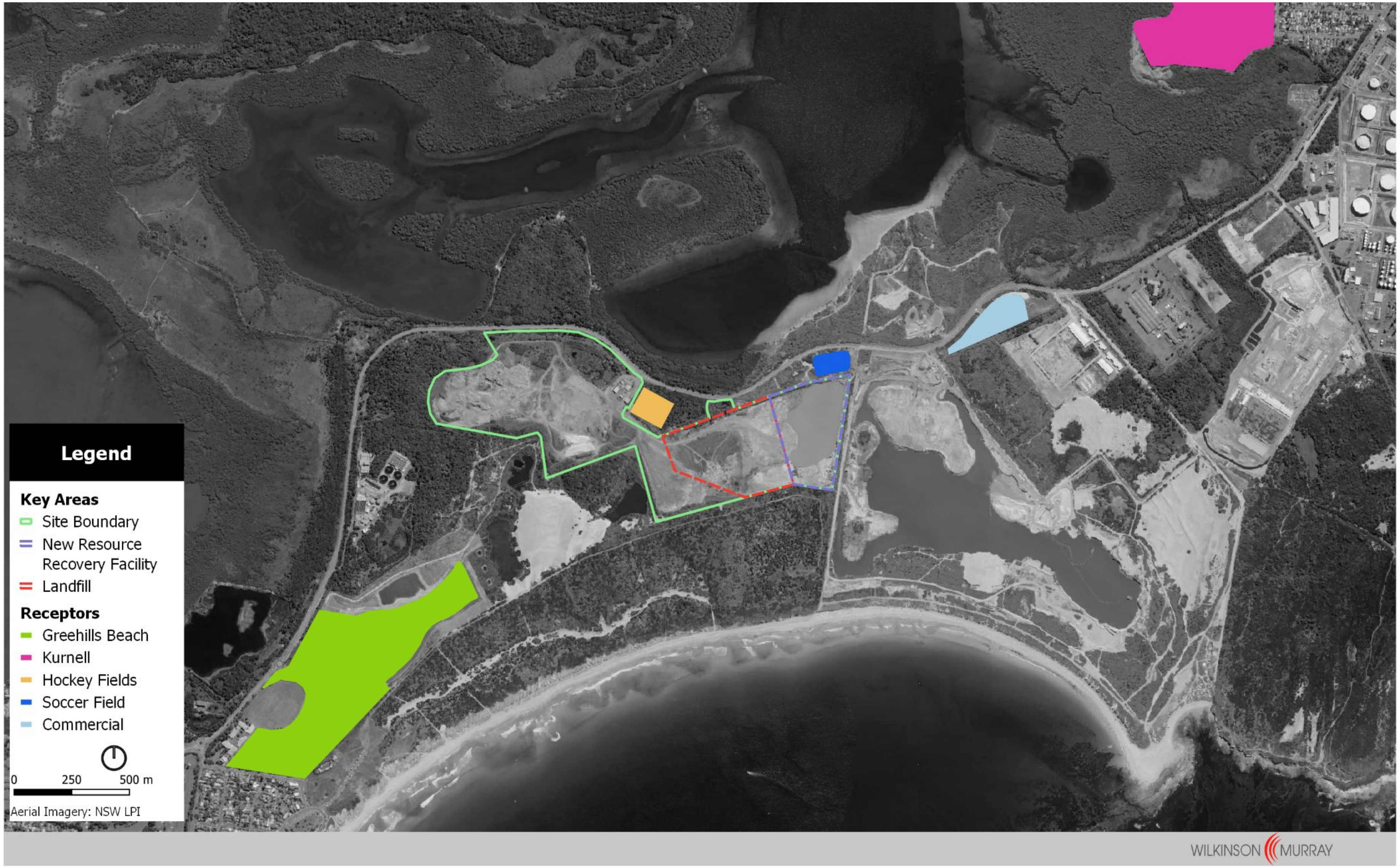


Figure 4-2 Kurnell BoM Station Wind Roses, 2015

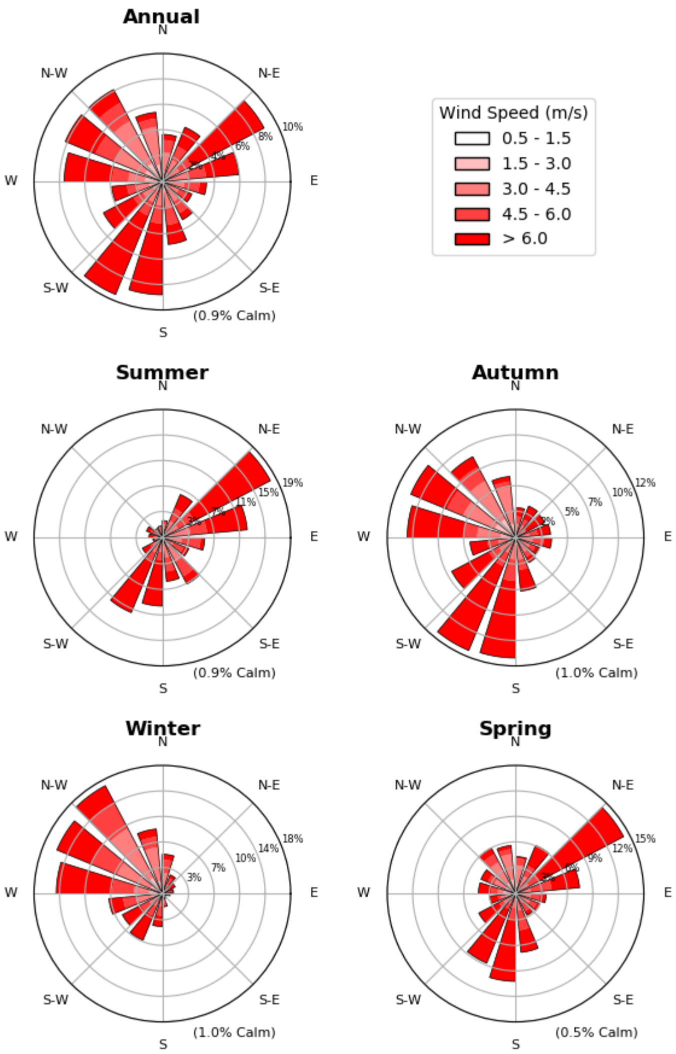


Figure 4-3 Kurnell BoM Station Wind Roses, 2016

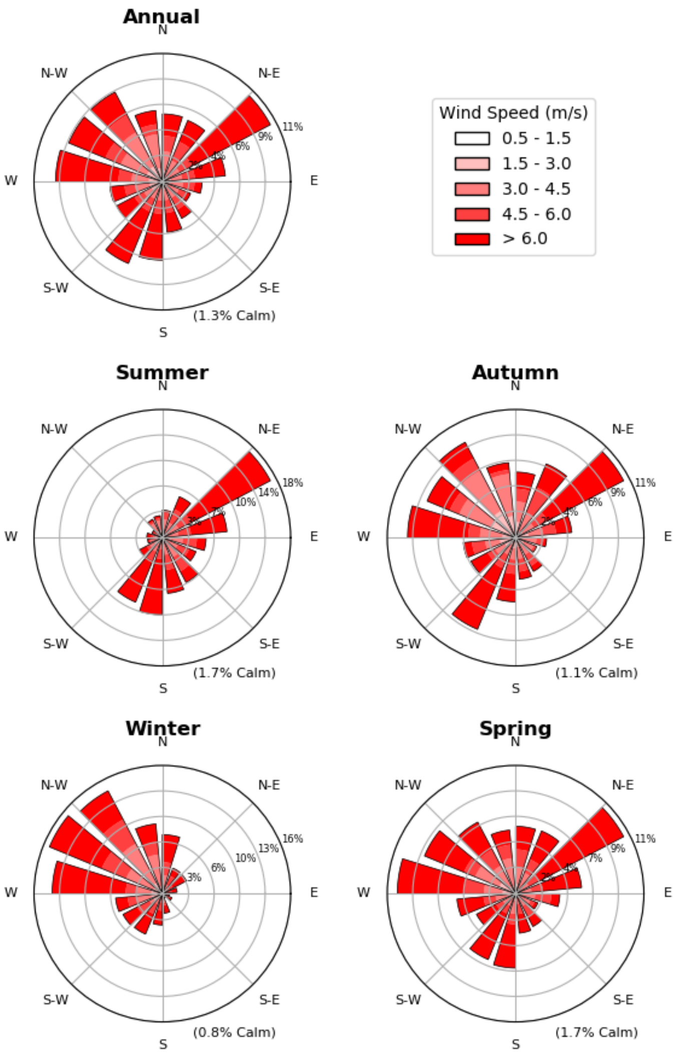


Figure 4-4 Kurnell BoM Station Wind Roses, 2017

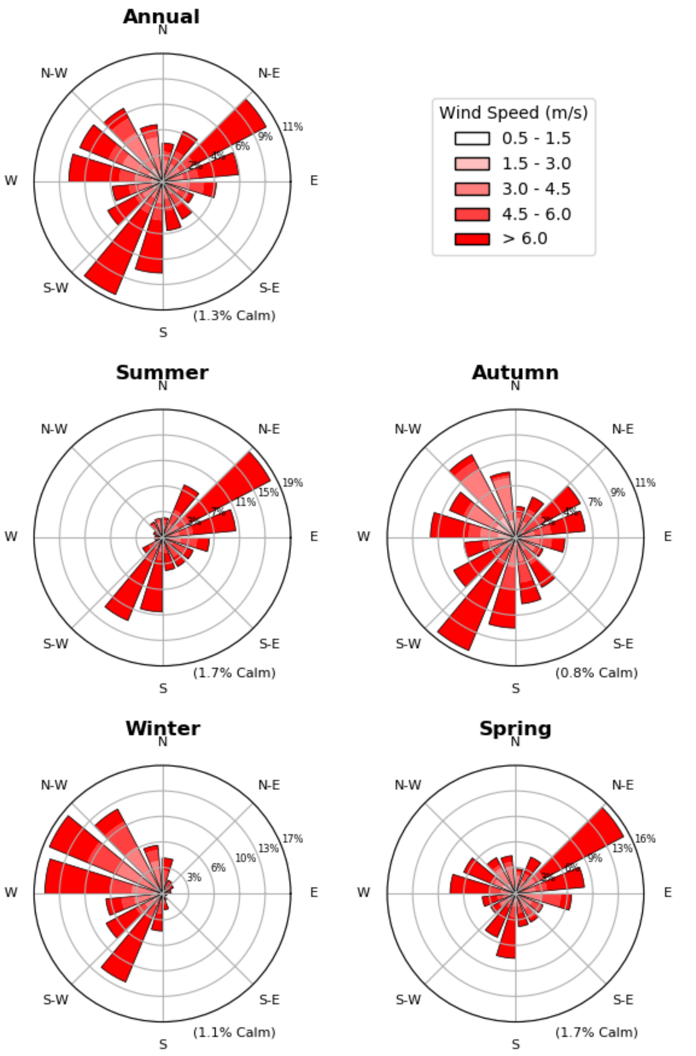


Figure 4-5 Kurnell BoM Station Wind Roses, 2018

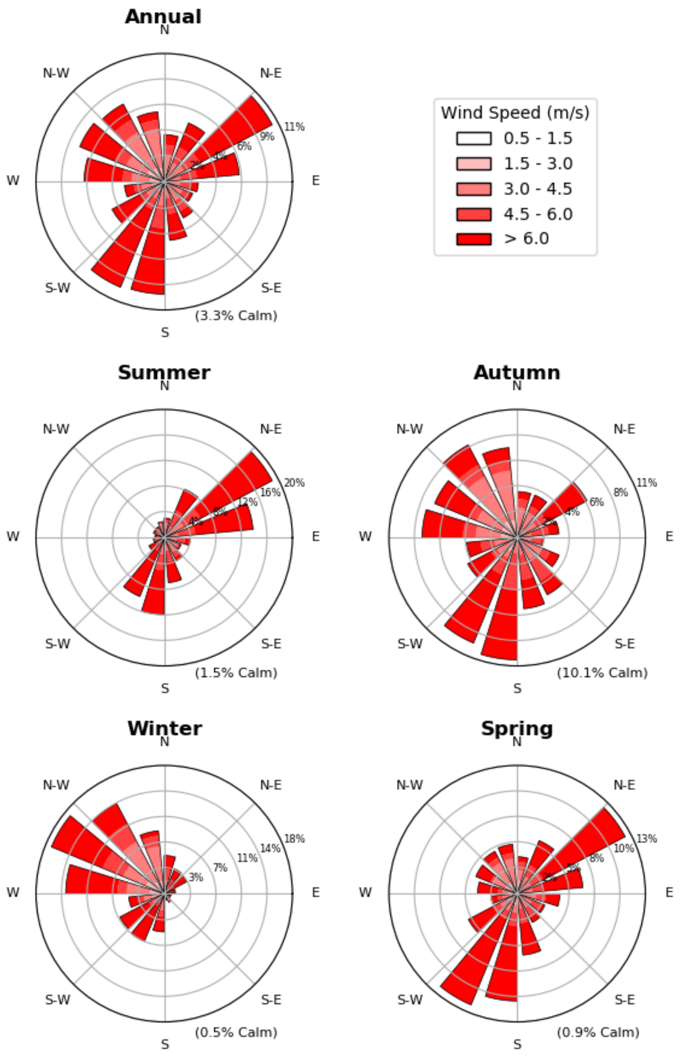


Figure 4-6 Kurnell BoM Station Wind Roses, 2019

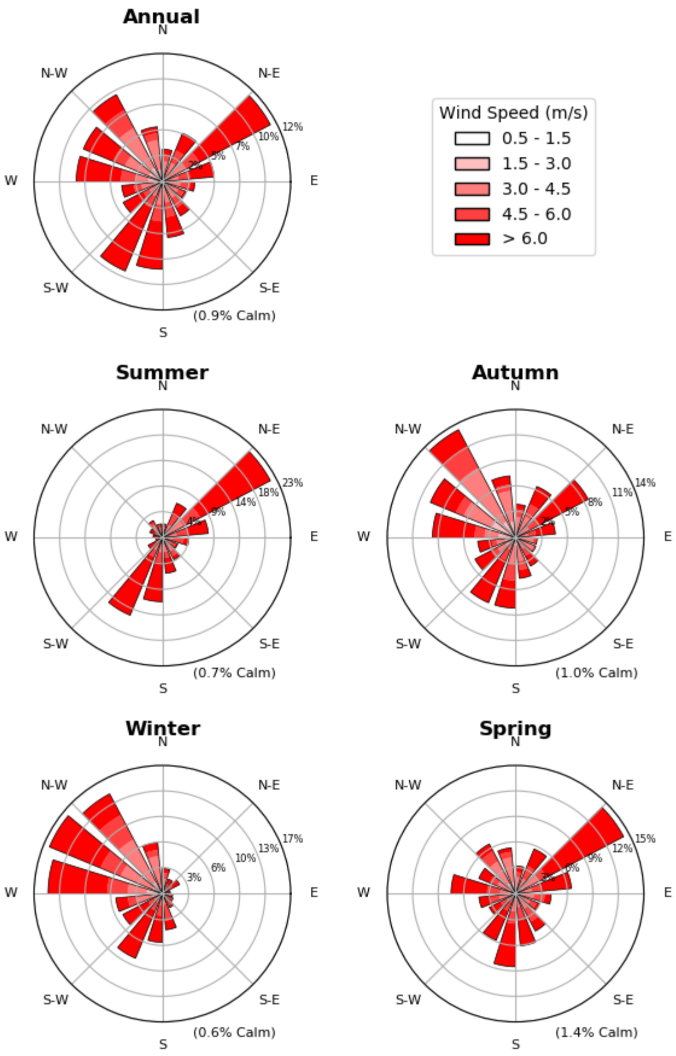
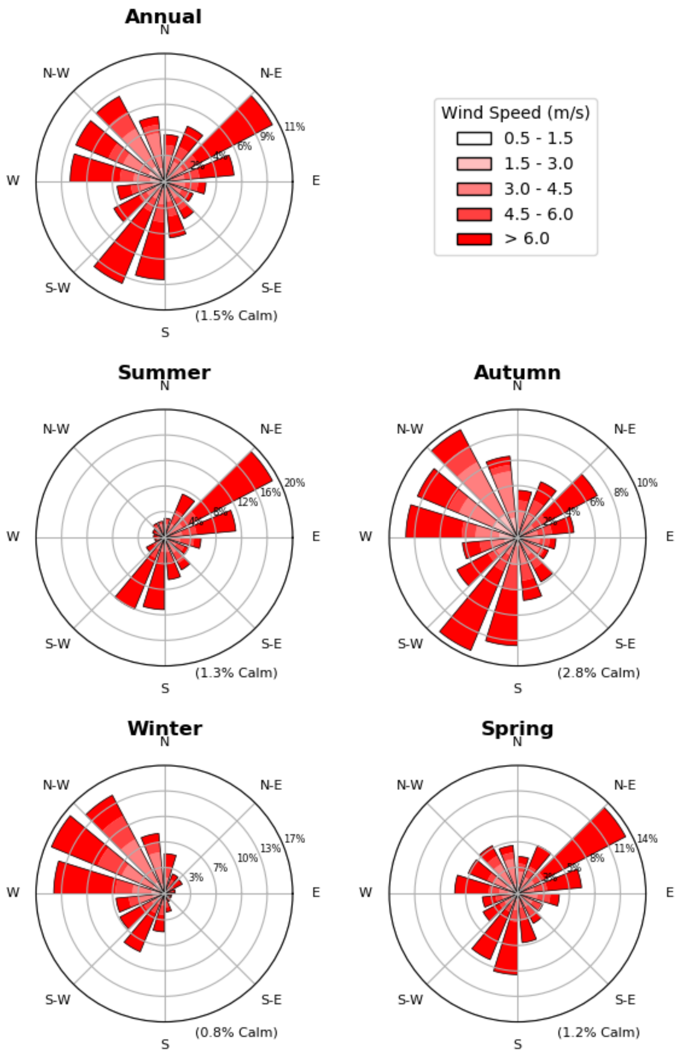


Figure 4-7 Kurnell BoM Station Wind Roses, 2015-2019



4.2.2 Temperature humidity and rainfall

Long-term climate statistics are presented in Table 4-1. Temperature data recorded at the Sydney Airport BoM station indicates that January is the hottest month of the year, with a mean daily maximum temperature of 26.7°C. July is the coolest month with a mean daily minimum temperature of 7.3°C. June is the wettest month with an average rainfall of 125 mm falling over 9 days. There are, on average, 96 rain days per year, delivering 1,077 mm of rain.

Table 4-1 Climate averages for Sydney Airport BoM station

Obs.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9am Mean Observations													
Temp (°C)	22.4	22.3	21.1	18.2	14.6	11.9	10.8	12.5	15.7	18.4	19.9	21.6	17.4
Hum (%)	70	73	73	71	73	74	71	65	62	61	64	66	69
3pm Mean Observations													
Temp (°C)	24.8	24.8	23.9	21.7	19.0	16.6	16.1	17.2	19.0	20.7	22.1	23.9	20.8
Hum (%)	60	63	61	59	58	57	52	49	51	54	56	58	57
Daily Minimum and Maximum Temperatures													
Min (°C)	19.0	19.1	17.6	14.3	11.0	8.8	7.3	8.2	10.6	13.3	15.5	17.6	13.5
Max (°C)	26.7	26.5	25.4	23.0	20.2	17.7	17.2	18.4	20.7	22.7	24.2	25.9	22.4
Rainfall													
Rain (mm)	94.1	114.2	118.1	106.0	95.3	124.8	69.2	75.7	60.0	70.1	79.9	72.8	1077.4
Rain (days)	8.1	8.6	9.4	8.4	8.3	8.9	6.6	6.8	6.8	7.8	8.3	7.7	95.7

4.3 Local ambient air quality

No site-specific data are available to determine the existing concentrations of dust and particulate matter at sensitive receptors near the Proposal. The NSW Department of Planning, Industry and Environment (DPIE) operates a network of air quality monitoring stations across NSW. The nearest DPIE monitoring station is located at Randwick. The Randwick monitoring station is located approximately 11.5 kilometres north east of the Proposal site.

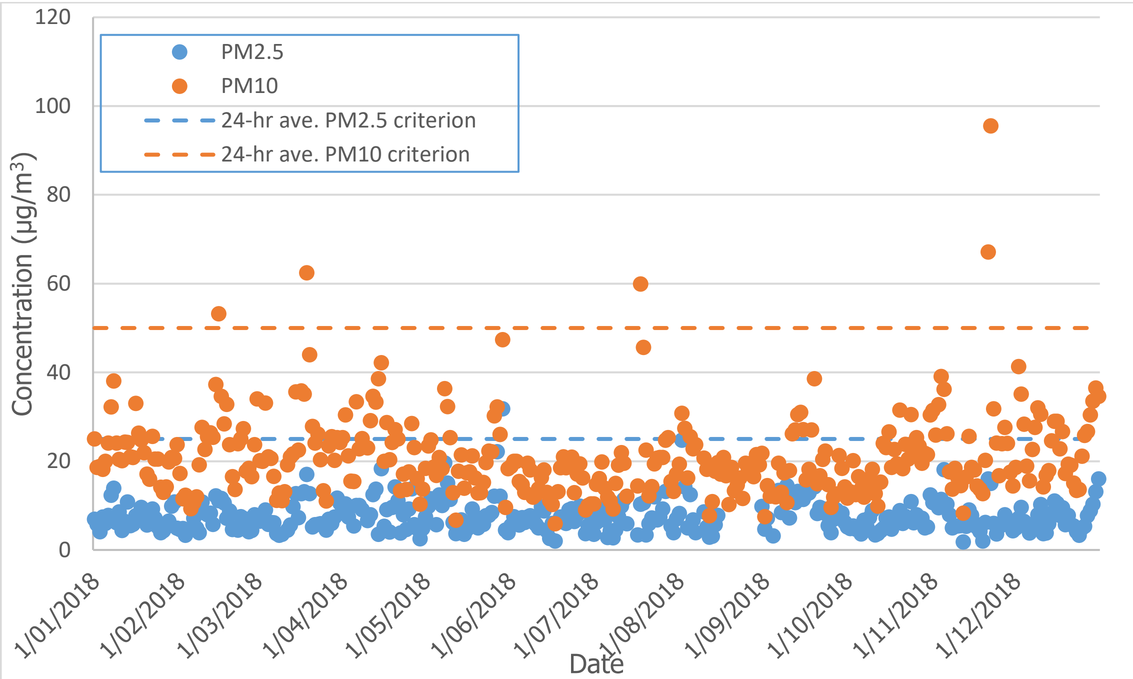
A summary of the PM_{10} and $PM_{2.5}$ monitoring results collected at the Randwick monitoring site during the modelling year (2018) is presented in Table 4-2.

Table 4-2 2018 Particulate matter monitoring results – Randwick

Statistic	$PM_{2.5}$	PM_{10}
24-hour average, max	31.8	95.5
24-hour average, max complying [a]	24.7	47.4
24-hour average, 99th percentile	19.1	56.0
24-hour average, 95th percentile	13.8	35.8
24-hour average exceedances	1	5
Annual average	7.6	21.2

When characterising typical ambient air quality, impacts from extreme events such as bushfires and dust storms are usually excluded. Figure 4-8 shows a plot of 24-hour average $PM_{2.5}$ and PM_{10} concentrations measured at Randwick during 2019. It is noted that ambient PM_{10} and $PM_{2.5}$ concentrations during 2018 were elevated. This is especially the case for $PM_{2.5}$ where the maximum 24-hour average and annual average $PM_{2.5}$ concentrations accounted for more than 90% of the impact assessment criteria. As noted in the *NSW Annual Air Quality Statement 2018*, particle pollution was elevated in 2018 due to "*… more frequent exceptional events, such as dust storms, bushfires and hazard reduction burns."*

Figure 4-8 Ambient PM monitoring – Randwick, 2018



There are no readily available site specific Total Suspended Particulates (TSP) and deposited dust monitoring data. The Randwick AQMS does not measure these components; however, estimates of the background levels for the area are required to assess the impacts of the Proposal on TSP and deposited dust.

Estimates of the annual average background TSP concentrations can be determined from a relationship between measured PM_{10} concentrations. This relationship assumes that 40% of the TSP is PM_{10} and was established as part of a review of ambient monitoring data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (NSW Minerals Council, 2000). This approach to estimating ambient TSP concentrations in the absence of monitoring data is common throughout NSW and is generally accepted by NSW EPA.

Applying this relationship with the 2018 annual average PM_{10} concentration of 21.2 µg/m3 at the Randwick AQMS estimates an annual average TSP concentration of 53.0 µg/m3.

To estimate annual average dust deposition levels, a similar process to the method used to estimate TSP concentrations is applied. This approach assumes that a TSP concentration of 90 µg/m3 will have an equivalent dust deposition value of 4 g/m^2/month; and indicates a background annual average dust deposition of 2.36 g/m^2/month for the area surrounding the Proposal site.

Table 4-3 summarises the background air quality adopted for assessment purposes.

Table 4-3 Background Air Quality Adopted for Assessment

Pollutant	Averaging Period	Adopted Background Concentration/Level
PM_{10}	24-hour	47.4 µg/m^3
	Annual	21.2 µg/m^3
$PM_{2.5}$	24-hour	24.7 µg/m^3
	Annual	7.6 µg/m^3
TSP	Annual	53.0 µg/m^3
Deposited Dust	Annual	2.36 g/m^2/month

5 DISPERSION MODELLING

5.1 Meteorological Modelling

5.1.1 TAPM

No meteorological observation data is available for the Proposal Site. Therefore, site-specific meteorological data was generated through the use of a prognostic model. The prognostic model used was The Air Pollution Model (TAPM), developed and distributed by the Commonwealth Scientific and industrial Research Organisation (CSIRO).

TAPM is an incompressible, non-hydrostatic, primitive equations prognostic model with a terrain-following vertical coordinate for three-dimensional simulations. It predicts the flows important to local scale air pollution, such as sea breezes and terrain induced flows, against a background of large scale meteorology provided by synoptic analyses. TAPM benefits from having access to databases of terrain, vegetation and soil type, leaf area index, sea-surface temperature, and synoptic scale meteorological analyses for various regions around the world.

The prognostic modelling domain was centred at 34.03° S, 151.18° E and involved four nesting grids of 30 km, 10 km, 3 km and 1km with 41 grids in the lateral dimensions and 25 vertical levels.

The TAPM model included assimilation of wind data collected at the Kurnell BoM Station during 2018.

5.1.2 AERMET

The TAPM results, including predictions of wind speed, wind direction, temperature, humidity, cloud cover, solar radiation, and rainfall, were used as inputs to AERMET – AERMOD's meteorological pre-processor. AERMET uses the TAPM data, along with land use data, to calculate mixing heights and velocity scaling parameters.

5.2 Dispersion Modelling

5.2.1 AERMOD

The dispersion model chosen for this assessment was AERMOD – the US EPA regulatory Gaussian plume air dispersion model.

AERMOD is a steady state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts. It includes treatment of both surface and elevated sources, and both simple and complex terrain.

AERMOD is accepted by NSW EPA for use in air quality impact assessments.

5.2.2 Peak to Mean Ratios

To account for the time-averaging limitations of the dispersion model, peak-to-mean ratios have been incorporated into all odour flux rates in accordance with the Approved Methods. Peak-to-mean ratios for various source types, as prescribed by the Approved Methods, are presented in Table 5-1.

Table 5-1 Peak-to-mean ratios

Source type	Pasquill-Gifford stability class	P/M60	
		Near-field	Far-field
Area	A,B,C,D	2.5	2.3
	D,E	2.3	1.9
Line	A-F	6	6
Surface wake-free point	A,B,C	12	4
	D,E,F	25	7
Tall wake-free point	A,B,C	17	3
	D,E,F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

6 EMISSIONS TO AIR

6.1 Dust Emissions

Dust emissions from the Proposal have been estimated using emission factors sourced from both locally developed and US EPA developed documentation and based on the following information provided by the client; Site plans, indicative equipment and processes and the project description.

6.1.1 Dust emissions during operations

Operational dust emissions from the Proposal would be generated by activities associated with the operation of the landfill and the New Resource Recovery Facility. Operational dust emissions from the Embellished Marang Parklands would be negligible.

The most significant dust generating activities during the operation of the Proposal would be:

- Wheel generated dust;
- Material processing and handling; and,
- Wind erosion.

Based on a site visit to the Existing Breen Resources Facility and advice from the client, the following dust controls are accounted for in the emissions estimation:

- Paved roads will be regularly swept;
- Soil and concrete recycling activities will be conducted in semi-enclosed buildings;
- Light waste processing activities will be conducted in a fully enclosed building;
- Water carts will be used on all unpaved roads; and,
- Water sprays will be used at the "working face" of stockpiles and to supress dust from crushing and screening activities.

Fully enclosed buildings will be used for processing light waste materials. It is proposed, following consultation with the NSW EPA, that the stockpiling of selected materials, including brick, concrete and soils, is proposed to take place external to buildings. This is considered reasonable since the dust generated by the outdoor storage of these materials is low compared to other dust sources associated with the Proposal. Although dust emissions associated with outdoor storage of these materials is low, dust suppression methods, including water-based dust suppression and moisture conditioning will be used to further reduce the potential for dust to be generated on both the processed and unprocessed stockpiles.

The processing of soils, bricks and concrete are proposed to be undertaken in covered buildings with wall sheeting on selected elevations. This design, incorporating both open and enclosed wall panels, allows efficient material transfer from the various machines processing the material, while simultaneously shielding the operations from prevailing winds. External stockpiles and adjacent buildings provide additional protection from prevailing winds.

No specific ventilation systems are proposed for the buildings. Truck loading and unloading activities and stockpiles will be located outside buildings, however dust emissions from these sources will be managed with water sprays.

The estimated dust emissions from these activities are presented in Table 6-1. A detailed emissions inventory is presented in Appendix B.

Table 6-1 Estimated operational dust emissions

Source/Activity	Annual Emissions (kg/year)		
	$PM_{2.5}$	PM_{10}	TSP
Paved roads	433.2	1790.4	9327.6
Unpaved roads	211.8	2118.2	9714.5
Soil – material handling	31.2	206.3	436.1
Soil – crushing and screening	78.0	825.0	2280.0
Soil – wind erosion	105.2	700.8	1401.6
Concrete – material handling	15.6	103.1	218.0
Concrete – crushing and screening	39.0	412.5	1140.0
Concrete – wind erosion	105.2	700.8	1401.6
Light waste – material handling	7.2	47.8	101.0
Light waste – crushing and screening	1.5	12.8	34.0
Light waste – wind erosion	26.3	175.2	350.4
Landfill – material handling	2.6	17.4	36.7
Landfill – wind erosion	26.3	175.2	350.4
Total	**1083.2**	**7285.4**	**26792.0**

6.1.2 Dust emissions during the Embellished Marang Parklands construction

During the construction of the Embellished Marang Parklands, the most significant dust generating activities would be:

- Wheel generated dust;
- Handling and shaping fill; and,
- Wind erosion.

The estimated dust emissions from these activities, assuming a two-year construction period, are presented in Table 6-2. These estimations include the use of a water cart on the unpaved roads. A detailed emissions inventory is presented in Appendix B.

Table 6-2 Estimated construction dust emissions

Source/Activity	Annual Emissions (kg/year)		
	$PM_{2.5}$	PM_{10}	TSP
Unpaved roads	702.3	7022.8	32208.0
Handling and shaping fill	440.2	4071.1	3814.8
Wind erosion	263.0	1752.0	3504.0
Total	**1405.5**	**12845.8**	**39526.8**

The construction of the Embellished Marang Parklands will utilise machinery from elsewhere on the site and would not result in a significant increase in the total number of plant items on the entire site. This will assist in reducing dust impacts.

6.2 Odour Emissions

The landfill on Lot 5 is the only activity associated with the Proposal considered likely to generate odour. A single operational scenario for the landfill, representing the typical worst-case odour emissions, has been modelled to assess the potential odour impacts from the Proposal.

Specific odour emission rates (SOER) for the active tipping area, daily cover, intermediate cover and leachate ponds have been adopted from values presented in an odour assessment for a similar landfill activity in Eastern Creek (Ramboll, 2017).

At the end of each day, a "daily cover" of approximately 150 mm of virgin excavated material or approved alternative daily cover material is applied to the active tipping area. The daily cover significantly reduces odour emissions from the active area during the night time, when the landfill is not operating. Table 6-3 presents the SOER and area for the various odour sources associated with the operation of the landfill on Lot 5.

Table 6-3 Odour emission estimate

Source	SOER (OU.m^3/m^2/s)	Area (m^2)
Active tipping area	0.7 / 0.4 [a]	800
Daily cover	0.4	800
Intermediate cover	0.1	10,000
Leachate Ponds	0.2	8,780

a. Daily cover SOER applied to active tipping area outside of operating hours.

7 ASSESSMENT OF IMPACTS

The following chapter presents quantitative assessments of the potential air quality impacts on nearby sensitive receptors from the Proposal. Contour plots are presented in Appendix A.

7.1 Dust and particulate matter

The following section presents the predicted dust and particulate matter impacts at sensitive receptors associated with the ongoing operations of the New Resource Recovery Facility and the landfill on Lot 5 (the Landfill) and also the cumulative impacts associated with the construction of the Embellished Marang Parklands in parallel with the operation of the New Resource Recovery Facility and the landfill on Lot 5. The construction of the Embellished Marang Parklands is described in Section 4.8 'Construction and Operation Staging, of the EIS for the Proposal.

7.1.1 Impacts during operation of the New Resource Recovery Facility and Landfill only

$PM_{2.5}$, PM_{10} and TSP

Table 7-1 presents the dispersion modelling results for particulate matter and TSP at sensitive receptors during operation of the New Resource Recovery Facility and the Landfill only.

Table 7-1 Predicted TSP and particulate matter impacts at sensitive receptors

Receptor	$PM_{2.5}$				PM_{10}				TSP	
	24-hour		Annual		24-hour		Annual		Annual	
	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Increment	Total
Goal	**25 µg/m³**		**8 µg/m³**		**50 µg/m³**		**25 µg/m³**		**90 µg/m³**	
Greenhills Beach	0.1	24.8	0.0	7.6	0.6	48.0	0.1	21.3	0.2	53.2
Kurnell	0.1	24.8	0.0	7.6	0.8	48.2	0.1	21.3	0.1	53.1
Soccer Field	3.0	**27.7**	0.6	**8.2**	24.0	**71.4**	4.8	26.0	10.4	63.4
Hockey Field	0.6	**25.3**	0.1	7.7	4.5	**51.9**	0.4	21.6	0.9	53.9
Commercial	0.4	25.1	0.1	7.7	2.9	**50.3**	0.4	21.6	1.1	54.1

Review of Table 7-1 indicates that the predicted concentrations of dust and particulate matter comply with the impact assessment criteria at all residential receptors. However, the results indicate the potential for exceedances of the 24-hour average impact assessment criteria for $PM_{2.5}$ and PM_{10} at the nearby sporting fields and commercial receptors and exceedance of the annual average impact assessment criteria for $PM_{2.5}$ at the soccer field.

The predicted exceedances of the 24-hour average impact assessment criteria for $PM_{2.5}$ and PM_{10} at nearby receptors are largely due to the conservative assessment methodology whereby the maximum predicted incremental concentration, due to the operation of the New Resource Recovery Facility and the Landfill, is added to the maximum ambient concentration. Therefore, in accordance with the Approved Methods, a "contemporaneous" assessment has been conducted to provide a more detailed analysis of the potential impacts of the operation of the New Resource Recovery Facility and the Landfill.

The contemporaneous assessment involves adding the existing background PM_{10} concentration, observed at the DPIE monitoring site in Randwick, to the predicted incremental concentration for each day of the simulation period.

The dispersion modelling results in Table 7-1 indicate that the soccer fields are the most potentially affected location due to the operation of the New Resource Recovery Facility and the Landfill . Accordingly, contemporaneous assessments of $PM_{2.5}$ and PM_{10} have been conducted at the soccer fields. Contemporaneous assessments of 24-hour average $PM_{2.5}$ and PM_{10} concentrations at the soccer field are presented in Figure 7-1 and Figure 7-2, respectively.

Figure 7-1 shows that the operational impacts of the New Resource Recovery Facility and the Landfill contribute only a small amount to total $PM_{2.5}$ concentrations, and that the operation of the New Resource Recovery Facility and the Landfill would be unlikely to result in additional exceedances of the goal of 25 $\mu g/m^3$. Therefore, in accordance with the Approved Methods, no further mitigation of $PM_{2.5}$ emissions is warranted for the operation of the New Resource Recovery Facility and the Landfill .

Figure 7-2 shows that the operation of the New Resource Recovery Facility and the Landfill would likely have a small to moderate contribution to total PM_{10} concentrations at the soccer field. The contemporaneous assessment indicates the potential for one additional exceedance of the goal of 50 $\mu g/m^3$.

The predicted incremental annual average $PM_{2.5}$ concentration at the soccer field is 0.6 $\mu g/m^3$. This value represents 7.5% of the impact assessment criterion. However, due to the existing ambient concentration being 95% of the impact assessment criterion, the small incremental concentration results in a predicted exceedance of the impact assessment criterion. As demonstrated in the contemporaneous assessment for the soccer field, the incremental increase in $PM_{2.5}$ due to the New Resource Recovery Facility and the Landfill would be largely indistinguishable from the existing background; therefore, specific measures to further mitigate $PM_{2.5}$ impacts are not warranted.

Deposited Dust

The predicted levels of deposited dust at sensitive receptors, during operation of the New Resource Recovery Facility and the Landfill only, are presented in Table 7-2.

Table 7-2 Predicted deposited dust impacts at sensitive receptors

Receptor	**Deposited Dust**	
	Annual	
	Increment	Total
Goal	**2 g/m^2/month**	**4 g/m^2/month**
Greenhills Beach	0.02	2.38
Kurnell	0.01	2.37
Soccer Field	1.29	3.65
Hockey Field	0.08	2.44
Commercial	0.08	2.44

The results in Table 7-2 indicate compliance with the impact assessment criteria for deposited dust.

Figure 7-1 Contemporaneous 24-hour Average $PM_{2.5}$ Concentrations at Soccer Field – Operational Impacts

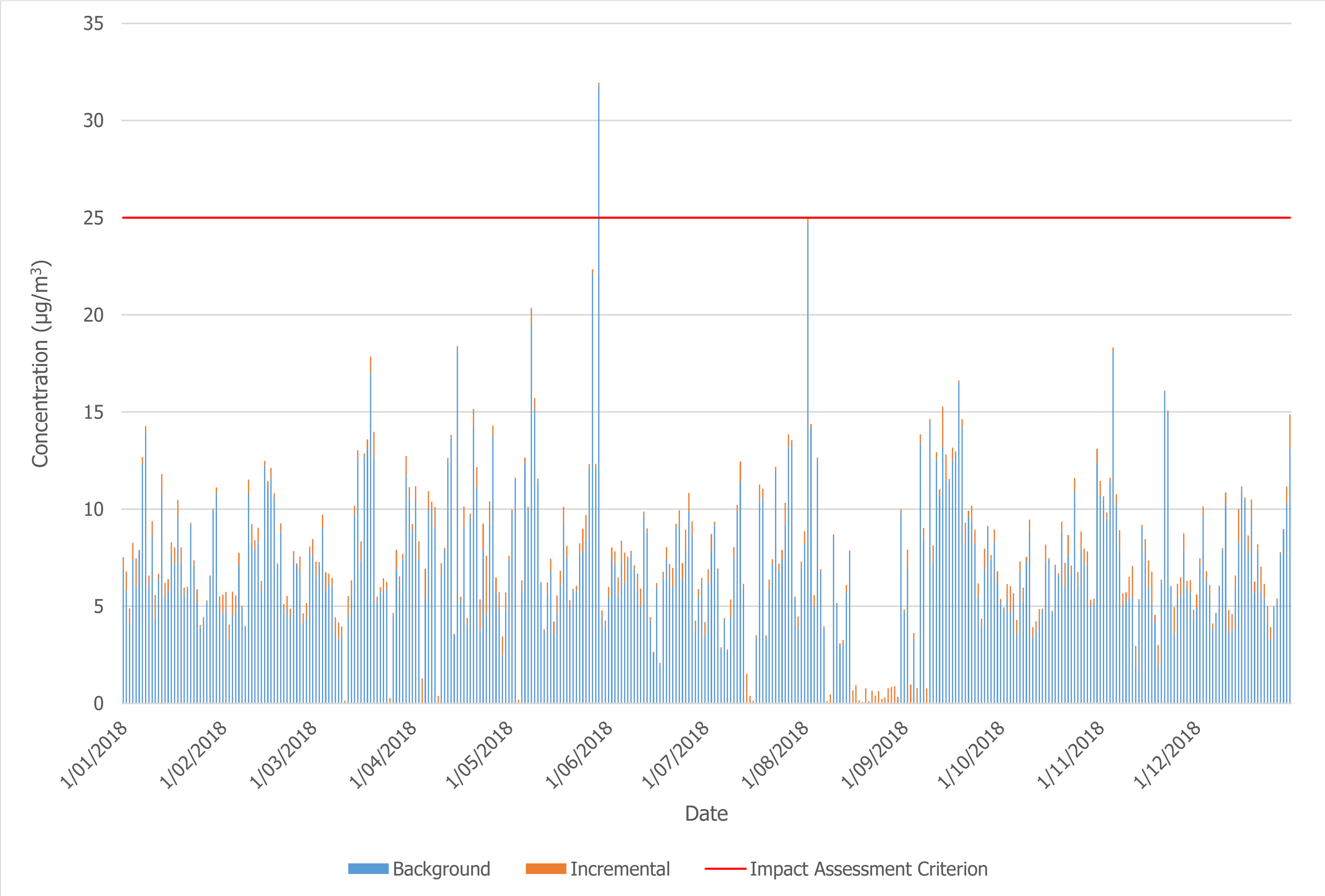
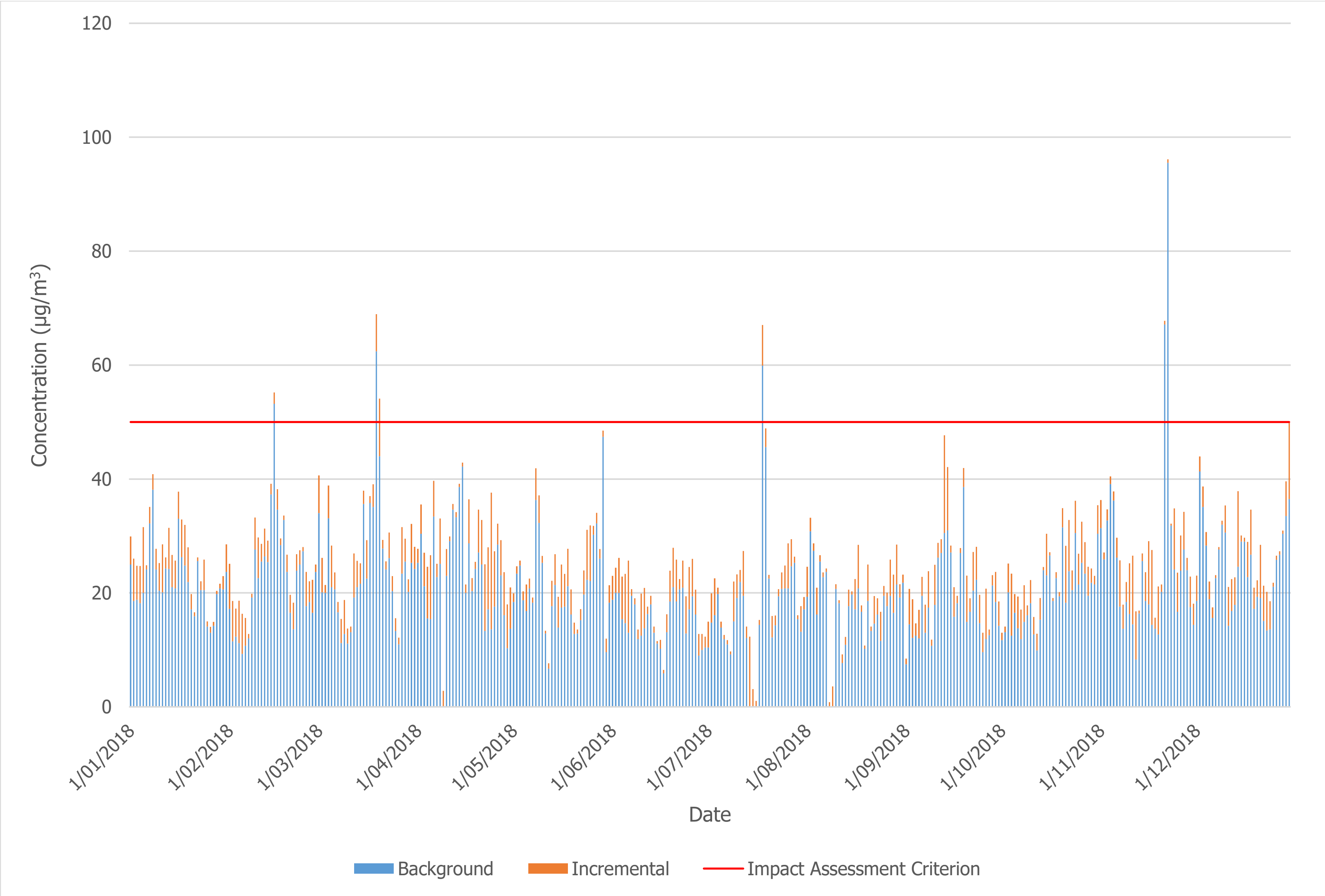


Figure 7-2 Contemporaneous 24-hour Average PM_{10} Concentrations at Soccer Field – Operational Impacts



7.1.2 Cumulative impacts during operation of the New Resource Recovery Facility and the Landfill and the construction of the Embellished Marang Parklands

To identify the potential for cumulative dust impacts, a qualitative review of the possible combinations of concurrent activities was undertaken, specifically:

- Construction of the New Resource Recovery Facility;
- Operation of the New Resource Recovery Facility;
- Construction of the Embellished Marang Parklands;
- Operation of the Embellished Marang Parklands; and,
- Landfill operations.

The highest dust impacts associated with concurrent activities were determined to be associated with construction of the Embellished Marang Parklands, and operation of the New Resource Recovery Facility and Landfill.

$PM_{2.5}$, PM_{10} and TSP

Table 7-3 presents the dispersion modelling results for particulate matter and TSP at sensitive receptors during operation of the New Resource Recovery Facility and the Landfill and the construction of the Embellished Marang Parklands.

Table 7-3 Predicted TSP and particulate matter impacts at sensitive receptors

Receptor	$PM_{2.5}$				PM_{10}				TSP	
	24-hour		Annual		24-hour		Annual		Annual	
	Increment	Total	Increment	Total	Increment	Total	Increment	Total	Increment	Total
Goal	**25 µg/m³**		**8 µg/m³**		**50 µg/m³**		**25 µg/m³**		**90 µg/m³**	
Greenhills Beach	0.4	25.1	0.1	7.7	3.5	50.9	0.6	21.8	1.1	54.1
Kurnell	0.1	24.8	0.0	7.6	1.1	48.5	0.1	21.3	0.2	53.2
Soccer Field	3.2	**27.9**	0.7	**8.3**	26.3	**73.7**	5.7	**26.9**	13.2	66.2
Hockey Field	2.3	**27.0**	0.7	**8.3**	23.0	**70.4**	6.5	**27.7**	22.3	75.3
Commercial	0.6	**25.3**	0.1	7.7	4.5	**51.9**	0.6	21.8	1.5	54.5

Review of Table 7-3 indicates that the predicted concentrations of dust and particulate matter comply with the impact assessment criteria at all residential receptors. However, the results indicate the potential for exceedances of the 24-hour average impact assessment criteria for $PM_{2.5}$ and PM_{10} at the nearby sporting fields and commercial receptors and exceedance of the annual average impact assessment criteria for $PM_{2.5}$ at the sporting fields.

Consistent with the approach taken for the assessment of operational impacts, contemporaneous assessments of 24-hour average $PM_{2.5}$ and PM_{10} impacts have been conducted. The hockey field is the most potentially affected location during construction of the Embellished Marang Parklands and has therefore been chosen as the location for the contemporaneous assessments.

Similar to the contemporaneous assessment of operational $PM_{2.5}$ impacts, Figure 7-3 shows that the combined impacts of the operation of the New Resource Recovery Facility and the Landfill and the construction of the Embellished Marang Parklands contribute only a small amount to total $PM_{2.5}$ concentrations. Figure 7-3 indicates the potential for one additional exceedance of the goal of 25 µg/m^3.

Figure 7-4 shows that the combined operation of the New Resource Recovery Facility and the Landfill and construction of the Embellished Marang Parklands would likely have a moderate contribution to total PM_{10} concentrations at the hockey field. The contemporaneous assessment indicates the potential for three additional exceedances of the goal of 50 µg/m^3.

Deposited Dust

The predicted levels of deposited dust at sensitive receptors, during operation of the New Resource Recovery Facility and the Landfill and construction of the Embellished Marang Parklands, are presented in Table 7-4.

Table 7-4 Predicted deposited dust impacts at sensitive receptors

Receptor	Deposited Dust	
	Annual	
	Increment	Total
Goal	**2 g/m²/month**	**4 g/m²/month**
Greenhills Beach	0.13	2.49
Kurnell	0.02	2.38
Soccer Field	1.52	3.88
Hockey Field	2.68	5.04
Commercial	0.11	2.47

The results in Table 7-4 indicate exceedances of both the incremental and total criteria at the hockey field. Compliance is indicated at all other receptors.

7.1.3 Summary of dust impacts

Analysis of the dispersion modelling results shows that the haul road from the New Resource Recovery Facility to the Embellished Marang Parklands would be the major contributor of dust and particulate matter at the hockey field. It is noted that, in the vicinity of the hockey field, the haul route passes through an intersection. At this location, haul trucks would be travelling much slower than elsewhere along the haul road. The wheel generated dust from haul trucks travelling at these lower speeds would be significantly lower than elsewhere along the haul road. Therefore, the predicted dust and particulate matter impacts at the hockey field are considered to be conservative.

Notwithstanding the conservativeness of the assessment, subject to the implementation of dust monitoring and reactive management, outlined in Section 8, dust impacts associated with the Proposal are expected to comply with the impact assessment criteria and would therefore be acceptable.

All material processing is proposed to be undertaken internal to buildings. Selected materials, including uncrushed brick and concrete, and moisture conditioned crushed brick and concrete products, may be handled or stockpiled external to buildings and where possible these stockpiles will be sheltered from prevailing wind conditions. Only materials that have acceptably low dust emitting potential are proposed to be stored external to a building. These materials are proposed to be further controlled with the use of water-based dust suppression. All dust emissions have been modelled as part of this assessment, and the off-site air quality impacts associated with the Proposal are acceptable. Therefore, the construction of additional sheltered areas is not warranted.

Figure 7-3 Contemporaneous 24-hour Average $PM_{2.5}$ Concentrations at Soccer Field – Cumulative Impacts

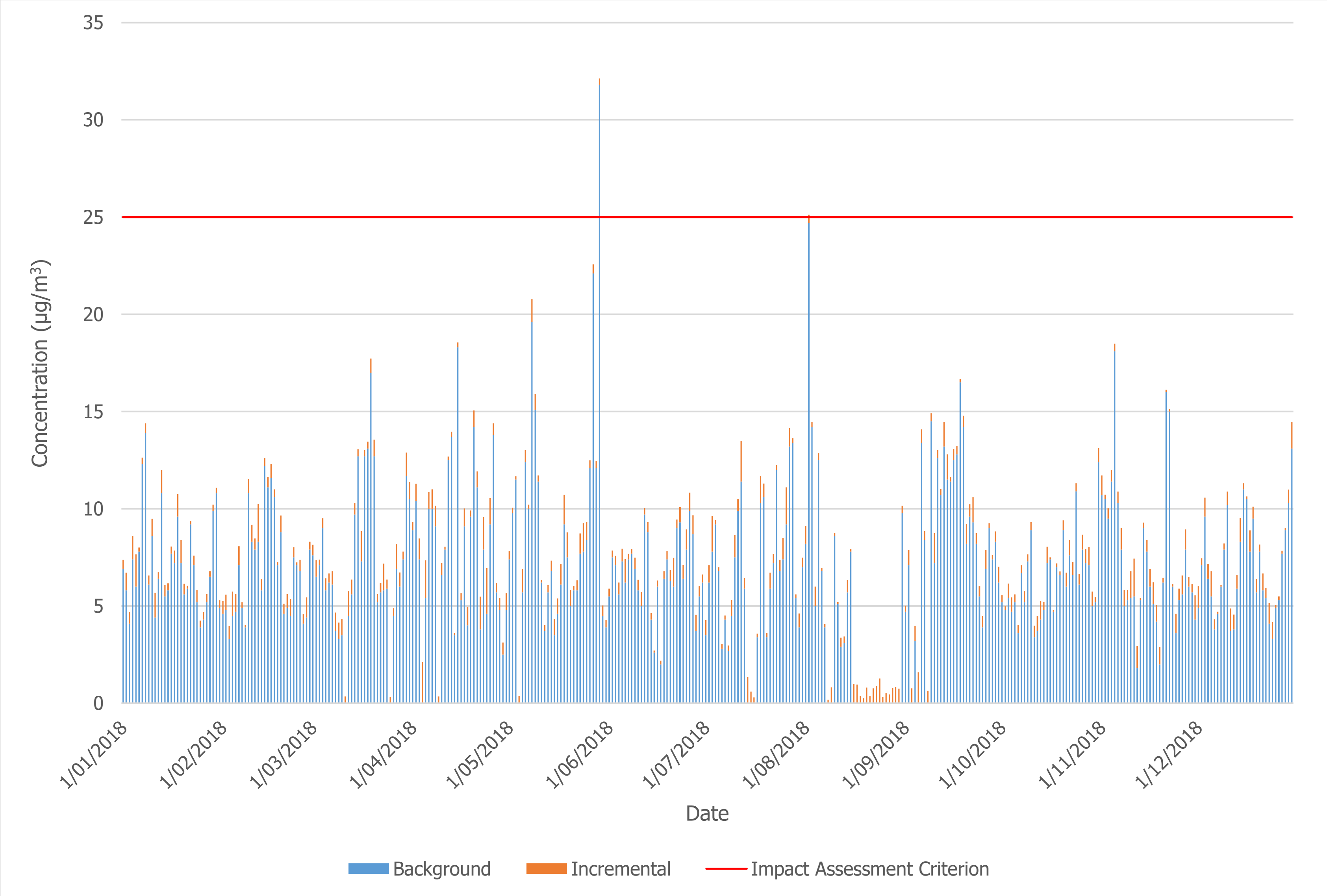
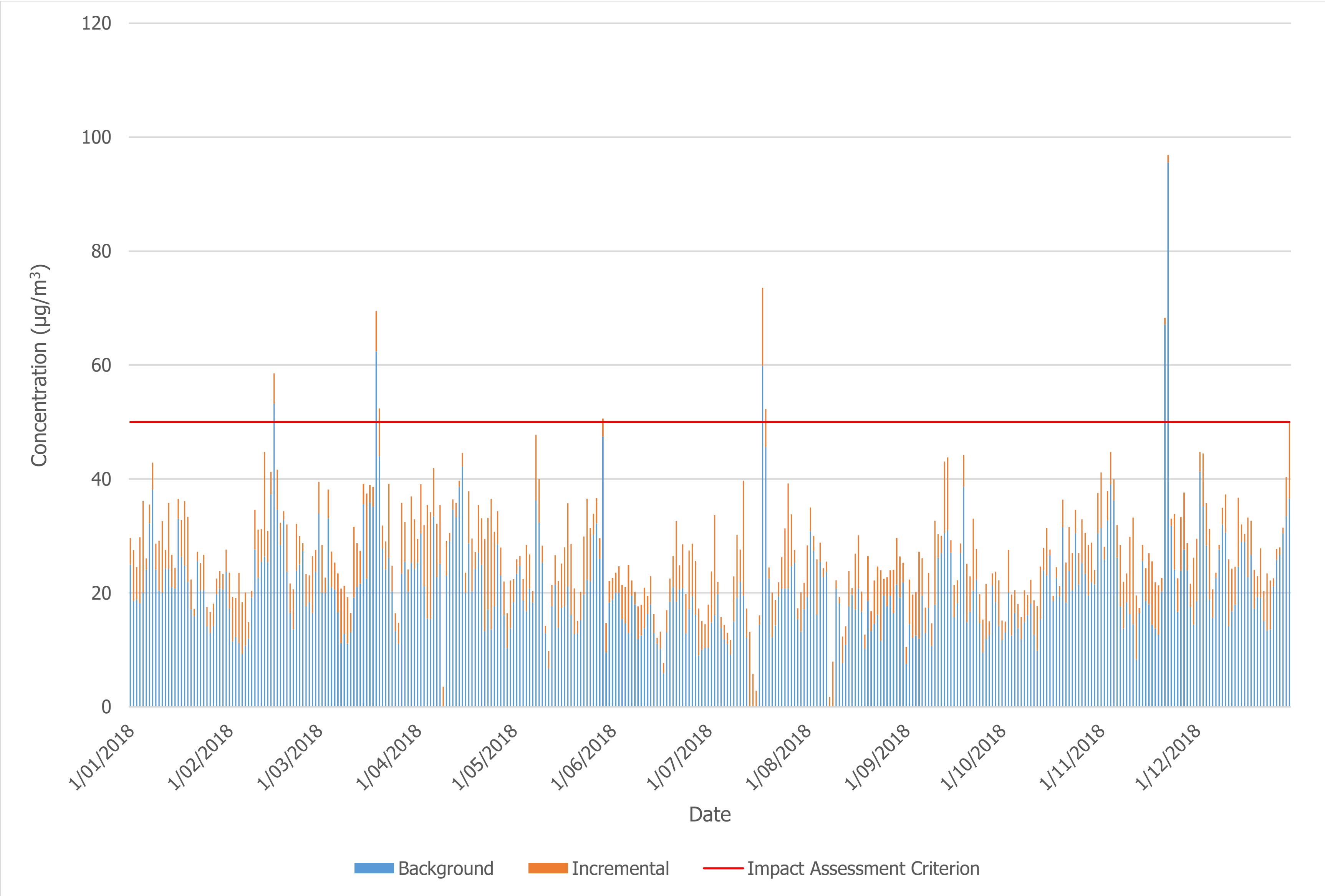


Figure 7-4 Contemporaneous 24-hour Average PM_{10} Concentrations at Soccer Field – Cumulative Impacts



7.2 Odour

The predicted ground level odour concentrations associated with the operation of the Landfill are presented in Table 7-5.

Table 7-5 Predicted 99th percentile peak odour concentrations

Receptor	Predicted peak odour concentration (OU/m^3)	Impact assessment criterion (OU/m^3)	Complies? (Yes/ No)
Greenhills Beach	0.2	2.0	Yes
Kurnell	0.1	2.0	Yes
Soccer Field	1.7	7.0	Yes
Hockey Field	1.7	7.0	Yes
Commercial	0.7	7.0	Yes

Review of Table 7-5 indicates that the predicted odour concentrations comply with the impact assessment criteria at all nearby sensitive receptors. On this basis, since no significant odours are expected to be generated from either the New Resource Recovery Facility or the Embellished Marang Parklands, odour impacts associated with the Proposal are considered acceptable.

8 DUST MANAGEMENT

The preceding impact assessment has identified the potential for exceedances of the impact assessment criteria for $PM_{2.5}$, PM_{10} and deposited dust at multiple off-site receptors, particularly the nearby soccer and hockey fields.

It is noted that, particularly at the hockey fields, the conservativeness of the emission estimation and dispersion modelling is likely contributing to the predicted exceedances.

It is also noted that the sporting fields would be used on a somewhat intermittent basis, and that individuals would typically visit the sporting fields for a short time (1 – 3 hours) only. Therefore, the application of 24-hour impact assessment criteria for these land uses is very conservative since individuals would spend significantly less than 24 hours at the sporting fields in any 24-hour period.

Nevertheless, it is recommended that dust impacts at the sporting fields are managed down towards the impact assessment criteria through real-time dust monitoring and reactive management.

The monitoring location(s) should be chosen to represent the most affected locations at the soccer and hockey fields. Since the predicted exceedances at the hockey field are associated with the Embellished Marang Parklands construction, monitoring at this location should only be conducted during such activities. Where practicable, all monitoring equipment should be sited in general accordance with *AS/NZS 3580.1. – 2003, Guide to Siting Air Monitoring Equipment*.

The monitoring equipment should be capable of measuring PM_{10} concentrations and providing notifications when levels exceed certain threshold values. It is considered most likely that, if PM_{10} concentrations are managed down to the 24-hour average impact assessment criterion, then $PM_{2.5}$ and deposited dust impacts would also comply with the relevant criteria, since $PM_{2.5}$ and deposited dust impacts would approximately scale with those of PM_{10}.

The notifications should be provided in a timely fashion, say within one hour, to facilitate the implementation of reactive management. It is recommended that optical type equipment, such as an Aeroqol Dust Sentry (or similar), is used for the monitoring. While it is noted that these units are not strictly in accordance with the *Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales* (EPA, 2007), they are considered appropriate for use in this application as they can provide data in near real-time, have a small footprint and have significantly lower capital costs compared to other equipment.

The trigger levels in Table 8-1 are proposed for reactive management. These values have been developed with a view to ensuring that ambient dust and particulate matter concentrations in the surrounding area comply with the impact assessment criteria but are expressed in time scales short enough to support reactive management. Similar trigger levels have been used for large dust generating activities in NSW, such as the Sydney Football Stadium Redevelopment.

Table 8-1 Reactive Management Trigger Levels

Trigger Stage	Averaging Period	Trigger Value ($\mu g/m^3$)		Action Required
		$PM_{2.5}$	PM_{10}	
1 Investigate	1 hour	45	85	Site Manager to undertake review of possible dust sources operating during the average period. Identify possible measures for these activities; action if deemed necessary.
	3 hour	40	80	
2 Action	1 hour	235	470	Site Manager to attend site and ensure implementation of the control. Effectiveness of control actions to be reviewed and escalate where appropriate.
	3 hour	80	160	
3 Stop Work	1 hour	470	940	Targeted shut down of dust-generating activities until the measured pollutant levels are below the stated trigger value. Identify long-term solutions to dust issues.
	3 hour	160	320	

A dust management plan should be developed for the Proposal, documenting the monitoring system and identifying management and mitigation measures that would be used during both construction and operations to achieve the reactive management trigger levels. Expected measures to reduce dust impacts during reactive management are provided in Table 8-2.

Table 8-2 Dust mitigation measures

Source / activity	Control measures
General	• Training all staff and personnel on the need to minimise dust • Site induction to include details regarding measures to minimise dust impacts • On-site vehicles and mobile plant engines switched off when not in use • Visually monitor to ensure no dust plumes travel off site • Review of complaints relating to dust • Monitor weather conditions and ambient air quality to identify periods where off-site dust impacts may be exacerbated
Traffic movements	• Watering of unpaved haul roads • Regular cleaning of paved haul roads • Restricting traffic to designated routes • Enforcing on-site speed limits
Material handling	• Minimising drop heights • Apply water sprays to loading/unloading activities and at active faces of stockpiles
Wind erosion	• Minimise size of exposed areas • Rehabilitate exposed areas as soon as practicable • Cover stockpiles when not in use

9 GREEHOUSE GAS ASSESSMENT

This section presents a greenhouse gas (GHG) assessment of the Proposal. This GHG Assessment has been conducted in general accordance with:

- *The National Greenhouse and Energy Reporting (Measurement) Technical Guidelines*; and,
- *National Greenhouse Accounts Factors* (DoE, 2019)

9.1 Reportable greenhouse gases

The following greenhouse gases have been identified as significant contributors to global warming:

- Carbon dioxide (CO_2);
- Methane (CH_4);
- Nitrous oxide (N_2O);
- Synthetic gases; and
- Hydro fluorocarbons HFCs, SF_6, CF_4, C_2F_6.

GHG emissions are categorized as Scope 1, Scope 2 and Scope 3 emissions; which are defined as follows:

- **Scope 1** – Direct emissions generated by the Proposal e.g. emissions generated by the use of diesel fuel in project construction, plant or equipment.
- **Scope 2** – Indirect emissions form the consumption of purchased electricity for project equipment or operation of the project.
- **Scope 3** – **Various emissions** – All other indirect emissions (not included in Scope 2) generated as a consequence of the project.

This GHG assessment considers the following GHG emissions and energy consumption activities associated with the Proposal:

Scope 1 – Direct Emissions:

- Combustion of fuel in facility owned stationary and mobile plant and equipment; and,
- Methane emissions associated with the operation of the landfill.

Scope 2 – Indirect Emissions:

- Electricity generated off-site of that is consumed on the site.

Scope 3 emissions are not included in this assessment.

9.2 Emission factors

Greenhouse gas emissions associated with the Proposal have been estimated using and published emissions factors and the following information from the client; historical electricity usage, indicative electrical and diesel plant list and the project description. The emissions estimates are based on the best available design data for the Proposal at the time of undertaken the assessment.

Based on the identified sources of GHG emissions from the Proposal, relevant emission factors have been adopted from the *National Greenhouse Accounts Factors, August 2019*. Table 9-1 presents the Scope 1 emissions factors used in this assessment.

Table 9-1 Scope 1 emission factors (transport fuels)

Fuel type	Energy content (GJ/kL)	Emission factor (kg CO_{2-e}/GJ)		
		CO_2	CH_4	N_2O
Diesel oil	38.6	69.9	0.1	0.6

Scope 1 emissions associated with the operation of the Landfill have been estimated using the emission factors in Table 9-2

Table 9-2 Scope 1 emission factors (waste to landfill)

Waste Type	Emission factor (t CO_2-e/t waste)
Commercial and industrial (C&I)	1.2
Construction and demolition (C&D)	0.2

Scope 2 emissions have been calculated using an emission factor of 0.81 kg CO_{2-e}/kWh, applicable to electricity produced in New South Wales.

9.3 Construction greenhouse gas emissions

The major source of construction greenhouse gas emissions for the Proposal will be the bulk earthworks activities associated with construction of the Embellished Marang Parklands. Emissions associated with the construction of the New Resource Recovery Facility will be small compared to those associated with the construction of the Embellished Marang Parklands and have therefore not been assessed herein.

Greenhouse gas emissions associated with the construction of the Embellished Marang Parklands will result from diesel fuel combusted in mobile plant and in generators used to power the site office. Mobile plant used during the earthworks are summarised in Table 9-3, along with typical fuel consumption rates for the plant as presented in the *Greenhouse Gas Assessment Workbook for Road Projects,* dated February 2013 and prepared by the Transport Authorities Greenhouse Group.

Table 9-3 Bulk earthworks plant and fuel consumption

Plant item	Quantity	Fuel consumption per unit (kL/month)
Generator for site office	1	3.1
Excavator (20t)	2	5.1
Excavator (35t)	2	5.1
Dump truck (40t)	4	12.5
Compactor	2	5.7
Dozer	1	12.9
Roller	1	4.8
Water cart	2	7.9

It is expected that the construction of the Embellished Marang Parklands would take approximately 28 months to complete.

The total diesel fuel consumption associated with the works would be 2,842 kL and the associated CO_2-e emissions would be 7,744 tonnes over the duration of the works.

9.4 Operational greenhouse gas emissions

Greenhouse gas emissions associated with the operation of the New Resource Recovery Facility and the Landfill will result from:

- Fuel combusted in mobile plant;
- Landfill methane emissions; and,
- Electricity used to power the processing equipment, and in offices.

The following section presents an estimation of greenhouse gas emissions associated with the operation of the New Resource Recovery Facility and the Landfill .

9.4.1 Fuel consumption

The estimated annual fuel consumption in facility-owned would be 155 kL. The CO_2-e emissions associated with fuel consumed in facility owned plant are 422 tonnes per annum.

9.4.2 Landfill emissions

It is expected that up to 90,000 tonnes per year of residual waste, comprising 22,500 tonnes of C&I waste and 67,500 tonnes of C&D waste, would be reduced, compressed, baled and exported from the facility as residual waste or Solid Recovered Fuel (SRF) for off-site energy recovery.

Annual CO_2-e emissions associated with landfilling 90,000 tonnes of waste would be 40,500 tonnes per annum.

9.4.3 Electricity use

The estimated annual electricity usage is summarised in Table 9-5. The CO_2-e emissions associated with electricity usage would be 5,694 tonnes per annum

Table 9-4 Annual electricity usage

Item	Electricity Use (kWh)
Soil recycling machinery	1,163,700
Concrete recycling machinery	1,026,000
C&D waste processing machinery	4,703,400
Office, weighbridge, security, lighting.	136,518
Total	**7,029,618**

9.4.4 Total operation GHG emissions

The total operational GHG emissions for the New Resource Recovery Facility and the Landfill are summarised in Table 9-5.

Table 9-5 Summary of estimated operational CO_2-e emissions

Source	CO_2-e emissions (tonnes)
Diesel	422
Landfill	40,500
Electricity	5,694
Total	**46,616**

9.5 Overall emissions

The total estimated annual GHG emissions for the Proposal, assuming that the Embellished Marang Parklands works are conducted over 28 months, are 57,988 tCO_2-e and are summarised in Table 9-5.

Table 9-6 Summary of estimated overall CO_2-e Emissions

Source	Annual CO_2-e Emissions (tonnes)
Operations	46,616
Parkland construction	3,319
Total	**49,935**

Australia's total greenhouse gas emissions in 2017 amounted to 533.7 million tonnes of carbon dioxide equivalent (MtCO2-e) (reference: Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2017), whilst New South Wales, in 2017, accounted for 128.87 Mt of the total. Therefore, the Proposal will account for approximately 0.04% of current NSW emissions.

9.6 Greenhouse gas mitigation and energy efficiency

Where reasonable and feasible, the following measures would be implemented to reduce greenhouse gas emissions associated with the operation of the Proposal:

- Utilise energy efficient building design features such as natural ventilation and lighting, and insulation; and,
- Consider on-site renewable energy, such as solar power.

It is noted that the Proposal's business activity of resource recovery would potentially have a positive effect on overall carbon emissions by diverting waste from landfill and reducing the need for new raw material generation. It is also noted that the majority of plant operated on site, which was previously diesel powered, will be electrically powered thereby reducing greenhouse gas emissions.

10 CONCLUSION

The Proposal involves:

- Construction and operation of a resource management facility;
- Use of suitable material processed by the New Resource Recovery Facility to cap, contour and re-profile areas of the Proposal Site and to construct the Embellished Marang Parklands on Lots 1122, 1123 and Lot 6;
- Re-profiling of parts of the Proposal Site within Lots 1122, 1123 and 6, with some existing waste materials from those lots;
- Delivery of an activated and integrated community space in the form of the Embellished Marang Parklands on Lots 1122,1123 and Lot 6, to provide a superior parkland to that proposed under the VPA as detailed in Section 4.4.3 of the EIS (referred to as the Embellished Marang Parklands).

Wilkinson Murray has undertaken an air quality and greenhouse gas assessment for the Proposal.

Potential air quality impacts associated with the Proposal have been assessed in general accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016).

Quantitative assessments of potential air quality impacts from the operation of the Proposal have been conducted, based on TAPM meteorological simulations and the AERMOD dispersion modelling system.

The results of the dispersion modelling indicate that dust and particulate matter concentrations due to the operation of the Proposal would comply with the established criteria at nearby residential receptors. Exceedances of criteria are predicted at nearby sporting fields.

Real-time PM_{10} monitoring and reactive management are recommended to manage off-site impacts down towards the impact assessment criteria. Subject to the implementation of PM_{10} monitoring and reactive management, dust impacts associated with the Proposal would be acceptable.

Predicted odour concentrations comply with the impact assessment criteria at all sensitive receptors and are considered acceptable.

A greenhouse gas assessment has been conducted for the Proposal. The estimated annual greenhouse gas emissions would account for approximately 0.04% of current NSW emissions.

APPENDIX A

CONTOUR PLOTS

Figure A-1 Contour plot: Incremental 24-hour average $PM_{2.5}$ (operations only)

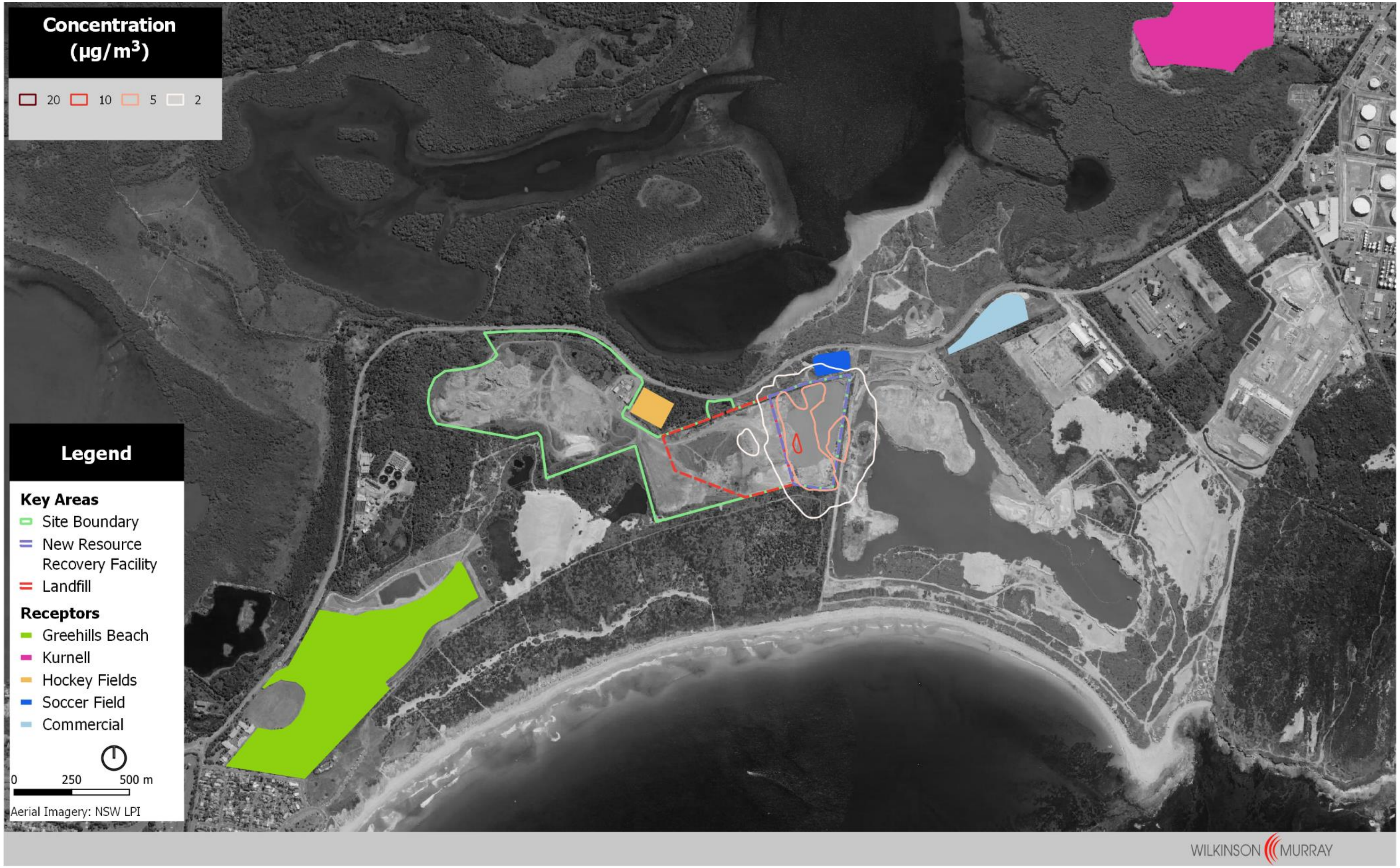


Figure A-2 Contour plot: Incremental 24-hour average $PM_{2.5}$ (operations and parkland construction)

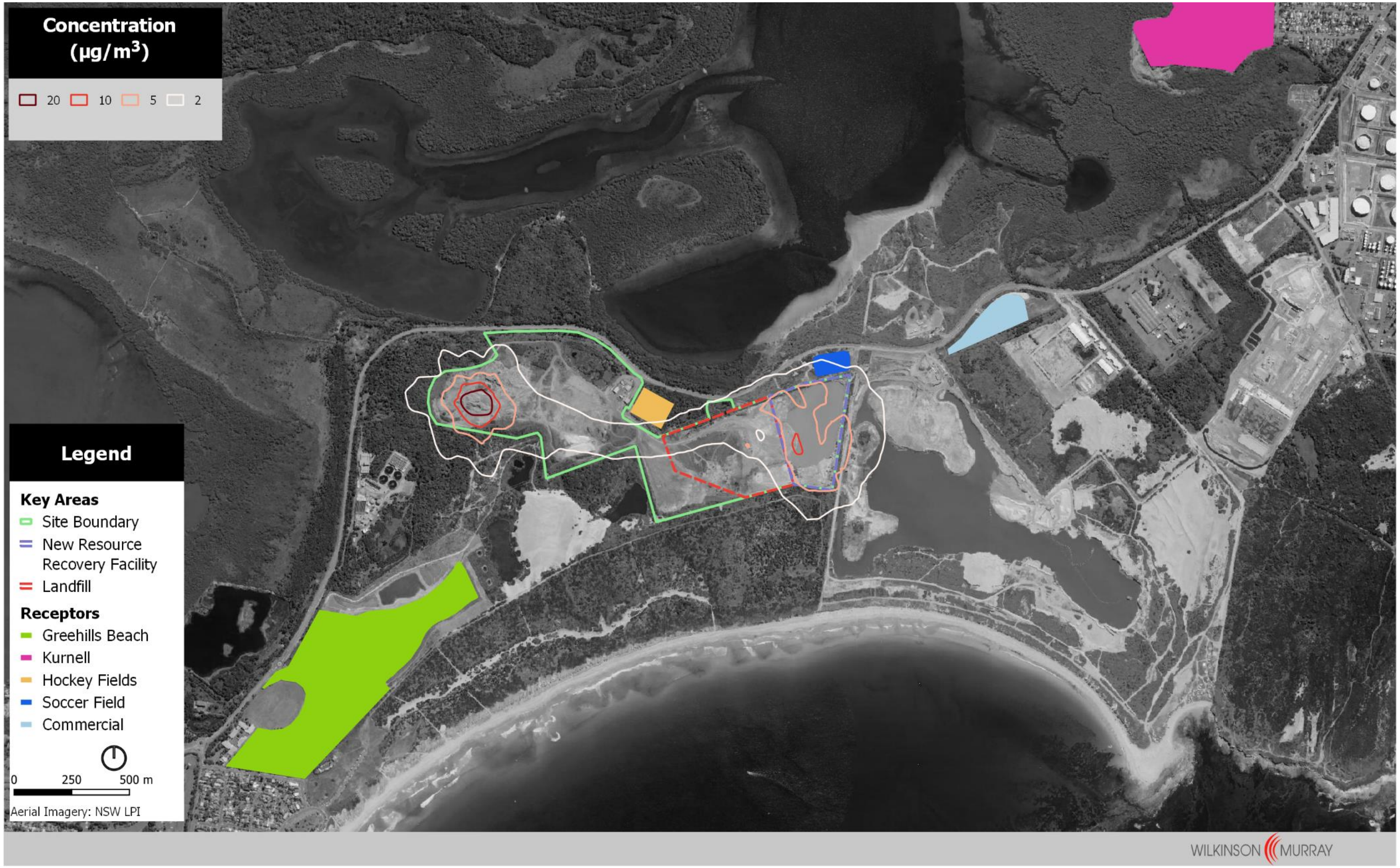


Figure A-3 Contour plot: Incremental 24-hour average PM_{10} (operations only)

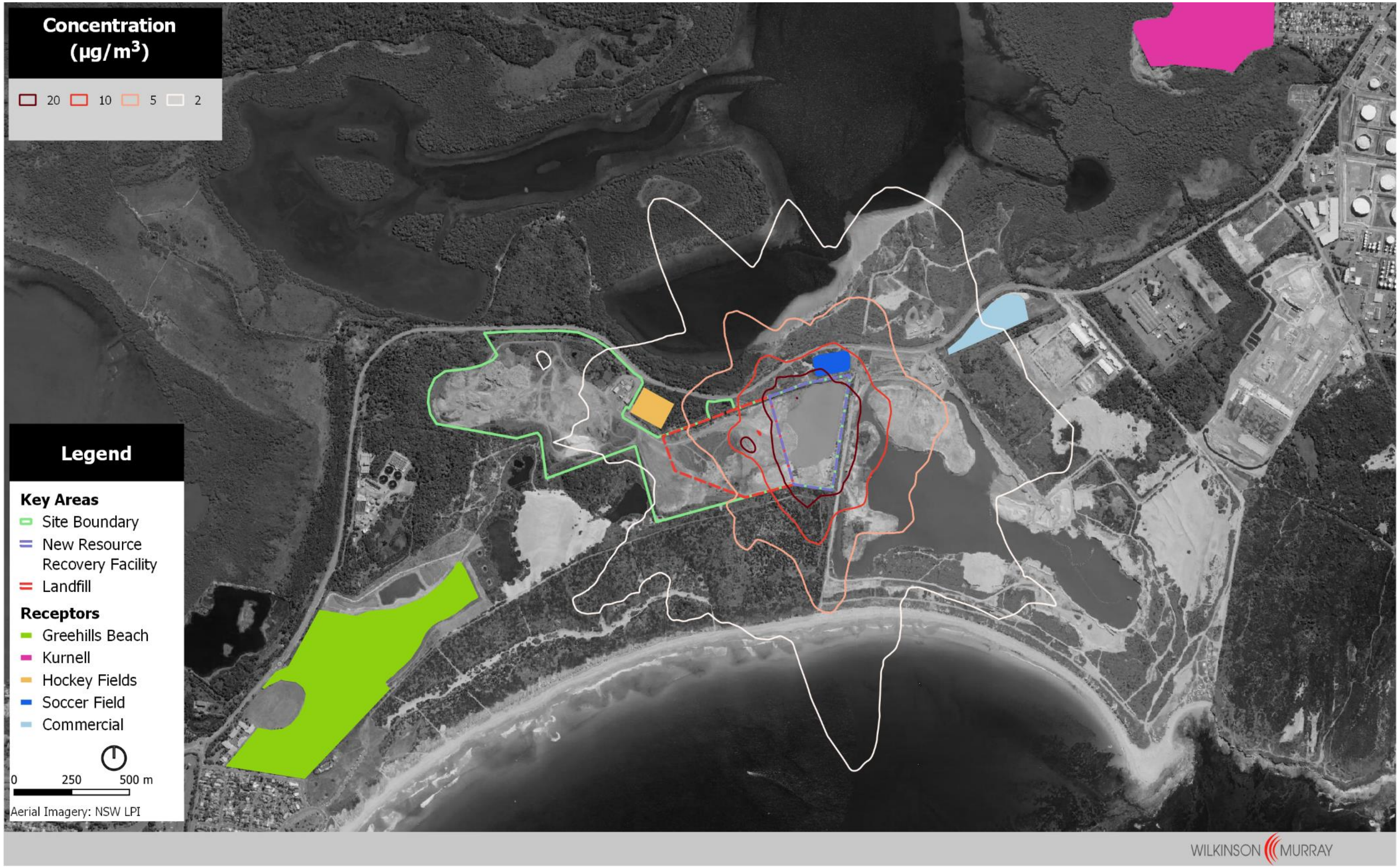


Figure A-4 Contour plot: Incremental 24-hour average PM_{10} (operations and parkland construction)

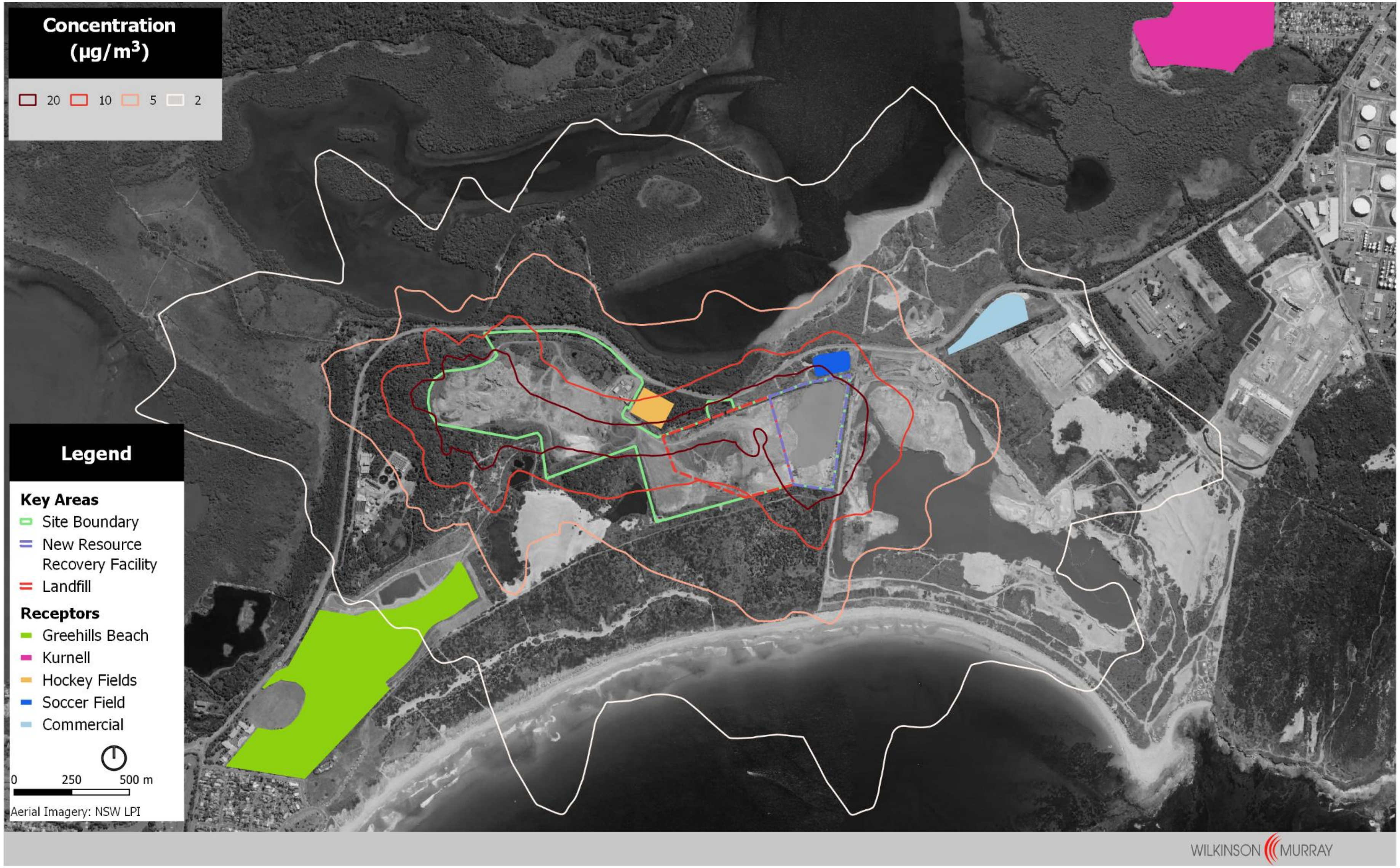
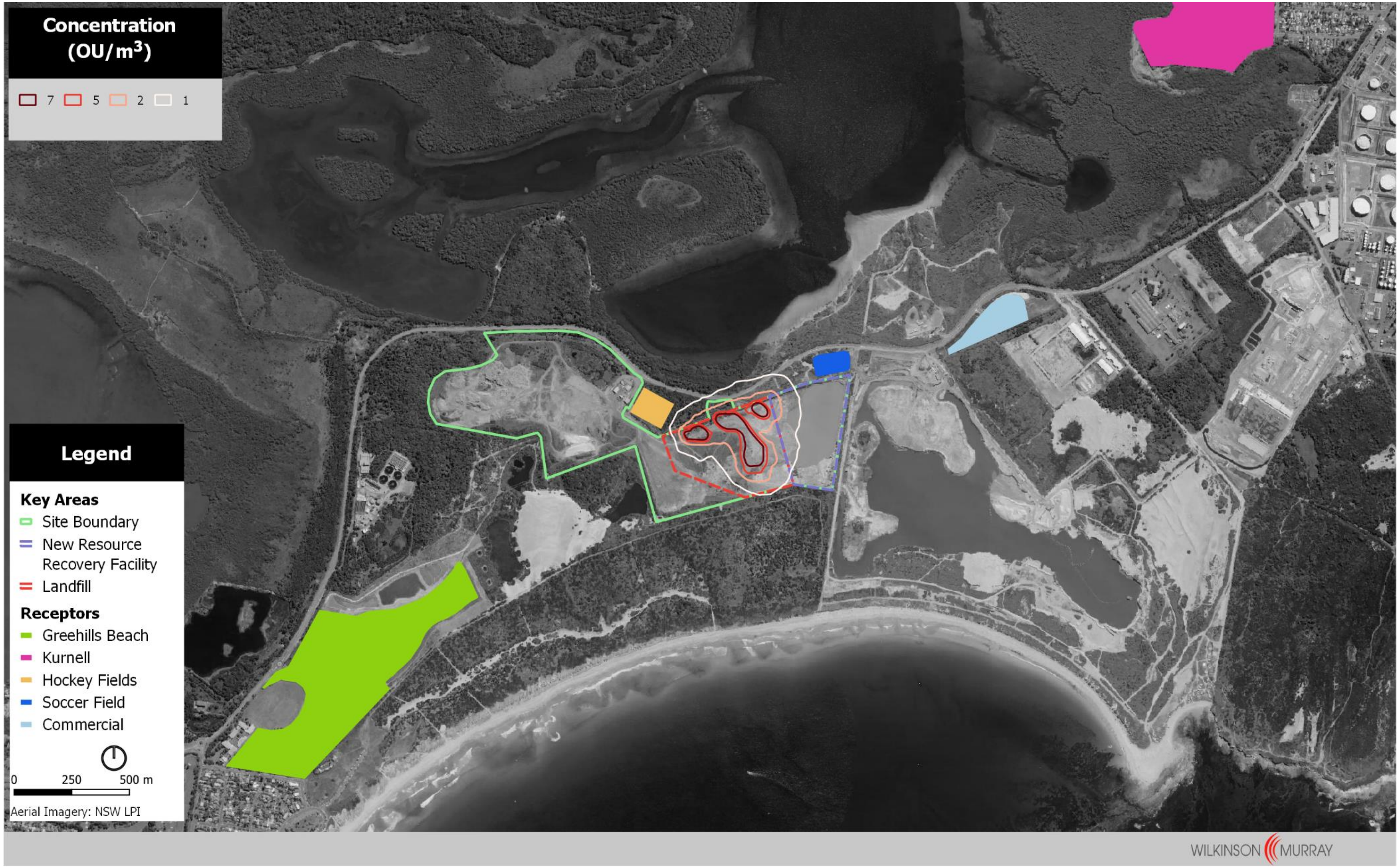


Figure A-5 Contour plot: Odour



APPENDIX B

EMISSIONS INVENTORY

Particulate Emission Factor Equations

Paved Roads

TSP emissions from vehicles on paved roads are a function of the mass of the vehicles and the amount of silt loading on the road. The following US EPA emission factor (US EPA, 1985 and updates) is used to calculated emissions from paved roads:

$$E[g/VKT] = k \times (sL)^{0.91}(W)^{1.02}$$

Where:

k = 3.23 for TSP

sL = road surface silt loading [g/m^2]

W = average vehicle weight [tons]

Unpaved roads

Wheel generated particulate emissions associated with material haulage are estimated using the following US EPA emission factors (US EPA, 1985 and updates):

$$E[kg/VKT] = 0.2819 \times a \times \left(\frac{s}{12}\right)^{b} \times \left(\frac{1.1023 \times W}{3}\right)^{0.45}$$

Where:

a = 4.9 for TSP, 1.5 for PM_{10} and 0.15 for $PM_{2.5}$

b = 0.7 for TSP and 0.9 for PM_{10} and $PM_{2.5}$

s = silt content [%] of road surface

W = weight of vehicle [t]

Loading / unloading / transferring material

Each tonne of material handles will generate quantities of particulate matter that will depend on the wind speed and the moisture content of the material according to the US EPA emission factor (US EPA, 1985 and updates) shown below:

$$E[kg/t] = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2.0}\right)^{1.4}}\right)$$

Where:

k = 0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$

U = wind speed [ms^{-1}]

M = moisture content [%]

For activities occurring outdoors, The wind speed is taken as the average wind speed from the TAPM dataset. For indoor activities, the wind speed is conservatively assumed to be 2.0 m/s.

Compactors shaping fill material

Particulate emissions for compactors have been estimated using US EPA emission factor equations (US EPA, 1985 and updates) for dozers on overburden as follows:

$$E[kg/h] = a \times \left(\frac{s^b}{M^c}\right)$$

Where:

a = 2.6 for TSP, 0.8775 for PM_{10} and 0.273 for $PM_{2.5}$

b = 1.2 for TSP, 1.5 for PM_{10} and 1.2 for $PM_{2.5}$

c = 1.3 for TSP, 1.4 for PM_{10} and 1.3 for $PM_{2.5}$

s = silt content [%]

M = moisture content [%]

Wind erosion

Particulate emission factors for wind erosion, taken from the National Pollutant Inventory (NPI), are 3,504 kg/ha/y for TSP and 1,752 kg/ha/y for PM_{10}. According to US EPA, $PM_{2.5}$ accounts for 0.75% of TSP emissions associated with wind erosion.

Crushing and screening

Particulate emission factors for crushing and screening have been taken from the US EPA (US EPA, 1985 and updates) and are summarised below:

Activity	Emission Factor [kg/t]		
	TSP	**PM_{10}**	**$PM_{2.5}$**
Tertiary crushing (uncontrolled)	0.0027	0.0012	0.00023
Screening (uncontrolled)	0.0125	0.0043	0.00029
Tertiary crushing (controlled)	0.0006	0.00027	0.00005
Screening (controlled)	0.0011	0.00037	0.000025

Table B-1 Emissions Inventory – $PM_{2.5}$

Activity	Emissions (kg/y)	Intensity		Emission Factor		Variable 1		Variable 2		Control	Description
		Value	Units	Value	Units	Value	Units	Value	Units		
Soil Recycling											
Raw material dumped to input stockpile	9.9	300000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to crusher	1.6	300000	t/y	1.09E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	50%	Semi-enclosed
Crushing	34.5	300000	t/y	2.30E-04	kg/t					50%	Semi-enclosed
Screening	43.5	300000	t/y	2.90E-04	kg/t					50%	Semi-enclosed
Product material unloaded to stockpile	9.9	300000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Product material loaded into trucks	9.9	300000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (paved)	199.9	20000.0	VKT/y	1.00E-02	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	128.5	19000	VKT/y	2.70E-02	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
wind erosion (raw stockpiles)	52.6	0.2	ha	2.63E+02	kg/ha/y						
wind erosion (product stockpiles)	52.6	0.2	ha	2.63E+02	kg/ha/y						
Concrete Recycling											
Raw material dumped to input stockpile	4.9	150000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to crusher	0.8	150000	t/y	1.09E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	50%	Semi-enclosed
Crushing	17.3	150000	t/y	2.30E-04	kg/t					50%	Semi-enclosed
Screening	21.8	150000	t/y	2.90E-04	kg/t					50%	Semi-enclosed
Product material unloaded to stockpile	4.9	150000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Product material loaded into trucks	4.9	150000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (paved)	100.0	10000	VKT/y	1.00E-02	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	33.8	5000	VKT/y	2.70E-02	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
wind erosion (raw stockpiles)	52.6	0.2		2.63E+02	kg/ha/y						
wind erosion (product stockpiles)	52.6	0.2		2.63E+02	kg/ha/y						

Activity	Emissions (kg/y)	Intensity		Emission Factor		Variable 1		Variable 2		Control	Description
		Value	Units	Value	Units	Value	Units	Value	Units		
Light Waste Processing											
Raw material dumped to input stockpile	6.6	200000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to processing plant	0.2	200000	t/y	1.09E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Crushing	1.0	200000	t/y	5.00E-05	kg/t					90%	Fully enclosed
Screening	0.5	200000	t/y	2.50E-05	kg/t					90%	Fully enclosed
Product material unloaded to stockpile	0.2	200000	t/y	1.09E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Product material loaded into trucks	0.2	200000	t/y	1.09E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Haulage (paved)	133.3	13333	VKT/y	1.00E-02	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	45.1	6668	VKT/y	2.70E-02	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion (input stockpiles)	26.3	0.1	ha	2.63E+02	kg/ha/y						
Landfill											
Material dumped	1.3	40000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Spreading & compacting	1.3	40000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (unpaved)	4.4	500	VKT/y	3.55E-02	kg/VKT	55	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion (active area)	26.3	0.1	ha	2.63E+02	kg/ha/y						
Parkland Construction											
Dumping material to stockpile	41.6	1265000	t/y	3.29E-05	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Dozer shaping	398.6	2112	hr/y	1.89E-01	kg/hr	6.9	silt content [%]	7.9	moisture content [%]		
Haulage (unpaved)	702.3	79063	VKT/y	3.55E-02	kg/VKT	55	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion	263.0	1	ha	2.63E+02	kg/ha/y						

Table B-2 Emissions Inventory – PM_{10}

Activity	Emissions (kg/y)	Intensity		Emission Factor		Variable 1		Variable 2		Control	Description
		Value	Units	Value	Units	Value	Units	Value	Units		
Soil Recycling											
Raw material dumped to input stockpile	65.1	300000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to crusher	10.8	300000	t/y	7.23E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	50%	Semi-enclosed
Crushing	180.0	300000	t/y	1.20E-03	kg/t					50%	Semi-enclosed
Screening	645.0	300000	t/y	4.30E-03	kg/t					50%	Semi-enclosed
Product material unloaded to stockpile	65.1	300000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Product material loaded into trucks	65.1	300000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (paved)	826.4	20000.0	VKT/y	4.13E-02	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	1284.8	19000	VKT/y	2.70E-01	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
wind erosion (raw stockpiles)	350.4	0.2	ha	1.75E+03	kg/ha/y						
wind erosion (product stockpiles)	350.4	0.2	ha	1.75E+03	kg/ha/y						
Concrete Recycling											
Raw material dumped to input stockpile	32.6	150000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to crusher	5.4	150000	t/y	7.23E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	50%	Semi-enclosed
Crushing	90.0	150000	t/y	1.20E-03	kg/t					50%	Semi-enclosed
Screening	322.5	150000	t/y	4.30E-03	kg/t					50%	Semi-enclosed
Product material unloaded to stockpile	32.6	150000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Product material loaded into trucks	32.6	150000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (paved)	413.2	10000	VKT/y	4.13E-02	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	338.1	5000	VKT/y	2.70E-01	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
wind erosion (raw stockpiles)	350.4	0.2		1.75E+03	kg/ha/y						
wind erosion (product stockpiles)	350.4	0.2		1.75E+03	kg/ha/y						
Light Waste Processing											

Activity	Emissions (kg/y)	Intensity		Emission Factor		Variable 1		Variable 2		Control	Description
		Value	Units	Value	Units	Value	Units	Value	Units		
Raw material dumped to input stockpile	43.4	200000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to processing plant	1.4	200000	t/y	7.23E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Crushing	5.4	200000	t/y	2.70E-04	kg/t					90%	Fully enclosed
Screening	7.4	200000	t/y	3.70E-04	kg/t					90%	Fully enclosed
Product material unloaded to stockpile	1.4	200000	t/y	7.23E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Product material loaded into trucks	1.4	200000	t/y	7.23E-05	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Haulage (paved)	550.9	13333	VKT/y	4.13E-02	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	450.9	6668	VKT/y	2.70E-01	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion (input stockpiles)	175.2	0.1	ha	1.75E+03	kg/ha/y						
Landfill											
Material dumped	8.7	40000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Spreading & compacting	8.7	40000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (unpaved)	44.4	500	VKT/y	3.55E-01	kg/VKT	55	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion (active area)	175.2	0.1	ha	1.75E+03	kg/ha/y						
Parkland Construction											
Dumping material to stockpile	274.7	1265000	t/y	2.17E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Dozer shaping	3796.4	2112	hr/y	1.80E+00	kg/hr	6.9	silt content [%]	7.9	moisture content [%]		
Haulage (unpaved)	7022.8	79063	VKT/y	3.55E-01	kg/VKT	55	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion	1752.0	1	ha	1.75E+03	kg/ha/y						

Table B-3 Emissions Inventory – TSP

Activity	Emissions (kg/y)	Intensity		Emission Factor		Variable 1		Variable 2		Control	Description
		Value	Units	Value	Units	Value	Units	Value	Units		
Soil Recycling											
Raw material dumped to input stockpile	137.7	300000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to crusher	22.9	300000	t/y	1.53E-04	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	50%	Semi-enclosed
Crushing	405.0	300000	t/y	2.70E-03	kg/t					50%	Semi-enclosed
Screening	1875.0	300000	t/y	1.25E-02	kg/t					50%	Semi-enclosed
Product material unloaded to stockpile	137.7	300000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Product material loaded into trucks	137.7	300000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (paved)	4305.1	20000.0	VKT/y	2.15E-01	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	5892.4	19000	VKT/y	1.24E+00	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
wind erosion (raw stockpiles)	700.8	0.2	ha	3.50E+03	kg/ha/y						
wind erosion (product stockpiles)	700.8	0.2	ha	3.50E+03	kg/ha/y						
Concrete Recycling											
Raw material dumped to input stockpile	68.9	150000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to crusher	11.5	150000	t/y	1.53E-04	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	50%	Semi-enclosed
Crushing	202.5	150000	t/y	2.70E-03	kg/t					50%	Semi-enclosed
Screening	937.5	150000	t/y	1.25E-02	kg/t					50%	Semi-enclosed
Product material unloaded to stockpile	68.9	150000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Product material loaded into trucks	68.9	150000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (paved)	2152.5	10000	VKT/y	2.15E-01	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	1550.6	5000	VKT/y	1.24E+00	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
wind erosion (raw stockpiles)	700.8	0.2		3.50E+03	kg/ha/y						
wind erosion (product stockpiles)	700.8	0.2		3.50E+03	kg/ha/y						
Light Waste Processing											

Activity	Emissions (kg/y)	Intensity		Emission Factor		Variable 1		Variable 2		Control	Description
		Value	Units	Value	Units	Value	Units	Value	Units		
Raw material dumped to input stockpile	91.8	200000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Raw material loaded to processing plant	3.1	200000	t/y	1.53E-04	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Crushing	12.0	200000	t/y	6.00E-04	kg/t					90%	Fully enclosed
Screening	22.0	200000	t/y	1.10E-03	kg/t					90%	Fully enclosed
Product material unloaded to stockpile	3.1	200000	t/y	1.53E-04	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Product material loaded into trucks	3.1	200000	t/y	1.53E-04	kg/t	2	wind speed [m/s]	7.9	moisture content [%]	90%	Fully enclosed
Haulage (paved)	2870.0	13333	VKT/y	2.15E-01	kg/VKT	30	vehicle mass [t]	2	silt loading [g/m^2]		
Haulage (unpaved)	2067.9	6668	VKT/y	1.24E+00	kg/VKT	30	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion (input stockpiles)	350.4	0.1	ha	3.50E+03	kg/ha/y						
Landfill											
Material dumped	18.4	40000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Spreading & compacting	18.4	40000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Haulage (unpaved)	203.7	500	VKT/y	1.63E+00	kg/VKT	55	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion (active area)	350.4	0.1	ha	3.50E+03	kg/ha/y						
Parkland Construction											
Dumping material to stockpile	18.4	40000	t/y	4.59E-04	kg/t	4.66	wind speed [m/s]	7.9	moisture content [%]		
Dozer shaping	3796.4	2112	hr/y	1.80E+00	kg/hr	6.9	silt content [%]	7.9	moisture content [%]		
Haulage (unpaved)	32208.0	79063	VKT/y	1.63E+00	kg/VKT	55	vehicle mass [t]	2.2	silt content [%]	75%	Water cart
Wind erosion	3504.0	1	ha	3.50E+03	kg/ha/y						