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AIR QUALITY



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Glenfield Waste Services, Cambridge Ave, Glenfield

Material Recycling Facility -Air Quality Impact Assessment

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Final Authority

This report must be regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below.



Martin Doyle

25th July 2022

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Non-Technical Summary

Northstar Air Quality was engaged by Glenfield Waste Services to perform an air quality impact assessment for the proposed operation of a materials recycling facility, to be located on Cambridge Avenue, Glenfield, NSW.

A number of air quality impact assessments have previously been performed for the Proposal site, and following review of those assessments by the NSW Environment Protection Authority, a number of issues were raised including the lack of detailed assessment of the best practice dust management measures which could be employed at the Proposal site to ensure that particulate emissions would be controlled from the site to the extent of best practice.

Following those comments, and through discussions with the NSW Environment Protection Authority, the proponent has performed a re-design of the Proposal, and are proposing to implement best practice dust control which includes (as requested by the NSW Environment Protection Authority), the performance of all activities within enclosed sheds.

A dispersion modelling assessment conducted in accordance with the relevant NSW Environment Protection Authority guidance has been performed to determine the likely air quality impacts upon surrounding receptor locations. Activity rates associated with average operational conditions have been used to determine the potential impact and compared against annual average criteria. To determine the potential maximum 24-hour impact of the Proposal, the materials unloading, handling and processing rates have been assumed to be double the annual average rates. This is considered to represent a conservative assumption.

Further levels of conservatism have been built into the modelling assessment, including the assumption that all material delivered to the Proposal site would be processed, and the assumption that the entire area of the tipping shed and processing shed would be available to be eroded by the wind. The results of the assessment can therefore be viewed as representing the maximum potential impacts, which would not be likely to be experienced in reality. Furthermore, the most recent iteration of the Proposal design (not modelled) results in reductions in vehicle kilometres travelled, and the results of the assessment can be viewed to be conservative.

The operation of the Proposal is not anticipated to result in any additional exceedances of the relevant air quality criteria. The best practice management measures proposed are shown to act to minimise impacts on surrounding receptor locations.

It is respectfully considered that the Proposal should not be rejected on the grounds of air quality.

Contents

1.	INTRODUCTION	7
1.1.	Background	7
1.1.1.	2013	7
1.1.2.	2015 & 2016	7
1.1.3.	2017	8
1.1.4.	2022	8
1.2.	Purpose of the Report	8
1.3.	Scope of Assessment	9
1.4.	Assessment Requirements.....	9
2.	THE PROPOSAL	11
2.1.	Environmental Setting.....	11
2.2.	Overview and Purpose.....	12
2.3.	Process Overview	13
2.4.	Identification of Potential Emissions to Atmosphere.....	15
2.5.	Environmental Controls	17
2.6.	Activity Rates	17
3.	LEGISLATION, REGULATION AND GUIDANCE	20
3.1.	Ambient Air Quality Standards	20
3.2.	NSW Government Air Quality Planning.....	20
4.	EXISTING CONDITIONS.....	22
4.1.	Surrounding Land Sensitivity.....	22
4.1.1.	Land Use Zoning	22
4.1.2.	Discrete Receptor Locations	23
4.1.3.	Uniform Receptor Locations	25
4.2.	Topography	25
4.3.	Meteorology	27
4.4.	Air Quality.....	29
5.	METHODOLOGY.....	31

5.1.	Dispersion Modelling.....	31
5.2.	Emissions Estimation.....	31
5.3.	Emissions Controls.....	35
6.	AIR QUALITY IMPACT ASSESSMENT	42
6.1.	Annual Average TSP, PM ₁₀ and PM _{2.5}	42
6.2.	Annual Average Dust Deposition Rates.....	44
6.3.	Maximum 24-hour PM ₁₀ and PM _{2.5}	45
7.	MITIGATION AND MONITORING.....	52
7.1.	Air Quality Management Plan	52
8.	CONCLUSION.....	54
9.	REFERENCES	56
	APPENDIX A.....	58
	APPENDIX B.....	66
	APPENDIX C.....	72

Tables

Table 1	Director Generals Requirements (Application Number SSD 6249)	9
Table 2	Estimated activity rates	18
Table 3	NSW EPA air quality standards and goals	20
Table 4	Discrete sensitive receptor locations used in the study	25
Table 5	Details of meteorological monitoring surrounding the Proposal site	27
Table 6	Closest DPIE AQMS to the Proposal site	29
Table 7	Summary of background air quality used in the previous AQIA	30
Table 8	Comparison of adopted emission factors	33
Table 9	Emission reduction methods and particulate control efficiencies	38
Table 10	Predicted annual average TSP, PM ₁₀ and PM _{2.5} concentrations	43
Table 11	Predicted annual average dust deposition	45
Table 12	Predicted maximum incremental 24-hour PM ₁₀ and PM _{2.5} concentrations	45
Table 13	Summary of contemporaneous impact and background – PM ₁₀	47
Table 14	Summary of contemporaneous impact and background – PM _{2.5}	48
Table 15	Summary of emission reduction methods adopted as part of Proposal operation	53

Figures

Figure 1	Proposal site location	11
Figure 2	Proposed site layout	13
Figure 3	Land use zoning	22
Figure 4	Population density and sensitive receptors surrounding the Proposal site	24
Figure 5	Three-dimensional representation of topography	26
Figure 6	Meteorological monitoring stations surrounding the Proposal site	28
Figure 7	Tipping and sorting shed	35
Figure 8	Stockpile pen processing shed	36
Figure 9	Calculated uncontrolled & controlled annual PM ₁₀ emissions	40
Figure 10	Incremental 24-hour PM ₁₀ concentrations – Proposal increment	49
Figure 11	Incremental 24-hour PM _{2.5} concentrations - Proposal increment	50

1. INTRODUCTION

Glenfield Waste Services (GWS) has engaged Northstar Air Quality Pty Ltd (Northstar) to perform an air quality impact assessment (AQIA) for the proposed operation of a materials recycling facility (the Proposal) located at Cambridge Avenue, Glenfield, NSW – Lot 1 DP 113201, Lot 2 DP 333578, Lot 3 DP 736881 & Lot 91 DP 1155962 (the Proposal site).

1.1. Background

The following sections provide a brief history of the air quality assessments conducted for the Proposal since 2015. This history is provided to assist in the understanding of the progression of the development and the performance of the air quality studies.

1.1.1. 2013

Director General's Requirements (DGRs) were provided by the then NSW Department of Planning & Infrastructure (DPI) for the Proposal on 19 December 2013, given that the Proposal was designated as State Significant Development (SSD 6249). DGRs for SSD 6249 are presented in **Table 1**.

1.1.2. 2015 & 2016

An AQIA was previously performed for the Proposal (SLR, 2015) to support an Environmental Impact Statement (EIS), prepared by Environmental Property Services Pty Ltd in 2016.

After the submission of the initial EIS, the Proposal was not approved and a letter from the NSW Environment Protection Authority (EPA) dated 25 July 2016 (reference DOC16/315608) was received with comments on the EIS. The identified issues relating to air quality, as raised within that letter, were as follows:

“The EPA previously commented on the suitability of the Environmental Impact Statement for public exhibition and advised there were four elements requiring additional information:

- *Justification of material handling in the open, benchmarking against industry best practice*
- *Justification for estimating the concentration of TSP as double that of PM₁₀*
- *Identification of all potential odour sources, at the least leachate and putrescible residues*
- *Installation of a meteorology station on the site to assist in deploying water sprays”*

Following the provision of supplementary information, the EPA declared that they were satisfied at that time that the last three points had been adequately addressed. The lack of justification for performing material handling in the open and benchmarking against industry best practice remained an unresolved issue.

1.1.3. 2017

A second letter from the EPA was received on 10 July 2017 (reference: DOC17/329859). The EPA comments from this letter relating to air quality were as follows:

“In relation to dust the Second Supplementary Report identifies exceedances with the relevant criteria for PM₁₀ 24-hour average, PM_{2.5} annual average and PM_{2.5} 24-hour average re-affirming the EPA’s position that activities should be enclosed and on suitable hardstand to help manage these issues to be within relevant guidelines.”

1.1.4. 2022

This AQIA has been commissioned to support an amended EIS for the Proposal, which reflects an updated Proposal layout. Importantly, all activities are now proposed to be performed within enclosed buildings on hardstand, with fast acting roller doors which would be closed at all times, except to allow the ingress and egress of vehicles.

Although a number of iterations of the AQIA have been provided to EPA over the course of the preceding five years, this current AQIA seeks to address the DGRs as provided in 2013 in their entirety, to ensure that all issues have been addressed and reflect the current proposed layout.

It is noted that the results of the quantitative dispersion modelling presented within this report reflect a superseded layout of the Proposal site. Modifications to that design in mid-2022 have resulted in a reduction in the number of vehicle kilometres travelled on roads external to the tipping and processing buildings. The total site emissions of PM₁₀ are calculated to be approximately 92 % of those modelled within this assessment (refer to **Section 2.3**, **Section 2.6**, and **Section 5.2** for a more detailed discussion of those changes). The results of this assessment should be considered to provide a conservative representation of the likely particulate matter impacts anticipated during the Proposal operation.

1.2. Purpose of the Report

The purpose of this report is to examine and identify whether the impacts of the operation of the Proposal may adversely affect local air quality.

This AQIA has been performed in accordance with, and with due reference to:

- *Protection of the Environment Operations Act 1997;*
- Protection of the Environment Operations (Clean Air) Regulation 2021; and
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2016).

1.3. Scope of Assessment

The AQIA has been performed to assess the potential effects of the operation of the Proposal upon air quality. The report presents data that summarise and characterise the existing environmental conditions, identifies the potential emissions to air associated with the operational phase of the Proposal, examines the potential for off-site impacts and identifies appropriate mitigation measures that would be required to reduce those potential impacts.

The available mitigation measures have been identified through a review of best practice measures applicable to the materials recycling industry. Where these can justifiably be included as part of the Proposal operation, the particulate control efficiencies have been adopted during the modelling phase of the assessment. Where these measures cannot be included, the reasons for non-inclusion are presented and justified.

1.4. Assessment Requirements

The (then) NSW DPI (now Department of Planning, Industry and Environment [DPIE]) issued the Director Generals Requirements (DGRs) for the Proposal on 19 December 2013. The DGRs relevant to air quality and odour are presented in **Table 1**.

Table 1 Director Generals Requirements (Application Number SSD 6249)

Assessment Requirements	Relevant Section
A quantitative assessment of the potential air quality and odour impacts of the development on surrounding landowners;	Section 6
Description of how the handling, transporting, production and storage of waste materials would be managed to control dust generation;	Section 5.3, Section 7
Details of all proposed mitigation, management and monitoring measures.	Section 5.3, Section 7

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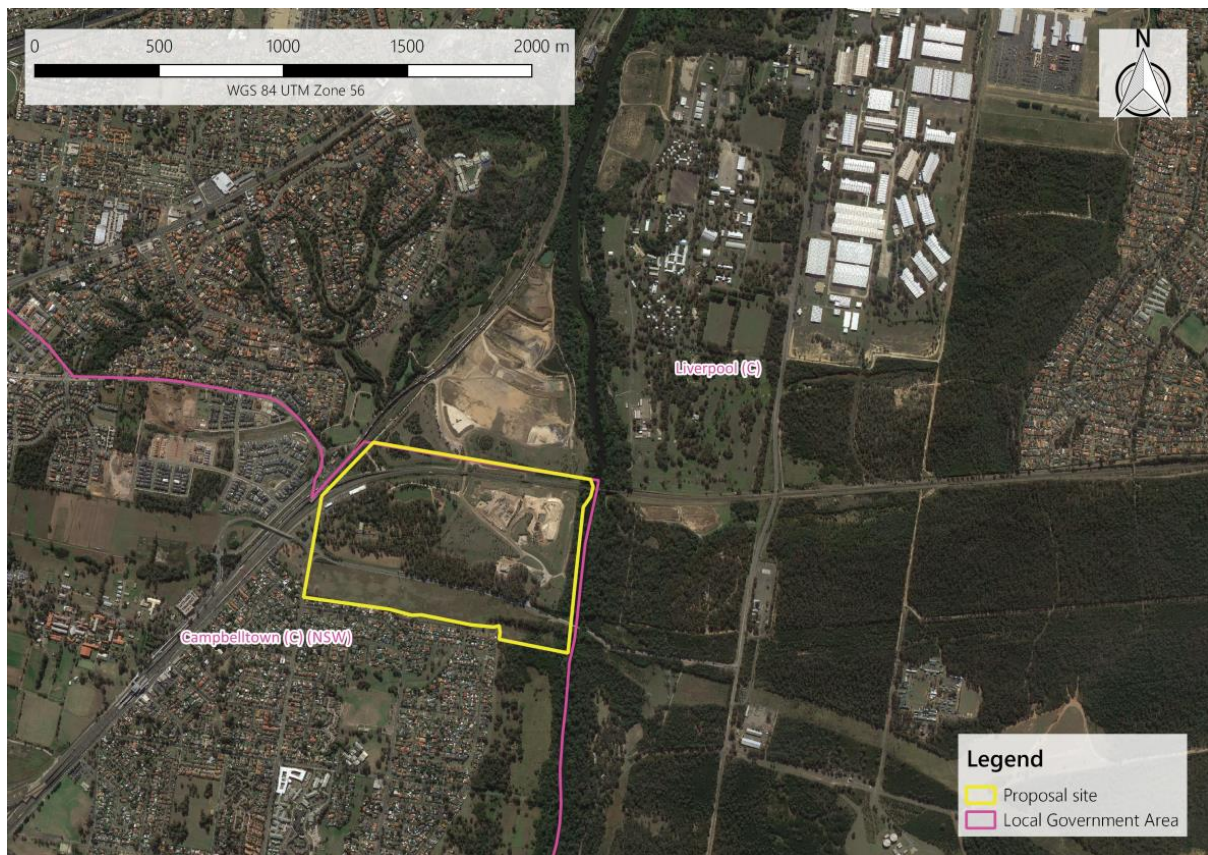
2. THE PROPOSAL

The following provides a description of the context, location, and scale of the Proposal and identifies the potential for emissions to air associated with the operation of the Proposal.

2.1. Environmental Setting

The Proposal site is located on Cambridge Avenue, Glenfield, NSW and is located within the Local Government Area (LGA) of the City of Campbelltown. A map showing the location of the Proposal site is presented in **Figure 1**.

Figure 1 Proposal site location



Note: Image courtesy of Google Maps

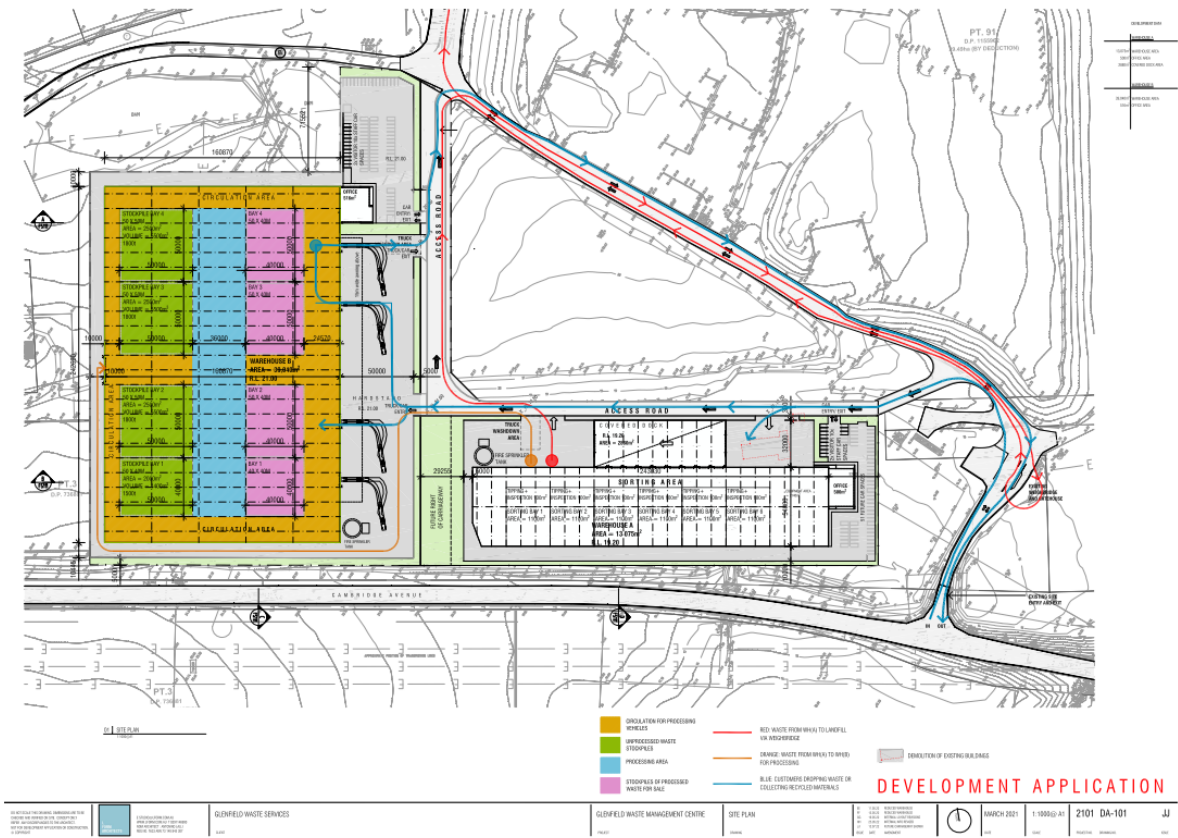
The land use surrounding the Proposal site is predominantly zoned as 'General Industrial', 'Public Recreation', and 'Infrastructure'. The closest residential areas are approximately 200 meters (m) to the south, and 550 m to the east of the Proposal site, in Glenfield and Casula.

A full description of the sensitivity of the surrounding land, and the identification of discrete receptor locations used in the AQIA is provided in **Section 4.1**.

2.2. Overview and Purpose

The Proposal seeks to gain development approval for the operation of a solid waste recycling facility on approximately 12 hectares (ha) of a 30 ha site that is zone IN1 'Industrial' under the Campbelltown Local Environmental Plan (LEP). Activities such as delivery, materials handling, processing (crushing, screening and shredding) storage and despatch of material would be performed at the Proposal site. A layout of the Proposal site is provided in **Figure 2**. Also presented in **Figure 2** are the proposed transport routes at the Proposal site, with blue lines indicating 'customers dropping waste or collecting recycled materials', the orange line representing the movement of waste from one building to another, and the red line representing the movement of residual waste to landfill.

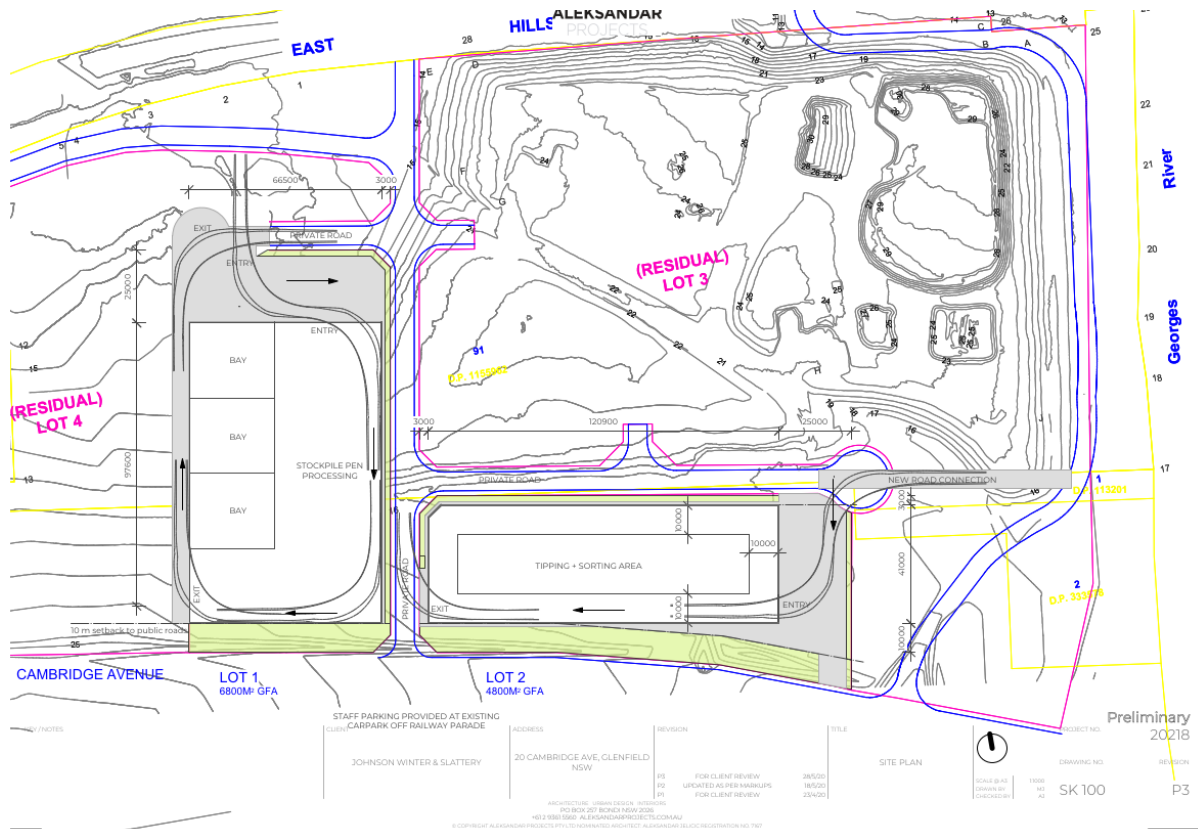
Figure 2 Proposed site layout



Source: L Form Architects (July 2022)

The Proposal site layout, which has been subject to assessment by dispersion modelling, is presented in **Figure 3**. It is noted that the modelling of emissions from the previously assessed layout (as illustrated in **Figure 3**) results in significantly greater truck travel distances (particularly to the processing building), as those vehicles were assumed to enter via the north and exit via the southwest of that building before travelling north to meet the access road. The updated layout (not modelled, and illustrated in **Figure 2**) reduces the travel distances through trucks largely entering and exiting via the eastern side of the (refer to **Section 2.6** for further quantification of those changes).

Figure 3 Proposed site layout, as modelled



Source: Aleksandar Projects

2.3. Process Overview

The waste receipt, processing and storage activities within the Proposal site would be located across an area of approximately 11.8 ha, shown as new Lot 1 and Lot 2 on **Figure 3**. Material would be delivered to the Proposal site via Cambridge Avenue, and deposited inside a purpose-built ‘tipping and sorting shed’ of approximately 13 075 square metres (m²) gross floor area (GFA) (Lot 2). The vehicles would then exit the building and exit the Proposal site on Cambridge Avenue. The deposited materials would then be inspected and sorted within the tipping and sorting shed, before being moved to the ‘processing shed’ by 35 tonne (t) dump truck. Processing of materials (including crushing, screening and/or shredding) would be performed within the stockpile pen processing shed (being a shed on Lot 1 of approximately 39 040 m² GFA) and recycled material would be stacked into sorted material bays within the processing shed. Vehicles arriving to collect materials would enter the Proposal site via Cambridge Avenue, travel to the processing shed, be loaded and depart the site via Cambridge Avenue.

The proposed development will be located on 2 newly created (paper) lots, (not actually subdivided until a subdivision application is lodged, with lots shown as Lot 1 and Lot 2, with the balance of the site being identified as residue, Lot 3). Lot 2 will be used to construct a warehouse for the initial receipt of all materials for recycling through the Solid Waste Recycling Facility. Lot 1 will be used to construct a warehouse within which all materials to be processed for recycling and sale will be handled and stored pending sale.

For clarity, the layout presented in **Figure 3** has been used as the basis for this AQIA, which represents a previous layout as discussed in **Section 2.2**.

The facility would receive and process up to 450 000 tonnes per annum (tpa) of non-putrescible waste, principally construction and demolition (C&D), commercial and industrial (C&I), and excavated natural material (ENM) for reuse in secondary markets.

Green waste would not be received by the facility. Any material that cannot be recycled (including green waste) is forwarded to the GWS landfill facility to the north of the Proposal site. It is anticipated that approximately 10 % of material received at the Proposal site may need to be disposed of in this manner (i.e. 45 000 tpa). The movement and unloading of this material to the GWS landfill has been characterised within this AQIA.

The Proposal site would operate between the hours of 0630 hrs (6.30 am) and 1630 hrs (4.30 pm) Monday to Friday, and 0800 hrs (8.00 am) and 1600 hrs (4.00 pm) Saturday. Access until 1800 hrs (6.00 pm) will be required for maintenance between Monday and Friday.

Operations will primarily comprise of:

- Receipt of waste materials:
 - It is anticipated that majority of the material received will be source separated, however there will be capacity to sort mixed loads;
 - All material entering the facility will be visually inspected upon arrival; and,
 - Material received will be charged based on weight and/or volume.
- Separation of C&I materials into different waste streams:
 - Paper/cardboard and plastics are to be separated for baling and recycling; and,
 - Timber, metals and glass are to be separated for recycling.
- Processing of C&D materials using the following methods depending on the type of treatment required:
 - Breakdown/pre-processing - material that is delivered in large sections (over 600 mm) is first to be broken down into manageable sizes using a pulveriser attached to an excavator;
 - Initial processing (pulverising) to remove reinforced steel that will be separated and stored until taken off-site for recycling;
 - The pulverised material will then be crushed using a mobile crushing plant;
 - The crushed material will then be blended ('mixed') into finished product, and stored in separate signposted stockpiles by blend type and specification; and,
 - The finished product will be tested (as relevant to that blend) prior to sale.

Waste will be received at the Solid Waste Recycling Facility via the main gatehouse where it would be weighed and directed along the main entry and then turn left at the sign post marked Solid Waste Recycling Facility. It will travel to the first warehouse which is approximately 13 075 m² GFA. The delivery would proceed through a fast-acting automated door which will close prior to tipping commencing. Once a load is tipped and sprayed (for dust mitigation purposes), the vehicle will continue in a forward direction to exit at the opposite end of the warehouse and then return to the gatehouse to exit.

The materials in the sorting warehouse would be sorted into respective stockpiles of metal, bricks, stone, wood etc. Green and non-recyclable material is removed from the recycling waste stream and transferred to the GWS landfill as soon as practicable. There is no capacity for green waste storage at the Proposal site.

Unprocessed recyclable materials will then be transferred by dump truck from the tipping and sorting shed to the processing shed. The processing shed will house the processing activities (crushing, screening and shredding). Processing of like materials would be performed in batches as received from the tipping and sorting shed, with processed materials stored in covered bins located along the internal western façade of the warehouse. A conveyer belt from the processing equipment will deliver the processed material to the relevant post-processing storage bin.

The processing and storage of the materials will be performed in an enclosed and dry environment, with dust suppression techniques while in operation. Stormwater will be collected both from the roof and hardstand for capture and re-use in dust mitigation. Run-off will be limited by both harvesting and bunding of the hardstand.

The following mobile machinery is proposed to be used:

- 3× front end loaders;
- 2× excavators, 1 with pulveriser;
- 2× water carts;
- 1× jaw crusher;
- 1× shredder;
- 1× screen and
- 2× dump trucks.

2.4. Identification of Potential Emissions to Atmosphere

During the operation of the Proposal, the following activities are anticipated to result in potential emissions to air:

- Wheel-generated particulate emissions from the operation of the trucks and other site vehicles on paved road surfaces (including materials deliveries, despatch, and transfer between buildings);
- Wheel-generated particulate emissions from the operation of trucks on unpaved road surfaces (between the Proposal site and GWS landfill);

- Particulate emissions from the unloading and loading of materials from trucks;
- Particulate emissions from the handling of materials by front-end loaders and excavators;
- Particulate emissions from the operation of the pulveriser, crusher, screen and shredder; and,
- Particulate emissions from materials storage areas generated by wind erosion.

For clarity, all roads at the Proposal site will be paved, with the exception of the road to the GWS landfill. Emissions from all roads have been calculated according to the level of paving.

All waste received at the Proposal site is non-putrescible. Although timber would be received, processed (to mulch) and stored at the Proposal site, it is not likely that the material would be retained at the Proposal site for a sufficient period of time to decay and become odorous. Furthermore, the product is of no commercial value as a mulch product if it does begin to decay and therefore the material will be managed and stored to reduce the potential for decay. Importantly, no composting is proposed as part of the Proposal operations.

The potential generation and emission of odour from raw timber products and shredded / chipped material would be minor. A review of odour emissions data and hedonic tone descriptors associated with raw timber and shredded/chipped wood materials indicates that odour from these sources would generally be described as exhibiting neutral hedonics and by a standard odour descriptor as 'earthy'. The final product is often used as a medium in biofilters (used to reduce odour from odorous processes) and intrinsically has a residual and minor woodchip odour. For context, a well operated and appropriately sized biofilter with odorous gas flowing through should typically not result in any discernible odour at around 10 m.

A minor odour may therefore be experienced in close proximity to the stockpiles of material, although given that any area in which timber is stored/handled or processed is at least approximately 190 m from the nearest project related residence, and over 200 m from the nearest non-project related residence, the potential for odour impacts is considered to be insignificant and easily contained within the Proposal site boundary.

Given the nature of the material to be accepted at the Proposal site, and the fact that the tipping, storage and processing areas are all enclosed, leachate is not anticipated to be generated in any significant quantities. Any minor quantity of leachate that is generated would be washed down on a regular basis to avoid any potential for odour generation.

Based upon the description provided above, it is anticipated that the potential for odour nuisance complaints is very low. However, an odour complaints procedure would be implemented as part of the Air Quality Management Plan (AQMP) and the complaint log would form part of the ongoing environmental management of the site.

Air quality impacts during construction would be limited to construction of the warehouses, sealing of the roads and minor earthworks. Any potential impacts during the limited construction activities would be managed through the considerate implementation of a Construction Environment Management Plan (CEMP), which would include an Air Quality Management Plan (AQMP) detailing a range of emissions controls.

2.5. Environmental Controls

A number of air quality management measures are to be employed as part of the operation of the Proposal to minimise the generation and off-site transport of particulate matter. A discussion of these adopted measures and their benchmarking to best practice is presented in **Section 5.3**.

2.6. Activity Rates

The AQIA requires a range of activity data that describes the activity rates performed on site, such as vehicle movements, processing rates etcetera.

As the AQIA is required to assess impacts over both shorter-term and longer-term periods, the activity data presented in **Table 2** are assumed to be representative of the proposed activity over the relevant assessment periods.

It is noted that the maximum daily rate of material handling and processing has been assumed to be twice that of the average daily rate. This is likely to be a highly conservative assumption although has been adopted to ensure that the predicted impacts associated with 24-hour criteria (PM₁₀ and PM_{2.5}) are not underestimated. The likelihood of the maximum daily handling and processing rate being coincidental with the meteorological conditions which may give rise to the worst-case impacts is low but is required to be assessed in this manner.

Table 2 Estimated activity rates

Parameter	Units	Annual	Daily
Operating hours	hrs	3 016	10 – Monday to Friday 8 - Saturday
Operating days	days	286	-
Material delivery, handling and processing rates			
Commercial and Industrial (C&I)	tonnes	Not more than 30 000	105 - average 210 - maximum ^(A)
Construction and Demolition (C&D)	tonnes	Not more than 120 000	420 - average 840 - maximum ^(A)
Excavated Natural Material (ENM)	tonnes	Not more than 300 000	1 049 - average 2 098 - maximum ^(A)
Length of haulage routes			
To tipping and sorting shed from Cambridge Avenue (material delivery)	km	0.30	0.30
Within tipping and sorting shed	km	0.23	0.23
From tipping and sorting shed to Cambridge Avenue	km	0.63	0.63
From tipping and sorting shed to stockpile pen and processing shed (dump truck transfer)	km	0.42	0.42
To stockpile pen and processing shed from Cambridge Avenue (material pickup)	km	0.86	0.86
Within stockpile pen and processing shed	km	0.31	0.31
From stockpile pen and processing to Cambridge Avenue	km	1.07	1.07
From stockpile pen and processing to GWS landfill (dump truck transfer)	km	0.75	0.75
Other			
Assumed vehicle movements (material delivery)	number	<u>ENM</u> 9 091 in 33 t loads <u>C&D, C&I</u> 16 667 in 4.5 t loads (skips) 2 083 in 12 t loads (tipper) 25 253 in 1 t loads (trailers) 5 556 in 4.5 t loads (vans)	<u>ENM</u> 64 in 33 t loads <u>C&D, C&I</u> 117 in 4.5 t loads (skips) 15 in 12 t loads (tipper) 177 in 1 t loads (trailers) 39 in 4.5 t loads (vans)

Parameter	Units	Annual	Daily
Average weight of vehicles to/from tipping and sorting shed (weighted average)	tonnes	8.6	8.6
Assumed vehicle movements (material transfer)	number	<u>All materials</u> 12 857 in 35 t loads	<u>All materials</u> 90 in 35 t loads
Average weight of vehicles from tipping and sorting shed to stockpile pen and processing shed	tonnes	46.6	46.6
Assumed vehicle movements (material dispatch)	number	<u>All materials</u> 13 636 in 33 t loads	<u>All materials</u> 95 in 33 t loads
Average weight of vehicles from stockpile pen and processing shed to exit	tonnes	31.5	31.5
Assumed vehicle movements (residual to GWS landfill)	number	<u>All materials</u> 1 285 in 35 t loads	<u>All materials</u> 315 in 35 t loads
Average weight of vehicles from stockpile pen and processing shed to GWS landfill	tonnes	46.6	46.6
Silt loading of paved road	g·m ⁻²	7.4	7.4
Silt loading of unpaved road (to GWS landfill)	%	6.4	6.4

Notes: (A) Maximum daily quantity handled assumed to be twice the daily average

As previously discussed, the Proposal layout subject to dispersion modelling represents a previous iteration of the design. In that design (as modelled), the entrance to the 'stockpile pen and processing' shed was located to the north of that building, with the exit on the southwest corner of that building. The currently proposed layout includes the entrance and exit to that building on the eastern façade, with an additional entrance/exit on the western side for material transfer from the 'tipping and sorting shed', which results in significantly lower vehicle transport distances at the site (77 984 VKT per annum compared to 93 617 VKT per annum as modelled).

The provision of updated air quality modelling for a layout with an improved environmental outcome is not considered to be required, especially considering that no exceedances of the relevant air quality criteria are anticipated as a result of the modelled previous layout.

3. LEGISLATION, REGULATION AND GUIDANCE

State air quality guidelines adopted by the NSW EPA are published in the *'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW'* (the Approved Methods (NSW EPA, 2016)) which has been consulted during the preparation of this assessment report.

3.1. Ambient Air Quality Standards

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the Proposal. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, DoE, WHO and ANZECC). Where relevant to this AQIA (coincident with the potential emissions identified in **Section 2.4**), the criteria have been adopted as set out in section 7.1 of NSW EPA (2016) which are presented in **Table 3**.

Table 3 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units ^(E)	Criterion	Notes
Particulates (as PM ₁₀)	24 hours	µg·m ⁻³ ^(A)	50	Numerically equivalent to the AAQ NEPM ^(B) standards and goals.
	1 year	µg·m ⁻³	25	
Particulates (as PM _{2.5})	24 hours	µg·m ⁻³	25	
	1 year	µg·m ⁻³	8	
Particulates (as TSP)	1 year	µg·m ⁻³	90	
Particulates (as dust deposition)	1 year ^(C)	g·m ⁻² ·month ⁻¹	2	
	1 year ^(D)	g·m ⁻² ·month ⁻¹	4	

Notes: (A): micrograms per cubic metre of air (B): National Environment Protection (Ambient Air Quality) Measure (C): Maximum increase in deposited dust level (D): Maximum total deposited dust level (E) Gas volumes are expressed at 25°C (298 K) and at an absolute pressure of 1 atmosphere (101.325 kPa)

3.2. NSW Government Air Quality Planning

NSW EPA has formed a comprehensive strategy with the objective of driving improvements in air quality across the State. This comprises several drivers, including:

- Legislation: formed principally through the implementation of the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulations 2010*. The overall objective of this legislative instruments is to achieve the requirements of the National Environment Protection (Ambient Air Quality) Measure;
- Clean Air for NSW: The 10-year plan for the improvement in air quality;

- Interagency Taskforce on Air Quality in NSW: a vehicle to co-ordinate cross-government incentives and action on air quality;
- Managing particles and improving air quality in NSW; and
- Diesel and marine emission management strategy.

In regard to the relevance of the NSW Government's drive to improve air quality across the State and this AQIA, it is imperative that it is demonstrated that the Proposal would lead to the development of the NSW economy (in terms of activity and employment) and not cause an unacceptable environmental detriment to achieve its objective.

4. EXISTING CONDITIONS

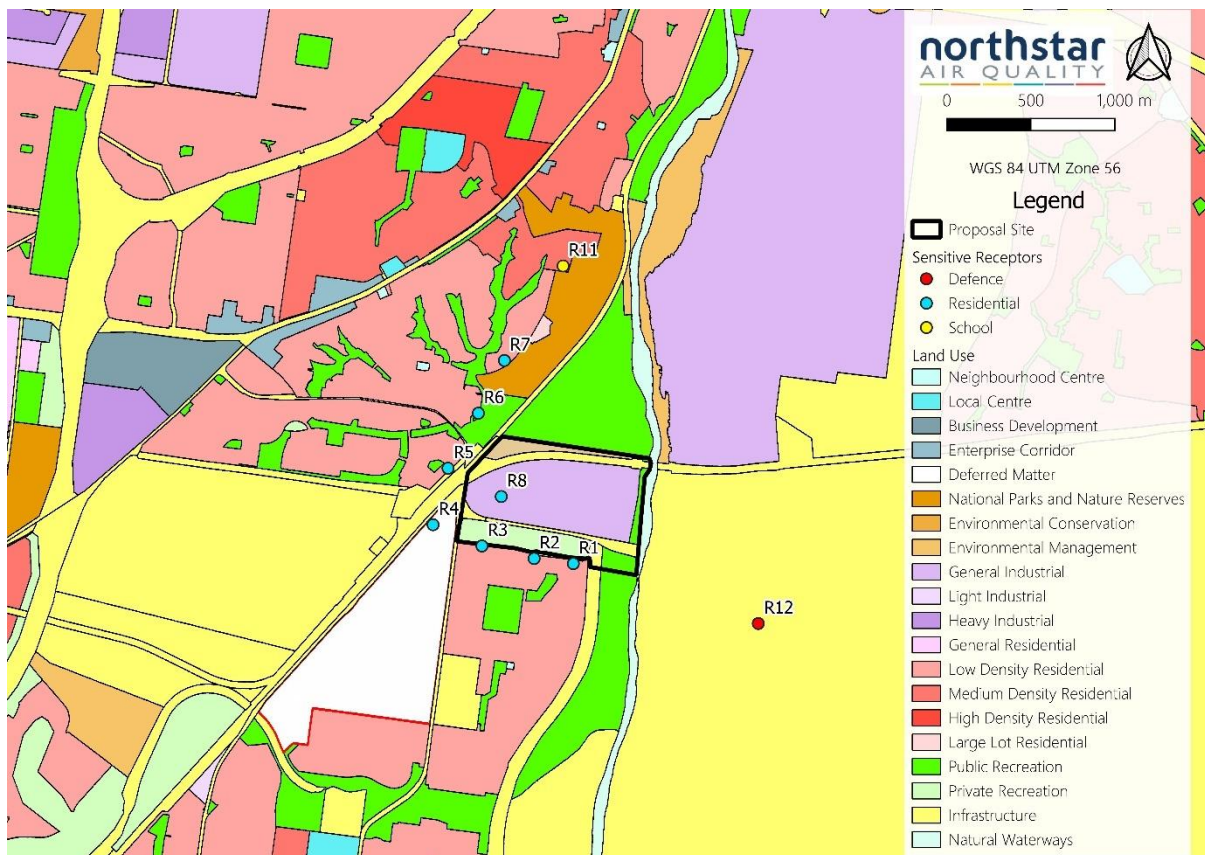
4.1. Surrounding Land Sensitivity

4.1.1. Land Use Zoning

Land use zoning as a mechanism to provide planning and environmental control to achieve the objectives of the *Environmental Planning and Assessment Act* (1979).

The land use surrounding the Proposal site is zoned by Campbelltown City Council in the Campbelltown City Council Local Environmental Plan (2015) and is illustrated in **Figure 4**. The land use zones immediately surrounding the Proposal site were gazetted on 15 June 2018.

Figure 4 Land use zoning



Source: Image courtesy of NSW Department of Planning and Environment

Portions of land surrounding the Proposal site are zoned as 'Public Recreation', 'General Industrial', 'Infrastructure' and 'Private Recreation'. The closest residential land uses are approximately 200 m to the south of the Proposal site in Glenfield, and 550 m to the east of the Proposal site in Casula.

4.1.2. Discrete Receptor Locations

Air quality assessments typically use a desk-top mapping study to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors refers to places at which humans may be present for a period representative of the averaging period for the pollutant being assessed. Typically, these locations are identified as residential properties although other sensitive land uses may include schools, medical centres, places of employment, recreational areas or ecologically sensitive locations.

It is noted that one of the assessment criteria applied to particulates (see **Section 3.1**) is over a 24-hour averaging period, and as such the predicted impacts need to be interpreted at commercial and industrial receptor locations with care. It is considered to be atypical for a person to be at those locations for a complete 24-hour period and as such the exposure risks at those locations would be over-estimated by the modelling assessment.

It is important to note that the selection of discrete receptor locations is not intended to represent a fully inclusive selection of all sensitive receptors across the study area. The location selected should be considered to be representative of its location and may be reasonably assumed to be representative of the immediate environs. In some instances, several viable receptor locations may be identified in a small area, for example a school neighbouring a medical centre. In this instance the receptor closest to the potential sources to be modelled would generally be selected and would be used to assess the risk to other sensitive land uses in the area.

It is further noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations (see **Section 4.1.3**) that are used to plot out the predicted impacts, and as such the accidental non-inclusion of a location sensitive to changes in air quality does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the Proposal site reside, population density data has been examined. Population density data based on the 2016 census have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km²) grid, covering mainland Australia (ABS, 2017). Using a Geographical Information System (GIS), the locations of sensitive receptor locations have been confirmed with reference to their population densities.

For clarity, the ABS use the following categories to analyse population density (persons·km⁻²):

- | | | | |
|-------------|--------|-----------------|------|
| • Very high | >8,000 | • Low | >500 |
| • High | >5,000 | • Very low | <500 |
| • Medium | >2,000 | • No population | 0 |

Using ABS data in a GIS, the population density of the area surrounding the Proposal site are presented in **Figure 5**.

The Proposal site is located in an area of very low / low population density which would be expected given the industrial nature of the surrounding area. Medium population densities are observed to the south and north-west of the Proposal site.

The receptors adopted for use within this AQIA are presented in **Table 4**. This selection is derived from the information presented in **Figure 4** and **Figure 5**.

It is noted that the residential receptor (R8) is located within the boundary of the Proposal site and is owned by the proponent. Given that this location is project-related, the air quality criteria outlined in **Section 3** do not apply. However, in the interests of transparency, impacts have been predicted at this project-related location and results are presented in **Section 6**. However, where discussion of maximum impacts is presented, these are limited to off-site (non-project related) locations to appropriately describe risks at off-site locations.

Figure 5 Population density and sensitive receptors surrounding the Proposal site

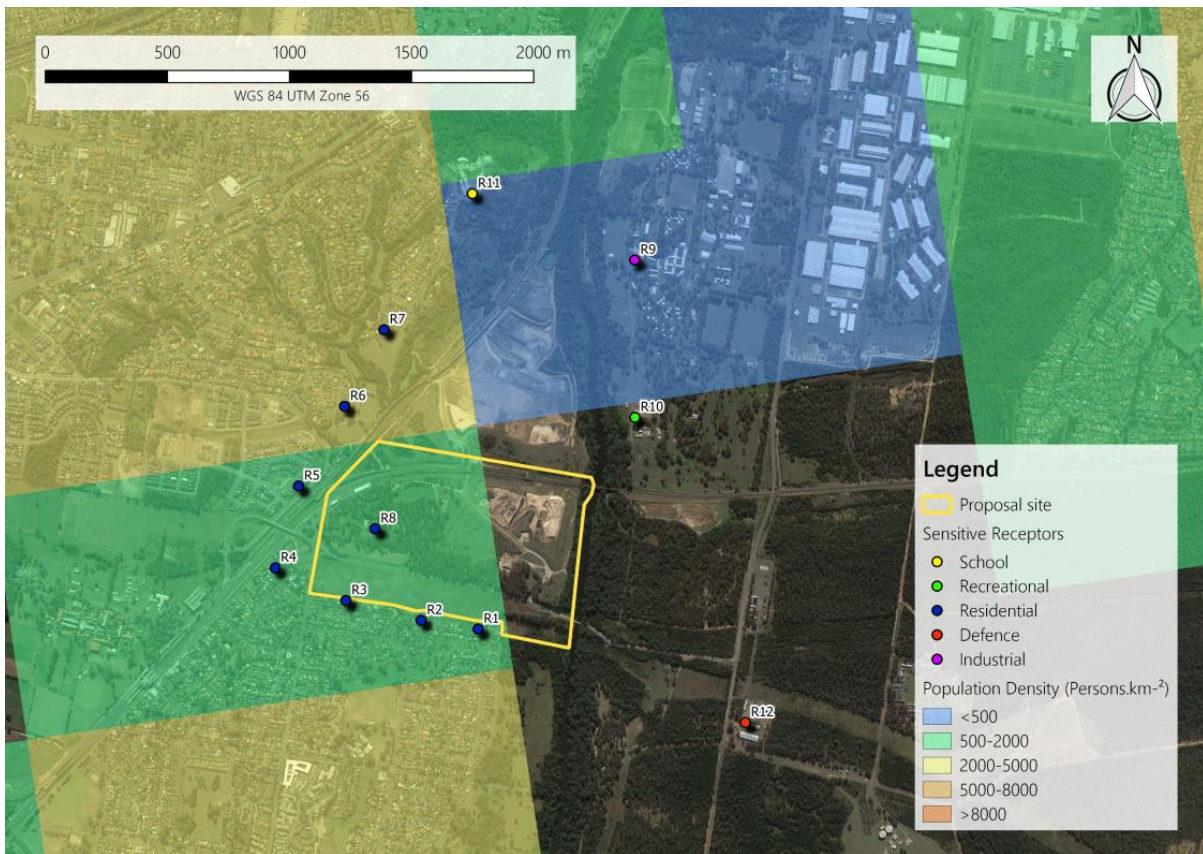


Image courtesy of Google Maps

Table 4 Discrete sensitive receptor locations used in the study

Rec.	Location	Land Use	Location (UTM)	
			mE	mS
R1	14 Goodenough St, Glenfield NSW 2167	Residential	306 713	6 239 166
R2	21 Goodenough St, Glenfield NSW 2167	Residential	306 479	6 239 196
R3	18 Ferguson St, Glenfield NSW 2167	Residential	306 169	6 239 271
R4	7 Foreman St, Glenfield NSW 2167	Residential	305 877	6 239 397
R5	12 Glory Rd, Glenfield NSW 2167	Residential	305 965	6 239 733
R6	17 Slessor Rd, Glenfield NSW 2167	Residential	306 147	6 240 061
R7	115 Leacocks Ln, Casula NSW 2170	Residential	306 302	6 240 376
R9	Moorebank Intermodal Company	Industrial	307 324	6 240 680
R10	RAE Golf Club	Recreational	307 338	6 240 040
R11	All Saints Senior College	School	306 653	6 240 937
R12	Holsworthy Barracks	Defence	307 815	6 238 808
R8	<i>Canterbury Rd, Glenfield (Project-related)</i>	<i>Residential</i>	<i>306 282</i>	<i>6 239 565</i>

Note: The requirements of this AQIA may vary from the specific requirements of other studies, and as such the selection and naming of receptor locations may vary between technical reports. This does not affect or reduce the validity of those assumptions.

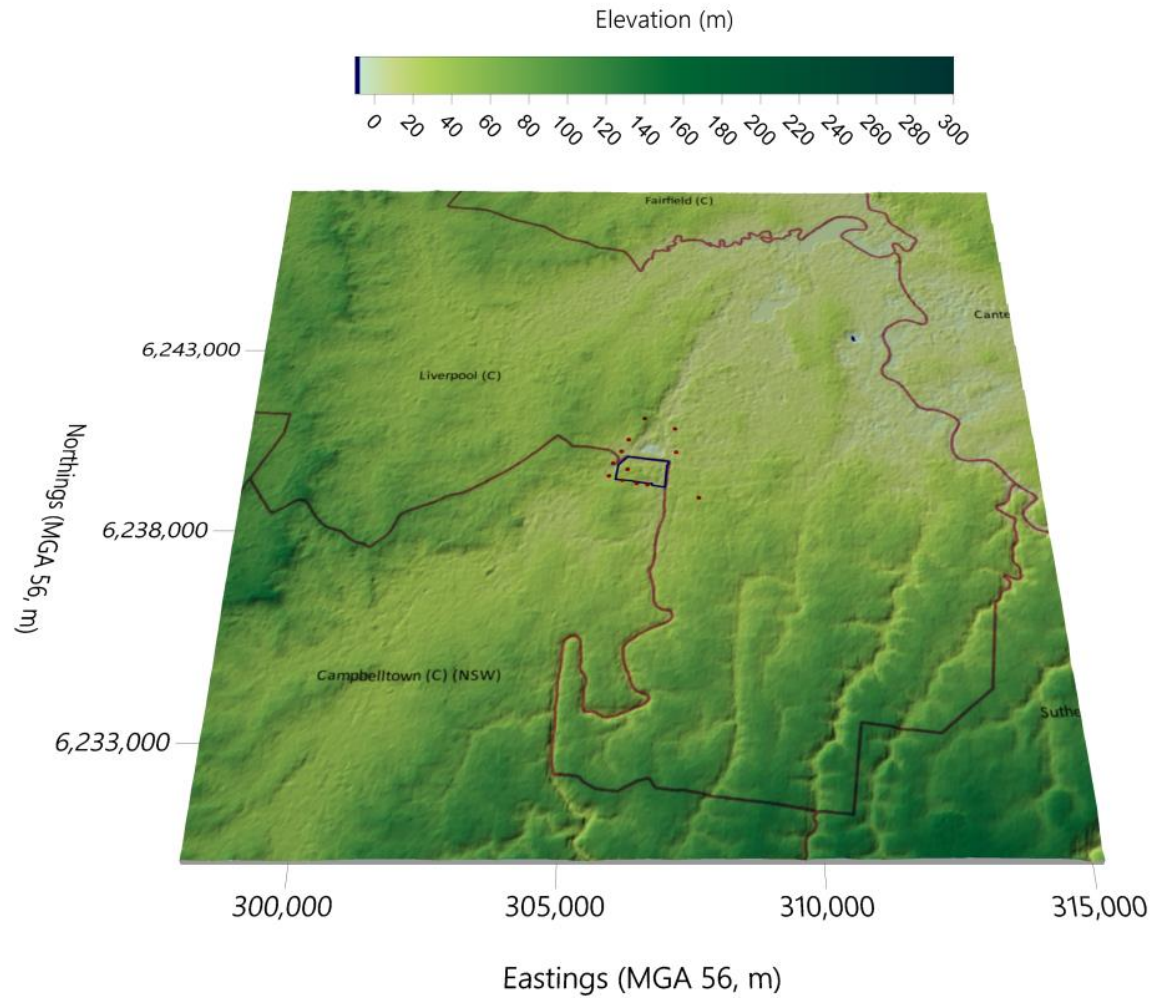
4.1.3. Uniform Receptor Locations

Additional to the sensitive receptors identified in **Section 4.1.2**, a grid of uniform receptor locations has been used in the AQIA to allow presentation of contour plots of predicted impacts.

4.2. Topography

The elevation of the Proposal site is approximately 30 m Australian Height Datum (AHD). The topography between the Proposal site and nearest sensitive receptor locations is uncomplicated. A 3-dimensional representation of the topography surrounding the Proposal site is presented in **Figure 6**.

Figure 6 Three-dimensional representation of topography



Source: Northstar Air Quality

4.3. Meteorology

The meteorology experienced within an area can govern the generation (in the case of wind-dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorological conditions surrounding the Proposal site have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at a number of surrounding Automatic Weather Stations (AWS). Meteorology is also measured by DPIE at a number of Air Quality Monitoring Station (AQMS) surrounding the Proposal site (refer **Section 4.4**).

To provide a characterisation of the meteorology which would be expected at the Proposal site, a meteorological modelling exercise has also been performed.

A summary of the inputs and outputs of the meteorological modelling assessment, including validation of those outputs is presented in **Appendix A**.

A summary of the relevant AWS operated by BoM and the DPIE is provided in **Table 5** below (listed by proximity) and also displayed in **Figure 7** overleaf.

Table 5 Details of meteorological monitoring surrounding the Proposal site

Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Holsworthy Control Range AWS -Station # 67117 (closed)	BoM	308 353	6 238 177	1.7
Liverpool AQMS	DPIE	306 439	6 243 322	3.4
Holsworthy Aerodrome AWS – Station # 66161	BoM	310 553	6 236 779	4.3
Bankstown Airport AWS – Station # 66137	BoM	313 855	6 245 099	8.6

Figure 7 Meteorological monitoring stations surrounding the Proposal site

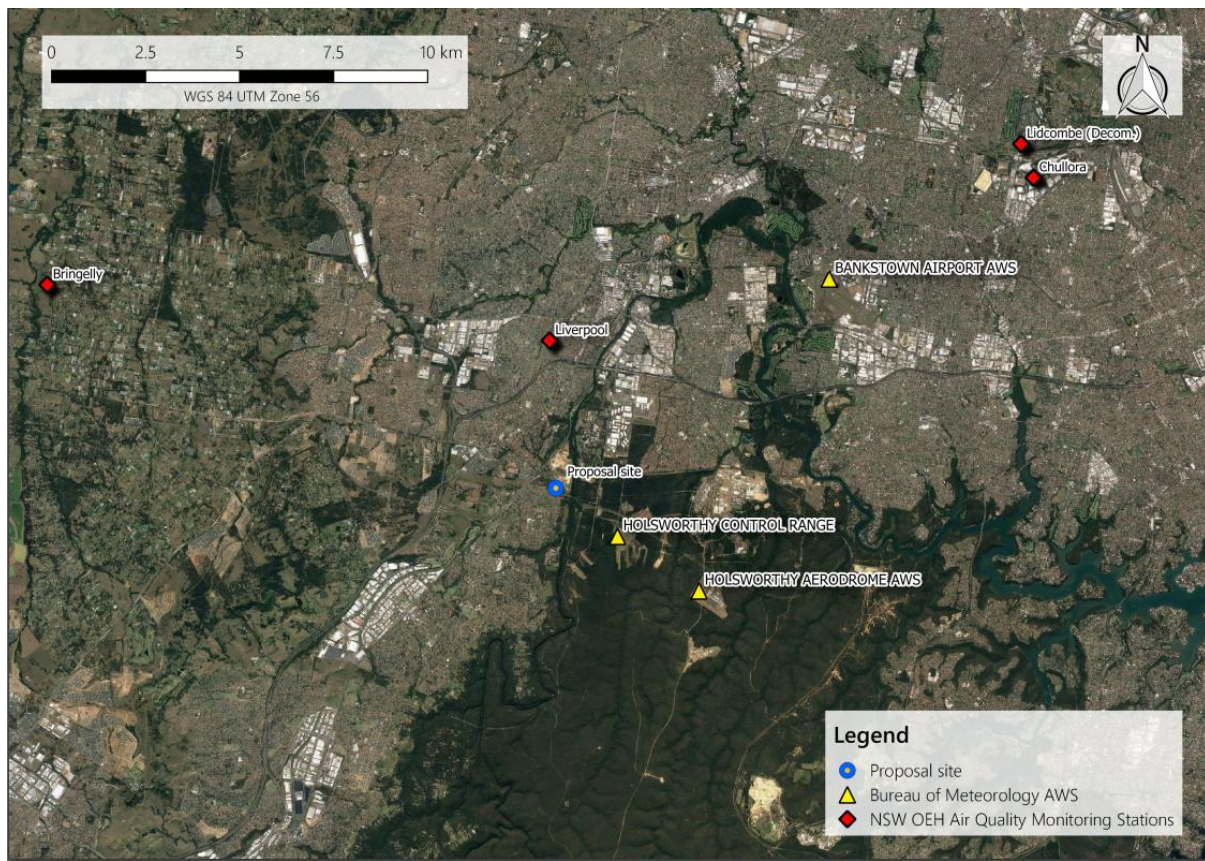


Image courtesy of Google Earth, adapted by Northstar Air Quality

The meteorological conditions measured at the identified meteorological stations, are presented in **Appendix A**.

It is considered that Holsworthy Aerodrome AWS is most likely to represent the conditions at the Proposal site, based upon its proximity and lack of significant topographical features between the two locations. The wind roses presented in **Appendix A** indicate that from 2015 to 2019, winds at Holsworthy Aerodrome AWS show similar wind distribution patterns across the years assessed, with a predominant south-westerly wind direction.

The majority of wind speeds experienced at Holsworthy Aerodrome AWS over the 5-year period 2015 to 2019 are generally in the range <0.5 metres per second ($\text{m}\cdot\text{s}^{-1}$) to 5.5 $\text{m}\cdot\text{s}^{-1}$ with the highest wind speeds (greater than 8 $\text{m}\cdot\text{s}^{-1}$) occurring from a westerly and south-easterly direction. Winds of this speed are not frequent, occurring <2 % of the observed hours over the 5-year period.

Given the wind distributions across the years examined, data for the year 2017 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied. Reference should be made to **Appendix A** for further details.

4.4. Air Quality

The air quality experienced at any location will be a result of emissions generated by natural and anthropogenic sources on a variety of scales (local, regional and global). The relative contributions of sources at each of these scales to the air quality at a location will vary based on a wide number of factors including the type, location, proximity and strength of the emission source(s), prevailing meteorology, land uses and other factors affecting the emission, dispersion and fate of those pollutants.

When assessing the impact of any particular source of emissions on the potential air quality at a location, the impact of all other sources of an individual pollutant should also be assessed. This 'background' (sometimes called 'baseline') air quality will vary depending on the pollutants to be assessed and can often be characterised by using representative air quality monitoring data.

The Proposal site is located proximate to a number of AQMS operated by NSW DPIE. These locations (listed by proximity) are briefly summarised in **Table 6** and presented in **Figure 7**.

Table 6 Closest DPIE AQMS to the Proposal site

AQMS Location	Data Availability	Distance to Site (km)	Screening Parameters			
			2017 Data	Measurements		
				PM ₁₀	PM _{2.5}	TSP
Liverpool	1988 - present	3.8	✓	✓	✓	✗
Bringelly	1993 - present	14.5	✓	✓	✓ ¹	✗
Chullora	2002 - present	15.1	✓	✓	✓	✗
Lidcombe	Decommissioned	15.4	✗	✓	✓	✗

The closest active AQMS is noted to be located at Liverpool and is generally considered to be the monitoring location most reflective of the conditions at the Proposal site, given its proximity and siting.

It is noted that none of the AQMS measure Total Suspended Particulate (TSP) which is of relevance to the expected emissions from the Proposal site. Based upon long-term historic monitoring data, a numerical relationship between TSP and PM₁₀ has been established for the Sydney Metropolitan region. Based upon these data, a relationship between ambient concentrations of TSP : PM₁₀ of 2.2434 : 1 is used to approximate background annual average TSP concentrations. This relationship is established and is used frequently to approximate background annual average TSP concentrations in similar locations (see **Appendix B**).

The impact assessment criteria used for deposited dust (see **Table 3**) are presented as (i) a cumulative deposition rate of 4 g·m⁻²·month⁻¹ and (ii) a discrete deposition rate of 2 g·m⁻²·month⁻¹. In lieu of a background deposition rate to derive a cumulative rate, the incremental impact assessment criterion (2 g·m⁻²·month⁻¹) will be used. This is a commonly adopted approach when background deposition rates are not available.

A summary of the AQMS data used in the previous assessment, and adopted within this assessment, is presented in **Table 7**.

Table 7 Summary of background air quality used in the previous AQIA

Pollutant	Ave Period	Measured Value	Notes
Particles (as TSP) (derived from PM ₁₀)	Annual $\mu\text{g}\cdot\text{m}^{-3}$	46.2	Estimated on a TSP:PM ₁₀ ratio of 2.2434 : 1
Particles (as PM ₁₀)	24-hour $\mu\text{g}\cdot\text{m}^{-3}$	Daily Varying	The 24-hour maxima for PM ₁₀ in 2017 was 74 $\mu\text{g}\cdot\text{m}^{-3}$
	Annual $\mu\text{g}\cdot\text{m}^{-3}$	20.6	
Particles (as PM _{2.5})	24-hour $\mu\text{g}\cdot\text{m}^{-3}$	Daily Varying	The 24-hour maxima for PM _{2.5} in 2017 was 56.4 $\mu\text{g}\cdot\text{m}^{-3}$
	Annual $\mu\text{g}\cdot\text{m}^{-3}$	8.9	
Dust deposition	Annual $\text{g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$	2	Difference in NSW EPA maximum allowable and incremental impact criterion

The AQIA has been performed to assess the contribution of the Proposal to the air quality of the surrounding area. A full discussion of how the Proposal impacts upon local air quality is presented in **Section 6**.

An additional source of particulate emissions exists within the immediate area, being material extraction and landfilling operations being performed on land owned by GWS, to the immediate north of the Proposal site. These activities do not form part of the SSD application, although may contribute to the 'background' air quality which is described above. To determine the contribution from these activities to the existing background air quality, a modelling assessment was performed in (SLR, 2015) which indicated that incremental impacts associated with the GWS landfilling operations were minor (maximum 24-hour average of $\leq 0.3 \mu\text{g}\cdot\text{m}^{-3}$) at all surrounding receptor locations. This is discussed further in **Section 6**.

5. METHODOLOGY

5.1. Dispersion Modelling

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion model. The modelling has been performed in CALPUFF 3-dimensional (3-D) mode.

The meteorological dataset has been developed using The Air Pollution Model (TAPM, v 4.0.4) and CALMET (see **Appendix A** for further information).

An assessment of the impacts of the operation of activities at the Proposal site has been performed which characterises the likely day-to-day operation, approximating average operational characteristics which are appropriate to assess against longer term (annual average) and shorter term (24-hour) criteria for the identified emissions to air.

The modelling scenario used in this AQIA provides an indication of the air quality impacts of the operation of activities at the Proposal site. Added to these impacts are background air quality concentrations (where available and discussed in **Section 4.4**) which represent the air quality which may be expected within the area surrounding the Proposal site, without the impacts of the Proposal itself.

The following provides a description of the determination of appropriate emissions of air pollutants resulting from the operation of the Proposal.

5.2. Emissions Estimation

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors which appropriately represent the processes under assessment. This assessment has adopted emission factors for materials handling processes, movement of trucks on paved and unpaved site roads, crushing and screening and wind erosion contained within the US EPA AP-42 emission factor compendium (USEPA, 2006) to represent the emission of particulate matter resulting from the operations occurring at the Proposal site as described in **Section 2.4**.

A full description of the emission sources included in the assessment for each scenario, and the emission factors and assumptions adopted are presented in **Appendix C**. The factors adopted (for PM₁₀) are presented in **Table 8**.

Applied conservatism

It is noted that the estimation of emissions from material processing operations represents a worst-case scenario. Each of the waste streams has been assumed to progress through the entirety of the available processing route. For example, all 30 000 tonnes of C&I material which arrives at site will not be in a form suitable for shredding/mulching. However, without detailed information on the breakdown of C&I material arriving at the site, the AQIA has adopted the assumption that all (i.e. 100 %) of that material would be shredded/mulched.

Similarly for C&D material, all 120 000 tonnes would not be suitable for crushing/screening but to provide a conservative assessment, all (i.e. 100 %) of that material has been assumed to be crushed/screened, and all (i.e. 100 %) of the 300 000 tonnes of ENM material has been assumed to be crushed and screened, where in reality a proportion of that would not be required to flow through the entire process.

Furthermore, the Proposal site layout subject to dispersion modelling results in a greater number of vehicle kilometres travelled (VKT) external to the buildings, and therefore results in a greater quantity of particulate matter being generated. Calculations of annual emissions of TSP, PM₁₀ and PM_{2.5} resulting from the operation of the modified and proposed layout show that emissions would be 13 %, 8 % and 17 % lower, respectively as a result of those changes.

The estimation of emissions, and the subsequent dispersion modelling results should be viewed with that conservatism in mind.

Table 8 Comparison of adopted emission factors

Emission Source	Location	Emission factor	PM ₁₀ emission rate	Justification	
Haulage (external roads)	External paved roads	Paved roads (13.2.1 – AP-42)	variable but up to 0.03443 kg·VKT ⁻¹	Factor associated with paved roads (AP42) with a silt content of 7.4 g·m ⁻² adopted)	
C&I, C&D, ENM Unloading/tipping raw material	Tipping and sorting shed	Batch drop (13.2.4.3 – AP-42)	0.0002 kg·t ⁻¹	AP-42 equation uses material and site-specific data and is used for the aggregate handling industry. Assumed material moisture content of 2 % for all materials and average wind speed of 1 m·s ⁻¹ (given the ambient wind speed would be reduced through the operation of activities within the sheds).	
C&I, C&D, ENM FEL Handling					
C&I, C&D, ENM Wind erosion		Wind erosion of exposed areas (11.9-4 AP-42)	0.048 kg·ha ⁻¹ ·hr ⁻¹ Equivalent to 425 kg·ha ⁻¹ ·yr ⁻¹ as quoted in AP-42		The AP-42 factor adopted is associated with seeded land, stripped or graded overburden which is considered to be appropriate.
Haulage (in shed)		Paved roads (13.2.1 – AP-42)	variable but up to 0.03443 kg·VKT ⁻¹		See above
C&I, C&D, ENM Unloading material from FEL	Stockpile pen processing shed	Batch drop (13.2.4.3 – AP-42)	0.0002 kg·t ⁻¹	See above	
C&I, C&D Loading processing equipment		Batch drop (13.2.4.3 – AP-42)	0.0002 kg·t ⁻¹	See above	
C&I Shredding		Screening (11.19.2 - AP-42)	0.0043 kg·t ⁻¹	Emission factor for uncontrolled screening adopted (AP-42) – controls applied as per Section 5.3	
C&D Pulverising		Crushing (11.19.2 - AP-42)	0.0012 kg·t ⁻¹	Emission factor for uncontrolled crushing adopted (AP-42) – controls applied as per Section 5.3	
C&D, ENM Crushing		Crushing (11.19.2 - AP-42)	0.0012 kg·t ⁻¹	Emission factor for uncontrolled crushing adopted (AP-42) – controls applied as per Section 5.3	
C&D, ENM Screening		Screening (11.19.2 - AP-42)	0.0043 kg·t ⁻¹	Emission factor for uncontrolled screening adopted (AP-42) – controls applied as per Section 5.3	
C&I, C&D, ENM Loading to stockpiles by FEL		Batch drop (13.2.4.3 – AP-42)	0.0002 kg·t ⁻¹	See above	

Emission Source	Location	Emission factor	PM ₁₀ emission rate	Justification
C&I, C&D, ENM Wind erosion		Wind erosion of exposed areas (11.9-4 AP-42)	0.048 kg·ha ⁻¹ ·hr ⁻¹	See above
Haulage (in shed)		Paved roads (13.2.1 – AP-42)	variable but up to 0.03443 kg·VKT ⁻¹	See above
Haulage (to landfill)	External unpaved road	Unpaved roads (13.2.2 – AP42)	0.863 kg·VKT ⁻¹	Factor associated with unpaved roads (AP42) with a silt loading of 6.4 % adopted)
Residual material Unloading/tipping at landfill	Landfill	Batch drop (13.2.4.3 – AP-42)	0.0002 kg·t ⁻¹	See above

5.3. Emissions Controls

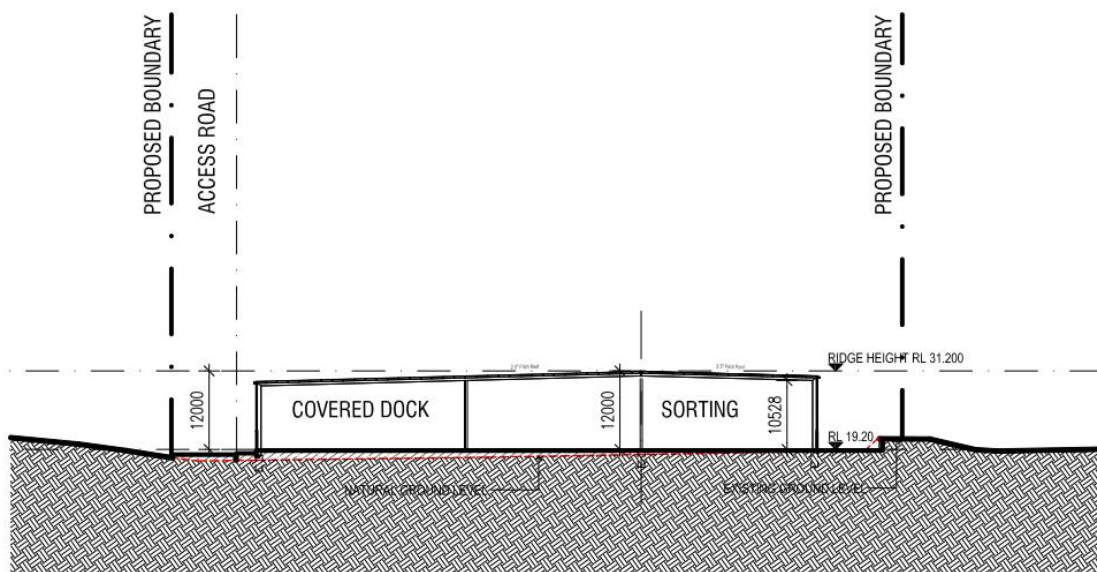
This section discusses the control measures to be adopted as part of the Proposal.

Since the submission of previous AQIA supporting the Proposal in 2015 and 2017, and following discussion with EPA, GWS have committed to providing full enclosure of all operations at the Proposal site. Critically, no material is to be unloaded, sorted, handled, processed, or stored external to a building.

The two buildings to be constructed at the Proposal site (the tipping and sorting shed [refer **Figure 8**], and the processing shed [refer **Figure 9**]) will each have a vehicle entry and exit (refer **Figure 3**), with fast-acting roller doors and both buildings would be constructed on hardstand. Neither building would have any open sides and can be considered to be fully enclosed. Given that the buildings will be fully enclosed, water mists would be required to ensure that particulate matter is managed to meet occupational air quality, safety and comfort criteria. Handheld hoses will also be available in each shed to ‘spot’ water any particularly dusty loads, as required.

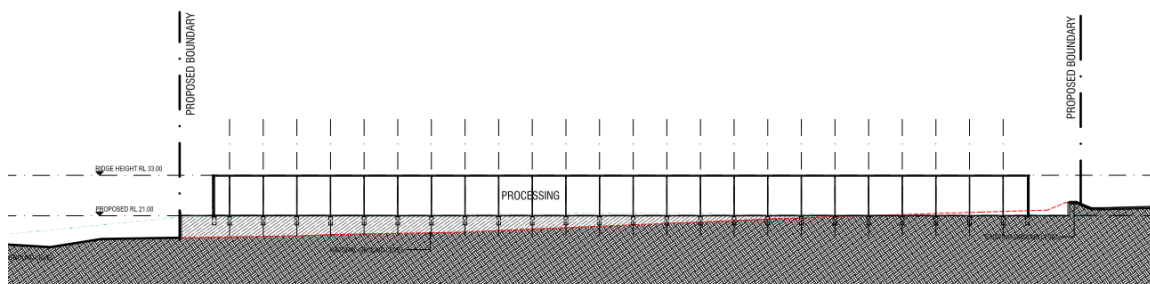
The fast-acting roller doors will be closed between vehicle entry and exit. Although vehicles may be entering the buildings regularly, the installation of fast-acting roller doors (as opposed to ‘normal’ roller doors) will ensure that they can be closed quickly when vehicles are not entering or exiting. The use of the water misting system within each building will ensure that particulate matter generation is minimised, and that any emission of particulate matter through the doors, when they are open, will be significantly reduced.

Figure 8 Tipping and sorting shed



Source: L Form Architects (2101-DA-A201_EE 220712)

Figure 9 Processing shed



Source: L Form Architects (2101-DA-A201_EE 220712)

Roadways within the Proposal site would all be constructed of hardstand/paved surface which would be regularly swept to ensure that silt loadings are minimised. In addition, vehicle speeds within the Proposal site will be limited to 15 km·hr⁻¹, which would also ensure that any resuspension of deposited material is reduced. A water cart would also be available to water road surfaces if required.

The performance of all activities within fully enclosed buildings with water mists, and the construction of fully sealed roads across the Proposal site, as requested by NSW EPA, represents best practice for operations of this nature.

Table 9 provides the emission control efficiencies associated with each adopted management measure. Emissions controls which would be implemented continuously have been included in the dispersion modelling assessment. Those which would be applied on an as-required basis have not been included as they cannot be defensibly included to impact (for example) the maximum 24-hour particulate concentrations.

The Proposal would employ best practice emission controls on all activities

The fast-acting roller shutter doors will be closed at all times except to allow the ingress and egress of vehicles. The control factor applied to account for the effect of enclosure on the propagation of particulate emissions assumes that 70 % of particulates would be controlled and, correspondingly, 30 % may be emitted (see **Table 9**). This control factor accounts for the potential emission during periodic door openings for vehicle access.

Applied conservatism

The emission controls outlined in **Table 9** are those which will be employed at the Proposal site. Some applied emission controls measures do not have an associated emission control efficiency, although their adoption would result in emissions from the Proposal, and subsequent impacts, being lower than those calculated, modelled, and assessed.

All of the control measures outlined in **Table 9** will be adopted, and their implementation will result in reductions in emissions from the Proposal. The results outlined in **Section 6** should therefore be viewed with that conservatism in mind.

Table 9 Emission reduction methods and particulate control efficiencies

Emission control method	Adoption	Control efficiency (%)	Adopted in dispersion modelling	Reference / Notes
Road haulage				
Vehicle restrictions that limit the speed of vehicles on the road.	✓	44	✓	44 % for speeds <40 km·hr ⁻¹ - table 6-6 of (Countess Environmental , 2006) ^(A)
Vacuum sweeping	✓	16	✓	Page 4-17 of (USEPA, 2011)
Surface treatment - watering (paved roads)	✓	30	✓	30 % at 2.2 L·m ⁻² - page 4-17 of (USEPA, 2011) ^(B)
Surface treatment - watering (unpaved roads)	✓	50	✓	50 % at 2 L·m ⁻² ·hr ⁻¹ – Table 4 of (NPI, 2012)
Materials handling				
Minimising the drop height from vehicles	✓	30	✓	Adopted as far as practicable. Reduction associated with a drop height reduction from 3 m to 1.5 m (Katestone Environmental Pty Ltd, 2011)
Application of water	✓	50	✓	Table 4 of (NPI, 2012) Water mists to be used in buildings
Covering loads with a tarpaulin	✓	-	-	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	✓	-	-	Not quantified
Enclosure	✓	70	✓	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011)
Minimising travel speeds and distances	✓	-	-	Not quantified
Keep travel routes and materials moist	✓	50	✓	Table 4 of (NPI, 2012) Applied to internal roadways at 30 % control (see road haulage)

Emission control method	Adoption	Control efficiency (%)	Adopted in dispersion modelling	Reference / Notes
Materials processing				
Application of water	☑	91.6 (screen) 77.7 (crush) 50 (shred)	☑	Control efficiency adopted from (USEPA, 2006) Control efficiency adopted from (USEPA, 2006) Table 4 of (NPI, 2012)
Enclosure	☑	70	☑	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011)
Wind erosion				
Application of water	☑	50	☑	Table 4 of (NPI, 2012) Water mists to be used in buildings
Enclosure	☑	70	☑	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011)

Notes: (A): For unpaved roads but applied to paved roads
 (B): Converted from quoted value of 0.48 gal·yd⁻²

Based on the foregoing, the distribution of calculated annual average uncontrolled and controlled particulate emissions across broad emissions categories is presented in **Figure 10** for PM₁₀. Note that these emissions represent the modelled Proposal site layout as previously discussed. For comparison purposes, the estimated PM₁₀ emissions associated with the proposed (not modelled) layout are presented in **Figure 11**.

Figure 10 Calculated uncontrolled & controlled annual PM₁₀ emissions (as modelled)

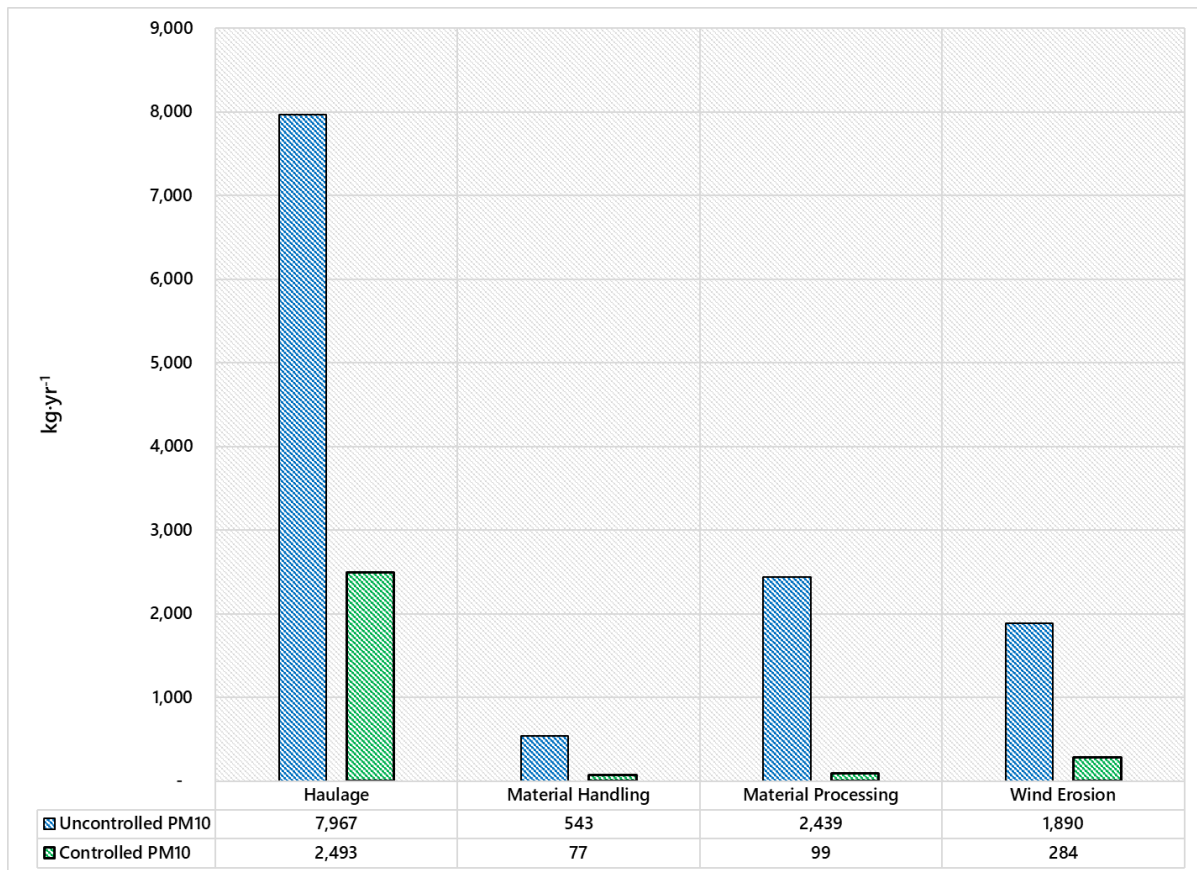
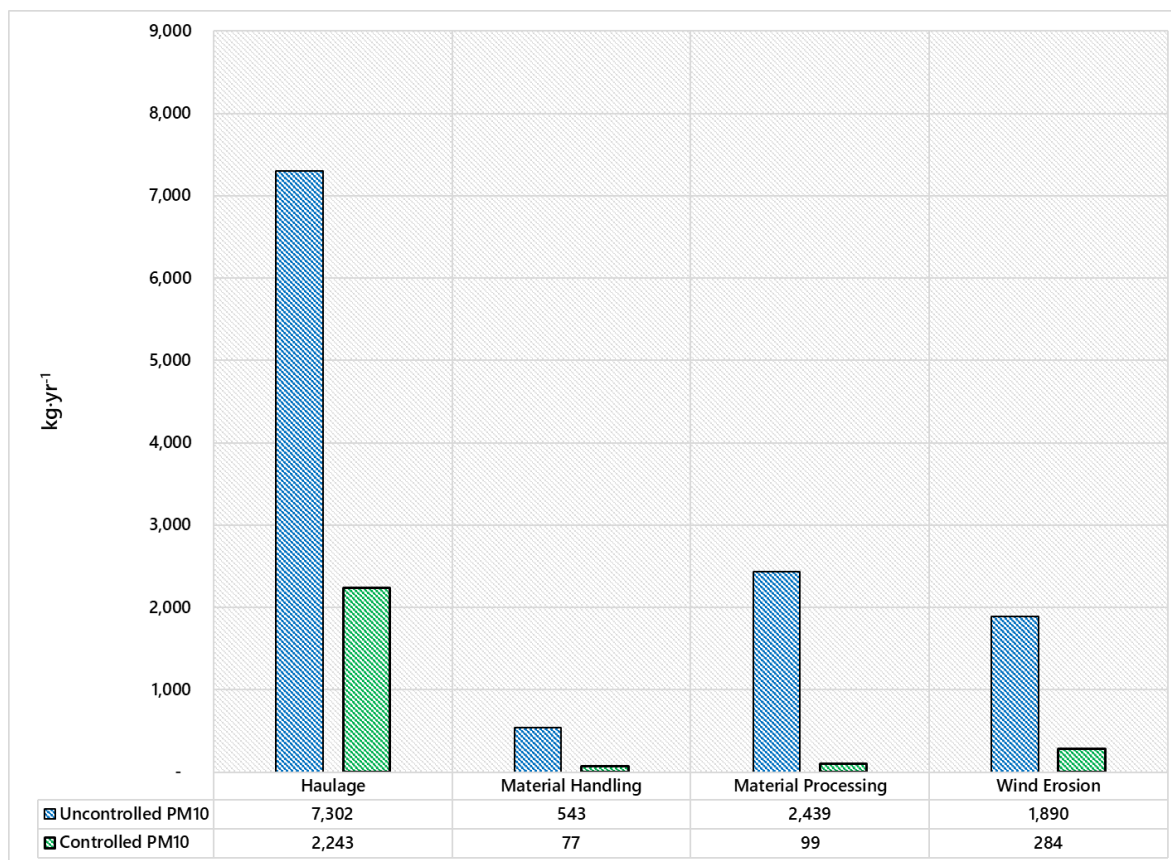


Figure 11 Calculated uncontrolled & controlled annual PM₁₀ emissions (proposed, not modelled)



Distributions for TSP and PM_{2.5} are presented in **Appendix C**, along with a full description of the emission factors and rates adopted for both the maximum 24-hour and annual average scenarios (as modelled).

Applied conservatism

The exposed areas adopted in the assessment which are available to be eroded by the wind have been assumed to be the full area of each shed. This is conservative for two reasons.

Firstly, in reality the area available for wind erosion at any one moment in time will be limited to those areas being (or having been recently) disturbed. That is, fresh particulate matter does not generally become available due to the action of the wind itself, but is made available by activities being performed on an area. However, a worst-case assessment has been performed which assumes a constant supply of particles for wind erosion.

Secondly, the use of enclosed building around all materials storage areas would result in decreases in wind-generated particulate matter. Although an emissions control factor of 70 % has been applied resulting from the use of enclosed sheds, it is likely that, in the case of wind erosion, this control would be greater through the reduction in wind shear.

6. AIR QUALITY IMPACT ASSESSMENT

The methodology used to assess operational phase impacts is discussed in **Section 5**. This section presents the results of the dispersion modelling assessment and uses the following terminology:

- **Incremental impact** – relates to the concentrations predicted as a result of the operation of the Proposal in isolation. Note that these incremental impacts represent the layout as presented in **Figure 3**.
- **Cumulative impact** – relates to the concentrations predicted as a result of the operation of the Proposal PLUS the background air quality concentrations discussed in **Section 4.4**. The impacts associated with the current GWS landfilling operations are presented separately.

The results are presented in this manner to allow examination of the likely impact of the Proposal in isolation and the contribution to air quality impacts in a broader sense.

In the presentation of results, the tables included shaded cells which represent the following:

Model prediction	Pollutant concentration / deposition rate less than the relevant criterion	Pollutant concentration / deposition rate equal to, or greater than the relevant criterion
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Results are presented in this section for the predictions of particulate matter (TSP, PM₁₀, PM_{2.5} and dust deposition). The averaging periods associated with the criteria for these pollutants is 24-hour and annual averages, as specified in **Table 3**. The emissions adopted for these scenarios reflect the operational profile of the Proposal over those averaging periods (refer **Section 5.2**).

6.1. Annual Average TSP, PM₁₀ and PM_{2.5}

The predicted annual average particulate matter concentrations (as TSP, PM₁₀ and PM_{2.5}) resulting from the Proposal operations are presented in **Table 10**.

The results indicate that predicted incremental concentrations of TSP, PM₁₀ and PM_{2.5} at all receptor locations (excluding the project-related receptor R8) are low ($\leq 1.6\%$ of the annual average TSP criterion, $< 1.8\%$ of the annual average PM₁₀ criterion and $< 0.1\%$ of the PM_{2.5} criterion).

The addition of existing background concentrations (refer **Section 4.4**), results in predicted concentrations of annual average TSP being $\leq 53\%$ and annual average PM₁₀ being $\leq 85\%$ of the relevant criteria at the nearest receptors (receptor R8 excluded).

The existing adopted annual average PM_{2.5} regional background concentration is shown to be in exceedance of the relevant criterion (highlighted in **Table 10**), even without the operation of the Proposal added.

Examination of the predicted PM_{2.5} impacts which would result from the operation of the Proposal indicates that these concentrations are predicted to be <0.1 µg·m⁻³ at all surrounding receptors (essentially an immeasurable change to background).

The inclusion of the best practice management dust control measures is shown to minimise offsite annual average PM_{2.5} impacts to the maximum extent possible.

The performance of the Proposal does not in itself result in any exceedances of the annual average particulate matter impact assessment criteria.

In regard to the potential cumulative impact with the operation of the GWS landfill operations, SLR (2015) predicted annual average incremental impacts of ≤0.9 µg·m⁻³ (TSP), ≤0.5 µg·m⁻³ (PM₁₀), and ≤0.1 µg·m⁻³ (PM_{2.5}), at all surrounding receptors. Even with the addition of those maximum predicted concentrations, the conclusions drawn above regarding compliance with annual average air quality criteria would not materially change.

Table 10 Predicted annual average TSP, PM₁₀ and PM_{2.5} concentrations

Receptor	Annual Average Concentration (µg·m ⁻³)								
	TSP			PM ₁₀			PM _{2.5}		
	Incremental Impact	Regional Background	Cumulative Impact	Incremental Impact	Regional Background	Cumulative Impact	Incremental Impact	Regional Background	Cumulative Impact
R1	1.5	46.2	47.7	0.4	20.6	21.0	<0.1	8.9	9.0
R2	1.3	46.2	47.5	0.4	20.6	21.0	<0.1	8.9	9.0
R3	0.7	46.2	46.9	0.3	20.6	20.9	<0.1	8.9	9.0
R4	0.4	46.2	46.6	0.2	20.6	20.8	<0.1	8.9	9.0
R5	0.6	46.2	46.8	0.2	20.6	20.8	<0.1	8.9	9.0
R6	0.6	46.2	46.8	0.2	20.6	20.8	<0.1	8.9	9.0
R7	0.5	46.2	46.7	0.2	20.6	20.8	<0.1	8.9	9.0
R9	<0.1	46.2	46.3	<0.1	20.6	20.7	<0.1	8.9	9.0
R10	0.6	46.2	46.8	0.2	20.6	20.8	<0.1	8.9	9.0
R11	0.2	46.2	46.4	<0.1	20.6	20.7	<0.1	8.9	9.0
R12	<0.1	46.2	46.3	<0.1	20.6	20.7	<0.1	8.9	9.0
Crit.	-	-	90	-	-	25	-	-	8
R8 ^(A)	2.3	46.2	48.5	0.8	20.6	21.4	0.2	8.9	9.1

Note: (A) Project-related receptor

No contour plots of annual average TSP, PM₁₀ or PM_{2.5} are presented, given the minor contribution from the Proposal at the nearest relevant sensitive receptors.

6.2. Annual Average Dust Deposition Rates

Table 11 presents the annual average dust deposition predicted as a result of the operations at the Proposal site. An assumed background dust deposition of 2 g·m⁻²·month⁻¹ is presented in **Table 11**, although comparison of the incremental concentration with the incremental criterion of 2 g·m⁻²·month⁻¹ is also valid (as discussed within **Section 4.4**). In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the Proposal site where the predicted impacts are <10 % of the incremental criterion at receptor locations.

No contour plot of annual average dust deposition is presented, given the minor contribution from the Proposal at the nearest sensitive receptors.

The performance of the Proposal does not result in any exceedances of the annual average dust deposition impact assessment criteria.

In regard to the potential cumulative impact with the operation of the GWS landfill operations, SLR (2015) predicted incremental dust deposition impacts of ≤0.1 g·m⁻²·month⁻¹ at all surrounding receptors. Even with the addition of that deposition rate, the conclusions drawn above regarding compliance with annual average air quality criteria would not materially change.

Table 11 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition ($\text{g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$)		
	Incremental Impact	Regional Background	Cumulative Impact
R1	<0.1	2.0	2.1
R2	<0.1	2.0	2.1
R3	<0.1	2.0	2.1
R4	<0.1	2.0	2.1
R5	<0.1	2.0	2.1
R6	<0.1	2.0	2.1
R7	<0.1	2.0	2.1
R9	<0.1	2.0	2.1
R10	<0.1	2.0	2.1
R11	<0.1	2.0	2.1
R12	<0.1	2.0	2.1
Criterion	2.0	-	4.0
<i>R8^(A)</i>	<0.1	2.0	2.1

Note: (A) Project-related receptor

6.3. Maximum 24-hour PM_{10} and $\text{PM}_{2.5}$

Table 12 presents the maximum 24-hour average PM_{10} and $\text{PM}_{2.5}$ concentrations predicted to occur at the nearest receptors as a result of the Proposal operations. No background concentrations are included within this table. The maximum predicted incremental impacts are highlighted in bold text.

Table 12 Predicted maximum incremental 24-hour PM_{10} and $\text{PM}_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM_{10}	$\text{PM}_{2.5}$
R1	8.1	2.0
R2	8.9	2.1
R3	6.9	1.5
R4	4.4	1.0
R5	5.4	1.2
R6	4.9	1.1
R7	3.6	0.8
R9	1.0	0.2

Receptor	Maximum incremental 24-hour average concentration ($\mu\text{g}\cdot\text{m}^{-3}$)	
	PM ₁₀	PM _{2.5}
R10	2.7	0.6
R11	1.1	0.2
R12	1.3	0.3
Criterion	50	25
<i>R8^(A)</i>	<i>12.0</i>	<i>2.6</i>

Note: (A) Project-related receptor

The predicted maximum incremental concentrations are demonstrated to represent up to 18 % of the PM₁₀ criterion, and up to 9 % of the PM_{2.5} criterion at receptor R2.

As previously indicated, the assessment of maximum 24-hour impacts assume that the daily waste receipt, processing and handling rate is twice that which would be experienced on average. Therefore, these results can be viewed as a worst-case scenario, with concentrations unlikely to reach these levels in practice.

The predicted cumulative maximum 24-hour average PM₁₀ and PM_{2.5} concentrations resulting from the operation of the Proposal, with regional background included are presented in **Table 13** and **Table 14** respectively.

Results are presented in **Table 13** and **Table 14** for the receptor at which the greatest impacts have been predicted (refer to **Table 12**) for PM₁₀ and PM_{2.5}.

- Maximum cumulative impact at receptor R10
- Maximum incremental impacts at receptor R2

The left side of **Table 13** and **Table 14** show the predicted concentration on days with the highest predicted cumulative impacts (generally driven by days of increased regional background contributions), and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations, respectively.

Table 13 Summary of contemporaneous impact and background – PM₁₀

Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor 10			Date	24-hour average PM ₁₀ concentration (µg·m ⁻³) – Receptor 2		
	Incr.	Regional Background	Cumul.		Incr.	Regional Background	Cumul.
14/08/2017	0.4	74.0	74.4	20/05/2017	8.9	11.0	19.9
24/09/2017	<0.1	59.2	59.3	3/07/2017	5.1	37.3	42.4
12/09/2017	<0.1	43.1	43.2	9/04/2017	4.8	17.4	22.2
15/08/2017	0.1	42.3	42.4	25/04/2017	4.5	17.6	22.1
25/01/2017	<0.1	39.3	39.4	2/07/2017	4.5	23.6	28.1
11/05/2017	0.8	38.2	39.0	28/01/2017	4.3	20.2	24.5
13/01/2017	<0.1	38.6	38.7	15/08/2017	4.3	42.3	46.6
20/12/2017	0.1	37.8	37.9	25/03/2017	4.2	20.3	24.5
3/07/2017	0.6	37.3	37.9	8/04/2017	4.2	17.0	21.2
22/09/2017	<0.1	37.7	37.8	5/05/2017	4.2	21.3	25.5
These data represent the highest Cumulative Impact 24-hour PM ₁₀ predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM ₁₀ predictions (outlined in blue) as a result of the operation of the project.			

Note: Incr = Increment, Reg = Regional background, Cumul = Cumulative impact

The analysis indicates that no additional exceedances of the 24-hour average impact assessment criterion for PM₁₀ or PM_{2.5} are likely to occur as a result of the operation of the Proposal. Examination of the results for all receptors indicates that no exceedances of the PM₁₀ criterion are predicted at any receptor location.

Table 14 Summary of contemporaneous impact and background – PM_{2.5}

Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor 10			Date	24-hour average PM _{2.5} concentration (µg·m ⁻³) – Receptor 2		
	Incr.	Regional Background	Cumul.		Incr.	Regional Background	Cumul.
14/08/2017	<0.1	56.4	56.5	20/05/2017	2.1	4.8	6.9
15/08/2017	<0.1	29.7	29.8	3/07/2017	1.1	27.1	28.2
3/07/2017	0.1	27.1	27.2	9/04/2017	1.0	5.5	6.5
17/07/2017	<0.1	24.8	24.9	3/09/2017	1.0	20.2	21.2
2/09/2017	0.2	22.8	23.0	2/07/2017	0.9	20.3	21.2
25/06/2017	<0.1	22.0	22.1	25/03/2017	0.9	6.5	7.4
22/07/2017	<0.1	21.1	21.2	5/05/2017	0.9	9.4	10.3
2/07/2017	0.3	20.3	20.6	8/04/2017	0.9	5.5	6.4
11/05/2017	0.2	20.1	20.3	28/01/2017	0.9	7.2	8.1
3/09/2017	<0.1	20.2	20.3	25/04/2017	0.9	8.3	9.2
These data represent the highest Cumulative Impact 24-hour PM _{2.5} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM _{2.5} predictions (outlined in blue) as a result of the operation of the project.			

Note: Incr = Increment, Reg = Regional background, Cumul = Cumulative impact

In regard to the potential cumulative impact with the operation of the GWS landfill operations, SLR (2015) predicted incremental PM₁₀ and PM_{2.5} impacts of ≤0.3 µg·m⁻³ and ≤0.1 µg·m⁻³, respectively at all surrounding receptors. Even with the addition of those maximum predicted concentrations to those predicted from the Proposal operation, the conclusions drawn above regarding compliance with maximum 24-hour average air quality criteria is not likely to materially change.

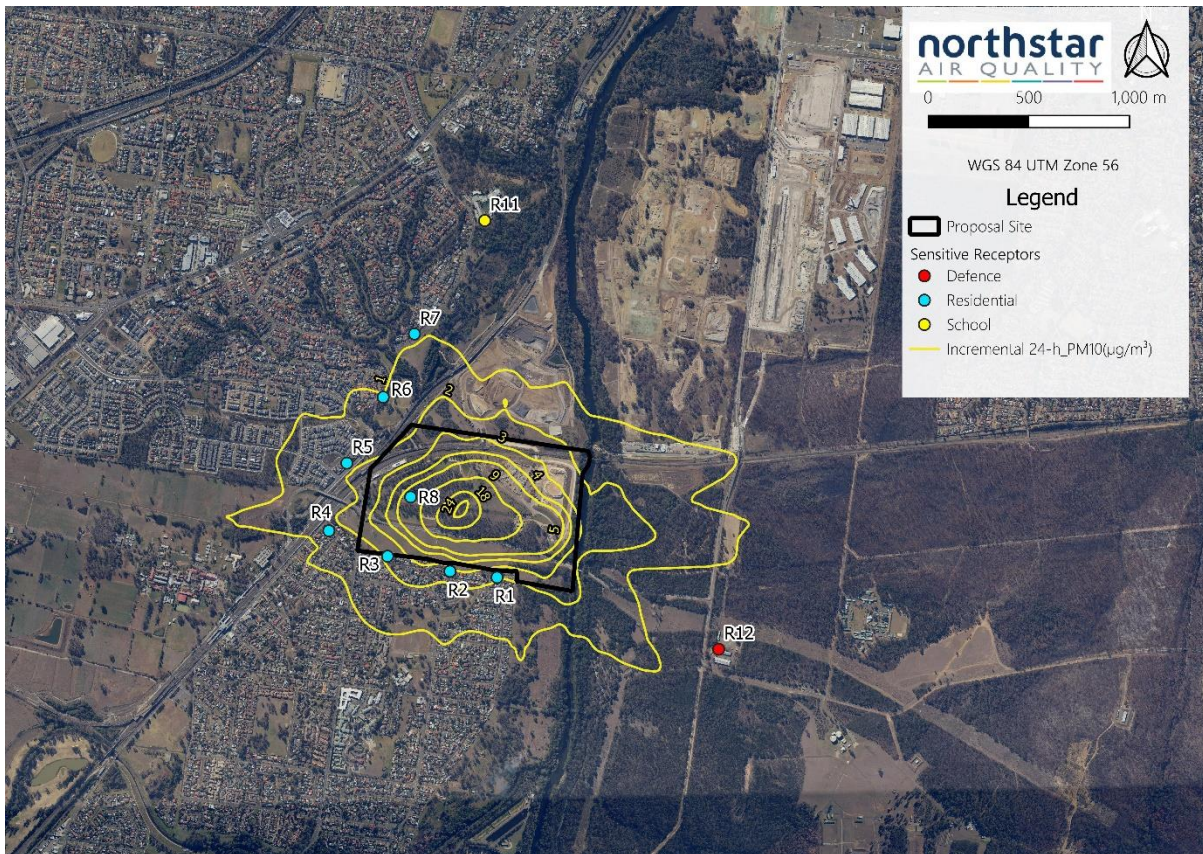
Once again, the assessment of maximum 24-hour impacts assume that the daily waste receipt, processing and handling rate is twice that which would be experienced on average. Therefore, these results can be viewed as a worst-case scenario, with concentrations unlikely to reach these levels in practice.

Contour plots of the incremental contribution of the operations at the Proposal site to the 24-hour average PM₁₀ and PM_{2.5} concentrations are presented in **Figure 12** and **Figure 13**, respectively.

The performance of the Proposal does not result in any exceedances of the maximum 24-hour average PM₁₀ and PM_{2.5} impact assessment criteria.

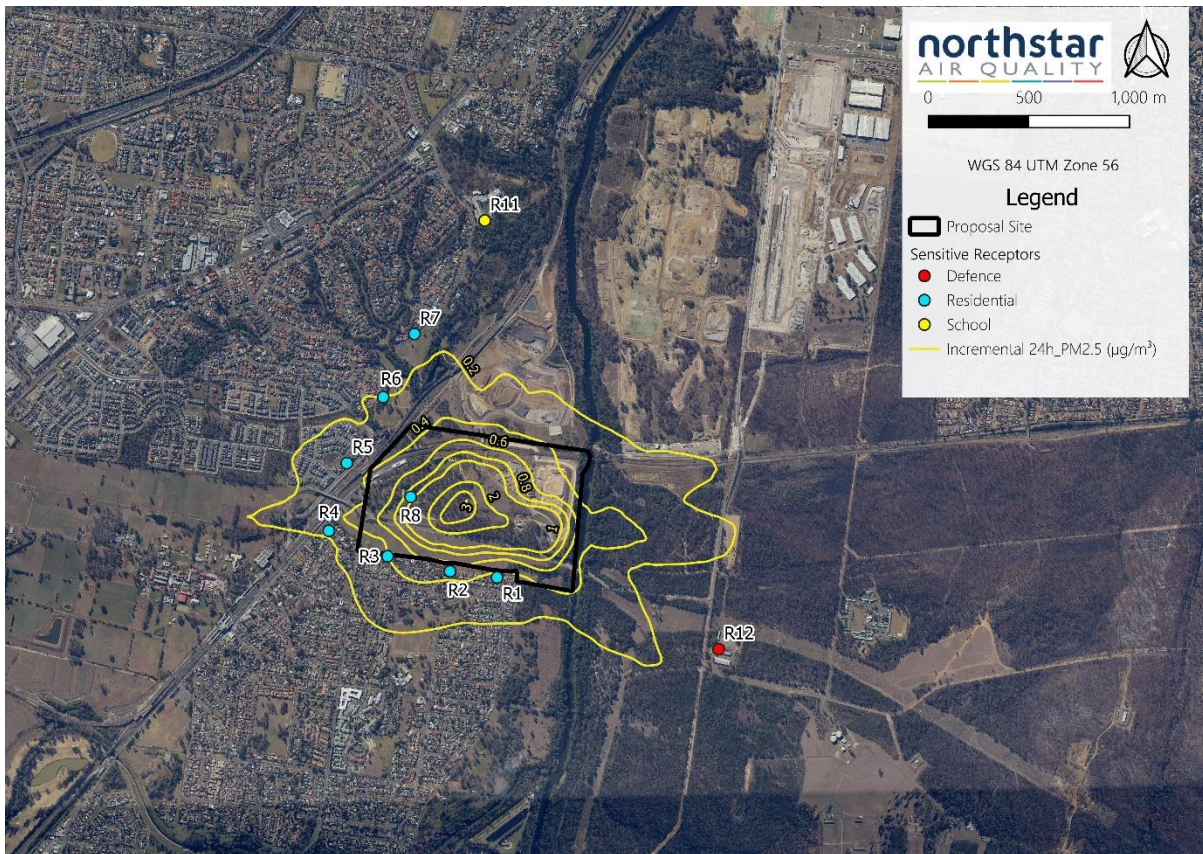
The implementation of best practice emission controls at the Proposal site results in the minimisation of PM₁₀ and PM_{2.5} concentrations at surrounding receptors.

Figure 12 Incremental 24-hour PM₁₀ concentrations – Proposal increment



Note 1: Criterion = 50 µg·m⁻³ (cumulative)

Figure 13 Incremental 24-hour PM_{2.5} concentrations - Proposal increment



Note 1: Criterion = 25 µg·m⁻³ (cumulative)

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7. MITIGATION AND MONITORING

Based on the findings of the air quality impact assessment, it is considered that the modelled Proposal layout and operation will be sufficiently controlled to ensure that exceedances (or additional exceedances in the case of 24-hour PM₁₀ and PM_{2.5}) would not be experienced as a result of the Proposal operation. The reduction in VKT afforded by the currently proposed layout presented in **Figure 2**, and discussed in **Section 2.6** will reduce predicted impacts by a further amount.

The Proposal has been designed to incorporate best practice particulate matter control, which includes the performance of all activities within enclosed, hardstand sheds, as fully described in **Section 5.3**.

The mitigation measures proposed to be included as part of the Proposal operation and the control efficiency afforded are presented overleaf in **Table 15**.

7.1. Air Quality Management Plan

Further to the above mitigation, it is recommended that the proponent implements and maintains an Air Quality Management Plan (AQMP), including procedures for the recording, evaluation and actioning of complaints arising from the proposed activities.

The AQMP should also include some air quality monitoring to confirm the findings of this AQIA and demonstrate compliance with the air quality impact assessment criteria and any other conditions of consent.

Table 15 Summary of emission reduction methods adopted as part of Proposal operation

Emission control method	Control efficiency (%)	Reference / Notes
Road haulage		
Vehicle restrictions that limit the speed of vehicles on the road.	44	44 % for speeds <40 km·hr ⁻¹ - table 6-6 of (Countess Environmental , 2006) ^(A)
Vacuum sweeping	16	Page 4-17 of (USEPA, 2011)
Surface treatment - watering (paved roads)	30	30 % at 2.2 L·m ⁻² - page 4-17 of (USEPA, 2011) ^(B)
Surface treatment - watering (unpaved roads)	50	50 % at 2 L·m ⁻² ·hr ⁻¹ - Table 4 of (NPI, 2012)
Materials handling		
Minimising the drop height from vehicles	30	Adopted as far as practicable. Reduction associated with a drop height reduction from 3 m to 1.5 m (Katestone Environmental Pty Ltd, 2011)
Application of water	50	Table 4 of (NPI, 2012) Water mists to be used in buildings
Covering loads with a tarpaulin	-	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	-	Not quantified
Enclosure	70	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011)
Minimising travel speeds and distances	-	Not quantified
Keep travel routes and materials moist	50	Table 4 of (NPI, 2012) Applied to internal roadways at 30 % control (see road haulage)
Materials processing		
Application of water	91.6 (screen) 77.7 (crush) 50 (shred)	Control efficiency adopted from (USEPA, 2006) Control efficiency adopted from (USEPA, 2006) Table 4 of (NPI, 2012)
Enclosure	70	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011)
Wind erosion		
Application of water	50	Table 4 of (NPI, 2012) Water mists to be used in buildings
Enclosure	70	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011)

8. CONCLUSION

Northstar Air Quality was engaged by Glenfield Waste Services to perform an air quality impact assessment (AQIA) for the proposed operation of a materials recycling facility, to be located on Cambridge Avenue, Glenfield, NSW.

A number of AQIA have previously been performed for the Proposal site, and following review of those assessments by the NSW EPA, a number of issues were raised including the lack of detailed assessment of the best practice dust management measures which could be employed at the Proposal site to ensure that particulate emissions would be controlled from the site to the extent of best practice.

Following those comments, and through discussions with NSW EPA, the proponent has performed a re-design of the Proposal, and are proposing to implement best practice dust control which includes (as requested by EPA), the performance of all activities within enclosed sheds.

A dispersion modelling assessment has been performed to determine the likely air quality impacts upon surrounding receptor locations. Activity rates associated with average operational conditions have been used to determine the potential impact and compared against annual average criteria. To determine the potential maximum 24-hour impact of the Proposal, the materials unloading, handling and processing rates have been assumed to be double the average. This is considered to represent a conservative assumption.

Further levels of conservatism have been built into the modelling assessment, including the assumption that all material delivered to the Proposal site would be processed, and the assumption that the entire area of the tipping shed and processing shed would be available to be eroded by the wind. The results of the assessment can therefore be viewed as representing the maximum potential impacts, which would not be likely to be experienced in reality. Furthermore, the most recent iteration of the Proposal design (not modelled) results in significant reductions in vehicle kilometres travelled, and the results of the assessment can be viewed to be conservative.

The operation of the Proposal is not anticipated to result in any additional exceedances of the relevant air quality criteria. The best practice management measures proposed are shown to act to minimise impacts on surrounding receptor locations.

It is respectfully considered that the Proposal should not be rejected on the grounds of air quality.

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9. REFERENCES

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APPENDIX A

Meteorology

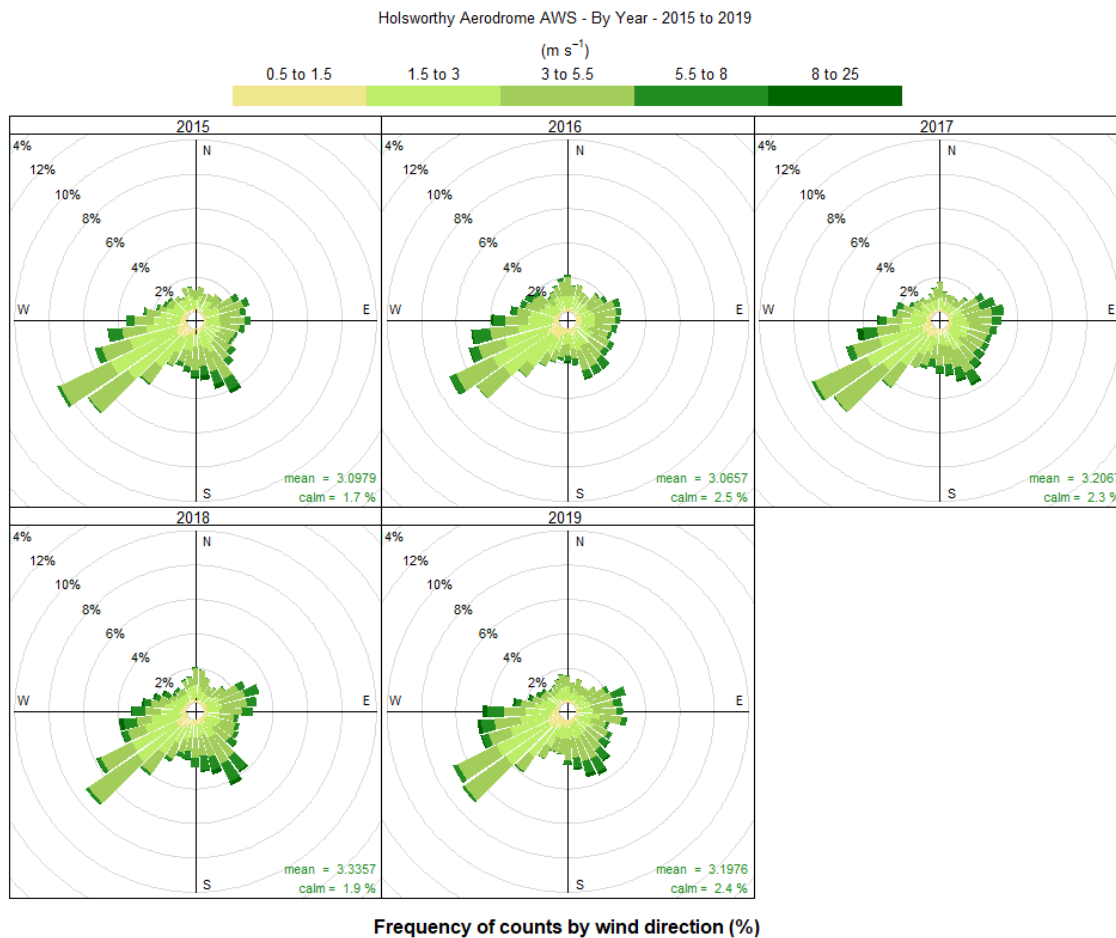
A summary of the relevant monitoring sites is provided in **Table A1**.

Table A1 Details of the meteorological monitoring surrounding the Proposal site

Site Name	Source	Approximate Location (UTM)		Approximate Distance
		mE	mS	km
Holsworthy Control Range AWS -Station # 67117 (closed)	BoM	308 353	6 238 177	1.7
Liverpool AQMS	DPIE	306 439	6 243 322	3.4
Holsworthy Aerodrome AWS – Station # 66161	BoM	310 553	6 236 779	4.3
Bankstown Airport AWS – Station # 66137	BoM	313 855	6 245 099	8.6

Meteorological conditions at Holsworthy Aerodrome AWS have been examined to determine a ‘typical’ or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2015 to 2019) are presented in **Figure A1**.

Figure A1 Annual wind roses 2015 to 2019, Holsworthy Aerodrome AWS



The wind roses indicate that from 2015 to 2019, winds at Holsworthy Aerodrome AWS show a predominant south-westerly wind direction with a south-easterly component also evident.

The majority of wind speeds experienced at the Holsworthy Aerodrome AWS between 2015 and 2019 are generally in the range 1.5 metres per second (m·s⁻¹) to 5.5 m·s⁻¹ with the highest wind speeds (greater than 8 m·s⁻¹) occurring from a westerly and south-easterly direction. Winds of this speed are rare and occur during 1.3 % of the observed hours during the years. Calm winds (<0.5 m·s⁻¹) occur for 3.7 % of hours across the years.

The distribution of winds in year 2017 was selected as the most representative year with a typical profile. Presented in **Figure A2** are the annual wind rose for the 2015 to 2019 period and the year 2017, and in **Figure A3** the annual wind speed distribution for Holsworthy Aerodrome AWS. These figures indicate that the distribution of wind speed and direction in 2017 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2017 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure A2 Annual wind roses 2015 to 2019, and 2017 Holsworthy Aerodrome AWS

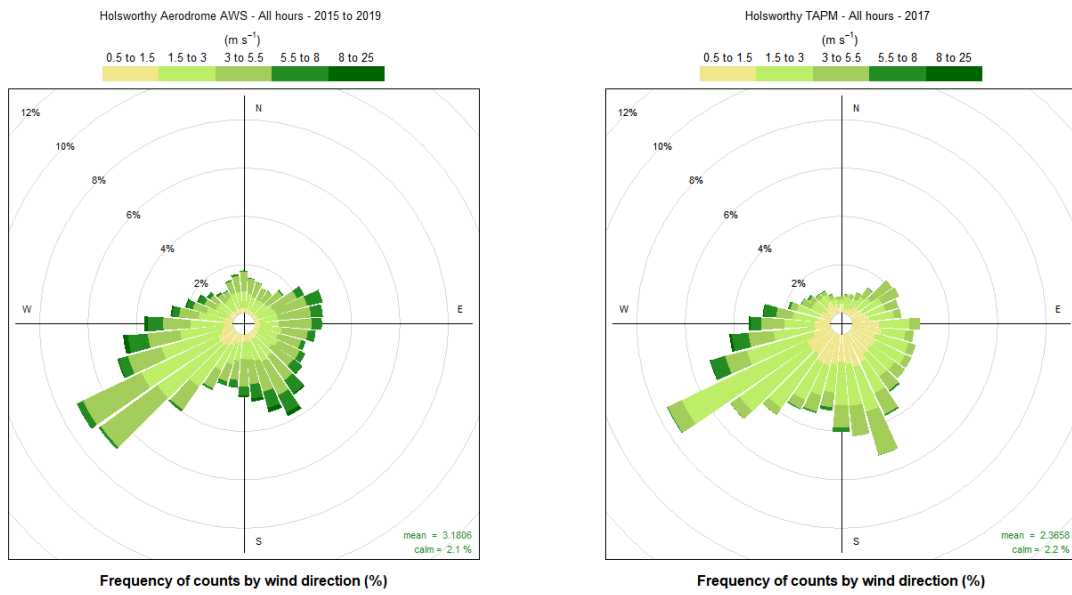
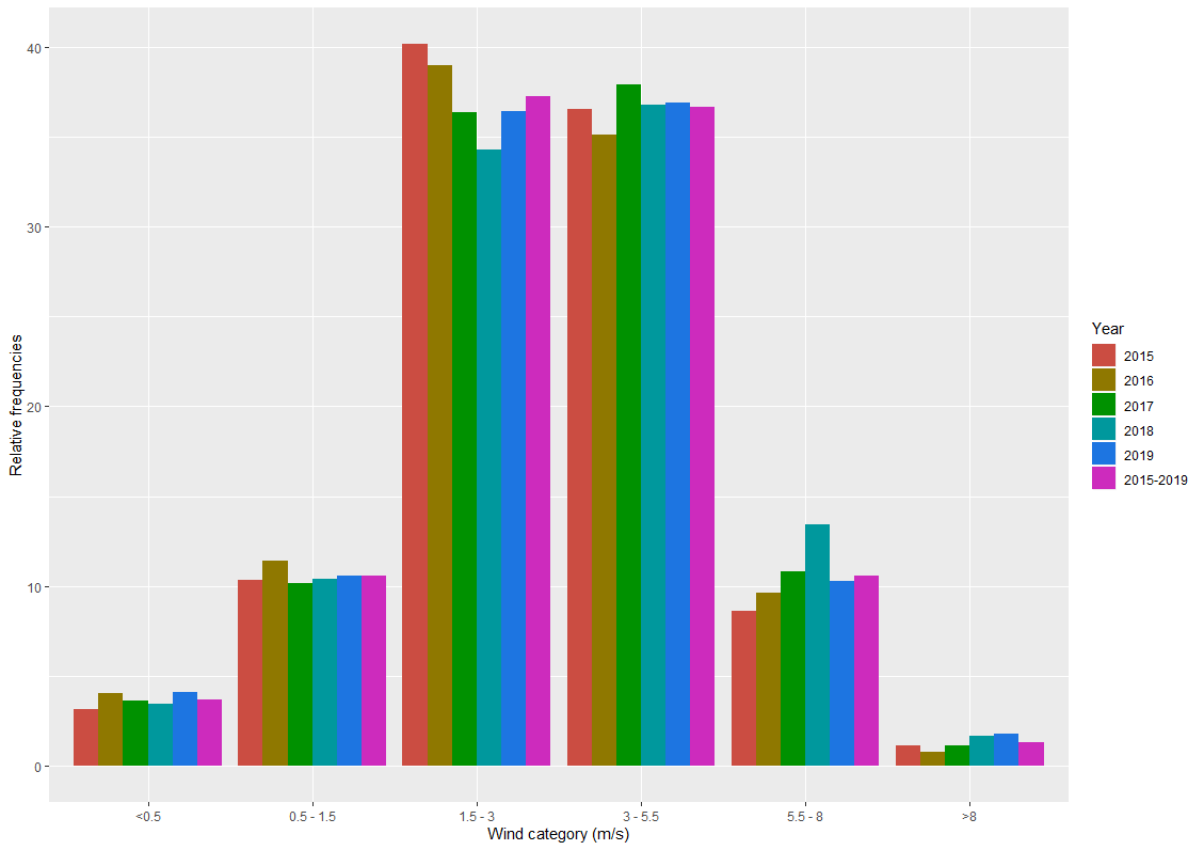


Figure A3 Annual wind speed distribution Holsworthy Aerodrome AWS



Meteorological Processing

The BoM data adequately covers the issues of data quality assurance, however it is limited by its location compared to the Proposal site. To address these uncertainties, a multi-phased assessment of the meteorological data has been performed.

In absence of any measured onsite meteorological data, site representative meteorological data for this project was generated using the TAPM meteorological model in a format suitable for using in the CALPUFF dispersion model (refer **Section 5.1**).

Meteorological modelling using The Air Pollution Model (TAPM, v 4.0.5) has been performed to predict the meteorological parameters required for CALPUFF. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which may be used to predict three-dimensional meteorological data and air pollution concentrations.

TAPM predicts wind speed and direction, temperature, pressure, water vapour, cloud, precipitation and turbulence. The program allows the user to generate synthetic observations by referencing databases (covering terrain, vegetation and soil type, sea surface temperature and synoptic scale meteorological analyses) which are subsequently used in the model input to generate site-specific hourly meteorological observations at user-defined levels within the atmosphere.

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field and thus the final wind field reflects the influences of local topography and current land uses.

The parameters used in TAPM and CALMET modelling are presented in **Table A1**.

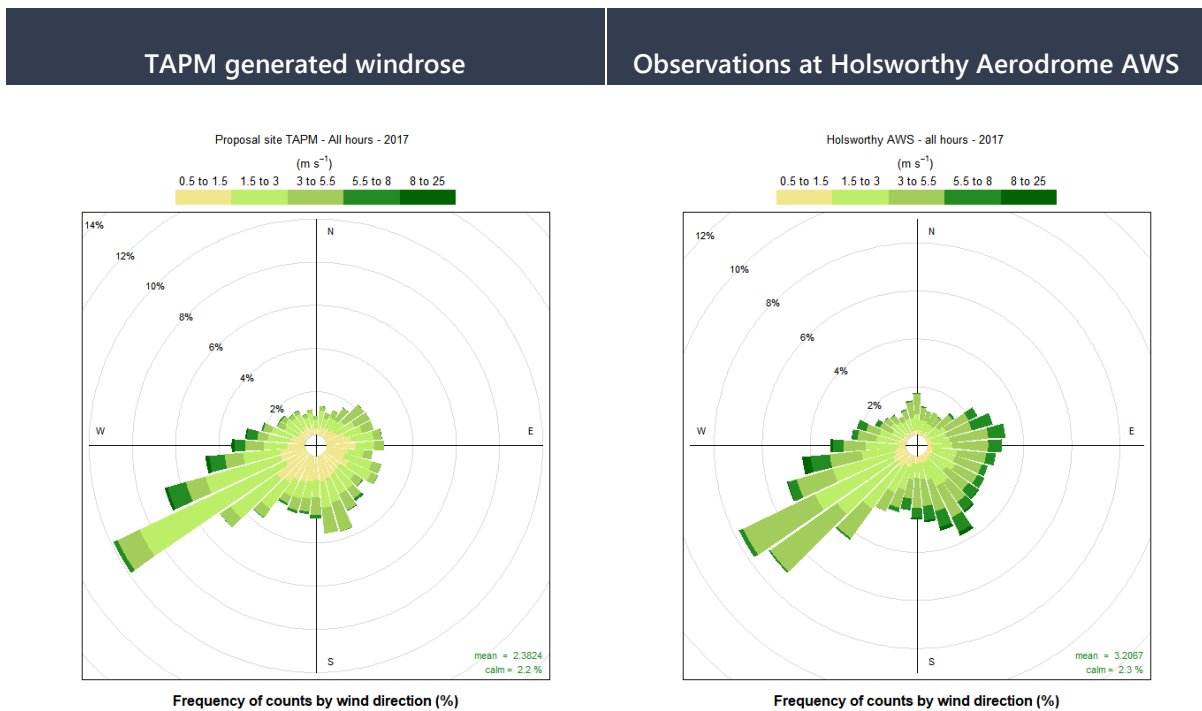
Table A1 Meteorological parameters used for this study (TAPM v 4.0.5)

TAPM v 4.0.5	
Modelling period	1 January 2017 to 31 December 2017
Centre of analysis	306 747 mE, 6 239 568 mS (UTM Coordinates)
Number of grid points	25 × 25 × 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	-
CALMET	
Modelling period	1 January 2017 to 31 December 2017
South-West corner of analysis	303 600 mE, 6 236 700 mS (UTM Coordinates)
Meteorological grid domain (resolution)	0.100 km × 60 × 60
Vertical resolution (cell heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1 200 m, 2 000 m, 3 000 m, 4 000 m)
Data assimilation	No-obs approach using TAPM – 3D.DAT file

A comparison of the TAPM generated meteorological data, and that observed at the Holsworthy Aerodrome AWS is presented in **Figure A4**.

These data generally compare well which provides confidence that the meteorological conditions modelled as part of this assessment are appropriate.

Figure A4 Modelled and observed meteorological data – Holsworthy Aerodrome AWS, 2017

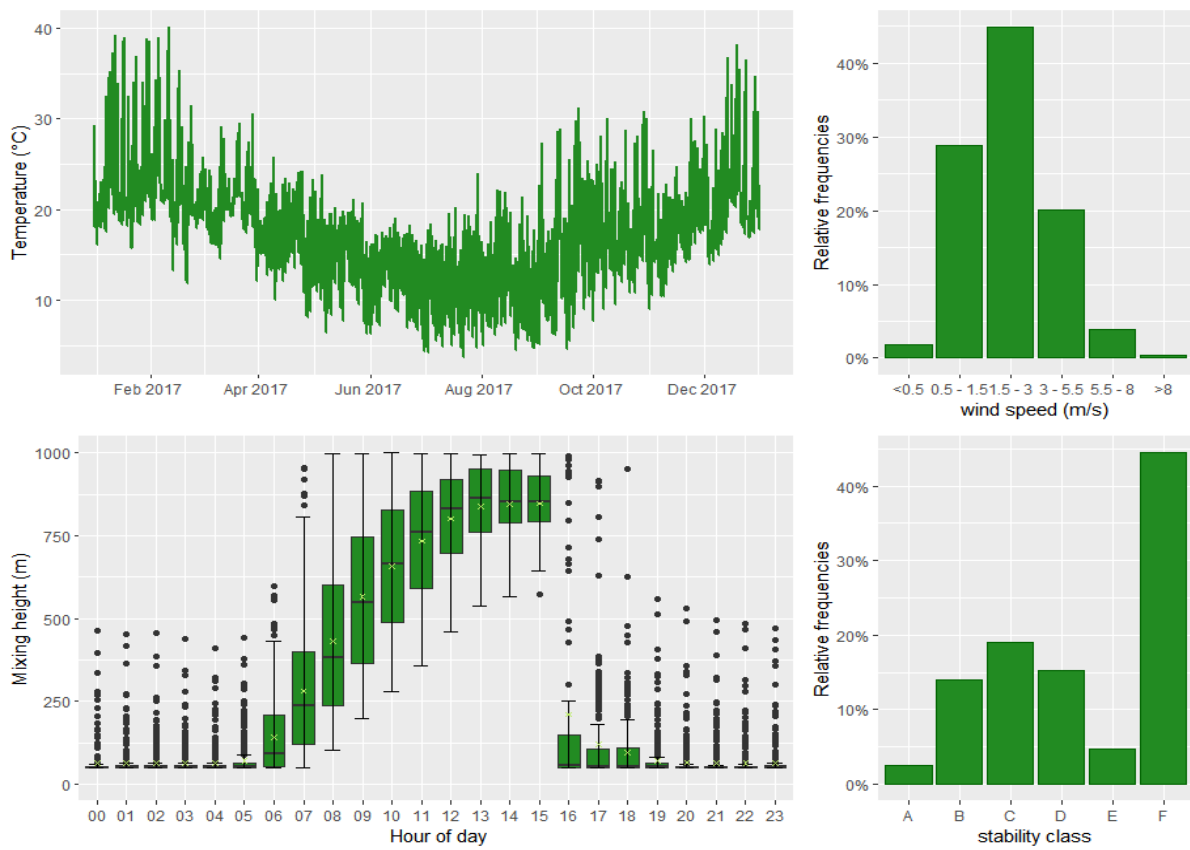


As generally required by the NSW EPA, the following provides a summary of the modelled meteorological dataset. Given the nature of the pollutant emission sources at the Proposal site, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirculation potential of the Proposal site has not been provided. Details of the predictions of wind speed and direction, mixing height and temperature at the Proposal site are provided below.

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Proposal site during 2017 period are illustrated in **Figure A5**. Also presented are predicted temperature, stability class and wind speed frequency.

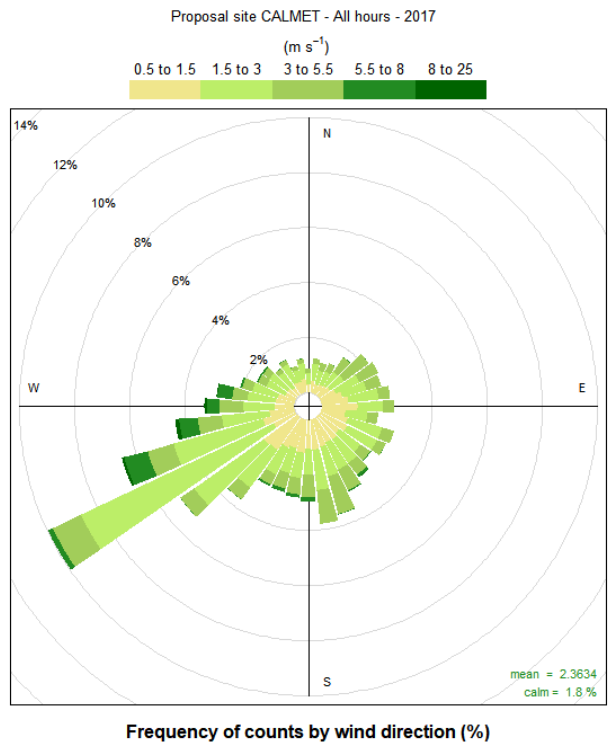
As expected, an increase in mixing height during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground based temperature inversions and growth of the convective mixing layer.

Figure A5 Predicted meteorological parameters – Proposal site 2017



The modelled wind speed and direction at the Proposal site during 2017 are presented in **Figure A6**.

Figure A6 Predicted wind speed and direction – Proposal site 2017



APPENDIX B

Background Air Quality Data

Air quality is not monitored at the Proposal site and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this assessment. Determination of data to be used as a location representative of the Proposal site and during a representative year can be complicated by factors which include:

- the sources of air pollutant emissions around the Proposal site and representative AQMS; and
- the variability of particulate matter concentrations (often impacted by natural climate variability).

Air quality monitoring is performed by the NSW Department of Planning, Industry and Environment (DPIE) at three air quality monitoring station (AQMS) within a 17 km radius of the Proposal site. Details of the monitoring performed at these AQMS is presented in **Table 6** and **Figure 7**.

Based on the sources of AQMS data available and their proximity to the Proposal site, Liverpool was selected as the candidate source of AQMS data for use in this assessment.

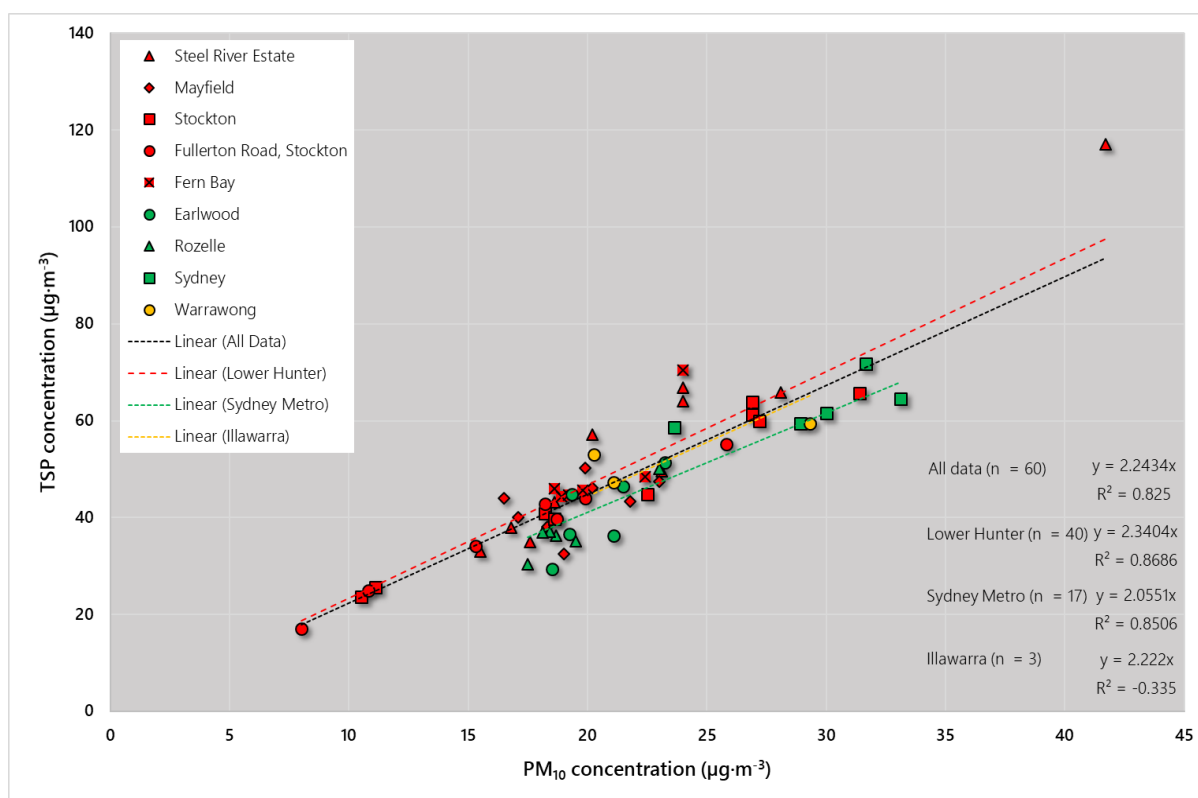
Summary statistics are for PM₁₀ and PM_{2.5} data are presented in **Table B1**.

Concentrations of TSP are not measured by the NSW DPIE at any AQMS surrounding the Proposal site. An analysis of co-located measurements of TSP and PM₁₀ in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in **Figure B1**.

The analysis concludes that, on the basis of the measurements collected across NSW between 1999 to 2011, the derivation of a broad TSP:PM₁₀ ratio of 2.2434 : 1 (i.e. PM₁₀ represents ~48 % of TSP) is appropriate to be applied to measurements in the Sydney Metro.

In the absence of any more specific information, this ratio has been adopted within this AQIA. These estimates have not been adjusted for background exceedances.

Figure B1 Co-located TSP and PM₁₀ Measurements, Lower Hunter, Sydney Metro and Illawarra



Similarly, no dust deposition data is available for the area surrounding the Proposal site. The incremental impact criterion of $2 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$ as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of $2 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$ (the total allowable deposition being $4 \text{ g}\cdot\text{m}^{-2}\cdot\text{month}^{-1}$).

A summary of background air quality data for the site for the year 2017 (consistent with the selected meteorological period) is presented in **Table B1**.

Graphs presenting the daily varying PM₁₀ and PM_{2.5} data recorded at Liverpool in 2017 are presented in **Figure B2** and **Figure B3**, respectively.

Table B1 Summary of Background Air Quality Data (Liverpool 2017)

Pollutant	TSP ($\mu\text{g}\cdot\text{m}^{-3}$)	PM ₁₀ ($\mu\text{g}\cdot\text{m}^{-3}$)	PM _{2.5} ($\mu\text{g}\cdot\text{m}^{-3}$)
Averaging Period	Annual	24-Hour	24-Hour
Data Points (number)	361	361	348
Mean	46.3	20.6	8.9
Standard Deviation	-	8.1	4.9
Skew ¹	-	+1.4	+3.5
Kurtosis ²	-	+5.5	+26.4
Minimum	46.3	4.6	2.0
Percentiles ($\mu\text{g}\cdot\text{m}^{-3}$)			
1	-	7.6	2.9
5	-	9.8	3.8
10	-	11.5	4.4
25	-	15.1	5.9
50	-	19.6	8.0
75	-	25.0	10.9
90	-	31.2	14.0
95	-	35.0	16.6
97	-	36.8	19.0
98	-	37.8	20.3
99	-	40.5	23.9
Maximum	46.3	74.0	56.4
Data Capture (%)	98.9	98.9	95.3

Notes: **1:** Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure B2 PM₁₀ Measurements, Liverpool 2017

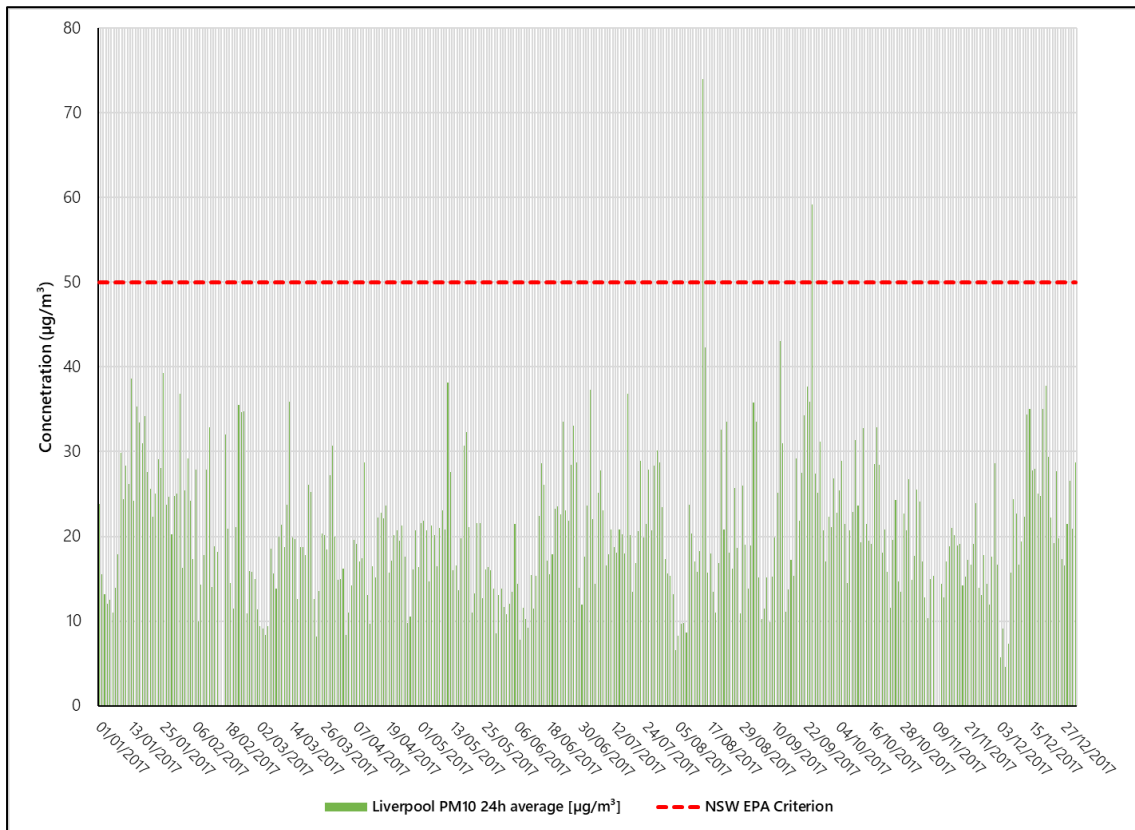
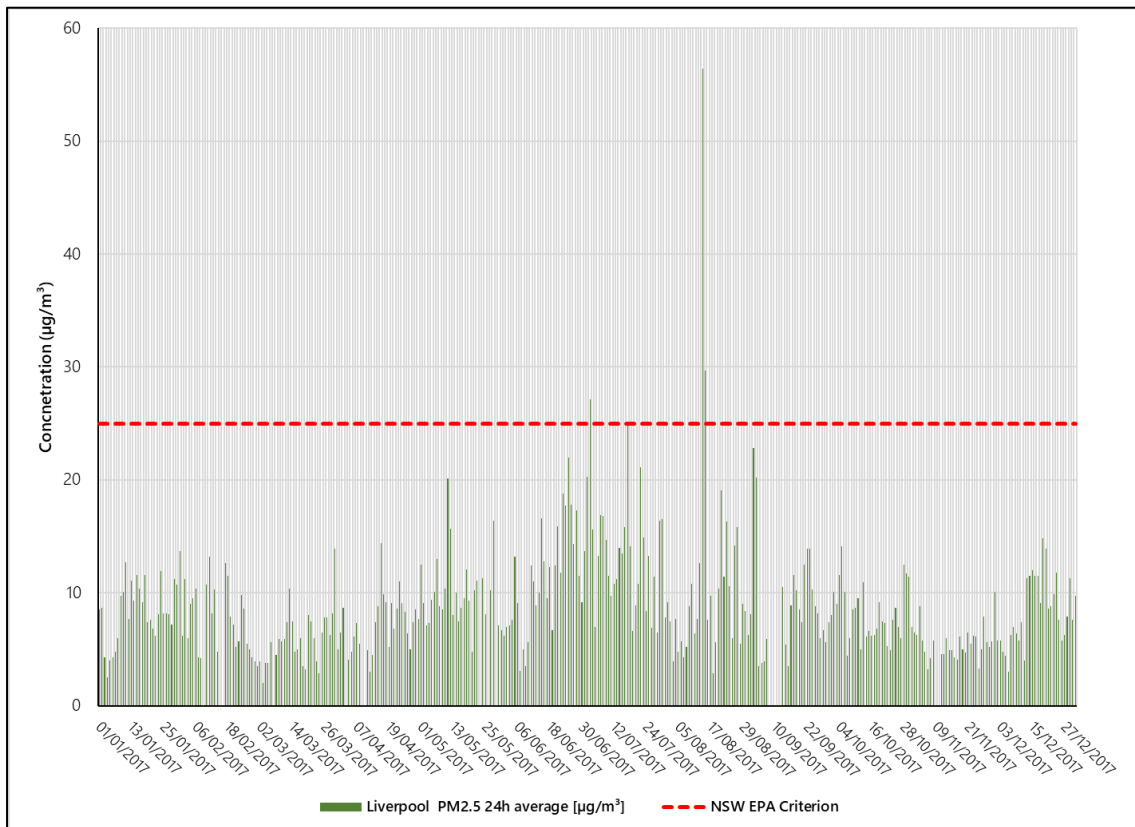


Figure B3 PM_{2.5} Measurements, Liverpool 2017



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APPENDIX C

Emissions Estimation

The activity rates as presented in **Table 2** have been used in the development of the particulate emissions inventory for the Proposal.

Emissions resulting from the loading of materials, transfer of materials (except for road transport), and the loading of crushers, screens and the shredder have been estimated using the US EPA AP-42 emission factor for batch drop. The emissions of particulate matter from these processes have been estimated using emission factors presented in Section 13.2.4.3 of AP-42 (Aggregate Handling and Storage Piles) (US EPA, 2006b).

This emission factor can result from several distinct source activities because the adding or removal of aggregate material from a storage pile or receiving surface results in batch drop operations and in other cases continuous drop operations. Either type of drop events emission factor can be estimated through:

$$EF (kg \cdot tonne^{-1}) = k(0.0016) \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where:

$EF_{(kg \cdot tonne^{-1})}$ = emission factor

k = particle size multiplier, where TSP = 0.74; PM₁₅ = 0.48; PM₁₀ = 0.35; PM₅ = 0.20; PM_{2.5} = 0.053;

U = mean wind speed, meters per second (m.s⁻¹)

M = material moisture content (%)

The quality rating for this application is rated A.

Note: Silt content is not included in this equation. It is reasonable to expect that silt content and emission factors are interrelated however no significant correlation was found under the parameters conducted by the US EPA. Hence it is recommended that if the source parameters lie outside of the studied range, that the equations quality rating be reduced by 1 level. The parameters of the study are: Silt Content (%) = 0.44 – 19; Moisture Content (%) = 0.25 – 4.8; Wind Speed (m.s⁻¹) = 0.6 – 6.7 (US EPA, 2006b).

Emissions of particulate matter resulting from the movement of materials on paved roads have been estimated using the emission factors presented in 13.2.1 (Paved Roads) of AP-42, (US EPA, 2011).

The emission factor on page 13.2.1.3 of (US EPA, 2011) has been adopted for the operations of vehicles on paved roads:

$$EF_{(g \cdot VKT^{-1})} = k(sL)^{0.91} (W \times 0.907185)^{1.02}$$

where:

$EF_{(g \cdot VKT^{-1})}$ = emission factor (g per vehicle kilometre travelled)

k = particle size multiplier (dimensionless)

sL = road surface silt loading ($\text{g}\cdot\text{m}^{-2}$)

W = average weight (tons) of vehicles travelling the road multiplied by 0.907185 to convert to metric tonnes

The particle size multipliers for TSP, PM_{10} and $\text{PM}_{2.5}$ (k) are provided in (US EPA, 2011) as 3.23, 0.62 and 0.15, respectively.

The quality rating for this emission factors are A for TSP, A for PM_{10} , D for $\text{PM}_{2.5}$.

The emission factor in section 13.2.2 of (US EPA, 2006a) has been adopted for the operations of vehicles on unpaved roads:

$$EF_{(kg.VKT^{-1})} = 0.2819 \times k \times \left(\frac{s}{12}\right)^a \times \left(\frac{W \times 0.907185}{3}\right)^b$$

where:

$EF_{(kg.VKT^{-1})}$ = emission factor (kg per vehicle kilometre travelled) multiplied by 0.2819 to convert from lb per vehicle mile travelled

k = particle size multiplier (dimensionless)

s = surface material silt content (%)

W = mean vehicle weight (tons) multiplied by 0.907185 to convert from metric tonnes

The particle size multipliers for TSP, PM_{10} and $\text{PM}_{2.5}$ (k) are provided in (US EPA, 2006a) as 4.9, 1.5 and 0.15, respectively.

The quality rating for this application is rated B for TSP, B for PM_{10} and B for $\text{PM}_{2.5}$.

Emissions resulting from the crushing and screening of materials at the Proposal site have been estimated using the US EPA AP-42 emission factor for crushed stone processing (USEPA, 2006). The emission factor for uncontrolled tertiary crushing:

- 0.0027 $\text{kg}\cdot\text{t}^{-1}$ for TSP
- 0.0012 $\text{kg}\cdot\text{t}^{-1}$ for PM_{10} and
- 0.00012 $\text{kg}\cdot\text{t}^{-1}$ for $\text{PM}_{2.5}$

have been adopted. Application of emissions controls (watering) result in these emissions being controlled by 77.7% (USEPA, 2006) with controlled emissions being:

- 0.0006 $\text{kg}\cdot\text{t}^{-1}$ for TSP
- 0.00027 $\text{kg}\cdot\text{t}^{-1}$ for PM_{10} and

- 0.00005 kg·t⁻¹ for PM_{2.5}

For screening uncontrolled emissions rates of:

- 0.0125 kg·t⁻¹ for TSP
- 0.0043 kg·t⁻¹ for PM₁₀ and
- 0.00043 kg·t⁻¹ for PM_{2.5}

have been adopted. Application of emissions controls (watering, or throughput of wetted material from the crusher) result in these emissions being controlled by 91.6 % (USEPA, 2006) with controlled emissions being:

- 0.0011 kg·t⁻¹ for TSP
- 0.00037 kg·t⁻¹ for PM₁₀ and
- 0.000025 kg·t⁻¹ for PM_{2.5}

Emissions of particulate matter resulting from the wind erosion of exposed areas have been estimated using the emission factors presented in Section 11.9-4 of AP-42 (Western Surface Coal Mining) (US EPA, 1998).

The emission factors within table 11.9-4 have been adopted for the operations outlined above. The emission factor applies to the materials: seeded land, stripped overburden and graded overburden. The emission factor is:

$$EF_{TSP} (\text{tonne} \cdot (\text{hectare} \cdot \text{year})^{-1}) = 0.85$$

where:

$EF_{TSP} (\text{tonne} \cdot (\text{hectare} \cdot \text{year})^{-1})$ = emission factor for total suspended particulate matter

PM₁₀ & PM_{2.5} emission factors are not available in AP-42 although have been taken to be 50 % of TSP for PM₁₀ and, 7.5 % of TSP for PM_{2.5} as per AP-42 section (13.2.5) for industrial wind erosion (US EPA, 2006c).

The quality rating for this emission factors is C.

Emissions controls will be employed at the Proposal site as discussed in **Section 5.3**. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the Proposal operation. A description of each emission reduction method to be employed as part of the Proposal is presented in **Section 5.3**.

Based on the foregoing, the distribution of particulate emission across broad emissions categories is presented in **Figure C1** (TSP) **Figure C2** (PM₁₀) and **Figure C3** (PM_{2.5}). The results are presented for the inventory associated with annual activity rates although the distribution is broadly similar for 24-hour maximum activity rates.

Figure C1 Calculated uncontrolled & controlled annual TSP emissions

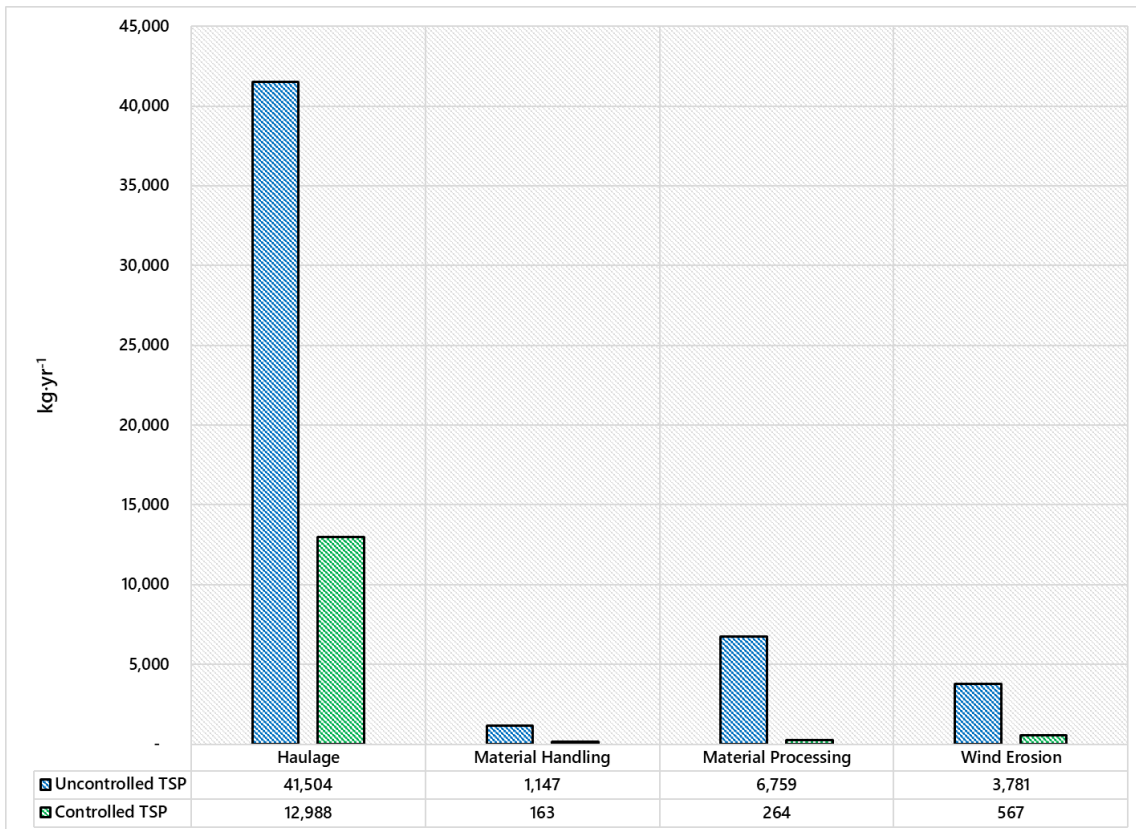


Figure C2 Calculated uncontrolled & controlled annual PM₁₀ emissions

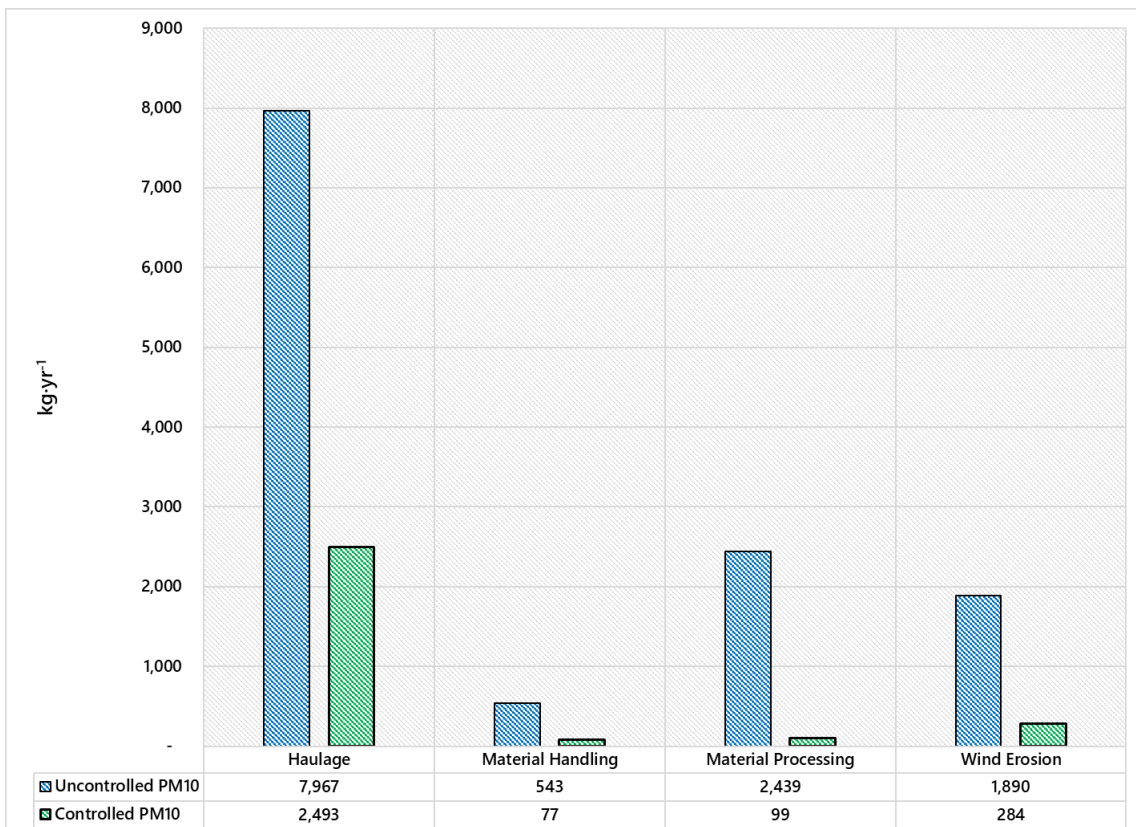
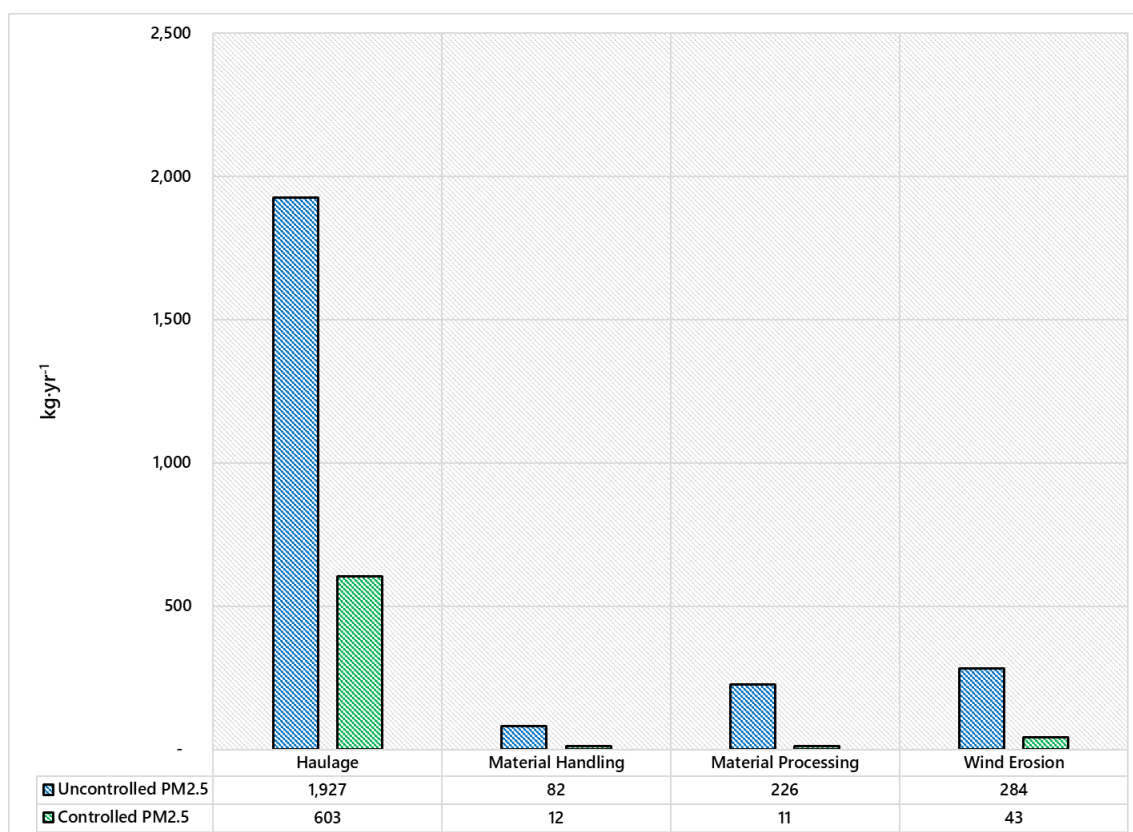


Figure C3 Calculated uncontrolled & controlled annual PM_{2.5} emissions



Particulate emissions have been modelled based on the groupings outlined in **Table C1** below:

Table C1 Modelled particulate fractions

Fraction	Representing	Geometric mass mean diameter (microns)	Geometric standard deviation (microns)
Coarse	TSP minus PM ₁₀ fraction	20	1.24
Intermediate	PM ₁₀ minus PM _{2.5} fraction	5	1.24
Fine	PM _{2.5} fraction	1.25	1.24

Source: (Government of Newfoundland and Labrador, 2012)

By adopting this approach, the dispersion model separates out the larger particulates which are more rapidly deposited from the atmosphere, closer to the site. This is a more realistic approach than the default adopted in CALPUFF (geometric mass mean diameter of 0.48 microns for all particulate size fractions) and results in the predicted off-site suspended and deposited particulate levels decreasing more rapidly with increasing distance from the source.

Emissions Inventory

Annual activity rates (refer **Table 2**):

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control eff. (%)	Controlled emission rate (kg-yr ⁻¹)		
	TSP	PM ₁₀	PM _{2.5}	Unit						TSP	PM ₁₀	PM _{2.5}
Dumping material in tipping and sorting shed (all material)	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	45000	t	Enclosure Water mist Minimize drop height	705030	20.1	9.5	1.4
FEL handling in tipping and sorting shed	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	45000	t	Enclosure Water mist	7050	28.7	13.6	2.1
FEL unloading in processing shed	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	45000	t	Enclosure Water mist	7050	28.7	13.6	2.1
FEL loading shredder	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	30000	t	Enclosure Water mist	7050	1.9	0.9	0.1
FEL loading crusher - C&D, ENM	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	42000	t	Enclosure Water mist	7050	26.8	12.7	1.9
Crushing - C&D, ENM	0.00270	0.0012	0.00022	kg-t ⁻¹	AP-42 - Primary crushing - Table 11.19.2.1	42000	t	Enclosure Water mist	7050	75.9	33.7	6.1
Screening - C&D, ENM	0.01250	0.0043	0.00030	kg-t ⁻¹	AP-42 - Screening - Table 11.19.2.1	42000	t	Enclosure Water mist	7050	132.3	45.5	3.2
Shredding - C&I	0.01250	0.0043	0.00030	kg-t ⁻¹	AP-42 - Screening - Table 11.19.2.1	30000	t	Enclosure Water mist	7050	56.3	19.4	1.4
Loading to stockpiles - C&I	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	30000	t	Enclosure Water mist	7050	1.9	0.9	0.1
Loading to stockpiles - C&D, ENM	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	42000	t	Enclosure	7050	26.8	12.7	1.9

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control eff. (%)	Controlled emission rate (kg·yr ⁻¹)		
	TSP	PM ₁₀	PM _{2.5}	Unit						TSP	PM ₁₀	PM _{2.5}
								Water mist				
Loading trucks with product - C&I, C&D, ENM	0.00042	0.0002	0.0003	kg·t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	45000	t	Enclosure Water mist	7050	28.7	13.6	2.1
Unloading 10% at landfill	0.00042	0.0002	0.0003	kg·t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	45000	t			19.1	9.0	1.4
Raw materials to site - tipping and sorting shed	0.17935	0.0344	0.00833	kg·VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	17771	VKT	Speed reduction Road sweep Watering	441630	1049.5	201.4	48.7
Empty vehicles leaving site from tipping and sorting shed	0.17935	0.0344	0.00833	kg·VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	36890	VKT	Speed reduction Road sweep Watering	441630	2178.6	418.2	101.2
Dump truck moving material to stockpile pen and processing shed	1.00452	0.1928	0.04665	kg·VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	10723	VKT	Speed reduction Road sweep Watering	441630	3546.8	680.8	164.7
Vehicles arriving, pick up in stockpile pen and processing shed	0.67372	0.1293	0.03129	kg·VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	11727	VKT	Speed reduction Road sweep Watering	441630	2601.6	499.4	120.8
Vehicles leaving stockpile pen and processing shed – to Cambridge Avenue	0.67372	0.1293	0.03129	kg·VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	14577	VKT	Speed reduction Road sweep Watering	441630	3233.9	620.7	150.2

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control eff. (%)	Controlled emission rate (kg·yr ⁻¹)		
	TSP	PM ₁₀	PM _{2.5}	Unit						TSP	PM ₁₀	PM _{2.5}
Vehicles in tipping and sorting shed	0.17935	0.0344	0.00833	kg·VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	13724	VKT	Speed reduction Enclosure Water mist	447030	289.5	55.6	13.4
Vehicles in stockpile pen and processing shed	0.17935	0.0344	0.00833	kg·VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	4159	VKT	Speed reduction Enclosure Water mist	447030	87.7	16.8	4.1
Dump truck transfer of material to landfill	3.19371	0.8621	0.08622	kg·VKT ⁻¹	AP-42 Unpaved roads - Section 13.2.2	1929	VKT	Speed reduction Watering	4450	1724.6	465.6	46.6
Tipping and sorting shed	850.0	425.0	63.75	kg·ha ⁻¹ ·yr ⁻¹	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	1.9	ha	Enclosure Water mist	7050	237.5	118.7	17.8
Stockpile pen and processing shed	850.0	425.0	63.75	kg·ha ⁻¹ ·yr ⁻¹	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	2.6	ha	Enclosure Water mist	7050	329.7	164.8	24.7

Maximum 24hr activity rates (refer **Table 2**) – presented as annual emissions

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control eff. (%)	Controlled emission rate (kg-yr ⁻¹)		
	TSP	PM ₁₀	PM _{2.5}	Unit						TSP	PM ₁₀	PM _{2.5}
Dumping material in tipping and sorting shed (all material)	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	90000	t	Enclosure Water mist Minimize drop height	705030	40.1	19.0	2.9
FEL handling in tipping and sorting shed	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	90000	t	Enclosure Water mist	7050	57.4	27.1	4.1
FEL unloading in processing shed	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	90000	t	Enclosure Water mist	7050	57.4	27.1	4.1
FEL loading shredder	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	60000	t	Enclosure Water mist	7050	3.8	1.8	0.3
FEL loading crusher - C&D, ENM	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	84000	t	Enclosure Water mist	7050	53.5	25.3	3.8
Crushing - C&D, ENM	0.00270	0.0012	0.00022	kg-t ⁻¹	AP-42 - Primary crushing - Table 11.19.2.1	84000	t	Enclosure Water mist	7050	151.7	67.4	12.1
Screening - C&D, ENM	0.01250	0.0043	0.00030	kg-t ⁻¹	AP-42 - Screening - Table 11.19.2.1	84000	t	Enclosure Water mist	7050	264.6	91.0	6.4
Shredding - C&I	0.01250	0.0043	0.00030	kg-t ⁻¹	AP-42 - Screening - Table 11.19.2.1	60000	t	Enclosure Water mist	7050	112.5	38.7	2.7
Loading to stockpiles - C&I	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	60000	t	Enclosure Water mist	7050	3.8	1.8	0.3
Loading to stockpiles - C&D, ENM	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	84000	t	Enclosure Water mist	7050	53.5	25.3	3.8

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control eff. (%)	Controlled emission rate (kg-yr ⁻¹)		
	TSP	PM ₁₀	PM _{2.5}	Unit						TSP	PM ₁₀	PM _{2.5}
Loading trucks with product - C&I, C&D, ENM	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	90000	t	Enclosure Water mist	7050	57.4	27.1	4.1
Unloading 10% at landfill	0.00042	0.0002	0.00003	kg-t ⁻¹	AP-42 - Batch drop - Section 13.2.4.3	90000	t			38.2	18.1	2.7
Raw materials to site - tipping and sorting shed	0.17935	0.0344	0.000833	kg-VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	35541	VKT	Speed reduction Road sweep Watering	44 16 30	2098.9	402.9	97.5
Empty vehicles leaving site from tipping and sorting shed	0.17935	0.0344	0.000833	kg-VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	73780	VKT	Speed reduction Road sweep Watering	44 16 30	4357.2	836.4	202.3
Dump truck moving material to stockpile pen and processing shed	1.00452	0.1928	0.04665	kg-VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	21446	VKT	Speed reduction Road sweep Watering	44 16 30	7093.5	1361.6	329.4
Vehicles arriving, pick up in stockpile pen and processing shed	0.67372	0.1293	0.03129	kg-VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	23455	VKT	Speed reduction Road sweep Watering	44 16 30	5203.2	998.8	241.6
Vehicles leaving stockpile pen and processing shed – to Cambridge Avenue	0.67372	0.1293	0.03129	kg-VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	29155	VKT	Speed reduction Road sweep Watering	44 16 30	6467.7	1241.5	300.4
Vehicles in tipping and sorting shed	0.17935	0.0344	0.000833	kg-VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	27448	VKT	Speed reduction	44	578.9	111.1	26.9

Emission source	Emission factor				Source	Activity rate	Unit	Control method	Control eff. (%)	Controlled emission rate (kg·yr ⁻¹)		
	TSP	PM ₁₀	PM _{2.5}	Unit						TSP	PM ₁₀	PM _{2.5}
								Enclosure Water mist	70 30			
Vehicles in stockpile pen and processing shed	0.179 35	0.0 34 4	0.00 833	kg· VKT ⁻¹	AP-42 Paved roads - Section 13.2.1	8 31 8	V K T	Speed reduction Enclosure Water mist	44 70 30	175.4	33.7	8.1
Dump truck transfer of material to landfill	3.193 71	0.8 621	0.08 622	kg· VKT ⁻¹	AP-42 Unpaved roads - Section 13.2.2	3 85 7	V K T	Speed reduction Watering	44 50	3 44 9.2	931.1	93.1
Tipping and sorting shed	850.0	42 5.0	63.7 5	kg· ha ⁻¹ · yr ⁻¹	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	1.9	h a	Enclosure Water mist	70 50	237. 5	118.7	17.8
Stockpile pen and processing shed	850.0	42 5.0	63.7 5	kg· ha ⁻¹ · yr ⁻¹	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	2.6	h a	Enclosure Water mist	70 50	329. 7	164.8	24.7