LUDDENHAM OPERATIONS

30 September 2022

The Planning Secretary
Department of Planning and Environment
4 Parramatta Square
12 Darcy Street
Parramatta NSW 2150

Dear Mr Cassel,

DA 315-7-2003 (MOD 5) Annual Review (Schedule 6 Condition 5)

Luddenham Operations Pty Ltd is the operator of the Luddenham Quarry situated at 275 Adams Road, Luddenham NSW 2745, which is approved to extract and transport up to 300,000 tonnes per annum of clay and shale products.

In accordance with Schedule 6 Condition 5 of development consent DA 315-7-2003 (MOD 5), we provide below and attached the results of the environmental performance review for the 12-month period ending 30 September 2022.

Review Requirement	**Proponent Response**
(a) describe the development (including rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;	Over the past 12 months, activities on site included: - Construction of a new access road from Adams Road, including sealed entry driveway and concrete crossover; - General works to prepare the site for extraction activities; - Relocation of existing clay and shale stockpiles; - Removal of existing clay and shale stockpiles; and - No rehabilitation works were undertaken during this period. Over the next 12 months, activities on site will consist of: - Clay and shale extraction activities; - Relocation of clay and shale stockpiles; - Removal of clay and shale stockpiles; and - No rehabilitation works are planned during this period.
(b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, which includes a comparison of these results against: - the relevant statutory requirements, limits or performance measures/criteria; - the monitoring results of previous years; and - the relevant predictions in the document/s listed in condition 2 of Schedule 3;	Please refer to the attached monitoring and assessment reports: - Dust Deposition Monitoring Report J190749_RP01 dated 21/09/2022 and prepared by EMM Consulting; - Water Review Report J190749_RP71 dated 28/09/2022 and prepared by EMM Consulting; - Real Time Air Quality Monitoring Report J190749_RP72 dated 30/09/2022 and prepared by EMM Consulting; and

info@luddenhamquarry.com.au
02 7207 9059

	- Noise Compliance Report J190749_RP73 dated 28/09/2022 and prepared by EMM Consulting.
(c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;	Over the past 12 months, no non-compliances have been identified. Refer to the to the attached monitoring and assessment reports for details.
(d) identify any trends in the monitoring data over the life of the development;	As the quarry was previously dormant for a number of years prior to the works over the past 12 months, no reliable trend data is available. This analysis will be provided as part of the next Annual Review.
(e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and	Over the past 12 months, no major discrepancies have been identified. Refer to the to the attached monitoring and assessment reports for details.
(f) describe what measures will be implemented over the current calendar year to improve the environmental performance of the development.	Over the next 12 months, activities on site will continue to be managed to meet all relevant statutory requirements, limits, and performance measures/criteria.

If you wish to discuss any aspect of this Annual Review, do not hesitate to contact the undersigned at info@luddenhamquarry.com.au or 02 7207 9059.

Yours faithfully,

LUDDENHAM OPERATIONS PTY LTD

Harry Scarlis

Harry Scarlis

Director

Encl.

J190749_RP01 Dust Monitoring Report

J190749_RP71 Water Review Report

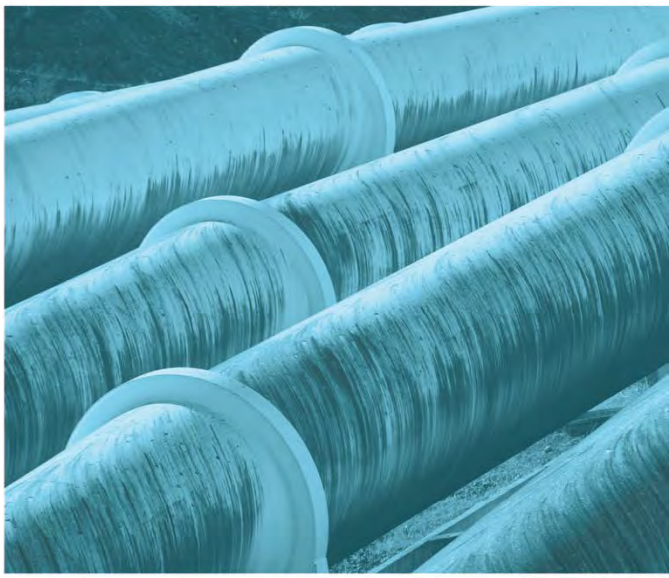
J190749_RP72 Real Time Air Quality Monitoring Report

J190749_RP73 Noise Compliance Report


Luddenham Quarry Dust Deposition Monitoring

August 2022 Monitoring Period

Prepared for Luddenham Operations
September 2022

EMM
creating opportunities

EMM
creating opportunities

Servicing projects throughout Australia and internationally

SYDNEY
Ground floor, 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3, 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 10, 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

ADELAIDE
Level 1, 70 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Ground floor, 188 Normanby Road
Southbank VIC 3006
T 03 9993 1900

PERTH
Level 6, 191 St Georges Terrace
Perth WA 6000

CANBERRA
PO Box 9148
Deakin ACT 2600

Luddenham Quarry Dust Deposition Monitoring

August 2022 Monitoring Period

Prepared for Luddenham Operations
September 2022

EMM Newcastle
Level 3, 175 Scott Street
Newcastle NSW 2300

T 02 4907 4800
E info@emmconsulting.com.au

www.emmconsulting.com.au

Luddenham Quarry Dust Deposition Monitoring

August 2022 Monitoring Period

Report Number

J190749 RP01

Client

Luddenham Operations

Date

21 September 2022

Version

v1

Approved by

David Bone
Associate Director
21 September 2022

Table of Contents

Appendices

Tables

Figures

1 Introduction

EMM Consulting has been contracted by Luddenham Operations to undertake environmental air quality monitoring activities for operation of the Luddenham Quarry Project off Adams Road Luddenham.

The air quality monitoring network consists of 3 dust deposition gauges installed, operated and analysed in accordance with AS 3580. 10. 1 2003. Static dust monitoring sites were chosen at locations adjacent to sensitive receivers in close proximity to the works in accordance with the approved AQMP.

2 Methodology

Dust gauges have been installed in accordance with the requirements *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) and AS 3580. 10. 1 2016.

Samples will continue to be taken on a monthly basis (30 days ± 2 days) until project completion.

In accordance with DEC (2007) '*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*', the project specific criterion for dust deposition is:

> Annual average dust deposition of no greater than 4g/m^2/month (assessed as total insoluble solids), and no more than a 2g/m^2/month increase on background (assessed as insoluble solids).

Samples are analysed in accordance with the *Approved Methods for the Sampling and Analysis of Air Pollutants in NSW* (DEC 2006) guidelines by a NATA Accredited laboratory. Analysis reports are included in Appendix A of each monthly dust monitoring report.

3 Results

Results for the August 2022 dust monitoring period are compiled in Table 3.1 below.

Table 3.1 August 2022 dust results

Site	Date on	Date off	No. days active	Insoluble solids (g/m²/mth)*	Comments
DG01	8/7/22	31/8/22	54	1.4	Gauge was active for two months.
DG02	8/7/22	31/8/22	54	0.7	Gauge was active for two months
DG03	8/7/22	31/8/22	54	1.1	Gauge was active for two months

*Note: As all gauges were active for two months, values are averaged over the exposure period to reflect dust deposition over this extended period for the graph shown in Figures 3.1.

A copy of the laboratory Certificate of Analysis is attached in Appendix A.

Figure 3.1 below show the monthly dust deposition results.

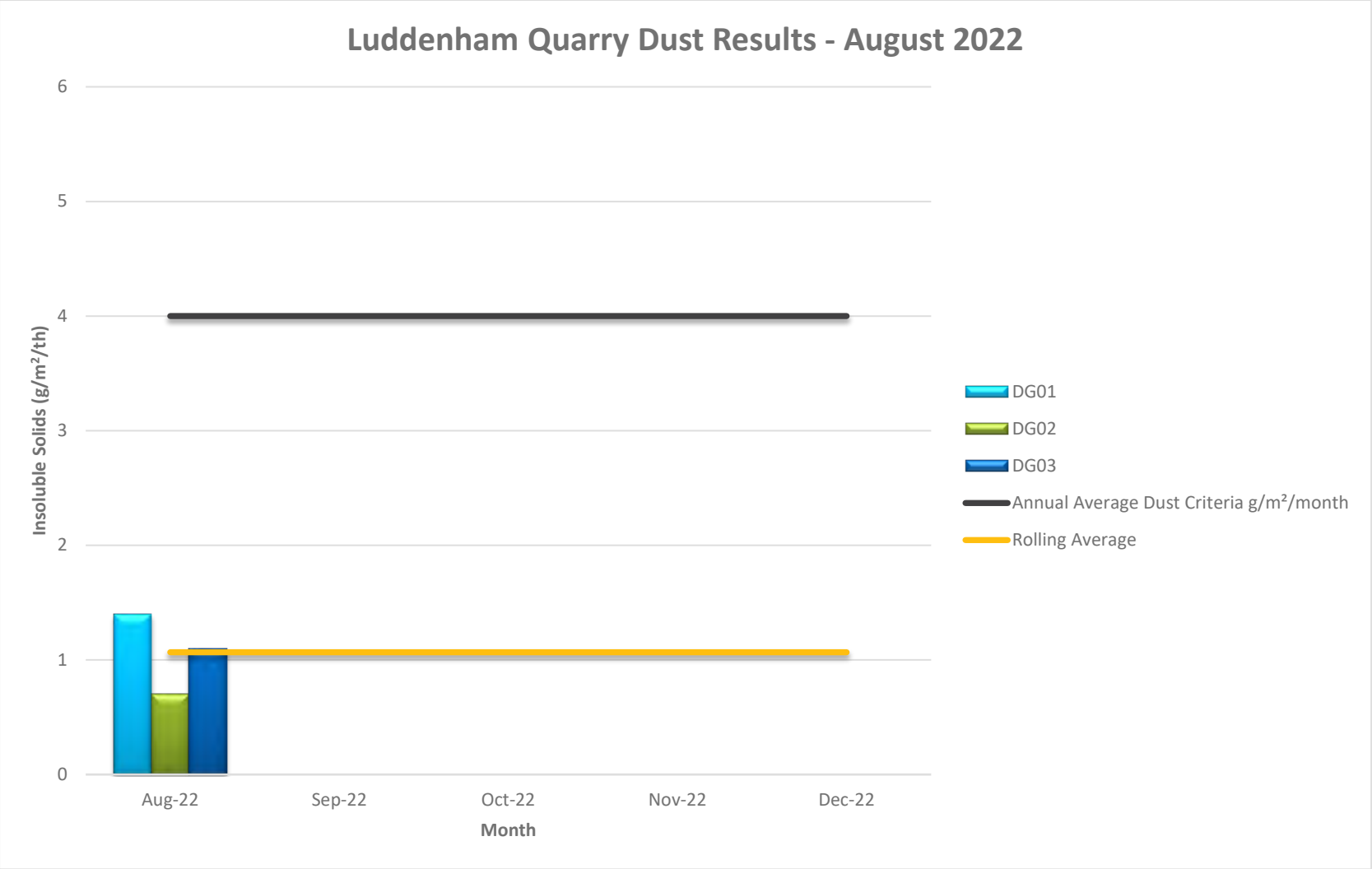


Figure 3.1 **August 2022 Dust deposition results**

4 Conclusion

Insoluble solids is the criterion which dust deposition is measured by the NSW EPA, and is considered to be the most representative measure of dust components such as soil and weathered rock disturbed during earthworks and construction activities. Other matter collected may include bird droppings, insects, organic matter such as pollen and seeds, coal and vegetative matter.

DG01 yielded a total insoluble solids value of 1.4 g/m^2/month. DG01 is currently compliant with the 4.0 g/m^2/month rolling annual average dust deposition criteria.

DG02 yielded a total insoluble solids value of 0.7 g/m^2/month. DG02 is currently compliant with the 4.0 g/m^2/month rolling annual average dust deposition criteria.

DG03 yielded a total insoluble solids value of 1.1 g/m^2/month. DG03 is currently compliant with the 4.0 g/m^2/month rolling annual average dust deposition criteria.

5 Discussion and recommendations

From the results reviewed this month, the following comments and recommendations are made:

- all gauges analysed during this monitoring period recorded dust deposition results under 4.0 g/m^2/month;
- all gauges are compliant with the 4.0 g/m^2/month rolling annual average dust deposition criteria; and
- it is recommended that site personnel exercise caution when working and operating machinery, ensure exposed surfaces are sealed or revegetated in accordance with approved measures and continued regular use of dust control measures such as the use of water carts and street sweepers.

Appendix A

Certificate of analysis

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EN2208640**	Page	: 1 of 2
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Newcastle
Contact	: Patrick Carolan	Contact	: Customer Services EM
Address	: Ground Floor Suite 1 20 Chandos Street St Leonards NSW NSW 2065	Address	: 5/585 Maitland Road Mayfield West NSW Australia 2304
Telephone	: 02 4907 4800	Telephone	: +61 3 8549 9600
Project	: J190749	Date Samples Received	: 02-Sep-2022 15:00
Order number	: ----	Date Analysis Commenced	: 06-Sep-2022
C-O-C number	: ----	Issue Date	: 13-Sep-2022 12:31
Sampler	: ADRIAN MA, JONATHON TAIT		
Site	: ----		
Quote number	: EN/112/21		
No. of samples received	: 3		
No. of samples analysed	: 3		

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Thomas Regan	Laboratory Technician	Newcastle - Inorganics, Mayfield West, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Analysis as per AS3580.10.1-2016. Samples passed through a 1mm sieve prior to analysis. NATA accreditation does not apply for results reported in g/m².mth as sampling data was provided by the client.
- Sample exposure period is 54 days which is outside the typical exposure period of 30 +/- 2 days as per AS3580.10.1.
- For dust analysis, the Limit of Reporting (LOR) referenced in the reports for deposited matter parameters represents the reporting increment rather than reporting limit.

Analytical Results

Sub-Matrix: **DEPOSITIONAL DUST** (Matrix: **AIR**)			Sample ID	**DG01** **08/07/22 - 31/08/22**	**DG02** **08/07/22 - 31/08/22**	**DG03** **08/07/22 - 31/08/22**	**----**	**----**
			Sampling date / time	31-Aug-2022 00:00	31-Aug-2022 00:00	31-Aug-2022 00:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EN2208640-001**	**EN2208640-002**	**EN2208640-003**	**--------**	**--------**
				Result	Result	Result	----	----
EA141: Total Insoluble Matter								
Total Insoluble Matter	----	0.1	g/m².month	**1.4**	**0.7**	**1.1**	**----**	**----**
Total Insoluble Matter (mg)	----	2	mg	**45**	**22**	**34**	**----**	**----**

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

CLAISTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: alsgstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5 Rose Gum Road Warabrook NSW 2304 Ph: 02 4968 9433 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024428 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: J190749	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☑ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE:		☐ Non Standard or urgent TAT (List due date):	Custody Seal Intact? Yes No N/A
PROJECT: J190749	ALS QUOTE NO.:	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: PAT CAROLAN	CONTACT PH:	OF: 1 2 3 4 5 6 7	Other comment: 19.8
SAMPLER: JONOTAN ADRIANMA	SAMPLER MOBILE: 0400573585	RELINQUISHED BY:	RECEIVED BY:
COC emailed to ALS? (YES (NO)	EDD FORMAT (or default):		
Email Reports to (will default to PM if no other addresses are listed):	PCAROLAN@EMMCONSULTANCE.COM.AU	DATE/TIME:	DATE/TIME: 31-8-22 13:45
Email Invoice to (will default to PM if no other addresses are listed):	" "	RELINQUISHED BY:	RECEIVED BY:
		DATE/TIME:	DATE/TIME: 2/9/22 15:00

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

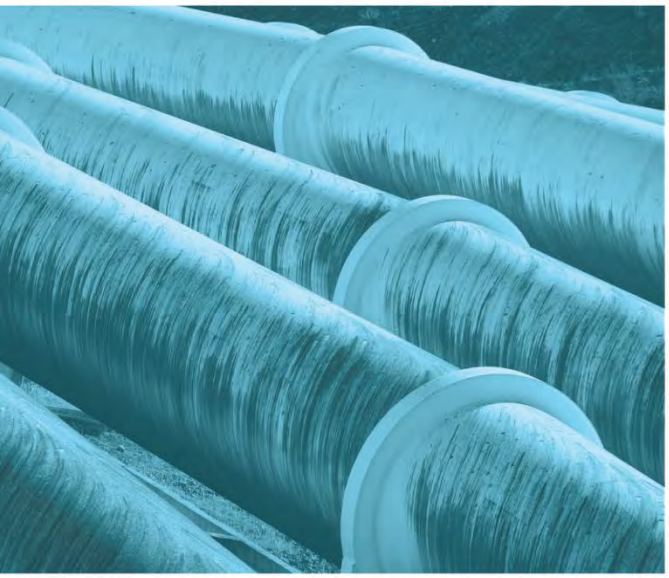
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required). TOTAL INSOLUBLE MATTER							Additional Information
	D1001	31.8.22		CuSO4	1	X							
	D1002	31.8.22		CuSO4	1	X							
	D1003	31.8.22		CuSO4	1	X							
				TOTAL									

Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.

Environmental Division
Newcastle
Work Order Reference
EN2208640

Telephone : +61 2 4014 2500

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.



Luddenham Quarry

Water review (September 2021 - August 2022)

Prepared for Luddenham Operations Pty Ltd

September 2022

Luddenham Quarry

Water review (September 2021 - August 2022)

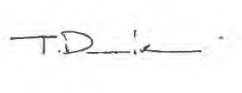
Luddenham Operations Pty Ltd

J190749 RP#71

September 2022

Version	Date	Prepared by	Approved by	Comments
1	23/09/2022	Adrian Ma	Tess Davies	Draft for client review
1	28/09/2022	Adrian Ma	Tess Davies	Final

Approved by



Tess Davies
Senior Water Resources Engineer
28 September 2022

Level 3 175 Scott Street
Newcastle NSW 2300

TABLE OF CONTENTS

Appendices

Tables

Figures

1 Introduction

1.1 Overview

Luddenham Quarry is located at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799, 'the site') within the Liverpool City Council municipality. The existing shale/clay quarry is approved by State significant development (SSD) consent DA 315-7-2003, issued by the NSW Minister for Planning under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The site is owned by CFT No 13 Pty Ltd, a member of the Coombes Property Group (CPG).

Luddenham Operations Pty Ltd is operating the quarry in accordance with Modification 5 (MOD 5) of DA 315-7-2003 which was granted on 24 May 2021.

1.2 Purpose of this report

This report outlines water balance modelling and water quality monitoring undertaken by EMM Consulting Pty Ltd (EMM) to support the Luddenham Quarry annual review report being prepared by Luddenham Operations Pty Ltd (Luddenham Operations), for the annual review period of 1 September 2021 to 31 August 2022.

1.3 Report structure

The following sections set out:

- an overview of EMM's understanding of the site operations (Section 2);
- the methodology and data applied to this assessment (Section 3);
- water balance results for the annual review period (Section 4);
- water quality results for the annual review period (Section 5); and
- a summary of work undertaken and recommendations for environmental compliance (Section 6).

2 Background

2.1 Overview

This section describes EMM's understanding of the site operations, water management and water quality monitoring program.

2.2 Summary of site operations

During the annual review period, the site has commenced reestablishment with the stockpiling of materials and reestablishment of internal access roads being undertaken during the last six months. Quarrying activities are yet to recommence. Luddenham Operations has advised that during the annual review period:

- no transfers between the water management dam and the quarry pit were undertaken;
- no dust suppression activities were undertaken; and
- no discharges were observed to occur from the water management dam to Oaky Creek.

2.3 Water quality monitoring program

A water quality monitoring program was developed for the Soil and Water Management Plan (SWMP) (EMM 2021) for the site. The program commenced in March 2022 and involves quarterly groundwater and annual surface water monitoring (refer Appendix A for monitoring locations). The following sections outline the program details.

2.3.1 Surface water monitoring locations

The surface water monitoring program consists of the following locations (refer Appendix A):

- Oaky Creek upstream of the site;
- Oaky Creek downstream of the site;
- water stored within the quarry pit; and
- water stored within the water management dam.

2.3.2 Groundwater monitoring locations

A groundwater monitoring bore network was installed before quarrying to understand the hydrogeology at the site and to monitor for potential impacts. Three monitoring bores were drilled and installed to a depth of approximately 30 m into the Bringelly Shale with the overlying unconsolidated material cased off. The monitoring bores were sited with one bore up-hydraulic gradient (BSM1) as a background bore (to the quarry footprint) and two bores down-hydraulic gradient of the pit (BSM2 and BSM3). The two down-hydraulic gradient bores are located along the eastern downslope perimeter of the quarry, outside the 40 m vegetated riparian zone associated with the western banks of Oaky Creek.

The BSM2 monitoring bore was reportedly damaged and is receiving rainfall and runoff, resulting in unrepresentative groundwater quality results. The most recent sampling round on 31 August 2022 found that the BSM1 monitoring bore was likely destroyed (refer Section 4.1). Before the commencement of any future monitoring, BSM1 and BSM2 should be rehabilitated or replaced with equivalent monitoring bores.

2.3.3 Analytes

The analytical suite for the surface and groundwater monitoring program are presented in Table 2.1. Physical and chemical stressors (except for total suspended solids) are monitored in the field with a calibrated hand-held water quality meter. All other parameters are analysed at a laboratory accredited by the National Association of Testing Authorities (NATA).

Table 2.1 Surface and groundwater quality analytes

Category	Parameters	Analysis method
Physical and chemical stressors	Dissolved oxygen, electrical conductivity, pH, total dissolved solids	In the field with a calibrated hand-held water quality meter
	Total suspended solids	Analysis undertaken at NATA accredited laboratory
Nutrients	Ammonia, nitrate, nitrite, total Kjeldahl nitrogen, total nitrogen, reactive phosphorus, total phosphorus	Analysis undertaken at NATA accredited laboratory
Dissolved metals	Aluminium, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc	Analysis undertaken at NATA accredited laboratory
Other	Total hardness, oil and grease	Analysis undertaken at NATA accredited laboratory

3 Water balance

3.1 Methodology and data

The site water balance model that was developed for the MOD5 approval (EMM 2020) was updated to assess the water management system during the annual review period. The following sections outline the model updates.

3.1.1 GoldSim representation

The water balance model was developed in GoldSim version 12.1. The model was created by representing the water cycle as a series of elements, each containing pre-set rules and data, that were linked together to simulate the interaction of these elements over the annual review period from 1 September 2021 to 31 August 2022.

To undertake the modelling the following simplifications and assumptions were made:

- No pumped water transfers between the water management dam and the quarry pit, dust suppression or irrigation was applied to the model (as advised by Luddenham Operations).
- A simulation timeframe was set from 12 February 2021 to 31 August 2022, as the last known quarry pit water level was observed on 12 February 2021.
- The initial water level in the water management dam was assumed to be 40% full at the beginning of the simulation. This assumption results in no discharges from the water management dam in line with advice from Luddenham Operations.

3.1.2 Data

i Climatic data

Daily rainfall and evaporation data from Bureau of Meteorology's Badgerys Creek AWS weather station (station number 67108) was adopted for the water balance model simulation period.

ii Catchment runoff

Surface runoff was estimated using the Australian Water Balance Model (AWBM). The AWBM was developed by Boughton (2004) and is widely used across Australia to estimate runoff. The hydrological model calculates runoff and baseflow components from rainfall after allowing for relevant losses and storage. The AWBM was incorporated into the GoldSim water balance model for the site.

For each surface type present on site, the AWBM was parameterised to achieve long-term average volumetric runoff coefficients (Cv) based on typical values. The assumed catchment breakdown and Cv applied to each surface type are provided in Table 3.1.

Table 3.1 Catchment runoff parameters

Surface type	Management areas	Area (ha)	Cv
Impervious – high runoff potential	Roofs, weighbridge, sealed roads	0.8	0.9
Disturbed – moderate runoff potential	Unsealed roads, stockpiles	9.7	0.6
Pasture – low runoff potential	Grassed catchments, vegetated bunds	2.8	0.4

iii Groundwater inflows

The predicted quantity of groundwater to be intercepted by the quarry pit was assumed to be a constant 5 m^3/day, based on the original groundwater assessment undertaken for the quarry (Douglas Nicolaisen & Associates 2003).

3.2 Water balance results

The water management system for Luddenham Quarry was modelled from 12 February 2021 to 31 August 2022. The estimated values for each of the inputs and outputs of the water management system for the annual review period (1 September 2021 to 31 August 2022) are provided in Figure 3.1. A summary of the estimated annual inputs and outputs of the water management systems is presented in Table 3.2. Total results have been rounded to 1 ML/year.

As shown in Table 4.1, there was an overall net increase of water predicted to be stored within the quarry pit and water management dam over the annual review period, which is consistent with site observations made at the beginning and end of the period. There were no modelled discharges from the water management dam into Oaky Creek during the annual review period.

Table 3.2 Summary of site water balance

Water management element	Volume (ML/year)
INPUTS	
Groundwater inflows	2
Rainfall	24
Catchment runoff	27
Total Inputs	**53**
OUTPUTS	
Evaporation	23
Total Outputs	**23**
CHANGE IN STORAGE	
Quarry pit	28
Water management dam	2
Total change in storage	30
BALANCE	**0**

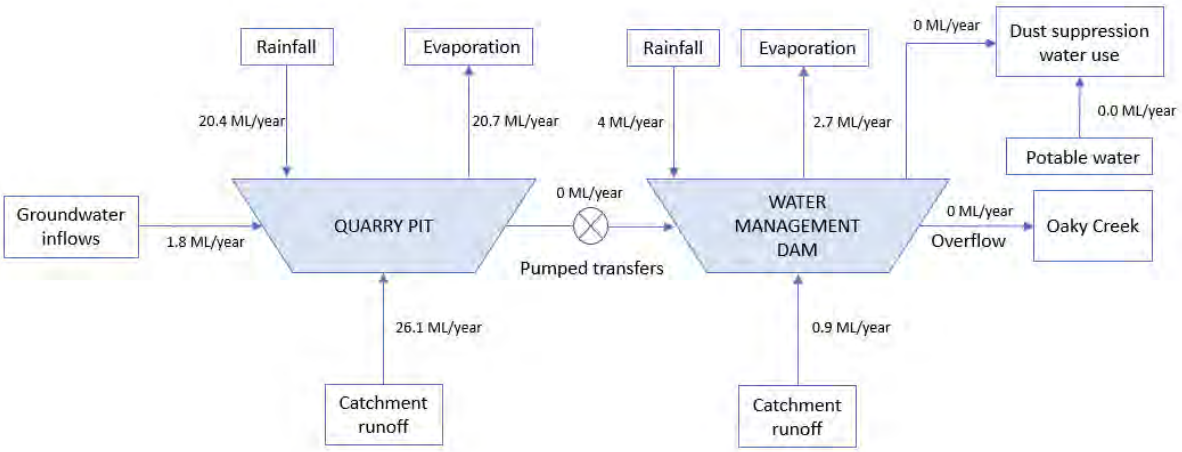


Figure 3.1 Water balance results

4 Water quality monitoring

4.1 Monitoring overview

The following monitoring rounds were undertaken for this annual review period:

- Groundwater monitoring – 11 March 2022. All three groundwater monitoring sites were sampled. However, it was found that BSM2 was damaged and receiving rainfall and runoff ingress, leading to unrepresentative results.
- Surface water and groundwater monitoring – 31 August 2022. Four surface water sites were sampled along with one groundwater monitoring site. BMS2 was noted to remain out of service and BSM1 was not found onsite. It is suspected that BSM1 has been destroyed during the construction of new internal access roads.

4.2 Rainfall context

The Bureau of Meteorology operates a rain gauge at Badgerys Creek (approximately 3 km from the site – Station number: 067108). The preceding one, three and five-day rainfall totals to 9:00 am on 31 August 2022 are presented in Table 4.1.

Table 4.1 Rainfall before 31 August 2022

Gauge location	One-day prior rainfall total (mm)	Three-day prior rainfall total (mm)	Five-day prior rainfall total (mm)
Badgerys Creek AWS	0	0.8	10.6

4.3 Completed monitoring

The following sections describe the completed monitoring and field observations. Key results are discussed in Section 4.6.

4.3.1 Groundwater

Field observations for completed groundwater monitoring is presented in Table 4.2.

Table 4.2 Field observations (groundwater monitoring)

Time of sample	Monitoring point	Site description	Field comments/context
Groundwater sampling locations			
11/03/2022 – 12:24 PM	BSM1	Upgradient bore to measure background contamination levels.	Clear, some suspended solids, no smell.
11/03/2022 – 09:10 AM	BSM2	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Bore requires rehabilitation or replacement – Sample taken, however not considered representative.
11/03/2022 – 11:23 AM	BSM3	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Mostly clear, some suspended solids, no smell.

Table 4.2 Field observations (groundwater monitoring)

Time of sample	Monitoring point	Site description	Field comments/context
Groundwater sampling locations			
31/08/2022	BSM1	Upgradient bore to measure background contamination levels.	Bore not found (suspected to be destroyed) – No sample taken.
31/08/2022	BSM2	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Bore requires rehabilitation or replacement – No sample taken.
31/08/2022 – 10:08 AM	BSM3	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Mostly clear, slight hydrogen sulphide smell.

4.3.2 Surface water

Field observations for completed surface water monitoring is presented in Table 4.3.

Table 4.3 Field observations (surface water)

Time of sample	Monitoring point	Site description	Field comments/context
Surface water management ponds			
31/08/2022 – 12:04 PM	Quarry Pit	Large storage body in the central part of the site. Stored water is used for dust suppression and storage of sediment-laden water.	Relatively clear, green tinge
31/08/2022 – 09:41 AM	Water management dam	Located toward the north-eastern edge of the site. Stored water is used for dust suppression and storage of sediment-laden water. Excess water from this dam discharges into Oaky Creek.	Muddy
31/08/2022 – 12:22 PM	Upstream	Oaky Creek, upstream of the site	Stagnant water, muddy, sediment floating on top
31/08/2022 – 12:49 PM	Downstream	Oaky Creek, downstream of the site	Stagnant water, cloudy and turbid.

4.4 Laboratory analysis

Water samples were transported to a NATA-accredited laboratory (Australian Laboratory Services (ALS) in Smithfield, NSW) for analysis. All laboratory analytes that were not additionally measured in situ (ie pH, electrical conductivity (EC), dissolved oxygen and oxidation-reduction potential) were received by the laboratory within the maximum holding times.

4.5 Quality assurance/quality control

Samples were collected in laboratory-provided sample containers with appropriate preservation. Samples were collected and sent to the laboratory under appropriate chain of custody protocols.

The field QA/QC procedures used to establish accurate, reliable, and precise results included:

- calibration of equipment by the supplier before use;

- keeping samples chilled;
- submitting laboratory samples within holding times; and
- wearing fresh disposable nitrile gloves during sampling at each sampling location.

4.6 Sampling results (annual review period)

Monitoring results for the annual review period are detailed in the following appendices:

- surface water monitoring results are provided in Appendix B; and
- groundwater quality results are provided in Appendix C.

Results were compared to trigger values presented in the SWMP for the site (EMM 2021).

Key results observations from the March 2022 groundwater monitoring event include:

- BSM3 slightly exceeded upgradient bore trigger values in ammonia, total nitrogen, total Kjeldahl nitrogen, nickel and turbidity.
- BSM3 exceeded upgradient bore trigger values in total phosphorus, reactive phosphorus and iron.

Key results observations from the August 2022 groundwater monitoring event include:

- BSM3 exceeded the lower bound trigger values for pH during the August monitoring round.
- Comparison of EC and nutrient trigger values to an upgradient bore was not possible due to the compromised quality of BSM1.

Key results observations from the August 2022 surface water monitoring event include:

- The quarry pit water showed elevated EC, ammonia, oxidised nitrogen, total nitrogen and phosphorus relative to the trigger values. There were slight elevations in aluminium, copper, and zinc concentrations.
- The water management dam had a slightly lower pH compared to trigger values, and elevated oxidised nitrogen concentration, with slightly elevated levels of ammonia and total nitrogen.
- Oaky Creek upstream water quality included slightly elevated EC and elevated levels of ammonia, oxidised nitrogen, total nitrogen and copper concentrations. However, results have the potential to be skewed by low flow conditions.
- Oaky Creek downstream water quality included elevated levels of oxidised nitrogen, total nitrogen and phosphorus. However, results have the potential to be skewed by low flow conditions.

5 Recommendations

The following recommendations are made:

- BSM1 and BSM2 require rehabilitation/replacement to be compliant with approval conditions. Comparison of groundwater quality to an upgradient bore is not possible while BSM1 remains out of service.
- Records of site water management transfers, dust suppression and levels within the quarry pit and water management should be made ahead of the next water balance model review to enable better results estimates.
- During the annual surface water monitoring event, Oaky Creek should be targeted during flow events to allow for more representative results.

6 References

EMM 2020, *Luddenham Quarry – Modification 5: Surface Water Assessment*, prepared by EMM Consulting Pty Limited for Coombes Property Group and KLF Holdings Pty Ltd.

– 2021, *Luddenham Quarry – Soil and Water Management Plan*, prepared by EMM Consulting Pty Limited for Luddenham Operations Pty Ltd.

Appendix A
Water quality monitoring locations

EMM
creating opportunities

KEY

- Study area
- Cadastral boundary
- Watercourse
- Water quality monitoring location
- Groundwater monitoring bore

Water quality monitoring locations

Source: EMM (2021); DFSI (2017); GA (2011); ASGC (2006); Nearmap (2020)

0 100 200 m

GDA 1994 MGA Zone 56

N

Luddenham Quarry
Water Management Plan
Figure 4.1

EMM
creating opportunities

\\Emmsvr1\emm\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02 Maps\Modification Reporting\Surface Water\Water Management\SWM003 WQMonitoringLocations 20210526 02.mxd 26/05/2021

Appendix B
Surface water quality results

EMM
creating opportunities

Table B.1 Water quality results – surface water

Group	Parameter	Units	LOR	Trigger value	Baseline data range	Oaky Creek upstream	Oaky Creek downstream	Quarry pit	Water management dam
Field	Temp	°C		–	–	12.8	12.4	16	14.7
	EC	µS/cm		125–2,200	773–5,990	2,272	1,118	3,986	341
	pH	–		6.5–8.5	7.82–8.65	6.57	6.87	8.01	6.16
	Dissolved oxygen (DO)	% sat		85%–110%	–	95.1	70.3	97.1	47.1
	DO	mg/L		–	8–10.5	9.93	7.47	9.47	4.74
	Redox potential	mV		–	–	-190	-185.4	-185.6	-140.2
	Total dissolved solids (TDS)	mg/L		–	398–3,720	1,475	728	2593	222
Nutrients	Ammonia as N	mg/L	0.01	0.02	<0.01–0.1	0.15	0.02	0.06	0.03
	Nitrite + nitrate as N	mg/L	0.01	0.04	<0.01–6.51	8.95	0.29	0.99	1.55
	Total Kjeldahl nitrogen	mg/L	0.1	–	0.2–1.4	2.8	1	2.3	0.5
	Nitrite (as N)	mg/L	0.01	–	<0.01–0.13	0.1	<0.01	<0.01	0.04
	Nitrate (as N)	mg/L	0.01	–	<0.01–6.38	8.85	0.29	0.99	1.51
	Nitrogen (total)	mg/L	0.1	0.5	0.2–7.9	11.8	1.3	3.3	2
	Phosphorus (total)	mg/L	0.01	0.05	<0.01–0.13	0.05	0.11	0.36	<0.01
	Reactive phosphorus (as P)	mg/1	0.01	0.02	<0.01–<0.01	<0.010	<0.010	0.010	<0.010
Metals (dissolved)	Aluminium	mg/L	0.01	0.055	<0.01–0.04	0.030	<0.010	0.080	0.010
	Arsenic	mg/L	0.001	0.013	<0.001–0.001	<0.001	<0.001	<0.001	0.001
	Boron	mg/L	0.05	0.37	<0.05–<0.05	<0.050	<0.050	<0.050	<0.050
	Cadmium	mg/L	0.0001	0.0002	<0.0001–<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	0.001	<0.001–0.0005	<0.001	<0.001	<0.001	<0.001

Table B.1 Water quality results – surface water

Group	Parameter	Units	LOR	Trigger value	Baseline data range	Oaky Creek upstream	Oaky Creek downstream	Quarry pit	Water management dam
	Copper	mg/L	0.001	0.0014	<0.001 - 0.019	0.002	0.003	0.008	0.001
	Iron	mg/L	0.05	0.3	<0.05– <0.05	0.080	<0.05	0.130	<0.05
	Lead	mg/L	0.001	0.0034	<0.001– <0.001	<0.001	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	1.9	<0.001– 0.059	1.790	0.330	0.015	<0.001
	Nickel	mg/L	0.001	0.011	<0.001– 0.004	0.002	0.001	0.003	<0.001
	Zinc	mg/L	0.005	0.008	<0.005– 0.026	<0.005	0.005	0.009	0.005
Other	Oil and grease	mg/L	5	Above detection	<5	<5	<5	<5	<5
	Total suspended solids (TSS)	mg/L	5	–	–	252	47	11	74
	Total hardness as $CaCO_3$	mg/L	1	–	–	303	154	426	71

Note: Results in red indicate an exceedance of the trigger value.

LOR = limit of reporting.

Appendix C
Groundwater quality results

EMM
creating opportunities

C.1 Groundwater quality results – March 2022

Table C.1 Water quality results - Groundwater

Group	Parameter	Units	LOR	Trigger value	Baseline median	BSM1	BSM3
Field	Temp	°C		–	20.5	24.10	19.5
	EC	µS/cm		Comparison with upgradient bore	23,100	25,681	25,332
	pH	–		6.5–8.5	6.7	6.71	6.96
	DO	% sat		–	–	14.40	22.5
	DO	mg/L		–	1.5	1.09	1.89
	Redox potential	mV		–	–	68.80	-88.1
	TDS	mg/L		–	–	16.69	16.46
Nutrients	Ammonia as N	mg/L	0.01	Comparison with upgradient bore		8.02	8.03
	Nitrite + nitrate as N	mg/L	0.01	Comparison with upgradient bore	–	0.28	0.16
	Total Kjeldahl nitrogen	mg/L	0.1	–	–	9.8	10.8
	Nitrite (as N)	mg/L	0.01	–	<0.005	<0.01	<0.01
	Nitrate (as N)	mg/L	0.01	–	0.01	0.28	0.16
	Nitrogen (total)	mg/L	0.1	Comparison with upgradient bore	–	10.1	11.0
	Phosphorus (total)	mg/L	0.01	Comparison with upgradient bore	0.05	0.05	0.28
	Reactive phosphorus (as P)	mg/1	0.01	Comparison with upgradient bore	0.4	<0.01	0.12
Metals (dissolved)	Aluminium	mg/L	0.01	0.055	–	<0.01	<0.01
	Arsenic	mg/L	0.001	0.013	<0.001	<0.001	<0.001
	Boron	mg/L	0.05	0.37	–	<0.05	<0.05
	Cadmium	mg/L	0.0001	0.0002	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	0.001	0.002	<0.001	<0.001
	Copper	mg/L	0.001	0.0014	<0.001	0.005	<0.001
	Iron	mg/L	0.05	0.3	8.5	<0.05	0.44
	Lead	mg/L	0.001	0.0034	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	1.9	–	0.36	0.34
	Nickel	mg/L	0.001	0.011	0.006	0.002	0.008
	Zinc	mg/L	0.005	0.008	0.06	0.052	0.011

Table C.1 Water quality results - Groundwater

Group	Parameter	Units	LOR	Trigger value	Baseline median	BSM1	BSM3
Other	Oil and grease	mg/L	5	Above detection	<5	<5	<5
	Turbidity	NTU	0.1	Comparison with upgradient bore	–	32.4	38.4

Note: Results in red indicate an exceedance of the trigger value.

LOR = limit of reporting.

C.2 Groundwater quality results – August 2022 sampling round

Group	Parameter	Units	LOR	Trigger Value	Baseline median	BSM3
Field	Temp	°C		–	20.5	17.7
	EC	µS/cm		Comparison with upgradient bore	23,100	27,929
	pH	–		6.5–8.5	6.7	6.28
	DO	% sat		–	–	39.9
	DO	mg/L		–	1.5	3.42
	Redox potential	mV		–	–	-164.8
	TDS	mg/L		–	–	18,154
Nutrients	Ammonia as N	mg/L	0.01	Comparison with upgradient bore	–	7.25
	Nitrite + nitrate as N	mg/L	0.01	Comparison with upgradient bore	–	<0.01
	Total Kjeldahl nitrogen	mg/L	0.1	–	–	7.6
	Nitrite (as N)	mg/L	0.01	–	<0.005	<0.01
	Nitrate (as N)	mg/L	0.01	–	0.01	<0.01
	Nitrogen (total)	mg/L	0.1	Comparison with upgradient bore	–	7.6
	Phosphorus (total)	mg/L	0.01	Comparison with upgradient bore	0.05	<0.05
	Reactive phosphorus (as P)	mg/1	0.01	Comparison with upgradient bore	0.4	<0.01
Metals (dissolved)	Aluminium	mg/L	0.01	0.055	–	<0.01
	Arsenic	mg/L	0.001	0.013	<0.001	<0.001
	Boron	mg/L	0.05	0.37	–	<0.05
	Cadmium	mg/L	0.0001	0.0002	<0.0001	<0.0001
	Chromium	mg/L	0.001	0.001	0.002	<0.001
	Copper	mg/L	0.001	0.0014	<0.001	0.001
	Iron	mg/L	0.05	0.3	8.5	1.66
	Lead	mg/L	0.001	0.0034	<0.001	<0.001
	Manganese	mg/L	0.001	1.9	–	0.308
	Nickel	mg/L	0.001	0.011	0.006	0.002
	Zinc	mg/L	0.005	0.008	0.06	0.006
Other	Oil and grease	mg/L	5	Above detection	<5	<5
	Total suspended solids	mg/L	5	–	–	57

Note: Results in red indicate an exceedance of the trigger value.

LOR = limit of reporting.

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9
109 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1
T 604 999 8297

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au

Luddenham Quarry

Real-time air quality monitoring campaign - September 2022

Prepared for Luddenham Operations Pty Ltd

September 2022

Luddenham Quarry

Real-time air quality monitoring campaign - September 2022

Luddenham Operations Pty Ltd

J190749 R72

September 2022

Version	Date	Prepared by	Approved by	Comments
1	30/09/20022	Amie Gilbert	Scott Fishwick	

Approved by

Scott Fishwick
National Technical Lead – Air Quality
30 September 2022

Ground floor 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

TABLE OF CONTENTS

Appendices

Tables

Figures

1 Introduction

Luddenham Quarry is located at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799, 'the site') within the Liverpool City Council municipality. The existing shale/clay quarry is approved by state significant development (SSD) consent DA 315-7-2003, issued by the NSW Minister for Planning under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The site is owned by CFT No 13 Pty Ltd, a member of the Coombes Property Group (CPG).

Luddenham Operations Pty Ltd will reactivate and operate the quarry in accordance with Modification 5 (MOD 5) of DA 315-7-2003 which was granted by the NSW Department of Planning and Environment (DPE then DPIE) on 24 May 2021.

This report provides a summary of the four week real-time particulate matter (PM) monitoring campaign conducted at the site during September 2022, to satisfy the requirements of the development consent (as modified).

1.1 Air quality management plan and monitoring program

Condition 4 (Schedule 4) of the development consent (as modified) requires the preparation of an air quality management plan (AQMP). The AQMP was completed in September 2021. As identified in Section 5 of the AQMP, the requirements for ambient air quality monitoring at the site are outlined in Condition 3 (Schedule 4) as follows:

> *"carry out regular air quality monitoring to determine whether the development is complying with the relevant conditions in this consent."*

The specific AQMP requirements outlined in Condition 4 (Schedule 4) requires a monitoring program that:

> *"(i) is capable of evaluating the performance of the development against the air quality criteria;*
>
> *(ii) adequately supports the air quality management system; and*
>
> *(iii) includes a protocol for identifying any air quality-related exceedance, incident or non-compliance and for notifying the Department and relevant stakeholders of these events*.

1.2 Continuous particulate matter monitoring

Section 5.2.2 of the AQMP relates to continuous particulate matter (PM) monitoring, and is reproduced in this section.

To evaluate compliance with the air quality criteria for TSP, PM_{10} and $PM_{2.5}$ (see Chapter 2), two continuous PM monitoring instructions will be deployed on a campaign basis[1].

The instruments will be solar powered and relocatable and will be positioned upwind and downwind of the main dust generation activities occurring during the monitoring campaign. The upwind and downwind monitoring will enable compliance assessment against the short-term air quality criteria, which are evaluated against the increment increase from the development alone, as follows:

- PM contribution from quarry = downwind concentration minus upwind concentration.

Seasonal wind roses for the Bureau of Meteorology (BoM) Badgerys Creek automatic weather station (AWS) are presented in Figure A.1 (of the AQMP), which can be used to determine which locations are upwind and downwind locations for each monitoring campaign. Compliance assessment will use the meteorological

[1] If all three size fractions cannot be measured simultaneously by the selected instrument, preference will be given to PM_{10} and $PM_{2.5}$ and TSP will be inferred from PM_{10} concentrations based on the assumption that PM_{10} is 40% of TSP.

monitoring data collected for the period of each monitoring campaign to determine upwind and downwind conditions on a daily basis.

The monitoring campaigns would run for a period of one month, repeated twice a year. After the first year, the need to continue the real-time particulate matter monitoring campaigns will be reviewed in conjunction with DPE.

Compliance assessment for the against the long-term air quality criteria will be based on monitoring data collected at both locations across each monitoring campaign. The monthly average concentrations will be used as a proxy for compliance assessment against the annual average concentrations. Any identified extraordinary events during each monitoring campaign will be excluded from the calculation of the monthly average.

2 Applicable criteria

Condition 1 of Schedule 4 lists the relevant air quality criteria for the development (replicated below in Table 2.1 and Table 2.2).

The long-term criteria in Table 2.1 are assessed against the total cumulative impact (the development contribution plus all other sources), whereas the short-term criteria in Table 2.2 apply to the incremental impact (development contribution alone).

Table 2.1 Long-term air quality criteria for particulate matter

Pollutant	Averaging period	Criterion	Basis
Total suspended particulate matter (TSP)	Annual	90 µg/m^3	Total impact (incremental increase from development plus all other sources) but excluding extraordinary events such as bushfires, prescribed burning, dust storms.
Particulate matter <10 µm (PM_{10})	Annual	25 µg/m^3	
Particulate matter <2.5 µm ($PM_{2.5}$)	Annual	8 µg/m^3	

Table 2.2 Short-term air quality criteria for particulate matter

Pollutant	Averaging period	Criterion	Basis
Particulate matter <10 µm (PM_{10})	24 hour	50 µg/m^3	Incremental impact (increase in concentrations from the development alone)
Particulate matter <2.5 µm ($PM_{2.5}$)	24 hour	25 µg/m^3	

As the monitoring campaign is four weeks in duration, the short term 24-hour average criteria will be the focus of this monitoring report. Discussion regarding compliance with the annual average criteria will be inferred from the period average concentrations recorded.

3 Monitoring network and methods

3.1 Monitoring network

In accordance with Section 5.2.2 of the AQMP, the continuous PM monitoring network installed at the site for the four-week campaign consists of two continuous PM monitoring units.

In the absence of site specific meteorological measurements, historical wind conditions recorded by the BoM Badgerys Creek AWS (located 2.3 km to the south-east of the site) for September were reviewed. The data analysis identified a dominance of winds from the north-east and south-west. Consequently, to record upwind and downwind PM concentrations at the site, the two continuous PM monitoring units were sited at the north-east and south-west corners of the site.

For the September monitoring campaign period, concurrent meteorological monitoring data from the BoM Badgerys Creek AWS was collated. Further, to provide an understanding of potential regional-scale air quality events, concurrent measurements from the DPE Bringelly air quality monitoring station (AQMS), located 5.9 km to the south-east of the site, have been collated.

The monitoring resources adopted in this campaign are summarised in Table 3.1, and the monitoring locations are shown in Figure 3.1.

Table 3.1 Summary of monitoring locations adopted in monitoring campaign at Luddenham quarry

	Location ID	Description of location	EPL identification Easting (m)	Coordinates (MGA 56) Northing (m)
Onsite air quality	AQM01	Site boundary in north-east corner	289187	6249479
	AQM02	Site boundary in south-west corner	288833	6249248
Reference air quality	DPE AQMS	Bringelly AQMS	293102	6244719
Meteorology	BoM AWS	Badgerys Creek AWS	289920	6246951

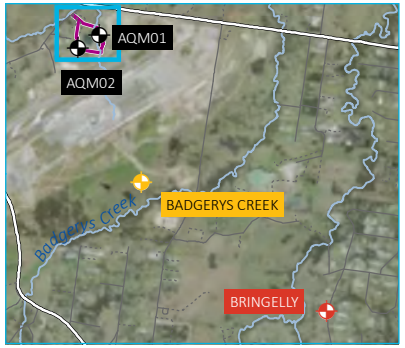
3.2 Monitoring methods

The BoM Badgerys Creek AWS continuously measures mean wind speed, mean wind direction, the standard deviation of wind direction (referred to as 'sigma-theta'), mean temperature, mean relative humidity, pressure and accumulated rainfall. The measurements are recorded as 1-hour averages from 1-minute data.

The onsite particulate matter monitoring was completed by Ektimo Pty Ltd, a NATA accredited monitoring specialist. Ektimo installed two FDS-17 continuous PM monitoring units at the site. The monitoring was conducted at ground level, with the inlet positioned at approximately 1.5 m. During the monitoring period the PM_{10} and $PM_{2.5}$ measurements were taken continuously and recorded as both 1-minute and 1-hour mean values in micrograms per cubic metre ($\mu g/m^3$). Daily average concentrations were also calculated. The PM monitoring installations are shown in Photograph 3.1 and Photograph 3.2.

Photograph 3.1 AQM01 monitoring location

Photograph 3.2 AQM02 monitoring location



KEY

- Study area
- On site air quality monitor
- Major road
- Minor road
- Vehicular track
- Named watercourse
- Cadastral boundary

INSET KEY

- Study area
- Major road
- Named watercourse
- BoM AWS
- DPE AQMS
- On site air quality monitor

Source: EMM (2022); ABS (2021); DFSI (2020, 2021); ESRI (2022); GA (2011)

0 100 200 m

GDA 1994 MGA Zone 56

N

\\emmsvr1\EMM\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02 Maps\Modification Reporting\Air Quality\AQ0010 QuarryMonitoring 20220923 01.mxd 27/09/2022

Luddenham quarry monitoring network

Luddenham Quarry
Air quality monitoring report
Figure 3.1

EMM
creating opportunities

4 Meteorological data

4.1 Overview of data for reporting period

This section of the report presents a summary and analysis of the meteorological data that were collected by the BoM Badgerys Creek AWS during the reporting period.

An overview of the continuous data from the BoM Badgerys Creek AWS is provided in Figure 4.1. The panel on the left shows the time series of 1-hour values for each parameter, with the grey bars indicating the presence of data and any red bars indicating missing data. Some summary statistics for the reporting period are also given, including the mean, median, 95th percentile, minimum, maximum and number of missing points. The data capture rate for September is shown in green font. The panel on the right shows the frequency distribution of the values for each parameter.

The key descriptive statistics and time series plots for the meteorological parameters collected at the BoM Badgerys Creek AWS during the reporting period are provided in the following sections.

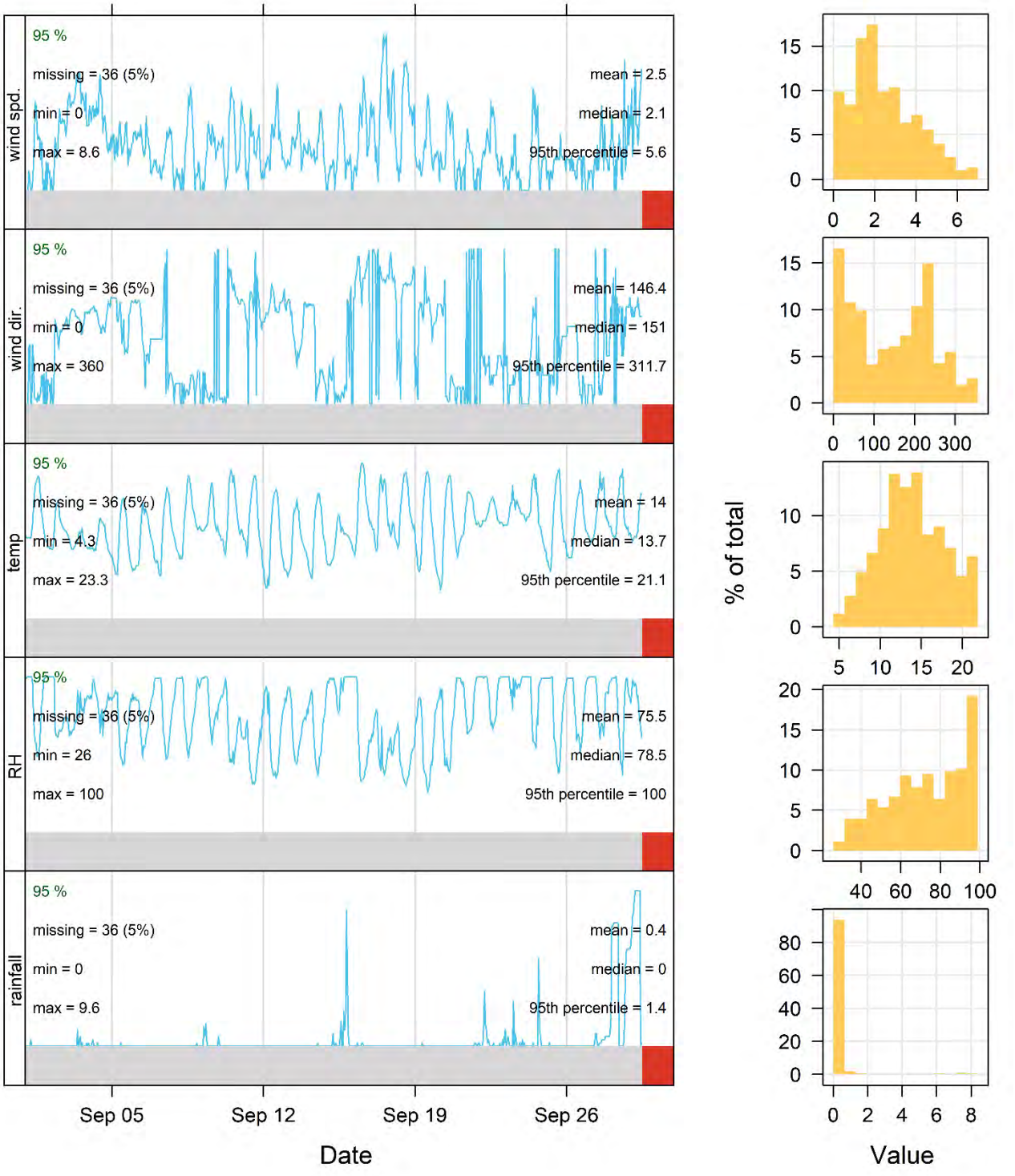


Figure 4.1 **Meteorological data summary – BoM Badgerys Creek AWS**

4.2 Meteorological data

Key descriptive statistics for the meteorological data collected at the BoM Badgerys Creek AWS during the reporting period are provided in Table 4.1. The statistics are calculated from the 1-hour values and are shown for the month of September.

Table 4.1 Summary of meteorological data – September 2022 – BoM Badgerys Creek AWS

Parameter	Minimum	Maximum	Median	Average	Standard Deviation
Temperature (°C)	4.3	23.3	13.7	14.0	4.1
Wind speed (m/s)	0.00	8.6	2.1	2.47	1.7
Rainfall (mm)	0.00	9.6	0	0.38	1.5
Relative Humidity (%)	26.00	100	78.5	75.50	20.6

The wind rose for the September monitoring campaign from the BoM Badgerys Creek AWS is presented in Figure 4.2. The wind rose shows that winds during September were predominately from the south-west and north-east, and therefore indicate that the two continuous PM monitoirng units installed at site are appropriatly located to record upwind and downwind particulate matter concentrations.

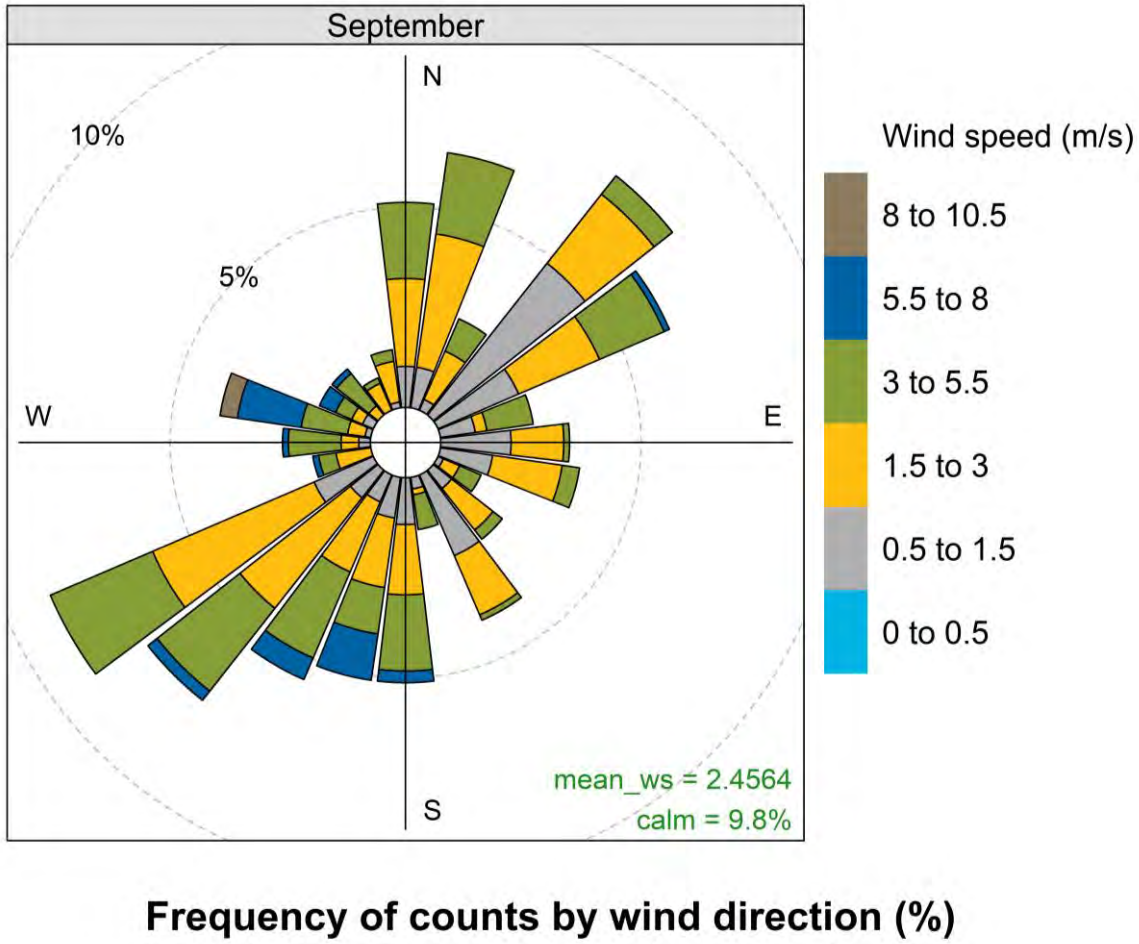


Figure 4.2 **Monthly wind rose – BoM Badgerys Creek AWS**

5 Air quality data

5.1 Overview of data reporting period

This section of the report presents a summary and analysis of the air quality (PM_{10} and $PM_{2.5}$) data that were collected at the onsite monitors during the reporting period. The data from the DPE Bringelly AQMS are included for comparison.

An overview of the continuous (hourly) data from the two PM_{10}/$PM_{2.5}$ monitors located at the site is provided in Figure 5.1. Measurements were collected starting from 12.00 am on 1 September 2022 to 9.00 am on 29 September 2022.

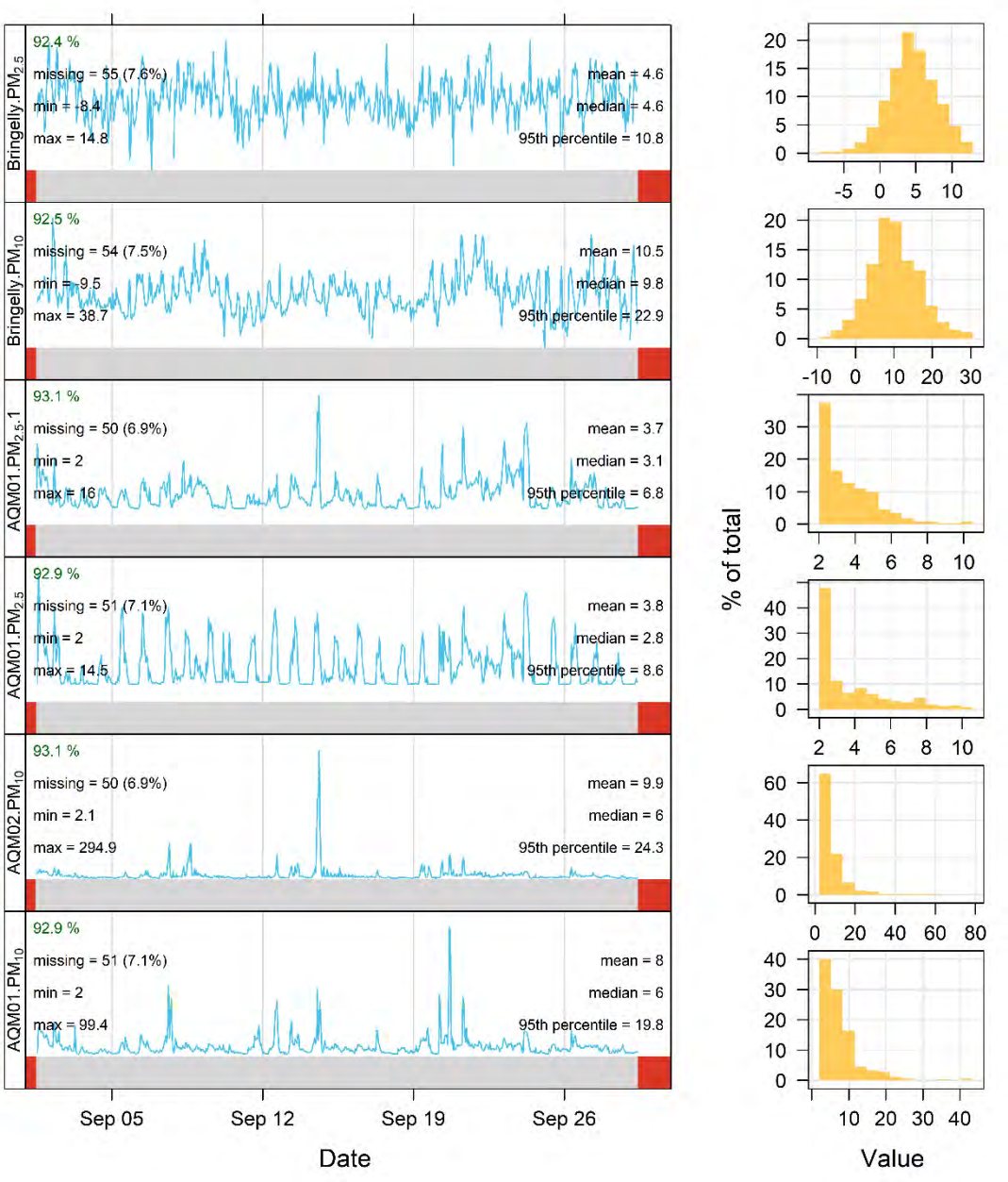


Figure 5.1 Air quality data summary from onsite monitors – September 2022 – the site

5.2 PM_{10} concentrations

PM_{10} concentrations are reported here as 24-hour mean values (midnight to midnight). A statistical summary of the 24-hour PM_{10} concentrations at the site during the reporting period is provided in Table 5.1. The corresponding values from the DPE Bringelly AQMS are included for comparison.

The period mean PM_{10} concentrations for the onsite monitors and the DPE Bringelly AQMS were generally similar. Concentrations at the AQM02 site are slightly lower than at the AQM01 site but show that there was a spike in the maximum.

No exceedances of the 24-hour PM_{10} criterion of 50 µg/m^3 were recorded at any location during the campaign.

Table 5.1 Statistics for PM_{10} 24hr average concentration

Monitoring location	Mean (µg/m^3)	Median (µg/m^3)	Maximum (µg/m^3)	Standard deviation	Days above 50 µg/m^3
AQM01	7.9	7.1	20.3	3.5	0
AQM02	9.8	7.8	45.1	8.2	0
DPE Bringelly AQMS	10.5	10.7	22.0	4.1	0

The time series of 24-hour PM_{10} concentrations recorded at the site and DPE Bringelly AQMS are plotted in Figure 5.2. The concentrations at all three sites were generally similar across the presented monitoring period. It is noted that AQM02 (south-west corner) recorded a notable spike (45.1 µg/m^3) on 14 September 2022 that was not recorded at the other monitoring locations. Wind conditions for this measurement were moderate to high (4.1 m/s to 8.2 m/s) and from the north-east to east. Under these conditions, it is considered that emissions from either the site or the neighbouring construction works for the Western Sydney Airport may have been contributing sources.

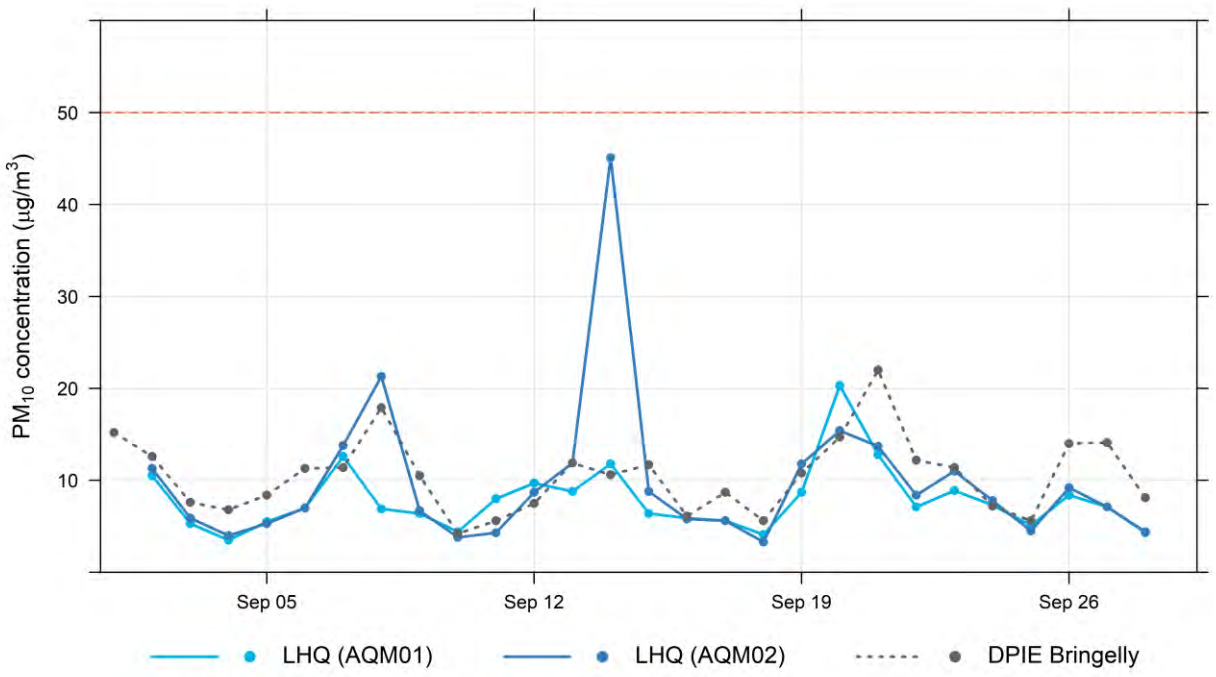


Figure 5.2 24 hour mean concentration of PM_{10}

PM_{10} concentrations measured by the two onsite monitors at site and by the DPE Bringelly AQMS are also presented below using bivariate polar plots and polar annulus plots.

The bivariate polar plots (Figure 5.3 to Figure 5.5) show how PM_{10} concentrations vary by wind speed and wind direction over the measuring period. The plots provide a graphical impression of potential sources influencing PM_{10} concentrations at the monitoring locations.

The following points are noted from the bivariate polar plots (Figure 5.3 to Figure 5.5):

- the bivariate polar plots for AQM01 and AQM02 (Figure 5.3 and Figure 5.4 respectively) show a distinct signal to the northwest, which is unlikely to be associated with emissions from the site;
- the bivariate polar plot for AQM02 (Figure 5.4) shows a notably stronger signal to the northeast than AQM01 (Figure 5.3), which is likely to be associated with emissions from the site;
- the bivariate polar plot for AQM02 (Figure 5.4) also shows a distinct signal when winds are from the south-west which is likely to be associated with emissions from construction activities at the Western Sydney Airport; and
- the bivariate polar plot for the DPE Bringelly AQMS (Figure 5.5) shows a signal to the east, which is likely to be associated with emissions from domestic heating and road traffic.

The polar annulus plots (Figure 5.6 to Figure 5.8) show the temporal variation in the PM_{10} concentration by wind direction during the whole reporting period. In this case the temporal variation is by hour of the day (0 to 23).

- the polar annulus plots for AQM01 and AQM02 (Figure 5.6 and Figure 5.7 respectively) show that the highest concentrations occur between 8.00 am and 4.00 pm, and are likely to be associated with operations at the site or neighbouring construction activities; and
- the polar annulus plots for the DPE Bringelly AQMS (Figure 5.8) shows that the highest concentrations occur between in the morning (approximately 8.00 am) and in the evening to night (6.00 pm to 12.00 am),

supporting the earlier conclusion that recorded concentrations are likely to be associated with emissions from domestic heating (night) and road traffic (morning).

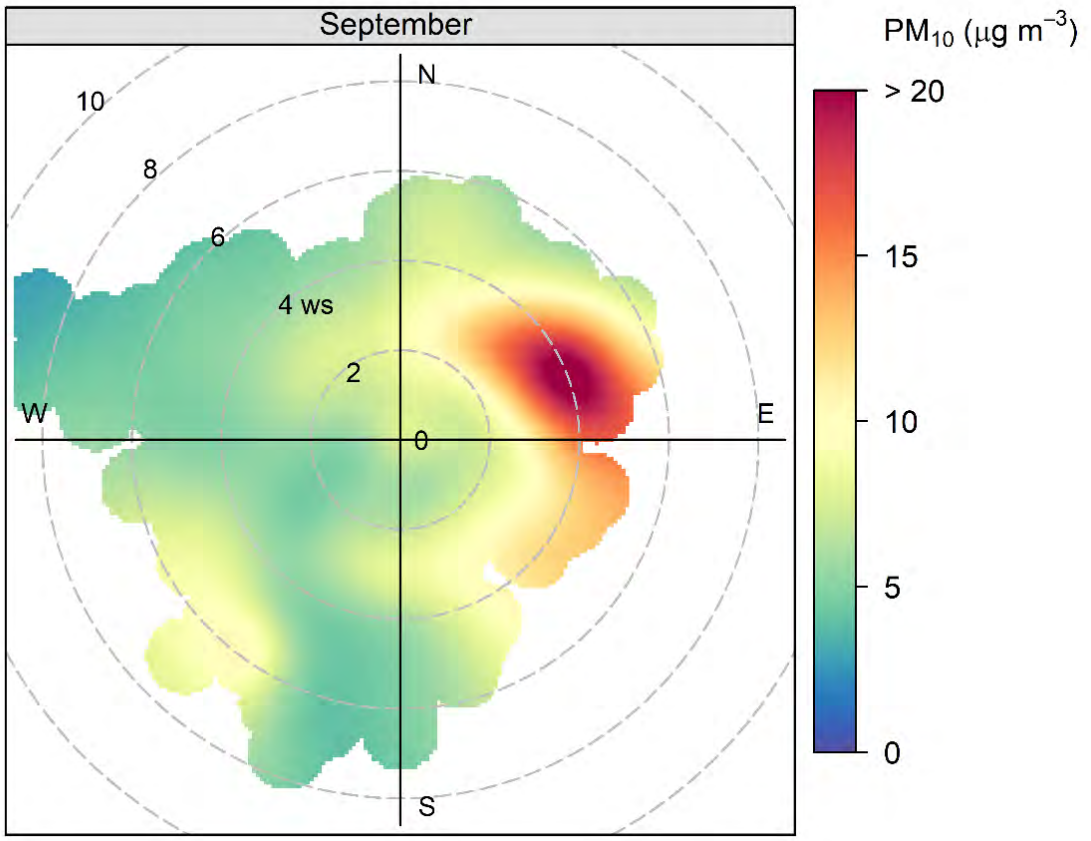


Figure 5.3 **Monthly bivariate polar plots for PM_{10} at AQM01**

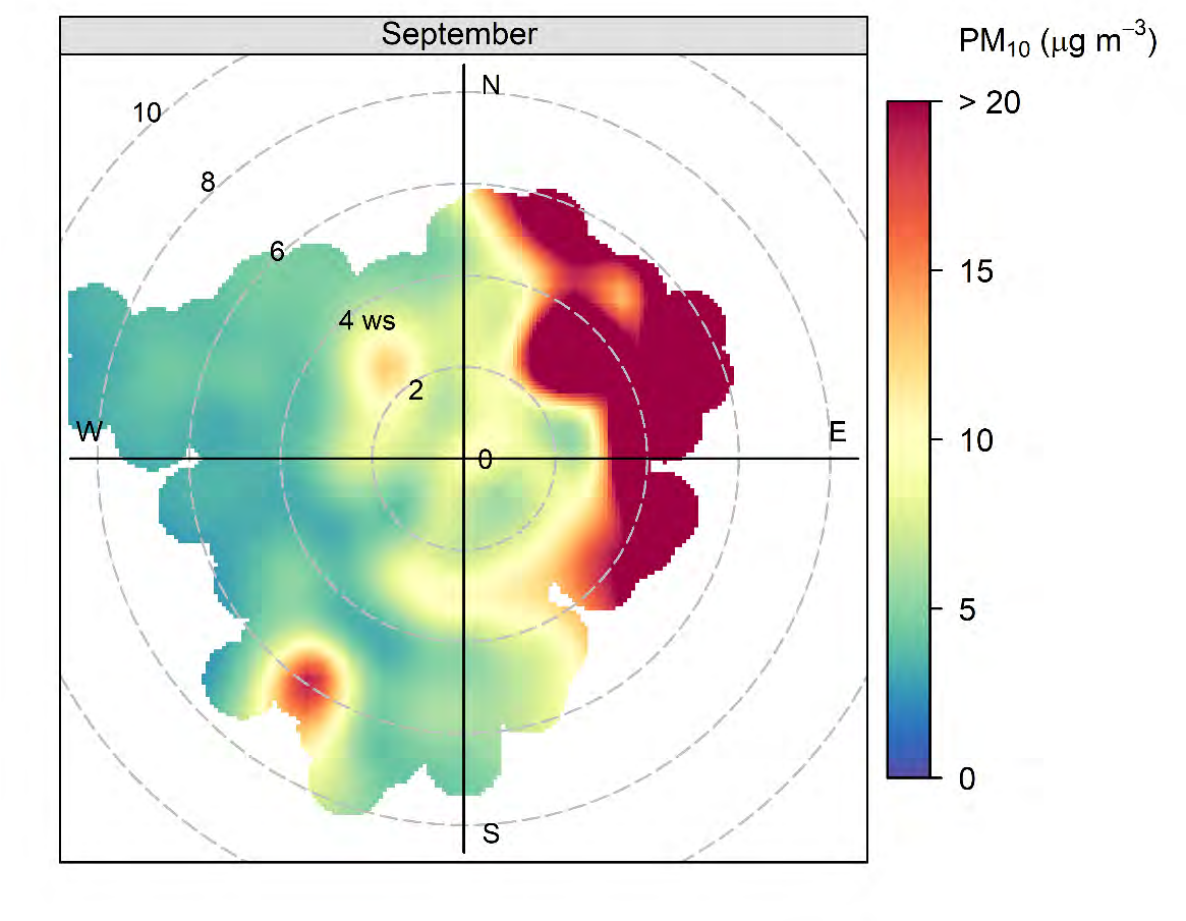


Figure 5.4 **Monthly bivariate polar plots for PM_{10} at AQM02**

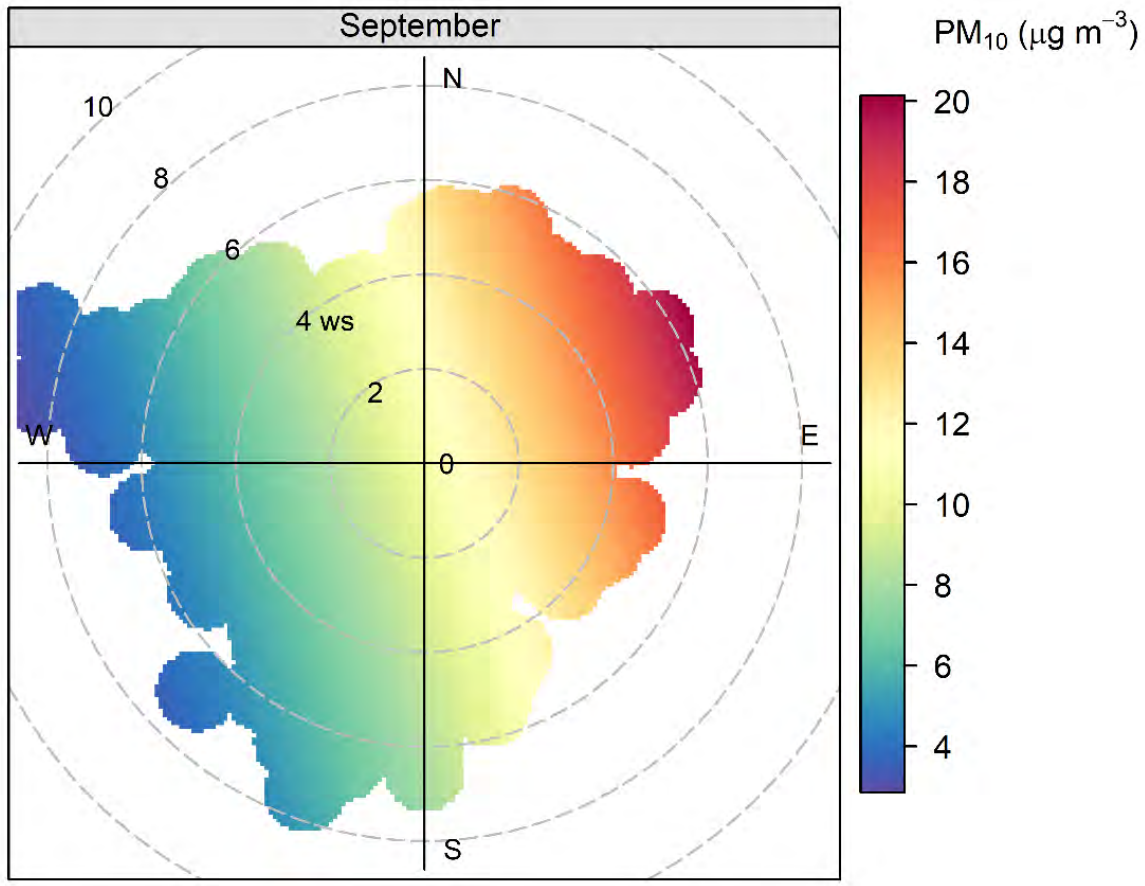


Figure 5.5 **Monthly bivariate polar plots for PM_{10} at DPE Bringelly**

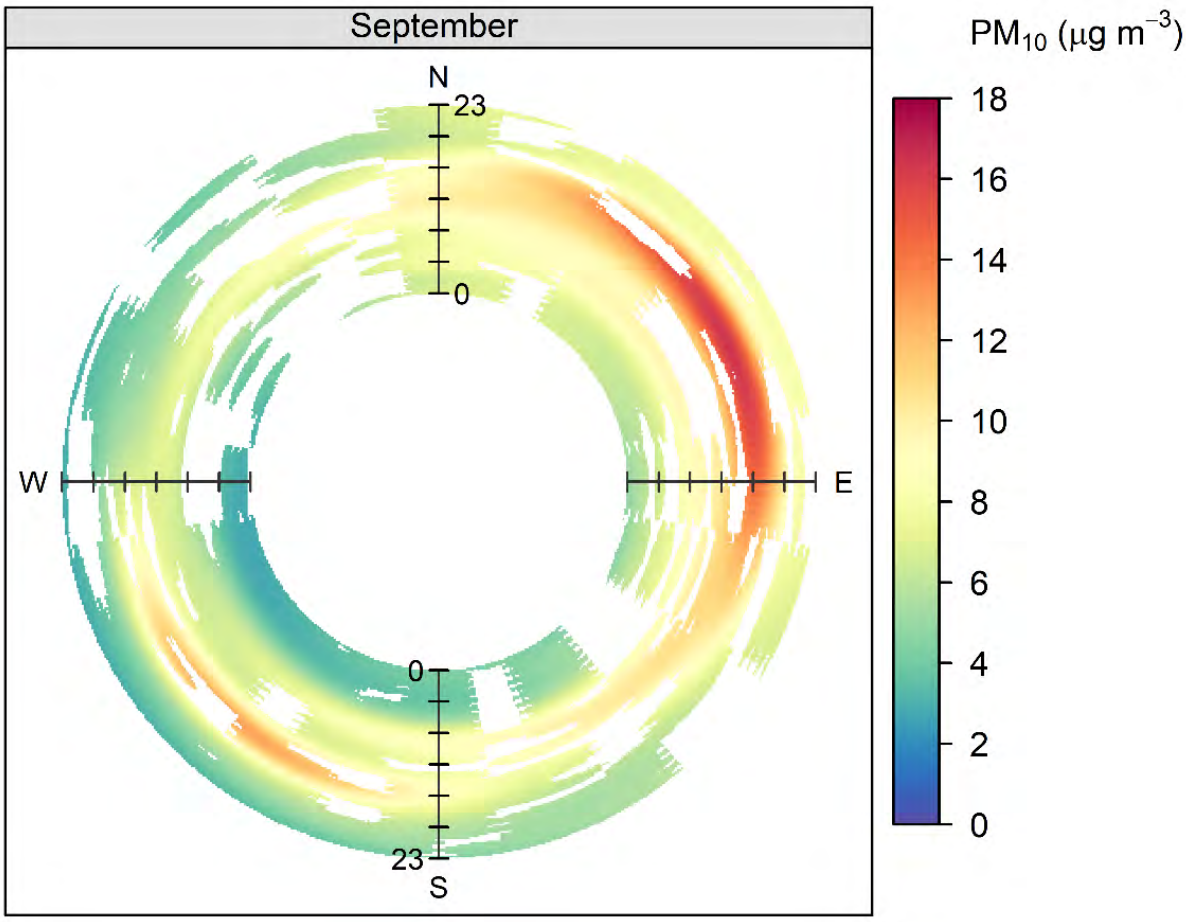


Figure 5.6 **Polar annulus plots for PM_{10} at AQM01**

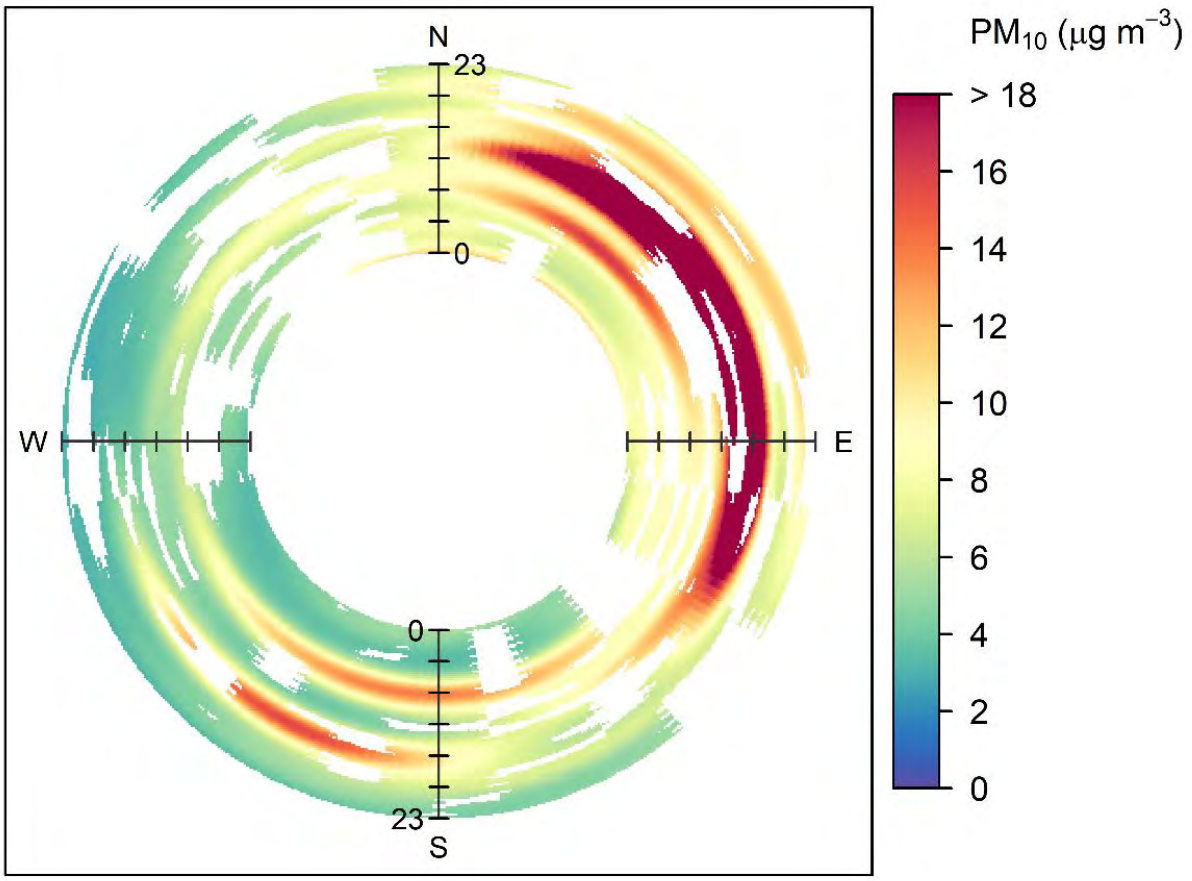


Figure 5.7 **Polar annulus plots for PM_{10} at AQM02**

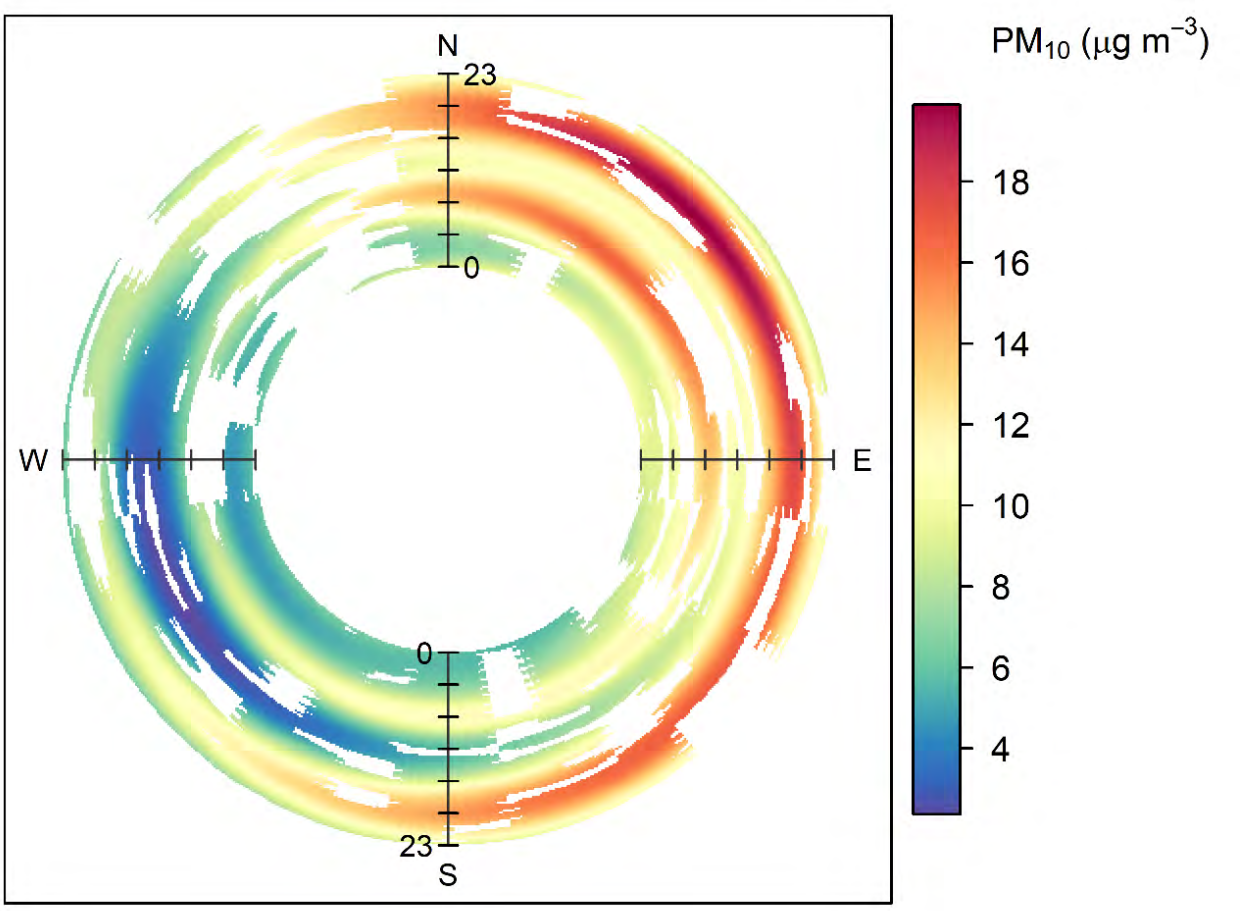


Figure 5.8 **Polar annulus plots for PM_{10} at DPE Bringelly AQMS**

5.3 $PM_{2.5}$ concentrations

The presentation of the $PM_{2.5}$ data follows the same format as that for PM_{10}. A statistical summary of the 24-hour $PM_{2.5}$ concentrations at Luddenham quarry during the reporting period is provided in Table 5.2. The corresponding values from the DPE Bringelly AQMS are included for comparison.

For the monitoring campaign period, the $PM_{2.5}$ concentrations at Luddenham quarry were generally lower than at the DPE Bringelly AQMS site.

Table 5.2 **Statistics for $PM_{2.5}$ 24hr average concentrations**

Monitoring location	Mean (µg/m³)	Median (µg/m³)	Maximum (µg/m³)	Standard deviation	Days above 50 µg/m³
AQM01	3.8	3.9	5.7	0.8	0
AQM02	3.7	3.5	6.5	1.0	0
DPE Bringelly AQMS	4.6	4.6	6.8	1.4	0

The time series of 24-hour $PM_{2.5}$ concentrations recorded at the site and Bringelly are plotted in Figure 5.9. As with PM_{10}, the concentrations at all three sites were generally similar.

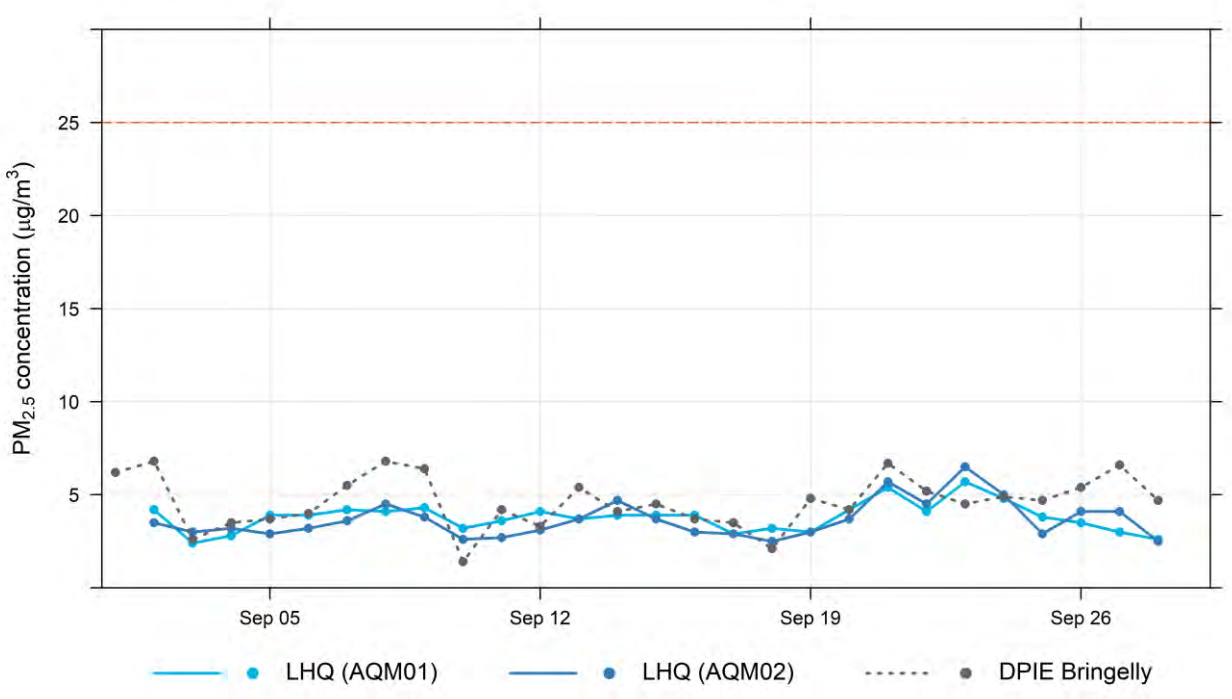


Figure 5.9 Daily mean $PM_{2.5}$ concentration

The bivariate polar plots for $PM_{2.5}$ are shown in Figure 5.10 to Figure 5.12, and the polar annulus plots are shown in Figure 5.13 to Figure 5.15.

The following points are noted from the bivariate polar plots (Figure 5.10 to Figure 5.11):

- the bivariate polar plots for AQM01 and AQM02 (Figure 5.10 and Figure 5.11 respectively) show generally low concentrations in all directions, however there are slightly higher concentrations recorded when winds are from the north-east to east; and
- the bivariate polar plot for the DPE Bringelly AQMS (Figure 5.12) shows a signal to the east, which is likely to be associated with emissions from domestic heating and road traffic.

The polar annulus plots (Figure 5.13 and Figure 5.14) show the temporal variation in the $PM_{2.5}$ concentration by wind direction during the whole reporting period. In this case the temporal variation is by hour of the day (0 to 23).

- the polar annulus plots for AQM01 and AQM02 (Figure 5.13 and Figure 5.14 respectively) show that the highest concentrations occur between 8.00 am and 4.00 pm, and are likely to be associated with neighbouring construction activities; and
- the polar annulus plots for the DPE Bringelly AQMS (Figure 5.15) shows that the highest concentrations occur between early afternoon to early the next morning (12.00 pm to 8.00 am) supporting the earlier conclusion that recorded concentrations are likely to be associated with emissions from domestic heating (night) and road traffic (early morning).

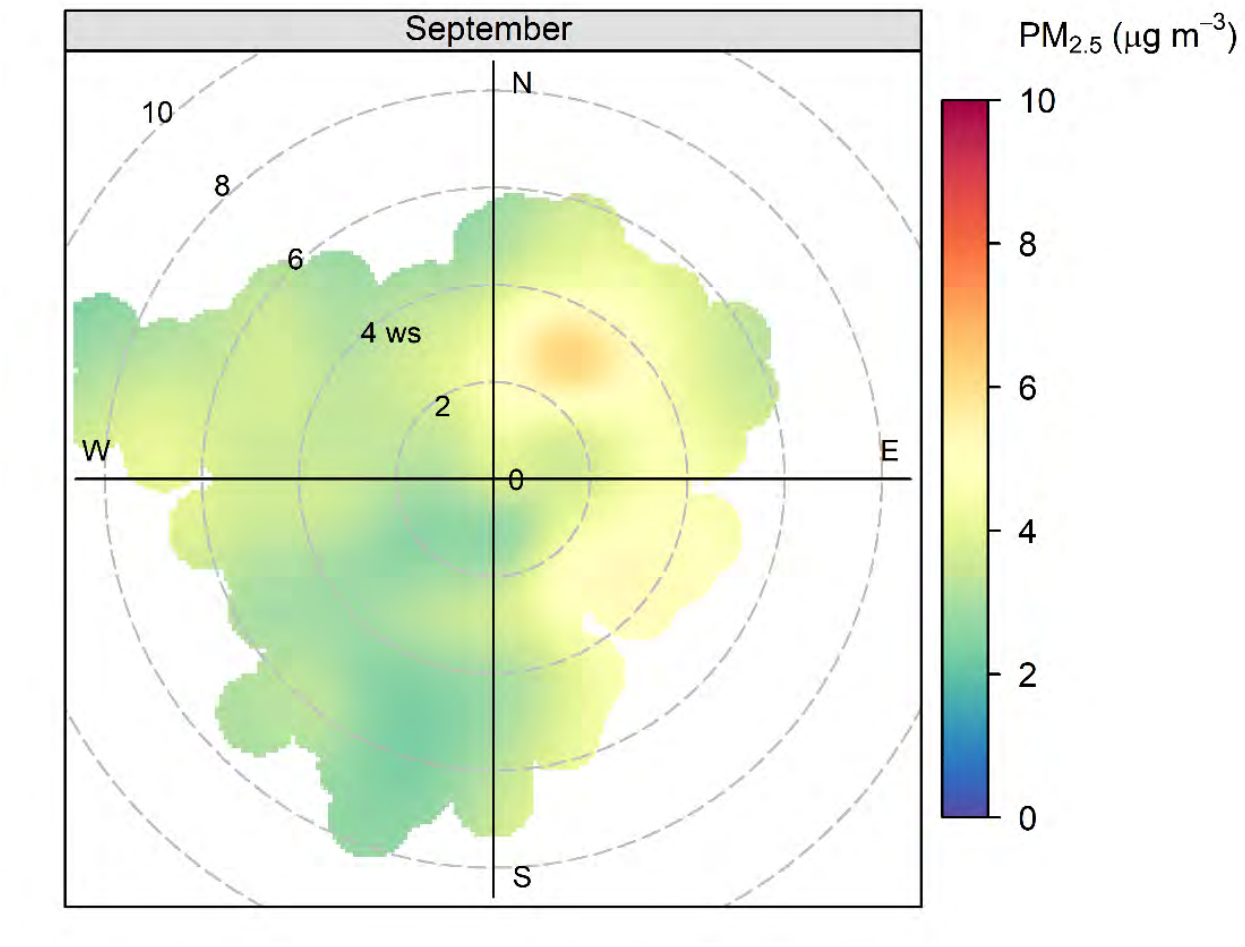


Figure 5.10 **Bivariate polar plot for $PM_{2.5}$ at AQM01**

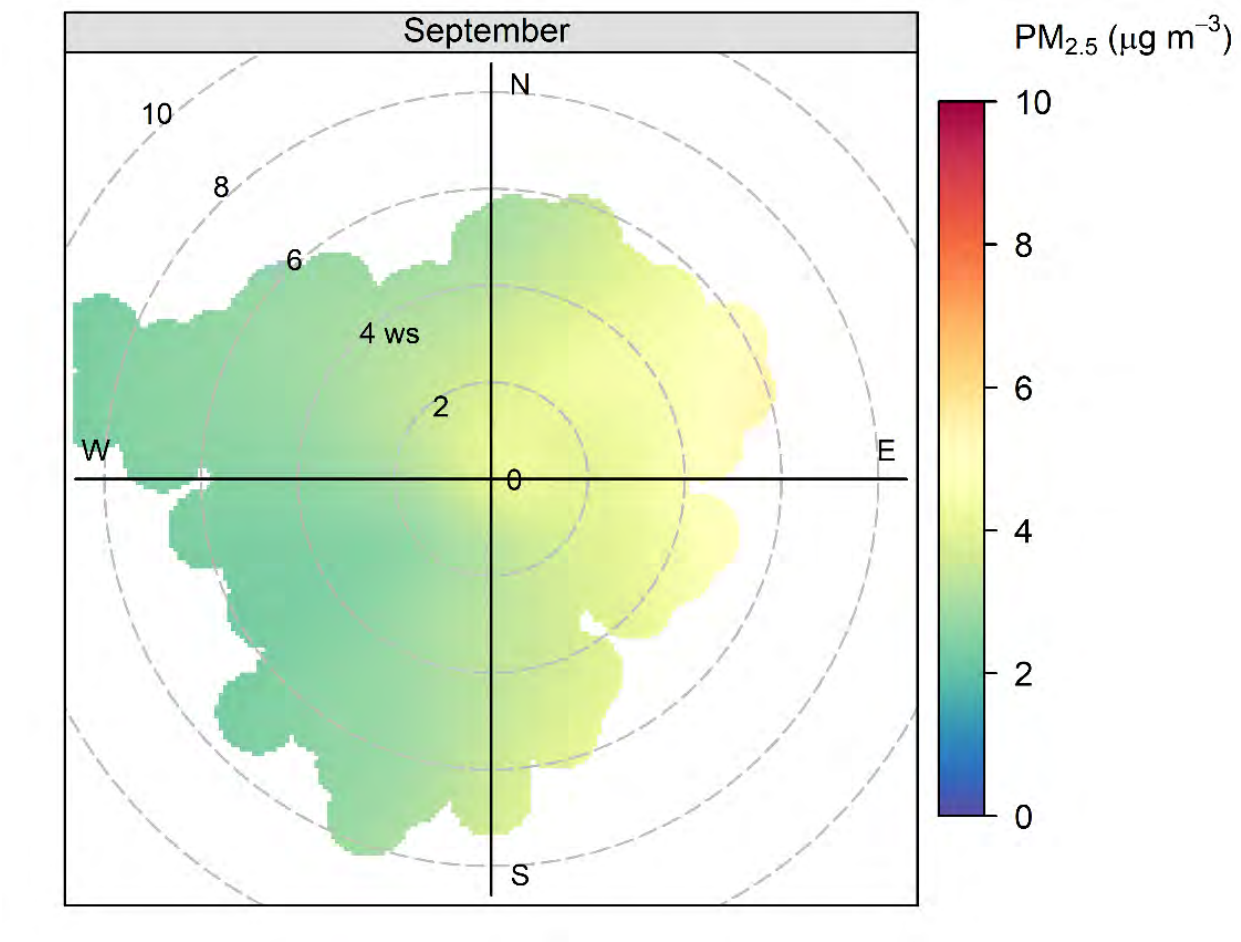


Figure 5.11 **Bivariate polar plot for $PM_{2.5}$ at AQM02**

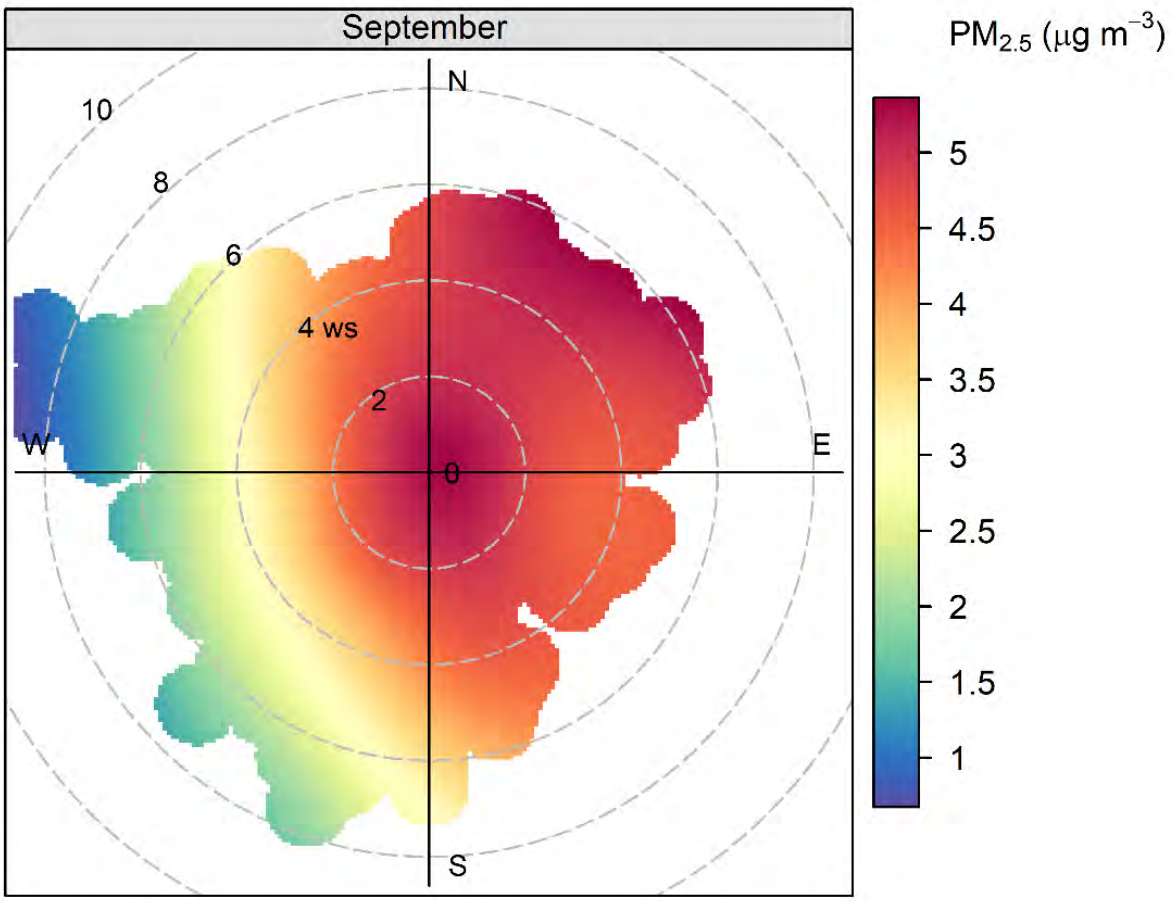


Figure 5.12 **Bivariate polar plot for $PM_{2.5}$ at DPE Bringelly**

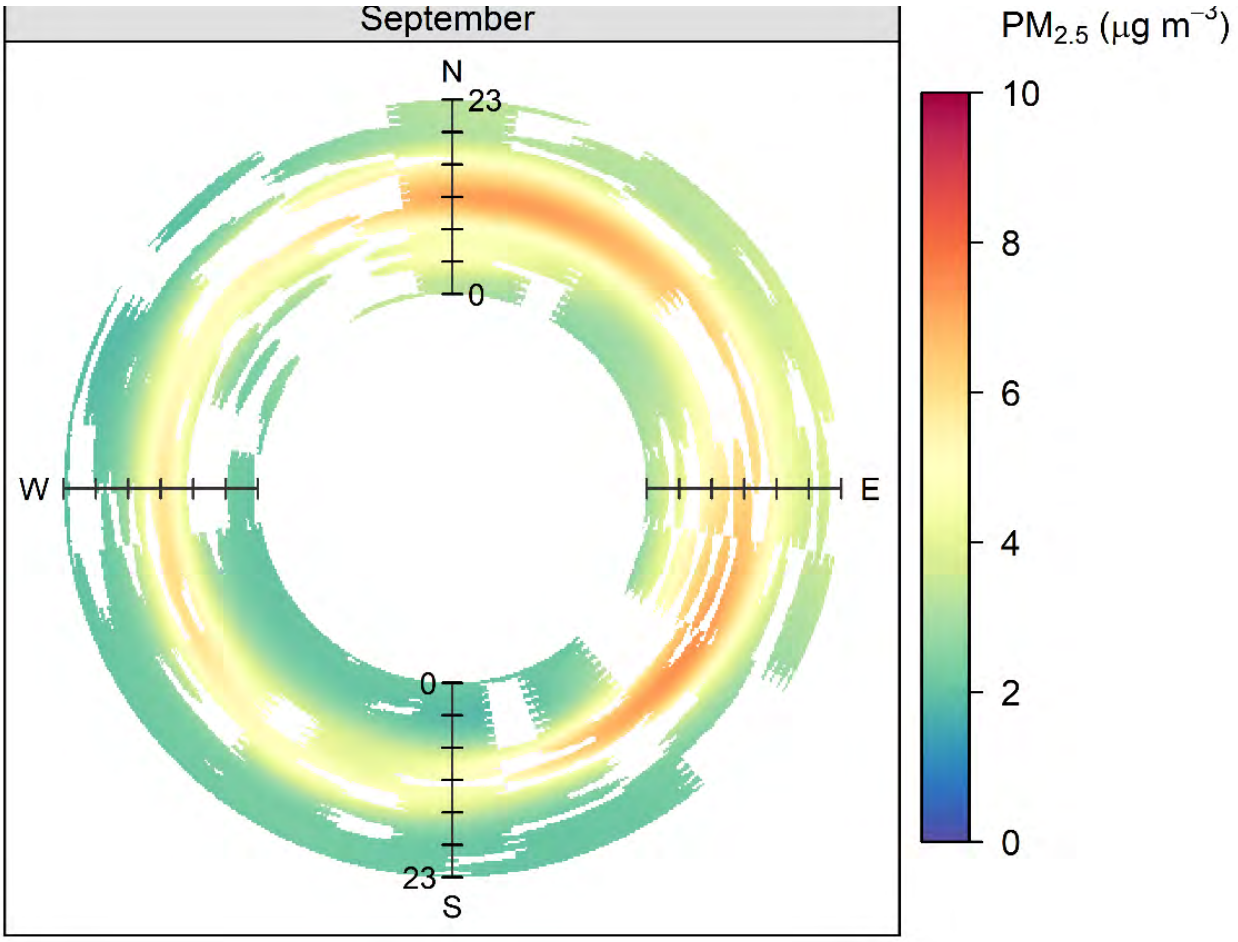


Figure 5.13 **Polar annulus plot for $PM_{2.5}$ at AQM01**

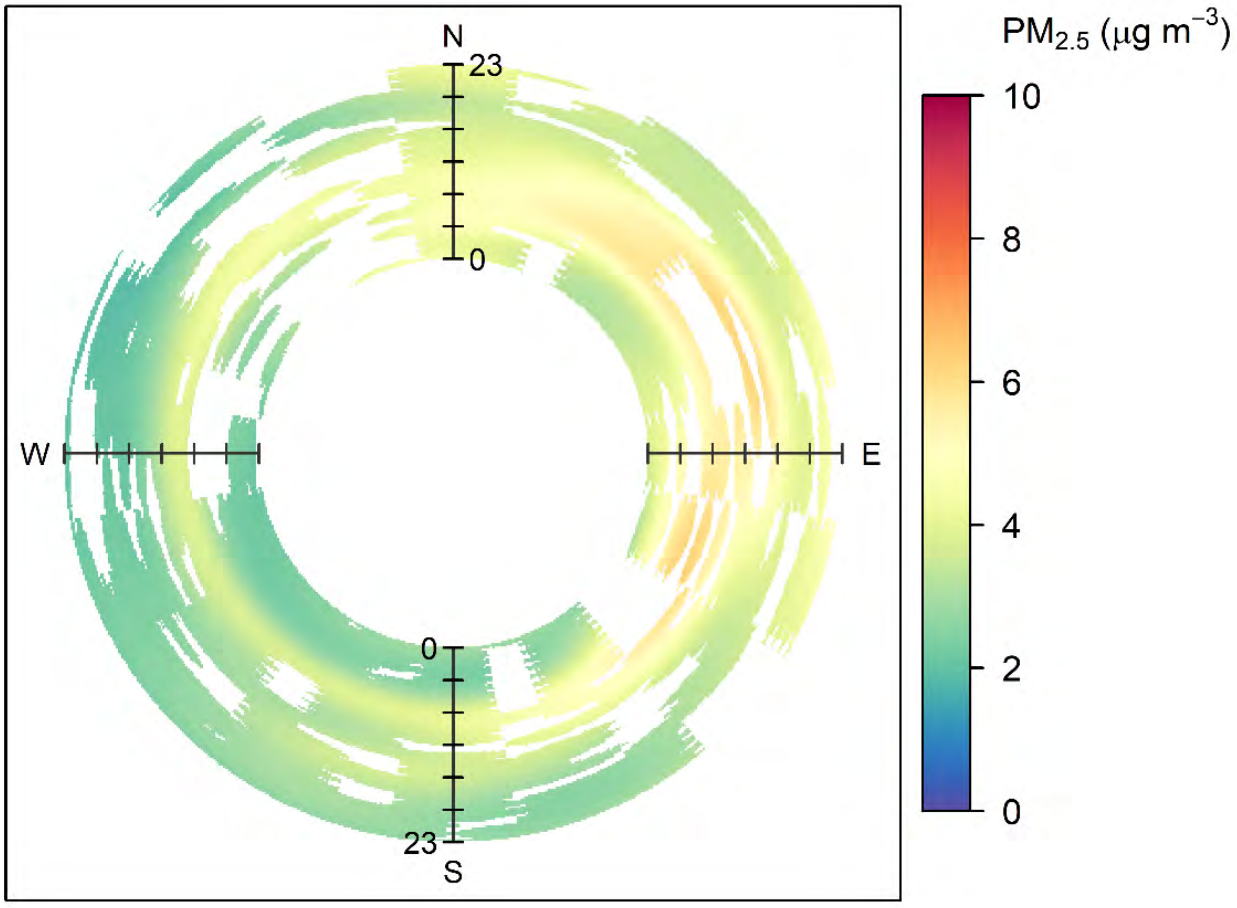


Figure 5.14 **Polar annulus plot for $PM_{2.5}$ at AQM02**

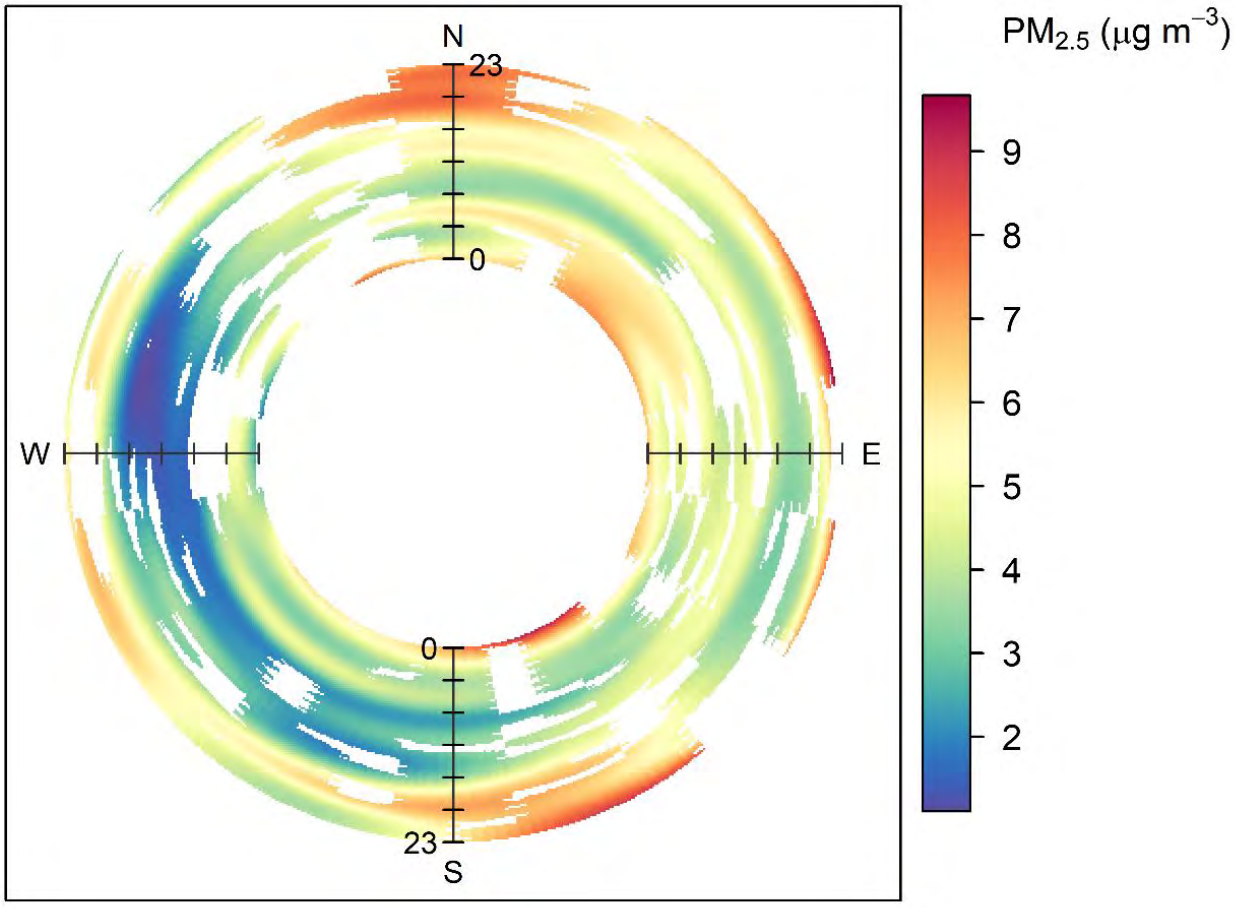


Figure 5.15 Polar annulus plot for $PM_{2.5}$ at DPE Bringelly

5.4 Upwind and downwind concentrations

As stated in Section 1.2, the upwind and downwind monitoring will enable compliance assessment against the short-term air quality criteria, which are evaluated against the increment increase from the development alone, as follows:

- PM contribution from quarry = downwind concentration minus upwind concentration.

To determine the potential contribution from the site to recorded concentrations, the periods of the September 2022 monitoring campaign where the wind direction aligned with the two onsite PM monitoring locations were interrogated. For the purpose of this analysis, upwind and downwind conditions were considered to occur when winds were between 15° and 65° (AQM01 is upwind, AQM02 is downwind of the site) and between 215° and 265° (AQM02 is upwind, AQM01 is downwind of the site).

The mean PM_{10} and $PM_{2.5}$ concentrations and wind speeds when the site was upwind or downwind of each monitor are given in Table 5.3. The number of hours for each condition is also provided.

For AQM01, PM_{10} and $PM_{2.5}$ concentrations were both higher upwind than downwind. For AQM02 PM_{10} and $PM_{2.5}$ concentrations were both higher downwind than upwind.

Table 5.3 PM_{10} and $PM_{2.5}$ concentrations upwind and downwind of site

		AQM upwind of site			AQM downwind of site		
Parameter		**Mean (µg/m³)**	**Mean wind speed (m/s)**	**Hours upwind**	**Mean (µg/m³)**	**Mean wind speed (m/s)**	**Hours downwind**
PM_{10}	AQM01	10.4	1.9	126	5.6	2.8	133
	AQM02	4.8	2.8	133	15.8	1.9	126
$PM_{2.5}$	AQM01	4.6	1.9	126	2.9	2.8	133
	AQM02	2.7	2.8	133	4.3	1.9	126

The potential contribution to recorded PM_{10} and $PM_{2.5}$ concentrations from onsite emission sources (eg quarrying, haulage of material, wind erosion) have been calculated by reviewing the differences in mean measurements at the two locations under upwind and downwind periods (ie AQM01 upwind and AQM02 downwind). The average difference at each site is presented in Table 5.4. For the monitoring period, the average difference (or site contribution) is between 0.8 µg/m³ and 5.4 µg/m³ for PM_{10}, and less than 0.2 µg/m³ for $PM_{2.5}$.

Table 5.4 PM contributions from quarry

Parameters		**Average contribution (µg/m³)**
PM_{10}	AQM01	5.4
	AQM02	0.8
$PM_{2.5}$	AQM01	negligible
	AQM02	0.2

5.5 TSP concentrations

Measurements of TSP were not collected at the site during the September 2022 monitoring campaign. As stated in Section 1.2, TSP concentrations would be inferred from PM_{10} concentrations based on the assumption that PM_{10} is 40% of TSP.

For the average PM_{10} concentrations recorded by the two onsite monitoring locations, the derived average TSP concentrations are 19.7 µg/m³ and 24.6 µg/m³ for AQM01 and AQM02 respectively. Both concentrations are well below the applicable assessment criteria of 90 µg/m³ (Table 2.1), however it is noted that the TSP assessment criteria applies to annual average concentrations.

6 Conclusions

EMM has been commissioned to manage a short-term ambient air quality monitoring campaign at the site.

A four week monitoring programme was completed during September 2022 using two continuous PM monitoring units (FDS PM monitoring system) to recorded concentrations of PM_{10} and $PM_{2.5}$. Meteorological measurements for the monitoring period were sourced from the nearby BoM Badgerys Creek AWS. The onsite PM monitoring data was also compared with monitoring data for the same period from the DPE Bringelly AQMS.

The monitoring equipment was deployed at the north-east and south-west corners of the site, with a specific focus of the monitoring study to record upwind and downwind concentrations.

A summary of the monitoring results is as follows:

- no exceedances of the 24-hour PM_{10} criterion of 50 µg/m^3 were recorded at either of the onsite monitoring locations;
- no exceedances of the 24-hour $PM_{2.5}$ criterion of 25 µg/m^3 were recorded at either of the onsite monitoring locations; and
- the PM_{10} and $PM_{2.5}$ concentrations recorded at the site were generally comparable with the concurrent measurements at the DPE Bringelly AQMS for the same period;
- when upwind and downwind concentrations were considered, the contribution from the site did not result in an exceedance of the criteria specified in Chapter 2; and
- it is inferred that no exceedances of the annual TSP criterion of 90 µg/m^3 would occur based on the recorded PM_{10} concentrations.

Appendix A

Summary of 24-hour average concentrations recorded at site

EMM
creating opportunities

A.1 Daily average PM_{10} and $PM_{2.5}$ data

Table A.1 Daily average PM_{10} and $PM_{2.5}$ concentration (µg/m^3)

Date	PM_{10} concentration (µg/m^3)		$PM_{2.5}$ concentration (µg/m^3)	
	AQMO1	AQMO2	AQMO1	AQMO2
1/09/2022	Less than 24-hours of data			
2/09/2022	10.5	11.3	4.2	3.5
3/09/2022	5.3	5.9	2.4	3.0
4/09/2022	3.5	4.0	2.8	3.2
5/09/2022	5.5	5.3	3.9	2.9
6/09/2022	7.0	7.0	3.9	3.2
7/09/2022	12.6	13.8	4.2	3.6
8/09/2022	6.9	21.3	4.1	4.5
9/09/2022	6.4	6.7	4.3	3.8
10/09/2022	4.4	3.8	3.2	2.6
11/09/2022	8.0	4.3	3.6	2.7
12/09/2022	9.7	8.7	4.1	3.1
13/09/2022	8.8	11.9	3.7	3.7
14/09/2022	11.8	45.1	3.9	4.7
15/09/2022	6.4	8.8	3.9	3.7
16/09/2022	5.9	5.8	3.9	3.0
17/09/2022	5.6	5.6	2.9	2.9
18/09/2022	4.1	3.3	3.2	2.5
19/09/2022	8.7	11.8	3.0	3.0
20/09/2022	20.3	15.4	4.2	3.7
21/09/2022	12.8	13.7	5.4	5.7
22/09/2022	7.1	8.4	4.1	4.5
23/09/2022	8.9	11.0	5.7	6.5
24/09/2022	7.3	7.8	4.8	5.0
25/09/2022	5.1	4.5	3.8	2.9
26/09/2022	8.4	9.2	3.5	4.1
27/09/2022	7.1	7.1	3.0	4.1
28/09/2022	4.3	4.4	2.6	2.5
29/09/2022	Less than 24-hours of data			

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Suite 2.04 Level 2
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8
454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9
109 St Georges Terrace
Perth WA 6000
T 08 6430 4800

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5
T 647 467 1605

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1
T 604 999 8297

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au

CPG Luddenham Quarry

Noise Compliance Report - September 2022

Prepared for Luddenham Operations Pty Ltd

September 2022

CPG Luddenham Quarry

Noise Compliance Report - September 2022

Luddenham Operations Pty Ltd

J190749 RP73

September 2022

Version	Date	Prepared by	Approved by	Comments
1	28 September 2022	Jared Blackburn	Carl Fokkema	

Approved by

Carl Fokkema
Associate - Acoustics
5 July 2022

Ground floor 20 Chandos Street
St Leonards NSW 2065
PO Box 21
St Leonards NSW 1590

TABLE OF CONTENTS

Appendices

Tables

Figures

1 Introduction

EMM Consulting Pty Limited (EMM) was engaged by Luddenham Operations Pty Ltd to complete bi-annual attended noise monitoring surveys, relating to Luddenham Quarry.

The purpose of the monitoring was to address the requirements of the site's Project Approval 06_0159 (PA) and Environment Protection License (EPL) 21562, and in accordance with the Noise Management Plan (NMP).

This report presents the results and findings of the attended noise monitoring surveys, conducted on 13 and 14 September 2022.

The following material was referenced as part of this assessment and were current as of 20 September 2022:

- Luddenham Operations Pty Ltd, Luddenham Quarry Noise Management Plan (NMP), updated on 30 September 2021;
- NSW Environment Protection Authority (EPA), Environmental Protection License (EPL) 21562 (updated 30 August 2021);
- NSW Environment Protection Authority (EPA), Industrial Noise Policy (INP), 2000;
- NSW Environment Protection Authority (EPA), Noise Policy for Industry (NPfI), 2017; and
- Australian Standard (AS) 1055-2018 'Acoustics – Description and measurement of environmental noise'.

Several technical terms are discussed in this report, these are explained in the Glossary.

2 Noise limits and monitoring requirements

Noise assessment criteria for the operations are provided in the site's EPL which is included as Appendix A. These are specified at locations which are representative of residences potentially impacted by quarry noise.

2.1 Noise Limits

EPL 21562 nominates noise monitoring locations and noise limits for Luddenham Quarry which are reproduced in Table 2.1 and shown in Figure 3.1.

Table 2.1 Monitoring locations

EPA Identification No.	Type of monitoring point	Location description	Noise Limits $dB_{LAeq,\ 15\ min}$
R1	Residential	2161–2177 Elizabeth Drive, Luddenham	41
R2	Residential	2111–2141 Elizabeth Drive, Luddenham	43
R3	Residential	285 Adams Road, Luddenham	53
R4	Residential	5 Anton Road, Luddenham	46
R5	Residential	185 Adams Road, Luddenham	45
R6	Residential	225 Adams Road, Luddenham	52
R7	Residential	161 Adams Road, Luddenham	41
R8	Residential	2510–2550 Elizabeth Drive, Luddenham	41

Notes: 1. Day is the period from 7 am to 6 pm Monday to Saturday and 8 am to 6 pm Sunday and public holidays. Evening is the period from 6 pm to 10 pm. Night is the period from 10 pm to 7 am Monday to Saturday and 10 pm to 8 am Sunday and public holidays.

2.2 Meteorological conditions

Condition L2.3 of the EPL states the meteorological conditions which the noise limits apply under:

L3.2 Noise-enhancing meteorological conditions:

a) The noise limits set out in condition L2.1 apply under the meteorological conditions listed in the table below.

b) For those meteorological conditions not referred to in condition L2.1(a) table, the noise limits that apply are the noise limits in conditions L2.1 table plus 5 dB.

The table from Condition L2.3 is reproduced in Table 2.2 below.

Table 2.2 Applicable meteorological conditions

Assessment period	Meteorological conditions
Day	Stability Categories A, B, C and D with wind speeds up to and including 3 m/s at 10 m above ground level.
Evening	Stability Categories A, B, C and D with wind speeds up to and including 3 m/s at 10 m above ground level.
Night	Stability Categories A, B, C and D with wind speeds up to and including 3 m/s at 10 m above ground level; or Stability category E and F with wind speeds up to and including 2 m/s at 10 m above ground level.

Condition L2.4 specifies the source of meteorological data to be used and method for determining stability categories:

L2.4 For the purpose of condition L2.3:

a) The meteorological conditions are to be determined from meteorological data obtained from the meteorological weather station identified as Bureau of Meteorology AWS at Badgerys Creek, NSW (Station no 067108).

b) Stability category shall be determined using the following method from Fact Sheet D of the Noise Policy for Industry (NSW EPA, 2017):

i. Use of sigma-theta data (section D1.4).

It is noted that the site only operates during the day period.

2.3 Modification Factors

Section L2.7 of the EPL states that noise generated by the site is subject to the modifying factors provided in Section 4 of the INP (EPA 2000), where applicable. The INP Application Notes (updated 2017) state that Section 4 of the INP has been withdrawn and the method for the application of modification factor corrections outlined in Fact Sheet C of the Noise Policy for Industry (NPfI) (EPA 2017) is to be used when assessing the presence of annoying characteristics of a noise source.

Modifying factor adjustments are required to be applied for noise levels with annoying characteristics such as tonal noise, impulsive noise and low frequency noise. Tonal or impulsive noise are not typical to pulp and paper mill operations, in particular when measured at significant distances from site. Furthermore, monitoring data confirmed that tonal and impulsive characteristics were present for measurements at R3, R6, R5, R6 and R7. A 2dB correction has been applied to these measurements. Low frequency noise was considered further in the assessment.

Fact Sheet C of the NPfI provides guidelines for applying modifying factor adjustments to account for low frequency noise emissions. The NPfI specifies that a difference of 15 dB or more between site 'C-weighted' and site 'A-weighted' noise emission levels indicates the potential for an unbalanced spectrum and potential increased annoyance. Where a difference of 15 dB or more between site 'C-weighted' and site 'A-weighted' noise emission levels has been identified, the one-third octave band centre frequency noise levels recorded has been compared to the values in Table C2 of the NPfI reproduced in Table 2.3.

Table 2.3 One-third octave low-frequency noise thresholds

	One-third octave $L_{Zeq,15min}$ threshold level												
Frequency (Hz)	**10**	**12.5**	**16**	**20**	**25**	**31.5**	**40**	**50**	**63**	**80**	**100**	**125**	**160**
dB (Z)	92	89	86	77	69	61	54	50	50	48	48	46	44

A modifying factor adjustment is to be applied where the site 'C-weighted' and site 'A-weighted' noise emission level is 15 dB or more and:

- where any of the one-third octave band centre frequency noise levels in Table 2.3 are exceeded by up to and including 5 dB and cannot be mitigated, a 2 dB positive adjustment to measured/predicted A-weighted levels applies for the evening/night period; or
- where any of the one-third octave band centre frequency noise levels in Table 2.3 are exceeded by more than 5 dB and cannot be mitigated, a 5 dB positive adjustment to measured/predicted A-weighted levels applies for the evening/night period and a 2 dB positive adjustment applies for the daytime period.

Hence, where possible throughout each survey the operator has estimated the difference between site 'C-weighted' and site 'A-weighted' noise emission levels by matching audible sounds with the response of the analyser (L_{Ceq}-L_{Aeq}). Where this was deemed to be 15 dB or greater, the measured one-third octave band centre frequencies have been compared to the values in Table 2.3 to identify the relevant modifying factor correction (if applicable). This method has been applied to this assessment as discussed in Section 5.

It is of note that the NPfI states that low frequency noise corrections only apply under the standard or noise-enhancing (ie applicable) meteorological conditions (refer Section 2.1).

3 Assessment methodology

3.1 Attended noise monitoring

To quantify noise emissions, 15-minute attended noise surveys were completed at privately-owned properties (referred to herein as assessment locations) surrounding the site. Where access to a property was not granted, access restricted due to local road closures and or measurement at assessment location was not practical due to localised construction activities, monitoring was completed at alternative representative locations and results were calculated back for the actual assessment location. This approach is consistent with the approved NMP for the site and the NPfI. The attended monitoring was completed during the day period in accordance with section M4.1 of the EPL. The assessment locations are listed in Table 3.1and shown on Figure 3.1

Table 3.1 Attended noise monitoring locations

Monitoring location	Description	Location	GDA94/MGA56	
			Easting (m)	Northing (m)
R1	Approximately 880 m northwest of the site	2161–2177 Elizabeth Drive, Luddenham	288807	6250432
R2	Approximately 680 m northwest of the site	2111–2141 Elizabeth Drive, Luddenham	289142	6250089
A1	Approximately 260 m north of site	Northern site boundary utilised to calculate for R3 – 285 Adams Road, Luddenham	288937	6249498
A2	Approximately 180 m southwest of the site	Southwestern site boundary utilised to calculate for R4 - 5 Anton Road, Luddenham, R5 – 185 Adams Road, Luddenham and R7 – 161 Adams Road, Luddenham	288880	6249230
A3	Approximately 260 m west of the site	Western site boundary utilised to calculate for R6 - 225 Adams Road, Luddenham	288912	6249491
A4	Approximately 1016 m northwest of the site	196 – 214 Adams Road, Luddenham utilised to calculate for R8 - 2510–2550 Elizabeth Drive, Luddenham	288632	6249769

3.2 Instrumentation

A Brüel & Kjær Type 2250 sound level meter (serial number 3008201) was used to conduct 15-minute attended measurements and record 1/3 octave band centre frequency and statistical noise indices. The sound analyser was calibrated before and on completion of the survey using a Svantek SV36 calibrator (s/n 86311). The instruments were within their NATA laboratory calibration period during the time of these readings. Refer to Appendix B for calibration certificates.

KEY

- Study area
- Cadastral boundary

Assessment location

- Active recreation
- Commercial
- Noise monitoring locations
- Noise assessment locations

\\emmsvr1\emm\Jobs\2019\I190749 - CPG Luddenham Quarry\GIS\02 Maps\Modification Reporting\Noise Management Plan\NMP001 AssessmentLocations 20210525 01.mxd 30/09/2022

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020)

0 100 200 m

GDA 1994 MGA Zone 56

N

Noise Compliance Report - September 2022

Luddenham Quarry Noise Compliance Report
Figure 3.1

EMM creating opportunities

3.3 Weather conditions

Weather data for the monitoring period was sourced from the Bureau of Meteorology (BoM) Automated Weather Station (AWS) located at Badgerys Creek (Station ID 067108). Wind speeds are stated with reference to a height of 10 m above ground level (AGL).

The presence of temperature inversion conditions was determined for the monitoring period in accordance with the Sigma Theta method specified in Fact Sheet D of the NPfI (EPA 2017). Table 3.2 is an excerpt from Fact Sheet D of the NpfI (EPA 2017) showing the range of vertical temperature gradients for each Pasquill-Guilford stability category.

Table 3.2 Stability categories and vertical temperature gradients

Stability category	Range of vertical temperature gradient, DT/DZ (°C/100 m)
A	DT/DZ < -1.9
B	-1.9 ≤ DT/DZ < -1.7
C	-1.7 ≤ DT/DZ < -1.5
D	-1.5 ≤ DT/DZ < -0.5
E	-0.5 ≤ DT/DZ < 1.5
F	1.5 ≤ DT/DZ < 4.0
G	DT/DZ ≥ 4.0

Source: NpfI (EPA 2017).

3.4 Site operating hours

In accordance with EPL 21562 the hours of operation are limited to between 7.00am and 6.00pm Monday to Friday. The Applicant must ensure that no haulage vehicles enter or leave the site between 6.00pm and 7.00am Monday to Friday, and on public holidays. Maintenance activities will be conducted between 7.00am and 6.00pm Monday to Friday or 7.00am and 1.00pm on Saturday. No other work is to be undertaken on Saturday, Sunday or public holidays.

4 Monitoring data and discussion

Attended noise monitoring results and calculated noise contributions are summarised in Table 4.1.

The weather data confirmed that EPL meteorological criteria (Condition L2.3) were exceeded during one of the 24 attended measurements.

In accordance with the EPL, noise limits for those periods were those listed in Condition L2.1 plus 5 dB. Average wind speed, wind direction, cloud cover and stability category present during each 15-minute attended measurement are provided in Table 4.1.

During the period that site was operational, typical activities included:

- Day (7:00 am to 6:00 pm):
  - one 50t excavator loading residual material out;
  - one D9 dozer operating
  - two 45t articulated dump trucks
  - trucks tipping/being loaded out.

Quarry operations were inaudible at location A5 and A6. If this type of noise source is inaudible, it is generally at least 10 dB below the background (L_{A90}) noise level in such environments. Given this, the quarry's $L_{Aeq\ (15\ min)}$ noise contribution is estimated at 10 dB less than the measured background (L_{A90}) and is therefore compliant with the relevant EPL limits.

Quarry operations were audible during attended measurements at A1 and A3. Site contributions were estimated using a combination of operator observations at the time of measurement, filtering of extraneous noise and the application of a low pass filter in order to exclude extraneous higher frequency noise such as birdsong and insects.

Site contributions were compliant (below) EPL $L_{Aeq,15min}$ criterion during all attended day period measurements.

Based on a detailed review and analysis of noise measurement data, there was evidence of low frequency noise and tonality as defined in the NPfI (EPA 2017) at locations A1, A2 and A3based on the alternate measurement locations considered (Figure 3.1); therefore, modifying factor penalties were applicable.

Table 4.1 Attended noise monitoring results –13-14 September, 2022

Location	Start time (period)[1]	Total noise levels, dB				Calculated site contribution, dB	EPL limits, dB	Meteorological conditions[2]	Exceedance, dB	Notes
		L_{Amin}	$L_{A90, 15min}$	$L_{Aeq, 15min}$	L_{Amax}	$L_{Aeq, 15min}$	$L_{Aeq, 15min}$		$L_{Aeq, 15min}$	
R6 (A3)[2]	9:42 am	44	46	49	72	46	52	2.5 m/s SE, Category B,	Nil	**Site audible. Persistent material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R3 (A1)[2]	10:04 am	40	42	47	64	43	53	2 5 m/s SSE, Category B,	Nil	**Site audible. Persistent material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R3 (A1)[2]	10:21 am	40	44	54	71	46	53	2.7 m/s SSE, Category A,	Nil	**Site audible. Persistent dozer noise, material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R2	10:45 am	48	51	61	76	IA (≤41)	43	2.6 m/s SSW, Category B,	Nil	**Site inaudible** Other noise sources included persistent livestock, hum of other industry and dominant local and distant traffic (constant). Aircraft pass by.
R2	11:38 am	44	48	62	81	IA (≤38)	43	2.5 m/s SE, Category B,	Nil	**Site inaudible** Other noise sources included persistent livestock, hum of other industry and dominant local and distant traffic (constant). Aircraft pass by.
R1	12:04 pm	44	47	65	82	IA (≤37)	41	2.3 m/s ESE, Category A,	Nil	**Site inaudible** Other noise included persistent local traffic (dominant), frequent livestock, non-site related construction noise and distant traffic (constant).
R1	12:40 pm	43	47	64	81	IA (≤37)	46[3]	3.2 m/s SE, Category A,	Nil	**Site inaudible** Other noise included persistent local traffic (dominant), frequent livestock, non-site related construction noise and distant traffic (constant). Aircraft pass by

Table 4.1 Attended noise monitoring results –13-14 September, 2022

Location	Start time (period)[1]	Total noise levels, dB				Calculated site contribution, dB	EPL limits, dB	Meteorological conditions[2]	Exceedance, dB	Notes
		L_{Amin}	$L_{A90, 15min}$	$L_{Aeq, 15min}$	L_{Amax}	$L_{Aeq, 15min}$	$L_{Aeq, 15min}$		$L_{Aeq, 15min}$	
R8 (A4)[2]	1:02 pm	40	43	56	85	37	41	2.5 m/s ESE, Category A,	Nil	**Site audible. Persistent material handling, engine revs, dozer sound and horn blasts.** Other noise included aircraft pass by, distant traffic and frequent insects and birdsong.
R8 (A4)[2]	1:19 pm	37	41	61	85	37	41	3.0 m/s E, Category A,	Nil	**Site audible. Persistent material handling, engine revs, dozer sound and horn blasts.** Other noise included aircraft pass by, distant traffic and frequent insects and birdsong.
R4 (A2)[2]	1:50 pm	41	45	48	61	39	46	2.9 m/s E, Category A,	Nil	**Site audible. Persistent dozer noise, material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R4 (A2)[2]	2:06 pm	40	45	49	64	40	46	2.9 m/s SSE Category A,	Nil	**Site audible. Persistent dozer noise, material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R5 (A2)[2]	1:50 pm	41	45	48	61	38	45	2.9 m/s E, Category A,	Nil	**Site audible. Persistent dozer noise, material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R5 (A2)[2]	2:06 pm	40	45	49	64	39	45	2.9 m/s SSE Category A,	Nil	**Site audible. Persistent dozer noise, material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R7 (A2)[2]	1:50 pm	41	45	48	61	34	41	2.9 m/s E, Category A,	Nil	**Site audible. Persistent dozer noise, material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.

Table 4.1 Attended noise monitoring results –13-14 September, 2022

Location	Start time (period)[1]	Total noise levels, dB				Calculated site contribution, dB	EPL limits, dB	Meteorological conditions[2]	Exceedance, dB	Notes
		L_{Amin}	$L_{A90, 15min}$	$L_{Aeq, 15min}$	L_{Amax}	$L_{Aeq, 15min}$	$L_{Aeq, 15min}$		$L_{Aeq, 15min}$	
R7 (A2)[2]	2:06 pm	40	45	49	64	31	41	2.9 m/s SSE Category A,	Nil	**Site audible. Persistent dozer noise, material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R6 (A3)[2]	2:26 pm	45	49	57	72	48	52	2.8 m/s SSE, Category A,	Nil	**Site audible. Persistent material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R3 (A1)[2]	8:19 am	41	45	49	65	46	53	1.9 m/s SW, Category D,	Nil	**Site audible. Persistent material handling, engine revs, dozer sound, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R3 (A1)[2]	8:36 am	40	44	47	40	44	53	2.5 m/s SW, Category D,	Nil	**Site audible. Persistent material handling, engine revs, haul trucks idling and horn blasts. Dozer operating inconsistently across measurement period.** Other noise included birdsong and aircraft pass over.
R6 (A3)[2]	8:53 am	40	43	48	64	43	52	1.9 m/s WSW, Category D,	Nil	**Site audible. Persistent material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R6 (A3)[2]	9:09 am	41	44	50	75	43	52	2.5 m/s SW, Category C,	Nil	**Site audible. Persistent material handling, engine revs, haul trucks idling and horn blasts.** Other noise included birdsong and aircraft pass over.
R5 (A2)[2]	9:34 am	42	46	57	73	38	45	1.7 m/s SSW, Category A,	Nil	**Site audible. Persistent material handling, engine noise and revs, horn blasts, haul trucks unloading material.** Other noise included persistent birdsong (dominant) and aircraft pass by.

Table 4.1 Attended noise monitoring results –13-14 September, 2022

Location	Start time (period)[1]	Total noise levels, dB				Calculated site contribution, dB	EPL limits, dB	Meteorological conditions[2]	Exceedance, dB	Notes
		L_{Amin}	$L_{A90, 15min}$	$L_{Aeq, 15min}$	L_{Amax}	$L_{Aeq, 15min}$	$L_{Aeq, 15min}$		$L_{Aeq, 15min}$	
R5 (A2)[2]	9:51 am	39	42	58	72	33	45	1.7 m/s SSW, Category A,	Nil	**Site audible. Persistent material handling, engine noise and revs, horn blasts, haul trucks unloading material.** Other noise included persistent birdsong (dominant) and aircraft pass by.
R4 (A2)[2]	9:34 am	42	46	57	73	39	46	1.7 m/s SSW, Category A,	Nil	**Site audible. Persistent material handling, engine noise and revs, horn blasts, haul trucks unloading material.** Other noise included persistent birdsong (dominant) and aircraft pass by.
R4 (A2)[2]	9:51 am	39	42	58	72	34	46	1.7 m/s SSW, Category A,	Nil	**Site audible. Persistent material handling, engine noise and revs, horn blasts, haul trucks unloading material.** Other noise included persistent birdsong (dominant) and aircraft pass by.
R7 (A2)[2]	9:34 am	42	46	57	73	34	41	1.7 m/s SSW, Category A,	Nil	**Site audible. Persistent material handling, engine noise and revs, horn blasts, haul trucks unloading material.** Other noise included persistent birdsong (dominant) and aircraft pass by.
R7 (A2)[2]	9:51 am	39	42	58	72	29	41	1.7 m/s SSW, Category A,	Nil	**Site audible. Persistent material handling, engine noise and revs, horn blasts, haul trucks unloading material.** Other noise included persistent birdsong (dominant) and aircraft pass by.
R2	10:17 am	39	44	65	85	IA (≤34)	43	1 7 m/s NNE, Category A	Nil	**Site inaudible** Other noise sources included persistent livestock, hum of other industry and dominant local and distant traffic (constant). Aircraft pass by.

Table 4.1 Attended noise monitoring results –13-14 September, 2022

Location	Start time (period)[1]	Total noise levels, dB				Calculated site contribution, dB	EPL limits, dB	Meteorological conditions[2]	Exceedance, dB	Notes
		L_{Amin}	$L_{A90, 15min}$	$L_{Aeq, 15min}$	L_{Amax}	$L_{Aeq, 15min}$	$L_{Aeq, 15min}$		$L_{Aeq, 15min}$	
R2	10:48 am	44	49	67	86	IA (≤39)	43	1. 7 m/s NNW, Category A	Nil	**Site inaudible** Other noise sources included persistent livestock, hum of other industry and dominant local and distant traffic (constant). Aircraft pass by.
R1	11:43 am	38	44	65	82	IA (≤34)	41	2.5 m/s NNW, Category A	Nil	**Site inaudible** Other noise included persistent local traffic (dominant), frequent livestock and distant traffic (constant).
R1	11:59 am	42	46	65	85	IA (≤36)	41	1.9 m/s NNE, Category A	Nil	**Site inaudible** Other noise included persistent local traffic (dominant), frequent livestock and distant traffic (constant).
R8 (A4)[2]	12:19 pm	40	42	54	77	38	41	1.7 m/s ENE, Category A	Nil	**Site audible. Persistent material handling, engine revs, dozer sound and horn blasts.** Other noise included aircraft pass by, distant traffic and frequent birdsong.
R8 (A4)[2]	12:35 pm	37	40	57	84	35	41	1.9 m/s NE, Category A	Nil	**Site audible. Persistent material handling, engine revs, dozer sound and horn blasts.** Other noise included aircraft pass by, distant traffic and frequent birdsong.

Notes: 1. Meteorological conditions stated are as recorded at the on-site weather station, wind speeds were recorded at 10m AGL.
2. Access to this property was not granted, access restricted due to local road closures and or measurement at assessment location was not practical due to localised construction activities, hence attended noise monitoring was completed at an alternative representative locations (refer to Figure 3.1) and site contribution calculated back to the assessment location in accordance with the approved NMP for the site.
3. In accordance with Condition L3.2, where meteorological conditions exceed those specified in Condition L3.2, the EPL limits for these periods are those listed in Condition L3.1 plus 5 dB.

5 Conclusion

EMM has completed a review of operational noise for the bi-annual Luddenham quarry operations..

Attended noise monitoring was conducted during the day period on 13 and 14 September 2022. The applicability of noise limits was assessed with reference to weather data from the BoM's Badgerys Creek AWS.

The site was operational during all attended measurements.

Attended noise monitoring observations and results demonstrate that operational noise from the site was audible during most attended measurements. Site contributions were demonstrated to be compliant during all 24 samples captured.

Glossary

Several technical terms are discussed in this report. These are explained in Table G.5.1.

Table G.5.1 Glossary of acoustic terms

Term	Description
dB	Noise is measured in units called decibels (dB). There are several scales for describing noise, the most common being the 'A-weighted' scale. This attempts to closely approximate the frequency response of the human ear.
L_{A1}	The 'A-weighted' noise level which is exceeded 1% of the time.
$L_{A1,1\ minute}$	The 'A-weighted' noise level exceeded for 1% of the specified time period of 1-minute.
L_{A10}	The 'A-weighted' noise level which is exceeded 10% of the time. It is approximately equivalent to the average of maximum noise level.
L_{A90}	Commonly referred to as the background noise level. The 'A-weighted' noise level exceeded 90% of the time.
L_{Aeq}	The energy average noise from a source. This is the equivalent continuous 'A-weighted' sound pressure level over a given period. The $L_{Aeq,15\ minute}$ descriptor refers to an L_{Aeq} noise level measured over a 15--minute period.
L_{Amin}	The minimum 'A-weighted' noise level received during a measuring interval.
L_{Amax}	The maximum root mean squared 'A-weighted' sound pressure level (or maximum noise level) received during a measuring interval.
L_{Ceq}	The equivalent continuous 'C-weighted' sound pressure level over a given period. The $L_{Ceq,15\ minute}$ descriptor refers to an L_{Ceq} noise level measured over a 15-minute period. C-weighting can be used to measure low frequency noise.
Day period	Monday – Saturday: 7 am to 6 pm, on Sundays and Public Holidays: 8 am to 6 pm.
Evening period	Monday – Saturday: 6 pm to 10 pm, on Sundays and Public Holidays: 6 pm to 10 pm.
Night period	Monday – Saturday: 10 pm to 7 am, on Sundays and Public Holidays: 10 pm to 8 am.
Temperature inversion	A meteorological condition where the atmospheric temperature increases with altitude.
Vibration Dose Value (VDV)	Vibration Dose is a parameter that combines the magnitude of vibration and the time for which it occurs. VDV is a cumulative measurement of the vibration level received over a 15-hour or 9-hour period (Day and night).

It is useful to have an appreciation of the decibel (dB), the unit of noise measurement. Table G.5.2 gives an indication as to what an average person perceives about changes in noise levels in the environment. Examples of common noise levels are provided in Figure G.1.

Table G.5.2 Perceived change in noise

Change in sound pressure level (dB)	Perceived change in noise in surrounding environment
up to 2	not perceptible
3	just perceptible
5	noticeable difference
10	twice (or half) as loud
15	large change
20	four times (or quarter) as loud

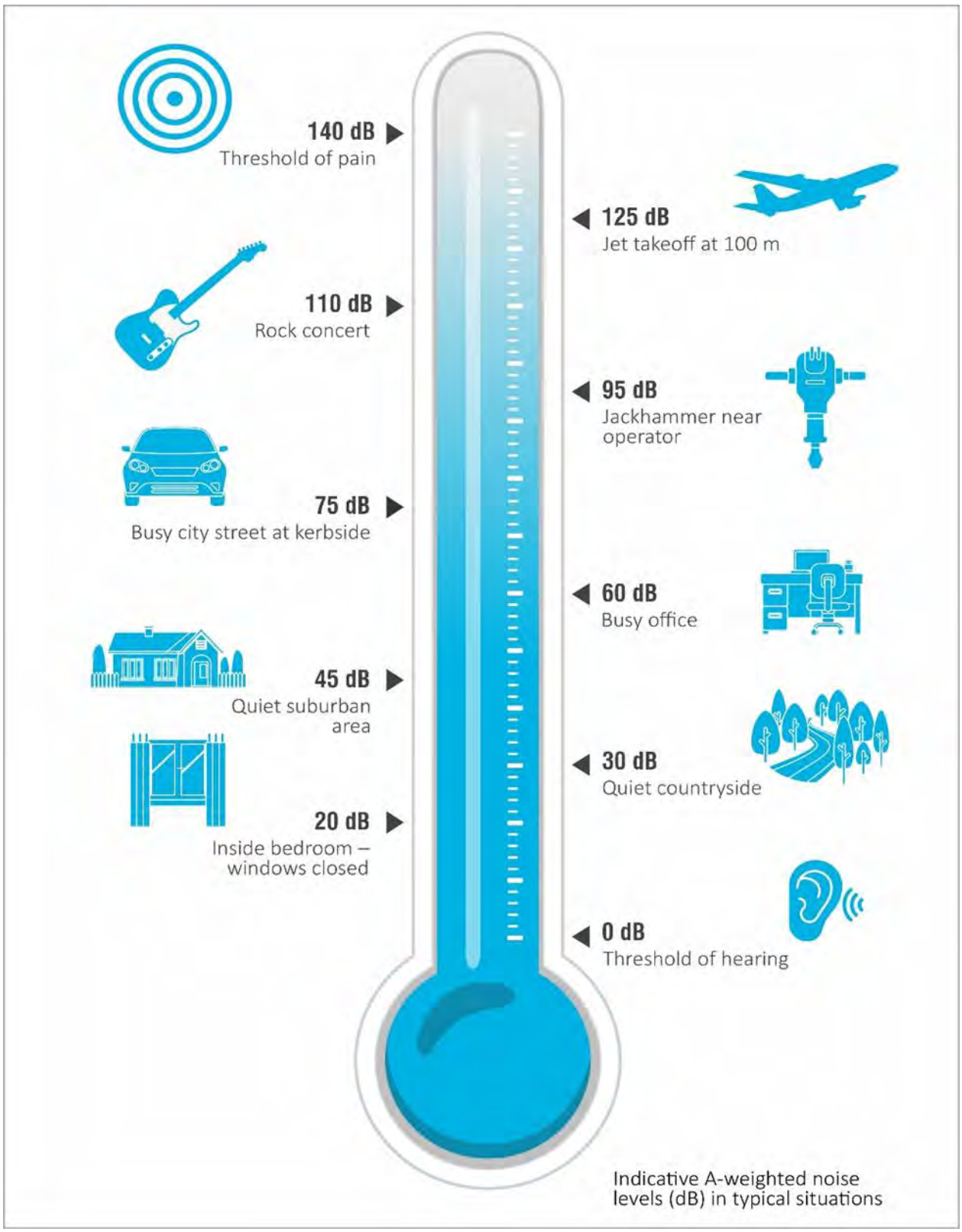


Figure G.1 Common noise levels

Appendix A
EPL 21562

EMM
creating opportunities

2 Discharges to Air and Water and Applications to Land

P1 Location of monitoring/discharge points and areas

P1.1 The following points referred to in the table below are identified in this licence for the purposes of weather and/or noise monitoring and/or setting limits for the emission of noise from the premises.

Noise/Weather

EPA identification no.	Type of monitoring point	Location description
1	Noise monitoring	2161-2177 Elizabeth Drive, Luddenham
2	Noise monitoring	2111-2141 Elizabeth Drive, Luddenham
3	Noise monitoring	285 Adams Road, Luddenham
4	Noise monitoring	5 Anton Road, Luddenham
5	Noise monitoring	185 Adams Road, Luddenham
6	Noise monitoring	225 Adams Road, Luddenham
7	Noise monitoring	161 Adams Road, Luddenham
8	Noise monitoring	2510-2550 Elizabeth Drive, Luddenham

3 Limit Conditions

L1 Pollution of waters

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.

L2 Noise limits

L2.1 Noise generated at the premises that is measured at each noise monitoring point established under this licence must not exceed the noise levels specified in Column 4 of the table below for that point during the corresponding time periods specified in Column 1 when measured using the corresponding measurement parameters listed in Column 2.

POINT 1

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)
Day	LAeq (15 minute)	2 times a year	41

POINT 2

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)
Day	LAeq (15 minute)	2 times a year	43

POINT 3

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)
Day	LAeq (15 minute)	2 times a year	53

POINT 4

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)
Day	LAeq (15 minute)	2 times a year	46

POINT 5

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)
Day	LAeq (15 minute)	2 times a year	45

POINT 6

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)
Day	LAeq (15 minute)	2 times a year	52

POINT 7

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)
Day	LAeq (15 minute)	2 times a year	41

POINT 8

Time period	Measurement parameter	Measurement frequency	Noise level dB(A)

Day	LAeq (15 minute)	2 times a year	41

Note: EPA Identification No. 4 and 7 are entitled to negotiated agreement under the *Voluntary Land Acquisition and Mitigation Policy*. Where negotiated agreements are in place noise limits will not apply.

L2.2 For the purposes of Condition L2.1:

a) Day means the period from 7am to 6pm Monday to Saturday and the period from 8am to 6pm Sunday and public holidays.

L2.3 Noise-enhancing meteorological conditions

a) The noise limits set out in Condition L2.1 apply under the meteorological conditions in the table below.
b) For those meteorological conditions not referred to in the table below, the noise limits that apply are the noise limits in Condition L2.1 plus 5dB.

Assessment Period	Meteorological Conditions
Day	Stability Categories A, B, C and D with wind speeds up to and including 3m/s at 10m above ground level.
Evening	Stability Categories A, B, C and D with wind speeds up to and including 3m/s at 10m above ground level.
Night	Stability Categories A, B, C and D with wind speeds up to and including 3m/s at 10m above ground level; or Stability category E and F with wind speeds up to and including 2m/s at 10m above ground level.

L2.4 For the purposes of Condition L2.3:

a) The meteorological conditions are to be determined from the meteorological weather station identified as BoM monitoring point at Badgerys Creek.
b) Stability category shall be determined using the following method from Fact Sheet D of the Noise Policy for Industry (NSW EPA, 2017):

i. Use of sigma-theta data (section D1.4).

L2.5 To assess compliance:

a) with the LAeq(15 minutes) noise limits in Condition L2.1 and L2.3, the noise measurement equipment must be located:

(i) approximately on the property boundary, where any residence is situated 30 metres or less from the property boundary closest to premises; or where applicable,
(ii) in an area within 30 metres of a residence façade, but not closer than 3 metres where any residence on the property is situated more than 30 metres from the property boundary closest to the premises; or, where applicable,
(iii) in an area within 50 metres of the boundary of a National Park or Nature Reserve,
(iv) at any other location identified in Condition L2.1.

Appendix B
Calibration certificates

EMM
creating opportunities

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: C30881

EQUIPMENT TESTED : Sound Level Calibrator

Manufacturer: Svantek
Type No: SV-36 **Serial No:** 86311
Owner: EMM Consulting
Suite 01, 20 Chandos St
St Leonards NSW 2065
Tests Performed: Measured Output Pressure level, Frequency & Distortion
Comments: See Details overleaf. All Test Passed.

Parameter	Pre-Adj	Adj Y/N	Output: (dB re 20 µPa)	Frequency (Hz)	THD&N (%)
Level1:	NA	N	94.05 dB	999.99 Hz	1.00 %
Level2:	NA	N	114.05 dB	999.99 Hz	1.00 %
Uncertainty			±0.11 dB	±0.05%	±0.20 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:

Ambient Pressure 1002 hPa ±1 hPa
Temperature 23 °C ±1° C
Relative Humidity 41 % ±5%

Date of Receipt : 20/10/2021
Date of Calibration : 20/10/2021
Date of Issue : 20/10/2021

Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2017

CHECKED BY: .....

AUTHORISED SIGNATURE: .....
Jack Kidd

Accredited for compliance with ISO/IEC 17025 - Calibration
Results of the tests, calibration and/or measurements included in this document are traceable to SI units through reference equipment that has been calibrated by the Australian National Measurement Institute or other NATA accredited laboratories demonstrating traceability.

This report applies only to the item identified in the report and may not be reproduced in part.

The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab No. 9262
Acoustic and Vibration Measurements

Acu-Vib Electronics
CALIBRATIONS SALES RENTALS REPAIRS

Head Office & Calibration Laboratory
Unit 14, 22 Hudson Ave Castle Hill NSW 2154
(02) 9680 8133
www.acu-vib.com.au

CERTIFICATE OF CALIBRATION

CERTIFICATE NO: SLM 30138

EQUIPMENT TESTED: Sound Level Meter

Manufacturer:	B & K		
Type No:	2250	**Serial No:**	3008201
Mic. Type:	B&K 4189	**Serial No:**	2888134
Pre-Amp. Type:	ZC0032	**Serial No:**	16037
Filter Type:	1/3 Octave	**Test No:**	FILT 6597

Owner: EMM Consulting
Ground Floor, Suite 01, 20 Chandos St
St Leonards NSW 2065

Tests Performed: IEC 61672-3:2013,
IEC 1260:1995, & AS/NZS 4476:1997

Comments: All Test passed for Class 1. (See overleaf for details)

CONDITIONS OF TEST:

Ambient Pressure	1001	hPa ±1 hPa	**Date of Receipt :** 23/07/2021
Temperature	22	°C ±1° C	**Date of Calibration :** 26/07/2021
Relative Humidity	36	% ±5%	**Date of Issue :** 26/07/2021

Acu-Vib Test Procedure: AVP10 (SLM) & AVP06 (Filters)

CHECKED BY: ..... **AUTHORISED SIGNATURE:** .....

Hein Soe

Accredited for compliance with ISO/IEC 17025 - Calibration

Results of the tests, calibration and/or measurements included in this document are traceable to SI units through reference equipment that has been calibrated by the Australian National Measurement Institute or other NATA accredited laboratories demonstrating traceability.

This report applies only to the item identified in the report and may not be reproduced in part.

The uncertainties quoted are calculated in accordance with the methods of the ISO Guide to the Uncertainty of Measurement and quoted at a coverage factor of 2 with a confidence interval of approximately 95%.

NATA
WORLD RECOGNISED ACCREDITATION
Accredited Lab No. 9262
Acoustic and Vibration Measurements

Acu-Vib Electronics
CALIBRATIONS SALES RENTALS REPAIRS

Head Office & Calibration Laboratory
Unit 14, 22 Hudson Ave, Castle Hill NSW 2154
(02) 9680 8133
www.acu-vib.com.au

Australia

SYDNEY
Ground floor 20 Chandos Street
St Leonards NSW 2065
T 02 9493 9500

NEWCASTLE
Level 3 175 Scott Street
Newcastle NSW 2300
T 02 4907 4800

BRISBANE
Level 1 87 Wickham Terrace
Spring Hill QLD 4000
T 07 3648 1200

CANBERRA
Level 2 Suite 2.04
15 London Circuit
Canberra City ACT 2601

ADELAIDE
Level 4 74 Pirie Street
Adelaide SA 5000
T 08 8232 2253

MELBOURNE
Suite 8.03 Level 8 454 Collins Street
Melbourne VIC 3000
T 03 9993 1900

PERTH
Suite 9.02 Level 9 109 St Georges Terrace
Perth WA 6000

Canada

TORONTO
2345 Younge Street Suite 300
Toronto ON M4P 2E5

VANCOUVER
60 W 6th Ave Suite 200
Vancouver BC V5Y 1K1

linkedin.com/company/emm-consulting-pty-limited

emmconsulting.com.au