Cleary Bros (Bombo) Pty Ltd
ABN: 28 000 157 808

Albion Park Quarry Extraction Area Stage 7 Extension

Air Quality Assessment

Prepared by

Northstar Air Quality Pty Ltd

February 2022

Specialist Consultant Studies Compendium
Part 1

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Addendum: The Air Quality Assessment identifies that Cleary Bros were continuing discussions with the owners of “Figtree Hill” regarding Project-related impacts, and an agreement had not been reached at the time the assessment was finalised. As identified in Section 2.5 of the EIS, a negotiated agreement has since been finalised between Cleary Bros and the owners of “Figtree Hill”. As such, the “Figtree Hill” property is now considered Project-related for the purposes of this assessment. Under that agreement, the owners have agreed to accept Project-related impacts to the extent identified in the Air Quality Assessment.

EXECUTIVE SUMMARY

Cleary Bros (Bombo) Pty Ltd has engaged Northstar Air Quality Pty Ltd to perform an air quality impact assessment and greenhouse gas assessment to support the continued operation and extension of the Albion Park Quarry.

This air quality impact assessment forms part of the Environmental Impact Statement prepared to accompany the development application for the Project, as required under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The air quality impact assessment presents an assessment of the impacts of the proposed operation of the Project and provides an assessment of the cumulative impacts of the Project with other relevant sources including general background conditions.

The greenhouse gas assessment provides an assessment of the potential greenhouse gas emissions throughout the operation of the Project.

Activity data associated with long term (annual) and short term (24-hour and 1-hour maximum) periods have been provided by Cleary Bros (Bombo) Pty Ltd, and emissions of particulate matter and nitrogen dioxide have been estimated using standard emission factors routinely adopted in Australia. A range of mitigation measures will be employed as part of the Project, and the control efficiency of each has been applied, to determine a total emission from each source.

The meteorology of the area surrounding the Project Area has been reviewed, and a meteorological modelling exercise has been performed to provide site-specific meteorology, which has been subsequently used in a dispersion modelling exercise.

The emissions and meteorological data have been used as input to the NSW Environment Protection Authority approved CALPUFF dispersion model to determine potential impacts at each identified surrounding receptor location.

An approximation of existing air quality in the area surrounding the Project has been determined, and the predicted impacts from the development have been added to that background, to result in a cumulative impact, which has then been compared to relevant air quality criteria as outlined in the NSW Environment Protection Authority Approved Methods document.

The results of the dispersion modelling assessment indicate that the air quality criteria are all predicted to be satisfied throughout the Project life.

The greenhouse gas assessment has calculated the likely emissions of greenhouse gas which would result from activities within the Project Area. A comparison of the calculated greenhouse gas emissions associated with the Project against Australian and State total emissions in 2018 indicates that the operation of the Project would contribute 0.0059 % of State total greenhouse gas emissions and less than 0.0014 % of Australian total greenhouse emissions in 2018 which are considered to be small.

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1. INTRODUCTION

Cleary Bros (Bombo) Pty Ltd (the Applicant/Cleary Bros) operates the Albion Park Quarry (the Quarry), which is located approximately 1 kilometre (km) southwest of the Princes Highway at Albion Park, NSW. The Quarry is operated to recover hard rock material to produce a range of aggregates and road pavement products used in construction and infrastructure projects.

The current extraction operation was originally approved in 2006 by the NSW Land and Environment Court (DC10639/2005) and the Development Consent has since been modified in 2009, 2015 and 2017. The Quarry currently has approval to extract up to 900 000 tonnes per annum (tpa) of hard rock material, from Stages 5 and 6 of the Quarry Plan with some minor works in Stages 1 to 4.

In addition to the above activities, the Applicant intends to increase the area of extraction activities to include a further stage of extraction, namely Stage 7, whilst maintaining the approved annual extraction limit at 900 000 tpa (the Project). The extraction processes are planned to be similar to the operations in the approved Stages 5 and 6, although as part of the Project, blasted rock is proposed to undergo primary crushing and screening within Stage 7, and then either further processed within the secondary crusher and screen within the extractable areas or transported through Stages 1 to 6, with further processing to occur at the approved and currently operating fixed processing plant and then stockpiled and subsequently delivered to customers.

Cleary Bros has engaged Northstar Air Quality Pty Ltd (Northstar) to perform an air quality impact assessment (AQIA) and greenhouse gas (GHG) assessment to support the continued operation and extension of the Albion Park Quarry (the Project) as described above.

This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the Project, as required under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The AQIA presents an assessment of the impacts of the proposed operation of the Project and provides an assessment of the cumulative impacts of the Project with other relevant sources including general background conditions.

The GHG assessment provides an assessment of the potential GHG emissions throughout the operation of the Project.

1.1 Assessment Requirements

The NSW Department of Planning, Industry & Environment (DPIE) provided Secretary's Environmental Assessment Requirements (SEARs) for the Project (application number SSD 10369), dated 3 October 2019. The requirements of the SEARs in relation to air quality are presented in **Table 1**, with the relevant section(s) of this AQIA in which they have been addressed.

Table 1 Relevant requirements of the SEARs (SSD 10369)

Authority	Requirement	Relevant section
SEARs (3 October 2019)	• a detailed assessment of potential construction and operational air quality impacts, in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, and with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10}, and having regard to the *Voluntary Land Acquisition and Mitigation Policy*	Section 5.1 Section 6, Section 6.5
NSW EPA (03 September 2019)	The environmental outcome for the project should ensure: • emissions do not cause adverse impact upon human health or the environment	Section 6
	• no offensive odour beyond the boundary of the premises	Section 2.2
	• compliance with the requirements of the POEO Act and its associated regulations	Section 3.2, Section 3.3
	• maintains or improves air quality to ensure National Environment Protection Measures for ambient air quality are not compromised	Section 6
	• all dust emissions from material handling, storage, processing, haul roads, transport and material transfer systems are prevented or minimised; and vehicular kilometres travelled are minimised.	Section 5.1, Section 6, Appendix D
	The EIS should: 1. Include a detailed description of the proposal. All processes that could result in air emissions must be identified and described. Sufficient detail to accurately communicate the characteristics and quantity of all emissions must be provided. Describe the receiving environment in detail. The proposal must be contextualised within the receiving environment (local, regional and inter-regional as appropriate). The description must include but need not be limited to: • meteorology and climate • topography • surrounding land-use • receptors • ambient air quality.	Section 2 Section 4.3 Section 4.1 Appendix B Appendix C
	2. Account for cumulative impacts.	Section 4.6, Section 6
	3. Assess the risk associated with potential discharges of fugitive and point source emissions for all stages of the proposal. Assessment of risk relates	Section 2.2

Authority	Requirement	Relevant section
	to environmental harm, risk to human health and amenity.	
	4. Describe any proposed emission control techniques, monitoring and management measures the proponent intends to apply to ensure the above goals are satisfied.	Section 2.1, Section 2.2
	5. Assess opportunities to minimise Vehicle Kilometres Travelled and measures to minimise the potential for air quality impacts associated with truck movements.	Section 2.1.6
	6. Demonstrate the proposal's ability to comply with the relevant regulatory framework, specifically the POEO Act 1997 and the *POEO (Clean Air) Regulation 2002*.	Section 3.2, Section 3.3
	The EIS must include an Air Quality Impact Assessment (AQIA). The AQIA must identify and describe in detail all possible sources of air pollution and activities/processes with the potential to cause air pollutants including odours and fugitive dust emissions beyond the boundary of any premises proposed to be licensed by an EPL. This should cover both the construction and operational phases of the development. The AQIA should include cumulative impacts associated with existing developments and any developments having been granted development consent but which have not commenced.	Section 4.6, Section 6
	*The AQIA must be prepared in accordance with the EPA's "*Approved Methods and Guidance for the Modelling & Assessment of Air Pollutants in NSW*'.* The AQIA must describe the methodology used and any assumptions made to predict the impacts. Air pollutant emission rates, ambient air quality data and meteorological data used in the assessment must be clearly stated and justified.	Section 4, Section 5.1 Appendix D
	The EIS should demonstrate that the facility will operate to minimise adverse effects on the amenity of local residents and sensitive land uses and to limit the effects of emissions on local, regional and interregional air quality.	Section 6
	The EIS must describe in detail the measures proposed to mitigate the impacts and quantify the extent to which the mitigation measures are likely to be effective in achieving the relevant environmental outcomes.	Section 8
	With extraction activities and processing increasing within the area of the existing quarry the EPA recommends that a site specific Best Management Practice determination be prepared as part of the AQIA. This would assist in informing the adequacy and performance of existing dust mitigation measures. It would also assist in identifying the most practicable means to reduce any particle emissions associated with the existing and expanded operations and identify any additional reasonable and feasible dust mitigation measures.	Section 5.1.4
Shellharbour City Council (26 September 2019)	Dust reduction measures and management to prevent impact on adjoining properties during and after operation. Management measures including but not limited to water cart rotation are to be specific where relevant.	Section 8

It is noted that there are no specific requirements relating to the GHG assessment provided within the SEARs. The GHG Assessment has been performed in accordance with standard practice and requirements.

The SEARs and the EPA outline the documents to be consulted in the preparation of the AQIA. These are reproduced below (in alphabetical order):

- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (NSW EPA, 2017);
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (NSW EPA, 2006);
- Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia' (Barclay & Scire, 2011);
- National Greenhouse Accounts Factors (DISER, 2020);
- NSW Government Resource Efficiency Policy (NSW OEH, 2019));
- Protection of the Environment Operations (Clean Air) Regulation 2010;
- The Assessment and Management of Odour from Stationary Sources in NSW: Technical Framework (NSW DEC, 2006);
- The Assessment and Management of Odour from Stationary Sources in NSW: Technical Notes (NSW DEC, 2006); and,
- Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments (NSW Government, 2018).

The AQIA has also referenced the following documents:

- Coal Mine Particulate Matter Control Best Practice – Site specific determination guide (OEH) (Katestone, 2011).

The Greenhouse Gas Assessment has been performed with reference to:

- Australian Government Department of the Environment, Australian National Greenhouse Accounts, National Greenhouse Accounts Factors, October 2020 (DISER, 2020);
- The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) GHG Protocol: A Corporate Accounting and Report Standard (WRI, 2004);
- ISO 14064-1:2006 (Greenhouse Gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removal;
- ISO 14064-2:2006 (Greenhouse Gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of GHG emission reductions or removal enhancements); and
- ISO 14064-3:2006 (Greenhouse Gases – Part 3: Specification with guidance for the validation and verification of GHG assertions) guidelines (internationally accepted best practice).

1.2 Previous AQIA for the Quarry

An AQIA was submitted to support the original EIS in 2003 (RHA, 2002) which sought approval for extraction of hard rock at a maximum rate of 400 000 tpa. AQIAs were also submitted to support subsequent modifications to the Development Consent, including:

- MOD1: increase in production limit from 400 000 tpa to 600 000 tpa (Heggies, 2008)
- MOD2: increase in production limit from 600 000 tpa to 900 000 tpa (SLR, 2012)
- MOD3: activation of Approved Stages 5 & 6 at a production limit of 900 000 tpa (SLR, 2016)

The most recent of these AQIAs (SLR, 2016) provided results of atmospheric dispersion modelling using the CALPUFF dispersion model for both Stage 5 and Stage 6 operations (at 900 000 tpa). Predicted impacts associated with drill and blast, load and haul operations indicated that during Stage 5 & 6 of operation, cumulative impacts would be less than the relevant NSW EPA impact assessment criteria for TSP and dust deposition (annual average), PM_{10} and $PM_{2.5}$ (annual and 24-hour averaging periods) at all surrounding receptor locations. Background (existing) air quality associated with the calendar year 2015 was adopted from the NSW OEH (now DPIE) air quality monitoring station at Albion Park South.

At the maximum extraction rate of 900 000 tpa, operations in Stage 5 & 6 were predicted to result in cumulative annual average impacts (project plus a background concentration) at sensitive receivers of:

- less than 40 % of the TSP criterion;
- less than or equal to 50 % of the PM_{10} criterion;
- less than 83 % of the $PM_{2.5}$ criterion; and
- less than 63 % of the dust deposition criterion.

Maximum cumulative 24-hour average impacts (project plus a background concentration) were predicted during Stage 5 & 6 to be:

- less than 82 % of the PM_{10} criterion; and
- less than 85 % of the $PM_{2.5}$ criterion.

An update to the Air Quality Management Plan (AQMP) for the Quarry was performed in December 2017 in response to a number of requirements included in the Modified Development Consent associated with Stage 5 and 6 activation (refer **Section 8**).

1.3 Overview and Purpose

The purpose of the AQIA is to identify and quantify the potential air quality risks to human health or the natural environment from the proposed operation of the Project and identify potential mitigation measures that may be required, in order to manage those risks to acceptable levels.

An important consideration for any AQIA is to identify and quantify the discrete impacts from the Project being assessed and place those potential impacts in context of the prevailing conditions at that location. In terms of air quality studies, that requirement includes a consideration of the general background conditions on a regional scale (performed by examination of available sources of air quality monitoring that may reasonably be compared to the Project location) and more localised emissions to air from more proximate activities that need to be considered in aggregation to the anticipated Project impacts. This consideration is typically called a 'cumulative impact assessment' and is a requirement of the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (NSW EPA, 2017) and the SEARs (see **Table 1**).

The geographical scale of the required cumulative impact assessment depends on the nature of proposed activities at the site under assessment and the likely impact footprint of those emissions. Further discussion relating to likely cumulative impacts is provided in **Section 4.6**.

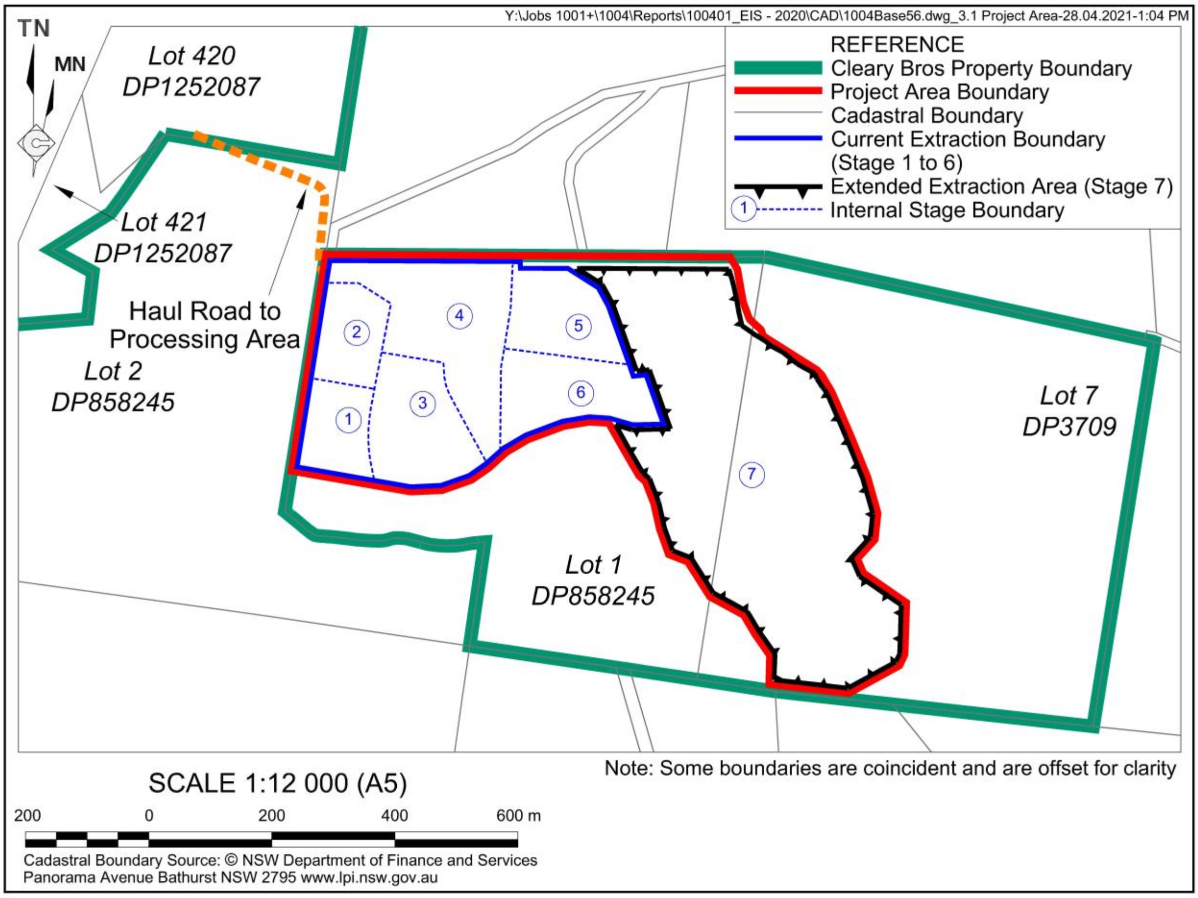
The aim of the GHG assessment is to provide an assessment of the potential GHG emissions during the operation of the Project and identify how those emissions would be managed in accordance with best practice.

2. PROJECT DESCRIPTION

2.1 Project Background

The Project Area covers Stages 1 to 6 of the current approved extraction area and the proposed Stage 7 extension area (see **Figure 1**). Stages 1 to 6 are included in the Project Area as a quantity of rock remains to be extracted in these stages and greater efficiencies would be achieved by extracting the remaining rock concurrently in Stages 5, 6 and 7. Furthermore, some of the overburden and soil from Stage 7 would be used for the rehabilitation of sections of Stages 1 to 4.

Figure 1 Project Area



Stages 1 to 6 are located wholly within Lot 1 DP858245. Stage 7 is located immediately east of Stages 1 to 6 and extends onto the adjoining Lot 7 DP3709. Both lots covering the Project Area are owned by Bridon Pty Ltd, an associated entity of Cleary Bros (Bombo) Pty Ltd.

The western and northern boundaries of the Project Area are coincident with the boundary of Lot 1 DP 858245. The remaining boundaries are coincident with the currently approved southern boundary of Stages 1, 3, 4 and 6 together with the proposed boundary of Stage 7.

The 250 metre (m) internal haul road located in the northern part of Lot 2 DP858245 (owned by Holcim (Australia) Pty Ltd) between the Project Area and the adjoining lot (Lot 420 DP 1252087) in which the fixed processing plant is located is not within the Project Area.

The existing extraction operations occur for Stages 5 and 6 on Lot 1 DP 858245, with the proposed Stage 7 to occupy part of Lot 1 DP 858245 and part of Lot 7 DP 3709.

The area of overall disturbance would be confined to the current approved extraction area (Stages 1 to 6) and the proposed Stage 7, as shown in **Figure 1**. Disturbance areas associated with the ongoing activities within Stages 1 to 6 cover approximately 16 hectares (ha) and 20 ha within Stage 7.

The main existing and proposed land uses within the Project Area comprise hard rock extraction, material processing, limited product stockpiling and despatch, and periodic receipt of virgin excavated natural material (VENM) and excavated natural material (ENM).

2.1.1 Extraction Operations

Extraction would be undertaken in a staged manner commencing with the removal of services, fences, buildings, associated structures and internal stone walls after which vegetation, topsoil, and subsoil would be removed. All vegetation removed would be mulched or retained as logs and branches for rehabilitation purposes. Topsoil and subsoil stripping would typically be undertaken annually to expose the area in which extraction is planned to occur during the following year. The area stripped annually would vary from approximately 0.5 ha to 2 ha in area. Topsoil and subsoil would either be stockpiled principally within the completed sections of the Stages 1 to 4 extraction area not yet reprofiled and/or rehabilitated, and within Stage 7 in later years of the development. However, during the initial stages of extraction in Stage 7, a proportion of the topsoil and subsoil would be utilised to form the extended amenity barrier along the northern side of Stage 7 and parts of the northern and eastern sides of Stage 7a.

The weathered rock (overburden) would then be extracted using a bulldozer rip method pushing material into stockpiles for excavator/haul truck removal. Weathered rock would either be sold as low-grade fill, incorporated within road pavement products, or incorporated within the final landform.

Stage 7 would be developed in conjunction with the ongoing extraction in Stages 4, 5 and 6. Some limited extraction also remains to be completed in the western parts of Stage 2. The drilling and blasting process would commence in Stage 7 with typical blasts yielding approximately 10 000 t to 100 000 t. Blasting in Stage 7 would be undertaken in the same manner as Stages 5 and 6, which involves best practice design and comprehensive risk assessments in accordance with the Albion Park Quarry Environmental Management Plan.

Extraction within Stage 7 would proceed in a sequential manner with the objective of ultimately operating three active extraction areas/benches for the Upper Latite, Agglomerate and Lower Latite.

2.1.2 Overburden Management

Overburden extracted from Stages 7a and 7b, VENM/ENM imported to the Quarry and low-quality rock unsuitable for use in the production of quarry products would be placed within the current extraction area and either profiled to form part of the final landform or stockpiled and reclaimed for sale, when required. Once extraction is underway in Stage 7c, overburden would be progressively placed as backfill into sections of Stages 7a and 7b where extraction has been completed to establish the final landform.

VENM and ENM would be consistent with the definitions of these products as described in the Protection of the Environment Operations Waste Regulation 2014 and/or the EPA's current Waste Classification Guidelines, and would be sourced as and when they become commercially available. The annual quantity of VENM and ENM imported to the Project Area would vary from 0 to 100 000 tpa.

2.1.3 Extraction Staging

Figure 2 displays the extraction stages within the existing extraction area (Stages 1 to 6) and the four substages of extraction within Stage 7. The Applicant proposes to integrate the proposed extraction in Stage 7 with the remaining resources within Stages 4, 5 and 6. The extraction of remaining resources within Stage 2 would occur throughout the Project life at a time determined by the Quarry Manager.

It is noted that extraction in Stages 7c and 7d would initially be confined to the western side of both substages with extraction concluding in the area referred to as the "Eastern Rim" – see **Figure 2**. This area would be the final area extracted in order to minimise views of extraction operations from the east.

A full description of the extraction staging is provided in Section 3.5.2.3 of the EIS.

For the purposes of the AQIA, three stages of the Project have been subject to quantitative modelling:

- **Stage 7a** – representing potentially significant haulage distances from the southern-most extent of the Stage 7 extraction area.
- **Stage 7b** – representing potentially significant haulage distances from the south-eastern-most extent of the Stage 7 extraction area, closest to the 'Kurrawong' residence (R6).
- **Stage 7d** – representing activities in the north-eastern-most extent of the Stage 7 extraction area, closest to the 'The Cottage' (R1), 'The Hill' (R2) and the approved residence (R3). Two different scenarios were modelled for activities in Stage 7d as described in **Section 2.1.7** and **Section 5.1.2**.

For clarity, extraction and processing of material in Stage 7 would occur in the same manner as it has in Stages 1 to 6 except for the use of the mobile primary jaw crusher in order to extract up to a maximum of 900 000 t of hard rock from the combined Project Area. Extraction and processing would occur in either Stages 1 to 6 or from Stage 7, although material from Stage 7 would be transported through Stages 1 to 6 to the fixed processing plant or the product stockpiling area. This AQIA has assumed that all 900 000 t of material is extracted, processed, loaded and hauled from the Stage 7 area. As such, given that the Stage 7 area is closest to the potentially affected receptors and further from Stages 1 to 6 to the fixed processing plant, emissions associated with the modelled scenarios can be viewed to represent a conservative scenario, and are appropriate to cover the maximum impact associated with extraction of 900 000 t of material in any stage of development, including for the extraction of the remaining resource from Stages 1 to 6.

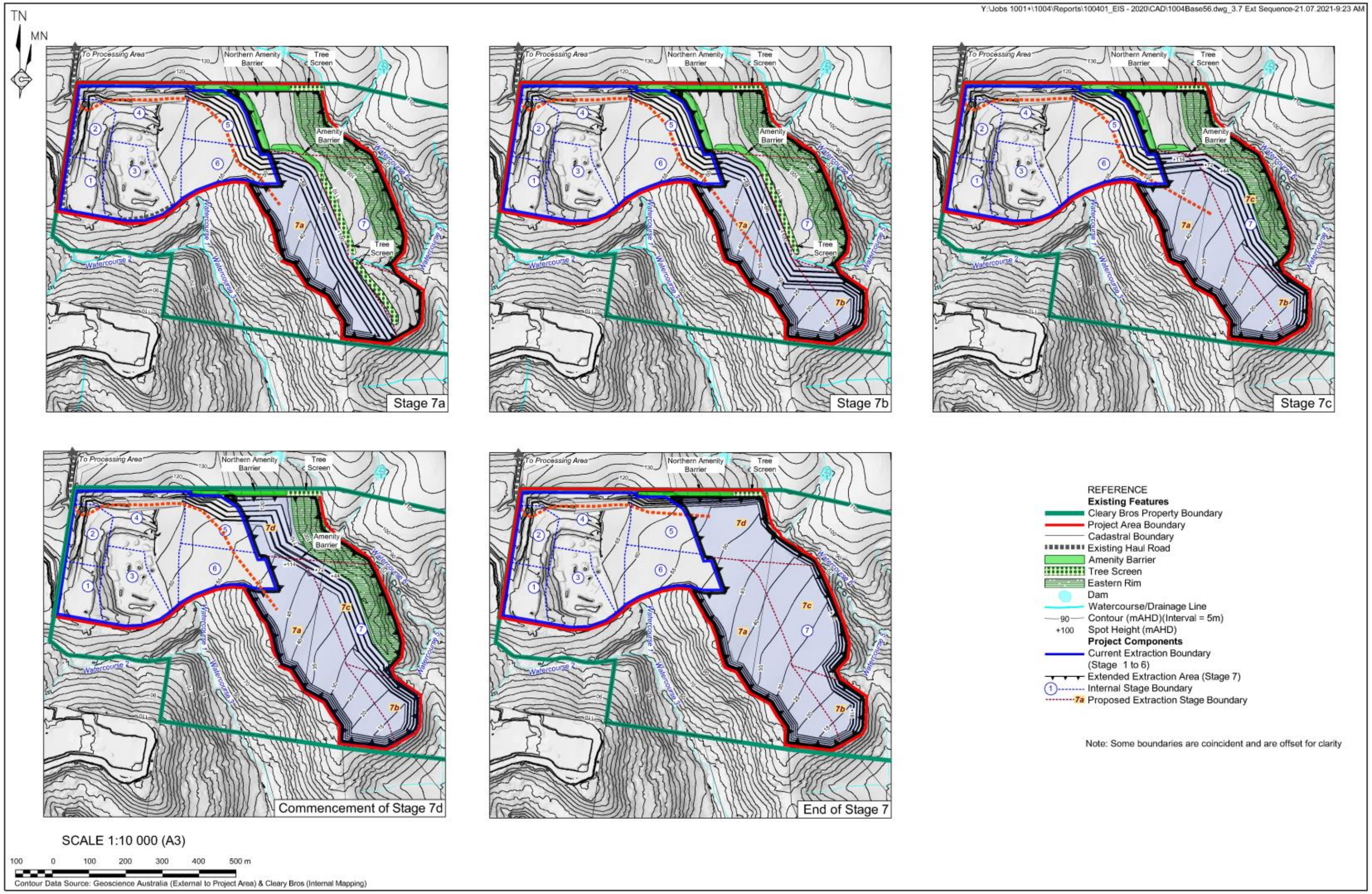
2.1.4 Extraction Rate

The ongoing operation of extraction within the Project Area would retain the current approved maximum annual production level of 900 000 tpa although for planning purposes, an annual average extraction rate of 750 000 tpa is assumed. Annual production levels would vary and reflect market demands for the quarry products. No changes are proposed to the rates of processing, product loading or product despatch. Rather, the rates of these activities would closely match the proposed extraction rates.

Dispersion modelling presented within this AQIA assumes an annual extraction rate of 900 000 tpa.

Cleary Bros (Bombo) Pty Ltd
Albion Park Quarry Extraction Area Stage 7 Extension

Figure 2 Extraction staging



2.1.5 Processing Operations

Primary crushing and screening of the majority of blasted material would be undertaken by a mobile jaw crusher and screen within the Project Area. These processed materials would be loaded into haul trucks and transported to the secondary crushing and screening plant within the Project Area or to the fixed processing plant for additional processing as necessary, stockpiling and load-out for delivery to customers.

The mobile secondary crushing and screening plant would continue to be used on a campaign basis within the Project Area to produce a range of customised products many of which are more suited for production from specialised plant rather than within the fixed processing plant. The principal mobile plant used for this additional crushing and screening is a combined Warrior screening plant used principally to manufacture gabion and ballast materials.

Small stockpiles of products produced within the mobile plants would be established surrounding each mobile plant before they are either transported by haul truck to the main stockpile area near the processing area or transported directly from the extraction area using highway trucks.

2.1.6 Transportation

The bulk of the processed quarry products would continue to be stockpiled adjacent to the fixed processing plant for loading from the product stockpiles and delivery to customers/projects using either Cleary Bros-owned highway trucks or trucks owned by self-haul customers. The transportation of quarry products would continue to operate under separate approvals.

2.1.7 Summary

Table 2 provides a summary of the operational characteristics of the Project in Stages 7a, 7b and 7d. It is noted that the operations in all stages are identical in terms of the materials being extracted and handled, although the routes and lengths of haulage routes, and locations of equipment change by Stage.

The average daily rock extraction and processing rates have been calculated to allow determination of the likely impact of the Project when compared to the relevant annual average air quality criteria. The potential maximum daily extraction and processing rates have been determined through discussions with the Applicant and represent potential 'worst case' rates which are suitable to allow comparison against short-term (24-hour) air quality criteria.

In the construction of the potential 'worst-case' 24-hour activity rates, consideration has been given to the quantity of equipment operating and, for example, the movement of maximum quantities of overburden and topsoil has not been assumed to be able to occur concurrently, due to the limited articulated haul truck (Moxy) fleet. Further description relating to the construction of those maximum daily activity rates can be seen in **Appendix D**.

For Stage 7d, two scenarios have been developed to appropriately account for potential variations of materials throughputs and emission source locations associated with the primary crusher and screen.

Stage 7d - Scenario 1 Primary processing at a location closest to receptors to the northeast of Stage 7d activities, with all overburden and soil removal activities not operational. The rationale for this inventory development is that those overburden and soil removal activities would have ceased by the time the primary crusher and screen is required to be operational at that location. This inventory results in lower total emissions when compared to Scenario 2.

Stage 7d - Scenario 2 Primary processing at a location within the middle of the Stage 7d extraction area, with overburden and soil removal activities operational. This results in higher total emissions that Stage 7d - Scenario 1, and has been developed to assess, in a more realistic sense, the potential impact of those higher total emissions at the nearest sensitive receptor locations.

Table 2 Proposed characteristics of the Project

Parameter	Stage 7a	Stage 7b	Stage 7d Scenario 1	Stage 7d Scenario 2
Extraction operations Drilling operations Blasting operations Processing operations	7.00 am to 5.30 pm, Mon to Fri, 7 am to 1 pm, Sat. No operations Sunday or Public Holiday			
Maintenance	24 hours per day (if inaudible at the nearest residence)			
Operating days per year	300			
Material extraction				
Annual rock extraction rate	900 000 tpa			
Average daily rock extraction rate	3 000 t			
Maximum daily rock extraction rate	4 000 t			
Annual soil extraction rate	20 700 t			
Average daily soil extraction rate	69 t			
Maximum daily soil extraction rate	2,500 t		0 t	2,500 t
Annual overburden extraction rate	99 667 t			
Average daily overburden extraction rate	332 t			
Maximum daily overburden extraction rate	2 500 t		0 t	2,500 t
Number of blast holes drilled	Average 68 holes per blast			
Blasting frequency	26 times per year			
Volume of material removed per blast	Between 10 000 t and 100 000 t			
Equipment	1 × Excavator (Hitachi EX1200 -6)		In pit material extraction	
	4 × Haul truck (CAT 777D (x3) CAT773E (x1))		Material haulage	
	1 × Loader #1 (CAT 992K)		In pit material movement	
	1 × Blasthole drill rig (Furukawa - 1500)		Blast hole drilling	
	1 × Grader (CAT 16G)		Road maintenance	
	1 × Excavator (Komatsu PC800)		Material extraction	
	2 x Articulated haul trucks (CAT Moxy)		Soil/overburden stripping	
	2 x Scrapers (CAT 637E)		Soil/overburden stripping	

Parameter	Stage 7a	Stage 7b	Stage 7d Scenario 1	Stage 7d Scenario 2
	1 x Dozer (Cat D11) Soil/overburden stripping 1 x Water truck (CAT 773B) Dust suppression			
Material processing (within Project area only – all other processing activities covered under separate Approvals)				
Annual material processing rate	900 000 t			
Average daily processing rate	3 000 t			
Maximum daily processing rate	4 500 t			
Equipment	1 × Excavator and Hammer (CAT 330) In pit material extraction and reduction of oversize fragmented rock 1 × Loader #9 (CAT 980C) In pit feeding mobile crusher 1 × Excavator (Kobelco 260B) In pit loading mobile crusher 1 × Mobile Plant, Primary crushing/screening unit (Premiertrak 600) In pit crushing and screening (continual) 1 × Mobile Plant, Secondary crushing/screening unit (Powerscreen Warrior) In pit crushing and screening (campaign)			
On-site material haulage				
Annual rock haulage rate out of Project Area	900 000 t			
Average daily rock haulage rate out of Project Area	3 000 t			
Maximum daily rock haulage rate out of Project Area	4 000 t			
Annual soil haulage rate to soil stockpile	20 700 t			
Average daily soil haulage rate to soil stockpile	69 t			
Maximum daily soil haulage rate to soil stockpile	2 500 t		0 t	2 500 t
Annual overburden haulage rate to overburden emplacement	99 667 t			
Average daily overburden haulage rate to overburden emplacement	332 t			
Maximum daily overburden haulage rate to overburden emplacement	2 500 t		0 t	2 500 t
Annual VENM/ENM import rate	50 000 t			

Parameter	Stage 7a	Stage 7b	Stage 7d Scenario 1	Stage 7d Scenario 2
Average daily VENM/ENM import rate	167 t			
Maximum daily VENM/ENM import rate	1 000 t		0 t	1 000 t
Exposed areas				
Disturbance area	10.5 ha	12.2 ha	26.6 ha	
Disturbance area (Stages 1-6)	9.3 ha			
Soil stockpile (in pit)	(covered by areas above)			
Overburden placed for rehab (in pit)	(covered by areas above)			

2.2 Identified Potential for Emissions to Air

The activities to be conducted throughout the operation of the Project would include:

- Vegetation clearance;
- Topsoil removal;
- Drilling and blasting;
- Materials handling, transfer and storage; and
- Processing of blasted rock through crushers and screens.

The key emissions to air are considered to include:

- Particulate emissions from the extraction, processing and storage of materials;
- Wheel-generated particulate emissions from the haulage of materials on unpaved road surfaces;
- Blasting emissions of particulate and products of combustion; and
- Wind erosion of exposed surfaces.

With regard to blasting emissions, the products of combustion are considered to include particulates (as various size fractions), carbon monoxide (CO) and volatile organic compounds (VOC) generated through the incomplete combustion of fuels in the explosives, and oxides of nitrogen (NO_X) generated through the thermal oxidation of nitrogen (N_2) during the combustion process. Combined, these are typically called 'blast fume'. A poorly managed blast can result in a reddish orange plume resulting from high concentrations of NO_2, with such plumes having a characteristic odour.

Although the overall rate of emission from blasting would be low compared to annualised emissions from the Project, their potential toxicity, rate of release and high concentration during a blasting event means that the AQIA needs to adequately account for those potential impacts and be demonstrated to be able to be managed accordingly.

- Of the components in blast fume, the emission of NO_X is of critical concern due to the toxicity of nitrogen dioxide (NO_2) and nitric oxide (NO). The aggregation of NO_2 and NO is termed as NO_X (NO_X = NO + NO_2).
- Correspondingly, the principal consideration in this AQIA to blasting emissions is particulate matter and NO_X (which is assessed as NO_2).

Further information regarding management of blast fume is detailed in the Noise and Blasting Assessment (SLR, 2021) and in Appendix D. This includes a range of measures aimed at reducing the impacts of blast fume, including odour.

Based upon the Applicant's experience gained in Stages 1 to 6, and the Applicant's use of low NO_X emission explosives, there are anticipated to be no significant sources of odour associated with the Project and 'odour' has not been assessed further in this AQIA.

Emissions of greenhouse gases (GHG) would also be generated through the combustion of fuel in mobile plant and equipment during the operation of the Project. Emissions of GHG may also be generated through the off-site transport of product to markets and through employee vehicle use.

3. LEGISLATION, REGULATION AND GUIDANCE

3.1 NSW EPA Approved Methods

State air quality guidelines adopted by the NSW EPA are published in the *'Approved Methods for the Modelling and Assessment of Air Quality in NSW'* (NSW EPA, 2017) (the Approved Methods) which has been consulted during the preparation of this assessment report.

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 to be applied.

The criteria listed in the Approved Methods are derived from a range of sources (including National Health and Medical Research Council [NHMRC], National Environment Protection Council [NEPC], Department of Environment [DoE], and World Health Organisation [WHO]).

The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW are presented in **Table 3**.

Table 3 NSW EPA air quality standards and goals

Pollutant	Averaging period	Units	Criterion	Notes
Particulates (as PM_{10})	24 hours	$\mu g{\cdot}m^{-3}$ (a)	50	Numerically equivalent to the Ambient Air Quality National Environment Protection Measure (AAQ NEPM)(b) standards and goals.
	1 year	$\mu g{\cdot}m^{-3}$	25	
Particulates (as $PM_{2.5}$)	24 hours	$\mu g{\cdot}m^{-3}$	25	
	1 year	$\mu g{\cdot}m^{-3}$	8	
Particulates (as total suspended particulate [TSP])	1 year	$\mu g{\cdot}m^{-3}$	90	
Deposited dust	1 year	$g{\cdot}m^{-2}{\cdot}month^{-1}$ (c)	2	Assessed as insoluble solids as defined by AS 3580.10.1
		$g{\cdot}m^{-2}{\cdot}month^{-1}$ (d)	4	
Nitrogen dioxide (NO_2)	1 hour	$\mu g{\cdot}m^{-3}$	246	Numerically equivalent to the AAQ NEPM(b) standards and goals.
	1 year	$\mu g{\cdot}m^{-3}$	62	

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

3.2 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations* (POEO) *Act* (1997) sets the statutory framework for managing air quality in NSW, including establishing the licensing scheme for major industrial premises (scheduled activities) and a range of air pollution offences and penalties.

The Project is currently regulated by the EPA under the POEO Act through Environment Protection Licence (EPL) 299. Should the Project be approved, an updated EPL would be issued which would contain a range of requirements related to minimisation of emissions from all activities undertaken on the Applicant's Albion Park property which would be defined as a scheduled activity under the POEO Act.

3.3 Protection of the Environment (Clean Air) Regulation 2010

The Protection of the Environment Operations (POEO) (Clean Air) Regulation (2010) sets standards of concentration for emissions to air from both scheduled and non-scheduled activities. For the activities undertaken within the Project Area, the POEO (Clean Air) Regulation provides general standards of concentration for scheduled premises which are presented in **Table 4** for the pollutants of relevance to this assessment.

Table 4 POEO (Clean Air) Regulation – general standards of concentration

Air Impurity	Activity	Standard of Concentration (Group 6)[1]
Solid particles (total)	Any activity or plant (except as listed below)	50 $mg{\cdot}m^{-3}$
	Any crushing, grinding, separating or materials handling activity	20 $mg{\cdot}m^{-3}$

Further to the requirements in **Table 4**, Part 4 Clause 15 of the POEO (Clean Air) Regulation requires that motor vehicles do not emit excessive air impurities which may be visible for a period of more than 10-seconds when determined in accordance with the relevant standard.

As part of the Project operation, all vehicles, plant and equipment to be used either at the Quarry site or to transport materials to and from the Quarry site, will be maintained regularly and in accordance with manufacturers' requirements. No burning of materials would be performed as part of the ongoing operation of the Quarry.

3.4 NSW Voluntary Land Acquisition and Mitigation Policy

The NSW Government published the "*Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments*" (hereafter, the policy) in September 2018 (NSW Government, 2018). The policy is to be applied by consent authorities when assessing and determining applications for mining, petroleum and extractive industry developments that are subject to State Significant Development provisions of the *Environmental Planning and Assessment Act* 1979.

A number of policies and guidelines include Air Quality Assessment criteria to protect the amenity, health and safety of people, including those outlined in **Section 3.1**. They typically require applicants to implement all reasonable and feasible avoidance and/or mitigation measures to minimise the impacts of a development. In some circumstances however, it may not be possible to comply with these assessment criteria even with the implementation of all reasonable and feasible avoidance and/or mitigation measures. This can occur with large resource projects where the resources are fixed, and there is limited scope for avoiding and/or mitigating impacts. However, as outlined within the policy it is important to recognise that:

- Not all exceedances of the relevant assessment criteria equate to unacceptable impacts.
- Consent authorities may decide that it is in the public interest to allow the development to proceed, even though there would be exceedances of the relevant assessment criteria, because of the broader social and economic benefits of the development.
- Some landowners may be prepared to accept higher impacts on their land, subject to entering into suitable negotiated agreements with applicants, which may include the payment of compensation.

Consequently, the assessment process can lead to a range of possible outcomes.

In the application of the policy, the applicant must demonstrate that all viable alternatives have been considered, and all reasonable and feasible avoidance and mitigation measures have been incorporated into the project design. Should acquisition or mitigation criteria (see **Table 5** and **Table 6**) be exceeded as a result of the project operation then the applicant should consider a negotiated agreement with the affected landowner or acquisition of the affected land. Full details of the negotiated agreement and acquisition process is provided in the policy (NSW Government, 2018).

In relation to air quality, the policy applies specifically to particulate matter (TSP, PM_{10}, $PM_{2.5}$ and dust deposition). Applicants are required to assess the impacts of the development in accordance with the Approved Methods guidance (NSW EPA, 2017). Should exceedances of the relevant particulate matter criteria (refer **Table 3**) be predicted, then comparison with the mitigation and acquisition criteria is performed.

3.4.1 Voluntary Mitigation

As outlined in the policy, a consent authority should only apply voluntary mitigation rights where, even with the implementation of best practice management, the development contributes to exceedances of the mitigation criteria outlined in **Table 7**:

- At any residence on privately-owned land; or
- At any workplace on privately-owned land where the consequences of those exceedances in the opinion of the consent authority are unreasonably deleterious to worker health or the carrying out of business at that workplace, including consideration of the following factors:
  - the nature of the workplace;
  - the potential for exposure of workers to elevated levels of particulate matter;
  - the likely period of exposure; and
  - the health and safety measures already employed in that workplace.

Table 5 Particulate matter mitigation criteria

Pollutant	Averaging period	Units	Criterion	Impact type
$PM_{2.5}$	Annual	$\mu g{\cdot}m^{-3}$ (a)	8	Human health
	24 hours	$\mu g{\cdot}m^{-3}$ (b)	25	Human health
PM_{10}	Annual	$\mu g{\cdot}m^{-3}$ (a)	25	Human health
	24 hours	$\mu g{\cdot}m^{-3}$ (b)	50	Human health
Total suspended particulate (TSP)	Annual	$\mu g{\cdot}m^{-3}$ (a)	90	Amenity
Deposited dust	Annual	$g{\cdot}m^{-2}{\cdot}month^{-1}$ (b)	2	Amenity
		$g{\cdot}m^{-2}{\cdot}month^{-1}$ (a)	4	Amenity

Notes: (a): Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources)
(b): Incremental impact (i.e. increase in concentrations due to the development alone), with zero allowable exceedances of the criteria over the life of the development)

Mitigation measures should be directed towards reducing the potential human health and amenity impacts of the development and must be directly relevant to the mitigation of those impacts.

3.4.2 Voluntary Acquisition

A consent authority should only apply voluntary acquisition rights where, even with the implementation of best practice management, the development is predicted to contribute to exceedances of the acquisition criteria in **Table 8**:

- At any residence on privately-owned land; or

- At any workplace on privately-owned land where the consequences of those exceedances in the opinion of the consent authority are unreasonably deleterious to worker health or the carrying out of business at that workplace, including consideration of the following factors:
  - the nature of the workplace;
  - the potential for exposure of workers to elevated levels of particulate matter;
  - the likely period of exposure; and
  - the health and safety measures already employed in that workplace.
- On more than 25 % of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls[1].

Table 6 Particulate matter acquisition criteria

Pollutant	Averaging period	Units	Criterion	Impact type
$PM_{2.5}$	Annual	$\mu g{\cdot}m^{-3}$ (a)	8	Human health
	24 hours	$\mu g{\cdot}m^{-3}$ (b)	25	Human health
PM_{10}	Annual	$\mu g{\cdot}m^{-3}$ (a)	25	Human health
	24 hours	$\mu g{\cdot}m^{-3}$ (b)	50	Human health
Total suspended particulate (TSP)	Annual	$\mu g{\cdot}m^{-3}$ (a)	90	Amenity
Deposited dust	Annual	$g{\cdot}m^{-2}{\cdot}month^{-1}$ (b)	2	Amenity
		$g{\cdot}m^{-2}{\cdot}month^{-1}$ (a)	4	Amenity

Notes: (a): Cumulative impact (i.e. increase in concentrations due to the development plus background concentrations due to all other sources)
(b): Incremental impact (i.e. increase in concentrations due to the development alone), with up to five allowable exceedances of the criteria over the life of the development.

3.5 Greenhouse Gas Legislation and Guidance

The Australian Government Clean Energy Regulator administers schemes legislated by the Australian Government for measuring, managing, reducing or offsetting Australia's carbon emissions.

Schemes administered by the Clean Energy Regulator include:

- National Greenhouse and Energy Reporting Scheme, under the *National Greenhouse and Energy Reporting Act* (2007).
- Emissions Reduction Fund, under the *Carbon Credits (Carbon Farming Initiative) Act* (2011).
- Renewable Energy Target, under the *Renewable Energy (Electricity) Act* (2000).

[1] Voluntary land acquisition rights should not be applied to address particulate matter levels on vacant land other than to vacant land specifically meeting these criteria.

- Australian National Registry of Emissions Units, under the *Australian National Registry of Emissions Units* Act (2011).

3.5.1 National Greenhouse and Energy Reporting Scheme

The National Greenhouse and Energy Reporting (NGER) scheme, established by the *National Greenhouse and Energy Reporting Act* (2007) (NGER Act), is a national framework for reporting and disseminating company information about greenhouse gas emissions, energy production, energy consumption and other information specified under NGER legislation.

The objectives of the NGER scheme are to:

- inform government policy.
- inform the Australian public.
- help meet Australia's international reporting obligations.
- assist Commonwealth, state and territory government programmes and activities.
- avoid duplication of similar reporting requirements in the states and territories.

Further information on the NGER scheme, specifically the definitions of various scopes and types of GHG emissions which have also been adopted for the purposes of this assessment, is provided in **Section 5.2**.

3.5.2 Relevant NSW Legislation

There is no specific GHG legislation administered within NSW. The NGER scheme (and other identified Commonwealth schemes in **Section 3.5.1**) forms the applicable legislation within NSW.

3.5.3 Guidance

The GHG accounting and reporting principles adopted within this GHG assessment are based on the following financial accounting and reporting standards:

- Australian Government Department of the Environment, Australian National Greenhouse Accounts, National Greenhouse Accounts Factors, July 2018 (DoE, 2018).
- The World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) GHG Protocol: A Corporate Accounting and Report Standard (WRI, 2004).
- ISO 14064-1:2006 (Greenhouse Gases – Part 1: Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removal).
- ISO 14064-2:2006 (Greenhouse Gases – Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of GHG emission reductions or removal enhancements).
- ISO 14064-3:2006 (Greenhouse Gases – Part 3: Specification with guidance for the validation and verification of GHG assertions) guidelines (internationally accepted best practice).

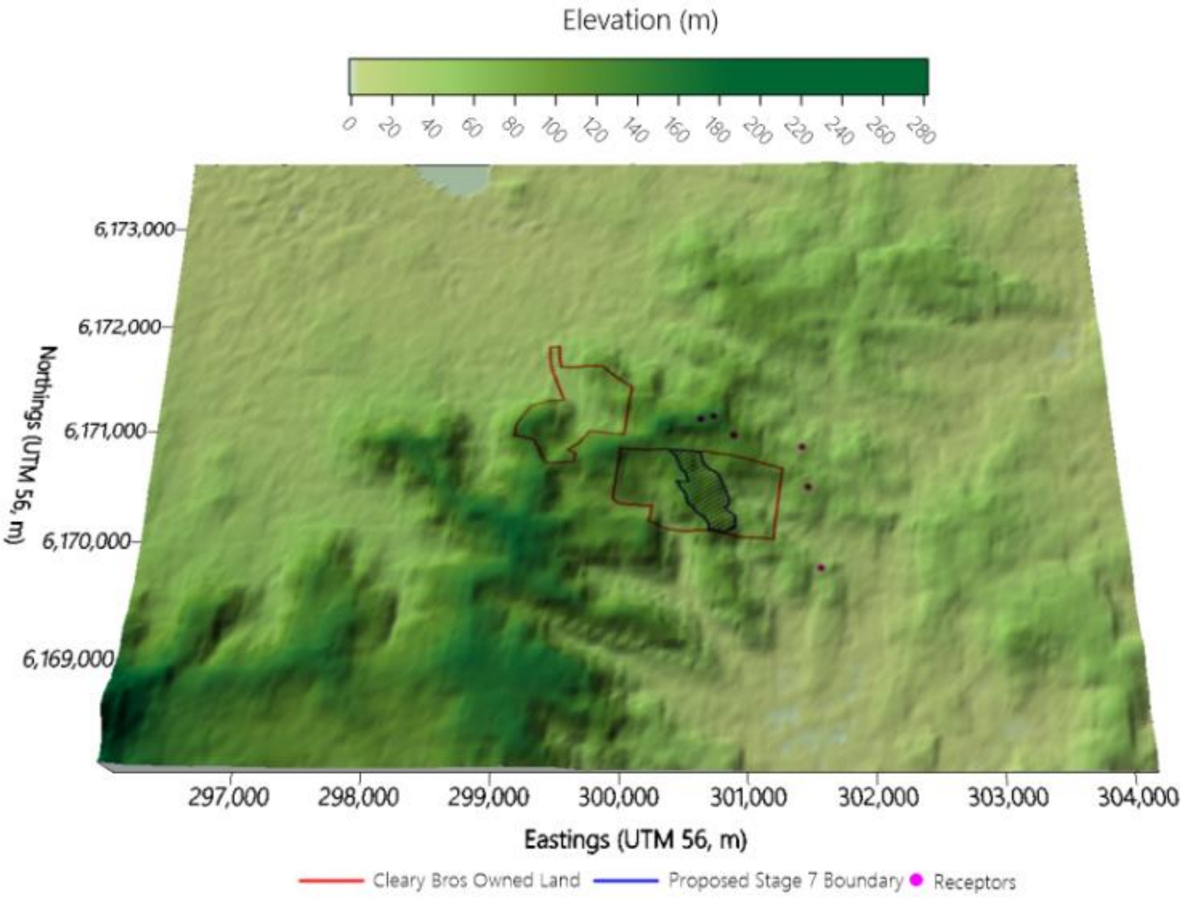
4. EXISTING CONDITIONS

This section provides an overview and description of the existing environment surrounding the Project Area.

4.1 Topography

The Project Area is located in an area of relatively undulating topography containing some ridge formations, as illustrated in **Figure 3**. The proposed Stage 7, as shown in **Figure 3**, occurs at elevations of approximately 120 m to 60 m Australian Height Datum (AHD), however it is noted that the ridges that the existing Quarry Site occupies have been partially excavated by the Applicant and have since reduced in elevation.

Figure 3 Topography surrounding the Project Area



Source: Northstar Air Quality, derived from NASA SRTM 1-arc second data

Figure 3 additionally shows the Project Area boundary and sensitive receptor locations (see **Section 4.2.1**). These are illustrated in the figure to show how topography varies between the Project Area and the various sensitive receptor locations used in the AQIA which is an important consideration in AQIA studies. The topography between the sensitive receptor locations and the Project Area can be considered 'uncomplicated' with gently undulating hills (in AQIA study terms).

4.2 Existing Land Use

4.2.1 Sensitive Land Uses and Land Ownership

AQIA studies typically use a desk-top mapping study to identify 'discrete receptor locations', or 'sensitive receptors', 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 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 can be reasonably assumed to be representative of the immediate environs.

It is further noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations that are used to generate graphical plots of the predicted impacts, and as such the 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.

In accordance with the requirements of the Approved Methods (NSW EPA, 2017), a number of receptor locations representing surrounding residences have been identified and these receptors adopted for use within this AQIA are presented in **Table 7** and illustrated in **Figure 4**. These sensitive receptors have been adopted from the previous assessments undertaken for modifications at the Quarry (refer to **Section 1.2**).

Receptors representing the low-density residential land zoning to the east of the Project Area (as shown on **Figure 5** in the following section), or the nearby school (Shellharbour Anglican College) have not been specifically included in this assessment. The receptors adopted in **Table 7** and illustrated in **Figure 4** are closer to the Project and should compliance with air quality criteria be achieved at these locations, compliance would be anticipated at all other locations further from the Project, in those directions.

Figure 4 Sensitive Receptor Locations

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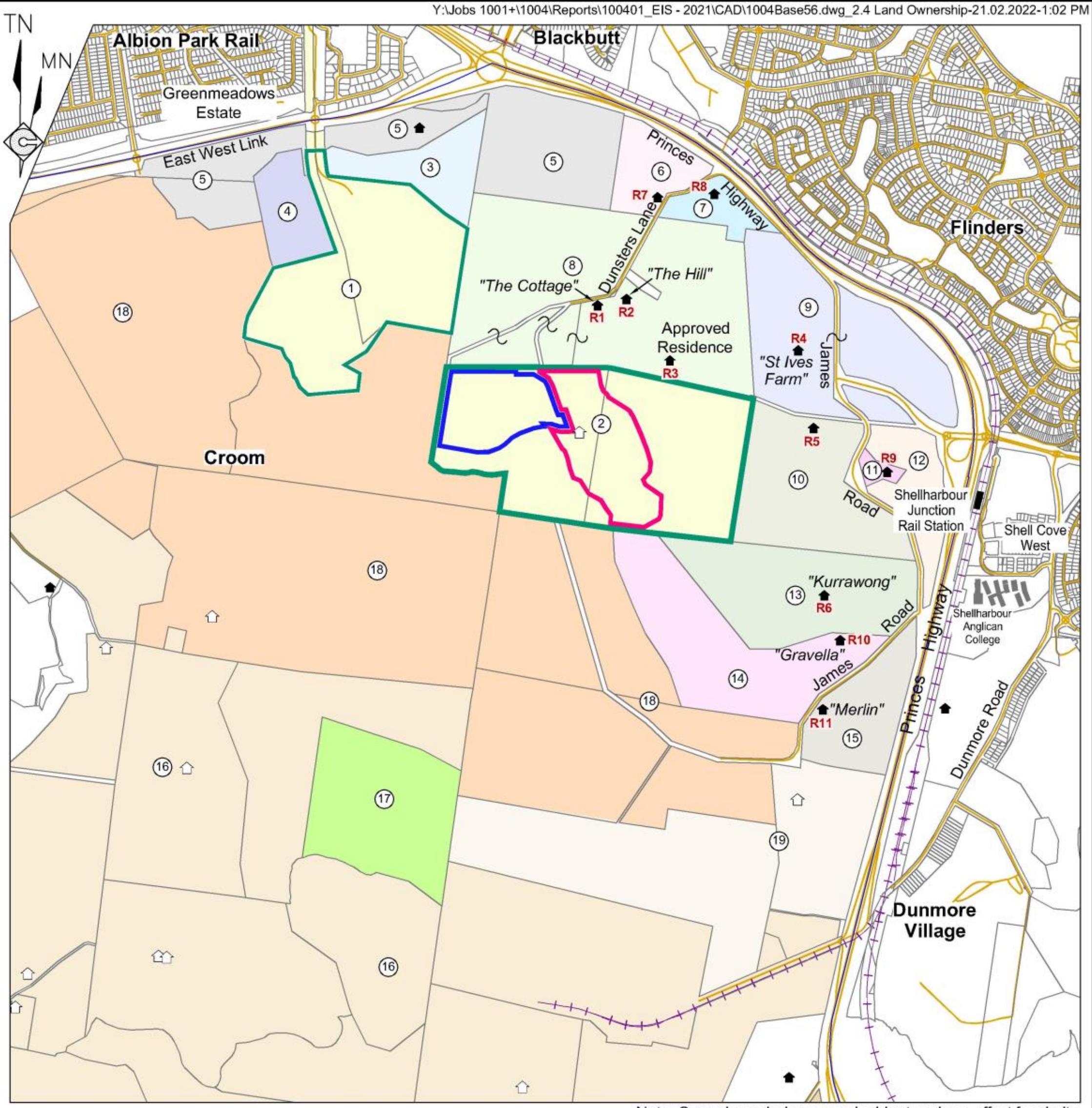


Note: Some boundaries are coincident and are offset for clarity

REFERENCE
- Cleary Bros Property Boundary
- Stages 1 to 6 Boundary
- Stage 7 Boundary
- Cadastral Boundary
- Existing Road (Sealed)
- Existing Railway Line
- Residence (Resource company-owned)
- R6 Residence (Privately-owned)
- Suburban Housing
- (1) Landowner Identifier (See table)
- **Croom** Suburb Identifier

Ref	Landowner
1	Cleary Bros (Bombo) Pty Ltd
2	Bridon Pty Ltd
5	Roads and Maritime Services
8	Figtree Hill Pty Limited
12	Rosemount Heights Pty Ltd
16	Boral Resources (NSW) Pty Ltd
17	Railcorp
18	Holcim (Australia) Pty Ltd
19	Dunmore Sand and Soil Pty Ltd
◯	All other numbered land is privately owned

SCALE 1:30 000 (A4)

500 0 500 1000 1500 m

Landowner Source: Global X Terrain - 2 February 2021

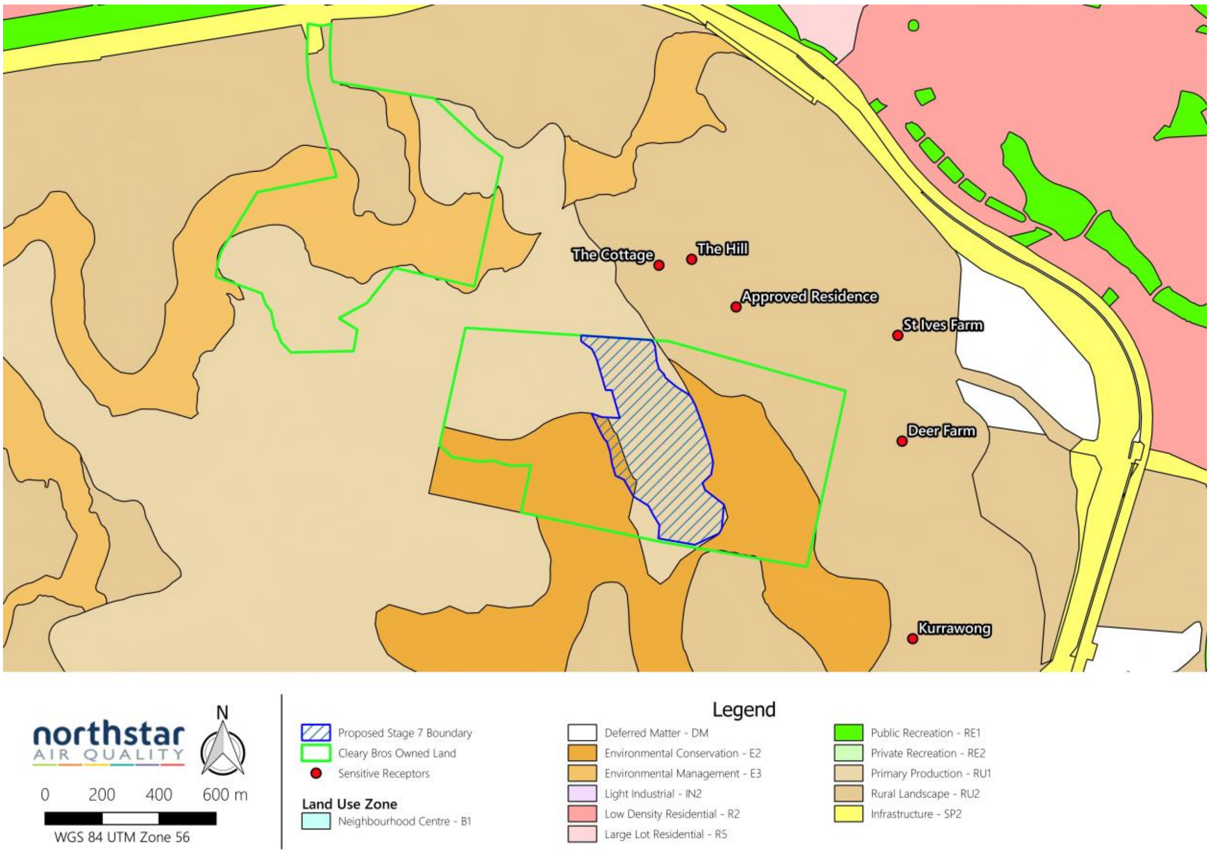
Table 7 Sensitive receptor locations

ID	Name	Location (m, UTM 56)		Distance (m) / direction from Project Area
		Easting	Northing	
R1	The Cottage	300 669	6 171 018	260 / NE
R2	The Hill	300 794	6 171 040	320 / NE
R3	Approved Residence	301 005	6 170 825	250 / ENE
R4	St Ives Farm	301 560	6 170 804	780 / E
R5	Deer Farm	301 616	6 170 465	710 / E
R6	Kurrawong	301 659	6 169 740	790 / SE

4.2.2 Land Use Zoning

The land surrounding the Project Area is predominantly zoned as 'primary production' (RU1) in the Shellharbour Local Environmental Plan (2013). To the west of the Project Area the land is zoned as 'rural landscape' (RU2) and 'environmental conservation' (E2) to the south. The land use and surrounding receptors adopted for this AQIA are illustrated in **Figure 5**.

Figure 5 Land use zoning



Source: Northstar Air Quality Pty Ltd

4.3 Meteorology

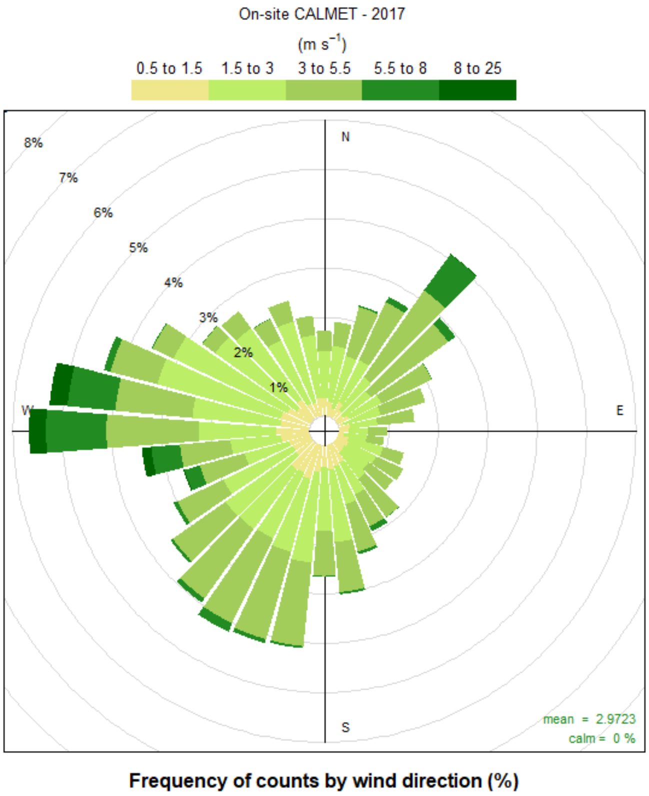
In accordance with the requirements of the NSW EPA Approved Methods, the AQIA is required to describe and account for the influence of the prevailing meteorological conditions.

The meteorology experienced within a given area can influence 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 Project Area have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at surrounding Automatic Weather Stations (AWS), and using measurements collected by the Applicant at the on-site AWS. These data have been used in the selection of a representative year for modelling, and used for the purposes of meteorological model validation. A full description is presented in **Appendix B**.

To provide a characterisation of the meteorology which would be expected at the Project Area, a meteorological modelling exercise has been performed. A full description of the modelling exercise, methods and input data used, and a validation exercise using available observational data is also presented in **Appendix B**.

A summary of the wind conditions predicted by the CALMET model at the Project Area for 2017 is presented in **Figure 6**. These data have been used in the dispersion modelling exercise, as described in **Section 5.1**.

Figure 6 CALMET predicted wind conditions – Project Area, 2017



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.

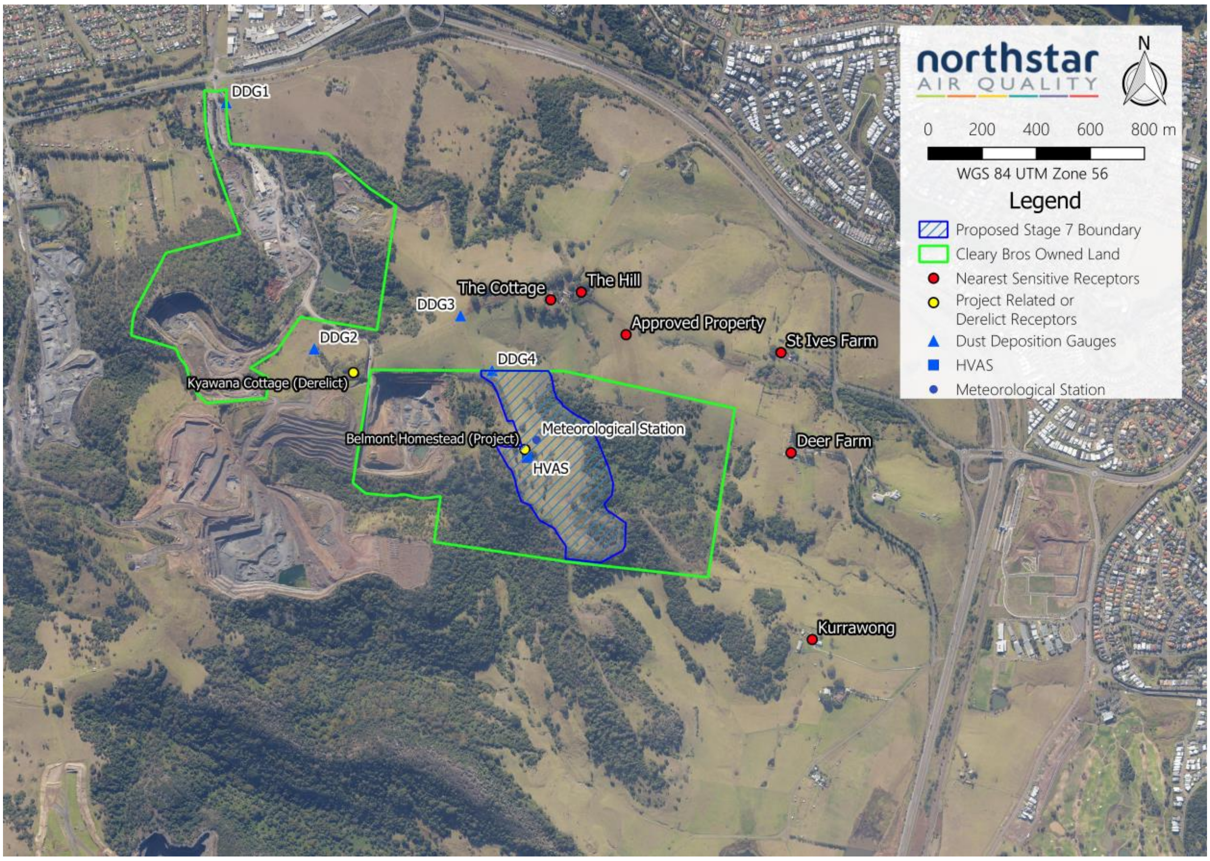
Air quality monitoring is conducted at the Quarry (refer to **Section 4.4.1**) using high volume air samplers (HVAS) for the purposes of assessing compliance with the Development Consent conditions ('compliance monitoring'), however the monitoring frequency (one-day-in-six) specified under Australian Standard (AS) 3580.9.6:2015 is not suitable for use as background air quality data in the AQIA, as it not continuous. Subsequently, alternative monitoring data has been sourced from a representative air quality monitoring station operated by the NSW DPIE (refer to **Section 4.4.2**).

4.4.1 Air Quality Monitoring at the Quarry

The Quarry operates under Development Consent 10639/2005 which includes air quality criteria for PM_{10}. The specified criteria for annual average and 24-hour PM_{10} is 30 $\mu g{\cdot}m^{-3}$ and 50 $\mu g{\cdot}m^{-3}$, respectively. The Development Consent criterion for 24-hour PM_{10} is specified as an incremental criterion (i.e. an increase due to the Quarry on its own).

The Applicant operates an air quality monitoring network at the Quarry for compliance monitoring purposes, including one HVAS for periodic (one-day-in-six) measurement of 24-hour PM_{10} concentrations and four dust deposition gauges (DDG) which measure the monthly rate of dust deposition. The Applicant additionally operates a meteorological monitoring station, as required under EPL 299 Condition M4. The locations of the air quality and meteorological monitoring performed at the Quarry are presented in **Figure 7**. It is noted that some of this equipment would be required to be relocated following activation of the Project, and this is discussed in **Section 8**.

Figure 7 Current Albion Park Quarry air quality monitoring network

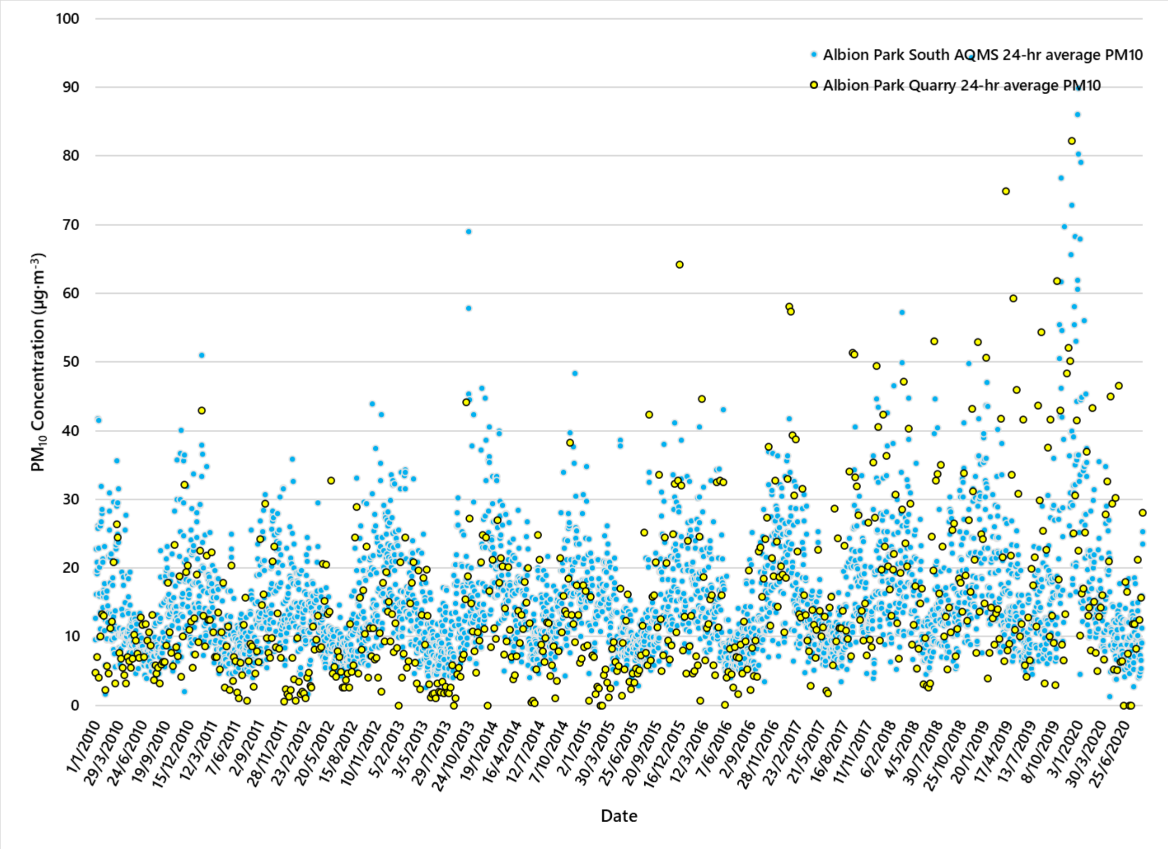


A summary review of PM_{10} monitoring results measured over the full calendar years from 2010 to 2019 is presented in **Table 8**. A graphical representation of these data is provided in **Figure 8** (to August 2020) which also includes 24-hour average PM_{10} measurements from the NSW DPIE air quality monitoring station at Albion Park South (refer **Section 4.4.2**).

Table 8 Existing environmental conditions – total PM_{10} monitoring data (2010 to 2019)

Location	Measured Value									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Maximum 24-hour PM_{10} ($\mu g \cdot m^{-3}$)	32.2	207.0	32.8	44.2	38.3	64.2	44.6	58.1	53.0	82.2
24-hour PM_{10} measurements >50 $\mu g \cdot m^{-3}$ (number)	0	1	0	0	0	1	0	4	2	9
Annual average PM_{10} ($\mu g \cdot m^{-3}$)	9.9	13.8	9.3	9.7	12.2	11.6	13.8	20.2	20.5	24.8

Figure 8 Comparison of PM_{10} measured at the Quarry and Albion Park South AQMS



Note: Y-axis truncated to 100 µg·m^{-3}

Elevated concentrations of 24-hour PM_{10} (over 50 µg·m^{-3}) are noted in the compliance monitoring data record and have been measured in 2011, 2015, 2017, 2018 and 2019. Investigations into these elevated PM_{10} concentrations (available within the Annual Review submissions) have indicated that they were not considered to be attributable to Quarry operations / incidents. The annual average PM_{10} criterion was achieved in all years of monitoring from 2010 to 2019.

The location of the HVAS is noted as being increasingly close to the edge of the current extraction area and not near to a 'sensitive receptor' location. Given the location, the overarching use of the data for compliance purposes, and due to the one-day-in-six frequency of 24-hour PM_{10} measurements using the HVAS, the data is not considered sufficient for use as background air quality data in the AQIA and an alternative source of data has been used (refer to **Section 4.4.2**). Due to the location, should it be used for the purposes of this AQIA, a significant amount of 'double counting' would occur given that the Quarry is currently approved to extract at a rate of up to 900 000 tpa.

The use of the Albion Park South AQMS data to represent 'background' conditions (i.e. all activities not represented by the dispersion modelling assessment presented in this AQIA) is shown through examination of the monitoring data to be appropriate and most likely to be conservative.

Although not required by Development Consent conditions, dust deposition monitoring is performed at the site at four locations in accordance with EPL 299 (DDG1, DDG2, DDG3 and DDG4, refer **Figure 7**). These monitoring results are presented in **Table 9**.

Table 9 Existing environmental conditions – dust deposition monitoring data (2010 to 2019)

Year	Annual Average Deposition Rate ($g \cdot m^{-2} \cdot month^{-1}$)				
	DDG1	DDG2	DDG3	DDG4	Site Average
2009	5.2	2.8	2.4	2.8	3.3
2010	2.8	2.7	2.0	1.8	2.3
2011	2.7	2.5	1.6	1.7	2.1
2012	4.4	1.6	1.6	2.2	2.4
2013	4.5	2.8	0.8	1.5	2.4
2014	3.1	2.8	0.9	1.8	2.2
2015	3.0	2.1	1.1	2.2	2.1
2016	3.2	2.3	2.7	1.6	2.4
2017	3.1	3.1	1.0	2.7	2.5
2018	5.0	2.2	1.0	1.4	2.4
2019	9.1	2.4	1.8	2.1	3.6

Measurements of dust deposition are generally below NSW EPA criteria levels with annual average dust deposition rates measured between 2009 and 2019 below 3.1 $g \cdot m^{-2} \cdot month^{-1}$ at DDG2, DDG3 and DDG4. Exceedances of the annual average dust deposition criterion of 4 $g \cdot m^{-2} \cdot month^{-1}$ have been measured at DDG1 which is located close to the site entrance onto the East West Link Road. Measurements of dust deposition at this location are likely to be influenced by traffic from outside the Quarry in addition to on-site activities. Elevated deposition rates at DDG1 were experienced in 2019 as a result of the Albion Park Rail Bypass works.

Based on the data presented in **Table 9**, a background dust deposition rate of 2.5 $g \cdot m^{-2} \cdot month^{-1}$ (expressed as an annual average) has been adopted for use in the AQIA. This value represents the highest Quarry site average deposition rate experienced over recent years (2017), excluding that associated with the Albion Park Rail bypass works (2019). Given that this dust deposition rate will include an element of current Quarry operations, its adoption can be viewed as conservative.

As outlined within the most recent Air Quality Management Plan (AQMP) for the Quarry (Northstar Air Quality, 2017) and the most recent Annual Review (Cleary Bros, 2020) an updated air quality monitoring network incorporating real-time measurements of PM_{10} is proposed, which will allow an adaptive management approach to minimising air emissions. As outlined on page 35 of (Cleary Bros, 2020):

> *As part of Modification 3 of the DC, Cleary Bros committed to establishing real-time particulate monitors at three locations around the site. During the period, Cleary Bros attempted calibration of the new real time PM_{10} monitors against the existing High Volume Air Sampler (HVAS), however encountered difficulties with this process. The real time particulate monitors have shown excellent consistency between the monitors, but less than acceptable correlation with the HVAS unit, especially during the cooler months*

of the year. These units are currently with the manufacturer for an update which is hoped will improve their performance, and which will then allow for their deployment at the designated locations described in the Air Quality Management Plan.

The AQMP outlines the proposed monitoring locations and the use of data measured at upwind/downwind locations to trigger the implementation of additional particulate controls. The controls implemented as part of the Development have been identified through the performance of a Best Management Practice (BMP) Assessment which was included as part of the AQMP. A brief summary of the BMP Assessment, and any changes which would occur as part of the Project, is discussed in **Section 5.1.4**.

4.4.2 Air Quality Monitoring at NSW DPIE AQMS

The NSW DPIE operates three air quality monitoring stations (AQMS) near the Quarry. The locations of the closest available sources of air quality monitoring data are presented in **Table 10** and in **Figure 9**. **Table 10** additionally provides a summary of the scope of monitoring performed at each AQMS and whether it was operating during 2017 (contemporaneous with the meteorological period used in the dispersion modelling component of this AQIA).

Table 10 Closest DPIE AQMS to the Project Area

Location AQMS	Approximate distance to Project (km)	2017	Measurements			
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Albion Park South (DPIE)	4.2	✓	✓	✓	×	✓
Kembla Grange (DPIE)	12.4	✓	✓	✓	×	✓
Wollongong (DPIE)	19.6	✓	✓	✓	×	✓

The closest identified AQMS to the Quarry with continuous data which is able to be adopted for use in this AQIA is located at Albion Park South and **Appendix C** provides a detailed assessment of the background air quality monitoring data collected at that AQMS.

It is noted that TSP is not measured at any of the identified AQMS which is of relevance to the expected emissions from the Project. Based upon long-term historic monitoring data, a numerical relationship between TSP and PM_{10} has been established for the Lower Hunter, Sydney Metropolitan and Illawarra regions of NSW. Although not site specific, based upon the available data measured within the Illawarra, a relationship between ambient concentrations of TSP : PM_{10} of 2.222 : 1 has been used to approximate background annual average TSP concentrations. This relationship is established and is used frequently in AQIA to approximate background annual average TSP concentrations (see **Appendix C**).

Figure 9 Air quality monitoring stations surrounding the Quarry Site

Source: Northstar Air Quality Pty Ltd

A detailed summary of the background air quality as measured at Albion Park South AQMS is presented in **Appendix C**, and a summary of the air quality monitoring data used in this assessment is presented in **Table 11**.

Table 11 Summary of background air quality used in the AQIA

Pollutant	Averaging Period	Value	Data Source
PM_{10}	24-hour	Daily varying	Albion Park South 2017 Maximum measured 24-hour average PM_{10} in 2017 - 44.7 µg·m^{-3}
	Annual	15.3 µg·m^{-3}	Albion Park South 2017
$PM_{2.5}$	24-hour	Daily varying	Albion Park South 2017 Maximum measured 24-hour average $PM_{2.5}$ in 2017 – 19.3 µg·m^{-3}
	Annual	6.6 µg·m^{-3}	Albion Park South 2017
TSP	Annual	33.9 µg·m^{-3}	Estimated on TSP:PM_{10} ratio of 2.222:1 for Albion Park South 2017
Dust Dep.	Monthly	2.5 g·m^{-2}·month^{-1}	Quarry DDG network average for 2017
NO_2	1-hour	Hourly varying	Albion Park South 2017 Maximum measured 1-hour NO_2 in 2017 – 77.9 µg·m^{-3}
	Annual	6.9 µg·m^{-3}	Albion Park South 2017

It is noted that the Approved Methods (NSW EPA, 2017) requires that background air pollutant concentrations (as summarised above) are added to dispersion model predictions to determine a 'cumulative' impact.

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

4.5 Air Quality Complaints at the Quarry

A review of complaints received by Cleary Bros from 1 July 2017 to 30 June 2020 indicate nine complaints were received relating to air quality issues at the Quarry i.e. the active extraction area, main processing area and product stockpile area. A review of these complaints indicated that the Quarry was being operated appropriately, although one complaint did assist in the identification of a ruptured dust filter on the fixed processing plant which was replaced, and another resulted in the review of site activities and control measures.

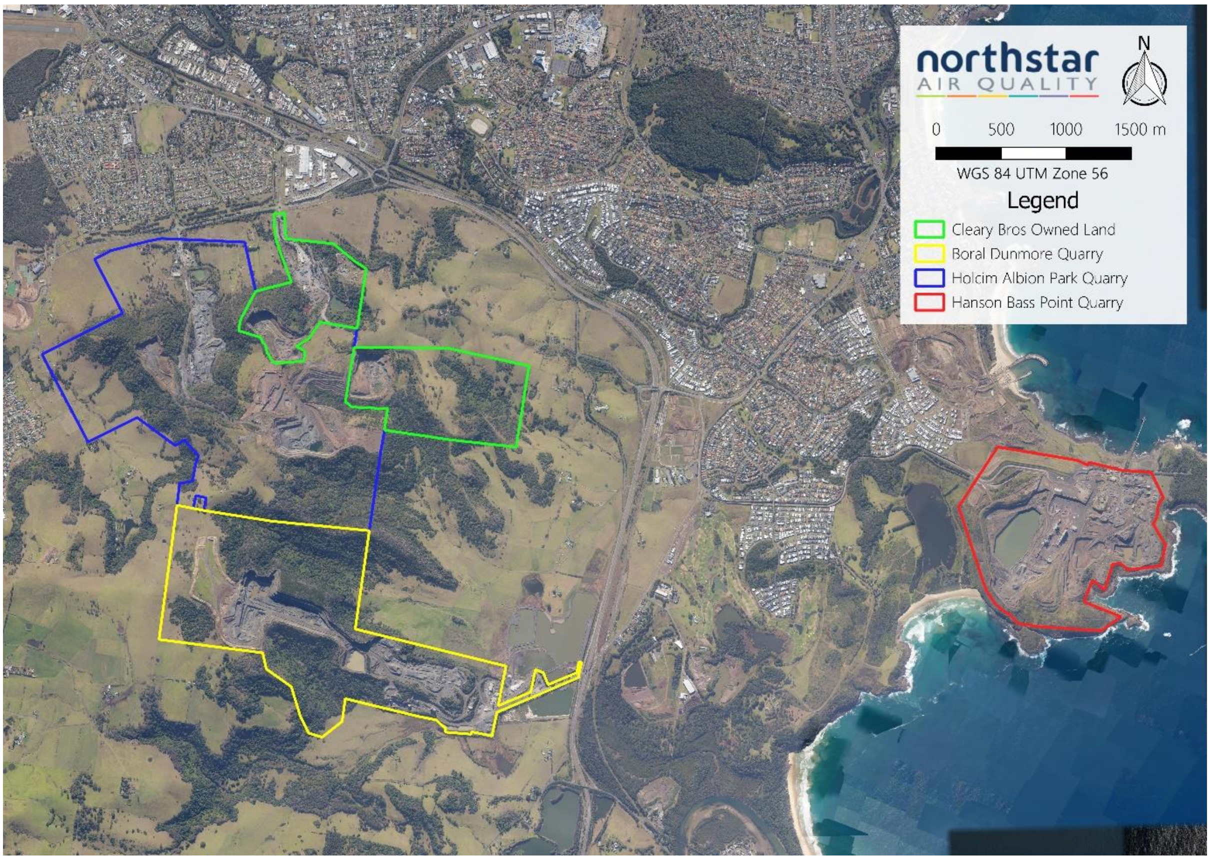
The implementation of the real-time monitoring program will assist in complaint review, with that process being detailed within the AQMP.

4.6 Potential for Cumulative Impacts

A desktop study has been performed to determine the potential for cumulative impacts from similar particulate generating operations conducted in proximity to the Project Area. Three hard rock quarries have been identified in the surrounding area and are illustrated in **Figure 10**.

There is potential for the surrounding quarry operations to result in cumulative impacts at the nearest identified sensitive receptors, and the proposed air quality monitoring program outlined in the AQMP (Northstar Air Quality, 2017) is designed to manage that risk. In relation to the AQIA, previous assessments performed for the Quarry ((Heggies, 2008) (SLR, 2012) (SLR, 2016)) have adopted air quality monitoring data from the Albion Park South AQMS to reflect those cumulative impacts, and this approach is continued within this AQIA.

Figure 10 Locations of surrounding quarrying activities



Source: Northstar Air Quality Pty Ltd

4.7 Greenhouse Gas

Emissions of GHG are tracked by the Commonwealth of Australia through the Australian National Greenhouse Accounts program. This program, and the reports and data submitted as part of the program, fulfils Australia's international and domestic reporting requirements. Carbon emission totals by State and Territory by year and by sector are reported in the 'State and Territory Greenhouse Gas Inventories' report for each reporting year.

These data are used to:

- Meet Australia's reporting commitments under the United Nations Framework Convention on Climate Change (UNFCCC);
- Track progress against Australia's emission reduction commitments; and
- Inform policy makers and the public.

Data from the 2018 report for Australia (DISER, 2020a) and NSW (DISER, 2020b) have been obtained for the purposes of this GHG assessment. These reports are the most recent available at the time of reporting.

Emissions of GHG from Australia in 2018 across all economic sectors were 537.5×10^6 tonnes (Mt) carbon dioxide equivalent (CO_2-e). Emissions from the quarrying industry sector (including metal ore and non-metallic mineral mining and quarrying) accounted for 12.7 Mt CO_2-e, or 2.3 % of total emissions (DISER, 2020a).

GHG emissions in NSW in 2018 were 131.7 Mt CO_2-e with no information provided on the sectoral split of these emissions (DISER, 2020b).

5. APPROACH TO ASSESSMENT

5.1 Air Quality Impact Assessment

The following provides a brief description of the methodology used to assess the potential air quality impacts resulting from the operation of the Project.

As described in **Section 2.2**, the key emissions to air anticipated during the operation of the Project are:

- Particulate emissions from the clearance of vegetation;
- Particulate emissions from the extraction, processing, and storage of materials;
- Wheel-generated particulate emissions from the haulage of materials on unpaved surfaces;
- Blasting emissions of particulate and products of combustion (principally NO_X); and
- Wind erosion of exposed surfaces.

For clarity, the AQIA has quantitatively assessed (i.e. modelled) the impacts of the above activities which occur within the Project Area (incremental impacts). To those incremental impacts are added the background concentrations of air pollutants to determine a cumulative impact. Activities performed by Cleary Bros which are not anticipated to be within the Project Area have been assumed to be represented by background air quality, as discussed in **Section 4.4**.

The calculation of emissions of particulate matter and NO_X from these processes is discussed in detail in **Appendix D**.

A quantitative assessment has been performed to assess the impact of these emissions on surrounding sensitive receptor locations.

5.1.1 Dispersion Modelling

A dispersion modelling assessment has been performed using the NSW EPA approved CALPUFF atmospheric dispersion modelling system.

The CALPUFF modelling system includes three main components: CALMET, CALPUFF and CALPOST and a large set of pre-processing programs designed to interface the model to routinely available meteorological and geophysical datasets.

In the simplest terms, CALMET is a meteorological model that develops hourly wind and temperature fields on a three-dimensional gridded domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET (refer to **Section 4.3** and **Appendix B**).

CALPUFF is a transport and dispersion model that advects "puffs" of material emitted from modelled sources (refer **Appendix D**), simulating dispersion and transformation processes along the way. In doing so, it typically uses the fields generated by CALMET. Temporal and spatial variations in the meteorological fields are explicitly incorporated into the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentrations or deposition fluxes evaluated at selected receptor locations.

CALPOST is used to process the CALPUFF output files, producing tabulations that summarise the results of the simulation (Scire, Strimaitis, & Yamartino, 2000).

In March 2011, NSW OEH (now DPIE) published generic guidance and optimal settings associated with the CALPUFF modelling system for inclusion in the Approved Methods (Barclay & Scire, 2011). These guidelines and settings have been considered in the performance of this assessment.

An assessment of the impacts of the operation of activities within the Project Area has been performed which characterises the likely day-to-day operations, approximating average operational characteristics which are appropriate to assess against longer term (annual average) criteria for particulate matter. The likely peak activities within the Project Area have also been characterised to allow comparison of potential impacts against shorter term (24-hour) criteria for particulate matter. It is noted that the previous assessments performed for the Quarry (refer **Section 1.2**) assumed that the daily peak emissions would be the average of the annual emission rates. Through experience with other assessments, Northstar has derogated from that approach in this AQIA, to allow confidence to the relevant regulatory bodies that the Project can be operated to ensure compliance with short-term air quality criteria, even assuming worst case activity rates and emissions.

The four modelling scenarios (refer **Section 2.1.3**) provide an indication of the air quality impacts of the operation of activities within the Project Area. Added to these impacts are regional background air quality concentrations (as discussed in **Section 4.4** and **Appendix C**) which represent the air quality which would be expected within the area surrounding the Project Area, without the impacts of the Project itself.

5.1.2 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 unpaved site roads, crushing, and wind erosion contained within the US EPA AP-42 emission factor compendium (US EPA, 1995 and updates) to represent the emission of particulate matter resulting from the operations occurring within the Project Area as described in **Section 2**. These factors are appropriate for adoption in Australia and are routinely adopted in the assessment of operations of this nature.

Potential emissions of particulate matter during operations have been quantified, with an emissions inventory associated with the average operational characteristics, and peak characteristics during each stage calculated.

For Stage 7d, two emissions inventories have been developed to appropriately account for potential variations of materials throughputs and emission source locations associated with the primary crusher and screen.

Stage 7d - Scenario 1 Primary processing at a location closest to receptors to the northeast of Stage 7d activities, with all overburden and soil removal activities not operational. The rationale for this inventory development is that those overburden and soil removal activities would have ceased by the time the primary crusher and screen is required to be operational at that location. This inventory results in lower total emissions when compared to Scenario 2.

Stage 7d - Scenario 2 Primary processing at a location within the middle of the Stage 7d extraction area, with overburden and soil removal activities operational. This results in higher total emissions that Stage 7d - Scenario 1, and has been developed to assess, in a more realistic sense, the potential impact of those higher total emissions at the nearest sensitive receptor locations.

Results for both scenarios are presented within this report.

A full description of the emission sources included in the assessment, and the emission factors and assumptions adopted are presented in **Appendix D**.

The AQMP for the Quarry operation (Northstar Air Quality, 2017) identifies that during certain wind conditions, activities at the Quarry would be modified to ensure that excessive dust is not generated and transported to nearby sensitive receptors. The quantification of emissions for the Project, especially during the 'worst-case' 24-hour scenarios, does not take into account these modifications, and therefore the modelled increments can be viewed as being highly conservative as operational controls implemented through the AQMP will have mitigated emissions and subsequent impacts.

5.1.3 Emissions Controls

Emissions controls will be employed as part of the Project. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the Project operation.

A summary of the emissions reductions measures that would be adopted as part of the Project operation is presented in **Table 12**. These emission reductions are outlined in the NPI EETM for Mining (NPI, 2012), (Katestone, 2011) and relevant AP-42 documentation (US EPA, 1995).

Table 12 Summary of emission reduction methods adopted as part of Project operation

Emission control method	Control efficiency (%)
Use of dust filters on drill rig	99
Application of water on haulage routes (internal) at a rate of >2 $L \cdot m^{-2} \cdot hr^{-1}$ subject to the prevailing meteorological conditions	75
Limiting of on-site vehicle speeds to less than or equal to 30 $km \cdot hr^{-1}$	50
Application of water during materials processing	77.7 (primary crushing) 91.2 (screening) 50 (movement of moist material to stockpiles immediately following processing)
Retention of particulate matter in sub-ground level areas (pit retention)	95 (TSP) 5 (PM_{10} and $PM_{2.5}$)

5.1.4 Best Management Practice

A site-specific Best Management Practice (BMP) assessment was performed for the Quarry as part of the AQMP (Northstar Air Quality, 2017). That assessment (based on an annual extraction rate of 900 000 tpa) indicated that the major source of particulate matter was associated with materials haulage. Based on the emissions inventories presented within this AQIA (refer **Appendix D**), that conclusion remains valid.

The Applicant operates a fleet of large capacity haul trucks (CAT 777 and CAT 773) which were purchased specifically to result in minimisation of vehicle kilometres travelled. Watering of haul roads occurs, and the operation of haulage activities mainly at sub-ground level (i.e. in-pit) results in retention of particulate matter.

The operation of the Trigger Action Response Plan (TARP) and the additional management procedures are discussed in **Section 8**, would also assist to reduce the quantity of particulate matter being generated within the Project Area during adverse conditions, and also act to minimise the transportation of any generated particulates towards sensitive receptor locations.

It is noted that there have been issues with the deployment of the real-time air quality monitoring network at the Quarry (refer **Section 4.4.1**), however Cleary Bros is committed to demonstrating their suitability as a tool for measuring particulate matter, which will allow for their deployment at the designated locations described in the Air Quality Management Plan (or subsequent updates).

Based on the foregoing, the distribution of uncontrolled and controlled particulate emissions in each stage subject to assessment is presented in **Appendix D**.

Further discussion of these control measures is presented in **Section 8**.

5.1.5 NO to NO_2 Conversion

The conversion of NO to NO_2 has been assumed to be in accordance with Method 2 of the NSW EPA Approved Methods (section 8.1.2 of (NSW EPA, 2017)). This is termed the Ozone Limiting Method (OLM). This method assumes that all the available ozone in the atmosphere will react with NO in the plume until either all the ozone (O_3) or all the nitrous oxide (NO) is depleted. This approach assumes that the atmospheric reaction is instant, although in reality the reaction takes place over a number of hours.

A level 2 assessment has been performed which uses the contemporaneous hourly model predictions of NO_X and measured hourly NO_2 and O_3 concentrations at the Albion Park South AQMS in 2017.

$$[NO_2]_{total} = \{0.1 \times [NO_x]_{pred}\} + MIN\left\{(0.9 \times [NO_x]_{pred}\ or\ \left(\frac{46}{48}\right) \times [O_3]_{bkgrd}\right\} + [NO_2]_{bkgrd}$$

where:

$[NO_2]_{total}$ = the predicted concentration of NO_2 in $\mu g{\cdot}m^{-3}$

$[NO_x]_{pred}$ = the dispersion model prediction of the ground level concentration of NO_X in $\mu g{\cdot}m^{-3}$

$[O_3]_{bkgrd}$ = the background ambient O_3 concentration in $\mu g{\cdot}m^{-3}$

$\left(\frac{46}{48}\right)$ = the ratio of molar mass of NO_2 and O_3

$[NO_2]_{bkgrd}$ = the background ambient NO_2 concentration in $\mu g{\cdot}m^{-3}$

5.2 Greenhouse Gas Assessment

The purpose of the GHG assessment is to examine the potential impacts of the operation of the Quarry relating to emissions of GHG. A quantitative assessment of emissions is performed with direct emissions compared with total national and NSW GHG emissions for context (refer **Section 4.7**).

The scope of the GHG assessment is to provide a quantitative assessment of GHG emissions arising from the operation of the Quarry. This report does not provide a definitive quantification of GHG emissions arising from the Quarry operation but provides the general context of the likely quantum of emissions.

Opportunities for reduction of GHG emissions are discussed.

5.2.1 Emission Types

The Australian Government Department of the Environment (DoE) document, "National Greenhouse Accounts Factors" Workbook (NGA Factors) (DISER, 2020) defines two types of GHG emissions (see **Table 13**), namely 'direct' and 'indirect'. This assessment considers both direct emissions and indirect emissions resulting from the Project operation.

Table 13 Greenhouse gas emission types

Emission Type	Definition
Direct	Produced from sources within the boundary of an organisation and as a result of that organisation's activities (e.g. consumption of fuel in on-site vehicles)
Indirect	Generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation (e.g. consumption of purchased electricity).

Note: Adapted from NGA Factors Workbook (DISER, 2020)

5.2.2 Emission Scopes

The NGA Factors (DISER, 2020) identifies two 'scopes' of emissions for GHG accounting and reporting purposes as shown in **Table 14**.

Table 14 Greenhouse gas emission scopes

Emission Scope	Definition
Scope 1	Direct (or point-source) emission factors give the kilograms of carbon dioxide equivalent (CO_2-e) emitted per unit of activity at the point of emission release (i.e. fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal, etc.). These factors are used to calculate Scope 1 emissions.
Scope 2	Indirect emission factors are used to calculate Scope 2 emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed. Scope 2 emissions are physically produced by the burning of fuels (coal, natural gas, etc.) at the power station.

Note: Adapted from NGA Factors Workbook (DISER, 2020)

A third scope of emissions, Scope 3 Emissions, are also recognised in some GHG assessments. The Greenhouse Gas Protocol (GHG Protocol) (WRI, 2004) defines Scope 3 emissions as "other indirect GHG emissions":

> *"Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of Scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services."*

Electricity would not be consumed as part of the Project, apart from minor requirements for small demands (such as the HVAS). Electricity consumption as part of the Proposal has been assumed to be negligible for the purposes of this assessment.

Scope 3 emissions related to the transport of materials from the Quarry Site are considered in this assessment. Emissions of GHG resulting from the extraction and transport of fuels, and the use of fuels in employee transport have also been considered.

5.2.3 Source Identification and Boundary Definition

The geographical boundary set for the GHG assessment covers the Project Area but also includes the transport of materials from the Quarry.

All Scope 1 and Scope 3 emissions within the defined boundary have been identified and reported as far as possible (as noted above, electricity [a Scope 2 emission] is not likely to represent a large contribution to total energy consumed as part of the Project).

5.2.4 Emission Source Identification

The activities/operations being performed as part of the Project which have the potential to result in emissions of GHG are presented in **Table 15**. Emissions of GHG resulting from land clearance have not been estimated, given that the site will be rehabilitated at the end of the extraction period.

Table 15 Greenhouse gas emission sources

Proposal Component	Scope	Emission Source Description
Consumption of diesel fuel in mobile plant and equipment at the Site	1,3	Emissions from combustion of fuel (scope 1) Emissions associated with extraction and processing of fuel (scope 3)
Consumption of diesel fuel / unleaded fuel for employee transport purposes	3	Emissions associated with the extraction and processing of fuels
Consumption of diesel fuel for product transport purposes	1,3	Emissions associated with the extraction and processing of fuels

5.2.5 Emissions Estimations

Emissions of GHG from each of the sources identified in **Table 15** have been calculated using activity data for each source per annum (e.g. kL diesel fuel) and the relevant emission factor for each source.

The assumptions used in the calculation of activity data for each emissions source are presented below. Emission factors are presented in the following section.

5.2.6 Activity Data

Information relating to the quantities of diesel and unleaded fuel used as part of the Project have been provided by the Applicant. In the calculation of certain values, assumptions have been made based on the levels of activity at the Site. These data and assumptions are outlined in **Table 16.**

Table 16 Calculated activity data

Project Component	Assumptions	Activity	Units
Consumption of diesel fuel in mobile plant and equipment at the Project Area	Information provided by the Applicant indicates the diesel fuel use to be 1 072.5 kL per annum	1 072.5	$kL{\cdot}annum^{-1}$
Consumption of diesel fuel / unleaded fuel for employee transport purposes	27 full-time equivalent positions to be generated by the Quarry Assume employees reside in Albion Park (13 km as a two-way journey) 300 days per year 10.6 L per 100km fuel efficiency (ABS, 2017)	11.2	$kL{\cdot}annum^{-1}$
Consumption of diesel fuel for product transportation purposes	Laden trucks to travel: Assumed on average 110 km round trip 30 000 trips (30 t loads) 53.6 L per 100 km fuel efficiency (ABS, 2017)	1 768.8	$kL{\cdot}annum^{-1}$

5.2.7 Emission Factors

Emissions factors used for the assessment of GHG emissions associated with existing operations and the operation of the Project have been sourced from the NGA Factors (DISER, 2020) (refer to **Table 17**).

Table 17 Greenhouse gas emission factors

Emission Scope	Emission Source	Emission Factor	Energy Content Factor
Scope 1	Diesel fuel for mobile plant and equipment	70.4 kg CO_2-e GJ^{-1}	38.6 $GJ{\cdot}kL^{-1}$
	Diesel fuel for product transportation	70.4 kg CO_2-e GJ^{-1}	38.6 GJ·kL-1
Scope 3	Diesel fuel for mobile plant and equipment	3.6 kg CO_2-e GJ^{-1}	38.6 $GJ{\cdot}kL^{-1}$
	Unleaded fuel for employee transport	3.6 kg CO_2-e GJ^{-1}	34.2 $GJ{\cdot}kL^{-1}$
	Diesel fuel for material transport	3.6 kg CO_2-e GJ^{-1}	38.6 $GJ{\cdot}kL^{-1}$

6. AIR QUALITY IMPACT ASSESSMENT

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 Project in isolation.
- Cumulative impact – relates to the incremental concentrations predicted as a result of the operation of the Project PLUS the background air quality concentrations discussed in **Section 4.4**.

The results are presented in this manner to allow examination of the likely impact of the Project 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

6.1 Particulate Matter - Annual Average TSP, PM_{10} and $PM_{2.5}$

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the operations in the four modelled stages of the Project are presented in **Table 18**, **Table 19** and **Table 20**, respectively.

The results indicate that predicted incremental concentrations of TSP at receptor locations are low, and less than (<) 5.9 % of the annual average criterion. With the addition of existing background concentrations which represent a regional baseline air quality, cumulative impacts are predicted to be <44 % of the criterion in all stages of operation.

The results indicate that predicted incremental concentrations of PM_{10} at receptor locations are low, and < 19 % of the annual average criterion. With the addition of existing background concentrations which represent a regional baseline air quality, cumulative impacts are predicted to be < 80.2 % of the criterion in all stages of operation.

Table 18 Predicted annual average TSP concentrations

Receptor	Annual Average TSP Concentration ($\mu g{\cdot}m^{-3}$)											
	Stage 7a			Stage 7b			Stage 7d – Scenario 1			Stage 7d – Scenario 2		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	2.2	33.9	36.1	2.4	33.9	36.3	5.3	33.9	39.2	5.0	33.9	38.9
R2	1.8	33.9	35.7	2.0	33.9	35.9	4.1	33.9	38.0	4.0	33.9	37.9
R3	1.6	33.9	35.5	2.2	33.9	36.1	4.3	33.9	38.2	4.3	33.9	38.2
R4	0.2	33.9	34.1	0.5	33.9	34.4	0.5	33.9	34.4	0.5	33.9	34.4
R5	0.4	33.9	34.3	0.7	33.9	34.6	0.9	33.9	34.8	0.9	33.9	34.8
R6	0.1	33.9	34.0	0.3	33.9	34.2	0.3	33.9	34.2	0.3	33.9	34.2
Criterion	-	90		-	90		-	90		-	90	

Table 19 Predicted annual average PM_{10} concentrations

Receptor	Annual Average PM_{10} Concentration ($\mu g \cdot m^{-3}$)											
	Stage 7a			Stage 7b			Stage 7d –Scenario 1			Stage 7d – Scenario 2		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	1.9	15.3	17.2	2.0	15.3	17.3	4.7	15.3	20.0	4.4	15.3	19.7
R2	1.5	15.3	16.8	1.7	15.3	17.0	3.7	15.3	19.0	3.6	15.3	18.9
R3	1.4	15.3	16.7	1.9	15.3	17.2	3.9	15.3	19.2	3.9	15.3	19.2
R4	0.2	15.3	15.5	0.3	15.3	15.6	0.5	15.3	15.8	0.4	15.3	15.7
R5	0.3	15.3	15.6	0.6	15.3	15.9	0.8	15.3	16.1	0.8	15.3	16.1
R6	0.1	15.3	15.4	0.2	15.3	15.5	0.3	15.3	15.6	0.3	15.3	15.6
Criterion	-	25		-	25		-	25		-	25	

Table 20 Predicted annual average $PM_{2.5}$ concentrations

Receptor	Annual Average $PM_{2.5}$ Concentration (µg·m^{-3})											
	Stage 7a			Stage 7b			Stage 7d – Scenario 1			Stage 7d – Scenario 2		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	0.3	6.6	6.9	0.3	6.6	6.9	0.7	6.6	7.3	0.3	6.6	6.9
R2	0.2	6.6	6.8	0.3	6.6	6.9	0.6	6.6	7.2	0.2	6.6	6.8
R3	0.2	6.6	6.8	0.3	6.6	6.9	0.6	6.6	7.2	0.2	6.6	6.8
R4	<0.1	6.6	6.7	<0.1	6.6	6.7	<0.1	6.6	6.7	<0.1	6.6	6.7
R5	<0.1	6.6	6.7	<0.1	6.6	6.7	0.1	6.6	6.7	<0.1	6.6	6.7
R6	<0.1	6.6	6.7	<0.1	6.6	6.7	<0.1	6.6	6.7	<0.1	6.6	6.7
Criterion	-	8		-	8		-	8		-	8	

The results indicate that predicted incremental concentrations of $PM_{2.5}$ at receptor locations are also low, and < 8.8 % of the annual average criterion. With the addition of existing background concentrations which represent a regional baseline air quality, cumulative impacts are predicted to be ≤ 91.3 % of the criterion in all stages of operation.

No contour plots of annual average TSP, PM_{10} or $PM_{2.5}$ are presented, given the minor predicted contribution from the operations within the Project Area at the nearest relevant sensitive receptors.

6.2 Particulate Matter – Annual Average Dust Deposition Rates

The predicted annual average dust deposition resulting from the operations in the four modelled stages of the Project are presented in **Table 21**.

The maximum modelled incremental dust deposition rates in any of the modelled stages is <5 % of the relevant criterion, and the addition of the assumed background dust deposition rate of 2.5 $g \cdot m^{-2} \cdot month^{-1}$ result in a maximum cumulative dust deposition rate of 65 % of the criterion.

No contour plot of annual average dust deposition is presented, given the minor predicted contribution from the operations within the Project Area at the nearest sensitive receptors.

Table 21 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition (g·m^{-2}·month^{-1})											
	Stage 7a			Stage 7b			Stage 7a			Stage 7d – Scenario 2		
	Incremental Impact	Background	Incremental Impact	Incremental Impact	Incremental Impact	Cumulative Impact	Incremental Impact	Background	Incremental Impact	Incremental Impact	Incremental Impact	Cumulative Impact
R1	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6
R2	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6
R3	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6
R4	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6
R5	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6
R6	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6	<0.1	2.5	2.6
Criterion	2	-	4	2	-	4	2	-	4	2	-	4

6.3 Particulate Matter - Maximum 24-hour Average

Presented in **Table 22** are the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest sensitive receptors as a result of the operations within the Project Area during each of the four stages of operation assessed. No background concentrations are included within this table. Maximum concentrations in each stage/phase are highlighted **in bold**.

Once again, it is noted that these predicted incremental concentrations represent a worst-case assessment, as operations within the Project Area are currently modified according to wind speed and direction as outlined within the AQMP (see **Section 5.1.3** and **5.1.4**). The use of the air quality monitoring network (currently being implemented) will allow real-time assessment of incremental and cumulative PM_{10} concentrations in the direction of the sensitive receptors, and subsequently allow the implementation of additional and pro-active control measures, and/or modification of activities to ensure that air quality criteria are not exceeded.

These predicted values should therefore be viewed as an assessment of compliance rather than the concentrations which would be likely to be experienced during operations, which would be anticipated to be significantly lower. Limitations in dispersion modelling do not allow the adjustment of emissions during specific wind conditions, and NSW EPA has previously indicated through other projects, that the inclusion of activity modification in specific wind directions/speeds is not an appropriate manner in which to demonstrate compliance.

Table 22 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average concentration (µg·m^{-3})							
	Stage 7a		Stage 7b		Stage 7d – Scenario 1		Stage 7d – Scenario 2	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
R1	18.2	2.4	15.3	1.9	**33.4**	4.4	31.0	3.9
R2	11.9	1.5	14.3	1.7	32.2	**4.7**	26.3	3.7
R3	15.9	2.2	16.5	2.2	22.6	3.9	24.7	3.9
R4	3.6	0.4	3.6	0.5	3.6	0.5	4.5	0.6
R5	4.3	0.6	5.4	0.7	4.3	0.6	5.5	0.7
R6	1.5	0.2	2.6	0.3	1.8	0.2	2.4	0.3
Criteria	50	25	50	25	50	25	50	25

Tables 23 to **26** present the predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the Project, with background included, i.e. for the stage of operations in which the highest concentrations are predicted (Stage 7d [both scenarios]) and for the receptor at which the highest incremental and cumulative PM_{10} and $PM_{2.5}$ impacts have been predicted.

The left side of the tables show the highest predicted cumulative concentrations (typically on days with the highest background contribution) (R3 for PM_{10}, R5 for $PM_{2.5}$), and the right side of the tables shows the highest predicted incremental concentrations and the resultant cumulative impacts (R1 for PM_{10}, R2 for $PM_{2.5}$).

Model predictions presented in **Table 23** and **Table 25** indicate that the Project can be operated without resulting in any exceedances of the 24-hour average PM_{10} impact assessment criterion.

Model predictions presented in **Table 24** and **Table 26** indicate that the Project can be operated without resulting in any exceedances of the 24-hour average $PM_{2.5}$ impact assessment criterion.

As previously indicated, these incremental concentrations are highly unlikely to occur as a result of the Project, due to the implementation of the Trigger Action Response Plan, which aids in the modification of activities based on measured particulate data. These concentrations are presented to provide confidence that the Project could be operated at those maximum rates, or with processing equipment located close to receptors, without additional exceedances of the PM_{10} criterion being experienced.

Contour plots of the incremental contribution of the proposed operations within the Project Area to the 24-hour average PM_{10} and $PM_{2.5}$ concentrations during Stage 7d -Scenario 1 are presented in **Figure 11** and **Figure 12** respectively.

Table 23 Summary of contemporaneous impact and background – PM_{10} Stage 7d – Scenario 1

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) Receptor 3			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$) Receptor 1		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
15/01/2017	22.6	24.9	47.5	19/06/2017	33.4	10.4	43.8
14/12/2017	<0.1	44.6	44.7	9/03/2017	28.2	16.3	44.5
19/12/2017	0.7	43.4	44.1	10/06/2017	28.1	11.6	39.7
24/09/2017	2.0	40.6	42.6	21/05/2017	26.3	10.5	36.8
23/01/2017	<0.1	41.7	41.8	17/06/2017	25.3	14.3	39.6
13/01/2017	2.3	35.6	37.9	16/04/2017	25.1	15.6	40.7
25/01/2017	2.8	33.9	36.7	12/06/2017	24.9	9.1	34.0
11/05/2017	12.8	23.7	36.5	2/04/2017	24.8	14.7	39.5
17/01/2017	<0.1	36.4	36.5	13/06/2017	22.9	10.4	33.3
1/12/2017	<0.1	36.3	36.4	16/06/2017	21.4	10.5	31.9
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.			

Table 24 Summary of contemporaneous impact and background – $PM_{2.5}$ Stage 7d – Scenario 1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor 5			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$) – Receptor 2		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
19/12/2017	0.1	19.3	19.4	13/06/2017	4.7	5.5	10.2
12/05/2017	<0.1	16.6	16.7	1/07/2017	3.1	7.8	10.9
11/05/2017	0.2	15.8	16.0	15/01/2017	3.1	9.8	12.9
14/12/2017	<0.1	15.2	15.3	1/08/2017	2.9	5.1	8.0
23/09/2017	<0.1	14.4	14.5	8/06/2017	2.8	5.7	8.5
12/02/2017	0.2	14.1	14.3	16/06/2017	2.7	8.8	11.5
13/01/2017	0.1	14.0	14.1	17/06/2017	2.6	10.9	13.5
11/02/2017	<0.1	14.1	14.2	4/06/2017	2.3	5.7	8.0
3/09/2017	0.2	13.8	14.0	24/03/2017	2.3	5.3	7.6
17/01/2017	<0.1	13.0	13.1	26/01/2017	2.1	6.9	9.0
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.			

Table 25 Summary of contemporaneous impact and background – PM_{10} Stage 7d – Scenario 2

Date	24-hour average PM_{10} concentration ($\mu g{\cdot}m^{-3}$) Receptor 3			Date	24-hour average PM_{10} concentration ($\mu g{\cdot}m^{-3}$) Receptor 1		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
15/01/2017	22.6	24.9	47.5	9/03/2017	31.0	16.3	47.3
14/12/2017	<0.1	44.6	44.7	17/06/2017	29.6	14.3	43.9
19/12/2017	0.7	43.4	44.1	19/06/2017	27.8	10.4	38.2
24/09/2017	2.2	40.6	42.8	13/06/2017	26.8	10.4	37.2
23/01/2017	<0.1	41.7	41.8	28/04/2017	25.9	10.2	36.1
13/01/2017	2.3	35.6	37.9	2/04/2017	25.2	14.7	39.9
11/05/2017	13.8	23.7	37.5	16/06/2017	24.6	10.5	35.1
25/01/2017	2.8	33.9	36.7	25/08/2017	23.9	11.2	35.1
17/01/2017	<0.1	36.4	36.5	10/06/2017	23.7	11.6	35.3
10/02/2017	3.7	32.6	36.3	8/06/2017	22.9	8.5	31.4
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.			

Table 26 Summary of contemporaneous impact and background – $PM_{2.5}$ Stage 7d – Scenario 2

Date	24-hour average $PM_{2.5}$ concentration ($\mu g{\cdot}m^{-3}$) – Receptor 5			Date	24-hour average $PM_{2.5}$ concentration ($\mu g{\cdot}m^{-3}$) – Receptor 2		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
19/12/2017	0.1	19.3	19.4	15/01/2017	3.9	9.8	13.7
12/05/2017	0.1	16.6	16.7	26/06/2017	3.4	5.3	8.7
11/05/2017	0.2	15.8	16.0	24/03/2017	2.7	5.3	8.0
14/12/2017	<0.1	15.2	15.3	10/05/2017	2.6	6.4	9.0
23/09/2017	<0.1	14.4	14.5	26/05/2017	2.6	5.8	8.4
12/02/2017	0.2	14.1	14.3	13/06/2017	2.5	5.5	8.0
13/01/2017	0.1	14.0	14.1	16/06/2017	2.5	8.8	11.3
11/02/2017	<0.1	14.1	14.2	27/06/2017	2.4	5.7	8.1
3/09/2017	0.2	13.8	14.0	21/05/2017	2.3	7.5	9.8
17/01/2017	<0.1	13.0	13.1	15/07/2017	2.3	7.2	9.5
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.			

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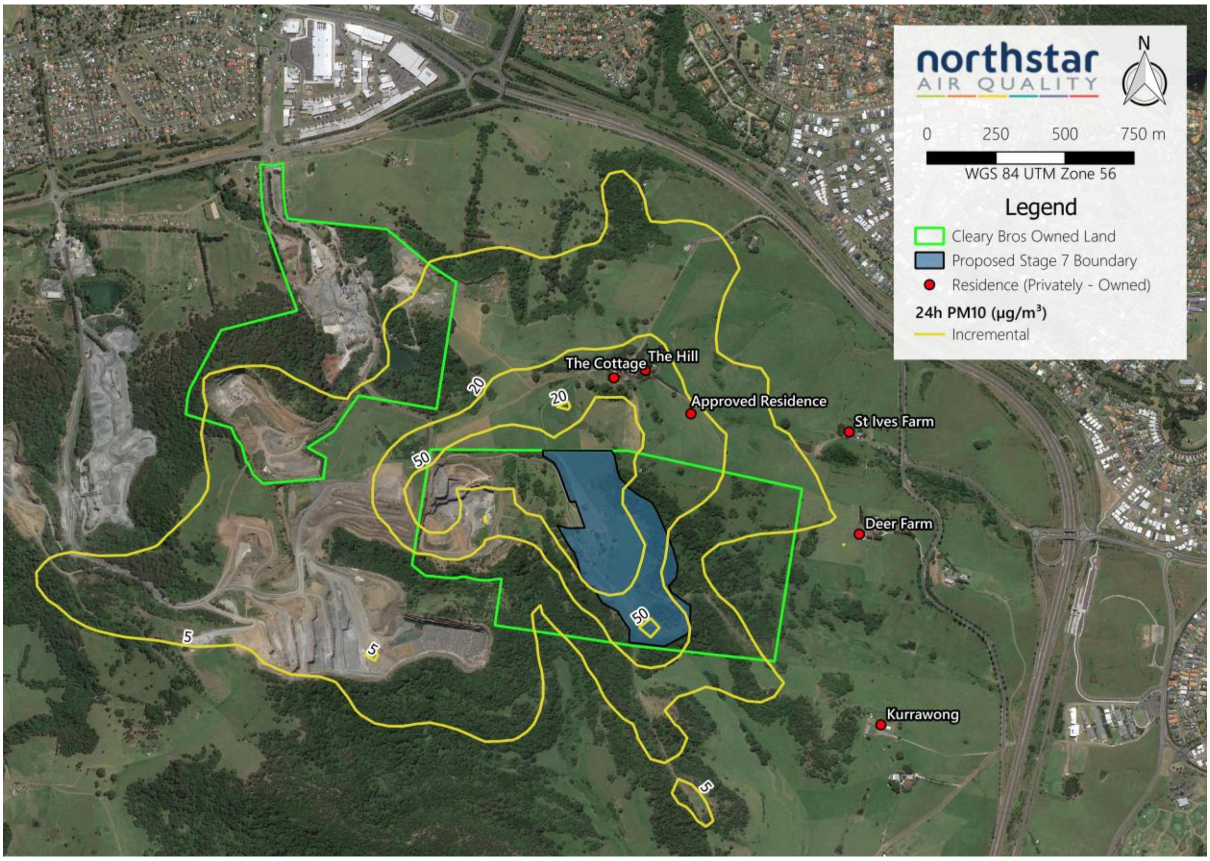
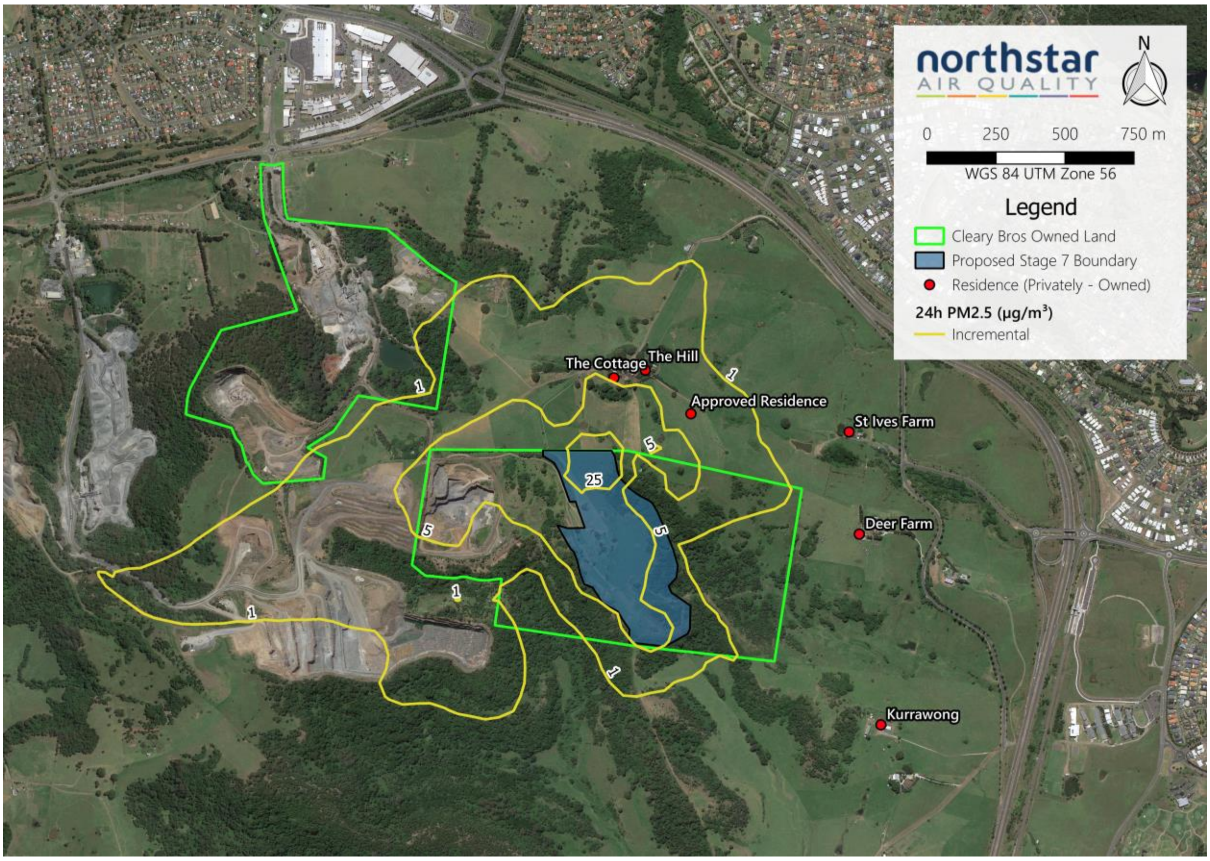
Figure 11 Incremental 24-hour PM_{10} concentrations, Stage 7d - Scenario 1



Note Criterion = 50 µg·m^{-3} (cumulative). Image shows predicted worst-case increment on any day, and any location (i.e. does not present a 'snapshot' in time)

Figure 12 Incremental 24-hour $PM_{2.5}$ concentrations, Stage 7d - Scenario 1



Note Criterion = 25 µg·m^{-3} (cumulative). Image shows predicted worst-case increment on any day, and any location (i.e. does not present a 'snapshot' in time)

6.4 Nitrogen Dioxide

The predicted annual average and maximum 1-hour NO_2 concentrations resulting from blasting operations in Stage 7d - Scenario 1 (when blasting is anticipated to occur in closest proximity to the receptors) are presented in **Table 27**.

The 1-hour NO_2 concentrations include a background concentration as calculated through the OLM described in **Section 5.1.5**.

The results indicate that predicted cumulative concentrations of NO_2 at all receptor locations are low, and easily achieve the annual and maximum 1-hour criteria.

The results presented in **Table 27** are based on emissions during every hour of the year (during which blasting is permitted), and during all wind conditions during those periods.

Table 27 Predicted annual average and maximum 1-hour NO_2 concentrations

Receptor	Annual Average NO_2 Concentration ($\mu g \cdot m^{-3}$)			Max 1-hour NO_2 Concentration ($\mu g \cdot m^{-3}$)		
	Stage 7d			Stage 7d		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	1.3	6.9	8.2	80.8	0.0	80.8
R2	1.0	6.9	7.9	74.7	3.2	77.9
R3	0.4	6.9	7.2	72.0	5.9	77.9
R4	0.2	6.9	7.0	30.3	47.6	77.9
R5	0.1	6.9	7.0	24.0	53.9	77.9
R6	<0.1	6.9	<7.0	12.6	65.3	77.9
Criterion	-	62		-	246	

6.5 Voluntary Land Acquisition and Mitigation Policy Criteria Assessment

The previous sections of this report confirm that the relevant criteria associated with the NSW Voluntary Land Acquisition and Mitigation Policy are not exceeded at any surrounding privately-owned residence.

The previous sections also confirm that the Voluntary Acquisition criteria are not exceeded at any surrounding sensitive receptor location, however the Voluntary Acquisition criteria are also to be applied across privately-owned land (rather than just residences). Specifically, voluntary acquisition rights may be applied by the consent authority "*where the development is predicted to result in exceedances of the relevant criteria on more than 25% of any privately-owned land where there is an existing dwelling or where a dwelling could be built under existing planning controls.*"

Figure 13 presents a visual representation of the three private landholdings over which the relevant air quality criteria are predicted to be exceeded on any parts of the landholdings. Outlined in **Table 28** are the results of the assessment of percentage of that landholding over which the criterion is exceeded, which is well below 25 %, and therefore the voluntary land acquisition criteria are not exceeded across any private landholding in the area.

Figure 13 Private landholdings over which air quality criteria may be exceeded (on unoccupied parts of the properties only)

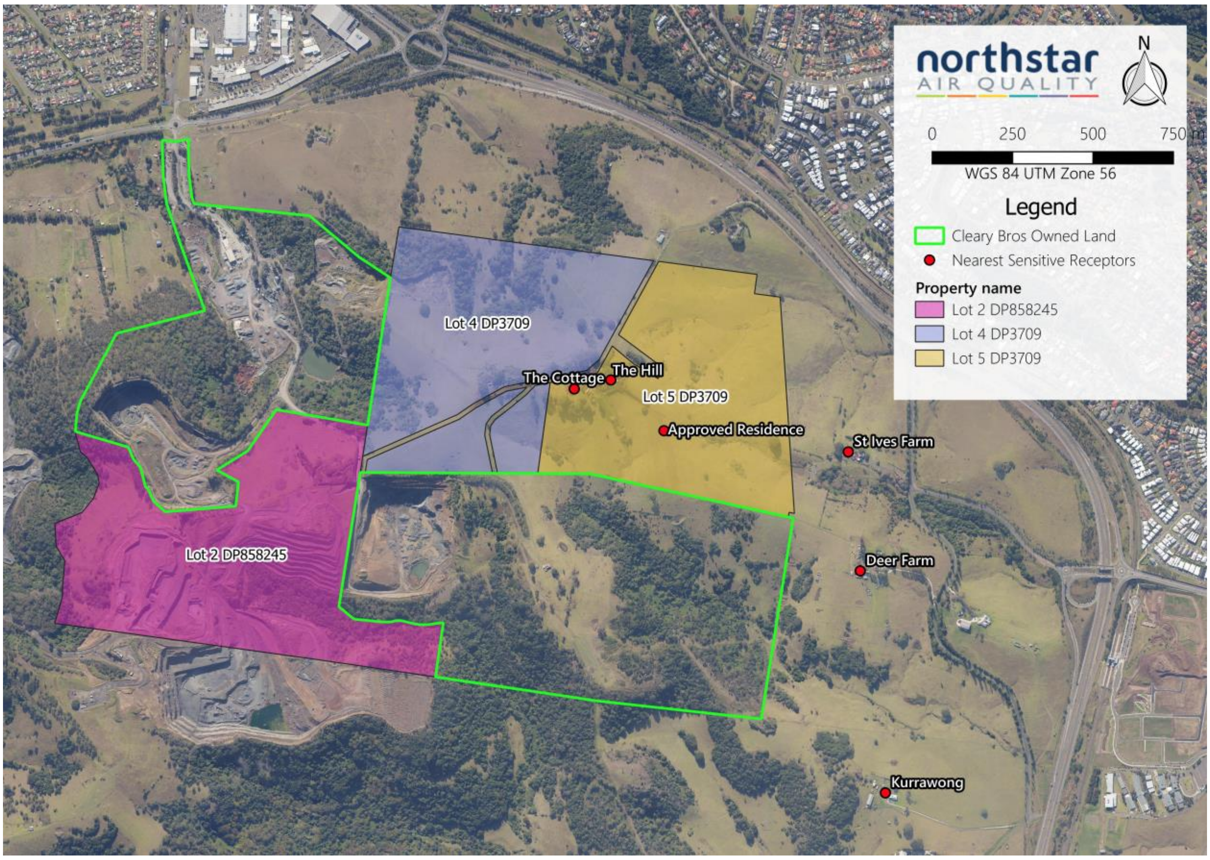


Table 28 Assessment of voluntary land acquisition criteria – Stage 7d – Scenario 1

Property Name	PM_{10}		$PM_{2.5}$		TSP	Deposited dust	
	Annual	24-hour	Annual	24-hour	Annual	Annual	Annual
	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.
Lot 2 DP858245	-	1.7%	1.9%	-	-	-	-
Lot 4 DP3709	0.6%	7.4%	7.7%	0.5%	0.1%	-	-
Lot 5 DP3709	1.5%	8.5%	3.6%	1.7%	0.8%	-	-
Criterion	25 $\mu g{\cdot}m^{-3}$	50 $\mu g{\cdot}m^{-3}$	8 $\mu g{\cdot}m^{-3}$	25 $\mu g{\cdot}m^{-3}$	90 $\mu g{\cdot}m^{-3}$	2 $g{\cdot}m^{-2}{\cdot}month^{-1}$	4 $g{\cdot}m^{-2}{\cdot}month^{-1}$

Table 29 Assessment of voluntary land acquisition criteria – Stage 7d – Scenario 2

Property Name	PM_{10}		$PM_{2.5}$		TSP	Deposited dust	
	Annual	24-hour	Annual	24-hour	Annual	Annual	Annual
	Cumul.	Incr.	Cumul.	Incr.	Cumul.	Incr.	Cumul.
Lot 2 DP858245	2.2%	3.2%	1.9%	-	-	-	-
Lot 4 DP3709	7.7%	10.2%	7.8%	-	-	-	-
Lot 5 DP3709	2.8%	4.8%	3.2%	-	-	-	-
Criterion	25 $\mu g{\cdot}m^{-3}$	50 $\mu g{\cdot}m^{-3}$	8 $\mu g{\cdot}m^{-3}$	25 $\mu g{\cdot}m^{-3}$	90 $\mu g{\cdot}m^{-3}$	2 $g{\cdot}m^{-2}{\cdot}month^{-1}$	4 $g{\cdot}m^{-2}{\cdot}month^{-1}$

6.6 Summary

Four dispersion modelling scenarios were constructed to examine the potential impacts of the Project during Stage 7a, Stage 7b and Stage 7d of operations These scenarios were adopted to represent the potential maximum impacts of the Project on nearby sensitive receptors, taking into account spatial changes in equipment locations, and changes in lengths of haulage routes.

The results of the air quality impact assessment indicate the following:

- Based on the maximum material extraction, processing, handling, and haulage rates anticipated in any stage assessed, all annual average particulate matter criteria are predicted to be satisfied at all residential locations surrounding the Project Area, in all of the scenarios assessed.
- Even assuming maximum (worst-case) daily (24-hour) material extraction, processing, handling, and haulage rates, and furthermore, not taking into account the provisions of the Air Quality Management Plan, and associated Trigger Action Response Plan, no additional exceedances of the maximum 24-hour average PM_{10} or $PM_{2.5}$ criterion are predicted at any privately-owned residences during any of the stages assessed.
- No exceedances of the 1-hour or annual average NO_2 concentrations are predicted at any surrounding residence.

In relation to the Voluntary Land Acquisition and Mitigation Policy, the particulate matter mitigation criteria as outlined in **Table 5** and **Table 6** would not be exceeded at any surrounding privately-owned residence or property.

7. GREENHOUSE GAS ASSESSMENT

This section presents the results of the GHG assessment, compares direct emissions totals with NSW and Australian totals, and provides a range of measures which might be considered to reduce GHG emissions.

7.1 Calculation of GHG Emissions

Based on the activity data for the operation of the Project and the emission factors outlined in **Section 5.2**, annual GHG emissions have been calculated and are presented in **Table 30**. The Project is calculated to result in direct (Scope 1) GHG emissions of 7 712.2 t CO_2-e per annum.

Table 30 Calculated Project GHG emissions

Scope		Activity Rate	Units	Energy Content	Units	Emission Factor		CO_2 (t·yr^{-1})
1	Diesel fuel in plant and machinery on site	1 072.5	kL·year^{-1}	38.6	GJ·kL^{-1}	70.4	kg CO_2-e·GJ^{-1}	2 914.6
	Product transportation	1 768.8						4 806.6
							Scope 1 (subtotal)	7 712.2
3	Diesel fuel in plant and machinery on site	1 072.5	kL·year^{-1}	38.6	GJ·kL^{-1}	3.6	kg CO_2-e·GJ^{-1}	149.0
	Product transportation	1 768.8						245.8
	Employee travel	11.2		34.2				1.4
							Scope 3 (subtotal)	396.2

7.2 Greenhouse Gas Emissions in Context

A comparison of the calculated GHG emissions associated with the Project against Australian (DISER, 2020a) and NSW (DISER, 2020b) total emissions in 2018, respectively is presented **Table 31**.

These data indicate that the operation of the Project, would contribute 0.0059 % of NSW total GHG emissions and less than 0.0014 % of Australian total GHG emissions in 2018.

Table 31 Proposal GHG emissions in context

Project Phase	Emissions (t CO_2-e per annum)		
	Project	NSW (2018)	Australia (2018)
		Total 131 685 000	Total 537 446 000
Operation	7 712.2	0.0059 %	0.0014 %

7.3 Management of GHG Emissions

The above assessment indicates that GHG emissions resulting from the operation of the Project are anticipated to be small, although emissions could be further reduced through the application of a number of measures:

- All vehicles/plant and machinery should be turned off when not in use and regularly serviced to ensure efficient operation, including the optimisation of tyre pressures;
- Truck routes and loading capacity should be designed to reduce the distance and effort required by the vehicles;
- Maintenance of roads in good condition to avoid meandering of vehicles;
- Reducing gradients around the Project Area where feasible; and
- Where possible, B5 fuel should be used in plant and equipment.

8. MITIGATION AND MONITORING

8.1 Air Quality Mitigation

Based on the findings of the operational phase air quality impact assessment, it is considered that the particulate control measures proposed to be implemented and relied upon in the predictive modelling will be more than sufficient to ensure that air quality impact at surrounding receptor locations satisfy all relevant air quality criteria.

The mitigation measures which will be used within the Project Area (and incorporated within the predictive modelling) are summarised in **Table 32** (a duplicate of **Table 12**, for clarity).

Table 32 Summary of emission reduction methods adopted as part of Project operation

Emission control method	Control efficiency (%)
Use of dust filters on drill rig	99
Application of water on haulage routes (internal) at a rate of >2 $L \cdot m^{-2} \cdot hr^{-1}$ subject to the prevailing meteorological conditions	75
Limiting of on-site vehicle speeds to less than or equal to 30 $km \cdot hr^{-1}$	50
Application of water during materials processing	77.7 (primary crushing) 91.2 (screening) 50 (movement of moist material to stockpiles immediately following processing)
Retention of particulate matter in sub-ground level areas (pit retention)	95 (TSP) 5 (PM_{10} and $PM_{2.5}$)

The Applicant intends to also implement additional controls that would assist to minimise air quality impacts throughout the Project life including:

- maintaining a real-time PM_{10} monitor at an agreed location within the "Figtree Hill" property;
- relocating, modifying and/or halting specific activities within the Project Area at appropriate times;
- turning off all vehicles and plant when not in use, where practicable;
- ensuring that all vehicles and plant are regularly serviced (including the optimisation of tyre pressures) to ensure efficient operation;
- designing truck routes and loading capacities to reduce the haul distance and effort required by vehicles;
- maintaining roads in good condition to avoid vehicle meandering; and
- reducing gradients within the Project Area, where feasible.

The Applicant would also continue to implement a Trigger Action Response Plan (TARP) developed as part of the AQMP in accordance with Schedule 4, Condition 17 (e) of the 2017 Development Consent. The TARP describes the actions to be taken when specific trigger levels are exceeded.

Should the trigger levels outlined in Section 4.4 of the AQMP be reached, then a hierarchy of management and mitigation options would be initiated. The options have been identified through a detailed assessment of the Development particulate matter emissions inventory which is presented in the AQMP. The AQMP would be updated following approval to reflect activities proposed as part of the Project.

As outlined in the AQMP:

> *Should trigger values be reached, then the controls would be implemented appropriate to the activities being performed on the Development site at that time.*
>
> *The site manager will maintain a log of activities being performed on the Development site. The log would be required to include the activity being performed and the general location of the activity. These variables would allow a management response to be initiated, and would provide options on how to deal with the triggering of any level.*
>
> *The hierarchy of response would be (each level including continual monitoring of particulate concentrations):*

- *Action Level A: Identify activities being performed and whether any additional emission controls can be applied to those activities (i.e. additional watering of roads and stockpiles, moving and/or restricting activities to the pit);*
- *Action Level B: Apply the controls identified during Action Level A.*
- *Action Level C: Depending on the activities being performed, progressively decrease the rate of activity or cease the operations according to the level of risk associated with each option (see Appendix A).*

8.2 Monitoring

The predictions presented in this AQIA indicate that there would be no predicted exceedances of the adopted air quality criteria at nearby sensitive receptors. However, the current program of air quality monitoring will be continued, to meet Development Consent conditions. The real-time air quality monitoring network, which informs the TARP, will be operational as soon as practicable.

The HVAS and meteorological monitoring station will be required to be relocated following Stage 7 activation, and their locations will be detailed within the updated AQMP.

8.3 Air Quality Management Plan

The AQMP will be updated to include the additional emission controls required as identified in this AQIA. A number of updates would be inserted within the AQMP, including an update to the best practice management assessment, which would allow the hierarchy of particulate controls to be updated, and any other minor updates included.

9. CONCLUSION

R.W. Corkery & Co. Pty. Ltd (RWC) has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Cleary Bros to perform an air quality impact assessment (AQIA) and greenhouse gas (GHG) assessment to support the continued operation and extension of the Albion Park Quarry (the Project).

This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the Project, as required under Part 4 of the *Environmental Planning and Assessment Act* 1979.

The AQIA presents an assessment of the impacts of the proposed operation of the Project and provides an assessment of the cumulative impacts of the Project with other relevant sources including general background conditions.

The GHG assessment provides an assessment of the potential GHG emissions throughout the operation of the Project.

Activity data associated with long term (annual) and short term (24-hour and 1-hour maximum) periods have been provided by the Applicant, and emissions of particulate matter and nitrogen dioxide have been estimated using standard emission factors routinely adopted in Australia. A range of mitigation measures will be employed as part of the Project, and the control efficiency of each has been applied, to determine a total emission from each source.

The meteorology of the area surrounding the Project Area has been reviewed, and a meteorological modelling exercise has been performed to provide site-specific meteorology, which has been subsequently used in a dispersion modelling exercise.

The emissions and meteorological data have been used as input to the NSW EPA approved CALPUFF dispersion model to determine potential impacts at each surrounding receptor location.

An approximation of existing air quality in the area surrounding the Project Area has been determined, and the predicted impacts from the development have been added to that background, to result in a cumulative impact, which has then been compared to relevant air quality criteria as outlined in the NSW EPA Approved Methods document.

The results of the dispersion modelling assessment indicate that the air quality criteria are all predicted to be satisfied throughout the Project life.

The GHG assessment has calculated the likely emissions of greenhouse gas which would result from activities within the Project Area. A comparison of the calculated greenhouse gas emissions associated with the Project against Australian and NSW total emissions in 2018 indicates that the operation would contribute 0.0059 % of NSW total greenhouse gas emissions and less than 0.0014 % of Australian total greenhouse emissions in 2018 which are considered to be small.

10. REFERENCES

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APPENDIX A

Report Units and Common Abbreviations

Units Used in the Report

All units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units. In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol. For example:

- 50 micrograms per cubic metre would be presented as 50 $\mu g \cdot m^{-3}$ and not 50 $\mu g/m^3$; and,
- 0.2 kilograms per hectare per hour would be presented as 0.2 $kg \cdot ha^{-1} \cdot hr^{-1}$ and not 0.2 kg/ha/hr.

Table A1 Common Abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
AWS	automatic weather station
BoM	Bureau of Meteorology
°C	degrees Celsius
CO	carbon monoxide
CO_2-e	carbon dioxide equivalent
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPIE	NSW Department of Planning, Industry and Environment
EETM	emission estimation technique manual
EPA	Environmental Protection Authority
FEL	front end loader
GDA	Geocentric Datum of Australia
GIS	geographical information system
K	kelvin (-273°C = 0 K, ±1°C = ±1 K)
kW	kilowatt
MGA	Map Grid of Australia
$mg \cdot m^{-3}$	milligram per cubic metre of air
$\mu g \cdot m^{-3}$	microgram per cubic metre of air
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
OEH	NSW Office of Environment and Heritage (now defunct)

Abbreviation	Term
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 µm or less
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SEE	Statement of Environmental Effects
TAPM	The Air Pollution Model
TPM	total particulate matter
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VKT	vehicle kilometres travelled

APPENDIX B

Meteorology

The meteorology experienced within a given area can govern the generation (in the case of wind dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. Dust generation is particularly dependent on wind magnitude and on the moisture budget, which is a function of evaporation and rainfall.

Meteorological parameters are measured at the Quarry Site, and these measurements have been used to validate the meteorological modelling performed. Additional data has been sourced from the Australian Government Bureau of Meteorology (BoM) to characterise the conditions which are likely to be experienced in the area surrounding the Quarry Site. The closest BoM automatic weather station (AWS) to the Quarry Site is located at Albion Park (Wollongong Airport), located 3.9 km from the Quarry.

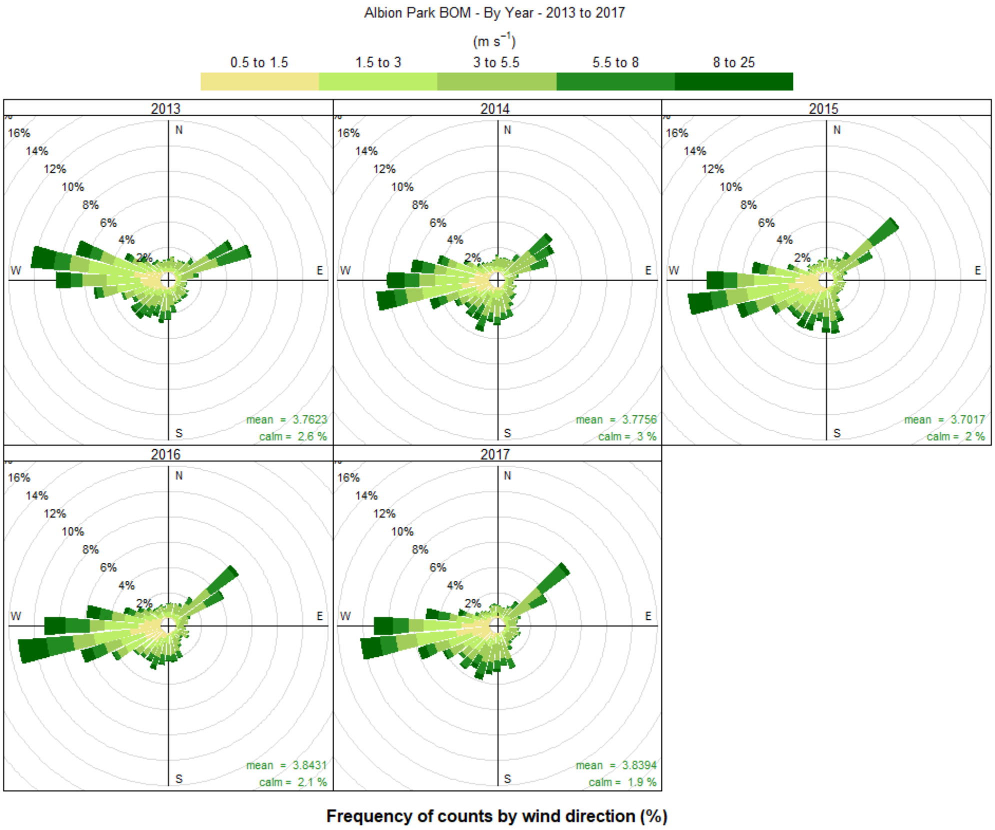
The location of the Albion Park (Wollongong Airport) AWS and surrounding monitoring sites are illustrated in **Figure B 1**.

Figure B 1 Meteorological and Air Quality Monitoring Surrounding the Project Area

Source: Northstar Air Quality Pty Ltd

Given the proximity to the Quarry Site, meteorological conditions at Albion Park (Wollongong Airport) AWS, has been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for 5 years of data (2013 to 2017) is presented in **Figure B 2**.

Figure B 2 Annual Wind Roses 2013 to 2017, Albion Park (Wollongong Airport) AWS



The wind roses indicate that from 2013 to 2017 winds at Albion Park (Wollongong Airport) show similar spatial distribution patterns with a predominant westerly component to the wind direction.

The majority of wind speeds experienced at Albion Park (Wollongong Airport) AWS over the 5-year period are generally in the range of 0.5 metres per second ($m \cdot s^{-1}$) to 8.0 m·s-1 with the highest wind speeds (greater than 8 $m \cdot s^{-1}$) occurring from a westerly direction. Winds of this speed are not uncommon, occurring during 7.6 % of the observed hours over the 5-year period. Calm winds (<0.5 $m \cdot s^{-1}$) occur during 4.6 % of hours on average across the 5-year period.

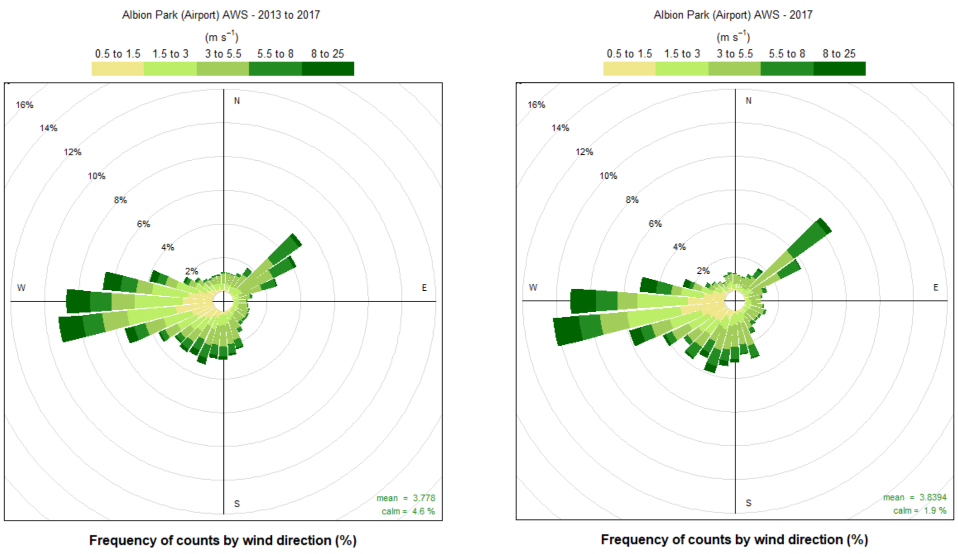
Given the wind distribution across the years examined, data for the year 2017 has been selected as being appropriate for further assessment, as it best represents the general trend across the 5-year period studied.

Presented in **Figure B 3** are the annual wind roses for the 2013 to 2017 period, and the year 2017 and in **Figure B 4** the annual wind speed distribution for Albion Park (Wollongong Airport) AWS. These figures indicate that the distribution of wind speed and direction in 2017 is similar to that experienced across the longer-term period.

In addition to the above discussion, PM_{10} concentrations measured at Albion Park South AQMS (refer to **Appendix C**) have also been analysed to determine the annual distribution and assist in determining a 'representative year' for assessment. The result of this analysis indicates that 2017 is also representative in terms of particulate concentrations in the area.

It is concluded that based on the analysis of background meteorology and air quality monitoring, conditions in 2017 can be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure B 3 Annual Wind Roses 2013 to 201, and 2017 Albion Park (Wollongong Airport) AWS



Site Specific Meteorology

As previously discussed, meteorological parameters are also measured at the Albion Park Quarry. These data have been used in the modelling exercise to characterise the site-specific conditions. Presented in **Figure B 5** are the annual wind roses for the Albion Park Quarry weather station for the 6 years of complete data from 2013 to 2018. As 2017 has been selected as the most representative year for modelling, the on-site meteorological data as measured in 2017 has been assimilated into the meteorological model to 'nudge' predictions. The wind rose presenting combined 2013 to 2018 conditions, and the 2017 wind rose for the Albion Park Quarry weather station is presented in **Figure B 6**.

Figure B 4 Annual wind speed distribution – Albion Park (Wollongong Airport) AWS

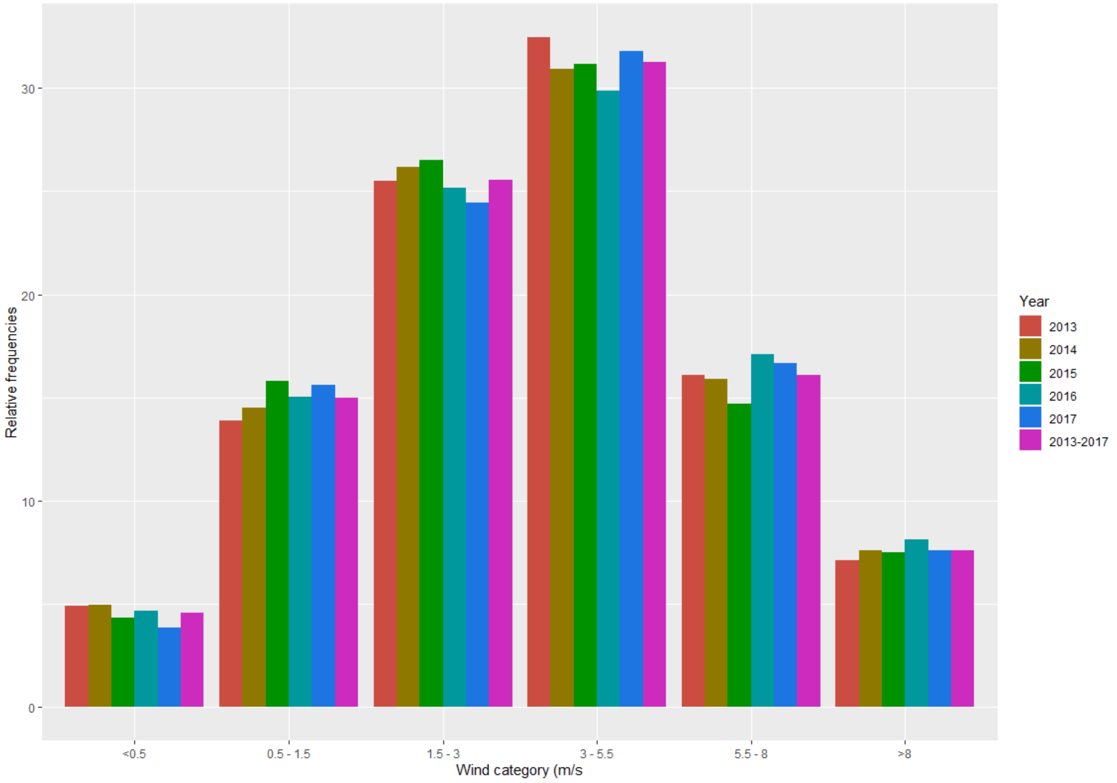


Figure B 5 Annual wind roses for 2013 to 2018, Albion Park Quarry Weather Station

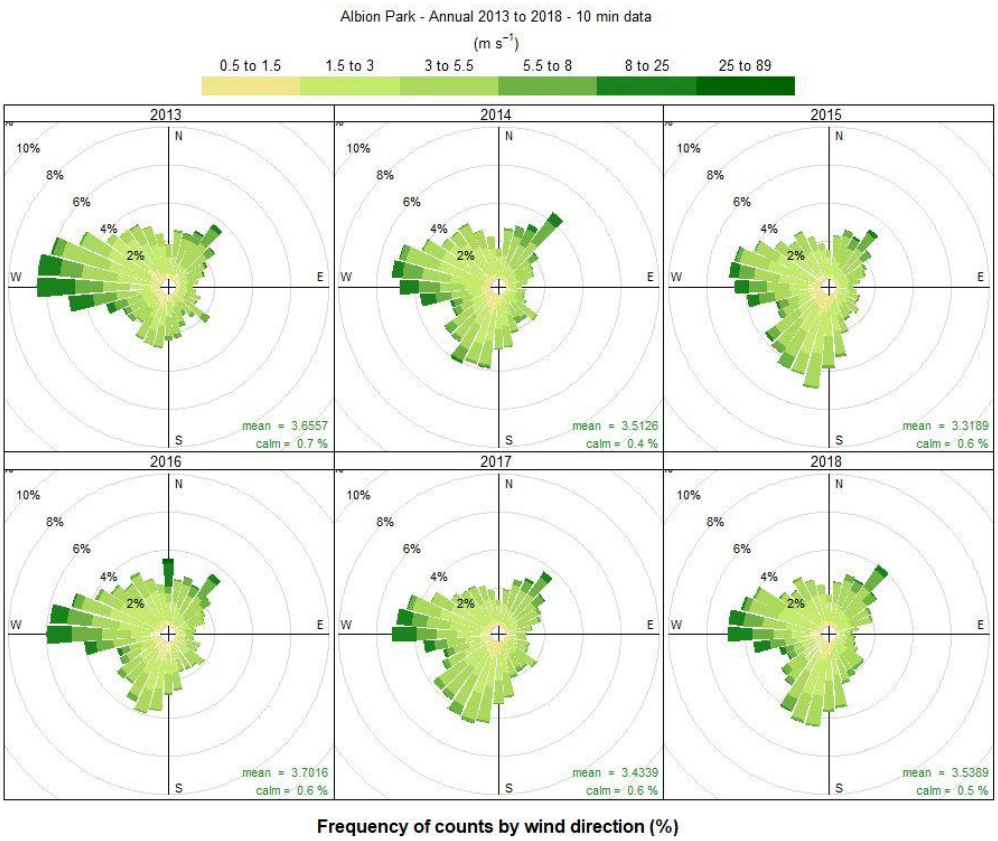
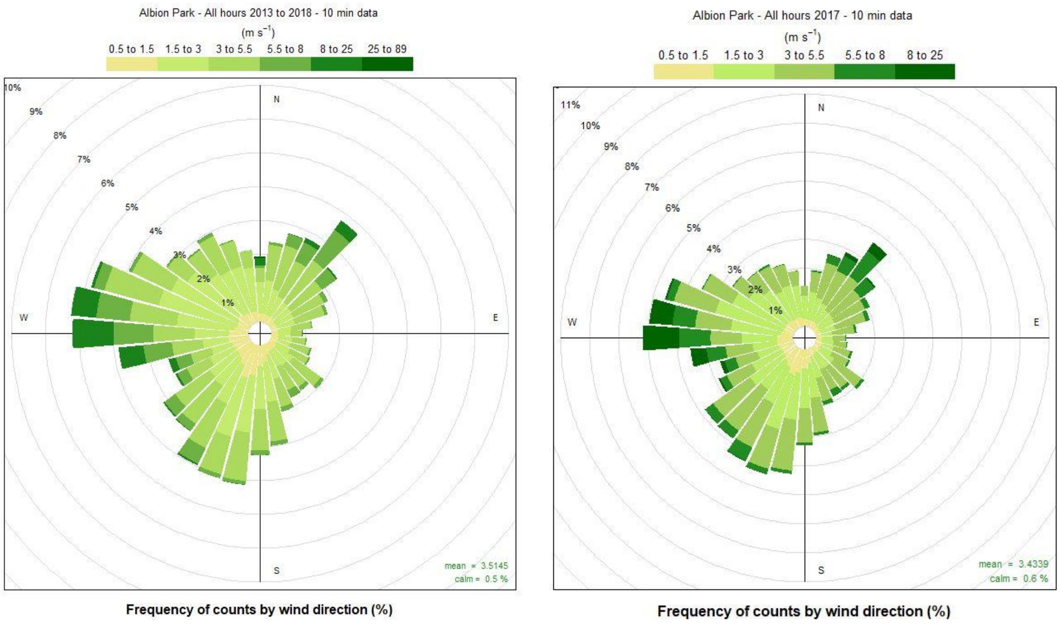


Figure B 6 Annual wind roses, 2013 to 2018, and 2017, Albion Park Quarry Weather Station



Meteorological Modelling

The BoM data adequately covers the issues of data quality assurance, however it is limited by its location compared to the Project Area. To address these uncertainties, an assessment of meteorological data has been performed.

Site representative meteorological data including all parameters required for dispersion modelling was generated using the TAPM meteorological model in a format suitable for use in in the CALPUFF dispersion model (refer **Section 5.1.1**).

The Air Pollution Model (TAPM, v 4.0.5), developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which predicts wind speed and direction, temperature, pressure, water vapour, cloud, rainwater 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.

TAPM has been run using observations as collected at the Albion Park Quarry weather station in 2017, to 'nudge' model predictions towards the observed values. TAPM data were formatted using the CALTAPM software and used as input to the CALMET meteorological pre-processor.

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 B1**.

Table B1 Meteorological Parameters Used for this Study

TAPM v 4.0.5	
Modelling period	1 January 2017 to 31 December 2017
Centre of analysis	299 745 mE, 6 171 000 mS (UTM Coordinates)
Number of grid points	30 x 30 x 25
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Terrain	AUSLIG 9 second DEM
Data assimilation	Albion Park Quarry Weather Station
CALMET	
Modelling period	1 January 2017 to 31 December 2017
Centre of analysis	300 251 mE, 6 170 554 mS (UTM Coordinates)
Number of grid points	60 x 60 x 10
Number of grids (spacing)	4 (3.4 km,1 km, 0.3 km, 0.1 km)
Data assimilation	-
Other variables required to be reported to the NSW EPA	Terrad = 0.8 km[a], IEXTRP = 1[b], RMin2 = 4[c], MCLOUD = 4[d]
Note	[a] - Set to 0.8 km radius of influence of terrain features. (Barclay & Scire, 2011, p. 51; Earth Tech, Inc., 2000) [b] - Set to 1 to not extrapolate any of the surface data. (Barclay & Scire, 2011, p. 51; Earth Tech, Inc., 2000) [c] - Set to 4 km, so that surface stations within 4 km of an upper air station will not be subject to vertical extrapolation within any of the IEXTRP. (Barclay & Scire, 2011, p. 55; Earth Tech, Inc., 2000) [d] - Set to 4, so that the numerical weather predictions (NWP) model used (4) computes the gridded cloud cover from prognostic relative humidity at all levels. (Barclay & Scire, 2011, p. 54; British Columbia Ministry of Environment, 2015)

Following output of data from CALMET, visual evaluation was performed. The results of this evaluation are presented below. These data have been adopted within the assessment.

A comparison of the TAPM generated meteorological data, and that observed at the Albion Park (Wollongong Airport) AWS and the Albion Park Quarry Weather Station is presented in **Figure B 7**. Validation of the TAPM output has been performed at Albion Park (Wollongong Airport) AWS has been performed as the CALMET grid does not extend that far. Validation of the CALMET output has been performed at the Albion Park Quarry Weather Station.

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 Project Area, detailed discussion of the humidity, evaporation, cloud cover, katabatic air drainage and air recirculation potential of the Project Area has not been provided. Details of the predictions of wind speed and direction, mixing height, temperature and stability class at the Project Area are provided below.

Diurnal variations in maximum and average mixing heights predicted by CALMET at the Project Area during 2017 are illustrated in **Figure B 8.**

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.

The modelled wind speed and direction at the Project Area during 2017 are presented in **Figure B 9**.

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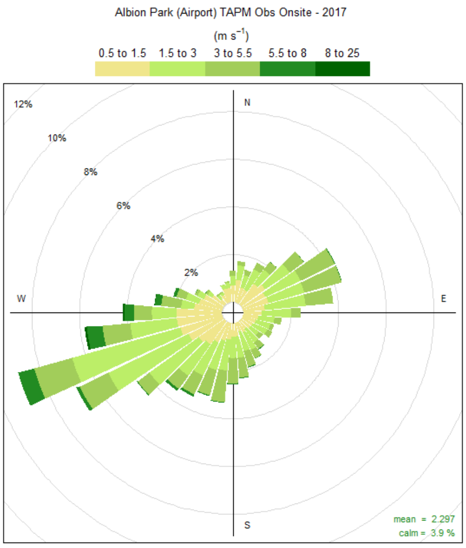
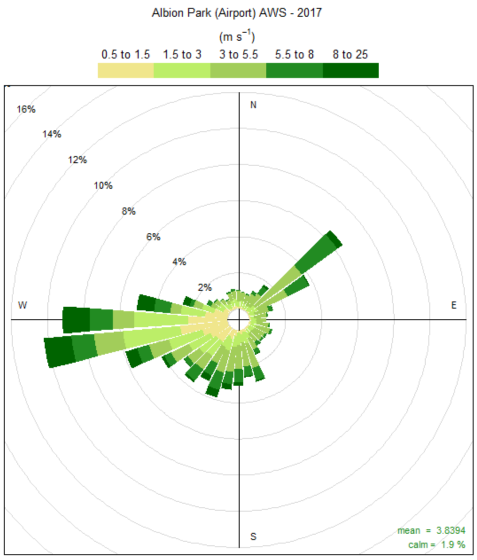
Figure B 7 Wind roses TAPM and Albion Park (Wollongong Airport) AWS 2017

TAPM generated wind rose at Albion Park AWS



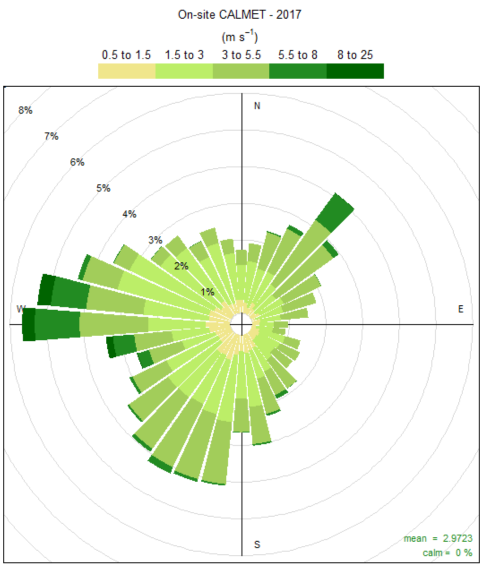
Frequency of counts by wind direction (%)

Observations at Albion Park AWS



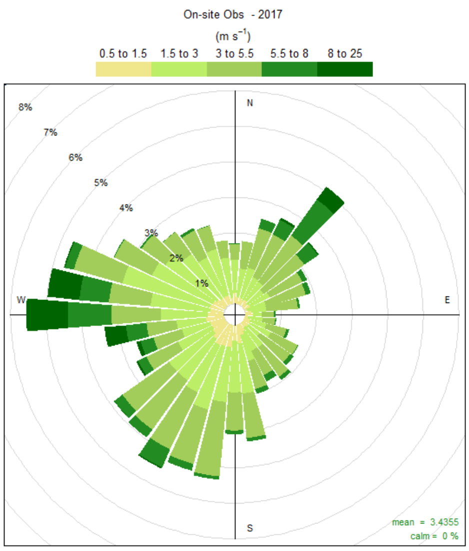
Frequency of counts by wind direction (%)

CALMET generated wind rose at Albion Park Quarry Weather Station



Frequency of counts by wind direction (%)

Observations at Albion Park Quarry Weather Station



Frequency of counts by wind direction (%)

Figure B 8 Predicted temperature, mixing height, wind speed frequency and stability class – Project Area 2017

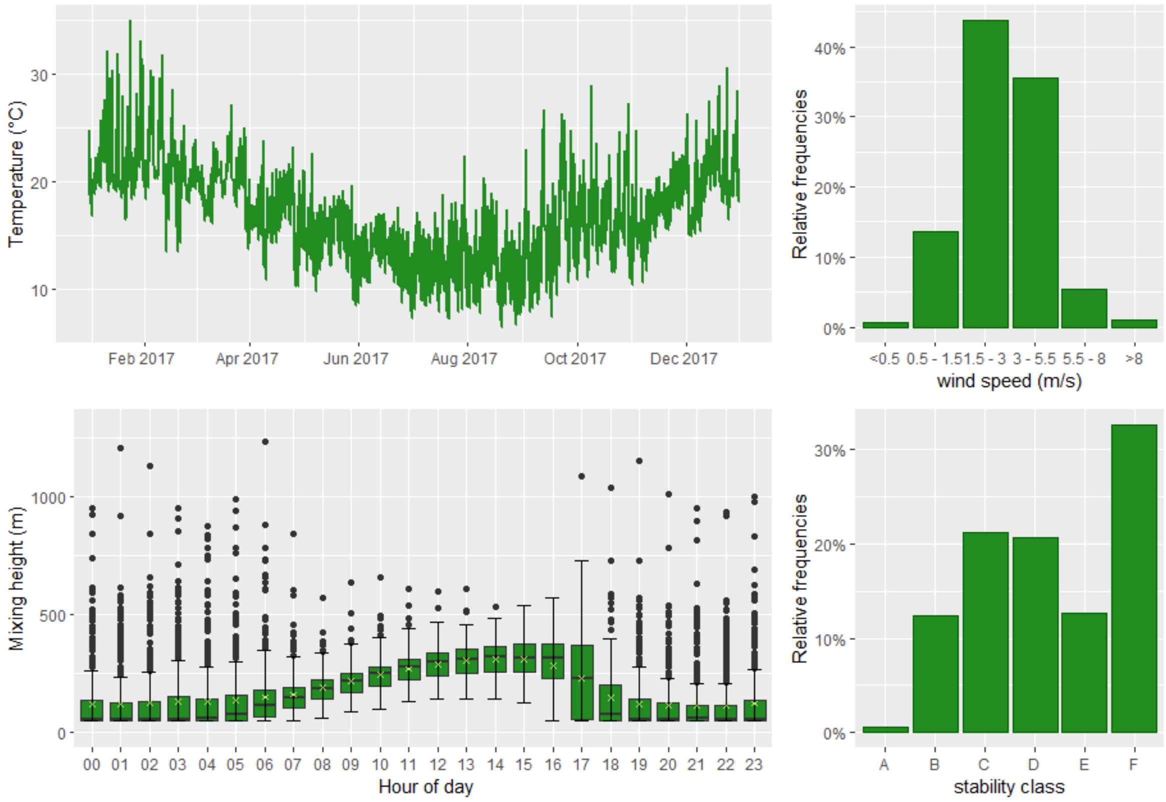
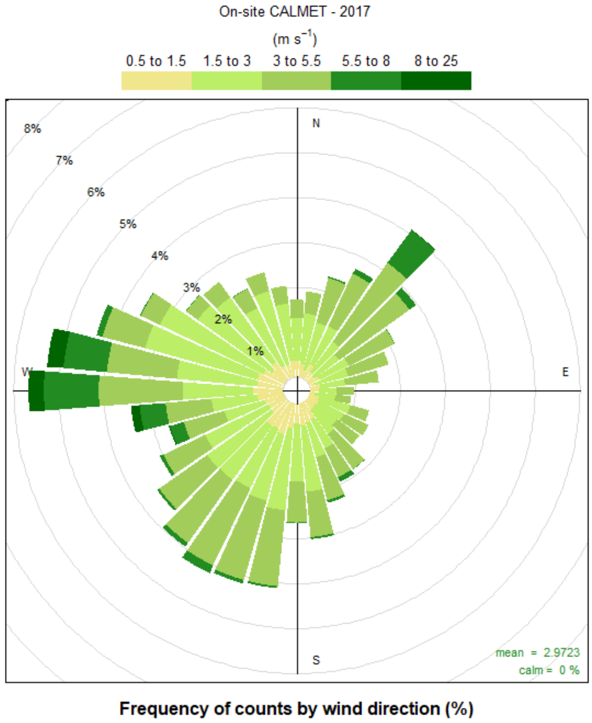


Figure B 9 Predicted wind speed and direction – Project Area 2017



APPENDIX C

Background Air Quality Data

Air quality data is monitored at the Quarry, which comprises 24-hour average PM_{10} measurements using one High Volume Air Sampler (HVAS) and dust deposition rates measured at four locations. As 24-hour average PM_{10} measurements are performed on a one-day-in-six frequency (as required under AS/NZS 3580.9.6:2015) it is not appropriate for use in the AQIA, and subsequently, alternative 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 Quarry and during a representative year can be complicated by factors which include:

- The sources of air pollutant emissions around the Project Area and representative air quality monitoring station(s); 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 20 km radius of the Project Area. Details of the monitoring performed at these AQMS is presented in **Table C1** and **Figure C1**.

Table C1 Details of Closest AQMS Surrounding the Project Area

AQMS Location	Approximate distance to Project (km)	Screening Parameters				
		2017 Data	Measurements			
			PM_{10}	$PM_{2.5}$	TSP	NO_2
Albion Park South	4.2	✓	✓	✓	×	✓
Kembla Grange	12.4	✓	✓	✓	×	✓
Wollongong	19.6	✓	✓	✓	×	✓

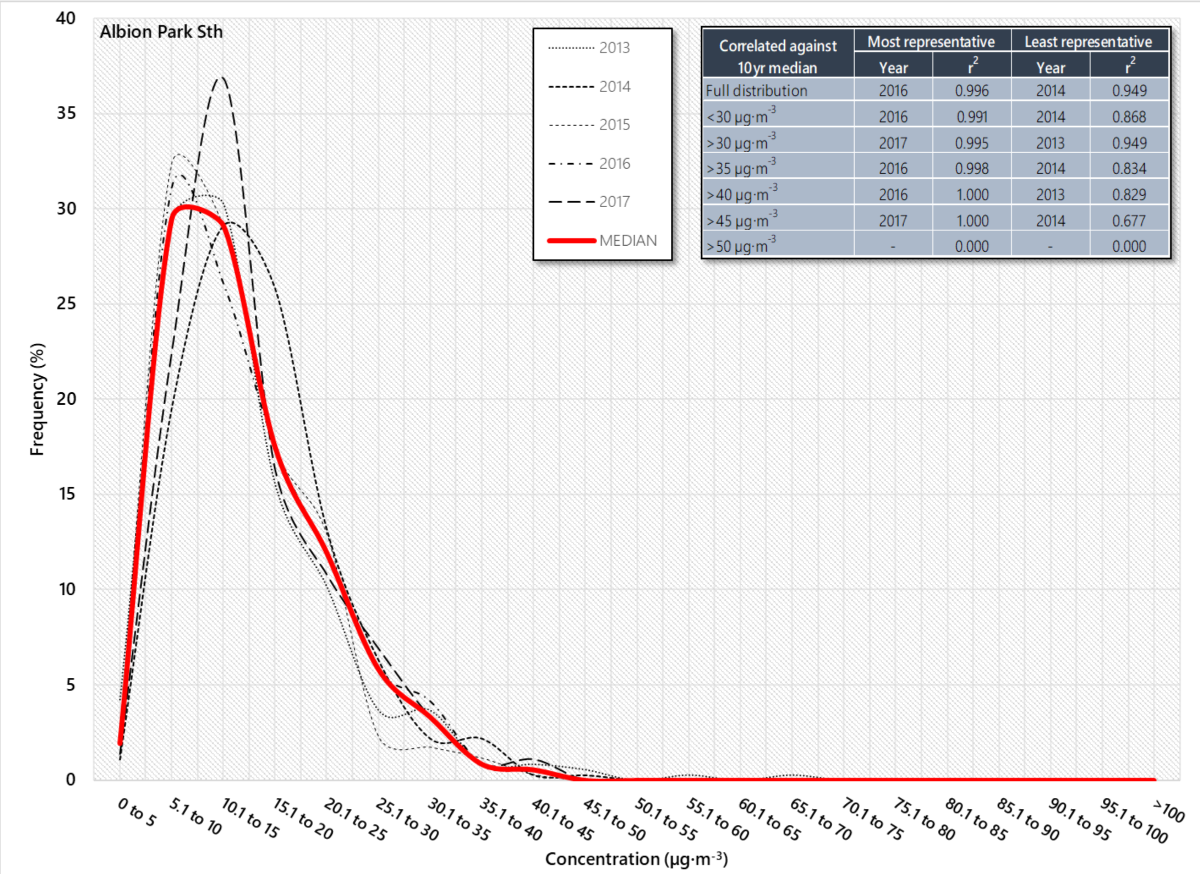
Figure C1 Air Quality Monitoring Stations Surrounding the Project Area

Source: Northstar Air Quality Pty Ltd

The closest representative AQMS is noted to be located at Albion Park South and is considered to be the closest monitoring location to reflect the conditions that would be experienced at the Project Area.

Given the proximity to the Project Area, air quality measured at Albion Park South AQMS has been examined to determine a 'typical' or representative dataset for use in this assessment. PM_{10} data for the period 2013 to 2017 has been analysed. The annual frequency distribution for the 5-year period is presented in **Figure C2**.

Figure C2 Distribution of Measured 24-hour PM10 at Albion Park South AQMS (2013 – 2017)



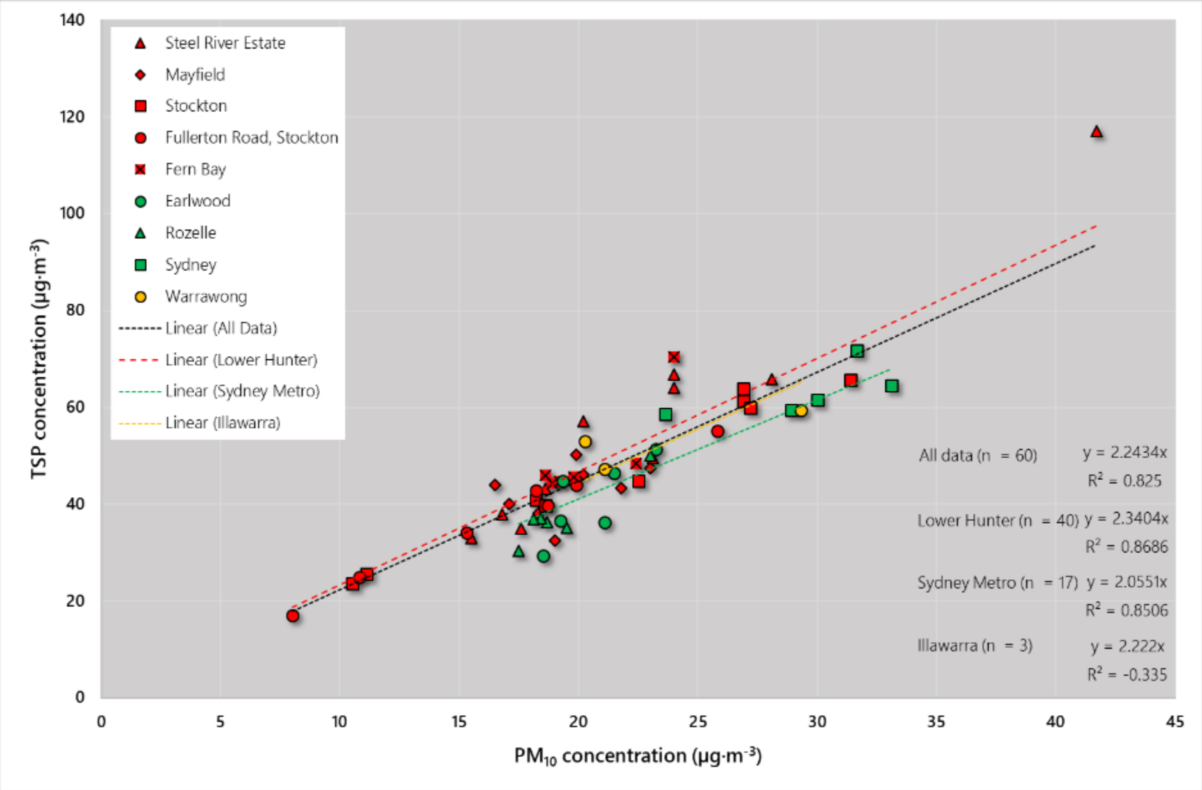
Correlated against 10yr median	Most representative		Least representative	
	Year	r^2	Year	r^2
Full distribution	2016	0.996	2014	0.949
<30 µg·m^{-3}	2016	0.991	2014	0.868
>30 µg·m^{-3}	2017	0.995	2013	0.949
>35 µg·m^{-3}	2016	0.998	2014	0.834
>40 µg·m^{-3}	2016	1.000	2013	0.829
>45 µg·m^{-3}	2017	1.000	2014	0.677
>50 µg·m^{-3}	-	0.000	-	0.000

The result of this analysis indicates that PM_{10} data measured in the years 2016 and 2017 best represent the general trend over the 5-year period.

It is concluded that based on the analysis of air quality monitoring, the most recent year (2017) is considered to provide a suitably representative dataset for use in this assessment.

It is noted that TSP is not measured at any of the identified AQMS. Based upon long-term historic monitoring data, an analysis of co-located measurements of TSP and PM_{10} in the Lower Hunter (1999 to 2011), Sydney Metropolitan (1999 to 2004) and Illawarra (2002 to 2004) regions is presented in **Figure C3**. The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.222 : 1 (i.e. PM_{10} represents ~45% of TSP) from the Illawarra is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA, resulting in a background annual average TSP concentration of 33.9 µg·m^{-3} being adopted.

Figure C3 Co-located TSP and PM10 Measurements, Lower Hunter, Sydney Metro and Illawarra



Summary statistics for TSP, PM_{10}, $PM_{2.5}$ and NO_2 are presented in **Table C2**.

Table C2 Background Air Quality Statistics 2017 – Albion Park South AQMS

Pollutant	TSP (µg.m^{-3})	PM_{10} (µg.m^{-3})	$PM_{2.5}$ (µg.m^{-3})	NO_2 (µg.m^{-3})
Averaging Period	Annual	24-Hour	24-Hour	1-Hour
Data Points (number)	361	361	327	8038
Mean	33.9	15.3	6.6	7.1
Standard Deviation	-	7.5	2.8	9.6
Skew[1]	-	1.2	1.0	2.1
Kurtosis[2]	-	1.4	1.6	5.4
Minimum	-	3.4	0.2	-2.1
Percentiles (µg·m^{-3})				
1	-	4.8	2.0	0.0
5	-	6.7	2.9	0.0
10	-	7.9	3.6	0.0
25	-	10.2	4.6	0.0
50	-	13.0	6.1	2.1
75	-	19.1	8.1	10.3
90	-	26.0	10.5	20.5
95	-	30.5	11.3	26.7
97	-	33.1	12.9	32.8
98	-	34.2	13.9	34.9
99	-	38.1	15.0	43.1
Maximum	99.1	44.6	19.3	77.9
Data Capture (%)	98.9	98.9	89.6	91.8

Note: 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.

Graphs presenting the daily varying PM_{10} and $PM_{2.5}$ data recorded at Albion Park South in 2017 are presented in **Figure C4** and **Figure C5**, respectively.

It is noted that the Approved Methods (NSW EPA, 2017) requires that background concentrations (as provided above) are added to dispersion model predictions to determine a 'cumulative' impact.

Figure C4 PM_{10} Measurements, Albion Park South AQMS 2017

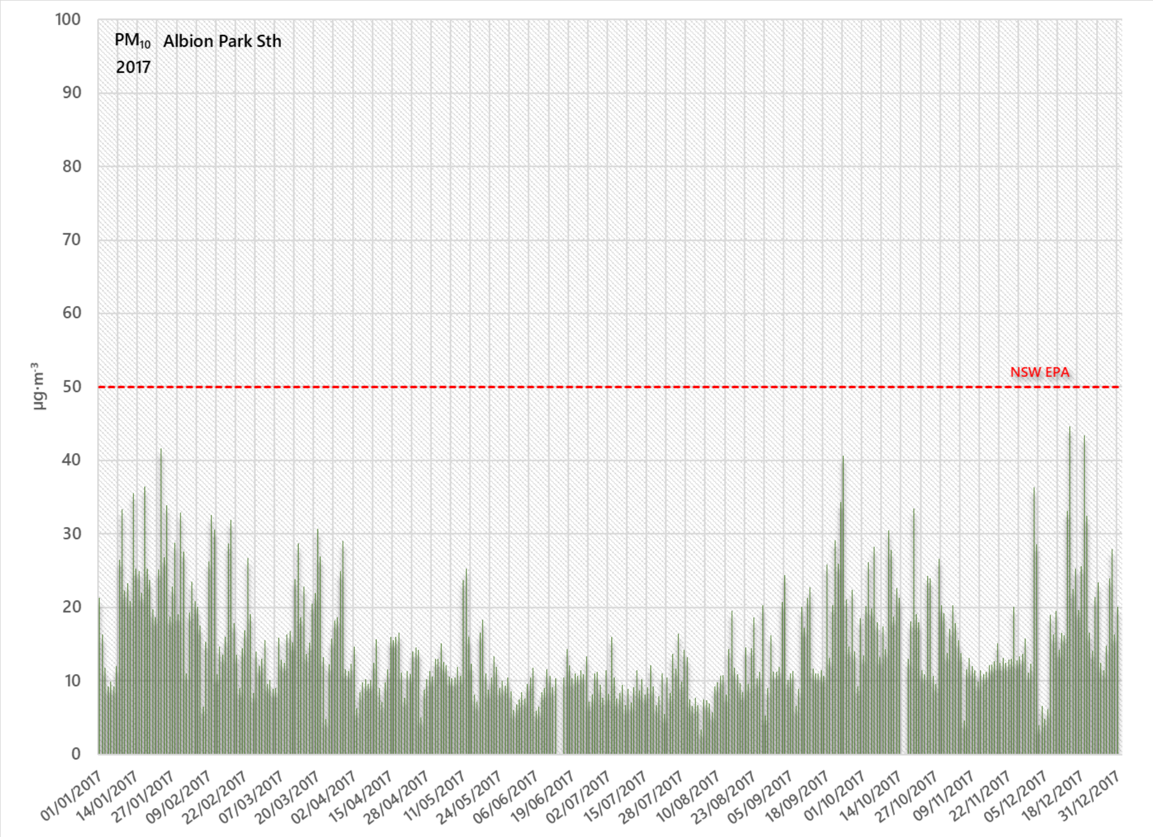
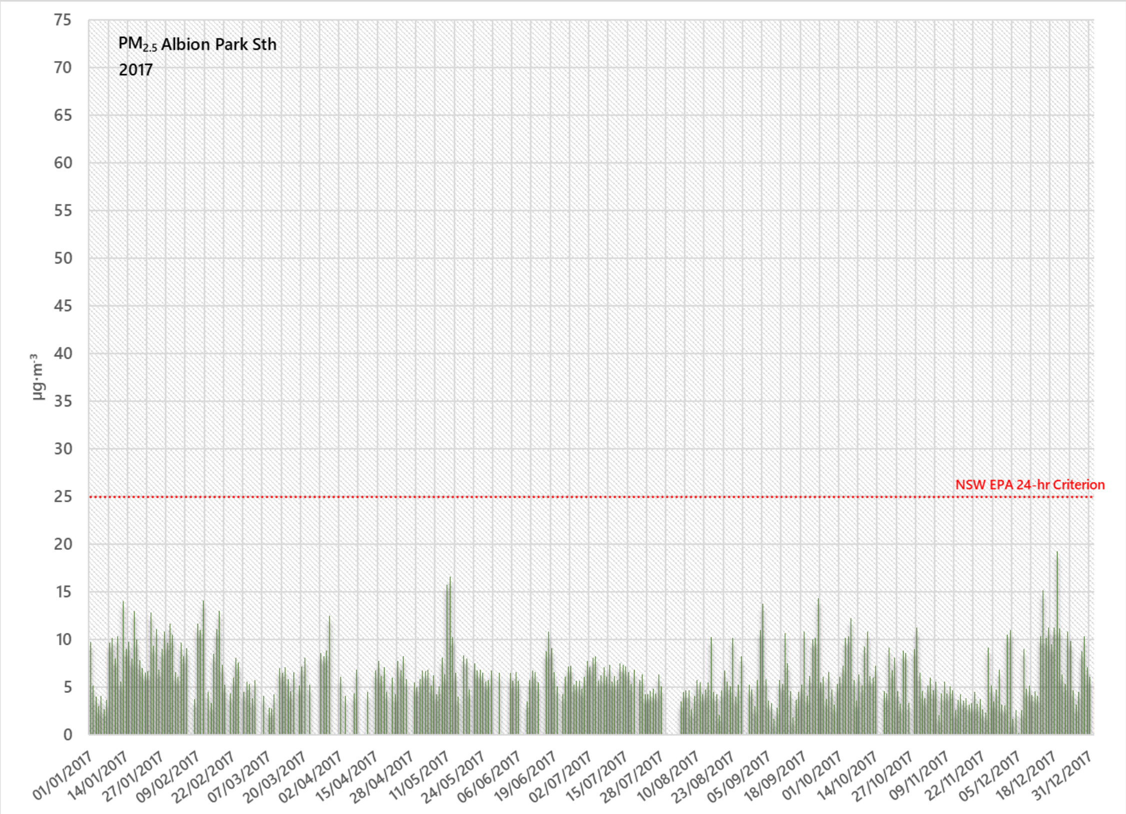


Figure C5 $PM_{2.5}$ Measurements, Albion Park South AQMS 2017



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APPENDIX D

Emissions Inventory

As outlined in **Section 2.2**, a number of operations to be performed as part of the Project operation have the potential to result in emissions of particulate matter. A detailed outline of the emission estimation techniques adopted to derive total emissions from the sources identified are presented in this Appendix.

A detailed summary and justification of all parameters adopted within the emissions estimation calculations is provided. Emission factors are presented in alphabetical order.

The silt and moisture content of overburden, rock and product has been taken to be 2 % which is considered to represent a conservative assumption.

Blasting

The emissions of particulate matter from blasting operations have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mine) (US EPA, 1995) The emission factors are:

$$EF_{TSP}\ (kg.blast^{-1}) = 0.00022 \times (A)^{1.5}$$

$$EF_{PM_{10}}\ (kg.blast^{-1}) = 0.52 \times (EF_{TSP})$$

$$EF_{PM_{2.5}}\ (kg.blast^{-1}) = 0.03 \times (EF_{TSP})$$

where:

$EF_{(kg \cdot blast^{-1})}$ = emission factor for particulate matter

A = horizontal area (m^2), with blasting depth ≤ 21 m.

The quality rating for this emission factor is rated is rated C for TSP, D for PM_{10}, and D for $PM_{2.5}$.

Crushing

Emissions of particulate matter resulting from the processing of materials have been estimated using the emission factors presented in Section 11.19.2 of AP-42 (Crushed Stone Processing and Pulverised Mineral Processing) (US EPA, 2004).

The emission factors within table 11.19.2-1 have been adopted for the operations outlined above. No emission factors associated with primary or secondary crushing are available within AP-42 although emission factors for tertiary crushers can be used as an upper limit for primary or secondary crushing (US EPA, 2004).

$PM_{2.5}$ emission factors are not available for uncontrolled crushing sources in AP-42 although have been taken to be 18% of PM10 as per controlled tertiary crushing in table 11.19.2-1 (US EPA, 2004).

For uncontrolled tertiary crushing (and uncontrolled primary and secondary crushing):

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0027$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.0012$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.00012$$

The quality rating for these emission factors is: Tertiary Crushing (uncontrolled) = E & C (TSP & PM_{10} respectively). All other crushing emission factors calculated have a quality rating of U (no rating).

Drilling

Emissions of particulate matter resulting from drilling (overburden) operations 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 is:

$$EF_{TSP}\ (kg.hole^{-1}) = 0.59$$

where:

EF_{TSP} = emission factor for total suspended particulate matter (kg per hole)

PM_{10} & $PM_{2.5}$ emission factors are not available in AP-42 although have been taken to be 52% of TSP for PM10 and, 3% of TSP for $PM_{2.5}$ as per AP-42 blasting (Table 11.9-2).

The quality rating for this emission factor is C.

Excavators/Front-end Loaders

Emissions associated with all loading and unloading operations have been characterised using the factor outlined in AP-42 for Batch Drop processes (Section 13.2.4.3) (US EPA, 2006b). This equation is consistent with that associated with the use of excavators, shovels and front-end loaders outlined in the NPI EETM for Mining (NPI, 2012):

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

where:

$EF_{TSP\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

$EF_{PM_{10}\ (kg \cdot tonne^{-1})}$ = emission factor for total suspended particles

k_{TSP} = 0.74 for particles less than 30 micrometres aerodynamic diameter

$k_{PM_{10}}$ = 0.35 for particles less than 10 micrometres aerodynamic diameter

$k_{PM_{2.5}}$ = 0.053 for particles less than 2.5 micrometres aerodynamic diameter

U = mean wind speed ($m \cdot s^{-1}$)

M = material moisture content (% by weight)

The quality rating for this application is rated U (no rating).

Grading

The emissions of particulate matter from grading operations have been estimated using emission factors presented in Section 11.9-2 of AP-42 (Western Surface Coal Mine) (US EPA, 1998). The emission factor is:

$$EF_{TSP}\ (kg.VKT^{-1}) = 0.0034 \times (S)^{2.5}$$

$$EF_{PM_{10}}\ (kg.VKT^{-1}) = 0.60 \times (EF_{PM_{15}})$$

$$EF_{PM_{2.5}}\ (kg.VKT^{-1}) = 0.031 \times (EF_{TSP})$$

where:

$EF_{\ (kg \cdot VKT^{-1})}$ = emission factor for particulate matter

S = mean vehicle speed ($km \cdot hr^{-1}$), taken to be 10 $km \cdot hr^{-1}$.

The quality rating for this emission factor is rated C for TSP, D for PM_{10}, D for $PM_{2.5}$.

Screening

Emissions of particulate matter resulting from the screening of material have been estimated using the emission factors presented in Section 11.19.2 of AP-42 (Crushed Stone Processing and Pulverised Mineral Processing) (US EPA, 2004).

The emission factors within table 11.19.2-1 have been adopted for the operations outlined above. $PM_{2.5}$ emission factors are not available for uncontrolled screening sources in AP-42 although have been taken to be 10% of PM_{10} as per aggregate handling sources (MRI, 2006). The control efficiency used for screening is 91.2% as calculated in AP-42 (US EPA, 2004).

For uncontrolled screening:

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0125$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.0043$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.00043$$

For controlled screening:

$$EF_{TSP}\ (kg.tonne^{-1}) = 0.0011$$

$$EF_{PM_{10}}\ (kg.tonne^{-1}) = 0.00037$$

$$EF_{PM_{2.5}}\ (kg.tonne^{-1}) = 0.000025$$

The quality rating for these emission factors is: screening (uncontrolled) = E & C (TSP & PM_{10} respectively), and screening (controlled) = E, C & E (TSP, PM_{10} & $PM_{2.5}$ respectively). All other screening emission factors calculated have a quality rating of U (no rating).

Unpaved Roads

Emissions of particulate matter resulting from the movement of materials on unpaved roads have been estimated using the emission factors presented in Section 13.2.2 (Unpaved Roads) of AP-42 (US EPA, 2006).

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

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

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)

a and b = empirical constants (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 $PM_{2.5}$ (k) are provided in (US EPA, 2006a) as 4.9, 1.5 and 0.15, respectively.

The empirical constant for TSP, PM_{10} and $PM_{2.5}$ (a) are provided in (US EPA, 2006a) as 0.7, 0.9 and 0.9, respectively. The empirical constant for TSP, PM_{10} and $PM_{2.5}$ (b) are provided in (US EPA, 2006a) as 0.45 for all size fractions.

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

The silt content of unpaved haul roads at the Project Area has been taken to be 8.3% which is consistent with haul roads at stone Mining and processing sites (Table 13.2.2-1 of (US EPA, 2006).).

The mean weight of vehicles use on site has been calculated based on the use of '90 t' haul trucks moving material to the main plant, such as the CAT777D (or similar) which has a load weight of 90 t, tare weight of 70.3 t and a loaded weight of 161 t. The average vehicle weight has therefore been calculated to be 115.6 t (metric).

Moxys (28 t) have been assumed to move overburden and topsoil, with an average load weight of 37 t, and VENM/ENM is brought to site in Truck and Dog vehicles with an average load weight of 28.5 t

Wind Erosion (Exposed Areas)

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:

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

where:

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

PM_{10} and $PM_{2.5}$ emission factors are not available in AP-42 although have been taken to be 50% of TSP for PM_{10} 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.

Blast Fume

Under ideal blasting conditions, blasting explosives react to form carbon dioxide, water and nitrogen. However, small changes in stoichiometry in either the bulk material, moisture in blast holes, mineral matter etc.) can result in a non-ideal explosive reaction and lead to the formation of carbon monoxide (CO) and nitric oxide (NO). In the presence of oxygen (O_2) and ozone (O_3), the nitric oxide (NO) may be oxidised to form nitrogen dioxide (NO_2) which may impact on downwind receptor locations.

The conditions under which blasting occurs can generally be well managed through the implementation of a blast management plan which would include measures including (but not limited to):

- Limiting the time of blasting to hours with generally better dispersion conditions;
- Using explosive suppliers with an externally accredited quality system; and
- Performance of visual checks at discharge point.

In some conditions however, emissions of NO_X can be experienced as a visible orange/red fume.

A study performed by (Attalla, Day, Lange, Lilley, & Morgan, 2008) measured varying emission rates of NO_X from 27 blast events of between 0 and 5.3 kg·tonne explosive^{-1} (ANFO). The National Pollutant Inventory (NPI) Emissions Estimation Technique Manual (EETM) for Explosives Detonation and Firing Ranges (DEE, 2016) provides an emission rate of NO_X for on-site mixed ANFO as 8 kg·tonne explosive^{-1}, 3.8 kg·tonne explosive^{-1} for branded <152 mm (small bore), and 1.4 kg·tonne explosive^{-1} for branded >152mm (large bore).

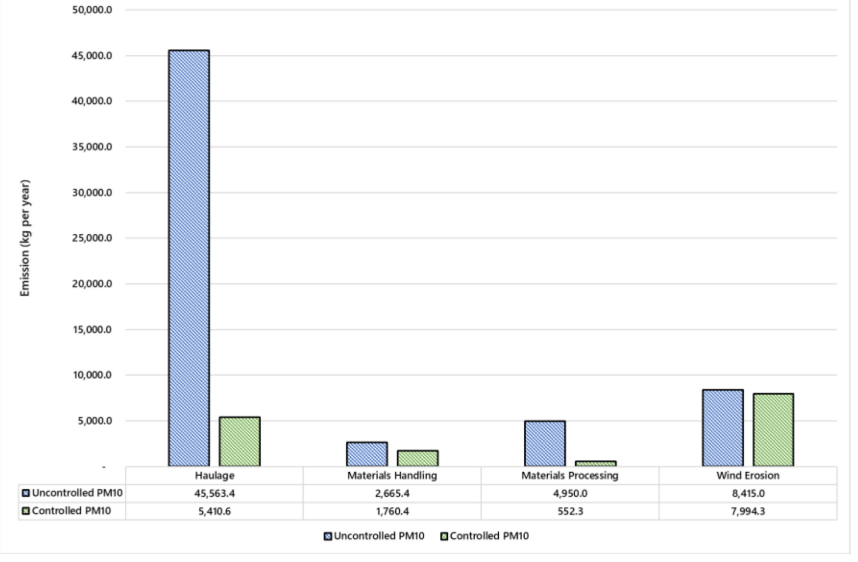
Discussions with the Applicant and blast sub-contractor indicated that ANFO explosives are not used within the existing extraction area, but water based gel emulsions are used. (DEE, 2016) outlines a NO_X emission factor for those explosives of 0.2 kg·tonne explosive^{-1}.

The Applicant indicates that the maximum blast within the Project Area would use 15 000 kg of explosives.

No cumulative impacts of short-term NO_2 concentrations are predicted for short term impacts given that it is unlikely that neighbouring sites would perform blasting within the same hour. Current blast planning and notification processes ensures that this does not occur.

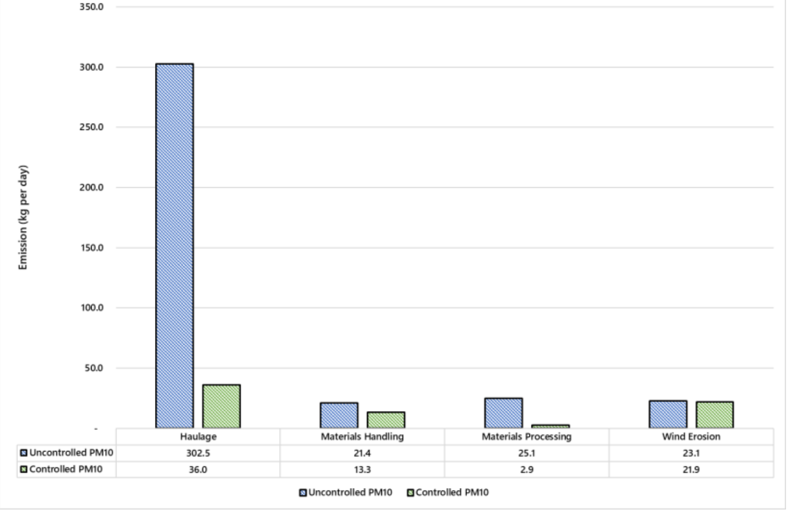
Stage 7a – Annual Average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·year^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	1,768	holes	Pit retention Dust filters (99%)	5.2	5.2	0.3
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	26	blasts	Pit retention	90.4	89.4	5.2
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	900,000	t	Pit retention	596.6	536.1	81.2
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t		27.4	13.0	2.0
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention	570.1	512.3	77.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	860,000	tonnes	Pit retention, watering (77.7%)	258.9	218.6	39.4
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	860,000	tonnes	Pit retention, watering (91.2%)	473.0	309.2	21.6
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention, moist material (50%)	285.0	256.2	38.8
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t		13.7	12.3	1.9
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	20,700	t	Pit retention Watering L2 (50%)	600.3	150.1	22.5
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	41	VKT	Pit retention	1.9	1.6	0.1
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	50,000	t		33.1	29.8	4.5
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention	26.5	23.8	3.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	40,000	tonnes	Pit retention, watering (77.7%)	12.0	10.2	1.8
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	40,000	tonnes	Pit retention, watering (91.2%)	22.0	14.4	1.0
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention, moist material (50%)	13.3	11.9	1.8
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	24,000.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	8,650.8	4,674.0	467.4
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	4,212.8	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	909.3	491.3	49.1
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	2,366.7	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	454.2	245.4	24.5
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	19.8	ha	Pit retention	8,415.0	7,994.3	1,199.1
								TOTAL	21,591.1	15,717.6	2,061.4



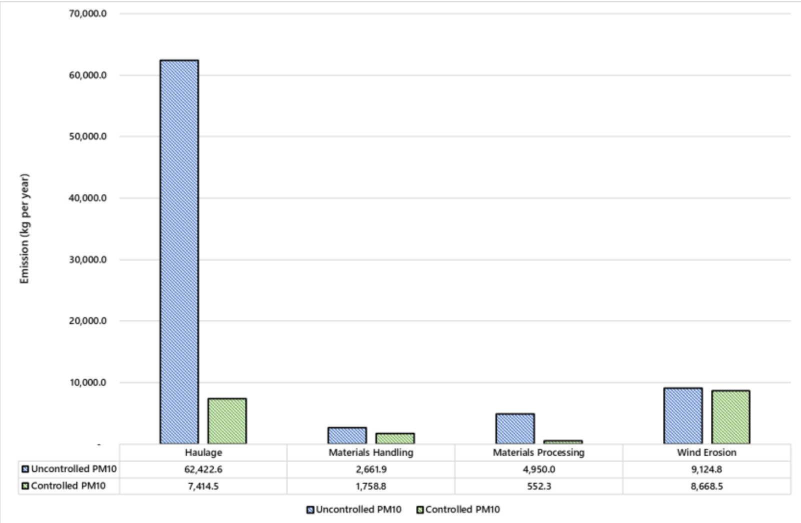
Stage 7a – 24-hr maximum

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	20	holes	Pit retention Dust filters (99%)	0.1	0.1	0.00
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	1	blasts	Pit retention	3.5	3.4	0.20
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	2,500	t	Pit retention	1.7	1.5	0.23
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t		-	-	-
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	4,000	tonnes	Pit retention, watering (77.7%)	1.2	1.0	0.18
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	4,000	tonnes	Pit retention, watering (91.2%)	2.2	1.4	0.10
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention, moist material (50%)	1.3	1.2	0.18
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	2,500	t	Pit retention	1.7	1.5	0.23
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t		-	-	-
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	-	t	Pit retention Watering L2 (50%)	-	-	-
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	3	VKT	Pit retention	0.2	0.1	0.01
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	1,000	t		0.7	0.6	0.09
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention	0.3	0.3	0.05
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	500	tonnes	Pit retention, watering (77.7%)	0.2	0.1	0.02
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	500	tonnes	Pit retention, watering (91.2%)	0.3	0.2	0.01
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention, moist material (50%)	0.2	0.1	0.02
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	106.7	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	38.4	20.8	2.08
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	87.5	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	18.9	10.2	1.02
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	47.3	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	9.1	4.9	0.49
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	19.8	ha	Pit retention	23.1	21.9	3.29
								TOTAL	108.1	74.2	8.9



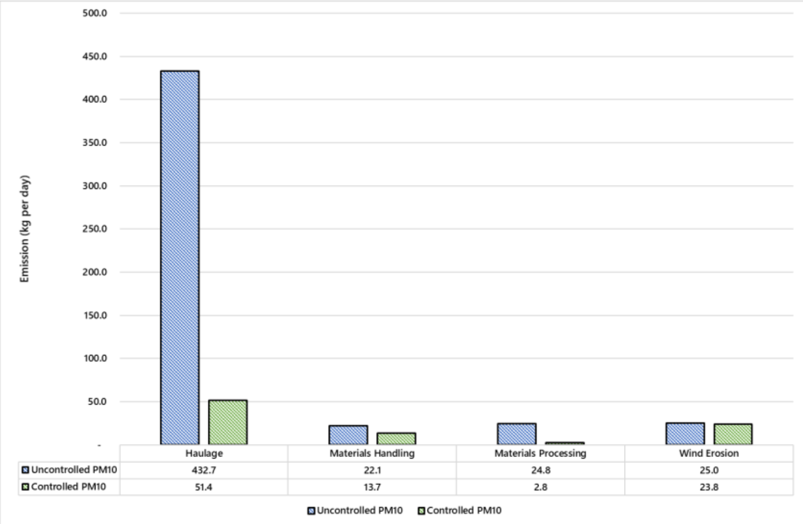
Stage 7b – Annual Average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·year^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	1,768	holes	Pit retention Dust filters (99%)	5.2	5.2	0.3
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	26	blasts	Pit retention	90.4	89.4	5.2
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	900,000	t	Pit retention	596.6	536.1	81.2
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t		27.4	13.0	2.0
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention	570.1	512.3	77.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	860,000	tonnes	Pit retention, watering (77.7%)	258.9	218.6	39.4
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	860,000	tonnes	Pit retention, watering (91.2%)	473.0	309.2	21.6
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention, moist material (50%)	285.0	256.2	38.8
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t	Pit retention	13.7	12.3	1.9
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	20,700	t		600.3	150.1	22.5
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	60	VKT	Pit retention Watering L2 (50%)	2.9	2.4	0.2
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	50,000	t	Pit retention	33.1	29.8	4.5
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention	26.5	23.8	3.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	40,000	tonnes	Pit retention, watering (77.7%)	12.0	10.2	1.8
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	40,000	tonnes	Pit retention, watering (91.2%)	22.0	14.4	1.0
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention, moist material (50%)	13.3	11.9	1.8
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	32,200.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	11,606.5	6,270.9	627.1
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	7,651.9	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	1,651.5	892.3	89.2
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	2,400.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	460.6	248.9	24.9
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	21.5	ha	Pit retention	9,124.8	8,668.5	1,300.3
								TOTAL	26,006.2	18,394.1	2,362.7



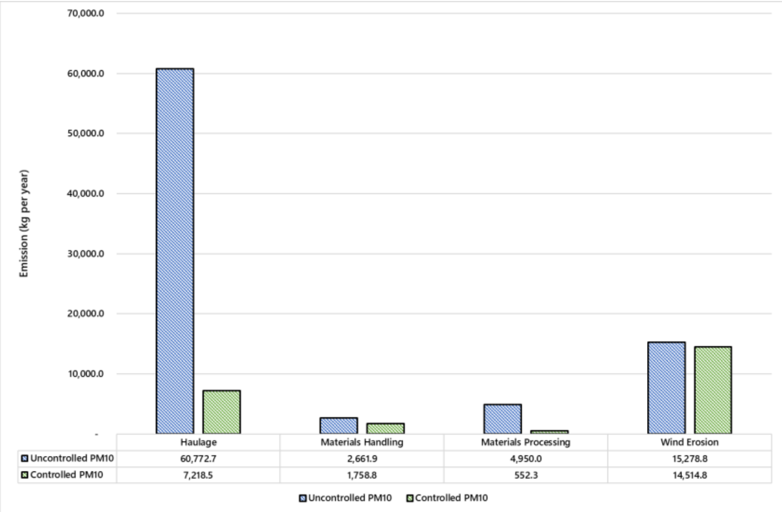
Stage 7b – 24 hour maximum

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	20	holes	Pit retention Dust filters (99%)	0.1	0.1	0.00
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	1	blasts	Pit retention	3.5	3.4	0.20
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	2,500	t	Pit retention	1.7	1.5	0.23
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t		-	-	-
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	4,000	tonnes	Pit retention, watering (77.7%)	1.2	1.0	0.18
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	4,000	tonnes	Pit retention, watering (91.2%)	2.2	1.4	0.10
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention, moist material (50%)	1.3	1.2	0.18
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	2,500	t	Pit retention	1.7	1.5	0.23
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t	Pit retention	-	-	-
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	-	t		-	-	-
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	5	VKT	Pit retention Watering L2 (50%)	0.2	0.2	0.01
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	1,000	t	Pit retention	0.7	0.6	0.09
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention	0.3	0.3	0.05
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	500	tonnes	Pit retention, watering (77.7%)	0.2	0.1	0.02
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	500	tonnes	Pit retention, watering (91.2%)	0.3	0.2	0.01
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention, moist material (50%)	0.2	0.1	0.02
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	143.1	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	51.6	27.9	2.79
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	158.9	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	34.3	18.5	1.85
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	48.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	9.2	5.0	0.50
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	21.5	ha	Pit retention	25.0	23.8	3.57
								TOTAL	138.8	91.6	10.8



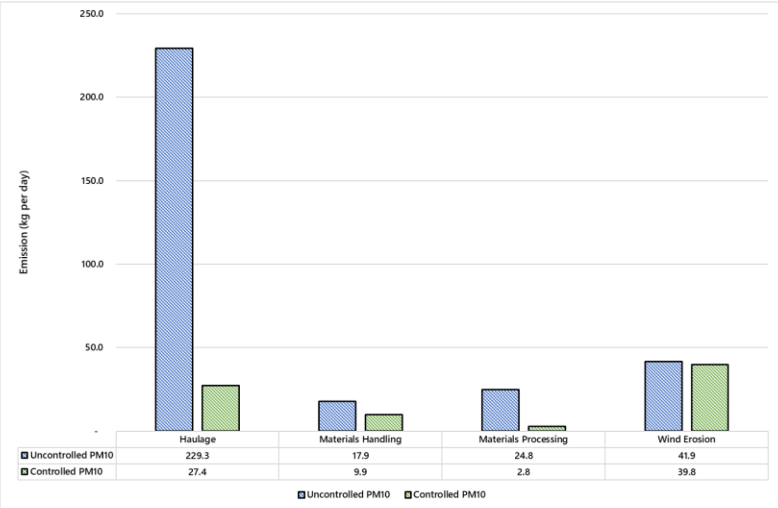
Stage 7d - Scenario 1 – Annual Average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions (kg·year^{-1})		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	1,768	holes	Pit retention Dust filters (99%)	5.2	5.2	0.3
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	26	blasts	Pit retention	90.4	89.4	5.2
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	900,000	t	Pit retention	596.6	536.1	81.2
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t		27.4	13.0	2.0
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention	570.1	512.3	77.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	860,000	tonnes	Pit retention, watering (77.7%)	258.9	218.6	39.4
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	860,000	tonnes	Pit retention, watering (91.2%)	473.0	309.2	21.6
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention, moist material (50%)	285.0	256.2	38.8
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t	Pit retention	13.7	12.3	1.9
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	20,700	t		600.3	150.1	22.5
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	58	VKT	Pit retention Watering L2 (50%)	2.8	2.3	0.2
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	50,000	t	Pit retention	33.1	29.8	4.5
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention	26.5	23.8	3.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	40,000	tonnes	Pit retention, watering (77.7%)	12.0	10.2	1.8
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	40,000	tonnes	Pit retention, watering (91.2%)	22.0	14.4	1.0
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention, moist material (50%)	13.3	11.9	1.8
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	31,400.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	11,318.2	6,115.1	611.5
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	7,308.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	1,577.3	852.2	85.2
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	2,400.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	460.6	248.9	24.9
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	36.0	ha	Pit retention	15,278.8	14,514.8	2,177.2
								TOTAL	31,797.5	24,044.4	3,220.1



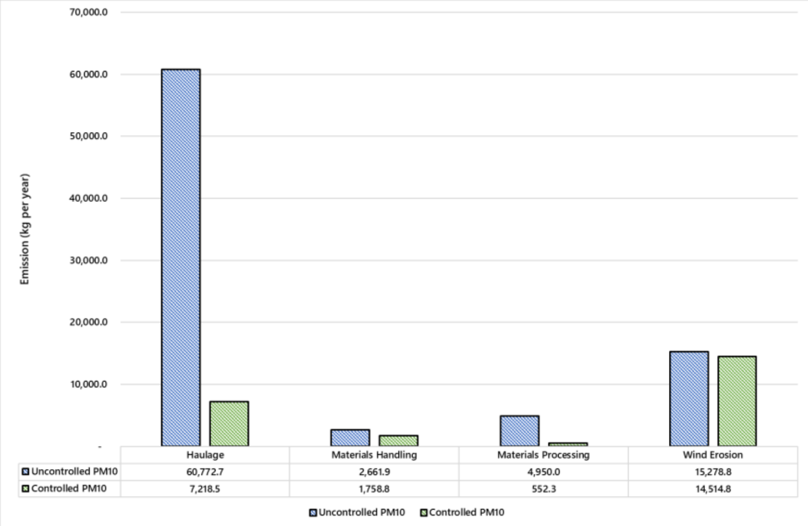
Stage 7d - Scenario 1 – 24 hour maximum

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$				(% efficiency)	TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	20	holes	Pit retention Dust filters (99%)	0.1	0.1	0.00
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	1	blasts	Pit retention	3.5	3.4	0.20
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t	Pit retention	-	-	-
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t		-	-	-
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	4,000	tonnes	Pit retention, watering (77.7%)	1.2	1.0	0.18
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	4,000	tonnes	Pit retention, watering (91.2%)	2.2	1.4	0.10
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention, moist material (50%)	1.3	1.2	0.18
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t	Pit retention	-	-	-
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t	Pit retention	-	-	-
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	-	t		-	-	-
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	5	VKT	Pit retention Watering L2 (50%)	0.2	0.2	0.01
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t	Pit retention	-	-	-
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention	0.3	0.3	0.05
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	500	tonnes	Pit retention, watering (77.7%)	0.2	0.1	0.02
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	500	tonnes	Pit retention, watering (91.2%)	0.3	0.2	0.01
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention, moist material (50%)	0.2	0.1	0.02
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	139.6	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	50.3	27.2	2.72
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	-	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	-	-	-
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	-	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	-	-	-
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	36.0	ha	Pit retention	41.9	39.8	5.96
								TOTAL	106.9	79.8	10.2



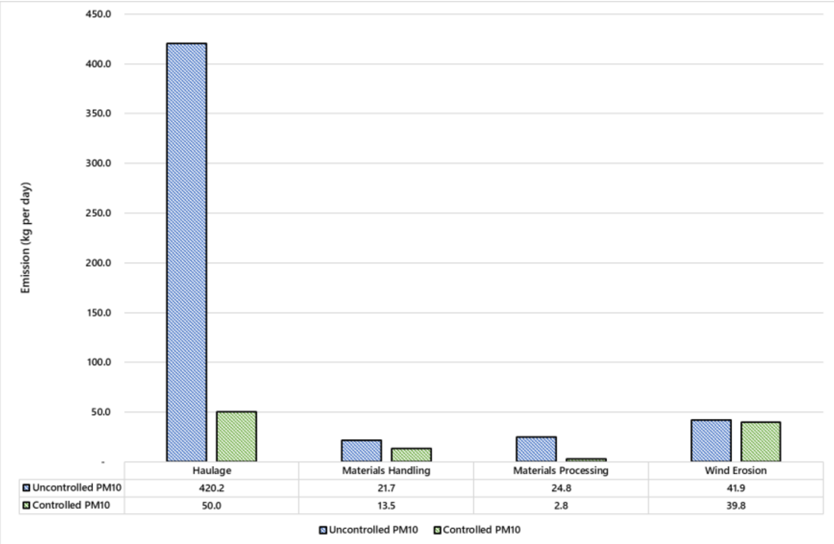
Stage 7d - Scenario 2 – Annual Average

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls (% efficiency)	Controlled Emissions ($kg \cdot year^{-1}$)		
		TSP	PM_{10}	$PM_{2.5}$					TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	1,768	holes	Pit retention Dust filters (99%)	5.2	5.2	0.3
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	26	blasts	Pit retention	90.4	89.4	5.2
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	900,000	t	Pit retention	596.6	536.1	81.2
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t		27.4	13.0	2.0
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention	570.1	512.3	77.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	860,000	tonnes	Pit retention, watering (77.7%)	258.9	218.6	39.4
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	860,000	tonnes	Pit retention, watering (91.2%)	473.0	309.2	21.6
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	860,000	t	Pit retention, moist material (50%)	285.0	256.2	38.8
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	99,667	t	Pit retention	66.1	59.4	9.0
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	20,700	t	Pit retention	13.7	12.3	1.9
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	20,700	t		600.3	150.1	22.5
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	58	VKT	Pit retention Watering L2 (50%)	2.8	2.3	0.2
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	50,000	t	Pit retention	33.1	29.8	4.5
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention	26.5	23.8	3.6
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	40,000	tonnes	Pit retention, watering (77.7%)	12.0	10.2	1.8
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	40,000	tonnes	Pit retention, watering (91.2%)	22.0	14.4	1.0
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	40,000	t	Pit retention, moist material (50%)	13.3	11.9	1.8
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	31,400.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	11,318.2	6,115.1	611.5
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	7,308.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	1,577.3	852.2	85.2
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	2,400.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	460.6	248.9	24.9
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	36.0	ha	Pit retention	15,278.8	14,514.8	2,177.2
								TOTAL	31,797.5	24,044.4	3,220.1



Stage 7d - Scenario 2 – 24 hour maximum

Description	Factor	Emission Rate			Units	Activity Rate	Units	Emission Controls	Controlled Emissions (kg·day^{-1})		
		TSP	PM_{10}	$PM_{2.5}$				(% efficiency)	TSP	PM_{10}	$PM_{2.5}$
Drilling blast holes	AP-42 - Drilling (Overburden) - Table 11.9-4	5.9E-01	3.1E-01	1.8E-02	kg/hole	20	holes	Pit retention Dust filters (99%)	0.1	0.1	0.00
Blasting	AP-42 - Blasting (Coal or Overburden) - Table 11.9-2	7.0E+00	3.6E+00	2.1E-01	kg/blast	1	blasts	Pit retention	3.5	3.4	0.20
Excavator loading haul trucks with rock	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Excavator loading haul trucks with overburden	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	2,500	t	Pit retention	1.7	1.5	0.23
Excavator loading haul trucks with soil	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t		-	-	-
Loading crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention	2.7	2.4	0.36
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	4,000	tonnes	Pit retention, watering (77.7%)	1.2	1.0	0.18
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	4,000	tonnes	Pit retention, watering (91.2%)	2.2	1.4	0.10
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	4,000	t	Pit retention, moist material (50%)	1.3	1.2	0.18
Unloading haul trucks of overburden (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	2,500	t	Pit retention	1.7	1.5	0.23
Unloading haul trucks of soil (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	-	t	Pit retention	-	-	-
Scraper on soil	AP-42 - Topsoil removal by scraper - Table 11.9-4	2.9E-02	7.3E-03	1.1E-03	kg/t	-	t		-	-	-
Grading of roads	AP-42 - Grading - Table 11.9-2	1.9E-01	8.4E-02	5.9E-03	kg/VKT	5	VKT	Pit retention Watering L2 (50%)	0.2	0.2	0.01
Unloading of VENM/ENM	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	1,000	t	Pit retention	0.7	0.6	0.09
Loading warrior crushing plant (in pit)	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention	0.3	0.3	0.05
Crushing in pit	AP-42 - Primary crushing - Table 11.19.2.1	2.7E-03	1.2E-03	2.2E-04	kg/tonne	500	tonnes	Pit retention, watering (77.7%)	0.2	0.1	0.02
Screening in pit	AP-42 - Screening - Table 11.19.2.1	1.3E-02	4.3E-03	3.0E-04	kg/tonne	500	tonnes	Pit retention, watering (91.2%)	0.3	0.2	0.01
Loading to stockpiles	AP-42 - Batch drop - Section 13.2.4.3	1.3E-03	6.3E-04	9.5E-05	kg/t	500	t	Pit retention, moist material (50%)	0.2	0.1	0.02
Haulage from pit to fixed processing plant	AP-42 Unpaved roads - Section 13.2.2	5.8E+00	1.6E+00	1.6E-01	kg/VKT	139.6	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	50.3	27.2	2.72
Haulage from pit to OB/TS inpit emplacement	AP-42 Unpaved roads - Section 13.2.2	3.5E+00	9.8E-01	9.8E-02	kg/VKT	151.8	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	32.8	17.7	1.77
Haulage of OB to OB emplacement	AP-42 Unpaved roads - Section 13.2.2	3.1E+00	8.7E-01	8.7E-02	kg/VKT	48.0	VKT	Pit retention Level 2 watering (75%) Vehicle speed limit to 30km/hr (50%)	9.2	5.0	0.50
Disturbance area	AP-42 - Wind erosion of exposed areas - annual - Table 11.9-4	8.5E+02	4.3E+02	6.4E+01	kg/ha/yr	36.0	ha	Pit retention	41.9	39.8	5.96
								TOTAL	152.8	106.1	13.0



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